


IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent of: Havish Koorapaty, et al.
U.S. Patent No.: 10,306,669 Attorney Docket No.: 39843-0100IP1
Issue Date: May 28, 2019
Appl. Serial No.: 16/203,391
Filing Date: November 28, 2018
Title: PHYSICAL UPLINK CONTROL CHANNEL (PUCCH)
RESOURCE ALLOCATION

DECLARATION OF DR. R. MICHAEL BUEHRER

I declare that all statements made herein on 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 under Section 1001 of Title 18 of the United States Code.

By: _____

R. Michael Buehrer, Ph.D.

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I. QUALIFICATIONS AND BACKGROUND INFORMATION

1. My education and experience are described more fully in the attached curriculum vitae (SAMSUNG-1004). For ease of reference, I have highlighted certain information below.
2. My academic and professional background is in Electrical and Computer Engineering, and I have been working in those fields since the completion of my Ph.D. over 20 years ago. The details of my background and education, and a listing of all publications that I have authored, are provided in my Curriculum Vitae. *See* SAMSUNG-1004. Below, I provide a short summary of my education and experience that I believe to be most pertinent to the opinions I have formed in this case.
3. I received a B.S. in Electrical Engineering from The University of Toledo in 1991, an M.S. in Electrical Engineering from The University of Toledo in 1993, and a Ph.D. in Electrical Engineering from Virginia Polytechnic Institute and State University in 1996. The focus of my graduate work was wireless communication systems. My Ph.D. thesis involved the application of multiuser detection (an advanced signal processing approach to interference mitigation) to CDMA-based cellular systems.
4. After completion of my Ph.D. in 1996, I joined Bell Laboratories, the research division of Lucent Technologies, where I worked for five years as a

Member of Technical Staff and later as a Distinguished Member of Technical Staff. My work there focused on developing advanced technologies for cellular telecommunications, including for 3G cellular standards. For example, while at Bell Labs, I developed and implemented algorithms for intelligent antenna systems which increased the voice capacity (*i.e.*, number of simultaneous phone calls) and data capacity of cellular systems. These algorithms were included in Lucent Technologies' 3G CDMA cellular base station. I also developed techniques known as transmit diversity techniques which increased reliability (*i.e.*, reduced the probability of a dropped call) of cellular systems. These transmit diversity techniques were standardized in the 3GPP2 cellular standard known as *cdma2000*. During that time, I supported the standardization of my ideas by writing contributions to the working groups developing the standards and attending standards meetings. In particular, I participated in the 3GPP2 standardization process. During that time, I worked with colleagues to include my ideas on the use of transmit diversity in CDMA systems in the 3GPP2 standard.

5. I am currently a Professor in the Bradley Department of Electrical and Computer Engineering at Virginia Polytechnic Institute and State University, where I have taught and conducted research in the area of wireless communications for nearly 20 years. Specifically, I have taught courses which cover wireless communications and signal processing (including the underlying

concepts) at the undergraduate and graduate levels. For example, I teach a sophomore-level course which introduces the concepts of signals and systems, a junior-level course which introduces the basic concepts of communication systems, senior-level and graduate-level courses which cover advanced digital communication topics, and also graduate-level courses which teach the advanced technologies underlying the latest wireless systems, such as Fourth and Fifth Generation (4G/5G) cellular communication standards (*e.g.*, LTE, LTE-Advanced, New Radio) and Wi-Fi. I also teach graduate courses on advanced topics such as Information Theory, Machine Learning Applied to Communication Systems, Spread Spectrum Communications and CDMA.

6. I am also the director of *Wireless @ Virginia Tech*, a comprehensive research group focusing on wireless communications which consists of 14 faculty members and approximately 85 graduate students. My specific research focuses on advanced wireless communications and geolocation techniques. This research has examined both advanced theoretical concepts as well as the application of these concepts to the latest wireless standards. As an example of the latter, I (along with my students) have conducted research applying multiuser/multi-antenna signal processing to LTE. I have also applied advanced geolocation techniques to LTE systems.

7. My research work has been funded by national agencies including the National Science Foundation (NSF), the Defense Advanced Research Projects Agency (DARPA), the Office of Naval Research (ONR), the Army Research Lab, the Air Force Research Lab as well as many industrial sponsors.

8. During 2009, I was a visiting researcher at the Laboratory for Telecommunication Sciences (LTS), a Federal Research Lab which focuses on telecommunication challenges for national defense. While at LTS, my research focus was in the area of cognitive radio with a particular emphasis on statistical learning techniques.

9. I have authored and co-authored over 250 publications in my area of expertise, which have been published in the leading journals in my field including *IEEE Transactions on Communications*, *IEEE Transactions on Wireless Communications*, *IEEE Transactions on Information Theory*, *Proceedings of the IEEE*, and *IEEE Transactions on Signal Processing*, and at all of the major conferences in my field. This research has been cited more than 9,000 times. A complete list of my publications over the last 25 years is included in my Curriculum Vitae.

10. I am a Fellow of the IEEE (so named “for contributions to wideband signal processing in communications and geolocation”). In 2010, I was awarded the Ellersick Best Paper Award in the Unclassified Technical Program, at the IEEE

Military Communications Conference. I received the SDR Forum Best Paper Award in 2007 and the Outstanding Paper Award at the SDR Forum in 2008. I received the Dean's Award for Teaching Excellence in April 2014 and the Dean's Award for Outstanding New Assistant Professor, College of Engineering in 2003. While at Bell Laboratories, I was awarded the Bell Labs President's Silver Award for outstanding research contributions and the 1999 Best Paper Award in the Bell Labs Technical Journal.

11. As a consultant, I have examined in detail various aspects of the physical layer, MAC layer, RLC layer, and RRC layer including both user data transmission and the control signaling of the standards for 2G, 3G, and 4G cellular systems. I have also specifically studied the standardization process in 3GPP as it relates to the standardization of a particular aspect of 4G (LTE). I have also taught short-courses in the areas of cellular systems, geolocation and Wi-Fi communications.
12. I also hold 18 issued patents in the area of wireless communications, many of which relate to cellular communication systems.
13. I currently serve as an area editor for *IEEE Transactions on Wireless Communications* supervising a team of 12 editors. I also recently served as a guest editor for a special issue of the *Proceedings of the IEEE*. I was formerly an associate editor for *IEEE Wireless Communications Letters*, *IEEE Transactions on Vehicular Technologies*, *IEEE Transactions on Communications*, *IEEE*

Transactions on Signal Processing, and *IEEE Transactions on Education*.

Additionally, I formerly served as the guest editor for the *IEEE Journal on Special Topics in Signal Processing*. I served as the Technical Program Chair for the Signal Processing for Communications Symposium at the 2017 IEEE International Conference on Communications. Previously, I was the Organizer and Technical Co-Chair for both the 2015 and 2016 IEEE Global Communications Conference Workshop on Localization and Tracking: Indoors, Outdoors and Emerging Networks (LION). I have also served on the technical program committees of several other conferences and workshops in my field.

14. I have been retained on behalf of Samsung Electronics Co., Ltd. and Samsung Electronics America, Inc. (“Samsung”) to offer technical opinions relating to U.S. Patent No. 10,306,669 (“the ’669 patent”) and prior art references relating to its subject matter. I have reviewed the ’669 Patent, and relevant excerpts of the prosecution history of the ’669 Patent. I have also reviewed the following prior art references:

Prior Art References
SAMSUNG-1005 – U.S. Patent Publication No. 2013/0208692 (“Seo”)
SAMSUNG-1006 – “NR PUCCH resource allocation,” 3GPP TSG RAN WG1 Meeting NR#3, R1-1715527, September 18-21, 2017 (“ZTE”)

<p>SAMSUNG-1007 – “Resource allocation for NR uplink control channel,” 3GPP TSG RAN WG1 NR Ad-Hoc Meeting, R1-1700369, January 16-20, 2017 (“Intel”)</p>

15. I have also reviewed various supporting references and other documentation.

16. Counsel has informed me that I should consider these materials through the lens of one of ordinary skill in the art related to the '669 Patent at the time of the earliest possible priority date of the '669 Patent, and I have done so during my review of these materials. The application leading to the '669 Patent claims the benefit of priority to a provisional application filed October 26, 2017 (“the Critical Date”). Counsel has informed me that the Critical Date represents the earliest possible priority date to which the challenged claims of '669 Patent are entitled, and I have therefore used that Critical Date in my analysis below.

17. I have no financial interest in the parties or in the outcome of this proceeding. I am being compensated for my work as an expert on an hourly basis. My compensation is not dependent on the outcome of these proceedings or the content of my opinions.

18. In writing this declaration, I have considered the following: my own knowledge and experience, including my work experience in the fields of electrical engineering, computer science, and computer engineering; my experience in

teaching those subjects; and my experience in working with others involved in those fields. In addition, I have analyzed various publications and materials, in addition to other materials I cite in my declaration.

19. My opinions, as explained below, are based on my education, experience, and expertise in the fields relating to the '669 Patent. Unless otherwise stated, my testimony below refers to the knowledge of one of ordinary skill in the fields as of the Critical Date, or before. Any figures that appear within this document have been prepared with the assistance of Counsel and reflect my understanding of the '669 Patent and the prior art discussed below.

II. OVERVIEW OF CONCLUSIONS FORMED

20. This declaration explains the conclusions that I have formed based on my analysis. To summarize those conclusions, based upon my knowledge and experience and my review of the prior art publications listed above, I believe that:

- Claims 1-3, 6-8, 11, 12, and 17-19 are rendered obvious by Seo (US2013/0208692) and ZTE (R1-1715527); and
- Claims 1-3, 6-8, 11, 12, and 17-19 are rendered obvious by Seo, ZTE, and Intel (R1-1700369).

III. LEVEL OF ORDINARY SKILL IN THE ART

21. In my opinion, a person of ordinary skill in the art ("POSITA") relating to, and at the time of, the '669 Patent's Critical Date would have been someone with a

working knowledge of telecommunications systems. The person would have had at least a Bachelor's Degree (or higher degree) in an academic area emphasizing telecommunications systems with two or more years of work experience in telecommunications systems. Alternatively, a POSITA would have had a Master of Science Degree in an academic area emphasizing telecommunications systems, or an equivalent field (or a similar technical Master's Degree, or higher degree) with a concentration in telecommunications systems. Additional education in a relevant field, or relevant industry experience may compensate for a deficit in one of the other aspects of the requirements stated above.

22. Based on my knowledge, skill, and experience, I have a good understanding of the capabilities of the POSITA. Indeed, I have taught, participated in organizations, and worked closely with many such persons over the course of my career. For example, from my industry experience, I am familiar with what an engineer would have known and found predictable in the art. From teaching and supervising my post-graduate students, I also have an understanding of the knowledge that a person with this academic experience possesses. Furthermore, I possess those capabilities myself.

IV. LEGAL STANDARDS

A. Terminology

23. I have been informed by Counsel and understand that the best indicator of claim meaning is its usage in the context of the patent specification as understood by one of ordinary skill. I further understand that the words of the claims should be given their plain meaning unless that meaning is inconsistent with the patent specification or the patent's history of examination before the Patent Office. Counsel has also informed me, and I understand that, the words of the claims should be interpreted as they would have been interpreted by one of ordinary skill at the time of the Critical Date. I have used the earliest possible priority date of the '669 Patent as the point in time for claim interpretation purposes. I understand that date was October 26, 2017, the Critical Date.

B. Legal Standards for Anticipation

24. I have been informed by Counsel and understand that documents and materials that qualify as prior art can render a patent claim unpatentable as anticipated. I am informed by Counsel and understand that all prior art references are to be looked at from the viewpoint of a person of ordinary skill in the art.

25. I am informed by Counsel and understand that a challenged claim is unpatentable as "anticipated" under 35 U.S.C. § 102 if it is determined that all the limitations of the claim are described in a single prior art reference. I am informed by Counsel and understand that, to anticipate a claim, a prior art reference must

disclose, either expressly or inherently, each and every limitation of that claim and enable one of ordinary skill in the art to make and use the invention.

26. I have been informed by Counsel and understand that in an *inter partes* review, “the petitioner shall have the burden of proving a proposition of unpatentability,” including a proposition of anticipation, “by a preponderance of the evidence.” 35 U.S.C. §316(e).

C. Legal Standards for Obviousness

27. I have been informed by Counsel and understand that documents and materials that qualify as prior art can render a patent claim unpatentable as obvious. I am informed by Counsel and understand that all prior art references are to be looked at from the viewpoint of a person of ordinary skill in the art at the Critical Date, and that this viewpoint prevents one from using his or her own insight or hindsight in deciding whether a claim is obvious.

28. I have been informed by Counsel and understand that a claim is unpatentable for obviousness “if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains.” I am informed by Counsel and understand that obviousness may be based upon a combination of references. I am informed by Counsel and understand that the combination of familiar elements

according to known methods is likely to be obvious when it does no more than yield predictable results. However, I am informed by Counsel and understand that a patent claim composed of several elements is not proved obvious merely by demonstrating that each of its elements was, independently, known in the prior art.

29. I am informed by Counsel and understand that when a patented invention is a combination of known elements, a court must determine whether there was an apparent reason to combine the known elements in the fashion claimed by the patent at issue by considering the teachings of prior art references, the effects of demands known to people working in the field or present in the marketplace, and the background knowledge possessed by a person having ordinary skill in the art.

30. I am informed by Counsel and understand that a patent claim composed of several limitations is not proved obvious merely by demonstrating that each of its limitations was independently known in the prior art. I am informed by counsel and understand that identifying a reason those elements would have been combined can be important because inventions in many instances rely upon building blocks long since uncovered, and claimed discoveries almost of necessity will be combinations of what, in some sense, is already known. I am informed by Counsel and understand that it is improper to use hindsight in an obviousness analysis, and that a patent's claims should not be used as a "roadmap."

31. I am informed by Counsel and understand that an obviousness inquiry requires consideration of the following factors: (1) the scope and content of the prior art; (2) the differences between the claims and the prior art; (3) the level of ordinary skill in the pertinent art; and (4) any objective indicia of non-obviousness, such as commercial success, long-felt but unresolved need, failure of others, industry recognition, copying, and unexpected results. I understand that the foregoing factors are sometimes referred to as the “Graham factors.”

32. I have been informed by Counsel and understand that an obviousness evaluation can be based on a combination of multiple prior art references. I understand that the prior art references themselves may provide a suggestion, motivation, or reason to combine, but that the nexus linking two or more prior art references is sometimes simple common sense. I have been informed by Counsel and understand that obviousness analysis recognizes that market demand, rather than scientific literature, often drives innovation, and that a motivation to combine references may be supplied by the direction of the marketplace.

33. I have been informed by Counsel and understand that if a technique has been used to improve one device, and a person of ordinary skill at the time of the Critical Date would have recognized that it would improve similar devices in the same way, using the technique is obvious unless its actual application is beyond his or her skill.

