

UNITED STATES PATENT AND TRADEMARK OFFICE

---

**BEFORE THE PATENT TRIAL AND APPEAL BOARD**

---

SAMSUNG ELECTRONICS CO., LTD.  
Petitioner

v.

TELEFONAKTIEBOLAGET LM ERICSSON  
Patent Owner

**U.S. PATENT NO. 10,476,722**

Case IPR2021-TBD

**DECLARATION OF DR. MATTHEW C. VALENTI**

## TABLE OF CONTENTS

I.	INTRODUCTION .....	1
II.	QUALIFICATIONS .....	2
III.	UNDERSTANDING OF PATENT LAW .....	7
A.	Claim Construction .....	7
B.	Obviousness.....	8
IV.	PERSON OF ORDINARY SKILL IN THE ART .....	12
V.	SUMMARY OF OPINIONS.....	14
VI.	OVERVIEW OF THE TECHNOLOGY.....	14
VII.	SUMMARY OF THE '722 PATENT .....	18
A.	Claims.....	18
B.	Summary of the Specification .....	19
C.	Summary of the Prosecution History .....	22
VIII.	CLAIM CONSTRUCTION .....	23
IX.	OVERVIEW OF THE PRIOR ART .....	23
A.	Luo.....	23
B.	Ly.....	29
X.	DETAILED ANALYSIS.....	41
A.	Ground I: Claims 1, 7, 8, 9, 11, 12, 13, 17, 18, 24, 25, 26 and 27 Are Rendered Obvious by Luo.....	41
1.	Independent Claims 1 and 13.....	41
2.	Independent Claims 7 and 25.....	53
3.	Dependent Claims 8 and 26 .....	57
4.	Dependent Claims 9 and 27 .....	58
5.	Dependent Claim 11 .....	59
6.	Dependent Claim 12 .....	60

7.	Dependent Claim 17 .....	61
8.	Dependent Claim 18 .....	62
9.	Dependent Claim 24 .....	63
B.	Ground II: Claims 1, 7, 8, 9, 11, 12, 13, 17, 18, 24, 25, 26 and 27 Are Rendered Obvious by Luo In View of Ly.....	64
1.	Independent Claims 1, 7, 13, and 25.....	69
2.	Dependent Claim 11 .....	73
3.	Dependent Claim 12 .....	75
4.	Dependent Claims 8, 9, 17, 18, 24, 26 and 27 .....	76
XI.	SECONDARY CONSIDERATIONS .....	77
XII.	CONCLUSION.....	77

## LIST OF EXHIBITS

<b>Exhibit No.</b>	<b>Description</b>
<b>1001</b>	U.S. Patent No. 10,476,722
<b>1002</b>	File History of U.S. Patent No. 10,476,722
<b>1003</b>	Declaration of Dr. Matthew C. Valenti for <i>Inter Partes</i> Review of U.S. Patent No. 10,476,722
<b>1004</b>	U.S. Patent No. 10,568,102 (“Luo”)
<b>1005</b>	Provisional Application No. 62/246,872, filed February 23, 2017 (“Luo Provisional”)
<b>1006</b>	U.S. Patent No. 10,194,410 (“Ly”)
<b>1007</b>	Provisional Application No. 62/459,973, filed February 16, 2017 (“Ly ’973 Provisional”)
<b>1008</b>	Provisional Application No. 62/462,258, filed February 22, 2017 (“Ly ’258 Provisional”)
<b>1009</b>	“4G, <i>LTE / LTE-Advanced For Mobile Broadband</i> ,” Erik Dahlman <i>et al.</i> (2011) (“Dahlman LTE”)
<b>1010</b>	“5G NR, <i>The Next Generation Wireless Access Technology</i> ,” Erik Dahlman <i>et al.</i> (1st Edition, 2018) (“Dahlman 5G”)

I, Mathew Valenti, do hereby declare as follows:

**I. INTRODUCTION**

1. I have been retained as an expert witness by Samsung Electronics Co., Ltd. (“Samsung” or “Petitioner”) in connection with the above-captioned Petition for *Inter Partes* Review (“IPR”) of U.S. Patent No. 10,476,722 (the “’722 Patent”) Ex. 1001.

2. I have been asked to prepare this Declaration to provide my opinions regarding the validity of claims 1, 7, 8, 9, 11, 12, 13, 17, 18, 24, 25, 26 and 27 (the “Challenged Claims”) of the ’722 Patent. As discussed below, it is my opinion that the Challenged Claims of the ’722 Patent are invalid as at least obvious in view of the prior art references discussed herein.

3. The ’722 Patent issued on November 12, 2019, from U.S. Application No. 16/204,265 filed on November 29, 2018, and claims priority to a PCT application (PCT/CN2017/078102) filed on March 24, 2017. Ex. 1002. For the purposes of my Declaration, I have been asked to assume that the priority date of the alleged invention recited in the ’722 Patent is March 24, 2017 (hereinafter the “Priority Date”).

4. In preparing my Declaration, I reviewed the ’722 Patent, the file history of the ’722 Patent, U.S. Pat. No. 10,568,102 (Ex. 1004, “Luo”), Provisional Application No. 62/246,872 (Ex. 1005, “Luo Provisional”), U.S. Patent No.

Declaration of Dr. Valenti for *Inter Partes* Review of U.S. Patent No. 10,476,722 10,194,410 (Ex. 1007, “Ly”), Provisional Application No. 62/459,973 (Ex. 1007, “Ly ’973 Provisional”), Provisional Application No. 62/462,258 (Ex. 1008, “Ly ’258 Provisional”), other publications from the time of the alleged invention discussed herein, and any other documents that may be referenced herein. My opinions are based, at least in part, on the references identified above, as well as on any other documents that may be referenced in my Declaration.

5. In forming the opinions expressed in my Declaration, I relied upon my education and experience, and I considered the viewpoint of a person having ordinary skill the art (“POSITA”), as discussed in Section IV below, as of the Priority Date of the ’722 Patent.

6. The agreed-upon hourly rate for my time in connection with this IPR is my standard consulting rate of \$500 per hour. I am being separately reimbursed for any out-of-pocket expenses. My compensation is not affected by or dependent in any way on my opinions or the outcome of this matter. I have never been an employee of Samsung, and I have no financial interest in Samsung.

## **II. QUALIFICATIONS**

7. I am currently a Professor of Computer Science and Electrical Engineering at West Virginia University in Morgantown, West Virginia. I hold the position of Raymond J. Lane Chair in Computer Science and Electrical Engineering and serve as the Chair of the Lane Department of Computer Science and Electrical

Engineering. I have over 25 years of experience in telecommunications and communication technology, with an emphasis on wireless and cellular networks. In particular, this experience includes physical-layer technology and issues related to cellular network call processing, and current standards including UMTS/WCDMA, LTE, 5G-NR, WiMAX and DVB-S2. I have particular research and teaching interests in communication theory and statistical signal processing. My full qualifications and experience are set out in my *Curriculum Vitae* (“CV”), attached to this Declaration as Appendix A.

8. I received my Bachelor of Science (B.S.) in Electrical Engineering from Virginia Polytechnic Institute and State University in 1992, and a Master of Science (M.S.) in Electrical Engineering at Johns Hopkins University in 1995. I subsequently completed a Ph.D. in Electrical Engineering from Virginia Polytechnic Institute and State University in 1999.

9. In 1992, I started as a full-time Electronics Engineer at the U.S. Naval Research Laboratory in Washington D.C. I subsequently became a Graduate Research Assistant and Instructor as the Bradley Fellow at Bradley Department of Electrical and Computer Engineering from August 1995 to July 1999.

10. Following this, in August 1999, I joined West Virginia University first as an Assistant Professor. I was promoted to Associate Professor in August 2005 and to Professor in August 2010, a position I still hold today. I acted as Interim

Department Chair from July 2019 to June 2020, and in July 2020 I was appointed as the Raymond Lane Department Chair. I have also been a licensed Professional Engineer in West Virginia since 2011.

11. I have published 35 journal papers and technical magazine articles and over 100 conference papers in the telecommunications field, focusing on wireless technologies, including ten papers in the journal *IEEE Transactions on Wireless Communications*. My CV, which is submitted herewith as Appendix A, contains a complete list of my publications. I have also acted as Editor-in-Chief of IEEE Communications Society Best Readings since 2015, which curates collections of papers focusing on technology including Device-to-Device Communication and Cloud Communication and Networking. I was also Chair, between 2016 and 2017, and a Member from 2014 to 2017, of the Executive Editorial Committee of *IEEE Transactions on Wireless Communications*. I have also acted as a Reviewer of a multitude of Journals since 2000, including for *IEEE Transactions on Communications*. I am also currently Chair of the IEEE Globecom/ICC Technical Content (GITC) committee, which is the technical steering committee for *IEEE Global Communications Conference* (GLOBECOM) and *IEEE International Conference on Communications* (ICC), the flagship global conferences on communication technology, and I have been a member of this committee since 2015. I have also been a member of the *IEEE Military Communications Conference*

(MILCOM) Board since 2014, and have held the Chair position for a significant number of IEEE International Conferences around the world since 2007, including those on Wireless Communications and Next Generation Networks.

12. I have received a number of academic awards and honors over the years, including awards for Outstanding Researcher in the Statler College of Engineering and Mineral Resources of West Virginia University in 2000, 2001 and 2008. In 2019, I received the MILCOM Award for Sustained Technical Achievement.

13. In my academic role, I am responsible for the design and delivery of academic courses in communication technologies at the undergraduate and graduate level. I have taught courses on Digital Signal Processing, Communication Theory and Communications Systems at West Virginia University, and also been instrumental in developing and creating resource workbooks for new courses in Wireless Networking, Wireless Communications and Coding Theory.

14. I run an active research program focused on the development and evaluation of advanced communication transmission technology, including physical-layer technologies such as error control coding, hybrid ARQ, synchronization, and channel estimation. I have secured external competitive funding from agencies including the National Science Foundation (NSF) and the Office of Naval Research (ONR) to support my work. My duties include the

mentoring of graduate students, many of whom support my research activities as research assistants. To date, I have supervised the research of 48 students successfully graduating with advanced degrees, 8 at the Ph.D. level and 40 at the M.S. level.

15. My work in the area of synchronization and error-control coding, as well as next-generation cellular systems includes, among other things, a journal paper titled “Joint synchronization and SNR estimation for turbo codes in AWGN channels,” published in 2005 in *IEEE Transactions on Communications*, where I explore the connection between synchronization and error-control coding. I have also published extensively on the use of pilot symbols (also referred to as reference symbols) for channel estimation in systems that use error-control coding. My work also include a journal paper titled “Analysis of a frequency-hopping millimeter-wave cellular uplink”, published in 2016 in *IEEE Transactions on Wireless Communications*, where I discuss and consider a 5G cellular system operating at millimeter-wave frequencies and using beamforming. I also discuss and explore millimeter-wave systems and beamforming in a journal paper titled “Device-to-device millimeter wave communications: Interference, coverage, rate, and finite topologies,” also published in 2016 in *IEEE Transactions on Wireless Communications*.

16. I have extensive experience in developing software for the simulation and implementation of various aspects of wireless communication systems, including key portions of the LTE, UMTS, HSDPA, WiMAX, and DVB-S2 standards. The code has been incorporated into several commercial products.

17. I previously have been retained as an expert witness in numerous proceedings in different jurisdictions, including the United States District Courts, the United States Patent and Trademark Office, and the International Trade Commission (ITC). This has included acting as an expert witness for major technology companies and wireless carriers in patent disputes and investigations involving telephone modems, mobile phone handsets, LTE, WCDMA/UMTS and other core wireless technologies.

### **III. UNDERSTANDING OF PATENT LAW**

18. I am not an attorney. For purposes of this declaration, I have been informed about certain aspects of the law that are relevant to my opinions. My understanding of the law is as listed below.

#### **A. Claim Construction**

19. I understand that claims in an IPR are given their plain and ordinary meaning as understood by a person of ordinary skill in the art in view of the specification and prosecution history, unless those sources show an intent to depart from such meaning.

**B. Obviousness**

20. I understand that a patent cannot be properly granted for subject matter that would have been obvious to a POSITA at the time of the claimed invention, and that a patent claim directed to such obvious subject matter is invalid under 35 U.S.C. § 103.

21. I understand that obviousness of a claim requires that the claim be obvious from the perspective of a person having ordinary skill in the relevant art at the time of the alleged invention. I understand that a claim may be obvious in view of a combination of two or more prior art references. I understand that prior art to the '722 Patent includes patents in the relevant art that predate the Priority Date of the '722 Patent.

22. I understand that an obviousness analysis requires an understanding of the scope and content of the prior art, any differences between the alleged invention and the prior art, and the level of ordinary skill in evaluating the pertinent art.

