

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

SAMSUNG ELECTRONICS CO., LTD.,
Petitioner,

v.

TELEFONAKTIEBOLAGET LM ERICSSON,
Patent Owner

U.S. PATENT NO. 10,306,669

Case IPR2021-TBD

DECLARATION OF FRIEDHELM RODERMUND
IN SUPPORT OF PETITION FOR *INTER PARTES* REVIEW OF U.S.
PATENT NO. 10,306,669

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I, Friedhelm Rodermund, do hereby declare as follows:

I. INTRODUCTION AND ENGAGEMENT

1. I have been retained in this matter by Samsung Electronics Co., Ltd (“Petitioner” or “Samsung”) to provide testimony regarding 3GPP’s standard business practices for record keeping and publishing technical specifications, change request proposals, reports, and other documents developed during the course of standards activities carried out by the 3rd Generation Partnership Project (“3GPP”) and the European Telecommunications Standards Institute (“ETSI”).

2. I have been asked to provide my opinions regarding the authenticity and dates of public accessibility of the following 3GPP documents:

- T-doc R1-1700369, which represents a document with the title “Resource allocation for NR uplink control channel” (hereinafter “R1-1700369”, SAMSUNG-1007)
- T-doc R1-1715527, which represents a document with the title “NR PUCCH resource allocation” (hereinafter “R1-1715527”, SAMSUNG-1006)

3. As an ETSI Project Manager and Secretary, from June 1998 to December 2004, I have personal knowledge of 3GPP’s standard business and records keeping practices. I continued following 3GPP’s work ever since. Thus, based on my experience, personal knowledge, and review of 3GPP’s business

records, I am able to testify regarding the authenticity of certain documents published by 3GPP and the timing of their publication.

4. I am being compensated for my time spent on this matter at my usual rate of €450 per hour. My fee is not contingent on the outcome of this or any matter, or on the content of any of the testimony I give in this declaration. I have no financial interest in Petitioner.

5. I have been informed that Ericsson (hereinafter referred to as “Patent Owner”) alleges ownership and is the current assignee of U.S. Patent No. 10,306,669 (“the ’669 Patent”) (SAMSUNG-1001). I have no financial interest in the Patent Owner or the ’669 patent.

II. BACKGROUND AND QUALIFICATIONS

6. I have more than 20 years of experience working with standards development organizations including the Third Generation Partnership Project (“3GPP”), the European Telecommunications Standards Institute (“ETSI”), and the Open Mobile Alliance (“OMA”). I have particular experience with the development of standards related to cellular telecommunications, including the standards for the Universal Mobile Telecommunications System (“UMTS”), Long Term Evolution (“LTE”), and 5G, which are all standards developed by the 3GPP. A true and correct copy of my curriculum vitae (C.V.) is attached as Appendix A.

7. I attended the University of Technology Aachen in Aachen, Germany, where I performed graduate studies in Electrical Engineering with a focus on telecommunications technologies (“Dipl.-Ing. TH” degree). I also attended the University of Technology Trondheim in Trondheim, Norway, and completed my Diploma thesis, “Design of a dual processor computer for digital signal processing in power electronics,” in 1993.

8. From December 1993 to June 1998, I worked at Mannesmann Mobilfunk as a System Engineer and Project Manager in Quality Assurance and Technical Standards. One of my responsibilities was to ensure by managing and performing related test activities that cellular network equipment was compatible with the Global System for Mobile Communications (“GSM”) standard developed by ETSI. During that time, I also started working as a standards delegate. I attended my first ETSI meeting in 1996 (although I was already following ETSI developments from 1992 during my studies).

9. From June 1998 to December 2004, I worked at ETSI as a project manager for various ETSI Special Mobile Group (“SMG”) and 3GPP working groups. First, I served as a secretary of SMG4 “Data Services” and SMG8 “Base Stations Testing.” Then, as a project manager with the ETSI Mobile Competence Center (“MCC”), I supported establishing 3GPP as the new international standards development organization for cellular telecommunications. One of my roles was

acting as Secretary for 3GPP's Technical Specifications Group Terminals, Working Group ("T2"), the group which played a leading role in the creation of standards for Multimedia such as the Multimedia Messaging Service ("MMS").

10. Later, I was a secretary of the highest-level Technical Specifications Group Terminals which was besides other things responsible for the development of test specifications including tests for the radio interface.

11. I edited all technical specifications produced by my working groups and presented results to the parent body for approval. I attended all meetings (apart from some sub-working group meetings) and was also responsible for compiling meeting reports, for handling all the meeting documents, and managing the work plan. It was also my role to guide the groups and to advise the chairmen regarding 3GPP working methods and procedures including document handling, and to make sure delegates were aware of their company's obligations under the 3GPP Intellectual Property Right policy.

12. As part of my responsibilities at ETSI, I acted as a 3GPP custodian of records by personally managing 3GPP's public File Transfer Protocol (ftp) folders, which I used to make publicly accessible various 3GPP documents, including versions of 3GPP specifications, technical reports, liaison statements, change requests, contributions, agendas, meeting reports, and other 3GPP documents from my working groups. I am also knowledgeable about document management

practices used in other working groups and within 3GPP in general with regard to making documents publicly accessible through the same, public ftp server of 3GPP.

13. Since I left ETSI as a staff member in 2005, I have been continuously involved in standardization activities, including with Open Mobile Alliance, ETSI, and 3GPP. Since 2017, I also have been attending the ETSI IPR Special Committee, which is responsible for the maintenance of the ETSI IPR Policy.

14. After I left ETSI, I worked from January 2005 to October 2014 at Vodafone, first as a Project Manager for Mobile Broadcast Standards, and then as Vice Chairman of the Device Management working group of the Open Mobile Alliance, and then as a Senior Standards Strategist, all with responsibilities as described on my C.V. At Vodafone, I was deeply involved in standards work with ETSI and 3GPP and other standards setting organizations, including as a delegate to 3GPP SA1 “Services.” As part of my responsibilities, I attended selected 3GPP meetings, submitted documents to 3GPP, used 3GPP resources (including 3GPP’s ftp server) extensively, and remained knowledgeable about 3GPP policies and procedures with regard to document management and public accessibility. I was also involved in the creation of patents, defense activities related to patent litigations, and patent evaluation, mostly in the context of standards development.

15. Since leaving Vodafone in 2014, I have performed consulting work regarding Internet of Things (IoT) and Machine to Machine (M2M) technology and standards, first at Friedhelm Rodermund Consulting and then as the Founder and Director of IOTECC GmbH. In connection with my work, I regularly deal with standards such as OMA's Lightweight M2M, 3GPP's LTE, Narrowband IoT (NB-IoT) and 5G standards. And I have extensively used 3GPP resources and have remained knowledgeable about 3GPP policies and procedures with regard to document management and public accessibility.

16. I also provide consulting services related to patents, in particular around 3GPP Standard Essential Patents ("SEPs"), and I have been working as an expert witness on a number of occasions. I continue to closely follow the maintenance of the ETSI IPR Policy as a delegate to the ETSI IPR Special Committee. Furthermore, I'm conducting a seminar on SEPs and the Internet of Things at the Technical University of Ilmenau, Germany.

17. At the time of writing this declaration, I am following – including attending selected meetings - the following standards committees: ETSI oneM2M, ETSI IPR Special Committee, Open Mobile Alliance, and 3GPP.

18. A copy of my curriculum vitae, which includes a detailed description of my experience and education, is attached as Appendix A. A list of litigation

matters on which I have worked over the last five years is also included in my curriculum vitae.

III. SUMMARY OF MY OPINIONS

19. It is my opinion that R1-1700369 (SAMSUNG-1007) is an authentic 3GPP T-doc and would have been publicly accessible through ftp.3gpp.org no later than January 10, 2017.

20. It is my opinion that R1-1715527 (SAMSUNG-1006) is an authentic 3GPP T-doc and would have been publicly accessible through ftp.3gpp.org no later than September 12, 2017.

IV. PUBLICATION OF 3GPP SPECIFICATIONS AND RELATED DOCUMENTS

A. General Practices

21. Unless otherwise noted, the following is an accurate description of 3GPP general practices from 1998 to the present, regardless of whether I use the present or past tense to describe those practices.

22. 3GPP was established in 1998 by a group of telecommunications standard development organizations from Japan, Korea, China, Europe, and the United States to jointly develop worldwide standards for mobile telecommunications. Today, 3GPP consists of seven partners: Association of Radio Industries and Businesses, Japan (“ARIB”), Alliance for Telecommunications Industry Solutions, USA (“ATIS”), China Communications Standards Association

(“CCSA”), European Telecommunications Standards Institute (“ETSI”), Telecommunications Technology Association, Korea (“TTA”), Telecommunication Technology Committee, Japan (“TTC”). In addition to being one of the founding partners, ETSI hosts the Mobile Competence Centre (“MCC”), which provides administrative and technical support to the day-to-day work of 3GPP. Furthermore, ETSI manages 3GPP’s IT services such as the 3GPP website, ftp server, and email exploders.

23. 3GPP is the world’s leading organization for developing and maintaining cellular telecommunications standards, which it has done since its foundation in 1998. As noted above and in my C.V., I began working for 3GPP, as part of my work at ETSI, the European-based organizational partner of 3GPP.

24. In the ordinary course of its regularly conducted business activities, and pursuant to its standard business practices, 3GPP publishes technical specifications, proposals, reports, and other documents related to the development of cellular telecommunications standards. Such documents are published for the purposes of discussion and establishment of industry standards for cellular telecommunications. This has been 3GPP’s ordinary course of business since when I began working at ETSI in 1998.

25. In the ordinary course of 3GPP’s regularly conducted business activities, and pursuant to its standard business practices, all draft technical

specifications, proposals, reports, and other temporary documents to be discussed or considered in relation to 3GPP's telecommunications standards activities were, and continue to be, assigned a temporary document number and made publicly available, including on the ftp server associated with the 3GPP website, currently residing at ftp.3gpp.org. Such documents are referred to as "T-docs." Final versions of the technical specifications also were, and continue to be, publicly available from that same ftp server.

26. The names and the structure of 3GPP working groups can be found below¹:

¹ See <https://www.3gpp.org/specifications-groups>

Project Co-ordination Group (PCG)		
TSG RAN Radio Access Network	TSG SA Service & System Aspects	TSG CT Core Network & Terminals
RAN WG1 Radio Layer 1 spec	SA WG1 Services	CT WG1 User Equipment to Core Network protocols
RAN WG2 Radio Layer 2 spec Radio Layer 3 RR spec	SA WG2 Architecture	CT WG3 Interworking with external networks
RAN WG3 Iub spec, Iur spec, Iu spec UTRAN O&M requirements	SA WG3 Security SA3-LI SA3 subgroup on Lawful Interception	CT WG4 Core Network Protocols
RAN WG4 Radio Performance Protocol aspects	SA WG4 CODECs	CT WG6 Smart Card Application Aspects
RAN WG5 Mobile Terminal Conformance Testing	SA WG5 Telecom Management	
	SA WG6 Mission-critical applications	

27. Each Technical Specification Group (TSG) or Working Group adopts a structured numbering system for the documents associated with their meetings, and those systems typically follow a consistent numbering system as shown in the following example: xminnnzzzz. The numbering system normally comprises five logical elements: (1) x: a single letter corresponding to the TSG; where in 2007/2008 x was one of R (Radio Access Network), C (Core and Terminals), S (Service and System Aspects), or G (GSM/EDGE Radio Access Network); (2) m:

A single character corresponding to the Working Group identity (typically 1, 2, 3, etc.) or, in the case of the TSG itself, the letter “P”; (3) i: Normally the hyphen character “-”; (4) nn: the calendar year of the meeting to which the document was submitted; (5) zzzz: a running number (some Working Groups use 5 digits).

28. In the ordinary course of 3GPP’s regularly conducted business activities, and pursuant to its standard business practices, from December 1998 onwards, 3GPP published all of its T-docs and all final versions of its technical specifications on its ftp server, which has always been easily and publicly accessible from its website and currently resides at [ftp.3gpp.org](ftp://ftp.3gpp.org).

29. As early as December 1998, 3GPP’s ftp server was freely accessible to the general public with no login, password, or membership requirement.

30. By 1999, at least 100 companies were members of 3GPP (by December 2020: 719 companies), ranging from Bosch to Ericsson to Nokia to Samsung and generally including those interested in the discussion, creation, and adoption of cellular telecommunications standards, including UMTS. Each of these companies typically delegated multiple individuals to regularly participate in 3GPP meetings. Further, pursuant to 3GPP’s standard business practices, 3GPP working groups sent emails notifying these individuals as soon as new or additional documents had been uploaded to 3GPP’s ftp server. Thus, not only did the general public have access to the documents on the ftp server, but some of the most

interested members of the public—those working to develop standards for cellular telecommunication or working to implement the standards—were personally informed of their availability by email. Based on my experience with 3GPP and the telecommunications industry, I would expect any person implementing a cellular network or device, e.g., an 5G network or device, to consult the corresponding specifications on the 3GPP ftp server, as well as other related documents. The whole purpose of 3GPP creating and making these specifications available was so that engineers and other individuals would have ready access to them when developing and implementing cellular networks and devices.

31. 3GPP specifications bear a specification number consisting of four or five digits, e.g., 09.02 or 29.002. The first two digits define the specification series which are defined to group the different aspects of the 3GPP system into e.g. requirements, service aspects, radio aspects codecs, security aspects, and test specifications. The series digits are followed by two additional digits for the 01 to 13 series or three further digits for the 21 to 55 series. The subjects of the individual specification series are explained on 3GPP's website at <https://www.3gpp.org/specifications/specification-numbering>, and reproduced below:

Subject of specification series	3G and beyond / GSM (R99 and later)	GSM only (Rel-4 and later)	GSM only (before Rel-4)
General information (long defunct)			00 series
Requirements	21 series	41 series	01 series
Service aspects ("stage 1")	22 series	42 series	02 series
Technical realization ("stage 2")	23 series	43 series	03 series
Signalling protocols ("stage 3") - user equipment to network	24 series	44 series	04 series
Radio aspects	25 series	45 series	05 series
CODECs	26 series	46 series	06 series
Data	27 series	47 series (none exists)	07 series
Signalling protocols ("stage 3") -(RSS-CN) and OAM&P and Charging (overflow from 32.- range)	28 series	48 series	08 series
Signalling protocols ("stage 3") - intra-fixed-network	29 series	49 series	09 series
Programme management	30 series	50 series	10 series
Subscriber Identity Module (SIM / USIM), IC Cards. Test specs.	31 series	51 series	11 series
OAM&P and Charging	32 series	52 series	12 series
Access requirements and test specifications		13 series (1)	13 series (1)
Security aspects	33 series	(2)	(2)
UE and (U)SIM test specifications	34 series	(2)	11 series
Security algorithms (3)	35 series	55 series	(4)
LTE (Evolved UTRA), LTE-Advanced, LTE-Advanced Pro radio technology	36 series	-	-
Multiple radio access technology aspects	37 series	-	-
Radio technology beyond LTE	38 series	-	-

32. The 5G New Radio (NR) standard is covered in the “38 series” and is further subdivided into separate sections or specifications. The 5G NR specifications start at TS 38.101 and end at TR 38.921. Excluding withdrawn specifications, the 5G NR standard consists of more than 140 specifications. Each specification can span from a few pages to hundreds of pages. One full version of the 5G standard is

massive, spanning tens of thousands of pages across the particular series of technical specifications.

33. In the ordinary course of 3GPP's regularly conducted business activities, and pursuant to its standard business practices, T-docs are usually uploaded to 3GPP's ftp server and website before the meeting where they are to be discussed. Documents created or revised during the course of a meeting are normally uploaded at the latest during the week following the meeting (e.g., the meeting report of the meeting is usually published for review during the week following the meeting).

34. In the ordinary course of 3GPP's regularly conducted business activities, and pursuant to its standard business practices, 3GPP maintains archives that include different versions of the specifications, as well as email communications to its membership, including emails announcing the uploading of new or additional documents to 3GPP's ftp server. These archives are created at the time the emails are initially sent.

35. 3GPP specifications almost always are duplicated in at least two and sometime more locations on the ftp server. One location corresponds to a "snapshot" of the specifications corresponding to a particular plenary meeting cycle, e.g., the 2018-12 snapshot contains a snapshot of numerous specifications after the December 2018 3GPP plenary meetings. The second location is an

“archive” that contains all versions over time for a given specification. While 3GPP aims to upload the updated specifications to both locations at the same time, occasionally there may be a small difference in the upload date, and thus the date stamp, for the same specification uploaded to the two locations. Additionally, specifications which are not yet approved (so call “draft” specifications) are available as T-docs at working group and at plenary meetings (as soon the working group decides to submit the specification to the plenary meeting for information or approval).

36. The timestamp on 3GPP’s ftp server shows the date when the document was uploaded the last time. Thus, the timestamp shows the latest possible date the document became publicly available and accessible on 3GPP’s ftp server. The given document might have been available earlier and the original timestamp might have been overwritten because the document was uploaded again. According to my experience, this is something which happened quite frequently. Thus, the ftp timestamp is reliable as the latest possible upload date but one cannot determine whether it represents the first upload of a document to the ftp server.

37. 3GPP’s working practice to store their documents on their ftp server, as described above, has not changed over time. Starting from the first 3GPP meetings in 1998 until present, all WGs and plenary meetings are represented by dedicated meeting folders on the ftp server. These meeting folders include the

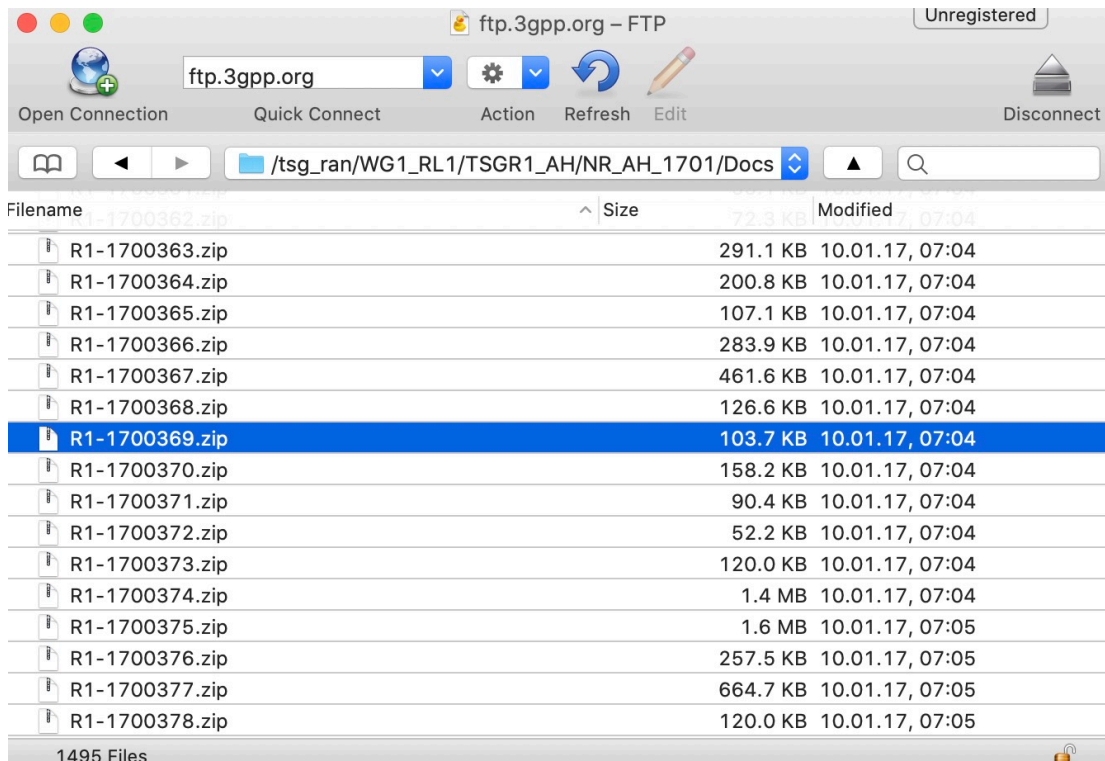
documents discussed at the meetings. Both the folders and the documents are accessible to the public. Almost every week, a new meeting folder with the respective documents is added. In addition to the plenary and WG meeting folders, and some other folders, there is also the “Specs” folder, which holds all 3GPP specifications including the aforementioned “snapshot” and archive folders. Since the early days of 3GPP a new folder is added inside the “Specs” folder after each TSG plenary meeting to hold the latest versions of specifications approved at those TSG plenary meetings. This is still 3GPP’s working practice today; thus, this practice has not changed over time.

B. Specific Documents

1. R1-1700369

38. Based on my personal knowledge and my review of 3GPP’s business records, I recognize SAMSUNG-1007 as a true and correct copy of T-doc R1-1700369, which represents a document submitted by Intel Corporation with the title “Resource allocation for NR uplink control channel.” The document presents the authors view on uplink control channel formats and resource allocation for HARQ ACK/NACK feedback sent via the New Radio uplink control channel. On its face, R1-1700369 refers to the RAN WG1 NR ad hoc meeting held on January 16-20, 2017 in Spokane, USA. Thus, based on my personal knowledge and experience with ETSI’s and 3GPP’s standard business practices, this information tells me that R1-

1700369 was available either prior or during that meeting to at least all attending 3GPP members. The availability of the document is confirmed by the date stamp, January 10, 2017, shown on the historic 3GPP ftp server for the corresponding downloadable file (“R1-1700369.zip”), as maintained by the Internet Archive at https://web.archive.org/web/20170217064446/http://www.3gpp.org:80/ftp/tsg_ran/WG1_RL1/TSGR1_AH/NR_AH_1701/Docs as well as the date stamp for the present-day listing of the same document on the 3GPP ftp server https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_AH/NR_AH_1701/Docs as can be seen at the screen shot below:



Filename	Size	Modified
R1-1700363.zip	291.1 KB	10.01.17, 07:04
R1-1700364.zip	200.8 KB	10.01.17, 07:04
R1-1700365.zip	107.1 KB	10.01.17, 07:04
R1-1700366.zip	283.9 KB	10.01.17, 07:04
R1-1700367.zip	461.6 KB	10.01.17, 07:04
R1-1700368.zip	126.6 KB	10.01.17, 07:04
R1-1700369.zip	103.7 KB	10.01.17, 07:04
R1-1700370.zip	158.2 KB	10.01.17, 07:04
R1-1700371.zip	90.4 KB	10.01.17, 07:04
R1-1700372.zip	52.2 KB	10.01.17, 07:04
R1-1700373.zip	120.0 KB	10.01.17, 07:04
R1-1700374.zip	1.4 MB	10.01.17, 07:04
R1-1700375.zip	1.6 MB	10.01.17, 07:05
R1-1700376.zip	257.5 KB	10.01.17, 07:05
R1-1700377.zip	664.7 KB	10.01.17, 07:05
R1-1700378.zip	120.0 KB	10.01.17, 07:05

1495 Files

39. In addition, the information for the downloaded and extracted T-doc file states a last Modified date of “9. January 2017.” Here is a screenshot showing those file details:

The screenshot displays a document titled "R1-1700369 Intel Resource allocation for NR uplink control channel". The document is a 3GPP TSG RAN WG1 NR Ad-Hoc Meeting document, dated 1700369, from Spokane, USA, 16th - 20th January 2017. The source is Intel Corporation, and the title is "Resource allocation for NR uplink control channel". The agenda item is 5.1.3.2, and the document is for discussion and decision.

1 Introduction

At the RAN1 #87 meeting, the following agreements were made regarding NR UL control channel [1]:

- Physical uplink control signaling should be able to carry at least hybrid-ARQ acknowledgements, CSI reports (possibly including beamforming information), and scheduling requests
- Support 'UCI on PUSCH', i.e. using some of the scheduled resources for UCI in case of simultaneous UCI and data
- Support 'simultaneous PUSCH and PUCCH at least for the long PUCCH format', i.e. transmit uplink control on PUCCH resources even in presence of data
- At least a low PAPR CM design should be supported for the 'long PUCCH'
- A combination of semi-static configuration and (at least for some types of UCI information) dynamic signaling is used to determine the PUCCH resource both for the 'long and short PUCCH formats'
- It should be possible to dynamically indicate (at least in combination with RRC) the timing between data reception and hybrid-ARQ acknowledgement transmission as part of the DCI

In addition, the following agreements were made with respect to NR UL control channel with short duration [1]:

- Support FDM of 'short UCI' and data, both within a UE and between UEs at least for the case where the PRBs for short UCI and data are non-overlapping
- FFS: PUSCH in the short UL duration can be scheduled independently
- In order to support TDM of short PUCCH from different UEs in the same slot, a mechanism to tell the UE in which symbol(s) in a slot to transmit the short PUCCH on is supported at least above 6 GHz (exact mechanism FFS)

Furthermore, the following agreements were made on NR UL control channel with long duration [1]:

- A UCI carried by long duration UL control channel at least with low PAPR design can be transmitted in one slot or multiple slots
 - Transmission across multiple slots should allow a total duration of [1] ms at least for some cases
 - FFS: more than [1] ms at least for some cases
 - FFS the numbers of the slots
- For UL control channel with long duration, TDM between RS and UCI is supported at least for DFT-s-OFDM
 - FFS on location of RS symbol(s) (e.g., front-loaded RS, fixed-location RS)

In this contribution, we present our view on UL control channel formats and resource allocation for NR uplink control channel for HARQ ACK/NACK feedback.

2 Discussion on UL control channel formats

In LTE, multiple PUCCH formats are specified to support various UCI payload sizes as follows:

- PUCCH format 1/1a/1b for positive SR, 1 or 2 bit HARQ-ACK or 4 bit HARQ-ACK with channel selection
- PUCCH format 2/2a/2b for CSI report with and without 1 or 2 bit HARQ-ACK
- PUCCH format 3 for CSI report, 1 bit positive/negative SR and HARQ-ACK
- PUCCH format 4 for more than 22 bits of UCI including HARQ-ACK, SR and CSI report
- PUCCH format 5 for more than 22 bits of UCI including HARQ-ACK, SR and CSI report

For NR, similar design principle can be considered, i.e., multiple NR PUCCH formats can be supported

R1-1700369 Intel
Resource all...PUCCH.doc
206 KB

Information [Show Less](#)

Created 9. January 2017 at 07:30
Modified 9. January 2017 at 07:30

40. The official meeting report of the RAN WG1 NR ad hoc meeting held on January 16-20, 2017 in Spokane, USA can be found in Appendix B. According to the 3GPP website at <https://portal.3gpp.org/Meetings.aspx#/> which is shown by the screen shot below, that meeting was attended by 355 individuals (out of 500 registered participants):

The screenshot shows a web browser window with the address bar displaying portal.3gpp.org. The main content area is titled "RAN1-NR#1 - Meeting information" and contains the following details:

Meeting identifier :	18511
Meeting Contacts :	Mr. Patrick Merias
Meeting Reference :	3GPPRAN1-NR#1
Meeting Type :	Ad Hoc
Location :	Spokane , US
Start Date :	16 Jan 2017 09:00 (GMT-08:00) Pacific Time (US & Canada); Tijuana
End Date :	20 Jan 2017 17:30 (GMT-08:00) Pacific Time (US & Canada); Tijuana
Check-In starts at :	08:30 (GMT-08:00) Pacific Time (US & Canada); Tijuana

Below the meeting information, there is a green bar with the text "More options" and an upward arrow. Underneath, there are two columns of links:

Meeting's contributions (Tdocs)	List of 1549 Tdocs
Agenda	Contribution not available
Report	Download TDoc list (Excel)
Invitation	

At the bottom, there is a green bar with the text "List of participants: 500 registered, 355 attended" and a downward arrow. A green "Close" button is located at the very bottom of the screenshot.

41. The meeting report has a document list attached (Appendix C) which has T-doc R1-1700369 marked as “available” which clearly indicates that the document was available at the meeting. The screen shot below shows the related excerpt of the document list:

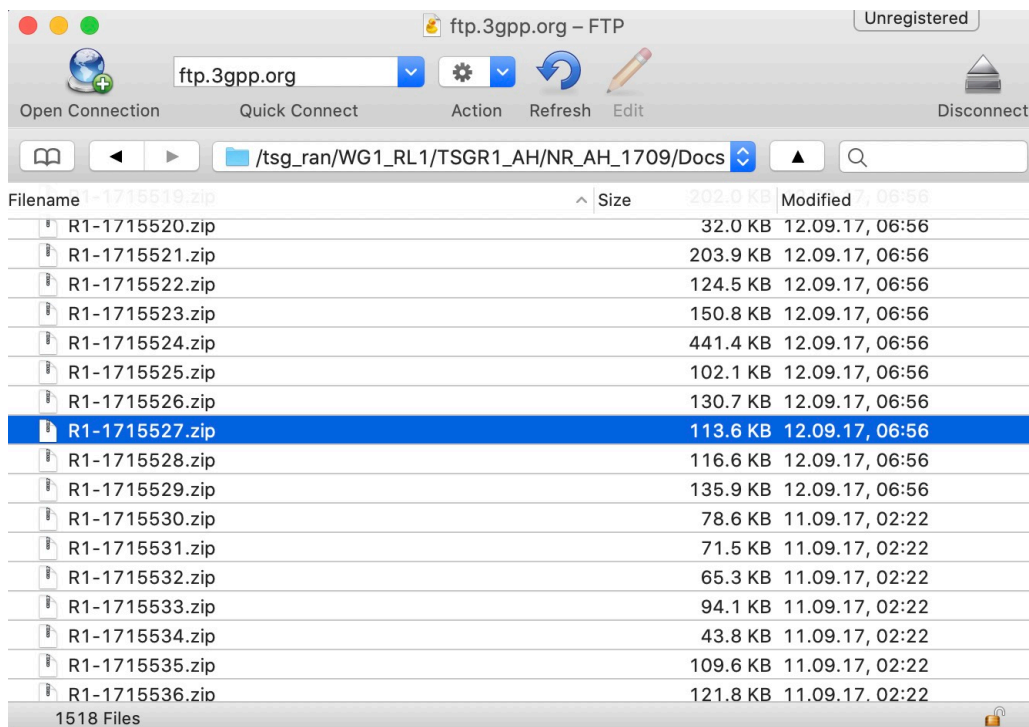
TDoc #	Title	Source	Agenda item #	TDoc Status	Reservation date	Uploaded
R1-1700369	Resource allocation for NR uplink control channel	Intel Corporation	5.1.3.2	available	2017-01-05 05:16:45	2017-01-10 07:09:33

42. Thus, based on my personal knowledge and experience with ETSI’s and 3GPP’s standard business practices, this information tells me that this document was available to all 3GPP members and the general public by January 10, 2017, at the latest.

2. **R1-1715527**

43. Based on my personal knowledge and my review of 3GPP’s business records, I recognize SAMSUNG-1006 as a true and correct copy of T-doc R1-1715527, which represents a document submitted by ZTE and Sanechips with the title “NR PUCCH resource allocation.” The document discusses considerations regarding the PUCCH and SR resources. On its face, R1-1715527 refers to the RAN WG1 meeting NR#3 held on September 18-21, 2017 in Nagoya, Japan. Thus, based on my personal knowledge and experience with ETSI’s and 3GPP’s standard business practices, this information tells me that R1-1715527 was available either

prior or during that meeting to at least all attending 3GPP members. The availability of the document is confirmed by the date stamp, September 12, 2017, shown on the historic 3GPP ftp server for the corresponding downloadable file (“R1-1715527.zip”), as maintained by the Internet Archive at https://web.archive.org/web/20170912121436/http://www.3gpp.org:80/ftp/TSG_RAN/WG1_RL1/TSGR1_AH/NR_AH_1709/Docs as well as the date stamp for the present-day listing of the same document on the 3GPP ftp server https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_AH/NR_AH_1709/Docs as can be seen at the screen shot below:



The screenshot shows an FTP client window titled 'ftp.3gpp.org - FTP'. The address bar displays '/tsg_ran/WG1_RL1/TSGR1_AH/NR_AH_1709/Docs'. A table of files is listed below, with 'R1-1715527.zip' selected. The table has columns for 'Filename', 'Size', and 'Modified'.

Filename	Size	Modified
R1-1715519.zip	202.0 KB	12.09.17, 06:56
R1-1715520.zip	32.0 KB	12.09.17, 06:56
R1-1715521.zip	203.9 KB	12.09.17, 06:56
R1-1715522.zip	124.5 KB	12.09.17, 06:56
R1-1715523.zip	150.8 KB	12.09.17, 06:56
R1-1715524.zip	441.4 KB	12.09.17, 06:56
R1-1715525.zip	102.1 KB	12.09.17, 06:56
R1-1715526.zip	130.7 KB	12.09.17, 06:56
R1-1715527.zip	113.6 KB	12.09.17, 06:56
R1-1715528.zip	116.6 KB	12.09.17, 06:56
R1-1715529.zip	135.9 KB	12.09.17, 06:56
R1-1715530.zip	78.6 KB	11.09.17, 02:22
R1-1715531.zip	71.5 KB	11.09.17, 02:22
R1-1715532.zip	65.3 KB	11.09.17, 02:22
R1-1715533.zip	94.1 KB	11.09.17, 02:22
R1-1715534.zip	43.8 KB	11.09.17, 02:22
R1-1715535.zip	109.6 KB	11.09.17, 02:22
R1-1715536.zip	121.8 KB	11.09.17, 02:22

1518 Files

44. In addition, the information for the downloaded and extracted T-doc file states a last Modified date of “12. Sep 2007.” Here is a screenshot showing those file details:

3GPP TSG RAN WG1 Meeting NR#3
Nagoya, Japan, 18th – 21st, September 2017

R1-1715527

Source: ZTE, Saneships
Title: NR PUCCH resource allocation
Agenda Item: 6.3.2.4
Document for: Discussion and Decision

1. Introduction
This contribution is revised and modified from contribution R1-1712454.
At the RAN1 #90 meeting, the following were agreed [1]:
Agreements:

- In order to identify PUCCH resource, at least, following are known by the UE:
 - PUCCH format
 - Starting symbol in a slot
 - Which slot(s) the PUCCH is transmitted
 - PRB allocation within the UL BWP
 - For 1-symbol short PUCCH for UCI of up to 2 bits,
 - Code/sequence indexes
 - For 1-symbol short PUCCH for UCI of more than 2 bits,
 - No additional parameters are identified
 - For 2-symbol short PUCCH for UCI of up to 2 bits,
 - Code/sequence indexes
 - Frequency-hopping pattern
 - For 2-symbol short PUCCH for UCI of more than 2 bits,
 - Frequency-hopping pattern
 - For long PUCCH for UCI of up to 2 bits,
 - Duration of the long PUCCH within a slot
 - Note: take the case of multi-slot into account.
 - Sequence/code index
 - OCC and, e.g., cyclic-shift
 - Frequency-hopping pattern
 - For long PUCCH for UCI of more than 2 bits with no multiplexing capacity,
 - Frequency-hopping pattern
 - Duration of the long PUCCH within a slot
 - Note: take the case of multi-slot into account.
 - For long PUCCH for UCI of more than 2 bits with multiplexing capacity,
 - FFS: details
 - FFS: for resource diversity
 - FFS: signaling aspects, e.g., implicit, explicit, table, etc.

Based on the existing agreements, further considerations about the PUCCH are made in this contribution. SR resources are also discussed.

2. PUCCH resource allocation
2.1. PUCCH resource set
It has been agreed to support ARB-based PUCCH resource allocation for HARQ-ACK transmission in RAN1#88 meeting [2]. That is a PUCCH resource set is configured by high layer signaling, and the physical layer signaling indicates the one PUCCH resource from the set.
In RAN1#90 meeting, the resource elements of the resource set for each PUCCH format are identified. It can be found that different PUCCH formats may require different resource elements. For example, cyclic shift index is not applicable to PUCCH format with more than 2 bits. Therefore, it is reasonable to define a separate PUCCH resource set for different PUCCH formats. On the other hand, in some transmission modes based on the current payload size, UE may know which PUCCH format should be used between formats with 2bits UCI and formats with more than 2bits UCI. It seems unnecessary to define a separate set for PUCCH format supporting the same number of UCI bits.
Proposal 1: For the PUCCH resource set

- Define two PUCCH resource sets, one set is for PUCCH format carrying up to 2 bits UCI and another set is for PUCCH format carrying more than 2 bits UCI.
- Each PUCCH resources in the PUCCH resource set can contain: PRB index, start symbol, duration, and corresponding slot. They can be independent, joint-coded or represented by tables.

In Table 1, an example is shown for PUCCH resource set definition for formats carrying up to 2bits UCI. Resource parameter including format types, PUCCH length, PUCCH resource value, time domain OCC

R1-1715527 NR PUCCH
resource allocation.docx
118 KB

Information

Created12. Sep 2017 at 14:36

Modified12. Sep 2017 at 14:36

45. The official meeting report of the RAN WG1 meeting NR#3 held on September 18-21, 2017 in Nagoya, Japan can be found in Appendix D. According to the 3GPP website at <https://portal.3gpp.org/Meetings.aspx#/> which is shown by the screen shot below, that meeting was attended by 347 individuals (out of 476 registered participants):

The screenshot shows a web browser window with the address bar displaying 'portal.3gpp.org'. The main content area is titled 'RAN1-NR#3 - Meeting information' in a green header bar. Below this, a table lists meeting details:

Meeting identifier :	18959
Meeting Contacts :	Mr. Patrick Merias
Meeting Reference :	3GPPRAN1-NR#3
Meeting Type :	Ad Hoc
Location :	Nagoya , JP
Start Date :	18 Sep 2017 09:00 (GMT+09:00) Osaka, Sapporo, Tokyo
End Date :	21 Sep 2017 17:30 (GMT+09:00) Osaka, Sapporo, Tokyo
Check-In starts at :	08:30 (GMT+09:00) Osaka, Sapporo, Tokyo

Below the table is a green bar with the text 'More options' and an upward arrow. Underneath, there are two columns of links:

Meeting's contributions (Tdocs)	List of 1584 Tdocs
Agenda	Contribution not available
Report	Download TDoc list (Excel)
Invitation	

At the bottom, a green bar displays 'List of participants: 476 registered, 347 attended' with a downward arrow. A green 'Close' button is located at the very bottom of the modal.

46. The meeting report has a document list attached (Appendix E) which has T-doc R1-1715527 marked as “available” which clearly indicates that the document was available at the meeting. The screen shot below shows the related excerpt of the document list:

TDoc	Title	Source	Agenda item	TDoc Status	Reservation date	Uploaded
R1-1715527	NR PUCCH resource allocation	ZTE, Sanechips	6.3.2.4	available	2017-09-06 12:37:33	2017-09-12 06:57:09

47. Thus, based on my personal knowledge and experience with ETSI’s and 3GPP’s standard business practices, this information tells me that this document was available to all 3GPP members and the general public by September 12, 2017, at the latest.

V. AVAILABILITY FOR CROSS-EXAMINATION

48. In signing this declaration, I recognize that the declaration may be filed as evidence in a contested case before the Patent Trial and Appeal Board of the United States Patent and Trademark Office. I also recognize that I may be subject to cross examination in the case and that cross examination will take place within the United States. If cross examination is required of me, I will cooperate to the best of my ability to appear for cross examination within the United States during the time allotted for cross examination.

A. Right To Supplement

49. I reserve the right to supplement my opinions in the future to respond to any arguments that the Patent Owner raises and to take into account new information as it becomes available to me.

B. Signature

50. I declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code.

51. I declare under penalty of perjury that the foregoing is true and correct.

Dated: March 18, 2021

A handwritten signature in black ink, appearing to read 'F. Rodermund', written over a horizontal line.

Friedhelm Rodermund

APPENDIX A

CURRICULUM VITAE

I. PERSONAL DATA

Name: **Friedhelm RODERMUND**

Mailing address: Am Steiner Graben 18
56077 Koblenz, Germany

Phone: +49 172 2606489

Email: friedhelm.roderrmund@iotecc.com

II. PROFESSIONAL EXPERIENCE

Summary

Senior expert in telecommunications and Internet of Things (IoT) technology. 25 years of experience within the mobile communications industry, and several years in the IoT domain in various roles such as project management, technology innovation and evolution, standards development, technology strategy, patent creation and support of patent litigations, and development/introduction of new services.

Widely recognized standards expert who was actively involved in leading roles in the development of key standards for mobile telephony/data and service enablers across standards development organizations such as 3GPP, ETSI, GSMA, IETF, OMA, and oneM2M. Currently focussing on standards for the Internet of Things.

Founder and director of IOTECC GmbH which provides consulting services around technologies and standards enabling the Internet of Things, and provides consulting services related to patents for mobile telecommunications and IoT.

01/2015 – present IOTECC GmbH Koblenz, Germany

Founder and CEO

- Mobile telecommunications, Internet of Things (IoT) and Machine to Machine (M2M) technology and standards consulting
- Telecommunications and IoT patent consulting
 - Consulting services around telecommunications and IoT patents in particular related to ETSI, 3GPP, and OMA standards
 - State of the art/prior art research, patent infringement analysis
 - Advising on Standards Development Organisations (SDO) working processes and IPR policy, ETSI IPR Special Committee delegate
 - Experienced expert witness (please see section III for a list of supported patent litigations and validity actions)

11/2014 – 12/2014 Friedhelm Rodermund Consulting Koblenz, Germany

Internet of Things (IoT) Consultant

- M2M/IoT standards development and introduction of new M2M/IoT services

01/2011 – 10/2014 Vodafone Germany / Vodafone Group R&D Düsseldorf, Germany

Senior Standards Strategist

- Representing Vodafone in various standardisation bodies

CURRICULUM VITAE

- Driving the standardisation of the Internet of Things
- Work item lead, technical editor and key contributor of Open Mobile Alliance (OMA) "Lightweight M2M (LwM2M)" – the new standard for the Internet of Things
- Advising and supporting various M2M projects related to e.g. automotive, smart metering, health, industry
- Advising on the introduction of new M2M technologies and services
- Leading Proof of Concepts of emerging technologies
- Involved in innovation projects
- Supporting the creation and protection of Intellectual Property

01/2009 – 12/2010 Vodafone Germany Düsseldorf, Germany

Vice Chairman Open Mobile Alliance (OMA) Device Management (DM)

- Responsible for Vodafone's Device Management standardisation
- As OMA DM Vice Chairman, co-leading the group, chairing committee meetings and web conferences, steering the technical direction, management of the different work items
- Editor of several specifications, rapporteur of various work items
- Support of projects for the introduction of device management
- Delegate to 3GPP SA1 where I was responsible for the introduction of MTC (machine type communications) related service/network requirements

01/2005 – 12/2008 Vodafone Germany Düsseldorf, Germany

Project Manager Mobile Broadcast Standards

- Responsible for Mobile Broadcast standardisation across different broadcast systems/standards bodies and across all Vodafone local operations
- Responsible for Mobile Broadcast standardisation strategy development and implementation
- Delegation Lead for the Open Mobile Alliance (OMA) BCAST working group
- Initiated and managed the BCAST device profile development in the BMCO Forum
- Leading the "Service Protection" (pay-TV) stream of the German DVB-H Consortium
- Filed several patents
- Supporting patent litigations and patent portfolio evaluation (various technical areas)

04/2003 – 12/2003 GSM Association London, United Kingdom

Member of the MMS Task Force

- Verification of the MMS operator interworking framework
- Supporting the definition and specification of the MMS functional evolution
- Acting as a "link" between 3GPP and GSMA in the area of MMS

06/1998 – 12/2004 European Telecommunications Standards Institute (ETSI) Sophia Antipolis, France

01/2002 – 12/2004: Secretary 3GPP Technical Specifications Group "Terminals" and Terminals Working Group 2 "Terminal Services and Capabilities"

01/1999 – 12/2001: Secretary 3GPP Terminals Working Group 2 "Terminal Services and Capabilities" and GERAN 3 "Base Station Testing"

06/1998 – 03/1999: Secretary ETSI SMG4 "Data Services" and SMG8 "Base Station Testing"

CURRICULUM VITAE

- Supported the establishment of 3GPP (3rd Generation Partnership Project) as the leading standards organization for mobile telecommunications
- Project manager and secretary of TSG “Terminals” responsible for Terminal Conformance Testing, Terminal Services and Capabilities, Universal Subscriber Identity Module (USIM)
- Project manager and secretary of Terminals Working Group 2 “Terminal Services and Capabilities” that was responsible for Terminal Execution Environments, Messaging including Short Message Service (SMS), Cell Broadcast Service (CBS), Enhanced Messaging Service (EMS), Multimedia Messaging Service (MMS), Terminal Interfaces incl. AT-commands, Generic User Profile, Data Synchronization and others
- Establishment and management of the Work Plan and follow-up and report on the progress of the related work items
- Advising the chairmen and the standards groups on technical, procedural and political issues
- Editorship of various GSM and UMTS technical specifications
- Responsible for presenting the technical results of the working groups to the parent body
- Responsible for the communication with other standards bodies inside and outside 3GPP
- PR activities (articles, interviews)

12/1993 – 06/1998 Mannesmann Mobilfunk GmbH

Düsseldorf, Germany

System Engineer and Project Manager in Quality Assurance and Technical Standards

- Leadership and management of acceptance test projects in the area of GSM Base Station Controller (BSC) and GSM Base Station (BTS) hardware and software.
- Leading project teams of around 15 people
- Responsible for the clearance of releasing new software/hardware into the network
- Supported Request for Quotations, supplier evaluation and pre-selection, project manager of System Verification as a central part of the supplier selection process.
- Representation of Mannesmann Mobilfunk to the ETSI standardization group “Standardization Technical Committee SMG3 System Architecture”
- Conduction of product and hardware development quality audits
- Representative of Mannesmann Mobilfunk in A-interface interoperability testing activities
- Member of BSS product planning group which was defining operator requirements for future BSS releases
- Development of process improvements for type acceptance

CURRICULUM VITAE

III. LIST OF SUPPORTED PATENT LITIGATIONS AND VALIDITY ACTIONS

2020

Panoptis Patent Management LLC et al. v. Apple Inc.
Civil Action No. 2:19-cv-66 (E.D. Tex.)
On behalf of Apple
Counsel: WilmerHale
Role: Expert witness (export report, deposition testimony, trial testimony) at bench trial

2020

Sol IP, LLC v. AT&T Mobility, LLC et al.
Civil Action No. 2:18-cv-526 (E.D. Tex.)
On behalf of AT&T, Verizon, Sprint
Counsel: Gibson Dunn
Role: Expert witness (export report) and consulting services

2020

Bell Northern Research LLC v. LG Electronics Inc. et al.
Civil Action No. 18-CV-2864-CAB-BLM (S.D. Cal.)
On behalf of LG Electronics Inc.
Counsel: Fish&Richardson
Role: Expert witness (declaration) and consulting services

2019

Conversant Wireless Licensing S.a.r.l. v. LG Electronics Deutschland GmbH
Civil Action No. 7 O 3277/18 (Landgericht Munich, Germany)
On behalf of LG Electronics Deutschland GmbH
Counsel: Wildanger Kehrwald Graf von Schwerin & Partner mbB
Role: Expert witness (export report) and consulting services

2019

Bell Northern Research, LLC v. Huawei Device Co., Ltd, et al.
Civil Action No. 3:18-cv-01784-CAB-BLM
On behalf of Huawei
Counsel: Fish&Richardson
Role: Expert witness (declaration) and consulting services

2019

Uniloc USA, Inc., et al. v. Samsung Electronics America, Inc. and Samsung Electronics Co. Ltd.
Civil Action Nos. 2:18-cv-00040-JRG, 2:18-cv-00041-JRG, 2:18-cv-00042-JRG and 2:18-cv-00044-JRG (United States District Court for the Eastern District of Texas)
On behalf of Samsung
Counsel: Greenberg Traurig
Role: Expert witness (export report, deposition testimony) and consulting services

2019

Uniloc USA, Inc., et al. v. Huawei Device USA, Inc. et al.
Civil Action No. 2:18-cv- 00072-JRG-RSP (E.D. Tex.)
On behalf of Huawei
Counsel: McGuireWoods
Role: Expert witness (export report) and consulting services

2019

Microsoft Corporation v. Uniloc 2017 LLC
Inter Partes Review of U.S. Pat. No. 7,167,487
Inter Partes Review of U.S. Pat. No. 7,075,917
On behalf of Microsoft and on behalf of Apple as joinder petitioner
Counsel: Klarquist Sparkman (Microsoft), Erise IP (Apple)

CURRICULUM VITAE

Role: Expert witness (declarations) and consulting services

2019

Qualcomm v. KFTC
South Korean Case, Seoul High Court
On behalf of intervenor Apple supporting the KFTC
Counsel: Boies Schiller Flexner
Role: Expert witness (trial testimony)

2018/19

Evolved Wireless, LLC v. Apple, Inc.
Civil Action No. 1:15-cv-00542-JFB-SRF
On behalf of Apple
Counsel: DLA Piper
Role: Expert witness (expert report, deposition testimony) and consulting services

2018/19

Cisco Systems Inc. v. Traxcell Technologies
Inter Partes Review of Traxcell Technologies patents
On behalf of Cisco
Counsel: King&Spalding
Role: Expert witness (declaration) and consulting services

2018/19

Qualcomm Inc. v. Apple Inc.
Civil Action No. 3:17- cv-02398-DMS-MDD (United States District Court for the Southern District of California)
Civil Action No. 3:17-cv-02402-WQH-MDD
Certain Mobile Electronic Devices and Radio Frequency and Processing Components Thereof (II), Inv. No. 337-TA-1093
Inter Partes Review of U.S. PATENT NO. 9,154,356
Cases IPR2019-00047, IPR2019-00048, IPR2019-00049, IPR2019-00128, IPR2019-00129
On behalf of Apple and Intel
Counsel: WilmerHale
Role: Expert witness (declaration) and consulting services

2018/19

Apple Inc. v. Qualcomm Inc.
Civil Action No. 3:17-CV-00108-GPC-MDD (United States District Court for the Southern District of California)
On behalf of Apple
Counsel: Fish&Richardson, Boies Schiller Flexner
Role: Expert witness (declaration, expert report, deposition testimony) and consulting services

2018

3G Licensing, S.A. et al. v. LG Electronics Inc. et al
Inter Partes Review of U.S. Patent No. 7,995,091
On behalf of LG Electronics
Counsel: Fish&Richardson
Role: Expert witness (declaration)

2017

Huawei Technologies Co. LTD. v. T-Mobile US, Inc. & T-Mobile USA, Inc.
E.D. Tex. Case Nos. 2:16-cv-00052-JRG-RSP; 2:16-cv-00055-JRG-RSP; 2:16-cv-00056-JRG-RSP; and 2:16-cv-00057-JRG-RSP
On behalf of T-Mobile
Counsel: Gibson Dunn
Role: Expert witness (expert reports, deposition testimony) and consulting services

2016

Koninklijke KPN N.V. v. Samsung Electronics America, Inc. et al.

CURRICULUM VITAE

Civil Action No. 14-cv-1165
On behalf of Samsung Electronics
Counsel: Baker Botts
Role: Expert witness (declaration and deposition testimony) and consulting services

2016

SSH v. Sony
OLG Düsseldorf, Germany
On behalf of SSH
Counsel: Cohausz&Florack
Role: Technical expert support

2015/16

LG Electronics v. Core Wireless Licensing S.A.R.L.
Inter Partes Review of U.S. Patent No. 8,165,049
On behalf of LG Electronics
Counsel: Greenberg Traurig
Role: Expert witness (declaration and deposition testimony)

2015/16

Core Wireless Licensing S.A.R.L. v. LG Electronics Inc. and LG Electronics MobileComm U.S.A., Inc
Civil Action No. 2:14-cv-911 (lead case) and Civil Action No. 2:14-cv-912 (consolidated)
On behalf of LG Electronics
Counsel: Greenberg Traurig, Sidley Austin
Role: Expert witness (expert report and deposition testimony)

2015

Intellectual Ventures I LLC v. T-Mobile USA, Inc. & T-Mobile US, Inc.
D. Del. Case No. 1:13-cv-01632
Intellectual Ventures II LLC v. T-Mobile USA, Inc. & T-Mobile US, Inc.
D. Del. Case No. 1:13-cv-01633
On behalf of T-Mobile
Counsel: Gibson Dunn
Role: Technical expert support

IV. EDUCATION

10/1984 – 10/1993 University of Technology Aachen Aachen, Germany
Graduate of Electrical Engineering with a focus on telecommunications technologies (Dipl.-Ing. TH)

10/1992 – 04/1993 University of Technology Trondheim Trondheim, Norway
Diploma Thesis "Design of a dual processor computer for digital signal processing in power electronics"

V. LANGUAGES

German, English, French

VI. RECENT PUBLICATIONS

- "Unlocking the internet of things and driving the need for interoperability", Global Telecoms Business, December 2013
- "The need for standardisation in the M2M services layer", Global Telecoms Business, February 2014

CURRICULUM VITAE

- Co-authored white paper “Lightweight M2M: Enabling device management and applications for the internet of things”, Open Mobile Alliance, March 2014
- “Objects are a new way to create M2M applications”, Global Telecoms Business, April 2014
- “The need for standardisation in the M2M services layer”, M2M Now, July 2015

APPENDIX B

3GPP TSG RAN WG1 Meeting #88
Athens, Greece, 13th – 17th February 2017

R1-1701553

Source: MCC Support

Title: Final Report of 3GPP TSG RAN WG1 #AH1_NR v1.0.0
(Spokane, USA, 16th – 20th January 2017)

Document for: Approval



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R1-1701553

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3GPP TSG RAN WG1 Meeting #88
Athens, Greece, 13th – 17th February 2017

R1-1701553

Main facts summary

3GPP TSG WG RAN1 #AH1_NR meeting, hosted by the North American Friends of 3GPP, was held at the Spokane Convention Center, Spokane, USA.
The meeting started at 9:00 on Monday 16th January and finished at 17:10 on Friday 20th January 2017.
The number of attending delegates, having confirmed their participation through the electronic check-in application, was **358**.
Note that the number of registered was 500.

The schedule of the week was as follows:

Schedule – RAN1 NR AH				
Monday	Tuesday	Wednesday	Thursday	Friday
			8:15 am	5.1.9, 5.1.11
1, 2, 3, 4	5.1.1 (RACH procedure PBCH, Mobility, paging)	5.1.5.1	4, 5.1.8	5.1.1
5.1	5.1.2.1	5.1.7	5.1.2	5.1.2
5.1.1	5.1.2.2	5.1.1 (SS, PBCH, Mobility)	5.1.5.1	5.1.3
5.1.2.2		5.1.2	5.1.1	5.1.6
5.1.2.3	5.1.2.3 (CSI-RS, SRS DMRS)	5.1.9 5.1.11	5.1.10 5.1.5.2	
5.1.8	5.1.10	5.1.1	14:50	Revisiting Als as necessary
5.1.9	5.1.11	5.1.12 5.1.3	5.1.1	
5.1.3 (5.1.3.1/2/3 first)	5.1.3 5.1.3.4 first	5.1.2	17:00	
5.1.4	5.1.4		5.1.5	
			19:00	
			5.1.1	

The list of action points that required RAN1 close follow-up is listed in Annex F (end of document).

The number of contributions for this meeting was 1491, and those documents were categorized as followed.

Agenda Item	Input Document	Treated Document
All	1491	501

Note: The amount of documents includes those discussed during the email discussion session post meeting.

	Contribution is agreed/approved
	Further discussion is required – come-back needed
	Working assumption
	Specific action needed from MCC
	Contribution is for email discussion/approval

1 Opening of the meeting

Mr Satoshi Nagata (RAN1 Chairman) welcomed the participants of the RAN WG1 AH1_NR meeting and opened the meeting at 09:00.

Mr Gary Jones from T-Mobile USA welcomed the delegates on behalf of the North American Friends of 3GPP, AT&T, BlackBerry, Cisco, DISH, Ericsson, Intel, InterDigital Communications, Motorola Solutions, NextNav, Nokia, QUALCOMM, Sprint, T-Mobile USA and Verizon Wireless, and detailed the domestic arrangements for the full week.

1.1 Call for IPR

The attention of the members of this Technical Specification Group was drawn to the fact that 3GPP Individual Members have the obligation under the IPR Policies of their respective Organizational Partners to inform their respective Organizational Partners of Essential IPRs they become aware of.

The members take note that they are hereby invited:

- to investigate whether their organization or any other organization owns IPRs which were, or were likely to become Essential in respect of the work of 3GPP.
- to notify their respective Organizational Partners of all potential IPRs, e.g., for ETSI, by means of the IPR Information Statement and the Licensing declaration forms (e.g. see the ETSI IPR forms <http://webapp.etsi.org/Ipr/>).

1.2 Competition law statement

The Chairman also drew Member's attention to the fact that 3GPP activities are subject to antitrust and competition laws and that compliance with said laws is therefore required of any participant of this WG meeting including the Chairman and Vice Chairmen. In case of question, please contact your legal counsel.

The present meeting will be conducted with strict impartiality and in the interests of 3GPP.

Furthermore, the Chairman reminded Members that timely submission of work items/contributions in advance of WG meetings is important to allow for full and fair consideration of such matters.

1.3 Network usage conditions

The PCG has laid down the following network usage conditions:

Users shall not use the network to engage in illegal activities. This includes activities such as copyright violation, hacking, espionage or any other activity that may be prohibited by local laws.

Users shall not engage in non-work related activities that consume excessive bandwidth or cause significant degradation of the performance of the network.

Since the **network is a shared resource**, users should exercise some basic etiquette when using the 3GPP network at a meeting. It is understood that high bandwidth applications such as downloading large files or video streaming might be required for business purposes, but delegates should be strongly discouraged in performing these activities for personal use. Downloading a movie or doing something in an interactive environment for personal use essentially wastes bandwidth that others need to make the meeting effective. The meeting chairman should remind end users that the network is a shared resource; the more one user grabs, the less there is for another. Email and its attachments already take up significant bandwidth (certain email programs are not very bandwidth efficient). In case of need the chair can ask the delegates to restrict IT usage to things that are essential for the meeting itself.

1. **DON'T place your WiFi device in ad-hoc mode**
2. **DON'T set up a personal hotspot in the meeting room**
3. **DO try 802.11a if your WiFi device supports it**
4. **DON'T manually allocate an IP address**
5. **DON'T be a bandwidth hog by streaming video, playing online games, or downloading huge files**
6. **DON'T use packet probing software which clogs the local network (e.g., packet sniffers or port scanners)**

2 Approval of Agenda

R1-1700001 Draft Agenda of RAN1 Ad-hoc meeting on New Radio RAN1 Chair

Satoshi Nagata (Chairman) proposed the agenda for the meeting, as well the schedule of the week.

Discussion: Intel suggested avoiding the overlap between 5.1.8 and 5.1.9 in Monday's afternoon parallel sessions.

Nokia/Huawei: although they agreed there might be a conflict, preference is to stick to the original schedule.

CATT questioned whether reference signals will be discussed in MIMO session only, yes according to RAN1 Chair but could be reconsidered.

Decision: The agenda is approved.

3 Highlights from RAN Plenary

R1-1700002 **Selected highlights from RAN#74 relevant to RAN1** **RAN1 Chair**

The document was presented by RAN1 chair for information to the group and provides the outcomes of last plenary meeting relevant to RAN1.

Decision: The document is noted.

4 Incoming Liaison Statements related to NR

R1-1700291 **Reply LS on NR RACH Procedure** **RAN2, Huawei**

The document was presented by Brian Classon from Huawei and provides the following agreement made by RAN2:

If 2 step RACH is supported:

- The 2-step RACH resources are optionally configurable by the NW
- FFS whether it can be configured by broadcast and/or by dedicated signalling.
- NW can configure/restrict the usage of the 2-step RACH for certain cases (e.g. procedures/services/radio condition,etc) (FFS for which cases for which it is possible to configure/restrict the usage)
 - RAN2 expects a benefit in latency for the 2 step RACH procedure
 - From RAN2 point of view, the 2-step RACH procedure is not restricted to be used with certain UE ID size.
 - Can provide RAN1 with the different size of message size and UE ID size for the different scenarios in LTE. Indicate to RAN1 that for some use cases the UE ID only would not be sufficient. For NR we are still studying.

Decision: The document is noted.

R1-1700290 **LS on UE capability aspects for LTE/NR tight interworking** **RAN2, Nokia**

The document was presented by Karri Ranta-aho from Nokia and asks RAN1 to provide feedback on the below questions as early as possible (even if the answers may not be complete), prioritizing your response to the questions on LTE/NR tight interworking.

- Q1: Which of the physical layer parameters and RF parameters relevant to LTE/NR tight interworking needs to be coordinated between eNB and gNB (c.f. Table 3)?
- Q2: Is dynamic sharing of HARQ soft buffer feasible between LTE and NR or will the total number of soft-channel bits be semi-statically split between LTE and NR?
- Q3: For NR operation above 6 GHz, is a frequency band viewed as a single wideband carrier or as multiple contiguous component carriers?
- Q4: The LTE UE capabilities support extensive UE implementation flexibility. In particular, the UE can indicate support for a feature (e.g. MIMO layers, CSI processes) per band of a band combination. Is a similar (signalling intense) flexibility assumed to be supported for NR?

Discussion: schedule for sending a reply was debated → Chair would like to target an answer by Feb meeting to RAN2.

Decision: The document is noted.

R1-1701154 **UE capability aspects for LTE/NR tight interworking** **Nokia, Alcatel-Lucent Shanghai Bell**

- Proposal 1: Agree on the L1/RF parameters that may be relevant for eNB/gNB coordination based on the list proposed
- Proposal 2: Discuss if a common soft buffer between LTE and NR is considered feasible in the UE architecture, and if so, whether it can be expected from all UEs or if this is to be left for UE implementation choice.
- Proposal 3: Agree on a solution for wide-band operation
- Proposal 4: Similar implementation constraints exist for NR as for LTE, and thus similar flexibility for UE capability signaling is needed per band of a band combination
- Proposal 5: Provide RAN2 with a response LS based on the discussions and agreements of the RAN1 ad hoc

Decision: The document is noted.

R1-1700698 **On UE capability aspects for LTE/NR tight interworking** **Ericsson**

The document was presented by Daniel Larsson from Ericsson.

- Q1: Further discussion is needed on the total set of physical layer and RF parameters to be able to answer the question.
- Q2: Further discussion within the channel coding discussions are needed to be able to determine the answer to the question.
- Q3: RAN1 will specify a generic approach that is band agnostic. In that sense the future RAN1 specifications will allow for the tools of multiple contiguous component carriers and large wideband carriers. How to utilize these tools in a band definition would be upto RAN4 to decide.
- Q4: RAN1 does not currently see any RAN1 impact whether or not a feature is band or band combination specifically supported. Determining whether or not a feature is a band or band combination specific is a RAN4 decision.

Decision: The document is noted.

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[R1-1701182](#) Discussion on UE capability aspects for LTE/NR tight interworking Samsung

The document was presented by Youngbum Kim from Samsung.

- Q1: At least the timing relation, e.g., synchronous/asynchronous operation, between LTE and NR needs to be coordinated.
- Q2: It is not clear yet whether the UE soft buffer between LTE and NR can be shared or not. Nevertheless, soft buffer sharing would have some limitations due to the support of multiple numerologies in NR.
- Q3: Frequency band concept for NR is maintained and the frequency band is viewed as multiple component carriers.
- Q4: The UE capability signalling should support flexible UE implementation. However, it is expected to be able to reduce signalling per band of band combination e.g., by separating baseband processing capability from RF/band specific capability.

Decision: The document is noted.

Continue offline discussion until Wednesday morning – Karri (Nokia) and interested proponents

Wednesday

[R1-1701355](#) [Draft] Response LS on UE capability aspects for LTE/NR tight interworking Nokia

The document was presented by Karri Ranta-aho from Nokia.

Discussion: Preliminary attempt drawing a reply to RAN2; Nokia expects feedback from other companies

Decision: The document is noted. Continue offline.

Thursday: revised in [R1-1701477](#) [Draft] Response LS on UE capability aspects for LTE/NR tight interworking

Discussion: Nokia → same content but includes clarification regarding answer 2

Qualcomm → regarding answer 3, concern with the sentence on maximum bandwidth. See [R1-1701360](#) under 5.1.8.

Decision: The document is noted. Further revised in:

[R1-1701479](#) DRAFT Response LS on UE capability aspects for LTE/NR tight interworking Nokia

Decision: The document is noted and final LS is [approved in R1-1701488](#), assuming the addition of the following agreements in relation to answer 3.

- If it is decided that maximum CC BW is greater than or equal to 400 MHz and smaller than or equal to 1000MHz
 - The maximum number of CCs in any aggregation is [either 8 or 16]
- If it is decided that the maximum CC BW is <=100MHz
 - The maximum number of CCs in any aggregation could be [either 16 or 32]
- If it is decided that the maximum CC BW is greater than 100 MHz and smaller than 400MHz
 - The maximum number of CCs is FFS

LS received from RAN2 in course of the week.

Friday

[R1-1701518](#) LS on PRACH preambles for on demand SI requests RAN2, BlackBerry

The LS requests RAN1 to provide feedback on the following questions:

- Q1: If the same PRACH preamble is transmitted by multiple UEs simultaneously resulting in collision, will the gNB be able to reliably detect the transmitted preamble?
- Q2: If each of the different PRACH preambles is transmitted by multiple UEs resulting in collisions, will the gNB be able to reliably detect the transmitted preambles?
- Q3: How many PRACH preambles/resources will be available in NR?

Discussion: Chair → due to remaining time for SI completion, it would be great if RAN1 could reply as earlier as possible and not wait until next meeting.

Decision: The document is noted. Revisit later on potential answers.

[R1-1701538](#) [Draft]Reply LS on PRACH preambles for on demand SI requests Ericsson

Decision: The document is noted and final LS is [approved in R1-1701544](#) with the following update regarding answer 1:

A1: If multiple UEs transmit the same PRACH preamble resulting in a collision, the gNB might be able to detect the preamble from the combined transmission from multiple UEs, but may not be able to distinguish the UEs. The probability of successful detection depends on the channel conditions, ~~received power differences between the preamble transmissions and implementation.~~

[R1-1701519](#) Response LS on minimum system information RAN2, LG Electronics

RAN2 agreed that minimum SI is always present and periodically broadcast at a cell, not subject to on-demand SI delivery. Only the other SI can be provisioned via on-demand basis. RAN2 agreed that the minimum SI comprises basic information required for initial access to a cell and information for acquiring any other SI broadcast periodically or provisioned via on-demand basis. In details, RAN2 agreed that the minimum SI includes at least the following parameters:

SFN

- a list of PLMNs
- A cell ID
- Cell camping parameters
- RACH parameters
- Scheduling information for other SI

- SIB type
- Validity information
- SI Periodicity
- SI-window information
- An indicator whether the concerned SI-block is periodically broadcast or provided on demand
- Parameters required for requesting other SI-block(s) (if any needed, e.g. RACH preambles for request), if network allows on demand mechanism.

Note that the minimum SI can include additional parameters on top of the above.

Additional information addresses the initial estimate of the size of the minimum system information for NR.

Decision: The document is noted.

5 NR

5.1 Study on New Radio Access Technology - SID in [RP-161596](#)

Additional RAN guidance is existed in [RP-162574](#) and [RP-161914](#)

[R1-1700590](#) Draft TR 38.802 Study on New Radio (NR) Access Technology - Physical Layer Aspects NTT DOCOMO, INC.

Discussion: NTT DOCOMO→ not available - comments currently received and/or to be considered through email discussions. Continue offline discussion until Wednesday morning – (NTT DOCOMO).

Wednesday

The document was presented by Kazuaki Takeda from NTT DOCOMO.

Discussion: NTT DOCOMO→ The document includes all comments received so far.

Decision: Agreed as version 1.1.0 in [R1-1701422](#) (by accepting all changes), as basis for further updates.

[R1-1700591](#) Text proposal of TR 38.912 Study on New Radio (NR) Access Technology NTT DOCOMO, INC.

Discussion: The contents are the same as those in TR38.802 – objective is to check the TR structure.

Decision: The document is noted.

[R1-1700638](#) Text Proposal to TR 38.804 on physical layer aspects NTT DOCOMO, INC.

Discussion: For information – same TP is going to be discussed in RAN2 during this week.

Decision: The document is noted.

[R1-1700533](#) Discussion on the options in NR design Panasonic Corporation
[R1-1700534](#) Discussion on the term "eMBB usage", "URLLC usage" and "mMTC usage" in study item Panasonic Corporation
[R1-1700589](#) Workplan for Study on NR Access Technology NTT DOCOMO, INC.

5.1.1 Initial access and mobility

5.1.1.1 Synchronization signal and initial access procedure

[R1-1700177](#) NR Initial Access Procedure with multi-stage synchronization signals CATT
[R1-1700546](#) Discussion on multi-beam based initial access for NR Guangdong OPPO Mobile Telecom.
[R1-1700863](#) Design for beamformed synchronization signals NEC

5.1.1.1.1 SS bandwidth, multiplexing

[R1-1700033](#) Discussion and evaluation on NR-SS multiplexing and bandwidth Huawei, HiSilicon

The document was presented by ... from Huawei.

- Proposal 1: The association of the SS-block time index indication and the beam(s) deployed for the SS-block is a network implementation choice. The UE is not aware of the association that is used by the network.
- Proposal 2: The number of NR cell IDs should be at most 504 as in LTE considering the detection complexity and performance as well as the system efficiency.
- Proposal 3: FDM of NR-PSS and NR-SSS should be considered as the first priority.
- Proposal 4: TDM of NR-PSS and NR-SSS should also be considered if the minimum UE bandwidth is not enough for FDM of NR-PSS and NR-SSS.
- Proposal 5: The overall SS block number in the level of ~30 should be considered.
- Proposal 6: The bandwidth of the NR-PSS and NR-SSS can be larger than 1.08 MHz at least for eMBB UEs but is decided only based on synchronization performance and detection complexity.
 - Other criteria, such as RRM measurements from SS, will not be decisive for determining the SS bandwidth.

Decision: The document is noted.

R1-1700292 NR SS bandwidth and multiplexing Ericsson

The document was presented by Havish Koorapaty from Ericsson.

- Proposal 1: Standardize 30kHz for synchronization signal subcarrier spacing in frequency bands below 6GHz, and 120kHz subcarrier spacing for higher frequency bands. For compatibility with LTE, also consider 15kHz subcarrier spacing.
- Proposal 2: No specific CP length definition is needed for the NR-PSS/SSS transmission
- Proposal 3: The bandwidth and time duration reserved for NR-PSS/SSS need to consider the requirements on the target detection rate and periodicity
- Proposal 4: NR-PSS, NR-SSS and NR-PBCH are multiplexed in the time domain
- Proposal 5: NR-PBCH could be demodulated and decoded based on the frequency synchronization and channel estimation derived from NR-SSS on the same ports

Decision: The document is noted.

R1-1700306 NR SS Design: Minimum Bandwidth and Multiplexing AT&T

The document was presented by Thomas Novlan from AT&T.

- Proposal 1: The relationship between NR SS bandwidth and subcarrier spacing should be frequency band agnostic from a RAN1 specification perspective.
- Proposal 2: The NR SS burst bandwidth should scale linearly based on subcarrier spacing with a reference value of 5MHz for 15kHz spacing.
- Proposal 3: The NR SS design should support flexible multiplexing of synchronization signals with other signals/channels and forward compatible introduction of additional SS bursts within a burst set.
- Proposal 4: A given UE should only need to be configured and aware of the signals required for its own cell discovery and synchronization procedures.

Decision: The document is noted.

Conclusion of Monday session: Continue offline discussion until Wednesday – (NTT DOCOMO)

Tuesday session

R1-1701270 WF on NR-SS structure NTT DOCOMO, IITL, Convida Wireless, ZTE, ZTE Microelectronics, InterDigital, Huawei, HiSilicon, Sony

The document was presented by Hiroki Harada from NTT DOCOMO.

- NR defines at least one basic sequence length for each synchronization signal in case of sequence-based synchronization signal design
 - Down-select from following candidates based on subcarrier spacing and bandwidth consideration for synchronization signals
 - Alt.1: sequence length is about 255
 - Alt.2: sequence length is about 127
 - Alt.3: sequence length is about 63
 - NR-SS for different usage scenario (e.g., different frequency range) can be generated by scaling subcarrier spacing value
 - FFS: Other approaches may also be applied, e.g., repetition/concatenation of same or different sequence with the same basic sequence length in frequency domain, repetition/concatenation of same or different sequence with the same basic sequence length in different OFDM symbols, single basic sequence mapped to multiple OFDM symbols, mapping the basic sequence to every N subcarriers, defining additional longer sequence than basic sequence
 - FFS on message-based synchronization signal design

Decision: The document is noted. Modified as follows further to offline session:

Agreements:

- NR defines at least one basic sequence length for each synchronization signal in case of sequence-based synchronization signal design
 - Down-select from following candidates based on at least subcarrier spacing and bandwidth consideration for synchronization signals
 - Alt.1: sequence length is about 255
 - Alt.2: sequence length is about 127
 - Alt.3: sequence length is about 63
 - Note even number is not precluded
 - Note that this is total length of basic sequence that may be constructed by concatenation of multiple sequences like LTE-SSS
 - Striving for the design where NR-SS for different usage scenario (e.g., different frequency range) can be generated by using basic sequence length (e.g., applying different subcarrier spacing value)

- FFS: repetition/concatenation of same or different sequence with the same basic sequence length in frequency domain, repetition/concatenation of same or different sequence with the same basic sequence length in different OFDM symbols, single basic sequence mapped to multiple OFDM symbols, mapping the basic sequence to every N subcarriers, defining additional longer sequence than basic sequence
- FFS on message-based synchronization signal design

R1-1701271 WF on NR-SS subcarrier spacing NTT DOCOMO, Qualcomm, LG Electronics, Samsung, Intel, InterDigital, Sony

The document was presented by Hiroki Harada from NTT DOCOMO.

- For default subcarrier spacing of SS, at least following two frequency range categories are defined
 - Frequency range category #1 is for below 6 GHz
 - Down select default subcarrier spacing value for this category from [15 kHz, 30 kHz]
 - Frequency range category #2 is for range from 6 to 52.6 GHz
 - Down select default subcarrier spacing value for this category from [120 kHz, 240 kHz]
 - FFS on the necessity of finer categorization
- FFS whether PBCH subcarrier spacing is default subcarrier spacing for the respective frequency range category or not

Decision: The document is noted, modified as follows:

Agreements:

- For default subcarrier spacing of SS, at least for evaluation purposes, following two frequency range categories are defined
 - Frequency range category #1 is evaluated for below 6 GHz
 - Evaluate default subcarrier spacing value for this category from [15 kHz, 30 kHz, 60 kHz] until the next meeting
 - Frequency range category #2 is evaluated for range from 6 to 52.6 GHz
 - Evaluate default subcarrier spacing value for this category from [120 kHz, 240 kHz] until the next meeting
 - FFS on the necessity of finer categorization
 - Note: The impact of SS block duration on the achievable latency should be considered in addition to existing criteria
- RAN1 aims to down select default subcarrier spacing from above listed subcarrier spacing values for each agreed frequency range categories
 - Note that final set of frequency categories may include more than the above two categories
- FFS whether PBCH subcarrier spacing is default subcarrier spacing for the respective frequency range category or not

Continue offline discussion until Wednesday – (NTT DOCOMO, Samsung)

Wednesday session

R1-1701272 WF on SS burst set composition Samsung, Ericsson, ZTE, ZTE Microelectronics, Interdigital, Cohere

The document was presented by Young-Han Nam from Samsung.

- For a given frequency band, an SS block corresponds to N OFDM symbols based on the default subcarrier spacing, and N is a constant.
 - The signal multiplexing structure is fixed in a specification
- UE shall be able to identify at least OFDM symbol index, slot index in a radio frame and radio frame number from an SS block.
 - The signals included in the SS block are FFS between
 - Alt 1: PSS, SSS and PBCH; and
 - Alt 2: PSS, SSS, TSS and PBCH.
 - Note 1: it does not preclude possibility of multiplexing MRS and/or data transmission in the SS block.
 - Note 2: It does not preclude the possibility of skipping PBCH in other SS blocks.
- From UE perspective, an SS burst comprises L consecutive SS blocks.
 - L corresponds to the number of SS blocks in a burst
 - L is FFS between
 - Alt 1: a fixed value specified in a given frequency band;
 - Alt 2: L is cell-specifically determined and \leq a fixed maximum value specified in a frequency band
- From UE perspective, an SS burst set comprises nL SS blocks.
 - n is cell-specifically determined and corresponds to the number of bursts in a burst set
 - Maximum number of n is fixed in spec in a frequency band.
 - For $<6\text{GHz}$, at least $n = L = 1$ is supported.
 - Note: It doesn't preclude possibility of configuring multiple SS blocks in a burst set for $<6\text{GHz}$
- [Note: By network implementation, actual number of transmitted SS blocks within a burst set can be less than nL ; and actual number of transmitted SS blocks within a burst can be less than L .]

- Note: Maximum possible number of SS blocks in a SS burst set is fixed in the spec, according to these proposals.

Decision: The document is noted.

Agreements:

- For a given frequency band, an SS block corresponds to N OFDM symbols based on the default subcarrier spacing, and N is a constant.
 - The signal multiplexing structure is fixed in a specification
- UE shall be able to identify at least OFDM symbol index, slot index in a radio frame and radio frame number from an SS block.
 - The signals included in the SS block are FFS between
 - Alt 1: PSS, SSS and PBCH; and
 - Alt 2: PSS, SSS, TSS and PBCH.
 - Note 1: it does not preclude possibility of multiplexing MRS and/or data transmission in the SS block.
 - Note 2: It does not preclude the possibility of skipping PBCH in other SS blocks.

Possible agreements:

- From UE perspective, an SS burst comprises L SS blocks
 - L is a fixed value specified in a given frequency band
 - FFS: SS blocks are always consecutive or not
- From UE perspective, an SS burst set comprises nL SS blocks.
 - n is cell-specifically determined and corresponds to the number of bursts in a burst set
 - Maximum number of n is fixed in spec in a frequency band.
 - For <6GHz, at least $n = L = 1$ is supported.
 - Note: It doesn't preclude possibility of configuring multiple SS blocks in a burst set for <6GHz
- FFS whether UE has different assumptions in idle and connected modes
- Note that network is not mandated to transmit SS blocks as UE assumed
- Note: Maximum possible number of SS blocks in a SS burst set is fixed in the spec, according to these proposals.

Continue offline discussion – Young-Han (Samsung)

Agreement:

- For initial cell selection, UE may assume default SS burst set periodicity which may be frequency band-dependent.
- UE may assume that a given SS block is repeated with a SS burst set periodicity
 - Note that NR-PBCH contents in a given repeated SS block may change
- A single set of possible SS block time locations is specified per frequency band.
 - FFS whether the set is defined with respect to SS burst set or radio frame
 - FFS whether idle/connected UE can be configured with additional information about which SS blocks in a SS burst set are transmitted

R1-1701367 **WF on NR-SS bandwidth** **NTT DOCOMO, Samsung, InterDigital, AT&T, ZTE, ZTE**

Microelectronics

The document was presented by Hiroki Harada from NTT DOCOMO.

- For frequency range category #1 (below 6 GHz) where [15 kHz, 30 kHz, 60 kHz] are candidate subcarrier spacing values:
 - Candidate minimum NR carrier bandwidth are [5 MHz, 10 MHz, 20 MHz]
 - Candidate transmission bandwidth of each synchronization signal are about [1.08 MHz, 2.16 MHz, 4.32 MHz, 8.64 MHz]
- For frequency range category #2 (above 6 GHz) where [120 kHz, 240 kHz] are candidate subcarrier spacing values:
 - Candidate minimum NR carrier bandwidth are [20 MHz, 40 MHz, 80 MHz]
 - Candidate transmission bandwidth of each synchronization signal are about [8.64 MHz, 17.28 MHz, 34.56 MHz]
- Note that above frequency range categories may be further divided into different categories with different parameters
- FFS on bandwidth of additional synchronization signal(s) if defined

Decision: The document is noted, modified and agreed as follows:

Agreements:

- For frequency range category #1 (below 6 GHz) where [15 kHz, 30 kHz, 60 kHz] are candidate subcarrier spacing values:
 - Candidate minimum NR carrier bandwidth are [5 MHz, 10 MHz, 20 MHz]
 - Candidate transmission bandwidth of each synchronization signal are about [1.08 MHz, 2.16 MHz, 4.32 MHz, 8.64 MHz]
- For frequency range category #2 (above 6 GHz) where [120 kHz, 240 kHz] are candidate subcarrier spacing values:

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- Candidate minimum NR carrier bandwidth are [20 MHz, 40 MHz, 80 MHz]
- Candidate transmission bandwidth of each synchronization signal are about [8.64 MHz, 17.28 MHz, 34.56 MHz, 69.12 MHz]
- The above frequency range categories may be further divided into different categories with different parameters
- FFS on bandwidth of additional synchronization signal(s) if defined
- NR minimum carrier bandwidth for carrier which does not support initial access is FFS

Possible agreements:

- Note that for a NR carrier that does not support initial access, other smaller NR carrier bandwidth can be considered
- Note that NR carrier bandwidth of 5 MHz and above may not support initial access
- Note that UE operating bandwidth may be smaller than NR SS bandwidth

Continue offline discussion until Thursday – (Huawei)

Agreement: FFS: UE bandwidth

R1-1701293 Multiplexing of PSS and SSS Qualcomm, Docomo, Intel, Ericsson, CATT, Sony, MediaTek, ZTE

- In both single beam and multi-beam scenario, time division multiplexing of PSS and SSS is supported.

Discussion: Also supported Motorola Mobility, InterDigital, LGE, AT&T, Sierra Wireless

Samsung ok for single beam case only.

Decision: The document is noted.

Agreement: At least for single beam scenario, time division multiplexing of PSS and SSS is supported.

Working assumption: Time division multiplexing of PSS and SSS is supported for multiple beam scenario

R1-1701377 SS block index indication Huawei, HiSilicon, NTT DOCOMO, ZTE, ZTE Microelectronics

Continue offline discussion until Wednesday – (NTT DOCOMO, Samsung)

Friday

R1-1701530 WF on SS-block Index Indication Huawei, HiSilicon, NTT DOCOMO, ZTE, ZTE Microelectronics,

Sierra Wireless, Samsung, CATT, InterDigital, Nokia, ASB, Intel, Ericsson

- The time index/indices of an SS block from which UE will derive symbol, slot index in a radio frame is/are to be down-selected from the following alternatives:
 - Alt.1: One time index for every SS-block within an SS-burst set
 - Alt.2: One time index that is specific to each SS-block within an SS-burst, and an SS burst index that is specific to each SS burst within an SS-burst set. SS burst index is common across SS blocks in each SS-burst.
- Possible mechanisms to indicate the SS block index includes
 - Implicit indication by PBCH
 - Explicit indication by PBCH
 - Indication by an additional SS, if such an additional SS is introduced
 - Indication by NR-SS
 - Note that this does not preclude other mechanisms
- By default, the UE may neither assume the gNB transmits the same number of physical beam(s), nor the same physical beam(s) across different SS-blocks within an SS burst set.

Decision: The document is agreed.

Not treated.

- [R1-1700097](#) NR-SS: Bandwidth, Multiplexing ZTE, ZTE Microelectronics
- [R1-1700159](#) TDM based unified SS block design for both above and below 6 GHz MediaTek Inc.
- [R1-1700178](#) NR-SS Bandwidth and multiplexing with NR-PBCH CATT
- [R1-1700288](#) Indication of the SS-block index in multi-beam cases Spreadtrum Communications
- [R1-1700328](#) Synchronization signal structure Intel Corporation
- [R1-1700456](#) Discussion on SS bandwidth and multiplexing LG Electronics
- [R1-1700608](#) Discussion and evaluation on NR- PSS/SSS structure NTT DOCOMO, INC.
- [R1-1700665](#) On NR synchronization signal design Sony
- [R1-1700735](#) Numerology for DL synchronization signals Sharp
- [R1-1700784](#) Synchronization signal bandwidth and multiplexing consideration Qualcomm Incorporated
- [R1-1700884](#) SS BW and multiplexing Samsung
- [R1-1701037](#) Synchronization Signal Structure Innovative Technology Lab Co.
- [R1-1701041](#) Synchronization in NR considering beam sweeping ASUSTEK COMPUTER (SHANGHAI)
- [R1-1701056](#) SS Block Bandwidth, Numerology and Multiplexing Nokia, Alcatel-Lucent Shanghai Bell

[R1-1701070](#) On transmission bandwidth and multiplexing synchronization signals CMCC

5.1.1.1.2 SS frequency raster

[R1-1700422](#) Frequency raster for synchronization signal and system carrier Intel Corporation

The document was presented by Daewon Lee from Intel.

- Proposal 1: NR channel raster of [100 kHz or 180 kHz] is supported for sub 6 GHz. Down select between 100 kHz and 180 kHz to be done with further analysis.
- Proposal 2: UE is only expected to monitor one synchronization signal within the NR component carrier bandwidth, and can assume all NR cells considered as intra-frequency handover have identical frequency position of the synchronization signal.
- Proposal 3: NR synchronization signal raster and NR channel raster is defined to be identical for below 6 GHz. This can be revisited if minimum system bandwidth is larger than the synchronization signal bandwidth.
- Proposal 4: NR synchronization signal raster and NR channel raster is defined to be identical for above 6 GHz. This can be revisited if minimum system bandwidth is larger than the synchronization signal bandwidth.

Decision: The document is noted.

[R1-1700785](#) Synchronization signal frequency raster consideration Qualcomm Incorporated

The document was presented by Haitong Sun from Qualcomm.

- Proposal 1: The frequency of synchronization signals should be aligned with the subcarriers of data channel. More specifically, the following considerations should be taken into account when designing the synchronization signal frequency raster.
 - The synchronization signal frequency raster is an integer multiple of data subcarrier spacing.
 - The maximum data subcarrier spacing is 120 kHz for below 6 GHz and 240 kHz for above 6GHz.
- Proposal 2: Two band categories can be defined for synchronization signals
 - Band category A: Synchronization signal has synchronization signal bandwidth 4.32MHz and synchronization signal SCS of 30kHz
 - Band category B: Synchronization signal has synchronization signal bandwidth 34.56MHz and synchronization signal SCS of 240kHz
- Proposal 3: The channel raster is either 120 kHz or 300 kHz for below 6GHz, and either 960 kHz or 1.92MHz for above 6GHz.
- Proposal 4: The synchronization signal frequency raster is 36MHz for band category B. In addition, the following options for the synchronization signal frequency raster can be considered for band category A
 - Synchronization signal frequency raster option 1: If the channel raster is 120 kHz, the synchronization signal frequency raster is 4.68MHz for band category A.
 - Synchronization signal frequency raster option 2: If the channel raster is 300 kHz, the synchronization signal frequency raster is 4.5MHz for band category A.
- Proposal 5: Both the channel and sync raster start at 0 Hz for all bands, irrespective of where the band boundaries are.

Decision: The document is noted.

Conclusion of Monday session: Continue offline discussion until Wednesday – Haitong (Qualcomm)

Friday

[R1-1701515](#) WF on Synchronization and Channel Raster Qualcomm, CATT, Samsung, Sierra Wireless

Decision: The document is noted and the following is agreed:

Agreements:

- When the sync bandwidth is smaller than the minimum system bandwidth for a given frequency band, RAN1 strives to make the synchronization signal frequency raster sparser compared to channel raster to reduce UE initial cell selection burden without limiting the NR deployment flexibility
 - FFS If UE is required to search for all the possible synchronization signal frequency locations defined by the synchronization signal frequency raster
- When the sync bandwidth is the same as the minimum system bandwidth for a given frequency band that UE searches, synchronization signal frequency raster is the same as the channel raster
 - FFS If UE is required to search for all the possible synchronization signal frequency locations defined by the synchronization signal frequency raster

Not treated.

[R1-1700038](#) Frequency location of the synchronization signals Huawei, HiSilicon

[R1-1700098](#) NR-SS: Frequency Raster ZTE, ZTE Microelectronics

[R1-1700160](#) Low Density Power Boosted Synchronization Signal for flexible NR frequency raster MediaTek Inc.

[R1-1700179](#) Consideration of NR Raster and UE behavior CATT

[R1-1700293](#) NR SS frequency raster Ericsson

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R1-1700307	NR SS Design: Frequency Raster	AT&T
R1-1700457	Discussion on SS frequency raster	LG Electronics
R1-1700885	SS frequency raster	Samsung
R1-1701057	On synchronization signal frequency raster	Nokia, Alcatel-Lucent Shanghai Bell

5.1.1.1.3 SS periodicity

[R1-1700180](#) NR SS periodicity CATT

The document was presented by Fang Chen Cheng from CATT.

- Proposal 1: NR-PSS/NR-SSS and NR-PBCH should be TDM multiplexed to minimize the UE detection complexity of synchronization signals and retrieve the system information from NR-PBCH.
- Proposal 2: The number of SS-blocks within a SS-burst should be flexibly determined in the deployment.
- Proposal 3: Considering the shadow fading cycle with ± 8 dB standard deviation, the SS-burst periodicity needs to be less than 20 ms to allow the UE detect the NR-PSS/NR-SSS with high probability of detection at SINR = -6 dB
- Proposal 4: The periodicity of SS-burst for channel tracking should not be more than 10 ms to allow accumulation of NR-PSS/NR-SSS for SINR improvement.
- Proposal 5: The periodicity of the SS-burst set should be defined based on long term inter-cell interference scheme and network power saving scheme

Decision: The document is noted.

[R1-1700294](#) NR SS burst set periodicity Ericsson

The document was presented by Asbjorn Grovlen from Ericsson.

- Obs.1: Significant network energy savings can be achieved by having default 80 ms periodicity for the SS burst set helping to meet the technical performance requirements for IMT-2020
- Obs.2: Good single-shot NR-PSS/SSS detection rate and sparser frequency raster for cell search will reduce the NR initial access cell search time
- Obs.3: Introduction of additional signals for connected mode measurements allows unloaded networks to fall back to low energy state transmitting only NR-PSS/SSS used for idle mode mobility measurements
- Adopt 80 ms for the default periodicity of the SS burst set

Decision: The document is noted.

[R1-1700329](#) Periodicity of synchronization signals Intel Corporation

The document was presented by Gregory Morozov from Intel.

- SS bursts consists of identical number of SS blocks with same relative transmission timing within the SS burst.
- SS burst set is repeated indefinitely
- In NR, a single value for the default periodicity of SS burst is used for a given carrier frequency.
- At least for below 6 GHz, the default periodicity of SS burst is 5 ms.

Decision: The document is noted.

Conclusion of Monday session: Continue offline discussion until Wednesday – (AT&T)

Wednesday session

[R1-1701373](#) WF on NR SS Periodicity AT&T, NTT DOCOMO

The document was presented by Thomas Novlan from AT&T.

- A large value for the SS burst set periodicity (e.g. 100ms) can be supported at least in case of NR deployments where network assistance signalling of the SS burst set periodicity for a given carrier frequency can be provided.
- FFS the value for the default SS burst set periodicity assumed in the case where network assistance signalling of the SS burst set periodicity cannot be provided.
 - A UE in this case is only expected to perform measurements based on the default SS burst set periodicity
 - Companies are encouraged to investigate the tradeoff between network flexibility/power consumption and UE complexity/power consumption (especially for IDLE mode and initial cell search)

Discussion: Also supported by Orange.

Samsung suggested replacing “FFS the value” (second main bullet) by “A small value”

Ericsson cannot agree with Samsung – FFS means that further study is required to get this bullet agreeable

Decision: The document is noted.

Possible agreements:

- At least one value for the SS burst set periodicity (e.g. [100ms]) can be supported at least in case of NR deployments where network assistance signalling of the SS burst set periodicity for a given carrier frequency can be provided.
- Smaller value for the default SS burst set periodicity (e.g. [10ms]) assumed in the case where network assistance signalling of the SS burst set periodicity cannot be provided
 - A UE in this case is only expected to perform measurements based on the default SS burst set periodicity
 - Companies are encouraged to investigate the tradeoff between network flexibility/power consumption and UE complexity/power consumption (especially for IDLE mode and initial cell search)

Friday

[R1-1701553](#)

WF on NR SS Periodicity

AT&T, NTT DOCOMO, Samsung, Sierra Wireless

- RAN1 aims to select a default SS burst set periodicity for each agreed frequency range category from the following candidate values:
 - For carrier frequency range #1 (below 6GHz): [5ms, 10ms, 20ms, 40ms, 80ms, 100ms]
 - For carrier frequency range #2 (above 6GHz): [5ms, 10ms, 20ms, 40ms, 80ms, 100ms]
 - Note that final set of frequency categories may include more than the above two categories
- Companies are encouraged to investigate the candidate default SS burst set periodicity values considering at least the following factors:
 - UE IDLE mode and initial cell search power consumption and latency
 - Including single/multi-beam operation at Tx and Rx
 - NW power consumption
 - Inter-RAT/Inter-frequency measurement
 - Forward compatibility and deployment flexibility including standalone and non-standalone NR deployments
 - Benefits and feasibility of SS burst set configuration assistance signaling (e.g. periodicity indication or measurement window) for CONNECTED and/or IDLE UEs
 - NW synchronization requirements/assumptions

Decision: The document is agreed.

Not treated.

[R1-1700046](#)

Discussion and evaluation on NR-SS periodicity Huawei, HiSilicon

[R1-1700099](#)

NR-SS: Periodicity ZTE, ZTE Microelectronics

[R1-1700161](#)

SS Block set periodicity considering beam tracking and initial acquisition MediaTek Inc.

[R1-1700308](#)

Periodicity of NR SS AT&T

[R1-1700453](#)

Synchronization signal transmission based on multi-beam for NR Potevio

[R1-1700458](#)

Discussion on SS periodicity LG Electronics

[R1-1700609](#)

Discussion on SS periodicity for NR NTT DOCOMO, INC.

[R1-1700666](#)

NR synchronization signal burst set periodicity Sony

[R1-1700727](#)

DL synchronization signal structure in NR Sharp

[R1-1700786](#)

Synchronization signal periodicity consideration Qualcomm Incorporated

[R1-1700871](#)

Considerations on SS periodicity for Synchronization in NR InterDigital Communications

[R1-1700886](#)

SS periodicity Samsung

[R1-1701058](#)

On Requirements and Design of SS Burst Set Nokia, Alcatel-Lucent Shanghai Bell

[R1-1701069](#)

Beam sweeping using multi-width beams CMCC

[R1-1701178](#)

Discussion on Synchronization Signal Periodicity ORANGE

5.1.1.1.4 SS sequence design

[R1-1700459](#)

NR Synchronization Signal Design

LG Electronics

The document was presented by ... from LGE.