34. I have been informed by Counsel and understand that practical and common sense considerations should guide a proper obviousness analysis, because familiar items may have obvious uses beyond their primary purposes. I have been informed by Counsel and understand that a person of ordinary skill looking to overcome a problem will often be able to fit together the teachings of multiple prior art references. I have been informed by Counsel and understand that obviousness analysis therefore takes into account the inferences and creative steps that a person of ordinary skill would have employed at the time of the Critical Date.

35. I have been informed by Counsel and understand that a proper obviousness analysis focuses on what was known or obvious to a person of ordinary skill at the time of the Critical Date, not just the patentee. Accordingly, I understand that any need or problem known in the field of endeavor at the time of the Critical Date and addressed by the patent can provide a reason for combining the elements in the manner claimed.

36. I have been informed by Counsel and understand that a claim can be obvious in light of a single reference, without the need to combine references, if the elements of the claim that are not found explicitly or inherently in the reference can be supplied by the common sense of one of skill in the art.

37. I have been informed by Counsel and understand that secondary indicia of non-obviousness may include (1) a long felt but unmet need in the prior art that was satisfied by the invention of the patent; (2) commercial success of processes covered by the patent; (3) unexpected results achieved by the invention; (4) praise of the invention by others skilled in the art; (5) taking of licenses under the patent by others; (6) deliberate copying of the invention; (7) failure of others to find a solution to the long felt need; and (8) skepticism by experts. I understand that evidence of secondary indicia of non-obviousness, if available, should be considered as part of the obviousness analysis.

38. I have been informed by Counsel and understand that there must be a relationship between any such secondary considerations and the invention, and that contemporaneous and independent invention by others is a secondary consideration supporting an obviousness determination.

39. In sum, my understanding is that prior art teachings are properly combined where one of ordinary skill having the understanding and knowledge reflected in the prior art and motivated by the general problem facing the inventor, would have been led to make the combination of elements recited in the claims. Under this analysis, the prior art references themselves, or any need or problem known in the field of endeavor at the time of the Critical Date, can provide a reason for combining the elements of multiple prior art references in the claimed manner.

40. I have been informed by Counsel and understand that in an *inter partes* review, “the petitioner shall have the burden of proving a proposition of unpatentability,” including a proposition of obviousness, “by a preponderance of the evidence.” 35 U.S.C. §316(e).

V. THE ’669 PATENT

A. Overview of the ’669 Patent

41. Prior to the Critical Date of the ’669 Patent, numerous products, publications, and patents existed that implemented or described the functionality claimed in the ’669 Patent. The claimed inventions of the ’669 Patent were therefore well-known in the prior art as of the Critical Date. Further, to the extent there was any problem to be solved in the ’669 Patent, it had already been solved in the prior art systems before the Critical Date of the ’669 Patent as I discuss below.

42. The ideas discussed in the ’669 patent include “[s]ystems and methods for determining an uplink control channel resource to use for transmitting uplink control information to a network node.” SAMSUNG-1001, Abstract. The ’669 patent includes four independent claims. Specifically independent claims 1 and 6 of the ’669 patent relate to a first process for determining the uplink control channel resource to transmit uplink control information (UCI), whereas

independent claims 11 and 18 of the '669 patent relate to a second (i.e., different) process for determining the uplink control channel resource to transmit UCI.

43. Independent claims 1 and 6 of the '669 patent are directed to the process described in Fig. 13 and termed “Embodiment 7.” SAMSUNG-1001, 33:23-40.

As shown in Fig. 13 (reproduced below), a user equipment (“UE”) receives, from a network node, two downlink control channel messages that schedule two downlink shared channel transmissions. *Id.*, 33:24-29. This general process has been the standard procedure for scheduling downlink transmissions in 3GPP-based cellular system since the initial version of LTE (*see, e.g.*, SAMSUNG-1009 (S. Sesia, I. Toufik and M. Baker “LTE: The UMTS Long Term Evolution” (“Sesia”)), p.202-206.) The UE then determines one uplink control channel resource to use for transmitting, to the network node, Hybrid Automatic Repeat Request (“HARQ”) feedback for both downlink shared channel transmissions. SAMSUNG-1001, 33:30-35. Again, this process was well known to a POSITA and goes back to the original version of LTE. *See* SAMSUNG-1009 (Sesia), p. 348-364. The determination of which uplink control channel resource to use for the HARQ feedback transmission is based on signaling received from the network node and a latest received one of the two downlink control channel messages. SAMSUNG-1001, 33:35-40. One example of this part of the process is described in “Embodiment 7.” Specifically, “if a UE receives a [Physical Downlink Control

Channel] PDCCH which points to a [Physical Uplink Control Channel] PUCCH resource ... and the UE receives a PDCCH at a later time, this latest scheduled PDCCH can override the PUCCH resource assignment as per the previously received PDCCH, and the HARQ feedback can be sent for both the PDSCHs corresponding to the prior and latest PDCCH using the PUCCH resources determined based on the latest received PDCCH.” *Id.*, 13:10-41. It is worth noting that the terms PDCCH, PUCCH and PDSCH were well-known terms to a POSITA at the time of the ’669 patent, since they were used in various versions of the 3GPP standard starting at least with LTE. *See* SAMSUNG-1009 (Sesia), p. 202-206, 348-350.

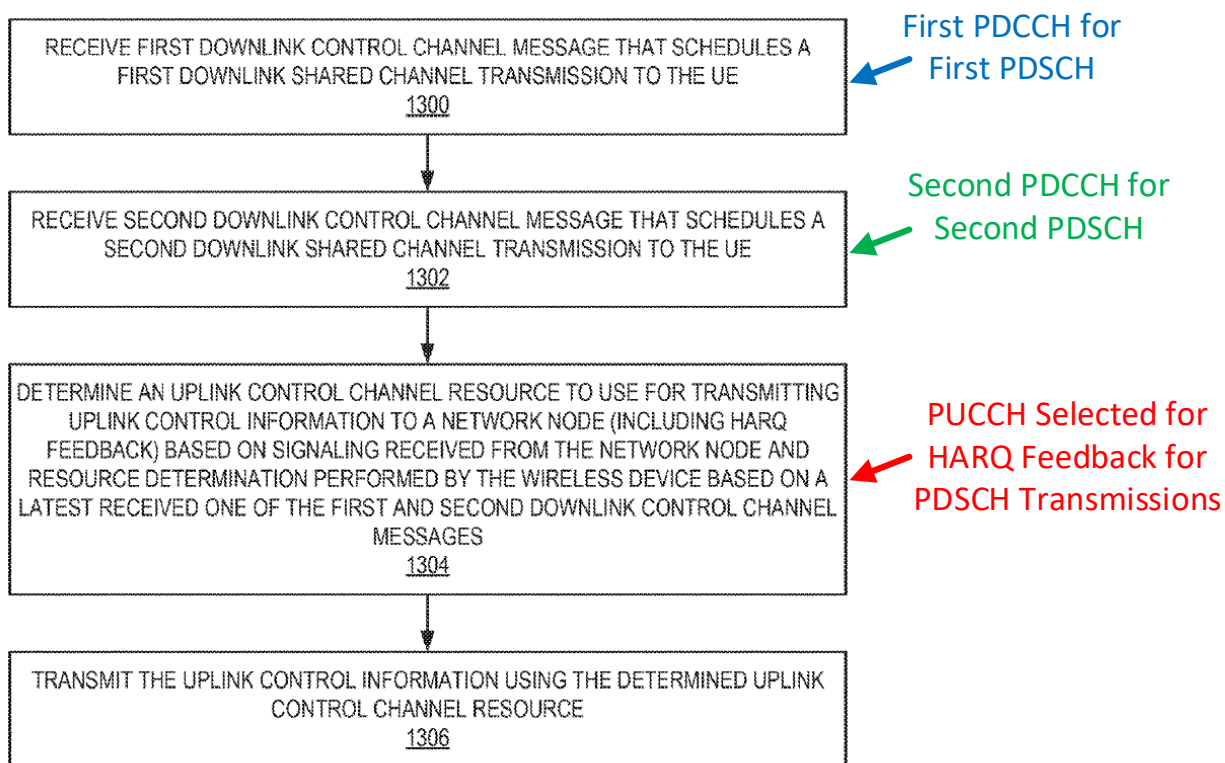
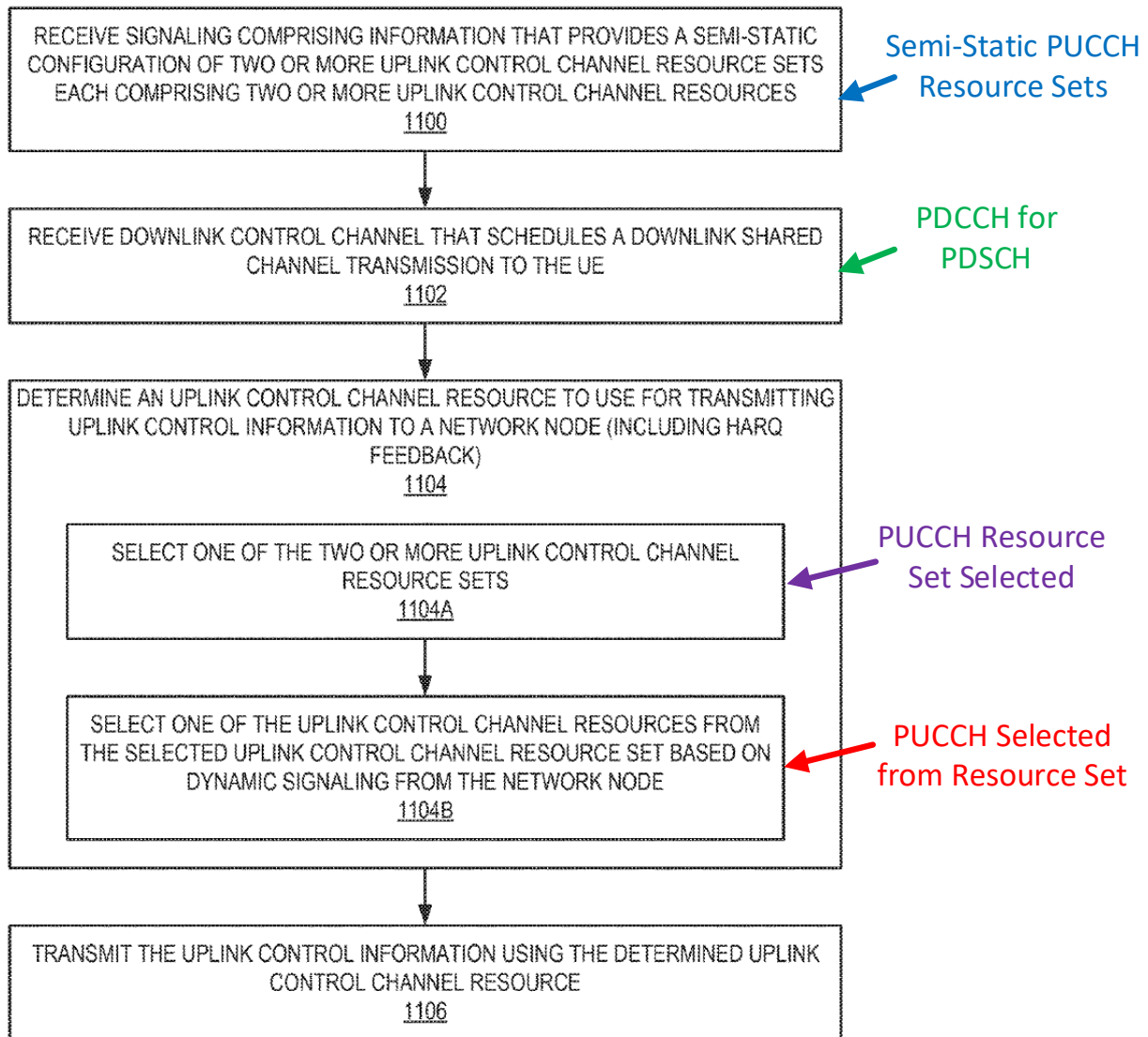


FIG. 13

SAMSUNG-1001, Fig. 13 (annotated)

44. Independent claims 11 and 18 of the '669 patent are directed to the description of Fig. 11 which is also described in “Embodiment 3.” SAMSUNG-1001, 31:36-32:38. As shown in Fig. 11 (reproduced below), a UE receives, from a network node (often termed an eNodeB in the 3GPP standard), “a semi-static configuration of two or more uplink control channel resource sets each comprising two or more uplink control channel resources” and “a downlink control channel that schedules a downlink shared channel transmission.” *Id.*, 31:37-44. The UE then determines an uplink control channel resource to use for transmitting, to the

network node, HARQ feedback for the downlink shared channel transmission. *Id.*, 31:44-49. Again, this was well known to a POSITA based on the LTE standard for at least six years prior to the '669 patent. *See* SAMSUNG-1009 (Sesia), p.348-364. The UE first selects an uplink control channel resource set based on the HARQ payload size and the starting Control Channel Element (CCE) index of the downlink control channel candidate (*id.*, 31:49-32:24), and then selects, from the selected resource set, an uplink control channel resource based on dynamic scheduling from the network node (*id.*, 32:32-37). One example of this is “Embodiment 3,” which states that “[w]hether a PUCCH format of up to 2 bits or greater than 2 bits is used is determined by the UE implicitly based on the payload size”. Further, “[t]he CCE index ... is then used to determine a single PUCCH resource set within the group of configured PUCCH resource sets corresponding to the chosen PUCCH format,” and “[d]ynamic signaling (2 bits) in the DCI message is used to determine a single PUCCH resource from within the chosen PUCCH resource set.” *Id.*, 10:13-26; 9:45-11:23.