23. I understand that certain factors—often called “secondary considerations”—may support or rebut an assertion of obviousness of a claim. I understand that such secondary considerations include, among other things, commercial success of the alleged invention, skepticism of those having ordinary skill in the art at the time of the alleged invention, unexpected results of the alleged invention, any long-felt but unsolved need in the art that was satisfied by the alleged

invention, the failure of others to make the alleged invention, praise of the alleged invention by those having ordinary skill in the art, and copying of the alleged invention by others in the field. I further understand that there must be a nexus—a connection—between any such secondary considerations and the alleged invention. I also understand that contemporaneous and independent invention by others is a secondary consideration tending to show obviousness.

24. I further understand that a claim can be found obvious if it unites old elements with no change to their respective functions, or alters prior art by mere substitution of one element for another known in the field, with that combination yielding predictable results. While it may be helpful to identify a reason for this combination, common sense should guide, and there is no rigid requirement for a teaching, suggestion, or motivation to combine. When a product is available, design incentives and other market forces can prompt variations of it, either in the same field or different one. If a person having ordinary skill in the relevant art can implement a predictable variation, obviousness likely bars patentability. Similarly, if a technique has been used to improve one device, and a person having ordinary skill in the art would recognize that the technique would improve similar devices in the same way, use of the technique is obvious. I further understand that a claim may be obvious if common sense directs one to combine multiple prior art references or add missing features to reproduce the alleged invention recited in the claims.

25. I also understand that the following rationales may support a finding of obviousness:

- a) Combining prior art elements according to known methods to yield predictable results;
- b) simple substitution of one known element for another to obtain predictable results;
- c) use of known technique to improve similar devices (methods, or products) in the same way;
- d) applying a known technique to a known device (method, or product) ready for improvement to yield predictable results;
- e) “obvious to try” – choosing from a finite number of identified, predictable solutions, with a reasonable expectation of success;
- f) known work in one field of endeavor may prompt variations of it for use in either the same field or a different one based on design incentives or other market forces if the variations are predictable to one of ordinary skill in the art; and
- g) some teaching, suggestion, or motivation in the prior art that would have led one of ordinary skill to modify the prior art reference or to combine prior art reference teachings to arrive at the claimed invention.

26. It is also my understanding that to determine whether it would have been obvious to combine known elements in a manner claimed in a patent, one may consider such things as the interrelated teachings of multiple pieces of prior art, the effects of demands known to the design community or present in the marketplace, and the background knowledge of an individual having ordinary skill in the art.

27. It is further my understanding that determining obviousness is expansive and flexible. I understand that there is no requirement for an obviousness

analysis to find precise teachings that are directed to specific subject matter of a claim; rather, the common sense, inferences, and creative steps that a person of ordinary skill in the art would employ should be taken into account.

28. It is also my understanding that a need or problem known in the field at the time of an invention can provide an obvious reason to combine elements in the manner claimed. A patent's subject matter would have been obvious, for example, if at the time of the invention, there was a known problem for which the patent claims encompassed an obvious solution. Further, if a patent claims a structure known in the prior art that only substitutes one element for another that is known in the field.

29. I understand that the combination would have been obvious unless the result is unexpected and fruitful. Therefore, a predictable variation of prior art is obvious. It is also my understanding that when there are a finite number of identified, predictable solutions to a known problem, the combination was obvious to try and thus might be obvious under 35 U.S.C. § 103. It is my additional understanding that items may have obvious uses beyond their primary purposes. I understand that neither a particular motivation nor an avowed purpose of a patentee controls how a piece of prior art may be used. It is also common sense that familiar items may have obvious uses beyond their primary purposes, and that a person of ordinary skill often will be able to fit the teachings of multiple patents together like

pieces of a puzzle. It is my understanding that this list of rationales is not exclusive and that other rationales may support a conclusion of obviousness.

30. It is further my understanding that multiple prior art references can be combined to show that a claim is obvious. Any need or problem known in the field and addressed by a patent claim can provide a reason for combining multiple references in the manner claimed. I 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 knowledge of an ordinarily skilled artisan.

31. As informed by Samsung's counsel, I understand that the obviousness analysis requires a comparison of the properly construed claim language to the prior art on a limitation-by-limitation basis.

#### **IV. PERSON OF ORDINARY SKILL IN THE ART**

32. It is my understanding that the level of ordinary skill in the art is based on a study of the patents at issue and their file histories, a study of the prior art cited therein, and knowledge of the following:

- a) The level of education and experience of persons actively working in the field at the time the subject matter at issue was developed;
- b) the types of problems encountered in the art at the time the subject matter was developed;
- c) the prior art patents and publications;
- d) the activities of others working in that field;

- e) prior art solutions to those problems; and
- f) the sophistication of the technology at issue in this case.

33. It is also my understanding that for determining the level of ordinary skill in the art, consideration should also be given to factors such as: (1) the sophistication of the relevant technology; (2) the rapidity with which innovations are made in that field; (3) the educational level of active workers in that field; and (4) the education and experience of the alleged inventors. It is further my understanding that these factors are not exhaustive and are merely a useful guide to determine the level of ordinary skill in the art.

34. Taking all of these considerations into account, it is my opinion that a POSITA at the time of the '722 Patent would have had a Master's degree in Electrical Engineering, Computer Science, Physics or equivalent and three to five years of experience working with wireless digital communication systems including the physical layer of such systems. Additional education might compensate for less experience, and vice-versa. Such a person would possess sufficient knowledge and experience to understand the types of problems and subject matter technology at issue here, in view of the relevant technology as described in the '722 Patent and the prior art discussed herein.

35. Based on this level of ordinary skill, I have been at least a POSITA since at least 1998. The opinions I am offering herein are from the perspective of a POSITA as of the Priority Date.

36. I also note that my opinions provided in this Declaration would not change in view of any minor modifications to this level of skill.

## **V. SUMMARY OF OPINIONS**

37. It is my opinion that claims 1, 7, 8, 9, 11, 12, 13, 17, 18, 24, 25, 26, 27 of the '722 Patent are at least rendered obvious under 35 U.S.C. § 103 by Luo (Ground I below).

38. It is my opinion that claims 1, 7, 8, 9, 11, 12, 13, 17, 18, 24, 25, 26, 27 of the '722 Patent are rendered obvious under 35 U.S.C. § 103 by Luo in combination with Ly (Ground II below).

## **VI. OVERVIEW OF THE TECHNOLOGY**

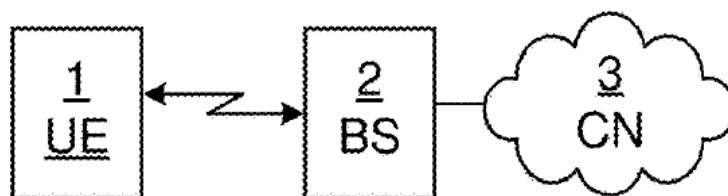
39. In the sections that follow, I discuss technical principles that are pertinent to the '722 Patent and the related prior art.

40. The '722 Patent is generally directed to synchronization of wireless devices with wireless communication systems, including in connection with the 5G New Radio (NR) Access technology. Ex. 1001, 1:6-9, 3:64-4:28, 6:27-34.

41. Long-Term Evolution (LTE) technology, also known as 4G LTE, is currently the most widespread wireless mobile broadband technology deployed

across the world. Ex. 1010, xv. Although 4G LTE is still expected to be used in the future, a new technology known as 5G New Radio (NR) has been standardized by the Third-Generation Partnership Project (3GPP) to meet future requirements. *Id.* Because both 4G LTE and 5G NR have been developed by 3GPP, they have a common background and share several technology components. *Id.*

42. A wireless communication system, such as 4G LTE and 5G NR, generally comprises a wireless device referred to as User Equipment (UE), such as a cellular phone, and a network node referred to as Base Station (BS), which is connected to the core network (CN), as shown, for example, in Figure 1 from the '722 Patent:



43. To properly communicate with the wireless communication network, a wireless device, such as a UE, must first achieve synchronization with the system through a base station (or BS). This synchronization is required to inform the UE when the wireless communication system (through the BS) will transmit various signals to the UE, such as broadcast of system information (SI). *See, e.g.,* Ex. 1001, 1:34-38; *see also* Ex. 1009, 301-302. System information includes information about how the wireless communication system is configured and is repeatedly

broadcast by the network to the UEs to enable them to access and, in general, operate properly within the network. Ex. 1009, 305.

44. In 4G LTE technology, two synchronization signals are used: a *Primary Synchronization Signal* (PSS) and a *Secondary Synchronization Signal* (SSS). A UE obtains both the PSS and SSS from a BS and uses them to synchronize with the BS. Ex. 1001, 1:52-62; *see also* Ex. 1009, 301-302. Once the UE synchronizes with the BS, it can read system information broadcast by the BS. Ex. 1009, 304-305.

45. In 4G LTE, system information is delivered by two different mechanisms relying on two different transport channels. *First*, a limited amount of system information is carried in a *Master-Information Block* (MIB) and is transmitted over a *Physical Broadcast Channel* (PBCH). Ex. 1009, 305; *see also* Ex. 1001, 1:62-67. The PBCH is a block of information transmitted from a BS to a UE. The MIB, carried by the PBCH, provides the UE with the minimum information needed to acquire further system information broadcast by the network. Ex. 1009, 305-306. *Second*, the remaining part of the system information is carried in *System-Information Blocks* (SIBs) and is transmitted over a *Downlink Shared Channel* (DL-SCH). Ex. 1009, 305. The system information carried by the SIBs includes, for example, information that UEs need to be able to access a cell, and that indicates whether a specific UE is allowed to camp on a specific cell. Ex. 1009, 308.

46. In 5G NR technology, PSSs and SSSs are similarly used to provide initial synchronization. However, although conceptually the same, the structure of the signals is different in 5G NR, and the new versions are referred to as NR-PSS and NR-SSS. Ex. 1001, 2:1-3. In addition, in 5G NR technology, a physical broadcast channel referred to as *NR Physical Broadcast Channel* (NR-PBCH) is defined, which carries a part of minimum system information in a MIB. Ex. 1001, 2:7-14; Ex. 1010, 87, 319. The NR-PBCH also includes a *Cyclic Redundancy Check* (CRC), which is an error-detecting code commonly used in digital networks to detect errors that inevitably and inadvertently arise during transmission. Ex. 1010, 320-321. A CRC is used, for example, by a UE to calculate whether a received value is incorrect, which would indicate a transmission error. In 5G NR technology, the NR-PSS, NR-SSS, and NR-PBCH are combined to form an SS block, which is a collection of synchronization signals and broadcast system information transmitted from a BS to a UE. Ex. 1001, 2:41-45; Ex. 1010, 311-321.

47. The SS block is transmitted on a set of time/frequency resources, meaning the BS multiplexes the NR-PSS, NR-SSS, and NR-PBCH in the frequency and/or time domain. Ex. 1010, 311-321; *see also* Ex. 1001, 3:10-13. However, as the '722 Patent notes in the background section, “multiplexing other signals within an SS block is not precluded.” Ex. 1001, 2:45-46.

48. In 5G NR technology, one or multiple SS block(s) compose an SS burst, and one or multiple SS burst(s) further compose an SS burst set. *Id.*, 2:53-55; Ex. 1010, 315-317. To determine the relative location of a particular SS block within the set of possible SS-block locations in a transmission from a BS to a UE, a “time index” is provided in the SS block that provides the relative location of the SS block within the sequence of possible SS-block locations in the SS burst set. Ex. 1010, 317, 319. According to the ’722 Patent, different ways of providing the SS block time index were under discussion in 3GPP, including a synchronization signal in the SS block referred to as *NR Tertiary Synchronization Signal* (NR-TSS). Ex. 1001, 3:20-25. I note, however, that in the current version of the 5G NR standard, the NR-TSS signal is not used. Rather, a *demodulation reference signal* called DMRS, which is carried by the PBCH, would convey part of the SS block time index. *See, e.g.*, Ex. 1005 (Luo), 12:28-31, 13:13-14; Ex. 1010, 319-20.

## **VII. SUMMARY OF THE ’722 PATENT**

### **A. Claims**

49. The ’722 Patent has 30 claims, including four independent claims (claims 1, 7, 13, and 25) and 26 dependent claims. Independent claims 1, 7, 13 and 25, as well as dependent claims 8, 9, 11, 12, 17, 18, 24, 26 and 27, are the Challenged Claims.