- Proposal 1: The subcarrier spacing and CP length of NR-SSS is the same as that of the other initial access channels (e.g., broadcast channel). The subcarrier spacing of NR-PSS is wider than that of NR-SSS and the CP length of NR-PSS is shorter than that of NR-SSS.
- Proposal 2: For below 6 GHz, the transmission bandwidth and time duration of NR synchronization signal is similar with that of LTE synchronization signal.
- Proposal 3: The single hypothesis of NR-PSS should be considered and at least cell-ID should be provided in NR-SSS.
- Proposal 4: Common sequence across different default numerologies should be considered

Decision: The document is noted.

[R1-1700610](#)

Discussion and evaluation on NR synchronization signal sequence design NTT DOCOMO, INC.

The document was presented by Hiroki Harada from NTT DOCOMO.

- Observation 1: It is beneficial to minimize number of IDs for NR-PSS sequence to minimize UE burden.
- Observation 2: Cell detection performance is almost same in the cases with different numbers of PSS IDs.
- Observation 3: Time-repetitive NR-PSS structure based on comb mapping would be helpful to mitigate residual frequency offset after NR-PSS detection and would provide flexibility for various NR-SS design.
 - Detailed PSS sequence design should be further studied.
- Observation 4: For NR-SSS detection, interleaving two sequences based on M sequence and Zadoff-Chu sequences provides almost the same performance.
- Observation 5: Zadoff-Chu sequence has distorted peak performance in cross-correlation between cyclic-shifted sequences in the presence of residual frequency offset.

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- Proposal 1: In order to avoid the PCI confusion issue and to relax corresponding planning effort, number of NR cell IDs should be extended to more than 504 while number of IDs supported by NR-PSS/SSS should be kept to 504 considering detection performance and complexity.
 - FFS carrying remaining part of NR cell ID by using NR-PBCH
- Proposal 2: Single NR-PSS sequence should be considered.
- Proposal 3: Zadoff-Chu based sequence should be applied for NR-PSS
- Proposal 4: M sequence based NR-SSS should be considered.

Decision: The document is noted.

Conclusion of Monday session: Continue offline discussion until Wednesday – (Samsung)

Tuesday session

[R1-1701268](#) WF on number of NR Cell IDs and NR-PSS sequences Samsung, Intel, LG Electronics, NTT DOCOMO, InterDigital, ZTE, ZTE Microelectronics

The document was presented by Hongbo Si from Samsung.

- Down-select the number of NR cell IDs from
 - Alt 1: 504.
 - Alt 2: about 1000 to 2000.
- Down-select from the following alternatives on the number of NR-PSS sequence(s):
 - Alt 1: One.
 - Alt 2: Two.
 - Alt 3: Three.
- Companies are encouraged to evaluate and down-select from the above alternatives in the next meeting.

Decision: The document is noted, modified and agreed as follows:

Agreements:

- Down-select the number of NR cell IDs in PSS and SSS from
 - Alt 1: 504
 - Alt 2: about 1000 to 2000
 - Alt 3: 600
 - Note that other information is not excluded from PSS/SSS
- Down-select from the following alternatives on the number of NR-PSS sequence(s):
 - Alt 1: One
 - Alt 2: Two
 - Alt 3: Three
 - Alt 4: Four
 - Alt 5: Six
- Companies are encouraged to evaluate and down-select from the above alternatives in the next meeting.

Not treated.

R1-1700887	SS sequence design	Samsung
R1-1700037	Synchronization signals for NR	Huawei, HiSilicon
R1-1700100	NR-SS: Sequence Design	ZTE, ZTE Microelectronics
R1-1700162	Candidate Sequences for NR PSS	MediaTek Inc.
R1-1700181	Numerology agnostic NR PSS design and performance evaluation results	CATT
R1-1700295	NR-PSS/SSS Sequence design	Ericsson
R1-1700330	Considerations for synchronization signal sequence	Intel Corporation
R1-1700450	Sync signal design for different beam approaches	KT Corp.
R1-1700547	Discussion on NR-PSS and NR-SSS design	Guangdong OPPO Mobile Telecom.
R1-1700576	Design of NR synchronization signals	ETRI
R1-1700787	Synchronization signal sequence design consideration	Qualcomm Incorporated
R1-1700847	Initial Synchronization Signal Design in NR InterDigital Communications	
R1-1700879	Concatenation based wideband synchronization signal	Motorola Mobility
R1-1701038	Considerations on Sequence Design for Synchronization Signal	Innovative Technology Lab Co.
R1-1701059	Synchronization signal design and performance analysis	Nokia, Alcatel-Lucent Shanghai Bell

5.1.1.2 Broadcast signal/channel

R1-1700788	PBCH design consideration	Qualcomm Incorporated
R1-1700047	Discussion and evaluation on broadcast channel/signals transmission for beam based initial access	
	Huawei, HiSilicon	
R1-1700888	System information delivery	Samsung

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R1-1701372 **WF on NR PBCH contents** **Samsung, NTT DOCOMO, CATT, Convida Wireless, Sony, ITL, InterDigital**

Agreement:

- NR-PBCH contents shall include:
 - At least part of the SFN (system frame number)
 - FFS on the number of bits used to indicate SFN
 - FFS how much of the SFN is indicated explicitly, and how much (if any) is indicated implicitly
 - CRC (FFS number of bits)
 - FFS:
 - In case remaining minimum system information is carried on PDSCH, configuration for PDSCH or control resource set for scheduling PDSCH
 - In case remaining minimum system information is carried on secondary physical broadcast channel, configuration of secondary physical broadcast channel
 - Configuration information for initial uplink transmission; in this case, it may not be necessary to include configuration information for remaining minimum system information
 - Other parameters

R1-1701314 **WF on NR-PBCH design** **LG Electronics, Intel, Nokia, ASB, Samsung, NTT DOCOMO, InterDigital, Mediatek**

Agreement:

- No blind detection of NR-PBCH transmission scheme or number of antenna ports is required by the UE
- For NR-PBCH transmission, a single fixed number of antenna port(s) is supported
- For NR-PBCH transmission, a single one of the following transmission schemes is supported; down-selection will be done in RAN1#88 to one of the following transmission schemes:
 - Alt.1: Two antenna port based SFBC
 - Alt.2: Two antenna port based precoder cycling
 - Alt.3: Single antenna port based transmission scheme
- For reference signal of NR-PBCH demodulation, down selection will be done in RAN1#88 to one of the following:
 - Alt.1: Synchronization Signal (e.g. NR-SSS)
 - Alt.2: Self-contained DMRS
 - NOTE: It does not preclude additional channel estimation aid from synchronization signal.
 - Alt.3: MRS multiplexed in an SS block, if MRS is supported in an SS block.
- Numerology: FFS whether NR-PBCH is the same as NR-SSS – decision to be taken at RAN1#88

Friday

R1-1701502 **WF on Simulation Assumptions for NR-PBCH** **LG Electronics, NTT DOCOMO, Ericsson, Samsung, InterDigital, ZTE, ZTE Microelectronics, Intel**

Decision: The document is noted and the following is agreed:

Agreements:

- Companies are encouraged to provide evaluation results based on the following assumptions:

Parameter	Value
Channel coding scheme	LTE TBCC Other channel coding schemes are not precluded. (e.g. Polar coding)
Carrier frequency, Channel model, UE speed, Antenna configuration, Number of interfering TRPs	Following evaluation assumptions for initial access
Performance Target	1% BLER @ -6dB (average received SNR)

- Companies should provide exact values for following parameters:
 - Payload size with CRC & Required number of REs (w/o reference signal)
 - DMRS overhead assumption if used
 - Number of OFDM symbols for NR-PBCH
 - Number of OFDM symbols for SS block
 - Transmission bandwidth for NR-PBCH
 - Periodicity for NR-PBCH
 - Multiplexing of NR-PBCH in the SS block
 - Subcarrier spacing
- Companies should mention if NR-PBCH implicitly convey other information, e.g. SS block timing
- Companies should provide frequency and time estimation errors

- o Note that above simulation assumptions will not affect the decisions of channel coding scheme of NR-PBCH

Not treated.

R1-1700101	NR-PBCH and Delivery of Minimum SI	ZTE, ZTE Microelectronics
R1-1700151	Broadcast channel design for system information acquisition	MediaTek Inc.
R1-1700182	NR PBCH and NR physical channel carried system information	CATT
R1-1700296	NR Minimum system information delivery	Ericsson
R1-1700331	Considerations for NR physical broadcast channel	Intel Corporation
R1-1700460	NR PBCH Design	LG Electronics
R1-1700535	Relation among BCH, SIBs and subcells	Panasonic Corporation
R1-1700611	Discussion on broadcast signal/channel design for NR	NTT DOCOMO, INC.
R1-1700667	Consideration on NR broadcast signal/channel	Sony
R1-1700846	Broadcast Signal and Channel Design in NR	InterDigital Communications
R1-1701042	Signaling of broadcast channel considering multiple numerologies	ASUSTEK COMPUTER (SHANGHAI)
R1-1701060	PBCH design	Nokia, Alcatel-Lucent Shanghai Bell

5.1.1.3 Paging design

[R1-1701441](#) WF on paging Huawei, HiSilicon, Samsung, CATT, Panasonic, NTT DOCOMO, Fujitsu, LG Electronics, MediaTek

The document was presented by Xi Zhang from Huawei.

- Companies are encouraged to compare the following options for channel design for paging, taking the necessity of beam sweeping into consideration
 - Opt-1: Paging message is scheduled by DCI carried by NR-PDCCH and is transmitted over PCH carried by NR-PDSCH
 - Opt-2: Paging message is transmitted in a non-scheduled physical channel indicated by NR-PBCH
 - Opt-3: Paging message is transmitted over PCH carried by NR-PDSCH without DCI. The resource is semi-statically configured
 - Opt-4: Paging message (e.g., only for SI change indication) is transmitted over NR-PDCCH without NR-PDSCH
- Companies are encouraged to provide their views on
 - Definitions of paging occasion and paging periodicity
 - Content and payload of paging message
- RAN1 sends a LS to RAN2, asking about
 - Paging payload and capacity requirement

Decision: The document is noted; further modified as follows:

Agreements:

- Companies are encouraged to compare the following options for channel design for paging, taking the necessity of beam sweeping into consideration
 - o Opt-1: Paging message is scheduled by DCI carried by NR-PDCCH and is transmitted over PCH carried by NR-PDSCH
 - o Opt-2: Paging message is transmitted in a non-scheduled physical channel
 - Where the paging indication may be carried by NR-PBCH or some other channel(s)
 - o Opt-3: Paging message is transmitted over PCH carried by NR-PDSCH without DCI. The resource is semi-statically configured
 - o Opt-4: Paging message (e.g., only for SI change indication) is transmitted over NR-PDCCH without NR-PDSCH
 - o Opt-5: Paging message is transmitted by PDSCH and paging indication is transmitted non-scheduled physical channel
- Companies are encouraged to provide their views on
 - o Definitions of paging occasion and paging periodicity
 - o Content and payload of paging message
 - o RAN1 sends a LS to RAN2, asking about paging payload and capacity requirement

Prepare draft LS to RAN2 (if possible within Thursday) in [R1-1701495](#) – Teck (Huawei)

[R1-1701495](#) LS on Paging Requirements RAN1, Huawei

Decision: The LS is approved.

Not treated.

R1-1700536	Paging design related to subcell	Panasonic Corporation
R1-1700789	Paging design consideration	Qualcomm Incorporated
R1-1700102	Paging in NR	ZTE, ZTE Microelectronics

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R1-1700048	Multi-beam Paging for NR	Huawei, HiSilicon
R1-1700183	NR Paging Channel	CATT
R1-1700297	NR Paging design	Ericsson
R1-1700461	Discussion on paging design in NR	LG Electronics
R1-1700612	Discussion on paging design for NR	NTT DOCOMO, INC.
R1-1700865	Discussion on NR paging design	Beijing Xiaomi Mobile Software
R1-1700889	Paging channel design	Samsung
R1-1701061	Paging in NR	Nokia, Alcatel-Lucent Shanghai Bell

5.1.1.4 Physical random access channel and random access procedure

5.1.1.4.1 PRACH design

R1-1700298	NR PRACH design	Ericsson
R1-1700309	PRACH Design for NR	AT&T
R1-1700034	RACH preamble design for NR	Huawei, HiSilicon

[R1-1701277](#) WF on PRACH preamble numerology ZTE, ZTE Microelectronics, Samsung, Nokia, NTT DOCOMO, CATT, Ericsson, LGE
Revised in [R1-1701458](#) WF on PRACH preamble numerology ZTE, ZTE Microelectronics, Samsung, Nokia, ASB, NTT DOCOMO, CATT, Ericsson, LGE, Huawei, HiSilicon, MediaTek, Qualcomm, Sony, Intel, Sharp, Fujitsu

Agreed next steps:

- For down selection purpose, until the next meeting do evaluation of the following RACH SCS alternatives at least considering
 - Robustness towards Doppler frequency, Beam sweeping latency, Link budget, Cell size, RACH capacity, frequency offset
- RACH SCS alternatives
 - SCS = [1.25 2.5 5 7.5 10 15 20 30 60 120 240] kHz
 - Note: in case RACH SCS = [15 30 60 120 240] there are two design options:
 - use the same SCS as the subsequent UL data and control
 - use different SCS than the subsequent UL data and control
- The following RACH preamble sequence types are considered
 - Zadoff-Chu
 - M-sequence
 - Zadoff-Chu with cover extension using M-sequence

Note that new designs are not precluded in the future.

[R1-1701493](#) WF on RACH preamble format Samsung, Qualcomm, ZTE, ZTE Microelectronics, NTT DOCOMO, Ericsson, DISH Network, Thales, MediaTek, CATT, Huawei ([R1-1701368](#))

Agreement:

For single/multi-beam operation,

- For multiple/repeated RACH preamble transmissions, consider only option 1, option 2 and option 4
 - Option 1: CP is inserted at the beginning of the consecutive multiple/repeated RACH OFDM symbols, CP/GT between RACH symbols is omitted and GT is reserved at the end of the consecutive multiple/repeated RACH symbols
 - Option 2/4: The same/different RACH sequences with CP is used and GT is reserved at the end of the consecutive multiple/repeated RACH sequences
 - Study:
 - Multiplexing with different orthogonal cover codes
 - Independent RACH sequences in a RACH preamble
- For supporting various coverage and forward compatibility, flexibility in the length of CP/GT and the number of repeated RACH preambles and RACH symbols is supported
- Note: specific use of these three options may depend on RACH subcarrier spacing and TRP beam correspondence

[R1-1701486](#) WF on PRACH preamble format definition NTT DOCOMO, Ericsson, CATT, Qualcomm, Samsung, Intel, ZTE, ZTE Microelectronics, Sony, Huawei, HiSilicon, Sharp, Nokia, ASB, LG Electronics, DISH Network

Agreement:

- NR defines that:

- a random access preamble format consists of one or multiple random access preamble(s),
- a random access preamble consists of one preamble sequence plus CP, and
- one preamble sequence consists of one or multiple RACH OFDM symbol(s)
- UE transmits PRACH according to the configured random access preamble format

Not treated.

R1-1700561	Consideration on the resource configuration of PRACH for UEs with/without TX/RX reciprocity	Lenovo
R1-1700890	PRACH design	Samsung
R1-1700103	PRACH Design Considerations	ZTE, ZTE Microelectronics
R1-1700184	On NR RACH Preamble Design	CATT
R1-1700332	PRACH preamble and resource allocation	Intel Corporation
R1-1700613	Views on random access channel for NR	NTT DOCOMO, INC.
R1-1700650	NR Physical Random Access Channel	Nokia, Alcatel-Lucent Shanghai Bell
R1-1700653	Discussion on PRACH configuration in NR	Fujitsu
R1-1700790	PRACH design consideration	Qualcomm Incorporated
R1-1701199	Discussion on NR PRACH Preamble	LG Electronics
R1-1701378	WF on PRACH design	Huawei, HiSilicon, CATT

5.1.1.4.2 4-step RA procedure

[R1-1700651](#) NR Random Access Procedure Nokia, Alcatel-Lucent Shanghai Bell

The document was presented by ... from Nokia.

- Observation 1: In single-beam DL and UL configuration (both gNB and UE), power ramp-up may be used for preamble re-transmission.
- Proposal 1: Whether to prioritize power ramp up, TX beam switch or PRACH preamble resource selection during random access procedure when no RAR is detected is up to UE as long as the UE follows the PRACH configuration and transmit power control rules.
- Proposal 2: UE re-starts power ramping-up process when the UE changes the preferred DL beam.
- Observation 2: gNB is unaware TX/RX beam correspondence capabilities of UEs that may start performing initial access into the cell.
- Observation 3: Lack of Tx/Rx correspondence at the UE, increases the complexity of the initial access procedure, increases access latency and leads to unnecessary interference.
- Observation 4: In case the UE doesn't have Tx/Rx correspondence, transmitting multiple preambles during the same RACH sweep reduces the initial access latency.
- Proposal 3: gNB provides a signal quality metric in the Random Access Response, to allow the UE to select the best UL Tx beam.
- Proposal 4: The network broadcasts to the UEs the maximum number of preambles that can be independently sent by one UE during a full RACH sweep.
- Observation 5: Having a many-to-one mapping between RACH preamble occasions and the RAR reception window, can lead to following drawbacks
 - Increases RACH procedure latency
 - Increases RACH procedure collision rate
 - UE ambiguity in determining the best UL Tx beam.
- Proposal 5: There is a one-to-one mapping between the RACH preamble occasions and the RAR reception window. During each RACH preamble occasion, the UE uses a single UL Tx beam.

Decision: The document is noted.

[R1-1700463](#) Discussion on RACH procedure LG Electronics

The document was presented by Eunsun Kim from LGE.

- Proposal 1: Selection of RACH resource can be based on the M-RS(Measurement RS) in idle mode.
- Proposal 2: Baseline is to allow a single RACH procedure per UE
- Proposal 3: NR RACH design should not be optimized considering UEs without beam correspondence.
- Proposal 4: A RACH resource is composed by a CP length based on preamble format and the number of repetition signalled from RACH configuration
- Proposal 5: PRACH preamble repetition is for the purpose of both of coverage extension and beam scanning at TRP side.
- Proposal 6: Since UE's received direction is determined by the selection of RACH resource, no additional signalling on the msg. 3 transmission beam direction is required in RAR.
- Proposal 7: PRAMBE_TRANSMISSION_COUNTER should be per UE irrespective of which RACH resource is used for the PRACH preamble transmission and the DL pathloss for OLPC should be estimated per RACH resource.
- Proposal 8: It should be UE choice whether the UE choose different RACH resource or not for its PRACH preamble transmission

Decision: The document is noted.

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Thursday session

[R1-1701462](#) WF on terminologies in 4-step RACH procedure LG Electronics, Qualcomm, NTT DOCOMO,
Samsung, Motorola Mobility, CATT (Revision of [R1-1701358](#))

Agreed Definition:

- For 4-step RACH procedure, a RACH transmission occasion is defined as the time-frequency resource on which a PRACH message 1 is transmitted using the configured PRACH preamble format with a single particular tx beam

Agreement: For 4-step RACH procedure,

- NR at least supports transmission of a single Msg.1 before the end of a monitored RAR window
- NR 4-step RACH procedure design should not preclude multiple Msg.1 transmissions until the end of RAR window if need arises

Proposal:

- RAN1 understanding on the PRACH preamble retransmission (i.e. msg. 1 retransmission) condition is the same as that from LTE specification point of view for discussion purpose, for example,
 - PRACH preamble transmission after previous random access procedure is not successfully completed
 - PRACH preamble transmission if UE didn't receive successful RAR until the expiration of RAR window
 - PRACH preamble transmission if UE fails in contention resolution during RACH procedure
 - The number of retransmissions is constrained by the maximum number of preamble transmissions configured by network
- FFS whether it is possible for a UE to send multiple PRACH transmissions before waiting to receive an RAR

[R1-1701419](#) 4-step RACH procedure ZTE, ZTE Microelectronics, Nokia, Alcatel-Lucent Shanghai Bell, Samsung, Huawei, HiSilicon, Sony (Revision of [R1-1701274](#))

[R1-1701365](#) WF on NR RACH Msg. 1 Re-transmission Samsung, Nokia, ASB, ZTE, ZTE Microelectronics, NTT DOCOMO, Mitsubishi Electric, MediaTek

Agreement: For NR RACH Msg. 1 retransmission at least for multi-beam operation:

- NR supports power ramping.
 - If the UE conducts beam switching, working assumption that one of the alternatives below will be selected (configurability between multiple alternatives may be considered if clear benefit is shown):
 - Alt 1: the counter of power ramping is re-set.
 - Alt 2: the counter of power ramping remains unchanged.
 - Alt 3: the counter of power ramping keeps increasing.
 - Other alternatives or combinations of the above are not precluded.
 - If UE doesn't change beam, the counter of power ramping keeps increasing.
 - Note: UE may derive the uplink transmit power using the most recent estimate of path loss.
 - The detail of power ramping step size is FFS.
- Whether UE performs UL Beam switching during retransmissions is up to UE implementation
 - Note: which beam UE switches to is up to UE implementation

[R1-1701366](#) Multiple RARs Samsung, ZTE, ZTE Microelectronics, NTT DOCOMO

Decision: Continue discussion at RAN1#88

Not treated.

R1-1700049	RACH procedures and resource configuration	Huawei, HiSilicon
R1-1700104	4-step Random Access Procedure	ZTE, ZTE Microelectronics
R1-1700185	Discussion on NR 4-step RA Procedure	CATT
R1-1700299	NR Four-step random access procedure	Ericsson
R1-1700304	On RACH retransmission	Mitsubishi Electric Co.
R1-1700310	4-Step RA Procedure for NR	AT&T
R1-1700333	Considerations for random access procedure	Intel Corporation
R1-1700431	RACH in Gradual UE-specific (GUS) initial access	CMCC
R1-1700548	Discussion on Random Access Procedure for NR	Guangdong OPPO Mobile Telecom.
R1-1700614	Discussion on 4-step random access procedure for NR	NTT DOCOMO, INC.

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R1-1700654	Discussion on RAR in NR Fujitsu	
R1-1700669	On Multiple Beams RACH Procedure	Sony
R1-1700702	Random access procedure INTERDIGITAL COMMUNICATIONS	
R1-1700736	RACH procedure for multi-Tx beam operation	Sharp
R1-1700791	4 step RACH procedure consideration	Qualcomm Incorporated
R1-1701250	Discussion on RACH procedure and resources	Cohere Technologies (R1-1700859)
R1-1700891	NR 4-step random access procedure	Samsung
R1-1701472	WF on RACH association	ZTE, ZTE Microelectronics

5.1.1.4.3 2-step RA procedure

Note that 2-step RACH procedure will be discussed at this adhoc meeting only

[R1-1700792](#) 2 step RACH procedure consideration Qualcomm Incorporated

The document was presented by Haitong Sun from Qualcomm.

- Proposal 1: Consider 2-step RACH procedure.
- Proposal 2: Consider fallback mechanisms for switching from 2-step RACH to 4-step RACH procedure.

Decision: The document is noted.

[R1-1700172](#) On 2-step random access procedure in NR MediaTek Inc.

The document was presented by ... from MediaTek.

- Observation 1: 2-step RACH and contention-based PUSCH are conceptually the same.
- Observation 2: The legacy LTE SR procedure can't meet the requirement of 4ms UL user plane latency.
- Observation 3: 2-step RACH has the potential to achieve the requirement of 4ms UL user plane latency.
- Observation 4: 2-step RACH can significantly reduce up to 41% control plane latency for RRC Connection Resume.
- Observation 5: After introducing 2-step RACH, it is processing time that dominates the control plane latency.
- Observation 6: 2-step RACH data signal can use the same subcarrier spacing, cyclic prefix as well as guard time as preamble signal to support asynchronous UL data transmission.
- Observation 7: To achieve lower receiver complexity, asynchronous 2-step RACH can use DMRS with higher density to avoid extra TA compensation at network.
- Observation 8: Asynchronous 2-step RACH can use the estimated timing advance at receiver to relax the requirement of DMRS density and achieve lower overhead DMRS design.
- Proposal 1: 2-step RACH should be supported for NR to achieve latency requirement.

Decision: The document is noted.

[R1-1700105](#) 2-step Random Access Procedure ZTE, ZTE Microelectronics

The document was presented by ... from ZTE.

- Obs.1: If 2-step RACH used for UL synchronization, the TA measurement accuracy should fulfil different scenarios.
- Obs.2: Whether the detection rate and false alarm rate should be the same between the preamble and payload should be studied.
- Obs.3: The target SNR and cell radius supported by 2-RACH payload should be studied.
- Obs.4: The collision of 2-step RACH should be evaluated and solved.
- Obs.5: Spreading can mitigate the collision of payload in Msg1 of 2-step RACH.
- Proposal: The non-orthogonal access scheme should be considered in the 2-step RACH evaluation.

Decision: The document is noted.

Conclusion of Monday session: Continue offline discussion until Wednesday – (Mediatek, Huawei, (ZTE)

Possible agreements:

- 2-step RACH should be supported for NR to achieve latency requirement
- 2-step RACH should be supported at least for small cell scenario

Tuesday session

[R1-1701275](#) WF on 2-step RACH ZTE, ZTE microelectronics, MediaTek

The document was presented by Shupeng Li from ZTE.

- 2-step RACH can reduce latency and signaling overhead
- Considering the potentials 2-step RACH could achieve, further study is needed, specifically for the following details
 - Use scenarios
 - Cell size, asynchronized and/or synchronized cases
 - Operation frequency
 - eMBB, mMTC, URLLC,...
 - Basic channel structure
 - Preamble

- Preamble + payload
- Payload only
- Note: The payload content is FFS
- Channel design for payload needs to consider collision issue
 - Suitable MCSs
 - w or w/o spreading
 - DMRS design
- Resource configuration and mapping between preamble and payload
- Mechanism to fall back to 4-step RACH
- FFS: Forward compatibility of 2-step RACH to be considered during Rel-14 study

Decision: The document is noted.

Conclusion:

- For RAN1 point of view, further study is needed for 2-step RACH
- RAN1 has no plan to spend 2-step RACH in Rel-14 SI timeframe

Not treated.

R1-1700035	Further consideration on two-step RACH	Huawei, HiSilicon
R1-1700186	Further considerations on a 2-step RA procedure	CATT
R1-1700300	NR Two-step random access procedure	Ericsson
R1-1700311	2-Step RA Procedure for NR	AT&T
R1-1700426	Discussion on 2-step RA procedure issues	ITRI
R1-1700464	Discussion on 2 step RACH	LG Electronics
R1-1700577	On 2-step RA procedure for NR	ETRI
R1-1700587	Design considerations for 2-step RACH	HTC Corporation
R1-1700652	On 2-step Random Access Procedure	Nokia, Alcatel-Lucent Shanghai Bell
R1-1700668	Discussions on 2 Steps RACH Procedure	Sony
R1-1700703	2-step random access procedure	INTERDIGITAL COMMUNICATIONS
R1-1700880	Physical channel design for 2-step RACH	Motorola Mobility
R1-1700892	NR 2-step random access procedure	Samsung

5.1.1.5 Mobility procedure

Focus on measurements

[R1-1701393](#) **WF on DL RS for RRM measurement** Huawei, HiSilicon, Intel, ZTE, ATT, Qualcomm, Ericsson, MediaTek, LG, NTT DOCOMO

- The following always-on signals are used for RRM measurement for L3 mobility in IDLE mode:
 - NR synchronization signal, or
 - NR synchronization signal, and additional DM-RS for PBCH if DM-RS is supported for PBCH, or
 - Note: How to use DM-RS for RRM measurement is up to UE implementation
 - DM-RS for PBCH if DM-RS is supported for PBCH
- For CONNECTED mode RRM measurement for L3 mobility, the following RS can be used if needed, in addition to IDLE mode RS:
 - FFS: CSI-RS,
 - FFS: MRS

Discussion: Samsung → would like that common RS is used for IDLE and CONNECTED (as shown in [R1-1700894](#))

OK if adding a note that possibility of multiplexing RS is not precluded.

Decision: The document is noted.

[R1-1700894](#) **Mobility RS, measurements and procedure** Samsung

Decision: The document is noted.

Agreements:

- The following always-on signals are used for RRM measurement for L3 mobility in IDLE mode:
 - NR synchronization signal, or
 - NR synchronization signal, and additional DM-RS for PBCH if DM-RS is supported for PBCH, or
 - Note: How to use DM-RS for RRM measurement is up to UE implementation
 - DM-RS for PBCH if DM-RS is supported for PBCH
 - Note that down selection will be needed if DM-RS for PBCH is supported
- For CONNECTED mode RRM measurement for L3 mobility, the following RS can be used if needed, in addition to IDLE mode RS:
 - FFS: CSI-RS,

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- FFS: RS separately designed from CSI-RS
- Note that possibility of multiplexing of wideband RS in SS block is not precluded

R1-1701497 [DRAFT] LS on NR Mobility Intel, Huawei

Decision: The document is noted and final LS is approved in R1-1701501 by adding RAN1 meeting schedule information and format refinement.

Continue offline discussion – (Samsung, Huawei, LGE)

R1-1701376 WF on Mobility Samsung, NTT DOCOMO

The document was presented by Young-Han Nam from Samsung.

- Both cell-level and beam-level RRM measurement quantities are supported.
- At least for CONNECTED mode, for beam-level measurement quantities, UE uses NR-SS to acquire physical cell ID and at least MRS to measure beam strength.
- MRS is a separately designed RS from NR-SSS, and used at least for beam-level RRM measurement in CONNECTED mode
 - MRS can be transmitted on multiple beams
 - Maximum number of antenna ports for MRS is [8].
 - At least some of MRS mapping/configuration parameters (e.g., number of MRS antenna ports, RE mapping, time locations (periodicity and offset), number of antenna ports, BW, scrambling, etc.) are configured/derived cell-specifically.
- The following aspects need to be further studied
 - Use of MRS for time/frequency tracking and estimation of QCL parameters
 - MRS can be turned off.
 - Association of MRS time frequency resources with beam(s)
 - Part of MRS is multiplexed in SS block
 - Whether MRS is a CSI-RS or an RS multiplexed in SS blocks

Decision: The document is noted.

Possible agreements:

- RSRP can be derived from IDLE mode RS
- FFS: Both cell-level and beam-level RSRP are supported
 - FFS how to derive association between cell and beam
- At least for CONNECTED mode, for beam-level measurement quantities, UE uses NR-SS to acquire physical cell ID and at least MRS to measure beam strength.
- MRS is a separately designed RS from NR-SSS, and used at least for beam-level RRM measurement in CONNECTED mode
 - MRS can be transmitted on multiple beams
 - Maximum number of antenna ports for MRS is [8].
 - At least some of MRS mapping/configuration parameters (e.g., number of MRS antenna ports, RE mapping, time locations (periodicity and offset), number of antenna ports, BW, scrambling, etc.) are configured/derived cell-specifically.
- The following aspects need to be further studied
 - Use of MRS for time/frequency tracking and estimation of QCL parameters
 - MRS can be turned off.
 - Association of MRS time frequency resources with beam(s)
 - Part of MRS is multiplexed in SS block
 - Whether MRS is a CSI-RS or an RS multiplexed in SS blocks

Thursday afternoon

R1-1701520 WF on Mobility Samsung

Agreement

- RSRP(s) can be measured from the IDLE mode RS.
 - One RSRP value is measured from the IDLE mode RS per SS block.
 - FFS: UE measures one RSRP value from multiple SS blocks in an SS burst set
 - The measured values are referred to “SS-block-RSRP”
 - It is RAN1’s understanding that “SS-block-RSRP” may correspond to the “beam quality” in RAN2 agreements in multi-beam case, at least in IDLE mode.
- RSRP(s) can be measured from the additional RS for CONNECTED mobility if such additional RS are defined (note that this is not yet agreed in RAN1)
 - FFS: How to derive RSRP value(s) utilizing the antenna ports and resource(s) of the RS
 - FFS: Association of the measured qualities in CONNECTED mode to the “beam quality” in RAN2 agreement in CONNECTED mode

- Note: It is up to RAN2 how to derive cell-level quality from the measured value(s) for L3 mobility

Agreement The additional RS for mobility if defined can be transmitted on multiple beams.

Summary of next steps:

- At least the following aspects need to be further studied for the additional RS for L3 mobility in CONNECTED mode
 - To acquire synchronization for RSRP measurement, consider the following options until RAN1#88:
 - Option 1: UE uses NR-SS
 - Option 2: UE uses the additional RS
 - Option 3: UE uses NR-SS and the additional RS
 - Maximum number of antenna ports
 - Configuration/derivation of mapping/configuration parameters (e.g., number of antenna ports, RE mapping, time locations (periodicity and offset), number of antenna ports, BW, scrambling, etc.)
 - Option 1: Cell-specific
 - Option 2: Non-UE-specific, e.g., beam-specific, or UE-group-specific
 - Option 3: UE-specific
 - Option 4: Combinations of above
 - Use of the RS for fine time/frequency tracking and estimation of QCL parameters
 - The RS can be turned off.
 - Association of time frequency resources with beam(s) if needed
 - The RS can be used for PBCH demodulation
 - Down-selection from MRS-1, MRS-2, MRS-3 and CSI-RS

Aim for downselection at RAN1#88.

R1-1701345 **WF on UL based mobility** **Huawei, HiSilicon, Qualcomm, Sony, Ericsson, Deutsche Telekom, China Unicom, Telefonica**

Also supported by Vodafone

Proposal:

- UL measurement for mobility is supported in NR for UEs at least in RRC Active state, in addition to DL-based mobility

Conclusion: FFS.

Not treated.

R1-1700036	UL based RRM measurement for mobility	Huawei, HiSilicon	
R1-1700106	Idle mode RRM Measurements	ZTE, ZTE Microelectronics	
R1-1700107	Connected mode RRM Measurements	ZTE, ZTE Microelectronics	
R1-1700148	Mobility RS for DL RRM Measurement	MediaTek Inc.	
R1-1700187	NR measurements and mobility management in IDLE and CONNECTED modes		CATT
R1-1700188	Mobility management based on UL Signals	CATT	
R1-1700273	Support beam operation for NR mobility	vivo	
R1-1700289	Discussion on the UL signal transmission in multi-beam cases	Spreadtrum Communications	
R1-1700301	NR Synchronization signals for idle and connected mode mobility	Ericsson	
R1-1700302	Synchronization signal options for active mode mobility RS	Ericsson	
R1-1700312	RRM Measurement for IDLE mode and CONNECTED mode UE	AT&T	
R1-1700334	Considerations for NR mobility	Intel Corporation Huawei, HiSilicon	
R1-1700432	On separating RSs for L3 mobility, L1/L2 mobility and data-related transmission		CMCC
R1-1700451	Discussion on mobility procedure	KT Corp.	
R1-1700465	Discussion on UL based measurement	LG Electronics	
R1-1700466	Discussion on RRM measurement in NR	LG Electronics	
R1-1700537	Mobility procedure and subcell	Panasonic Corporation	
R1-1700615	Discussion on mobility procedure for NR	NTT DOCOMO, INC.	
R1-1700616	Discussion on RS design for NR inter-cell RRM measurement	NTT DOCOMO, INC.	
R1-1700670	UL mobility for NR	Sony	
R1-1700671	Cell quality measurements for DL mobility	Sony	
R1-1700739	UL based mobility design and performance evaluation	Qualcomm Incorporated	
R1-1700793	DL based Mobility measurement consideration	Qualcomm Incorporated	
R1-1700870	Discussion on the MRS design and RRM measurement	Shenzhen Coolpad Technologies	
R1-1700893	Mobility support for RRC Inactive UEs	Samsung	
R1-1701049	Discussion on NR RRM measurements for IDLE and CONNECTED states	China Unicom	
R1-1701062	Considerations on DL and UL mobility in NR	Nokia, Alcatel-Lucent Shanghai Bell	
R1-1700403	Analysis and evaluation on RS configuration for RRM measurement of connected and idle UEs	Huawei,	

HiSilicon

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[R1-1701063](#) DL Signals for Mobility Measurements and mobility schemes in NR Nokia, Alcatel-Lucent Shanghai Bell

5.1.1.6 Other

[R1-1700005](#) On numerology determination during initial access Huawei, HiSilicon
[R1-1700303](#) RACH procedure in non-standalone operation Mitsubishi Electric Co.
[R1-1700404](#) On the size of UE identity Huawei, HiSilicon
[R1-1700701](#) A framework for initial access for NR INTERDIGITAL COMMUNICATIONS
[R1-1701064](#) Cell Identification in NR Nokia, Alcatel-Lucent Shanghai Bell
[R1-1701065](#) On gNB Energy Consumption Nokia, Alcatel-Lucent Shanghai Bell

5.1.2 MIMO

[R1-1701175](#) Multi-antenna requirements for NR Ericsson

5.1.2.1 Multi-antenna scheme

Including codeword-to-layer mapping, closed-loop/open-loop/semi-open-loop MIMO and transmit diversity, NW coordination, advanced receiver, etc.

[R1-1700338](#) Study on the number of codewords for NR Intel Corporation

The document was presented by Alexey Davydov from Intel. Provide study results for the number of CWs focusing on the SU-MIMO and NC-JT scenarios with maximum of two MIMO layers. Based on the performance results it has been observed that two MIMO layers should be supported with single CW.

Decision: The document is noted.

[R1-1700469](#) Discussion on diversity achieving schemes LG Electronics

The document was presented by ... from LGE.

- Proposal 1: Beam/precoder cycling transmission technique based on semi-OL feedback should be considered in NR for both DL and UL,
- Proposal 2: The set of cycling beams/precoders can be narrowed down based on long-term channel information, UE mobility information (e.g., speed, direction, etc.) or gNB indication.
- Proposal 3: For transparent scheme, proper size of time/frequency resource for beam cycling needs to be determined by taking into account diversity gain and impact on DMRS design.
- Proposal 4: Transparent scheme should be considered unless performance gap from non-transparent scheme is not significant.
- Proposal 5: Primary design target of (semi-)OL MIMO is for rank 1 and rank 2 transmissions.

Decision: The document is noted.

[R1-1700797](#) UL MIMO transmission schemes Qualcomm Incorporated

The document was presented by ... from Qualcomm.

- Proposal 1: DFT-S-OFDM based waveform shall be used for single-stream transmission when the UE is link budget limited, for both single-stream only transmission and the rank-1 transmission in a multi-stream transmission with rank-adaption.
- Proposal 2: For uplink spatial multiplexing with rank adaption, a UE can be dynamically indicated with one of CP-OFDM or DFT-S-OFDM waveform for rank-1 transmission.
- Proposal 3: Study OTA UE calibration solutions for non-codebook based UL MIMO transmission at below 6GHz.
- Proposal 4: Adopt STBC as one option of the open-loop transmission scheme for PUSCH with DFT-S-OFDM based waveform.
- Proposal 6: Adopt CDD as one option of the open-loop transmission scheme for PUSCH with DFT-S-OFDM based waveform.
- Proposal 5: NR UL MIMO shall support single antenna port transmission using DFT-S-OFDM based waveform.
- Proposal 7: Frequency selective precoding is not supported for UL MIMO with CP-OFDM waveform when the transmission ports is 2.

Decision: The document is noted.

[R1-1701279](#) Way Forward on number of CWs for NR ZTE, ZTE Microelectronics, ASTRI, AT&T, CATT, Xinwei

The document was presented by Ruyue Li from ZTE.

- At least for DL multi-layer transmission (i.e. number of layers>1), the number of codewords per one scheduled physical data channel in NR can be configurable at least between 1 and 2.
 - Number of codeword and CW-layer mapping should be indicated to UE for PDSCH transmission.
 - Support UE reporting to assist network configuration on the number of codewords and CW-layer mapping per UE.
 - FFS: Other configurability

Decision: The document is noted.

Possible agreements:

- At least for DL multi-layer transmission (i.e. number of layers>2), the number of codewords per one scheduled physical data channel in NR can be configurable at least between 1 and 2.
 - Number of codeword and CW-layer mapping should be indicated to UE for PDSCH transmission.
 - Support UE reporting to assist network configuration on the number of codewords & CW-layer mapping per UE.
 - FFS: Other configurability
 - FFS: Number of layer = 2

R1-1701291 **WF on Number of Codewords for NR** **Samsung, KT Corporation, Ericsson**

The document was presented by Eko Onggosanusi from Samsung.

- NR supports single CW per PDSCH/PUSCH assignment per UE
 - One UL- or DL-related DCI includes one MCS and one HARQ-related (NDI and RV) fields
 - One CQI calculated for all layers regardless of RI value
- The number of PDSCH/PUSCH assignments a UE can receive in a scheduling time unit (slot) is a UE capability
 - E.g. for NC-JT use case

Decision: The document is noted.

Possible agreements:

- NR supports single CW per PDSCH/PUSCH assignment per UE for 1 and 2 layers
 - One UL- or DL-related DCI includes one HARQ-related (NDI and RV) fields
 - FFS: the number of CQIs
 - FFS: 3 and more layers
- The number of PDSCH/PUSCH assignments a UE can receive in a scheduling time unit (slot) is a UE capability
 - E.g. for NC-JT use case

R1-1701311 **WF on DL transmission scheme** **Samsung, Intel, LGE**

- For NR, remove the misleading association between Scheme 1/2 and ‘closed-loop’/‘open-loop’/‘semi-open-loop’ and simplify the description as follows:
 - Transmission scheme 1 (TS 1): data and DMRS are transmitted with the same precoding matrix
 - Demodulation of data at the UE does not require knowledge of the precoding matrix used at the transmitter
 - Transmission scheme 2 (TS 2): diversity-based scheme where data and DMRS may or may not be restricted to be transmitted with the same precoding matrix
 - Demodulation of data at the UE may or may not require knowledge of the relation between DMRS ports and data layers
- For Transmission scheme 2, down selection(s) on DMRS based transmission schemes will be done in RAN1#88
 - For rank 1,
 - Precoder cycling with transparent DMRS
 - Small-delay CDD with transparent DMRS
 - DMRS based SFBC with non-transparent DMRS
 - For rank>1,
 - Precoder cycling with transparent DMRS
 - Layer shifting may or may not be applied
 - Small-delay CDD with transparent DMRS
 - Large-delay CDD with non-transparent DMRS

Decision: The document is noted.

Agreements:

- For Transmission scheme 2, down selection(s) on DMRS based transmission schemes will be done in RAN1#88 at least for rank 1
 - For rank 1,
 - Precoder cycling with transparent DMRS
 - Precoder cycling with non-transparent DMRS
 - Small-delay CDD with transparent DMRS
 - DMRS based SFBC
 - For rank>1,
 - Precoder cycling with transparent DMRS
 - Precoder cycling with non-transparent DMRS
 - Layer shifting
 - Precoder cycling with transparent DMRS and layer shifting

- Small-delay CDD with transparent DMRS
- Large-delay CDD with non-transparent DMRS

R1-1701312 **WF on PRB bundling** **Samsung, ZTE, ZTE Microelectronics**

- For NR, support configurable PRG Size for DMRS
 - Down selection(s) will be done in RAN1#88 with the following:
 - Specified value which is system BW dependent
 - Specified value which is UE dependent
 - Contiguous scheduled PRBs to UE when at least X contiguous PRBs are allocated to the UE where X FFS
 - Semi-statically configured contiguous PRBs that correspond to the UE-specific RF BW
 - Dynamic selection of semi-statically configured PRBs
 - One PRB
- For DMRS channel estimation, study continuous precoding in time domain with the following:
 - Semi-static measurement window
 - Dynamic indication of precoding sets
 - Support of continuous precoding when eNB supports slot aggregation
- Study multiplexing of DMRS ports using time domain OCC within aggregated slots

Decision: The document is noted. Continue offline discussion.

R1-1701323 **WF on PRB bundling** **Samsung, ZTE, ZTE Microelectronics**

Agreements:

- For the DL, NR supports configurable PRG size for data DMRS
 - FFS: Signaling for the configuration of PRG size (semi-static or dynamic)
 - FFS: available options/schemes.
- FFS: continuous precoding in time domain for DMRS channel estimation with the following examples:
 - Semi-static measurement window
 - Dynamic indication of precoding sets
 - Support of continuous precoding when gNB supports slot aggregation
 - Contiguous time allocations
- FFS: multiplexing of DMRS ports using time domain OCC between aggregated slots
 - Note: Consider impact of DMRS pattern
 - Note: Other code is not precluded.

Thursday session

R1-1701398 **WF on UL MIMO transmission** **Huawei, HiSilicon, Intel**

Agreements:

- Support at least the following UL transmission schemes for data in NR
 - Scheme A: Codebook based UL transmission
 - Support frequency selective precoding for CP-OFDM when the number of transmission port is greater than X (FFS: Value of X).
 - Study codebook design including single-stage and multi-stage, e.g., W1W2 structure, codebook
 - Study the following DL signaling, e.g.,
 - One level DCI
 - Two level DCI
 - MAC CE
 - DCI associated with PDSCH (like UCI associated with PUSCH in LTE)
 - Scheme B: Non-codebook based UL transmission
 - Support frequency selective precoding for CP-OFDM when the number of transmission port is greater than Y (FFS: Value of Y).
 - Support the indication of DL measurement RS for UE to calculate candidate precoder
 - Study the mechanisms for UL precoder determination, e.g. precoded SRS based, non-precoded SRS based, hybrid precoded and non-precoded SRS based
 - Diversity-based transmission schemes
 - FFS: Whether the scheme has specification impact or not
 - FFS: Merging of the schemes
- Support rank determination by gNB
- Support PRB bundling for CP-OFDM
 - Study configurability of PRG size for CP-OFDM
 - Study the PRG size

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R1-1701553

- FFS: Single port transmission is supported for the UE capable for multiple antenna port transmission.

R1-1701333 WF on Number of Codewords for NR Samsung, Ericsson, Intel Corporation, Qualcomm, Nokia, Alcatel-Lucent Shanghai Bell, CATT, KT Corporation, Verizon, Softbank Corp

The document was presented by Eko Onggosanusi from Samsung.

- NR supports single CW per PDSCH/PUSCH assignment per UE for 1 and 2 layers
 - One UL- or DL-related DCI includes one HARQ-related (NDI and RV) fields
 - FFS: the number of CQIs and MCS fields in DCI
 - FFS: number of CWs for 3 and more layers

Discussion: Above proposal (so-called alt.1) is also supported by InterDigital, LGE, ETRI, NTT DOCOMO.

- Alt 2: NR supports configurability regarding the number of CWs for 1 and 2 layers
 - Supported by Huawei, HiSilicon, Xinwei, ZTE, ZTE Microelectronics, AT&T, ASTRI, NI
- Alt 3: NR supports 2 CWs for 2 layers
 - Supported by Huawei, HiSilicon

Decision: The document is noted.

Agreements:

- RAN1 will down select among the followings and select one alternative in the next meeting
 - Alt. 1: NR supports single CW per PDSCH/PUSCH assignment per UE for 1 and 2 layers
 - One UL- or DL-related DCI includes one HARQ-related (NDI and RV) fields
 - FFS: the number of CQIs and MCS fields in DCI
 - FFS: number of CWs for 3 and more layers
 - Alt. 2: NR supports configurability regarding the number of CWs for 1 and 2 layers
 - Alt. 3: NR supports 2 CWs for 2 layers

R1-1701287 WF on Evaluation Assumptions for Advanced Receivers based on Network Coordination Samsung, Huawei, Intel, ZTE, Orange

Agreements:

- The following additional five antenna array configurations for TRP are encouraged to be evaluated as optional:
 - (M,N,P,Mg,Ng) = (8,8,2,1,1) with 16 CSI-RS ports
 - (M,N,P,Mg,Ng) = (8,4,2,1,1) with 8 CSI-RS ports
 - (M,N,P,Mg,Ng) = (8,2,2,1,1) with 4 CSI-RS ports
 - (M,N,P,Mg,Ng) = (8,1,2,1,1) with 2 CSI-RS ports.
 - (M,N,P,Mg,Ng) = (1,1,2,1,1) with 2 CSI-RS ports.
- Agreed pages 6, 7 by adding “optional” to each row in the yellow color parts

R1-1701380 WF on CW to layer mapping and RE mapping for data channels Qualcomm, Ericsson, Intel, InterDigital

- *For the DL/UL data channels, layer mapping to physical resources is happening across layer first, then across subcarriers and then across OFDM symbols.*
- *For the DL/UL data channels, RAN1 to study the option of introducing a per-OFDM-symbol subcarrier interleaver in the codeword to layer mapping procedure.*

Decision: The document is noted. Continue offline discussion.

Friday

Agreement: For the DL/UL data channels, study whether/how the interleaving is performed in the codeword to layer mapping procedure (e.g., a per-OFDM-symbol subcarrier interleaver in the codeword to layer mapping procedure, etc.)

- This may or may not be connected with coding design

R1-1701457 WF on nonlinear precoding Mitsubishi Electric, Huawei, HiSilicon, InterDigital, NTT DOCOMO, IITH, CeWiT, IITM, Tejas Networks, AT&T

The document was presented by Fumihito Hasegawa from Mitsubishi.

- At least the following schemes are considered for the study
 - nonlinear precoding (NLP) schemes, e.g., Tomlinson-Harashima precoding, vector perturbation
 - hybrid precoding schemes (e.g., semi-dynamic or dynamic switching between linear precoding and NLP)
- Consider the following evaluation assumptions:
 - MU-MIMO DMRS in R1-1700480, multiple access in TR38.802, COMP coherent joint transmission, other evaluation assumptions are not precluded
- Consider the following issues related to performance evaluation

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R1-1701553

- Abstraction methods for SLS, channel estimation error modeling, etc
- Study the impact of the following impairments/implementation aspects on NLP:
 - Channel estimation error, CSI feedback error, SRS reciprocity error, ordering process of users at transmitter, receiver implementation, complexity of implementation of NLP, etc.
- Study spec impact including following:
 - Signaling methods for NLP: indication of filter types, indication of use of linear/nonlinear precoding, etc.
 - DMRS designs for NLP
 - Other studies on spec. impact are not precluded

Discussion: several companies (Mitsubishi Electric, Huawei, ...) would like capturing their analysis of nonlinear precoding in TR 38.802.

Decision: The document is noted. RAN1 recommends to continue discussions about [R1-1701457](#) in the future meeting.

Friday session

[R1-1701397](#) Multi-panel-based UL MIMO Huawei, HiSilicon, Xinwei

Agreements:

- Study whether or not support non-coherent transmission scheme in uplink MIMO transmission to improve the reliability and capacity
 - Study multiple timing advance for one component carrier (example scenario: multiple antenna ports / beams at UE pointing to different directions)
 - Antenna port / beam indication in timing advance commands
 - Multiple timing advance commands for one component carrier
 - Study multiple power control for multiple antenna ports/beams
 - Antenna port / beam indication in power control commands
 - UE reporting of the capability of multiple power control
 - Study whether or not there is spec impact

[R1-1701342](#) WF on Evaluation assumption for NW coordination Huawei

[R1-1701511](#) WF on coordinated Tx scheme Huawei, HiSilicon, Samsung, CATT, LGE, AT&T

Agreements:

- Support NR downlink transmission of same NR-PDSCH data stream(s) from multiple TRPs at least with ideal backhaul, and different NR-PDSCH data streams from multiple TRPs with both ideal and non-ideal backhaul:
 - Note: the case of supporting same NR-PDSCH data stream(s) may or may not have spec impact (to be further studied especially comparing performance/complexity relative to standard-transparent operation)
 - Study how to perform resource scheduling especially with respect to whether to use one or more NR-PDCCH for a UE
 - Consider, e.g., backhaul conditions, UE complexity, feasibility of NR-PDCCH demodulation if from multiple TRPs, NR-PDCCH overhead, performance, etc.
- Study network coordination schemes with ideal & non-ideal backhaul links, considering
 - Fast CSI acquisition
 - e.g. coordinated TRPs obtain CSIs through physical air interface
 - e.g. SRS configuration exchanging between different TRPs
 - Other techniques are not precluded

Not treated.

R1-1700050	Discussion on DMRS-based open loop transmission scheme for DL data channel	Huawei, HiSilicon
R1-1700051	Discussion on transmission parameter sets	Huawei, HiSilicon
R1-1700052	Discussion on network coordination schemes with non-ideal backhaul links in NR	Huawei, HiSilicon
R1-1700053	Non-linear precoding for downlink multiuser MIMO	Huawei, HiSilicon
R1-1700065	Considerations on multi-panel based uplink transmission	Huawei, HiSilicon
R1-1700117	Aspects of DL MIMO Transmission	ZTE, ZTE Microelectronics
R1-1700118	Aspects of UL MIMO Transmission	ZTE, ZTE Microelectronics
R1-1700119	Multi-TRP Transmission considering advanced receiver	ZTE, ZTE Microelectronics
R1-1700120	Discussion on interference issues in NR	ZTE, ZTE Microelectronics
R1-1700215	On codeword-to-layer mapping	CATT
R1-1700216	On DL transmission schemes	CATT
R1-1700217	On non-coherent and coherent MIMO	CATT
R1-1700218	Discussion on network coordination	CATT
R1-1700219	On precoding granularity	CATT

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R1-1700220	On UL transmission schemes	CATT	
R1-1700221	Discussion on UL frequency selective precoding	CATT	
R1-1700313	Flexible Transport Block, Codeword and Layer Mapping Concepts for NR	AT&T	
R1-1700335	On DMRS based DL (open Loop and semi-open Loop) MIMO	Intel Corporation	
R1-1700336	On UL Frequency Selective Precoding	Intel Corporation	
R1-1700337	On Interference Measurement	Intel Corporation	
R1-1700339	On codeword to MIMO layer mapping	Intel Corporation	
R1-1700340	On MIMO layer adaptation	Intel Corporation	
R1-1700407	Analysis on interference estimation for open loop transmission scheme	Huawei, HiSilicon	
R1-1700408	Discussion on UL MIMO transmission	Huawei, HiSilicon	
R1-1700409	Discussion on UL MU-MIMO between CP-OFDM and DFT-s-OFDM	Huawei, HiSilicon	
R1-1700410	Evaluation of DPS-based coordinated transmission scheme	Huawei, HiSilicon	
R1-1700411	Evaluation of non-coherent JT-based coordinated transmission scheme	Huawei, HiSilicon	
R1-1700412	Number of codewords for physical data channel	Huawei, HiSilicon	
R1-1700413	PRB bundling size for DL data precoding	Huawei, HiSilicon	
R1-1700434	Discussion and evaluation on spatial-based and panel-based MU-MIMO transmission schemes	CMCC	
R1-1700467	Discussion on UL-MIMO	LG Electronics	
R1-1700468	Discussion on intra/inter-TRP CoMP	LG Electronics	
R1-1700592	DL MIMO transmission schemes for beam management	NTT DOCOMO, INC.	
R1-1700593	Higher-order MU-MIMO for NR	NTT DOCOMO, INC.	
R1-1700594	Non-linear precoding for NR	NTT DOCOMO, INC.	
R1-1700648	PAPR preserving transmit diversity for DFTsOFDM	Mitsubishi Electric RCE	
R1-1700710	Impact of UE Calibration in a Reciprocity-based UL MIMO Transmission	InterDigital Communications	
R1-1700711	Non-linear Precoding for NR	InterDigital Communications	
R1-1700712	Reciprocity-based UL Beamformed Transmit Diversity	InterDigital Communications	
R1-1700713	On Enhanced Frequency Selective Precoding for MIMO Transmission	InterDigital Communications	
R1-1700740	On codebook based UL MIMO transmission with non-precoded SRS	Ericsson	
R1-1700741	On codebook based UL MIMO transmission with precoded SRS	Ericsson	
R1-1700742	Robust UL Transmission Schemes	Ericsson	
R1-1700743	Robust Transmission Schemes for PDSCH	Ericsson	
R1-1700744	About the number of codewords	Ericsson	
R1-1700745	UL transmission in NR	Ericsson	
R1-1700746	On PDSCH and PUSCH to RE Mapping	Ericsson	
R1-1700747	On PRB bundling for NR	Ericsson	
R1-1700777	Evaluation Results and Considerations on Number of Codewords	Beijing Xinwei Telecom Techn.	
R1-1700778	Evaluation and Discussion on PRB Bundling Size	Beijing Xinwei Telecom Techn.	
R1-1700795	CW to layer mapping	Qualcomm Incorporated	
R1-1700796	DL MIMO transmission schemes	Qualcomm Incorporated	
R1-1700798	Discussion on PRB bundling	Qualcomm Incorporated	
R1-1700799	Network OTA reciprocity calibration and phase synchronization	Qualcomm Incorporated	
R1-1700873	Views on abstraction techniques of nonlinear precoding schemes for SLS	Mitsubishi Electric Co.	
R1-1700876	Performance evaluation of nonlinear precoding schemes with channel estimation	Mitsubishi Electric Co.	
R1-1700877	Views on possible specification impacts of nonlinear precoding schemes	Mitsubishi Electric Co.	
R1-1700895	Transmission schemes, transmission modes and control signaling	Samsung	
R1-1700896	DMRS-based spatial multiplexing for DL NR MIMO	Samsung	
R1-1700897	DMRS-based spatial multiplexing for UL NR MIMO	Samsung	
R1-1700899	DMRS-based precoder cycling and simulation results	Samsung	
R1-1700900	Discussions on open- and semi-open-loop transmissions for NR	Samsung	
R1-1700901	Initial results on network coordination	Samsung	
R1-1700902	Discussions on NR network coordination	Samsung	
R1-1700903	Transmission and reception of coordinated interference cancellation	Samsung	
R1-1700904	Network coordination for coordinated interference cancellation	Samsung	
R1-1700905	Physical layer abstraction method for coordinated interference cancellation	Samsung	
R1-1700906	Evaluation assumption for advanced receivers based on network coordination	Samsung	
R1-1700907	Initial evaluation results for advanced receivers based on network coordination	Samsung	
R1-1701068	Hybrid beamforming and transmit diversity scheme	CEWiT	
R1-1701071	On the number of codewords in NR	Nokia, Alcatel-Lucent Shanghai Bell	
R1-1701072	UE advanced receiver utilization in NR	Nokia, Alcatel-Lucent Shanghai Bell	
R1-1701073	Impact of Antenna Panel Array Structures in UMa 30GHz	Nokia, Alcatel-Lucent Shanghai Bell	
R1-1701074	High-level principles for beam coordination and Link Adaptation in NR	Nokia, Alcatel-Lucent Shanghai Bell	
R1-1701075	Non-coherent Multi-node Transmission for URLLC in the 5G New Radio	Nokia, Alcatel-Lucent	
R1-1701076	Decoupled control and data transmission for NR	Nokia, Alcatel-Lucent Shanghai Bell	
R1-1701077	On the support of open-loop transmission in NR	Nokia, Alcatel-Lucent Shanghai Bell	

R1-1701078	DL transmission mode configuration for NR	Nokia, Alcatel-Lucent Shanghai Bell
R1-1701079	UL MIMO transmission in NR	Nokia, Alcatel-Lucent Shanghai Bell
R1-1701080	On the support for frequency selective precoding in UL MIMO	Nokia, Alcatel-Lucent Shanghai Bell
R1-1701082	DL SU-MIMO Performance Characteristics in UMa 30GHz	Nokia, Alcatel-Lucent Shanghai Bell
R1-1701083	DL MU-MIMO Performance Characteristics in UMa 30GHz	Nokia, Alcatel-Lucent Shanghai Bell
R1-1701084	Network Coordination to support advanced receivers	Nokia, Alcatel-Lucent Shanghai Bell
R1-1701085	Interference Aware Inter Cell Rank Coordination	Nokia, Alcatel-Lucent Shanghai Bell
R1-1701086	Nonlinear Precoding for Interference Mitigation in HetNets	Nokia, Alcatel-Lucent Shanghai Bell
R1-1701087	On MU MIMO non-linear precoding in NR	Nokia, Alcatel-Lucent Shanghai Bell
R1-1701201	Codeword-to-layer mapping for DL and UL NR MIMO	Samsung
R1-1701483	Performance Results for COMP Coherent JT Performance with THP (Cloud RAN)	IITH, IITM, CEWIT, Tejas Networks

5.1.2.2 Beam management and CSI acquisition

Including UE reporting

Note that only the linear combination based CSI feedback is continued to study including the contents (e.g., channel covariance matrix) to be represented by the linear combination codebook will be studied for type II (enhanced) CSI feedback

[R1-1700748](#) On robust beam management Ericsson

The document was presented by Stephen Grant from Ericsson.

- Observation 1: Using multiple beam-pair links can improve the robustness in beam-based systems
- Observation 2: There is a need to handle BPL failure in a quick and efficient way to maintain high and reliable performance for the users.
- Proposal 1: An active beam pair link is supported for which the UE is monitoring PDCCH
- Proposal 2: One or more monitored beam-pair links is supported to improve the robustness and to discover new links
- Proposal 3: Support configurable PDCCH reception on monitored BPLs as a mean for increase robustness against BPL blocking.

Decision: The document is noted.

[R1-1700803](#) Beam recovery procedures Qualcomm Incorporated

The document was presented by Muhammad Islam from Qualcomm.

- Proposal 1: NR supports scheduling request and beam recovery request region in RACH slot in multi-beam scenario.
- Proposal 2: NR supports higher number of cyclic shifts in each SR/beam recovery request subcarrier region compared to the number of cyclic shifts in RACH subcarrier region. NR decides this number based on the duration of SR/beam recovery request preamble and expected delay spread of the cell.
- Proposal 3: NR supports gNB allotting dedicated SR or beam recovery request resources to UEs.
- Proposal 4: NR shall support beam recovery request and scheduling request when gNB and UE are UL synchronized and gNB and UE are UL out-of-sync.
- Proposal 5: NR shall support beam recovery request and scheduling request through the beam recovery request and scheduling request regions when gNB and UEs are UL synchronized.
- Proposal 6: If beam correspondence is available at gNB, NR supports UE mapping a good DL SYNC resource to the symbol index of scheduling request or beam recovery request in RACH slot.
- Proposal 7: If beam correspondence is not available at gNB, NR supports UE conveying its best DL TX beam ID through a combination of the selected subcarrier region and the cyclic shift of scheduling request/beam recovery request preamble.
- Proposal 8: NR shall support beam recovery request and scheduling request using contention-based RACH when gNB and UE are UL out-of-sync.

Decision: The document is noted.

[R1-1700128](#) On RS and CSI report settings ZTE, ZTE Microelectronics

The document was presented by Ruyue Li from ZTE.

- Proposal 1: To support efficient resource sharing among CSI-RS resources for interference and channel measurement, IM settings and RS settings should be merged.
- Proposal 2: Configuration of CSI report resource pooling should be contained in CSI settings.
- Proposal 3: NR should support flexible CSI report resource indication based on CSI report resource pooling.
- Proposal 4: CSR configuration should be contained in CSI settings.
- Proposal 5: CSR should be used to support flexible codebook configuration in NR.

Decision: The document is noted.

[R1-1700919](#) Discussions on periodic and semi-persistent CSI reporting for NR Samsung

The document was presented by ... from Samsung.

- Support only Type I feedback for P-CSI in NR

- Support both Type I and Type II feedback for S-CSI in NR
- P-CSI and S-CSI procedure for NR should be designed by considering following proposals:
 - Support level-2 CSI-RS transmission with relatively low CSI-RS overhead for P-CSI
 - Support both level-1 and level-2 CSI-RS transmission for S-CSI.
 - When CSI-RS transmission is not available, CSI reporting based on other RS needs to be considered.
 - Consider only wideband/partial band CQI feedback with no PMI/single PMI.
 - Excessive inter-subframe dependency should be avoided.
- For the activation and deactivation of S-CSI, MAC CE signalling should be supported.
- For the configuration of P-CSI, configuration of CSI reporting setting, RS setting and measurement setting via higher layer signalling should be supported.
- For the configuration of S-CSI, dynamic signalling of measurement setting should be supported.
 - Configuration of CSI reporting setting, RS setting via higher layer should be supported.

Decision: The document is noted.

R1-1700414 Design for Type I Feedback Huawei, HiSilicon

The document was presented by Min Zhang from Huawei.

- Proposal 1: A dual-stage W_1 W_2 codebook-based PMI feedback should be supported in NR, where
 - W_1 consists of a common subset of basis for all subbands
 - W_2 consists of coefficients for each subband
- Proposal 2: A set of basis are generated based on configurations, which includes
 - Antenna configuration, i.e. N1, N2
 - Oversampling parameter configuration, i.e. O
- Proposal 3: The wideband W_1 codebook-based feedback with orthogonal constraints constitutes
 - Index for optimal orthogonal basis
 - Indices for selected columns in the optimal orthogonal basis
- Proposal 4: The wideband W_1 codebook-based feedback with orthogonal constraints should be supported as baseline, and W_1 based feedback without orthogonal constraints can be further studied.
- Proposal 5: Subband W_2 codebook calculation based on an orthogonal basis should be studied in NR MIMO.
- Proposal 6: If the selected W_1 consists of non-orthogonal basis, orthogonalization method of the non-orthogonal W_1 should be studied.
- Proposal 7: Rank $k > 1$ W_1 codebook design should be studied in order to reduce the overall feedback overhead in NR.
- Proposal 8: The subband W_2 codebook-based feedback constitutes
 - Amplitude information of the beam coefficients
 - Phase information of the beam coefficients

Decision: The document is noted.

R1-1700342 CSI for Type II feedback Intel Corporation

The document was presented by ... from Intel.

- Consider orthogonal DFT basis for channel covariance matrix compression.
 - UE feeds back the best M orthogonal DFT basis vectors along with corresponding covariance matrix entities

Decision: The document is noted.

Continue offline discussion about the followings

- Beam recovery/Link failure related issues until Tuesday – Qualcomm (Sundar)/Huawei/Intel
- Robust transmission including Beam management for control channel until Tuesday – DOCOMO/Intel (Wookbong)
- CSI feedback until Wednesday
 - Type I – Huawei (Min)/ZTE/CATT
 - Type II – Ericsson (Mark)
 - CSI framework – Samsung (Eko)/AT&T/DOCOMO/Xinwei/CMCC
- Interference measurement until Wednesday – LG/Nokia (Dan)
- UL beam management until Wednesday – MTK (Brianz)
- Beam management until Wednesday
 - Beam indication procedure - Samsung (Boon)/ZTE
 - Beam correspondence – Samsung/MTK/CMCC/DOCOMO (Osawa)
 - Beam reporting – Samsung/ZTE (Ruyue)
- UL CSI acquisition until Wednesday – LG (Jonghyun)
- Reciprocity based CSI acquisition – Huawei (Leiming)

Tuesday session

Possible agreements:

- Network triggered beam reporting and UE triggered link recovery should be supported
- Network explicitly configures to UE with resources for UL/[DL] transmission of signals for recovery purpose
 - FFS: Triggering condition of recovery signal
 - Support configurations of resources in the regions where the base station [or UE] can listen from all or partial directions, e.g., random access region
- For the UE triggered link recovery, the message from the UE to gNB is:
 - FFS: Preferably non contention based for time SYNCed UEs. For UEs not SYNCed, contention based approach is preferable
 - Message from UE to gNB should be received in a region where the base station can listen from all or partial directions, e.g. beam sweep
 - Link recovery mechanism(s) should consider tradeoff between performance and RS overhead
- Support transmission of some RS and/or control channel and/or data channel, (e.g. periodic CSI-RS signals which are beam swept. NR-SSS) on DL/UL for allowing the UE/gNB to monitor the beams
- Note that link recovery is used in the situation where the all the agreed links between gNB and UE are unavailable or broken

Continue offline discussion until Wednesday.

Thursday

R1-1701481

WF on Beam Recovery in multi-beam NR systems Qualcomm, Nokia, ASB, Xinwei, Intel,

Interdigital

Also supported by LG, Ericsson, OPPO

Possible agreements:

- UE triggered beam recovery should be supported
 - FFS: Network triggered beam recovery
- Network explicitly configures to UE with resources for UL transmission of signals for recovery purpose
 - Support configurations of resources where the base station is listening from all or partial directions, e.g., random access region
- FFS: Triggering condition of recovery signal associated UE behavior of monitoring RS/control channel/data channel
- Support transmission of DL signal for allowing the UE to monitor the beams for identifying new potential beams
 - FFS: Transmission of a beam swept control channel is not precluded
 - Beam recovery mechanism(s) should consider tradeoff between performance and DL signaling overhead

Friday

Agreements:

- NR supports that UE can trigger mechanism to recover from beam failure
- Network explicitly configures to UE with resources for UL transmission of signals for recovery purpose
 - Support configurations of resources where the base station is listening from all or partial directions, e.g., random access region
- FFS: Triggering condition of recovery signal (FFS new or existing signals) associated UE behavior of monitoring RS/control channel/data channel
- Support transmission of DL signal for allowing the UE to monitor the beams for identifying new potential beams
 - FFS: Transmission of a beam swept control channel is not precluded
 - This mechanism(s) should consider tradeoff between performance and DL signaling overhead

Possible agreements:

- NR-PDCCH transmission supports robustness against beam pair link blocking
 - UE can be configured to monitor NR-PDCCH on different beam pair link(s) with different time resources
 - FFS: UE may be configured to monitor NR-PDCCH on different beam pair link(s) in different OFDM symbols in the same or different slot
 - UE can be configured to monitor NR-PDCCH on M beam pair links simultaneously, where
 - [M = 1 or 2, or M ≥ 1]. Maximum value of M may depend at least on UE capability.
 - [FFS: other values M]
 - [FFS: UE may choose one beam out of M for NR-PDCCH reception]
 - [FFS: The definition of monitoring NR-PDCCH on beam pair link(s).]
 - Parameters related to [UE Rx beam setting for] monitoring NR-PDCCH on multiple beam pair links are configured by higher layer signaling [or dynamic signaling] [and/or considered in the search space design]
 - FFS: Required parameters

Continue offline discussion until Wednesday

Agreements (further to offline):

- NR-PDCCH transmission supports robustness against beam pair link blocking
 - UE can be configured to monitor NR-PDCCH on M beam pair links simultaneously, where
 - $M \geq 1$. Maximum value of M may depend at least on UE capability.
 - FFS: UE may choose at least one beam out of M for NR-PDCCH reception
 - UE can be configured to monitor NR-PDCCH on different beam pair link(s) in different NR-PDCCH OFDM symbols
 - FFS: NR-PDCCH on one beam pair link is monitored with shorter duty cycle than other beam pair link(s).
 - FFS: time granularity of configuration, e.g. slot level configuration, symbol level configuration
 - FFS: Note that this configuration applies to scenario where UE may not have multiple RF chains
 - FFS: The definition of monitoring NR-PDCCH on beam pair link(s).
 - Parameters related to UE Rx beam setting for monitoring NR-PDCCH on multiple beam pair links are configured by higher layer signaling or MAC CE and/or considered in the search space design
 - FFS: Required parameters
 - FFS: Need to support both higher layer signaling and MAC CE

Wednesday session

R1-1701321 WF on beam reporting Samsung, KT

Decision: The document is noted, modified as follows:

Agreements:

- UE measurement based on RS for beam management (at least CSI-RS) composed of K (= total number of configured beams) beams and reporting measurement results of N selected beams:
 - N is not necessarily fixed number
 - FFS: whether/how to configure and/or indicate the values of N
 - Note: The above procedure based on RS for mobility purpose is not precluded.
- Reporting information at least include
 - Measurement quantities for N beam(s)
 - FFS: Detailed reporting contents, e.g., CSI, RSRP or both
 - FFS: How to select N beam(s)
 - FFS: how to identify the subset
 - Information indicating N DL Tx beam(s), if $N < K$
 - FFS: the details on this information, e.g., CSI-RS resource IDs, antenna port index, a combination of antenna port index and a time index, sequence index, etc.

R1-1701324 WF on Type II CSI Codebook Ericsson, Samsung

Decision: The document is noted, modified as follows:

Agreements:

- The following two categories of Type II CSI are considered:
 - Category 1: Precoder feedback
 - Category 2: Covariance matrix feedback
 - Category 3: Hybrid CSI feedback i.e. Type II CSI codebook can be used in conjunction with LTE-Class-B-type-like CSI feedback (e.g. based on port selection/combination codebook)
- For Category 1, study the following candidates.
 - Scheme 1-1:
 - Support dual-stage $W = W1W2$ codebook for Type II codebook for single-panel
 - For W1: orthogonal basis based on, e.g. DFT beams
 - Freely select $L \in \{2,3,4, [6,8]\}$ beams out of the group (L is configurable)
 - FFS: down selection of L
 - Beam selection is wideband
 - For W2: L beams are combined in W2 independently per layer with common W1
 - Subband reporting of phase quantization
 - FFS: alphabet size for phase quantization
 - Beam amplitude scaling can be wideband or subband reporting
 - With subband reporting, independent amplitude on different polarizations and layers
 - FFS: different wideband amplitude on different polarizations and/or layers
 - FFS: either configurability or down selection between wideband or subband
 - FFS: the number of bits for quantization
 - $B = [b_{k_1^{(0)}, k_2^{(0)}}, \dots, b_{k_1^{(L-1)}, k_2^{(L-1)}}]; B^H B = I;$

- $P_{r,l} = L \times L$ diagonal matrix with diagonal elements in [0,1] which correspond to amplitudes of L coefficients for polarization r and layer l
 - $c_{r,i} = [c_{r,i,0}, \dots, c_{r,i,L-1}]^T$, phase combining coefficients
 - For rank 1: $W = \begin{bmatrix} \tilde{w}_{0,0} \\ \tilde{w}_{1,1} \end{bmatrix} = W_1 W_2$,
 - For rank 2: $W = \begin{bmatrix} \tilde{w}_{0,0} & \tilde{w}_{0,1} \\ \tilde{w}_{1,0} & \tilde{w}_{1,1} \end{bmatrix} = W_1 W_2$
 - $\tilde{w}_{r,i} = B P_{r,l} c_{r,i} = \sum_{k_1=0}^{L-1} b_{k_1^{(0)} k_2^{(0)}} \cdot p_{r,i,i} \cdot c_{r,i,i}; r = 0,1, l = 0,1$
 - b_{k_1, k_2} is a 2D DFT beam where
 - $k_1 = O_1 n_1 + q_1, n_1 = 0,1, \dots, N_1 - 1, q_1 = 0,1, \dots, O_1 - 1$
 - $k_2 = O_2 n_2 + q_2, n_2 = 0,1, \dots, N_2 - 1, q_2 = 0,1, \dots, O_2 - 1$
 - $2N_1 N_2$ corresponds to the number of CSI-RS ports
 - $0 \leq p_{r,i,i} \leq 1$ beam amplitude scaling factor for beam i and on polarization r and layer l (diagonal elements of P)
 - FFS if $p_{r,i,i} = p_{r,2,i}$ (common amplitude on layers), or $p_{0,i,i} = p_{1,i,i}$ (common amplitude on polarization)
 - $c_{r,i,i}$ beam combining coefficient (phase) for beam i and on polarization r and layer l

$$c_{r,i,i} = \exp\left(\frac{j2\pi n}{2^N}\right) \forall r, l, i; N \in \{2,3,4\}$$
 - Further refinement on details can be done
- Scheme 1-2: similar to Scheme 1-1 except for
- $P_{r,l} = L \times L$ diagonal matrix with diagonal elements in [0,1] which correspond to amplitudes of L coefficients for port group r and layer l
 - $c_{r,i} = [c_{r,i,0}, \dots, c_{r,i,L-1}]^T$, phase combining coefficients

$$W = \begin{bmatrix} \tilde{w}_{0,0}^0 & \tilde{w}_{0,0}^1 & \tilde{w}_{0,0}^2 & \tilde{w}_{0,0}^3 \\ \tilde{w}_{1,1}^0 & \tilde{w}_{1,1}^1 & \tilde{w}_{1,1}^2 & \tilde{w}_{1,1}^3 \\ \tilde{w}_{2,0}^0 & \tilde{w}_{2,0}^1 & \tilde{w}_{2,0}^2 & \tilde{w}_{2,0}^3 \\ \tilde{w}_{3,0}^0 & \tilde{w}_{3,0}^1 & \tilde{w}_{3,0}^2 & \tilde{w}_{3,0}^3 \end{bmatrix} = W_1 W_2$$
 - For rank 1:
 - $W = \begin{bmatrix} \tilde{w}_{0,0}^0 & \tilde{w}_{0,1}^0 & \tilde{w}_{0,2}^0 & \tilde{w}_{0,3}^0 \\ \tilde{w}_{1,1}^0 & \tilde{w}_{1,1}^1 & \tilde{w}_{1,1}^2 & \tilde{w}_{1,1}^3 \\ \tilde{w}_{2,0}^0 & \tilde{w}_{2,1}^0 & \tilde{w}_{2,1}^1 & \tilde{w}_{2,1}^2 \\ \tilde{w}_{3,0}^0 & \tilde{w}_{3,1}^0 & \tilde{w}_{3,1}^1 & \tilde{w}_{3,1}^2 \end{bmatrix} = W_1 W_2$
 - For rank 2:
 - $\tilde{w}_{r,i} = B P_{r,l} c_{r,i} = \sum_{k_1=0}^{L-1} b_{k_1^{(0)} k_2^{(0)}} \cdot p_{r,i,i} \cdot c_{r,i,i}; r = 0,1,2,3, l = 0,1$
 - b_{k_1, k_2} is a 2D DFT beam where
 - $k_1 = O_1 n_1 + q_1, n_1 = 0,1, \dots, M_1 - 1, q_1 = 0,1, \dots, O_1 - 1$
 - $k_2 = O_2 n_2 + q_2, n_2 = 0,1, \dots, M_2 - 1, q_2 = 0,1, \dots, O_2 - 1$
 - $N_1=2M_1, N_2=M_2$ or $N_1=M_1, N_2=2M_2$
 - $2N_1 N_2$ corresponds to the number of CSI-RS ports
- $0 \leq p_{r,i,i} \leq 1$ beam amplitude scaling factor for beam i and on port group r and layer l (diagonal elements of P)
 - FFS if $p_{r,i,i} = p_{r,2,i}$ (common amplitude on layers), or $p_{0,i,i} = p_{1,i,i} = p_{2,i,i} = p_{3,i,i}$ (common amplitude on port group)
- $c_{r,i,i}$ beam combining coefficient (phase) for beam i and on port group r and layer l

$$c_{r,i,i} = \exp\left(\frac{j2\pi n}{2^N}\right) \forall r, l, i; N \in \{2,3,4\}$$
- Further refinement on details can be done
- Scheme 1-3: similar to Scheme 1-1 except for
- W1 consists of orthogonal DFT beams
 - $W_1 = \begin{bmatrix} B_1 & B_2 \\ B_1 & -B_2 \end{bmatrix} B_i = \begin{bmatrix} b_{k_1^{(0)} k_2^{(0)}}, \dots, b_{k_1^{(L-1)} k_2^{(L-1)}} \end{bmatrix}; B_i^H B_i = I$
 - b_{k_1, k_2} is a 2D DFT beam where
 - $k_1 = O_1 n_1^i + q_1^i, n_1^i = 0,1, \dots, N_1 - 1, q_1^i = 0,1, \dots, O_1 - 1$
 - $k_2 = O_2 n_2^i + q_2^i, n_2^i = 0,1, \dots, N_2 - 1, q_2^i = 0,1, \dots, O_2 - 1$
 - Rotation factors q_1^i, q_2^i common for all beams in B_i

- W2
 - Beams are combined on subband
 - For layer l , $\mathbf{W}^l = \mathbf{W}_1 \mathbf{W}_2^l$, $\mathbf{W}_2^l = [c_{l,0}, \dots, c_{l,2L-1}]^T$, $l = 0, 1, 2, \dots$
 - $c_{l,0} = 1$ and $c_{l,i} = P_i \exp\left(\frac{j2\pi n}{N_i}\right) \forall l, i; N_i, P_i \in \{FFS\}$;
 - Same or different number of quantization bits for N_i or P_i
- Scheme 1-4: similar to Scheme 1-1 except for
 - W1 consists of non-orthogonal DFT beams
 - $\mathbf{W}_1 = \begin{bmatrix} \mathbf{B}_1 & \mathbf{B}_2 \\ \mathbf{B}_2 & -\mathbf{B}_2 \end{bmatrix}$ $\mathbf{B}_i = [b_0^i, \dots, b_{L-1}^i]$;
 - b_j^i is a 2D DFT beam and $b_j^2 = \emptyset b_j^1$, where $\emptyset \in \{FFS\}$ and reported on wideband
 - W2
 - Beams are combined on subband
 - For layer l , $\mathbf{W}^l = \mathbf{W}_1 \mathbf{W}_2^l$, $\mathbf{W}_2^l = [c_{l,0}, \dots, c_{l,2L-1}]^T$, $l = 0, 1, 2, \dots$
 - $c_{l,0} = 1$ and $c_{l,i} = P_i \exp\left(\frac{j2\pi n}{N_i}\right) \forall l, i; N_i, P_i \in \{FFS\}$;
 - Same or different number of quantization bits for N_i or P_i
- Scheme 1-5: similar to Scheme 1-1 except for
 - W1 consists of orthogonal DFT beams selected from configured beam groups
 - W2: L beams are combined in W2 with common W1
 - Coefficients for all layers and beams are designed jointly to achieve inter-layer orthogonality, i.e., for L beams (beam 0 – beam $L-1$), R layers (layer 1 – layer R) and two pols (pol 0 – pol 1)

$$\mathbf{W}_2 = \begin{bmatrix} p_{0,1,0}c_{0,1,0} & \dots & p_{0,R,0}c_{0,R,0} \\ \vdots & \ddots & \vdots \\ p_{1,L-1}c_{1,L-1} & \dots & p_{1,R,L-1}c_{1,R,L-1} \end{bmatrix}, \mathbf{W}_2^H \mathbf{W}_2 = \mathbf{I}$$
- Other candidates are not precluded
- For Category 2, study the following candidates:
 - Scheme 2-1: UE feedbacks the best M orthogonal DFT basis vectors along with corresponding covariance matrix entities
 - UE selects best $\mathbf{u}(\theta_1, \phi_1)$ from the specified NR Type I, and then find the remaining vectors $\mathbf{u}(\theta_i, \phi_i)$ to construct \mathbf{U} matrix accordingly which fulfils $\mathbf{U}^H \mathbf{U} = \mathbf{I}$, $\mathbf{U} = [\mathbf{u}(\theta_1, \phi_1) \mathbf{u}(\theta_2, \phi_2) \dots \mathbf{u}(\theta_M, \phi_M)]$.
 - UE feedbacks best M indices and $\mathbf{A}(\pi(1:M), \pi(1:M))$ values where $\mathbf{A} = \mathbf{U}^H \mathbf{Cov} \mathbf{U}$ and \mathbf{Cov} is wideband covariance matrix.
 - Scheme 2-2: Use the same codebook as Category 1 to quantize $M (\geq 1)$ dominant eigenvectors of the (sample) covariance matrix
 - Other candidates are not precluded
- For Category 3, study the following candidates:
 - W1: Long term CSI W1 can be acquired by the following approaches
 - W1 codebook in Category 1 e.g orthogonal DFT beams selected from configured beam groups
 - Beam selection based on beamformed CSI-RS (e.g. DFT beams based)
 - Channel reciprocity
 - NOTE that RSRP-like report may be used instead of CQI
 - Some restrictions should be considered in Beam/Beam group based feedback
 - E.g. To avoid two or more selected DFT beams corresponding to one path, the direction difference should be sufficient for any two selected beams.
 - Other restriction is not precluded
 - FFS: Criteria for beam selection
 - Both CQI and RSRP-like reporting should be studied.
 - FFS: How to determine the number of reported beams
 - Both Configured by gNB and determined by UE can be considered
 - W2: Full CSI feedback based on beamformed CSI-RS and ports selection/combination codebook (Class-B-like codebook). (NOTE: W1 and W2 are derived from different set of CSI-RS resources)

R1-1701338 **WF on Type I CSI Codebook** **Huawei, HiSilicon**

Decision: The document is noted, modified as follows:

Agreements:

- For Type I for single panel case with two-stage, i.e. W1W2, codebook-based PMI feedback,
 - \mathbf{B}_i in W1 consists of a set of L DFT beams

- For all ranks: FFS value(s) of L
 - FFS: Orthogonal or non-orthogonal beams
 - Select from following alternatives:
- Alt 1: $W_1 = \begin{bmatrix} B_1 & B_2 \\ B_1 & -B_2 \end{bmatrix}$, $B_i = [b_0^i, \dots, b_{L-1}^i]$;
- Alt 2: $W_1 = \begin{bmatrix} B_1 & B_1 \\ B_2 & -B_2 \end{bmatrix}$, $B_i = [b_0^i, \dots, b_{L-1}^i]$;
- Alt 3: $W_1 = \begin{bmatrix} B & 0 \\ 0 & B \end{bmatrix}$, $B = [b_0, \dots, b_{L-1}]$;
- Alt4: $W_1 = \begin{bmatrix} B & & \\ & B & \\ & & B \\ & & & B \end{bmatrix}$, B as Alt 3
- Other alternatives are not precluded
 - Note: the above matrices are constructed with 2D DFT precoders
 - W2 is constructed, by down-selecting from following alternatives:
 - Alt 1: co-phasing only; beam selected wideband (in W1).
 - Alt 2: basis combination coefficient based on L basis based W1
 - Alt 3: beam selection and co-phasing from L-beam based W1
 - Alt 4: LTE-Class-B-type-like CSI feedback (e.g. based on port selection/combination codebook) (NOTE: W1 and W2 are derived from different set of CSI-RS resources)
 - Other alternatives are not precluded

R1-1701299 WF on unified framework for beam management and CSI acquisition LG Electronics, AT&T, CATT, Ericsson, NTT DOCOMO

- NR supports the previously agreed CSI framework for the purposes of both CSI acquisition and beam management.

Decision: The document is noted.

Possible agreements:

- NR supports the previously agreed CSI framework including RS, measurement, reporting settings for the purposes of both CSI acquisition and beam management
 - FFS on necessary different aspects for beam management

Continue offline discussion until Wednesday

Thursday

R1-1701480 WF on DL beam management framework LG Electronics, AT&T, CATT, Ericsson, NTT DOCOMO

Possible agreements:

- DL beam management is at least supported by the agreed framework (i.e., $N \geq 1$ Reporting settings, $M \geq 1$ Resource settings, and 1 Measurement setting, where the Measurement setting includes $L \geq 1$ links)
 - Reporting setting supports beam reporting for DL beam management, including at least: Configuration for reporting CSI-RS resource selection and quality-related metric
 - Details FFS
 - P-1 and P-2 can be supported with configuring Reporting/Resource/Measurement settings.
 - P-3 can be supported at least with configuring Resource setting.
 - FFS on RSs used for resource setting

Friday

R1-1701546 WF on framework for DL beam mangement LG Electronics, Ericsson, NTT DOCOMO

- Strive for applying agreed CSI framework (i.e., resource, measurement, and reporting settings) for the purpose of DL beam management.
 - FFS: Whether or not any setting(s) need to be designed separately.
 - FFS: Content of each setting
 - FFS: Configuration of each setting
 - FFS: Link between settings
 - Note: It does not imply same setting has to be configured for CSI acquisition and beam management.
 - Note: Introduction of new setting(s) is not precluded.
 - Note: P-1 and P-2 can be supported with configuring reporting, resource, and measurement settings.
 - Note: P-3 can be supported at least with configuring resource setting.

Decision: The document is noted.

R1-1701292 WF on CSI Framework for NR Samsung, Ericsson, LG Electronics, NTT DOCOMO, ZTE, ZTE Microelectronics, KT Corporation, Huawei, HiSilicon, Intel Corporation

- Refine the agreement on RS and IM settings as follows:

- “RS setting” is renamed as “Resource setting”, comprising configuration for signal for channel and/or interference measurement
- Remove “IM setting”
- Terminology clarification
 - A UE can be configured with $N \geq 1$ CSI reporting settings, $M \geq 1$ Resource settings, and 1 CSI measurement setting, where the CSI measurement setting includes $L \geq 1$ links
 - Each of the L links corresponds to a CSI reporting setting and a Resource setting
- At least the following configuration parameters are signaled via RRC at least for CSI acquisition:
 - N , M , and L – indicated either implicitly or explicitly
 - In each CSI reporting setting, at least: reported CSI parameter(s), CSI Type (I or II) if reported, codebook configuration including codebook subset restriction, time-domain behavior, frequency granularity for CQI and PMI, measurement restriction configurations for desired signal measurements and interference measurements
 - In each Resource setting:
 - A configuration of $S \geq 1$ CSI-RS resource set(s)
 - Note: each set corresponds to different selections from a “pool” of all configured CSI-RS resources to the UE
 - A configuration of $K_s \geq 1$ CSI-RS resources for each set s , including at least: mapping to REs, the number of ports, time-domain behavior, RS frequency span, RS power, mapping to OFDM symbol in a slot
 - In each of the L links in CSI measurement setting: CSI reporting setting indication, Resource setting indication, quantity to be measured (either channel or interference)
 - One CSI reporting setting can be linked with one or multiple Resource settings
 - Multiple CSI reporting settings can be linked with the same Resource setting
- At least the following are dynamically selected by L1 or L2 signaling
 - One or multiple CSI reporting settings within the CSI measurement setting
 - One or multiple CSI-RS resource sets selected from at least one Resource setting
 - One or multiple CSI-RS resources selected from at least one CSI-RS resource set

Decision: The document is noted.

Agreements:

- Refine the agreement on RS and IM settings as follows:
 - “RS setting” is renamed as “Resource setting”, comprising configuration for signal for channel and/or interference measurement
 - Remove “IM setting”
- Terminology clarification
 - A UE can be configured with $N \geq 1$ CSI reporting settings, $M \geq 1$ Resource settings, and 1 CSI measurement setting, where the CSI measurement setting includes $L \geq 1$ links
 - Each of the L links corresponds to a CSI reporting setting and a Resource setting
- At least the following configuration parameters are signaled via RRC at least for CSI acquisition:
 - N , M , and L – indicated either implicitly or explicitly
 - In each CSI reporting setting, at least: reported CSI parameter(s), CSI Type (I or II) if reported, codebook configuration including codebook subset restriction, time-domain behavior, frequency granularity for CQI and PMI, measurement restriction configurations
 - In each Resource setting:
 - A configuration of $S \geq 1$ CSI-RS resource set(s)
 - Note: each set corresponds to different selections from a “pool” of all configured CSI-RS resources to the UE
 - A configuration of $K_s \geq 1$ CSI-RS resources for each set s , including at least: mapping to REs, the number of ports, time-domain behavior, etc.
 - In each of the L links in CSI measurement setting: CSI reporting setting indication, Resource setting indication, quantity to be measured (either channel or interference)
 - One CSI reporting setting can be linked with one or multiple Resource settings
 - Multiple CSI reporting settings can be linked with the same Resource setting
- At least following are dynamically selected by L1 or L2 signaling, if applicable
 - One or multiple CSI reporting settings within the CSI measurement setting
 - One or multiple CSI-RS resource sets selected from at least one Resource setting
 - One or multiple CSI-RS resources selected from at least one CSI-RS resource set
- FFS until the next meeting about details of dynamic triggering

R1-1701313 WF on Periodic/Semi-Persistent/Aperiodic CSI Reporting NTT DOCOMO, Intel, LGE, Mitsubishi, Sharp, Softbank

Decision: The document is noted. Also supported by InterDigital.

Agreements:

- For periodic CSI-RS,
 - Semi-persistent CSI reporting is activated/deactivated by MAC CE and/or DCI
 - Aperiodic CSI reporting is triggered by DCI
 - FFS: Necessity of additional signaling with MAC CE
- For semi-persistent CSI-RS,
 - Periodic CSI reporting is not supported.
 - Semi-persistent CSI reporting is activated/deactivated by MAC CE and/or DCI
 - Semi-persistent CSI-RS is activated/deactivated by MAC CE and/or DCI
 - FFS: Relationship of signaling between CSI reporting and CSI-RS transmission
 - Aperiodic CSI reporting is triggered by DCI
 - Semi-persistent CSI-RS is activated/deactivated by MAC CE and/or DCI
 - FFS: Necessity of additional signaling with MAC CE
- For aperiodic CSI-RS,
 - Periodic [and semi-persistent] CSI reporting is not supported
 - Aperiodic CSI reporting is triggered by DCI
 - Aperiodic CSI-RS is triggered by DCI and/or MAC CE
 - FFS: Relationship of signaling between CSI reporting and CSI-RS transmission, e.g., common DCI signaling between CSI reporting and CSI-RS transmission
 - FFS: Necessity of additional signaling with MAC CE
- Note that further down selection can be done later between MAC CE and DCI in above bullets
- Note that it is possible to dynamically trigger RS and reports through links in the measurement setting

R1-1701356 WF on timings for aperiodic CSI-RS and aperiodic CSI reporting LG Electronics, Samsung, Ericsson, ZTE, ZTE Microelectronics

Decision: The document is noted.

Agreements:

- NR supports mechanism(s) to trigger aperiodic CSI-RS and aperiodic CSI reporting simultaneously.
 - FFS: signaling details (e.g. single DCI or separate DCI)
 - FFS: method(s) for interference measurement
 - FFS: reference resource of aperiodic CSI reporting
- For aperiodic CSI-RS timing offset X, support X=0 at least, if aperiodic CSI-RS triggering is done by DCI
 - FFS: supporting other values of X
 - Note: 'aperiodic CSI-RS timing offset X' refers to the time gap between aperiodic CSI-RS triggering and aperiodic CSI-RS transmission w.r.t. number of slots.
- For CSI reporting timing offset Y that is fixed or configurable by the network but with certain restriction on lower limit of Y to provide sufficient CSI computation time.
 - Candidate values of Y are fixed or pre-determined by certain rule(s).
 - Rule is FFS (e.g. number of CSI measurement/RS/reporting settings, CSI feedback type, number of ports, nearest CSI-RS transmission timing, UE capability, etc.)
 - Note: 'aperiodic CSI reporting timing offset Y' refers to the time gap between aperiodic CSI reporting triggering and aperiodic CSI reporting w.r.t. number of slots.
 - FFS Y is fixed or configurable
 - FFS configuration is done by DCI and/or MAC CE and/or higher layer signaling

R1-1701317 WF on UL Beam Management MediaTek, LG, InterDigital, vivo, Xinwei, ZTE, ZTE Microelectronics, Intel, ITRI, Huawei, HiSilicon, CMCC, OPPO, Ericsson, DOCOMO

- NR supports NW-controlled UL beam management procedure(s)
- Details of UL beam management procedure(s) are FFS and study should include at least
 - Signal(s) for UL beam management procedure(s)
 - E.g., SRS, PRACH preamble, UL DMRS
 - Additional contents can also be included, e.g., beam reporting
 - Method(s) and content for TRP to indicate selected UE Tx beam and configure UE sweeping
 - Impact of beam correspondence Status
 - E.g., When to use UL beam management mechanism(s) procedure(s)
 - E.g., Procedures such as U-1, U-2, U-3, and beam correspondence based procedure
 - UE capability reporting
 - E.g., capability of analog beamforming
 - Consider the cases when UL and DL are from the same TRP and from different TRPs

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R1-1701553

Discussion: Also supported by Samsung.