SAMSUNG-1001, Fig. 11 (annotated)

B. Prosecution History of the '669 Patent

45. The '669 patent issued on May 28, 2019 from U.S. Patent Application No. 16/203,391 ("the '391 application"), which was filed on November 28, 2018. *See* SAMSUNG-1002. My understanding is that the '391 application was filed with a

Track One Request for Prioritized Examination and a Request to Participate in the First Action Interview Pilot Program. *Id.* In a Pre-Interview Communication, the Examiner identified claims 3, 9, and 14 as reciting allowable subject matter. *Id.* An interview was held afterwards and the Examiner subsequently issued a Notice of Allowance with an Examiner's amendment. The amendment modified the independent claims to include the allowable subject matter identified in the Pre-Interview Communication. *Id.* In the Notice of Allowance, the Examiner claimed that the prior art does not teach:

wherein the signaling received from the network node comprises information that provides a semi-static configuration of two or more uplink control channel resource sets each comprising two or more uplink control channel resources ... selecting one of the two or more uplink control channel resource sets, and selecting, as the uplink control channel resource to use for transmitting the uplink control information to the network node, one of the two or more uplink control channel resources from the selected uplink control channel resource set based on dynamic signaling from the network node. *Id.*

VI. SUMMARY OF THE PRIOR ART

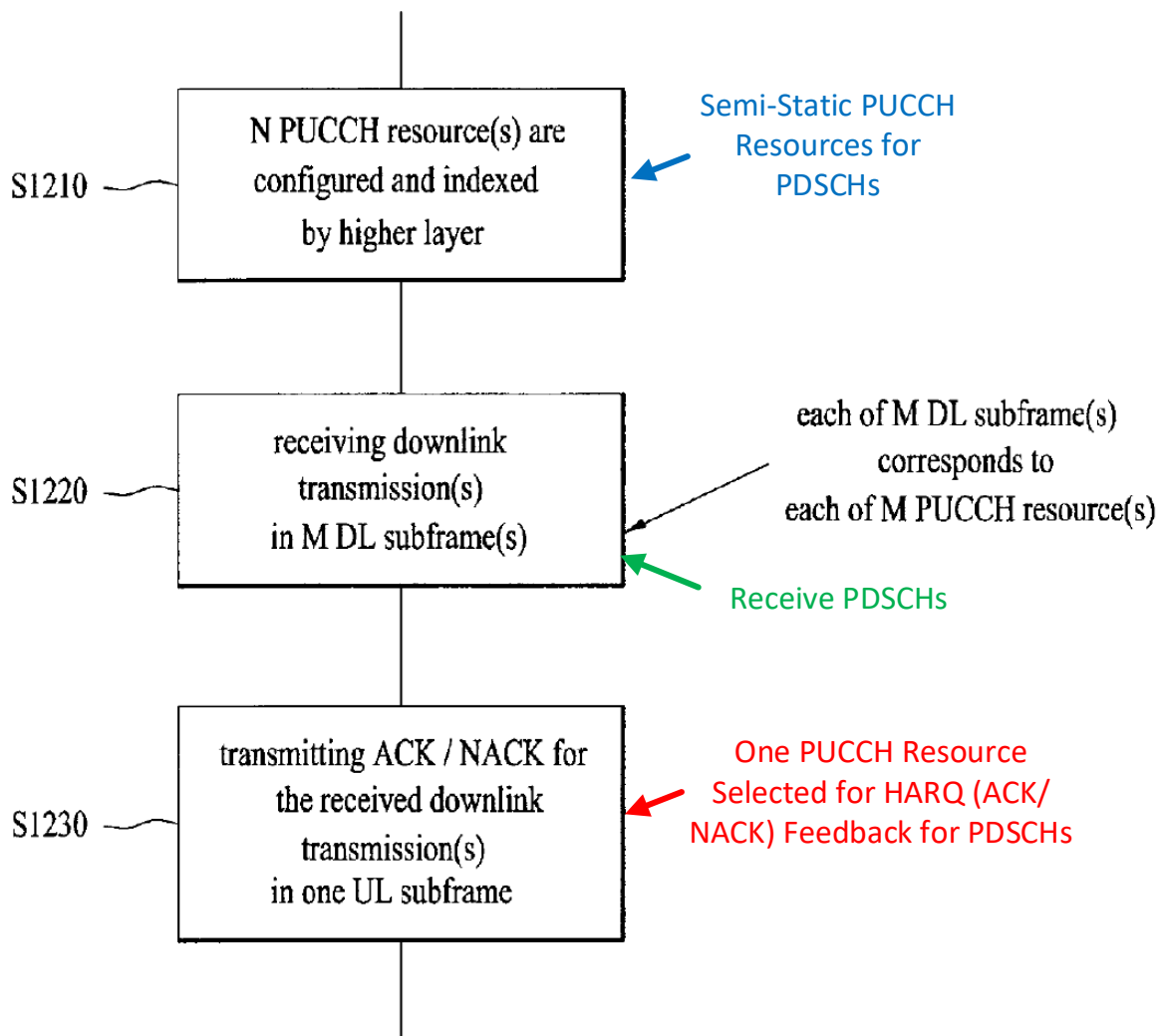
A. Seo

46. Seo is directed towards uplink control signaling related to downlink transmissions and specifically describes “a method and apparatus for transmitting ACK/NACK for downlink transmission in a wireless communication system.” SAMSUNG-1005, [0001]. Seo’s teaching uses “a Physical Downlink Control Channel (PDCCH)” to transmit “Downlink Control Information (DCI)” that “includes uplink or downlink scheduling information.” *Id.*, [0051], [0013]-[0014]. Similar to the ’669 patent, Seo’s scheduling information includes information related to data transmissions on “a Physical Downlink Shared Channel (PDSCH)” and HARQ feedback related to PDSCH data transmissions. *Id.*, [0051], [0052], [0006], [0011]-[0012].

47. Seo also provides a detailed description concerning the “Determination of Resources Used to Transmit ACK/NACK Information.” *Id.*, [0133]-[0216]. For instance, the base station (eNB in 3GPP terminology) sends, to a UE (3GPP term for mobile station), “control information for downlink data transmission ... via a PDCCH”. The UE then “receives data scheduled via the PDCCH to the UE via a PDSCH,” and “transmit[s] ACK/NACK via a PUCCH.” *Id.*, [0138]; *see also* [0134]-[0137]. In some of Seo’s embodiments, the UE aggregates “HARQ ACK/NACK information,” e.g., it transmits ACK/NACKs for “PDSCH

transmission of one or more downlink subframes in one uplink subframe.” *Id.*, [0147]; *see also* [0150], [0155].

48. As shown in Fig. 12 (reproduced below), a UE in Seo’s system receives PDDCH transmissions that schedule PDSCH transmissions and “semi-statically configured ... PUCCH resources.” *Id.*, [0208]; *see also* [0204] (“semi-statically configuring a plurality of ACK/NACK resource sets”), [0205] (“higher layer signaling (e.g., RRC signaling)”), [0212] (“downlink subframes may be PDSCH transmission(s)”), [0215] (“ACK/NACK feedback for a PDSCH indicated by detection of a corresponding PDCCH”). Seo’s UE then receives “PDSCH transmission(s)” in “downlink subframes” *Id.*, [0209]-[0210]; *see also* [0212], [0215]. The UE in Seo’s system then transmits “ACK/NACK information” for the multiple “downlink subframes” in “one of the M PUCCH resources.” *Id.* Seo refers to this as “ACK/NACK bundling.” *Id.*, [0211].



SAMSUNG-1005, Fig. 12 (annotated)

49. Seo teaches several different approaches for selecting the PUCCH resource to be used for the transmission of the HARQ ACK/NACK feedback. One relevant example provided by Seo is where the “ACK/NACK bundling result may be transmitted via an ACK/NACK resource set *mapped to a last DL subframe* in which the PDSCH is transmitted (*a latest DL subframe*, in which the PDSCH is

received, from among m DL subframes).” SAMSUNG-1005, [0183]; *see also* [0184]-[0188] (“the PUCCH resource set 0 mapped to the last DL subframe (that is, the DL subframe #9) in which the PDSCH is received.”), [0202] (“if ACK/NACK bundling is applied, bundled ACK/NACK information may be transmitted using ACK/NACK resources mapped to the last (or highest) control channel number count value of the DL subframes associated with one UL subframe.”). In this approach, dynamic signaling (e.g., control information that is sent each subframe) may be used to determine the latest DL subframe and consequently select the PUCCH resource. *Id.*, [0183]. More specifically, the “control channel transmitted from the transmitter may include a control channel number count value,” which “gradually increases for each control channel” and is “similar to a downlink assignment index (DAI) field included in a PDCCH.” *Id.*; *see also* [0187]-[0189], [0196]-[0202] (“bundled ACK/NACK information may be transmitted using ACK/NACK resources mapped to the last (or highest) control channel number count value of the DL subframes associated with one UL subframe”), [0212] (“[t]he control channel may include control channel number count information”). When the control channel number count value is used, Seo’s ACK/NACK UCI is sent via an uplink control channel that is “mapped to the last (or highest) control channel number count value of the DL subframes associated with one UL subframe.” *Id.*, [0202].

50. Seo also describes selecting the PUCCH resource based on control channel elements (CCEs). *Id.*, [0051], [0139]. For instance, “the UE may transmit ACK/NACK via a PUCCH having an index corresponding to an index of a specific (e.g., first) CCE of the CCEs configuring the PDCCH received by the UE.” *Id.*, [0139]-[0140]. Seo also describes PUCCH resource selection using equations that include the value “ n_{CCE} ,” which “denotes the smallest value of CCE indexes used for PDCCH transmission in a subframe $n-k_m$ (k_m is the smallest value of the set K).” *Id.*, [0142]-[0143], [0150]-[0152].

51. Although Seo describes various embodiments for determining the PUCCH resource for transmitting ACK/NACK information (*id.*, [0133]-[0216]), a POSITA would have viewed the various techniques collectively. As a result, a POSITA would have found it obvious to apply techniques from one embodiment in combination with various other described embodiments. Specifically, Seo’s embodiments relate to conventional resource determination and ACK/NACK signaling and a POSITA would have viewed the various techniques together as a collective set of available options for resource determination and ACK/NACK signaling. For example, the existing cellular standard had several options for choosing resources for UCI signaling and thus a POSTIA would be familiar with various options that could be used in combination. *See* SAMSUNG-1009 (Sesia), 348-366. Additionally, Seo itself explains that “two or more embodiments may be

simultaneously applicable.” SAMSUNG-1005, [0216]. Through Seo’s suggestion to consider multiple embodiments together and based on the many similar and well-known techniques in the existing 3GPP standard (*see* SAMSUNG-1009 (Sesia)), a POSITA would have found it obvious to consider teachings from different embodiments together. Thus, , a POSITA would have had reason to consider various embodiments described by Seo together and would have found it obvious to apply techniques in one embodiment to other of the described embodiments.

B. ZTE

52. ZTE is a 3GPP contribution that describes “PUCCH resource allocation” in 3GPP New Radio (NR) and Long-Term Evolution (LTE) systems. SAMSUNG-1006, 1-6. ZTE describes an approach where PUCCH resources are determined via a combination of higher layer signaling and dynamic signaling. More specifically, it proposes “ARI-based PUCCH resource allocation for HARQ-ACK transmission” where “a PUCCH resource set is configured by high layer signaling, and the physical layer signaling indicates the one PUCCH resource from the set.” *Id.*, 2. As part of this approach, ZTE proposed “a separate PUCCH resource set for different PUCCH formats.” *Id.* Specifically, ZTE proposed “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.” *Id.* (emphasis omitted).

In the ZTE proposal, the “PUCCH resource set is configured by high layer signaling” and “4 bits in DCI is used to indicate one PUCCH resource group index to the UE” (e.g., dynamic signaling). *Id.* As shown in Table 1 (reproduced below), a PUCCH resource set in ZTE includes multiple PUCCH resources.

SAMSUNG-1006, 3.

Table 1– PUCCH resource set for formats carrying up to 2 bits

PUCCH Resource Set With
Multiple PUCCH Resources

PUCCH Resource Selected
Based On Index in DCI

PUCCH format	PUCCH length	PUCCH resource value	Time domain OCC	Cyclic shift index	PUCCH resource group index
Short Format 0	1	a0	-	CS set #0	0
		a1	-	CS set #1	1
	1	a2	-	CS set #2	2
		a3	-	CS set #3	3
	2	a4	-	CS set #4	4
		a5	-	CS set #5	5
	2	a6	-	CS set #6	6
		a7	-	CS set #7	7
Long Format 0	4	a8	OCC #0	CS set #8	8
		a9	OCC #1	CS set #9	9
	8	a10	OCC #0	CS set #10	10
		a11	OCC #1	CS set #11	11
	8	a12	OCC #0	CS set #12	12
		a13	OCC #1	CS set #13	13
	14	a14	OCC #0	CS set #14	14
		a15	OCC #1	CS set #15	15

SAMSUNG-1006, Table 1 (annotated)

53. ZTE’s approach also stipulates that “[f]or PUCCH formats with more than 2 bits, a similar resource set like Table 1 would be introduced.” SAMSUNG-1006, 3. In other words, ZTE’s proposal describes two PUCCH resource sets: (1) a first resource set with multiple PUCCH resources for 2-bit PUCCH formats (as shown

in Table 1) and (2) a second resource set with multiple PUCCH resources for PUCCH formats with more than 2 bits (similar to Table 1, but not shown). *Id.*

54. ZTE also explains that, “[i]n LTE, a combination of a semi-static configuration and dynamic signalling is used to determine the PUCCH resource for ACK/NACK in the frequency domain” and further that “[a] similar concept could be envisioned for NR.” SAMSUNG-1006, 4. In particular, “[a] set containing four PUCCH candidate resources is configured through semi-static signalling, and then the specific PUCCH resources to be used are indicated via the physical layer DCI.” *Id.*, 5. It should be noted that a POSITA would understand “semi-static signaling” to be equivalent to “higher layer signaling”. For example, *see* SAMSUNG-1009 (Sesia), p. 355 (stating “[a] UE is **semi-statically** configured by **higher layer signalling** to report periodically different CQI, PMI, and RI types”, emphasis added), p. 360 (stating “the PUCCH ACK/NACK resource index $n^{(1)}_{PUCCH}$ to be used by a UE is **semi-statically configured by higher layer signalling**”, emphasis added), p. 415 (stating “For the SRS, an additional **semi-static offset** relative to the PUSCH power operating point may be **configured by RRC signalling.**”)

55. With this background, ZTE proposed “a new method to achieve semi-static + dynamic PUCCH frequency resource allocation” with “an enhanced ARI mechanism.” *Id.* Specifically, in ZTE’s enhanced ARI mechanism:

The base station always configures 3 *candidate PUCCH resources for the UE through higher layer signalling* and implicitly assumes that 1 candidate PUCCH resource is located within the frequency domain of the PUSCH / PDSCH of the UE. Then, *physical layer signalling is used to indicate the specific PUCCH resource to be used out of the set from the four PUCCH candidate resources. Id.*

56. ZTE further describes that this “enhanced ARI mechanism (dynamic + semi-static method) can promptly adjust at least one PUCCH candidate frequency resource to immediately follow the channel quality” and, therefore, “make full use of channel quality to transmit PUCCH.” *Id.*, 6. And, ZTE confirms that its enhanced ARI mechanism applies to multiple PUCCH sets based on PUCCH format, as “dynamic frequency resource allocation and the enhanced ARI mechanism can be used simultaneously for long/short PUCCHs.” *Id.*

C. Combination of Seo and ZTE

57. A POSITA would have found it obvious to combine teachings of Seo and ZTE. Specifically, Seo and ZTE are in the same field and each relate to PUCCH resource allocation for ACK/NACK information. SAMSUNG-1005, Abstract, [0001], [0133] (“Determination of Resources Used to Transmit ACK/NACK

Information”), [0138] (“ACK/NACK via a PUCCH”); SAMSUNG-1006, 2 (“PUCCH resource allocation for HARQ-ACK transmission”). Further, both Seo and ZTE relate to uplink control resource allocation in 3GPP systems. Given this extensive overlap in subject matter, a POSITA would have had reason to consult ZTE when reviewing Seo’s disclosure. Indeed, ZTE was published in 2017, four years after Seo, and a POSITA would have had reason to look to publications, such as ZTE, that discussed advancements to PUCCH resource allocation subsequent to Seo’s writing.