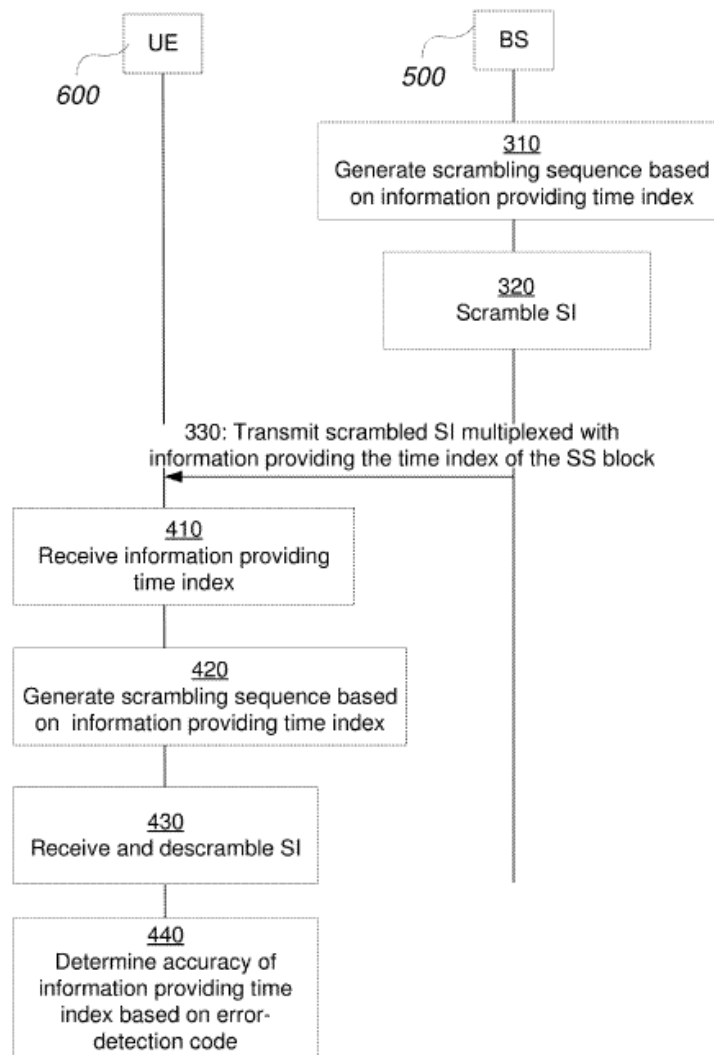
**B. Summary of the Specification**

50. The '722 Patent is directed to “methods for transmitting system information in a synchronization signal block,” as well as to a wireless device and a network node that implement the claimed methods. Ex. 1001, 1:6-9.

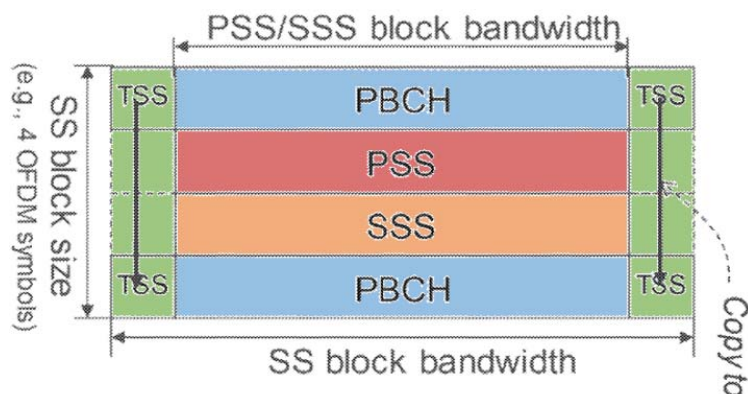
51. The '722 Patent explains that in standardized 5G NR technology, synchronization signals, such as NR-PSS and NR-SSS signals, and also the NR-PBCH, which includes part of the system information, will be transmitted in an SS block. *Id.*, 3:1-9. The '722 Patent notes that the 5G NR Standard provides that the NR-PSS, NR-SSS and NR-PBCH will be multiplexed in an SS block in the time domain, *i.e.*, using time division multiplexing (TDM). *Id.*, 3:10-13. Further, according to the '722 Patent, an NR-TSS signal was proposed by 3GPP to provide the time index of an SS block—which will be used by the UE to detect or identify a specific SS block within an SS burst or SS burst set—and that such NR-TSS signal is also multiplexed in the SS block. *Id.*, 3:14-25.

52. The '722 Patent further contends that because the NR-TSS signal is delivered without a CRC attachment—*i.e.*, without an error detection code—errors in the NR-TSS can lead to delays related to the initial access process and the receiving of system information. *Id.*, 6:26-28 (“The problem of delays related to the process of receiving system information and performing initial access, introduced due to errors in the received NR-TSS of the SS block...”). The '722

Patent purports to solve this problem through a scheme that allows the UE to quickly determine whether the value of the time index (that is being derived from the NR-TSS signal) is correct or not and prevent delays by stopping the synchronization process as soon as an error is detected. *Id.*, 3:58-63; 7:48-54. The proposed scheme includes several steps performed by a BS and a UE in this regard is shown in Figure 7 of the '722 Patent:



53. First, as shown in figure 7, the BS generates a scrambling sequence, meaning a code used to scramble certain information, where the sequence is based on information providing a time index (*e.g.*, the NR-TSS signal) (*Id.*, Fig. 7, step 310). Second, the BS scrambles the system information carried by the NR-PBCH for transmission to the UE using the scrambling sequence (*Id.*, Fig. 7, step 320), where a CRC is attached to the system information (*Id.*, 7:27-30; Fig. 2c, step 240). Third, the BS transmits the scrambled system information (*e.g.*, within the PBCH) multiplexed with information providing the time index (*e.g.*, NR-TSS), together with other synchronization signals, in an SS block (*Id.*, Fig. 7, step 330). Specifically, the system information included in the NR-PBCH, the NR-TSS payload or bits, and the NR-PSS and NR-SSS, are multiplexed in an SS block in the frequency and time domains, as shown in Figure 2a of the '722 Patent (annotated). Specifically, annotated Figure 2a shows an SS block comprised of 4 OFDM (orthogonal frequency division multiplexing) symbols, which are the smallest time units used in the types of wireless communication systems described by the '722 Patent. The system information of the NR-PBCH (shown in blue), the NR-TSS bits (shown in green), and the NR-PSS (shown in red) and NR-SSS (shown in orange), are multiplexed in the SS block.



54. Fourth, the UE receives the information providing the time index within the SS block. (*Id.*, Fig. 7, step 410). Fifth, the UE generates a scrambling sequence based on the information providing the time index it has received in the SS block (*Id.*, Fig. 7, step 420). Sixth, the UE uses the scrambling sequence to descramble the system information contained in the NR-PBCH (and CRC bits attached) (*Id.*, Fig. 7, step 430). Lastly, the UE performs the CRC check on the received system information, to determine the accuracy of the information providing a time index (e.g., NR-TSS) (*Id.*, Fig. 7, step 440; *see also id.*, 8:22-51, 10:1-3). If there is an error, the procedure of initial access would be stopped, as soon as the CRC check indicates an error, and a new SS block could then be detected, thus avoiding unnecessary delay. *Id.*, 7:48-51.

### C. Summary of the Prosecution History

55. I reviewed the prosecution history of the '722 patent. The applicant did not make any substantive arguments during prosecution to distinguish the prior art, but instead simply noted that the two references—Jung (U.S. Pub. No.

2018/0324623) and Tamaki (U.S. Pub. No. 2013/0301618)—that the Examiner relied upon in its office action for an obviousness rejection, had a priority date that was later than the '722 Patent Priority Date (based on the filing date of its PCT application).

## **VIII. CLAIM CONSTRUCTION**

56. It is my opinion that it is not necessary to construe any claim term of the '722 Patent for purposes of evaluating the prior art in this Petition, and I have applied plain and ordinary meaning. Should Patent Owner propose any claim constructions, I reserve the right to respond at that time.

## **IX. OVERVIEW OF THE PRIOR ART**

### **A. Luo**

57. Luo was filed on November 2, 2017, and it is my understanding that it is entitled to a priority date of February 23, 2017, based on an earlier filed provisional patent application. Ex. 1004, Ex. 1005. Similar to the '722 Patent, Luo aims to improve 5G NR technology and addresses the initial access process and transmission of synchronization signals and system information in an SS block in a 5G network. Ex. 1004, 1:1-2, 1:17-19, 1:48-52.

58. Specifically, Luo teaches a scheme similar to the scheme described by the '722 Patent, in which a base station scrambles system information based on an SS block index. *Id.*, 1:65-2:2 (“a base station/user equipment (UE) that scramble/descramble information based on at least a portion of an SS block index,

where the SS block index indexes a particular SS block within an SS burst within an SS burst set.”). Luo further teaches that the information that is scrambled can include system information for NR-PBCH, which also includes a CRC that can also be scrambled based on the SS block index. *Id.*, 12:25-37 (“[i]n one configuration, ... the broadcast information is for a PBCH. When the information includes a scrambled CRC, the control information associated with the scrambled CRC may or may not be scrambled itself based on the SS block index.”). Luo further teaches that the scrambled information may include a reference signal (*Id.*, 12:25-28) that includes time index information, and that the reference signal may be a DMRS for PBCH. *Id.*, 12:28-31. Luo further discloses that the SS block may include the scrambled DMRS for PBCH. *Id.*, 13:13-14 (“[t]he SS block may include the scrambled information.”).

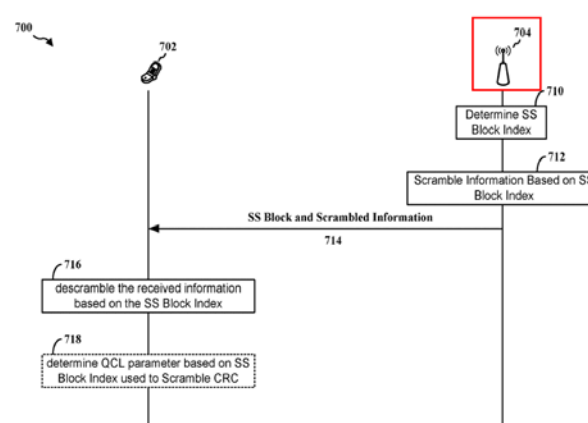
59. Luo further teaches that the SS block transmitted by the BS includes two synchronization signals—PSS and SSS—and further includes a PBCH that includes the MIB (which stores system information). *Id.*, 10:44-46. Luo also teaches that each SS block has a corresponding SS block index. *Id.*, 10:52-53. Luo further discloses that the PSS, SSS, and PBCH may be multiplexed in the SS block. *Id.*, 10:54-62. (“[t]he PSS, SSS, and PBCH may be time division multiplexed and/or frequency division multiplexed with the SS block.”) Luo further discloses that other signals (other than PSS, SSS, and PBCH) may be multiplexed in the SS block as

well. *Id.*, 10:62-65 (“[t]he SS block may include other signals/channels, and therefore other signals/channels other than the PSS, SSS, and PBCH may be multiplexed into the SS block.”)

60. Luo further discloses that the SS block and the scrambled information (which may be system information and may include a CRC) that is scrambled based on SS block index is transmitted to the UE, which then descrambles the scrambled information based on the SS block index. *Id.*, 13:12-14, 13:51-55. Luo also teaches that after descrambling the system information, the UE can then perform CRC decoding (*i.e.*, apply the error-detecting code) on the received system information to determine the accuracy of the time index. *Id.*, 13:62-14:2.

61. I understand that for Luo to be entitled to the February 23, 2017 filing date of the Luo Provisional, the Luo Provisional must provide written description support for at least one claim of Luo to enable a POSITA to practice the invention claimed in that claim. I have reviewed the Luo Provisional and it is my opinion that the Luo Provisional provides a detailed disclosure of the scheme disclosed and claimed in Luo, including scrambling of system information based on an SS block index and transmitting it to a UE in an SS block with the information providing a time index, which is similar to the level of disclosure in Luo itself. In my opinion, the disclosure of the Luo Provisional therefore provides sufficient written description to enable a POSITA to practice the inventions claimed in at least claims

1 and 9 of Luo. The chart below identifies where written description support can be found in the Luo Provisional for claims 1 and 9 of Luo.