Decision: The document is noted. Continue offline.

Working assumption:

- NR supports at least one NW-controlled mechanism for beam management for UL transmission(s)
 - Details are FFS, including at least the following study:
 - Signal(s) for the mechanism(s) if necessary
 - E.g., SRS, PRACH preamble, UL DMRS
 - Additional contents can also be included, e.g., beam reporting
 - Method(s) and content for TRP to indicate selected UE Tx beam and configure UE sweeping
 - Impact of beam correspondence Status
 - E.g., When to use the mechanism(s)
 - E.g., Procedures such as U-1, U-2, U-3, and beam correspondence based procedure
 - UE capability reporting
 - E.g., capability of analog beamforming
 - Consider the cases when UL and DL are from the same TRP and from different TRPs
 - Conditions when the mechanism is particularly useful

R1-1701351 **WF on beam correspondence** **NTT DOCOMO, Samsung, Mitsubishi Electric, MediaTek, Sharp, OPPO, MTI**

Agreement:

- For the definition of beam correspondence:
 - Confirm the previous working assumption of the definition
 - Note: this definition/terminology is for convenience of discussion
 - The detailed performance conditions are up to RAN4

Agreement:

- Support capability indication of UE beam correspondence related information to TRP
 - FFS details including capability definition, case(s) (if any) when the indication is not necessary

R1-1701394 **WF on SRS for UL beam management** **LG Electronics, Intel, MediaTek**

Agreements:

- For NR UL, support transmissions of SRS precoded with same and different UE Tx beams within a time duration
 - Detailed FFS, including the resulting overhead, time duration (e.g., one slot), and configuration, e.g., in the following:
 - Different UE Tx beam: FFS per SRS resource and/or per SRS port
 - Same UE Tx beam across ports: for a given SRS resource and/or a set of SRS resources
 - FFS: The SRS resources can be mapped in TDM/FDM/CDM manner.
 - FFS: overhead reduction schemes such as IFDMA or larger subcarrier spacing
 - FFS gNB can indicate selected SRS port/resource for UE after receiving the SRS.

Thursday session

R1-1701371 **WF on interference measurement method** **Nokia, ASB, Intel, InterDigital, IITL, KT, LG Electronics, Samsung**

Agreements:

- For NR, support at least two types of resources used for interference measurement in CSI configuration based on the following candidates:
 - ZP CSI-RS, NZP CSI-RS, DMRS
 - Including independent or joint usage of any combination of the above three candidates
 - Selection is to be done in RAN1#88

R1-1701286 **WF on CRI reporting** **Samsung, CATT, Ericsson, DOCOMO**

Agreements:

- When a UE is configured with $K > 1$ NZP CSI-RS resources, a UE can report a set of N UE-selected CSI-RS-resource-related indices
 - FFS: The name of the corresponding CSI reporting parameter
 - FFS: Maximum value of N (support of $N=1$ only is not precluded)

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- FFS: What other CSI parameter(s) are reported together with the CSI-RS-resource-related indices, if any, and joint reporting mechanism (in case of multiple reporting parameters)
- FFS: Extension of this feature to other types of Resources

R1-1701499 **WF on Type II Codebook** **Samsung, Ericsson, Huawei, HiSilicon**

Agreements:

- Support at least one scheme taken from Category 1, 2, and/or 3 for Type II CSI
 - Possible down selection can be performed throughout Phase I W1
 - If more than one schemes is supported, these schemes should be complementary
 - This includes further refinement within each category
 - Note: other schemes within each category are not precluded
 - Descriptions for Category 1 and 2 are given in the following slides
 - For the purpose of summary in TR38.802
- Category 1: precoder feedback based on linear combination codebook
 - Dual-stage $W = W1W2$ codebook
 - $W1$ consists of a set of L orthogonal beams, e.g. 2D DFT beams
 - The set of L beams is selected out of a basis, e.g. oversampled 2D DFT beams
 - Beam selection is wideband
 - $W2$: L beams are combined in $W2$ with common $W1$
 - Subband reporting of phase quantization of beam combining coefficients
 - Beam amplitude scaling quantization can be configured for wideband or subband reporting
- Category 2: covariance matrix feedback
 - A quantized/compressed version of covariance matrix is reported by the UE
 - Quantization/compression is based on a set of M orthogonal basis vectors
 - Reporting can include indicators of the M basis vectors along with a set of coefficients
 - FFS: basis set
- Category 3: Hybrid CSI feedback
 - Type II Category 1 or 2 CSI codebook can be used in conjunction with LTE-Class-B-type-like CSI feedback (e.g. based on port selection/combination codebook)
 - The LTE-Class-B-type-like CSI feedback can be based on either Type I or Type II CSI codebook

R1-1701403 **WF on codebook design for DL multi-panel MIMO in NR** **Huawei, HiSilicon, Intel**

Agreements:

- At least Type I CSI feedback should support multi-panel scenarios by choosing one of the two following alternatives:
 - Alt1: only wideband co-phasing factor across panels
 - Alt2: wideband and subband co-phasing factor across panels
- At least the following criteria should be used:
 - Performance-overhead tradeoff
 - Description of design goal, e.g. for channel compensation or hardware impairments
- FFS: How to capture this feature (co-phasing factor across panels) in codebook design
 - Examples: in $W3$ with $W1W2W3$, $W1W3W2$ or $W3W1W2$ structure, $W1W2$ where multi-panel co-phasing is included in either $W1$ or $W2$
 - Other examples are not precluded

R1-1701281 **WF on Hybrid CSI** **ZTE, ZTE Microelectronics, ASTRI, CATR, China Telecom, China Unicom, CMCC, InterDigital, NTT DOCOMO**

Agreements:

- The CSI acquisition framework (including CSI measurement, Resource, and CSI reporting settings) supports configurations that provide CSI similar to Rel.14 eFD-MIMO hybrid CSI mechanisms 1 and 2, e.g.
 - Long-term CSI for a number of antenna ports or multiple NZP CSI-RS resources
 - Short-term CSI for a number of antenna ports with one or more NZP CSI-RS resources
 - The number of ports for long-term and short-term CSIs can be the same or different
- Contents of the CSI report are FFS
- This is achieved without introducing new features into the agreed upon CSI acquisition framework

R1-1701325 **WF on Reciprocity based CSI acquisition** **Huawei, HiSilicon, IITH, CEWIT, IITM, Tejas Networks, Sony, Fujitsu, Softbank, Interdigital, National Instruments**

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Possible agreements:

- Support DL CSI feedback for different degree of channel reciprocity, e.g.,
 - For full channel reciprocity
 - Study explicit interference/channel feedback: e.g., Interference covariance matrix, diagonal elements of interference covariance matrix, CSI of multiple TRPs
 - Study implicit interference feedback: e.g., Interference PMI feedback
 - For partial channel reciprocity, e.g., more Rx ports than Tx ports at UE
 - Study partial CSI feedback for eNB to acquire full CSI
- Support DL CSI-RS and SRS transmission in the same slot for fast CSI acquisition

Friday

R1-1701531 **WF on Reciprocity based CSI Acquisition** **Huawei, HiSilicon, Fujitsu, IITH, CEWIT, IITM, Tejas Networks, Softbank, Xinwei**

Agreements:

- Study the following DL CSI feedback for different degree of channel reciprocity,
 - For full channel reciprocity
 - Explicit interference feedback: e.g., Interference covariance matrix, diagonal elements of interference covariance matrix
 - Implicit interference feedback: e.g., Interference PMI feedback
 - Explicit channel feedback: e.g., CSI of multiple TRPs
 - For partial channel reciprocity (e.g., more Rx ports than Tx ports at UE)
 - Partial CSI feedback for eNB to acquire full CSI
- Study whether or not to support CSI-RS and SRS transmission in the same slot (e.g., for fast CSI acquisition)
 - Study if a limitation on the number of SRS and/or CSI-RS ports due to UE complexity, slot duration of different numerology are needed.

R1-1701400 **WF on UL codebook design in NR** **Huawei, HiSilicon, Samsung**

Possible agreement: For UL, NR supports SRS port selection codebook

R1-1701328 **WF on UL CSI acquisition** **LG Electronics, Huawei, HiSilicon, InterDigital, KT Corporation, Samsung**

Possible agreements:

- For UL CSI acquisition, UE can be configured with multiple SRS resources, where
 - UE can be configured to transmit SRS ports in a configured SRS resource. Adopt at least one of alternative(s) below:
 - Alt.1: UE applies gNB-transparent precoder (e.g., determine Tx beam for each SRS port)
 - Alt.2: UE should apply a precoder according to gNB indication with details FFS (e.g., Tx beam for each SRS port is indicated by gNB)
 - Other schemes are not precluded.
 - gNB can indicate a selected SRS resource for which the UE should transmit UL data on the same antenna ports of the indicated SRS resource.
 - PMI for data transmission (if indicated in the scheduling grant) should also be applied across the antenna ports.

Friday

Agreements:

- For UL CSI acquisition, UE can be configured with multiple SRS resources, where
 - UE can be configured to transmit SRS in each configured SRS resource. Adopt at least one of alternative(s) below:
 - Alt.1: UE applies gNB-transparent Tx beamformer to SRS (e.g., UE determines Tx beam for each SRS port)
 - Alt.2: UE should apply a Tx beamformer to SRS according to gNB indication with details FFS (e.g., Tx beam for each SRS port is indicated by gNB)
 - Alt.3: Other possible scheme (not precluded)

R1-1701503 **Way Forward on Beam Reporting for NR MIMO** **ZTE, ZTE Microelectronics, Ericsson, Intel, MediaTek, Nokia, ASB, Samsung**

Working assumptions:

- Support at least one of these two alternatives of beam reporting:
 - Alt 1: UE reports information about TRP Tx Beam(s) that can be received using selected UE Rx beam set(s).
 - where a Rx beam set refers to a set of UE Rx beams that are used for receiving a DL signal
 - Note: It is UE implementation issues on how to construct the Rx beam set.

- One example: each of Rx beam in a UE Rx beam set corresponds to a selected Rx beam in each panel.
 - For UEs with more than one UE Rx beam sets, the UE can report TRP Tx Beam(s) and an identifier of the associated UE Rx beam set per reported TX beam
 - NOTE: Different TRP Tx beams reported for the same Rx beam set can be received simultaneously at the UE.
 - NOTE: Different TRP TX beams reported for different UE Rx beam set may not be possible to be received simultaneously at the UE
- Alt 2: UE reports information about TRP Tx Beam(s) per UE antenna group basis
 - where UE antenna group refers to receive UE antenna panel or subarray
 - For UEs with more than one UE antenna group, the UE can report TRP Tx Beam(s) and an identifier of the associated UE antenna group per reported TX beam
 - NOTE: Different TX beams reported for different antenna groups can be received simultaneously at the UE.
 - NOTE: Different TX beams reported for the same UE antenna group may not be possible to be received simultaneously at the UE
- FFS: How UE antenna group or Rx beam set is captured in the specification

Friday session

[R1-1701506](#) WF on beam indication Samsung, Ericsson, KT Corp., Verizon, NTT DOCOMO, AT&T, LGE

Agreements:

- For reception of DL control channel, support indication of spatial QCL assumption between an DL RS antenna port(s), and DL RS antenna port(s) for demodulation of DL control channel
 - FFS: signaling method
 - Note: Indication may not be needed for some cases:
- For reception of DL data channel, support indication of spatial QCL assumption between DL RS antenna port(s) and DMRS antenna port(s) of DL data channel
 - FFS: which DL RS(s) to use for this purpose
 - Different set of DMRS antenna port(s) for the DL data channel can be indicated as QCL with different set of RS antenna port(s)
 - Option 1: Information indicating the RS antenna port(s) is indicated via DCI
 - FFS: whether the information indicating the RS antenna port(s) will be assumed only for the scheduled “PDSCH” or until the next indication
 - Option 2: Information indicating the RS antenna port(s) is indicated via MAC-CE, and will be assumed until the next indication
 - Option 3: Information indicating the RS antenna port(s) is indicated via a combination of MAC CE and DCI
 - At least one option is supported
 - FFS: whether to support either or both options
 - FFS: whether the information indicating the RS antenna port(s) for DMRS ports for DL control channel also applies to DMRS ports for DL data channel
 - Note: Indication may not be needed for some cases:

[R1-1701276](#) WF on UE assistant CSI reporting setting selection ATT, ZTE

[R1-1701504](#) WF on beam management for DL control channel and data channel ZTE, ZTE Microelectronics,

ASTRI, Intel

[R1-1701514](#) Way Forward on Evaluation for Beam Management ZTE, ZTE Microelectronics, Ericsson, Nokia,

ASB

Email discussion until the next meeting – Ruyue (ZTE)

Not treated.

R1-1700039	Discussion on downlink beam measurement and UE reporting procedure	Huawei, HiSilicon
R1-1700040	Beam diversity for data and control channels	Huawei, HiSilicon
R1-1700041	Discussion on link recovery procedure for beam blockage	Huawei, HiSilicon
R1-1700042	Enhanced CRI reporting for NR MIMO	Huawei, HiSilicon
R1-1700043	Discussion on beam management aspects for UL MIMO	Huawei, HiSilicon
R1-1700044	Beam management across multiple carriers	Huawei, HiSilicon
R1-1700045	DL beam management with reduced overhead	Huawei, HiSilicon
R1-1700054	CSI measurement and reporting for coordinated transmission schemes	Huawei, HiSilicon
R1-1700055	Consideration on interference measurement for downlink CSI acquisition	Huawei, HiSilicon
R1-1700056	Independent and joint control of CSI-RS transmission and CSI reporting for NR MIMO	Huawei, HiSilicon

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R1-1700057 Considerations on two-level configuration of CSI acquisition settings Huawei, HiSilicon
R1-1700058 Mechanism of shared CSI-RS transmission Huawei, HiSilicon
R1-1700059 Discussion on reciprocity based DL CSI feedback Huawei, HiSilicon
R1-1700060 Discussion on DL CSI feedback for SFBC Huawei, HiSilicon
R1-1700061 Discussion on UL CSI acquisition Huawei, HiSilicon
R1-1700062 UL codebook design in NR Huawei, HiSilicon
R1-1700066 DL Codebook design for multi-panel structured MIMO in NR Huawei, HiSilicon
R1-1700121 High level views on beam management for NR MIMO ZTE, ZTE Microelectronics
R1-1700122 Group based beam management ZTE, ZTE Microelectronics
R1-1700123 Beam related indication for DL and UL beam management ZTE, ZTE Microelectronics
R1-1700124 UE reporting for beam management ZTE, ZTE Microelectronics
R1-1700126 Beamforming procedure considering high frequency channel characteristics ZTE, ZTE Microelectronics
R1-1700127 Discussion on evaluation assumptions for beam management ZTE, ZTE Microelectronics
R1-1700130 Linear combination based CSI feedback design for NR MIMO ZTE, ZTE Microelectronics
R1-1700131 Beam management for DL control channel ZTE, ZTE Microelectronics
R1-1700132 Discussion on beam recovery mechanism ZTE, ZTE Microelectronics
R1-1700143 Channel Reciprocity Based Massive MIMO for FDD ZTE, ZTE Microelectronics
R1-1700145 Linear combination codebook design for multiple panels ZTE, ZTE Microelectronics
R1-1700147 Beam selection and CSI acquisition for NR MIMO ZTE, ZTE Microelectronics
R1-1700163 Considerations on beam correspondence MediaTek Inc.
R1-1700192 Beam management for control and data channel CATT
R1-1700193 QCL between CSI-RS for beam management CATT
R1-1700201 Discussion on beam reporting CATT
R1-1700223 On Type II feedback CATT
R1-1700224 Discussion on CSI reporting CATT
R1-1700225 Discussion on beam recovery CATT
R1-1700226 Consideration on beam reciprocity CATT
R1-1700227 Further discussion beam management CATT
R1-1700274 Discussion on beam management for NR MIMO vivo
R1-1700286 On the explicit feedback for NR Spreadtrum Communications
R1-1700314 Further Evaluation of Component Based NR-MIMO Feedback AT&T
R1-1700320 UE Assisted UCI Format Selection for NR AT&T
R1-1700341 Further discussion on NR Type I codebook design Intel Corporation
R1-1700343 Discussion on codebook for multi-panel support Intel Corporation
R1-1700344 On NR CSI acquisition signaling Intel Corporation
R1-1700345 Further discussion on network initiated beam recovery in NR Intel Corporation
R1-1700346 On Beam State Reporting Intel Corporation
R1-1700348 Reference Signal and Procedure for UL Beam Management Intel Corporation
R1-1700349 On UE initiated beam recovery Intel Corporation
R1-1700396 Discussion on DL Beam Management National Taiwan University
R1-1700405 QCL indication of downlink control channel and beam management reference signals Huawei, HiSilicon
R1-1700415 Design for Type II Feedback Huawei, HiSilicon
R1-1700435 Digital codebook design principle for NR MIMO CMCC
R1-1700436 Discussion on UE triggered beam reporting for beam recovery CMCC
R1-1700470 Discussion on DL and UL beam management procedure LG Electronics
R1-1700471 Discussion on providing robustness for beamformed systems LG Electronics
R1-1700472 On beam relationship between control channel and data channel LG Electronics
R1-1700473 Discussion on CSI timing LG Electronics
R1-1700474 Discussion on interference measurement LG Electronics
R1-1700475 Discussion on CSI feedback LG Electronics
R1-1700476 Discussion on CSI acquisition framework LG Electronics
R1-1700538 Beam management and subcell Panasonic Corporation
R1-1700549 Beam association relationship between data and control channels Guangdong OPPO Mobile Telecom.
R1-1700550 Discussion on Beam Management in NR Guangdong OPPO Mobile Telecom.
R1-1700595 Views on beam recovery for NR NTT DOCOMO, INC.
R1-1700596 CSI Acquisition Schemes for NR NTT DOCOMO, INC.
R1-1700597 CSI Feedback Types for NR MIMO NTT DOCOMO, INC.
R1-1700598 Hybrid beamforming for NR NTT DOCOMO, INC.
R1-1700599 Definition of beam correspondence and beam correspondence determination mechanism NTT DOCOMO, INC.
R1-1700655 Discussion on paging in NR Fujitsu
R1-1700672 Joint DL/UL beam management operation for NR Sony
R1-1700723 Considerations on beam recovery for NR InterDigital Communications
R1-1700749 On UL beam management Ericsson
R1-1700750 On beam grouping Ericsson

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R1-1700751	Type I CSI Feedback	Ericsson
R1-1700752	Type II CSI Feedback	Ericsson
R1-1700753	About interference measurements	Ericsson
R1-1700754	On measurement restriction	Ericsson
R1-1700755	CSI Framework	Ericsson
R1-1700756	CSI reporting configurations	Ericsson
R1-1700757	Lightweight CSI feedback	Ericsson
R1-1700758	On Type I CSI feedback extension to multi-panel operation	Ericsson
R1-1700759	Preliminary simulation results on system performance with 64 ports	Ericsson
R1-1700760	On Supported Codebook Sizes	Ericsson
R1-1700761	On Dynamic Signalling for Aperiodic and Semi-Persistent CSI-RS	Ericsson
R1-1700762	On CSI-RS Pooling and Resource Allocation	Ericsson
R1-1700763	DL beam management overview	Ericsson
R1-1700764	CSI feedback for beam management	Ericsson
R1-1700765	On UE initiated beam recovery	Ericsson
R1-1700779	Further Discussion on CSI Acquisition Settings and Beam Management	Beijing Xinwei Telecom Techn.
R1-1700800	Beam management for NR	Qualcomm Incorporated
R1-1700801	Discussion on CSI acquisition	Qualcomm Incorporated
R1-1700855	On Type I CSI feedback for NR	InterDigital Communications
R1-1700856	On CSI Measurement for NR	InterDigital Communications
R1-1700909	CSI acquisition for UL NR MIMO	Samsung
R1-1700910	Type II CSI reporting for NR	Samsung
R1-1700911	Type I CSI reporting for NR	Samsung
R1-1700912	Codebook design framework for NR MIMO	Samsung
R1-1700913	Simulation results for explicit (Type II) CSI reporting for NR MIMO	Samsung
R1-1700914	UL MIMO codebook	Samsung
R1-1700915	Overview of beam management for > 6GHz	Samsung
R1-1700916	Cell-specific measurements for beam management for > 6GHz	Samsung
R1-1700917	Rx beam mode for beam management	Samsung
R1-1700918	Beam management for control channel	Samsung
R1-1700920	Discussions on aperiodic CSI reporting for NR	Samsung
R1-1700921	Discussions on channel and interference measurements for NR	Samsung
R1-1700922	Discussions on service specific CSI for NR	Samsung
R1-1700923	Discussion on UE initiated beam switching	Samsung
R1-1700924	Discussion on NW initiated beam switching	Samsung
R1-1700925	Discussion on beam correspondence	Samsung
R1-1700926	Discussion on UL beam management	Samsung
R1-1701088	On beam grouping reporting in NR	Nokia, Alcatel-Lucent Shanghai Bell
R1-1701089	Beam management - DCI monitoring	Nokia, Alcatel-Lucent Shanghai Bell
R1-1701090	Beam Measurements and TX/RX Beam Correspondence	Nokia, Alcatel-Lucent Shanghai Bell
R1-1701091	Beam Management – Beam Reporting	Nokia, Alcatel-Lucent Shanghai Bell
R1-1701092	Beam Recovery in NR	Nokia, Alcatel-Lucent Shanghai Bell
R1-1701093	Multi-beam control channel transmission	Nokia, Alcatel-Lucent Shanghai Bell
R1-1701094	Beam Management – Beam Reciprocity Impacts	Nokia, Alcatel-Lucent Shanghai Bell
R1-1701095	On the need for UL beam management	Nokia, Alcatel-Lucent Shanghai Bell
R1-1701096	DRX and Beam Management	Nokia, Alcatel-Lucent Shanghai Bell
R1-1701097	On the impact of number of UE panels	Nokia, Alcatel-Lucent Shanghai Bell
R1-1701098	On type I CSI feedback in NR	Nokia, Alcatel-Lucent Shanghai Bell
R1-1701099	On the CSI timing relationships	Nokia, Alcatel-Lucent Shanghai Bell
R1-1701100	On the channel and interference estimation in NR	Nokia, Alcatel-Lucent Shanghai Bell
R1-1701138	Initial results on number of beams to be maintained	Nokia, Alcatel-Lucent Shanghai Bell
R1-1701188	Beam grouping evaluation for beam management	ZTE, ZTE Microelectronics
R1-1701189	On Type I codebook design for NR MIMO	ZTE, ZTE Microelectronics
R1-1701190	Hybrid CSI feedback for NR MIMO	ZTE, ZTE Microelectronics
R1-1701192	Discussion on DL Beam Management	Intel Corporation
R1-1701194	CSI acquisition for DL NR MIMO	Samsung
R1-1701278	WF on beam recovery in multi-beam NR systems	Qualcomm, Nokia, ASB, Xinwei, Intel
R1-1701280	Way Forward on Beam Reporting for NR MIMO	ZTE, ZTE Microelectronics, ASTRI, Mediatek, Intel, Nokia, ASB
R1-1701295	WF on CSI-RS and Codebook Size for NR	Ericsson, Intel, Samsung, Nokia, ASB, CATT, Kathrein-Werke KG, NTT DOCOMO, AT&T, Verizon Wireless, Sprint, Deutsche Telekom, Xilinx, KT, Orange, Mitsubishi
R1-1701352	WF on code book design for DL multi-panel MIMO	Huawei, HiSilicon

5.1.2.3 Reference signals and QCL

5.1.2.3.1 CSI-RS

Limit to 1 contribution per 1 company/organization/university for beam management and CSI acquisition, independently

R1-1701304 WF on CSI-RS design principle LG Electronics, Xinwei, Intel

- In NR, a UE can be configured with a CSI-RS resource configurations with up to x-port CSI-RS.
 - Supported values of x include 1, 2, 4, 8, 12, 16, 24 and 32.
 - Same QCL between any ports within the same CSI-RS resource
- N port CSI-RS pattern is composed of aggregation of multiple M port CSI-RS patterns (N>M).
 - A CSI-RS RE pattern is defined within a slot
 - A CSI-RS RE pattern can span multiple configurable consecutive OFDM symbols
 - FFS: non-consecutive symbols
 - Value(s) of M will be down-selected among 1, 2 or 4.
- In NR, OCC length of y is supported.
 - Supported values of y include 2, 4
 - FFS on y=8.
 - Details are FFS

Decision: The document is noted. Continue offline.

R1-1701282 WF on beam-related indication for CSI-RS measurement ZTE, ZTE Microelectronics, ASTRI, Xinwei, vivo, Docomo

- QCL is supported for connection between different CSI-RS resources
 - E.g. Two different CSI-RS resources corresponding CSI-RS in P-1 and P-2 respectively. Rx beams for P-2 is determined based on QCL information from P-1.
 - Partial QCL parameters (e.g., only spatial QCL parameter at UE side) should be considered.
- For downlink, NR supports CSI-RS measurement with and without beam-related indication,
 - When beam-related indication is provided, information pertaining to UE-side beamforming/receiving procedure used for CSI-RS-based measurement can be indicated through QCL to UE
 - QCL information includes spatial parameter(s) at UE side of CSI-RS ports
 - FFS: information other than QCL

Decision: The document is noted. Continue offline.

Wednesday: Revised in R1-1701381

Agreements:

- Indication of QCL between the antenna ports of two CSI-RS resources is supported.
 - By default, no QCL should be assumed between antenna ports of two CSI-RS resources.
 - Partial QCL parameters (e.g., only spatial QCL parameter at UE side) should be considered.
- For downlink, NR supports CSI-RS reception with and without beam-related indication,
 - When beam-related indication is provided, information pertaining to UE-side beamforming/receiving procedure used for CSI-RS-based measurement can be indicated through QCL to UE
 - QCL information includes spatial parameter(s) for UE side reception of CSI-RS ports
 - FFS: information other than QCL

R1-1701300 WF on CSI-RS for beam management Intel, Qualcomm, ZTE

- For P-1, study whether the CSI-RS can be multiplexed with other physical channel or signals.
- Support sub-time unit partition with shorter OFDM symbol length
 - Down select from the following options:
 - IFDMA
 - Larger subcarrier spacing
 - FFS: whether the CSI-RS structure should be utilized for P-1/P-2/P-3
 - FFS: whether DMRS can have the same structure for P-3
- Study overhead savings when combining CSI-RS sweeps P-3 with P-1 or P-2 sweeps.
- Study how to support UE with higher beam switch time in those cases

Decision: The document is noted. Continue offline.

Wednesday session

R1-1701402 WF on CSI-RS design principle LG Electronics, Ericsson (revision of R1-1701304)

Agreements:

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- The CSI-RS RE mapping pattern of one N-port CSI-RS resource is composed of one or multiple CSI-RS RE mapping patterns of CSI-RS resources of equal or smaller number of ports, [e.g., 2, 4, or 8]
 - A CSI-RS RE mapping pattern is defined within a slot
 - FFS: A CSI-RS RE mapping pattern can span multiple configurable consecutive/non-consecutive OFDM symbols
 - FFS on mapping of ports to the CSI-RS RE mapping pattern
 - Density per port in terms of RE per port per PRB is configurable supports for density greater than 1 is not precluded

Thursday session

[R1-1701484](#) Way Forward on CSI-RS for Beam Management Intel, Qualcomm, Ericsson, Nokia, Alcatel-Lucent Shanghai Bell, Verizon Wireless, CATT, MTK, NTT Docomo, CMCC, ZTE, ZTE Microelectronics, KT

Possible agreements:

- Support sub-time unit shorter than 1 OFDM symbol in a reference numerology.
 - Support at least one of the following options:
 - IFDMA
 - Larger subcarrier spacing
 - FFS: whether the above structure should be utilized for P-1, P-2 and/or P-3
- Consider overhead savings when combining P-3 with P-1 or P-2 CSI-RS beam sweeps.
- Consider UE beam switch latency.

Friday session

[R1-1701536](#) Way Forward on CSI-RS for Beam Management Intel, Qualcomm, Ericsson, Nokia, Alcatel-Lucent Shanghai Bell, Samsung, Verizon Wireless, CATT, MTK, NTT Docomo, CMCC, ZTE, ZTE Microelectronics, KT, LG, vivo

Agreements:

- Beam management overhead and latency are to be considered during the CSI-RS design for NR beam management, considering the following possible candidate solutions:
 - Opt1. IFDMA
 - Opt2. Larger subcarrier spacing
 - Other solutions are not precluded
 - FFS: whether the above structure should be utilized for P-1 and/or P-2 and/or P-3.
- Other aspects considered during the CSI-RS design for NR beam management include, e.g. CSI-RS multiplexing, UE beam switch latency and UE implementation complexity (e.g. AGC training time), coverage of CSI-RS, etc.
- Note that it does not imply prioritizing different aspects in CSI-RS design

Not treated

R1-1700070	CSI-RS design for CSI acquisition	Huawei, HiSilicon
R1-1700477	Considerations on NR CSI-RS design for beam management	LG Electronics
R1-1700069	CSI-RS design for beam management	Huawei, HiSilicon
R1-1700133	On CSI-RS for CSI acquisition	ZTE, ZTE Microelectronics
R1-1700134	On CSI-RS for beam management	ZTE, ZTE Microelectronics
R1-1700228	Discussion on CSI-RS for CSI	CATT
R1-1700229	Discussion on CSI-RS for beam management	CATT
R1-1700315	Design and Evaluation of CSI-RS for NR MIMO with Mixed Numerology Support	AT&T
R1-1700350	CSI-RS Structure for Beam Management	Intel Corporation
R1-1700351	Further discussion on CSI-RS for NR	Intel Corporation
R1-1700478	Considerations on NR CSI-RS design for CSI acquisition	LG Electronics
R1-1700551	CSI-RS design for NR	Guangdong OPPO Mobile Telecom.
R1-1700559	Discussion of CSI-RS for beam management	Lenovo
R1-1700600	CSI-RS design for NR	NTT DOCOMO, INC.
R1-1700674	Views on CSI-RS design for NR	Sony
R1-1700714	On CSI-RS design for NR	InterDigital Communications
R1-1700766	On CSI-RS design	Ericsson
R1-1700804	Discussion on CSI-RS design	Qualcomm Incorporated
R1-1700927	CSI-RS for beam management	Samsung
R1-1700928	Discussions on CSI-RS design for NR MIMO	Samsung
R1-1701101	On the CSI-RS configurations for NR CSI acquisition	Nokia, Alcatel-Lucent Shanghai Bell
R1-1701102	On CSI-RS Design for DL Beam Management	Nokia, Alcatel-Lucent Shanghai Bell
R1-1701327	WF on CSI-RS design	Huawei

5.1.2.3.2 DMRS

R1-1700479 Summary of [87-28] email discussion on DMRS design for DL data channel LG Electronics

The document was presented by Hyunsoo Ko from LGE.

Decision: The document is noted.

R1-1700480 Summary of [87-29] email discussion on Simulation assumption for NR DMRS LG Electronics

The document was presented by Hyunsoo Ko from LGE.

Discussion: Intel → still an issue (on using the full buffer traffic model from the email discussion) – insisted that the email discussion was concluded with non consensus on traffic model to use for DM-RS demodulation, not properly captured in the summary.

Decision: The document is noted.

R1-1700806 Discussion on DL DMRS design Qualcomm Incorporated

The document was presented by Alexandros Manolakis from Qualcomm.

- Proposal 1: Design a limited set of uniformed DMRS patterns for all scalable numerology options.
- Proposal 2: NR supports configurable DMRS patterns based on some limited set of available patterns.
- Proposal 3: Data and RS frequency domain multiplexing is supported.
- Proposal 4: NR supports comb-based DMRS patterns for the DL data channel where cyclic shifts are used for port multiplexing inside each comb.
- Proposal 5: Patterns with comb offsets (time-domain staggering) should be studied. Further study is also needed in down selecting the number of combs and the comb offsets.
- Proposal 6: In a self-contained slot, NR supports a front-loaded DMRS pattern at symbol indices {3} and {3,4} (starting counting at 1).
- Observation 1: In a self-contained slot, using a 2-symbol DMRS pattern at symbol indices {3,6} can provide additional robustness to mobility, compared to a DMRS pattern in symbol 3, or {3, 4} (starting counting at 1).
- Proposal 7: NR supports a 2-symbol front-loaded DMRS pattern at symbol indices {3,6} (starting counting at 1).
- Proposal 8: In a no-self-contained slot, NR supports a 2-symbol DMRS pattern at symbol indices {3,12} (starting counting at 1).
- Proposal 9: In a no-self-contained slot, NR supports a 4-symbol DMRS pattern at symbols indices {3,6,9,12} or {3,6,10,13} (starting counting at 1). Further study is needed for downselection.
- Proposal 10: DMRS sequence should be resource specific, instead of UE specific.

Decision: The document is noted.

R1-1701103 On the DL DMRS structure for NR physical data channels Nokia, Alcatel-Lucent Shanghai Bell

The document was presented by ... from Nokia.

- Proposal 1: NR DMRS resources should be placed equally in frequency as it would ensure better estimation of channel correlation in frequency and low-complexity channel estimation filter due to uniformity in frequency domain.
- Proposal 2: Any empty resources on the OFDM symbol containing DMRS could be used for data.
- Proposal 3: The basic design criteria for the higher rank design structure should have the multiple DMRS ports on the same symbol at the beginning or as close as possible in the beginning of data symbol transmission for faster processing.
- Proposal 4: Configuring multiple ports for either single user with multiple ports (SU-MIMO) or multiple user with single/multiple ports (MU-MIMO) should use FDM up to number 4 (number of users * number of DMRS ports) and OCC of length 2 + FDM up to number 8 (number of users * number of DMRS ports).
- Proposal 5: For MU-MIMO beyond 8 ports, additional DM-RS symbol(s) composed of FDM4 + OCC of length 2 should be supported.
- Proposal 6: If significant gains are observed with any of the two following alternatives for DMRS patterns in comparison to basic front-loaded DMRS pattern for practical high-speed scenario, then only they should be configured:
 - Front-loaded DMRS + PTRS
 - Front-loaded DMRS + Additional DMRS with a spacing of 7 OFDM symbol
- Proposal 7: Impact of increasing the bundling size for high-speed scenarios should be analyzed and configurable PRB bundling size can be considered for different scenarios.

Decision: The document is noted.

R1-1701209 WF on DMRS NTT DOCOMO, INC.

- The number of DMRS patterns to be supported should be minimized.
 - FFS: The number of DMRS patterns
- Basic DMRS should be located at the front of data channel.
 - Basic DMRS is mapped over 1 or 2 OFDM symbols
- FDM (including comb), CDM (including OCC and Cyclic shift) should be considered in basic DMRS port multiplexing for up to 8-port.
- For higher Doppler frequency support, the additional DMRS should be supported.
 - Candidate set of additional DMRS is 1, 2, and 3 OFDM symbol(s)

- FFS: Pattern details
 - Same pattern proposed in DL DMRS should be introduced in UL DMRS.
- Decision:** The document is noted. Continue offline discussion until Tuesday –(DOCOMO, Huawei)

Tuesday session

Agreements

- For the design of front-loaded DMRS, Alt. 1 is agreed as a working assumption.
 - Alt. 1: Front-loaded DMRS is mapped over 1 or 2 adjacent OFDM symbols.
 - FFS: Further down-selection between 1 and 2, if necessary
 - Companies are encouraged to propose further details
 - Companies are encouraged to provide comparison between Alt. 1 and Alt. 2.
 - Alt. 2: Design in [R1-1700352](#) (Front-loaded DMRS is mapped over 3 or 4 adjacent OFDM symbols).
- Additional DMRS can be configured for the later part of the slot.
 - FFS: Density reduction compared to front-loaded DMRS
- DMRS configuration can be up to the max. number of DMRS ports.
- Note: DMRS design should take into account channel estimation accuracy for low-to-high SINR scenario, throughput performance for SU and MU-MIMO, DMRS overhead, receiver complexity, receiver implementation, support of the use cases/features, UL/DL symmetry, etc.
- FFS: Relative timing relationship between front-loaded DMRS and NR-PDSCH
 - Option 1: The first symbol of front-loaded DM-RS is fixed regardless of the first symbol of NR-PDSCH.
 - Option 2: The first symbol of front-loaded DM-RS is no later than the first symbol of NR-PDSCH.

[R1-1701294](#) WF on DL DM-RS Huawei, HiSilicon, IITH, CEWIT, IITM, Tejas Networks, Ericsson, Nokia, NTT DOCOMO, Mitsubishi, Softbank, Fujitsu, Xinwei

The document was presented by Leimin Zhang from Huawei.

- Support maximal 16 DL layers for MU-MIMO transmission
 - FFS until next meeting:
 - Option 1: with 16 orthogonal DMRS ports or
 - Option 2: with non-orthogonal DMRS ports in addition to 8 orthogonal ports

Decision: The document is noted. Continue offline discussion until Tuesday –(NTT DOCOMO, Huawei)

Agreement

- Study the following options:
 - Option 1: with 16 orthogonal DMRS ports or
 - Option 2: with non-orthogonal DMRS ports in addition to 8 orthogonal ports
 - Other options are not precluded.

Friday session

[R1-1701461](#) Observation of DMRS evaluation Huawei, HiSilicon, MediaTek Inc., Mitsubishi Electric, vivo, CATT, Xinwei, Ericsson, AT&T, CMCC

Conclusion:

- Companies are encouraged to provide additional evaluation results in next meeting.
- Observations are to be drawn based on additional evaluation results with further aligned simulation assumptions
 - FTP traffic model is baseline, full-buffer traffic model is optional
 - Each company is to report assumption of the traffic model

Not treated.

R1-1700067	Design of DL DMRS for data transmission	Huawei, HiSilicon
R1-1700068	Evaluation results of DMRS design for DL data channel	Huawei, HiSilicon
R1-1700071	UL DMRS design for data transmission	Huawei, HiSilicon
R1-1700135	Discussion on downlink DMRS design	ZTE, ZTE Microelectronics
R1-1700136	Discussion on uplink DMRS design	ZTE, ZTE Microelectronics
R1-1700137	Simulation results for downlink DMRS	ZTE, ZTE Microelectronics
R1-1700175	DMRS pattern analysis and evaluation	MediaTek Inc.
R1-1700230	Discussion on DMRS design for DL	CATT
R1-1700231	Discussion on DMRS design for UL	CATT
R1-1700275	Discussion on DMRS configurations	vivo
R1-1700316	Design of DM-RS for NR MIMO	AT&T
R1-1700352	Downlink DM-RS design for NR	Intel Corporation
R1-1700353	Uplink DM-RS design for NR	Intel Corporation

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R1-1700437	DMRS density for high speed scenario	CMCC
R1-1700481	DL DMRS Design	LG Electronics
R1-1700483	UL DMRS Design	LG Electronics
R1-1700606	Views on DMRS	NTT DOCOMO, INC.
R1-1700715	Considerations on UL DM-RS design for NR	InterDigital Communications
R1-1700780	DMRS Design and Evaluation Results	Beijing Xinwei Telecom Techn.
R1-1700805	Discussion on UL DMRS design	Qualcomm Incorporated
R1-1700844	Pilot Scrambling Sequences for DMRS Port Multiplexing	Cohere Technologies
R1-1700874	DMRS designs for NR MIMO	Mitsubishi Electric Co.
R1-1700875	Performance evaluations of DMRS designs for NR MIMO	Mitsubishi Electric Co.
R1-1700929	PRB bundling and precoding granularity in UL DMRS	Samsung
R1-1700930	Precoding granularity of NR DMRS	Samsung
R1-1700931	Evaluation results for NR DMRS patterns	Samsung
R1-1701104	DL DMRS patterns link performance evaluation	Nokia, Alcatel-Lucent Shanghai Bell
R1-1701173	On UL DMRS design	Ericsson
R1-1701174	On DL DMRS design	Ericsson
R1-1701193	Evaluation results for DM-RS	Intel Corporation
R1-1701196	Discussion on DMRS design for high speed scenario	ETRI
R1-1701197	Evaluation of DL DMRS design	Qualcomm Incorporated
R1-1701200	Evaluation Result of NR DMRS	LG Electronics
R1-1701375	WF on DMRS configuration	Samsung, CATT

5.1.2.3.3 RS for phase tracking

R1-1701379 WF on PT-RS Huawei, HiSilicon, Ericsson, National Instruments, Nokia, Alcatel-Lucent Shanghai Bell, ETRI, Intel, NTT DOCOMO, Panasonic
 Also supported by LG.

Agreements:

- Regarding PT-RS for CP-OFDM, the following is supported
 - For a given UE, the designated PT-RS is confined in scheduled resource as a baseline
 - Whether/how to share DL PT-RS among UEs is FFS
 - Presence of PT-RS in scheduled resource is UE-specifically configured/indicated
 - Multiple PT-RS densities defined in time/frequency domain are supported
 - UE can assume same precoding for a DM-RS port and a PT-RS port
 - Among which ports and mapping rules (fixed and/or configurable, etc) are FFS
 - Number of PT-RS ports can be fewer than number of DM-RS ports in scheduled resource
- Study the following for PT-RS, taking overhead and forward compatibility into account
 - Details on frequency domain patterns/densities
 - How to indicate presence/patterns of PT-RS
 - E.g., implicitly indicated based on association with numerology/MCS/number of allocated PRBs/UE category
 - E.g., explicit indication by L1/L2/L3 signaling
 - Port multiplexing methods
 - E.g., non-orthogonal multiplexing within PT-RS ports and with data
 - Using PT-RS for CFO/Doppler estimation
 - QCL relationship between PT-RS and DM-RS
 - Joint transmission of CSI-RS and PT-RS for improving CSI acquisition accuracy
 - Others are not precluded

Friday session

R1-1701435 WF on PT-RS for DFTsOFDM Mitsubishi Electric, CATT, InterDigital, Intel, Qualcomm

The document was presented by Cristina Ciocina-Duchesne from Mitsubishi.

- Support PT-RS for DFTsOFDM
 - FFS the exact pattern (e.g. pre-DFT insertion, post-DFT insertion)

Discussion: Also supported by Sony.

NTT DOCOMO concern that PT-RS increases the receiver complexity and PAPR

Decision: The document is noted. The following is agreed:

Agreements:

- NR considers frequency offset and PN compensation for DFTsOFDM
 - FFS the exact method (e.g. pre-DFT /post-DFT insertion of PT-RS, blind detection, DM-RS)
 - Consider receiver complexity, PAPR, modulation order to be supported, ...

Not treated.

R1-1700073 Further details for PT-RS design Huawei, HiSilicon
R1-1700138 Discussion on RS for phase tracking ZTE, ZTE Microelectronics
R1-1700232 Further discussion on Phase tracking for DL CATT
R1-1700233 Further discussion on Phase tracking for UL CATT
R1-1700355 Discussion on RS for Phase Tracking Intel Corporation
R1-1700394 DMRS Based Phase Noise Compensation for NR AT&T
R1-1700438 Phase-tracking reference signal design for high-frequency systems CMCC
R1-1700484 Discussion on Phase Tracking RS for DL LG Electronics
R1-1700485 Discussion on Phase Tracking RS for UL LG Electronics
R1-1700579 Discussion on phase tracking RS design ETRI
R1-1700607 Views on RS for phase tracking NTT DOCOMO, INC.
R1-1700646 On the need of PT-RS for DFTsOFDM Mitsubishi Electric RCE
R1-1700781 Discussion and Evaluation of Phase Tracking RS Design Beijing Xinwei Telecom Techn.
R1-1700808 Phase and frequency tracking reference signal considerations Qualcomm Incorporated
R1-1700854 Study of Time & Frequency Density of UE-Specific & Cell-Specific Phase Noise RS With Different CPE
Estimation Techniques National Instruments Corp.
R1-1700857 PT-RS performance evaluation with different time domain densities InterDigital Communications
R1-1700932 Time/Frequency pattern for PTRS Samsung
R1-1701105 On PT-RS Design for NR Nokia, Alcatel-Lucent Shanghai Bell
R1-1701161 On DL and UL phase noise tracking RS (PTRS) Ericsson
R1-1701308 WF on PT-RS CATT

5.1.2.3.4 SRS

R1-1701307 WF on SRS CATT, National Instruments

The document was presented by Rakesh Tamrakar from CATT.

- NR SRS design should support any kind of antenna configuration at UE and should support dynamic port selection either by UE or by gNB
 - E.g., UE with 4 ports can be configured with 2 ports SRS by gNB
 - E.g., UE sends 2 ports SRS even though configured with 4 ports SRS by gNB
- The size of partial-band N is relatively a large value in terms of number of PRBs and consists multiple sub-bands which forms tree like structure.
- Frequency hopping within a partial-band is supported and numerology does not change within a hopping cycle.
- NR supports configuration of multiple numerologies for SRS transmission to an UE however simultaneous transmission with multiple numerologies by an UE is not supported.

Decision: The document is noted, modified as follows:

Agreements:

- NR SRS design should not assume a particular antenna configuration at UE and should support dynamic port/antenna/resource selection by gNB and UE
 - In the case of UE selection, it can be disabled/enabled by gNB (if the UE selection is not transparent). FFS whether or not the selection is transparent
 - E.g., UE with 4 ports can be configured with 2 ports SRS by gNB
 - E.g., UE sends 2 ports SRS even though configured with 4 ports SRS by gNB

R1-1701437 WF on SRS Transmission for NR Samsung, Nokia, ASB, InterDigital, NTT DOCOMO, KDDI, Huawei, HiSilicon, Sony

Decision: The document is noted.

Agreements:

- NR supports periodic and semi-persistent NR-SRS transmission.
 - Note aperiodic SRS transmission has been agreed
- Out of $K \geq 1$ configured NR-SRS resources:
 - For aperiodic transmission, the UE can be configured to transmit a subset of or all K NR-SRS resources with no precoding, the same or different precoding
 - For periodic and semi-persistent transmission, the UE can be configured to transmit K NR-SRS resources with no precoding, the same or different precoding
- FFS details related position & timing of SRS transmission (including configurable)
- NR supports SRS transmission including
 - Number of SRS ports are 1, 2, 4, FFS 3, 8 (possibly other values)
 - Comb levels are 2 and 4
 - Configurable frequency hopping (details FFS)

- Clarify the following agreed configurations are applicable to each NR-SRS resource from K configured NR-SRS resources:
 - NR-SRS bandwidth
 - Number of CP-OFDM/DFT-S-OFDM symbols
 - Number of SRS ports
 - Comb level

R1-1701315 **Way Forward on SRS Sequence generation method** **Intel, ZTE**

Agreements:

- To down-select one method for NR SRS sequence generation based on at least the following alternatives:
 - Alt-1: SRS sequence is a function of the sounding bandwidth and does not depend on the sounding bandwidth position or the PRB position.
 - Sequence design and other design details are FFS.
 - Alt-2: SRS sequence is a function of the sounding bandwidth position or the PRB position.
 - Sequence design and other design details are FFS.
 - Taking into account metrics such as PAPR, capacity/flexibility, etc.
 - Other parameters, if any, determining SRS sequence are FFS (e.g. SRS sequence ID)

R1-1700356 **Further discussion on SRS for NR** **Intel Corporation**

Not treated.

R1-1700074	UL SRS design for CSI acquisition and beam management	Huawei, HiSilicon
R1-1700139	Discussion on SRS design for NR	ZTE, ZTE Microelectronics
R1-1700234	Further discussion on SRS transmission	CATT
R1-1700285	Discussion on SRS in NR	Spreadtrum Communications
R1-1700318	CSI-RS Based Design of SRS for Sounding in NR	AT&T
R1-1700486	Considerations on NR SRS design	LG Electronics
R1-1700552	SRS design for NR	Guangdong OPPO Mobile Telecom.
R1-1700673	Views on SRS design for NR	Sony
R1-1700716	On SRS design for NR	InterDigital Communications
R1-1700769	SRS Design	Ericsson
R1-1700809	Discussion on SRS design	Qualcomm Incorporated
R1-1700933	SRS design for NR	Samsung
R1-1701106	UL SRS design considerations in NR	Nokia, Alcatel-Lucent Shanghai Bell
R1-1701285	WF on NR-SRS	Samsung, Nokia, ASB, InterDigital, NTT DOCOMO, KDDI

5.1.2.3.5 QCL

R1-1701284 **Way Forward on QCL association between DL and UL antenna ports** **ZTE, ZTE Microelectronics, ASTRI, CMCC, Ericsson, Huawei, HiSilicon**

R1-1701449 **Way Forward on QCL on NR** **Huawei, HiSilicon, ZTE, ZTE Microelectronics**
Also supported by AT&T

Thursday session

R1-1701476 **WF on QCL assumption for NR** **Huawei, HiSilicon, ZTE, ZTE Microelectronics, vivo, Sony, AT&T**

Agreements:

- Support DMRS ports grouping, and DMRS ports within one group are QCL-ed, and DMRS ports in different groups are non-QCLed.
 - FFS the grouping principle, e.g. grouping DMRS according to CWs, analog beams, etc.
 - FFS the signalling method of QCL indication, e.g., RRC, MAC CE, DCI, etc.
- Study RS for performing estimation of large scale properties of channel (E.g., Doppler shift/Doppler spread/delay spread)
- QCL supports following functionalities
 - Beam management functionality: at least including spatial parameters
 - Frequency/timing offset estimation functionality: at least including Doppler/delay parameters
 - RRM management functionality: at least including average gain
 - Others are not precluded

Not treated.

R1-1700072	Details of QCL assumptions and related RS design considerations	Huawei, HiSilicon
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[R1-1700140](#) QCL/QCB design for DL MIMO ZTE, ZTE Microelectronics
[R1-1700141](#) QCL/QCB design for UL MIMO ZTE, ZTE Microelectronics
[R1-1700235](#) Further discussion on QCL for DL CATT
[R1-1700317](#) View on QCL Type and Definition for NR-MIMO Framework AT&T
[R1-1700357](#) On cross-carrier QCL Intel Corporation
[R1-1700487](#) Discussion on QCL assumptions for NR LG Electronics
[R1-1700771](#) On spatial QCL definition Ericsson
[R1-1700810](#) Discussion on QCL Qualcomm Incorporated
[R1-1700934](#) On QCL for NR Samsung
[R1-1701107](#) On QCL Framework and Configurations in NR Nokia, Alcatel-Lucent Shanghai Bell

5.1.2.3.6 Other

[R1-1701455](#) **Way Forward on RS for time/frequency tracking Qualcomm, Samsung, MediaTek**

Proposals:

- For fine time/frequency tracking, consider:
 - The required RE resource/patterns, periodicity, # of ports, bandwidth, and the corresponding configurations, if required
 - Tracking requirements

Continue discussion offline

Thursday session

R1-1701509 WF on RS for time/frequency tracking Samsung, Qualcomm, Ericsson, MediaTek, Intel, Xinwei, KT

Agreements:

- For fine time/frequency tracking, consider
 - The required RE resource/patterns
 - E.g. CSI-RS, RS for mobility (if adopted, may be CSI-RS or other RSs), DM-RS for broadcast/unicast/control (if introduced), PT-RS, a dedicated RS (if required), etc.
 - Other RSs are not precluded
 - The required periodicity and the corresponding configurations
 - Tracking performance

Not treated.

[R1-1700276](#) RS design for beam management vivo
[R1-1700416](#) Symmetric RS design for duplexing flexibility Huawei, HiSilicon
[R1-1700811](#) Discussion on tracking RS and RLM Qualcomm Incorporated
[R1-1700852](#) Introducing port coherency regions Ericsson Inc.

5.1.2.4 Other

Including MIMO calibration issues

Friday session

[R1-1701513](#) **WF on uplink power control Nokia, ASB, Huawei, Intel, KDDI, NTT DOCOMO, Samsung, SoftBank**

Agreements:

- Pathloss measurement for UL power control to be based on at least one type of DL RS for beam measurement is supported.
 - Notes: beam measurement RS includes CSI-RS, RS defined for mobility purpose, FFS: SS & DMRS
 - FFS: on multiple type of RS
 - FFS: other DL RS
- FFS: Whether beam pair link and/or beam group and/or layer specific power control parameter set(s) includes $\alpha(j)$ and/or P_0 .
- Separate power control process can be supported for transmission of different channel/RS (i.e., PUSCH, PUCCH, SRS).
 - Same gNB antenna port can be used for pathloss measurement for multiple process.
 - FFS: Different gNB antenna ports can be used for pathloss measurement for each process
- NR supports power control for UE side multiple panel transmission
 - FFS: specification impact to support multiple panel
- FFS: waveform independent/dependent parameters for power control

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R1-1701516 WF on MIMO Calibration NTT DOCOMO, ZTE, ZTE Microelectronics, LG Electronics, Samsung, Xinwei, Spreadtrum, ETRI

Agreements:

- Set-up email discussions to collect phase1~3 results separately – Chuangxin (ZTE)
 - For updating phase-1 results: Until Feb. 6
 - Companies are encouraged to update results (particularly for the micro layer of dense urban scenario)
 - If further clarification of simulation assumptions is needed, it can also be discussed under this email thread
 - For phase-2 results: Until Mar. 31
 - For phase-3 results: Until Apr. 28
- Separate the excel sheet(s) for link level and system level.
- Email discussion moderator to summarize the above results and submit separate tdocs.
- Add in TR 38.802 A.1 link level evaluation assumptions/results for MIMO calibration
 - Summarize evaluation assumptions based on email discussion
 - Capture the reference tdoc # containing the link level evaluation assumption
 - Capture the reference tdoc # containing the excel sheet(s)
- Add in TR 38.802 A.2 system level evaluation assumptions/results for MIMO calibration
 - Summarize evaluation assumptions based on email discussion
 - Capture the reference tdoc # containing the system level evaluation assumption
 - Capture the reference tdoc # containing the excel sheet(s)
- FFS: how to capture the phase-2 and phase-3 results

R1-1701526 NR-MIMO Phase-1 and Phase-2 Calibration Results ZTE, ZTE Microelectronics

Decision: The document is agreed in principle. Subject to further updates from the email discussion.

R1-1701517 Summary of email discussion [87-30] on NR-MIMO calibration ZTE, ZTE Microelectronics

Decision: The document is agreed.

Not treated.

R1-1700063	General discussion of UL power control for NR	Huawei, HiSilicon
R1-1700064	Detailed considerations on UL power control design for NR	Huawei, HiSilicon
R1-1700085	Discussion on system-level calibration for NR-MIMO	Huawei, HiSilicon
R1-1700086	Discussion on link-level calibration for NR-MIMO	Huawei, HiSilicon
R1-1700142	Discussion on UL power control for NR	ZTE, ZTE Microelectronics
R1-1700144	Further clarification on assumptions for Phase 1 NR MIMO calibration	ZTE, ZTE Microelectronics
R1-1700236	NR MIMO calibration results	CATT
R1-1700287	NR MIMO calibration results	Spreadtrum Communications
R1-1700358	Discussion on UL Power Control	Intel Corporation
R1-1700439	Phase 1 calibration results for NR MIMO	CMCC
R1-1700488	Phase I SLS calibration results for NR MIMO	LG Electronics
R1-1700490	Phase I LLS calibration results for NR MIMO	LG Electronics
R1-1700491	Phase II LLS calibration results for NR MIMO	LG Electronics
R1-1700492	Discussion on UL power control for NR	LG Electronics
R1-1700553	Uplink power control for NR	Guangdong OPPO Mobile Telecom.
R1-1700601	Uplink power control considering waveform switching	NTT DOCOMO, INC.
R1-1700602	System-level calibration result for NR MIMO	NTT DOCOMO, INC.
R1-1700603	Discussion on mobility model for MIMO phase-3 calibration	NTT DOCOMO, INC.
R1-1700656	System Level Simulation Result for NR MIMO Calibration – Phase I	Fujitsu
R1-1700772	On forming wide beams	Ericsson
R1-1700773	NR MIMO Phase 1 SNR system level calibration results for above 6 GHz	Ericsson
R1-1700774	NR MIMO Phase 1 SNR system level calibration results for below 6 GHz	Ericsson
R1-1700775	Phase 1 NR MIMO LLS Calibration Results	Ericsson
R1-1700782	NR MIMO Link Level Phase 2 Calibration Results	Beijing Xinwei Telecom Techn.
R1-1700783	NR MIMO System Level Phase 2 Calibration Results	Beijing Xinwei Telecom Techn.
R1-1700812	Phase 1 and Phase 2 calibration results for sub6GHz	Qualcomm Incorporated
R1-1700848	Initial Calibration Results of NR MIMO	CATR
R1-1700850	Simulation results on Phase 1 NR MIMO calibration	ZTE, ZTE Microelectronics
R1-1700851	Simulation results on Phase 2 NR MIMO calibration	ZTE, ZTE Microelectronics
R1-1700868	UL power control in multi-beam based approaches	ASUSTEK COMPUTER (SHANGHAI)
R1-1700935	MIMO Phase-2 LLS calibration results on 4GHz frequency band	Samsung
R1-1700936	MIMO Phase-1 SLS calibration results on 30GHz frequency band	Samsung
R1-1700937	MIMO Phase-1 LLS calibration results on 30GHz frequency band	Samsung

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R1-1700938	MIMO Phase-2 SLS calibration results on 30GHz frequency band	Samsung
R1-1700939	MIMO Phase-2 LLS calibration results on 30GHz frequency band	Samsung
R1-1700940	UL power control aspects	Samsung
R1-1701108	Dynamic network coordination for URLLC in the 5G New Radio	Nokia, Alcatel-Lucent Shanghai Bell
R1-1701109	Power control for MIMO	Nokia, Alcatel-Lucent Shanghai Bell
R1-1701219	Phase II SLS calibration results for NR MIMO	LG Electronics

5.1.3 Scheduling/HARQ aspects

Friday

R1-1701533 Action plans for RAN1#88 NTT DOCOMO

The document was presented by Fred Takeda from NTT DOCOMO.

Discussion: NTT DOCOMO clarified that the plans were for information only – any feedback will be welcome.

Decision: The document is noted.

[R1-1700011](#) Mechanisms of bandwidth adaptation Huawei, HiSilicon

5.1.3.1 Physical downlink control channel

Mainly for eMBB.

[R1-1701036](#) Summary of e-mail discussions on downlink control signaling Ericsson LM

The document was presented by Stefan Parkvall from Ericsson.

PDCCH structure

- Proposal: In one OFDM symbol, multiple PDCCHs cannot be transmitted on the same PRB except for spatial multiplexing to different UEs (MU-MIMO).

DM-RS for downlink control signaling

- Proposal: Focus on a 'hierarchical' structure where the channel estimate obtained for one RE is reusable across multiple blind decodings involving that RE but ensure that PDCCH blocking does not become a too large problem.

Duration of control resource set

- Adopt a semi-static duration of the control resource set, considering the possibility for data to dynamically reuse unused parts of the (OFDM symbols occupied by the) control resource set.
- The data DM-RS location does not vary dynamically from slot to slot.

DCI content

- Proposal: It is too early to fill in all details in the excel sheet, but keep it as a starting point for future discussions.

Two-stage DCI design

- Proposal: Further discussions are needed if a two-stage DCI design should be part of the first NR release in addition to the already agreed inclusion of a single-stage DCI design.

'PCFICH-like' channel

- Adopt a 'common PDCCH' for NR under the assumption that a missed 'common PDCCH' for a UE does not have a detrimental effect on reception of PDCCH/PDSCH for the same UE.
- Continue the discussion on the exact content of the 'common PDCCH'.

Decision: The document is noted.

Possible agreements:

- NR supports at least following functionalities
 - In one OFDM symbol, multiple PDCCHs cannot be transmitted on the same PRB except for spatial multiplexing to different UEs (MU-MIMO)
 - Focus on a 'hierarchical' structure where the channel estimate obtained for one RE is reusable across multiple blind decodings in one search space involving that RE but ensure that PDCCH blocking does not become a too large problem.
 - [Adopt non-dynamic non-per slot duration of the control resource set, considering the possibility for data to dynamically reuse parts of the OFDM symbols occupied by the control resource set.]
 - The front loaded data DM-RS location is fixed relative to the start of slot
 - [Adopt a 'common PDCCH' for NR under the assumption, it does not have a detrimental effect on reception of PDCCH/PDSCH. Common is not necessary to be common per cell]
 - Continue the discussion on the exact content of the 'common PDCCH'.

Continue offline discussion until Tuesday – Stefan (Ericsson)

[R1-1700149](#) Transmission scheme of NR-PDCCH MediaTek Inc.

The document was presented by ... from MediaTek.

- Observation 1: The gain of SFBC over random BF decreases significantly with the increase of delay spread.

- Observation 2: The gain of SFBC over random BF decreases significantly when RS overhead is taken into account.
- Observation 3: Random BF scheme has similar/better performance than SFBC scheme when the delay spread and RS overhead are both considered, e.g., RMS delay spread is 300ns in Case#2/3.
- Observation 4: RE mapping of CCE has large impact on the performance of SFBC.
- Proposal: Evaluate SFBC and random beamforming with practical factors taken into consideration, such as delay spread, RS overhead, RE mapping of CCE.

Decision: The document is noted.

R1-1700947 Performance Evaluation of DL Control Channels Samsung

The document was presented by Aris Papasakellariou from Samsung.

- The performance of PDCCH transmission diversity scheme may depend on the code rate, channel environment, DMRS design, channel estimation scheme, etc.
- SFBC is more sensitive than precoder cycling to channel estimation errors in low SNR region.

Decision: The document is noted.

R1-1700260 Issues related to UE/PDCCH-specific DMRS of NR-PDCCH ZTE, ZTE Microelectronics

The document was presented by Zhisong Zuo from ZTE.

- Observation1: The overhead of UE/NR-PDCCH-specific DMRS will be much higher than in LTE (where it is 5.56% for one port when 3 OS are used), if inefficient rules for CCE mapping are applied.
- Observation2: Mechanisms for DMRS overhead reduction should be studied for UE/NR-PDCCH-specific DMRS.
- Observation3: Further reduction of DMRS overhead should be considered when UE/PDCCH-specific DMRS is applied.
- Proposal 1: A PDCCH candidate is composed by a number of CCEs. The CCE is defined in number of PRBs spanning in 1 OFDM symbol.
- Proposal 2: Time-first CCE mapping of NR-PDCCH candidate should be supported. A CCE should not accommodate DMRS if its preceding CCE in same frequency for the same NR-PDCCH candidate contain DMRS.
- Proposal 3: The mapping scheme of the self-contained DMRS should be supported by NR when UE/PDCCH-specific DMRS is used.
- Proposal 4: NR supports dynamic indication of DMRS location in time domain in order to further reduce DMRS overhead.
- Proposal 5: To enable multiple beam operation, NR supports mapping search space in subset of control OFDM symbols of the whole control region of a slot.

Decision: The document is noted.

R1-1700562 Views on DL control channel for NR Guangdong OPPO Mobile Telecom.

The document was presented by Hua Xu from OPPO.

- A PRB with 12 RE in frequency and one symbol in time is the control resource unit size for control channel.
- Consider to include the time domain information as part of resource allocation in DCI for PDSCH and PUSCH scheduling.
- Common channel with information on slot structure and PDCCH symbols could be transmitted on different symbols with different beams

Decision: The document is noted.

R1-1700942 UE-Group Common Control Signaling Samsung

The document was presented by Aris Papasakellariou from Samsung.

- Proposal 1: UE-common control signaling informs of a current slot structure and of subsequent UL-only slots.
- Proposal 2: UE-common control signaling in a slot informs of a number of slot symbols for transmissions of DL control channels in the slot.
- Proposal 3: A network is not mandated to transmit UE-common control signaling in order to schedule UE-specific DL/UL transmissions in a slot.
- Observation 1: NR incurs significant losses in spectral efficiency relative to LTE if the number of symbols for transmissions of DL control channels in a slot is not configured per slot.

Decision: The document is noted.

R1-1700820 UE power evaluation for DRX with wake-up signaling Qualcomm Incorporated

The document was presented by ... from Qualcomm.

- Observation 1: Reference signal processing is required for any coherent detection scheme and this is often the long pole for timeline and energy consumption reduction. Substantial energy consumption reduction could be feasible with non-coherent signal detection.
- Proposal 1: Wake-up signalling based on non-coherent signal detection should be considered for DRX for 5G NR. This should be compared against other candidates based on coherent detection including PDCCH and indicator channel in terms of energy saving, performance, and robustness.

- Observation 2: Substantial DoU power saving can be achieved with wake-up signaling, especially for use cases with high power consumption contributed by ON-duration-only DRX cycles.
- Proposal 2: DRX with wake-up signaling should be considered as one of the design options and studied for 5G NR

Decision: The document is noted.

Tuesday session

R1-1701334 Outcome of offline discussion on downlink control signalling Ericsson

The document was presented by Stefan Parkvall from Ericsson.

- In one OFDM symbol, multiple CCEs cannot be transmitted on the same PRB except for spatial multiplexing to different UEs (MU-MIMO)
- A PDCCH candidate consists of a set of CCEs. A CCE consists of a set of REGs. A REG is one RB during one OFDM symbol (minus the REs used for DM-RS).
- For one UE, the channel estimate obtained for one RE should be reusable across multiple blind decodings involving that RE in at least the same control resource set and type of search space (common or UE-specific).
- The DL data DM-RS location in time is not dynamically varying relative to the start of slot
- NR supports a 'group common PDCCH' carrying information of e.g. the slot structure.
 - If the UE does not receive the 'group common PDCCH' the UE should be able to receive at least PDCCH in a slot, at least if the gNB did not transmit the 'group common PDCCH'.
 - The network will inform through RRC signalling the UE whether to decode the 'group common PDCCH' or not
 - Common does not necessarily imply common per cell.
 - Continue the discussion on the detailed content of the 'group common PDCCH' including usage for TDD and FDD.
 - The term 'group common PDCCH' refers to a channel (either a PDCCH or a separately designed channel) that carries information intended for the group of UEs.

Decision: The document is noted, refined as follows:

Agreements:

- NR supports at least following functionalities
 - At least for eMBB, in one OFDM symbol, multiple CCEs cannot be transmitted on the same PRB except for spatial multiplexing to different UEs (MU-MIMO)
 - A PDCCH candidate consists of a set of CCEs. A CCE consists of a set of REGs. A REG is one RB during one OFDM symbol.
 - For one UE, the channel estimate obtained for one RE should be reusable across multiple blind decodings involving that RE in at least the same control resource set and type of search space (common or UE-specific).
 - At least for DL data scheduled for a slot, the DL data DMRS location in time is not dynamically varying relative to the start of slot

Agreements:

- NR supports a 'group common PDCCH' carrying information of e.g. the slot structure.
 - If the UE does not receive the 'group common PDCCH' the UE should be able to receive at least PDCCH in a slot, at least if the gNB did not transmit the 'group common PDCCH'.
 - The network will inform through RRC signalling the UE whether to decode the 'group common PDCCH' or not
 - Common does not necessarily imply common per cell.
 - Continue the discussion on the detailed content of the 'group common PDCCH' including usage for TDD and FDD
 - The term 'group common PDCCH' refers to a channel (either a PDCCH or a separately designed channel) that carries information intended for the group of UEs.

R1-1701220 WF for NR DL control CCE ZTE, ZTE Microelectronics, Qualcomm, Huawei, HiSilicon, OPPO

The document was presented by Zhisong Zuo from ZTE.

- Each candidate of NR DL Control channel search space is composed by K NR-CCE(s) in unified size
 - A NR-CCE is defined in fixed number of PRBs
 - Each PRB is in 1 OFDM symbol duration
 - Different PRBs can be in different symbols depending on PRB to NR-CCE mapping
 - NR-CCE includes the REs of UE/PDCCH-specific DM-RS to demodulate that NR-CCE
 - FFS: PRB to NR-CCE mapping within a control resource set is frequency first, time first or gNB configurable
 - E.g. K can be 1, 2, 4, or 8, etc

Decision: The document is noted, modified and agreed as follows:

Agreements:

- Each candidate of NR DL Control channel search space is composed by K NR-CCE(s)

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- A NR-CCE is defined in fixed number of REGs
 - FFS: Different REGs can be in the same or different symbols depending on REG to NR-CCE mapping
 - FFS: NR-CCE includes the REs assumed for UE-specific DMRS to demodulate that NR-CCE
- FFS: REG to NR-CCE mapping within a control resource set is frequency first, time first or gNB configurable
- FFS: Down selection of REG to NR-CCE mapping
- E.g. K can be 1, 2, 4, or 8, etc

Continue offline discussion until Wednesday – (ZTE, NTT DOCOMO)

Wednesday session

R1-1701420 **WF on Transmission Schemes for DL control channel** **LG Electronics, NTT DOCOMO, Samsung, Ericsson, Qualcomm, OPPO, MediaTek, Huawei, HiSilicon, CATT, Intel, ZTE, ZTE Microelectronics**

Agreements:

- Transmit diversity scheme for DL control channel is supported.
 - FFS: SFBC or precoder-cycling, etc
 - Other schemes are not precluded
 - FFS number of antenna ports (1 or 2)
- A UE assumes fixed number of RS REs per REG for control channel rate matching when the REG contains RS REs
 - FFS: if the fixed number is configurable

R1-1701391 **WF on the clarification of control resource set and control search space** **Qualcomm, Ericsson, LGE, ETRI, CATT, ZTE, VIVO, Intel, NTT DoCoMo, MediaTek, Panasonic, Samsung**
Also supported by OPPO, Interdigital

Agreements:

- A control resource set is defined as a set of REGs under a given numerology
- Control search space includes at least the following properties
 - Aggregation level(s)
 - Number of decoding candidates for each aggregation level
 - The set of CCEs for each decoding candidate
- FFS: if any of the following properties belong to control resource set or control search space
 - Transmission/diversity scheme
 - CCE to REG mapping
 - RS structure
 - PRB bundling size
- FFS: if the control resource sets can overlap or not
- FFS: whether the mapping between control resource set and control search space is one-to-one or one-to-many

R1-1701421 **WF on Study of wake up signal for NR** **Qualcomm, CATT, Sony, Ericsson**

- Study the benefit and cost to introduce a Wake-up signal along with DRX, with waveform options such as:
 - FFS: details on wake-up signal waveform
 - FFS: The UE behavior after detecting the signal (wake up to receive PDCCH or skip the PDCCH reception)
- Consider low power circuit or passive circuit
- Notes: Example metrics for the evaluation of WUS can be
 - Miss-detection and false alarm probability
 - Power saving with WUS mechanism
- Performance in AWGN and fading channels (e.g., CDL-C, 100/300 ns delay spread with UE speed 3km/h) can be studied

Decision: The document is noted. Continue offline.

Thursday session

R1-1701498 **Summary of offline discussion on group common PDCCH** **Ericsson**

Agreements:

- The starting position of downlink data in a slot can be explicitly and dynamically indicated to the UE.
 - FFS: signaled in the UE-specific DCI and/or a 'group-common PDCCH'
 - FFS: how and with what granularity the unused control resource set(s) can be used for data

Agreements:

- The UE will have the possibility to determine whether some blind decodings can be skipped based on information on a 'group common PDCCH' (if present).

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- FFS: if the data starting position is signaled on the group common PDCCH, the UE may exploit this information to skip some blind decodings
- FFS: if the end of the control resource set is signaled on the 'group common PDCCH', the UE may exploit this information to skip some blind decodings
- FFS: how to handle the case when there is no 'group common PDCCH' in a slot
- When monitoring for a PDCCH, the UE should be able to process a detected PDCCH irrespective of whether the 'group common PDCCH' is received or not

R1-1701442 WF on the channel estimation for DL control channel LG Electronics, Samsung, Qualcomm, ETRI

Possible agreements:

- For a control channel candidate mapped to multiple OFDM symbols, UE can assume;
 - Channel estimation from the NR-REG (which is included in the candidate) having DMRS is reusable to NR-REGs without DMRS in a PRB (i.e. same frequency location)

Friday session

R1-1701478 WF on 2-Stage DCI for NR Qualcomm, Huawei, HiSilicon, National Instrument, Vivo, ZTE, Sony, MediaTek

Decision: Document is for email discussion until Feb. 7th – (Qualcomm)

R1-1701521 Summary of offline discussion on group common PDCCH – part 2 Ericsson

Agreements:

- 'Slot format related information'
 - Information from which the UE can derive at least which symbols in a slot that are 'DL', 'UL' (for Rel-15), and 'other', respectively
 - FFS: if 'other' can be subdivided into 'blank', 'sidelink', etc
- FFS: 'Control resource set duration'
 - FFS: Indicates the duration of the control resource set(s)
 - FFS: Can help the UE skip some of the semi-statically configured blind decodings. If not received, the UE performs all blind decodings.

Not treated.

R1-1700004	Numerology for DL control channel	Huawei, HiSilicon
R1-1700007	DL control channels for CA and DC	Huawei, HiSilicon
R1-1700012	Two-stage downlink control structure	Huawei, HiSilicon
R1-1700013	Transmission schemes of DL control channel	Huawei, HiSilicon
R1-1700014	Design of control resource set	Huawei, HiSilicon
R1-1700015	Demodulation RS design for DL control channel	Huawei, HiSilicon
R1-1700078	DCI monitoring occasions and blind detections	Huawei, HiSilicon
R1-1700150	Design of NR-PDCCH resource allocation and search space	MediaTek Inc.
R1-1700153	On Dynamic Switching between Single & Aggregated DCI	MediaTek Inc.
R1-1700189	NR DL control channel structure	CATT
R1-1700190	Construction and mapping of DCI formats	CATT
R1-1700191	Common control signaling for NR	CATT
R1-1700194	Indication of NR-PDSCH starting symbol	CATT
R1-1700195	DM RS design for DL Control Channel	CATT
R1-1700196	Configurable DL control channel monitoring for power saving and blank resource indication in NR	

CATT

R1-1700197	Wakeup signal for on-demand access for UE power saving in NR system design	CATT
R1-1700257	DL control structure	ZTE, ZTE Microelectronics
R1-1700258	DL common control	ZTE, ZTE Microelectronics
R1-1700259	DL control procedure	ZTE, ZTE Microelectronics
R1-1700277	NR-PDCCH Control Resource Set	vivo
R1-1700278	Use case for two-step DCI reception	vivo
R1-1700279	CCE Link-level performance evaluation for polar code	vivo
R1-1700305	On DL control channel design	Mitsubishi Electric Co.
R1-1700319	Details on The Design of Two Stage Downlink Control Channel for NR	AT&T
R1-1700359	Physical Downlink Control Channel Design for NR	Intel Corporation
R1-1700360	On common physical DL control channel	Intel Corporation
R1-1700361	On multi-stage physical DL control	Intel Corporation
R1-1700362	On the bandwidth adaptation for NR	Intel Corporation
R1-1700397	Dynamic resource multiplexing of downlink control and data	Huawei, HiSilicon
R1-1700398	Discussion on PCFICH-like control channel	Huawei, HiSilicon

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R1-1700419	Discussion on PRB sharing between NR-PDCCH and eMBB data	Huawei, HiSilicon
R1-1700440	Discussion on DCI in NR CMCC	
R1-1700493	Discussion on control channel design	LG Electronics
R1-1700494	Discussion on reference signal for DL control channel	LG Electronics
R1-1700495	On DCI contents for NR	LG Electronics
R1-1700496	Discussion on NR DCI design	LG Electronics
R1-1700497	Further discussion on bandwidth adaptation	LG Electronics
R1-1700498	Indication of blank resource	LG Electronics
R1-1700499	Discussion on downlink design in multi-beam operation	LG Electronics
R1-1700500	Discussion on common signal considering fallback operation	LG Electronics
R1-1700501	Discussion on CSS and USS in NR	LG Electronics
R1-1700539	PCFICH like signalling	Panasonic Corporation
R1-1700540	DL control channel design	Panasonic Corporation
R1-1700563	DL control channel design for multi-beam transmission above 6GHz	Guangdong OPPO Mobile Telecom.
R1-1700564	RS design consideration for NR PDCCH	Guangdong OPPO Mobile Telecom.
R1-1700565	On NR PDCCH search space configuration	Guangdong OPPO Mobile Telecom.
R1-1700580	Discussion for slot type indication	ETRI
R1-1700581	Discussion on control resource set and DMRS for DL control channel	ETRI
R1-1700619	Discussion on the NR-PDCCH design	NTT DOCOMO, INC.
R1-1700620	Monitoring of DL control channel for NR	NTT DOCOMO, INC.
R1-1700639	Configuration of control resource set and UE bandwidth	PANASONIC
R1-1700704	Downlink control channel framework	INTERDIGITAL COMMUNICATIONS
R1-1700705	DL control channel common search space	INTERDIGITAL COMMUNICATIONS
R1-1700717	On UE-Specific search space design for DL control channel	InterDigital Communications
R1-1700732	Resource unit aggregation and control resource set duration for DL control channel in NR	Sharp
R1-1700733	DL Control Channel and data multiplexing in NR	Sharp
R1-1700734	Reference signals for DL Control Channel in NR	Sharp, MTI
R1-1700814	L1 broadcast control channel	Qualcomm Incorporated
R1-1700815	2-Stage DCI	Qualcomm Incorporated
R1-1700816	Common control resource set and UE-specific control resource set	Qualcomm Incorporated
R1-1700817	UE power saving for PDCCH monitoring	Qualcomm Incorporated
R1-1700818	Methodology for UE DOU analysis	Qualcomm Incorporated
R1-1700819	Evaluation of frame structure design for UE power consumption	Qualcomm Incorporated
R1-1700821	WF on evaluation for wake-up signal	Qualcomm Incorporated
R1-1700860	Numerology indication for a mixed numerology carrier	NEC
R1-1700882	Downlink Control Channel for NR	Motorola Mobility
R1-1700941	Single Carrier Wide BW Operational Aspects	Samsung
R1-1700943	Operation with Reduced Bandwidth for DL Control Channel Monitoring	Samsung
R1-1700944	Transmission Schemes for DL Control Channels	Samsung
R1-1700945	Bandwidth Adaptation for UE Power Savings	Samsung
R1-1700946	Resource mapping aspects for NR-PDCCH	Samsung
R1-1701010	On the DL control channel DM-RS design for NR	Nokia, Alcatel-Lucent Shanghai Bell
R1-1701011	On the PDCCH search space structure for NR	Nokia, Alcatel-Lucent Shanghai Bell
R1-1701012	Dynamic reuse of DL control resources for data in NR	Nokia, Alcatel-Lucent Shanghai Bell
R1-1701013	On the usage of PDCCH DMRS as a complementary synchronization signal in DL	Nokia, Alcatel-Lucent Shanghai Bell
R1-1701066	Discussion on Blind Decoding for NR-PDCCH	WILUS Inc.
R1-1701117	On DL Control Signaling Structure	Ericsson
R1-1701118	On Blind Detection of DL Control Channels	Ericsson
R1-1701119	On DM-RS for DL Control Channels	Ericsson
R1-1701120	On Two-Stage DCI	Ericsson
R1-1701121	On PCFICH-like Channels	Ericsson

5.1.3.2 Physical uplink control channel

Mainly for eMBB.

R1-1700618 Summary of [87-32]: UL L1/L2 control channel design for NR NTT DOCOMO, INC.

The document was presented by Fred Takeda from NTT DOCOMO. Following is proposed:

- For PUCCH in short-duration,
 - At least following is supported for PUCCH in 1-symbol duration:
 - UCI and RS are multiplexed in the given OFDM symbol in FDM manner if RS is multiplexed.
 - Same SCS between DL/UL data and PUCCH in short-duration in the same slot.
 - At least a PUCCH in short-duration spanning 2-symbol duration of a slot is supported.

- FFS actual structure and waveform.
 - Same SCS between DL/UL data and PUCCH in short-duration in the same slot.
- At least semi-static configuration for the following is supported.
 - Position of a PUCCH of a given UE within a slot.
 - I.e., short-PUCCHs of different UEs can be TDM'ed within the given duration in a slot.
 - FFS: Support of dynamic indication
- PUCCH in short-duration can span until the end of a slot.
 - No explicit gap symbol is necessary after the PUCCH in short-duration.
- For a slot having short UL-part (i.e., DL-centric slot):
 - 'Short UCI' and data can be FDMed by one UE if a data is scheduled on the short UL-part.
- For a slot having long UL-part (i.e., UL-centric slot or UL-only slot), following are FFS:
 - Whether/how a UL data in the long UL-part can be extended until the end of the slots.
 - Whether/how a UL data can be scheduled on the short-duration.
- For PUCCH in long-duration,
 - Long UL-part of a slot can be used for transmission of PUCCH in long-duration.
 - I.e., PUCCH in long-duration is supported for both UL-only slot and a slot with the number of uplink symbols greater than X ($X \geq 2$).
 - In addition to simultaneous PUCCH-PUSCH transmission, UCI on PUSCH is supported.
 - Intra-TTI frequency-hopping is supported.

Decision: The document is noted.

Agreements:

- For PUCCH in short-duration,
 - At least following is supported for PUCCH in 1-symbol duration:
 - UCI and RS are multiplexed in the given OFDM symbol in FDM manner if RS is multiplexed.
 - Same SCS between DL/UL data and PUCCH in short-duration in the same slot.
 - At least a PUCCH in short-duration spanning 2-symbol duration of a slot is supported.
 - FFS actual structure and waveform.
 - Same SCS between DL/UL data and PUCCH in short-duration in the same slot.
 - At least semi-static configuration for the following is supported.
 - Position of a PUCCH of a given UE within a slot.
 - i.e., short-PUCCHs of different UEs can be TDM'ed within the given duration in a slot.
 - FFS: Support of dynamic indication
 - PUCCH in short-duration can span until the end of a slot from UE perspective
 - No explicit gap symbol is necessary after the PUCCH in short-duration.
 - For a slot having short UL-part (i.e., DL-centric slot):
 - 'Short UCI' and data can be FDMed by one UE if a data is scheduled on the short UL-part.
 - For a slot having long UL-part (i.e., UL-centric slot or UL-only slot), following are FFS:
 - Whether/how a UL data in the long UL-part can be extended until the end of the slots.
 - Whether/how a UL data can be scheduled on the short-duration.

Continue offline discussion about PUCCH structure including split symbol and sequence based - (Qualcomm, DOCOMO) and PAPR issue - (Huawei)

Friday: Above agreement is modified as follows:

Agreements:

- For PUCCH in short-duration,
 - At least following is supported for PUCCH in 1-symbol duration:
 - UCI and RS are multiplexed in the given OFDM symbol in FDM manner if RS is multiplexed.
 - Same SCS between DL/UL data and PUCCH in short-duration in the same slot.
 - At least a PUCCH in short-duration spanning 2-symbol duration of a slot is supported.
 - FFS actual structure and waveform.
 - Same SCS between DL/UL data and PUCCH in short-duration in the same slot.
 - At least semi-static configuration for the following is supported.
 - A PUCCH resource of a given UE within a slot.
 - i.e., short-PUCCHs of different UEs can be TDM'ed within the given duration in a slot.
 - The PUCCH resource includes time, frequency and, when applicable, code domains.
 - FFS details e.g., if the time in the PUCCH resource includes both slot and symbol, or only symbol in a slot
 - PUCCH in short-duration can span until the end of a slot from UE perspective
 - No explicit gap symbol is necessary after the PUCCH in short-duration.
 - For a slot having short UL-part (i.e., DL-centric slot):
 - Short UCI' and data can be FDMed by one UE if a data is scheduled on the short UL-part.
 - For a slot having long UL-part (i.e., UL-centric slot or UL-only slot), following are FFS:

- Whether/how a UL data in the long UL-part can be extended until the end of the slots.
- Whether/how a UL data can be scheduled on the short-duration.

Agreements:

- For PUCCH in long-duration,
 - Long UL-part of a slot can be used for transmission of PUCCH in long-duration.
 - i.e., PUCCH in long-duration is supported for both UL-only slot and a slot with the number of uplink symbols greater than X ($X \geq 2$).
 - FFS exact value of X
 - In addition to simultaneous PUCCH-PUSCH transmission, UCI on PUSCH is supported.
 - Intra-slot frequency-hopping is supported

R1-1700622 UL control channel structure in short duration NTT DOCOMO, INC.

The document was presented by Liu Liu from NTT DOCOMO.

Proposal 1:

- Two structures of short PUCCH for NR should be supported:
 - Format A: One-symbol with normal subcarrier spacing (i.e. $f_0=15$ KHz for below 6GHz, $f_0=[60]$ KHz for above 6GHz).
 - Format B: Split-symbol with scaled value of normal subcarrier spacing, i.e. $2^n f_0$ ($n = [1, 2, 3]$) kHz, etc., according to different usage scenarios.
- Discuss whether configurability is necessary for the choice of these 2 formats and the DMRS density.

Proposal 2:

- PUCCH and PUSCH could dynamically share the resource in FDMed and/or TDMed manner by eNB indication or implicit manner.
- The scheduling of PUSCH in the short-duration could be done by mini-slot scheduling.

Proposal 3:

- RAN1 needs to investigate potential impact from transient period onto PUCCH or PUSCH performance.

Observation 1:

- Optimal number of DMRS REs per RB is different depending on coding rate for both Format A and B.
- 4-split and 8-split symbol perform better than one-symbol structures at 4GHz with SCS 15 KHz.

Observation 2:

- NR PUCCH in short duration with PF1-like structure (2-bit UCI payload) could support a cell coverage range from 200~300m at 4GHz and 200~350m at 28GHz.
- NR PUCCH in short duration with PF5-like structure (16-bit UCI payload) could support a cell coverage range from 100~150m at 4GHz and 100~200m at 28GHz.
- Higher number of PRBs does not provide benefit in expanding cell coverage, especially in low payload size.

Observation 3:

- PUCCH having 1-symbol duration with above I~V cases can be used for a small cell of up to less than 70~140m at 4GHz and 70~170m at 28GHz.
- Dynamic TDD using PUCCH in short-duration works well in small cell scenarios

Decision: The document is noted.

R1-1700367 Link level evaluation and comparison of sequence vs. DMRS based structure for short UL control channel Intel Corporation

The document was presented by Joonyoung Cho from Intel.

Observations:

- For short UL control channel carrying 1-bit payload
 - DM-RS based structure with perfect channel estimation offers better performance than sequence based structure.
 - With real channel estimation (MMSE), these two structures may deliver similar link level performance.
 - For larger delay spread, DM-RS based structure (with or without channel estimation error) always outperforms sequence based structure.
- For short UL control channel carrying 2-bit payload
 - DM-RS based structure with perfect channel estimation offers ~1 dB better performance than sequence based structure.
 - With real channel estimation (MMSE), DM-RS based structure may fall short of sequence based structure in detection performance by ~2 dB. This gap, however, may reduce with better channel estimate.
 - For larger delay spread, the relative merit of DM-RS based structure (without channel estimation error) over sequence based structure scales with SNR.

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Proposal: For UL control channel with short duration and 1~2 bit payload, DM-RS based structure should be preferred over sequence based structure for NR.

Decision: The document is noted.

Wednesday possible working assumption:

- For UL control channel with short duration and 1~2 bit payload, DM-RS based structure is supported
 - Supported by Intel, Samsung, Nokia, LG (also support sequence based)
 - Objected by Huawei, HiSilicon, MediaTek, Motorola Mobility

[R1-1700262](#) **UL control time position ZTE, ZTE Microelectronics**

The document was presented by Thorsten Schier from ZTE.

- Observation 1: Not all UEs are required to have self-contained capabilities.
- Observation 2: It cannot bring significant benefits if the UL control is placed at the last symbol(s) of the uplink slot.
- Observation 3: With UC at the end of the UL slot, a DL data transmission that occurs in slot n cannot be retransmitted in slot n+2.
- Observation 4: Compared to UC placement at the end of the uplink slot, it can be obtained with more timely HARQ ACK feedback and sufficient retransmission time if the UC is placed in front of the UL data.
- Observation 5: In unlicensed spectrum, UC placed before the uplink data will become more necessary to minimize the number of GAPS to avoid source waste.
- Proposal: NR should also support UC is placed in the starting symbol(s) of uplink transmission part in uplink slot, in addition to being placed in the ending symbol(s) in the slot.

Decision: The document is noted.

Wednesday session

[R1-1701418](#) **WF on PUCCH NTT DOCOMO, INC., Mitsubishi, Panasonic, Qualcomm, Huawei, HiSilicon, Ericsson, Intel, OPPO, InterDigital, CATT, MediaTek, Samsung, LG Electronics, Motorola Mobility**

Agreements:

- For further discussion of PUCCH in short-duration, UCI payload of 1 – at least a few tens of bits (or SR) is assumed.
- For further discussion of PUCCH in long-duration, UCI payload of 1 – at least a few hundreds of bits (or SR) is assumed.
- For PUCCH in long-duration, DFT-s-OFDM waveform is supported.
- For PUCCH in long-duration, transmit antenna diversity is supported.
 - FFS: PUCCH in short-duration

[R1-1701439](#) **WF on resource mapping for one-symbol NR-PUCCH LG Electronics, Panasonic**

[R1-1701340](#) **WF on long duration NR-PUCCH LG Electronics, Intel, Panasonic**

- Inter-slot hopping is supported for multi-slot NR-PUCCH.
 - Intra/inter-slot hopping is configurable by higher layer signaling for multi-slot NR-PUCCH.
- At least following parameters can be configured for long duration NR-PUCCH.
 - For inter/intra-slot hopping,
 - Hopping bandwidth
 - Hopping bandwidth can be configured, e.g., smaller than UE bandwidth.
 - Hopping period (i.e., switching point(s) to perform hopping)
 - Minimum hopping period may need to be defined considering the impact of power transient period, channel estimation, etc.
 - For time-domain resource allocation,
 - Allocated number/location of symbols in a slot (or in each slot for multi-slot NR-PUCCH)
 - FFS: Allocated number/location of slots for multi-slot NR-PUCCH

Decision: The document is noted. [Continue offline.](#)

[R1-1701434](#) **Outcome of offline discussion on Wednesday NTT DOCOMO**

[R1-1700822](#) **Channel multiplexing for long PUCCH Qualcomm Incorporated** [R1-1701123](#) **Short PUCCH Transmission - Impact on Short PUSCH Ericsson**

Thursday session

[R1-1701485](#) **WF on short-duration PUCCH LG Electronics, NTT DOCOMO, Qualcomm**

Possible agreements:

- For a given UE, at least the position of short PUCCH within the configured symbols for short-duration PUCCH is indicated by L1 signaling

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- Short PUCCH format resource that can be dynamically indicated includes at least the the position of short PUCCH within the configured symbols for short-duration PUCCH

Friday session

[R1-1701523](#) WF on PUCCH resource indication for NR **LG Electronics, Qualcomm, NTT DOCOMO, Samsung, Ericsson, Panasonic**
Also supported by Huawei, HiSilicon

Agreements (updating RAN1 #87 agreements):

- A combination of semi-static configuration and (at least for some types of UCI information) dynamic signaling is used to determine the PUCCH resource both for the ‘long and short PUCCH formats’
 - The PUCCH resource includes time, frequency and, when applicable, code domains.
 - FFS details e.g., if the time in the PUCCH resource includes both slot and symbol, or only symbol in a slot

[R1-1701542](#) WF on PUCCH in one symbol short duration low PAPR design **IITH, CEWiT, IITM, Tejas Networks, Huawei, Qualcomm, Interdigital**
Also supported by INL

Not treated.

R1-1700008	UL control channels for CA and DC	Huawei, HiSilicon
R1-1700016	Short duration UL control channel design	Huawei, HiSilicon
R1-1700017	Long duration UL control channel design	Huawei, HiSilicon
R1-1700018	Resource allocation of UL control channel	Huawei, HiSilicon
R1-1700019	Multiplexing of UL control channel and SRS in NR	Huawei, HiSilicon
R1-1700173	Discussion on UL control channel structures with short duration	MediaTek Inc.
R1-1700174	Discussion on multiplexing of short PUCCH and UL data	MediaTek Inc.
R1-1700198	Long PUCCH structure	CATT
R1-1700199	Short PUCCH structure	CATT
R1-1700200	On waveform configuration for PUCCH	CATT
R1-1700261	UL control structure	ZTE, ZTE Microelectronics
R1-1700263	UL control resource design	ZTE, ZTE Microelectronics
R1-1700363	Short UL control channel early in a slot	Intel Corporation
R1-1700364	UL control channel design with short duration	Intel Corporation
R1-1700365	CM evaluation for short UL control channel	Intel Corporation
R1-1700366	Link level evaluation and comparison of DMRS structures for short UL control channel	Intel Corporation
R1-1700368	UL control channel design with long duration	Intel Corporation
R1-1700369	Resource allocation for NR uplink control channel	Intel Corporation
R1-1700370	Scheduling request design for NR	Intel Corporation
R1-1700399	On UCI transmission over PUCCH and PUSCH	Huawei, HiSilicon
R1-1700441	Discussion on long duration UL control channel design	CMCC
R1-1700502	Overall structure of NR-PUCCH formats	LG Electronics
R1-1700503	Design of one-symbol NR-PUCCH format	LG Electronics
R1-1700504	Design of short duration NR-PUCCH format	LG Electronics
R1-1700505	Design of long duration NR-PUCCH format	LG Electronics
R1-1700506	Multiplexing of UL channels and signals in NR	LG Electronics
R1-1700507	Initial evaluation results on NR-PUCCH structures	LG Electronics
R1-1700543	Discussion on uplink control channel for NR	Panasonic Corporation
R1-1700566	Discussion on uplink control channel in short duration	Guangdong OPPO Mobile Telecom.
R1-1700567	Discussion on uplink control channel in long duration	Guangdong OPPO Mobile Telecom.
R1-1700568	Multiplexing of UCI and UL data	Guangdong OPPO Mobile Telecom.
R1-1700569	Resource indication UL control channel	Guangdong OPPO Mobile Telecom.
R1-1700582	Design considerations for UL control channel	ETRI
R1-1700621	UCI transmission procedure with and without uplink data	NTT DOCOMO, INC.
R1-1700623	UL control channel structure in long duration	NTT DOCOMO, INC.
R1-1700657	Design of efficient CQI reports for high reliability transmission	Fujitsu
R1-1700675	MU-MIMO impact on frame structure for NR	Sony
R1-1700729	UCI reporting on PUCCH and PUSCH	Sharp
R1-1700730	5G NR short PUCCH considerations	Sharp
R1-1700731	5G NR long PUCCH considerations	Sharp
R1-1700823	Channelization of short PUCCH	Qualcomm Incorporated
R1-1700824	Location of short PUCCH	Qualcomm Incorporated

R1-1700825	UL transmit diversity for PUCCH	Qualcomm Incorporated
R1-1700864	Considerations on the design of uplink control channel	NEC
R1-1700881	Design for short duration uplink control channel	Motorola Mobility
R1-1700948	On UCI Multiplexing in PUSCH	Samsung
R1-1700949	On UCI Multiplexing with Multi-Layer UL Data Transmissions	Samsung
R1-1700950	UCI and data multiplexing for slot aggregation	Samsung
R1-1700951	UL Control Channel Design: Long Format	Samsung
R1-1700952	UL Control Channel Design: Short Format	Samsung
R1-1700953	UCI and Data Multiplexing	Samsung
R1-1700954	Scaled Numerology for UL Control Channels	Samsung
R1-1700955	Performance Evaluation of UL Control Channels	Samsung
R1-1701014	On the design of long PUCCH for NR	Nokia, Alcatel-Lucent Shanghai Bell
R1-1701015	On the design of short PUCCH for NR	Nokia, Alcatel-Lucent Shanghai Bell
R1-1701016	UCI multiplexing in the presence of UL data	Nokia, Alcatel-Lucent Shanghai Bell
R1-1701017	DFT-S-OFDM impacts in the NR UL design	Nokia, Alcatel-Lucent Shanghai Bell
R1-1701018	On HARQ feedback determination	Nokia, Alcatel-Lucent Shanghai Bell
R1-1701122	Short PUCCH Transmission - Impact on PUSCH Performance	Ericsson
R1-1701124	On Long PUCCH	Ericsson
R1-1701181	On long PUCCH with simultaneous data transmission	Ericsson LM
R1-1701183	On Long PUCCH for Medium to Large Payload Sizes	Ericsson LM
R1-1701353	WF on split symbol design for ULSB	Qualcomm, NTT DOCOMO
R1-1701382	On short (1-symbol) PUCCH design	Ericsson

5.1.3.3 DL/UL data scheduling and HARQ procedure

Mainly for eMBB.