58. Further, a POSITA reviewing Seo’s disclosure would have been motivated to look to 3GPP technical documents, such as contributions to 3GPP (like ZTE), for technical and implementation details and advancements in cellular communication technology. In particular, one reading Seo would understand that Seo is written in the context of a 3GPP system: “[f]or clarity, the [] description [in Seo] focuses on the 3GPP LTE and 3GPP LTE-A system.” SAMSUNG-1005, [0042]. As stated, ZTE’s proposal is one example of such a contribution. A POSITA would have understood that these contributions would provide information about proposals relating to the standard that are being considered by the 3GPP and by wireless companies, prior to adoption by the 3GPP.

59. Regardless of whether information disclosed in contributions are eventually adopted, a POSITA would have been prompted to look to contributions, generally,

in order to learn of and understand alternatives to those adopted. Indeed, the very process of standards-based deliberation compels participants to consider the various proposals as collections of teachings directed to advancing the field.

60. Although a POSITA would have turned to 3GPP contributions based on the subject matter of Seo's PUCCH resource allocation for ACK/NACK information, Seo explicitly suggests turning to 3GPP documents, such as ZTE. SAMSUNG-1005, [0041], [0042]. That is, Seo claims that, "[e]xemplary embodiments of the present invention are supported by standard documents disclosed for at least one of wireless access systems including ... a 3rd Generation Project Partnership (3GPP) system, a 3GPP Long Term Evolution (LTE) system, and a 3GPP2 system." *Id.*, [0041]; *see also* [0042] ("the following description focuses on the 3GPP LTE and 3GPP LTE-A system"). "In particular, the steps or parts, which are not described to clearly reveal the technical idea of the present invention, in the embodiments of the present invention may be supported by the above documents." *Id.*, [0041].

When considering the teachings of Seo, a POSITA would have been motivated to consider 3GPP contributions, such as ZTE, based on Seo's explicit statement that its description of various embodiments of the invention are supported by 3GPP documents.

61. For these reasons, a POSITA would have been motivated to consult ZTE and would have found it obvious to employ teachings from ZTE's PUCCH resource

allocation in Seo. Specifically, in the combination, a POSITA would have found it obvious to modify Seo to use ZTE's PUCCH resource sets that are defined for different PUCCH formats. SAMSUNG-1006, 2-3. A POSITA also would have found it obvious to modify Seo to use ZTE's "dynamic + semi-static" signalling to select a PUCCH resource from the defined PUCCH resource sets. SAMSUNG-1006, 4-6.

62. In fact, combining the teachings of Seo with ZTE would have merely involved combining prior art elements according to known methods to yield predictable results. ZTE, like Seo, discloses selection of a PUCCH resource to use in providing HARQ ACK/NACK feedback. SAMSUNG-1005, Abstract, [0001], [0133], [0138]; SAMSUNG-1006, 2-6. A POSITA would have been motivated to combine the teachings of Seo with the teachings of ZTE to realize, in Seo, the advancements in PUCCH resource allocation described by ZTE in view of development of the same 3GPP standard described in Seo. The combination of Seo and ZTE would have been predictable and foreseeable because 1) Seo and ZTE disclose PUCCH resource allocation, and 2) the combination merely involves incorporating PUCCH resource advancements that are explicitly disclosed by ZTE as part of development of the 3GPP standard upon which Seo is based. The combination is predictable, at least in part, because elements of the combined system would each perform similar functions they had been known to perform

prior to the combination. This is particularly true given that both were described in the context of the same standard (3GPP LTE/NR). For example, Seo's wireless device would still perform the same PUCCH resource allocation as it did prior to the combination with ZTE, but with updates to account for ZTE's different PUCCH resource sets and ZTE's dynamic + semi-static PUCCH resource selection.

63. Additionally, a POSITA would have been motivated to modify Seo's system to include ZTE's PUCCH resource allocation because the use of ZTE's PUCCH resource allocation technique in Seo's system would have been recognized as simply applying a known technique (e.g., PUCCH resource sets with dynamic + semi-static signalling) to a known system (e.g., Seo's communication system) ready for improvement to yield predictable results (e.g., enable efficient use of different PUCCH formats). A POSITA would have recognized that using multiple PUCCH resource sets would have been an obvious design choice selected from among a set of known options (e.g., using individual PUCCH resources versus using sets of PUCCH resources).

64. Further, a POSITA would have been motivated to employ ZTE's different PUCCH resource sets and PUCCH resource selection techniques to gain the benefits of these techniques described by ZTE. As to different PUCCH formats, ZTE explains that:

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*. SAMSUNG-1006, 2.

65. From this description, a POSITA would have been motivated to use, in Seo, separate PUCCH resource sets to allow for different PUCCH formats that have different resource elements. In particular, tailoring PUCCH formats with different resource elements to different PUCCH resource sets would have led to more efficient PUCCH transmissions because PUCCH resource elements could be tailored to the elements needed for separate PUCCH formats. For example, a cyclic shift index element can be included when needed (e.g., for a 2-bit PUCCH format) and can be excluded when it is not applicable (e.g., for a PUCCH format with more than 2 bits). Because ZTE's separate PUCCH resource sets enable flexibility in including or excluding particular resource elements and enable tailoring of resource elements to only those resource elements applicable to the PUCCH format associated with the defined resource set, a POSITA would have perceived benefits to ZTE's use of different PUCCH resource sets for different PUCCH formats. Because PUCCH resource elements are tailored to include only

those needed for the PUCCH format associated with the PUCCH resource set, a POSITA would have perceived enhanced efficiency in ZTE's solution, recognizing that unnecessary resource elements (e.g., a cyclic shift index for a PUCCH format with more than 2 bits) can be avoided where inapplicable, thereby providing more useful options.

66. Further, adoption of ZTE's separate PUCCH resource sets in Seo allows for this additional flexibility without significant additional signaling. In Seo, all PUCCH resources are available and signaled whenever PUCCH resources are needed. By adopting ZTE's separate resource sets, a POSITA would have understood and found obvious that you can more easily switch between PUCCH resource sets using higher layer signaling, thereby offering additional flexibility with reduced signaling overhead.

67. Also, a POSITA would have been motivated to use ZTE's "enhanced ARI mechanism" to take advantage of channel quality in PUCCH transmissions. As ZTE explains, the "enhanced ARI mechanism (dynamic + semi-static method) can promptly adjust at least one PUCCH candidate frequency resource to immediately follow the channel quality" and, therefore, "***make full use of channel quality to transmit PUCCH.***" SAMSUNG-1006, 6. Because ZTE's "enhanced ARI mechanism" takes advantage of channel quality for PUCCH transmission, a POSITA would have perceived benefits to ZTE's "enhanced ARI mechanism" and

would have been motivated to achieve these channel quality benefits in Seo.

Exploiting channel quality was a well-known feature in cellular systems for data transmission, and would have provided predictable benefits for control information transmission. *See* SAMSUNG-1009 (Sesia), pp. 215-223.

D. Intel

68. Intel is a 3GPP contribution directed to “Resource allocation for NR uplink control channel.” SAMSUNG-1007, 1. Intel describes that “multiple PUCCH formats are specified to support various UCI payload sizes.” *Id.*

- 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

69. In Intel’s proposal, “multiple NR PUCCH formats can be supported in order to accommodate various UCI types and payload sizes.” *Id.*, 2.

70. Intel’s proposal also suggests that the “resource index for PUCCH format 1a/1b is derived from the first CCE in the PDCCH which is used to schedule the downlink data transmission.” *Id.*

71. Intel further suggests that “it is more desirable to configure a set of resource indexes from high layer signalling and explicitly signal one resource index from the set of resource indexes in the DCI for HARQ ACK/NACK feedback on UL control channel.” *Id.*, 3. Specifically, a “set of resource indexes for HARQ ACK/NACK feedback on UL control channel are configured via high layer signalling and one resource index among the set of resource indexes is explicitly signaled in the DCI.” *Id.*

E. Combination of Seo, ZTE, and Intel

72. A POSITA would have found it obvious to combine teachings of Seo and ZTE with Intel. Specifically, Seo, ZTE, and Intel are in the same field and each relate to PUCCH resource allocation for ACK/NACK information in a cellular system. SAMSUNG-1005, Abstract, [0001], [0133] (“Determination of Resources Used to Transmit ACK/NACK Information”), [0138] (“ACK/NACK via a PUCCH”); SAMSUNG-1006, 2 (“PUCCH resource allocation for HARQ-ACK transmission”); SAMSUNG-1007, 1-3. In particular all three prior art references are directed towards a particular cellular standard, the 3GPP family of standards. Given this extensive overlap in subject matter, a POSITA would have had reason to consult Intel when reviewing Seo’s and ZTE’s disclosure. Indeed, Intel was published in 2017, four years after Seo, and a POSITA would have had reason to

look to publications, such as Intel, that discussed advancements to PUCCH resource allocation subsequent to Seo's writing.

73. Further, a POSITA reviewing Seo's disclosure would have been motivated to look to 3GPP technical documents, such as contributions to 3GPP, for technical and implementation details and advancements in cellular communication technology. This is particularly true since Seo is described within the context of 3GPP standards LTE and LTE-Advanced. SAMSUNG-1005, [0042]. Examples of these contributions include the proposals offered in Intel's contribution. A POSITA would have understood that these contributions would provide information about proposals relating to the standard that are being considered by the 3GPP and by wireless companies, prior to adoption by the 3GPP.

74. Regardless of whether information disclosed in contributions are eventually adopted, a POSITA would have been prompted to look to contributions, generally, in order to learn of and understand alternatives or other options being considered. Indeed, the very format of standards-based deliberation compels participants to consider different documents, not in isolation, but as collections of teachings directed to advancing the field.

75. Although a POSITA would have turned to 3GPP contributions based on the subject matter of Seo's PUCCH resource allocation for ACK/NACK information, Seo explicitly suggests turning to 3GPP documents, such as Intel. SAMSUNG-

1005, [0041], [0042]. As Seo explains, “[e]xemplary embodiments of the present invention are supported by standard documents disclosed for at least one of wireless access systems including ... a 3rd Generation Project Partnership (3GPP) system, a 3GPP Long Term Evolution (LTE) system, and a 3GPP2 system.” *Id.*, [0041]; *see also* [0042] (“the following description focuses on the 3GPP LTE and 3GPP LTE-A system”). “In particular, the steps or parts, which are not described to clearly reveal the technical idea of the present invention, in the embodiments of the present invention may be supported by the above documents.” *Id.*, [0041]. In evaluating Seo, a POSITA would have been motivated to consider 3GPP contributions, such as Intel, based on Seo’s explicit indication that its description is supported by 3GPP documents.

76. For these reasons, a POSITA would have been motivated to consult Intel and would have found it obvious to employ teachings from Intel’s resource allocation in Seo and ZTE. Specifically, in the combination, a POSITA would have found it obvious to modify Seo to use Intel’s PUCCH resource formats based on UCI payload size. SAMSUNG-1007, 1-2. A POSITA also would have found it obvious to modify Seo to use Intel’s techniques for deriving the resource index for the PUCCH format based on “the first CCE in the PDCCH.” SAMSUNG-1007, 2. A POSITA further would have found it obvious to modify Seo to use Intel’s techniques where “[a] set of resource indexes for HARQ ACK/NACK feedback on

UL control channel are configured via high layer signalling and one resource index among the set of resource indexes is explicitly signaled in the DCI.” SAMSUNG-1007, 3.

77. In fact, combining the teachings of Seo and ZTE with Intel would have merely involved combining prior art elements according to known methods to yield predictable results. Intel, like Seo and ZTE, discloses selection of a PUCCH resource to use in providing HARQ ACK/NACK feedback. SAMSUNG-1005, Abstract, [0001], [0133], [0138]; SAMSUNG-1006, 2-6; SAMSUNG-1007, 1-3. A POSITA would have been motivated to combine the teachings of Seo and ZTE with the teachings of Intel to realize, in Seo, the advancements in PUCCH resource allocation described by Intel in view of development of the same 3GPP standard described in Seo. The combination of Seo, ZTE, and Intel would have been predictable and foreseeable because 1) Seo, ZTE, and Intel disclose PUCCH resource allocation, and 2) the combination merely involves incorporating PUCCH resource advancements that are explicitly disclosed by Intel as part of development of the 3GPP standard upon which Seo is based. The combination is predictable, at least in part, because elements of the combined system would each perform similar functions they had been known to perform prior to the combination. For example, the Seo/ZTE wireless device would still perform the same PUCCH resource allocation as it did prior to the combination with Intel, but with updates to account

for Intel's PUCCH formats based on UCI payload size, Intel's scheduling based on the first CCE, and Intel's higher layer and DCI signaling.

78. Additionally, a POSITA would have been motivated to modify the Seo/ZTE system to include Intel's PUCCH resource allocation because the use of Intel's PUCCH resource allocation technique in the Seo/ZTE system would have been recognized as simply applying a known technique to a known system ready for improvement to yield predictable results.

VII. GROUND 1: Claims 1-3, 6-8, 11, 12, and 17-19 are obvious over Seo and ZTE

A. Manner in which Seo and ZTE render obvious claims 1-3, 6-8, 11, 12, and 17-19

1. Claim 1

[1pre] A method performed by a wireless device:

79. Seo and ZTE render obvious a method performed by a wireless device. Specifically, Seo describes “a *method* and apparatus *for transmitting ACK/NACK for downlink transmission* in a wireless communication system.” SAMSUNG-1005, [0001]; *see also* [0135], [0148], [0162], [0170], [0173], [0180]-[0181], [0190]-[0191], [0196], [0203], [0207], [0213]; Fig. 12. Seo's method is performed by a wireless device, such as “a UE.” *Id.*, [0171]; *see also* [0003], [0038], [0223].

[1a] receiving a first downlink control channel message that schedules a first downlink shared channel transmission;

80. Receiving a first downlink control channel message that schedules a first downlink shared channel transmission would have been obvious to a POSITA in light of Seo and ZTE. SAMSUNG-1005, [0051], [0138]. In fact, this was an integral part of the well-known 3GPP standard at the time which Seo and ZTE use as the context of their teachings. SAMSUNG-1009, pp. 202-206. Like this standard, Seo's framework uses "a Physical Downlink Control Channel (PDCCH)" to transmit "Downlink Control Information (DCI)" that "includes uplink or downlink scheduling information." SAMSUNG-1005, [0051], [0013]-[0014]. Seo's downlink scheduling information schedules data transmissions on "a Physical Downlink Shared Channel (PDSCH)." *Id.*, [0051], [0052], [0006], [0011]-[0012].