Luo U.S. 10,568,102 (Ex. 1004)	Luo Provisional (Ex. 1005)
<p><b>Preamble 1:</b> A method of wireless communication of a base station, comprising:</p>	<p>Luo Provisional discloses a method performed by a base station 704 of a wireless communication system. <i>See, e.g.,</i> Figure 7:</p>  <p><i>See also id.</i> ¶¶ 0005-6, 0049-55.</p>
<p><b>Claim 1.1:</b> determining a synchronization signal (SS) block index associated with an SS block for transmission;</p>	<p><i>See, e.g.,</i> ¶ 0049: “As illustrated in FIG. 7, at 710, the base station 704 determines an SS block index associated with an SS block for transmission at 714.”</p>
<p><b>Claim 1.2:</b> scrambling information based on a SS block index portion comprising at least a portion of the determined SS block index,</p>	<p><i>See, e.g.,</i> ¶ 0050: “At 712, the base station 704 scrambles information based on the determined SS block index. The base station 704 may scramble the information by generating a scrambling sequence based on a sequence</p>

	initialization that is based at least in part on the SS block index.”
<b>Claim 1.3:</b> the information including at least one of data, paging information, control information, or a cyclic redundancy check (CRC) associated with control information; and	<i>See, e.g.</i> , ¶ 0050: “The information includes at least one of a reference signal, data, paging information, control information, broadcast information, or a CRC associated with control information.”
<b>Claim 1.4:</b> transmitting the SS block and the scrambled information.	<i>See, e.g.</i> , ¶ 0051: “At 714, the base station 704 transmits the SS block and the scrambled information to the UE 702.”
<b>Preamble 9:</b> A method of wireless communication of a user equipment (UE), comprising:	<p>Luo Provisional discloses a method performed by a user equipment (UE 702) of a wireless communication system. <i>See, e.g.</i>, Figure 7:</p> <p><i>See also id.</i> ¶¶ 0005-7, 0049-55.</p>

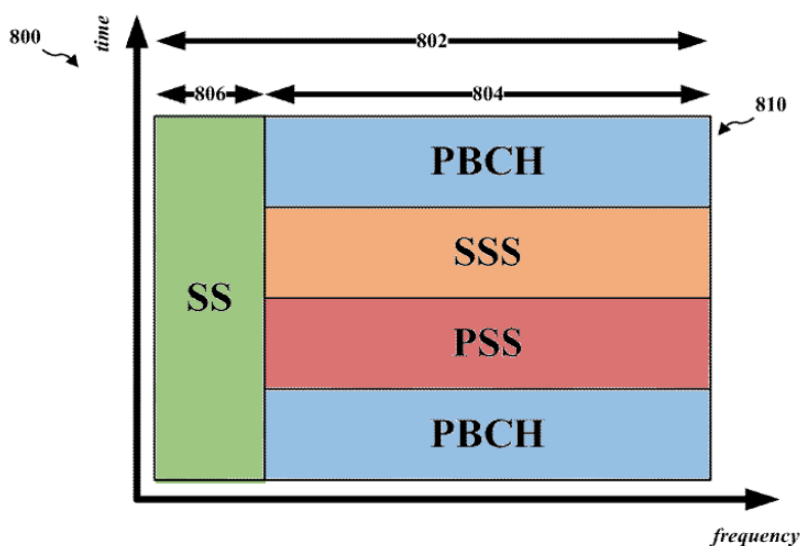
<p><b>Claim 9.1:</b> receiving a synchronization signal (SS) block and information scrambled based on a SS block index portion comprising at least a portion of an SS block index associated with the SS block,</p>	<p><i>See, e.g., ¶ 0053:</i> “At 714, the UE receives the SS block including information scrambled based on the SS block index associated with the SS block.”</p> <p><i>See, e.g., ¶ 0050:</i> “At 712, the base station 704 scrambles information based on the determined SS block index. The base station 704 may scramble the information by generating a scrambling sequence based on a sequence initialization that is based at least in part on the SS block index.”</p>
<p><b>Claim 9.2:</b> the information including at least one of a data, paging information, control information, or a cyclic redundancy check (CRC) associated with control information; and</p>	<p><i>See, e.g., ¶ 0050:</i> “The information includes at least one of a reference signal, data, paging information, control information, broadcast information, or a CRC associated with control information.”</p>
<p><b>Claim 9.3:</b> descrambling the scrambled information based on the SS block index portion.</p>	<p><i>See, e.g., ¶ 0054:</i> “At 716, the UE 702 descrambles the scrambled information based on the SS block index.”</p>

**B. Ly**

62. Ly was filed on February 15, 2018, and it is my understanding that it is entitled to a priority date of February 16, 2017 and/or February 22, 2017 based on two provisional patent applications. Ly's provisional applications were filed just several days before the provisional application that led to the '102 Luo patent was filed. Ex. 1006; Ex. 1007; Ex. 1008. In addition, I note that Ly was filed by and assigned to Qualcomm, Inc., the same applicant and assignee of Luo. Further, both Ly and Luo share a common named inventor, Tao Luo. *Id.*

63. Like Luo and the '722 Patent, Ly is directed to improvements in 5G NR technology that relate to the transmission of SS blocks and the initial synchronization process, and specifically addresses synchronization signal (SS) blocks that include time index information. Ex. 1006, 1:19-21, 1:48-52. Ly similarly discloses that the synchronization signals (PSS and SSS), and a PBCH, are multiplexed for transmission in a SS block. *Id.*, 6:64-66. Ly further teaches that an SS block index is carried in one (or more) of the synchronization signals. *Id.*, 16:39-40 ("SS block index which may be carried in one or more synchronization signals.") Consistent with Luo's disclosure that "signals/channels other than the PSS, SSS, and PBCH may be multiplexed into the SS block" (Ex. 1004, 10:54-65), Ly discloses that another signal, such as TSS or another synchronization signal (SS), may be multiplexed in the SS block with the PSS, SSS, and PBCH. Ex. 1006, 16:44-48 ("SS

block index may be carried in a synchronization signal (*e.g., the TSS or other SS*) which may be frequency division multiplexed with the other synchronization signals of the SS block”) (emphasis added). This is also shown, for example, in Figure 8 (annotated), which shows two PBCHs (in blue), a PSS (in red), a SSS (in orange), and a SS signal (in green) multiplexed in the time and frequency domains in a SS block.

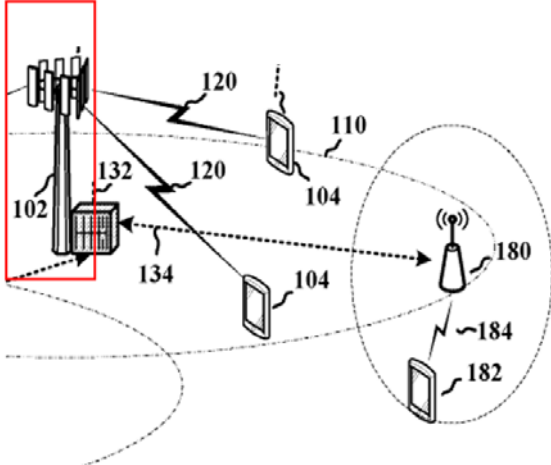


*See also id.*, 16:6-9 (“a plurality of synchronization signals that are multiplexed together. The plurality of synchronization signals may include one or more of a PSS, an SSS, a TSS, or a PBCH.”). Ly also discloses that the SS signal, shown for example in Figure 8 above (in green), can convey the SS block index. *Id.*, 16:25-26 (“the SS signal may convey index information for the SS block.”).

64. I understand that for Ly to be entitled to the February 16, 2017 filing date of the Ly ’973 Provisional and/or the February 22, 2017 filing date of the Ly

'258 Provisional, the Ly '973 Provisional and Ly '258 Provisional must provide written description support for at least one claim of Ly to enable a POSITA to practice the invention claimed in that claim. I have reviewed the Ly '973 Provisional and Ly '258 Provisional and it is my opinion that they provide a detailed disclosure of the scheme disclosed and claimed in Ly, including multiplexing in a SS block a SS signal (such as TSS or DMRS) that conveys a SS block time index, with system information carried by PBCH, for transmission to a UE, which is similar to the level of disclosure in Ly. In my opinion, the disclosure of the Ly '973 Provisional and Ly '258 Provisional provides sufficient written description to enable a POSITA to practice the invention claimed in at least claims 1 and 3 of Ly. The chart below identifies where written description support can be found in the Ly Provisionals for claims 1 and 3 of Ly.

Ly U.S. 10,194,410 (Ex. 1006)	Ly '973 Provisional (Ex. 1007) Ly '258 Provisional (Ex. 1008)
<p><b>Preamble 1:</b> A method of wireless communication by a base station, comprising:</p>	<p>Ly '973 Provisional (Ex. 1007) discloses a method performed by a base station (<i>e.g.</i>, eNB/gNB 102) of a wireless communication system, shown, for example, in an excerpt of Figure 1 (annotated):</p>

	 <p><i>See also id.</i>, ¶¶ 0007, 0027-29, 0034-35, 0051, 0054, 00107-00131. Ly '258 Provisional discloses the same. <i>See, e.g.</i>, Ex. 1008, Fig. 1; <i>see also id.</i> ¶¶ 0007, 0027-29, 0036-37, 00129-158.</p>
<p><b>Claim 1.1:</b> determining a synchronization signal (SS) index for a SS block, the SS block comprising a plurality of synchronization signals multiplexed for transmission on predetermined resources;</p>	<p>Ly '973 Provisional discloses that the base station (<i>e.g.</i>, eNB/gNB) determines a synchronization signal (SS) index (<i>e.g.</i>, a block index for the SS block). <i>See, e.g.</i>, Ex. 1007 ¶ 00116: “the eNB/gNB may determine a block index for the SS block. For example, the eNB/gNB (102, 310, 402) determines a block index for the SS block (610, 710, 810, 910).” Ly '258 Provisional (Ex. 1008) discloses the same. <i>See, e.g.</i>, Ex. 1008 ¶ 00140.</p>

	<p>Ly '973 Provisional further discloses that the SS block comprising a plurality of synchronization signals (e.g., a TSS, a PSS, a SSS, and/or a PBCH) multiplexed for transmission on predetermined resources. <i>See, e.g.</i>, Ex. 1007 ¶ 0035: “in certain aspects, the eNB/gNB 102 may be configured to multiplex a TSS with at least one of a PSS, a SSS, or a PBCH for transmission in a SS block, and transmitting the SS block including the TSS, the PSS, the SSS, and the PBCH (196).” Ly '258 Provisional discloses the same. <i>See, e.g.</i>, Ex. 1008 ¶ 0037.</p>
<p><b>Clam 1.2:</b> generating a first SS of the plurality of synchronization signals using the SS index;</p>	<p>Ly '973 Provisional discloses that a BS generates a first SS (e.g., TSS signal) of the plurality of synchronization signals. <i>See, e.g.</i>, Ex. 1007 ¶ 0006: “Some systems may also include a TSS. The TSS may need to be transmitted, e.g., from a base station to a user equipment (UE).” Ly '258 Provisional discloses the same. <i>See, e.g.</i>, Ex. 1008 ¶ 0006.</p> <p>Ly '973 Provisional discloses that the TSS is generated using the SS block</p>

	<p>index. <i>See, e.g.</i>, Ex. 1007 ¶ 0036: “The TSS may provide a block index that may be used to determine a beam direction.” <i>See also, e.g., id.</i> ¶ 0076: “the TSS signal may convey index information that relates to beams, e.g., the beam index or indices of SS block repetitions within a beam ... the TSS may be used to provide the beam index and/or SS block repetition index to a UE. Decoding the TSS may provide the beam index and/or SS block repetition index to the UE.”; <i>id.</i> ¶ 0039: “In NR systems, the TSS may be used to SS block indices to facilitate beams, mmWave commination.” Ly ’258 Provisional discloses the same. <i>See, e.g.</i>, Ex. 1008 ¶¶ 0006, 0041.</p>
<p><b>Claim 1.3:</b> frequency division multiplexing the first SS with at least a second synchronization signal (SSS) of the SS block, wherein the SSS comprises a secondary synchronization signal that carries information about a physical layer cell identity group number for the base station; and</p>	<p>Ly ’973 Provisional discloses that the BS multiplexes the first SS (<i>e.g.</i>, TSS signal) with at least second synchronization signal (SSS) of the SS block (<i>e.g.</i>, SSS signal). <i>See, e.g.</i>, Ex. 1007 ¶ 0107: “At block 1202, the eNB/gNB multiplexes a TSS with at least one of a PSS, an SSS, or a PBCH</p>

	<p>for transmission in an SS block.” Ly ’258 Provisional discloses the same. <i>See, e.g.</i>, Ex. 1008 ¶ 00129.</p> <p>Ly ’973 Provisional further discloses that the multiplexing of the first SS with at least a second synchronization signal is frequency division multiplexing. <i>See, e.g.</i>, Ex. 1007 ¶ 0077: “FIG. 6 is a diagram illustrating an example of frequency-division multiplexing ... illustrat[ing] an example placement of the PSS, the SSS, the TSS (TSS1, TSS2), and the PBCH (two PBCHs) in time and frequency.” <i>See also id.</i>, Figures 6-9. Ly ’258 Provisional discloses the same. <i>See, e.g.</i>, Ex. 1008 ¶ 0079, Figures 8-9.</p> <p>Ly ’973 Provisional further discloses that the SSS signal carries information about a physical layer cell identity group number for the base station. <i>See, e.g.</i>, Ex. 1007 ¶ 0039: “The secondary synchronization signal (SSS) ... is used by a UE to determine a physical layer cell identity group number and radio</p>
--	---

	frame timing.” Ly ’258 Provisional discloses the same. <i>See, e.g.</i> , Ex. 1008 ¶ 0041.
<b>Claim 1.4:</b> transmitting the SS block including the first SS generated using the SS index frequency division multiplexed with the SSS on the predetermined resources,	Ly ’973 Provisional discloses that the BS transmits the SS block including the first SS ( <i>e.g.</i> , TSS) multiplexed with the SSS on the predetermined resources. <i>See, e.g.</i> , Ex. 1007 ¶ 0108: “At block 1004, the eNB/gNB transmits the SS block including the TSS, the PSS, the SSS, and the PBCH. For example, the eNB/gNB (102, 310, 402) transmits the SS block (610, 710, 810, 910) including the TSS (‘TSS’ FIGS. 6-9), the PSS (‘PSS’ FIGS. 6-9), the SSS (‘SSS’ FIGS. 6-9), and the PBCH (‘PBCH’ FIGS. 6-9).” Ly ’258 Provisional discloses the same. <i>See, e.g.</i> , Ex. 1008 ¶ 00130.
<b>Claim 1.5:</b> wherein the first SS is frequency division multiplexed with the SSS in at least one OFDM symbol, and wherein the SS index is conveyed using a shift of a pseudo-noise (PN) sequence of the first SS.	Ly ’973 Provisional discloses that the first SS ( <i>e.g.</i> , TSS) is frequency division multiplexed with the SSS in at least one OFDM symbol ( <i>e.g.</i> , in the same set of OFDM symbols). <i>See, e.g.</i> , Ex. 1007 ¶ 0131: “In an aspect, the TSS may be frequency division multiplexed with the