[R1-1700625](#) Data scheduling and HARQ-ACK feedback procedures for NR NTT DOCOMO, INC.

The document was presented by Lihui Wang from NTT DOCOMO.

Proposal 1: A scheduling unit having 7 symbols or more is realized by aggregating one or more of a slot.

- Each slot having 7 symbols contains all DL, all UL, or {one DL part and one UL part}.

Proposal 2:

- For DL data scheduling:
 - Minimum timing between DL assignment and the scheduled DL data is zero for all UEs.
- For UL data scheduling:
 - Minimum timing between a UL grant and the scheduled UL data can be different among UEs.
- For DL HARQ-ACK:
 - Minimum timing between a DL data and its HARQ-ACK feedback can be different among UEs.

Proposal 3: Use a combination of indication by higher layers and dynamic L1 signaling (e.g., DCI) to achieve above flexible timings.

Proposal 4:

- Default timing value(s) is necessary for RRC reconfiguration the timing values or before RRC configuration is obtained and/or for signalling transmitted in common channels.
 - The default timing for DL assignment and the scheduled DL data is zero.
 - The default timing for UL data scheduling and DL HARQ-ACK should be 4 for SCS = 15KHz and 1 slot = 14 symbols.
 - FFS the default value for other SCS and/or other number of symbols per slot.
- Default timing value(s) can be applied with or without timing indication field.

Proposal 5: For UL HARQ-ACK,

- Re-transmission or new data transmission is scheduled by a UL grant.

Proposal 6: For HARQ-ACK bundling/multiplexing,

- Both dynamic and semi-static HARQ-ACK codebook size adaptation is supported with reasonable increases in control signaling overhead and scheduler complexity.
 - FFS: code-block or code-block-group based HARQ-ACK feedback

Decision: The document is noted.

[R1-1700696](#) On the number of HARQ processes Ericsson

The document was presented by Daniel Larsson from Ericsson.

- Determine the number of HARQ processes in NR considering
 - Supported cell sizes
 - Fronthaul delay
 - UE processing time
 - eNB processing time
 - Different numerologies
 - Soft buffer memory strategy in the UE

- Number of HARQ processes stored

Decision: The document is noted.

R1-1700026 Scheduling scheme for slot aggregation Huawei, HiSilicon

The document was presented by David Mazzaresse from Huawei.

- Proposal 1: Single DCI can schedule one or multiple slots, where the number of scheduled slots is dynamically indicated.
- Proposal 2: One and multiple TBs can be mapped on multiple slots which are scheduled by single DCI.
- Following options can be considered.
 - Option 1: Single DCI schedules 1 TB and N slots, where the TB is mapped across multiple slots.
 - Option 2: Single DCI schedules N TBs and N slots, where each TB is mapped on one slot.
 - Option 3: Single DCI schedules M TBs and N slots. The details for data mapping can be further studied.

Decision: The document is noted.

R1-1700958 TB/CB handling for eMBB Samsung

The document was presented by ... from Samsung.

- Observation 1: Single slot scheduling with CBG-level HARQ-ACK and multi-slot scheduling for multiple TBs with TB-level HARQ-ACK supports efficient partial retransmission for eMBB.
- Observation 2: Single mini-slot scheduling for eMBB is not proper.
- Observation 3: If multiple mini-slots scheduling is supported, both TB-level and CBG-level could be considered to support partial retransmission for eMBB.
- Proposal: Support the flexible configuration of proper TB/CB mechanism, including,
 - Switching between single slot scheduling with CBG-level HARQ-ACK and multi-slot scheduling for multiple TBs with TB-level HARQ-ACK.
 - Configuring variable number of CBGs for CBG-level HARQ-ACK feedback/retransmission.

Decision: The document is noted.

Tuesday session

R1-1701330 Multiple HARQ ACK bits per TB Samsung, NTT DOCOMO, Fraunhofer HHI, Lenovo, Nokia, Alcatel-Lucent Shanghai Bell, MediaTek, ZTE, ZTE Microelectronics

- HARQ-ACK feedback with one bit per TB is supported.
- HARQ-ACK feedback with more than one bit per TB is supported.

Discussion: Also supported by HTC

Decision: The document is noted.

Agreement:

- HARQ-ACK feedback with one bit per TB is supported.

Possible agreement:

- HARQ-ACK feedback with more than one bit per TB is supported.

Agreements (Thursday):

- RAN1 will down select between the following options to utilize HARQ-ACK feedback with more than one bit per TB until the next meeting
 - Option 1: CB-group based re-transmission (Samsung)
 - Option 2: Decoder state information feedback (Nokia)
 - Option 3: CB-level outer erasure code (Qualcomm)
 - Option 4: Any combination of Option 1-3
 - Other options are not precluded
- Note that if RAN1 cannot reach consensus in the next meeting, no support of utilization HARQ-ACK feedback with more than one bit per TB in Rel-15.

Wednesday session

R1-1701354 WF on scheduling and HARQ-ACK feedback timing NTT DOCOMO, INC., Nokia, Alcatel-Lucent Shanghai Bell, Panasonic, LG Electronics, Ericsson, Huawei, HiSilicon

Agreements:

- Timing between DL assignment and corresponding DL data transmission is indicated by a field in the DCI from a set of values
 - The set of values is configured by higher layer
- Timing between UL assignment and corresponding UL data transmission is indicated by a field in the DCI from a set of values

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- The set of values is configured by higher layer
- Timing between DL data reception and corresponding acknowledgement is indicated by a field in the DCI from a set of values
 - The set of values is configured by higher layer
- Timing(s) is (are) defined at least for the case where the timing(s) is (are) unknown to the UE
 - FFS the value for the timing

R1-1701443 WF on HARQ process number Huawei, HiSilicon, Nokia

- The number of HARQ processes is configurable to UE at least in a semi-static way

Discussion: Also supported by CATT.

Decision: The document is noted. Continue offline.

R1-1701440 WF on HARQ timing for NR LG Electronics, NTT DOCOMO, Huawei

Agreements:

- NR UE supports a set of minimum HARQ processing time
 - FFS: set size
- NR supports different minimum HARQ processing time at least for across UEs
 - The HARQ processing time at least includes:
 - Delay between DL data reception timing to the corresponding HARQ-ACK transmission timing
 - Delay between UL grant reception timing to the corresponding UL data transmission timing
 - NR UE is required to indicate its capability of minimum HARQ processing time to gNB
 - FFS how the capability is indicated by UE
 - e.g. reported processing time granularity
 - e.g. dependency of DMRS pattern configuration
 - FFS definition of minimum HARQ processing time

R1-1701444 WF on scheduling for slot and slot aggregation Huawei, HiSilicon

- For slot aggregation, the number of aggregated slots for a given UE can be dynamically indicated in DCI
 - NR supports single DCI schedules one TB mapped across multiple slots
 - FFS: Single DCI schedules one or multiple TBs mapped on one slot.

Decision: The document is noted.

Possible agreement:

- If slot aggregation is configured, the number of aggregated slots for a given UE can be dynamically indicated in DCI
 - NR supports single DCI schedules one TB mapped across multiple slots
 - FFS: Single DCI schedules one or multiple TBs mapped on one slot.

Thursday session

R1-1701491 WF on Resource Allocation Huawei, HiSilicon, OPPO, Nokia, Panasonic, NTT DoCoMo, InterDigital, Fujitsu

For FDM/TDM of numerologies, NR supports partitioning of carrier BW into sub-bands

- Each sub-band is associated with one numerology for a transmission.
- PRBs can be indexed over a sub-band or multiple sub-bands of a given carrier BW
- The sub-band configuration and/or the associated numerology is signaled to UEs (FFS: semi-statically and/or dynamically)
 - FFS sub-band signaling is UE specific and/or cell specific
- Note: sub-band refers to a confined frequency partition, where each partition has a BW less or equal to the carrier BW.

Decision: The document is noted. Continue offline.

Not treated.

R1-1700009	Power control for CA and DC	Huawei, HiSilicon
R1-1700020	Discussion on timing relations and signaling of HARQ timing for NR	Huawei, HiSilicon
R1-1700028	Dynamic resource allocation of different numerologies	Huawei, HiSilicon
R1-1700029	Discussion on resource allocation and indication for data channel	Huawei, HiSilicon
R1-1700030	Consideration of PRB misalignment between NR and LTE in the coexistence case	Huawei, HiSilicon
R1-1700165	DL/UL data scheduling and HARQ procedure	MediaTek Inc.
R1-1700202	NR Scheduling and HARQ operation	CATT
R1-1700371	Scheduling and bandwidth configuration in wide channel bandwidth	Intel Corporation
R1-1700372	Time Domain Aspects of NR Data Scheduling	Intel Corporation
R1-1700373	Frequency Domain Aspects of NR Data Scheduling	Intel Corporation

R1-1700400	Number of HARQ processes	Huawei, HiSilicon
R1-1700402	Consideration of NR signals and channels mapping around LTE CRS	Huawei, HiSilicon
R1-1700508	Discussion on HARQ timing and resource for NR	LG Electronics
R1-1700509	Discussion on scheduling in time domain for NR	LG Electronics
R1-1700510	Discussion on potential HARQ operation for NR	LG Electronics
R1-1700511	Discussion on control signaling for HARQ in NR	LG Electronics
R1-1700541	HARQ timing design in	Panasonic Corporation
R1-1700544	Discussion on flexible bandwidth operation in NR	Panasonic Corporation
R1-1700555	On data scheduling of eMBB and URLLC	Lenovo
R1-1700556	Enhanced HARQ feedback for downlink transmission	Lenovo
R1-1700570	DL resource allocation and indication for NR	Guangdong OPPO Mobile Telecom.
R1-1700588	Enhanced HARQ for NR	HTC Corporation
R1-1700624	Processing time and HARQ process number for NR	NTT DOCOMO, INC.
R1-1700676	Discussion on DL/UL data scheduling and HARQ procedure	Sony
R1-1700695	On timing of uplink hybrid-ARQ acknowledgement	Ericsson
R1-1700706	Multi-bit HARQ feedback INTERDIGITAL COMMUNICATIONS	
R1-1700707	HARQ feedback for downlink	INTERDIGITAL COMMUNICATIONS
R1-1700728	DL HARQ and UL scheduling timing in NR	Sharp
R1-1700826	Number of HARQ processes	Qualcomm Incorporated
R1-1700869	NR HARQ Procedures in Different UL/DL Slot Length	KT Corp.
R1-1700872	On Indicating HARQ timing and PUCCH resource	ZTE Corporation, ZTE Microelectronics
R1-1700956	HARQ-ACK feedback for CA with Different Numerologies	Samsung
R1-1700957	HARQ-ACK Feedback with Flexible Timing	Samsung
R1-1700959	Discussion on partial retransmission for eMBB	Samsung
R1-1700960	Evaluation results of partial retransmission for eMBB	Samsung
R1-1700961	DCI Formats and Contents for NR	Samsung
R1-1700962	Slot aggregation in DL	Samsung
R1-1701019	On HARQ/scheduling timing and self-contained operation	Nokia, Alcatel-Lucent Shanghai Bell
R1-1701020	Enriched feedback for adaptive HARQ	Nokia, Alcatel-Lucent Shanghai Bell
R1-1701021	HARQ operation for large transport block sizes	Nokia, Alcatel-Lucent Shanghai Bell
R1-1701022	On the Number of HARQ Processes	Nokia, Alcatel-Lucent Shanghai Bell
R1-1701043	Resource allocation for data channel in NR	ASUSTEK COMPUTER (SHANGHAI)

5.1.3.4 URLLC specific aspects

Including multiplexing of eMBB/URLLC.

[R1-1700972](#) Summary of e-mail discussion on multiplexing eMBB and URLLC in DL Samsung

The document highlighted the following proposals:

- Support indication of time and/or frequency region of preempted/impacted eMBB resources to respective eMBB UE(s)
 - FFS: Details of granularity of indication for preempted/impacted region
 - Granularity could be symbol (group)/mini-slot (group)/CB (group)/TB.
 - The indication can be during and/or after current eMBB TTI.
- For URLLC, support PRB or multiple PRBs level granularity for frequency-domain scheduling unit as a baseline.

Decision: The document is noted.

Possible agreements:

- Support indication of time and/or frequency region of impacted eMBB resources to respective eMBB UE(s)
 - FFS: Details of granularity of indication for impacted region
 - Granularity could be symbol (group)/mini-slot (group)/CB (group)/TB
 - The indication can be during and/or after current eMBB TTI

Continue offline discussion until Wednesday – Yeohun (Samsung)

Wednesday

[R1-1701456](#) Summary of offline discussion on multiplexing of eMBB and URLLC in DL Samsung, ZTE, Qualcomm, NTT Docomo, Sony, Oppo, Sequans, Sharp

Also supported LG

Agreements:

- For DL, support indication of time and/or frequency region of impacted eMBB resources to respective eMBB UE(s)
 - FFS: Details of the granularity for impacted region used in the indication
 - e.g., PRB (group)/symbol (group)/mini-slot (group)/CB (group)/TB/Slot
 - The indication is transmitted at one of the following (will be down selected later)
 - during current eMBB TTI
 - after current eMBB TTI

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- during and after current eMBB TTI
- The indication is one of the following (will be down selected later)
 - explicit
 - implicit
 - explicit and implicit

R1-1701318 **WF on resource configuration for UL grant-free transmission** **Huawei, HiSilicon, CATR, CATT, Ericsson, Fujitsu, Spreadtrum**

- For an UL transmission scheme without grant
 - at least semi-static resource (re-)configuration is supported
 - The resource includes at least physical resource(s) in time and frequency domain and RS parameters,
 - The resource is configured at least via higher layer signaling, e.g. like in LTE semi-persistent scheduling mechanism
 - FFS additional complementary signaling,
 - FFS MCS
 - RS is transmitted together with data
 - channel structure of grant-based data transmission can be starting point
 - DMRS design as in UL MU-MIMO can be starting point

Decision: The document is noted, modified and agreed as follows:

Agreements:

- For an UL transmission scheme without grant
 - at least semi-static resource (re-)configuration is supported
 - FFS: The resource configuration includes at least physical resource in time and frequency domain and RS parameters
 - Higher-layer signaling could be similar to Rel-8 LTE SPS
 - FFS: MCS
 - RS is transmitted together with data
 - channel structure of grant-based data transmission can be starting point

R1-1701319 **WF on consecutive transmission for URLLC** **Huawei, HiSilicon, Ericsson, NTT Docomo, Spreadtrum, Intel**

- For an UL transmission scheme without grant
 - K transmissions ($K \geq 1$) for the same transport block with semi-static configured resources are supported,
 - FFS the way K is determined, e.g.,
 - Option 1: the number of transmissions until ACK is received, or
 - Option 2: a pre-configured or fixed number
 - FFS: hopping mechanisms over the transmissions

Decision: The document is noted, modified and agreed as follows:

Agreements:

- For an UL transmission scheme with/without grant
 - K repetitions including initial transmission (with the same or different RV and FFS with different MCS) ($K \geq 1$) for the same transport block are supported
 - FFS the way K is determined
 - FFS: hopping mechanisms over the transmissions

R1-1701310 **WF on retransmission for UL URLLC** **ZTE, ZTE Microelectronics, NTT Docomo**

- Dynamic switching from grant free transmission to grant based retransmission is supported
 - If UL grant containing UE identification and scheduling information is received, UE switches to grant based retransmission.
 - Otherwise, UE can continue grant free transmission.
 - FFS details on identifying UE from grant free transmission

Decision: The document is noted. Continue offline discussion until Wednesday – Shupeng (ZTE)

Wednesday

R1-1701459 **WF on retransmission for UL URLLC** **ZTE, ZTE Microelectronics, NTT Docomo, Sony, CATT, Qualcomm, CEWiT, IITH, IITM, Tejas Networks**

Also supported by Idaho National Laboratory, Nokia

Possible agreements:

- gNB can schedule grant based transmission after receiving grant free transmission for the same UE

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- UL grant overrides any UL grant free transmission in the same slot or mini-slot
- Switching from UL grant free transmission to grant based re-transmission is supported
 - FFS some UE can be configured not to receive UL grant

Continue offline discussion until Thursday – Shupeng (ZTE)

Friday

R1-1701505 WF on retransmission for UL URLLC ZTE, ZTE Microelectronics, NTT Docomo, Huawei, Hisilicon, Intel, CATT, Nokia, ASB, Sony, CEWiT, IITH, IITM, Tejas Networks, InterDigital

R1-1701543 WF on retransmission for UL URLLC ZTE

Wednesday session

R1-1701404 WF on scheduling-based approach for DL dynamic resource sharing between URLLC and eMBB Huawei, Hisilicon, NTT DOCOMO, CATT, CATR, Ericsson, vivo, MediaTek, Panasonic, InterDigital, LGE, Nokia, AT&T, China Unicom, Sequans, OPPO

Agreements:

- DL dynamic resources sharing between eMBB and URLLC is supported without pre-emption by scheduling the eMBB and URLLC services on non-overlapping time/frequency resources.
 - No specific specification work is expected
- The above should be captured into TR 38.802

R1-1701214 WF on URLLC & eMBB with Indication Sony, Sequans, MediaTek

Possible agreements:

- For DL, dynamic resource sharing between URLLC and eMBB, a post-indicator is transmitted to the eMBB UE after the URLLC pre-emption
 - post-indicator indicates the eMBB resources that are pre-empted (punctured/superposed) by URLLC transmission
 - The post-indicator can optionally schedule a retransmission of the portion of eMBB transmissions that is pre-empted by URLLC
 - FFS whether the post-indicator is within the same eMBB TTI or in the next eMBB scheduling interval

R1-1701436 WF on DL transmission for URLLC LG Electronics, Ericsson, Huawei, Hisilicon, Samsung, OPPO

Possible agreements:

- For an DL transmission scheme
 - N repetitions including initial transmission (with the same or different RV and FFS with different MCS) ($N \geq 1$) for the same transport block are supported,
 - FFS the way N is determined

R1-1701405 WF on NR-PDCCH design for URLLC Huawei, Hisilicon, CATR, Sony, Samsung, Ericsson, Qualcomm, ZTE, ZTE Microelectronics

Also supported by Nokia, CATT

Agreements:

- To ensure the reliability requirement of NR-PDCCH for URLLC, at least the following aspects should be supported
 - Defining a compact DCI format targeting low BLER operation
 - The highest aggregation level should target a BLER of Y for this compact DCI format
 - FFS Y, $Y < 1\%$
 - FFS highest aggregation levels, e.g., 16, 32
 - FFS other enhancements

Friday session

R1-1701508 WF on NR-PDCCH Blocking Probability for URLLC InterDigital, NTT DOCOMO, Intel

Agreement Blocking probability of DL control channel should be taken into account in NR-PDCCH design

R1-1701494 SR-triggered UL transmission for URLLC LG Electronics, Intel, OPPO, Lenovo

Revised in **R1-1701548** SR-triggered UL transmission for URLLC LG Electronics, Intel, OPPO, Lenovo, Ericsson, NTT Docomo, CATT, Nokia, ASB, Qualcomm

Agreement Time interval between SR resources configured for a UE can be smaller than a slot

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[R1-1701524](#) WF on Scheduling Request for URLLC UL transmissions Idaho National Laboratory, Qualcomm
[R1-1700268](#) Zero-wait-time Scheduling Request Underlay Channel Idaho National Laboratory

Not treated.

[R1-1700021](#) Control channel design for URLLC Huawei, HiSilicon
[R1-1700022](#) On DL multiplexing of URLLC and eMBB transmissions Huawei, HiSilicon
[R1-1700023](#) Discussion on mini-slot for URLLC Huawei, HiSilicon
[R1-1700024](#) Support of URLLC in UL Huawei, HiSilicon
[R1-1700025](#) On UL multiplexing of URLLC and eMBB transmissions Huawei, HiSilicon
[R1-1700154](#) On dynamic multiplexing between eMBB & URLLC for DL MediaTek Inc.
[R1-1700176](#) URLLC and eMBB DL Multiplexing using CRC masking and multi-bit NACK feedback MediaTek Inc.
[R1-1700204](#) NR frame structure for multiplexing of URLLC and eMBB traffic CATT
[R1-1700205](#) URLLC HARQ operation CATT
[R1-1700206](#) UL grant-free transmission for URLLC CATT
[R1-1700207](#) DL control channel monitoring for URLLC based on mini-slot scheduling CATT
[R1-1700253](#) Basic grant-free transmission for URLLC ZTE, ZTE Microelectronics
[R1-1700254](#) Advanced grant-free transmission for URLLC ZTE, ZTE Microelectronics
[R1-1700264](#) About URLLC/eMBB multiplexing ZTE, ZTE Microelectronics
[R1-1700265](#) Analysis of URLLC reliability in DL HARQ ZTE, ZTE Microelectronics
[R1-1700281](#) Discussion on URLLC and eMBB multiplexing vivo
[R1-1700374](#) Downlink multiplexing of eMBB and URLLC transmissions Intel Corporation
[R1-1700376](#) Uplink URLLC transmission based on scheduling request and grant Intel Corporation
[R1-1700377](#) Uplink multiplexing of eMBB and URLLC transmissions Intel Corporation
[R1-1700378](#) URLLC link adaptation aspects Intel Corporation
[R1-1700401](#) Support of URLLC in DL Huawei, HiSilicon
[R1-1700442](#) Discussion on eMBB/URLLC multiplexing CMCC
[R1-1700448](#) Multiplexing of eMBB and URLLC in DL NEC
[R1-1700452](#) Consideration on URLLC HARQ design Beijing Xiaomi Mobile Software
[R1-1700454](#) Discussion on resource configuration for UL URLLC Potevio
[R1-1700455](#) Discussion on URLLC transmission aspects Potevio
[R1-1700512](#) Discussion on multiplexing of eMBB and URLLC LG Electronics
[R1-1700513](#) Discussion on URLLC UL transmission LG Electronics
[R1-1700514](#) Discussion on URLLC HARQ operation and reliability enhancement schemes LG Electronics
[R1-1700515](#) SLS results on coexistence between eMBB and URLLC LG Electronics
[R1-1700554](#) Overview on URLLC design and the coexistence with eMBB Lenovo
[R1-1700557](#) HARQ design for UL grant-free URLLC transmission Lenovo
[R1-1700558](#) UL eMBB transmission multiplexing with UL URLLC Lenovo
[R1-1700571](#) Uplink grant-less transmission for URLLC Guangdong OPPO Mobile Telecom.
[R1-1700572](#) On multiplexing eMBB and URLLC in DL Guangdong OPPO Mobile Telecom.
[R1-1700583](#) Multiplexing eMBB and URLLC UL control channels ETRI
[R1-1700586](#) Discussion on eMBB and URLLC multiplexing in UL III
[R1-1700626](#) On multiplexing of eMBB and URLLC in downlink NTT DOCOMO, INC.
[R1-1700627](#) On UL grant free for URLLC NTT DOCOMO, INC.
[R1-1700640](#) Considerations of grant-free transmission of UL URLLC Sequans Communications
[R1-1700642](#) On dynamic resource sharing between URLLC and eMBB in DL Sequans Communications
[R1-1700647](#) Aggressive early Hybrid ARQ for NR Fraunhofer HHI
[R1-1700658](#) DL Scheduling and UL control information for URLLC Fujitsu
[R1-1700659](#) Preemption based multiplexing eMBB and URLLC Fujitsu
[R1-1700660](#) Discussions on grant-free for UL URLLC Fujitsu
[R1-1700677](#) Considerations on Dynamic Resource Sharing for eMBB/URLLC in DL Sony
[R1-1700678](#) Discussion on Grant-free based transmission Sony
[R1-1700681](#) Feedback for URLLC transmissions Sony
[R1-1700684](#) On URLLC characteristics Ericsson
[R1-1700685](#) On URLLC design principles Ericsson
[R1-1700686](#) On aspects of downlink control for high-reliability communication Ericsson
[R1-1700687](#) On high-level considerations on URLLC design Ericsson
[R1-1700688](#) Discussion on URLLC puncturing of data Ericsson
[R1-1700689](#) Framework for grant-free access for URLLC Ericsson
[R1-1700690](#) Contention resolution for grant-free access Ericsson
[R1-1700691](#) On Reference Signal Design for Grant-free Access Ericsson
[R1-1700692](#) Synchronization aspects for grant-free access Ericsson
[R1-1700693](#) Resource Configuration for Grant-free Access Ericsson
[R1-1700718](#) Blocking probability of control channel for URLLC InterDigital Communications

R1-1700719	URLLC Scheduling and HARQ considerations	InterDigital Communications
R1-1700720	High Reliable Transmission for URLLC by Network Coding	InterDigital Communications
R1-1700721	Preemption/superposition-based multiplexing of eMBB and URLLC	InterDigital Communications
R1-1700722	Scheduling-based URLLC and eMBB multiplexing	InterDigital Communications
R1-1700737	A narrative on potential solutions for eMBB and URLLC multiplexing contextualized by 5G requirements	
	Sharp	
R1-1700738	Further results on Outer Codes for eMBB/URLLC coexistence	Sharp
R1-1700827	URLLC/eMBB dynamic multiplexing schemes	Qualcomm Incorporated
R1-1700828	Simultaneous scheduling request and data transmission for uplink URLLC	Qualcomm Incorporated
R1-1700964	DMRS consideration for multiplexing of eMBB and URLLC	Samsung
R1-1700966	Preemption-based multiplexing between eMBB and URLLC for DL	Samsung
R1-1700967	URLLC control channel	Samsung
R1-1700968	Performance of eMBB receiver with blind detection for preempted eMBB resources	Samsung
R1-1700969	Evaluation Results of Superposition for Multiplexing eMBB and URLLC	Samsung
R1-1700970	Performance of eMBB with HARQ retransmission for multiplexing eMBB and URLLC	Samsung
R1-1700971	Dynamic TDD for Latency Reduction	Samsung
R1-1700973	User plane latency for URLLC	Samsung
R1-1700974	Dynamic Resource Selection for UL URLLC Channels	Samsung
R1-1701007	Discussions on the multiplexing for eMBB and URLLC	CATR
R1-1701009	HARQ retransmission in grant-free NOMA	HTC Corporation
R1-1701023	Punctured Scheduling for Low Latency Downlink Transmissions	Nokia, Alcatel-Lucent Shanghai Bell
R1-1701024	Pause-Resume Scheduling for Low Latency Uplink Transmissions	Nokia, Alcatel-Lucent Shanghai Bell
R1-1701025	Overview of UL data transmission schemes for URLLC	Nokia, Alcatel-Lucent Shanghai Bell
R1-1701026	Contention-based grant-free transmission for URLLC	Nokia, Alcatel-Lucent Shanghai Bell
R1-1701027	Flexible semi-persistent scheduling for UL URLLC	Nokia, Alcatel-Lucent Shanghai Bell
R1-1701067	Discussion on Multiplexing between eMBB and URLLC in DL	WILUS Inc.
R1-1701139	Discussion on eMBB and URLLC mixing	Conviva Wireless LLC
R1-1701179	UL Data Channel Transmission for URLLC	Samsung Research America
R1-1701206	Uplink URLLC transmission without grant	Intel Corporation
R1-1701335	SR-triggered UL transmission	LG Electronics, Intel

5.1.3.5 Other

R1-1700266	Implicit DC indication	ZTE, ZTE Microelectronics
R1-1700280	RNTI and CRC size for NR	vivo
R1-1700428	Enhanced redundancy matching and HARQ transmission process in NR	ITRI
R1-1700708	Impact of supporting different numerologies	INTERDIGITAL COMMUNICATIONS
R1-1700963	UL Power Control for CA with Different Numerologies	Samsung

5.1.4 Mini-slot design

Including mini-slot length(s)

[R1-1700617](#) Summary of [87-36]: Mini-slot designs for NR NTT DOCOMO, INC.

The document was presented by Fred Takeda from NTT DOCOMO.

- Take into account following targets/use-cases to design mini-slots:
 - Support of very low latency including URLLC for certain slot lengths
 - Target slot lengths are at least 1ms, 0.5ms, [0.25ms], 1ms and 0.5ms.
 - Support of finer TDM granularity of scheduling for the same/different UEs within a slot
 - Especially if TRxP uses beam-sweeping (e.g., above 6GHz).
 - NR-LTE co-existence
 - Note that this use case also exists for slot-based scheduling
 - Forward compatibility towards unlicensed spectrum operation
 - FFS until phase II
- Take the following into account for designing slot-level channels/signals/procedures:
 - Possible occurrence of mini-slot/slot transmission(s) occupying resources scheduled for ongoing slot transmission(s) of a given carrier for the same/different UEs
 - At least one of DMRS format/structure/configuration for slot-level data channel is re-used for mini-slot-level data channel
 - At least one of DL control channel format/structure/configuration for slot-level data scheduling is designed to be applicable to mini-slot-level data scheduling
 - At least one of UL control channel format/structure/configuration for slot-level UCI feedback is designed to be applicable to mini-slot-level UCI feedback
- Take the following into account as starting point for designing mini-slot-level channels/signals/procedures:

- Possible occurrence of mini-slot/slot transmission(s) occupying resources scheduled for ongoing slot transmission(s) of a given carrier for the same/different UEs
- DMRS for mini-slot-level data channel is just a re-use of that for slot-level data channel
- DL control channel for mini-slot-level data scheduling is just a re-use of that for slot-level data scheduling
- UL control channel for mini-slot-level UCI feedback is just a re-use of that for slot-level UCI feedback
- Scheduling/HARQ timelines for a mini-slot can be based on scheduling/HARQ timelines for a slot
- Scheduling/HARQ timelines for a mini-slot can be based on scheduling/HARQ timelines shorter than those for a slot. FFS: exact timelines
- FFS: One mini-slot does not contain symbols for different link directions (i.e., DL-only or UL-only)

Decision: The document is noted. **Summary is agreed** including the above modifications.

R1-1700282 MBMS design in Mini-slot below 6 GHz vivo

The document was presented by Ding Yu from Vivo.

- Proposal 1: MBMS design in Mini-slot level multiplexing with unicast should be introduced at the first stage for NR.
- Proposal 2: At least one subcarrier spacing in numerology family with $15 \text{ kHz} \cdot 2^n$ (7.5 kHz or 3.75 kHz) should be supported for NR MBSFN Mini-slot below 6 GHz.

Decision: The document is noted.

R1-1700424 About mini-slot design ZTE, ZTE Microelectronics, Nokia, Ericsson

The document was presented by Thorsten Schier from ZTE.

Proposal 1: RAN1 should strive for a mini-slot design that is agnostic to the sub-carrier spacing (and carrier frequency), and would have maximal commonality with the slot design.

Proposal 2: The specific mini-slot configurations shall be derived from the same generic mini-slot frame-work

- Note: The 1-symbol mini-slot may require specific optimizations.

Proposal 3: Mini-slots should have the following properties

- Mini-slot of length 1 is supported in general (not just for above 6 GHz)
- Mini-slots can have a floating starting position, i.e. can start at any OFDM symbol
 - Mini-slot length and starting position can be defined independently from each other
- A contiguous mini-slot based transmission may cross slot boundaries.
 - Note: This is regardless whether the mini-slot based transmission is built up of one or several aggregated mini-slots.
- Mini-slot based transmissions can be aligned with 1 ms sub-frame boundaries by scheduler implementation.
 - Note: specification does not need to enforce this, just enable this
- At least at 2 and 4 OS mini-slot based transmission is supported
 - FFS if it shall be realized by one 4 OS mini-slot or an aggregation of $2 \cdot 2\text{OS}$ mini-slots
 - Other lengths FFS
- Control monitoring is possible at every symbol
 - Note: This does not apply to all UEs
- For TDD, the mini-slot should be DL-only or UL-only, and not contain UL/DL switching gap, at least for shorter mini-slots lengths

Decision: The document is noted.

R1-1700381 Demodulation reference signals design aspects for URLLC mini-slots Intel Corporation

The document was presented by Alexey Khoryaev from Intel.

- Proposal 1
 - Further study reference signal structures considering the URLLC specific design implications.
 - Consider a wide range of channel conditions and different SINR regimes for evaluation of URLLC reference signals to achieve the very low target BLER requirements.
- Proposal 2
 - URLLC reference signal design should take into account potential interference variation during mini-slot transmission.
 - Consider “each-symbol” or “every two symbol” RS patterns in application to URLLC services.

Decision: The document is noted.

R1-1700628 Mini-slot for latency reduction NTT DOCOMO, INC.

The document was presented by Lihui Wang from NTT DOCOMO.

Proposal 1: Take into account slot-level design/operation for mini-slot design/operation.

- The length, position and alignment of mini-slot operation for latency reduction can be concluded after identifying slot-level designs further.

Proposal 2: Take into account LTE sTTI for the design of mini-slot for latency reduction.

- Control channels and DMRS for a data in a mini-slot should be contained in the given mini-slot to achieve fast decoding/scheduling/HARQ-ACK feedback.
- UE configured with mini-slot for latency reduction is assumed to be configured with slot-level operation.
 - ✧ Mini-slot configuration is provided by RRC signalling.
 - ✧ No stand-alone operation only by mini-slot is considered.

Decision: The document is noted.

R1-1700829 Mini-slot design for URLLC Qualcomm Incorporated

The document was presented by Jing Jiang from Qualcomm.

- Proposal 1: Mini-slots should be aligned with NCP-symbol boundaries of eMBB data numerology of the slot across different sub-carrier spacings.
- Proposal 2: Mini-slot aggregation should be supported in NR.
- Proposal 3: NR should support mini-slot length for URLLC only of 2 and 4 symbol duration.
- Proposal 4: Mini-slots control interval for URLLC is defined on a configurable grid, every mini-slot.
- Observation 1: 2-symbol and 4-symbol mini-slots with 60kHz SCS and NCP have substantial performance gain compared with 7-symbol mini-slot with 60kHz SCS and NCP.
- Observation 2: A 2-symbol mini-slot with 30kHz and NCP has substantial performance gain compared with 6-symbol mini-slot with 60kHz based on LTE ECP numerology.
- Observation 3: HARQ RTT should be carefully optimized to achieve high reliability with low latency for NR URLLC in addition to latency reduction based on numerology scaling and subframe shortening.

Decision: The document is noted.

R1-1701207 WF on mini-slots ZTE, ZTE Microelectronics, Ericsson, Nokia, Qualcomm, Convida Wireless

The document was presented by Thorsten Schier from ZTE.

Mini-slots shall have the following properties

- Length 1 is supported in general (not just for above 6 GHz)
- Can be configured to have a floating starting position, i.e. can start at any OFDM symbol
 - Mini-slot length and starting position can be defined independently from each other
- Mini-slot occurrence and monitoring interval can be configured on a fixed grid
- A contiguous mini-slot based transmission may cross slot boundaries.
- Mini-slot based transmissions can be aligned with 1 ms sub-frame boundaries by scheduler implementation.
 - Note: specification does not need to enforce this, just enable this
- At least at 2 and 4 OS mini-slot based transmission is supported
 - FFS if it shall be realized by one 4 OS mini-slot or an aggregation of 2 * 2OS mini-slots
 - Other length FFS
- Control monitoring can be configured to be possible at every symbol
 - Note: This does not apply to all UEs
- For TDD, the mini-slot should be DL-only or UL-only, and not contain UL/DL switching gap, at least for shorter mini-slots lengths (for example 2-symbol mini-slot)

Decision: The document is noted. Continue offline discussion until Tuesday evening – (ZTE)

Tuesday session

R1-1701343 Summary of off-line discussion Mini-slots ZTE, ZTE Microelectronics

The document was presented by Thorsten Schier from ZTE.

Discussion: Ericsson → all what RAN1 needs about mini-slots to complete the SI phase is there

Decision: The document is noted.

Thursday session

R1-1701336 WF on coexistence between slot and mini-slot LG Electronics, NTT DOCOMO, Panasonic

- For DL dynamic multiplexing of eMBB & URLLC where URLLC can puncture on-going eMBB transmission,
 - Avoiding URLLC transmission to be overlapped with at least following signals of eMBB transmission should be supported
 - Control channel
 - RS for control
 - RS for data
 - FFS on other signals
 - FFS on how to handle the above issue

Decision: The document is noted.

Not treated.

R1-1700027 Mini-slot usage for eMBB above 6GHz Huawei, HiSilicon

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[R1-1700208](#) Mini-slot and slot configuration CATT
[R1-1700209](#) DL control channel design for mini-slot based scheduling CATT
[R1-1700321](#) Mini Slot Design and Operations in NR AT&T
[R1-1700322](#) Scheduling on Mini-Slot in NR AT&T
[R1-1700379](#) Considerations on mini-slot for NR Intel Corporation
[R1-1700380](#) Mini-slot length and start time for URLLC Intel Corporation
[R1-1700420](#) Discussion on the usage of mini-slot in unlicensed band below 6GHz Huawei, HiSilicon
[R1-1700516](#) Discussion on frame structure for Mini-slot LG Electronics
[R1-1700517](#) Discussion on control/data and DM-RS design for Mini-slot LG Electronics
[R1-1700573](#) Discussion on mini-slot for mmWave eMBBGuangdong OPPO Mobile Telecom.
[R1-1700629](#) Mini-slot for analog beam-forming NTT DOCOMO, INC.
[R1-1700661](#) Discussion on reference signal in mini-slot Fujitsu
[R1-1700853](#) Design considerations for mini-slots InterDigital Communications
[R1-1700858](#) Downlink scheduling using slots and mini-slots INTERDIGITAL COMMUNICATIONS
[R1-1700861](#) DCI monitoring configuration for mini-slot NEC
[R1-1700862](#) Time domain resource allocation for mini-slot NEC
[R1-1700975](#) Design Aspects of Mini-slot Structure Samsung
[R1-1701051](#) On the mini-slot scenarios in NR Nokia, Alcatel-Lucent Shanghai Bell
[R1-1701052](#) On the mini-slot design in NR Nokia, Alcatel-Lucent Shanghai Bell
[R1-1701140](#) Control Channel Design with Mini Slot Convida Wireless LLC
[R1-1701144](#) On the number of symbols in a slot and TTI for mini-slot multiplexing Nokia, Alcatel-Lucent Shanghai Bell
[R1-1701145](#) On the benefits of mini-slot for eMBB use cases Nokia, Alcatel-Lucent Shanghai Bell

Decision: The document is noted.

5.1.5 Channel coding

[R1-1701384](#) **Chairman's notes of AI 5.1.5 on channel coding** Ad-Hoc chair (Nokia)

The document was presented by Matthew Baker from Nokia.

Decision: The document is endorsed, content incorporated below.

5.1.5.1 LDPC code design

Agree details of protomatrix design

[R1-1700092](#) LDPC design for eMBB data Huawei, HiSilicon
[R1-1700094](#) Performance evaluation of LDPC codes Huawei, HiSilicon
[R1-1700237](#) LDPC codes design for eMBB CATT
[R1-1700108](#) LDPC Code Design Ericsson
[R1-1700110](#) On LDPC Code Parameters for NR Ericsson
[R1-1700383](#) LDPC prototype matrix design Intel Corporation
[R1-1700831](#) LDPC design considerations Qualcomm Incorporated
[R1-1701210](#) High performance LDPC design features MediaTek Inc. (Revision of [R1-1700166](#))
Further revised in R1-1701470
[R1-1700976](#) Discussion on LDPC Code DesignSamsung
[R1-1701028](#) LDPC design for eMBB data Nokia, Alcatel-Lucent Shanghai Bell

Implementation Aspects

[R1-1700093](#) Implementation aspects of LDPC codes Huawei, HiSilicon
[R1-1700111](#) Implementation and Performance of LDPC Decoder Ericsson
[R1-1701211](#) High efficiency LDPC design features MediaTek Inc. (Revision of [R1-1700167](#))
[R1-1700245](#) Consideration on flexibility of LDPC codes for eMBB ZTE, ZTE Microelectronics
[R1-1701030](#) CRC attachment for eMBB data Nokia, Alcatel-Lucent Shanghai Bell

[R1-1700109](#) Investigation of LDPC codes with CRC attachment Ericsson

[R1-1701289](#) **WF on Parity Check Matrix Structure** Samsung

Also supported by Intel, Ericsson, LG, Qualcomm.

Working Assumptions

- For at least one base graph,
 - the parity check matrix consists of five sub-matrices (A, B, C, D, E)

A	B	C
D	E	

- A may contain systematic and parity bits
- B:
 - B is not necessarily square
 - One of the columns has weight-three
 - The columns of B after the weight-three column have a dual diagonal structure, e.g.:

1	1			
	1	1		
1		1	1	
			1	1
1				1

- C is a zero matrix
- E is an identity matrix for the above base graph
- Other structures can be considered for other base graph(s), if any
- Can be revisited if another structure is shown to be superior in performance and complexity

[R1-1701454](#) **WF on LDPC** Qualcomm

[R1-1701264](#) **WF on LDPC design for NR** Samsung

Agreement:

- Number of base graphs N_{BG} is FFS between 1, 2 and 3, considering the trade-offs
 - If $N_{BG} > 1$,
 - Each base graph covers a different range of block sizes and/or code rates (not necessarily precluding partially overlapping ranges)
 - FFS whether one range can be fully covered by another range

[R1-1701466](#) **WF on LDPC design parameters** Ericsson, LG (Revision of [R1-1701256](#))

Agreement:

- The largest info block size supported by LDPC encoder K_{max} and the largest shift size Z_{max} defined for a H matrix are selected from the following set of $\{K_{max}, Z_{max}\}$ pairs:
 - $\{8192, 256\}$, $\{8192, 512\}$, $\{8192, 1024\}$,
 - $\{FFS \text{ near } 8192, 320\}$, $\{FFS \text{ near } 8192, 384\}$
- The exact $\{K_{max}, Z_{max}\}$ pair to be selected from the above 5 at RAN1#88

Agreement:

- Base graph for supporting K_{max} has minimum code rate $R_{min, k_{max}} = \sim 1/3$
 - ‘ \sim ’ means approximately
 - This does not preclude extending the same base graph to code rate lower than $\sim 1/3$ when supporting $K < K_{max}$, provided that the number of variable nodes (after lifting) of any parity check matrix, N_{max} , is not exceeded, where:
 - $N_{max} = K_{max} / R_{min, k_{max}} + N_{sys, punct}$
 - $N_{sys, punct}$ is the number of built-in punctured systematic bits
- Base graph for any info block sizes K has
 - $R_{min, k} \geq \sim 1/5$, provided that N_{max} is not exceeded

[R1-1701463](#) **WF on LDPC Design for NR** Samsung, Nokia, ASB

Working Assumption:

- For the purpose of H matrix design, minimum Code Block Size (including CRC) in the range 40-100 bits should be considered

Conclusion:

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- Evaluations at BLER of a single code block = $1e-2$ (for performance comparison between codes) and $1e-4$ (for the purpose of comparing the error floor performance of the codes)
 - (Note that this does not preclude other comparison criteria)

Email discussion until RAN1#88 on granularity of information block sizes to be evaluated. - Hongsil Jeong (Samsung)

Email discussion until RAN1#88 on details of other evaluation criteria - Hongsil Jeong (Samsung)

R1-1701230 WF on other criteria for LDPC design comparison ZTE, ZTE Microelectronics, Huawei, HiSilicon, CATT, MediaTek

R1-1701469 WF on LDPC comparisons MediaTek, Huawei HiSilicon, CATT, CATR, ZTE, ITRI

Conclusion:

- At least the following criteria are considered for LDPC design comparison in addition to BLER performance
 - Implementation complexity
 - Latency
 - discuss details in the email discussion.
- Companies are encouraged to provide at least the following for the base matrix for the considered code rates:
 - Z_{max}
 - Total number of edges
 - Maximum row weight
 - Maximum column weight
- FFS if/how to define and compare numbers of (quasi) layers

R1-1701269 WF on circulant weight for LDPC codes Qualcomm, Intel, Ericsson, LG

Agreement:

- For the QC-LDPC design, the non-zero sub-blocks have circulant weight = 1
 - Circulant weight is the number of superimposed circularly shifted $Z \times Z$ identity matrices

R1-1701464 WF on shortening of LDPC codes Ericsson, Qualcomm, LG, Intel, Nokia, ASB, Samsung (Revision of R1-1701254)

Agreement:

- Shortening is applied before LDPC encoding when necessary
 - **Working assumption:** Filler bits F are attached at the end of info block B to form vector $U = [B \ F]$
 - Can be verified at RAN1#88
 - Vector U is the input to LDPC encoding
 - The filler bits F are not transmitted

R1-1701465 WF on rate matching of LDPC codes Ericsson, Qualcomm, Intel, LG, Samsung, ZTE, MediaTek, Nokia, ASB, InterDigital (Revision of R1-1701255)

Agreement:

- Built-in puncturing of systematic bits is supported for LDPC coding, that is:
 - At least for the initial transmission, the coded bits are taken after skipping the first $N_{sys,punct}$ systematic bits
- $N_{sys,punct}$ is selected from: 0, Z, and $2 \times Z$
- The rate matching for LDPC code is circular buffer based (same concept as in LTE)
 - The circular buffer is filled with an ordered sequence of systematic bits and parity bits
 - FFS: Order of the bits in the circular buffer
 - For IR-HARQ, each Redundancy Version (RV), RV_i , is assigned a starting bit location S_i on the circular buffer
 - For IR retransmission of RV_i , the coded bits are read out sequentially from the circular buffer, starting with the bit location S_i
 - Limited buffer rate matching (LBRM) is supported

R1-1701467 WF on CRC attachment Ericsson, LG, Nokia, ASB (Revision of R1-1701257)

Agreement:

- Before code block segmentation, $L_{TB,CRC}$ bit TB-level CRC are attached to the end of the transport block

- o $L_{TB,CRC} \leq 24$ bits
- o $L_{TB,CRC}$ value is determined to satisfy probability of misdetection of TB error $\leq 10^{-6}$
- o Inherent error detection of LDPC codes is taken into account in determining the $L_{TB,CRC}$ value

Not treated.

R1-1700238	Optimization on the first offset row of QC-LDPC codes	CATT
R1-1700239	Optimization on adjacent offset rows of QC-LDPC codes	CATT
R1-1700240	IR-HARQ scheme for LDPC codes	CATT
R1-1700244	Performance evaluation of LDPC code for eMBB	ZTE, ZTE Microelectronics
R1-1700246	Complexity, throughput and latency analysis on LDPC codes for eMBB	ZTE, ZTE Microelectronics
R1-1700248	Bit rearrangement of LDPC for high order modulation	ZTE, ZTE Microelectronics
R1-1700382	Data channel encoding chain	Intel Corporation
R1-1700384	LDPC HARQ design	Intel Corporation
R1-1700518	LDPC code design for eMBB	LG Electronics
R1-1700519	Performance results of LDPC code for eMBB	LG Electronics
R1-1700520	Discussion on MET LDPC codes for eMBB data channel	LG Electronics
R1-1700521	Discussion on maximum code block size for eMBB	LG Electronics
R1-1700644	IR-HARQ scheme support with double QC-LDPC codes of degree-3	National Taiwan University
R1-1700645	Evaluation on double QC-LDPC codes with degree-3 for URLLC	National Taiwan University
R1-1700830	LDPC rate compatible design	Qualcomm Incorporated
R1-1700977	Discussion on Rate Matching for LDPC Codes	Samsung
R1-1701008	Views on protomatrix selection for LDPC	CATR
R1-1701029	Code segmentation for eMBB data	Nokia, Alcatel-Lucent Shanghai Bell
R1-1701031	Padding for LDPC codes	Nokia, Alcatel-Lucent Shanghai Bell
R1-1701256	WF on LDPC Design Parameters	Ericsson
R1-1701273	Evaluation of LDPC codes for eMBB data channels	NTT DOCOMO, INC.
R1-1701288	WF on LDPC base matrix	ZTE, ZTE Microelectronics
R1-1701460	WF on LDPC lift size	ZTE, ZTE Microelectronics, Qualcomm
R1-1701470	High performance LDPC design features	MediaTek Inc.
R1-1701473	Compact LDPC design for eMBB	ZTE, ZTE Microelectronics

5.1.5.2 Control channel coding

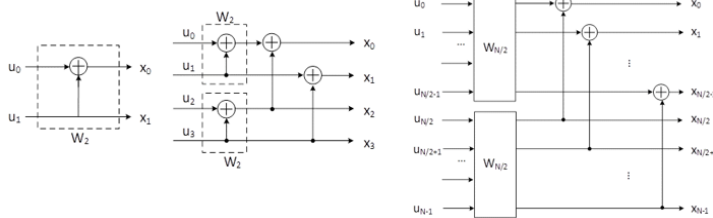
5.1.5.2.1 Polar code design

R1-1700088	Summary of polar code design for control channels	Huawei, HiSilicon
R1-1700089	Performance of polar codes for control channels	Huawei, HiSilicon
R1-1700979	Discussion on CA-Polar and PC-Polar Codes	Samsung
R1-1700523	Discussion on polar code for control channel	LG Electronics
R1-1700832	Design of Polar codes for control channel	Qualcomm Incorporated
R1-1701186	Comparison of Polar codes for control channel	Qualcomm Incorporated (Revision of R1-1700833)
R1-1700385	Considerations in Polar code design	Intel Corporation
R1-1700386	Polar code design	Intel Corporation
R1-1701212	Polar code design features for control channels	MediaTek Inc. (Revision of R1-1700168)
R1-1701032	Polar code design for DL control	Nokia, Alcatel-Lucent Shanghai Bell
R1-1700241	Discussion on polar codes for eMBB control channel	CATT
R1-1700250	Construction of polar codes for eMBB	ZTE, ZTE Microelectronics
R1-1700324	Design of Polar Codes for Control Channel in NR AT&T	

[R1-1701258](#) WF on Description of Polar Code for NR Ericsson, AT&T, LG, Intel, Qualcomm, Nokia, ASB, ZTE, Samsung

Agreed Description Method:

- In NR Polar Code discussion, polar codes will be described without bit reversal in the encoder, i.e.:
 - The output of the polar encoder is: $x_0^{N-1} = u_0^{N-1} G_N$
 - G_N is the generator matrix of size N
 - $G_2 = \begin{bmatrix} 1 & 0 \\ 1 & 1 \end{bmatrix}$
 - $G_N = F^{\otimes n}$ for any $N = 2^n, n \geq 1$, where
 - $F = \begin{bmatrix} 1 & 0 \\ 1 & 1 \end{bmatrix}$, and $F^{\otimes n}$ is the n -th Kronecker power of matrix F



Note that this does not affect any aspect of the Polar code design.

R1-1701347 **WF on Max Code Size for Polar Codes** **Ericsson, Intel, AT&T, Qualcomm, Samsung, Nokia, ASB, LG**

Agreement

- Maximum mother code size of Polar code, $N=2^n$, is:
 - $256 \leq N_{\max,DCI} \leq 1024$ for downlink control information
 - $1024 \leq N_{\max,UCI} \leq 2048$ for uplink control information
 - Exact values to be revisited with the aim of agreeing at RAN1#88

R1-1701474 **WF on evaluation methodology of Polar Code for NR** **LG, Samsung, Ericsson**

Agreement

- To compare CRC-related aspects of polar code design,
 - The same FAR performance (the same as LTE) should be considered for a fair comparison
 - List size L_{\max} 8 is the baseline (evaluations of other values are not precluded)
- Performance metrics (may be based on analytic derivation)
 - BLER
 - FAR (with AWGN as input to the decoder)
- Polar codes for control channels support one of the following alternatives:
 - Alt. 1: CRC + “basic polar” (i.e. as per above agreed description) codes
 - 1a: Longer CRC
 - e.g. $(J+J')$ bits CRC + basic polar
 - 1b: J bit CRC
 - The J bits can be distributed
 - The CRC can be used for both error detection and error correction
 - Alt. 2: J bits CRC + concatenated polar codes
 - e.g. J bits CRC + J' bits CRC + basic polar;
 - J bits CRC + J' bits distributed CRC + basic polar;
 - J bits CRC + PC bits + basic polar; (i.e. PC-Polar)
 - J bits CRC + Hash sequence + basic polar;
 - ...
 - J bits CRC is only used for error detection

R1-1701331 **WF on Polar Code Design** **NTT DOCOMO, Ericsson, Qualcomm, Nokia, ASB, Intel**

R1-1701468 **WF on SCL List Size for Polar Codes** **Ericsson, Nokia, ASB, LG, Samsung**

Not treated.

R1-1700090	On latency, power consumption and implementation complexity for polar codes	Huawei, HiSilicon
R1-1700112	Polar Code Design for Control Channel of NR	Ericsson
R1-1700113	Practical Issues of Polar Code for NR	Ericsson
R1-1700114	Investigation of Segmented Polar Codes	Ericsson
R1-1700242	Polar codes design for eMBB control channel	CATT
R1-1700249	Rate matching of polar codes for eMBB	ZTE, ZTE Microelectronics
R1-1700325	Control Channel FEC for Small Block Size in NR	AT&T
R1-1700425	Scalable processing for accelerated DCI blind detection	Coherent Logix
R1-1700522	Principles of Polar code design	LG Electronics
R1-1700724	Preliminary performance evaluation of polar codes puncturing InterDigital Communications	

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[R1-1700867](#) Discussion on Polar codes design NTT DOCOMO, INC.
[R1-1700978](#) Discussion on Polar Code Design Samsung
[R1-1701033](#) Polar codes design for UL control Nokia, Alcatel-Lucent Shanghai Bell
[R1-1701187](#) Polar code information bit allocation and nested extension construction Qualcomm Incorporated
[R1-1701259](#) WF on Max Code Size and Rate Matching for Polar Codes Ericsson, Intel, AT&T, Qualcomm, MediaTek, Nokia, ASB, LG, InterDigital, Samsung
[R1-1701301](#) WF on Channel Coding Design Huawei, HiSilicon, CATT, CATR, Coherentlogix, Mediatek, ZTE, ZTE Microelectronics
[R1-1701349](#) WF on information and frozen bit Selection on NR Polar Codes LG Electronics, Samsung, AT&T
[R1-1701488](#) WF on frozen set selection of Polar Codes NTT DOCOMO, InterDigital, MediaTek, Qualcomm, ZTE, ZTE Microelectronics

5.1.5.2.2 Other

[R1-1701302](#) **WF on Channel Coding for Very Small Control Information Blocks** Huawei, HiSilicon, ZTE, ZTE Microelectronics, Mediatek, CATT, CATR, Coherentlogix

Not treated.

[R1-1700091](#) Channel coding for very small control block lengths Huawei, HiSilicon
[R1-1700834](#) Block codes for very small block length Qualcomm Incorporated
[R1-1701034](#) Coding for Short Blocks in Control Channel Nokia, Alcatel-Lucent Shanghai Bell
[R1-1701348](#) Control channel coding scheme for small block length LG Electronics
[R1-1701471](#) WF on coding scheme for small block length LG Electronics, AT&T, Ericsson, Nokia, ASB

5.1.5.3 Other

Agreement

- The channel coding working assumptions from RAN1#87 are agreed, with clarification that the mentioned DL control information means DCI (i.e. does not include PBCH, SIBs or PCFICH (if it exists for NR))

Not treated.

[R1-1700075](#) Channel coding for URLLC scenario Huawei, HiSilicon
[R1-1700115](#) Channel Coding Techniques for URLLC Ericsson
[R1-1700116](#) On Channel Coding of PBCH Ericsson
[R1-1700169](#) PBCH enhancement with Polar code MediaTek Inc.
[R1-1700243](#) Performance comparison of LDPC and polar codes for URLLC CATT
[R1-1700251](#) Consideration on outer code for NRZTE, ZTE Microelectronics
[R1-1700406](#) HARQ for polar codes Huawei, HiSilicon
[R1-1700725](#) Performance evaluation of URLLC channel codes InterDigital Communications
[R1-1700835](#) Energy efficiency of channel coding Qualcomm Incorporated
[R1-1700837](#) PBCH channel coding Qualcomm Incorporated
[R1-1700980](#) Discussion on Channel Coding for eMBB Data Channel Samsung
[R1-1700981](#) Discussion on Channel Coding for URLLC Channel Samsung
[R1-1700982](#) Channel Coding for Short-Length Information Samsung
[R1-1701035](#) LDPC design for URLLC codes Nokia, Alcatel-Lucent Shanghai Bell

5.1.6 Modulation

[R1-1701482](#) **WF on pi/2 BPSK Modulation with frequency domain shaping** IITH, CEWiT, IITM, Tejas Networks, ATT, NTT DoCoMo, KDDI, Qualcomm, Deutsche Telekom, Samsung, INL, Panasonic, MediaTek, Straightpathcommunications, NI, IAESI, Interdigital, Sony, Kyocera, Intel

The document was presented by Kiran Kuchi from IITH.

- NR supports 0.5π BPSK modulation for DFT-s-OFDM
 - While using DFT-s-OFDM, 0.5π -BPSK modulation using DFT-S-OFDM with frequency domain spectrum shaping can be further considered at least for eMBB uplink data for up to 40GHz
 - FFS
 - The details of frequency domain spectrum shaping
 - This does not preclude the case where no spectrum shaping is needed

Discussion: Also supported by CMCC

Ericsson → RAN4 has already discussed the issue long time ago, worse sending an LS to RAN4 and check whether there are no concern from RAN4 point of view, why could RAN1 agree now something that RAN4 didn't

Nokia: concern under which conditions this proposal can be explored - coverage gain to be confirmed

IITH: Performance simulation results have been provided, both to RAN1 and RAN4.

INL noted that additional results have been submitted – contribution is available ([R1-1700845](#))

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Chair would prefer asking RAN4 of the feasibility via an LS

Decision: The document is noted.

Agreement: NR supports 0.5π BPSK modulation for DFT-s-OFDM

Agreement:

- Prepare draft LS to RAN4 to inform current RAN1 modulation agreement and WA (from RAN1#87), including the following RAN1 assumptions
 - Frequency band
 - Bandwidth allocation
- RAN1 also ask feasibility of it in the draft LS
- Note that additional performance results to address concerns from RAN4 have been submitted in RAN1

[R1-1701040](#) Draft LS to RAN4 on rotated modulations for DFT-S-OFDM uplink Nokia, Alcatel-Lucent Shanghai Bell

Discussion: Nokia No need to present – can be used as basis for further updates

Decision: The document is noted.

[R1-1701545](#) **DRAFT LS on $\pi/2$ BPSK with spectrum shaping for DFT-S-OFDM uplink** IITH, Nokia

Decision: The document is noted and final LS is **approved in [R1-1701547](#)**.

Friday afternoon

[R1-1701522](#) **WF for NR Modulation** MediaTek, IITH, CEWiT, IITM, Tejas Networks, NTU, Samsung, AT&T,

Xiaomi

- NR Support QPSK based low PAPR modulation for DFT-s-OFDM
 - QPSK based low PAPR modulation includes, but not limited to:
 - For example: Interpolated-QPSK, Rotated-QPSK, Trellis Coded MPSK
 - While using DFT-s-OFDM, QPSK based low PAPR modulation using DFT-s-OFDM with frequency domain spectrum shaping (FDSS) can be further considered at least for eMBB uplink data for up to 40GHz.
 - FFS
 - The details of frequency domain spectrum shaping
 - This does not preclude the case where no spectrum shaping is needed

Decision: The document is noted.

[R1-1701534](#) **WF on Enhanced Modulation Schemes** Sony, Samsung, InterDigital

The document was presented by Martin Beale from Sony and suggests capturing in TR the enhanced modulation schemes proposed for NR.

Discussion: Nokia unclear what to really capture in the TR.

Decision: The document is noted. Further revised in:

[R1-1701549](#) **WF on Enhanced Modulation Schemes** Sony, Samsung, InterDigital

Discussion: Nokia still would like to see a concrete TP and agree what goes to the TR.

Decision: The document is noted.

Not treated.

[R1-1700076](#) Signal shaping for QAM constellations Huawei, HiSilicon

[R1-1700164](#) Low PAPR Modulation Design MediaTek Inc.

[R1-1700252](#) Discussion on modulation schemes for NR ZTE, ZTE Microelectronics

[R1-1700679](#) Non-uniform constellations for NR Sony

[R1-1700726](#) Evaluation of Spatial Modulation with Spatial Correlation and Imperfect Channel Estimation InterDigital

Communications

[R1-1700845](#) PAPR and ACLR performance for SC-CPS waveforms including $\pi/2$ -BPSK Idaho National Laboratory

[R1-1700983](#) Discussion on modulation schemes for high spectral efficiency Samsung

[R1-1701039](#) Rotated modulations for DFT-S-OFDM uplink Nokia, Alcatel-Lucent Shanghai Bell

[R1-1701162](#) Signal Space Diversity Use in NR Sony

[R1-1701180](#) Comparison of $\pi/2$ BPSK with and without frequency domain pulse shaping: Results with PA model

TSDSI

5.1.7 Duplex and interference management

Note that PHY layer design on flexible duplex of paired spectrum other than a common PHY layer design between paired and unpaired spectrum is already listed as scope reduction item (see [RP-162574](#))

[R1-1701385](#) **Chairman's notes of AI 5.1.7 on duplex and interference management** Ad-Hoc chair (Qualcomm)

The document was presented by Wanshi Chen from Qualcomm.

Decision: The document is endorsed, content incorporated below.

[R1-1700269](#) Overview of Duplexing and Cross-link Interference Mitigation ZTE, ZTE Microelectronics

5.1.7.1 Performance evaluation

[R1-1700082](#) Evaluation of duplexing flexibility in indoor hotspot scenario Huawei, HiSilicon
[R1-1700283](#) Proposal on the slot basis dynamic TDD vivo
[R1-1700155](#) System performance evaluation with dynamic TDD MediaTek Inc.
[R1-1700387](#) Evaluation results of dynamic TDD at 4 GHz Intel Corporation
[R1-1700525](#) Evaluation results of duplexing flexibility in dense urban scenario LG Electronics
[R1-1700634](#) Performance evaluation of dynamic TDD in dense urban scenario NTT DOCOMO, INC.
[R1-1700838](#) Dynamic TDD performance evaluation Qualcomm Incorporated
[R1-1700984](#) Performance evaluation of dynamic TDD Samsung
[R1-1701126](#) Performance of Dynamic TDD in a Dense Urban Environment Ericsson

Conclusion:

- Discuss further offline on how to capture performance evaluation results – Zukang (Huawei). Revisit later this week.
- Companies are encouraged to further update the evaluation results

[R1-1701329](#) WF on flexible duplexing evaluation NTT DOCOMO, Huawei, HiSilicon, ZTE, ZTE Microelectronics, Ericsson, Intel, CATT, LG Electronics, Qualcomm

Conclusion:

- The WF in [R1-1701329](#) is agreed
- Companies are encouraged to perform evaluations under various RU percentage values
 - Note: the RU for a link direction (DL or UL) herein is defined as the amount of occupied resources for the given link direction divided by the total number of resources (irrespective of link directions)
- Companies should also report assumptions regarding backhaul
- In performing evaluations for flexible duplexing operation, companies should take into account additional overhead for the operation.

[R1-1700087](#) Further clarification of channel model implementation for cross link in flexible duplex evaluation
Huawei, HiSilicon

Conclusion:

- The proposal of adding a note as in [R1-1700087](#) is agreed

Not treated.

[R1-1700083](#) Evaluation of duplexing flexibility in urban macro scenario Huawei, HiSilicon
[R1-1700084](#) Evaluation of duplexing flexibility in dense urban scenario Huawei, HiSilicon
[R1-1700633](#) Performance evaluation of dynamic TDD in Indoor hotspot scenario NTT DOCOMO, INC.
[R1-1701127](#) Performance of Dynamic TDD in an Indoor Hotspot Environment at 4 GHz Ericsson
[R1-1701128](#) Performance of Dynamic TDD in an Indoor Hotspot Environment at 30 GHz Ericsson

5.1.7.2 Interference management

[R1-1700095](#) On cross-link interference cancellation/suppression for duplexing flexibility Huawei, HiSilicon
[R1-1700156](#) Interference management techniques for dynamic TDD MediaTek Inc.
[R1-1700212](#) Interference management for dynamic TDD and flexible duplex CATT
[R1-1700271](#) Discussion on Measurement and RS design for Cross-link Interference Mitigation ZTE, ZTE Microelectronics
[R1-1701202](#) Desing of Interference Measurement and Feedback in NR AT&T (Revision of [R1-1700326](#))
[R1-1700444](#) Considerations on flexible duplex in NR CMCC
[R1-1700527](#) Discussion on cross-link interference cancellation for duplexing flexibility LG Electronics
[R1-1700635](#) Mechanism of data channel for dynamic TDD NTT DOCOMO, INC.
[R1-1700663](#) Cross-link interference mitigation for duplexing in NR Fujitsu
[R1-1700839](#) Dynamic TDD interference management considerations Qualcomm Incorporated
[R1-1700985](#) Cross-link interference management based on UE measurements Samsung
[R1-1701129](#) Cross-Link Interference Mitigation for Dynamic TDD in Dense Urban Environments Ericsson
[R1-1701147](#) Dynamic TDD Interference Mitigation Concepts in NR Nokia, Alcatel-Lucent Shanghai Bell

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[R1-1701369](#) Offline summary on cross-link interference mitigation for duplexing flexibility Huawei, HiSilicon

Conclusion:

- Companies shall provide the following information in RAN1#88 for analyzing interference mitigation schemes for TRP-to-TRP and/or UE-to-UE cross-link interference
 - Gains provided by the considered interference mitigation scheme
 - Potential specification impacts (not limited to RAN1) of the considered interference mitigation scheme

[R1-1701215](#) Way Forward on SRS for duplexing flexibility Huawei, HiSilicon, CATT, DoCoMo, CATR, Deutsche Telekom, LG Electronics

[R1-1701370](#) WF on Study of CLI Measurements AT&T, MediaTek, Ericsson

[R1-1701217](#) WF on inter-TRP signaling for duplexing flexibility LG Electronics, ZTE, ZTE Microelectronics, MediaTek, CATT

[R1-1701218](#) WF on Cross-link Interference Measurement for Duplexing Flexibility LG Electronics, ZTE, ZTE Microelectronics

Not treated.

[R1-1700096](#) On cross-link interference coordination for duplexing flexibility Huawei, HiSilicon

[R1-1700157](#) Considerations on receiver based techniques for interference management MediaTek Inc.

[R1-1700211](#) Dynamic TDD slot structure CATT

[R1-1700270](#) Discussion on dynamic TDD and Cross-link Interference Mitigation Schemes ZTE, ZTE Microelectronics

[R1-1700388](#) Considerations on reference signal for interference measurement Intel Corporation

[R1-1700443](#) Discussion on semi-static TDD configurations CMCC

[R1-1700526](#) Discussion on power control and sensing for duplexing flexibility LG Electronics

[R1-1700542](#) Discussion on NR duplexing Panasonic Corporation

[R1-1700636](#) Control channels/signals for dynamic TDD NTT DOCOMO, INC.

[R1-1700662](#) Implementation framework for duplexing in NR Fujitsu

[R1-1700986](#) Cross-link interference management based on coordinated beamforming Samsung

[R1-1701130](#) Cross-Link Interference Mitigation for Dynamic TDD in Indoor Hotspot Environments Ericsson

[R1-1701146](#) Dynamic TDD Interference Mitigation Concepts in NR Nokia, Alcatel-Lucent Shanghai Bell

[R1-1701213](#) WF on control signaling for transmission direction change LG Electronics, ZTE, ZTE Microelectronics

5.1.7.3 Other

[R1-1700079](#) On control signaling for duplexing flexibility Huawei, HiSilicon

[R1-1700080](#) Discussion on TDD operation on an unpaired spectrum Huawei, HiSilicon

[R1-1700081](#) On unified design for duplexing flexibility Huawei, HiSilicon

[R1-1700272](#) Sensing based Schemes for Cross-link Interference Mitigation in NR ZTE, ZTE Microelectronics

[R1-1700528](#) Cross-link interference management for coexistence between NR and LTE LG Electronics

[R1-1700683](#) Way Forward on TP for Duplexing Flexibility in TR 38.802 v1.0.0 ZTE, ZTE Microelectronics

5.1.8 Wider bandwidth operations

Including mechanisms to achieve wider bandwidth operation via carrier aggregation and dual-connectivity

[R1-1700006](#) On the maximum carrier bandwidth and multiple carriers operation Huawei, HiSilicon

The document was presented by ... from Huawei.

- Observation 1: To support 1 GHz contiguous spectrum, multiple sets of SCH may be required for the single carrier operation; one set of SCH exists in one carrier for the multi-carrier operation.
- Observation 2: RAN1 should assume a single RF chain and PA for one carrier operation. The feasibility of wideband RF chain and PA are needed to be studied in RAN4.
- Observation 3: No extra specification work is needed when CA is used to support 1GHz contiguous spectrum. While for the single wideband carrier operation, extra specification work is required.
- Proposal 1: The largest component carrier bandwidth should be separately defined for different bands, for example,
 - 40MHz for licensed bands below 6 GHz; 80MHz for licensed bands above 6 GHz but below 52.6 GHz;
 - FFS for licensed bands above 52.6 GHz and unlicensed bands.
- Proposal 2: Striving for a common physical layer design between different aggregations of carrier on MAC layer or PDCP layer should be considered in NR.
- Proposal 3: The maximum number of NR carriers for CA and DC should be 32.
- Proposal 4: A carrier without certain channels, e.g. PBCH, control channel, should be considered in NR CA and DC.
- Proposal 5: NR should support aggregating multiple carriers with same and different numerologies.

Discussion: Ericsson → most of these proposals are RAN4 type of discussion/decision – ack by Spring, CATT as well

Decision: The document is noted.

[R1-1700389](#) Wide bandwidth operation and UE capability Intel Corporation

The document was presented by Joonyoung Cho from Intel.

- Proposal 1: Bandwidth per carrier
 - Minimum bandwidth per component carrier is assumed as 20 MHz in RAN1 NR standardization.
 - Maximum bandwidth per component carrier is assumed as 100 MHz or larger (TBD) in Phase I.
- Proposal 2: UE specific bandwidth/CA configuration
 - Whether for a UE to operate in a single wideband carrier or CA/DC modes is configured in a UE specific manner.
 - UEs in the different modes and different bandwidth per carrier can co-exist within an NR carrier.

Decision: The document is noted.

R1-1700840 Views on wideband NR operation Qualcomm Incorporated

The document was presented by Peter Gaal from Qualcomm.

- Observation 1: In the future, NR is likely to operate on at least 1.6 – 2 GHz aggregated BW, therefore the NR design should be scalable beyond 1 GHz.
- Proposal 1: RAN1 should define either one of the following but exclude allowing both
 - Large maximum TB BW together with small number of maximum simultaneous TBs the UE is required to process (preferred)
 - Small maximum TB BW together with larger number of maximum simultaneous TBs the UE is required to process (not preferred)
- Proposal 2: NR should limit the total number of simultaneous TBs to no more than 8, even in future > 1 GHz aggregated BW cases, and the maximum TB BW should be selected at least 400 MHz, at least for > 6GHz.
- Proposal 3: NR should define a maximum CB BW to be the lesser of the Device RF BW and an appropriately chosen maximum (e.g. 100 MHz).
- Proposal 4: In order to make HW implementation more efficient, NR should define “CB subbands” either by configuration or by specification, and each CB is confined within one CB subband.
- Observation 2: It should be studied what the maximum useful BW of the DFT-S-OFDM waveform is for > 6GHz.
- Proposal 5: For below 6 GHz, the maximum RF Channel BW should be defined as 100 MHz.
- Proposal 6: For above 6 GHz, the maximum RF Channel BW should be defined as at least 100 MHz.
- Proposal 7: Larger than 100 MHz RF Channel BW should be only defined if Device RF BW of 100 MHz will be fully supported in RF Channel BW larger than 100 MHz. Device RF BW of 100 MHz must be a valid UE implementation in any NR deployment.
- Proposal 8: If larger than 100 MHz RF Channel BW is defined for above 6 GHz, consider whether it should be limited to above a certain nominal subcarrier spacing.

Decision: The document is noted.

Possible agreements:

- NR defines followings
 - “RF Channel BW”, which is the BW over which waveforms are defined
 - Note that the RF channel BW of a CC may be greater than the implemented Device RF BW of the devices receiving its signal but in general it should not be greater than the implemented Device RF BW of the devices transmitting the signal
 - “CB subbands” either by configuration or by specification, and each CB is confined within one CB subband

Continue offline discussion until Wednesday morning – Peter (Qualcomm)

Possible agreements:

- From RAN1 specification perspective, maximum bandwidth per one NR carrier is [400, 800] MHz in Rel-15
 - RAN1 recommends RAN4 to consider at least 100 MHz maximum RF channel bandwidth per one NR carrier in Rel-15 considering the carrier frequency bands
 - RAN1 asks the feasibility of at least followings
 - For sub-6 GHz, 100 MHz is considered and for above-6 GHz, wider than 100 MHz is considered
 - Other cases can be considered by RAN4, e.g., 40 MHz, 200 MHz
 - Note that RAN1 will specify all details for bandwidth at least up to 100 MHz per one NR carrier in Rel-15
 - Also note that RAN1 will try to achieve one scalable design up to maximum bandwidth
- The maximum number of NR carriers for CA and DC is 8 in Rel-15
- Configurable UE bandwidth that can be equal or narrower than channel bandwidth is defined
 - FFS: Details on configurable UE bandwidth
- FFT size is not larger than [8192, 4096]

Agreements

- From RAN1 specification perspective, maximum channel bandwidth per NR carrier is [400, 800, 1000] MHz in Rel-15

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- RAN1 recommends RAN4 to consider at least 100 MHz maximum channel bandwidth per NR carrier in Rel-15 considering carrier frequency bands
 - RAN1 asks the feasibility of at least followings
 - For sub-6 GHz, 100 MHz is considered and for above-6 GHz, wider than 100 MHz is considered
 - Other cases can be considered by RAN4, e.g., 40 MHz, 200 MHz
 - Note that RAN1 will specify all details for channel bandwidth at least up to 100 MHz per NR carrier in Rel-15
 - Also note that RAN1 will consider scalable design(s) for up to maximum channel bandwidth per NR carrier
- From RAN1 specification perspective, the maximum number of NR carriers for CA and DC is [8, 16, 32]
- The maximum FFT size is not larger than [8192, 4096, 2048]
- Prepare draft LS to RAN4 within today including the above agreements and past UE supporting bandwidth related agreement from the last RAN1 meeting.

Continue offline discussions about above square brackets until Wednesday morning – Kazuaki (DOCOMO)
Thursday: no changes – values in square brackets stay as they are

[R1-1701222](#) [Draft] LS on wider bandwidth operation for NR NTT DOCOMO

Decision: The document is noted and final LS is [approved in R1-1701223](#)

Thursday session

[R1-1701360](#) **Way forward on Limiting Wideband Options** Qualcomm Incorporated

The document was presented by Peter Gaal from Qualcomm.

- If it is decided that one of [400, 800, 1000]MHz CC BW is supported in >6GHz
 - The maximum number of CCs in any aggregation is 8
- If it is decided that the maximum BW over which a TB can be mapped is <=100MHz
 - The maximum number of CCs in any aggregation could be either 16 or 32
 - (The intent of the proposal is to avoid enabling both 16x100MHz and 4x400MHz in the specification, for example)
- Note: The subject of the proposal is not avoiding 32 x 800MHz, for example, since this is assumed obvious

Discussion: Fujitsu/NTT DOCOMO: ok with the intention, maybe premature deciding on such detailed proposal – involve RAN4 in the decision.

Samsung supports the proposal assuming maximum number of CCs is left FFS – same view for MediaTek

Ericsson would like to wait feedback from RAN4

Qualcomm: ok that the figures are questionable, ok to have them in brackets but proposed WF is agreeable whatever RAN4 decides

Decision: The document is noted.

Agreements:

- If it is decided that maximum CC BW is greater than or equal to 400 MHz and smaller than or equal to 1000MHz
 - The maximum number of CCs in any aggregation is [either 8 or 16]
- If it is decided that the maximum CC BW is <=100MHz
 - The maximum number of CCs in any aggregation could be [either 16 or 32]
- If it is decided that the maximum CC BW is greater than 100 MHz and smaller than 400MHz
 - The maximum number of CCs is FFS

[R1-1701359](#) **Way forward on Code Block subbands** Qualcomm Incorporated

The document was presented by Peter Gaal from Qualcomm.

- If RF channel BW larger than 100MHz is defined
 - In order to make HW implementation more efficient, NR should define “CB subbands” either by configuration or by specification
 - The gNB and UE must have the same assumption on the subband boundaries in order to perform the same codeblock to RE mapping
 - Each CB is confined within one CB subband

Decision: The document is noted.

Friday

[R1-1701528](#) **Way forward on Wideband Carrier Support** Qualcomm Incorporated

The document was presented by Peter Gaal from Qualcomm.

- At least for the case where the maximum CC BW is greater than 100 MHz, a UE operating in a wideband carrier with using multiple Rx / Tx chains (Case 3 in Figure) should be supported
- Determine whether the discontinuities due to the UE Rx / Tx chain arrangement need any handling in the eNB requiring physical layer support

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Discussion: Qualcomm – no need to agree now, but would be great that companies look at it for the next meeting.

Decision: The document is noted.

Not treated.

[R1-1700158](#) UE-specific RF bandwidth adaptation for single component carrier MediaTek Inc.
[R1-1700213](#) NR wider bandwidth operation up to 1GHz CATT
[R1-1700449](#) Number of component carriers in NR NEC
[R1-1700529](#) Discussion on wider bandwidth including CA/DC LG Electronics
[R1-1700637](#) Views on wider bandwidth operations for NR NTT DOCOMO, INC.
[R1-1700643](#) On support of joint UCI feedback in NR CA Sequans Communications
[R1-1700697](#) On wider bandwidth operations Ericsson
[R1-1700709](#) Bandwidth adaptation in NR INTERDIGITAL COMMUNICATIONS
[R1-1700987](#) Wider Bandwidth Operation: CA/DC vs. Single Carrier Samsung
[R1-1701148](#) Solutions for wider bandwidth options Nokia, Alcatel-Lucent Shanghai Bell

5.1.9 NR-LTE co-existence

[R1-1701540](#) [R1-1701386](#) **Chairman's notes of AI 5.1.9 on NR-LTE coexistence** Ad-Hoc chair (Qualcomm) ([R1-](#)

The document was presented by Wanshi Chen from Qualcomm.

Decision: The document is endorsed, content incorporated below.

[R1-1700031](#) Coexistence of NR DL and LTE Huawei, HiSilicon
[R1-1700214](#) Adjacent channel co-existence of NR and LTE in unpaired spectrum CATT
[R1-1700327](#) Further Details and Techniques on LTE and NR Co-Existence AT&T
[R1-1700390](#) Further Considerations on NR/LTE Coexistence Intel Corporation
[R1-1700530](#) Discussion on NR-LTE coexistence for DL transmission LG Electronics
[R1-1700631](#) LTE-NR co-existence for uplink NTT DOCOMO, INC.
[R1-1700682](#) Considerations on initial LTE-NR coexistence Sony
[R1-1700841](#) NR-LTE coexistence Qualcomm Incorporated
[R1-1700989](#) LTE-NR Coexistence for UL Samsung
[R1-1701055](#) On LTE and NR coexistence in the same frequency Nokia, Alcatel-Lucent Shanghai Bell
[R1-1701131](#) On Coexistence Between LTE and NR Ericsson
[R1-1701198](#) Uplink operation for LTE+NR Dual Connectivity VODAFONE Group Plc (Revision of [R1-1701177](#))

[R1-1701361](#) **WF on LTE-NR Coexistence Scenarios with UL Sharing** Huawei, HiSilicon, Vodafone, China Unicom, China Telecom, CATR, Orange

Agreements:

- LTE-NR co-existence should support the following UL sharing scenarios:
 - Collocated LTE and NR base stations with network operating UL on frequency F1 where LTE UL and NR UL share UL subframes of LTE
 - Detailed sharing on the UL is FFS
 - Note: this is not intended to have impact on legacy LTE UEs
 - LTE DL on a paired frequency F3
 - NR DL transmission on frequency F2 (different than LTE DL frequency)
 - NR UE operates in either of the following cases based on a common NR design:
 - Standalone NR: UE accesses standalone NR carrier on F2. The UE may not be connected to an LTE carrier (some UE may not even support LTE).
 - FFS whether NR UL frequency F1 is signaled in NR broadcast system information or derived from MIB/PBCH, or implicitly from NR DL frequency F2
 - Dual connectivity of LTE and NR: UE accesses LTE PCell (with LTE UL on F1), then is configured by dual connectivity to also operate NR on F1 (UL) and F2 (DL).
 - NR DL and UL frequencies (and/or NR band number) are signaled by RRC
 - Non-collocated LTE and NR base stations is FFS

[R1-1701362](#) **WF on LTE-NR FDM Coexistence Scenarios** Huawei, HiSilicon, Vodafone, China Unicom, Telefonica, Orange

Proposals:

- LTE-NR co-existence should study how to support adjacent LTE and NR carriers when the NR carrier bandwidth is smaller than the NR PSS/SSS bandwidth

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- In particular, NR design should support a SCell bandwidth smaller than the NR PSS/SSS bandwidth without transmission of NR SS/PBCH where LTE carrier is adjacent
 - When LTE and NR base stations are collocated, a NR UE obtains downlink synchronization from the LTE carrier in the case where UE is operating with LTE/NR dual connectivity
 - Ask RAN4 to confirm the feasibility
 - FFS support of this scenario without LTE/NR dual connectivity

[R1-1701363](#) **WF on LTE-NR DL TDM Coexistence** **Huawei, HiSilicon, China Unicom, AT&T, CATR, Orange**

Conclusion:

- NR should study the case of having DL transmissions in MBSFN and non-MBSFN subframes of LTE
 - Including details on transmissions of NR slots/mini-slots, resource reservations, potential unified mechanisms for forward compatibility, handling LTE control region/CRS symbols, RSSI/CSI measurements, sync requirements, etc.

[R1-1701389](#) **WF on coexistence between NR and LTE** **LG Electronics, Intel**

Agreements:

- NR supports the case when an NR UE is not expected to understand or detect LTE signals/channels in the frequency band shared by NR and LTE.
 - Detailed conditions are FFS
- Initial access procedure design for NR should be used as a baseline for the case of NR-LTE coexisting
 - FFS whether or not additional impact

[R1-1701392](#) **WF on LTE-NR coexistence** **Samsung, KDDI**
[R1-1701390](#) **WF on NR-LTE co-existence** **CMCC, Softbank, CATT, Nokia, ASB**

Friday

[R1-1701512](#) **WF on LTE-NR Coexistence in UL** **Samsung, KDDI, AT&T, DT, Softbank, Verizon,**
Nokia, ASB, Ericsson, LGE ([R1-1701392](#))
Also supported by Intel

Conclusion:

- For LTE-NR coexistence in UL, at least for collocated LTE and NR base stations, study further resource allocation aspects for NR-PUSCH to facilitate handling FDM'ed NR and LTE transmissions

R1-1701423 **WF on NR-LTE co-existence** **CMCC, Softbank, CATT, Nokia, ASB** ([R1-1701390](#))

Agreements:

- NR supports efficient adjacent channel co-existence with LTE-TDD using UL-DL configurations 0,1,2,3,4,5 in unpaired spectrum
 - FFS detailed mechanism
- NR supports efficient adjacent channel co-existence with LTE-TDD using all the special subframe configurations in unpaired spectrum
- Notes:
 - The above bullets does not necessarily imply that two or more frame structures are to be defined for NR
 - The wording “efficient” in the above two bullets does not imply exact alignment of configurations
 - RAN1 has agreed the following
 - Design at least one semi-statically assigned DL/UL transmission direction configuration for NR that avoids DL/UL interference with at least one LTE TDD DL/UL configuration and special subframe configuration

R1-1701527 **WF on LTE-NR DL TDM Coexistence Mechanisms** **Huawei, HiSilicon, AT&T, LG Electronics**

Agreements:

- Supporting NR DL in MBSFN subframes of LTE
 - FFS details

Not treated.

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R1-1701553

R1-1700032	Considerations of NR UL operation on the uplink band of LTE	Huawei, HiSilicon
R1-1700531	Discussion on NR-LTE coexistence for UL transmission	LG Electronics
R1-1700630	LTE-NR co-existence for downlink	NTT DOCOMO, INC.
R1-1700988	LTE-NR Coexistence for DL	Samsung

5.1.10 Channel model

[R1-1701387](#) Chairman's notes of AI 5.1.10 on channel model Ad-Hoc chair (Nokia)

The document was presented by Matthew Baker from Nokia.

Decision: The document is endorsed, content incorporated below.

5.1.10.1 Consistent channel modelling for < 6 GHz and > 6 GHz

[R1-1700418](#) Discussion on multi-band channel model Huawei, HiSilicon

[R1-1700445](#) New measurements on RMA 3D model CMCC

[R1-1700417](#) Discussion on Rural channel model for below 6GHz Huawei, HiSilicon

[R1-1700421](#) Draft CR to TR36.873 on rural channel model Huawei, HiSilicon

[R1-1700446](#) 3d extension for InH Scenario CMCC

[R1-1700447](#) LoS Probability for InH Scenario CMCC

[R1-1701170](#) On channel model harmonization Ericsson

[R1-1701195](#) Correction for low and high frequency model harmonization Ericsson, Samsung, NTT DOCOMO,
Nokia, Intel, Telstra (Revision of [R1-1701168](#))

Agreement

- Two alternatives are provided for single-band and multi-band simulations above and below 6 GHz:
 - A single model documented in 38.900 covering the range 0.5-100 GHz, as proposed in [R1-1701195](#)
 - 36.873 / M.2135 models below 6 GHz, updated according to R1-1700421/R1-1700446/R1-1700447, and 38.900 model above 6 GHz
- Companies are free to select which alternative they use, or the alternative to be used may be agreed on a case-by-case basis
- [R1-1701195](#) is agreed in principle, subject to updating to remove the “applicability” sentence in section 8 – revised in [R1-1701225](#) → agreed in [R1-1701406](#) as CR0066 of 38.900 (Rel-14).
- RAN Plenary / ETSI MCC to be requested to update the title of the TR accordingly.
- [R1-1700421](#) is agreed in principle → agreed in [R1-1701407](#) as CR0012 of 36.873 (Rel-12)
- CMCC to prepare a CR covering [R1-1700446](#) and [R1-1700447](#) which is agreed in principle - [R1-1701224](#) “CR to TR36.873 on indoor hotspot channel model” – revisit on Thursday.
 - CR remains agreed in principle; prepare a revision as follows (revisit on Friday) in [R1-1701233](#):
 - Need to correct RMA->InH in Table 7.3-9
 - Discuss how to include values for scaling factor for K value compensation (if not time to reach agreement on this aspect by Friday, the corrected CR can be agreed anyway and an update agreed at RAN1#88).
- Huawei to prepare a CR covering [R1-1700445](#) - [R1-1701228](#) 36.873 CRxxxx – revisit at RAN1#88.

Friday

[R1-1701510](#) WF on evaluation methodology & channel models Telecom Italia, Deutsche Telekom, Orange, Ericsson, Nokia

The document was presented by Enrico Buracchini from Telecom Italia.

- For comparisons between technologies or technical solutions it is recommended to use the same channel model for all alternatives
 - e.g. comparisons between LTE and NR or between low and high frequency bands

Discussion: Also supported by Vodafone.

Huawei's alternative proposal:

- For future work in 3GPP, if any comparison between technologies (e.g. within the same band) is required, it is recommended to use the same channel model for the comparison.

Telecom Italia: gave up after offline attempt to reach a consensus – Note that Telecom Italia intention was not to revert the agreement but to help clarifying the comparison between technologies

Decision: The document is noted.

[R1-1701233](#) TR36.873 CR Adding 3D-InH Scenario CMCC (revision of [R1-1701224](#))

Decision: The draft CR is agreed in [R1-1701435](#) as CR0021 of 36.873 (Rel-12).

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R1-1701553

Not treated.

R1-1701184 Phase 3 channel model calibration results Ericsson
R1-1701296 Way Forward on channel model for NR evaluation Huawei, HiSilicon, CATR, CATT

5.1.10.2 Other essential corrections

TR38.900

Section 7.2

R1-1701163 Correction for scenario description Ericsson, Fraunhofer HHI

Decision: Agreed in [R1-1701410](#) as CR0067 of 38.900 (Rel-14).

Section 7.5

R1-1701169 Correction for fast fading model Ericsson

Decision: Agreed in [R1-1701411](#) as CR0068 of 38.900 (Rel-14).

R1-1701158 TR38.900 draftCR_Ground_Reflection_Model Fraunhofer HHI

Decision: Agreed in [R1-1701412](#) as CR0069 of 38.900 (Rel-14).

R1-1701159 TR38.900_draftCR_Initial_PhaseFraunhofer HHI

R1-1701167 Correction for initial phase Ericsson

Decision: No longer needed following agreement of [R1-1701412](#).

R1-1701160 TR38.900_draftCR_Normalize_Cluster_Powers Fraunhofer HHI, Ericsson

Decision: Agreed in [R1-1701413](#) as CR0070 of 38.900 (Rel-14).

Section 7.6.3

R1-1701164 Correction for spatial consistencyEricsson

Decision: Agreed in [R1-1701414](#) as CR0071 of 38.900 (Rel-14).

R1-1701171 Correction for spatially-consistent UT mobility modelling Ericsson, Nokia

Revised in [R1-1701415](#) CR0072

Decision: Revisit at RAN1#88.

R1-1700604 Clarification for spatial consistency procedure NTT DOCOMO, INC.

Decision: Revisit at RAN1#88.

Section 7.6.4

R1-1701166 Clarifications on blockage model B Ericsson

R1-1701221 Correction for blockage model B and its calibration assumptions Ericsson

Revision of [R1-1701165](#)

Decision: Agreed in [R1-1701416](#) as CR0073 of 38.900 (Rel-14).

Section 7.6.5

R1-1701172 Correction for correlation modeling for multi-frequency simulations Ericsson, Fraunhofer HHI

Decision: Agreed in [R1-1701417](#) as CR0074 of 38.900 (Rel-14).

R1-1701267 Correction for channel generation for multi-frequency simulations Ericsson (Revision of [R1-1701176](#))

Revised in [R1-1701475](#) (CR0076 of 38.900)

Check on Friday – if not agreeable, then revisit at RAN1#88.

Friday

R1-1701507 Correction for channel generation for multi-frequency simulations Ericsson, Fraunhofer HHI

Decision: Email approval until 26th January – (Ericsson)

Section 7.8.3

R1-1700605 Correction for calibration assumptions for spatial consistency NTT DOCOMO, INC.

Clarify that the first non-d.c. sub-carrier is intended - [R1-1701226](#) – agreed in [R1-1701231](#) as CR0077 of 38.900 (Rel-14).

R1-1700990 e-mail discussion summary [87-35] on updating calibration results on additional features Samsung

R1-1700991 Draft CR for TR38.900 to update calibration results on additional features Samsung

Decision: Agreed in [R1-1701425](#) as CR0075 of 38.900 (Rel-14).