81. Seo also provides more details on the "Determination of Resources Used to Transmit ACK/NACK Information." *Id.*, [0133]-[0216]. Again following the well-known 3GPP standard, in Seo an eNB sends, to a UE, "control information for downlink data transmission ... via a PDCCH" and the UE "receives data scheduled via the PDCCH to the UE via a PDSCH." *Id.*, [0138]; *see also* [0134]-[0137]. In some embodiments, a UE in Seo transmits "HARQ ACK/NACK

information” related to “PDSCH transmission of one or more downlink subframes in one uplink subframe.” *Id.*, [0147]; *see also* [0150], [0155].

82. As in 3GPP’s LTE, Seo’s UE receives PDCCH transmissions that schedule PDSCH transmissions. *Id.*, [0208]; *see also* [0212] (“downlink subframes may be PDSCH transmission(s)”), [0215] (“a PDSCH indicated by detection of a corresponding PDCCH”), Fig. 12. Seo’s UE then receives “downlink subframes” as “PDSCH transmission(s).” *Id.*, [0209]-[0210]; *see also* [0212], [0215]. *See also* SAMSUNG-1009 pp. 202-206 for a description of the PDCCH used for scheduling PDSCH transmissions in LTE.

83. By describing a UE that receives PDCCH transmissions that schedule PDSCH transmissions, Seo teaches receiving a first downlink control channel message (e.g., first PDCCH) that schedules a first downlink shared channel transmission (e.g., first PDSCH).

[1b] receiving a second downlink control channel message that schedules a second downlink shared channel transmission;

84. The combination of Seo and ZTE renders obvious receiving a second downlink control channel message that schedules a second downlink shared channel transmission. SAMSUNG-1005, [0051], [0138], [0147]. As I explained above at [1a], Seo (following the well-known 3GPP LTE standard) describes multiple PDCCH transmissions that schedule multiple PDSCH transmissions.

These multiple PDCCH transmissions include the first PDCCH transmission for scheduling the first PDSCH transmission and a second PDCCH transmission for scheduling a second PDSCH transmission.

[1c] determining an uplink control channel resource to use for transmitting uplink control information to a network node on an uplink control channel;

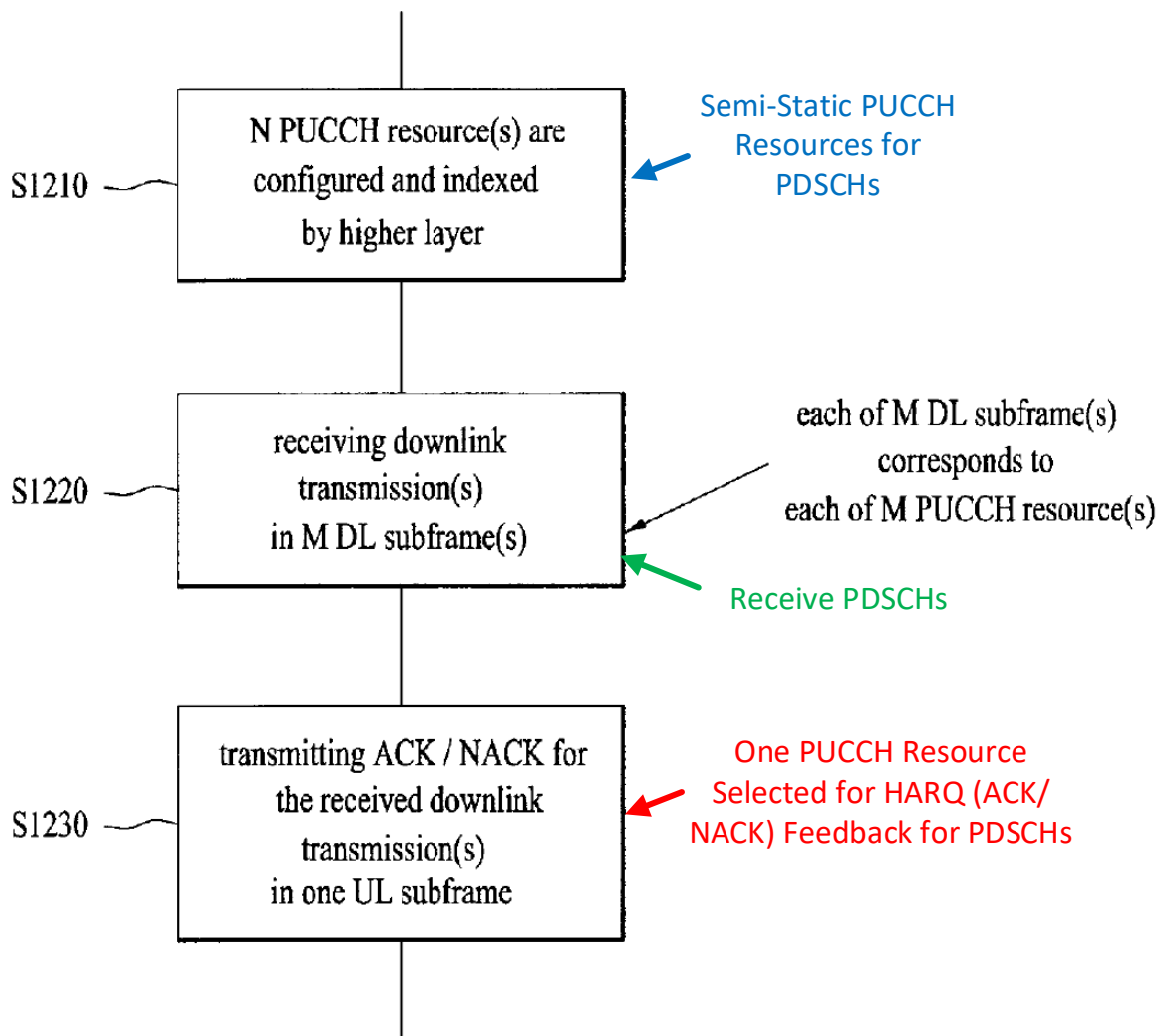
85. The combination of Seo and ZTE renders obvious determining an uplink control channel resource to use for transmitting uplink control information to a network node on an uplink control channel. SAMSUNG-1005, [0148]-[0160].

86. Specifically, Seo provides more details on “Determination of *Resources* Used to Transmit ACK/NACK Information.” *Id.*, [0133]-[0216]. For instance, a UE in Seo transmits, to a network node (eNB), ACK/NACK for the PDSCH transmissions “via a PUCCH.” *Id.*, [0138]; *see also* [0134]-[0137]. In some examples, Seo’s UE transmits “HARQ ACK/NACK information” for “PDSCH transmission of one or more downlink subframes in one uplink subframe.” *Id.*, [0147]; *see also* [0150], [0155].

87. As shown in Fig. 12 (reproduced below), Seo’s UE receives “semi-statically configured ... PUCCH resources.” *Id.*, [0208]; *see also* [0204] (“semi-statically configuring a plurality of ACK/NACK resource sets”), [0205] (“higher layer signaling (e.g., RRC signaling)”), [0215] (“ACK/NACK feedback for a PDSCH indicated by detection of a corresponding PDCCH”). “[H]igher layer signaling” is

slower than dynamic (e.g., PHY/MAC layer) signaling and would have been interpreted by a POSITA as “semi-static” signaling. SAMSUNG-1005, [0204]-[0208]; SAMSUNG-1006, 2 (“a PUCCH resource set is configured by high layer signaling”), 5 (“A set containing four PUCCH candidate resources is configured through semi-static signalling, and then the specific PUCCH resources to be used are indicated via the physical layer DCI. ... Since four PUCCH candidate frequency resources are always pre-allocated through higher layer signaling.”). As I discuss above a POSITA would understand that the term “higher layer signaling” is often used interchangeably with “semi-static signaling”. For example, *see* SAMSUNG-1009 (Sesia), p. 355, 360, 415.

88. Similar to well-known 3GPP standards of the time, a UE in Seo’s teaching then uses “one of the M PUCCH resources” to transmit “ACK/NACK information” for the multiple “downlink subframes.” SAMSUNG-1005, [0211] (“ACK/NACK bundling”). ACK/NACK information in Seo is a form of uplink control information. SAMSUNG-1005, [0138] (“transmit **ACK/NACK via a PUCCH** for transmitting **uplink control information.**”), [0052] (“Physical Uplink Control Channel (PUCCH) including uplink control information”); SAMSUNG-1001, 1:24-27 (“Examples of such Uplink Control Information (UCI) are Hybrid Automatic Repeat Request (HARQ) Acknowledgements (ACKs)”), 34:39-44.



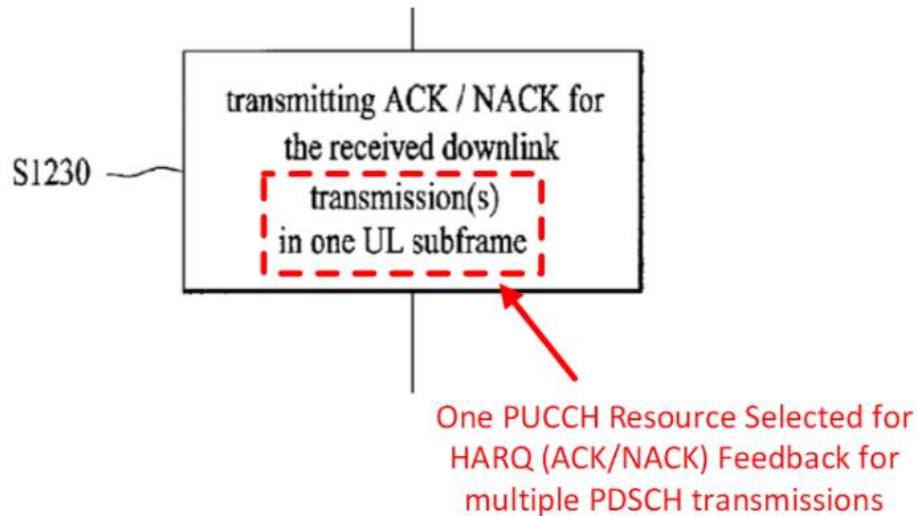
SAMSUNG-1005, Fig. 12 (annotated)

89. By selecting a PUCCH resource (uplink control channel resource) to use for transmitting ACK/NACK information (uplink control information) to a network node on the PUCCH (uplink control channel), Seo determines an uplink control channel resource to use for transmitting uplink control information to a network node on an uplink control channel.

[1d] wherein the uplink control information comprises Hybrid Automatic Repeat Request, HARQ, feedback for both the first downlink shared channel transmission and the second downlink shared channel transmission; and

90. Based on Seo and ZTE a POSITA would find obvious uplink control information comprising Hybrid Automatic Repeat Request, HARQ, feedback for both the first downlink shared channel transmission and the second downlink shared channel transmission. SAMSUNG-1005, [0134], [0147]-[0150], [0141], [0160], and [0182]. Seo's UE transmits "HARQ ACK/NACK information" for "PDSCH transmission of one or more downlink subframes in *one uplink subframe*." SAMSUNG-1005, [0147]; *see also* [0150], [0155].

91. As shown in Fig. 12 (reproduced below), Seo's UE uses "one of the M PUCCH resources" to transmit "ACK/NACK information" for the multiple "downlink subframes." *Id.*, [0211] ("ACK/NACK bundling"). By transmitting ACK/NACK information for multiple PDSCH transmissions in one uplink subframe (one PUCCH resource) and performing ACK/NACK bundling, the uplink control information in Seo comprises HARQ feedback for both the first downlink shared channel transmission (first PDSCH) and the second downlink shared channel transmission (second PDSCH).

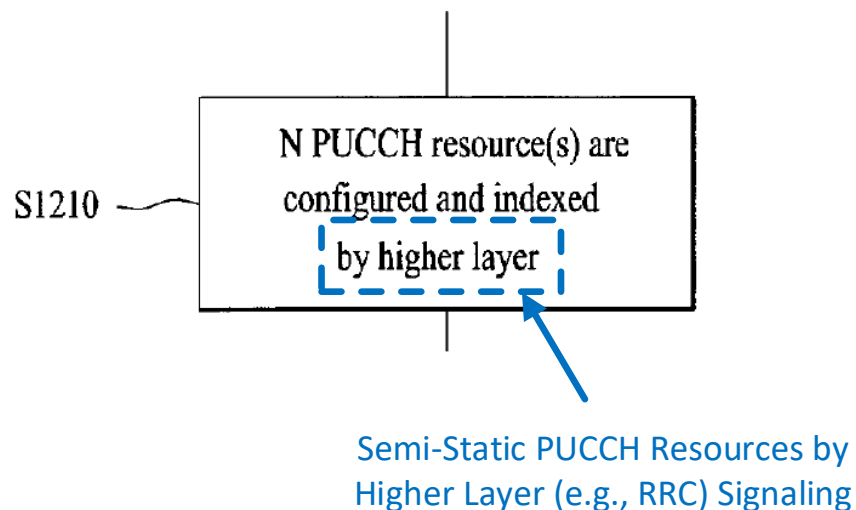


SAMSUNG-1005, Fig. 12 (excerpt; annotated)

[1e] wherein determining the uplink control channel resource to use for transmitting the uplink control information comprises determining the uplink control channel resource based on (a) signaling received from the network node and (b) resource determination performed by the wireless device based on a latest received one of the first downlink control channel message and the second downlink control channel message; and

92. The combination of Seo and ZTE renders obvious determining the uplink control channel resource based on (a) signaling received from the network node and (b) resource determination performed by the wireless device based on a latest received one of the first downlink control channel message and the second downlink control channel message. SAMSUNG-1005, [0052], [0133]-[0134], [0147]-[0152], [0160], and [0169].

93. Specifically, Seo provides more details on “Determination of *Resources* Used to Transmit ACK/NACK Information.” *Id.*, [0133]-[0216]. As shown in Fig. 12 (reproduced below), a UE in Seo receives “semi-statically configured ... PUCCH resources.” *Id.*, [0208]; *see also* [0204] (“semi-statically configuring a plurality of ACK/NACK resource sets”), [0205] (“higher layer signaling (e.g., RRC signaling)”), [0215] (“ACK/NACK feedback for a PDSCH indicated by detection of a corresponding PDCCH”). Seo’s UE then uses “one of the M PUCCH resources” to transmit “ACK/NACK information” for the multiple “downlink subframes.” *Id.*, [0211] (“ACK/NACK bundling”). Since PUCCH resources are semi-statically configured by higher layer signaling (e.g., RRC signaling) in Seo, the teachings of Seo disclose determining the uplink control channel resource based on signaling received from the network node.