	<p>PSS and the SSS in the same set of OFDM symbols.” Ly ’258 Provisional discloses the same. <i>See, e.g.</i>, Ex. 1008 ¶ 00155.</p> <p>Ly ’973 Provisional discloses that the SS index (or SS block indices) is conveyed (or signaled) using a shift of a pseudo-noise (PN) sequence of the first SS (<i>e.g.</i>, TSS). <i>See, e.g.</i>, Ex. 1007 ¶ 0098: “TSS can be constructed based on pseudo-noise (PN) sequences and cyclic shifts of pseudo-noise (PN) sequences may be used to signal SS block indices.” Ly ’258 Provisional discloses the same. <i>See, e.g.</i>, Ex. 1008 ¶ 77.</p>
<p><b>Preamble 3:</b> A method of wireless communication by a user equipment (UE), comprising:</p>	<p>Ly ’973 Provisional discloses a method performed by a UE. <i>See, e.g.</i>, Ex. 1007 ¶ 00132: “FIG. 11 is a flowchart 1100 of a method of wireless communication in accordance with the systems and methods described herein. The method may be performed by a UE (<i>e.g.</i>, the UE 104, 350, 404) such as part of an initial acquisition procedure in which the UE performs cell identification, acquires</p>

	<p>frame timing, etc.” Ly ’258 Provisional discloses the same. <i>See, e.g.</i>, Ex. 1008 ¶ 00159.</p>
<p><b>Claim 3.1:</b> receiving a synchronization signal (SS) block with a first SS comprising a SS index for the SS block frequency division multiplexed with a second synchronization signal (SSS) on predetermined resources,</p>	<p>Ly ’973 Provisional discloses that the UE receives a SS block with a first SS (<i>e.g.</i>, TSS) multiplexed with a SSS. <i>See, e.g.</i>, Ex. 1007 ¶ 00132: “At block 1102, the UE receives a SS block comprising a TSS multiplexed with at least one of a PSS, an SSS, or a PBCH.” Ly ’258 Provisional discloses the same. <i>See, e.g.</i>, Ex. 1008 ¶ 00159.</p> <p>Further, Ly ’973 Provisional and Ly ’258 Provisional disclose that the TSS and SSS are frequency division multiplexed. <i>See</i> claim element 1.3 above.</p> <p>Ly ’973 Provisional further discloses that the first SS (<i>e.g.</i>, TSS) comprising a SS index for the SS block. <i>See, e.g.</i>, Ex. 1007 ¶ 0036: “The TSS may provide a block index that may be used to determine a beam direction.”; <i>see also id.</i> ¶ 0039. Ly ’258 Provisional</p>

	discloses the same. <i>See, e.g.</i> , Ex. 1008 ¶¶ 0038, 0041.
<b>Claim 3.2:</b> wherein the SSS comprises a secondary synchronization signal that carries information about a physical layer cell identity group number for a base station, wherein the first SS is frequency division multiplexed with the SSS in at least one OFDM symbol;	<p>Ly '973 Provisional discloses that the SSS comprises a secondary synchronization signal that carries information about a physical layer cell identity group number for a base station. <i>See, e.g.</i>, Ex. 1007 ¶ 0039: “The secondary synchronization signal (SSS) ... is used by a UE to determine a physical layer cell identity group number and radio frame timing.” Ly '258 Provisional discloses the same. <i>See, e.g.</i>, Ex. 1008 ¶ 0041.</p> <p>Further, Ly '973 Provisional and Ly '258 Provisional disclose that the first SS is frequency division multiplexed with the SSS in at least one OFDM symbol. <i>See</i> claim element 1.5 above.</p>
<b>Claim 3.3:</b> demultiplexing the first SS and the SSS and obtaining the SS index and the information about the physical layer cell identity group number for the base station,	Ly '973 Provisional discloses that the UE demultiplexes the SS block to obtain the TSS. <i>See, e.g.</i> , Ex. 1007 ¶ 00133: “At block 1104, the UE demultiplexes the SS block to obtain the at least one of the TSS, the PSS, the SSS, and the

	<p>PBCH.” Ly ’258 Provisional discloses the same. <i>See, e.g.</i>, Ex. 1008 ¶ 00160.</p> <p>Further, Ly ’973 Provisional and Ly ’258 Provisional disclose that the TSS comprises the SS index and the information about the physical layer cell identity group number for the base station. <i>See</i> claim elements 3.1 and 3.2 above.</p>
<b>Claim 3.4:</b> wherein the SS index is conveyed using a shift of a pseudo-noise (PN) sequence of the first SS; and	<i>See</i> claim element 1.5 above.
<b>Claim 3.5:</b> communicating with the base station based on information obtained from the SS block.	<p>Ly ’973 Provisional discloses that the UE communicates with the BS based on information obtained from the SS block. <i>See, e.g.</i>, Ex. 1007 ¶ 0027: “The UEs described herein may be able to communicate with various types of base stations and network equipment including macro eNBs, small cell eNBs, gNBs, relay base stations, and the like.”</p> <p>Ly ’258 Provisional discloses the same. <i>See, e.g.</i>, Ex. 1008 ¶ 0029.</p>

## **X. DETAILED ANALYSIS**

### **A. Ground I: Claims 1, 7, 8, 9, 11, 12, 13, 17, 18, 24, 25, 26 and 27 Are Rendered Obvious by Luo**

65. In performing my claim analysis, I have grouped similar claims together in order to streamline this Declaration. A chart comparing these claims is also included in the Petition, which I have reviewed and agree with. Because method claim 1 is substantially identical to apparatus claim 13, and because method claims 7, 8 and 9 are substantially identical to apparatus claims 25, 26 and 27 respectively, I addressed them together in this Declaration.

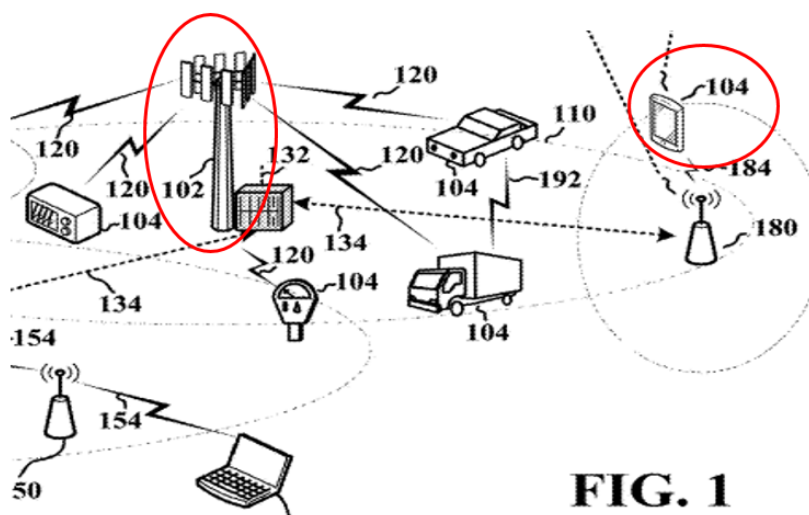
66. It is my opinion that claims 1, 7, 8, 9, 11, 12, 13, 17, 18, 24, 25, 26, 27 of the '722 Patent are at least rendered obvious under 35 U.S.C. § 103 by Luo.

#### **1. Independent Claims 1 and 13**

67. As I explain below, Luo at least renders obvious claim 1 (a method performed by a wireless device) and claim 13 (a wireless device) of the '722 Patent by disclosing a scheme in which a BS scrambles a DMRS signal for PBCH based on a scrambling sequence generated from the SS block time index and transmits the scrambled DMRS (which conveys the information providing a time index) to a UE multiplexed with system information (within PBCH) in a SS block. Luo further discloses that the UE descrambles the system information using the scrambling sequence generated from the SS block time index and performs a CRC check to determine the accuracy of the time index and the received system information.

- a) *Preamble [1a]: “A method performed by a wireless device, for receiving system information from a network node of a wireless communication system, the system information being received in a synchronization signal (SS) block of an SS burst set comprising at least one SS block”*
- b) *Preamble [13a]: “A wireless device configured to receive system information from a network node of a wireless communication system, the system information being in a synchronization signal (SS) block of an SS burst set comprising at least one SS block”*

68. For purposes of this declaration, I will treat the preambles of all Challenged Claims as limitations, although I understand that preambles are presumed to be not limiting. With that in mind, Luo discloses a wireless device (*e.g.*, UE 104) and a network node (*e.g.*, BS 102), as part of a wireless communication system, as shown in the annotated excerpt of Figure 1. Ex. 1004 (Luo), 4:21-25; Ex. 1005 (Luo Provisional) ¶ 26.



69. Luo further discloses that the wireless device (UE) receives system information from the network node (BS) in a synchronization signal (SS) block of an SS burst set. For example, Luo teaches that the UE receives from the BS a SS

block that includes a PBCH, which contains a MIB with system information. Ex. 1004, 10:44-48 (“The base station 402 transmits an SS block including the PSS, SSS, and the PBCH (including the MIB) ... The UE 404 receives the transmission 402e including the PSS, SSS, and PBCH.”). Luo also teaches that the received SS block is part of an SS burst set. Ex. 1005 ¶ 0045; Ex. 1004, 10:65-11:3 (“One or multiple SS blocks make up an SS burst. ... One or multiple SS bursts make up an SS burst set.”); Ex. 1005 ¶ 0046. *See also* Ex. 1004, 8:37-47 (“FIG. 3 is a block diagram of a base station 310 in communication with a UE 350 in an access network... The controller/processor 375 provides RRC layer functionality associated with broadcasting of system information (e.g., MIB, SIBs).”); Ex. 1005 ¶ 37.

- c) *Preamble [1b]: “wherein the system information is multiplexed with information providing a time index indicating which SS block of the SS burst set that is being received, the method comprising:”*
- d) *Preamble [13b]: “wherein the system information is multiplexed with information providing a time index indicating which SS block of the SS burst set that is being received, the wireless device comprising:”*

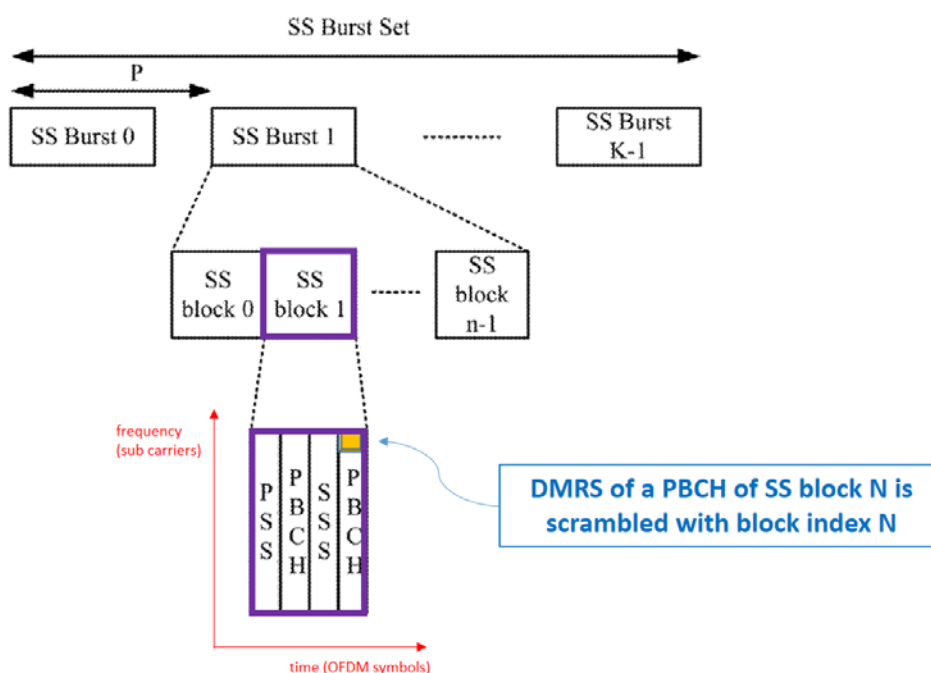
70. Luo also discloses that the BS transmits system information (e.g., information within MIB carried by PBCH) multiplexed with information providing a time index (e.g., a scrambled DMRS in the PBCH) indicating which SS block of the SS burst set is being received.