R1-1700560 Calibration results of additional features for channel model above 6GHZ Lenovo

TR36.873

Section 6

[R1-1701152](#) TR36.873 draftCR Scenarios Fraunhofer HHI, Ericsson

Decision: Agreed in [R1-1701426](#) as CR0013 of 36.873 (Rel-12)

Section 7.1

[R1-1701143](#) TR36.873 draftCR Section 7.1 Fraunhofer HHI, Ericsson

Decision: Agreed in [R1-1701427](#) as CR0014 of 36.873 (Rel-12)

Section 7.2

[R1-1701157](#) TR36.873 draftCR Section 7.2 Fraunhofer HHI

Decision: Agreed in [R1-1701428](#) as CR0015 of 36.873 (Rel-12)

Section 7.3

[R1-1701141](#) TR36.873 draftCR Incorrect Reference Fraunhofer HHI, Ericsson

Decision: Agreed in [R1-1701429](#) as CR0016 of 36.873 (Rel-12)

[R1-1701142](#) TR36.873 draftCR Align LSP Notation Fraunhofer HHI, Ericsson

Decision: Agreed in [R1-1701430](#) as CR0017 of 36.873 (Rel-12)

[R1-1701153](#) TR36.873 draftCR Notation of Cluster Angular Spreads Fraunhofer HHI, Ericsson

Decision: Agreed in [R1-1701431](#) as CR0018 of 36.873 (Rel-12)

[R1-1701155](#) TR36.873 draftCR Normalize Cluster Powers Fraunhofer HHI, Ericsson

Decision: Agreed in [R1-1701432](#) as CR0019 of 36.873 (Rel-12)

[R1-1701156](#) TR36.873 draftCR Incorrect Reference to LSP_Table Fraunhofer HHI, Ericsson

Decision: Agreed in [R1-1701433](#) as CR0020 of 36.873 (Rel-12)

TR36.814

[R1-1701112](#) TR36.814 draftCR Align LSP Notation Fraunhofer HHI, Ericsson

Decision: Agreed in [R1-1701436](#) as CR0004 of 36.814 (Rel-9)

[R1-1701113](#) TR36.814 draftCR Correction of B-22 Fraunhofer HHI

Decision: Revised and agreed in [R1-1701452](#) as CR0008 of 36.814 (Rel-9)

[R1-1701114](#) TR36.814 draftCR Incorrect Reference to LSP_Table Fraunhofer HHI, Ericsson

Decision: Agreed in [R1-1701437](#) as CR0005 of 36.814 (Rel-9)

[R1-1701115](#) TR36.814 draftCR Normalize Cluster Powers Fraunhofer HHI, Ericsson

Decision: Agreed in [R1-1701438](#) as CR0006 of 36.814 (Rel-9)

[R1-1701116](#) TR36.814 draftCR Notation of Cluster Angular Spreads Fraunhofer HHI

Decision: Agreed in [R1-1701227](#) as CR0007 of 36.814 (Rel-9) with corrected affected clause on cover sheet.

TR25.996

[R1-1701110](#) TR25.996 draftCR Correction of Channel Coefficient Indexes Fraunhofer HHI

Decision: Revised and agreed in [R1-1701451](#) as CR0005 of 25.996 (Rel-13)

[R1-1701111](#) TR25.996 draftCR Correction of Circular Angle Spread Fraunhofer HHI, Ericsson

Decision: Agreed in [R1-1701450](#) as CR0004 of 25.996 (Rel-13)

5.1.11 Extended CP study for 60 kHz subcarrier spacing

[R1-1701388](#) Chairman's notes of AI 5.1.11 on extended CP study for 60 kHz subcarrier spacing Ad-Hoc chair (Qualcomm)

The document was presented by Wanshi Chen from Qualcomm.

Decision: The document is noted.

[R1-1700003](#) Discussion on evaluation on ECP Huawei, HiSilicon

[R1-1700267](#) ECP at 60 kHz SCS ZTE, ZTE Microelectronics

[R1-1700391](#) Extended CP numerology Intel Corporation

[R1-1700532](#) Discussion on extended CP LG Electronics

[R1-1700680](#) Discussion on CP lengths for 60 kHz SCS Sony

[R1-1700843](#) Considerations on ECP use cases with 60kHz SCS Qualcomm Incorporated

[R1-1700992](#) Extended CP Aspects Samsung

[R1-1701046](#) NR extended cyclic prefix Ericsson

[R1-1701149](#) On extended CP for 60 kHz SCS Nokia, Alcatel-Lucent Shanghai Bell

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R1-1701553

Further discussion offline on ECP details (duration, how to configure, whether or not to extend to other SCS, etc.) – revisit later this week

R1-1701357 **WF on extended CP** **Huawei, HiSilicon, Nokia, ASB, CATT, Sony, Ericsson, LGE, Vodafone, Deutsche Telekom, Samsung, Intel, OPPO**

Proposals:

- The length of NR extended CP is scaled from LTE extended CP according to the scaling of NR SCSs.
- From RAN1 specification perspective, the same scalable ECP design supports ECP for all SCSs
- How ECP is indicated is FFS

Friday

R1-1701544 **WF on extended CP** **Huawei, HiSilicon, Nokia, ASB, NTT DOCOMO, Ericsson, LGE, Vodafone, Deutsche Telekom, Samsung, Intel, OPPO, AT&T, China Unicom, CATT, Sony, vivo, InterDigital, Mediatek, Verizon**

- The length of NR extended CP is scaled from LTE extended CP according to the scaling of NR subcarrier spacing relative 15KHz.
- From RAN1 specification perspective, the same scalable extended CP design supports ECP for all NR subcarrier spacings.
 - Symbol level alignment across all subcarrier spacings shall be maintained in case of using extended CP
 - How ECP is indicated is FFS
 - Which SCSs support extended CP may depend on UE type/capability
- Other ECP design for new scenarios is not precluded

Discussion: Qualcomm cannot agree, even cannot take it as a working assumption – would like to agree having the decision postponed to the WI phase.

ZTE there is no need for rush regarding ECP.

Decision: The document is noted.

5.1.12 Other

Including remaining issues on waveform and multiple access

Also including forward compatibility not covered by above agenda items

R1-1701054 **Forward compatibility: NR performance via Aerial platforms** **Thales, Fraunhofer IIS, Dish Network**

The document was presented by Nicolas Chuberre from Thales and provides preliminary link budget analysis for NR radio interface performance evaluation via satellite/HAPS (for mMTC service). The main purpose is to study the forward compatibility of the proposed NR waveform with satellite links as part of the Rel-16/NR Phase 2.

Discussion: Thales will welcome any feedback from RAN1.

Decision: The document is noted.

R1-1700700 **Satellite Aspects- Forward Compatibility Consideration for Random Access Preamble Format**
DISH Network, Thales, Fraunhofer IIS, SES S.A.

The document was presented by Medhi Alasti from Dish and studies the satellite considerations of the PRACH preamble format for the NR access technology to ensure forward compatibility for support via satellite in Phase II.

- Proposal 1: Flexible preamble formats allowing different length are needed in order to support the forward compatibility of NR with satellite systems.

Decision: The document is noted.

R1-1700545 **Remaining issues on NR frame structure focusing on frequency domain** **Panasonic Corporation**

The document was presented by Tetsuya Yamamoto from Panasonic.

- Proposal 1: Common PRB boundary should be used regardless of the system bandwidth for the same numerology in the same carrier.
- Proposal 2: NW centre is located at the boundary of PRBs or edge subcarrier of PRBs.
- Proposal 3: Common PRB boundary should be used among UL, DL, and sidelink for the same numerology in the same carrier.
- Proposal 4: PRB grid is defined on absolute frequency position.
- Proposal 5: DC subcarrier is located at the boundary of PRBs or edge subcarrier of PRBs.
- Proposal 6: Subcarriers affected by DC is modulated but EVM is not specified and collision at least with RS should be avoided.
- Proposal 7: DC offset is specified at each band.

Decision: The document is noted.

Agreements:

- Handling of transmitter DC subcarrier at the transmitter

- DL
 - Transmitter DC subcarrier at the transmitter (gNB) side is modulated but EVM is not specified
 - Note that gNB can suppress DC interference to the required level by implementation
- UL
 - The transmitter DC subcarrier at the transmitter (UE) side should avoid collisions at least with DMRS
 - The specification should define at least one particular subcarrier as the candidate position of DC subcarrier, e.g., DC subcarrier is located at the boundary of PRBs
 - This should be considered in the RS design for NR
 - Specify means for the receiver to determine DC subcarrier location
 - This involves semi-static signalling from UE and also standard specified DC subcarrier location
 - FFS how to determine and how to indicate DC subcarrier location in the case of bandwidth adaptation
- Note that above DC subcarrier can be interpreted as DC subcarrier candidate

Friday: Above agreement is modified as follows (further to the proposal in R1-1701525)

- Handling of transmitter DC subcarrier at the transmitter
 - DL
 - UE may assume transmit DC subcarrier at the transmitter (gNB) side is modulated i.e., data is neither rate-matched nor punctured.
 - Signal quality requirement (e.g., EVM) corresponding to DC subcarriers is up to RAN4.
 - UL
 - Transmit DC subcarrier at the transmitter (UE) side is modulated i.e., data is neither rate-matched nor punctured.
 - Signal quality requirement (e.g., EVM) corresponding to DC subcarriers is up to RAN4.
 - The transmitter DC subcarrier at the transmitter (UE) side should avoid collisions at least with DMRS if possible
 - The specification should define at least one particular subcarrier as the candidate position of DC subcarrier, e.g., DC subcarrier is located at the boundary of PRBs
 - This should be considered in the RS design for NR
 - Specify means for the receiver to determine DC subcarrier location
 - This involves semi-static signalling from UE and also standard specified DC subcarrier location
 - FFS how to determine and how to indicate DC subcarrier location in the case of bandwidth adaptation
- Note that above DC subcarrier can be interpreted as DC subcarrier candidate

Possible agreements

- Handling of receiver DC subcarrier at the transmitter
 - DL
 - Transmitter should be aware of the DC subcarrier position (or potential positions) used at receiver side in order to avoid collisions at least with RS
 - FFS: need to avoid collisions with other signals or channels, e.g., sync signals and broadcast channels
 - Note that this includes being aware of whether the receiver DC subcarrier is present within the transmitter bandwidth
 - This should be considered in the RS design for NR
 - UL
 - The receiver (gNB) DC subcarrier at the transmitter (UE) side is modulated but EVM is not specified
 - Note that gNB can suppress DC interference to the required level by implementation

Continue discussion until Thursday – (Panasonic)

Friday

R1-1701525 **WF on DC handling** **Panasonic, Intel, Huawei, HiSilicon**

The document was presented by Tetsuya ... from Panasonic.

Decision: The document is noted.

Agreement

- RAN1 should consider the impact of the potential receiver DC subcarrier collision with RS used by that receiver, and whether NR design would offer the possibility of collision free operation

- o Note that this does not create the requirement for receiver on receiver DC subcarrier handling

Not treated.

R1-1700010	Handling of DC subcarrier in NR	Huawei, HiSilicon
R1-1700077	Discussion on further PAPR reduction of uplink DFT-s-OFDM	Huawei, HiSilicon
R1-1700255	Non-orthogonal data transmission for eMBB	ZTE, ZTE Microelectronics
R1-1700256	Remaining issues on system level simulation for multiple access	ZTE, ZTE Microelectronics
R1-1700284	Discussion on numerology multiplexing	vivo
R1-1700392	Transmitter side dc subcarrier handling in NR	Intel Corporation
R1-1700427	Results of additional feature calibration	ITRI
R1-1700574	Discussion on the waveform for the one Tx port UE	Guangdong OPPO Mobile Telecom.
R1-1700584	Discussion on NR reserved resources	ETRI
R1-1700585	Remaining issues on NR frequency domain frame structure	ETRI
R1-1700632	Frequency-domain aspects of frame structure	NTT DOCOMO, INC.
R1-1700641	Further waveform considerations for UL URLLC	Sequans Communications
R1-1700649	UW DFTsOFDM performance evaluation above 40GHz	Mitsubishi Electric RCE
R1-1700664	Further LLS results for UL non-orthogonal multiple access	Fujitsu
R1-1700694	DM-RS design for multiple access	Ericsson
R1-1700699	On scrambling	Ericsson
R1-1700878	Performance evaluations of UW-DFT-s-OFDM in the 30GHz high speed train scenario	Mitsubishi Electric Co.
R1-1700993	Basic channel structure for grant-free based multiple access	Samsung
R1-1700994	Indication of Reserved Resources	Samsung
R1-1700995	DC subcarrier handling	Samsung
R1-1700996	Guard-band Considering Inter-numerology Interference	Samsung
R1-1700997	Remaining Issues on RB Grid	Samsung
R1-1700998	Design aspects of frequency domain spectral shaping for DFT-s-OFDM	Samsung
R1-1700999	Modulation/waveform optimization for further PAPR reduction	Samsung
R1-1701000	Performance evaluation results of DFT-s-OFDM with FDSS	Samsung
R1-1701001	DFT-based IGMA	Samsung
R1-1701002	PAPR evaluation results for DFT-based IGMA	Samsung
R1-1701003	Grant-free Based Multiple Access	Samsung
R1-1701004	Collision Analysis of Grant-Free Based Multiple Access	Samsung
R1-1701005	Overview of NR Unlicensed and Shared Spectrums	Samsung
R1-1701006	Discussion on vehicular communications for NR	Samsung
R1-1701044	On mMTC, NB-IoT and eMTC battery life evaluation	Ericsson LM
R1-1701045	On mMTC, NB-IoT and eMTC latency evaluation	Ericsson LM
R1-1701047	On mMTC multiple access	Ericsson LM
R1-1701048	On NB-IoT, eMTC and NR coexistence	Ericsson LM
R1-1701050	On the evolution of mMTC	Ericsson LM
R1-1701053	On the signalling support for forward compatibility	Nokia, Alcatel-Lucent Shanghai Bell
R1-1701132	On NR Operation in the 60 GHz Unlicensed Band	Ericsson
R1-1701133	On Channel Access Mechanisms for NR in Unlicensed Spectrum	Ericsson
R1-1701134	Technology Components for Unlicensed Operation	Ericsson
R1-1701135	On Autonomous UL Transmissions for NR in Unlicensed Spectrum	Ericsson
R1-1701136	Discussion of Multi-Antenna and Highly Directional Beam-Forming for Operation in Unlicensed Spectrum	Ericsson
R1-1701137	On Physical Layer Design Policies for Unlicensed Operation of NR	Ericsson
R1-1701150	Intra-carrier sub-band for mixed numerology	Nokia, Alcatel-Lucent Shanghai Bell
R1-1701151	Guard band arrangement supporting mixed numerology	Nokia, Alcatel-Lucent Shanghai Bell

6 Closing of the meeting

As a conclusion, Mr Chair expressed his good feeling regarding the merit of having set-up such an ad-hoc meeting, hoping that the week had been helpful to all.

Mr Chair thanked all for the hard work performed during the week. Only one remaining meeting to complete the SI on NR, coming up soon in February 2017. Due to the short gap and taken into consideration that this gap will include the Chinese New Year, Mr Chair announced an extended deadline for the submission of contributions to the next meeting (Monday 6th Feb instead of Friday 3rd Feb).

Before closing the meeting, Mr Chair also told RAN1 about his decision to candidate to the upcoming RAN election, now officially announced – see 3GPP web site. Whatever the result will be, he shall remain and chair RAN1 meetings until August 2017 – date of the next RAN1 election.

Meeting was closed at 17:10.

See you all in Athens.

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Annex A: List of Tdocs at RAN1 #AHI_NR

Please see excel file attached to this report

R1-1701553

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Annex B: List of CRs agreed at RAN1 #AH1_NR

TR	CR	Rev	Rel	Title	Cat	Vsn	@ Mng	TD#	Source to WG	Work Item
25.996	4		Rel-13	TR25.996_CR_Correction_of_Circular_Angle_Spread	F	13.1.0	R1#AH1_NR	R1-1701450	Fraunhofer HHI, Ericsson	MIMO
25.996	5		Rel-13	TR25.996_CR_Correction_of_Channel_Coefficient_Indices	F	13.1.0	R1#AH1_NR	R1-1701451	Fraunhofer HHI	MIMO
36.814	4		Rel-9	TR36.814_CR_Align_LSP_Notation	F	9.1.0	R1#AH1_NR	R1-1701446	Fraunhofer HHI, Ericsson	FS_RAN_LTEA
36.814	5		Rel-9	TR36.814_CR_Incorrect_Reference_to_LSP_Table	F	9.1.0	R1#AH1_NR	R1-1701447	Fraunhofer HHI, Ericsson	FS_RAN_LTEA
36.814	6		Rel-9	TR36.814_CR_Normalize_Cluster_Powers	F	9.1.0	R1#AH1_NR	R1-1701448	Fraunhofer HHI, Ericsson	FS_RAN_LTEA
36.814	7		Rel-9	TR36.814_CR_Notation_of_Cluster_Angular_Spreads	F	9.1.0	R1#AH1_NR	R1-1701227	Fraunhofer HHI	FS_RAN_LTEA
36.814	8		Rel-9	TR36.814_CR_Correction_of_B-22	F	9.1.0	R1#AH1_NR	R1-1701452	Fraunhofer HHI	FS_RAN_LTEA
36.873	13		Rel-12	TR36.873_CR_Scenarios	F	12.3.0	R1#AH1_NR	R1-1701426	Fraunhofer HHI, Ericsson	FS_LTE_3D_channel
36.873	14		Rel-12	TR36.873_CR_Section_7.1	F	12.3.0	R1#AH1_NR	R1-1701427	Fraunhofer HHI, Ericsson	FS_LTE_3D_channel
36.873	15		Rel-12	TR36.873_CR_Section_7.2	F	12.3.0	R1#AH1_NR	R1-1701428	Fraunhofer HHI	FS_LTE_3D_channel
36.873	16		Rel-12	TR36.873_CR_Incorrect_Reference	F	12.3.0	R1#AH1_NR	R1-1701429	Fraunhofer HHI, Ericsson	FS_LTE_3D_channel
36.873	17		Rel-12	TR36.873_CR_Align_LSP_Notation	F	12.3.0	R1#AH1_NR	R1-1701430	Fraunhofer HHI, Ericsson	FS_LTE_3D_channel
36.873	18		Rel-12	TR36.873_CR_Notation_of_Cluster_Angular_Spreads	F	12.3.0	R1#AH1_NR	R1-1701431	Fraunhofer HHI, Ericsson	FS_LTE_3D_channel
36.873	19		Rel-12	TR36.873_CR_Normalize_Cluster_Powers	F	12.3.0	R1#AH1_NR	R1-1701432	Fraunhofer HHI, Ericsson	FS_LTE_3D_channel
36.873	20		Rel-12	TR36.873_CR_Incorrect_Reference_to_LSP_Table	F	12.3.0	R1#AH1_NR	R1-1701433	Fraunhofer HHI, Ericsson	FS_LTE_3D_channel
38.900	67	-	Rel-14	Correction for scenario description	F	14.2.0	R1#AH1_NR	R1-1701410	Ericsson, Fraunhofer HHI	FS_6GHz_CH_model
38.900	68	-	Rel-14	Correction for fast fading model	F	14.2.0	R1#AH1_NR	R1-1701411	Ericsson, Fraunhofer HHI	FS_6GHz_CH_model
38.900	69		Rel-14	TR38.900_CR_Ground_Reflection_Model	B	14.2.0	R1#AH1_NR	R1-1701412	Fraunhofer HHI, ZTE, Ericsson	FS_6GHz_CH_model
38.900	70		Rel-14	TR38.900_CR_Normalize_Cluster_Powers	F	14.2.0	R1#AH1_NR	R1-1701413	Fraunhofer HHI, Ericsson	FS_6GHz_CH_model
38.900	71	-	Rel-14	Correction for spatial consistency	F	14.2.0	R1#AH1_NR	R1-1701414	Ericsson	FS_6GHz_CH_model
38.900	73	-	Rel-14	Correction for blockage model B and its calibration assumptions	F	14.2.0	R1#AH1_NR	R1-1701416	Ericsson, Fraunhofer HHI	FS_6GHz_CH_model

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38.900	74	-	Rel-14	Correction for correlation modelling for multi-frequency simulations	F	14.2.0	R1#AH1_NR	R1-1701417	Eriasson, Fraunhofer HHI	FS_6GHz_CH_model
38.900	75	-	Rel-14	CR to capture additional feature calibration results	F	14.2.0	R1#AH1_NR	R1-1701425	Samsung	FS_6GHz_CH_model
38.900	77	-	Rel-14	Correction for calibration assumptions for spatial consistency	F	14.2.0	R1#AH1_NR	R1-1701231	NTT DOCOMO	FS_6GHz_CH_model
36.873	12		Rel-12	Draft CR to TR36.873 on rural channel model	F	12.3.0	R1#AH1_NR	R1-1701407	Huawei, HiSilicon	FS_LTE_3D_channel
36.873	21		Rel-12	TR36.873_CR_Adding_3D-InH_Scenario	F	12.3.0	R1#AH1_NR	R1-1701535	CMCC	FS_LTE_3D_channel
38.900	66	-	Rel-14	Correction for low and high frequency model harmonization	F	14.2.0	R1#AH1_NR	R1-1701406	Eriasson, Samsung, NTT DOCOMO, Nokia, Intel, Telstra, Verizon Wireless, Deutsche Telekom, T-Mobile US	FS_6GHz_CH_model

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Annex C-1: List of Outgoing LSs from RAN1 #AHI_NR

TDoc #	Title	Source	Release	Related WIs	Reply to	To	Cc	Original LS	Reply in
R1-1701223	LS on wider bandwidth operation for NR	RAN1, NTT DCOMO, INC.	Rel-14	FS_NR_newRAT		RAN4	RAN2		
R1-1701487	Response LS on UE capability aspects for LTE/NR tight interworking	RAN1, Nokia	Rel-14	FS_NR_newRAT	R2-168961	RAN2	RAN4		
R1-1701495	LS on Paging Requirements	RAN1, Huawei	Rel-14	FS_NR_newRAT		RAN2			
R1-1701501	LS on NR Mobility	RAN1, Huawei, Intel	Rel-14	FS_NR_newRAT		RAN2			
R1-1701541	Reply LS on PRACH preambles for on demand SI requests	RAN1, Ericsson	Rel-14	FS_NR_newRAT	R2-1700653	RAN2			
R1-1701547	LS on pi/2 BPSK with spectrum shaping for DFT-S-OFDM uplink	RAN1, IITH, Nokia	Rel-14	FS_NR_newRAT		RAN4			

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Annex C-2: List of Incoming LSs from RAN1 #AH1_NR

TDoc #	Title	Source	Release	Related WIs	Reply to	To	Cc	Original LS	Reply in
R1-1700290	LS on UE capability aspects for LTE/NR tight interworking	RAN2, Nokia	Rel-14	FS_NR_newRAT		RAN4, RAN1		R2-168961	
R1-1700291	Reply LS on NR RACH Procedure	RAN2, Huawei	Rel-14	FS_NR_newRAT		RAN1		R2-169141	
R1-1701518	LS on PRACH preambles for on demand SI requests	RAN2, BlackBerry	Rel-14	FS_NR_newRAT		RAN1		R2-1700653	
R1-1701519	Response LS on minimum system information	RAN2, LG Electronics	Rel-14	FS_NR_newRAT	R1-1613692	RAN1		R2-1700654	

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Annex D: List of Approved updated WIDs

None

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Annex E: List of draft TSs/TRs agreed at RAN1 #AHL_NR

Tdoc Number	Title	Source	Conclusion/Decision
R1-1701422	TR 38.802 v1.1.0 Study on New Radio (NR) Access Technology - Physical Layer Aspects	NTT DOCOMO, INC.	Agreed as basis for further updates

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Annex F: List of actions

- Outgoing LS

None

- CR approval

[NRAH1-07] Henrik (Ericsson)

R1-1701507 Correction for channel generation for multi-frequency simulations Ericsson, Fraunhofer HHI

Email approval until 26th January

Done: No consensus – A revised CR based on the discussion in this email thread should be submitted to the upcoming meeting.

- Text proposal for TS and TR

None

- Miscellaneous

[NRAH1-01] Ruyue (ZTE)

R1-1701514 Way Forward on Evaluation for Beam Management ZTE, ZTE Microelectronics, Ericsson, Nokia, ASB

Email discussion until Feb. meeting

Done: Summary in R1-1701827 for further discussion at RAN1#88.

[NRAH1-02-Ph1] Chuangxin (ZTE)

NR MIMO calibration Phase 1 - updating phase-1 results until Feb. 6th based on

R1-1701526 NR-MIMO Phase-1 and Phase-2 Calibration Results ZTE, ZTE Microelectronics

Companies are encouraged to update results (particularly for the micro layer of dense urban scenario)

If further clarification of simulation assumptions is needed, it can also be discussed under this email thread

Done: Summaries for further discussion at RAN1#88 as follows:

R1-1701829 Calibration results for Phase 1 NR MIMO link level calibration

R1-1701830 Calibration results for Phase 1 NR MIMO system level calibration

[NRAH1-02-Ph2] Chuangxin (ZTE)

For phase-2 results until Mar. 31st

Done: Summaries for further discussion at RAN1#88 as follows:

R1-1701831 Calibration results for Phase 2 NR MIMO link level calibration

R1-1701832 Calibration results for Phase 2 NR MIMO system level calibration

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[NRAH1-02-Ph3] Chuangxin (ZTE)
For phase-3 results until Apr. 28th

[NRAH1-03] Jing (Qualcomm)
R1-1701478 WF on 2-Stage DCI for NR Qualcomm, Huawei, HiSilicon, National Instrument, Vivo, ZTE, Sony, MediaTek
Email discussion until 7th February
Done: Summary in R1-1702629 for further discussion at RAN1#88.

[NRAH1-04] Hongsil (Samsung)
Granularity of information block sizes to be evaluated for email discussion until the meeting
Done: Status to be checked at RAN1#88.

[NRAH1-05] Hongsil (Samsung)
Details of other evaluation criteria for information block sizes of LDPC for email discussion until the meeting
Done: Status to be checked at RAN1#88.

[NRAH1-06] Jan (ZTE)
Option 2/4 agreements of PRACH for email approval until 27th January
Done: According to Chair's email posted on Jan 28th, the following is agreed

- Agreement (under 5.1.1.4.1) on PRACH design is modified as follows:
 - For single/multi-beam operation in the Option 2/4 case
 - The same/different RACH sequences with CP is used and GT is reserved at the end of the consecutive multiple/repeated RACH sequences preambles

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Annex G: List of participants at RAN1 #AH1_NR

Please see excel file attached to this report

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R1-1701553

Annex H: TSG RAN WG1 meetings in 2017 – 2018

TITLE	TYPE	DATES	LOCATION	CTRY
3GPPRANI#88	WG	13 – 17 Feb 2017	Athens	Greece
3GPPRANI#88bis	WG	03 – 07 Apr 2017	Spokane	US
3GPPRANI#89	WG	15 – 19 May 2017	Hangzhou (TBC)	China
3GPPRANI-NR	AH	27 – 30 Jun 2017	TBD	China
3GPPRANI#90	WG	21 – 25 Aug 2017	Prague	Rep Czech
3GPPRANI-NR	AH	18 – 21 Sep 2017	Nagoya	Japan
3GPPRANI#90bis	WG	09 – 13 Oct 2017	Prague	Rep Czech
3GPPRANI#91	WG	27 Nov – 01 Dec 2017	TBD	US
3GPPRANI#92	WG	26 Feb – 2 Mar 2018	Athens (TBC)	Greece
3GPPRANI#92bis	WG	16 – 20 Apr 2018	TBD	TBD
3GPPRANI#93	WG	21 – 25 May 2018	TBD	Korea
3GPPRANI#94	WG	20 – 24 Aug 2018	Gothenburg (TBC)	Sweden
3GPPRANI#94bis	WG	8 – 12 Oct 2018	TBD	TBD
3GPPRANI#95	WG	12 – 16 Nov 2018	TBD	TBD

MEETING TYPES	
AH = Ad Hoc	RG = Rapporteurs Group
JM = Joint	SG = Steering Group
PM = Preparatory Meeting	TG = Task Group
RM = Resolution Meeting	XO = Extraordinary

End of document

APPENDIX C

Project Details		Timeline		Status		Risk		Impact		Mitigation		Notes	
Project ID	Project Name	Start Date	End Date	Current Status	Next Review	Overall Risk	Specific Risk	Impact Level	Mitigation Strategy	Notes	Comments	Owner	
1	Project A	2023-01-01	2023-03-31	Completed	2023-03-31	Low	Scope Creep	Medium	Scope Creep	Scope Creep	Scope Creep	Scope Creep	
2	Project B	2023-04-01	2023-06-30	In Progress	2023-06-30	Medium	Resource Allocation	High	Resource Allocation	Resource Allocation	Resource Allocation	Resource Allocation	
3	Project C	2023-07-01	2023-09-30	On Hold	2023-09-30	Low	Technical Debt	Medium	Technical Debt	Technical Debt	Technical Debt	Technical Debt	
4	Project D	2023-10-01	2023-12-31	Planned	2023-12-31	Medium	Market Volatility	High	Market Volatility	Market Volatility	Market Volatility	Market Volatility	
5	Project E	2024-01-01	2024-03-31	Completed	2024-03-31	Low	Scope Creep	Medium	Scope Creep	Scope Creep	Scope Creep	Scope Creep	
6	Project F	2024-04-01	2024-06-30	In Progress	2024-06-30	Medium	Resource Allocation	High	Resource Allocation	Resource Allocation	Resource Allocation	Resource Allocation	
7	Project G	2024-07-01	2024-09-30	On Hold	2024-09-30	Low	Technical Debt	Medium	Technical Debt	Technical Debt	Technical Debt	Technical Debt	
8	Project H	2024-10-01	2024-12-31	Planned	2024-12-31	Medium	Market Volatility	High	Market Volatility	Market Volatility	Market Volatility	Market Volatility	
9	Project I	2025-01-01	2025-03-31	Completed	2025-03-31	Low	Scope Creep	Medium	Scope Creep	Scope Creep	Scope Creep	Scope Creep	
10	Project J	2025-04-01	2025-06-30	In Progress	2025-06-30	Medium	Resource Allocation	High	Resource Allocation	Resource Allocation	Resource Allocation	Resource Allocation	
11	Project K	2025-07-01	2025-09-30	On Hold	2025-09-30	Low	Technical Debt	Medium	Technical Debt	Technical Debt	Technical Debt	Technical Debt	
12	Project L	2025-10-01	2025-12-31	Planned	2025-12-31	Medium	Market Volatility	High	Market Volatility	Market Volatility	Market Volatility	Market Volatility	
13	Project M	2026-01-01	2026-03-31	Completed	2026-03-31	Low	Scope Creep	Medium	Scope Creep	Scope Creep	Scope Creep	Scope Creep	
14	Project N	2026-04-01	2026-06-30	In Progress	2026-06-30	Medium	Resource Allocation	High	Resource Allocation	Resource Allocation	Resource Allocation	Resource Allocation	
15	Project O	2026-07-01	2026-09-30	On Hold	2026-09-30	Low	Technical Debt	Medium	Technical Debt	Technical Debt	Technical Debt	Technical Debt	
16	Project P	2026-10-01	2026-12-31	Planned	2026-12-31	Medium	Market Volatility	High	Market Volatility	Market Volatility	Market Volatility	Market Volatility	
17	Project Q	2027-01-01	2027-03-31	Completed	2027-03-31	Low	Scope Creep	Medium	Scope Creep	Scope Creep	Scope Creep	Scope Creep	
18	Project R	2027-04-01	2027-06-30	In Progress	2027-06-30	Medium	Resource Allocation	High	Resource Allocation	Resource Allocation	Resource Allocation	Resource Allocation	
19	Project S	2027-07-01	2027-09-30	On Hold	2027-09-30	Low	Technical Debt	Medium	Technical Debt	Technical Debt	Technical Debt	Technical Debt	
20	Project T	2027-10-01	2027-12-31	Planned	2027-12-31	Medium	Market Volatility	High	Market Volatility	Market Volatility	Market Volatility	Market Volatility	
21	Project U	2028-01-01	2028-03-31	Completed	2028-03-31	Low	Scope Creep	Medium	Scope Creep	Scope Creep	Scope Creep	Scope Creep	
22	Project V	2028-04-01	2028-06-30	In Progress	2028-06-30	Medium	Resource Allocation	High	Resource Allocation	Resource Allocation	Resource Allocation	Resource Allocation	
23	Project W	2028-07-01	2028-09-30	On Hold	2028-09-30	Low	Technical Debt	Medium	Technical Debt	Technical Debt	Technical Debt	Technical Debt	
24	Project X	2028-10-01	2028-12-31	Planned	2028-12-31	Medium	Market Volatility	High	Market Volatility	Market Volatility	Market Volatility	Market Volatility	
25	Project Y	2029-01-01	2029-03-31	Completed	2029-03-31	Low	Scope Creep	Medium	Scope Creep	Scope Creep	Scope Creep	Scope Creep	
26	Project Z	2029-04-01	2029-06-30	In Progress	2029-06-30	Medium	Resource Allocation	High	Resource Allocation	Resource Allocation	Resource Allocation	Resource Allocation	
27	Project AA	2029-07-01	2029-09-30	On Hold	2029-09-30	Low	Technical Debt	Medium	Technical Debt	Technical Debt	Technical Debt	Technical Debt	
28	Project AB	2029-10-01	2029-12-31	Planned	2029-12-31	Medium	Market Volatility	High	Market Volatility	Market Volatility	Market Volatility	Market Volatility	
29	Project AC	2030-01-01	2030-03-31	Completed	2030-03-31	Low	Scope Creep	Medium	Scope Creep	Scope Creep	Scope Creep	Scope Creep	
30	Project AD	2030-04-01	2030-06-30	In Progress	2030-06-30	Medium	Resource Allocation	High	Resource Allocation	Resource Allocation	Resource Allocation	Resource Allocation	
31	Project AE	2030-07-01	2030-09-30	On Hold	2030-09-30	Low	Technical Debt	Medium	Technical Debt	Technical Debt	Technical Debt	Technical Debt	
32	Project AF	2030-10-01	2030-12-31	Planned	2030-12-31	Medium	Market Volatility	High	Market Volatility	Market Volatility	Market Volatility	Market Volatility	
33	Project AG	2031-01-01	2031-03-31	Completed	2031-03-31	Low	Scope Creep	Medium	Scope Creep	Scope Creep	Scope Creep	Scope Creep	
34	Project AH	2031-04-01	2031-06-30	In Progress	2031-06-30	Medium	Resource Allocation	High	Resource Allocation	Resource Allocation	Resource Allocation	Resource Allocation	
35	Project AI	2031-07-01	2031-09-30	On Hold	2031-09-30	Low	Technical Debt	Medium	Technical Debt	Technical Debt	Technical Debt	Technical Debt	
36	Project AJ	2031-10-01	2031-12-31	Planned	2031-12-31	Medium	Market Volatility	High	Market Volatility	Market Volatility	Market Volatility	Market Volatility	
37	Project AK	2032-01-01	2032-03-31	Completed	2032-03-31	Low	Scope Creep	Medium	Scope Creep	Scope Creep	Scope Creep	Scope Creep	
38	Project AL	2032-04-01	2032-06-30	In Progress	2032-06-30	Medium	Resource Allocation	High	Resource Allocation	Resource Allocation	Resource Allocation	Resource Allocation	
39	Project AM	2032-07-01	2032-09-30	On Hold	2032-09-30	Low	Technical Debt	Medium	Technical Debt	Technical Debt	Technical Debt	Technical Debt	
40	Project AN	2032-10-01	2032-12-31	Planned	2032-12-31	Medium	Market Volatility	High	Market Volatility	Market Volatility	Market Volatility	Market Volatility	
41	Project AO	2033-01-01	2033-03-31	Completed	2033-03-31	Low	Scope Creep	Medium	Scope Creep	Scope Creep	Scope Creep	Scope Creep	
42	Project AP	2033-04-01	2033-06-30	In Progress	2033-06-30	Medium	Resource Allocation	High	Resource Allocation	Resource Allocation	Resource Allocation	Resource Allocation	
43	Project AQ	2033-07-01	2033-09-30	On Hold	2033-09-30	Low	Technical Debt	Medium	Technical Debt	Technical Debt	Technical Debt	Technical Debt	
44	Project AR	2033-10-01	2033-12-31	Planned	2033-12-31	Medium	Market Volatility	High	Market Volatility	Market Volatility	Market Volatility	Market Volatility	
45	Project AS	2034-01-01	2034-03-31	Completed	2034-03-31	Low	Scope Creep	Medium	Scope Creep	Scope Creep	Scope Creep	Scope Creep	
46	Project AT	2034-04-01	2034-06-30	In Progress	2034-06-30	Medium	Resource Allocation	High	Resource Allocation	Resource Allocation	Resource Allocation	Resource Allocation	
47	Project AU	2034-07-01	2034-09-30	On Hold	2034-09-30	Low	Technical Debt	Medium	Technical Debt	Technical Debt	Technical Debt	Technical Debt	
48	Project AV	2034-10-01	2034-12-31	Planned	2034-12-31	Medium	Market Volatility	High	Market Volatility	Market Volatility	Market Volatility	Market Volatility	
49	Project AW	2035-01-01	2035-03-31	Completed	2035-03-31	Low	Scope Creep	Medium	Scope Creep	Scope Creep	Scope Creep	Scope Creep	
50	Project AX	2035-04-01	2035-06-30	In Progress	2035-06-30	Medium	Resource Allocation	High	Resource Allocation	Resource Allocation	Resource Allocation	Resource Allocation	
51	Project AY	2035-07-01	2035-09-30	On Hold	2035-09-30	Low	Technical Debt	Medium	Technical Debt	Technical Debt	Technical Debt	Technical Debt	
52	Project AZ	2035-10-01	2035-12-31	Planned	2035-12-31	Medium	Market Volatility	High	Market Volatility	Market Volatility	Market Volatility	Market Volatility	
53	Project BA	2036-01-01	2036-03-31	Completed	2036-03-31	Low	Scope Creep	Medium	Scope Creep	Scope Creep	Scope Creep	Scope Creep	
54	Project BB	2036-04-01	2036-06-30	In Progress	2036-06-30	Medium	Resource Allocation	High	Resource Allocation	Resource Allocation	Resource Allocation	Resource Allocation	
55	Project BC	2036-07-01	2036-09-30	On Hold	2036-09-30	Low	Technical Debt	Medium	Technical Debt	Technical Debt	Technical Debt	Technical Debt	
56	Project BD	2036-10-01	2036-12-31	Planned	2036-12-31	Medium	Market Volatility	High	Market Volatility	Market Volatility	Market Volatility	Market Volatility	
57	Project BE	2037-01-01	2037-03-31	Completed	2037-03-31	Low	Scope Creep	Medium	Scope Creep	Scope Creep	Scope Creep	Scope Creep	
58	Project BF	2037-04-01	2037-06-30	In Progress	2037-06-30	Medium	Resource Allocation	High	Resource Allocation	Resource Allocation	Resource Allocation	Resource Allocation	
59	Project BG	2037-07-01	2037-09-30	On Hold	2037-09-30	Low	Technical Debt	Medium	Technical Debt	Technical Debt	Technical Debt	Technical Debt	
60	Project BH	2037-10-01	2037-12-31	Planned	2037-12-31	Medium	Market Volatility	High	Market Volatility	Market Volatility	Market Volatility	Market Volatility	
61	Project BI	2038-01-01	2038-03-31	Completed	2038-03-31	Low	Scope Creep	Medium	Scope Creep	Scope Creep	Scope Creep	Scope Creep	
62	Project BJ	2038-04-01	2038-06-30	In Progress	2038-06-30	Medium	Resource Allocation	High	Resource Allocation	Resource Allocation	Resource Allocation	Resource Allocation	
63	Project BK	2038-07-01	2038-09-30	On Hold	2038-09-30	Low	Technical Debt	Medium	Technical Debt	Technical Debt	Technical Debt	Technical Debt	
64	Project BL	2038-10-01	2038-12-31	Planned	2038-12-31	Medium	Market Volatility	High	Market Volatility	Market Volatility	Market Volatility	Market Volatility	
65	Project BM	2039-01-01	2039-03-31	Completed	2039-03-31	Low	Scope Creep	Medium	Scope Creep	Scope Creep	Scope Creep	Scope Creep	
66	Project BN	2039-04-01	2039-06-30	In Progress	2039-06-30	Medium	Resource Allocation	High	Resource Allocation	Resource Allocation	Resource Allocation	Resource Allocation	
67	Project BO	2039-07-01	2039-09-30	On Hold	2039-09-30	Low	Technical Debt	Medium	Technical Debt	Technical Debt	Technical Debt	Technical Debt	
68	Project BP	2039-10-01	2039-12-31	Planned	2039-12-31	Medium	Market Volatility	High	Market Volatility	Market Volatility	Market Volatility	Market Volatility	
69	Project BQ	2040-01-01	2040-03-31	Completed	2040-03-31	Low	Scope Creep	Medium	Scope Creep	Scope Creep	Scope Creep	Scope Creep	
70	Project BR	2040-04-01	2040-06-30	In Progress	2040-06-30	Medium	Resource Allocation	High	Resource Allocation	Resource Allocation	Resource Allocation	Resource Allocation	
71	Project BS	2040-07-01	2040-09-30	On Hold	2040-09-30	Low	Technical Debt	Medium	Technical Debt	Technical Debt	Technical Debt	Technical Debt	
72	Project BT	2040-10-01	2040-12-31	Planned	2040-12-31	Medium	Market Volatility	High	Market Volatility	Market Volatility	Market Volatility	Market Volatility	
73	Project BU	2041-01-01	2041-03-31	Completed	2041-03-31	Low	Scope Creep	Medium	Scope Creep	Scope Creep	Scope Creep	Scope Creep	
74	Project BV	2041-04-01	2041-06-30	In Progress	2041-06-30	Medium	Resource Allocation	High	Resource Allocation	Resource Allocation	Resource Allocation	Resource Allocation	
75	Project BW	2041-07-01	2041-09-30	On Hold	2041-09-30	Low	Technical Debt	Medium	Technical Debt	Technical Debt	Technical Debt	Technical Debt	
76	Project BX	2041-10-01	2041-12-31	Planned	2041-12-31	Medium	Market Volatility	High	Market Volatility	Market Volatility	Market Volatility	Market Volatility	
77	Project BY	2042-01-01	2042-03-31	Completed	2042-03-31	Low	Scope Creep	Medium	Scope Creep	Scope Creep	Scope Creep	Scope Creep	
78	Project BZ	2042-04-01	2042-06-30	In Progress	2042-06-30	Medium	Resource Allocation	High	Resource Allocation	Resource Allocation	Resource Allocation	Resource Allocation	
79	Project CA	2042-07-01	2042-09-30	On Hold	2042-09-30	Low	Technical Debt	Medium	Technical Debt	Technical Debt	Technical Debt	Technical Debt	
80	Project CB	2042-10-01	2042-12-31	Planned	2042-12-31	Medium	Market Volatility	High	Market Volatility	Market Volatility	Market Volatility	Market Volatility	
81	Project CC	2043-01-01	2043-03-31	Completed	2043-03-31	Low	Scope Creep	Medium	Scope Creep	Scope Creep	Scope Creep	Scope Creep	
82	Project CD	2043-04-01	2043-06-30	In Progress	2043-06-30	Medium	Resource Allocation	High	Resource Allocation	Resource Allocation	Resource Allocation	Resource Allocation	
83	Project CE	2043-07-01	2043-09-30	On Hold	2043-09-30	Low	Technical Debt	Medium	Technical Debt	Technical Debt	Technical Debt	Technical Debt	
84	Project CF	2043-10-01	2043-12-31	Planned	2043-12-31	Medium	Market Volatility	High	Market Volatility	Market Volatility	Market Volatility	Market Volatility	
85	Project CG	2044-01-01	2044-03-31	Completed	2044-03-31	Low	Scope Creep	Medium	Scope Creep	Scope Creep	Scope Creep	Scope Creep	
86	Project CH	2044-04-01	2044-06-30	In Progress	2044-06-30	Medium	Resource Allocation	High	Resource Allocation	Resource Allocation	Resource Allocation	Resource Allocation	
87	Project CI	2044-07-01	2044-09-30	On Hold	2044-09-30	Low	Technical Debt	Medium	Technical Debt	Technical Debt	Technical Debt	Technical Debt	
88	Project CJ	2044-10-01	2044-12-31	Planned	2044-12-31	Medium	Market Volatility	High	Market Volatility	Market Volatility	Market Volatility	Market Volatility	
89	Project CK	2045-01-01	2045-03-31	Completed	2045-03-31	Low	Scope Creep	Medium	Scope Creep	Scope Creep	Scope Creep	Scope Creep	
90	Project CL	2045-04-01	2045-06-30	In Progress	2045-06-30	Medium	Resource Allocation	High	Resource Allocation	Resource Allocation	Resource Allocation	Resource Allocation	
91	Project CM	2045-07-01	2045-09-30	On Hold	2045-09-30	Low	Technical Debt	Medium	Technical Debt	Technical Debt	Technical Debt	Technical Debt	
92	Project CN	2045-10-01	2045-12-31	Planned	2045-12-31	Medium	Market Volatility	High	Market Volatility	Market Volatility	Market Volatility	Market Volatility	
93	Project CO	2046-01-01	2046-03-31	Completed	2046-03-31	Low	Scope Creep	Medium	Scope Creep	Scope Creep	Scope Creep	Scope Creep	
94	Project CP	2046-04-01	2046-06-30	In Progress	2046-06-30	Medium	Resource Allocation	High	Resource Allocation	Resource Allocation	Resource Allocation	Resource Allocation	
95	Project CQ	2046-07-01	2046-09-30	On Hold	2046-09-30	Low	Technical Debt	Medium	Technical Debt	Technical Debt	Technical Debt	Technical Debt	
96	Project CR	2046-10-01	2046-12-31	Planned	2046-12-31	Medium	Market Volatility	High	Market Volatility	Market Volatility	Market Volatility	Market Volatility	
97	Project CS	2047-01-01	2047-03-31	Completed	2047-03-31	Low	Scope Creep	Medium	Scope Creep	Scope Creep	Scope Creep	Scope Creep	
98	Project CT	2047-04-01	2047-06-30	In Progress	2047-06-30	Medium	Resource Allocation	High	Resource Allocation	Resource Allocation	Resource Allocation	Resource Allocation	
99	Project CU	2047-07-01	2047-09-30	On Hold	2047-09-30	Low	Technical Debt	Medium	Technical Debt	Technical Debt	Technical Debt	Technical Debt	
100	Project CV	2047-10-01	2047-12-31	Planned	2047-12-31	Medium	Market Volatility	High	Market Volatility	Market Volatility	Market Volatility	Market Volatility	

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APPENDIX D

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Source: MCC Support

Title: Final Report of 3GPP TSG RAN WG1 #AH_NR3 v1.0.0
(Nagoya, Japan, 18th – 21st September 2017)

Document for: Approval



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Main facts summary

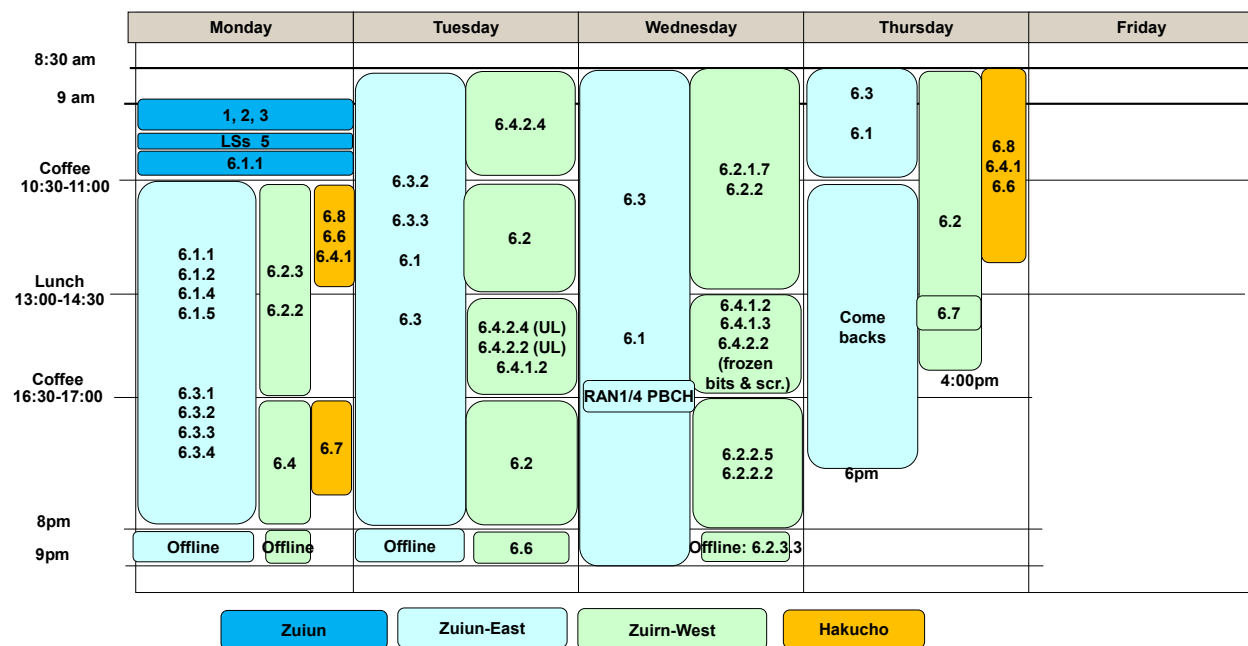
The third 3GPP TSG WG RAN1 ad-hoc meeting on NR, hosted by the Japanese Friends of 3GPP, was held at the Mielparque Nagoya hotel, Nagoya, Japan.

The meeting started at 9:00 on Monday 18th September and finished at 18:30 on Thursday 21st September 2017.

The number of attending delegates, having confirmed their participation through the electronic check-in application, was **348**.

Note that the number of registered was 476.

The schedule of the week was as follows:



The list of action points that required RAN1 close follow-up is listed in Annex F (end of document).

The number of contributions for this meeting was 1515.

Note: The amount of documents includes those discussed during the email discussion session post meeting.

	Contribution is agreed/approved
	Contribution is not pursued (no consensus)
	Further discussion is required – come-back needed
	Working assumption
	Specific action needed from MCC
	Contribution is for email discussion/approval

1 Opening of the meeting

Mr Wanshi Chen (RAN1 Chairman) welcomed the participants of the third RAN WG1 ad-hoc meeting on NR and opened the meeting at 09:00.

Mr Kazuaki Takeda from NTT DOCOMO on behalf of the Japanese Friends of 3GPP, Anritsu, Ericsson Japan, Fujitsu, Huawei Technologies Japan, KDDI, KYOCERA, MITSUBISHI ELECTRIC, NEC, Nokia Networks Japan, NTT DOCOMO, OKI, Panasonic, Qualcomm Japan, SHARP, SoftBank, and Sony Mobile Communications Japan, welcomed the delegates, and detailed the domestic arrangements for the four days.

1.1 Call for IPR

The attention of the members of this Technical Specification Group was drawn to the fact that 3GPP Individual Members have the obligation under the IPR Policies of their respective Organizational Partners to inform their respective Organizational Partners of Essential IPRs they become aware of.

The members take note that they are hereby invited:

- *to investigate whether their organization or any other organization owns IPRs which were, or were likely to become Essential in respect of the work of 3GPP.*
- *to notify their respective Organizational Partners of all potential IPRs, e.g., for ETSI, by means of the IPR Information Statement and the Licensing declaration forms (e.g. see the ETSI IPR forms <http://webapp.etsi.org/lpr/>).*

1.2 Competition law statement

The Chairman also drew Member's attention to the fact that 3GPP activities are subject to antitrust and competition laws and that compliance with said laws is therefore required of any participant of this WG meeting including the Chairman and Vice Chairmen. In case of question, please contact your legal counsel.

The present meeting will be conducted with strict impartiality and in the interests of 3GPP.

Furthermore, the Chairman reminded Members that timely submission of work items/contributions in advance of WG meetings is important to allow for full and fair consideration of such matters.

1.3 Network usage conditions

The PCG has laid down the following network usage conditions:

Users shall not use the network to engage in illegal activities. This includes activities such as copyright violation, hacking, espionage or any other activity that may be prohibited by local laws.

Users shall not engage in non-work related activities that consume excessive bandwidth or cause significant degradation of the performance of the network.

Since the **network is a shared resource**, users should exercise some basic etiquette when using the 3GPP network at a meeting. It is understood that high bandwidth applications such as downloading large files or video streaming might be required for business purposes, but delegates should be strongly discouraged in performing these activities for personal use. Downloading a movie or doing something in an interactive environment for personal use essentially wastes bandwidth that others need to make the meeting effective. The meeting chairman should remind end users that the network is a shared resource; the more one user grabs, the less there is for another. Email and its attachments already take up significant bandwidth (certain email programs are not very bandwidth efficient). In case of need the chair can ask the delegates to restrict IT usage to things that are essential for the meeting itself.

- 1. DON'T place your WiFi device in ad-hoc mode**
- 2. DON'T set up a personal hotspot in the meeting room**
- 3. DO try 802.11a if your WiFi device supports it**
- 4. DON'T manually allocate an IP address**
- 5. DON'T be a bandwidth hog by streaming video, playing online games, or downloading huge files**
- 6. DON'T use packet probing software which clogs the local network (e.g., packet sniffers or port scanners)**

1.4 Check-in for Registered Delegates

The attention of the delegates to this meeting was drawn to the fact that it is not permitted to check in other delegates on their behalf. In the event of technical difficulties preventing check-in, delegates should present themselves in person to the Secretary.

2 Approval of Agenda

[R1-1715350](#) Draft Agenda of RAN1#AH_NR3 meeting RAN1 Chair

Wanshi Chen (RAN1 Chair) proposed the agenda for the meeting, as well the schedule of the week.

Discussion: Huawei regarding the schedule of the week: Coexistence was heavily discussed in the plenary – AI 6.6 may require additional slots during the week

Nokia: agreed with Huawei as contributions were submitted before plenary and lot of things have changed since then w.r.t coexistence – companies may need more time

MCC: WID on NR has been updated in RP-172115.

Decision: The agenda is approved.

3 Highlights from RAN plenary

[R1-1715352](#) Highlights from RAN#77 RAN1 Chair

The document was presented by Wanshi Chen (RAN1 Chair) and provides highlights relevant to RAN1 from the last plenary.

Decision: The document is noted.

4 Approval of Minutes from previous meeting

[R1-1715351](#) Report of RAN1#90 meeting ETSI

The document was not presented online.

Decision: The document is noted for information. Final version will be approved at the next meeting.

5 Incoming Liaison Statements

[R1-1715372](#) LS on Channel Raster and Synchronisation of Channel Raster RAN4, Qualcomm

RAN4 asks RAN1 to enable “floating sync” operation in NR subject to feasibility. If this design is not feasible, RAN4 should be informed because this will impact the ongoing channel raster and sync raster design.

Decision: The document is noted.

[R1-1715426](#) Draft LS reply on channel raster and synchronization Channel Raster Huawei

[R1-1716540](#) On Channel Raster and Synchronisation Channel Raster Ericsson

Details to be handled in 6.1.1

[R1-1715373](#) LS on NR minimum carrier bandwidth and SS block numerology RAN4, DISH, Ericsson

RAN1 is asked to find a solution how to support the following cases:

- 1) Minimum required channel BW and SS SCS for a Sub-6GHz band are 5MHz and 15kHz, respectively. An operator plans to operate with 10MHz bandwidth 30kHz SCS in order to deploy NR/LTE DL co-existence within the same band.
- 2) For bands above 6GHz, the minimum required channel BW and SS SCS are 50MHz and 120kHz, respectively. An operator who has at least 100MHz contiguous spectrum, plans to operate with 240kHz SS SCS within the same band.
- 3) RAN1 is asked to find a solution that shall support the ability for a UE to perform initial access to the NR cells operating with the above carrier bandwidth/SS SCS combinations.

Decision: The document is noted.

[R1-1715906](#) Discussion on LS on UE minimum carrier BW Samsung

[R1-1716159](#) Discussion on NR minimum carrier bandwidth and SS block numerology AT&T

[R1-1716541](#) On NR minimum carrier bandwidth and SS block numerology Ericsson

[R1-1716626](#) Discussion on multiple SS block numerologies in RAN4 LS R4-1709187 MediaTek Inc.

Details to be handled in 6.1.1

[R1-1715363](#) Reply LS on multiple SSBs within a wideband carrier RAN2, MediaTek

Decision: The document is noted.

[R1-1715574](#) Reply LS on multiple SS blocks within a wideband carrier Huawei

[R1-1716533](#) [Draft] Response LS on multiple SSBs within a wideband carrier Nanjing Ericsson Panda Com Ltd

Details to be handled in 6.1.1

[R1-1715370](#) LS on uplink and downlink channel bandwidth for NR RAN4, Intel

RAN4 agreed that UEs can support different maximum channel bandwidth in DL and UL, and that UEs can operate with asymmetric UL and DL bandwidths. RAN4 will further discuss the supported channel bandwidths for DL and UL, and related UE capability indication.

Decision: The document is noted.

Details to be handled in 6.1.1

[R1-1715353](#) LS on RACH agreements RAN2, Ericsson

Q1: What is the size of the RAPID field (Random Access Preamble Identifier)?

Q2: What is the size of the Uplink grant field?

Q3: What is the size of the Timing advance command (field TA above)?

Q4: What is RAN1's preferred size of the Temporary C-RNTI?

Q5: Does the Uplink grant in the RAR contain a HARQ process ID?

Q6: Has RAN1 agreed to add any additional fields?

Decision: The document is noted.

[R1-1715410](#) Draft LS Reply on RACH agreements Huawei

[R1-1715783](#) [DRAFT] LS on response to RACH agreements CATT

Details to be handled in 6.1.4.1

[R1-1715358](#) LS on NR handover related parameters RAN2, Nokia

Questions to RAN1:

- Is it required to include antenna-related information (i.e. similar to LTE's *antennaInfoCommon* parameter) and DL carrier frequency (similar to LTE's *sourceDL-CarrierFreq* parameter) in the AS Configuration (*AS-Config*) sent as a part of HO REQUEST?
- Is it necessary to inform the UE in HO command about the target cell's carrier bandwidth?

Decision: The document is noted.

[R1-1715359](#) LS on measurement model for cell quality derivation in NR RAN2, ZTE

RAN2 has agreed the measurement model for cell quality derivation in NR. See R2-1707748 (draft 3GPP TS 38.300 v0.6.0, sub clause 9.2.4). Specifically, the following aspects of the modelling were agreed in RAN2:

- Beam specific measurements are reported by layer 1 to layer 3 after layer 1 filtering
- Beam specific measurements are consolidated in layer 3 to derive cell quality by averaging the best beam with up to N-1 best beams above an absolute threshold (both N and the threshold are configured by the network).

Decision: The document is noted.

[R1-1715368](#) LS on SSRRP Measurements for Mobility in NR RAN4, Ericsson

RAN4 has discussed suitable measurement definitions for RSRP and CSI RSRP in NR, including the impact of receive beamforming and the reference point to define the measurement when no physical antenna connector is present, eg above 6GHz. RAN4 agreed that the RSRP and CSI-RSRP definition should include Rx beamforming gain for OTA.

RAN4 opinion is that when multiple antenna elements are combined for analogue, digital or hybrid RX beamforming purposes (as for example in an antenna panel), the measurement definition should assume that RSRP and CSI-RSRP measurements are performed on the combined signal. Where multiple receiver branches are used in the measurement (for example where signals are received from multiple antenna panels) the same approach as LTE should be used (the reported value shall not be lower than the corresponding RSRP of any of the individual branches).

Decision: The document is noted.

[R1-1715369](#) LS on Definitions of Intra-frequency and Inter-frequency Measurements RAN4, Ericsson

Asks RAN2 to take into account the proposed definitions of intra-frequency measurement and inter-frequency measurements in their future work on NR

Decision: The document is noted. No action to RAN1.

Details to be handled in 6.1.5

[R1-1715354](#) Response LS on BWP operation in NR RAN2, Samsung

- It is RAN2 understanding that there will be at least one active DL BWP per carrier, per UE, at any given time, and similarly at least one active UL BWP. Could RAN1 please advise on whether – according to e.g. any recent developments in RAN1 – it has been agreed to fix this to a maximum of one active BWP (one per DL and one per UL), or to definitely support more than one active BWP at a time?
- RAN2 would like to understand the number of SR configurations that can be supported in a single BWP for a UE?

Decision: The document is noted.

[R1-1715905](#) [Draft] Reply LS on BWP Operation in NR Samsung

Details to be handled in 6.3.4

[R1-1715355](#) LS on Transport Block Sizes RAN2, Nokia

RAN1 to provide the following L1 characteristics:

- minimum TB size;
- TB granularity;
- maximum number of bits that can be allocated for uplink transmission (i.e. maximum TB size and maximum number of TBs that can be transmitted in parallel);
- HARQ RTT.

Decision: The document is noted.

[R1-1715907](#) [Draft] Reply LS on Transport Block Sizes Samsung

Details to be handled in 6.3.3.1

[R1-1715367](#) LS on Mixed numerologies FDM operation RAN4, Intel

Decision: The document is noted.

Details to be handled in 6.3.3.6

[R1-1715361](#) LS on UE categories and capabilities RAN2, Ericsson

Q1: Do RAN1 and RAN4 agree that a peak data rate per-cell, per-cell-group and per-UE can be calculated based on the signalled band combinations and baseband capabilities and that an explicit UE category (for NR and NR-NR DC and MR-DC) is not needed if the UE supports a peak data rate at least equal to the calculated data rate?

Q2: Do RAN1 and RAN4 agree with the suggested handling of UE categories described above?

Q3: How does RAN1 intend to define the UE category (if needed) in a numerology-agnostic manner?

[R1-1715544](#) [Draft] Response to LS on UE categories and capabilities Ericsson

Discussion: Huawei → answer should be handled with the RAN liaison to RAN1.

Decision: The document is noted.

[R1-1716676](#) LS on NR UE Category RAN, MediaTek

Invite RAN1 to provide any input on methods, parameters or restrictions RAN should take into account once deciding on the max. throughput numbers for UE category for eMBB (for Dec/2017) and for URLLC (for June/2018).

Discussion: Direct reply to plenary can be delayed until next meeting – focus should be put on the reply to RAN2.

Decision: The document is noted.

Continue offline discussion – Kazuaki (NTT DOCOMO)

- Target sending reply LS to RAN2 in this meeting
- Target sending reply LS to RAN plenary in Nov.

Thursday

[R1-1716844](#) [Draft] Reply LS on UE categories and capabilities NTT DOCOMO

Decision: The document is endorsed and final LS is approved in [R1-1716924](#).

[R1-1715366](#) LS on Power class and power control RAN4, InterDigital

1. For UE Power Class definition for above 24 GHz range:
 - a. RAN4 agreed to define the UE power class for this spectrum range based on EIRP values.
 - b. A UE Maximum TRP limit will be defined in order to limit the UL interference.
2. P_{max} will be defined for above 24 GHz range in terms of EIRP that includes the antenna beam-forming gain.
3. For the power control related topics, RAN4 made the following agreements so far:
 - a. The RSRP and CSI-RSRP measurements definition include the Rx beamforming gain for OTA measurements (above 24 GHz range).
 - b. For conducted testing (sub-6GHz range) RSRP and CSI-RSRP measurements reference point can be maintained at the UE antenna connectors.

Question: RAN4 is asking RAN1 if the above power class and P_{max} definition related agreements are compatible with all possible type of transmissions (PUSCH, PUCCH, SRS, PRACH).

Decision: The document is noted.

[R1-1715595](#) Discussion of RAN4 LSs on Power Control Huawei, HiSilicon

[R1-1715727](#) Draft LS Reply on UE Power Class and Power Control Huawei

[R1-1716264](#) [DRAFT] Reply LS on UE Power Class and Power Control InterDigital, Inc.

Details to be handled in 6.7

[R1-1715371](#) LS on beam management impact on power control RAN4, Qualcomm

Asks RAN1 to inform RAN4 if power control is assumed independent for each beam and if power changes due to UE beam changes are included in the same power control process.

Decision: The document is noted.

[R1-1715728](#) Draft LS Reply on Beam management impact on power control Huawei

[R1-1716603](#) Discussion on beam management and power control Ericsson

Details to be handled in 6.7

[R1-1715374](#) LS on NR L1 processing chain RAN3, NTT DOCOMO

RAN3 requests RAN1 to provide feedback on:

- 1) Which functions have been discussed and agreed for NR in RAN1?
- 2) What are the possible implementation variations (presence, order and implementation dependency of the function blocks)?
- 3) Where would fronthaul bandwidth dependency change between number of transmission layers and number of antenna ports?
- 4) Clarify whether the figure above is accurate and provide amendments and further clarifications (if any)

Decision: The document is noted.

[R1-1716068](#) [Draft] Reply LS on NR L1 processing chain NTT DOCOMO, INC.

Continue discussion offline whether or not an LS is necessary in this meeting and if so regarding how to reply especially taking into account RAN plenary's decision – Yuichi (NTT DOCOMO)

Thursday

[R1-1716903](#) [Draft] Reply LS on NR L1 processing chain NTT DOCOMO, INC.

Discussion: ZTE → RAN1 can only reply to the issues related to specs – questions in relation to implementation should be left aside

Ericsson → could our answer be drafted in a simpler way? – text could be simplified

Decision: The document is noted. Discuss further.

[R1-1716916](#) [Draft] Reply LS on NR L1 processing chain NTT DOCOMO, INC

Discussion: Email discussion request from NTT DOCOMO. RAN1 chair not in favor of spending too much time, esp. due to short gap between meetings.

Decision: The document is noted. To continue discussion till next meeting

[R1-1715375](#) LS on simultaneous transmission and/or reception over EPC/E-UTRAN and 5GC/NR SA2, Intel, HTC

SA2 kindly asks RAN1, RAN2 and RAN4 to provide their views on the feasibility, necessary conditions and potential restrictions for UE's to operate in Dual Rx/Tx and Dual Rx modes with respect to EPC/E-UTRA and 5GC/NR, in particular in absence of tight coordination at RAN level between the two systems.

Decision: The document is noted.

[R1-1716275](#) [Draft] Response LS on simultaneous transmission and/or reception over EPC/E-UTRAN and 5GC/NR Intel Corporation

Decision: The document is noted. Continue offline discussion – Hong (Intel)

Thursday: To continue discussion till next meeting

Mr Chair suggested that following LSs to be just noted as RAN1 is in Cc. No online presentation, no complain/comments from the group.

[R1-1715356](#) Reply LS on spectrum utilization RAN2, Huawei

[R1-1715357](#) LS on Baseband capability signaling RAN2, Intel

[R1-1715360](#) Reply LS to SA2 on 5QIs for URLLC RAN2, Ericsson

[R1-1715362](#) LS reply on Support for fake gNB detection mechanismss RAN2, Ericsson

[R1-1715364](#) Reply LS on shared baseband capabilities for MR-DC RAN4, Huawei

[R1-1715365](#) Reply LS on UE measurement capability across LTE and NR RAN4, Huawei

[R1-1716674](#) LS on IMT-2020 submission RAN, NEC

RAN has agreed on the name, format and schedule of the 3GPP IMT-2020 submission to ITU-R, which is captured in the attached document (RP-172098).

Decision: The document is noted.

[R1-1716675](#) LS on single Tx switched UL RAN, Qualcomm, Intel

RAN asks RAN2 and RAN4 groups to take the attached documents RP-172064, RP-172085 into account and complete the work. The approval of single UL support in LTE – NR DC and related specification text in text proposals, draft TS proposals (presented for approval) and CRs (e.g. LTE specifications) will be done as a package in RAN#78.

Decision: The document is noted. No action to RAN1.

[R1-1716671](#) LS to RAN1 on aperiodic indications based on beam failure recovery procedure RAN2, Samsung

Q1: Is RAN1 planning to provide an aperiodic indication to higher layers after a successful beam failure recovery?

Q2: If a beam failure recovery is un-successful, will the L1 continue monitoring RS(s) for RLM for periodic IS/OOS indications?

Q3: If a beam failure recovery is successful for one or more beam pair links, will the L1 continue monitoring RS(s) for RLM and provide periodic IS indication(s) following successful recovery?

Decision: The document is noted. Aim having a reply LS in the next meeting.

[R1-1716691](#) Draft Reply LS to RAN2 on aperiodic indications based on beam recovery procedure AT&T

Withdrawn.

LS received during the week

[R1-1716896](#) UE timing advance adjustment step size RAN4, Ericsson

RAN1 to analyse the TA command step size needed to maintain UL coherence, maintain demodulation performance and UL capacity, and conclude how TA command step size map to different UL SCS.

Decision: The document is noted. Aim having a reply LS in the next meeting.

R1-1716897 LS Reply to LS related to SRS hopping RAN4, Qualcomm

RAN4 requests information what is expected UE behaviour for compensating the power difference between primary Tx antenna ports and Rx antenna ports.

Decision: The document is noted. Aim having a reply LS in the next meeting.

6 NR - WID in RP-172115

RP-172108 Updated work plan of RAN 1 and RAN4 NR NTT DOCOMO, INC.

R1-1716613 Skeleton for RAN1 input to TS38.300 Nokia, Nokia Shanghai Bell

Late submission

The document was not formally presented by Nokia. Mr Chair suggested delegates reading the contribution and providing their comments to Karri (Nokia), if any.

Decision: The document is noted.

R1-1716627 On open issues in 38.211 Ericsson

The document was presented by Stefan Parkvall from Ericsson.

Decision: The document is noted.

Thursday

Spec editors (38.201, 38.202, 38.211, 38.212, 38.213, 38.214, 38.215) to prepare updated versions incorporating this meeting's agreements and working assumptions by 9/28.

Email approval of updated RRC parameters – Daniel (Ericsson) – to have the doc ready by 9/28, aim to conclude by 10/6.

6.1 Initial access and mobility

Refer to [R1-1709821](#) for work plan.

6.1.1 Remaining Details on Synchronization signal

Including wideband CC related aspects.

R1-1716069 Discussion on remaining details on NR-SSNTT DOCOMO, INC.

- Proposal 1: Confirm working assumptions that actually transmitted SS/PBCH block is indicated by UE-specific RRC signaling with full bitmap.
- Proposal 2: NR supports to configure common information about actually transmitted SS/PBCH block of all neighbor cells on a carrier for helping UE RRM measurement at least in CONNECTED mode.
 - Single full bitmap indication applicable to all cells on a carrier is used.
 - When separate full bitmap indication for serving cell is provided, UE applies this information for measurement on serving cell SS/PBCH blocks instead of common information.
- Proposal 3: For above 6 GHz frequency range, indication scheme of actually transmitted SS blocks in RMSI should be selected from either Alt. 1 (group-bitmap and bitmap in group) or Alt. 5 (The number of actually transmitted SS/PBCH blocks + starting index + gap between two consecutive SS/PBCH blocks)
- Proposal 4: If Alt. 1 (group-bitmap and bitmap in group) is applied, actually transmitted SS block is indicated through RMSI with following scheme
 - Below 6 GHz: Full bitmap (8 bits)
 - Above 6 GHz: Bitmap in group of [8 or 16] bits and group-bitmap of [8 or 4] bits
- Proposal 5: Only for specific bands, UE is required to assume two candidates of SS SCS for NR-SS detection in initial access.
 - RAN1 send reply LS to RAN4 with informing that frequency band where UE needs to assume two candidates of SS SCS for initial access and number of SS raster in the band should be limited considering UE effort on SS detection for initial access.
- Proposal 6: SS block can be located at any of the SS frequency raster within the wideband CC.
 - Number of SS blocks and locations of SS blocks in wideband CC are left to NW choice.
- Proposal 7: By default, a UE may not assume that antenna ports used for transmissions of SS/PBCH blocks with different frequency locations within a CC (even with same indexes) are quasi-collocated with respect to spatial, average gain, delay and Doppler parameters.
- Proposal 8: NR supports to configure RRM measurement on multiple SS/PBCH block frequency locations within wideband CC.
 - Measurement reporting in such case is based on the measurement results on multiple SS/PBCH block frequency locations, and would need to include frequency location index information for each measurement result.

Decision: The document is noted.

R1-1716276 Remaining Details of SS Blocks Intel Corporation

- Proposal 1: LS to RAN2:
 - RAN1 has identified that multiple SSB could be transmitted in a wideband carrier to support synchronization and measurement for UEs with smaller RF BWs (compared to the wideband CC). RAN1 would need to conclude how the cell IDs need to be configured as RAN1 expect that there will be different signaling required for Alt 1 and 2.
 - RAN1 has not identified specific use cases that absolutely require either Alt 1 (same cell ID) or Alt 2 (different cell ID) to be specified. Wideband deployment cases could be operated by either Alt 1 or Alt 2 (with appropriate specification support). However, RAN1 assumes that Alt 1 and Alt 2 would have quite different specification impact and therefore would like to get guidance from RAN2 on whether only Alt 1, only Alt 2, or both Alt 1 and Alt 2 should be supported in specification.
- Proposal 2: All SS blocks within a CC must have same cell ID.
- Proposal 3: All actual transmitted SS blocks in a wideband CC is informed to the UE.
- Proposal 4: All SS blocks within a CC must have same set of SS block indices (i.e. aligned transmission instances).
- Proposal 5: In case gNB transmits multiple SS blocks in different frequency positions, UEs are configured measure and monitor a particular frequency layer and the required cell detection time and measurement period is increased proportionally to the number of frequency layers the UE needs to monitor.
- Proposal 6:
 - RAN1 should send a reply LS to RAN4 in [R1-1715373](#) with the latest agreements in RAN1 on SCS of SS Blocks.
 - RAN1 should ask RAN4 whether the latest agreements in RAN on SCS of SS Blocks satisfy the request to have the ability for a UE to perform initial access to the NR cells operating with two different bandwidth/SS SCS combinations.
 - RAN1 should ask RAN4, whether reducing the PBCH bandwidth from 288 subcarriers to 144 subcarriers would resolve the issue identified in question (2), and if not ask RAN4 to clarify the background motivation for the need to support both 120 kHz and 240 kHz SCS of SS Blocks in same carrier frequency.

Decision: The document is noted.

Continue discussion offline – Asbjorn (Ericsson)

- RAN1#90 working assumption related
- Wide CC related multiple SS blocks
- Proposals:
 - From UE perspective, NR supports only a single PCID for the one or more SSBs in a wideband CC
 - Discuss particularly the use cases for potentially multiple PCIs for SSBs in a wideband CC
- The multiple related LSs

Tuesday

[R1-1716795](#)

Summary 6.1.1 Remaining Details on Synchronization signal

Ericsson

Agreements:

- From UE perspective, a cell is associated with a single SS block
 - Note: The cell defining SS block has an associated RMSI
 - Note: From the RAN1 perspective, the cell defining SS block could for example be used for
 - Common PRB indexing
 - Scrambling
 - Etc.
- Multiple SS blocks can be transmitted within the bandwidth of a wideband carrier
 - Note: This is a clarification of the previous agreement
- Send an LS to RAN2 – Asbjorn (Ericsson)

Thursday

[R1-1716835](#)

[Draft] LS on Multiple SS blocks within the bandwidth of a wideband carrier

Ericsson

Discussion: Nokia → RAN4 is also discussing the matters, and could benefit from the LS, add RAN4 to CC.

Decision: The document is noted and final LS is **approved in [R1-1716907](#)** with the following updates:

- Adding cc-ing to RAN4, and
- Removing “Note: From the RAN1 perspective, the cell defining SS block could for example be used for
 - Common PRB indexing
 - Scrambling
 - Etc.”
- Removing “Note: This is a clarification of the previous agreement”

Agreements:

- For rate matching purpose
 - For UE specific PDSCH and UE specific CORESET
 - If the UE has received no bitmap through RRC signalling, the UE assumes SS/PBCH block transmission according to the signalling in RMSI
 - If the UE has received a bitmap through RRC signalling, the UE assumes SS/PBCH block transmission according to the bitmap in RRC based signalling
 - For PDSCH carrying RMSI and the corresponding PDCCH CORESET, the UE assumes that no SS block is transmitted in the allocated resources
 - **Working assumption** For other channels, the UE assumes SS/PBCH block transmission according to the signalling in RMSI
 - FFS: Confirm for each channel
 - The signalling in RMSI is only for the associated SS/PBCH block
- FFS: Other uses of the signalled SS/PBCH block indication in RMSI and/or RRC

Agreements:

- Confirm working assumption of:
 - UE-specific RRC signaling with full bitmap can be used for indicating the actually transmitted SS blocks for both sub6GHz and over6GHz cases
 - The actually transmitted SS blocks is indicated in RMSI for both sub6GHz and over6GHz cases
 - Indication is in compressed form in above 6 GHz case
 - Indicated resources are reserved for actually transmitted SS blocks
 - Data channels are rate matched around actually transmitted SS blocks

Working assumption:

- For indication in RMSI:
 - Alt.1: Group-Bitmap(8 bits) + Bitmap in Group (8 bits)
 - A Group is defined as consecutive SS/PBCH blocks
 - Bitmap in Group can indicate which SS/PBCH block is actually transmitted within a Group, where each Group has the same pattern of SS/PBCH block transmission, and Group-Bitmap can indicate which Group is actually transmitted

Agreements:

- The entire SS/PBCH block can offset from the resource block grid
- Indicate the offset of the SS/PBCH block in the BCH
 - Offset is in the number of subcarriers of the SS/PBCH block numerology
- Send a reply LS to RAN4 – Asbjorn (Ericsson)

Thursday

[R1-1716834](#) [Draft] Reply LS on Channel Raster and Synchronization Channel Raster Ericsson

Discussion: Huawei → should RAN1/RAN4 further study the number of subcarriers?

Decision: The document is noted and final LS is **approved in R1-1716906**.

Proposals:

- Alt 1: Redesign the SS block design, i.e., reduce PBCH BW to 12 PRBs so that UE minimum BW does not exceed 5 MHz for sub6GHz and 50MHz for over6GHz, regardless of the selected subcarrier spacing
- Alt 2: RAN4 is allowed to select up to two SCS values for SS/PBCH and the corresponding UE minimum BW for each band of a limited set of bands

Continue offline discussion

Thursday: Continue discussion until next meeting.

Not treated.

R1-1715376	Remaining details of NR-SS	ZTE, Sanechips
R1-1715385	Remaining Details on NR SS Blocks	Huawei, HiSilicon
R1-1715508	Cell searching with multiple SS blocks in wideband CC	Spreadtrum Communications
R1-1715606	Remaining issues for SSB and SS burst set composition	vivo
R1-1715676	Remaining details on SS block transmissions	Guangdong OPPO Mobile Telecom.
R1-1715784	Actually transmitted SS block and SS blocks in wideband	CATT

R1-1715840	Remaining Details on SS/PBCH block design	LG Electronics
R1-1715908	Remaining details on SS burst set related procedures	Samsung
R1-1716043	Discussion on SS block repetition transmission	CMCC
R1-1716149	Remaining details on synchronization signal design	Ericsson
R1-1716160	Remaining details of SS Block and SS Burst Set configuration	AT&T
R1-1716194	Multiple SS block transmissions in a wideband CC	ASUSTEK COMPUTER (SHANGHAI)
R1-1716203	Remaining details on SS block indication for rate matching and transmissions within wideband CC	MediaTek Inc.
R1-1716239	On Multiple SS blocks in a Wideband Carrier	Sony
R1-1716378	Remaining details on synchronization signal design	Qualcomm Incorporated
R1-1716457	On Remaining Issues of Synchronization Signal	InterDigital, Inc.
R1-1716523	Remaining details related to SS blocks	Nokia, Nokia Shanghai Bell
R1-1716566	Discussion on remaining details of SS/PBCH block	ITL
R1-1716637	SS/PBCH block transmission and indication	Motorola Mobility, Lenovo
R1-1716659	Indication of actually transmitted SS blocks	Sharp
R1-1716760	WF on the indication of actual SS/PBCH block transmission for the purpose of rate matching	LG Electronics
R1-1716828	WF on actually transmitted SS block indication for RRM measurement	Huawei, HiSilicon, Samsung, LGE, InterDigital

6.1.2 Remaining Details on Broadcast signal/channel

6.1.2.1 Remaining details on NR-PBCH

[R1-1716150](#) Remaining details on NR-PBCH design Ericsson

- Proposal 1: The NR-PBCH payload should be the same for below-6 and above-6 GHz
- Proposal 2: The 1st scrambling applied to the NR-PBCH payload prior to CRC attachment and encoding process is supposed to carry 3 SFN LSB bits.
- Proposal 3: The RMSI configuration in NR-PBCH contains 1 QCL-indication bit indicating if the NR-PDCCH providing RMSI is spatially QCL with the SS Block or not.
- Proposal 4: The RMSI configuration in NR-PBCH contains 2 bits used to configure the numerology for the NR-PDCCH/NR-PDSCH used to receive NR-SIB1.
- Proposal 5: The RMSI configuration in NR-PBCH contains 3 bit used to configure the physical resources used for the NR-PDCCH scheduling the transmission of NR-SIB1.
- Proposal 6: NR-PBCH does not need to contain multiple spare bits in all cases.
- Proposal 7: NR-PBCH contains at least one extension bit that may or may not be defined in a future release.
- Proposal 8: The number of system information bits delivered in NR-PBCH is 21 and the total code block size is 40 bits including 19-bit CRC.
- Proposal 9: Confirm the working assumptions on the NR-PBCH DMRS sequence in RAN1#90.
- Proposal 10: The half-frame can be indicated by the 2nd scrambling applied to the encoded NR-PBCH bits or 1 explicit bit in the NR-PBCH payload.

Decision: The document is noted.

[R1-1716379](#) Remaining details on NR-PBCH Qualcomm Incorporated

- Proposal 1: For the 1st scrambling sequence initialization, a long Gold sequence is initialized with $m_init = N_ID^{cell}$, and timing bits used for determining a sequential non-overlapping portion of the sequence.
- Proposal 2: Two timing bits, namely, $\{s_2, s_1\}$ are used for determining the scrambling/masking sequence.
- Proposal 3: For the 2nd PBCH scrambling, the encoded rate-matched PBCH bits are scrambled by a cell ID dependent time-invariant Gold sequence.
- Proposal 4: The PBCH DMRS sequence of length 144 is initialized by $c_init = 2^{12} N_ID^{cell} + 580 \bmod(b, 8)$.
- Proposal 5: RMSI presence flag is indicated either by one bit in PBCH payload or by a default RMSI CORESET configuration.
- Proposal 6: The PBCH payload includes information as listed in Table 1. [R1-1716458](#) On Remaining Issues for NR-PBCH Designs InterDigital, Inc.

Discussion: .

Decision: The document is noted.

Continue offline discussion – Asbjorn (Ericsson)

- PBCH DMRS details
- PBCH scrambling codes
- PBCH payloads

Tuesday

Agreement: Working assumption is confirmed, thanks to ZTE and Sony who agreed moving forward for the sake of progress. Sony still believes that there is a complexity issue with the single long sequence.

Working assumption:

- Regarding the number of sequences and sequence mapping rule:
 - Single long sequence is mapped to all PBCH-DMRS REs within a SS block
 - LTE PN generator is reused for PBCH DMRS sequence generation, and related parameters are
 - Gold Code LFSR size: 31
 - Gold Code Polynomials: $x^{31} + x^3 + 1$, $x^{31} + x^3 + x^2 + x + 1$
 - Note that RAN1 may revisit the PN generator for PBCH DMRS if NR supports different PN generator for other usages
- Regarding EPRE offset between PBCH-DMRS and NR-PBCH data:
 - FFS: UE may assume that same EPRE between NR-PBCH DMRS and NR-PBCH data is applied
 - Note that power boosting is up to NW implementation
- Regarding Cell-ID-based frequency shift for PBCH-DMRS RE locations:
 - $v_{\text{shift}} = N_{\text{ID}}^{\text{cell}} \bmod 4$
- Regarding PBCH-DMRS sequence generation:
 - PBCH-DMRS sequence is based on long Gold sequence (e.g., polynomial order ≥ 30)
 - Sequence modulation is QPSK

R1-1715841 Remaining Details on PBCH design and contents LG Electronics

Proposals:

- The half-frame is indicated by an explicit bit in the NR-PBCH payload
 - Discuss further offline particularly taking into account the performance results in [R1-1715841](#)

Agreement:

- UE may assume that same EPRE between NR-PBCH DMRS and NR-PBCH data is applied

Thursday

R1-1716837 Summary of 6.1.2.1 Ericsson

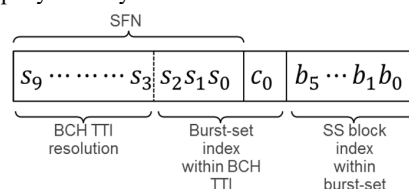
Proposals:

- For 5 ms SS/PBCH block periodicity
 - The half-frame is indicated by an explicit bit in the NR-PBCH payload
- For 10 ms and higher SS/PBCH block periodicity
 - The SS/PBCH blocks are transmitted in the first half-frame of a frame
 - FFS: Use of half-frame bit in PBCH

Continue discussion next meeting

Agreements:

- The 1st PBCH scrambling is a Gold sequence initialized by cell ID. The 2nd and 3rd LSBs of SFN are used for determining a sequential non-overlapping portion of the sequence.
 - Generate a Gold sequence of length $4M$ where M is the number of bits to be scrambled
 - Partition the generated sequence into 4 non-overlapping portions
 - The 2nd and 3rd LSBs uniquely identify indices of each of the non-overlapping portion of the sequence



3 rd LSB of SFN (bit s2)	2 nd LSB of SFN (bit s1)	Seq index used for each PBCH payload
0	0	0 ~ M-1
0	1	M ~ 2M-1
1	0	2M ~ 3M-1
1	1	3M ~ 4M-1

Agreement:

- Support 2nd scrambling based on cell ID for PBCH. To conclude one of the following alternatives next meeting:
 - Alt 1: initialization based on cell ID only and is identical in SS/PBCH blocks
 - Alt 2: initialization based on both cell ID and 3 LSB of SS/PBCH block index

Agreement:

- Gold sequence generation for PBCH 1st and 2nd scrambling is identical to LTE PN sequence generation.
 - Note that RAN1 may revisit the PN generator for PBCH scrambling if NR supports different PN generator for other usages.

Agreement:

- For power offset SSS to PBCH DMRS, to down-select between:
 - Alt 1: 0 dB offset
 - Alt 2: 3 dB offset
 - FFS whether the same or different offsets are selected for sub-6 GHz vs. mmw

R1-1715377	Remaining details of NR-PBCH	ZTE, Sanechips
R1-1715386	Remaining issues in PBCH	Huawei, HiSilicon
R1-1715458	Scrambling sequence design for PBCH	Sequans Communications
R1-1715607	Remaining aspects on NR-PBCH contents and payload	vivo
R1-1715661	On SFN and half-radio frame timing indication	NEC Corporation
R1-1715785	Remaining details on PBCH	CATT
R1-1715909	Remaining details on NR-PBCH	Samsung
R1-1716070	Discussion on remaining details on NR-PBCH and PBCH-DMRS	NTT DOCOMO, INC.
R1-1716204	Remaining details on PBCH-DMRS/data scrambling and PBCH contents	MediaTek Inc.
R1-1716277	Remaining Details of NR PBCH	Intel Corporation
R1-1716458	On Remaining Issues for NR-PBCH Designs	InterDigital, Inc.
R1-1716524	Remaining details on NR-PBCH	Nokia, Nokia Shanghai Bell
R1-1716567	Discussion on remaining details of NR-PBCH design	ITL
R1-1716650	Comparison of PBCH DMRS mapping schemes	Sony

6.1.2.2 Remaining details on Remaining minimum system information

[R1-1715378](#) Remaining details of RMSI ZTE, Sanechips

- Proposal 1: Due to the long time-domain duration, the discontinuous RMSI block position should be supported to not block the other transmissions.
- Proposal 2: The symbol number of RMSI PDSCH in each beam direction for another round of beam sweeping should be configurable to support the reduction of duration for another round beam sweeping.
- Proposal 3: To reduce the duration for another round beam sweeping for RMSI, multiple multiplexing mode for RMSI should be supported, and which multiplexing mode is selected should be decided by the gNB.
- Proposal 4: To reduce the complexity of PDCCH blind detection, QCL association between RMSI and SS blocks should be supported for delivery of RMSI.
- Proposal 5: Scheduling flexibility for RMSI delivery should be supported; one group of RMSI blocks is associated to one SS block.

Decision: The document is noted.

[R1-1715842](#) RMSI delivery and CORESET configuration LG Electronics

- Proposal 1: Within initial active DL/UL BWP pair, NR system operates initial access procedure for SS/PBCH block transmission, system information delivery, RACH procedure (i.e. Msg1, Msg2, Msg3 and Msg4 transmission), if UE can operate within the bandwidth of initial active DL/UL BWP.
- Proposal 2:
 - At least for the initial active DL BWP, it is defined that the bandwidth of initial active DL BWP is wider than the bandwidth of SS/PBCH block, and is equal to or smaller than a certain DL bandwidth of NR that all UE can support in each frequency range. (e.g. For below 6GHz frequency range, the bandwidth of the BWP is from 5MHz to 20MHz)
 - Also, for the initial active UL BWP, it is defined that the bandwidth of initial active UL BWP is wider than the bandwidth of PRACH preamble, and is equal to or smaller than a certain bandwidth of NR that all UE can support in each frequency range.
- Proposal 3:
 - The information for initial active DL BWP (e.g. offset from PRB 0 to SS/PBCH block, maximum number of PRB, etc.) is configured by PBCH.

- It is assumed that the bandwidth of initial access DL BWP is same with the bandwidth of common CORESET.
 - The information for initial active UL BWP related information is configured in the RMSI.
- Proposal 4: For the initial active DL/UL bandwidth part, two numerologies (i.e. 15kHz and 30kHz SCS) are used at below 6GHz frequency range, and other two numerologies (i.e. 60kHz and 120kHz) are used at above 6GHz frequency range.
- Proposal 5: CORESET information including frequency resource (i.e. bandwidth, frequency location), time resource (i.e. stating OFDM symbol, time duration), common search space monitoring parameters (i.e. monitoring periodicity, offset, duration) can be defined in PBCH contents. Also, detail parameters or bit sizes can be followed by the discussion result of DL control channel design.
- Proposal 6: In PBCH contents, about 11bits can be designated for indication of numerology, bandwidth, and CORESET information.

Details	Bit size	
	For b6GHz	For a6GHz
Reference numerology	1	1
CORESET / Initial active BWP (Frequency resource – bandwidth, location) (Time resource – starting OFDM symbol, Duration) (UE Monitoring Periodicity, offset, duration)	About [10]	About [10]

Decision: The document is noted.

Continue offline discussion focusing on – Da Ren (CATT)

- RMSI CORESET related issues
- Interaction of RMSI with SS block

Thursday

[R1-1716806](#)

Offline summary for AI 6.1.2.2 Remaining details of minimum system information CATT

Agreements:

- NR supports both slot based PDCCH and PDSCH, and non-slot based PDSCH transmissions for RMSI/broadcast OSI delivery
 - For the non-slot based transmission, 2, 4 and 7 OFDM-symbol duration for the RMSI/broadcast OSI PDSCH is supported
 - FFS the handling of PDCCH for non-slot based transmissions

Conclusion:

- FFS FDM between SS/PBCH block and CORESET/NR-PDSCH for RMSI is supported
 - Note: this discussion is related to the bandwidth restriction related to UE

R1-1715388	RMSI Delivery	Huawei, HiSilicon
R1-1715536	Discussion on RMSI delivery	Lenovo, Motorola Mobility
R1-1715608	Discussion on Remaining Minimum System Information	vivo
R1-1715699	Discussion on the RMSI delivery	Guangdong OPPO Mobile Telecom.
R1-1715757	Remaining details on remaining minimum system information	ETRI
R1-1715786	Remaining details on RMSI	CATT
R1-1715910	Remaining details on remaining minimum system information delivery	Samsung
R1-1716044	Common CORESET Design for RMSI scheduling	CMCC
R1-1716071	Discussion on remaining details on RMSI delivery	NTT DOCOMO, INC.
R1-1716151	NR delivery of remaining minimum system information	Ericsson
R1-1716161	Remaining details of RMSI delivery	AT&T
R1-1716205	Discussion on RMSI transmission	MediaTek Inc.
R1-1716278	RMSI Contents and Delivery Mechanism	Intel Corporation
R1-1716380	Remaining system information delivery consideration	Qualcomm Incorporated
R1-1716459	On Remaining Issues for Remaining Minimum System Information Delivery	InterDigital, Inc.
R1-1716525	On Remaining System Information Delivery	Nokia, Nokia Shanghai Bell

6.1.2.3 Other system information delivery

[R1-1715911](#)

Other system information delivery Samsung

- Numerology for OSI
 - Proposal 1:

- The numerology for OSI for initial access, i.e., irrespective whether it is on-demand basis or not, is informed in NR-PBCH payload and the same with the numerology for RMSI.
- The numerology for the on-demand OSI provisioned by dedicated signalling is configured when the RRC connection is established, i.e. the same with the numerology for dedicated PDCCH/PDSCH.
- MSG1 based SI request
 - Proposal 2: For MSG1 based SI request, the PRACH preamble and/or PRACH resource should be associated with each SI message or set of SI messages. (This is aligned with RAN2 agreement)
 - Proposal 3: For MSG1 based SI request, the initial power for SI request (i.e. PRACH preamble) transmission is calculated in same manner like any other PRACH preamble transmission.
- MSG3 based SI request
 - Proposal 4: PRACH Preambles and/or PRACH resources are not reserved for transmitting PRACH preamble in MSG 3 based approach. (This is aligned with RAN2 agreement)
 - Proposal 5: For MSG3 based SI request, UE randomly selects PRACH preamble and PRACH resource for PRACH preamble transmission from PRACH preambles and PRACH resources configured for initial access in minimum system information.

Decision: The document is noted.

Discuss further offline – Young Bum (Samsung)

- Focusing on numerology for OSI, CORESET management for OSI, etc.
 - Proposals:
 - The numerology for OSI (if broadcasted) for initial access is assumed by the UE to be the same with the numerology for RMSI
- Note that discussion on the on-demanding OSI procedure is up to RAN2

Thursday

R1-1716793

WF on numerology for OSI

Samsung, Ericsson, Huawei, HiSilicon, Nokia

Agreement: The numerology for on-demand OSI via broadcast delivery is assumed by the UE to be the same with the numerology for RMSI

R1-1716809

Offline summary of AI 6.1.2.3 other system information delivery

Samsung

Agreements:

- For broadcast OSI CORESET, to down-select one from the following alternatives
 - Alt.1: the instances for broadcast OSI CORESET are the same as or a subset of instances derived from the CORESET signalled in PBCH for RMSI
 - FFS whether it's the same or a subset of
 - Alt.2: the CORESET configuration is signalled in RMSI
 - Alt 3: a combination of Alt 1 and Alt 2
 - FFS whether or not to share, at least partially, broadcast OSI CORESET and paging CORESET

R1-1715379

Remaining details of OSI delivery

ZTE, Sanechips

R1-1715537

Discussion on OSI delivery

Lenovo, Motorola Mobility

R1-1715700

Discussion on the on demand SI

Guangdong OPPO Mobile Telecom.

R1-1715758

Delivery of other system information

ETRI

R1-1715787

OSI delivery

CATT

R1-1715843

Other system information delivery

LG Electronics

R1-1716152

NR delivery of other system information

Ericsson

R1-1716206

Discussion on OSI delivery

MediaTek Inc.