SAMSUNG-1005, Fig. 12 (excerpt; annotated)

94. Seo also describes that the “ACK/NACK bundling result may be transmitted via an ACK/NACK resource set *mapped to a last DL subframe* in which the PDSCH is transmitted (*a latest DL subframe*, in which the PDSCH is received, from among m DL subframes).” SAMSUNG-1005, [0183]; *see also* [0184]-[0188] (“the PUCCH resource set 0 mapped to the last DL subframe (that is, the DL subframe #9) in which the PDSCH is received.”), [0202] (“if ACK/NACK bundling is applied, bundled ACK/NACK information may be transmitted using ACK/NACK resources mapped to the last (or highest) control channel number count value of the DL subframes associated with one UL subframe.”). By mapping the PUCCH resource to the last DL subframe, the resource determination performed by the wireless device in Seo is based on a *latest* received one of the first downlink control channel message (first PDCCH) and the second downlink control channel message (second PDCCH).

95. Further, dynamic signaling may be used to identify the latest DL subframe and select the PUCCH resource. SAMSUNG-1005, [0183]. Specifically, the “control channel transmitted from the transmitter may include a control channel number count value,” which “gradually increases for each control channel” and is “similar to a downlink assignment index (DAI) field included in a PDCCH.” *Id.*; *see also* [0187]-[0189], [0196]-[0202] (“bundled ACK/NACK information may be transmitted using ACK/NACK resources mapped to the last (or highest) control

channel number count value of the DL subframes associated with one UL subframe”), [0212] (“[t]he control channel may include control channel number count information”). When the control channel number count value is used, ACK/NACK resources in Seo are “mapped to the last (or highest) control channel number count value of the DL subframes associated with one UL subframe.” *Id.*, [0202]. By selecting the PUCCH resource associated with the latest received PDCCH (e.g., using the control channel number count value), Seo determines the uplink control channel resource based on (a) signaling received from the network node (the higher layer (e.g., RRC) signaling discussed above and/or the signaling of the control channel message with the control channel number count value (e.g., DAI)) and (b) resource determination performed by the wireless device based on a latest received one of the first downlink control channel message (first PDCCH) and the second downlink control channel message (second PDCCH).

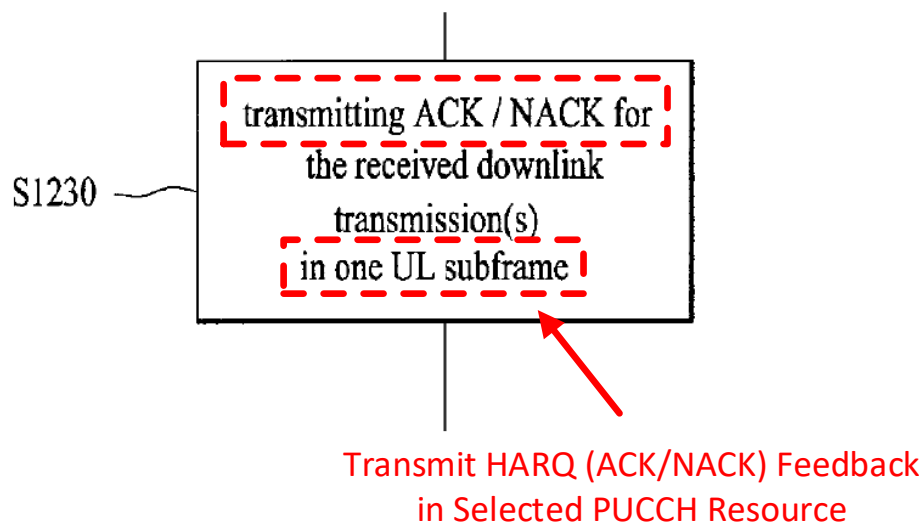
[1f] transmitting the uplink control information using the determined uplink control channel resource,

96. The combination of Seo and ZTE renders obvious transmitting the uplink control information using the determined uplink control channel resource.

SAMSUNG-1005, [0052], [0133]-[0134], [0141], [0150]-[0152], and [0160]. This step is also consistent with the 3GPP LTE standard which provides the context of both Seo and ZTE. Seo provides several details concerning the “Determination of

Resources Used to *Transmit ACK/NACK Information.*” SAMSUNG-1005, [0133]-[0216]. As one example, the UE “transmit[s] ACK/NACK via a PUCCH.” *Id.*, [0138]; *see also* [0134]-[0137]. Again, this would be consistent with the well-known LTE standard of that time. In other examples, Seo’s UE transmits “HARQ ACK/NACK information” for “PDSCH transmission of one or more downlink subframes in one uplink subframe.” *Id.*, [0147]; *see also* [0150], [0155].

97. As shown in Fig. 12 (reproduced below), Seo’s UE uses “one of the M PUCCH resources” to transmit “ACK/NACK information” for the multiple “downlink subframes.” *Id.*, [0211] (“ACK/NACK bundling”). By using one uplink subframe to transmit the ACK/NACK information (uplink control information) Seo teaches transmitting the uplink control information using the determined uplink control channel resource (PUCCH resource).



SAMSUNG-1005, Fig. 12 (excerpt; annotated)

[1g] wherein the signaling received from the network node comprises information that provides a semi-static configuration of two or more uplink control channel resource sets each comprising two or more uplink control channel resources; and

98. The combination of Seo and ZTE renders obvious information that provides a semi-static configuration of two or more uplink control channel resource sets each comprising two or more uplink control channel resources. As I explained above at [1c]-[1e], Seo discloses use of ACK/NACK resource sets and Seo's PUCCH resources are semi-statically configured by higher layer signaling (e.g., RRC signaling). Although Seo discloses PUCCH resource sets with semi-static configuration, Seo does not explicitly disclose a semi-static configuration of two or more uplink control channel resource sets each comprising two or more uplink control channel resources.

99. On the other hand ZTE does disclose a semi-static configuration of two or more uplink control channel resource sets each comprising two or more uplink control channel resources. Specifically, ZTE describes "ARI-based PUCCH resource allocation for HARQ-ACK transmission" where "a PUCCH resource set is configured by high layer signaling." SAMSUNG-1006, 2. For example, ZTE proposed "a separate PUCCH resource set for different PUCCH formats." *Id.* Additionally, ZTE proposed the use of "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.” *Id.* (emphasis omitted). The multiple PUCCH resource sets in ZTE each include multiple PUCCH resources. Further, each “PUCCH resource set is configured by high layer signaling,” which is a form of semi-static configuration. *Id.* This is confirmed in Table 1 (reproduced below), where a PUCCH resource set in ZTE is shown to include multiple PUCCH resources. SAMSUNG-1006, 3.

PUCCH Resource Set With
Multiple PUCCH Resources

Table 1– PUCCH resource set for formats carrying up to 2 bits

PUCCH format	PUCCH length	PUCCH resource value	Time domain OCC	Cyclic shift index	PUCCH resource group index
Short Format 0	1	a0	-	CS set #0	0
		a1	-	CS set #1	1
	1	a2	-	CS set #2	2
		a3	-	CS set #3	3
	2	a4	-	CS set #4	4
		a5	-	CS set #5	5
	2	a6	-	CS set #6	6
		a7	-	CS set #7	7
Long Format 0	4	a8	OCC #0	CS set #8	8
		a9	OCC #1	CS set #9	9
	8	a10	OCC #0	CS set #10	10
		a11	OCC #1	CS set #11	11
	8	a12	OCC #0	CS set #12	12
		a13	OCC #1	CS set #13	13
	14	a14	OCC #0	CS set #14	14
		a15	OCC #1	CS set #15	15

SAMSUNG-1006, Table 1 (annotated)

100. Although ZTE does not provide a table of a second resource set, it explicitly states that “[f]or PUCCH formats with more than 2 bits, a similar resource set like Table 1 would be introduced.” SAMSUNG-1006, 3. Thus, ZTE describes two PUCCH resource sets: (1) a first resource set with multiple PUCCH resources for 2-bit PUCCH formats (as shown in Table 1) and (2) a second resource set with multiple PUCCH resources for PUCCH formats with more than 2 bits (similar to Table 1, but not shown). *Id.*

101. Further, ZTE explains that, “[i]n LTE, a combination of a *semi-static configuration* and dynamic signalling is used to determine the PUCCH resource for ACK/NACK in the frequency domain” and “[a] similar concept could be envisioned for NR.” SAMSUNG-1006, 4. As LTE was the dominant cellular standard of the time, a POSITA would have found it obvious to use a combination of semi-static configuration and dynamic signaling. In particular, ZTE states that “[a] set containing four PUCCH candidate resources is configured through *semi-static signalling*.” *Id.*, 5.

102. Using this as background, ZTE proposed “a new method to achieve *semi-static* + dynamic PUCCH frequency resource allocation” with “an enhanced ARI mechanism.” *Id.* In other words, combining semi-static and dynamic signaling for specifying PUCCH resources was well known prior to ZTE, ZTE is describing a new method of doing this. Specifically, in ZTE’s enhanced ARI mechanism:

The base station always configures 3 *candidate PUCCH resources for the UE through higher layer signalling* and implicitly assumes that 1 candidate PUCCH resource is located within the frequency domain of the PUSCH / PDSCH of the UE. *Id.*

103. ZTE further describes that this “enhanced ARI mechanism (dynamic + *semi-static* method) can promptly adjust at least one PUCCH candidate frequency resource to immediately follow the channel quality” and, therefore, “make full use of channel quality to transmit PUCCH.” *Id.*, 6. That is, by using dynamic signaling, channel quality information can be exploited for PUCCH transmission. ZTE also confirms that its enhanced ARI mechanism applies to multiple PUCCH sets based on PUCCH format, as “dynamic frequency resource allocation and the enhanced ARI mechanism can be used simultaneously for *long/short PUCCHs*.” *Id.*

104. As I explained above when I addressed the motivation to combine Seo and ZTE, a POSITA would have found it obvious to combine teachings of Seo with teachings of ZTE. In doing so, in the combined system, ZTE’s different PUCCH resource sets, each with multiple PUCCH resources, and ZTE’s semi-static configuration of the different PUCCH resource sets would find obvious application in Seo’s method for transmitting ACK/NACK signalling.

[1h] determining an uplink control channel resource to use for transmitting uplink control information to a network node on an uplink control channel;

105. The combination of Seo and ZTE renders obvious selecting one of the two or more uplink control channel resource sets, and selecting, as the uplink control channel resource to use for transmitting the uplink control information to the network node, one of the two or more uplink control channel resources from the selected uplink control channel resource set based on dynamic signaling from the network node. More specifically, in ZTE, “the physical layer signaling indicates the one PUCCH resource from the set.” SAMSUNG-1006, 2. ZTE proposed “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.” *Id.* (emphasis omitted). The resource set selection in ZTE is based on PUCCH format or payload size of the uplink control information (e.g., “2 bits UCI” or “more than 2 bits UCI”) along with “4 bits in DCI ... to indicate one PUCCH resource group index.” *Id.* As shown in Table 1 (reproduced below), a PUCCH resource set in ZTE includes multiple PUCCH resources and a specific resource within a set (e.g., within Table 1) is selected based on DCI. SAMSUNG-1006, 3.

PUCCH Resource Set With
Multiple PUCCH Resources

PUCCH Resource Selected
Based On Index in DCI

Table 1– PUCCH resource set for formats carrying up to 2 bits

PUCCH format	PUCCH length	PUCCH resource value	Time domain OCC	Cyclic shift index	PUCCH resource group index
Short Format 0	1	a0	-	CS set #0	0
		a1	-	CS set #1	1
	1	a2	-	CS set #2	2
		a3	-	CS set #3	3
	2	a4	-	CS set #4	4
		a5	-	CS set #5	5
	2	a6	-	CS set #6	6
		a7	-	CS set #7	7
Long Format 0	4	a8	OCC #0	CS set #8	8
		a9	OCC #1	CS set #9	9
	8	a10	OCC #0	CS set #10	10
		a11	OCC #1	CS set #11	11
	8	a12	OCC #0	CS set #12	12
		a13	OCC #1	CS set #13	13
	14	a14	OCC #0	CS set #14	14
		a15	OCC #1	CS set #15	15

SAMSUNG-1006, Table 1 (annotated)

106. As stated above, although a table for a second resource set is not provided, ZTE states that “[f]or PUCCH formats with more than 2 bits, a similar resource set like Table 1 would be introduced.” SAMSUNG-1006, 3. In other words, ZTE clearly describes two PUCCH resource sets: (1) a first resource set with multiple PUCCH resources for 2-bit PUCCH formats (as shown in Table 1) and (2) a second resource set with multiple PUCCH resources for PUCCH formats with more than 2 bits (similar to Table 1, but not shown). *Id.* In this approach, ZTE defines the resource sets (e.g., the 2-bit resource set shown in Table 1 or the more

than 2-bit resource set in a table similar to Table 1, but not shown) based on a semi-static configuration through higher layer signaling. SAMSUNG-1006, 2-5.

107. Additionally, ZTE teaches that, “[i]n LTE, a combination of a semi-static configuration and *dynamic signalling* is used to determine the PUCCH resource for ACK/NACK in the frequency domain” and “[a] similar concept could be envisioned for NR.” SAMSUNG-1006, 4. In particular, “the *specific PUCCH resources* to be used are indicated via the *physical layer DCI*.” *Id.*, 5.

108. As I describe above, with this as the background, ZTE proposed “a new method to achieve semi-static + *dynamic* PUCCH frequency resource allocation” with “an enhanced ARI mechanism.” *Id.* Specifically, in ZTE’s enhanced ARI mechanism:

Then, *physical layer signalling is used to indicate the specific PUCCH resource to be used out of the set from the four PUCCH candidate resources.* *Id.*

109. In describing the advantages of this approach, ZTE states that this “enhanced ARI mechanism (dynamic + semi-static method) can promptly adjust at least one PUCCH candidate frequency resource to immediately follow the channel quality” and, therefore, “make full use of channel quality to transmit PUCCH.” *Id.*, 6. In other words, ZTE teaches the use of channel quality information to enhance the performance of control channel transmissions. Additionally, ZTE confirms that

this proposed enhanced ARI mechanism applies to multiple PUCCH sets based on PUCCH formats, as “dynamic frequency resource allocation and the enhanced ARI mechanism can be used simultaneously for long/short PUCCHs.” *Id.*

110. As I explained above in addressing the combination of Seo and ZTE, a POSITA would have found it obvious to combine teachings of Seo with teachings of ZTE and use, in the combined system, ZTE’s selection of one of the two or more uplink control channel resource sets based on PUCCH format (e.g., “2 bits UCI” or “more than 2 bits UCI”) and ZTE’s selection of a specific PUCCH resource from the set based on dynamic signaling from the network node (e.g., DCI).

2. Claim 2

[2] The method of claim 1 wherein the uplink control channel is a physical uplink control channel.

111. The combination of Seo and ZTE renders obvious a physical uplink control channel. As I explained above at [1C], Seo’s uplink control channel is a “Physical Uplink Control Channel (PUCCH).” SAMSUNG-1005, [0051], [0052], [0006], [0011]-[0012]. As stated previously, the common cellular standard of the time, LTE (which is the context for both Seo and ZTE) used a physical uplink control channel as its uplink control channel.