71. The SS block index disclosed in Luo corresponds to “a time index” of claims 1 and 13, and the scrambled DMRS of PBCH disclosed in Luo corresponds to “information providing a time index” required by those claims. Specifically, Luo discloses that the base station transmits an SS block including the PSS, SSS, and the PBCH (including the MIB) to the UE. Ex. 1004, 11:67-12:1 (“the SS block may include at least one of a PSS, an SSS, or a PBCH.”), 10:44-47, Fig. 4; Ex. 1005 ¶¶ 0045-46, 0051, Fig. 4. Luo further discloses that each SS block includes a corresponding “SS block index.” Ex. 1004, 10:52-54 (“Each SS block has a corresponding SS block index (also referred to as SS/PBCH block index) indicated in FIG. 4 as one of 0, 1, . . . , n-1.”), Fig. 4; Ex. 1005 ¶ 0046, Fig. 4. The SS block index disclosed in Luo is a time index. This is because it indexes (*e.g.*, it indicates or identifies) a particular SS block within an SS burst within an SS burst set, and it does so on a time axis. Ex. 1004, 11:55-57 (“SS block index may refer to one or more indices for indicating an SS block within an SS burst within an SS burst set.”). For example, Luo discloses that the SS burst set has a particular time length of  $N \times 10$  ms, and that the block index is used to indicate a specific block over that time length. Ex. 1005 ¶ 0048; Ex. 1004, 11:30-57 (“The time length of the SS burst set may be  $N \times 10$  ms ... [where] the SS block index may be used to indicate an SS block within an SS burst or within an SS burst set.”); Figs. 6A-6B; Ex. 1005 ¶¶ 0047-48, Figs. 6A-6B. Luo further teaches that the BS will determine an SS block index and will

transmit it to the UE. Ex. 1004, 11:64-67; Ex. 1005 ¶ 0049. Luo further discloses a “demodulation reference signal (DMRS),” which is a reference signal for PBCH. Ex. 1004, 12:28-31; Ex. 1005 ¶ 0036. For example, Figure 2C of Luo shows a DMRS signal carried in a 5G NR frame structure. Ex. 1004, Fig. 2C; Ex. 1005, Fig. 2C (disclosing the same).

72. Luo teaches that the BS provides the SS block index (*i.e.*, the time index) to the UE through scrambling of the DMRS by using a scrambling sequence that is generated based on the SS block index and by transmitting the scrambled DMRS, which includes information providing a time index (by virtue of being scrambled based on the time index), to the UE. Specifically, Luo teaches that the BS scrambles certain information by using the SS block index. Ex. 1004, 12:5-6; Ex. 1005 ¶ 0050 (“the base station 704 scrambles information based on the determined SS block index”). Luo also teaches that the scrambled information includes at least one reference signal (Ex. 1004, 12:25-28; Ex. 1005 ¶ 0050), and that the reference signal may be a DMRS for PBCH. Ex. 1004, 12:28-31; Ex. 1005 ¶ 0036. Luo further teaches that the scrambled information, which includes the scrambled DMRS, is included in the SS block and transmitted to the UE. Ex. 1004, 13:13-14 (“...the base station 704 transmits the SS block and the scrambled information to the UE 702. The SS block may include the scrambled information.”); Ex. 1005 ¶ 0051. A POSITA would therefore recognize that Luo discloses that the

scrambled DMRS for PBCH—which conveys information providing a time index—is transmitted within the PBCH field of the SS block, in the same manner that Fig. 2C of Luo, for example, discloses a DMRS signal carried in a 5G NR frame structure. This is shown, for example, in annotated Figure 4, which demonstrates how the DMRS of a PBCH (represented by an annotated orange box) is carried by the PBCH field of an SS block.<sup>1</sup>



<sup>1</sup> The '722 Patent itself notes that “the information providing the time index of the SS block may in embodiments correspond to another type of signal than the NR-TSS.” Ex. 1001, 6:19-22.

73. Luo further discloses that once the DMRS is received by the UE, it is unscrambled to recover the SS block index. Ex. 1004, 12:5-6; Ex. 1005 ¶ 0050. A POSITA would have understood that the scheme disclosed in Luo allows the UE to perform blind decoding to recover the SS block index associated with the SS block, thereby avoiding the need to add an extra signal to the SS block to explicitly convey the SS block index.

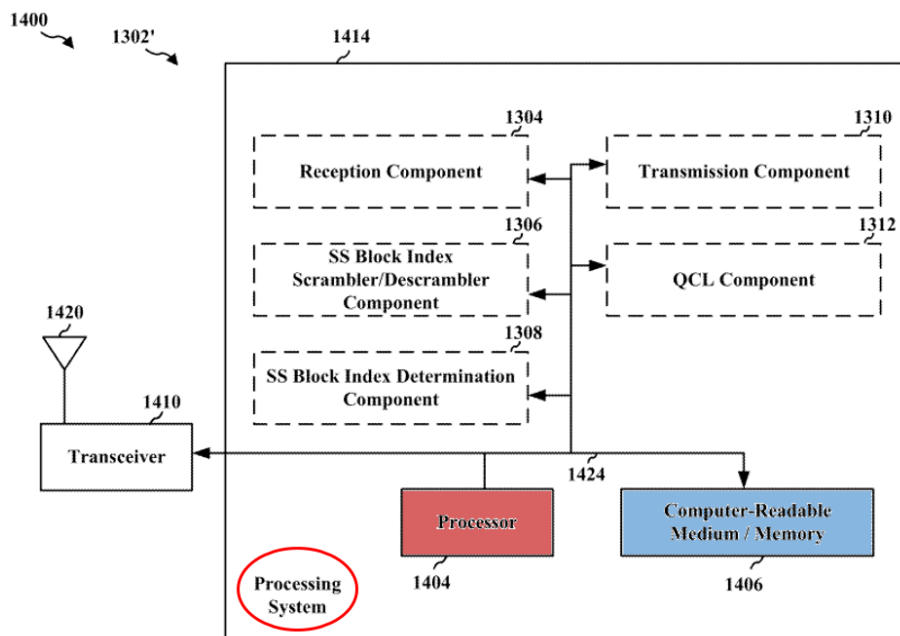
74. Luo further teaches that the system information (information within MIB carried by PBCH) can be multiplexed with information providing a time index (the scrambled DMRS). Specifically, Luo teaches that the system information within MIB carried by PBCH is multiplexed in the SS block. Ex. 1004, 10:51-58, Fig. 4; Ex. 1005 ¶ 0046, Fig. 4 (“The PSS, SSS, and PBCH may be time division multiplexed and/or frequency division multiplexed with the SS block”). Luo also teaches that the SS block similarly includes the scrambled DMRS (*e.g.*, annotated in orange in figure 4 above), which, as explained above, conveys information providing the time index. Ex. 1004, 13:13-14 (“[t]he SS block may include the scrambled information.”); Ex. 1005 ¶ 0051.

*e) Element [13.1]: “a processing circuitry”*

75. Luo discloses processing circuitry. Specifically, Luo discloses an apparatus 1302’ (*e.g.*, UE) employing a “processing system 1414,” that includes a

processing circuitry such as “processor 1404,” annotated in red in Figure 14 below.

Ex. 1004, 21:7-9, 21:35-39; 1005 ¶ 0024, 0041, Fig. 3.

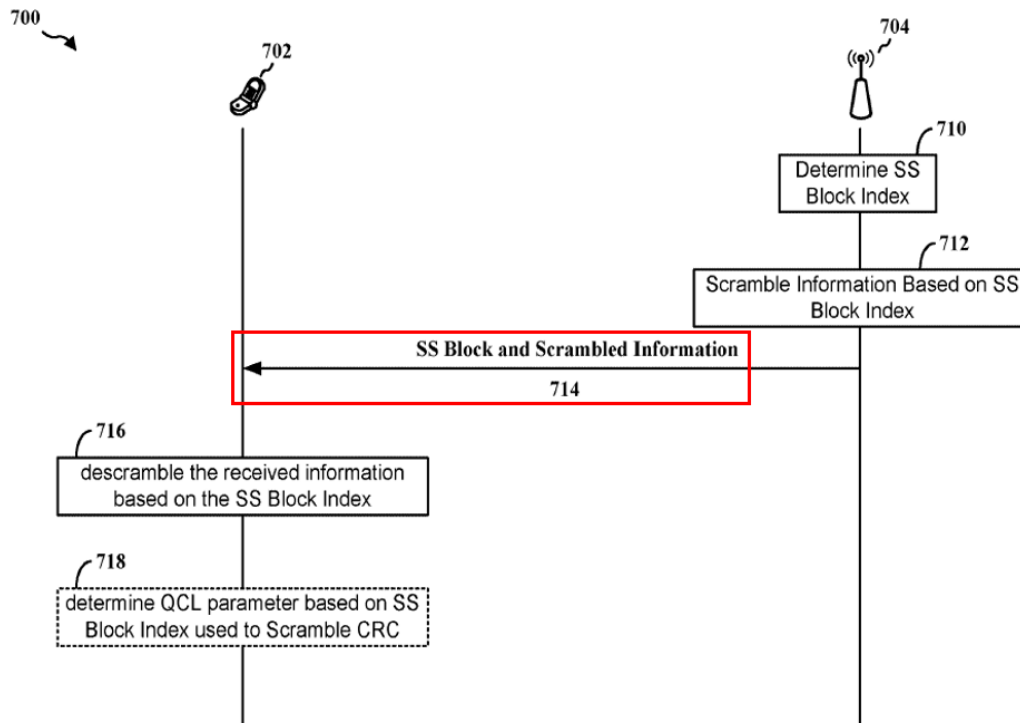


f) *Element [13.2]: “a memory, the memory containing instructions executable by the processing circuitry whereby the wireless device is configured to:”*

76. Luo discloses an apparatus 1302' (e.g., UE) employing a memory, such as “computer-readable medium/memory 1406,” annotated in blue in Figure 14 shown above. Ex. 1004, 21:7-9; 1005 ¶ 0025, 0041, Fig. 3. Luo further teaches that the memory contains instructions executable by the processing circuitry. Ex. 1004, 21:35-39 (“The processor 1404 is responsible for general processing, including the execution of software stored on the computer-readable medium/memory 1406.”); 1005 ¶ 0025, 0041, Fig. 3.

- g) *Element [1.1]: “receiving, from the network node, the information providing the time index”*
- h) *Element [13.3]: “receive, from the network node, the information providing the time index”*

77. Luo discloses a UE 702 receiving from a network node (*e.g.*, base station 704) information providing the time index (*e.g.*, scrambled DMRS signal for PBCH), as shown in red in annotated Figure 7 below. Specifically, Figure 7 shows that at step 714 the UE receives the SS block and the scrambled information from the BS, and that the scrambled information (which includes the scrambled DMRS, as explained above) is scrambled based on the time index (and therefore conveys information providing the time index). Ex. 1004, 13:51-53 (“[a]t 714, the UE 702 receives the SS block including information scrambled based on the SS block index associated with the SS block.”); Ex. 1005 ¶ 0053.



- i) *Element [1.2]: “receiving the system information, wherein receiving comprises descrambling the system information using a scrambling sequence generated based on the information providing the time index; and”*
- j) *Element [13.4]: “receive the system information by descrambling the system information using a scrambling sequence generated based on the information providing the time index, and”*

78. Luo teaches these claim elements. *First*, Luo discloses a UE receiving system information (e.g., information within MIB carried by PBCH) from the network node (BS) in an SS block, as I explained in sections X.A.1.a/b. Luo further discloses a UE 702 receiving from a network node (e.g., base station 704) system information, as shown for example in Figure 7. Ex. 1004, Fig. 7, 13:51-53 (“the UE 702 receives the SS block including information scrambled based on the SS block index associated with the SS block.”); Ex. 1005 ¶ 0053.

79. *Second*, Luo teaches that receiving the system information comprises descrambling the system information using a scrambling sequence generated based on the information providing the time index. Specifically, Luo teaches that the BS scrambles information based on the SS block time index. Ex. 1004, 12:5-6; Ex. 1005 ¶ 0050 (“the base station 704 scrambles information based on the determined SS block index”). Luo further teaches that the scrambled information includes broadcast information that is included in a PBCH, which, as explained above, carries system information (in a MIB). Ex. 1004, 12:34-35; Ex. 1005 ¶ 0050; *see also* Ex. 1004, 12:48-49 (“...the information is broadcast information for a PBCH.”); Ex. 1005 ¶ 0050. Luo further teaches that after the UE receives the scrambled system information carried by PBCH, as shown in Figure 7 at 716, the UE descrambles the system information using a scrambling sequence generated based on the SS block index carried by the scrambled DMRS. Ex. 1004, 13:54-55 (“the UE 702 descrambles the scrambled information based on the SS block index.”); Ex. 1005 ¶ 0054.