R1-1716381

Other system information delivery consideration

Qualcomm Incorporated

R1-1716460

On Other System Information Delivery

InterDigital, Inc.

R1-1716526

On Other System Information delivery

Nokia, Nokia Shanghai Bell

6.1.3 Paging design

R1-1715389

Finalization of NR Paging

Huawei, HiSilicon

Observation 1: The issue of beam sweeping overhead for paging transmission should be addressed in Rel-15, especially for high frequency band with up to 64 SS block beams.

Proposal 1: NR adopts the LTE paging indication mechanism as baseline, where paging indication is based on P-RNTI of NR-PDCCH.

- The total number of UEs that can be paged simultaneously is larger than 16 and FFS the exact number.

Proposal 2: Paging and RMSI share the same search space within the CORESET signalled in PBCH and the number of time slots in a PO can be derived by the number of SS blocks.

Proposal 3: NR Support *cmas-Indication*, *etws-Indication*, *systemInfoModification* being transmitted over NR-PDCCH, if they are supported in paging.

Decision: The document is noted.

R1-1715609 Discussion on NR paging design vivo

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Decision: The document is noted.

Continue discussion offline – Teck (Huawei)

- Paging indication mechanisms, CORESET related issues, interaction with beam sweeping etc.

Tuesday

R1-1716799 Summary 6.1.3 Paging design Huawei

Proposal:

- NR adopts the following paging mechanism at least for sub-6GHz: P-RNTI based NR-PDCCH + the corresponding PDSCH (which contains the paging message)

Thursday

R1-1716895 Summary of remaining details on paging Huawei

Agreements:

- For paging, RAN1 to down-select from the following options
 - Option 1: Paging DCI followed by Paging Message
 - Note: These do not imply that they are consecutive
 - Option 2: Paging group indicator triggering UE feedback and Paging DCI followed by Paging Message
 - Option 3: Paging group indicator and Paging DCI followed by Paging Message
 - Option 4: Paging DCI indicates use of Option 1 or 2.
- RAN1 to send LS to RAN2 on whether Paging DCI and Paging Message can be in the same or different POs, including the above options. LS to be drafted in [R1-1716912](#).

R1-1716912 [Draft] LS on NR Paging Occasion Huawei

Decision: The document is endorsed and final LS is **approved in [R1-1716913](#)**.

R1-1715380	Paging design	ZTE, Sanechips	
R1-1715677	On NR paging design and transmission		Guangdong OPPO Mobile Telecom.
R1-1715788	NR Paging Channel	CATT	
R1-1715844	Paging design in NR	LG Electronics	
R1-1715912	Paging design	Samsung	
R1-1716045	Discussion on NR paging design	CMCC	
R1-1716072	Discussion on paging design for NR		NTT DOCOMO, INC.
R1-1716153	On NR paging design	Ericsson	
R1-1716207	Discussion on paging design	MediaTek Inc.	
R1-1716260	NR paging based on paging indication		InterDigital, Inc.
R1-1716279	NR Paging Design	Intel Corporation	
R1-1716382	Paging design consideration	Qualcomm Incorporated	
R1-1716456	Consideration on NR paging design	Xiaomi Technology	
R1-1716521	Reduced overhead paging design	Sequans Communications	
R1-1716527	Paging in NR	Nokia, Nokia Shanghai Bell	

6.1.4 Physical random access channel and random access procedure

6.1.4.1 Remaining details on PRACH formats

R1-1715381 Remaining details of PRACH formats ZTE, Sanechips

- Proposal 1: At least for the short sequence preamble format (A and B), the network can indicate a time advance for PRACH transmission.
 - Time advance values equal to the normal CP length of the data symbols is supported.
- Proposal 2: The short sequence preamble format should be sent in time advance regardless the principle of the symbol boundary alignment in case of coverage enhancement scenario.
 - The parameter of time advance (RA TA) can be as long as the CP length of RACH preamble format.
 - The RA TA value is indicated in the RACH configuration
- Proposal 3: The common Ncs value for all short sequence preamble formats is used.
- Proposal 4:
 - RACH capacity enhancement is not supported in NR Rel-15.
 - PRACH preamble sequence length 139 is supported.
- Proposal 5:
 - For format 2, the Ncs values from LTE are used.
 - For format 3, the Ncs values in the LTE Ncs table with index 6-15 are used.
- Proposal 6: Parameters of PRACH are configured as below:
 - Preamble format
 - Subcarrier spacing
 - Root(s) sequence index
 - Restricted set type (none/A/B)
 - Zero Correlation Zone Configuration
 - RA TA value
 - Preamble format starting slot index in half frame
 - Preamble format starting symbol index in one slot
 - Period and offset of RACH half radio frame
 - Frequency index of PRACH channels
 - The association time period
 - The number of PRACH groups per PRACH resource
 - The number of preamble indices per PRACH group
 - The number of associations per PRACH group

Decision: The document is noted.

R1-1716073 Discussion on remaining details on PRACH formats NTT DOCOMO, INC.

- Proposal 1: No additional PRACH preamble format to already agreed formats should be introduced in Rel-15.
- Observation 1: Small cyclic shift value for NR PRACH preamble format 3 can be useful in terms of available number of preambles in an environment of small delay spread.
- Proposal 2: Same cyclic shift values as defined in LTE are applied for NR PRACH preamble format 2 and 3.
- Proposal 3: NR should support sequence length of 139 for NR-PRACH based on short sequence.
- Proposal 4: Any restricted set is not supported for short sequence.
- Proposal 5: Which kind of preamble format between preamble format A and B is assigned for each RACH occasion can be informed implicitly by location of the RACH occasions in time domain.
- Proposal 6: PRACH preamble formats/configurations should be classified in different groups at least for below 6 GHz bands and for above 6 GHz bands.

Decision: The document is noted.

Continue offline discussion – Jan (ZTE)

- Focus on sequence length, configurations, cyclic shifts, etc.

Tuesday

R1-1716762 Summary of off-line discussion of AI 6.1.4.1, Remaining details on PRACH formats ZTE, Sanechips

Agreement:

- For format 2, same cyclic shift values as for format 0 and 1 are used

Working assumption:

- L = 139 is adopted as the sequence length for the RACH Preamble Formats using the short sequence

Agreements:

- Use one common table for cyclic shift (Ncs) values for short sequence based PRACH formats for all SCS
 - Alt 1: The number of cyclic shift values is up to 16 values represented by 4 bits
 - Alt 2: The number of cyclic shift values is up to 8 values represented by 3bits
 - Down-selection to be done this week. In addition, to come up with the actual set of values

Thursday

[R1-1716892](#) Summary of off-line discussion of AI 6.1.4.1, Remaining details on PRACH formats ZTE, Sanechips

Agreements:

- For format 3, use table below.
- The values in red are **working assumption**

ZeroCorrelationZoneConfig	Sequence length 839, SCS = 5KHz		
	Unrestricted	Restricted set type A	Restricted set type B
0	0	36	36
<u>1</u>	<u>13</u>	57	57
<u>2</u>	26	72	60
3	33	81	63
4	38	89	65
5	41	94	68
6	49	103	71
7	55	112	77
8	64	121	81
9	76	132	85
10	93	137	97
11	119	152	109
12	139	173	122
13	209	195	137
14	279	216	-
15	419	237	-

Agreements:

- Restricted set is not supported for NR PRACH preamble based on short sequence length
- Use one common table for cyclic shift (Ncs) values for short sequence based PRACH formats for all SCS
 - The number of cyclic shift values is up to 16 values represented by 4 bits, the following table is adopted

ZeroCorrelationZoneConfig	Ncs values
0	0
1	2
2	4
3	6
4	8
5	10
6	12
7	13
8	15
9	17
10	19
11	23
12	27
13	34
14	46
15	69

Agreements:

- NR defines the pattern of the slots that contain PRACH resource(s) in a larger time interval
 - FFS: time interval e.g 5/10/20ms
 - FFS pattern
 - FFS numerology of the slot e.g SS block, UL/DL, Msg1 or PUSCH
- FFS: Within each slot
 - Alt1: RACH resources within a slot are consecutive
 - Alt2: RACH resources within a slot are not consecutive, e.g to handle the case of CORESET monitoring, in the 2/4/7 symbols

[R1-1716686](#) Cyclic-shift dimensioning and capacity shortfall solution for agreed NR PRACH formats Huawei, HiSilicon
Revision of [R1-1715390](#)

[R1-1715789](#) Further consideration on NR RACH preamble sequence and preamble format for capacity enhancement
CATT

[R1-1715845](#) Discussion on PRACH preamble format details LG Electronics

[R1-1715913](#) Remaining details on PRACH formats Samsung

[R1-1716137](#) Remaining details on PRACH formats Nokia, Nokia Shanghai Bell

[R1-1716154](#) Remaining details on NR-RACH formats Ericsson

[R1-1716280](#) Remaining details of PRACH formats Intel Corporation

[R1-1716383](#) Remaining details on PRACH formats Qualcomm Incorporated

[R1-1716461](#) On PRACH Preamble Format for Capacity Enhancement and Beam Management InterDigital, Inc.

6.1.4.2 Remaining details on RACH procedure

[R1-1715387](#) Remaining Issues in RACH Procedure Huawei, HiSilicon

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 - gNB may schedule multiple UL grants for Msg3 retransmissions to reduce the access delay and provide contention mitigation.
 - NR supports assignment of an optional C-RNTI field in Msg4 that contains a C-RNTI different from the temporary C-RNTI assigned in Msg2 for any decoded colliding UE.

Decision: The document is noted.

[R1-1715846](#) RACH Procedure LG Electronics

- Proposal: Define RACH resource group as a set of RACH resources sharing the same RA-RNTI
 - DCI(s) scheduling RAR(s) on the PRACH preamble on each of the RACH resources within the RACH resource group is masked with the same RA-RNTI
 - Network signals the number of RACH resources per RACH resource group
 - Network signals the number of RAPIDs
 - UE calculates the number of preambles per RACH resource within a RACH resource group
- Proposal: Single PRACH preamble format per cell is applied over all RACH resources at least for initial access.
- Proposal: For the signalling of time-frequency information for the RACH resource,
 - Specify M states of slot location information per PRACH msg.1 SCS, with different RACH slot intensity and/or periodicity
 - Provide slot type information in order to indicate the starting symbol index of RACH resource within a slot, which can be OFDM symbol numbers, like {0, 1, 2 }
 - The slot type is applied over all RACH slots
 - Frequency location of the RACH resource is obtained by UL initial BWP resource allocation information for PRACH transmission within the BWP
- Proposal: SS blocks are to be mapped to RACH resource group in time domain in a sequential manner
 - Actual transmitted SS blocks are mapped to RACH resource group
- Proposal: UE is configured common CORESET for broadcasted system information (like RMSI, OSI and paging) including RAR and message 4 reception as well
- Proposal: RA-RNTI is shared among RACH resources within RACH resource group, for example,
 - RA-RNTI is calculated in a similar manner as in LTE, with some modifications on T_{id} as
 - T_{id} is unique value among RACH resource group
 - T_{id} can be a function of slot index and starting symbol index within the slot
- **Proposal: DCI based and asynchronous HARQ for message 3 (re)transmission are supported.**

Decision: The document is noted.

[R1-1716384](#) PRACH procedure considerations Qualcomm Incorporated

- Proposal 1: NR should support SS block to PRACH resource/preamble mapping configuration where PRACH resources corresponding to different SS blocks are time division multiplexed.
- Proposal 2: NR should support SS block to PRACH resource/preamble mapping configuration where PRACH resources corresponding to multiple SS blocks are located together. UE can select its preamble index, constructed from the

combination of selected waveform and subcarrier region, to inform the SS block index to gNB. The selected waveform depends on selected root, cyclic shift and orthogonal cover code index.

- Proposal 3: During handover scenarios, NR considers to allow source cell the flexibility to indicate a set of dedicated time resources for contention free random access.
- Proposal 4: NR only supports single Msg1 transmission till the expiration of RAR window in contention-based random access.
- Proposal 5: For contention free random access, NR does not support multiple Msg1 transmission before the expiration of RAR window in dedicated preambles within the common RACH time/frequency region.
- Proposal 6: For contention free random access during handover scenarios, NR considers multiple Msg1 transmission with same or different UE TX beams in dedicated time domain RACH region.
- Proposal 7: NR supports gNB configuring reporting of SS block index, e.g., strongest SS block index, through Msg3 of contention based random access.
- Proposal 8: At least during CFRA to convey beam failure recovery request, NR supports transmission of dedicated CSI-RS sent along with Msg2 and reporting based on CSI-RS in the subsequent dedicated UL resource.
- Proposal 9: During CFRA procedure of handover through dedicated time/frequency domain RACH resources, NR supports reporting of multiple SS block indices through Msg1.
- Proposal 10: NR should support the gap (expressed in number of slots) between Msg2 reception and Msg3 transmission, and between retransmission of Msg1 of RACH procedure, to depend on numerology.
- Proposal 11: NR should support Msg2 and Msg 3 transmission in mini-slots or slots.
- Proposal 12: NR should support joint encoding of Msg3 waveform and resources.
- Proposal 13: NR supports gNB configuring contention based random access procedure to convey beam failure recovery request. gNB can configure a dedicated time/frequency region to transmit contention based random access for conveying beam failure recovery request.
- Proposal 14: NR studies uplink transmit power selection policies so that UEs without beam correspondence reduce interference to other UEs of the network.
- Proposal 15: NR supports network providing UE specific transmit power control command for transmitting CFRA through dedicated time/frequency region, if CFRA through dedicated time/frequency region is agreed.
- Proposal 16: NR should support DCI based retransmission of Msg3.
- Proposal 17: If UE is retransmitting Msg3 after receiving DCI, it should select its Msg3 transmit power based on the uplink transmit power control parameter conveyed in the DCI.
- Proposal 18: If UE is retransmitting Msg3 on its own, UE's transmit power for Msg3 should increase, with respect to normalized path loss, if UE uses the same beam to retransmit Msg3. UE's transmit power for Msg3 remains unchanged, with respect to normalized path loss, if UE uses a different TX beam to retransmit Msg3.

Decision: The document is noted.

Continue offline discussion – Nazmul (Qualcomm)

Tuesday

R1-1716800

Discussion Points on remaining details about RACH Procedure

Qualcomm Inc.

Agreements:

- At least for initial access,
 - The PDSCH for RAR is confined within NR UE minimum DL BW for a given frequency band
 - The PDSCH for Msg4 is confined within NR UE minimum DL BW for a given frequency band.
 - FFS: If PDSCH for RAR and Msg4 are confined within initial active DL BWP.
- Send an LS to RAN4 informing tone spacing and bandwidth of different RACH preamble formats
 - Check if these RACH preamble formats are confined within UE's minimum UL BW
 - Assigned to Dhiraj (Samsung)

R1-1716805

[Draft] LS on NR PRACH BW aspects

Samsung

Decision: The document is noted and **approved in R1-1716814** with the following updates:

- The minimum uplink bandwidth needed for supporting this PRACH preamble format is 1.25MHz for 1.25kHz SCS and 5 MHz for 5kHz SCS.
- Update the action to: RAN1 would like to ask RAN4 to take the above information into account in their future work, and to inform RAN1 if there are concerns over the above information.

Agreement:

- At least for initial access, the association between SS blocks and RACH preamble indices and/or RACH resources is based on the actually transmitted SS blocks indicated in RMSI

Proposals:

- For RAR, X can be supported for the timing gap between the end of MSg1 transmission and the starting position of the CORESET for RAR
 - Option 1: Value of $X = 0 T_s$
 - Sufficient Tx-Rx switching latency is guaranteed on top of $0 T_s$
 - Note: Tx-Rx switching latency is up to RAN4
 - Option 2: Value of $X = 1$ symbol where the symbol is based on the RAR numerology
 - Other options

[R1-1716822](#) Discussion Points on remaining details about RACH Procedure Qualcomm Inc. (rev. of [R1-1716810/R1-1716800](#))

Agreements:

- For RAR, X can be supported for the timing gap between the end of MSg1 transmission and the starting position of the CORESET for RAR
 - Value of $X = \text{ceiling}(\Delta/(\text{symbol duration})) \cdot \text{symbol duration}$, where the symbol duration is based on the RAR numerology
 - Where Δ is to accommodate sufficient time for UE Tx-Rx switching if needed (e.g., for TDD)
 - Note: UE Tx-Rx switching latency is up to RAN4

Agreements:

- RMSI indicates only a single transmit power for SS blocks in Rel-15
- For initial access, threshold for SS block selection for RACH resource association is configurable by network, where the threshold is based on RSRP
 - FFS details, including ping-pong effect handling

Proposals:

- NR supports mini-slot based transmission during RACH procedure
 - Option 1: NR supports Msg2 and Msg3 transmission in mini-slots or slots.
 - Option 2: For contention free random access, NR supports gNB configuring Msg2 transmission in mini-slots based on UE capability
- Discuss further offline, especially considering the need of ITU submission (detailed analysis is necessary also considering different SCS)

Proposal:

- Support QCL associations in contention based RACH procedure as follows:
 - Message 2 is transmitted using the same TX beam as was used to transmit SS block the preamble the UE sent is associated to
 - Message 3 is received assuming the same RX beam at gNB as was used for PRACH preamble reception to which received RAR is associated to
 - Message 4 is transmitted assuming the same TX beam as was used to transmit Message 2 if no beam reporting procedure was applied before Message 4

Thursday
[R1-1716898](#) Summary of discussion regarding remaining details of RACH procedure Qualcomm

Agreements:

- NR supports at least slot based transmission of Msg2, Msg3 and Msg4
 - Check if slot based scheduling can satisfy ITU requirement. If not, investigate ways to meet ITU requirement, e.g., non-slot based transmission of Msg2, Msg3 and Msg4

Agreements:

- Msg3 is scheduled by the uplink grant in RAR
- Msg3 is transmitted after a minimum time gap from the end of Msg2 over-the-air reception
 - gNB has the flexibility to schedule the transmission time of Msg3 while ensuring the minimum time gap
 - FFS the minimum time gap w.r.t. UE processing capability

Conclusion:

- FFS Message 2 PDCCH/PDSCH is received by the UE assuming that the PDCCH/PDSCH DMRS conveying message 2 is QCL'ed with the SS block which the preamble/RACH occasion the UE sent is associated to
- FFS Message 3 is transmitted by the UE assuming that the same Rx beam as was used for PRACH preamble reception by gNB to which the received RAR is associated to
- FFS If there is no beam reporting in RACH message 3, Message 4 PDCCH/PDSCH is received by the UE assuming that the PDCCH/PDSCH DMRS conveying message 4 is QCL'ed with that of Msg 2
 - FFS: If there is beam reporting in RACH message 3
 - FFS: If and how beam reporting in RACH message 3 impacts message 4 Tx QCL assumption

R1-1715382	Remaining details of RACH procedure	ZTE, Sanechips
R1-1715481	Discussion on RA procedure	Fujitsu
R1-1715694	Discussion on NR 4-Step Random Access Procedure	Guangdong OPPO Mobile Telecom.
R1-1715759	Remaining details on Msg. 1 power ramping during RA procedure in NR	ETRI
R1-1715790	Further details on NR 4-step RA Procedure	CATT
R1-1715914	Remaining details on PRACH procedure	Samsung
R1-1716046	Discussion on RACH configuration CMCC	
R1-1716074	Discussion on remaining details on RACH procedure	NTT DOCOMO, INC.
R1-1716138	Remaining details on PRACH procedure	Nokia, Nokia Shanghai Bell
R1-1716155	Remaining details on RACH procedure	Ericsson
R1-1716162	Remaining details of RACH Procedure and RACH Configuration	AT&T
R1-1716219	NR 4-step RACH procedure	MediaTek Inc.
R1-1716240	Remaining Issues in RACH Procedure	Sony
R1-1716254	RACH configuration of Multiple Msg1 transmissions before the end of a monitored RAR window	InterDigital, Inc.
R1-1716267	Remaining issues on RACH procedure in NR	Sharp
R1-1716281	NR RACH procedures	Intel Corporation
R1-1716638	Remaining details on random access procedure	Motorola Mobility, Lenovo

6.1.5 Mobility procedure

6.1.5.1 Remaining details on measurement for mobility management

Including both SS block and CSI-RS related aspects

[R1-1716528](#) Measurements for mobility management Nokia, Nokia Shanghai Bell

- **Error! Reference source not found.**
- Proposal 1: For spatial domain characteristics perspective, the RSSI value used in determining the RSRQ, should be obtained through same RX spatial filtering as used for RSRP.
- Proposal 2: Define the resources used for RSSI estimation in the specification.
- Regarding the LS sent by RAN4 [[R1-1715368](#)] we observe following:
- Observation 2: RAN1 could try to clarify from RAN4 what should be the behaviour and reporting assumption in case UE supports multiple RX beams.
- In context of CSI-RS for L3 mobility we presented results looking the achievable accuracy with different assumptions, and considering different methods for CSI-RS resource configuration conclude:-
- Proposal 3: Support power boosting for CSI-RS for L3 Mobility
- Proposal 4: Support higher densities (in frequency domain) at least for 1, 2 and possible for 4 port CSI-RS resource configurations. Density values [12 6 3] REs/port/PRB.
- Proposal 5: Support time domain repetition of CSI-RS symbols for CSI-RS for L3 Mobility
- Further on different approaches to configure CSI-RS resources we propose:-
- Proposal 6: CSI-RS for L3 mobility are confined in a 5ms window for a given cell.
- Proposal 7: Define the time instance for CSI-RS transmission for specific SS block as timeoffset relative to the beginning of the configured 5ms CSI-RS Burst Set Window
- Proposal 8: CSI-RS transmitted inside the SS Burst Set Window can be configured to use unused symbol locations.
- Proposal 9: CSI-RS transmitted inside the SS Burst Set Window can be configured in frequency to the symbol locations occupied by SS block.
- The relation between CSI-RS and SS block we make following observation and proposals:-
- Acknowledging that the CSI-RS sequence design has not been concluded in the beam management, we discuss the sequence initialization from L3 mobility perspective:
- Observation 3: Physical Cell ID could be used as an one input parameter to the sequence initialization.
- Observation 4: Time domain varying parameter for sequence initialization could also be considered.

- Observation 5: Additional parameters would be needed to separate overlapping resources if sent under the same cell ID.
- Observation 6: RE mapping and density could also be used as parameters for the initialization.
- In Section 4 we discuss the mobility measurements in C-DRX:-
- Observation 7: Amount of relaxation of measurement requirements in C-DRX may depend on the carrier frequency.
- Observation 8: C-DRX mobility requirements in NR would need to consider SS burst set duration and periodicity, together with UE side RX beam sweeping.
- Proposal 10: SS block based mobility measurement requirements with C-DRX need to consider SS burst set duration and periodicity, together with UE side RX beam sweeping.
- Observation 9: In LTE, mobility performance requirements when C-DRX is configured follow the data activity.
- Observation 10: Requiring that network can only configure CSI-RS resources within UE's active time will severely hinder the use of CSI-RS for L3 mobility
- Proposal 11: CSI-RS resource configuration is under network control and can be configured independently of C-DRX.
- Proposal 12: UE should not assume that configured CSI-RS resources for L3 mobility are present outside the active time.

Decision: The document is noted.

R1-1716618 Discussion on Measurement for Mobility Management MediaTek Inc.

- Observation 1: L1-RSRP for beam management and for RRM could have different number of measurement samples evaluation period.
- Proposal 1: The RSRP definition with RX beam is left for RAN4 to decide.
- Proposal 2: RSSI for SS block based RSRQ is measured by extending the duration in time to include the contribution of OFDM symbols without SS block.
- Proposal 3: UE follows network's indication of RMTC when measuring RSSI.
- Proposal 4: The interference part of SS block based RS-SINR is measured by subtracting SSS contribution from the received signal on those SSS REs
- Proposal 5: The interference part of CSI-RS based RSRQ is measured based on the time duration indicated by RMTC and the same bandwidth as the CSI-RS RSRP.
- Proposal 6: The interference part of CSI-RS based RS-SINR is measured based on IMR.
- Observation 2: The signal and interference measurements of a given measurement quantity may be performed by using the same RX beam
- Proposal 7: In the synchronized network, the slot offset of CSI-RS is based on serving cell for intra-/inter-frequency measurement. FFS asynchronized network.
- Proposal 8: For one cell, all CSI-RS resources for L3 mobility are confined to one slot.
- Proposal 9: Design of 1 port CSI-RS resources for beam management is reused for CSI-RS for L3 mobility
- Observation 3: The number of CSI-RS resources to be measured by UE depends on UE capability

Decision: The document is noted.

Continue discussion offline – Hiroki/Tomoya (DCM)

Tuesday

R1-1716798

Offline summary on remaining details on RRM measurements

NTT DoCoMo

Agreements:

- For a SS-RSRQ measurement, the same RX beam shall be applied between RSSI measurement and RSRP measurement
- For a CSI-RSRQ measurement, the same RX beam shall be applied between RSSI measurement and RSRP measurement
- It is up to UE implementation how to select a set of RX beams to perform RRM measurement on a carrier
 - Different sets of RX beams can be used in measurements based on different measurement objects
- Same set of RX beams shall be used in measurement of each TX beam based on a measurement object
- FFS
 - Alt.1: Measurement to be reported shall be greater than average of measurements based on each RX beam in the selected set
 - Alt.2: Measurement to be reported shall be the best among measurements based on each RX beam in the selected set
 - Other alternatives are not precluded

Proposals:

- SS block based RSSI measurement resource(s) is confined within SMTC window duration
- SS block based interference measurement resource(s) is confined within SMTC window duration

Agreement: Candidate value(s) for SMTC window duration

- At least 1ms, 5 ms are supported
- FFS other values

Thursday

[R1-1716861](#)

Offline summary for mobility NTT DOCOMO

Agreements:

- At least for inter-frequency measurement, SS block based RSSI measurement resource(s) is confined within at most the measurement gap duration, e.g., 6 msec
- At least for inter-frequency measurement, SS block based interference measurement resource(s) is confined within at most the measurement gap duration, e.g., 6 msec

Agreements:

- Study further between the two alternatives on the type of the RSSI measurement resource in time domain:
 - Alt 1: RSSI is measured within the resource without considering whether the resource is DL or UL or both
 - Alt 2: RSSI is measured only within the DL part
 - Note: UE at least knows that the OFDM symbols corresponding to the SS block locations indicated in the RMSI is for DL
 - Note: Identification of the DL part of a slot of a serving/selected cell for the RSRQ measurement purpose, if necessary, will follow the decisions from the control sessions
- Study further among the following alternatives on the configurability of the RSSI measurement resource in time domain:
 - Alt a: The resource is predefined in the spec
 - Alt b: The resource is explicitly configured in the SI for IDLE mode measurements and in the RRC signaling for CONNECTED mode measurements
 - Alt c: UE detects RSSI measurement resource
 - Alt d: The resource is implicitly derived by other parameters in SI, e.g., the actually transmitted SS blocks indicated in RMSI
 - To down select, consider applicability of these alternatives for inter & intra frequency measurements, IDLE & CONNECTED mode and initial cell selection

R1-1715383	Remaining details of RRM measurements	ZTE, Sanechips
R1-1715392	CSI-RS Configurations and definitions of RSRP/RSRQ for L3 Mobility	Huawei, HiSilicon
R1-1715482	Measurement based on SSB	Fujitsu
R1-1715509	Discussion on the association between the SMTc and the measurement object	Spreadtrum Communications
R1-1715678	Remaining details on NR RRM measurement	Guangdong OPPO Mobile Telecom.
R1-1715791	Mobility Management based on SS block and CSI-RS measurements	CATT
R1-1715847	Remaining Details on L3 measurement and mobility management	LG Electronics
R1-1715915	Remaining issues on the NR mobility	Samsung
R1-1716047	Discussion on RSSI measurement for RSRQ and interference measurement for RS-SINR	CMCC
R1-1716075	Discussion on NR RRM measurement for L3 mobility	NTT DOCOMO, INC.
R1-1716156	Mobility measurements on SS block and CSI-RS	Ericsson
R1-1716163	Measurements for L3 mobility based on SS block and CSI-RS	AT&T
R1-1716282	RRM Measurements for NR	Intel Corporation
R1-1716385	Remaining details on measurement for mobility management	Qualcomm Incorporated
R1-1716639	SS/PBCH block based measurement in wideband carrier	Motorola Mobility, Lenovo

6.1.5.2 Radio link monitoring for mobility management

[R1-1716076](#)

Discussion on NR RLM and RLF NTT DOCOMO, INC.

Proposal 1: Default RLM-RS resource is defined as all actually transmitted SS/PBCH blocks from PCell or PSCell.

Proposal 2

- The resource configuration method or resource definition for interference measurement for SS/PBCH block based RLM should be the same as that for RSSI/interference measurement for SS-RSRQ/SS-SINR measurement.
- The resource configuration method or resource definition for interference measurement for CSI-RS based RLM should be the same as that for RSSI/interference measurement for CSI-RSRQ/CSI-SINR measurement.

Proposal 3

- NR supports to configure multiple in-sync BLERs and/or multiple out-of-sync BLERs for a UE at a time.
 - For a RLM-RS resource for a CORESET, only one in-sync BLER and one out-of-sync BLER are configured at a time.

Proposal 4: NR supports to configure whether aperiodic IS indication based on beam recovery success and/or aperiodic OOS indication based on beam recovery failure is/are applied to RLM procedure or not.

Decision: The document is noted.

R1-1716283 Radio Link Monitoring for NR Intel Corporation

Proposal 1:

- *Interference and noise Measurement Resource (IMR) for RLM can be configured by the network.*
- *IMR for RLM is a separate configuration from IMR for CSI feedback.*
- *IMR for RLM uses the same signaling framework as the IMR for CSI feedback and is baseline for design.*

Proposal 2:

- *Network can configure a subset of the SSB for RLM.*
- *By default (i.e. unless configured otherwise), RLM measurement of all actually transmitted SSB (indicated by RMSI) is performed by the UE.*

Proposal 3:

- *CSI-RS based RLM is based on CSI-RS configuration for P-1 beam management. This implies if CSI-RS configuration for P-1 beam management is not configured for the UE, UE would by default use SSB for RLM.*

Proposal 4:

- *Only 1 RLM process is supported for a UE.*
 - *Only one IS/OOS report at a given time regardless of RS configurations for RLM*

Proposal 5:

- *Periodic IS is indicated if the estimated link quality corresponding to hypothetical PDCCH BLER based on at least 1 (i.e. Y = 1) RLM-RS resource among all configured X RLM-RS resource(s) is above Q_{in} threshold.*

Proposal 6:

- *At most 2 Q_{in} and Q_{out} threshold pairs are configured for RLM.*
- *Each Q_{in} and Q_{out} value set can be associated with set of RS(s) for RLM.*
 - *IS if at least 1 RLM-RS meets its configured Q_{in}/Q_{out} value set*
 - *OOS if all RLM-RS failed to meet its configured Q_{in}/Q_{out} value set*

Decision: The document is noted.

Continue discussion offline focusing on issues such as RLM-RS resource, IS/OOS BLER, etc. - Hiroki/Tomoya (NTT DOCOMO)

Tuesday

R1-1716808 Summary on remaining details on Radio Link Monitoring NTT DOCOMO

Proposals:

- Default RLM-RS resource(s) is defined as
 - Option 1: all actually transmitted SS/PBCH blocks
 - Option 2: the SS/PBCH block which is associated with selected CORESET and used for initial access by UE

Agreements:

- For a cell group,
 - A single IS or OOS is reported by the UE
 - A single IS BLER is configured for a UE at time
 - A single OOS BLER is configured for a UE at time
 - Configurable from two pairs of values for IS/OOS BLERs
 - Detailed pair of values up to RAN4 to decide
 - FFS whether the configuration is an explicit RRC configuration or implicitly derived from other parameter
 - FFS the case of URLLC & mMTC
- Send an LS to RAN4 capturing the above agreements, and also add:
 - For the two pairs of values for IS/OOS BLERs, RAN1 discussed use cases such as VoIP vs. eMBB.
 - LS to be drafted by Tomoya (NTT DOCOMO)

Agreements:

- When UE is configured to perform RLM on one or multiple RLM-RS resource(s),
 - Periodic IS is indicated if the estimated link quality corresponding to hypothetical PDCCH BLER based on at least Y=1 RLM-RS resource among all configured X RLM-RS resource(s) is above Q_{in} threshold
 - FFS the interference measurement resource related to the estimated link quality corresponding to the hypothetical PDCCH BLER

Thursday

[R1-1716862](#) [Draft] LS on in-sync/out-of-sync BLER for RLM NTT DOCOMO

Decision: The document is endorsed and final LS is [approved in R1-1716917](#).

[R1-1716861](#) Offline summary for mobility NTT DOCOMO

Agreement:

- RLM-RS is undefined until explicitly/implicitly configured.
 - Note: This implies that the network needs to configure the RLM-RS for UE to perform RLM

Agreements:

- When SS blocks are used as RLM-RS
 - A set of SS blocks are explicitly configured by RRC
- When CSI-RS is used as RLM-RS
 - a set of CSI-RS resources are explicitly configured as RLM RS by RRC
 - FFS whether a subset of CSI-RS resources configured for P1 BM is configured as RLM-RS

R1-1715384	RLM in NR	ZTE, Sanechips
R1-1715391	RLM and Beam Recovery Procedure	Huawei, HiSilicon
R1-1715610	Radio link monitoring in NR	vivo
R1-1715679	Remaining details on NR radio link monitoring	Guangdong OPPO Mobile Telecom.
R1-1715792	NR Radio Link Monitoring	CATT
R1-1715848	Discussion on Radio Link Monitoring in NR	LG Electronics
R1-1715916	Radio link monitoring	Samsung
R1-1716048	Relationship between RLM and beam recovery	CMCC
R1-1716157	Radio link monitoring	Ericsson
R1-1716164	Radio link monitoring procedure and thresholds	AT&T
R1-1716261	Radio Link monitoring	InterDigital, Inc.
R1-1716386	Radio link monitoring consideration	Qualcomm Incorporated
R1-1716529	Radio Link Monitoring In NR	Nokia, Nokia Shanghai Bell
R1-1716619	Discussion on Radio Link Monitoring	MediaTek Inc.
R1-1716640	Beam recovery and radio link monitoring	Motorola Mobility, Lenovo

6.1.6 Other

R1-1715393	On numerology determination during initial access	Huawei, HiSilicon
R1-1715565	On QCL Indication and Time Repetition of SS blocks	Huawei, HiSilicon
R1-1715573	Discussion on multiple SS blocks within wideband carrier	Huawei, HiSilicon
R1-1715713	On initial access for wideband carrier	Huawei, HiSilicon
R1-1715716	Discussion on the PRACH for SUL	Huawei, HiSilicon
R1-1715720	Relationship between beam failure recovery and RLF	Huawei, HiSilicon
R1-1715849	Discussion on PRACH preamble for capacity enhancement	LG Electronics
R1-1715917	RAR contents	Samsung
R1-1715918	Discussion on RACH capacity enhancement	Samsung
R1-1715919	Discussion on MSG. 3 tx timing determination	Samsung
R1-1715920	Discussion on RACH configuration	Samsung
R1-1715921	Assisted information for MSG. 3 tx beam determination	Samsung
R1-1715922	RAR detection for contention-free random access	Samsung
R1-1715923	Discussion on additional RACH resource for contention free RACH	Samsung
R1-1715924	RRM for wider bandwidth operations	Samsung
R1-1715925	Remaining details on power control during RACH procedure	Samsung
R1-1716158	Additional synchronization provision	Ericsson
R1-1716522	On different deployments and SS SCS combinations	Nokia, Nokia Shanghai Bell

6.2 MIMO

[R1-1716870](#) Chairman's notes of AI 6.2 MIMO Ad-Hoc chair (Samsung)

The document was presented by Younsun Kim from Samsung.

Decision: The document is endorsed and content is incorporated as below.

[R1-1716629](#) Sectorized uniform planar arrays versus stacked uniform circular arrays Fraunhofer HHI, Fraunhofer IIS

6.2.1 Multi-antenna scheme

Physical control channel related issues are to be discussed in the agenda item for scheduling/HARQ aspects.

[R1-1716148](#) Comparison of DFT-codebook-based and Antenna Response-Matched Precoding with Real-World Antenna Arrays Fraunhofer IIS

[R1-1716921](#) Summary of offline discussion on UL MIMO Open Issues Ericsson

6.2.1.1 Remaining details on codeword mapping

[R1-1716723](#) Remaining details of codeword mapping in NR Huawei, HiSilicon (revision of [R1-1715459](#))

[R1-1716663](#) Finalizing Layer Mapping Samsung (revision of [R1-1715926](#))

[R1-1716174](#) Codeword to layer mapping for DL and UL data channels AT&T

[R1-1716387](#) Remaining issues on CW to layer mapping Qualcomm Incorporated

[R1-1716858](#) Summary of offline of NZP CSI-RS for interference measurement and CW to layer mapping Huawei, HiSilicon

Agreements:

- For RE mapping for DFT-S-OFDM without frequency hopping:
 - Option 1
- For RE mapping for DFT-S-OFDM with frequency hopping, downselect between the following alternatives in RAN1#90bis:
 - Option 1
 - Option 3

Reminder (agreed WF on RE mapping for DFT-s-OFDM - [R1-1715161](#)):

- Option 1: Subcarriers then OFDM symbols
- Option 3: Subcarriers in 1st hop, then subcarriers in 2nd hop, repeat the mapping by starting from the subsequent OFDM symbol in the 1st hop.

[R1-1715430](#) Remaining details of codeword mapping ZTE, Sanechips

[R1-1715611](#) On remaining details of codeword mapping vivo

[R1-1715793](#) On codeword mapping CATT

[R1-1715850](#) Discussion on codeword mapping LG Electronics

[R1-1716077](#) Remaining Details on Resource Element Mapping NTT DOCOMO, INC.

[R1-1716208](#) Codeword mapping for DFTs-OFDM based UL MediaTek Inc.

[R1-1716284](#) Remaining details on CW to MIMO layer mapping Intel Corporation

[R1-1716340](#) Further details on CW mapping Ericsson

[R1-1716797](#) Summary of Open Issues on Layer Mapping Samsung

6.2.1.2 Codebook based transmission for UL

[R1-1716737](#) Summary of Issues and WFs on Codebook based transmission for UL Intel

[R1-1716882](#) WF on UE Autonomous Antenna Selection Vivo, MediaTek, Samsung

Agreement:

- For DFT-S-OFDM, support LTE 4Tx rank 1 UL codebook for TPMI 0-15
 - Additional codewords for antenna port selection will be also supported
 - FFS: Details on the additional codewords for antenna port selection (e.g. number of codewords, scale factors, etc)

[R1-1716824](#) WF on calibration signal for NR Intel

[R1-1715431](#) Codebook based UL transmission ZTE, Sanechips

[R1-1715584](#) Codebook based transmission for UL MIMO Huawei, HiSilicon

[R1-1715612](#) Discussion on codebook based UL transmission vivo

[R1-1715668](#) Remaining issues on UL codebook design Guangdong OPPO Mobile Telecom.

[R1-1715794](#) Discussion on codebook based transmission for UL CATT

[R1-1715851](#) Discussion on codebook based transmission for UL LG Electronics

[R1-1715927](#) Codebook-Based UL Transmission Samsung

R1-1716078	Codebook design for uplink	NTT DOCOMO, INC.
R1-1716175	UL MIMO for codebook based transmission	AT&T
R1-1716285	Remaining issues on codebook based UL transmission	Intel Corporation
R1-1716341	UL MIMO for codebook based transmission	Ericsson
R1-1716388	Codebook based UL transmission	Qualcomm Incorporated
R1-1716462	TPMI Indication for Frequency Selective UL Precoding	InterDigital, Inc.
R1-1716490	UL Codebook Based Transmission and Codebook Design	Nokia, Nokia Shanghai Bell
R1-1716785	Codebook based transmission for UL	MediaTek
R1-1716886	WF on WF on 4Tx UL codebook for DFTs-OFDM	LG Electronics, CATT

6.2.1.3 Non-codebook based transmission for UL

R1-1716769	Summary of issues on UL non-codebook based transmission	Nokia, Nokia Shanghai Bell
R1-1716791	WF on non-codebook based transmission for UL MIMO	Huawei, HiSilicon, Nokia, NSB, NTT DOCOMO, InterDigital, Ericsson, ZTE, Sanechips, CATT, Deutsche Telekom, vivo

Working assumption

- For PUSCH precoder determination using wideband SRI only indication in non-codebook based UL MIMO, only one SRS port per SRS resource can be configured
 - Note: to support high rank transmission, multiple SRS resources should be indicated
 - FFS: subband SRI indication
 - FFS: Details of DCI for wideband SRI indication
 - FFS: Details on how to reduce the overhead and SRS resource

R1-1715460	Non-codebook based transmission for UL MIMO	Huawei, HiSilicon
R1-1715669	Further discussion on uplink non-codebook transmission	Guangdong OPPO Mobile Telecom.
R1-1716286	Remaining issues on non-codebook based UL transmission	Intel Corporation
R1-1716342	UL MIMO for non-codebook based transmission	Ericsson
R1-1716389	Non-codebook based UL transmission	Qualcomm Incorporated
R1-1715432	Non-Codebook based UL transmission	ZTE, Sanechips
R1-1715613	Discussion on non-codebook based UL transmission	vivo
R1-1715795	Discussion on non-codebook based transmission for UL	CATT
R1-1715852	Discussion on non-codebook based transmission for UL	LG Electronics
R1-1715928	Discussion on Non-Codebook-Based UL Transmission	Samsung
R1-1716079	Sub-band indication for non-codebook based transmission for uplink	NTT DOCOMO, INC.
R1-1716176	Non codebook based transmission for UL MIMO	AT&T
R1-1716491	Non-codebook based UL-MIMO transmission	Nokia, Nokia Shanghai Bell

6.2.1.4 Diversity transmission for UL

R1-1716776	Summary of AI 6.2.1.4 Diversity transmission for UL	Mitsubishi Electric
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Agreement:

- For DFTsOFDM waveform based PUSCH, UL transmit diversity is not supported for PUSCH with DFTsOFDM from NR specification point of view
 - Above applies for the RAN1 specification for completion by Dec, 2017 due to lack of simulation results
 - Previous studies and decisions on UL TxD will be taken into account in future RAN1 discussions

R1-1716811	WF on uplink 1Tx transmission mode	Nokia, NSB, Qualcomm, Samsung, MediaTek, Ericsson, CATT
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R1-1716343	Robust Transmission Scheme for PUSCH	Ericsson
R1-1715555	UL diversity transmission for DFTsOFDM	Mitsubishi Electric RCE
R1-1715433	Diversity based uplink transmission schemes	ZTE, Sanechips
R1-1715516	Consideration on UL diversity transmission	Spreadtrum Communications
R1-1715614	Discussion on diversity transmission for UL	vivo
R1-1715717	Diversity-based transmission for UL	Huawei, HiSilicon
R1-1715796	Considerations on UL transmit diversity	CATT
R1-1715853	Discussion on diversity transmission for UL	LG Electronics
R1-1715929	Diversity transmission for UL	Samsung
R1-1716177	On UL Diversity based Transmission Scheme for NR	AT&T
R1-1716287	Remaining issues on diversity based UL transmission	Intel Corporation

R1-1716730	On UL diversity transmission scheme	Qualcomm Incorporated
R1-1716463	On the Performance of Uplink Transmit Diversity Schemes	InterDigital, Inc.
R1-1716492	UL-MIMO diversity-based transmission	Nokia, Nokia Shanghai Bell
R1-1716520	Views on UL transmit diversity	IITH

6.2.1.5 PRB bundling for DL

R1-1716784	Summary of Issues on DL PRB bundling	Vivo
R1-1716879	Summary of Issues on DL PRB bundling and Offline Agreement	Vivo

Agreement:

- The PRB bundle defined in the absolute PRB grid of the wideband CC from network perspective is aligned with RBG boundary

Agreement:

- Support the 1 bit DCI indication for PRB bundling size
 - Dynamic PRB bundling is part of UE capability signalling discussion
 - FFS details
 - If UE does not support dynamic PRB bundling, then only one PRB bundling size is higher layer configured
 - FFS the detailed usage of the 1 bit

R1-1715434	On PRB Bundling	ZTE, Sanechips
R1-1715461	PRB bundling size for DL data precoding	Huawei, HiSilicon
R1-1715615	Discussion on PRB bundling for DL	vivo
R1-1715797	PRB bundling for DL transmission	CATT
R1-1715854	Discussion on PRB bundling	LG Electronics
R1-1715930	PRB bundling for NR DMRS	Samsung
R1-1716288	On PRB bundling for DL	Intel Corporation
R1-1716344	PRB bundling for DL	Ericsson
R1-1716464	On Dynamic PRG Size Configuration in NR	InterDigital, Inc.
R1-1716493	On remaining issues on PRB bundling	Nokia, Nokia Shanghai Bell
R1-1716796	Discussion on PRB bundling for DL	Qualcomm Incorporated

6.2.1.6 Multi-TRP and multi-panel transmission

R1-1715435	Multi-TRP Transmission/Reception for DL and UL	ZTE, Sanechips
R1-1715462	Enabling Multiple NR-PDCCH for Multiple TRP transmission	Huawei, HiSilicon
R1-1715483	Discussion on multiple NR-PDCCHs in NC-JT scheme	Fujitsu
R1-1715616	Discussion on Multi-panel Multi-TRP transmission for UL	vivo
R1-1715695	On NR Multi-TRP and Multi-panel Transmission	Guangdong OPPO Mobile Telecom.
R1-1715798	Considerations on DL multi-panel and multi-TRP transmission	CATT
R1-1715855	Discussion on cooperative transmission	LG Electronics
R1-1715931	Discussion on DL/UL multi-TRP/-panel supports	Samsung
R1-1716049	Discussion on multi-layer transmission with analog beam	CMCC
R1-1716165	Remaining details on supporting multi-TRP transmission and reception	AT&T
R1-1716211	Multi-TRP and multi-panel transmission	MediaTek Inc.
R1-1716246	Considerations on Multiple TRP/Panel Transmission	Sony
R1-1716289	Discussion on multi-panel and multi-TRP operation	Intel Corporation
R1-1716345	Multi-TRP and multi-panel transmission	Ericsson
R1-1716392	On multi-TRP and multi-panel transmission	Qualcomm Incorporated
R1-1716465	NR-PDCCH for Multi-TRP Transmission	InterDigital, Inc.
R1-1716494	Remaining details on multi-TRP transmission	Nokia, Nokia Shanghai Bell
R1-1716546	Discussion on Multi-TRP DL Transmission	ASUSTEK COMPUTER (SHANGHAI)
R1-1716877	Summary of views on multi-TRP/panel transmission	CATT

6.2.1.7 Rate matching

R1-1716773	Summary of views on PDSCH and PUSCH rate matching	LG Electronics
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Agreement: RMR(s) for PDSCH resource mapping includes CSI-RS REs at least.

R1-1716855	WF on Rate Matching for PUSCH	LG Electronics, CATT, Ericsson
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R1-1715463	Rate matching for data channels	Huawei, HiSilicon
R1-1715617	Discussion on rate matching	vivo
R1-1716393	On PDSCH and PUSCH RE mapping	Qualcomm Incorporated
R1-1715436	Discussion on rate matching	ZTE, Sanecips
R1-1715484	CSI-RS resource indication for rate matching	Fujitsu
R1-1715670	On PDSCH and PUSCH Rate matching	Guangdong OPPO Mobile Telecom.
R1-1715856	Discussion on rate matching	LG Electronics
R1-1715932	On PDSCH rate matching for NR	Samsung
R1-1716166	On the need of per RE level PDSCH rate-matching and RE mapping signalling	AT&T
R1-1716290	Rate matching for NR	Intel Corporation
R1-1716346	On rate matching	Ericsson
R1-1716466	On PDSCH rate matching for NR	InterDigital, Inc.
R1-1716495	Discussion on rate matching resource	Nokia, Nokia Shanghai Bell

6.2.1.8 Other

R1-1715437	On Transmission Setting	ZTE, Sanecips	
R1-1715464	Discussion on transmission parameter sets	Huawei, HiSilicon	
R1-1715706	Discussion on UL transmission mode design	Guangdong OPPO Mobile Telecom.	
R1-1715718	On the performance of the multi-subband UL MIMO and channel rank properties		Huawei, HiSilicon
R1-1715719	Discussion on UL multi-panel/TRP operation	Huawei, HiSilicon	
R1-1715933	Discussion on transmission parameter sets	Samsung	
R1-1715934	Continuous Precoding for NR DMRS in Time Domain	Samsung	
R1-1715935	CSI Feedback Overhead Reduction for NCJT	Samsung	
R1-1715936	Discussion on transition between NR network coordination schemes	Samsung	
R1-1715937	Preliminary system level evaluation for NCJT in NR	Samsung	
R1-1716291	On antenna calibration signal	Intel Corporation	
R1-1716369	UL multi-panel transmission	Ericsson	
R1-1716496	NC-JT for uplink multi-panel multi-TRP operation	Nokia, Nokia Shanghai Bell	

6.2.2 CSI acquisition and beam management

R1-1716347	CSI framework	Ericsson
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6.2.2.1 CSI measurement

R1-1716803	Summary of CSI measurement	ZTE, NTT DOCOMO
R1-1716804	Way forward on reciprocity based CSI	ZTE, Sanecips, Qualcomm, Intel, NTT DOCOMO, LG Electronics, vivo, ASTRI

Also supported by Samsung

Agreements:

For non-PMI codebook, down-select one between the following alternatives

- Alt A: Port selection codebook is used for CQI calculation for non-PMI feedback
 - Each column of each precoding matrix in the port selection codebook contains only one non-zero entry
 - Codebook subset restriction is supported to indicate a single precoder per rank in the codebook used for CQI calculation
 - FFS whether this indication can be done by using L1/L2 signaling or RRC signaling
 - Support at least up to 8 CSI-RS ports and 8 layers
- Alt B: Port index indication is signaled to UE for RI/CQI calculation in non-PMI feedback
 - Port index indication selects the CSI-RS port(s) used for RI/CQI calculation per rank
 - Identity matrix is assumed by UE on the selected CSI-RS ports for RI/CQI calculation
 - N ports are selected for rank N
 - FFS Signaling details e.g. whether this indication can be done by using L1/L2 signaling or RRC signaling
 - Support up to 8 layers and at least up to 8 CSI-RS ports
- If down-selection between the above alternatives cannot be achieved until RAN1#90bis, it's up to editor how to capture Alt A or Alt B in specifications

R1-1716788	WF on NZP CSI-RS for interference measurement	Huawei, HiSilicon, Intel, Qualcomm, Spreadtrum, vivo, Ericsson, MediaTek, OPPO
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Agreements: UE can be configured with a set of NZP CSI-RS ports for interference measurement

- Downselect in next meeting for the following schemes:
 - Alt.1, a single CSI-RS resource for both channel and interference measurement
 - Alt.2, separately configured CSI-RS resources for channel and interference measurement
- UE shall assume each port in the set corresponds to an interference layer
- Note: It is up to gNB implementation to choose the precoder to apply on the NZP CSI-RS for IM

[R1-1716827](#) **WF on remaining issues on ZP CSI-RS based IMR** **LG Electronics, Intel, NTT DOCOMO, Samsung**
(Continue offline discussion: To be coordinated by LGE, Jiwon)

[R1-1716854](#) **WF on remaining issues on ZP CSI-RS based IMR** **LG Electronics, Intel, NTT DOCOMO, Samsung, CEWiT**

Agreement: Confirm the working assumption: NR supports semi-persistent IMR based on ZP CSI-RS for interference measurement for CSI feedback

[R1-1716902](#) **WF on remaining issues on ZP CSI-RS based IMR** **LG Electronics, Huawei, HiSilicon, CATT, CEWiT**
Contents of [R1-1716902](#) have been **agreed**.

[R1-1715465](#) Channel and interference measurement for CSI acquisition Huawei, HiSilicon
[R1-1716348](#) On interference measurement and CSI for reciprocity based operation Ericsson
[R1-1716080](#) Views on CSI measurement for NR NTT DOCOMO, INC.
[R1-1716292](#) Discussion on interference measurement for CSI Intel Corporation
[R1-1716497](#) Remaining aspects on interference estimation options and configuration Nokia, Nokia Shanghai Bell
[R1-1715438](#) On CSI measurement ZTE, Sanechips
[R1-1715799](#) Discussion on CSI framework CATT
[R1-1715857](#) Discussion on CSI measurement LG Electronics
[R1-1715938](#) Discussions on CSI measurements Samsung
[R1-1716179](#) Remaining details on CSI measurements for NR AT&T
[R1-1716243](#) Considerations on interference measurement Sony
[R1-1716394](#) Details of CSI measurement Qualcomm Incorporated

6.2.2.2 CSI reporting

[R1-1716801](#) **Summary of views on CSI reporting** **Ericsson**
[R1-1716726](#) **WF for Open Issues on CSI Reporting** **Samsung, Ericsson, Huawei, HiSilicon, ZTE, Sanechips, Mediatek, NTT DOCOMO, Nokia, Nokia Shanghai Bell, KDDI, Vodafone, CEWiT, ITH, IITM, Tejas Networks, Verizon, Deutsche Telekom, Softbank, CHTTL, NEC, WILUS, Sharp, China Unicom, IITL, KRRI, CMCC, ASTRI, KT Corporation, BT**
Also supported by Sprint.

Conclusion:

The WF was presented and discussed in the MIMO session with clear majority to agree on all the slides in the WF. However, due to objection by Intel, LGE, an agreement could not be reached. The issue will be revisited in the main session on Thursday. Intel and LGE had concerns on Slides 6, 7 (for long PUCCH for part1, support of A-CSI on long PUCCH), 11, 16 in [R1-1716726](#). Rest of the slides were acceptable to LGE and Intel.

Thursday comeback:

Intel highlighted again their concerns regarding slides 6, 7, 11 and 16, due to spec/implementation complexity and new open issues resulting from the proposals.
LGE acknowledged that there was no counter WF – shared same concern, each proposal should be (or should have a chance to be) checked in the online session from a procedure perspective
Samsung: LGE concern has been addressed in [R1-1716901](#) (co-sourced by LGE)

[R1-1716901](#) **WF for Open Issues on CSI Reporting** **Samsung, Ericsson, Huawei, HiSilicon, ZTE, Sanechips, Mediatek, NTT DOCOMO, Nokia, Nokia Shanghai Bell, KDDI, Vodafone, CEWiT, ITH, IITM, Tejas Networks, Verizon, Deutsche Telekom, Softbank, CHTTL, NEC, WILUS, Sharp, China Unicom, IITL, KRRI, CMCC, ASTRI, KT Corporation, BT, Sprint, LG Electronics, AT&T**

Discussion: Intel still cannot agree; suggested to make a note that the following features will not be specified within Rel-15 if the related normative works are not finished until RAN1#91 (November 2017):

- Method/procedure of omitting CSI parameters in slide 6
- Partial type 2 CSI on long PUCCH in slide 7

As the only objecting company, Intel finally decided to follow the majority for the sake of progress.

Decision: The document is noted and the WF is agreed with the following note further to Intel's request:

Intel: strong concerns on implementation and spec complexity, and timely completion of Rel-15 NR due to approving the WF [R1-1716901](#).

R1-1715439	Remaining details on CSI reporting	ZTE, Sanechips
R1-1715858	Discussions on CSI reporting	LG Electronics
R1-1715939	CSI Reporting and UCI Multiplexing	Samsung
R1-1716349	On CSI reporting	Ericsson
R1-1715466	Details of CSI reporting on PUCCH/PUSCH	Huawei, HiSilicon
R1-1715515	Discussion on CSI reporting	Spreadtrum Communications
R1-1715618	Discussion on CSI reporting	vivo
R1-1715800	Considerations on CSI reporting	CATT
R1-1716081	Feedback Design for CSI Type I and Type II	NTT DOCOMO, INC.
R1-1716178	On Codebook subset restriction for NR	AT&T
R1-1716212	CSI framework considerations for beam management and timing requirement	MediaTek Inc.
R1-1716293	Remaining issues on CSI reporting	Intel Corporation
R1-1716395	On Type I and Type II CSI reporting	Qualcomm Incorporated
R1-1716467	On flexible CSI reporting timing	InterDigital, Inc.
R1-1716498	On the general framework of CSI and beam management	Nokia, Nokia Shanghai Bell

6.2.2.3 Beam measurement and reporting

Including Beam Indication, UL beam management

R1-1716758	Summary on Beam Management Offline	Qualcomm
R1-1716842	WF on QCL Indication for DL Physical Channels	Ericsson, CATT, NTT Docomo, Samsung, Qualcomm

Agreements:

A UE is RRC configured with a list of up to M candidate Transmission Configuration Indication (TCI) states at least for the purposes of QCL indication

- Whether M equal to or larger than 2^N is for further study, where N is the size of the DCI field for PDSCH
- FFS: Mapping between the candidate states to the states described by N bit DCI field for PDSCH
- Each TCI state can be configured with one RS Set
- Each ID (FFS: details of ID) of DL RS at least for the purpose of spatial QCL in an RS Set can refer to one of the following DL RS types:
 - SSB
 - Periodic CSI-RS
 - Aperiodic CSI-RS
 - Semi-persistent CSI-RS
- FFS: Other RS (e.g. TRS, PTRS) in an RS set depending on outcome of discussions in the QCL agenda item
- FFS: Mechanisms to initialize/update the ID of a DL RS(s) in the RS Set used at least for spatial QCL purposes
 - At least the following two mechanisms are FFS: (1) explicit signalling to the UE of the DL RS(s) ID and corresponding TCI state (2) implicit association of the DL RS ID(s) to a TCI state based on measurements by the UE.
 - The mechanisms used for different RS types are FFS
- FFS: Whether or not a TCI state includes other parameters(s), e.g., for PDSCH rate matching purposes
- FFS: Value of N, where N is at most [3] bits

Note: More details on specification of more than one DMRS port group and more than one RS Set per TCI state is to be completed after the December release.

Agreement:

The QCL configuration for PDCCH contains the information which provides a reference to a TCI state

- Alt 1: The QCL configuration/indication is on a per CORESET basis
 - The UE applies the QCL assumption on the associated CORESET monitoring occasions. All search space(s) within the CORESET utilize the same QCL.
- Alt 2: The QCL configuration/indication is on a per search space basis

- The UE applies the QCL assumption on an associated search space. This could mean that in the case where there are multiple search spaces within a CORESET, the UE may be configured with different QCL assumptions for different search spaces.

- Note: The indication of QCL configuration is done by RRC or RRC + MAC CE (FFS: by DCI)

Note: The above options are provided as input to the control channel agenda item discussion

R1-1716890 Summary on Beam Management Offline Qualcomm

Agreement:

- For QCL indication for PDSCH:
 - When TCI states are used for QCL indication, the UE receives an N-bit TCI field in DCI
 - The UE assumes that the PDSCH DMRS is QCL with the DL RS(s) in the RS Set corresponding to the signaled TCI state
 - FFS: whether or not a QCL type is configured, configuration details are for further study
 - Whether or not the TCI field is always present in a given DL-related DCI is FFS
 - FFS: Whether or not the TCI field is in the same DCI as that containing the PDSCH scheduling assignment
- FFS: Timing between when the UE receives a QCL configuration/indication and the first time that the QCL assumption may be applied for demodulation of PDSCH or PDCCH

Conclusion:

The range of values for the following set of parameters are for further email discussion for beam management until Oct 6th

- Minimum time between aperiodic CSI-RS for beam management and its DCI shall be at least K_B symbols. Symbols measured from last symbol containing the DCI to first symbol of CSI-RS.
 - For further discussion on the scenarios (where UE beam is changed or not from the last symbol containing the DCI to the first symbol containing the CSI-RS)
 - Note: the latency may include the DCI decoding latency
- The number of symbols between CSI-RS for beam management and the associated report shall be at least R_B .
 - Note: The start is calculated from the last symbol of the CSI-RS used for the measurement report and end time is calculated to be the first symbol of the associated report
 - Note: CSI-RS may be for P1/P2/P3 procedures

The following set of parameters will be discussed over email until Oct 6th.

- Number of slots or symbols between indication of the spatial QCL for PDSCH and application of the PDSCH beam switch shall be at least D_B
- Number of slots or symbols between indication of the spatial QCL for PDCCH and application of the PDCCH beam switch shall be at least S_B
- Maximum number of Rx beam changes a UE can conduct during a slot shall not exceed B_B .
- The number of measurement reports with L1-RSRP only per slot, per TRP, per component carrier shall not exceed $C1_B$
- For beam management and CQI, the number of antenna ports per CSI-RS burst, for which the UE measures the channel, shall not exceed P_B
- The max number of CSI resources to measure L1-RSRP within a slot shall not exceed M_B .
- The max number of simultaneously triggered CSI/beam reports is at most T_B
- Maximum number of Tx beam changes a UE can conduct during a slot shall not exceed D_3 .
- Minimum time between aperiodic SRS for beam management and its DCI shall be at least D_4 symbols. Symbols measured from last symbol containing the DCI to first symbol of SRS.
- Maximum index of SRI for beam indication is D_5

Agreements:

- Support configuration of SSB for a UE to measure and report one or more L1-RSRP(s)
 - FFS: whether the set of SSBs is all of the SSB beams or a subset of them
 - **Alt1:** Support configuration of SSB resources within a resource setting for beam management.
 - L1-RSRP measurement on these resources is reported
 - **Alt2:** Support configuration of the RS type (e.g. SSB, CSI-RS) in a reporting setting for beam management.
 - L1-RSRP measurement on these resources is reported
- Down-select between the two options

R1-1716845 Way forward on beam reporting based on CSI-RS for BM with repetition ZTE, Sanechips, ASTRI, Ericsson

R1-1715440 Discussion on beam management ZTE, Sanechips
R1-1715467 Beam measurement and reporting Huawei, HiSilicon

R1-1715510	Differential RSRP report and beam indication	Spreadtrum Communications
R1-1715530	Discussion of beam measurement and reporting	Lenovo, Motorola Mobility
R1-1715619	Discussion on beam measurement, beam reporting and beam indication	vivo
R1-1715696	Discussion on Remaining Issues of Beam Management	Guangdong OPPO Mobile Telecom.
R1-1715707	Considerations on L1-RSRP reporting	NEC
R1-1715743	Discussion on beam indication	ITRI
R1-1715760	Discussion on beam measurement and reporting	ETRI
R1-1715801	Details of beam management	CATT
R1-1715859	Discussion on DL/UL beam management	LG Electronics
R1-1715940	On Beam Management, Measurement and Reporting	Samsung
R1-1716050	Considerations on beam reporting and beam indication	CMCC
R1-1716082	Views on NR Beam Management	NTT DOCOMO, INC.
R1-1716168	Beam measurement and reporting	AT&T
R1-1716213	Remaining details on beam management	MediaTek Inc.
R1-1716245	Considerations on UL beam management	Sony
R1-1716294	Discussion on Beam Management	Intel Corporation
R1-1716350	On beam indication, measurement, and reporting	Ericsson
R1-1716396	Beam management for NR	Qualcomm Incorporated
R1-1716453	Discussions for UL beam management	National Taiwan University
R1-1716468	On DL and UL beam management	InterDigital, Inc.
R1-1716499	On beam grouping and reporting	Nokia, Nokia Shanghai Bell
R1-1716550	Discussion on UL Beam Management	ASUSTEK COMPUTER (SHANGHAI)
R1-1716689	Beam measurement and reporting	AT&T
R1-1716819	WF on remaining details on SRS Tx beam association	LG Electronics
R1-1716831	WF on SRS beam sweeping behavior	LG, Intel Corp., ZTE, Sony

6.2.2.4 Mechanism to recover from beam failure

Handling of RAN2 LS, [R1-1716671](#), in 6.2.2.4.

Conclusion:

Details of the LS include issues related to both MIMO and initial access / mobility AIs and therefore should be discussed in the main session.

[R1-1716767](#) **Summary on Beam Recovery Mechanism MediaTek**

[R1-1716874](#) **Offline Summary on Beam Recovery Mechanism MediaTek**

Agreement:

WA on trigger condition 1 for beam recovery request transmission is confirmed with following revision

- “Support at least the following triggering condition(s) for beam failure recovery request transmission:

Condition 1: when beam failure is detected and candidate beam is identified ~~at least for the case when only CSI-RS is used for new candidate beam identification~~

Agreement:

The following working assumption is confirmed

- For beam failure recovery request transmission on PRACH, support using the resource that is CDM with other PRACH resources
 - Note that CDM means the same sequence design with PRACH preambles.
 - Note that the preambles for PRACH for beam failure recover request transmission are chosen from those for contention-free PRACH operation in Rel-15
 - Note: this feature is not intended to have any impact on design related to other PRACH resources
 - Further consider whether TDM with other PRACH is needed

Note: Companies may further study the necessity and feasibility of additional cyclic shifts on the preamble sequences for transmission of beam failure recovery requests

[R1-1716881](#) **Way Forward on Beam Failure Recovery Request Transmission** Intel, ZTE, Sanechips, Oppo, vivo

[R1-1716872](#) **WF on relationship between RLF and beam recovery** NTT DOCOMO, CHTTL, Ericsson,

InterDigital, LGE, CMCC, AT&T

Also supported by Samsung

[R1-1716920](#) **Way Forward on Dedicated PRACH Allocation for Beam Failure Recovery Mechanism** MediaTek, InterDigital, Huawei, Hisilicon, LG, Intel, Ericsson

Agreement:

- For new candidate beam identification purpose
 - In CSI-RS only case, a direct association is configured between only CSI-RS resources and dedicated PRACH resources
 - In SS block only case, a direct association is configured between only SS block resources and dedicated PRACH resources
 - In CSI-RS + SS block case (if supported), an association is configured between resources of CSI-RS/SSB and dedicated PRACH resources
 - CSI-RS and SSB can be associated with the same dedicated resource through QCL association

**R1-1716922
InterDigital**

Way Forward on Candidate beam identification for Beam Failure Recovery Huawei, Hisilicon, LG, Intel,

R1-1715441	Discussion on beam recovery	ZTE, Sanecips
R1-1715468	Beam Failure Recovery Design Details	Huawei, HiSilicon
R1-1715531	Discussion of beam recovery mechanism	Lenovo, Motorola Mobility
R1-1715620	Discussion on beam failure recovery	vivo
R1-1715697	Discussion on Beam Recovery Mechanism	Guangdong OPPO Mobile Telecom.
R1-1715708	Discussion on beam failure recovery	NEC
R1-1715802	Beam failure detection and recovery	CATT
R1-1715860	Discussion on beam failure recovery	LG Electronics
R1-1715941	Beam failure recovery	Samsung
R1-1716083	Views on Beam Recovery	NTT DOCOMO, INC.
R1-1716169	On beam recovery for partial and full control channel failure	AT&T
R1-1716214	Discussion on Beam Recovery Mechanism	MediaTek Inc.
R1-1716241	Considerations on beam recovery	Sony
R1-1716295	Remaining issues on beam failure recovery	Intel Corporation
R1-1716351	Basic beam recovery	Ericsson
R1-1716397	Beam recovery procedures	Qualcomm Incorporated
R1-1716469	Remaining issues on beam recovery	InterDigital, Inc.
R1-1716500	Beam Recovery in NR	Nokia, Nokia Shanghai Bell
R1-1716543	Details of Improved Beam Failure Handling	National Instruments Corp.
R1-1716660	Discussion on mechanisms for beam failure recovery	Sharp
R1-1716690	On beam recovery for partial and full control channel failure	AT&T

6.2.2.5 CQI and MCS

R1-1716296	CQI and MCS design for NR	Intel Corporation
R1-1716501	Consideration on new MCS and CQI table for NR	Nokia, Nokia Shanghai Bell

Agreement:

- Different CQI tables can be configured to a UE at least in order to support different maximum order of modulations
 - FFS: Whether the different CQI tables should consider minimum coding rate

R1-1715442	On CQI and MCS	ZTE, Sanecips
R1-1715469	CQI and MCS design	Huawei, HiSilicon
R1-1715861	Discussion on CQI and MCS tables	LG Electronics
R1-1715942	CQI Definition	Samsung
R1-1716180	Adaptive CQI and MCS Indication in NR	AT&T
R1-1716352	Discussion on CQI and MCS	Ericsson
R1-1716398	Consideration for MCS table	Qualcomm Incorporated

6.2.2.6 Other

R1-1715594	Codebook subset restriction	Huawei, HiSilicon
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R1-1715803	Discussion on reciprocity based operation	CATT
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R1-1715443	Enhancements on CSI framework	ZTE, Sanecips
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R1-1715444	Details and evaluation results on beam reporting	ZTE, Sanechips
R1-1715445	Details and evaluation results on beam indication	ZTE, Sanechips
R1-1715446	Details of UL beam management	ZTE, Sanechips
R1-1715455	On reciprocity based CSI acquisition	ZTE, Sanechips
R1-1715456	Overhead reduction for Type II CSI	ZTE, Sanechips
R1-1715585	Beam indication for control and data channels	Huawei, HiSilicon
R1-1715587	A holistic procedure for beam failure recovery	Huawei, HiSilicon
R1-1715588	Network-side beam failure detection and new candidate beam identification	Huawei, HiSilicon
R1-1715589	Beam indication for network-based beam failure recovery	Huawei, HiSilicon
R1-1715590	Full reciprocity based CSI acquisition mechanism	Huawei, HiSilicon
R1-1715591	CSI acquisition details for NCJT	Huawei, HiSilicon
R1-1715592	CSI acquisition details for hybrid CSI	Huawei, HiSilicon
R1-1715593	Encoding of Type I and Type II CSI parameters	Huawei, HiSilicon
R1-1715722	Partial reciprocity based CSI acquisition mechanism	Huawei, HiSilicon
R1-1715723	CSI acquisition for DL robust transmission	Huawei, HiSilicon
R1-1715724	Remaining issues for multiple-panel codebook	Huawei, HiSilicon
R1-1715725	Category 2 codebook design for type II codebook	Huawei, HiSilicon
R1-1715726	Codebook design for beamformed CSI-RS	Huawei, HiSilicon
R1-1715742	Discussion on beam measurement and reporting	ITRI
R1-1715804	Consideration on interference estimation in NR	CATT
R1-1715862	Discussion on overhead reduction for Type II codebook	LG Electronics
R1-1715943	Discussion on CSI-RS Resource Allocation	Samsung
R1-1715944	L1 RSRP reporting for beam management	Samsung
R1-1715945	CSI support for transparent precoder cycling	Samsung
R1-1715946	Discussions on service specific CSI for NR	Samsung
R1-1715947	Discussion on joint CLI measurement and beam management	Samsung
R1-1715948	DL beam management configuration	Samsung
R1-1715949	QCL associations for beam management RS	Samsung
R1-1715950	L1-RSRP measurement duration	Samsung
R1-1715951	Parameters for beam management	Samsung
R1-1715952	CSI Acquisition and Beam Management Framework	Samsung
R1-1715953	CSI Reporting for Reciprocity Operation	Samsung
R1-1715954	Port selection codebook for beamformed CSI-RS	Samsung
R1-1715955	Extension of Type I multi-panel codebook	Samsung
R1-1715956	Remaining details of Type II CSI codebook	Samsung
R1-1715957	Differential reporting of Type II CSI	Samsung
R1-1715958	On higher rank Type II CSI	Samsung
R1-1715959	On codebook subset restriction	Samsung
R1-1715960	Discussion on Tx beam grouping configuration for multi-panel TRP and multi-TRP	Samsung
R1-1715961	Discussion on beam indication for PDSCH	Samsung
R1-1715962	Discussion on beam indication for UL transmission	Samsung
R1-1715963	Discussion on cross-carrier beam management	Samsung
R1-1715964	On Beam Indication	Samsung
R1-1716084	Framework for CSI acquisition and beam management	NTT DOCOMO, INC.
R1-1716085	Investigation on beam pattern design for beam management	NTT DOCOMO, INC.
R1-1716086	Performance investigation on beam reporting	NTT DOCOMO, INC.
R1-1716215	CSI reporting details	MediaTek Inc.
R1-1716297	On Timing Advance for multi-beam operation	Intel Corporation
R1-1716353	On Dynamic Triggering for CSI Reports and CSI-RS	Ericsson
R1-1716354	A comparison of CSI-RS activation schemes based on MAC CE and DCI	Ericsson
R1-1716355	Further details of measurement restriction	Ericsson
R1-1716356	Performance impact of inactive antenna ports	Ericsson
R1-1716357	On semi-persistent CSI reporting on PUSCH	Ericsson
R1-1716358	NR CSI Computation Capability	Ericsson
R1-1716359	Frequency parametrization for Type II CSI codebook	Ericsson
R1-1716360	Partial band CSI reporting	Ericsson
R1-1716361	CSI feedback and Transparent PDSCH Tx	Ericsson
R1-1716362	On codebook subset restriction	Ericsson
R1-1716363	CSI feedback for multi-TRP	Ericsson
R1-1716364	On multi-panel codebook extension	Ericsson
R1-1716365	Beam management in C-DRX	Ericsson
R1-1716366	Performance of beam management without beam indication	Ericsson

R1-1716367	Analysis of beam indication signalling options	Ericsson
R1-1716368	Multi-cell beam recovery	Ericsson
R1-1716399	Details of CSI framework	Qualcomm Incorporated
R1-1716400	Details of Type I and Type II CSI reporting	Qualcomm Incorporated
R1-1716401	Details of Type I and Type II CSI parameters encoding	Qualcomm Incorporated
R1-1716402	Details of Type I and Type II codebook subset restriction	Qualcomm Incorporated
R1-1716403	Details of CSI feedback for open- or semi-open-loop transmission	Qualcomm Incorporated
R1-1716502	On the channel reciprocity support for CSI acquisition	Nokia, Nokia Shanghai Bell
R1-1716503	PUSCH feedback transmission for Type II codebook	Nokia, Nokia Shanghai Bell
R1-1716504	Codebook subset restriction configuration for type II codebook	Nokia, Nokia Shanghai Bell
R1-1716505	Reduced PMI Payload in the NR Type II Codebooks	Nokia, Nokia Shanghai Bell
R1-1716506	SRS transmission for beam management	Nokia, Nokia Shanghai Bell

6.2.3 Reference signals and QCL

Highest priority in NR MIMO agenda items

6.2.3.1 Multiplexing of different types of RSs

[R1-1716725](#) Summary of RS multiplexing Huawei, HiSilicon

R1-1716298	On multiplexing of different RS types	Intel Corporation
R1-1716404	On multiplexing of different types of RSs	Qualcomm Incorporated
R1-1715447	Discussion on multiplexing of different RSs	ZTE, Sanechips
R1-1715470	Multiplexing different types of RSs for DL and UL	Huawei, HiSilicon
R1-1715511	On DL RS multiplexing	Spreadtrum Communications
R1-1715621	On multiplexing of different types of RSs	vivo
R1-1715705	Discussion on RS multiplexing	Guangdong OPPO Mobile Telecom.
R1-1715805	Consideration on RS multiplexing	CATT
R1-1715863	On multiplexing of different types of RSs	LG Electronics
R1-1715965	Discussion on DL/UL RS multiplexing	Samsung
R1-1716051	Discussion on multiplexing of different types of RSs	CMCC
R1-1716170	Multiplexing different type of RSs	AT&T
R1-1716227	On multiplexing of different reference signals	MediaTek Inc.
R1-1716370	On Multiplexing of RS types	Ericsson
R1-1716507	On multiplexing of different RS types	Nokia, Nokia Shanghai Bell

6.2.3.2 Remaining details on CSI-RS

R1-1715448	On CSI-RS for CSI acquisition and beam management	ZTE, Sanechips
R1-1716299	Remaining details on CSI-RS	Intel Corporation
R1-1716405	Discussion on CSI-RS design	Qualcomm Incorporated
Further revised in R1-1716721		
R1-1716728	Summary of views on NR CSI-RS	Huawei, HiSilicon

Agreements:

- NR should support non-adjacent mapping of CSI-RS components in frequency domain.
 - The REs in each CSI-RS component should be adjacent
- Uniform RE mapping across all 4 symbols for N=4 is supported.
 - Support of non-uniform case is FFS

[R1-1716848](#) WF on reference signals for ECP Huawei, HiSilicon, MediaTek, Vivo, Intel, Ericsson

Agreements:

- For ECP, NR supports the following:
 - CSI-RS reuses NCP CSI-RS resources
 - For beam management purpose, reuse 1-port NCP CSI-RS for beam management
 - For beam management purpose, reuse 2-port NCP CSI-RS with D=1 for ECP in Rel-15 subject to RAN4 feedback
- Send LS to RAN4 to request feedback on the following issues (Huawei, Xi):
 - Feasibility of 2-port ECP/NCP CSI-RS with D=1 for beam management
 - Feasible densities of 1-port ECP/NCP CSI-RS for beam management

[R1-1716782](#) Way forward on CSI-RS Samsung, NTT DOCOMO, Intel, Qualcomm, LGE, ZTE, Sanechips, Ericsson, Nokia, NSB, CATT

Agreement:

All slides in [R1-1716782](#) with the following revision to slide 5

- Down-select among the following options
 - Opt. 1: The starting subcarrier of a CSI-RS component RE pattern is constrained to be one among even subcarriers, in the given PRB
 - Opt. 2: The starting subcarrier of a CSI-RS component RE pattern is not constrained, subcarrier in the given PRB.
 - FFS, additional constraints, e.g. considering size of the component RE pattern
- At least {6th, 7th, 13th, 14th} OFDM symbol in a slot structure can be configured for CSI-RS transmission
 - Note: The dependency of CSI reporting timing on the CSI-RS OFDM symbol locations will be discussed separately
 - FFS: additional OFDM symbol locations

[R1-1716919](#) [Draft] LS on CSI-RS patterns and densities Huawei

Decision: The document is endorsed and final LS is approved in [R1-1716744](#).

[R1-1716812](#) WF on CSI-RS port ZTE, Sanechips, Samsung, LG Electronics, Ericsson

R1-1715471	CSI-RS design in NR	Huawei, HiSilicon
R1-1715622	Discussion on CSI-RS design	vivo
R1-1715673	Discussion on CSI-RS design	Guangdong OPPO Mobile Telecom.
R1-1715806	Remaining issues on CSI-RS	CATT
R1-1715864	On CSI-RS design	LG Electronics
R1-1715966	Remaining details on NR CSI-RS	Samsung
R1-1716087	Remaining details on CSI-RS	NTT DOCOMO, INC.
R1-1716372	Details on CSI-RS design	Ericsson
R1-1716508	On the CSI-RS configurations for NR CSI acquisition	Nokia, Nokia Shanghai Bell
R1-1716721	Discussion on CSI-RS design	Qualcomm Incorporated
R1-1716866	WF on CSI-RS bandwidth	Samsung
R1-1716894	WF on remaining details for CSI-RS design	LG Electronics
R1-1716899	WF on CSI-RS bandwidth	Samsung
R1-1716913	Way forward on CSI-RS	Samsung

6.2.3.3 Remaining details on DMRS

Including remaining details of $\pi/2$ -BPSK for PUSCH

[R1-1716228](#) On downlink DMRS remaining issues MediaTek Inc.

Agreement:

- For 1-symbol front loaded DMRS, three additional DMRS symbols may be configured for slot-based transmissions
 - The above applies for PDSCH and PUSCH without hopping
 - FFS: The applicable subcarrier spacing for the three additional DMRS will be finalized in RAN1#91
 - Note: The above agreement is for PDSCH / PUSCH length of FFS OFDM symbols

Agreement: Frequency-domain staggering of additional DMRS with respect to the front-load DMRS inside a DL slot is not supported in Rel-15.

[R1-1716735](#) Details on DMRS design Ericsson

Working assumption

- For broadcast/multicast PDSCH (other than PBCH): support using the front-load DMRS Configuration 1
 - FFS: Whether the above applies for unicast PDSCH transmission before RRC connection

[R1-1716783](#) Remaining issues on NR DM-RS Qualcomm

Agreements:

For a slot, for 2-symbol front-load DMRS, one 2-symbol additional DMRS may be configured.

- further discuss next meeting the support of the case of two 2-symbol additional DMRS.

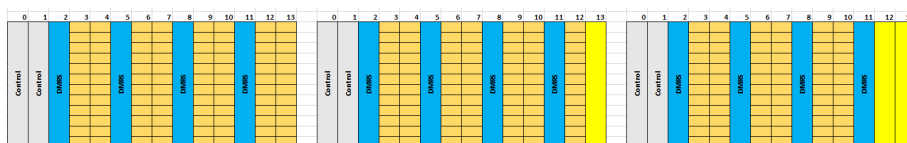
- companies are encouraged to consider the use case of HST and high order MU-MIMO with more than 6 orthogonal DM-RS ports, with realistic CSI feedback, etc.
- DMRS sequence for CP-OFDM based PDSCH and PUSCH is resource specific w.r.t to a wideband CC from network perspective.

Agreement: NR supports up to 4 ports per-UE in MU-MIMO

- Study further the relation of the maximum number of per-UE MU-MIMO ports to the 1-symbol and 2-symbol DMRS and the configuration type.

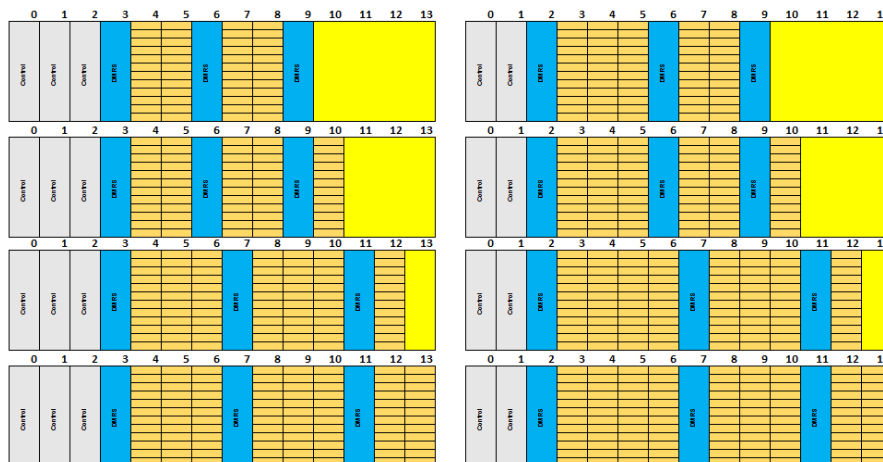
Agreement:

- For slot-based scheduling, for PDSCH, when three additional DMRS symbols are configured for the 1-symbol front-load DMRS with front-load DMRS on the 3rd symbol, the three additional DMRS symbol can be at least configured in the 6th, 9th and 12th symbols.
 - Note: See the agreed positions in the figure below.
 - The yellow region in the figure below does not contain PDSCH.

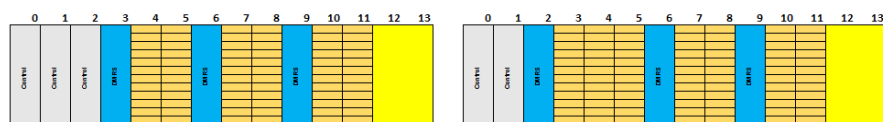


Agreement:

- For slot-based scheduling, for PDSCH, when two additional DMRS symbols are configured for the 1-symbol front-load DMRS with front-load DMRS on the 3rd or 4th symbol, the two 1-symbol additional DMRS symbols can be configured in the {8th, 12th} and {7th, 10th} symbol.
 - Note: See agreed positions in the figure below.
 - The yellow region in the figure below does not contain PDSCH

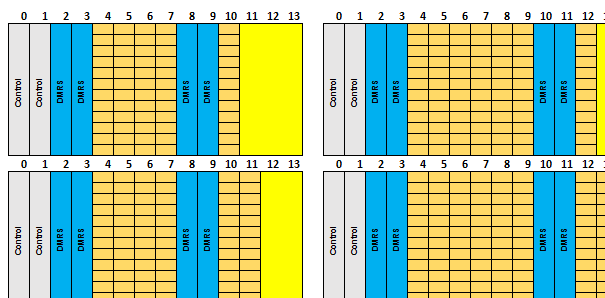


- When the last two symbol of the slot do not contain PDSCH:
 - The two additional DMRS can be configured in the {7th, 10th} symbol



Agreement:

- For slot-based scheduling, for PDSCH, when one 2-symbol additional DMRS symbol is configured for the 2-symbol front-load DMRS with the first symbol of front-load DMRS on the 3rd or 4th symbol, the one additional 2-symbol DMRS can be at least configured in the {9th-10th} or {11th-12th} OFDM symbols in a slot
 - Example of applicability of the patterns for first symbol of front-load DMRS on the 3rd symbol.



[R1-1715472](#) Design of DMRS for DL/UL data transmission Huawei, HiSilicon

[R1-1715865](#) On DMRS design LG Electronics

[R1-1715449](#) Remaining details on DL DMRS and UL DMRS ZTE, Sanechips
[R1-1715512](#) Considerations on DMRS for CP-OFDM Spreadtrum Communications
[R1-1715539](#) Remaining issues on DMRS Lenovo, Motorola Mobility
[R1-1715623](#) Remaining details on DMRS design vivo
[R1-1715709](#) Discussion on DMRS configurations NEC
[R1-1715761](#) Discussion on DMRS design ETRI
[R1-1715807](#) Discussion on remaining details of DMRS CATT
[R1-1715967](#) Remaining details on DMRS Samsung
[R1-1716088](#) Remaining details on DM-RS NTT DOCOMO, INC.
[R1-1716125](#) Additional DMRS in the control region TCL Communication Ltd.
[R1-1716181](#) Remaining details for DM-RS AT&T
[R1-1716300](#) On the remaining details of DM-RS Intel Corporation
[R1-1716406](#) Remaining details on DMRS Qualcomm Incorporated
[R1-1716470](#) Remaining issues on DM-RS InterDigital, Inc.
[R1-1716509](#) On remaining issues of DL DM-RS for NR physical data channels Nokia, Nokia Shanghai Bell
[R1-1716537](#) Views on DL DMRS designs Mitsubishi Electric Co.
[R1-1716569](#) Remaining details on DL DMRS for NR ITL
[R1-1716570](#) Discussion on remaining details of DMRS KT Corp.
[R1-1716609](#) On remaining details of NR DL DMRS Panasonic
[R1-1716654](#) Consideration on the DM RS design for broadcast/multicast PDSCH CATR
[R1-1716741](#) WF on DMRS design for broadcast channel Huawei, HiSilicon

6.2.3.4 Remaining details on PT-RS

[R1-1716736](#) Summary of PTRS open issues Ericsson

Agreements:

For both contiguous and non-contiguous scheduling for the purposes of selecting RBs for mapping PTRS for CP-OFDM:

- N_{RB} is interpreted as the number of scheduled RBs
- The scheduled RBs are indexed as 0 to $N_{RB}-1$ from the one with lowest PRB index to the one with highest PRB index

The same PT-RS frequency density table is used for contiguous and non-contiguous scheduling where N_{RB} is the scheduled BW.

[R1-1716790](#) Summary of PTRS open issues and offline agreements Ericsson

Agreements:

- The subcarrier for which the PTRS associated with a certain DMRS port is mapped is the same in all RBs where PT-RS is present
- The maximum number of DL PT-RS ports is the same as the number of DMRS groups per PDSCH, which is 2 in Rel-15
- The subcarrier in the RB where PTRS is mapped among the subcarriers used for the associated DMRS port, consider further these alternatives until Wednesday:
 - Alt.1 Fixed to smallest subcarrier index k
 - Alt.2 Default is fixed to largest subcarrier index k . Can be configured to other subcarriers by higher layer signalling.

- Alt.3a Implicitly given by Cell ID
- Alt.3b Implicitly given by another UE specific parameter (DMRS/PT-RS scrambling ID (if defined), C-RNTI,...)
- Alt.4 Each DMRS port maps PT-RS to a different subcarrier by a specified rule

Agreements:

For mapping of PT-RS to RBs among the scheduled RBs for DL and UL: The no RB offset (=0, PT-RS is present in the scheduled RB with lowest RB index and then follows the pattern according to the PT-RS freq. density) is the default value if supported.

Down-selection among the following alternatives in RAN1#90bis:

- Alt.1: RB offset is fixed (e.g., RB offset=0) in Rel. 15
- Alt.2: RB offset is determined based on UE-specific-configuration
 - FFS default RB offset is needed
 - FFS the RB offset is explicitly signaled via higher layer signaling or implicitly determined based on the UE specifically configured parameter (e.g., C-RNTI, SCID)
- Companies are encouraged to provide evaluation results for next meeting to assess whether higher layer configuration of RB offset is beneficial for interference randomization

[R1-1716724](#) Further details of PTRS Huawei, HiSilicon (revision of [R1-1715473](#))
[R1-1716840](#) WF on pre-DFT PT-RS pattern for DFTsOFDM Mitsubishi Electric, Huawei, HiSilicon, Ericsson, InterDigital, Nokia, Nokia Shanghai Bell, Sharp, IITH, IITM, CEWiT, Tejas Networks, Reliance Jio, AT&T, Vivo, CMCC, Sony, Intel, ZTE, Sanecchips, Spreadtrum, Qualcomm, DoCoMo

Agreements:

- For chunk-based pre-DFT PTRS insertion for DFTsOFDM, support the following
 - The supported values for K (chunk size) are 2 and 4
 - Implicit configuration depending on MCS/BW
 - The supported values for X (number of chunks/DFTsOFDM symbol) are at least 2 and 4
 - X implicitly depends on allocated bandwidth and/or MCS and/or K value
 - Implicit configuration can be subcarrier spacing dependent
 - FFS if K=1 is also supported and exact mechanism
 - When X=2 is configured, downselect among the following:
 - Alt. 1: chunks are placed head/tail of DFTsOFDM symbols containing PTRS
 - Alt. 2: chunks are placed middle/tail of the DFTsOFDM symbols containing PTRS
 - Alt. 3: chunks are placed head/middle of the DFTsOFDM symbols containing PTRS
 - Alt. 4: chunks are placed middle of each of the X equally-sized parts of the DFTsOFDM symbols containing PTRS
 - For PTRS sequence, downselect from the following options:
 - Option 1:
 - $\pi/2$ BPSK PTRS is used for $\pi/2$ BPSK PUSCH
 - [FFS] PTRS sequence consists of the outermost points of the PUSCH constellation
 - Option 2
 - Reuse the same sequence as PTRS or DMRS sequence for UL CP-OFDM
 - FFS: Time-domain PTRS density reduction is supported at least for allocated bands below N RB and/or some MCS
 - Time-domain pattern depends on DM-RS positions (DFTsOFDM positions near DMRS do not contain PTRS)
 - FFS: N value
 - FFS: every other DFTsOFDM symbol not neighbouring DM-RS positions does not contain PTRS
 - For RB allocation larger than N, PTRS density reduction is configured by RRC

[R1-1715450](#) Remaining details on PT-RS ZTE, Sanecchips
[R1-1715513](#) Considerations on PT-RS for CP-OFDM Spreadtrum Communications
[R1-1715538](#) Remaining issues on PTRS Lenovo, Motorola Mobility
[R1-1715624](#) Discussion on remaining details on PT-RS vivo
[R1-1715756](#) PT-RS design Panasonic Corporation
[R1-1715773](#) Discussion on PTRS configurations NEC Corporation
[R1-1715808](#) Remaining issues on PT-RS CATT
[R1-1715968](#) Discussion on PT-RS Samsung
[R1-1716052](#) Discussion on PT-RS design CMCC

R1-1716089	Views on PT-RS	NTT DOCOMO, INC.	
R1-1716238	On pre-DFT PTRS insertion patterns for UL DFTsOFDM waveform		Mitsubishi Electric RCE
R1-1716301	Remaining details on PT-RS	Intel Corporation	
R1-1716373	Details on PTRS design	Ericsson	
R1-1716407	PTRS considerations	Qualcomm Incorporated	
R1-1716471	Remaining issues on PT-RS	InterDigital, Inc.	
R1-1716510	On remaining details of PT-RS design	Nokia, Nokia Shanghai Bell	
R1-1716815	WF on PT-RS frequency density table	LG Electronics	
R1-1716816	WF on PT-RS port mapping for 2 codewords	LG Electronics	
R1-1716838	WF on default value of N _{RB1} in PTRS frequency density table		Huawei
R1-1716860	WF on PTRS port	ZTE	

6.2.3.5 Remaining details on SRS

Including SRS carrier based switching

[R1-1716732](#) **Summary of SRS** Sony

Agreement: Confirm the working assumption

- SRS sequence for NR is supported for up to 272 PRBs by using LTE SRS sequences generation equation
- Note: 272 PRBs corresponds to the maximum bandwidth support by NR
- FFS: On the set of supported SRS bandwidths

Agreement: SRS ports more than 4 per SRS resource is not supported in Rel-15

[R1-1716787](#) **WF on antenna switching for SRS transmission** Huawei, HiSilicon, Intel, CeWiT, Samsung, IITM, Tejas Networks, Softbank, CATT, China Unicom, Spreadtrum, IITH, SONY, Deutsche Telekom, Nokia, NSB, CMCC, Vodafone, NEC, OPPO, KDDI

Also supported by DOCOMO

Agreements:

- For antenna switching for SRS transmission within a carrier, at least support 1Tx (in the case of UE with 1T2R) and 2Tx (in the case of UE with 2T4R) antenna switching scheme
 - Design principle in LTE for SRS transmission can be a starting for the details in NR
 - FFS: For the case UE with 2Tx, where one antenna have the capability of 1Tx to 3 antenna switching, and another antenna have no switching
 - FFS: SRS transmission for antenna switching and associated SRS resource / resource group configurations
 - FFS: Antennas in a antenna group can transmit SRS simultaneously, and FFS on antenna indexing in each antenna group
 - FFS: The relationship between SRS antenna switching and SRS resource hopping considering SRS repetition within one SRS resource
 - This feature is used at least to acquire downlink channel information

[R1-1716915](#) **Summary of SRS** Sony

Agreements:

An SRS resource can be configured to occupy a location within at least the last 6 symbols in a slot.

- FFS other location in a slot or using all UL OFDM symbols in a slot depending on the results of antenna switching discussions
- From UE perspective, no FDM between SRS and short PUCCH
- From UE perspective, when PUSCH is scheduled in a slot, SRS may be configured at least after the scheduled PUSCH and the corresponding DMRS. Study further whether SRS may be configured before the scheduled PUSCH and the corresponding DMRS

Working assumption from RAN1#90 on SRS short PUCCH prioritization is confirmed.