3. Claim 3

[3] The method of claim 1 wherein:

112. As I explained above at [1pre], the combination of Seo and ZTE renders obvious a method.

[3.1] each of the first downlink control channel message and the second downlink control channel message comprises bits for use to select one of the two or more uplink control channel resources from the selected uplink control channel resource set;

113. The combination of Seo and ZTE renders obvious each of the first downlink control channel message and the second downlink control channel message comprises bits for use to select one of the two or more uplink control channel resources from the selected uplink control channel resource set. In the combination, Seo's "control channel transmitted from the transmitter may *include a control channel number count value*," which "gradually increases for each control channel" and is "similar to a downlink assignment index (DAI) field included in a PDCCH." SAMSUNG-1005, [0183]; *see also* [0187]-[0189], [0196]-[0202] ("bundled ACK/NACK information may be transmitted using ACK/NACK resources mapped to the last (or highest) control channel number count value of the DL subframes associated with one UL subframe"), [0212] ("[t]he control channel may include control channel number count information"). When the control channel number count value is used, Seo's ACK/NACK

resources are “mapped to the last (or highest) control channel number count value of the DL subframes associated with one UL subframe.” *Id.*, [0202]. By using the control channel number count value (e.g., DAI) to select the PUCCH resource associated with the latest received PDCCH, Seo’s PDCCH transmissions include bits for use to select one of the two or more uplink control channel resources.

[3.2] selecting the one of the two or more uplink control channel resources comprises selecting based on the bits comprised in the latest received one of the first downlink control channel message and the second downlink control channel message.

114. The combination of Seo and ZTE renders obvious selecting based on the bits comprised in the latest received one of the first downlink control channel message and the second downlink control channel message. SAMSUNG-1005, [0052], [0133]-[0134], [0147]-[0152], [0160], and [0169]. As explained above at [1e] and [3.1], Seo and ZTE render obvious determining the uplink control channel resource based on (a) signaling received from the network node and (b) resource determination performed by the wireless device based on a latest received one of the first downlink control channel message and the second downlink control channel message. SAMSUNG-1005, [0052], [0133]-[0134], [0147]-[0152], [0160], and [0169]. Seo’s uplink scheduling information schedules resources on a

“Physical Uplink Control Channel (PUCCH)” for the PDSCH data transmissions. SAMSUNG-1005, [0051], [0052], [0006], [0011]-[0012].

115. In the combination, Seo’s “control channel transmitted from the transmitter may *include a control channel number count value*,” which “gradually increases for each control channel” and is “similar to a downlink assignment index (DAI) field included in a PDCCH.” SAMSUNG-1005, [0183]; *see also* [0187]-[0189], [0196]-[0202] (“bundled ACK/NACK information may be transmitted using ACK/NACK resources mapped to the last (or highest) control channel number count value of the DL subframes associated with one UL subframe”), [0212] (“[t]he control channel may include control channel number count information”).

When the control channel number count value is used, Seo’s ACK/NACK resources are “mapped to the last (or highest) control channel number count value of the DL subframes associated with one UL subframe.” *Id.*, [0202]. By using the control channel number count value (e.g., DAI) to select the PUCCH resource associated with the latest received PDCCH, Seo’s PDCCH transmissions include bits for use to select one of the two or more uplink control channel resources.

116. Additionally, ZTE also describes the use of bits to select one of the two or more uplink control channel resources. For example, ZTE describes “*4 bits* in DCI ... to indicate one PUCCH resource group index.” SAMSUNG-1006, 2. ZTE’s 4

DCI bits are used to select the PUCCH resource from the selected PUCCH resource set.

4. Claim 6

[6pre] A wireless device, comprising:

117. The combination of Seo and ZTE also renders obvious a wireless device. SAMSUNG-1005, [0038] (“[t]he term ‘terminal’ may also be replaced with a User Equipment (UE), a Mobile Station (MS), a Mobile Subscriber Station (MSS) or a Subscriber Station (SS) as necessary.”); *see also* [0007], [0218], [0220], Fig. 13, claim 11.

[6a] an interface; and

118. The combination of Seo and ZTE renders obvious an interface. First, it would have been obvious to a POSITA to include an interface in a wireless device. Further, the apparatus in Seo (e.g., wireless device) includes “a reception (RX) module,” “a transmission (TX) module,” and “antennas 1350,” which serve as an interface for Seo’s wireless device. SAMSUNG-1005, [0007], [0218], [0220], Fig. 13, claim 11. It should be noted that the ’669 patent uses the term “interface” broadly and provides examples of an air interface similar to Seo’s air interface (e.g., RX module, TX module, and antennas). For example, with reference to Fig. 1, the ’669 patent describes that “interface 114 comprises radio front end circuitry 112 and antenna 111.” SAMSUNG-1001, 19:54-20:11 (“radio front end circuitry

and/or antenna 111 may be considered an interface”). Further, with reference to Fig. 2, the ’669 patent describes that “RF interface 209 may be configured to provide a communication interface to RF components such as a transmitter, a receiver, and an antenna.” *Id.*, 23:42-44. Thus, the air interface described in Seo (e.g., RX module, TX module, and antennas) aligns with examples of an interface described in the ’669 patent. SAMSUNG-1005, [0007], [0218], [0220], Fig. 13, claim 11.

[6b] processing circuitry configured to cause the wireless device to:

119. The combination of Seo and ZTE renders obvious processing circuitry configured to cause the wireless device to perform operations referenced below. Specifically, the apparatus described in Seo (e.g., wireless device) includes “a processor,” which serves processing circuitry for Seo’s wireless device that is configured to cause the wireless device to perform the operations referenced below. SAMSUNG-1005, [0007], [0218]-[0226], Fig. 13, claim 11.

[6c] receive a first downlink control channel message that schedules a first downlink shared channel transmission;

120. As I explained at [1a], Seo and ZTE render obvious a wireless device that receives a first downlink control channel message that schedules a first downlink shared channel transmission.

[6d] receive a second downlink control channel message that schedules a second downlink shared channel transmission;

121. As I explained at [1b], Seo and ZTE render obvious a wireless device that receives a second downlink control channel message that schedules a second downlink shared channel transmission.

[6e] determine an uplink control channel resource to use for transmitting uplink control information to a network node on an uplink control channel;

122. As I explained at [1c], Seo and ZTE render obvious a wireless device that determines an uplink control channel resource to use for transmitting uplink control information to a network node on an uplink control channel.

[6f] wherein the uplink control information comprises Hybrid Automatic Repeat Request, HARQ, feedback for both the first downlink shared channel transmission and the second downlink shared channel transmission;

123. As I explained at [1d], Seo and ZTE render obvious that the uplink control information comprises Hybrid Automatic Repeat Request, HARQ, feedback for both the first downlink shared channel transmission and the second downlink shared channel transmission.

[6g] wherein determining the uplink control channel resource to use for transmitting the uplink control information comprises determining the uplink control channel resource based on (a) signaling received from the network

node and (b) resource determination performed by the wireless device based on a latest received one of the first downlink control channel message and the second downlink control channel message; and

124. As I explained at [1e], Seo and ZTE render obvious determining the uplink control channel resource based on (a) signaling received from the network node and (b) resource determination performed by the wireless device based on a latest received one of the first downlink control channel message and the second downlink control channel message.

[6h] transmit the uplink control information using the determined uplink control channel resource;

125. As I explained at [1f], Seo and ZTE render obvious a wireless device that transmits the uplink control information using the determined uplink control channel resource.

[6i] wherein the signaling received from the network node comprises information that provides a semi-static configuration of two or more uplink control channel resource sets each comprising two or more uplink control channel resources; and

126. As I explained at [1g], Seo and ZTE render obvious that the signaling received from the network node comprises information that provides a semi-static

configuration of two or more uplink control channel resource sets each comprising two or more uplink control channel resources.

[6j] wherein determining the uplink control channel resource based on (a) and (b) comprises selecting one of the two or more uplink control channel resource sets, and selecting, as the uplink control channel resource to use for transmitting the uplink control information to the network node, one of the two or more uplink control channel resources from the selected uplink control channel resource set based on dynamic signaling from the network node.

127. As I explained at [1h], Seo and ZTE render obvious that determining the uplink control channel resource based on (a) and (b) comprises selecting one of the two or more uplink control channel resource sets, and selecting, as the uplink control channel resource to use for transmitting the uplink control information to the network node, one of the two or more uplink control channel resources from the selected uplink control channel resource set based on dynamic signaling from the network node.

5. Claim 7

[7] The wireless device of claim 6 wherein the uplink control channel is a physical uplink control channel.

128. As I explained at [2], Seo and ZTE render obvious that the uplink control channel is a physical uplink control channel.

6. Claim 8

[8pre] The wireless device of claim 6 wherein:

129. As I explained at [6pre], Seo and ZTE render obvious a wireless device.

[8a] each of the first downlink control channel message and the second downlink control channel message comprises a downlink control information message comprising bits for use to select one of the two or more uplink control channel resources from the selected uplink control channel resource set;

130. As I explained at [3a], Seo and ZTE render obvious that each of the first downlink control channel message and the second downlink control channel message comprises a downlink control information message comprising bits for use to select one of the two or more uplink control channel resources from the selected uplink control channel resource set.

[8b] selecting the one of the two or more uplink control channel resources from the selected uplink control channel resource set based on dynamic signaling from the network node comprises selecting, as the uplink control channel resource to use for transmitting the uplink control information to the network node, the one of the two or more uplink control channel resources from the selected uplink control channel resource set based on the bits for use to select one of the two or more uplink control channel resources from the selected uplink control channel resource set that are comprised in the latest

received one of the first downlink control channel message and the second downlink control channel message.

131. As I explained at [3b], Seo and ZTE render obvious selecting, as the uplink control channel resource to use for transmitting the uplink control information to the network node, the one of the two or more uplink control channel resources from the selected uplink control channel resource set based on the bits for use to select one of the two or more uplink control channel resources from the selected uplink control channel resource set that are comprised in the latest received one of the first downlink control channel message and the second downlink control channel message.

7. Claim 11

[11pre] A wireless device, comprising:

132. As I explained at [6pre], Seo and ZTE render obvious a wireless device.

[11a] an interface; and

133. As I explained at [6a], Seo and ZTE render obvious an interface.

[11b] processing circuitry configured to cause the wireless device to:

134. As I explained at [6b], Seo and ZTE render obvious processing circuitry configured to cause the wireless device to perform operations.

[11c] receive a downlink control channel that schedules a downlink shared channel transmission to the wireless device;

135. As I explained at [1a], [1b], [6c], and [6d], Seo and ZTE render obvious a wireless device that receives a downlink control channel that schedules a downlink shared channel transmission to the wireless device.

[11d] receive, from the network node, signaling comprising information that provides a semi-static configuration of two or more uplink control channel resource sets each comprising two or more uplink control channel resources;

136. As I explained at [1g] and [6i], Seo and ZTE render obvious a wireless device that receives, from the network node, signaling comprising information that provides a semi-static configuration of two or more uplink control channel resource sets each comprising two or more uplink control channel resources.

[11e] determine an uplink control channel resource to use for transmitting uplink control information to a network node;

137. As I explained at [1c] and [6e], Seo and ZTE render obvious a wireless device that determines an uplink control channel resource to use for transmitting uplink control information to a network node.

[11f] wherein the uplink control information comprises Hybrid Automatic Repeat Request, HARQ, feedback for the downlink shared channel transmission

138. As I explained at [1d] and [6f], Seo and ZTE render obvious that the uplink control information comprises Hybrid Automatic Repeat Request, HARQ, feedback for the downlink shared channel transmission.

[11g] wherein determining the uplink control channel resource comprises selecting the uplink control channel resource from uplink control channel resources in two or more uplink control channel resource sets based on:

139. As I explained at [1h] and [6j], Seo and ZTE render obvious a wireless device where determining the uplink control channel resource comprises selecting the uplink control channel resource from uplink control channel resources in two or more uplink control channel resource sets.

[11h] a payload size of the uplink control information;

140. Seo and ZTE render obvious selecting the uplink control channel resource from uplink control channel resources in two or more uplink control channel resource sets based on a payload size of the uplink control information. Although Seo does not describe selecting the uplink control channel resource based on a payload size of the uplink control information, ZTE does. ZTE proposed “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.” SAMSUNG-1006, 2-3 (emphasis omitted). In this regard, ZTE selects a resource set based on PUCCH format or payload size of the uplink control information (e.g., “2 bits

UCI” or “more than 2 bits UCI”). *Id.* Based on this description, a POSITA would have found that selection of ZTE’s PUCCH resource relates to the size (e.g., 2 bits or more than 2 bits) of the uplink control information.

[11i] a starting control channel element index of a downlink control channel candidate on which the downlink control channel was received; and

141. Seo and ZTE render obvious selecting the uplink control channel resource from uplink control channel resources in two or more uplink control channel resource sets based on a starting control channel element index of a downlink control channel candidate on which the downlink control channel was received. SAMSUNG-1005, [0150]-[0152]. Seo describes selecting the PUCCH resource based on control channel elements (CCEs). SAMSUNG-1005, [0051], [0139]. For instance, “the UE may transmit ACK/NACK via a PUCCH having an index corresponding to an index of a specific (*e.g., first*) CCE of the CCEs configuring the PDCCH received by the UE.” *Id.*, [0139]-[0140]. Seo also describes PUCCH resource selection using equations that include the value “ n_{CCE} ,” which “denotes the *smallest value of CCE indexes* used for PDCCH transmission.” *Id.*, [0142]-[0143], [0150]-[0152]. From Seo’s disclosure, a POSITA would have found it obvious to select the uplink control channel resource based on a starting control channel element index.

[11j] dynamic signaling received from the network node; and

142. As I explained at [1h] and [6j], Seo and ZTE render obvious selecting the uplink control channel resource from uplink control channel resources in two or more uplink control channel resource sets based on dynamic signaling received from the network node.

[11k] transmit the uplink control information using the determined uplink control channel resource;

143. As I explained at [1f] and [6h], Seo and ZTE render obvious a wireless device that transmits the uplink control information using the determined uplink control channel resource.

[11l] wherein selecting the uplink control channel resource from the two or more uplink control channel resources in the two or more uplink control channel resource sets comprises selecting one of the two or more uplink control channel resource sets, and selecting, as the uplink control channel resource to use for transmitting the uplink control information to the network node, one of the two or more uplink control channel resources from the selected uplink control channel resource set based on dynamic signaling from the network node.

144. As I explained at [1h] and [6j], Seo and ZTE render obvious selecting one of the two or more uplink control channel resource sets, and selecting, as the uplink

control channel resource to use for transmitting the uplink control information to the network node, one of the two or more uplink control channel resources from the selected uplink control channel resource set based on dynamic signaling from the network node.