- k) *Element [1.3]: “determining an accuracy of the information providing the time index, based on an error-detection code related to the received system information.”*
- l) *Element [13.5]: “determine an accuracy of the information providing the time index, based on an error-detection code related to the received system information.”*

80. Luo teaches that the UE determines an accuracy of the information providing the time index (*e.g.*, the scrambled DMRS), by applying an error-detection code (*e.g.*, CRC) that is attached, and related to, the system information (*e.g.*, within PBCH). Ex. 1004, 12:25-28, 12:35-37, 13:61-14:8; Ex. 1005 ¶¶ 0050, 0055. Specifically, Luo teaches that the CRC is descrambled based on a sequence generated based on the information providing the time index. Ex. 1004, 13:54-55 (“the UE 702 descrambles the scrambled information based on the SS block index.”); Ex. 1005 ¶ 0054. Luo further teaches that a CRC check is performed on the system information. Ex. 1004, 13:61-14:8 (“[w]hen the scrambled information 714 includes a CRC scrambled based on an SS block index, the UE 702 may descramble the CRC based on the SS block index, and decode received control information based on the descrambled CRC... to determine whether the control information was decoded/descrambled successfully.”); Ex. 1005 ¶ 0055. Therefore, performing a CRC check on the system information (in PBCH), as disclosed by Luo, would indicate whether the received information providing a time index is accurate or not, because the CRC check uses the time index. This is the

## 2. Independent Claims 7 and 25

81. Luo discloses a network node (*e.g.*, BS 102) and a wireless device (*e.g.*, UE 104), as part of a wireless communication system, as shown in the annotated excerpt of Figure 1. Ex. 1004, 4:21-25; Ex. 1005 ¶ 26.

82. Luo further discloses a method performed by network node 102 for transmitting system information to a wireless device (*e.g.*, UE) in a synchronization signal (SS) block of an SS burst set comprising at least one SS block, as I explained above in sections X.A.1.a/b and c/d.

- c) *Preamble [7b]: “wherein the system information is multiplexed with information providing a time index indicating which SS block of the SS burst set that is being transmitted, the method comprising:”*

83. Luo teaches this claim element, as I explained above in sections X.A.1.c/d.

- d) *Element [25.1]: “a processing circuitry”*

84. Luo teaches this claim element, as I explained above in section X.A.1.e.

- e) *Element [25.2]: “a memory, the memory comprising instructions executable by the processing circuitry whereby the network node is configured to:”*

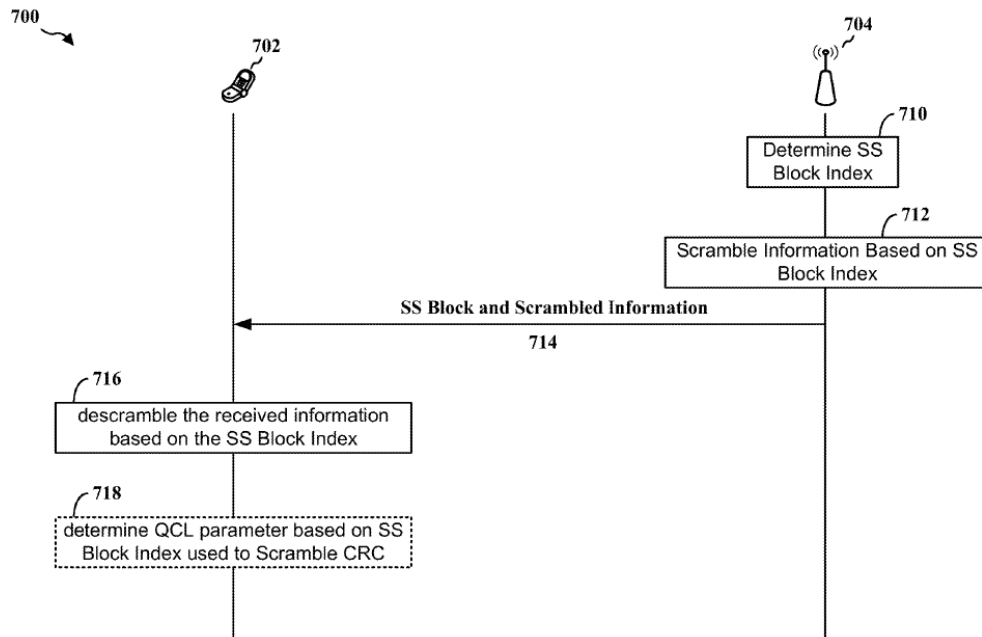
85. Luo teaches this claim element, as I explained above in section X.A.1.f.

- f) *Element [7.1]: “scrambling the system information using a scrambling sequence generated based on the information providing the time index, and”*

- g) *Element [25.3]: “scramble the system information using a scrambling sequence generated based on the information providing the time index, and”*

86. Luo teaches these claim elements. In Luo, a network node (*e.g.*, base station 704) scrambles system information (*e.g.*, information carried by PBCH) using a scrambling sequence generated based on the information providing a time index (*e.g.*, the scrambled DMRS that conveys the SS block index). Ex. 1004, 12:6-9 (“The base station 704 may scramble the information by generating a scrambling sequence based on a sequence/scrambling initialization that is based at least in part on the SS block index.”); Ex. 1005 ¶ 0050.

87. Specifically, in Figure 7, Luo discloses a call-flow diagram for a UE 702 and a base station 704, as shown below. Ex. 1004, 11:63-64; Ex. 1005 ¶ 0049.



88. As shown in Figure 7, in step 710 the BS determines an SS block. Ex. 1004, 11:64-67 (“at 710, the base station 704 determines an SS block index associated with an SS block for transmission at 714.”); Ex. 1005 ¶ 0049. Figure 7 of Luo further shows, at step 712, that the BS scrambles information based on the SS block index, and Luo further explains that the scrambling is performed by generating a scrambling sequence that is based (at least in part) on the SS block index. Ex. 1004, 12:5-9 (“[a]t 712, the base station 704 scrambles information based on the determined SS block index” using “a sequence/scrambling initialization that is based at least in part on the SS block index.”) Luo further teaches that the

scrambled information includes a reference signal and broadcast information. Ex. 1004, 12:25-28 (“[t]he information includes at least one of a reference signal...broadcast information, or a CRC associated with control information.”); Ex. 1005 ¶ 0050. Luo further teaches that the reference signal is a DMRS for PBCH (Ex. 1004, 12:28-31; Ex. 1005 ¶ 0050) and that the broadcast information is for a PBCH. Ex. 1004, 12:31-34; Ex. 1005 ¶ 0050. Luo further teaches that the apparatus 1102’ includes means for scrambling system information based the SS block index. Ex. 1004, 19:8-13 (“the apparatus may include means for scrambling information based on at least a portion of the determined SS block index, where the information includes at least one of a reference signal, data, paging information, control information, broadcast information, or a CRC associated with control information.”); Ex. 1005, Claim 41, Fig. 3.

- h) *Element [7.2]: “transmitting, to the wireless device, the scrambled system information multiplexed with the information providing the time index of the SS block”*
- i) *Element [25.4]: “transmit to the wireless device, in a synchronization signal (SS) block of an SS burst set comprising at least one SS block, the scrambled system information multiplexed with the information providing the time index of the SS block”*

89. Luo teaches these claim elements, as I explained above in sections X.A.1.c/d; *see also* Ex. 1004, 19:13-15; Ex. 1005, Claim 41, Fig. 3 (apparatus 1102’ includes “means for transmitting the SS block and the scrambled information.”).

- j) *Element [7.3]: “wherein an error detection code is related to the system information.”*
- k) *Element [25.5]: “wherein an error detection code is related to the system information.”*

90. Luo teaches these claim elements. Luo discloses that the system information may include cyclic redundancy check (CRC), *i.e.*, an error detection code that is related to, and associated with, the system information, as I explained above in sections X.A.1.k/l.

### **3. Dependent Claims 8 and 26**

- a) *Preamble 8: “The method of claim 7”*
- b) *Preamble 26: “The network node of claim 25”*

91. Luo teaches the method of claim 7 and the network node of claim 25, as I explained above in Section X.A.2.

- c) *Element [8.1]: “wherein scrambling the system information comprises scrambling coded bits of the system information”*
- d) *Element [26.1]: “wherein the network node is configured to scramble the system information by scrambling coded bits of the system information.”*

92. Luo teaches these claim elements. Luo discloses that the network node (*e.g.*, BS) scrambles the system information (*e.g.*, the PBCH payload) by scrambling coded bits of the system information. Specifically, Luo teaches that the base station 704 shown in Figure 7 scrambles the PBCH payload and then scrambles the encoded bits (M number of bits) of the PBCH using the time index. Ex. 1004, 12:48-61 (BS “scramble[s] the PBCH payload,” and “[s]ubsequently, after the encoding/CRC

process, the base station 704 may scramble the encoded PBCH based on a scrambling sequence that is based on its cell ID ... and X LSBs of the SS block index,” where “M is the number of bits to be scrambled.”); Ex. 1005 ¶ 0050. Thus, a POSITA in March 2017 would have understood Luo to disclose that scrambling of system information is performed by scrambling coded bits of the system information. *Id.*

#### **4. Dependent Claims 9 and 27**

- a) *Preamble 9: “The method of claim 7”*
- b) *Preamble 27: “The network node of claim 25”*

93. Luo teaches the method of claim 7 and the network node of claim 25, as I explained above in Section X.A.2.

- c) *Element [9.1]: “wherein the error detection code is a Cyclic Redundancy Check (CRC) attachment to information bits corresponding to the system information.”*
- d) *Element [27.1]: “wherein the error detection code is a Cyclic Redundancy Check (CRC) attachment to information bits corresponding to the system information.”*

94. Luo teaches these claim elements. Specifically, Luo discloses an error detection code, and specifically Cyclic Redundancy Check (CRC), scrambled with system information (*e.g.*, broadcast information for PBCH). Ex. 1004, 2:10-16 (“The base station scrambles information based on at least a portion of the determined SS block index. The information includes at least one of a reference signal, data, paging information, control information, broadcast information, or a

cyclic redundancy check (CRC) associated with control information.”); Ex. 1005 ¶¶ 0005, 0007, 0050. *See also* Ex. 1004, 14:35-39 (“[a]t 814, the UE 804 transmits the scrambled information to a base station 802. When the scrambled information includes a CRC scrambled by the SS block index, the UE 804 may transmit UL control information along with the SS-block-index scrambled CRC.”); Ex. 1005 ¶ 0058. Thus, Luo teaches that the CRC is attached to the system information (*e.g.*, broadcast information for PBCH) and both are included in the scrambled information. Ex. 1004, 14:35-39; Ex. 1005 ¶ 0058.

## **5. Dependent Claim 11**

### *a) Preamble 11: “The method of claim 7”*

95. Luo teaches the method of claim 7, as I explained above in Section X.A.2.

### *b) Element [11.1]: “wherein the SS block has a certain size in the time dimension during which synchronization signals, the information providing the time index, and system information are transmitted.”*

96. Luo teaches that the SS block has a certain size in the time dimension during which synchronization signals (*e.g.*, PSS and SSS), the information providing the time index (*e.g.*, scrambled DMRS), and system information (*e.g.*, information carried by PBCH) are transmitted. Specifically, as explained above, Luo teaches that information providing a time index (*e.g.*, the scrambled DMRS) and the system information (*e.g.*, information within MIB carried by PBCH) are transmitted within an SS block. Ex. 1004, 10:51-58, 13:13-14. Luo further teaches that the PBCH and

the synchronization signals PSS and SSS “may be time division multiplexed and/or frequency division multiplexed with the SS block.” Ex. 1004, 10:51-58, Fig. 4 (showing the PSS, SSS, and PBCH time division multiplexed within an SS block); Ex. 1005 ¶ 0046, Fig. 4. Thus, a POSITA in March 2017 would have recognized Luo to describe that the information providing a time index (*e.g.*, the scrambled DMRS) is time multiplexed in the SS block, which has a certain size in the time dimension, with the system information (PBCH) and synchronization signals (PSS and SSS).