[R1-1716302](#) Discussion on SRS for NR Intel Corporation
[R1-1715809](#) **Remaining issues on SRS** CATT
[R1-1716408](#) **Remaining details on SRS** Qualcomm Incorporated
[R1-1716374](#) Details on SRS design Ericsson
[R1-1716904](#) **WF on SRS Bandwidth** Huawei, HiSilicon, Ericsson

Also supported by Qualcomm

Agreement: NR supports C_SRS and B_SRS to be UE-specifically configurable

For information for future discussions:

- For SRS bandwidth tables, at least the following design rules are used as a starting point:
 - Single SRS bandwidth table (C_SRS is a row index into the SRS bandwidth table)
 - 4 values of B_SRS (same as LTE)
 - For BWP less than or equal to 96 PRBs, the table includes at least the LTE SRS bandwidths (next slide)
 - For additional entries, at least the following rules are used:
 - For every supported CC/[BWP] bandwidth with N PRBs, table contains at least one entry with SRS bandwidth $m_{\text{SRS},0} = \text{floor}(N/4) * 4$ PRB
 - Support additional entries with $m_{\text{SRS},0} = \text{floor}(N/4) * 4$ PRB for sounding flexibility
 - To support intra-slot hopping within a BWP over 2 and 4 OFDM symbols:
 - Table contains at least one entry with SRS bandwidth $m_{\text{SRS},0} = \text{floor}(N/16) * 16$ PRBs with $N_1 = 2$ and $N_2 = 2$
 - Note: intra-slot hopping is subject to RAN4 feedback

[R1-1715451](#) Discussion on SRS design for NR ZTE, Sanechips
[R1-1715474](#) UL SRS design for beam management and CSI acquisition Huawei, HiSilicon
[R1-1715625](#) Discussion on SRS design and related aspects vivo
[R1-1715674](#) Further discussion on SRS design for NR Guangdong OPPO Mobile Telecom.
[R1-1715867](#) On SRS design and related operations LG Electronics
[R1-1715969](#) SRS design for NR Samsung
[R1-1716090](#) Discussions on NR SRS Design NTT DOCOMO, INC.
[R1-1716216](#) Remaining details on SRS MediaTek Inc.
[R1-1716242](#) Considerations on SRS design Sony
[R1-1716302](#) Discussion on SRS for NR Intel Corporation
[R1-1716374](#) Details on SRS design Ericsson
[R1-1716472](#) Remaining issues on SRS InterDigital, Inc.
[R1-1716511](#) SRS design considerations in NR Nokia, Nokia Shanghai Bell
[R1-1716536](#) Views on SRS designs Mitsubishi Electric Co.
[R1-1716843](#) WF on priority rules between SRS and PUCCH LG, Nokia, NSB, Mitsubishi
[R1-1716863](#) WF on Antenna switching for 1T4R Samsung, Huawei, HiSilicon, Intel, Qualcomm Incorporated, ZTE, Sanechips, KT Corp.

6.2.3.6 Remaining details on TRS

[R1-1716753](#) Summary on TRS remaining issues MediaTek Inc.

Agreement: The TRS symbol number in each slot for $X=2$

- At least 2+2 is supported
- FFS: Support of 3+1

[R1-1715626](#) Discussion on TRS vivo

[R1-1716409](#) Remaining open issues on TRS Qualcomm Incorporated

[R1-1716821](#) Way forward on TRS Intel, ZTE, Sanechips, vivo, Samsung, Ericsson, Docomo, Spreadtrum, AT&T, MTK, Huawei, HiSilicon
Also supported by CMCC

Agreement:

- For TRS, support TRS burst length $X=2$ slot.
- A slot containing SSB can be configured for TRS
 - TRS may be TDM with SSB to avoid collision
 - FFS: TRS may be FDM with SSB to avoid collision
 - Strive to have same burst pattern of TRS configurations with and without slot containing SSB

[R1-1715452](#) Remaining details on TRS ZTE, Sanechips
[R1-1715475](#) Reference signal for fine time and frequency tracking Huawei, HiSilicon

R1-1715868	Discussion on fine time/frequency tracking of channel	LG Electronics
R1-1715970	Discussion on Fine Time/Frequency Tracking	Samsung
R1-1716229	On TRS design and remaining issues	MediaTek Inc.
R1-1716244	Considerations on TRS	Sony
R1-1716303	Remaining Details on TRS	Intel Corporation
R1-1716375	Details on TRS design	Ericsson
R1-1716512	Views on the fTFT-RS in NR	Nokia, Nokia Shanghai Bell
R1-1716655	Consideration on the TRS design for NR	CATR
R1-1716841	WF on TRS design	MediaTek

6.2.3.7 Remaining details on QCL

R1-1716692	Summary of QCL	Nokia, Nokia Shanghai Bell
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Agreement:

- The source and target RSs of a QCL configuration can be in the same CC or in different CCs by configuration
 - Above is supported at least for CCs with same numerology in the same band from UE perspective
 - FFS: Whether all or part of QCL parameters are derived from the reference CC
 - FFS: Specification details on restriction on using this configuration (e.g.: based on UE capability, UE report)

R1-1716807	Summary of offline discussions on QCL	Nokia, Nokia Shanghai Bell
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Agreements: RS combinations holding QCL assumptions:

- Before RRC configuration of TRS and CSI-RS for both below and above 6GHz
 - SSB → DMRS for PDSCH w.r.t Doppler shift, Doppler spread, average delay, delay spread, spatial RX parameters (spatial RX parameters are used only for above 6GHz)
 - FFS whether restriction on PDSCH scheduling
 - SSB → DMRS for PDCCH w.r.t Doppler shift, Doppler spread, average delay, delay spread, spatial RX parameters (spatial RX parameters are used only for above 6GHz)
- After RRC configuration of TRS and CSI-RS for below 6 GHz for single TRP
 - SSB (can be from a different CC) + TRS + CSI-RS for CSI acquisition + DMRS for PDSCH
 - SSB → TRS: [Doppler shift, average delay]
 - Type A:
 - TRS → CSI-RS for CSI acquisition: *Doppler shift, Doppler spread, average delay, delay spread*
 - TRS/CSI-RS → DMRS: *Doppler shift, Doppler spread, average delay, delay spread*
 - FFS: Type B:
 - TRS → CSI-RS for CSI acquisition: *Doppler shift, Doppler spread*
 - CSI-RS → DMRS: *Doppler shift, Doppler spread, average delay, delay spread*
 - Study whether the widebeam TRS can be QCLed referenced for a narrow beam CSI-RS
 - Study whether widebeam CSI-RS can be QCLed with a narrow beam DMRS
- After RRC for above 6 GHz
 - RS combinations holding QCL assumptions TBD.

R1-1715453	QCL design for UL and DL MIMO	ZTE, Sanechips
R1-1716513	On QCL Framework and Configurations	Nokia, Nokia Shanghai Bell
R1-1715869	Discussion on QCL for NR	LG Electronics
R1-1715476	Details of QCL assumptions and related RS design considerations	Huawei, HiSilicon
R1-1715627	Discussion on QCL	vivo
R1-1715810	On QCL for NR	CATT
R1-1715971	Remaining details on QCL	Samsung
R1-1716091	General Views on QCL Design for NR	NTT DOCOMO, INC.
R1-1716171	Cross Carrier QCL between different type of RSs	AT&T
R1-1716304	On QCL for NR	Intel Corporation
R1-1716376	Details on QCL	Ericsson
R1-1716410	Discussion on QCL	Qualcomm Incorporated
R1-1716473	Remaining issues on QCL	InterDigital, Inc.

6.2.3.8 Other

R1-1715596	SRS antenna switching	Huawei, HiSilicon
R1-1715597	Evaluation results of DMRS design for DL/UL data channel	Huawei, HiSilicon
R1-1715598	Common UL/DL DMRS design	Huawei, HiSilicon
R1-1715599	Signaling of DMRS ports for SU/MU-MIMO	Huawei, HiSilicon

R1-1715600	Considerations on UE-specific RS Sequence Design	Huawei, HiSilicon
R1-1715601	DMRS design for URLLC	Huawei, HiSilicon
R1-1715602	Reference signals for ECP	Huawei, HiSilicon
R1-1715603	SRS switching among CCs and bandwidth parts	Huawei, HiSilicon
R1-1715701	Beam association relationship between data and control channels	Guangdong OPPO Mobile Telecom.
R1-1715811	Evaluations on DL DMRS	CATT
R1-1715972	PTRS Design for 40 GHz and Higher Frequency Bands	Samsung
R1-1715973	Evaluations on pre-DFT PTRS Insertion	Samsung
R1-1715974	Evaluation Results on DMRS	Samsung
R1-1716092	Views on DM-RS for mini-slot	NTT DOCOMO, INC.
R1-1716377	On the collision between DMRS and DC subcarrier	Ericsson
R1-1716411	Discussion on Bursty Interference Measurement Resources	Qualcomm Incorporated
R1-1716412	Evaluation of DMRS design	Qualcomm Incorporated
R1-1716514	DL DM-RS patterns link level simulation	Nokia, Nokia Shanghai Bell

6.2.4 Other

Including MIMO calibration

R1-1715477	Considerations on timing advance design in NR	Huawei, HiSilicon
R1-1715586	Multi-beam transmission for DL control channel	Huawei, HiSilicon
R1-1715721	Robust transmission for UL control channel	Huawei, HiSilicon
R1-1715975	Beamforming Gain for Spatial Channels with Angular Spread	Samsung
R1-1715976	Discussion on Feasibility of Mobile mmWave	Samsung
R1-1715977	Evaluation results for dense urban on 30GHz frequency band	Samsung
R1-1716548	Calibration results for Phase 1 NR MIMO system level calibration	Motorola Mobility, Lenovo

6.3 Scheduling/HARQ aspects

6.3.1 Physical downlink control channel

6.3.1.1 PDCCH structure

Remaining details on REG, CCE, RS, interleaving, RE mapping, etc.

[R1-1715394](#) On NR-PDCCH structure Huawei, HiSilicon

Observation 1: It is NOT necessary for UE to assume same precoder over multiple REG bundles.

Proposal 1: For a CORESET with more than 1-symbol, frequency-first CCE-to-REG mapping without interleaving is supported with following REG bundle pattern:

- 1 symbol in time domain and 6 consecutive REGs in frequency domain.

Proposal 2: For a CORESET with more than 1-symbol, frequency-first CCE-to-REG mapping with interleaving is supported with following REG bundle pattern:

- 1 symbol in time domain and {2, 6} consecutive REGs in frequency domain.

Proposal 3: The interleaver will be confined to be used over a group of REG bundles, where REGs within a CORESET can be divided to more than one group of REG bundles.

Regarding to DMRS for NR-PDCCH, we have the following proposals:

Proposal 4: Confirm the following working assumption:

- DM-RS density per REG is 1/4 at least for normal CP.

Proposal 5: DMRS density per REG for extended CP is same as that for normal CP.

Proposal 6: MU-MIMO with orthogonal DMRS should be supported for NR-PDCCH.

Proposal 7: The DMRS antenna port for NR-PDCCH in UE-specific search space is determined at least based on UE-specific ID.

Proposal 8: Further multi-user interference mitigation schemes could be considered in NR-PDCCH to support MU-MIMO using non-orthogonal DMRS.

Proposal 9: DMRS sequence for NR-PDCCH can be obtained according to a reference point in frequency domain.

- For the CORESET configured by MIB, the reference point is the centre or boundary of the SS block.
- For a CORESET configured by higher layer signaling, the reference point is configured by RMSI or higher layer signaling.

Decision: The document is noted.

[R1-1715748](#) Remaining details of PDCCH construction Nokia, Nokia Shanghai Bell

- Proposal #1: Adopt a block interleaver where REG bundle indexes are written in row-wise, and read in column wise
- Proposal #2: The number of rows in the interleaver matrix is
 - with REG bundle sizes [3, 6]
 - with REG bundle size 2.

- Proposal #3: Confirm the working assumption that precoder granularity in frequency domain is equal to the REG bundle size in the frequency domain.
- Proposal #4: By default, precoder cycling granularity in time corresponds to the duration of REG bundle in time
- Proposal #5: Support precoder cycling granularity of one OFDM symbol as a configuration option for CORESETs with multiple OFDM symbols.
- Proposal #6: NR Rel-15 supports only one DMRS density for PDCCH
- Proposal #7: The 2nd orthogonal DMRS port for MU-MIMO is supported in NR Rel-15 only if DMRS density 1/3 is selected for NR PDCCH.

Decision: The document is noted.

R1-1716413 Remaining issues on PDCCH structure Qualcomm Incorporated

- Proposal 1: Frequency-first CCE-to-REG mapping is also supported with multi-symbol CORESET.
- Proposal 2: REG bundling size = 2 and 6 are supported with frequency-first CCE-to-REG mapping for multi-symbol CORESET.
- Proposal 3: CORESET can be configured with either wideband RS, or narrowband RS.
 - Wideband RS refers to the case when DMRS for PDCCH span the entire CORESET BW with the same precoding whenever there is PDCCH transmission.
- Proposal 4: Do not introduce orthogonal MU-MIMO DM RS for NR DL control channel.
- Observation 1: Configuring overlapping Coresets with different length can support efficient PDCCH resource reuse for PDSCH.
- Proposal 5: For 1-symbol and 2-symbol time first CORESET, the aggregation level of 1, 2, 4, 8 is adopted. For a 3-symbol time first mapping CORESET, the aggregation level of 1, 3, 6, 12 is adopted. A larger aggregation level is FFS.
- Proposal 6: Consider 2-step interleaving to support better coexistence between overlapping coresets with different lengths.

Decision: The document is noted.

Agreements:

- Confirm the following working assumption:
 - DM-RS density per REG is 1/4 at least for normal CP.
 - FFS: orthogonal DMRS for MU-MIMO at RAN1 NR AH#3.
 - FFS: URLLC
- DMRS density per REG for extended CP is same as that for normal CP

Proposals:

- Confirm the working assumption that precoder granularity in frequency domain is equal to the REG bundle size in the frequency domain.
- FFS whether or not to support wideband RS
- FFS whether or not to indicate larger precoding granularity

Discuss further offline – Fred (NTT DOCOMO)

Wednesday

Proposals:

- Precoder granularity in frequency domain is:
 - Equal to the REG bundle size in the frequency domain for aggregation levels other than the two largest aggregation levels
 - Configurable between i) equal to the REG bundle size in the frequency domain; or ii) equal to all consecutive RBs in the frequency domain for the CORESET configured to the two largest aggregation levels

Thursday

Proposed working assumption on precoder granularity in frequency-domain

Set a working assumption on option 1.

- Opt.1:
 - For a CORESET, precoder granularity in frequency domain is:
 - Configurable between i) equal to the REG bundle size in the frequency domain; or ii) equal to the number of contiguous RBs in the frequency domain within the CORESET
 - For ii), DMRS is mapped over all REGs within the CORESET.

Objected by: Nokia, ZTE, LGE

- Opt.2:
 - For a CORESET, precoder granularity in frequency domain is:

- Configurable between i) equal to the REG bundle size in the frequency domain; or ii) equal to all contiguous RBs in the frequency domain for a given PDCCH
 - DMRS is mapped over all REGs within the PDCCH.
 - Interleaving is per REG bundle group/set
 - FFS: whether this is applicable to all ALs or a subset of ALs

Supported by: Nokia, ZTE, LGE

Objected by: Qualcomm,

Still Nokia objected option 1, requesting a vote on option 2 – not sustained, for the sake of progressing

Working assumption

- For a CORESET, precoder granularity in frequency domain is:
 - Configurable between i) equal to the REG bundle size in the frequency domain; or ii) equal to the number of contiguous RBs in the frequency domain within the CORESET
 - For ii), DMRS is mapped over all REGs within the CORESET.

Agreement: DMRS positions for PDCCH

- **Working assumption:** Equally-distributed within a REG

R1-1715556	Remaining issues of PDCCH DMRS and PDCCH interleaving	ZTE, Sanechips
R1-1715685	On NR PDCCH structure design	Guangdong OPPO Mobile Telecom.
R1-1715710	Discussion on CCE-REG inter-leaver	NEC
R1-1715744	Discussion on DMRS density for PDCCH	ITRI
R1-1715762	Remaining details of NR-PDCCH structure	ETRI
R1-1715812	Remaining details of PDCCH structure	CATT
R1-1715870	Discussion on NR-PDCCH structure	LG Electronics
R1-1715978	On PDCCH Structure	Samsung
R1-1716093	PDCCH structure	NTT DOCOMO, INC.
R1-1716197	Remaining issues on NR-PDCCH structure	MediaTek Inc.
R1-1716305	Remaining details of PDCCH structure	Intel Corporation
R1-1716474	On interleaver design for PDCCH	InterDigital, Inc.
R1-1716549	Discussion on DMRS and multiple REG bundles precoding of NR-PDCCH	CMCC
R1-1716577	On NR-PDCCH Structure	Ericsson
R1-1716643	PDCCH mapping structure	Motorola Mobility, Lenovo
R1-1716673	NR PDCCH structure	vivo

6.3.1.2 Search space

Including CORESET configuration, common vs. UE-specific search space design details, number of blind decodes, multi-beam operation, etc.

[R1-1715519](#) CORESET configuration and Search space for NR-PDCCH ZTE, Sanechips

- Proposal 1: Each CORESET should be configured with a monitoring occasion which is defined in pattern of slots or OFDM symbols. Different CORESETs can be configured with the same monitoring occasions and with overlapped resources.
- Proposal 2: CSS and USS can be configured in the same or different CORESETs. For one type of search spaces (CSS or USS) in a CORESET, only 1 search space per aggregation level is needed to be defined in that CORESET.
- Proposal 3: For one type of search spaces in a CORESET, NR-PDCCH search spaces for low aggregation level should reuse the CCEs of candidates for the highest aggregation level.
- Observation 1: Nested structure with full randomization without candidates overlapping each other shows the least blocking probability for all simulated cases.
- Proposal 4: Full randomization of search space candidates without overlapping in each aggregation level within the resources of CORESET should be supported
- Proposal 5: For search space at the highest aggregation level, the first CCE index of a PDCCH candidate is identified by a randomization function which receives its input parameters from the CORESET configuration. None of candidates should be overlapped.
- Proposal 6: For search space at lower aggregation level, candidates should be mapping within the resource of highest aggregation levels. Candidate patterns should be introduced for full randomization without overlapping.

Decision: The document is noted.

[R1-1716198](#) Discussions on search space and CORESET designs MediaTek Inc.

Proposal #1: A common CORESET has one CSS and one USS.

Proposal #2: An additional CORESET can have both GC-SS and USS or only USS. Multiple USS can exist in one additional CORESET.

Proposal #3: In RRC CONNECTED mode, an UE doesn't monitor the USS of the common CORESET.

Proposal #4: For the common CORESET, at least following parameters are configured.

- Frequency resource
- Time resource
- Timing duration, i.e., the length of a CORESET burst, of CORESET monitoring

Proposal #5: For the additional CORESET, at least following parameters are configured.

- Frequency resource
- Time resource
- Periodicity
- REG-to-CCE mapping
- Search space configurations
- REG bundle size
- DMRS configurations
- Beam information

Proposal #6: If the search space of an aggregation level exist in multiple CORESETs, CCE indices of PDCCH candidates in multiple CORESETs should be different.

Proposal #7: For the nested structure, the PDCCH candidates of the aggregation levels should not be placed outside the resources used for the candidates of the highest aggregation level.

Proposal #8: Distributed search space should be used for all aggregation levels.

Proposal #9: The maximum number of PDCCH blind decodes per slot per carrier is numerology specific.

- The value is fixed per slot per carrier for a given numerology.

Proposal #10: For carrier aggregation, the total number of blind decodes is UE capability.

- Minimal requirement for the UE capability of blind decodes should be defined.
- Based on the UE capability, gNB can configure UE
 - Number of PDCCH candidates per CCE aggregation level per DCI format size
 - Set of aggregation levels
 - Set of DCI format sizes

Proposal #11: The maximum number of PDCCH blind decodes per slot per carrier is numerology specific. The value is given below

- 15 kHz SCS: the maximum number of blind decodes is 44
- 30 kHz SCS: the maximum number of blind decodes is 22
- 60 kHz SCS: the maximum number of blind decodes is 11
- 120 kHz SCS: the maximum number of blind decodes is 5

Proposal #12: The common CORESET comprising PDCCH related to SI should support beam sweeping.

Proposal #13: The common CORESET comprising PDCCH related to paging should support beam sweeping.

Proposal #14: NR supports spatial QCL between additional CORESET and RS resource.

Proposal #15: An additional CORESET is associated to only a RS resource.

Decision: The document is noted.

Discuss further offline – Fred (NTT DOCOMO)

Wednesday

Proposals:

- As the frequency-domain configuration of a CORESET configured by UE-specific signalling,
 - Re-use NR DL RA Type 0 basis in units of 6 RBs
- There is no restriction on the maximum number of segments for a given CORESET

Proposal:

- Monitoring periodicities of CSS and UE-SS and another UE-SS in a CORESET can be different

Thursday

Working assumption:

- Re-use NR DL RA Type 0 basis in units of 6 RBs, where no restriction on the maximum number of segments for a given CORESET.

Agreements:

- At least two DCI sizes are defined.
 - One DCI size, which is at least for the purpose of fallback.
 - FFS: for other purposes.

- One DCI size depending on configuration
 - FFS: whether both DL and UL have the same size or different.
- FFS: for group-common DCI/PDCCH
- Note: the UE is not necessarily required to monitor two DCI sizes at the same monitoring occasion

Agreement:

- In a given CORESET
 - Alt 1: different DCI formats
 - Alt 2: different search spacescan have different monitoring periodicities.
 - FFS which one

R1-1715395	CORESET configuration and search space design	Huawei, HiSilicon
R1-1715485	Multi-beam operation for NR-PDCCH	Fujitsu
R1-1715629	Remaining issues on search space design	vivo
R1-1715686	Discussion of search space design	Guangdong OPPO Mobile Telecom.
R1-1715749	On the CORESET configuration and search space design	Nokia, Nokia Shanghai Bell
R1-1715763	Search space design for multi-beam operation	ETRI
R1-1715813	PDCCH search space design	CATT
R1-1715871	Discussion on search space design	LG Electronics
R1-1715979	On Search Space Design	Samsung
R1-1716054	Discussion on PDCCH search space	CMCC
R1-1716094	Search space design	NTT DOCOMO, INC.
R1-1716306	On CORESETs and search spaces	Intel Corporation
R1-1716414	Control resource set and search space	Qualcomm Incorporated
R1-1716475	Remaining issues related to CORESET configuration	InterDigital, Inc.
R1-1716542	Configuration of CORESET and search space design	Panasonic
R1-1716564	Discussion on the CORESET configuration	Xiaomi Technology
R1-1716578	On Configuration of Control Resource Sets and Search Space	Ericsson

6.3.1.3 Resource sharing between PDCCH and PDSCH

[R1-1715814](#) Further details on multiplexing of PDCCH and PDSCH CATT

- Observation: semi-static configuration of resource sets has several applications including configuration of reserved resources, reuse of PDCCH resources for PDSCH and indication of pre-empted PDSCH resources.
- Proposal 1: A unified resource configuration is specified for both flexible and inflexible semi-statically configured resource sets.
- Proposal 2: Two solutions can be considered with respect to dynamic signaling for PDCCH resource reuse for PDSCH transmission
 - Option 1: A bitmap of length equal to the number of semi-statically configured resource sets is included in the DCI scheduling a PDSCH. Each bit in the bitmap indicates whether PDSCH is mapped onto or rate matched around overlapping resources in the indicated resource set.
 - Option 2: A 1-bit ON-OFF indicator field is included in the DCI scheduling PDSCH. The ON value indicates that resources in resource sets that overlap with a given PDSCH are used for PDSCH transmission whereas the OFF value indicates that PDSCH is rate matched around overlapping resource sets.

Decision: The document is noted.

[R1-1716307](#) Resource sharing between PDCCH and PDSCH Intel Corporation

- Proposal 1: For resource set configuration,
 - In frequency, CORESET level frequency domain granularity is configured.
 - In time, a bitmap of symbol indices is configured.
- Proposal 2: Bitmap based approach is employed for dynamically indicate which resource set(s) is (are) used for PDSCH rate-matching.
- Proposal 3: Aggregation level identification is essential for resource sharing between PDCCH and PDSCH.
- Proposal 4: Shared DM-RS for control and data channel can be considered for non-slot based transmission.

Decision: The document is noted.

Continue discussion offline – Karol (Nokia)

Wednesday

Proposal:

- Each of the one or more resource set(s) for PDSCH rate matching can be configured with RB-level granularity, and per-symbol-level granularity

Thursday

No progress.

R1-1715557	Resource sharing between PDCCH and PDSCH	ZTE, Sanechips
R1-1715566	Resource multiplexing between PDCCH and PDSCH	Huawei, HiSilicon
R1-1715750	Resource sharing between PDCCH and PDSCH in NR	Nokia, Nokia Shanghai Bell
R1-1715872	Remaining issues on resource sharing between PDCCH and PDSCH	LG Electronics
R1-1715980	Multiplexing NR-PDCCH and PDSCH	Samsung
R1-1716095	Resource sharing between PDCCH and PDSCH	NTT DOCOMO, INC.
R1-1716189	Remaining Details of Resource Sets	AT&T
R1-1716199	Resource sharing between PDCCH and PDSCH	MediaTek Inc.
R1-1716415	Resource reuse for data in DL control region	Qualcomm Incorporated
R1-1716579	On Data Transmission in Control Resource Sets	Ericsson
R1-1716630	PDSCH/PDCCH resource sharing for NR	WILUS Inc.

6.3.1.4 Remaining details on group-common PDCCH

[R1-1715873](#) Discussion on group common PDCCH LG Electronics

- Proposal 1: Before discussing exact structure, first finalize the payload sizes. If indeed GC PDCCH supports various payload sizes, consider supporting multiple set of {coding, CRC bit} depending on payload size.
- Proposal 2: The search spaces for group common PDCCH shares CCEs/candidates of CSS.
- Proposal 3: Slot pattern can be used for the SFI indication contents.
- Proposal 4: For the carrier aggregation, CCs can be grouped and SFIs for group can be defined with a single group common PDCCH.
- Proposal 5: A group common PDCCH can indicate slot structure based on a reference numerology, and SFIs for multiple numerology can be indicated with single GC PDCCH. Reference numerology can be indicated by the network.
- Proposal 6: SFI can be applied to FDD band for flexible duplex.
- Proposal 7: Use cases of transmission of SFI in multi-beam scenario first need to be clarified. One possible use case is to allow periodic change of semi-static DL/UL assignment over multiple slots aligned with SS block transmission periodicity. If indeed more dynamic SFI transmission is necessary, consider separate SS configuration with beam-sweeping.
- Proposal 8: If semi-static slot format configuration is given and it cannot be changed by GC-PDCCH, semi-static configuration can be followed in this case. Otherwise, UE can assume resource type is 'Unknown' on the resources that the UE has not acquired GC-PDCCH.
- Proposal 9: The priority between semi-static configuration and GC PDCCH can be different depending on the semi-static configuration. One criteria can be cell-specifically configured fixed DL or UL resource which impacts on IDLE UEs are not overridden by GC PDCCH.

Decision: The document is noted.

[R1-1716096](#) Remaining details on group-common PDCCH NTT DOCOMO, INC.

Proposal 1: *Group common PDCCH is designed with CRC attachment and polar coding.*

- *CRC attachment and polar coding procedure are exactly same as for regular PDCCH.*

Proposal 2: *Conform the following working assumptions:*

- *'Reserved' resource is 'not transmit' and 'not receive' but cannot be overridden by DCI/SFI indication.*
 - *'Reserved' is signalled at least by RRC*
 - *FFS: handling of 'gap'*
- *For semi-static DL/UL transmission direction, 'Unknown' can be informed as part of the semi-static configuration.*

Proposal 3: *Semi-static SFI can achieve at least the following:*

- *For SCS = 15kHz and 30kHz, switching periodicities of 5ms and 10ms are supported.*
 - *UL-DL assignment aligned with LTE TDD UL/DL configuration #1, #2 and #5 with any special subframe configurations should be available;*
- *For all SCSs, switching periodicities of 1ms and 2ms and infinite (i.e., DL/UL-only) are supported.*
- *For SCS >= 30kHz, switching periodicity of 0.5ms is supported.*

Proposal 4: *NR support dynamic resource reservation bases on the group-common PDCCH:*

- *'Reserved' can be indicated by dynamic SFI.*

Proposal 5:

- *Dynamic SFI should support at least the following:*
 - *SFI monitoring periodicity is configured by higher-layer signalling for particular SCS(s):*

- For SCS = 15kHz and 30kHz, monitoring periodicities of 5ms and 10ms are supported.
 - UL-DL assignment aligned with LTE TDD UL/DL configuration #1, #2 and #5 with any special subframe configurations should be available;
- For all SCSs, monitoring periodicities of 1ms and 2ms are supported.
 - At most one switching periodicity is available;
- For SCS >= 30kHz, switching periodicity of 0.5ms is supported.
 - At most one switching periodicity is available.
- Dynamic SFI is used to indicate one configuration for {UL, DL, Unknown, Reserved} from multiple configurations.
 - The candidate configurations are configured by higher layer signaling.

Proposal 6: For dynamic SFI, NR should support SFI indication per numerology.

Proposal 7: For dynamic SFI, one SFI is used to indicate the slot format related information for multiple numerologies:

- A mapping relationship between the SFI value and the slot patterns {UL, DL, Unknown} of different numerologies can be defined in a table.
- The slot patterns {UL, DL, Unknown} in the defined table can be configured by higher layer signalling.

Proposal 8: The following UE behaviour related to SFI and DCI can be defined:

Table I. Relationship between semi-static SFI and dynamic SFI

UE behavior		Dynamic SFI			
		DL	UL	Unknown	Reserved
Semi-static SFI	DL	DL	Error	DL	Reserved
	UL	Error	UL	UL	Reserved
	Unknown	DL	UL	Unknown	Reserved
	Reserved	Reserved	Reserved	Reserved	Reserved

Table II. Relationship between semi-static SFI and DCI

UE behavior		Semi-static SFI			
		DL	UL	Unknown	Reserved
DCI	DL scheduling	DL	Error	DL	Reserved
	UL scheduling	Error	UL	UL	Reserved

Table III. Relationship between dynamic SFI and DCI

UE behavior		Dynamic SFI			
		DL	UL	Unknown	Reserved
DCI	DL scheduling	DL	Depends on timing	DL	Reserved
	UL scheduling	Depends on timing	UL	UL	Reserved

Discussion: Also supported by Samsung.

A few (Panasonic, CMCC) have concern with proposal 4

Decision: The document is noted.

Continue discussion offline – Jing S. (Qualcomm)

Thursday

[R1-1716883](#)

Offline discussion on GC-PDCCH for SFI Qualcomm

Agreements:

- Regarding dynamic SFI content definition
 - The SFI carries an index to a table that is UE-specifically configured via RRC
 - FFS how to manage the table for future proof
 - FFS how to define entries in the table
 - FFS whether to have separate or joint management of slot based SFI (SFI indicates the slot format of the corresponding slot) vs. multi-slot SFI (SFI indicates the slot format of more than one corresponding slots)

Agreements:

- Confirm the following WA
 - ‘Unknown’ resource is ‘flexible’ and can be overridden by at least by DCI indication; ‘Unknown’ is used to achieve the (FFS: exactly/approximately) the same as ‘Reserved’ if not overridden.
 - ‘Unknown’ is signalled at least by SFI in a group-common PDCCH
 - FFS: Possibility of overridden by some types of RRC (e.g., measurement configuration)
 - ‘Reserved’ resource is ‘not transmit’ and ‘not receive’ but cannot be overridden by DCI/SFI indication.
 - ‘Reserved’ is signalled at least by RRC
 - FFS: handling of ‘gap’
 - For semi-static DL/UL transmission direction, ‘Unknown’ can be informed as part of the semi-static configuration.

Agreements:

- For semi-static DL/UL assignment
 - Cell-specific RRC configuration (SIB) + additionally UE-specific RRC configuration
 - UE-specific RRC configuration only overwrites the “unknown” state of the cell-specific RRC configuration

R1-1715396	Remaining details on group-common PDCCH	Huawei, HiSilicon
R1-1715520	Remaining details on group-common PDCCH	ZTE, Sanechips
R1-1715631	Design of group-common PDCCH	vivo
R1-1715751	On the remaining aspects of group-common PDCCH in NR	Nokia, Nokia Shanghai Bell
R1-1715781	Remaining details on group-common PDCCH	Panasonic
R1-1715815	Outstanding aspects of slot format indication	CATT
R1-1715981	On UE-Group Common PDCCH	Samsung
R1-1716055	Discussion on Signalling and UE behavior for DL and UL transmission assignment	CMCC
R1-1716187	Remaining details on group common PDCCH	AT&T
R1-1716200	Design of GC PDCCH	MediaTek Inc.
R1-1716247	On remaining details on group-common PDCCH	Sony
R1-1716269	Remaining details on Group common PDCCH design for NR	Sharp
R1-1716308	On group-common PDCCH	Intel Corporation
R1-1716416	Remaining issues on slot format indication	Qualcomm Incorporated
R1-1716476	On Group-Common PDCCH Structure and Contents	InterDigital, Inc.
R1-1716552	Slot Format Indicator in Group-common PDCCH	Apple Italia S.R.L.
R1-1716555	Discussion on grouping rule for GC PDCCH	ASUSTEK COMPUTER (SHANGHAI)
R1-1716565	Discussion on the content and structure of group common PDCCH	Xiaomi Technology
R1-1716580	On Group-Common PDCCH	Ericsson
R1-1716631	Discussion on UE behavior for group-common PDCCH for NR	WILUS Inc.
R1-1716644	Group-common PDCCH contents and UE behavior	Motorola Mobility, Lenovo
R1-1716923	WF on SFI pattern and contents	LG Electronics, Panasonic, CATT

6.3.1.5 DCI contents and formats

[R1-1716581](#) Summary of e-mail discussion on DCI contents Ericsson

Summary of the agreed DCI information included in the associated excel sheet in [R1-1716581](#).

Conclusion:

- The information listed in [R1-1716581](#) is endorsed by RAN1 as a baseline for further discussion
- Further email discussion till next meeting on DCI contents including bitwidths for each information – Stefan (Ericsson)

R1-1715397	DCI contents and formats in NR	Huawei, HiSilicon
R1-1715632	DCI format size and blind decoding	vivo
R1-1715687	Considerations on DCI formats and DCI contents	Guangdong OPPO Mobile Telecom.
R1-1715752	On DCI formats, DCI content and the configurability of DCI fields in NR	Nokia, Nokia Shanghai Bell
R1-1715816	Discussion on NR DCI formats	CATT
R1-1715874	Discussion on DCI formats	LG Electronics
R1-1715982	DCI Contents and Formats	Samsung
R1-1716067	DCI for CBG based retransmission	Sequans Communications
R1-1716188	On TB size determination for NR	AT&T
R1-1716417	Views on DCI contents and formats	Qualcomm Incorporated

6.3.1.6 Other

Including URLLC related aspects

R1-1715398	Dynamic and semi-static DL/UL resource partition	Huawei, HiSilicon
R1-1715413	UE procedure of PDCCH monitoring for URLLC	Huawei, HiSilicon
R1-1715418	DCI design for URLLC	Huawei, HiSilicon
R1-1715521	Supporting Multi-beam in NR-PDCCH	ZTE, Sanechips
R1-1715633	DCI contents and design	vivo
R1-1715634	Discussion on ultra-reliable design for PDCCH	vivo
R1-1715688	PDCCH for URLLC	Guangdong OPPO Mobile Telecom.
R1-1715753	On the URLLC specific aspects for DL control channel	Nokia, Nokia Shanghai Bell
R1-1715754	On the usage of PDCCH DMRS as a complementary synchronization signal in DL	Nokia, Nokia Shanghai Bell
R1-1715875	Discussion on DL control with ultra-reliability requirement	LG Electronics
R1-1715983	On UE Power Savings	Samsung
R1-1715984	PDCCH Design for URLLC	Samsung
R1-1715985	Remaining Aspects for PDCCH	Samsung
R1-1715986	DL and UL Assignment for NR TDD	Samsung
R1-1715987	Slot Reconfiguration for Low Latency in TDD	Samsung
R1-1716097	DL control channel design for URLLC	NTT DOCOMO, INC.
R1-1716248	Reliable PDCCH operation for NR	Sony
R1-1716255	Considerations for ultra-reliable DCI transmission	InterDigital, Inc.
R1-1716309	Ultra-reliability for NR PDCCH	Intel Corporation
R1-1716418	Advanced Grant Indication for UE Power Saving	Qualcomm Incorporated
R1-1716477	Frequency-first REG bundling for multi-symbol CORESETs	InterDigital, Inc.
R1-1716553	Control Information for UE Power Saving	Apple Italia S.R.L.
R1-1716562	CRC for NR PDCCH	Shenzhen Coolpad Technologies
R1-1716582	On PDCCH for Ultra-Reliable Transmission	Ericsson
R1-1716620	HARQ design and PDCCH reliability for URLLC	MediaTek Inc.
R1-1716778	PDCCH reliability for URLLC	Huawei, HiSilicon

6.3.2 Physical uplink control channel

6.3.2.1 PUCCH structure in short-duration

6.3.2.1.1 Short-PUCCH for UCI of up to 2 bits

Focus on short-PUCCH on a OFDM symbol.

[R1-1716772](#) Short PUCCH for UCI of up to 2 bits Intel Corporation (rev of [R1-1716310](#))

- Proposal 1: Sequence-selection based 1-symbol short PUCCH uses Zadoff-Chu or computer generated CAZAC sequence.
- Proposal 2: For HARQ-ACK transmission
 - m-bit HARQ-ACK is transmitted using 2^m equally-spaced cyclic shifts of a CAZAC sequence.
 - The distance between consecutive cyclic shifts is $\lfloor N/2^m \rfloor$ for sequence length N.
 - Multiple UEs can be multiplexed on the same PRB by assigning different cyclic shifts.
- Proposal 3: For SR transmission
 - A configured CAZAC sequence is transmitted in case of positive SR.
 - Multiple UEs can be multiplexed on the same PRB by assigning different cyclic shifts.
- Proposal 4: Additional resource(s) in the frequency and/or code domain can be configured in case of simultaneous HARQ-ACK + SR transmission to support single channel transmission.

Decision: The document is noted.

[R1-1716665](#) Short PUCCH for UCI of 1 or 2 Bits Samsung (rev of [R1-1715988](#))

- Proposal 1: For 1-symbol PUCCH, support two formats,
 - Format 0 for UCI payload size ≤ 2 bits using sequence selection.
 - Format 1 for $3 \text{ bits} \leq \text{UCI payload size} \leq X$ bits using FDM between DMRS and UCI carriers.
- Proposal 2: In NR phase I, UCI transmitted on 1-symbol PUCCH format 0 with sequence selection includes only HARQ-ACK, SR, or HARQ-ACK and SR.
- Proposal 3: The number of PRB for 1-symbol PUCCH format 0 is 1.
- Proposal 4: Consider adopting CGS sequences different than the LTE ones for PUCCH format 0.

- Proposal 5: Support Alt. 3 for multiplexing of HARQ-ACK and SR in 1-symbol PUCCH format 0, e.g., additional frequency resource is allocated for simultaneous transmission of HARQ-ACK and positive SR.

Decision: The document is noted.

Continue offline discussion – Sorour (Ericsson)

Wednesday

Agreements:

- For simultaneous transmission of 2-bit HARQ-ACK and SR, short PUCCH for UCI of up to 2 bits is used
 - Aim to conclude one solution in the next meeting (e.g., # of sequences, potential resource selection, potential spatial bundling, etc.)
- Confirm the following working assumption:
 - For short-PUCCH with UCI of up to 2 bits (with/without SR), option 4 is supported.
 - Note: option 4 is sequence selection

Conclusion:

- Study further the following alternatives:
 - Alt 1: The same set of sequences is used in short PUCCH and long PUCCH when each is used for transmission of up to 2 UCI bits on one PRB.
 - Alt 2: The different set of sequences can be used in short PUCCH and long PUCCH when each is used for transmission of up to 2 UCI bits on one PRB.

R1-1715399	Short PUCCH for UCI of up to 2 bits	Huawei, HiSilicon
R1-1715522	On short PUCCH for up to 2 bits UCI	ZTE, Sanecips
R1-1715635	Design of short-PUCCH for UCI up to 2 bits	vivo
R1-1715680	Short-PUCCH for up to 2 UCI bits	Guangdong OPPO Mobile Telecom.
R1-1715764	RE mapping for PUCCH of 1 or 2 bits	ETRI
R1-1715817	On short PUCCH formats supporting up to two UCI bits	CATT
R1-1715876	Design of short PUCCH for UCI of up to 2 bits for NR	LG Electronics
R1-1716098	Short-PUCCH for UCI of up to 2 bits	NTT DOCOMO, INC.
R1-1716119	Discussion on 1-symbol short-PUCCH for UCI of up to 2 bits	Panasonic Corporation
R1-1716139	Remaining details of short PUCCH for UCI up to 2 bits	Nokia, Nokia Shanghai Bell
R1-1716419	Channelization of 1-symbol short PUCCH with 1 or 2 bits payload	Qualcomm Incorporated
R1-1716478	Sequence design for 1-symbol short-PUCCH of up to 2 bits	InterDigital, Inc.
R1-1716518	Design of short PUCCH for UCI up to 2 bits	IITH
R1-1716632	Discussion on Short PUCCH for UCI of up to 2 bits	WILUS Inc.
R1-1716641	Remaining details on short PUCCH for up to 2 bit UCI	Motorola Mobility, Lenovo
R1-1716662	On the Design of 1-Symbol PUCCH for up to 2 bits	Ericsson
R1-1716818	WF on evaluation of PUCCH sequences	InterDigital, Inc.

6.3.2.1.2 Short-PUCCH for UCI of more than 2 bits

Focus on short-PUCCH on a OFDM symbol.

[R1-1716099](#) Short-PUCCH for UCI of more than 2 bits NTT DOCOMO, INC.

- Proposal 1: For short-PUCCH for UCI of more than 2 bits, DMRS is mapped on #1, #4, #7, #10 REs for a given RB.
- Proposal 2: PN sequences as for PUSCH (opt. 1) should be used for DMRS sequence of short-PUCCH for UCI of more than 2 bits.
- Proposal 3:
 - For short-PUCCH of more than 2 bits,
 - A PUCCH resource is defined by one PRB index for the given UL BWP on one OFDM symbol.
 - UE transmits short-PUCCH of more than 2 bits using one or multiple PUCCH resource(s).
 - It can be contiguous or non-contiguous PRBs for the same symbol.
 - It can be the same or different PRBs across two symbols.

Decision: The document is noted.

Agreements:

- Confirm the following working assumption:
 - For 1-symbol short-PUCCH for UCI of more than 2 bits,
 - DMRS REs are evenly distributed within a PRB

- For short-PUCCH for UCI of more than 2 bits, DMRS is mapped on #1, #4, #7, #10 REs for a given RB
 - Note: the RE indexing starts from 0
- PN sequences as for PUSCH (opt. 1) is used for DMRS sequence of short-PUCCH for UCI of more than 2 bits

R1-1716140 On remaining details of short PUCCH for UCI of more than 2 bits Nokia, Nokia Shanghai Bell

- Proposal 1: Confirm working assumption from RAN1#90:
 - For 1-symbol short-PUCCH for UCI of more than 2 bits,
 - DMRS REs are evenly distributed within a PRB
- Proposal 2: Adopt DMRS structure shown in Figure 2 for short PUCCH for UCI of more than two bits.
- Proposal 3: Support two orthogonal DMRS ports for short PUCCH for UCI of more than two bits. Support CDM as multiplexing scheme between orthogonal DMRS ports.
- Proposal 4: SR bit is appended to the end UCI payload before encoding and modulation when SR occurs in same slot/symbol with short PUCCH with UCI payload more than 2 bits.
- Proposal 5: Support data scrambling with short PUCCH for UCI of more than 2 bits
- Proposal 6: Consider cell specific hopping between PUCCH resource units.
- Proposal 7: For short PUCCH with UCI payload larger than 2 bits, the PRB allocation size is configurable between 1 and 8 PRBs.
- Proposal 8: For short PUCCH with UCI having more than 2 bits the DMRS sequence is a PN sequence.

Decision: The document is noted.

Continue offline discussion – Sorour (Ericsson)

Thursday: No further progress.

R1-1715400	Short PUCCH for UCI of more than 2 bits	Huawei, HiSilicon
R1-1715636	Design of short-PUCCH for UCI of more than 2 bits	vivo
R1-1715765	RE mapping for short PUCCH of 3 or more UCI bits	ETRI
R1-1715818	On short PUCCH formats supporting more than two UCI bits	CATT
R1-1715877	Design of short PUCCH for UCI of more than 2 bits for NR	LG Electronics
R1-1715989	Short PUCCH for UCI of More than 2 Bits	Samsung
R1-1716311	Short PUCCH for UCI of more than 2 bits	Intel Corporation
R1-1716420	Channelization of 1-symbol short PUCCH with more than 2 bits payload	Qualcomm Incorporated
R1-1716584	On the Design of 1-Symbol PUCCH for more than 2 bits	Ericsson

6.3.2.1.3 Support of short-PUCCH over 2 OFDM symbols

R1-1715401 Short PUCCH over 2 OFDM symbols Huawei, HiSilicon

- Observation 1: When code rate is high, such as 3/16 and 1/4, Option 1-2 will outperform Option 1-1 by the higher channel coding gain; when code rate is low, such as 1/8, Option 1-1 and Option 1-2 will show the similar performance.
- Proposal 1: For 2-symbol PUCCH with more than 2 bits, if PRB allocation is distributed in each symbol, both option 1-1 and option 1-2 can be supported based on the UCI payload:
 - Option 1-1 (UCI is repeated between two symbols) is applied when code rate is low, such as corresponding to less than or equal to 8 bits payload per PRB.
 - Option 1-2 (UCI is joint encoded across two symbols) is applied when coding rate is high, such as corresponding to more than 8 bits payload per PRB.
- Proposal 2: For 2-symbol PUCCH with UCI more than 2 bits, if PRB allocation is localized in each symbol, repetition of encoded UCI across two symbols should be supported for the purpose of multi-beam transmission.

Discussion: Option 1-2 is already supported.

Decision: The document is noted.

Agreement:

- For 2-symbol PUCCH with more than 2 bits, option 1-1 is not supported in Rel-15
 - Note: Option 1-1 (UCI is repeated between two symbols)

R1-1716585 On the Design of 2-Symbols PUCCH Ericsson

- For 2-symbols PUCCH for UCI up to 2 bits, contiguous PRB allocation per symbol is supported.
- For 2-symbols PUCCH for UCI ~~up to~~ more than 2 bits, both contiguous and non-contiguous PRB allocation are supported.
 - If prioritization is necessary, contiguous PRB allocation is prioritized.
- For 2-symbols PUCCH with more than 2 UCI bits, the DM-RS density and pattern of 1-symbol PUCCH with UCI more than ~~one bit~~ two bits is used for each symbol of the 2-symbols PUCCH.

- For 2-symbol short-PUCCH for UCI of more than 2 bits, introducing additional signaling or a new PUCCH format to enable repetition of the encoded UCI bits over two symbols instead of distribution of the encoded UCI bits is not supported.
- For 2-symbols PUCCH with more than 2 bits, scrambling of the encoded UCI bits and randomizing the DMRS sequence in each symbol are supported similarly to the 1-symbol PUCCH with more than 2 UCI bits.
- For 2-symbols PUCCH with up to 2 bits, sequence hopping for each symbol is supported similarly to the 1-symbol PUCCH with up to 2 UCI bits.

Decision: The document is noted.

Agreement:

- For 2-symbol PUCCH with more than 2 UCI bits, the DM-RS density and pattern (i.e., the DM-RS locations) of 1-symbol PUCCH with UCI more than two bits are used for each symbol of the 2-symbol PUCCH

Continue offline discussion – Sorour (Ericsson)

Wednesday

Agreements

- For two-symbol short-PUCCH with up to 2 UCI bits, sequence hopping between the two symbols is supported.
 - FFS: The details of sequence hopping.
- For one or two symbol(s) short-PUCCH for UCI of more than 2 bits, the encoded bits are scrambled.
 - FFS on the scrambling initialization for the encoded bits

R1-1715637	Support of short-PUCCH over 2 OFDM symbols	vivo
R1-1715878	Support of short PUCCH over 2 OFDM symbols for NR	LG Electronics
R1-1715990	Short PUCCH over 2 OFDM symbols	Samsung
R1-1716122	Discussion on support of long-PUCCH over multiple slots	Panasonic Corporation
R1-1716141	On 2-symbol short PUCCH design	Nokia, Nokia Shanghai Bell
R1-1716312	2-symbol NR PUCCH	Intel Corporation
R1-1716421	Channelization of 2-symbol short PUCCH	Qualcomm Incorporated

6.3.2.2 PUCCH structure in long-duration

6.3.2.2.1 Long-PUCCH for UCI of up to 2 bits

Focus on long-PUCCH within a slot.

[R1-1715523](#) On long-PUCCH for up to 2 bits ZTE, Sanechips

- Proposal 1: Overall design for long PUCCH should be considered to support the flexible number of symbols and small signaling overhead.
 - Configure the number of base units for a UE's long PUCCH by higher layer.
 - The physical layer signalling indicates a specific location.
- Proposal 2: Consider to build a long PUCCH for UCI of 1~2 bits by concatenating multiple basic units.
 - The basic unit for 1~2 bits consists one DMRS symbol and one UCI symbol.
 - The basic unit is the minimum granularity of the frequency hopping and multi-beam transmitting.
 - Frequency hopping can only occur at the boundary of a base unit to ensure that the base unit is not split.
 - Frequency-hopping is enabled/disabled long-PUCCH regardless of durations.
- Proposal 3: In the slot, separate frequency domain resources are allocated for long PUCCHs with different lengths.
- Proposal 4: The end of long PUCCHs of different lengths align at the last UL symbol in a slot except symbols for possible short PUCCH.

Decision: The document is noted.

[R1-1716759](#) Long PUCCH design with 1 or 2 bits UCI payload Qualcomm Incorporated (rev of [R1-1716422](#))

- Proposal 1: For a long PUCCH with 1 or 2 bits UCI, new sequences with PAPR lower than LTE should be adopted. Spectral shaping could be applied to further lower PAPR. FFS details of filter design for spectral shaping.
- Proposal 2: For a long PUCCH with N symbols to carry 1 or 2 bits UCI, if hopping is enabled, the length for the two parts after hopping is determined as following
 - If $\text{mod}(N,4)=0$, the length of part 1 is $\frac{N}{2}$, while the length of part 2 is $\frac{N}{2}$
 - If $\text{mod}(N,4)=1$, the length of part 1 is $\left\lfloor \frac{N}{2} \right\rfloor$, while the length of part 2 is $\left\lfloor \frac{N}{2} \right\rfloor + 1$
 - If $\text{mod}(N,4)=2$, the length of part 1 is $\frac{N}{2} - 1$, while the length of part 2 is $\frac{N}{2} + 1$

- If $\text{mod}(N,4)=3$, the length of part 1 is $\left\lfloor \frac{N}{2} \right\rfloor$, while the length of part 2 is $\left\lfloor \frac{N}{2} \right\rfloor + 1$

Decision: The document is noted.

Continue discussion offline – Hua (Huawei)

Wednesday

Agreement:

- For long PUCCH for UCI of up to 2 bits, DM-RS is located in all the even symbols, where the symbol is indexed from the start of the long PUCCH of value 0

Conclusion:

- Study further frequency hopping boundary for long PUCCH of up to 2 bits with N symbols focusing on the following options:
 - Floor ($N/2$)
 - Ceiling ($N/2$)
 - $N/2-1$ where $\text{mod}(N,4)=2$; floor($N/2$) otherwise
 - Floor(Ceiling ($N/2$)/2) $\times 2$
 - Starting symbol driven frequency hopping boundary
- Companies are encouraged to perform further evaluations and analysis, also considering alignment (if necessary) of PUCCH of different durations

Thursday

Agreements:

- For long-PUCCH for UCI up to 2 bits, up to 3 OCC multiplexing capacity are supported with frequency hopping
 - FFS: OCC multiplexing capacity values without frequency hopping.
 - FFS: whether to have the same multiplexing capacity w/ and w/o frequency hopping for a given duration of long PUCCH.
- OCC multiplexing capacity for each long PUCCH duration (including FFS values) as listed in the following table
 - FFS on OCC length
 - Note: It doesn't imply that the OCC multiplexing capacity for DMRS and UCI are the same

Long-PUCCH duration N	OCC Multiplexing capacity M	
	with hopping	without hopping FFS
4	1	FFS [2]
5	1	FFS[2]
6	1	FFS[2]
7	FFS [1 or 2]	FFS[2]
8	2	FFS[3-4]
9	2	FFS[3-4]
10	2	FFS[3-5]
11	FFS [2 or 3]	FFS[3-5]
12	3	FFS[3-6]
13	3	FFS[3-6]
14	3	FFS[3-7]

Agreements:

- NR studies a new set of sequences for short PUCCH and long PUCCH for UCI bits up to 2
- For a fair comparison of at least length 12 NR CGS designs for PUCCH, the companies are encouraged to provide/re-evaluate their proposed sequences based on the following all or a subset of performance metrics

- Maximum PAPR/CM, minimum PAPR/CM, mean PAPR/CM (assuming at least 8x oversampling)
- Maximum cross-correlation
 - Between the base sequences for new NR sequences by applying all CS values
 - Between the base sequences for new NR and LTE sequences by applying all CS values (LTE CGS for 1 and 2 PRBs ,and ZC sequences for >2PRBs up to 100MHz bandwidth) considering all partial overlapping
- Other examples for metrics can be but not limited to
 - Statistics of cross-correlation (mean/max/std dev/95% tile)
 - with both Method 1 (with NFFT=12*32) and Method 5 (Based on [R1-163437](#))
 - Note: Timing miss-alignment with other values for oversampling can also be realized with Method 5.
 - And/or with aperiodic cross-correlation for different timing arrivals
 - Modulation type, EVM
- Receiver complexity
- LTE CGS are used as the reference for performance comparison

R1-1715402	Long PUCCH for UCI of up to 2 bits	Huawei, HiSilicon
R1-1715541	Long PUCCH design for UCI of up to 2 bits	Lenovo, Motorola Mobility
R1-1715638	Design of long-PUCCH for UCI of up to 2 bits	vivo
R1-1715681	Discussion on long PUCCH for up to 2 UCI bits	Guangdong OPPO Mobile Telecom.
R1-1715819	Remaining details of long PUCCH for small UCI payloads	CATT
R1-1715879	Design of long PUCCH for UCI of up to 2 bits for NR	LG Electronics
R1-1715991	Long PUCCH for UCI of 1 or 2 Bits	Samsung
R1-1716100	Long-PUCCH for UCI of up to 2 bits	NTT DOCOMO, INC.
R1-1716120	Channel structure and frequency-hopping details of long-PUCCH for UCI of up to 2 bits	Panasonic Corporation
R1-1716142	Long PUCCH with small UCI payload	Nokia, Nokia Shanghai Bell
R1-1716182	On long PUCCH for UCI up to 2 bits	AT&T
R1-1716313	Long PUCCH for up to 2 UCI bits	Intel Corporation
R1-1716517	Design of Long PUCCH for UCI up to 2 bits	IIITH
R1-1716586	On the Design of Long PUCCH for up to 2 bits	Ericsson
R1-1716887	WF on The Hopping Bandwidth of Long-duration PUCCH	LG Electronics, Panasonic

6.3.2.2.2 Long-PUCCH for UCI of more than 2 bits

Focus on long-PUCCH within a slot.

[R1-1715567](#) Long-PUCCH for UCI of more than 2 bits Huawei, HiSilicon

Proposal: For long PUCCH for large payload,

- Number of DMRS symbols is decided by X (symbol number of each hopping part) and payload size.
 - When payload size is less than 60 bits,
 - ✓ For each frequency-hop with less than 6 symbols, there is one DMRS symbol;
 - ✓ or each frequency-hop with equal to or more than 6 symbols, there is two DMRS symbols;
 - When payload size is equal to or more than 60 bits,
 - ✓ For each frequency-hop, there is one DMRS symbol;

Observation 1: For long PUCCH for moderate payload,

- When UE speed is 3km/h and payload size is 4 bits, performance of Alt1 (time domain OCC scheme), Alt 2 (pre-DFT-OCC) and Alt 3(FDM within the PRB) are almost same, regardless 300ns or 1000ns delay spread.
- When UE speed is 3km/h and payload size is 20 bits, performance of Alt 2 (pre-DFT-OCC) and Alt 3(FDM within the PRB) both outperform Alt1 (time domain OCC scheme) about 0.5 to 2 dB, which is caused by the reduced multiplexing capacity and increased channel coding gain.
- When UE speed is 120km/h and payload size is 4 bits, performance of Alt 2 (pre-DFT-OCC) and Alt 3(FDM within the PRB) both outperform Alt1 (time domain OCC scheme) about 0.1 to 0.3 dB, which is caused by enabling interpolated channel estimation.
- When UE speed is 120km/h and payload size is 20 bits, performance of Alt 2 (pre-DFT-OCC) and Alt 3(FDM within the PRB) both outperform Alt1 (time domain OCC scheme) about 0.5 to 3 dB, which is caused by previous reasons.

Observation 2: For long PUCCH for large payload,

- When payload size is 20 bits per PRB,
 - For each frequency-hop with 6 symbols and 7 symbols, 2 DMRS symbols is similar or better than 1 DMRS symbol, which is caused by the performance of channel estimation.
 - For each frequency-hop with 4 symbols and 5 symbols, 1 DMRS symbol is better than 2 DMRS symbols, which is caused by the channel coding gain.

- When payload size is 60 bits per PRB,
 - For most case of each frequency-hop with 4 symbols to 7 symbols, 1 DMRS symbol is better than 2 DMRS symbol, which is caused by the channel coding gain.
 - For each frequency-hop with 7 symbols and 120 km/h UE speed, 2 DMRS symbols is better than 1 DMRS symbol, which is caused by the performance of channel estimation.
- When payload size is 100 bits per PRB,
 - For each frequency-hop with 7 symbols and 3 km/h UE speed, 1 DMRS symbol is better than 2 DMRS symbols, which is caused by the channel coding gain.
 - For each frequency-hop with 7 symbols and 120 km/h UE speed, 2 DMRS symbols is better than 1 DMRS symbol, which is caused by the performance of channel estimation.

Decision: The document is noted.

R1-1715731 Design of Long-PUCCH for UCI of more than 2 bits Cohere Technologies

- Proposal: Adopt PUCCH-LD format EF3, described in Section 2 of this document, for PUCCH-LD for UCI of more than 2 bits with some multiplexing capability.

Decision: The document is noted.

Continue discussion offline – Hua (Huawei)

Wednesday

Conclusion:

- For long PUCCH moderate payload size with multiplexing capability, aim to downselection between Alt 2 and Alt 3 next meeting – companies are encouraged to perform additional evaluations and analysis especially considering power imbalance

Proposals:

- For long PUCCH with large payload size without multiplexing capability, downselection
 - Alt1: an additional DMRS symbol in each frequency-hop can be configured
 - FFS: The locations of DMRS symbols in case an additional DMRS symbol is configured
 - Alt2: Fixed number of DMRS symbol in each frequency-hop (e.g., 1 DMRS symbol)
 - Alt3: $X=6/7$, for each frequency-hop with less than X symbols, there is one DMRS symbol in each frequency-hop, for each frequency-hop with equal to or more than X symbols, there are two DMRS symbols in each frequency-hop
 - Alt4: Additional DMRS using pre-DFT multiplexing of DMRS and data (?)
 - Alt5: Two DMRS symbol per frequency-hop when the payload size is less than Y and each frequency-hop with less than or equal to $X=6$ number of symbols; Otherwise, one DMRS symbol per frequency-hop;

R1-1715524	On long-PUCCH for more than 2 bits	ZTE, Sanechips
R1-1715542	Long PUCCH design for UCI of more than 2 bits	Lenovo, Motorola Mobility
R1-1715639	Design of long-PUCCH for UCI of more than 2 bits	vivo
R1-1715820	Design of long PUCCH formats with different multiplexing capacities	CATT
R1-1715880	Design of long PUCCH for UCI of more than 2 bits for NR	LG Electronics
R1-1715992	Long PUCCH for UCI of More than 2 Bits	Samsung
R1-1716056	Long-PUCCH DMRS evaluation and design	CMCC
R1-1716065	On pre-DFT additional RS insertion for long PUCCH	Mitsubishi Electric RCE
R1-1716101	Long-PUCCH for UCI of more than 2 bits	NTT DOCOMO, INC.
R1-1716121	Design of long-PUCCH for UCI of more than 2 bits	Panasonic Corporation
R1-1716143	On the remaining details of long PUCCH for UCI more than 2 bits	Nokia, Nokia Shanghai Bell
R1-1716183	On long PUCCH for more than 2 bits	AT&T
R1-1716270	DMRS pattern for NR long PUCCH with more than 2 bits	Sharp
R1-1716314	Long PUCCH for more than 2 UCI bits	Intel Corporation
R1-1716423	Long PUCCH design with more than 2 bits UCI payload	Qualcomm Incorporated
R1-1716479	Evaluation of Long-PUCCH for moderate UCI payload with multiplexing capacity	InterDigital, Inc.
R1-1716519	Design of Long PUCCH for UCI more than 2 bits	IITH
R1-1716587	On the Design of Long PUCCH for more than 2 bits	Ericsson

6.3.2.2.3 Support of long-PUCCH over multiple slots

R1-1715993 Multi-Slot Long PUCCH Transmission Samsung

- Proposal 1: UE-specific higher layer signaling enables/disables multi-slot long PUCCH transmissions.
- Proposal 2: The number of symbols or the number of slots for multi-slot long PUCCH transmission is configured by UE-specific higher layer signaling.

- Proposal 3: Available slots for multi-slot PUCCH transmissions are configured by higher layers and a starting slot for repetitions can be indicated by L1 or by higher layers.
- Proposal 4: A UE can be configured by higher layers the available symbols for long PUCCH transmission in a slot. A single configuration applies for all slots for a multi-slot long PUCCH transmission.
- Proposal 5: A PUCCH resource in the first slot can be determined by either explicit signaling or a combination of explicit and implicit signaling and PUCCH resources in subsequent slots are FFS (a) configured by UE specific-higher layer signaling or (b) are same as the PUCCH resource in the first slot.
- Proposal 6: A single frequency hop applies for multi-slot long PUCCH transmissions and frequency hopping for multi-slot long PUCCH transmission in M slots applies after the first ceil(M/2) (or floor(M/2)) slots.
- Proposal 7: If the number of symbols for PUCCH transmission per slot can vary among slots, the number of available OCCs is same for all slots and corresponds to the smallest number of DMRS or UCI symbols.
- Proposal 8: A UE drops PUSCH/SRS transmissions when the UE transmits a long PUCCH over multiple slots.

Decision: The document is noted.

R1-1715543 Long PUCCH over multiple slots Lenovo, Motorola Mobility

- Proposal 1: Long PUCCH transmission cross multiple slots is supported to avoid collision with other signaling, e.g. PRACH, SRS.
- Proposal 2: Long PUCCH transmission cross multiple slots is supported due to UL resource shortage in dynamic/semi-static TDD frame structure.
- Proposal 3: Long PUCCH resource allocation should be defined in a way considering the tradeoff between flexibility, complexity and signaling overhead.

Decision: The document is noted.

Continue discussion offline – Hua (Huawei)

Wednesday

Proposals:

- For long PUCCH over multiple slots,
 - For > 2 UCI bits, the UCI can be repeated within N slots (N>1)
 - The number of available symbols for long-PUCCH may vary in each slot
 - The number of slots N provides at least a target of [1ms] of symbols of long-PUCCH (i.e., 14 symbols for 15kHz SCS)
 - FFS N is calculated and/or configured and/or indicated

Thursday

Agreements:

- For long PUCCH over multiple slots, the duration(s) of long PUCCH in each slot can be down-selected from following alternatives:
 - Alt1: The duration of long PUCCH in each slot is the same
 - Alt2: The duration(s) of long PUCCH in each slot could be different

R1-1715403	Support of long-PUCCH over multiple slots Huawei, HiSilicon
R1-1715514	Support of long-PUCCH transmission over multiple slots Spreadtrum Communications
R1-1715525	Support of long-PUCCH over multiple slots ZTE, Sanechips
R1-1715766	Long-PUCCH over multiple slots ETRI
R1-1715821	Design of multi-slot PUCCH transmission CATT
R1-1715881	Support of long PUCCH over multiple slots for NR LG Electronics
R1-1716144	Long PUCCH over multiple slots Nokia, Nokia Shanghai Bell
R1-1716184	On long PUCCH over multiple slots AT&T
R1-1716271	Structure of NR long PUCCH over multiple slots Sharp
R1-1716315	Long PUCCH over multiple slots Intel Corporation
R1-1716424	Long PUCCH over multiple slots Qualcomm Incorporated
R1-1716588	On Support of Long PUCCH Over Multiple Slots Ericsson

6.3.2.3 UCI multiplexing

For both PUSCH with CP-OFDM waveform and PUSCH with DFT-s-OFDM waveform, PUCCH-PUSCH multiplexing, etc.

R1-1716777 Multiplexing of PUCCH and PUSCH Qualcomm Incorporated (rev of [R1-1716425](#))

Proposal 1: Up to 2 bits ACK is mapped to REs distributed in time and frequency. More than 2 bits ACK is jointly encoded with RI and mapped to REs next to front loaded DMRS.

Proposal 2: RI and other CSI are separately encoded.

Proposal 3: Strive for ACK and CSI mapping to orthogonal REs so ACK does not puncture CSI.

Proposal 4: Consider dynamic selection of β_{offset} values for UCI on PUSCH.

Proposal 5: For FDM simultaneous PUCCH and PUSCH on the long PUCCH burst:

- PUCCH is in contiguous RB as PUSCH to reduce MPR.
- PUCCH is on both edges of PUSCH to create more frequency diversity for PUCCH.
- PUCCH is based on DFT-S-OFDM waveform regardless of PUSCH waveform to simplify efforts of design/specification/implementation.

Proposal 6: When frequency hopping is enabled, adopt the same hopping position for FDMed simultaneous long PUCCH and PUSCH.

Proposal 7: Only support FDM simultaneous PUCCH and PUSCH with the same number of symbols.

Decision: The document is noted.

R1-1716102 UCI multiplexing NTT DOCOMO, INC.

- Proposal 1: Intra-slot frequency-hopping is supported for PUSCH with CP-OFDM waveform.
 - Hopping boundary, DMRS design, and data mapping order should follow intra-slot frequency-hopping for PUSCH with DFT-s-OFDM waveform.
- Proposal 2:
 - UCI on PUSCH is designed such that:
 - UCI REs are distributed over the frequency.
 - UCI REs are distributed across frequency-hops (when intra-slot frequency-hopping is enabled).
 - For HARQ-ACK piggyback on PUSCH with puncturing UL data,
 - UCI REs are distributed over the CBs for one TB
 - Option 1: Time-first mapping when data uses frequency-first mapping
 - Option 2: At the last of each data CB
- Proposal 3: At least for non-slot based scheduling for both downlink and uplink, the transmission timing and transmission duration of a PDSCH/PUSCH and a UCI should be flexible.

Decision: The document is noted.

R1-1716589 On UCI on PUSCH Ericsson

- Proposal 1: Confirm the working assumption: For slot-based scheduling, for HARQ-ACK with more than 2 bits, PUSCH is rate-matched. For slot-based scheduling, for HARQ-ACK with up to 2 bits, PUSCH is punctured.
- Proposal 2: Include ACK/NACK size indicator in UL grant scheduling PUSCH containing ACK/NACK.
- Proposal 3: UCI is not mapped to OFDM symbols carrying DM-RS.
- Proposal 4: UCI is mapped to all PUSCH symbols except DM-RS symbols.
- Proposal 5: For OFDM-based PUSCH, UCI is mapped to resource elements that are distributed across the PUSCH bandwidth.
- Proposal 6: For DFTS-OFDM based PUSCH, UCI is mapped to modulation symbols that are distributed (prior DFT-spreading) with the same distribution pattern as for OFDM.

Decision: The document is noted.

Continue discussion offline – Yi (Qualcomm)

Thursday

R1-1716853 Summary of remaining issues for UCI multiplexing on PUSCH Qualcomm Incorporated

- Proposal 1: ACK always puncture PUSCH (Vivo, QC, LGE, Intel, MediaTek)
- Proposal 2: ACK always rate-match PUSCH (E///, LGE, Samsung, Huawei, Intel, CATT, Nokia)
- Proposal 3: UL grant indicate (estimated) # ACK bits (FFS indicate resource details). ACK rate match PUSCH based on # ACK bits indicated in UL grant. ACK puncture PUSCH in certain cases (Vivo, QC, Panasonic, Nokia, E///, DCM, MediaTek, CATT, Huawei)
- Proposal 4: confirm the following working assumption (VIVO, QC)
 - For slot-based scheduling, for HARQ-ACK with more than 2 bits, PUSCH is rate-matched.
 - For slot-based scheduling, for HARQ-ACK with up to 2 bits, PUSCH is punctured.

R1-1716145 On multiplexing of UCI Nokia, Nokia Shanghai Bell

Nokia's view: drawbacks of PUSCH puncturing by 1-2 bit HARQ-ACK is that puncturing requires more resources than rate matching with explicit UL grant indication to reach reliable enough DTX performance (figure 3 of [R1-1716145](#)).

Decision: The document is noted.

Agreement: Confirm the working assumption:

- For slot-based scheduling, for HARQ-ACK with more than 2 bits, PUSCH is rate-matched.
- For slot-based scheduling, for HARQ-ACK with up to 2 bits, PUSCH is punctured.

Agreement:

- For UCI on PUSCH, support both dynamic and semi-static β_{offset} indication
 - FFS the applicable case(s) for dynamic vs. semi-static indications

R1-1715404	On UCI multiplexing	Huawei, HiSilicon
R1-1715526	UCI multiplexing on PUSCH	ZTE, Sanechips
R1-1715640	On UCI multiplexing	vivo
R1-1715682	Discussion on UCI multiplexing	Guangdong OPPO Mobile Telecom.
R1-1715822	Multiplexing of UCI and UL data on PUSCH	CATT
R1-1715882	Considerations on UCI and UL channel multiplexing for NR	LG Electronics
R1-1715994	On UCI Multiplexing in PUSCH	Samsung
R1-1716123	Discussion on UCI multiplexing	Panasonic Corporation
R1-1716218	Discussion on UCI multiplexing	MediaTek Inc.
R1-1716272	Simultaneous PUCCH and PUSCH transmission and collision handling	Sharp
R1-1716316	UCI embedding and PUSCH/PUCCH multiplexing	Intel Corporation
R1-1716480	On UCI resource mapping on PUSCH	InterDigital, Inc.
R1-1716633	Discussion on UCI multiplexing for NR	WILUS Inc.

6.3.2.4 Other aspects for PUCCH

Including transmit diversity, resource allocation, signalling, etc.

[R1-1715405](#) Resource allocation and transmit diversity for PUCCH Huawei, HiSilicon

- Observation 1: SORTD can be used to support long PUCCH with up to 2 bits.
- Observation 2: SORTD can be used to support long PUCCH with moderate payload.
- Proposal 1: The following two options can be considered for resource allocation for PUCCH HARQ-ACK:
 - Option 1: Indicating time domain resource separately with frequency and/or code domain resource
 - One field in DCI to indicate the symbol(s) for PUCCH transmission
 - The time-domain position of PUCCH could be implicitly derived from the DL transmission beam pair in case of PUCCH supporting beam based transmission
 - Option 2: Indicating time domain resource jointly with frequency and/or code domain resource
 - Different PUCCH resources within the PUCCH resource set configured by higher layer can correspond to different number of symbols
- Proposal 2: When slot-type changes, resource for periodic transmission should be reconfigured.
- Proposal 3: When two NR-PUCCHs can be transmitted from one UE on the same slot in TDM manner, UCI can be transmitted on short PUCCH or long PUCCH or both in a separately way.
- Proposal 4: SORTD will be considered as starting point to support transmit diversity for long PUCCH.
- Proposal 5: SORTD will be used for 1&2-symbol PUCCH with up to 2 bits.
- Proposal 6: SFBC will be used for 1& 2-symbol PUCCH with more than 2bits.

Decision: The document is noted.

[R1-1715486](#) PUCCH resource allocation Fujitsu

- Proposal 1: NR supports implicit PUCCH resource allocation as a complement to explicit signaling.
- Proposal 2: For implicit PUCCH resource allocation, similar methods as in LTE TDD (using the lowest CCE index

n_{CCE} , offsets $\sum_{k=0}^{m-1} N_{CCE,n-k}$, DCI field Δ_{ARO} and higher layer configured N_{PUCCH}) can be considered with necessary modifications.

Decision: The document is noted.

Continue offline discussion – Jia (OPPO)

Wednesday

[R1-1716826](#) Summary of open issues on PUCCH resource allocation OPPO

Proposals:

- For each PUCCH format for HARQ-ACK, the corresponding resource(s) can be semi-statically configured.
- For a given PUCCH format for HARQ-ACK of different parameters, the corresponding resource(s) can be semi-statically configured.
 - FFS the parameters (e.g., durations, etc.)

Thursday

R1-1716888

Summary of offline discussions on PUCCH resource allocation OPPO

Agreements:

- A set of PUCCH resources at least for HARQ-ACK which is configured to a UE by high layer signaling is defined as one of followings (to be down-selected).
 - Opt.1: One or multiple set(s) of PUCCH resources consisting of same or different PUCCH formats.
 - Opt.2: One or multiple set(s) of PUCCH resources for each PUCCH format.
 - Opt.3: A set of PUCCH resources for each duration of each PUCCH format.
 - Opt.4: A set of PUCCH resources for PUCCH formats carrying up to 2 bits UCI. Another set of PUCCH resources for PUCCH formats carrying more 2 bits UCI.
- FFS: How to identify a PUCCH resource from the set of PUCCH resource.
 - At least for HARQ-ACK, the starting slot of PUCCH is indicated by DCI.
 - Earliest transmission timing is based on UE capability
- FFS how PUCCH resource is defined

[R1-1715527](#) NR PUCCH resource allocation ZTE, Sanechips
[R1-1715641](#) Resource allocation for NR PUCCH vivo
[R1-1715689](#) Resource allocation for PUCCH Guangdong OPPO Mobile Telecom.
[R1-1715767](#) Resource allocation for PUCCH ETRI
[R1-1715883](#) Considerations on PUCCH resource allocation for NR LG Electronics
[R1-1715995](#) Resource Allocation for PUCCH Transmissions Samsung
[R1-1716057](#) Subband-based resource allocation for NR PUCCH CMCC
[R1-1716116](#) Resource allocation for PUCCH to support URLLC Sequans Communications
[R1-1716124](#) Discussion on resource allocation for uplink control channel Panasonic Corporation
[R1-1716146](#) PUCCH Resource Allocation and PUCCH Transmit Diversity Nokia, Nokia Shanghai Bell
[R1-1716167](#) On multi-TRP PUCCH reception AT&T
[R1-1716185](#) Transmit diversity schemes for PUCCH AT&T
[R1-1716237](#) Transmit diversity for DFTsOFDM-based PUCCH in long duration Mitsubishi Electric RCE
[R1-1716317](#) Transmit diversity and resource allocation for PUCCH Intel Corporation
[R1-1716426](#) Resource allocation and Transmit diversity for PUCCH Qualcomm Incorporated
[R1-1716481](#) On transmit diversity for Long PUCCH InterDigital, Inc.
[R1-1716572](#) Views on frequency hopping for PUCCH KT Corp.
[R1-1716590](#) On PUCCH Resource Allocation and Other Open Aspects Ericsson
[R1-1716642](#) PUCCH resource allocation Motorola Mobility, Lenovo
[R1-1716657](#) Further discussion on PUCCH resource allocation CATT

6.3.2.5 Other

Including URLLC aspects

[R1-1715416](#) Discussion on UCI feedback for URLLC Huawei, HiSilicon
[R1-1715528](#) Analysis of URLLC reliability for uplink control channel ZTE, Sanechips
[R1-1715768](#) UCI multiplexing of different usage scenario ETRI
[R1-1715884](#) Discussion on UL control with ultra-reliability LG Electronics
[R1-1715996](#) Transmit Diversity for PUCCH Samsung
[R1-1715997](#) On Simultaneous PUSCH and PUCCH Transmissions Samsung
[R1-1715998](#) PUCCH Design for URLLC Samsung
[R1-1715999](#) Performance Results for Long PUCCH Samsung
[R1-1716000](#) Performance Results for UCI and Data Multiplexing Samsung
[R1-1716001](#) BSI Reporting on PUCCH Samsung
[R1-1716002](#) Multiplexing PUSCH with Short PUCCH or SRS Samsung
[R1-1716003](#) PUCCH Resource Configuration for Bandwidth Restricted UE Samsung
[R1-1716103](#) UL control channel design for URLLC NTT DOCOMO, INC.
[R1-1716147](#) On URLLC UCI transmission Nokia, Nokia Shanghai Bell
[R1-1716256](#) Considerations for ultra-reliable UCI transmission InterDigital, Inc.
[R1-1716318](#) On UL control channel design aspects for URLLC Intel Corporation

R1-1716319	Configurations of various long PUCCH lengths	Intel Corporation
R1-1716427	SR design for GF/GB UL URLLC transmission	Qualcomm Incorporated
R1-1716576	Considerations for UCI for URLLCIII	
R1-1716591	On PUCCH Multiplexing from the Same or Different UEs	Ericsson
R1-1716592	On Simultaneous Transmission of PUCCH and PUSCH	Ericsson
R1-1716593	On PUCCH for Ultra-Reliable Transmission	Ericsson
R1-1716621	ACK/NACK feedback design and reliability for URLLC	MediaTek Inc.

6.3.3 DL/UL data scheduling and HARQ procedure

6.3.3.1 DL/UL resource allocation

Including TBS aspects

[R1-1716004](#) DL/UL Resource Allocation Samsung

Proposal 1: For determining RBG size in RA Type 0, support the following options

- Default RBG size determined by BWP size for slot based scheduling and non-slot based scheduling respectively.
- The RBG size(s) can be configured.

Proposal 2: Further investigate the dynamic switching of RBG sizes, considering the tradeoff or dynamic scheduling granularity switching and extra signaling overhead.

Proposal 3: Support the coarse granularity (more than 1 RB) in RA Type1. The granularity of power of 2 RBs is preferred.

Proposal 4: For intra-slot frequency hopping, consider the following options to determine the hopping position in the time domain:

- Opt. 1: Pre-defined symbol position in the slot
- Opt. 2: Symbol position determined by the number of allocated data symbols in the slot
- Opt.3: Symbol position determined based on gNB configuration

Proposal 5: NR supports both localized and distributed VRB allocation for RA Type 1 like LTE.

- For distributed VRB allocation, interleaving for VRB-to-PRB mapping should be confined within the active BWP.
- Study BWP-specific interleaving design considering BWP size/numerology, RBG size, etc.

Proposal 6: Consider the following methods for slot-level time-domain resource indication:

- For one-slot and mini-slot scheduling, the slot-level time resource is derived by scheduling timing.
- For multi-slot scheduling, the slot level time resource is derived by scheduling timing as well as the slot-level duration.
- The scheduling time is determined,
 - o With reference to slots for PDSCH/PUSCH transmissions. If the UE detects a PDCCH of which the last symbol is within slot n, the UE shall assume the scheduled PDSCH/PUSCH is within slot n+k (K0 for DL, and K2 for UL), where k is a number of slots and is indicated by the scheduling timing field in the DCI format.
 - o Sets of DL/UL scheduling timing values are separately configured by higher-layer signaling for different numerologies.

Proposal 7: When the configured scheduling timings are unknown to UE,

- DL scheduling timing is fixed as 0 for SIB.
- DL scheduling timing for Msg 2 and Msg 4 during the random access procedure can be fixed as 0 or provided by SIB, UL scheduling timing for Msg 3 can be indicated by the combination of the common reference timing provided by SIB and UE-specific offset by UL delay field in RAR.
- For other case, DL/UL scheduling timing could be either fixed as 0 (DL)/4 (UL) or delivered by SIB.

Proposal 8: Symbol-level time-domain resource is indicated according to the following methods.

- The starting symbol is indicated by the starting symbol of a slot, and the ending symbol (duration) is indicated by the symbol number from the starting symbol.
 - o For one-slot scheduling, the indicated starting and ending symbol is in the same slot.
 - o For multi-slot scheduling, the indicated starting and ending symbol is in the same slot, and it applies to all aggregated slots.
 - o For mini-slot scheduling, the indicated starting and ending symbol can locate in different slot.
- Support joint coding of starting and ending symbol indication.

Proposal 9: When the configured starting/ending symbol are unknown to UE,

- Support default value(s) of starting/ending symbol.

Proposal 10: Slot-level and symbol-level time-domain resource is indicated separately.

Proposal 11: The formula to determine TBS uses the total number of REs available for rate-matching of the PDSCH/PUSCH as an input to the formula.

Proposal 12: Ensure TBS plus TB-CRC as a multiple of $8 \times C$ where C denotes the number of CBs in the TB.

Proposal 13: Code rates for TBS determination can be explicitly signaled by a DCI.

Decision: The document is noted.

R1-1716428 Discussion TB size determination Qualcomm Incorporated

On VRB to PRB mapping:

Observation 1: Depending on the allocation, MCS and rank, the number of codeblocks for NR may be up to approximately 11 codeblocks per OFDM symbol.

Observation 2: In regimes of high spectral efficiency, an interleaved VRB-to-PRB mapping using a PRG-based granularity may provide multi-dB performance gains over a non-interleaved PRB mapping.

Proposal 1: NR supports an interleaved VRB-to-PRB mapping on a PRG-based granularity for the PDSCH and PUSCH resource allocation.

On TBS determination:

Error! Reference source not found.Error! Reference source not found.Error! Reference source not found.Error! Reference source not found.Error! Reference source not found.

Decision: The document is noted.

R1-1716594 On DL/UL Resource Allocation Ericsson

Regarding TB size determination

- Proposal 1-1: To ensure the same TBS can be used and signalled reliably for retransmissions, TBS is determined based on configured/signalled reference parameter of available frequency/time resources.
- Proposal 1-2: The reference parameter of available frequency/time resources can be semi-statically configured or L1 signalled to support different scheduling unit sizes and/or different service requirements.
- Proposal 1-3: For important services expected to generate large number of packages in the system, explicit optimization of the TBS to handle these specific sizes is considered.

Regarding PUSCH scheduling

- Proposal 2-1: Support fast switching between OFDM and DFT-S-OFDM waveforms for NR PUSCH via DCI signalling.

Regarding Time Domain RA

- Proposal 3-1
 - The DCI contains a bitfield that (together with RRC configuration) defines the starting and ending OFDM symbol within a slot.
 - When slot aggregation/repetition is applied, the UE assumes the same time resource allocation in slots wherein the transmission is repeated.
- Proposal 3-2:
 - The bitfield in the DCI message indicating the starting and ending OFDM symbol within a slot is configured separately per CORESET
- Proposal 3-3
 - For PUSCH transmissions, an bitfield of up to 4 bits is introduced in the DCI message to indicate which UL slot the PUSCH is transmitted within
 - For PDSCH, indication of which DL slot the PDSCH is transmitted is either joint coded with the location information within the slot or a single bit could be introduced to indicate scheduling in the next preceding slot.

Regarding Frequency Domain RA

- Proposal 4-1: RBG size is determined depending on the size of the BWP for DL/UL RA type 0.
- Proposal 4-2: Await the DCI format design before agreeing to granularity of the DL/UL RA type 1 that is different than 1 PRB.
- Proposal 4-3: For each RS (UL and DL) and BW part the UE is configured with an offset that is applied in the RS generation. The offset should be sufficiently large to be able to handle large difference between BW parts and potential reception/transmission BWs at/from the gNB.

Decision: The document is noted.

Continue discussion offline – Stefan (Ericsson)

Thursday

R1-1716884 Summary of 6.3.3.1 Ericsson

The document does not list every single issue raised in the contributions under 6.3.3.1 but tries to capture the most important ones together with some observations of possible solutions. The main topics are

- frequency-domain allocation
- time-domain allocation
- transport-block size determination

Decision: The document is noted.

R1-1715427	Resource allocation and TBS	Huawei, HiSilicon
R1-1715487	Discussion on frequency domain resource allocation	Fujitsu
R1-1715545	On resource allocation for PDSCH and PUSCH in NR	Nokia, Nokia Shanghai Bell
R1-1715558	Considerations on resource allocation issues	ZTE, Sanechips
R1-1715642	On DL/UL resource allocation	vivo
R1-1715690	Resource allocation for PDSCH/PUSCH	Guangdong OPPO Mobile Telecom.
R1-1715779	DL/UL resource allocation	Panasonic
R1-1715824	PDSCH and PUSCH resource allocation	CATT
R1-1715885	Discussion on resource allocation and TBS determination	LG Electronics
R1-1716104	DL/UL resource allocation	NTT DOCOMO, INC.
R1-1716195	Two-step resource allocation for data channel in NR	ASUSTEK COMPUTER (SHANGHAI)
R1-1716230	DL/UL RA schemes for NR	NEC
R1-1716320	Resource allocation and TBS	Intel Corporation
R1-1716482	On data resource allocation for NR	InterDigital, Inc.
R1-1716574	Discussion on time domain resource allocation	Potevio
R1-1716622	TB size determination and non-slot-based scheduling considerations	MediaTek Inc.
R1-1716645	On RBG size for frequency domain resource allocation	Motorola Mobility, Lenovo
R1-1716653	Discussion on the resource allocation of time domain	CATR
R1-1716823	WF on TB Mapping for Slot Aggregation	MediaTek

6.3.3.2 DL/UL scheduling and HARQ management

Including scheduling and HARQ timing taking into account gNB/UE processing time, # HARQ processes, HARQ payload considerations, HARQ multiplexing/bundling, etc.

[R1-1715886](#) Considerations on HARQ process and feedback for NR LG Electronics

- Proposal 1: SCS/BW, DMRS pattern, RE mapping, PDCCH duration, CSI reporting should be considered as the factors contributing to the minimum UE processing time (N1, N2) or the minimum HARQ timing (K1, K2).
- Proposal 2: NR UE is required to report its minimum processing time (N1, N2) to the gNB per each of the factors, and consequently, the UE can be configured with the set of HARQ timing candidates per each of the factors by gNB based on the reported (N1, N2) or the estimated (K1, K2), with consideration of both HARQ latency reduction and HARQ timing flexibility.
- Proposal 3: It needs to be supported to configure different DL HARQ timing (set) according to the ending symbol of DL data transmission.
- Proposal 4: It is necessary to consider reasonable DCI overhead in case with dynamic HARQ timing indication for both DL data and HARQ-ACK.
- Proposal 5: It needs to be considered in NR to determine the minimum HARQ RTT (for the purpose of configuring the maximum HARQ process number to a UE) at least based on the configured maximum HARQ delay, with consideration of dynamic HARQ timing indication.
- Proposal 6: It needs to be considered in NR to configure same or smaller number than that of slots within the minimum HARQ RTT (determined based on the configured maximum HARQ delay) as the maximum HARQ process number, with consideration of dynamic UL/DL configuration.
- Proposal 7: It needs to be considered in NR to set an upper limit of the number used for soft buffer dimensioning, with consideration of performance degradation.
- Proposal 8: HARQ-ACK bundling (within slot and/or across slots) should be supported in NR for both UL coverage limitation and PUCCH payload limitation.
- Proposal 9: Semi-static codebook should be supported for the HARQ-ACK multiplexing in NR with consideration of different TTI length (and different bundling window) per CC.
- Proposal 10: Dynamic codebook should be supported for the HARQ-ACK multiplexing in NR with consideration of DAI signalling and PUCCH transmission across multiple CCs with different TTI length and/or different CBG configuration.

Decision: The document is noted.

[R1-1716429](#) UE processing time and HARQ management Qualcomm Incorporated

- Proposal 1: The processing times (N1,N2) given in Tables 1 and 2 should be considered when determining the HARQ timelines to be supported by NR specification.
- Observation 1: For both DL and UL PHY channels, TDD and FDD can share the same design. RMSI can provide TDD/FDD information.
- Observation 2: TDD-like HARQ timeline can be achieved in FDD with UL and DL slot boundaries aligned at the gNB.
- Observation 3: HD-FDD can be easily adopted for FDD when UL and DL slot boundaries are aligned at the gNB.
- Observation 4: HD-FDD can achieve 78.5% duty cycle with 1 symbol RF switching, 1 symbol control and 1 symbol RF switching in a 14-symbol slot structure when UL and DL slot boundaries are aligned at the gNB.

- Proposal 2: RMSI should provide TDD/FDD information to allow UL and DL slot boundaries to be aligned at the gNB.
- Proposal 3: For the HARQ timelines considered in NR specification, the maximum timing advance used in combination with the processing times (N1,N2) given in Tables 1 and 2 should be based on the maximum RTT of the cell.

Decision: The document is noted.

R1-1716190 HARQ Management for Mini-Slot based Transmissions AT&T

- Proposal 1: At least for some UEs, only a single mini-slot per slot can be allocated
 - There is no restriction on the number of mini-slots scheduled per slot from the network perspective
- Proposal 2: For mini-slot and slot based transmissions to at least some UEs the following should be observed:
 - If a UE is scheduled for a slot based transmission it cannot be scheduled for a mini-slot based transmission
 - If a UE is not scheduled for a slot based transmission it can be scheduled for up to one mini-slot based transmission
- Proposal 3: Both mini-slot based and slot based transmissions should use the same HARQ mechanism including things such as number of processes, feedback periodicity and interlace design.
- Proposal 4: Maximum number of HARQ processes per carrier supported in NR is 8

Decision: The document is noted.

Continue discussion offline – Joseph (Qualcomm)

Wednesday

Agreements:

- For a set of operation conditions, two minimum (K1, K2) values representing two different UE capabilities are supported at least for slot-based scheduling
 - Note: each of the minimum (K1, K2) is based on assumptions of a respective UE turn-around times (N1, N2)
 - FFS the set of operation conditions (e.g., SCS, DM-RS locations, etc.)
 - FFS detailed signalling of UE capability based on (N1, N2) or (K1, K2)

Agreements:

- The set of operation conditions at least include the contents & the notes of Table 1 and the 1st column and the 1st row of Table 4 & Table 5 in [R1-1716865](#)
 - The values in Table 4 can be used as a starting point for further discussion for one of the two UE capabilities at least for slot-based scheduling
 - Note: the values for 60kHz and 120kHz are less mature
 - The values in Table 5 can be used as a starting point for further discussion for the other of the two UE capabilities at least for slot-based scheduling
 - Note: these values are less mature than those in Table 4

Ericsson's comment w.r.t the above agreements: no objection, but what does "slot-based scheduling" mean? That wording has no clear definition...and should be clarified.

RAN1 chair: should be compared to "mini-slot based scheduling"

Proposals:

- All Rel. 15 UEs support mini-slot based scheduling with the following limitations:
 - At least mini-slot lengths of {2,4,7} OFDM symbols
 - At least 14-symbol CORESET monitoring periodicities are supported
 - Except for RMSI, OSI, paging,
 - For 14-symbol CORESET monitoring periodicity
 - Some UEs support at most one mini-slot based allocation per slot
 - If these UEs are scheduled for a slot based transmission they cannot be scheduled for a mini-slot based transmission in the same slot in the same transmission direction
 - If these UEs are not scheduled for a slot based transmission, they can be scheduled for up to one mini-slot based transmission in the same transmission direction
 - At least for these UEs, both mini-slot based and slot based transmissions should use the same HARQ mechanism
 - Note: there is no restriction on the number of mini-slots scheduled per slot from the network perspective

Proposals:

- Slot aggregation is supported by repetition of the same TB on each slot using a single or multiple RVs (Option 1)
 - FFS: other options for TB to slot mapping

Agreement: Bundling of HARQ-ACKs across different CCs for a UE is not supported in Rel-15

Thursday

Agreements:

- For grant-based DL or UL, transmissions where a TB spans multiple slots or mini-slots can be composed of repetitions of the TB
 - The repetitions follow an RV sequence
 - FFS how the sequence is defined in specification
 - FFS if there is one repetition of the TB per slot in the case of repetitions using mini-slots
 - FFS for grant-based DL or UL transmissions, if a TB can span multiple slots without repetitions

R1-1715408	HARQ timing, multiplexing, and bundling	Huawei, HiSilicon
R1-1715488	Discussion on HARQ-ACK codebook	Fujitsu
R1-1715532	On HARQ-ACK multiplexing and bundling	Lenovo, Motorola Mobility
R1-1715546	On the open aspects of HARQ management	Nokia, Nokia Shanghai Bell
R1-1715559	HARQ multiplexing/bundling	ZTE, Sanechips
R1-1715643	UE processing time and HARQ timing	vivo
R1-1715683	Discussion on HARQ-ACK multiplexing	Guangdong OPPO Mobile Telecom.
R1-1715778	HARQ-ACK codebook for CBG-based transmission	Panasonic
R1-1716005	HARQ Management and Feedback	Samsung
R1-1716058	Discussion on timing design with semi-static DL/UL assignment	CMCC
R1-1716105	HARQ-ACK feedback	NTT DOCOMO, INC.
R1-1716262	HARQ timing and management	InterDigital, Inc.
R1-1716321	DL and UL scheduling and HARQ feedback in NR	Intel Corporation
R1-1716538	Number of HARQ processes for co-existence with TD-LTE	NEC
R1-1716545	Discussion on CBG-based HARQ feedback multiplexing	HTC Corporation
R1-1716575	Discussion on HARQ feedback timing	Potevio
R1-1716595	On HARQ Management	Ericsson
R1-1716616	UE-based HARQ-ACK bundling for NR	Sequans Communications
R1-1716635	HARQ-ACK multiplexing for CBG-based (re)transmission	WILUS Inc.
R1-1716658	Discussion on DL/UL scheduling and HARQ management	CATT
R1-1716661	UE Processing Time Evaluation and Timing Relationship	MediaTek Inc.
R1-1716859	WF on HARQ-ACK bundling for NR	LG Electronics

6.3.3.3 CBG-based (re)transmission

[R1-1715407](#) On CBG-based (re)transmission Huawei, HiSilicon

Proposal 1: For CBG-based retransmission, CBGTI is not re-interpreted as NDI.