8. Claim 12

[12pre] The wireless device of claim 11 wherein:

145. As I explained at [6pre], Seo and ZTE render obvious a wireless device.

[12a] the downlink control channel comprises a downlink control information message comprising bits for use to select one of the two or more uplink control channel resources from the selected uplink control channel resource set; and

146. As I explained at [3a] and [8a], Seo and ZTE render obvious that the downlink control channel comprises a downlink control information message comprising bits for use to select one of the two or more uplink control channel resources from the selected uplink control channel resource set.

[12b] selecting the one of the two or more uplink control channel resources from the selected uplink control channel resource set based on dynamic signaling from the network node comprises selecting, as the uplink control channel resource to use for transmitting the uplink control information to the network node, the one of the two or more uplink control channel resources from the selected uplink control channel resource set based on the bits for use

to select one of the two or more uplink control channel resources from the selected uplink control channel resource set that are comprised in the downlink control channel.

147. As I explained at [3b] and [8b], Seo and ZTE render obvious selecting, as the uplink control channel resource to use for transmitting the uplink control information to the network node, the one of the two or more uplink control channel resources from the selected uplink control channel resource set based on the bits for use to select one of the two or more uplink control channel resources from the selected uplink control channel resource set that are comprised in the downlink control channel.

9. Claim 17

[17pre] The method of claim 1, wherein determining the uplink control channel resource further comprises selecting the uplink control channel resource from uplink control channel resources in two or more uplink control channel resource sets based on:

148. As I explained at [1h] and [6j], Seo and ZTE render obvious selecting the uplink control channel resource from uplink control channel resources in two or more uplink control channel resource sets.

[17a] a payload size of the uplink control information;

149. As I explained at [11h], Seo and ZTE render obvious selecting the uplink control channel resource from uplink control channel resources in two or more uplink control channel resource sets based on a payload size of the uplink control information.

[17b] a starting control channel element index of the latest received one of the first downlink control channel message and the second downlink control channel message downlink control channel; and

150. As I explained at [11i], Seo and ZTE render obvious selecting the uplink control channel resource from uplink control channel resources in two or more uplink control channel resource sets based on a starting control channel element index of the latest received one of the first downlink control channel message and the second downlink control channel message downlink control channel.

[17c] dynamic signaling received from the network node.

151. As I explained at [1h], [6j], and [11j], Seo and ZTE render obvious selecting the uplink control channel resource from uplink control channel resources in two or more uplink control channel resource sets based on dynamic signaling received from the network node.

10. Claim 18

[18pre] A method of operating a wireless device, comprising:

152. As I explained at [1pre], Seo and ZTE render obvious a method of operating a wireless device.

[18a] receiving a downlink control channel that schedules a downlink shared channel transmission to the wireless device;

153. As I explained at [1a], [1b], [6c], [6d], and [11c], Seo and ZTE render obvious receiving a downlink control channel that schedules a downlink shared channel transmission to the wireless device.

[18b] receiving, from the network node, signaling comprising information that provides a semi-static configuration of two or more uplink control channel resource sets each comprising two or more uplink control channel resources,

154. As I explained at [1g], [6i], and [11d], Seo and ZTE render obvious receiving, from the network node, signaling comprising information that provides a semi-static configuration of two or more uplink control channel resource sets each comprising two or more uplink control channel resources.

[18c] determining an uplink control channel resource to use for transmitting uplink control information to a network node,

155. As I explained at [1c], [6e], and [11e], Seo and ZTE render obvious determining an uplink control channel resource to use for transmitting uplink control information to a network node.

[18d] wherein the uplink control information comprises Hybrid Automatic Repeat Request, HARQ, feedback for the downlink shared channel transmission,

156. As I explained at [1d], [6f], and [11f], Seo and ZTE render obvious that the uplink control information comprises Hybrid Automatic Repeat Request, HARQ, feedback for the downlink shared channel transmission.

[18e] wherein determining the uplink control channel resource comprises selecting the uplink control channel resource from uplink control channel resources in two or more uplink control channel resource sets based on:

157. As I explained at [1h], [6j], and [11g], Seo and ZTE render obvious that determining the uplink control channel resource comprises selecting the uplink control channel resource from uplink control channel resources in two or more uplink control channel resource sets.

[18f] a payload size of the uplink control information;

158. As I explained at [11h], Seo and ZTE render obvious selecting the uplink control channel resource from uplink control channel resources in two or more

uplink control channel resource sets based on a payload size of the uplink control information.

[18g] a starting control channel element index of a downlink control channel candidate on which the downlink control channel was received; and

159. As I explained at [11i], Seo and ZTE render obvious selecting the uplink control channel resource from uplink control channel resources in two or more uplink control channel resource sets based on a starting control channel element index of a downlink control channel candidate on which the downlink control channel was received.

[18h] dynamic signaling received from the network node; and

160. As I explained at [1h], [6j], and [11j], Seo and ZTE render obvious selecting the uplink control channel resource from uplink control channel resources in two or more uplink control channel resource sets based on dynamic signaling received from the network node.

[18i] transmitting the uplink control information using the determined uplink control channel resource;

161. As I explained at [1f], [6h], and [11k], Seo and ZTE render obvious transmitting the uplink control information using the determined uplink control channel resource.

[18j] wherein selecting the uplink control channel resource from the two or more uplink control channel resources in the two or more uplink control channel resource sets comprises selecting one of the two or more uplink control channel resource sets, and selecting, as the uplink control channel resource to use for transmitting the uplink control information to the network node, one of the two or more uplink control channel resources from the selected uplink control channel resource set based on dynamic signaling from the network node.

162. As I explained at [1h], [6j], and [11l], Seo and ZTE render obvious selecting one of the two or more uplink control channel resource sets, and selecting, as the uplink control channel resource to use for transmitting the uplink control information to the network node, one of the two or more uplink control channel resources from the selected uplink control channel resource set based on dynamic signaling from the network node.

11. Claim 19

[19pre] The method of claim 18:

163. As I explained at [1pre] and [18pre], Seo and ZTE render obvious a method.

[19a] wherein the downlink control channel comprises a downlink control information message comprising bits for use to select one of the two or more

uplink control channel resources from the selected uplink control channel resource set; and

164. As I explained at [3a], [8a], and [12a], Seo and ZTE render obvious that the downlink control channel comprises a downlink control information message comprising bits for use to select one of the two or more uplink control channel resources from the selected uplink control channel resource set.

[19b] wherein selecting the one of the two or more uplink control channel resources from the selected uplink control channel resource set based on dynamic signaling from the network node comprises selecting, as the uplink control channel resource to use for transmitting the uplink control information to the network node, the one of the two or more uplink control channel resources from the selected uplink control channel resource set based on the bits for use to select one of the two or more uplink control channel resources from the selected uplink control channel resource set that are comprised in the downlink control channel.

165. As I explained at [3b], [8b], and [12b], Seo and ZTE render obvious selecting, as the uplink control channel resource to use for transmitting the uplink control information to the network node, the one of the two or more uplink control channel resources from the selected uplink control channel resource set based on the bits for use to select one of the two or more uplink control channel resources

from the selected uplink control channel resource set that are comprised in the downlink control channel.

VIII. GROUND 2: Claims 1-3, 6-8, 11, 12, and 17-19 are obvious over Seo, ZTE, and Intel

A. Manner in which Seo, ZTE, and Intel render obvious Claims 1-3, 6-8, 11, 12, and 17-19.

166. The combination of Seo, ZTE, and Intel renders the Challenged Claims obvious as set forth below. Specifically, Intel offers additional disclosure that corroborates the analysis of Seo and ZTE above and further supports obviousness of features [1g], [1h], [6i], [6j], [11h], [11i], [11j], [11l], [17a],[17b], [17c],[18f], [18g], [18h], and [18j]. The above analysis of other features in Ground 1 apply equally to Ground 2 and the analysis of features [1g], [1h], [6i], [6j], [11h], [11i], [11j], [11l], [17a], [17b],[17c] [18f], [18g], [18h], and [18j] in Ground 1 apply equally to Ground 2, but are supported and supplemented by additional disclosure from Intel as set forth below.

[1g] wherein the signaling received from the network node comprises information that provides a semi-static configuration of two or more uplink control channel resource sets each comprising two or more uplink control channel resources; and

167. Intel describes that “multiple PUCCH formats are specified to support various *UCI payload sizes*.” SAMSUNG-1007, 1.

- 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

168. Intel suggests that “it is more desirable to configure a set of resource indexes from high layer signalling and explicitly signal one resource index from the set of resource indexes in the DCI for HARQ ACK/NACK feedback on UL control channel.” SAMSUNG-1007, 3. Specifically, a “set of resource indexes for HARQ ACK/NACK feedback on UL control channel are configured via high layer signalling and one resource index among the set of resource indexes is explicitly signaled in the DCI.” *Id.* From this disclosure, a POSITA would have found it obvious to use semi-static configuration of two or more uplink control channel resource sets (e.g., different PUCCH formats) each comprising two or more uplink control channel resources.

[1h] wherein determining the uplink control channel resource based on (a) and (b) comprises selecting one of the two or more uplink control channel resource sets, and selecting, as the uplink control channel resource to use for transmitting the uplink control information to the network node, one of the two or more uplink control channel resources from the selected uplink control channel resource set based on dynamic signaling from the network node.

169. Intel describes that “multiple PUCCH formats are specified to support various *UCI payload sizes*.” SAMSUNG-1007, 1.

- 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

170. Intel suggests that “it is more desirable to configure a set of resource indexes from high layer signalling and explicitly signal one resource index from the set of resource indexes in the DCI for HARQ ACK/NACK feedback on UL control channel.” SAMSUNG-1007, 3. Specifically, a “set of resource indexes for HARQ ACK/NACK feedback on UL control channel are configured via high layer signalling and one resource index among the set of resource indexes is explicitly signaled in the DCI.” *Id.* From this disclosure, a POSITA would have found it obvious to select one of the two or more uplink control channel resource sets (e.g., different PUCCH formats), and select one of the two or more uplink control channel resources from the selected uplink control channel resource set based on dynamic signaling from the network node (e.g., explicitly signaled in the DCI).

[6i] wherein the signaling received from the network node comprises information that provides a semi-static configuration of two or more uplink control channel resource sets each comprising two or more uplink control channel resources; and

171. As I explained above at Ground 2 [1g], Seo, ZTE, and Intel render obvious that the signaling received from the network node comprises information that provides a semi-static configuration of two or more uplink control channel resource sets each comprising two or more uplink control channel resources.

[6j] wherein determining the uplink control channel resource based on (a) and (b) comprises selecting one of the two or more uplink control channel resource sets, and selecting, as the uplink control channel resource to use for transmitting the uplink control information to the network node, one of the two or more uplink control channel resources from the selected uplink control channel resource set based on dynamic signaling from the network node.

172. As I explained above at Ground 2 [1h], Seo, ZTE, and Intel render obvious selecting one of the two or more uplink control channel resource sets, and selecting, as the uplink control channel resource to use for transmitting the uplink control information to the network node, one of the two or more uplink control channel resources from the selected uplink control channel resource set based on dynamic signaling from the network node.

[11h] a payload size of the uplink control information;

173. Intel describes that “multiple PUCCH formats are specified to support various *UCI payload sizes*.” SAMSUNG-1007, 1.

- 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

174. As Intel proposed, “multiple NR PUCCH formats can be supported in order to accommodate various *UCI types and payload sizes*.” *Id.*, 2. From this disclosure, a POSITA would have found it obvious that PUCCH resource selection is based on a payload size of the uplink control information.

[11i] a starting control channel element index of a downlink control channel candidate on which the downlink control channel was received; and

175. Intel suggests that the “resource index for PUCCH format 1a/1b is derived from *the first CCE in the PDCCH* which is used to schedule the downlink data transmission.” SAMSUNG-1007, 2. From this disclosure, a POSITA would have found it obvious that PUCCH resource selection is based on a starting control

channel element index of a downlink control channel candidate on which the downlink control channel was received.

[11j] dynamic signaling received from the network node; and

176. As I explained at Ground 2 [1h] and [6j], Seo, ZTE, and Intel render obvious PUCCH resource selection based on dynamic signaling received from the network node.

[11l] wherein selecting the uplink control channel resource from the two or more uplink control channel resources in the two or more uplink control channel resource sets comprises selecting one of the two or more uplink control channel resource sets, and selecting, as the uplink control channel resource to use for transmitting the uplink control information to the network node, one of the two or more uplink control channel resources from the selected uplink control channel resource set based on dynamic signaling from the network node.

177. As I explained at Ground 2 [1h] and [6j], Seo, ZTE, and Intel render obvious selecting one of the two or more uplink control channel resource sets, and selecting, as the uplink control channel resource to use for transmitting the uplink control information to the network node, one of the two or more uplink control channel resources from the selected uplink control channel resource set based on dynamic signaling from the network node.

[17a] a payload size of the uplink control information;

178. As I explained at Ground 2 [11h], Seo, ZTE, and Intel render obvious PUCCH resource selection based on a payload size of the uplink control information.

[17b] a starting control channel element index of the latest received one of the first downlink control channel message and the second downlink control channel message downlink control channel; and

179. As I explained at Ground 2 [11i], Seo, ZTE, and Intel render obvious PUCCH resource selection based on a starting control channel element index of the latest received one of the first downlink control channel message and the second downlink control channel message downlink control channel.

[17c] dynamic signaling received from the network node.

180. As I explained at Ground 2 [1h], [6j], and [11j], Seo, ZTE, and Intel render obvious PUCCH resource selection based on dynamic signaling received from the network node.

[18f] a payload size of the uplink control information;

181. As I explained at Ground 2 [11h], Seo, ZTE, and Intel render obvious PUCCH resource selection based on a payload size of the uplink control information.

[18g] a starting control channel element index of a downlink control channel candidate on which the downlink control channel was received; and

182. As I explained at Ground 2 [11i], Seo, ZTE, and Intel render obvious PUCCH resource selection based on a starting control channel element index of a downlink control channel candidate on which the downlink control channel was received.

[18h] dynamic signaling received from the network node; and

183. As I explained at Ground 2 [1h], [6j], and [11j], Seo, ZTE, and Intel render obvious PUCCH resource selection based on dynamic signaling received from the network node.

[18j] wherein selecting the uplink control channel resource from the two or more uplink control channel resources in the two or more uplink control channel resource sets comprises selecting one of the two or more uplink control channel resource sets, and selecting, as the uplink control channel resource to use for transmitting the uplink control information to the network node, one of the two or more uplink control channel resources from the selected uplink control channel resource set based on dynamic signaling from the network node.

184. As I explained at Ground 2 [1h], [6j], and [11l], Seo, ZTE, and Intel render obvious selecting one of the two or more uplink control channel resource sets, and

selecting, as the uplink control channel resource to use for transmitting the uplink control information to the network node, one of the two or more uplink control channel resources from the selected uplink control channel resource set based on dynamic signaling from the network node.

IX. CONCLUSION

185. I reserve the right to supplement my opinions to address any information obtained, or positions taken, based on any new information introduced throughout this proceeding.

186. I declare under penalty of perjury that the foregoing is true and accurate to the best of my ability.