Proposal 2: A bitmap CBGTI per TB is adopted

- “1” represents the corresponding CBG is (re)transmitted, and “0” represents the corresponding CBG is not (re)transmitted.
- The status “all ones” of CBGTI represents (re)transmission of all CBG(s) and indicates multiple-bits HARQ-ACK feedback, i.e., CBG-level feedback.
- The status “all zeros” of CBGTI represents (re)transmission of all CBG(s) and indicates 1-bit HARQ-ACK feedback, i.e., TB-level feedback.

Proposal 3: The size of the bitmap for the CBGTI is configured by RRC signaling. Further consider:

- Option 1: A dedicated bitmap is adopted.
- Option 2: A common field can be interpreted as the CBGTI (and even for the CBGFI) or other existing usage, e.g., MCS indication.
 - ✓ One explicit bit is added in the DCI for the above interpretation.
 - ✓ The common field should not be interpreted as the CBGTI or the CBGFI when the initial TB contains only one CBG or when all CBGs are retransmitted.

Proposal 4: For UEs configured with CBG-based retransmission, the DCIs scheduling initial transmission and re-transmission should be of the same length to avoid increasing of blind decoding.

Proposal 5: Flush the buffer if DCI scheduling (re)transmission before A/N is detected.

Proposal 6: 1-bit CBGFI is adopted for multiple CW case if configured.

Proposal 7: For multiple CW cases, the gNB configures the maximum number of CBGs per TB.

- Each TB configured with same maximum number of CBGs is preferred.
- Consider each TB configured with different maximum number of CBGs if clear benefits are identified.

Proposal 8: The number of CBG HARQ-ACK bits for a TB is determined as follows

- For the case with HARQ-ACK multiplexing, the number of CBG HARQ-ACK bits for a TB is equal to the configured maximum number of CBG(s).

- For the case without HARQ-ACK multiplexing, the number of CBG HARQ-ACK bits for a TB is equal to the number of CBG(s) consisting of the TB.

Proposal 9: When CBG-based retransmission is configured, use all NACK of CBG-level HARQ-ACK bits to support TB-level NACK if TB CRC fails even though all CB CRCs pass.

Proposal 10: Falling back to TB-based feedback is supported when all CBGs are correctly decoded or all CBGs are not correctly decoded.

Decision: The document is noted.

R1-1715560 Discussion on CBG based (re)transmission ZTE, Sanechips

- Proposal 1: At least for single CW case, it is supported that the maximum number of CBGs per TB is indicated by RRC signaling, and it is supported that the configured number of CBGs per TB can be modified by L1 signaling.
- Proposal 2: The gNB configures the maximum number of CBGs to be shared by both CWs. The number of CBGs per CW is divided from the maximum number of shared CBGs based on TB size or the allocated number of layers.
- Proposal 3: RAN1 shall support the possibility of CBG based feedback together with TB-based feedback.
- Proposal 4: RAN1 shall support dynamic feedback based on TB or CBG HARQ-ACK in the same resource. The detailed method is FFS.
- Proposal 5: Each CBG is grouped by CBs with similar BLER
- Proposal 6: RAN1 should allow for configurable intra slot regions in which uniform CBG is performed for each respective region.
- Proposal 7: NR supports lower overhead CBG based ACK/NACK feedback scheme which indicates only the start position of the first NACK and the number of consecutive NACKs.

Decision: The document is noted.

Discussion further offline – LGE (Yunjung)

Wednesday

Proposals:

- When a UE is configured with CBG-level re-transmission, the UE can be scheduled with either TB level (re)transmission or CBG-level retransmission for a given TB dynamically. In consideration of UE blind decoding complexity, the following options are considered
 - The same DCI payload size is used for DCIs scheduling between TB level (re)transmission and CBG level retransmission for the same TB(s)
 - Including NDI/CBGTI aspects

Thursday

Agreements:

- For a UE configured with CBG-based (re)transmission, the same DCI payload size is assumed for initial transmission and retransmission for the same TB(s)
 - Note that this does not intend to address fallback DCI aspect
- L1 signalling to indicate the number of CBGs per TB is not supported in Rel-15

R1-1715489	Discussion on DL control signaling and compressed HARQ-ACK feedback for CBG based (re-)transmission;
R1-1715533	Fujitsu
R1-1715533	Remaining issues on CBG-based (re)transmission
R1-1715547	Lenovo, Motorola Mobility
R1-1715547	On remaining aspects of CBG based transmissions
R1-1715644	Nokia, Nokia Shanghai Bell
R1-1715644	Support of CBG-based (re)transmission
R1-1715684	vivo
R1-1715684	Discussion on CBG-based (re)transmission
R1-1715745	Guangdong OPPO Mobile Telecom.
R1-1715745	Discussion on the remaining issues of CBG-based (re)transmission
R1-1715780	ITRI
R1-1715780	CBG-based (re)transmission
R1-1715826	Panasonic
R1-1715826	Remaining aspects of CBG-based operation
R1-1715887	CATT
R1-1715887	Considerations on CBG based retransmission for NR
R1-1716006	LG Electronics
R1-1716006	CBG-Based DL/UL Retransmissions
R1-1716066	Samsung
R1-1716066	HARQ-Ack/Nack for DL CBG based transmission
R1-1716106	Sequans Communications
R1-1716106	Signalling design for CBG-based (re)transmission
R1-1716135	NTT DOCOMO, INC.
R1-1716135	HARQ-ACK Feedback for CBG-based (re-)transmission
R1-1716186	Fraunhofer HHI
R1-1716186	Remaining details for CBG based re(transmissions)
R1-1716249	AT&T
R1-1716249	DL control signalling for CBG-based (re)transmission
R1-1716257	Sony
R1-1716257	CBG-based (re)transmission
R1-1716273	InterDigital, Inc.
R1-1716273	Discussion on CBG-based (re)transmission
R1-1716273	Sharp

R1-1716322	Details of CBG-based transmissions for NR	Intel Corporation
R1-1716430	CBG-based (re)-transmission	Qualcomm Incorporated
R1-1716544	Discussion on DL/UL control signalling for CBG-based retransmission	HTC Corporation
R1-1716571	Considerations on HARQ for CBG-based transmission	KT Corp.
R1-1716596	On CBG Based Transmissions and Retransmissions	Ericsson
R1-1716634	On DCI Design for CBG-based (re)transmission	WILUS Inc.

6.3.3.4 UL data transmission procedure

Including details for single/multiple SR configurations, aspects related to with and without grants, etc.

[R1-1715540](#) Discussion on SR related procedures Lenovo, Motorola Mobility

- Proposal 1: No matter 1 bit or multi-bit SR is supported, latency requirement and traffic characteristic related information should be indicated to gNB as early as possible to reduce scheduling latency. Both implicit and explicit ways can be further studied.
- Proposal 2: The tradeoff between flexibility and resource efficiency needs to be considered for deciding one or multiple SR configurations.
- Proposal 3: SR should support flexible grant-free transmission adjustment and switching between transmission with and without grant.

Decision: The document is noted.

[R1-1715548](#) Remaining issues on UL transmission without grant Nokia, Nokia Shanghai Bell

- Proposal 1: A RV pattern is applied in the repeated transmission of the grant-free TB.
- Proposal 2: The configuration of repetition is through combined RRC signaling and L1 activation.
- Proposal 3: RNTI for both type 1 and type 2 grant-free transmission is configured through RRC signaling.
- Proposal 4: The number of HARQ processes for grant-free should be configurable.
- Proposal 5: An explicit ACK is transmit to the user when a grant-free transmission is successful. The ACK can be transmitted during or after K repetitions.
- Proposal 6: The HARQ process ID is implicitly decided by the logical slot index and/or T-F resources.
- Proposal 7: When multiple resources are configured at a time, the UE follows a preconfigured pattern to choose/camp on a specific resource based on at least the slot index.

Decision: The document is noted.

Continue offline discussion – Lihui (DoCoMo)

Wednesday

[R1-1716851](#) Offline summary for UL transmission procedures NTT DOCOMO

[R1-1716847](#) [Draft] Reply LS on BWP operation in NR Samsung

Decision: The LS in [R1-1716847](#) is endorsed and approved in [R1-1716874](#) with the following update:

- In RAN1#90, RAN1 agreed that it is up to RAN2 how many SR configurations the UE can be configured with. ~~Therefore, RAN1 recommends RAN2 to make a decision within their scope particularly regarding the max number of SR configurations within a single UL BWP. -Therefore, from RAN1 perspective, up to [8] SR configurations can be supported in a single UL BWP for a UE.~~

Agreement: Type 3 UL transmission without UL grant is not supported in Rel.15.

Proposals:

- Multiple resource configurations for UL tx without UL grant can be configured to a UE
- For UL tx without UL grant, the same resource configuration is used for K repetitions including the initial transmission
 - Note: RAN1 needs to discuss K repetitions vs. slot aggregation
- Note: multiple configurations may be used for following cases, for example:
 - Use case 1: for different services
 - Use case 2: for different HARQ processes for the same/different services

Agreements:

- The design for Type 1 and Type 2 UL transmission without UL grant is based on both slot and mini-slot based tx (at least 7, 4, and 2 OFDM symbols for Dec. 2017)
- FFS BWP related information for frequency domain resource allocation

Proposals:

- RRC configured frequency-hopping across repetitions is supported
 - FFS details

Proposals:

- At least for Type 1, RV(s) used cross repetitions is/are configured by RRC.
- To discuss further especially w.r.t. slot aggregation related discussion

Thursday

Agreements:

- For UL transmission with grant, to down-select (including possible combinations) from:
 - Option 1: waveform type is determined from DCI
 - 1-1: Explicit 1-bit field in the UL grant
 - 1-2: Implicitly derived by other information
 - 1-2-1: Some entries of MCS table are for DFT-s-OFDM for 1 layer transmission, while others for CP-OFDM
 - 1-2-2: Based on the different DCI sizes
 - 1-2-3: Based on the search space where the UL grant is detected
 - FFS: the DCI-based determination is always enabled or is enabled/disabled by RRC signalling
- Option 2: waveform type is configured by UE-specific RRC
- Option 3: waveform type follows the information by RMSI for Msg3
- Option 4: waveform type is indicated by MAC CE
- Note: For Msg3, waveform is informed by the RMSI
 - If no agreement is done, all UE follows the information by the RMSI

Agreements:

- For Type 1 UL transmission without grant, to down-select (including possible combinations) from:
 - Option 1: waveform type is determined from UE-specific RRC
 - 1-1: Explicitly configured by the RRC
 - 1-2: Implicitly derived by other information in RRC
 - E.g., some entries of MCS table are for DFT-s-OFDM for 1 layer transmission, while others for CP-OFDM
 - Option 2: waveform type follows the information by RMSI for Msg3

Agreements:

- For Type 2 UL transmission without grant, to down-select (including possible combinations) from:
 - Option 1: waveform type is determined from DCI
 - 1-1: Explicit 1-bit field in the UL grant
 - 1-2: Implicitly derived by other information
 - 1-2-1: Some entries of MCS table are for DFT-s-OFDM for 1 layer transmission, while others for CP-OFDM
 - 1-2-2: Based on the different DCI sizes
 - 1-2-3: Based on the search space where the UL grant is detected
 - FFS: the DCI-based determination is always enabled or is enabled/disabled by RRC signalling
- Option 2: waveform type is configured by UE-specific RRC
- Option 3: waveform type follows the information by RMSI for Msg3
- Option 4: waveform type is indicated by MAC CE
- Note: For Msg3, waveform is informed by the RMSI
 - If no agreement is done, all UE follows the information by the RMSI
- Aim to have the same solution as in the UL with grant case

Agreements:

- Multiple resource configurations for UL tx without UL grant can be configured to a UE
- For UL tx without UL grant, the same resource configuration is used for K repetitions for a TB including the initial transmission

R1-1715562	Further discussion on UL transmission without grant	ZTE, Sanechips	
R1-1715605	High overhead in low periodicity PUCCH-SR and the advantages of Underlay SR		Idaho National Laboratory
R1-1715645	Support of UL data transmission without grant	vivo	
R1-1715656	Interleaved Repetition Transmission for UL Grant-Free Transmission	NICT	
R1-1715662	Remaining issues on UL transmission without grant	NEC Corporation	
R1-1715769	DL HARQ-ACK for GF PUSCH transmission	ETRI	
R1-1715827	Grant-based and grant-free UL transmission procedures	CATT	
R1-1715888	Discussion on UL data transmission procedure	LG Electronics	
R1-1716007	Procedures for UL Transmissions	Samsung	
R1-1716059	Discussion on scheduling for SPS	CMCC	
R1-1716117	UL Transmission without Grant	Sequans Communications	
R1-1716250	Discussion on the pre-emption and HARQ of UL transmission without grant		Sony
R1-1716274	K Repetitions of UL Transmission: L1 Signaling Is Needed	Sharp	
R1-1716323	UL data transmission procedures in NR	Intel Corporation	
R1-1716431	L1 signaling for GF UL transmission	Qualcomm Incorporated	
R1-1716483	On remaining details of UL data transmission without grant	InterDigital, Inc.	
R1-1716516	Resource configuration and HARQ operation for UL transmission without grant	China Telecommunications	
R1-1716563	Data transmission and HARQ-ACK feedback for URLLC	Shenzhen Coolpad Technologies	
R1-1716568	Discussion on Grant-Free UL transmission	ITL	
R1-1716597	On UL Data Transmission Procedures	Ericsson	
R1-1716623	On UL data transmission without grant: design and configuration		MediaTek Inc.
R1-1716664	UL data transmission without UL grant	NTT DOCOMO, INC.	
R1-1716846	Way Forward on SR Periodicity for NR	Idaho National Laboratory, IITH, CEWIT, IITM,	Tejas Networks, Interdigital, KDDI

6.3.3.5 Soft-buffer management for NR

Including multi-carrier aspects within NR and DC with LTE

[R1-1716598](#) On Transmit, Decode and Soft Buffers Ericsson

- Proposal 1 Limited buffer rate matching is not used in NR. Both transmit buffer and decode buffer support the mother code rate of the LDPC code.
- Proposal 2:
 - The soft buffer memory size does not have to be designed with simultaneous support of peak rate, full IR support, and the maximum number of HARQ processes in mind.
 - The UE should be capable of soft buffering a certain number of code blocks (the number may depend on UE capabilities).
 - UE implementation is encouraged to incorporate dynamic sharing of soft buffer amongst multiple carriers.
 - For UEs with no dynamic sharing between carriers, the soft buffer is of size N code blocks per carrier.
 - For UEs with dynamic sharing between carriers, the soft buffer is of size $M < C \cdot N$ where C is the number of supported carriers.
- Proposal 3 LTE and NR carriers can share the soft buffer dynamically to increase effectiveness of the soft buffer memory.
- Proposal 4 A UE category for LTE-NR dual connectivity is no different than a UE category supporting the same total number of connected carriers.

Decision: The document is noted.

[R1-1716432](#) Considerations for soft buffer management Qualcomm Incorporated

- Proposal 1: Limited buffer rate matching (LBRM) should be applied per HARQ process such that TBs at the peak spectral efficiency can support HARQ down to an effective code rate of 4/9.
- Proposal 2: Define reference number of HARQ processes to be the minimum number that considers fundamental UE and gNB processing delay assuming all slots are DL centric slots. In this case, the reference number of HARQ processes should be defined to be 3 for NR.
- Proposal 3: The maximum number of HARQ processes in NR specification is 8 across all SCS, but should also be semi-statically configurable to a lower number for each UE depending on other aspects such as RTT, bandwidth, and throughput configurations.
- Proposal 4: A set of reference parameters should be considered soft buffer dimensioning which targets a downlink HARQ RTT of 1.5ms for a data rate of 5Gbps.
- Proposal 5: Soft buffer management based on semi-static partitioning across HARQ processes should be at least supported in NR.

- Proposal 6: Soft buffer management should support semi-statically configuring the number of HARQ processes needed for IR HARQ on a UE-specific basis.

Decision: The document is noted.

Continue discussion offline – Ajit (Intel)

Wednesday

[R1-1716873](#)

Summary for 6.3.3.5

Intel

Conclusion:

- RAN1 aims to finalize details of transmit buffer rate-matching (for PDSCH/PUSCH) in RAN1#90bis
- FFS UE soft buffer dimensioning especially in relation to UE capability/category
- FFS NR soft buffer management
- FFS LTE-NR soft buffer dimensioning and management, especially in relation of UE capability/category

[R1-1715406](#)

Soft buffer handling Huawei, HiSilicon

[R1-1715549](#)

On the HARQ soft buffer handling Nokia, Nokia Shanghai Bell

[R1-1715746](#)

Soft Buffer Handling for CBG-based (re)transmission ITRI

[R1-1715828](#)

Soft buffer management for NR CATT

[R1-1715889](#)

Discussion on soft buffer management for NR LG Electronics

[R1-1716008](#)

Soft Buffer Management Samsung

[R1-1716324](#)

Soft-buffer management Intel Corporation

[R1-1716530](#)

Views on soft-buffer management for NR NTT DOCOMO INC.

6.3.3.6 Multiplexing data with different transmission durations

[R1-1715646](#)

Multiplexing data with different transmission durations vivo

- Observation 1: DL reference signal may be preempted by URLLC data transmission.
- Observation 2: Considering the high priority requirement of URLLC data transmission, to avoid preemption of reference when scheduling may lead to URLLC performance degradation and increased transmission latency.
- Observation 3: eMBB UE suspending transmission based on an announcement signal during the on-going UL transmission may lead to additional UE power consumption, complexity, or interference arise.
- Proposal 1: For a PDSCH transmitted in slot n and corresponding HARQ-ACK to be transmitted in slot n+k, UE behavior is dependent on the timing of preemption indication and the UE processing time
 - UE is not expected to receive a preemption indication after slot n+k-x, where x depends on the minimum processing time of UE
 - If there is sufficient processing time between a preemption indication and the HARQ-ACK feedback timing regarding PDSCH in slot n, UE can discard the preempted part of data and re-decode the PDSCH in slot n before generating HARQ-ACK.
 - If there is no sufficient processing time between a preemption indication and the HARQ-ACK feedback timing regarding PDSCH in slot n, UE would not re-decode the PDSCH in slot n but flush the preempted part of data in the soft buffer
- Proposal 2: Whether and how to handle preemption of reference signal and the related UE behavior need to be further studied.
- Proposal 3: UL multiplexing data with different transmission durations based on gNB scheduling should be the baseline scheme.
- Proposal 4: The grant to suspend UL transmission of eMBB UE should be further investigated.
- Proposal 5: In case of multiplexing of URLLC grant-free data transmission and eMBB data transmission for a UE, whether and how to prioritize URLLC data transmission should be further discussed.

Decision: The document is noted.

[R1-1716251](#)

Remaining issues on pre-emption indicator

Sony

- Proposal 1: The group common DCI carrying the pre-emption indicator is transmitted separately from SFI.
- Proposal 2: The periodicity and offset of the GC-PDCCH search space carrying the pre-emption indicator are configurable.
- Proposal 3: The frequency region of the reference downlink region is semi-statically configured.
- Proposal 4: The time region of the reference downlink region is implicitly configured, i.e. the length of the time region is equal to the period of the GC-PDCCH carrying the pre-emption indicator.

- Proposal 5: The time and frequency granularities of the pre-emption indicator are determined implicitly by the configuration of the periodicity of the GC-PDCCH carrying the pre-emption indicator and the frequency region of the reference downlink region.
- Proposal 6: A 2 dimensional time-frequency bitmap (e.g. 5×7) of fixed size (e.g. 35 bits) is used for the pre-emption indicator.
- Proposal 7: The UE can be configured to monitor multiple pre-emption indicators during a single eMBB transmission. The UE monitors the pre-emption indicator whose corresponding GC-DCI reference downlink region overlaps the UE's eMBB transmission.
- Proposal 8: Simultaneous monitoring of multiple pre-emption indicators is not supported. If simultaneous pre-emption indicators are present, The UE monitors the pre-emption indicator whose corresponding GC-DCI reference region overlaps majority of the UE's eMBB transmission.
- Proposal 9: If subsequent retransmission is supported, the pre-emption indicator should also indicate whether the UE should monitor for a subsequent retransmission after the eMBB transmission and before the UE sends the HARQ feedback.
- Proposal 10: If subsequent retransmission is scheduled, the DCI scheduling the subsequent retransmission would indicate a new resource (time and frequency) for the HARQ feedback that overrides the resources for the original HARQ feedback.

Decision: The document is noted.

Continue discussion offline – Xueming (vivo)

Wednesday

Agreement:

- UE can be configured to monitor the group common PDCCH for SFI and the group common DCI for DL preemption indication within the same or different CORESETs

Thursday

R1-1716911

Summary of offline discussion on preemption indication vivo

Agreements:

- As a **working assumption**
 - The time duration of the reference downlink resource for preemption indication equals to the monitoring periodicity of the group-common DCI carrying the preemption indication
- For determination of the frequency region of the reference downlink resource for preemption indication, down select between the following options in RAN1#90bis
 - Option 1: The frequency region of the reference downlink resource is configured explicitly by RRC
 - Option 2: The frequency region of the reference downlink resource is implicitly derived by the active DL BWP
- NOTE: Companies are encouraged to address the issues highlighted in the offline summary T-doc [R1-1716911](#)

Agreement:

- The minimum periodicity for UE to monitor group common DCI for DL preemption indication is down-selected between
 - Option 1: one slot
 - Option 2: less than a slot

R1-1715409	On pre-emption indication for DL multiplexing of URLLC and eMBB	Huawei, HiSilicon
R1-1715491	On eMBB and URLLC multiplexing for Uplink	Fujitsu
R1-1715550	Pause-Resume Scheduling for Low Latency Uplink Transmissions	Nokia, Nokia Shanghai Bell
R1-1715561	About DL pre-emption indication	ZTE, Sanechips
R1-1715691	Multiplexing between slot-based and symbol-based transmissions and pre-emption indication	Guangdong
OPPO Mobile Telecom.		
R1-1715711	Discussion on DL preemption indication	NEC
R1-1715829	On multiplexing of data with different transmission durations	CATT
R1-1715890	Remaining issues on pre-emption indication for downlink	LG Electronics
R1-1716009	Indication of Preempted Resources in DL	Samsung
R1-1716191	Scheduling Details for Mini-Slot based Transmissions	AT&T
R1-1716196	Multiplexing of UL eMBB and URLLC in NR	ASUSTEK COMPUTER (SHANGHAI)
R1-1716325	Multiplexing of different data channel durations	Intel Corporation
R1-1716433	On slot aggregation	Qualcomm Incorporated
R1-1716484	On UL multiplexing of data with different transmission durations	InterDigital, Inc.
R1-1716531	Multiplexing data with different transmission durations	NTT DOCOMO INC.
R1-1716573	Remaining on preemption indication for DL	KT Corp.

R1-1716599	On Multiplexing Data with Different Transmission Durations	Ericsson
R1-1716617	On remaining aspects for preemption-based data multiplexing	Sequans Communications
R1-1716636	Discussion on UE behavior by pre-emption indication	WILUS Inc.
R1-1716646	Discussion of pre-emption indication design for downlink	KDDI Corporation
R1-1716652	Discussion on the design of DL preemption indication	CATR
R1-1716910	WF on preemption indication	Huawei

6.3.3.7 Other

Including URLLC related aspects.

R1-1715411	Support of URLLC for TDD	Huawei, HiSilicon
R1-1715412	On supporting ultra reliability in a resource efficient way	Huawei, HiSilicon
R1-1715414	Link adaption and CSI reporting for URLLC transmission	Huawei, HiSilicon
R1-1715415	Discussion on over-the-air time synchronization for URLLC	Huawei, HiSilicon, SIA
R1-1715420	On multiple resource configuration for UL grant-free transmission	Huawei, HiSilicon
R1-1715421	Discussion on UL multiplexing of grant-based eMBB and grant-free URLLC	Huawei, HiSilicon
R1-1715529	Ultra-reliable part of URLLC for scheduling/HARQ procedure	ZTE, Sanecips
R1-1715534	HARQ design for uplink grant-free transmission	Lenovo, Motorola Mobility
R1-1715551	CSI measuring and reporting procedure for URLLC	Nokia, Nokia Shanghai Bell
R1-1715552	Discussion on scheduling based URLLC transmission	Nokia, Nokia Shanghai Bell
R1-1715553	On reliability enhancement for scheduling information transmission	Nokia, Nokia Shanghai Bell
R1-1715554	Generalization of PDCCH resource reuse as forward compatibility resource reservation	Nokia, Nokia Shanghai Bell
R1-1715568	Consideration on subsequent transmission after pre-emption	Huawei, HiSilicon
R1-1715569	PDSCH reliability for URLLC	Huawei, HiSilicon
R1-1715572	On cross-BWPs and cross-numerology retransmission	Huawei, HiSilicon
R1-1715575	HARQ operation and feedback indication design for UL grant-free transmission	Huawei, HiSilicon
R1-1715647	Discussion on scheduling and HARQ for URLLC reliability	vivo
R1-1715702	Discussion on the UL waveform indication	Guangdong OPPO Mobile Telecom.
R1-1715714	On uplink data scheduling and hopping	Huawei, HiSilicon
R1-1715715	On data channel scrambling	Huawei, HiSilicon
R1-1715891	Discussion on scheduling and HARQ procedure for URLLC	LG Electronics
R1-1716010	Indication of Preempted Resources for TB-based Retransmission	Samsung
R1-1716011	Latency Analysis for Preemption based Multiplexing in DL	Samsung
R1-1716012	Multiplexing Transmissions with Different Durations	Samsung
R1-1716013	Procedure for UL Transmissions without Grant	Samsung
R1-1716014	Scheduling/HARQ Procedures for URLLC	Samsung
R1-1716015	Indication of Preempted Resources in UL	Samsung
R1-1716016	Downlink Preemption Indication Prior to HARQ-ACK Feedback	Samsung
R1-1716017	Triggered UCI Transmissions	Samsung
R1-1716018	On SS Block/PDSCH/DMRS Multiplexing	Samsung
R1-1716108	Scheduling and HARQ procedures for URLLC	NTT DOCOMO, INC.
R1-1716126	Resource Configuration and HARQ RV details for Uplink Grant Free	TCL Communication Ltd
R1-1716136	Early HARQ for URLLC	Fraunhofer HHI
R1-1716231	Frequency hopping for NR UL PUSCH	NEC
R1-1716263	Supporting downlink SPS in NR	InterDigital, Inc.
R1-1716326	On link adaptation enhancements to support URLLC	Intel Corporation
R1-1716434	URLLC DL pre-emption and UL suspension indication channel design	Qualcomm Incorporated
R1-1716435	Timing advance for different numerology	Qualcomm Incorporated
R1-1716436	UL URLLC Capacity Based on URLLC and eMBB dynamic multiplexing	Qualcomm Incorporated
R1-1716437	MPR issue with distributed RB allocation in UL	Qualcomm Incorporated
R1-1716438	Uplink Resource for SR	Qualcomm Incorporated
R1-1716439	Short PUSCH transmission in UL short duration	Qualcomm Incorporated
R1-1716539	On reliability of URLLC UL grant-free transmission	III
R1-1716554	Discussion on URLLC transmitted in same or different numerology resources	ASUSTEK COMPUTER
(SHANGHAI)		
R1-1716600	On Supporting High Reliability for Data Transmissions	Ericsson
R1-1716624	On use of scrambling for UL Grant-free URLLC transmission	MediaTek Inc.
R1-1716625	HARQ procedure for DL URLLC	MediaTek Inc.

6.3.4 Other aspects on carrier aggregation and bandwidth parts

Including dual connectivity (if any)

R1-1715755 On remaining aspects of NR CA/DC and BWPs Nokia, Nokia Shanghai Bell

- Proposal-1: In NR, a primary cell:
 - consists of UL PCC and DL PCC that carry the RRC connection, UCI, PUCCH and common search space.
 - UL and/or DL PCC can be semi-statically changed between CCs of a cell-group
- Proposal-2: SCC can be UL-only CC, DL-only CC or UL&DL CC.
- Proposal-3: In R15, in each cell a single UL and/or DL BWP is active at a given time.
- Observation-1: To enable full support of cross-numerology-carrier scheduling, RAN1 specification should support both: one-to-many slot-based cross-numerology scheduling and many-to-one slot-based cross-numerology scheduling.
- Proposal-4:
 - In R15 NR, support cross-carrier scheduling only by means of single-slot/mini-slot scheduling.
 - For future NR releases consider support of cross-carrier scheduling also by means of multi-slot scheduling.
 - One TB is mapped per each slot per codeword to reduce latency and enable peak data rate.
- Proposal-5: RAN1 should consider joint coding of CIF and BWPI.
- Proposal-6: For slot-based scheduling, the first cross-numerology and cross-carrier schedulable slot is the first slot starting not earlier than the slot where it was scheduled.
- Proposal-7: For mini-slot/symbol-based scheduling, the first cross-numerology and cross-carrier schedulable symbol is the first symbol starting not earlier than the CORESET where it was scheduled.
- Observation-2: Latency can be reduced when DL component carriers with different UE minimum processing times use different DL association sets.
- Proposal-8: Determination of DL association set for HARQ feedback is flexible and based on the indicated timing relationship between DL data reception and corresponding acknowledgement.
- Proposal-9: DL association set is determined separately for DL CCs having different UE minimum (configured) processing time.
 - Same DL association set may be used for DL CCs with the same UE minimum (configured) processing time.
- Proposal-10: In case of dynamic codebook determination, HARQ ACK sub-codebook is determined separately for each DL CC set sharing the same UE minimum (configured) processing time.
- Proposal-11: In case of dynamic codebook determination, counter DAI and total DAI mechanism are used in the HARQ ACK codebook determination.
- Proposal-12: TAG can contain component carriers with BWPs of different numerologies.
- Proposal-13: Adopt DL assignment/UL grant based activation/deactivation/adaptation of an active BWP.
- Proposal-14: A UE monitors a single DCI format size for DL assignments and a single DCI format size for UL grants irrespective of which BWP is active on the carrier. FFS same DCI format size for DL assignment and UL grants.
- Proposal-15: If a UE is configured with more than one BWP, a DL assignment or UL grant contains an explicit DCI field (BWPI), which indicates to a UE a BWP on which the data transmission has been scheduled.
- Proposal-16: For TDD, a single BWP is configured for both UL and DL. UE may adapt active BWP among configured BWPs either by UL grant or DL assignment.
- Observation-3: A DRX-inactivity-timer may order a UE to retune to default BWP. Therefore, the specification of an additional timer is unnecessary.
- Observation-4: Reception of a scheduling DCI should not cause automatic activation of another BWP.
- Proposal-17: The reference point for common indexing is configured to a UE by means of dedicated/user-specific RRC signalling.
- Proposal-18: For FDD, a separate reference point for common indexing is configured for UL. The reference point is user-specifically configured with respect to initial UL BWP defined by RACH resource (details of an initial UL BWP are up to initial access).
- Proposal-19: Revise the previous agreement accordingly:
 - *When a UE performs measurement or transmit SRS outside of its active BWP, it is considered as a measurement resp. SRS switching gap*
 - *FFS: details of measurement gap configuration*
 - *FFS: detail of SRS switching gap configuration*
 - *During the measurement gap, UE is not expected to monitor CORESET.*
- Proposal-20: Support at least aperiodic/triggered RRM measurements and SRS transmissions outside of active BWP
 - FFS on periodic.

Decision: The document is noted.

R1-1716202 Remaining Details on Bandwidth Part Operation in NR MediaTek Inc.

Proposal #1: At least for the case of TDM between SS-block and RMSI, the configuration of initial active DL bandwidth part is the same as that for RMSI and its corresponding CORESET and it's signalled in PBCH.

- FFS for the case of FDM between SS-block and RMSI

Proposal #2: The configuration of initial active UL bandwidth part is signalled in RMSI and it should include RACH resources for initial access.

- For TDD, a UE is not expected to retune the center frequency of channel BW between DL and UL if the configurations of initial active DL bandwidth part and initial active UL bandwidth part are different.

Proposal #3: The maximal number of configured BWPs is 8 in NR R15.

Proposal #4: Support one of the following options for CSS monitoring.

- Option #1: No periodic gap for CSS monitoring on PCell
 - For PCell, one of configured DL bandwidth parts includes one CORESET with the CSS type for RMSI & OSI
 - For PCell, each configured DL bandwidth part includes one CORESET with the CSS type for RACH response & paging control
 - For each serving cell, each configured DL bandwidth part includes one CORESET with the CSS type for pre-emption indication and other group-based commands.
- Option #2: Periodic gap for CSS monitoring on PCell
 - For PCell, one of configured DL bandwidth parts includes one CORESET with CSS type for RMSI, OSI, RACH response & paging control
 - For each serving cell, each configured DL bandwidth part includes one CORESET with the CSS type for pre-emption indication and other group-based commands.

Proposal #5: Support explicit signalling in PDSCH/PUSCH scheduling DCI

Proposal #6: The maximal number of DL/UL bandwidth part configurations for a UE per carrier is 8.

Proposal #7: DL bandwidth part configuration further includes periodic TRS configuration for time/frequency tracking & AGC settling if it exists.

- FFS the necessity of aperiodic TRS triggered by DCI-based activation/deactivation signaling

Proposal #8: For the scheduling DCI used for active DL BWP change, the corresponding DL scheduling timing, K0, is larger than zero.

Proposal #9: A UE is not expected to perform CSI measurement outside the active BWP.

Proposal #10: For a UE, CSI-RS RRM measurement configuration doesn't reuse BWP configurations.

Proposal #11: For a UE, SS-block RRM measurement configuration doesn't reuse BWP configurations.

Decision: The document is noted.

R1-1716440 CA and BWP Qualcomm Incorporated

Proposal 1: NR adopts a unified framework for configuration/activation/deactivation of CC and BWP.

- Pre-configuration via UE-specific RRC signalling
- L1 activation/deactivation via DCI followed by ACK

Proposal 2: For BWP activation, implicit scheduling based activation is also supported. ACK to the activation can be merged to the ACK for the scheduled data.

Proposal 3: Emission mask requirement is common to all the BWPs within a CC.

Observation 1: DCI-based CA/BWP activation/deactivation command provides shorter latency than the MAC CE-based activation/deactivation.

Proposal 4: Improved CA/BWP activation/deactivation timeline should be considered for NR compared to LTE.

- ACK timing and action time for CA/BWP activation/deactivation should be further studied in RAN1.
- Improved overall CA/BWP activation timeline that UE is ready to report valid CSI report should be further studied in RAN4.

Proposal 5: Cross carrier slot-based scheduling is allowed toward equal or later slot only (defined by the beginning of the slot).

Proposal 6: When a larger SCS schedules a smaller SCS for DL data, the overlapping slot is considered as K0=0.

Proposal 7: When a smaller SCS schedules a larger SCS for DL data, K0=0 is defined for the slot whose beginning slot boundary is aligned with that of the slot containing PDCCH with DL grant.

Proposal 8: A separate DCI per grant is supported for cross carrier scheduling with mixed numerology. A joint grant is also supported for NR.

Proposal 9: When a larger SCS schedules a smaller SCS for UL data, the overlapping slot is considered as K2=0.

Proposal 10: When a smaller SCS schedules a larger SCS for UL data, K2=0 is defined for the slot whose beginning slot boundary is aligned with that of the slot containing PDCCH with UL grant.

Proposal 11: When A/N is transmitted on a carrier with a smaller SCS, the overlapping slot is considered as K1=0.

Proposal 12: When A/N is transmitted on a carrier with a larger SCS, K1=0 is defined for the slot whose ending slot boundary is aligned with that of the slot containing PDSCH.

Proposal 13: NR supports cross carrier group common PDCCH.

Proposal 14: NR supports a single power control group corresponding to a group of the same numerology per band.

Proposal 15:

- For Rel-15 phase 1, introduce the support of cross carrier DCI/UCI/CSI/UL TA within a group of the same numerology.
- For Rel-15 phase 2, introduce the support of cross carrier DCI/UCI/CSI between mixed numerology.

Decision: The document is noted.

Continue offline discussion – Aris (focusing on CA)/Peikai (focusing on BWP)

Wednesday
[R1-1716832](#)

Summary of Offline Discussion on Bandwidth Part Operation

MediaTek

Agreement: In Rel-15, for a UE, there is at most one active DL BWP and at most one active UL BWP at a given time for a serving cell

Agreements:

- For each UE-specific serving cell, one or more DL BWPs and one or more UL BWPs can be configured by dedicated RRC for a UE
 - FFS association of DL BWP and UL BWP
 - FFS definition of an active cell in relation to DL BWP and UL BWP, whether or not there are cross-cell/cross-BWP interactions

Agreements:

- NR supports the case that a single scheduling DCI can switch the UE's active BWP from one to another (of the same link direction) within a given serving cell
 - FFS whether & how for active BWP switching only without scheduling (including the case of UL scheduling without UL-SCH)

Proposals:

- For an Scell (including primary Scell in case of DC), a reference location is signaled to the UE for common PRB indexing for the Scell
 - FFS details of reference location
- Further discussion offline especially w.r.t. the interaction w/ SS block presence on the Scell

[R1-1716830](#) **Open Issues for CA** Samsung

The document summarizes the outcomes of Tuesday's offline.

Agreement: Maximum number of HARQ processes for unicast PDSCH is configured per cell for a UE

- FFS impact on DCI design

Number of CIF bits:

Majority prefers a fixed number of 3 bits - Ericsson, Huawei, HiSilicon, NTT DOCOMO, Intel, NEC, OPPO, Mediatek, LGE, Nokia, NSB, MotM, Lenovo, Sharp

Sized to the number of configured cells: supported by Qualcomm, Samsung, Panasonic – did not object, ok to go with the majority but warned that payload size will require optimization

Agreements:

- For NR CA:
 - If CIF is present in DCI, the bitwidth is fixed at 3 bit
 - Note: BWP index (if available) is always a separate information field
 - FFS detailed conditions for CIF presence

Working assumption:

- In case of cross-carrier scheduling, UESS search spaces for the scheduling cell and for the scheduled cell(s) are separated by offset(s) if they are in the same CORESET
 - The offset(s) depends on CIF
 - FFS details
 - FFS the case of same DCI size (whether to have shared search space or not)

Agreements:

- UE can be configured to monitor group common CSS for at least pre-emption indication on a Scell
- UE can be configured to monitor SFI in group common PDCCH for a Scell at least on the same Scell, or on a different cell (as a **working assumption**)
 - FFS details

Discuss further offline numerology in a PUCCH group especially for SUL case

R1-1715425	Overview of bandwidth part, CA, and DC operation including SRS switching	Huawei, HiSilicon
R1-1715492	Considerations on UCI feedback for carrier aggregation	Fujitsu
R1-1715517	Consideration on monitoring preemption indication in bandwidth parts	Spreadtrum Communications
R1-1715535	HARQ-ACK codebook size determination for CA with different numerologies	Lenovo, Motorola Mobility
R1-1715648	Remaining details for bandwidth part operation	vivo
R1-1715692	Remaining issues on bandwidth part configuration and activation	Guangdong OPPO Mobile Telecom.
R1-1715770	Remaining details of bandwidth part for initial access ETRI	
R1-1715774	Combining DRX with BWP adaptation	PANASONIC
R1-1715830	Remaining aspects of CA and wider bandwidth operation	CATT
R1-1715892	Discussion on carrier aggregation and bandwidth parts	LG Electronics
R1-1716019	On Bandwidth Part Operation	Samsung
R1-1716109	Remaining issues on bandwidth parts for NR	NTT DOCOMO, INC.
R1-1716192	Remaining Details of Carrier Aggregation and Bandwidth Parts	AT&T
R1-1716258	Remaining details of BWPInterDigital, Inc.	
R1-1716327	Remaining aspects for carrier aggregation and bandwidth parts	Intel Corporation
R1-1716601	On CA related aspects and BWP related aspects	Ericsson
R1-1716647	Discussion on BWP Design	Conviva Wireless LLC
R1-1716909	WF on common PRB indexing	Huawei

6.3.5 Other

Including remaining aspects related to forward compatibility (if any)

[R1-1716829](#) WF on reserved resources Ericsson, Huawei, ATT, Vodafone, Sony, Deutsche Telekom, Orange

- Reserved resource can be configured as one of the following types (both types will be supported):
 - PRB and symbol-level reserved resources:
 - one or more PRBs are reserved (in a numerology within a bandwidth)
 - one or more OFDM symbols are reserved (in a numerology within a duration)
 - Resource-element (RE) level reserved resources where specific resource-element patterns are reserved
- NR supports the configuration of RE-level reserved resources with reserved-resource patterns that match REs used by specific LTE (including LTE-MTC) and NB-IoT signals.
 - Example of such LTE/LTE-MTC signals: CRS, PSS/SSS, PBCH, other RS,
 - Example of such NB-IoT signals: NRS, NPSS/NSSS, NPBCH, NPRACH,
 - These resources are signaled on X2 and to the UE via RRC
- UE assumption/behavior for avoiding reserved resources
 - PDSCH (except system information) /PUSCH: Rate matching
 - PDCCH/PUCCH: Rate matching or puncturing (FFS)
 - Other physical signals and channels: Puncturing

Decision: The document is noted.

R1-1715428	Overview of reserved resources	Huawei, HiSilicon
R1-1715570	Coexistence of different UE types on a wideband carrier	Huawei, HiSilicon
R1-1715571	Bandwidth part activation and adaptation	Huawei, HiSilicon
R1-1715693	On resource reservation	Guangdong OPPO Mobile Telecom.
R1-1715771	Discussion on ‘unknown’ and ‘reserved’ resources for NR	ETRI
R1-1715893	Discussion on data scrambling in NR	LG Electronics
R1-1716020	Indication of Reserved Resources	Samsung
R1-1716021	On UL Transmission Timing Aspects	Samsung
R1-1716022	Remaining Scheduling Aspects for CA Operation	Samsung
R1-1716337	Resource reservation for forward compatibility	Intel Corporation
R1-1716602	On Resource Reservation	Ericsson
R1-1716610	Further details on scrambling	Ericsson

6.4 Channel coding

[R1-1716868](#) Chairman's notes of AI 6.4 Channel coding Ad-Hoc chair (Nokia)

The document was presented by Matthew Baker from Nokia.

Decision: The document is endorsed and content is incorporated as below.

6.4.1 LDPC code

6.4.1.1 Bit-level interleaver design

[R1-1716667](#) Bit-level interleaver design for data channel Samsung (Revision of [R1-1716023](#))

[R1-1715501](#) Bit interleaver for LDPC codes Huawei, HiSilicon
[R1-1715663](#) On bit level interleaving for LDPC code ZTE, Sanechips
[R1-1715831](#) Bit-level interleaver design for eMBB data channel CATT
[R1-1716556](#) Bit-interleaving for LDPC Nokia, Nokia Shanghai Bell
[R1-1716656](#) On bit reverse mapping of LDPC LG Electronics
[R1-1716694](#) On Bit-interleaver for LDPC Intel Corporation
[R1-1716780](#) On design of bit-level interleaver MediaTek Inc.
[R1-1716781](#) WF on interleaver row re-ordering MediaTek Inc.

Agreement: For the per-codeblock bit-interleaver for LDPC:

- Row-column interleaver with number of rows equal to the modulation order is adopted, with row-wise write and column-wise read.
 - Note that this achieves Systematic Bit Priority Ordering for RV0
- The number of coded bits in a code block is an integer multiple of the modulation order

[R1-1716733](#) Bit-level interleaving Qualcomm Incorporated (Revision of [R1-1716441](#))

Working Assumption:

- The interleaver is located after the whole rate matching functionality including repetition
- To be confirmed at RAN1#90bis.

Conclusions:

FFS until RAN1#90bis, and take decisions then:

- Whether mapping order of bits to modulation symbols is reversed in retransmissions, subject to defining how to avoid ambiguity, e.g. by using the natural order for the first transmission of RV0, and the reverse order for retransmissions of RV0 (as indicated by NDI)
 - Suggested cases when this may be beneficial:
 - When Chase combining with RV0 is used?
 - With HOM and repetition?
 - With HOM and low code rate?
 - In fading channels?
 - ...

6.4.1.2 Remaining details on rate matching

[R1-1716734](#) Non-uniform RV positions for LDPC Nokia, Nokia Shanghai Bell (Revision of [R1-1716557](#))
[R1-1715894](#) On rate matching for LDPC code LG Electronics
[R1-1715664](#) On rate matching for LDPC code ZTE, Sanechips
[R1-1716225](#) On LDPC rate matching MediaTek Inc.

[R1-1715502](#) Rate matching for LDPC codes Huawei, HiSilicon
[R1-1715732](#) Redundancy Version for HARQ of LDPC Codes Ericsson
[R1-1715832](#) Rate matching scheme for NR LDPC codes CATT
[R1-1716668](#) Rate matching details for data channel Samsung (Revision of [R1-1716024](#))
[R1-1716329](#) Finalization of remaining details of rate-matching Intel Corporation
[R1-1716442](#) LDPC rate matching Qualcomm Incorporated
[R1-1716485](#) LDPC rate matching design InterDigital, Inc.

Observations:

- Some small gains are seen in some cases for non-uniform starting positions
- But many companies propose uniform starting positions as a “safe choice”
- Some advantages have been mentioned for having another self-decodable RV available at all code rates
 - Bit reordering proposal has additional complexity associated with it

Agreement: (as a good compromise considering self-decodability, performance and complexity)

- When LBRM is not applied, fix RVs $\{0,1,2,3\}$ at $\{0,17,33,56\} \times Z$ for BG1 and $\{0,13,25,43\} \times Z$ for BG2

Default RV order for any special cases where RV index is not explicitly signalled but there is no ambiguity about which instance of a transmission occurred:

- Evaluate at least $\{0,2,3,1\}$ and $\{0,3,2,1\}$ until RAN1#90bis.
- Take final decision at RAN1#90bis.

FFS for cases where there may be ambiguity, if any such cases exist – discuss offline until RAN1#90bis.

Note that order of RVs should be discussed in the channel coding session, e.g. if it is decided elsewhere to support RV cycling.

6.4.1.3 Other

Including confirmation of Working Assumptions on segmentation, etc.

[R1-1715733](#) Summary of email discussion [90-28] Definition of R_{init} Ericsson

Agreement:

- R_{init} value to be used in the Working Assumption from RAN1#90 is
 - 0.25

Working Assumption from RAN1#90, to be checked after finalisation of the TBS table and confirmed if TBSs exist for which the following is meaningfully beneficial and does not cause meaningful degradation:

- For initial transmissions with code rate $R_{init} > 1/4$, BG2 is not used when $TBS > 3824$
 - If the FFS on UE capabilities w.r.t. support of both BGs is resolved such that it is possible that a UE does not support BG1, then the above bullet only applies if the UE supports BG1.
- BG2 is used for initial transmissions with code rate $R_{init} \leq 1/4$ for all TBS supported at that code rate
 - For BG2 with TBSs larger than 3824, the TB is segmented into CBs no larger than 3840

Alternative proposal: BG2 is not used when $TBS > 3824$.

[R1-1716330](#) Finalization of remaining aspects of LDPC segmentation Intel Corporation

[R1-1715734](#) Code Rate Threshold for BG2 Application Ericsson

Conclusion:

- FFS until RAN1#90bis what is the highest code rate supportable by each BG with acceptable performance.

[R1-1715736](#) Application of BG1 and BG2 for NR Data Channel Ericsson

Working Assumption:

- Use base graph #1 for combinations of block lengths $K > 308$ and code rates (as defined in previous email discussion) $R > 2/3$.
- Base graph #2 may be used for block lengths $K \leq 308$ and code rates $R > 2/3$, but the scheduler should take into account that no base graph is optimized for this region of K and R and therefore allow extra link adaptation margin.

To be confirmed at RAN1#90bis.

R1-1715503	Code block segmentation for BG2	Huawei, HiSilicon
R1-1715735	Code block segmentation for NR data channel	Ericsson
R1-1715833	CB segmentation for data channel	CATT
R1-1715895	Code block segmentation for eMBB data transmission	LG Electronics
R1-1716025	Code rate definition for BG selection	Samsung
R1-1716026	Code rate threshold for BG selection	Samsung
R1-1716443	Considerations for BG2 segmentations	Qualcomm Incorporated
R1-1716486	Code rate threshold for LDPC base graph selection	InterDigital, Inc.

R1-1716558 Code segmentation for LDPC Nokia, Nokia Shanghai Bell
R1-1716739 On code block segmentation for BG#2 MediaTek Inc.

6.4.2 Polar code

6.4.2.1 Downlink code construction

CRC & Interleaver

[R1-1716677](#) Check on Polar distributed CRC function MediaTek Inc. (Revision of [R1-1716220](#))
[R1-1716681](#) Performance evaluation for distributed CRC Qualcomm Incorporated (Revision of [R1-1706444](#))
[R1-1715494](#) Distributed CRC for Polar code construction Huawei, HiSilicon
[R1-1716771](#) Distributed CRC for Polar code construction Huawei, HiSilicon
[R1-1716729](#) On DL polar code construction using distributed CRC and interleaver NEC Corporation
(Revision of [R1-1715703](#))
[R1-1716669](#) Downlink polar code construction Samsung (Revision of [R1-1716027](#))
[R1-1716765](#) On interleaver pattern for downlink polar code construction InterDigital, Inc. (Revision of [R1-1716487](#))
[R1-1716695](#) DL control code construction Nokia, Nokia Shanghai Bell (Revision of [R1-1716559](#))
[R1-1715737](#) Polar Code Construction for DL Ericsson
[R1-1716331](#) Details of DL Polar code construction Intel Corporation

Section 2.

Conclusions:

- Several companies have shown that the working assumption proposal (7 distributed CRC bits) has at least one case where the FAR target is missed with DMRS overhead 1/3.
- No missed FAR targets are observed with the working assumption with the agreed DMRS overhead 1/4.
- Other proposals:
 - HW [R1-1715494](#) (8 distributed CRC bits)
 - NEC [R1-1716729](#) (3 distributed CRC bits)
 - Nokia [R1-1716695](#) (6 distributed CRC bits)
 - Ericsson [R1-1715737](#) (3 or 4 distributed CRC bits)
- Best FAR performance (based on evaluations available at this meeting) is from [R1-1715494](#); this also has the largest number of distributed CRC bits (8).

From the available evaluation results, the following schemes satisfy the FAR targets for all cases:

- Working assumption (modified as in 38.212v1.0.0) when DMRS overhead is 1/4
- Modified proposal in [R1-1715494](#)

Agreement:

- Confirm working assumption on CRC and interleaver (as modified as in 38.212v1.0.0)
- ~~Can be reviewed on Thursday if further evaluations available by 8:30am Nagoya time for DMRS overhead 1/4 with the agreed simulation assumptions contradict those already provided.~~
- When the conclusions on DCI payload size for Rel-15 are agreed, the K_{\max} in 38.212 will be reduced from the current value of 200 (which is only a placeholder)
 - the current working assumption for K_{\max} remains a **working assumption** (to be revisited when there is progress in offline discussion); the final value of K_{\max} will not be greater than the working assumption.

Tsofun expressed concern about whether the interleaver based dCRC approach is a robust solution to satisfying the FAR target.
Thursday (afternoon comeback): Thanks to additional evaluation results provided by companies, no contradictions appeared - above statement is deleted.

Frozen bit values and scrambling

[R1-1715896](#) Scrambling on information bits for distributed CRC LG Electronics
[R1-1716110](#) UEID scrambling design for Polar codes NTT DOCOMO, INC.
[R1-1716220](#) Check on Polar distributed CRC function MediaTek Inc.
[R1-1716534](#) Linear Codeword Scrambling for Early Termination on DCI Blind Detection Coherent Logix
[R1-1716850](#) WF on Linear Codeword Scrambling for Early Termination on DCI Blind Detection Coherent Logix Inc.,
AT&T, NTT DOCOMO, Tsofun, Huawei, Nokia, LG Electronics
[R1-1716880](#) UER Verification of DL dCRC with 1/4 DMRS Density Qualcomm
[R1-1715498](#) UE-ID and value of frozen bits for Polar code Huawei, HiSilicon
[R1-1716331](#) Details of DL Polar code construction Intel Corporation

Section 3.

[R1-1716032](#) UE-specific scrambling for polar codes Samsung

6.4.2.2 Uplink code construction

[R1-1715738](#) Summary of email discussion [90-29] K and n_{FAR} for UL Polar Construction Ericsson

Proposal:

- For $1 \leq K \leq 11$,
 - o No CRC bits are attached.
- For $K > 22 - n_{FAR1}$, where n_{FAR1} is associated with $12 \leq K \leq 22 - n_{FAR1}$,
 - o At least $n_{FAR2}=8$ is adopted, with CRC polynomial length = $8+3=11$.
- FFS in scheduling/HARQ session whether same n_{FAR} value is applied to UCI on PUCCH and PUSCH
- FFS in scheduling/HARQ session whether the n_{FAR} value should be dependent on the UCI contents and payload size

[R1-1716770](#) Remaining aspects of UL Polar code construction Intel Corporation (Revision of [R1-1716332](#))
[R1-1715495](#) Uplink code construction Huawei, HiSilicon

Agreement:

- Confirm Working Assumption that CRC bits are attached as a block to the end of the information bits.
- At least $L_{CRC}=11$ is supported, with the following polynomial: $D^{11} + D^{10} + D^9 + D^5 + 1$
 - o Range of K values for CRC11 is FFS
- Which other CRC lengths and associated K values are also supported is FFS.

Next steps:

- After n_{FAR} values are decided, the complete set of supported CRC polynomials will be selected, preferably at RAN1#90bis.
- FFS whether the n_{FAR} value should be dependent on the UCI contents and payload size.
- FFS whether same n_{FAR} value is applied to UCI on PUCCH and PUSCH.
- Only the CRC polynomials listed in the Table below are candidates :

L_{CRC}	3	4	5	6	8	16
Poly-nomial	$D^3 + D^2 + 1$	$D^4 + D^3 + 1$	$D^5 + D^3 + 1$	$D^6 + D^5 + 1$	$D^8 + D^6 + D^5 + D^3 + 1$	$D^{16} + D^{15} + D^{14} + D^{13} + D^{12} + D^{11} + D^8 + D^7 + D^6 + D^4 + 1$
	Or				Or	
	$D^3 + D + 1$				$D^8 + D^7 + D^6 + D^4 + D^2 + D + 1$	
					Or	
					$D^8 + D^7 + D^3 + D^2 + 1$	

[R1-1716682](#) Consideration of the number of CRC bits for uplink Qualcomm Incorporated (Revision of [R1-1716445](#))

R1-1715834 Polar codes construction for uplink CATT
 R1-1715897 Discussion on UL code construction LG Electronics
 R1-1716028 Uplink polar code construction Samsung
 R1-1716111 CRC polynomial for UL Polar codes NTT DOCOMO, INC.
 R1-1716560 UL control code construction Nokia, Nokia Shanghai Bell
 R1-1716742 On CRC Polynomial for Uplink Polar Code Construction InterDigital, Inc.
 R1-1716756 Polar Code Construction for UL Ericsson

6.4.2.3 Remaining details of rate matching

[R1-1716029](#) Rate matching for control channel Samsung
[R1-1716446](#) Details of Polar code rate-matching Qualcomm Incorporated
[R1-1715775](#) On the hardware implementation of frozen bit insertion and removal AccelerComm Ltd
[R1-1716651](#) Improved Rate Matching Method for Polar Codes Ericsson
[R1-1715665](#) Parameters of Polar code rate matching ZTE, Sanecchips

Trade off in increasing beta slightly: removal of significant spikes with L=1, vs. small degradation with L=8.

Agreement:

- Confirm working assumption on Polar rate matcher, with the following modification:

$$N_M \text{ is } \frac{N_{DM}}{L} \text{ if } M \leq \frac{B \cdot N_{DM}}{L} \text{ and } \frac{K}{M} < R_{repthr}$$

[R1-1715496](#) Rate matching for Polar code Huawei, HiSilicon
[R1-1716678](#) Check on Polar rate-matching function MediaTek Inc.
 Revision of [R1-1716221](#)
[R1-1716648](#) Polar code rate-matching evaluations Intel Corporation

6.4.2.4 Remaining details of channel interleavers

Downlink

[R1-1715497](#) Channel interleaver for DCI Huawei, HiSilicon
[R1-1715666](#) Performance evaluation of Polar code channel interleaver ZTE, Sanechips
[R1-1716447](#) Considerations for channel interleavers Qualcomm Incorporated

[R1-1716740](#) Downlink Channel Interleaver for Polar Codes Ericsson (Revision of [R1-1715740](#))
[R1-1716030](#) Necessity of channel interleaver for downlink Samsung
[R1-1715835](#) Interleaver design for NR polar codes CATT
[R1-1716489](#) Performance evaluation of channel interleaver InterDigital, Inc.
 Sections 2.1, 2.2
[R1-1716679](#) On channel bit interleaver design for NR DL control MediaTek Inc. (Revision of [R1-1716222](#))

Working Assumption:

- If a DL bit-level channel interleaver is adopted:
 - Its span is equal to the number of coded bits corresponding to 1 CCE
 - The span can be increased to the number of coded bits corresponding to 2 CCEs if there is a benefit of doing so
 - FFS whether the interleaver is not used at higher ALs
 - Companies are encouraged to assess by RAN1#90bis the implementation impacts of using or not using the interleaver at higher ALs

Conclusions and next steps to help towards a decision on the Working Assumption from RAN1#90:

- From the cases evaluated so far, gains of DL channel interleaver are not significant for AL >2
- Continue evaluations until RAN1#90bis, according to the above working assumption
 - Focus on AL=1,2 cases, with and without REG bundle interleaver
 - Include evaluations with up to 3 OFDM symbols for the control channel
- Companies are also encouraged to compare block parallel interleaver with low-complexity block interleavers, e.g. single block interleaver.

Uplink

[R1-1716031](#) Evaluation of channel interleavers for high-order modulation Samsung
[R1-1716786](#) Bit-interleaving for polar codes Nokia, Nokia Shanghai Bell (Revision of [R1-1716561](#))
[R1-1716489](#) Performance evaluation of channel interleaver InterDigital, Inc.
 Section 2.3

Agreement:

- Confirm Working Assumption that the uplink channel interleaver is a triangular interleaver
- The interleaver from [R1-1713474](#) is adopted.

6.4.2.5 Other

[R1-1715667](#) Segmentation of Polar code for large UCI ZTE, Sanechips
[R1-1716852](#) WF of Polar code segmentation for large UCI ZTE, Sanechips

6.4.3 PBCH

[R1-1715499](#) Polar code for PBCH and soft combining Huawei, HiSilicon
[R1-1715518](#) Scrambling sequence design for PBCH Sequans Communications
[R1-1715836](#) Consideration on Polar codes for PBCH CATT

R1-1715899	Coding aspects of PBCH transmission	LG Electronics
R1-1716757	Polar Code Design for NR-PBCH	Ericsson
R1-1716033	PBCH polar code construction	Samsung
R1-1716680	NR PBCH coding design	MediaTek Inc. (Revision of R1-1716223)
R1-1716448	PBCH design using Polar codes	Qualcomm Incorporated

6.4.4 Other

R1-1715457	Essential enhancement to rate matching of Reed Muller code	Sequans Communications
R1-1715500	Channel coding for URLLC	Huawei, HiSilicon
R1-1715507	Channel Coding for URLLC	Tsfun Algorithm

6.5 Duplexing

6.5.1 Cross-link interference management

R1-1715422	UE-to-UE measurement for cross-link interference mitigation	Huawei, HiSilicon
R1-1715493	Discussion on cross-link interference management	Fujitsu
R1-1715563	UE-to-UE measurement as an enabler for CLI mitigation schemes	ZTE, Sanecips
R1-1715649	Details of UE-UE CLI measurements	vivo
R1-1715659	Discussions on UE-to-UE interference measurement and report	Panasonic
R1-1715747	On Cross-link interference measurement framework	Nokia, Nokia Shanghai Bell
R1-1715772	Discussion on dynamic TDD and cross-link interference measurement in high-speed train scenario	ETRI
R1-1715837	Remaining details of UE-to-UE cross link interference measurements	CATT
R1-1715900	Discussion on UE-to-UE CLI measurement and reporting for duplexing flexibility	LG Electronics
R1-1716034	Discussion on UE-to-UE cross-link interference measurement and management	Samsung
R1-1716060	Discussion on UE-to-UE cross-link interference management	CMCC
R1-1716112	Views on UE-to-UE interference measurement	NTT DOCOMO, INC
R1-1716118	UE-to-UE cross-link interference management	CEWiT
R1-1716173	Cross link interference management	AT&T
R1-1716217	Cross-link interference management	MediaTek Inc.
R1-1716233	RSSI and RSRP Cross Link Interference Measurement	Ericsson
R1-1716333	On CLI measurement for NR dynamic TDD	Intel Corporation
R1-1716449	Cross-link interference management	Qualcomm Incorporated

6.5.2 Other

R1-1715423	Timing alignment on cross-link	Huawei, HiSilicon
R1-1715424	UL Power control for cross-link interference mitigation	Huawei, HiSilicon
R1-1715657	Discussion on symbol alignment in NR duplex	Panasonic
R1-1715658	Discussions on intended DL/UL direction configuration via Xn signalling	Panasonic
R1-1715901	Discussion on details of backhaul signaling for duplexing flexibility	LG Electronics
R1-1716035	Joint CLI Mitigation and beam management	Samsung
R1-1716036	Cross-link Interference Management based on Coordinated Beamforming	Samsung
R1-1716037	Timing Alignment on Cross-Link for Dynamic TDD	Samsung
R1-1716038	Cross-Link Interference Management based on Power Control	Samsung
R1-1716039	Interference Measurement Table and Beam Coordination	Samsung
R1-1716234	On Hybrid TDD and Measurements for Cross-link Interference Mitigation	Ericsson
R1-1716235	On Dynamic TDD Scenarios	Ericsson
R1-1716236	On Duplexing in Paired Spectrum	Ericsson

6.6 NR-LTE co-existence

Refer to [R1-1709844](#) for work plan

[R1-1716871](#) Chairman's notes of AI 6.6 NR-LTE co-existence Ad-Hoc chair (Nokia)

The document was presented by Matthew Baker from Nokia.

Decision: The document is endorsed and content is incorporated as below.

Note relevant RAN plenary contributions:

RP-172104

RP-172108

[R1-1715704](#) Discussion on the scheduling based solution for the NR-LTE self-interference
Mobile Telecom

Guangdong OPPO

[R1-1716334](#) Remaining issues on NR-LTE co-existence Intel Corporation

Topics for offline discussion during this week:

- Assume that there is no impact on the LTE specifications for non-EN-DC UEs
- Assume that there is no impact on the LTE specifications for any frequency-domain solution
- At least to support the multi-vendor scenario:
 - Develop details of possible frequency-domain and time-domain solutions
 - e.g. do we need to specify support for semi-static configuration of a time domain pattern for half-duplex handling of the harmonic issue?
 - What further guidance do we need to give to RAN3 for X2/Xn signalling?
 - Can the single-UL tx solutions be reused as-is for the harmonic issue? (e.g. can it achieve half-duplex?)
- Does UE behaviour need to be specified in case of collisions between UL tx and DL rx, or can this be left unspecified?
 - Note that the 2-UL transmission collision case was already handled by RAN plenary
- Is it necessary to specify how it is identified when the problematic interference scenarios arise?
 - In cases where carrier frequencies give rise to harmonic issues, is it assumed that the interference is always present?

[R1-1716696](#) Offline discussions and proposals on harmonic interference handling Vivo

Agreement:

- Following Backhaul signalling is specified (enhanced X2 and Xn) to facilitate time-domain and frequency domain based network scheduling solution in case of harmonic interference from UL to DL, send LS to RAN3 to ask them to specify the signalling details:
 - Semi-static time pattern indicating intended reception/transmission on an LTE UL carrier and an NR DL carrier on non-overlapping frequencies
 - Semi-static frequency pattern indicating intended reception/transmission on an LTE UL carrier and an NR DL carrier on non-overlapping frequencies
 - These patterns can be at least UE-specific.

Xueming to prepare a draft LS to RAN3 for review on Thursday - [R1-1716697](#).

- include examples of granularity required in the patterns (details to be developed offline).

LS [approved in R1-1716698](#) with the following changes:

To RAN32

RAN1 would like ask RAN3 to specify the above necessary backhaul signalling. [RAN1 recognises that discussion will be needed on the procedure for the signalling and assumes that such discussion will take place in RAN3.](#)

Discuss further offline:

- For the EN-DC case, the LTE DL reference HARQ timing can be signalled to the UE when time-domain based network scheduling solution is used; reuse the signalling for single UL Tx operation.
- FFS TDM pattern between an LTE UL carrier and NR DL carrier can be signaled to UE
- If UE is scheduled with simultaneous LTE UL Tx and NR DL Rx, and there is UE self-interference between them due to harmonic issues, down select among following options
 - Option 1: UE behaviour is not specified, i.e. up to UE implementation
 - Option 2: Specify that UE consider the above scheduling to be error case
 - Option 3: Specify the UE behaviour, e.g. channel dropping rule between the Tx and Rx.
- Specification impacts to non-EN-DC UEs
 - No specification impacts for UE configured with LTE only
 - FFS specification impacts for UE configured with NR-NR DC
 - to be addressed after solutions for EN-DC is finalized.

Power control aspects of the following tdocs are to be treated under agenda item 6.7.

[R1-1716454](#) Discussion on Remaining Issues of NR-LTE co-existence China Telecommunications

[R1-1716532](#) NR and LTE coexistence Nanjing Ericsson Panda Com Ltd

[R1-1716252](#) NR coexistence with eMTC Sony

[R1-1716455](#) Discussion on design of msg2 for SUL China Mobile (Suzhou) Software

[R1-1715429](#) Discussion on the remaining issues of LTE-NR DC and UL coexistence Huawei, HiSilicon
[R1-1715904](#) Remaining issues in NR LTE coexistence LG Electronics
[R1-1716062](#) On LTE-NR Coexistence Samsung R&D Institute India
[R1-1716113](#) Remaining issues on single UL transmission NTT DOCOMO, INC.
[R1-1716193](#) Supporting 2Tx UE and Single UL Transmission in NR AT&T
[R1-1716614](#) Single UL transmission in LTE-NR DC Nokia, Nokia Shanghai Bell
[R1-1716232](#) Views on UL sharing of NR and LTE NEC

[R1-1716885](#) **WF of joint proposal on SUL** Huawei, HiSilicon, BT Group, CMCC, CATR, China Telecom, China Unicom, Deutsche Telekom, Intel, LGE, MediaTek, Nokia, Nokia Shanghai Bell, NTT DOCOMO, OPPO, Orange, Vivo, Vodafone

Agreement:

- **Working Assumption** that, an UL carrier can use a subcarrier spacing smaller than the subcarrier spacing of the associated DL carrier, in the following cases:
 - The carriers are in different PUCCH groups, or
 - The UL carrier is operating in a SUL band combination as defined in RAN4 specifications
- Can be revisited if technical problems (e.g. with scheduling and CSI feedback) are identified and cannot be resolved by RAN1#91.
- Minimizing specification impact should be the primary consideration in finalising the solution, unless major performance differences exist.
- An UL carrier can carry UCI for the DL carrier that it supplements
- An UL carrier is scheduled from the DL carrier that it supplements

For further discussion:

- whether SUL has the same cell ID as the associated DL
- whether SUL can be PCell and/or SCell
- whether all UEs support PUSCH on a different carrier from the SUL carrying UCI
- which combinations of DL/UL SCSs are supported

Objection from Qualcomm, but not sustained:

Qualcomm expressed concern at the possibility of introducing incompatibility with CA from the above.

[R1-1716889](#) **RACH procedure towards SUL carrier** NEC, LGE, vivo
Discuss further until RAN1#90bis.

[R1-1715712](#) Remaining issues on LTE/NR coexistence CATT
[R1-1716339](#) Handling of harmonics related interference ZTE, Sanechips
[R1-1716722](#) WF on uplink operation with SUL Huawei, HiSilicon
[R1-1716864](#) WF on the opportunistic uplink transmission in TDM for single Tx LG Electronics, Ericsson, Vodafone, Nokia, NSB

6.7 UL power control

[R1-1716869](#) **Chairman's notes of AI 6.7 UL Power control** Ad-Hoc chair (Samsung)

The document was presented by Younsun Kim from Samsung.

Decision: The document is endorsed and content is incorporated as below.

Handling of RAN4 LS, [R1-1715366](#), and related tdocs ([R1-1715595](#), [R1-1715727](#), [R1-1716264](#)) in 6.7.

Offline discussion to be coordinated by InterDigital (Afshin)

[R1-1716857](#) **[Draft] LS reply to RAN4 on UE Power Class and Power Control** InterDigital

[R1-1716914](#) **[Draft] LS reply to RAN4 on UE Power Class and Power Control** InterDigital

revision of [R1-1716857](#)

Approved in [R1-1716743](#) with updated actions as follows

Actions:

Question 1: If the UE supports a set of beams for a desired directivity, RAN1 would like to kindly inquire RAN4 when a UE selects a beam with a desired directivity from a limited set of beam choices, whether the UE could have an estimate of the directivity of the employed beam, and the possible accuracy of the estimation.

Question 2: RAN1 would like to kindly inquire RAN4 whether the approach B (e.g., P_{cmax} based on TRP) can be supported, and if it would result in any critical issue from RAN4 perspective.

Handling of RAN4 LS, [R1-1715371](#), and related tdocs ([R1-1716603](#), [R1-1715728](#)) in 6.7.
Offline discussion to be coordinated by ZTE (Bo)

[R1-1716893](#) [Draft] LS reply to RAN4 on Beam management impact on power control ZTE

Conclusion:

More details on RAN1 power control specification support is needed before a reply LS can be sent to RAN4.

[R1-1716761](#) Offline summary for AI 6.7 NR UL power control ZTE

6.7.1 NR power control framework

[R1-1716114](#) Power control framework for PUSCH NTT DOCOMO, INC.

[R1-1715478](#) General considerations on UL power control design Huawei, HiSilicon

[R1-1716040](#) On UL Power Control Samsung

[R1-1715838](#) NR Power Control Framework CATT

Agreement:

For PL estimation, NR supports

- At least higher layer filtered RSRP is supported for PL estimation based on configured CSI-RS and/or SS block
 - Note: Above includes the support for at least beam-specific RSRP measurement
 - FFS: Whether L1 RSRP is additionally supported
 - Note: Companies are encouraged to study the benefits of additionally using L1 RSRP for PL estimation
 - FFS: Details on the L3 filter in NR specification (including whether to define or not) should be discussed in the mobility session

[R1-1716763](#) WF on power control framework NTT DOCOMO, Panasonic, Nokia, NSB, Intel, Sharp, LG, Mitsubishi, Huawei, HiSilicon

Agreements:

$$P_{\text{PUSCH},c}(i) = \min \left\{ P_{\text{CMAX},c}(i), 10 \log_{10} (M_{\text{PUSCH},c}(i)) + P_{0,c}(j) + \alpha_c(j) \cdot PL_c(k) + \Delta_{TF,c}(i) + f_c(i, l) \right\}$$

- Support at least $P_{\text{cmx},c}(i)$, $M_{\text{PUSCH},c}(i)$, $P_{0,c}(j)$, $\alpha_c(j)$, $PL_c(k)$, $\Delta_{TF,c}(i)$ for NR PUSCH power control for serving cell c
 - i is slot number
 - j is the index of open-loop parameter
 - K is the index of RS resource(s) for pathloss measurement
 - FFS: exact $P_{\text{cmx},c}(i)$ definition and notation for above 6 GHz
 - $M_{\text{PUSCH},c}$ is related to the scheduled BW, FFS on the details
 - $\Delta_{TF,c}$ is for single layer transmissions
- Support up to N closed-loop power control processes, i.e., $f_c(i, l)$, for NR PUSCH power control for serving cell c
 - $N=2$ is working assumption
 - l is the index of closed-loop power control process
 - FFS: reset trigger, e.g., parameter set reconfiguration and/or explicit signaling
- FFS: linkage and indication of $\{j, k, l\}$, explicit/implicit signalling
- Note: Exact way to capture the details of the above proposal depends on the uplink beam management and the editor

[R1-1716766](#) WF on power offset of SUL Huawei, HiSilicon, CMCC

Also supported by China Telecom, OPPO, Orange, CATR

Agreement:

- For PRACH/PUSCH/SRS on an SUL carrier associated with a NR DL/UL carrier, the range of the following values shall be sufficiently large to compensate the pathloss difference between the SUL carrier and the NR DL/UL carrier
 - Received target power for PRACH power control,
 - P_0 for PUCCH(if supported on SUL) power control, PUSCH power control, and SRS power control
- FFS maximum pathloss difference to be compensated

Thursday comeback

Huawei's comment: 'PUCCH (if supported on SUL)' should not be used later by anyone to say PUCCH on SUL was not agreed.
RAN1 chair: Of course - let's keep the agreement as is and endorse [R1-1716869](#).

[R1-1716764](#) **WF on PHR** **NTT DOCOMO, Panasonic**

[R1-1716878](#) **WF on NR Closed-loop Power Control** **Samsung, Nokia, NSB, NTT DOCOMO, InterDigital, Motorola Mobility, Lenovo, Intel, CATT, LGE, Sharp, Verizon, Panasonic, AT&T, KDDI, ZTE, IITH, IITM, CEWiT, Reliance-jio, Tajas Networks**

Agreement:

- For NR-PUSCH
 - Accumulative TPC command mode is supported.
 - FFS: when UE has to reset $f_c(i)$
 - FFS on K_{PUSCH}

Working Assumption:

- For NR-PUSCH
 - Absolute TPC command mode is supported.
 - FFS on K_{PUSCH}

[R1-1716128](#) Considerations on Power headroom report in NR **Nokia, Nokia Shanghai Bell**
Sections 2 and 3

[R1-1716451](#) Power control and PHR for NR **Qualcomm Austria RFFE GmbH**

[R1-1715454](#) On NR power control **ZTE, Sanechips**

[R1-1715505](#) UL transmission power control **Mitsubishi Electric Co.**

[R1-1715651](#) NR UL power control framework **vivo**

[R1-1715675](#) Uplink power control for NR **Guangdong OPPO Mobile Telecom.**

[R1-1715902](#) Discussion on UL power control for NR **LG Electronics**

[R1-1716061](#) Discussion on power control framework **CMCC**

[R1-1716127](#) Discussion on NR power control framework **Nokia, Nokia Shanghai Bell**

[R1-1716515](#) Further Details on Uplink Power Control **InterDigital, Inc.**

[R1-1716535](#) Discussion on NR power control framework **Panasonic Corporation**

[R1-1716547](#) Power control on different SRS groups **ASUSTEK COMPUTER (SHANGHAI)**

[R1-1716604](#) NR Power Control Framework **Ericsson**

6.7.2 Other

Including any remaining details for power sharing

[R1-1715480](#) Discussion on the UL power control for LTE -NR uplink coexistence **Huawei, HiSilicon**

[R1-1716335](#) Remaining aspects on power sharing between LTE and NR **Intel Corporation**

[R1-1716041](#) On UL Power Sharing for Multi-Cell Transmissions **Samsung**

[R1-1715839](#) Network Assist Dynamic Power Sharing Mechanism **CATT**

[R1-1715903](#) Discussion on further details on dynamic power sharing for LTE-NR DC **LG Electronics**

[R1-1716115](#) LTE-NR power sharing mechanism **NTT DOCOMO, INC.**

[R1-1716172](#) Remaining details on the power sharing in MR-DC **AT&T**

[R1-1716259](#) Power Control Modes for NR DC and NR CA **InterDigital, Inc.**

[R1-1715604](#) General considerations on power headroom calculation and reporting **Huawei, HiSilicon**

[R1-1715698](#) Discussion on PHR and other Issues for LTE-NR Dual Connectivity **Guangdong OPPO Mobile Telecom.**

[R1-1716042](#) On PHR Requirements and Calculation **Samsung**

[R1-1716605](#) Power headroom reporting in NR **Ericsson**

[R1-1715479](#) Power control for CA and DC **Huawei, HiSilicon**

[R1-1716336](#) Remaining Details On UL Power Control Framework **Intel Corporation**

[R1-1716606](#) Closed loop PC in NR **Ericsson**

[R1-1716607](#) Beam specific PC in NR **Ericsson**

[R1-1716608](#) Impact of power class definition on power control procedures **Ericsson**

6.8 Other

Including channel model

[R1-1716867](#) **Chairman's notes of AI 6.8 Other – Channel Modelling** Ad-Hoc chair (Nokia)

The document was presented by Matthew Baker from Nokia.

Decision: The document is endorsed and content is incorporated as below.

Channel Modelling

[R1-1715776](#) **Correction on 3D-InH channel model in TR 36.873** CATT, CATR, Huawei, ZTE

Decision: The draft CR is **agreed in principle**. Bring CRs for both 36.873 and 38.901 for agreement at RAN1#90bis.

[R1-1716687](#) **Correction on car penetration loss in TR 38.901** CATT, CATR, ZTE (Revision of [R1-1715782](#))

Decision: The draft CR is agreed in principle.

To be clarified with meaning of “LN”.

Final CR to be prepared in [R1-1716693](#) – revisit on Thursday.

Thursday

Text under formula is agreed in principle.

Email discussion until Thursday 28th September to agree the details of the formula – Ying (CATT).

[R1-1716064](#) **Analysis of a Map-based Hybrid Channel Model** Samsung R&D Institute India

Unlicensed Spectrum

[R1-1715564](#) **On Design Aspects for NR-based access to Unlicensed Spectrum** PANASONIC R&D Center Germany

[R1-1715578](#) **High level consideration on NR unlicensed band operation** Huawei, HiSilicon

[R1-1715579](#) **NR Numerology on unlicensed bands** Huawei, HiSilicon

[R1-1715580](#) **NR Frame structure on unlicensed bands** Huawei, HiSilicon

[R1-1715581](#) **Coexistence and Channel access for NR unlicensed band operations** Huawei, HiSilicon

[R1-1715582](#) **NR standalone operation on unlicensed bands** Huawei, HiSilicon

[R1-1716129](#) **On Autonomous UL Transmissions for NR in Unlicensed Spectrum** Ericsson GmbH, Eurolab

[R1-1716130](#) **On Channel Access Mechanisms for NR in Unlicensed Spectrum** Ericsson GmbH, Eurolab

[R1-1716131](#) **On NR Operation in the 60 GHz Unlicensed Band** Ericsson GmbH, Eurolab

[R1-1716132](#) **On Physical Layer Design Policies for Unlicensed Operation of NR** Ericsson GmbH, Eurolab

[R1-1716133](#) **Technology Components for Unlicensed Operation** Ericsson GmbH, Eurolab

[R1-1716134](#) **Discussion of Multi-Antenna and Highly Directional Beam-Forming for Operation in Unlicensed Spectrum**

Ericsson GmbH, Eurolab

[R1-1716253](#) **DRS Design for Unlicensed Spectrum** Sony

[R1-1716551](#) **LBT Considering Beamforming in Unlicensed Spectrum** ASUSTEK COMPUTER (SHANGHAI)

Non-orthogonal Multiple Access

[R1-1715576](#) **Discussion on NoMA study for Rel-15 SI** Huawei, HiSilicon

[R1-1715577](#) **Discussion on LLS evaluation for NoMA** Huawei, HiSilicon

Non-terrestrial Networks

[R1-1715729](#) **NTN channel modeling** Huawei, HiSilicon

V2X

[R1-1715730](#) **V2X channel modeling** Huawei, HiSilicon, Spirent

Miscellaneous

[R1-1715583](#) **Remaining issues on ECP** Huawei, HiSilicon

[R1-1715653](#) **Forward compatibility consideration for ECP design and NR-MBMS** vivo

[R1-1715654](#) **Measurement results and analysis on UE power consumption** vivo

[R1-1715655](#) **NR UE power saving** vivo

[R1-1716649](#) **UE Power Saving in NR** Sony

[R1-1716063](#) **On Modulation Scheme for URLLC with Pre-emption based Multiplexing in DL** Samsung R&D Institute India

[R1-1716452](#) **Low PAPR Modulation** Qualcomm Austria RFFE GmbH

[R1-1716612](#) **RS design options for pi/2 BPSK with spectrum shaping** IITH

[R1-1716615](#)

On positioning in NR Rel-15

Nokia, Nokia Shanghai Bell

7 Closing of the meeting

RAN1 chair thanked all delegates for their efforts during the last four days.

He commented that “the December deadline for NR is a challenging target. Clearly there is a strong need for the group to have sense of pressure in concluding and making progress, sometimes it may appear to be impatient or impolite (but nothing personal). The group should now be more focused on the essential decisions to reach that target within the only two meetings left... “

Meeting was closed at 18:30.

See you all in Prague.

**3GPP TSG RAN WG1 Meeting #90bis
Prague, Czech Rep, 9th – 13th October 2017**

R1-1716942

Annex A: List of Tdocs at RAN1 #AH_NR3

Please see excel file attached to this report

**3GPP TSG RAN WG1 Meeting #90bis
Prague, Czech Rep, 9th – 13th October 2017**

R1-1716942

Annex B: List of CRs agreed at RANI #AH_NR3

TS/TR	CR	Rev	Rel	Title	Cat	Vsn	@ Mtg	TD#	Source to WG	Work Item

**3GPP TSG RAN WG1 Meeting #90bis
Prague, Czech Rep, 9th – 13th October 2017**

R1-1716942

Annex C-1: List of Outgoing LSs from RAN1 #AH_NR3

TDoc #	Title	Source	Release	Related WIs	Reply to	To	Cc	Original LS	Reply in
R1-1716698	LS on backhaul signalling for UE harmonic interference handling	RAN1, vivo	Rel-15	NR_newRAT-Core		RAN3			
R1-1716743	LS reply to RAN4 on UE Power Class and Power Control	RAN1, InterDigital	Rel-15	NR_newRAT-Core	R4-1708807	RAN4			
R1-1716744	LS on CSI-RS patterns and densities	RAN1, Huawei	Rel-15	NR_newRAT-Core		RAN4			
R1-1716814	LS on NR PRACH BW aspects	RAN1, Samsung	Rel-15	NR_newRAT-Core		RAN4			
R1-1716875	Reply LS on BWP operation in NR	RAN1, Samsung	Rel-15	NR_newRAT-Core	R2-1709801	RAN2			
R1-1716906	Reply LS on Channel Raster and Synchronization Channel Raster	RAN1, Ericsson	Rel-15	NR_newRAT-Core	R4-1709175	RAN4	RAN2		
R1-1716907	Reply LS on multiple SSBs within a wideband carrier	RAN1, Ericsson	Rel-15	NR_newRAT-Core	R2-1709983	RAN2	RAN4		
R1-1716917	LS on in-sync/out-of-sync BLER for RLM	RAN1, NTT DOCOMO	Rel-15	NR_newRAT-Core		RAN4			
R1-1716918	LS on NR Paging Occasion	RAN1, Huawei	Rel-15	NR_newRAT-Core		RAN2			
R1-1716924	Reply LS on UE categories and capabilities	RAN1, NTT DOCOMO, Ericsson	Rel-15	NR_newRAT-Core	R2-1709979	RAN2	RAN4		
R1-1716933	LS on RRC parameters for NR	RAN1, Ericsson	Rel-15	NR_newRAT-Core		RAN2			

**3GPP TSG RAN WG1 Meeting #90bis
Prague, Czech Rep, 9th – 13th October 2017**

R1-1716942

Annex C-2: List of Incoming LSs from RAN1 #AH_NR3

TDoc #	Title	Source	Release	Related WIs	Reply to	To	Cc	Original LS	Reply in
R1-1715353	LS on RACH agreements	RAN2, Ericsson	Rel-15	NR_newRAT-Core		RAN1		R2-1709800	
R1-1715354	Response LS on BWP operation in NR	RAN2, Samsung	Rel-15	NR_newRAT-Core		RAN1		R2-1709801	
R1-1715355	LS on Transport Block Sizes	RAN2, Nokia	Rel-15	NR_newRAT-Core		RAN1		R2-1709802	
R1-1715356	Reply LS on spectrum utilization	RAN2, Huawei	Rel-15	NR_newRAT-Core	R2-1707639	RAN4, RAN1		R2-1709816	
R1-1715357	LS on Baseband capability signaling	RAN2, Intel	Rel-15	NR_newRAT-Core		RAN4	RAN1	R2-1709954	
R1-1715358	LS on NR handover related parameters	RAN2, Nokia	Rel-15	NR_newRAT-Core		RAN1, RAN4		R2-1709955	
R1-1715359	LS on measurement model for cell quality derivation in NR	RAN2, ZTE	Rel-15	NR_newRAT-Core		RAN1, RAN4		R2-1709971	
R1-1715360	Reply LS to SA2 on SQIs for URLLC	RAN2, Ericsson	Rel-15	NR_newRAT-Core, LTE_HRLLC, LTE_sTTandPT	R2-1707655	SA2	RAN1	R2-1709976	
R1-1715361	LS on UE categories and capabilities	RAN2, Ericsson	Rel-15	NR_newRAT-Core		RAN1, RAN4	RAN	R2-1709979	
R1-1715362	LS reply on Support for fake gNB detection mechanisms	RAN2, Ericsson	Rel-15	NR_newRAT-Core		SA3	RAN1, RAN4	R2-1709980	
R1-1715363	Reply LS on multiple SSBs within a wideband carrier	RAN2, MediaTek	Rel-15	NR_newRAT-Core	R2-1709861	RAN1		R2-1709983	
R1-1715364	Reply LS on shared baseband capabilities for MR-DC	RAN4, Huawei	Rel-15	NR_newRAT-Core	R2-1707505	RAN2	RAN1	R4-1708284	
R1-1715365	Reply LS on UE measurement capability across LTE and NR	RAN4, Huawei	Rel-15	NR_newRAT-Core	R2-1706140	RAN2	RAN1	R4-1708694	
R1-1715366	LS on Power class and power control	RAN4, InterDigital	Rel-15	NR_newRAT-Core		RAN1		R4-1708807	
R1-1715367	LS on Mixed numerologies FDM operation	RAN4, Intel	Rel-15	NR_newRAT-Core		RAN1, RAN2		R4-1708864	
R1-1715368	LS on SSRRP Measurements for Mobility in NR	RAN4, Ericsson	Rel-15	NR_newRAT-Core		RAN1, RAN2		R4-1709017	
R1-1715369	LS on Definitions of Intra-frequency and Inter-frequency Measurements	RAN4, Ericsson	Rel-15	NR_newRAT-Core		RAN2	RAN1	R4-1709108	
R1-1715370	LS on uplink and downlink channel bandwidth for NR	RAN4, Intel	Rel-15	NR_newRAT-Core		RAN1, RAN2		R4-1709136	
R1-1715371	LS on beam management impact on power control	RAN4, Qualcomm	Rel-15	NR_newRAT-Core		RAN1		R4-1709147	
R1-1715372	LS on Channel Raster and Synchronisation of Channel Raster	RAN4, Qualcomm	Rel-15	NR_newRAT-Core		RAN1	RAN2	R4-1709175	
R1-1715373	LS on NR minimum carrier bandwidth and SS block numerology	RAN4, DISH, Ericsson	Rel-15	NR_newRAT-Core	R4-1707016	RAN1		R4-1709187	
R1-1715374	LS on NR L1 processing chain	RAN3, NTT DOCOMO	Rel-15	FS_NR_CU_DU_LLS		RAN1		R3-173439	

TDoc #	Title	Source	Release	Related WIs	Reply to	To	Cc	Original LS	Reply in
R1-1715375	LS on simultaneous transmission and/or reception over EPC/E-UTRAN and 5GC/NR	SA2, Intel, HTC	Rel-15	5GS_Ph1, NR_newRAT-Core		RAN1, RAN2, RAN4		S2-176689	
R1-1716671	LS to RAN1 on aperiodic indications based on beam failure recovery procedure	RAN2, Samsung	Rel-15	NR_newRAT-Core		RAN1		R2-1709993	
R1-1716674	LS on IMT-2020 submission	RAN, NEC	Rel-15			SA, RAN1, RAN2, RAN3, RAN4, RAN5	CT, RAN6	RP-172099	
R1-1716675	LS on single Tx switched UL	RAN, Qualcomm, Intel	Rel-15	NR_newRAT-Core		RAN4, RAN2	RAN1, RAN3	RP-172100	
R1-1716676	LS on NR UE Category	RAN, MediaTek	Rel-15	NR_newRAT-Core		RAN1	RAN2, RAN4	RP-172113	
R1-1716896	UE timing advance adjustment step size	RAN4, Ericsson	Rel-15	NR_newRAT-Core		RAN1	RAN2	R4-1709899	
R1-1716897	LS Reply to LS related to SRS hopping	RAN4, Qualcomm	Rel-15	NR_newRAT-Core	R1-1709836	RAN1		R4-1710048	

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Annex D: List of Approved updated WIDs

None

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Annex E: List of draft TSs/TRs agreed at RAN1 #AH_NR3

Tdoc Number	Title	Source	Conclusion/Decision

3GPP TSG RAN WG1 Meeting #90bis Prague, Czech Rep, 9th – 13th October 2017

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Annex F: List of actions

- Outgoing LS

[NR#3-02] Daniel (Ericsson)

Email approval of the LS to RAN2 on updated RRC parameters for NR

Done: According to Mr Chair's email posted on Oct.7th, the final LS is approved in R1-1716933.

- CR approval

None

- Text proposal for TS and TR

[NR#3-01-spec#]

Spec editors (38.201, 38.202, 38.211, 38.212, 38.213, 38.214, 38.215) to prepare updated versions incorporating this meeting's agreements and working assumptions by 9/28.

Done:

R1-1716925	TS38.201 v1.0.1 NR; Physical layer; General description	NTT DOCOMO, INC.	No updates post AH3_NR
R1-1716926	TS 38.202 v1.0.1 Services provided by the physical layer	Qualcomm Incorporated	No updates post AH3_NR
R1-1716927	TS38.211 v1.0.1 NR; Physical channels and modulation	Ericsson	revised (decision at RAN1#90bis)
R1-1716928	TS38.212 v1.0.1 NR; Multiplexing and channel coding	Huawei	endorsed
R1-1716929	TS38.213 v1.0.1 NR; Physical layer procedures for control	Samsung	revised (decision at RAN1#90bis)
R1-1716930	TS 38.214 v1.0.1 NR; Physical layer procedures for data	Nokia	revised (decision at RAN1#90bis)
R1-1716931	TS38.215 v1.0.1 NR; Physical layer measurements	Intel Corporation (UK) Ltd	endorsed

- Miscellaneous

[NR#3-02] Daniel (Ericsson)

Email approval of updated RRC parameters, draft ready by 9/28, aim to conclude by 10/6.

Done: According to Mr Chair's email posted on Oct.7th, the updated RRC parameters are agreed as:

R1-1716932 Higher parameters for NR Ericsson

[NR#3-03] Sundar (Qualcomm)

The range of values for the following set of parameters are for further email discussion for beam management until Oct 6th

- Minimum time between aperiodic CSI-RS for beam management and its DCI shall be at least K_B symbols. Symbols measured from last symbol containing the DCI to first symbol of CSI-RS.
 - For further discussion on the scenarios (where UE beam is changed or not from the last symbol containing the DCI to the first symbol containing the CSI RS)

- Note: the latency may include the DCI decoding latency
- The number of symbols between CSI-RS for beam management and the associated report shall be at least R_B .
 - Note: The start is calculated from the last symbol of the CSI-RS used for the measurement report and end time is calculated to be the first symbol of the associated report
 - Note: CSI-RS may be for P1/P2/P3 procedures

The following set of parameters will be discussed over email until Oct 6th.

- Number of slots or symbols between indication of the spatial QCL for PDSCCH and application of the PDSCCH beam switch shall be at least D_B
- Number of slots or symbols between indication of the spatial QCL for PDCCH and application of the PDCCH beam switch shall be at least S_B
- Maximum number of Rx beam changes a UE can conduct during a slot shall not exceed B_B .
- The number of measurement reports with L1-RSRP only per slot, per TRP, per component carrier shall not exceed C_{LB}
- For beam management and CQI, the number of antenna ports per CSI-RS burst, for which the UE measures the channel, shall not exceed P_B
- The max number of CSI resources to measure L1-RSRP within a slot shall not exceed M_B .
- The max number of simultaneously triggered CSI/beam reports is at most T_B
- Maximum number of Tx beam changes a UE can conduct during a slot shall not exceed D_3 .
- Minimum time between aperiodic SRS for beam management and its DCI shall be at least D_4 symbols. Symbols measured from last symbol containing the DCI to first symbol of SRS.
- Maximum index of SRI for beam indication is D_5

[NR#3-04] Stefan (Ericsson)

Further email discussion till next meeting on DCI contents including bitwidths for each information.

Done: Status to be checked at RAN1#90bis.

[NR#3-05] Ying (CATT)

Email discussion until Thursday 28th September to agree the details of the formula.

Done: According to Mr Chair's email posted on Sep.29th, more discussion is needed - Status to be checked at RAN1#90bis.

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Annex G: **List of participants at RAN1 #AH_NR3**

Please see excel file attached to this report

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Annex H: TSG RAN WG1 meetings in 2017 – 2018

TITLE	TYPE	DATES	LOCATION	CTRY
3GPPRAN1#90bis	WG	09 – 13 Oct 2017	Prague	Rep Czech
3GPPRAN1#91	WG	27 Nov – 01 Dec 2017	Reno	US
3GPPRAN1-AH-1801	AH	22 – 26 Jan 2018	TBD	US
3GPPRAN1#92	WG	26 Feb – 2 Mar 2018	Athens	Greece
3GPPRAN1#92bis	WG	16 – 20 Apr 2018	TBD	China
3GPPRAN1#93	WG	21 – 25 May 2018	TBD	Korea
3GPPRAN1#94	WG	20 – 24 Aug 2018	Gothenburg	Sweden
3GPPRAN1#94bis	WG	8 – 12 Oct 2018	TBD	China
3GPPRAN1#95	WG	12 – 16 Nov 2018	TBD	US

MEETING TYPES			
AH = Ad Hoc	ST = Startup Meeting	RG = Rapporteurs Group	
JM = Joint	WG = Working Group	SG = Steering Group	
PM = Preparatory Meeting	CM = Chairmen's meeting	TG = Task Group	
RM = Resolution Meeting	OR = Ordinary	XO = Extraordinary	

End of document

APPENDIX E

[illegible]