## **6. Dependent Claim 12**

*a) Preamble 12: “The method of claim 7”*

97. Luo teaches the method of claim 7, as I explained above in Section X.A.2.

*b) Element [12.1]: “wherein the information providing the time index is a tertiary synchronization signal (TSS) in the SS block.”*

98. Luo discloses an “SS block index” that indexes a particular SS block within an SS burst within an SS burst set. Ex. 1004, 11:55-57 (“SS block index may refer to one or more indices for indicating an SS block within an SS burst within an SS burst set.”); Ex. 1005 ¶ 0048; *see also* Ex. 1004, 2:1-2; Ex. 1005 ¶ 0006. A POSITA in March 2017 would have recognized that an SS block index could be conveyed by a TSS signal in the SS block. Indeed, the ’722 Patent itself admits that

the use of TSS signal to convey the time index was generally known in the art and “has been under discussion in several 3GPP contributions.” Ex. 1001, 3:21-25.

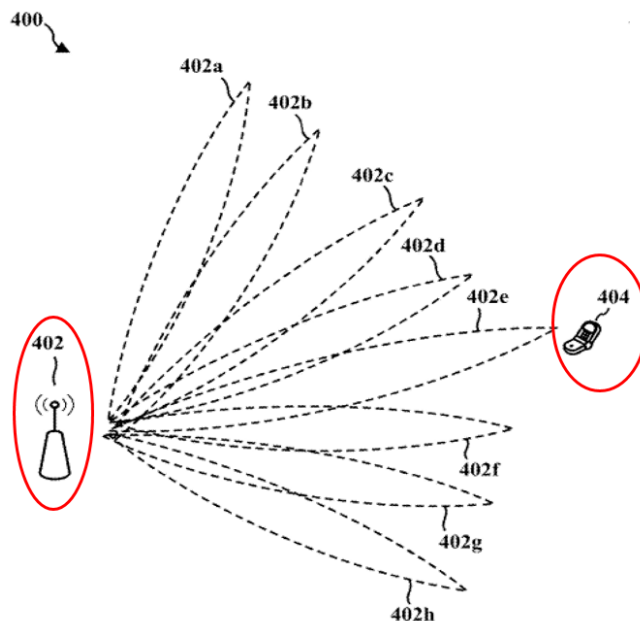
## 7. Dependent Claim 17

- a) *Preamble 17: “The wireless device of claim 13, wherein the wireless device is further configured to:”*

99. Luo teaches the wireless device of claim 13, as I explained above in Section X.A.1.

- b) *Element [17.1]: “acquire synchronization with the network node based on the information in the SS block.”*

100. Luo discloses a wireless device (*e.g.*, UE 404) that acquires synchronization with the network node (*e.g.*, BS 402) based on the information in the SS block (*e.g.*, PSS, SSS, and PBCH including the MIB), as shown in the annotated excerpt of Figure 4 below. Ex. 1004, 10:40-50, Fig. 4; Ex. 1005 ¶ 0045, Fig. 4.



101. Specifically, Luo teaches that when the UE discovers the BS, it uses the information in the SS block (such as the synchronization signals PSS and SSS and the system information in PBCH) to synchronize with the BS and the wireless network. Ex. 1004, 10:41-50 (“when the UE 404 turns on, the UE 404 searches for a nearby NR network. ***The UE 404 discovers the base station 402***, which belongs to an NR network. The base station 402 transmits an ***SS block including the PSS, SSS, and the PBCH (including the MIB)*** periodically in different transmit directions 402 *a*-402 *h*. The UE 404 receives the transmission 402 *e* including the PSS, SSS, and PBCH. Based on the received SS block, ***the UE 404 synchronizes to the NR network*** and camps on a cell associated with the base station 402.”) (emphasis added); Ex. 1005 ¶ 0045.

## **8. Dependent Claim 18**

*a) Preamble 18: “The wireless device of claim 13”*

102. Luo teaches the wireless device of claim 13, as I explained above in Section X.A.1.

*b) Element [18.1]: “wherein the wireless device is configured to descramble the system information by descrambling coded bits of the system information.”*

103. Luo teaches this claim element and at least renders it obvious. In Luo, the UE descrambles system information (e.g., the PBCH payload) by descrambling coded bits of the PBCH payload, which constitutes the claimed system information. As I explained above in sections X.A.3.c/d, Luo discloses, or at least renders

obvious, the network node (*e.g.*, BS) scrambles the PBCH payload by scrambling coded bits of the system information. Ex. 1004, 14:48-61; Ex. 1005 ¶ 0050. Luo further teaches that the wireless device (*e.g.*, UE) is configured to descramble the system information received from the network node (*e.g.*, BS). Ex. 1004, 21:62-64 (“[t]he apparatus may further include means for descrambling the scrambled information based on the at least the portion of the SS block index.”); Ex. 1005, Claim 41, Fig. 3. Since, as I explained above, the scrambling of system information described in Luo is performed by scrambling coded bits of system information (Ex. 1004, 14:48-61 (“M is the number of bits to be scrambled...”); Ex. 1005 ¶ 0050), a POSITA in 2017 would have recognized that the *descrambling* of system information described in Luo is similarly performed by descrambling the coded bits of the system information. This also would have been obvious to a POSITA.

## **9. Dependent Claim 24**

a) *Preamble 18: “The wireless device of claim 13”*

104. Luo teaches the wireless device of claim 13, as I explained above in Section X.A.1.

b) *Element [24.1]: “wherein the wireless device is a User Equipment (UE).”*

105. Luo discloses that the wireless device is a User Equipment (UE). Ex. 1004, 21:55-56 (“[i]n one configuration, the apparatus 1302/1302’ for wireless communication is a UE.”), Figure 14; Ex. 1005, Claim 36, Fig. 3. *See also* Ex. 1004, 4:21-25, Fig. 1; Ex. 1005 ¶ 26.

**B. Ground II: Claims 1, 7, 8, 9, 11, 12, 13, 17, 18, 24, 25, 26 and 27  
Are Rendered Obvious by Luo In View of Ly**

106. As described below, it is my opinion that claims 1, 7, 8, 9, 11, 12, 13, 17, 18, 24, 25, 26, 27 of the '722 Patent are rendered obvious under 35 U.S.C. § 103 by Luo in combination with Ly.

107. As a threshold matter, it is my opinion that a POSITA would have been motivated to combine the teachings of Luo with the teachings of Ly. Combining the teachings of Luo and Ly would have involved routine implementation (largely in software), would have posed no technical risks given their related and complementary teachings, and would have achieved the predictable benefits of providing more flexible support for continuing improvements of 5G wireless communication systems.

108. Luo and Ly relate to the same field—*i.e.*, synchronization signal blocks in 5G NR technology—and both seek to address the same problem, *i.e.*, improvement of 5G NR technology with respect to the transmission of SS block index information in an SS block to achieve synchronization between UE and BS in a wireless network. Ex. 1004, Abstract, 1:48-49; Ex. 1006, Abstract, 1:48-49. A POSITA would have been motivated to improve Luo's scheme of transmission of SS block index information by a BS to a UE (as shown, for example in Figure 7 of Luo) by incorporating Ly's specific teaching of the generally known technique of multiplexing a specific signal that carries the time index with other SS signals and

the PBCH in a SS block, because simultaneous transmission of this information in the same SS block is more efficient, reduces latencies and delays, and provides a way for the accuracy of the time index to be checked early in the synchronization process.

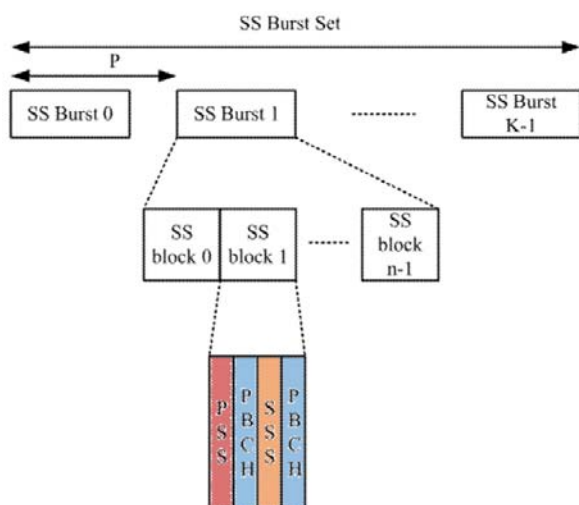
109. A POSITA would have viewed the addition of Ly's specific disclosure of multiplexing PSS, SSS, PBCH, and a TSS (or other SS signal) in a SS block to the scheme described by Luo as the application of a known technique (*e.g.*, multiplexing of SS signals) to a known method and device to yield predictable results (*e.g.*, transmission of SS block time index with system information). A POSITA would also have a reasonable expectation of success in arriving at the alleged invention recited in the Challenged Claims of the '722 Patent by combining the teachings of Luo and Ly because, consistent with the teaching of Luo that information providing a time index is transmitted in the SS block, and that other signals may be multiplexed into the SS block, Ly teaches how to multiplex an SS signal that conveys information providing the time index, and such implementation would have involved a routine software implementation.

110. More specifically, Luo teaches that the SS block transmitted by the BS includes "PSS, SSS, and the PBCH (including the MIB)." Ex. 1004, 10:44-46. Luo further teaches that the PBCH (with the system information) and the synchronization signals PSS and SSS are multiplexed in an SS block, but Luo also teaches that other

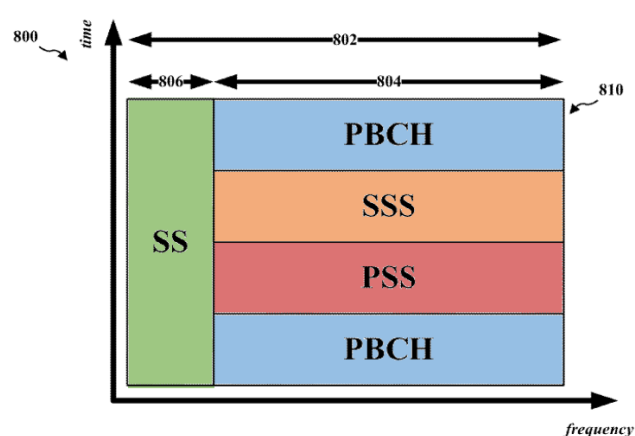
signals and channels (in addition to PSS, SSS and PBCH) may also be multiplexed into the SS block. Ex. 1004, 10:54-65 (“[t]he PSS, SSS, and PBCH may be time division multiplexed and/or frequency division multiplexed with the SS block” ... “[t]he SS block may include other signals/channels, and therefore other signals/channels other than the PSS, SSS, and PBCH may be multiplexed into the SS block.”) Further, Luo discloses that each SS block has a corresponding SS block index. Ex. 1004, 10:52-53 (“[e]ach SS block has a corresponding SS block index.”) Luo further teaches that the SS block index could be conveyed through a scrambled DMRS signal for PBCH (Ex. 1004, 12:5-6, 12:25-31) and that the scrambled DMRS is included in the SS block and transmitted to the UE. Ex. 1004, 13:13-14. Ly provides specific details on how to multiplex the information providing the time index (*e.g.*, TSS, SS, or DMRS for PBCH) in the SS block. Specifically, consistent with the disclosure in Luo that “other signals/channels other than the PSS, SSS, and PBCH may be multiplexed into the SS block,” Ly teaches that in addition to PSS, SSS, and PBCH, a TSS or other signal, may also be multiplexed in the SS block in order to carry and convey the SS block time index. Ex. 1006, 16:36-48. A POSITA, thus would have been motivated to turn to Ly for the additional disclosure on how to multiplex the information providing time index in the SS block and would have recognized the benefit of multiplexing another signal (*e.g.*, SS, TSS or DMRS) in the SS block of Luo (in addition to PSS, SSS, and the PBCH) to convey the

information providing a time index with the synchronization signals in the SS block. Indeed, such multiplexing in the SS block is more efficient, reduces latencies and delays, and provides a way for the accuracy of the time index to be checked early in the synchronization process. Such benefit would have been achieved by applying a known technique (*e.g.*, multiplexing multiple synchronization signals in an SS block) to improve similar devices (*e.g.*, wireless 5G NR devices) in the same way (time/frequency division multiplexing) to yield predictable results (*e.g.*, conveying of information providing a time index in an SS block).

111. A side-by-side comparison of an annotated excerpt from Figure 4 of Luo (showing the multiplexing of PSS, SSS, and PBCH in SS block) and annotated Figure 8 of Ly (showing that in addition to PSS, SSS, and PBCH an additional SS signal is multiplexed in the SS block) demonstrates that a POSITA would have been encouraged to apply the specific teachings of Ly to improve the disclosure of Luo, in particular, in view of Luo's explicit disclosure that "other signals/channels other than the PSS, SSS, and PBCH may be multiplexed into the SS block." Ex. 1004, 10:54-65. As shown below, annotated Figure 8 of Ly shows a similar SS block as shown in annotated Figure 4 of Luo, with the one addition of the SS signal (shown in green) that is also multiplexed into the SS block. This addition (of the SS signal) is consistent with Luo's teaching that other signals/channels could also be multiplexed into the SS block.



**Luo (Ex. 1004), Fig. 4 (excerpt)**



**Ly (Ex. 1006), Fig. 8**

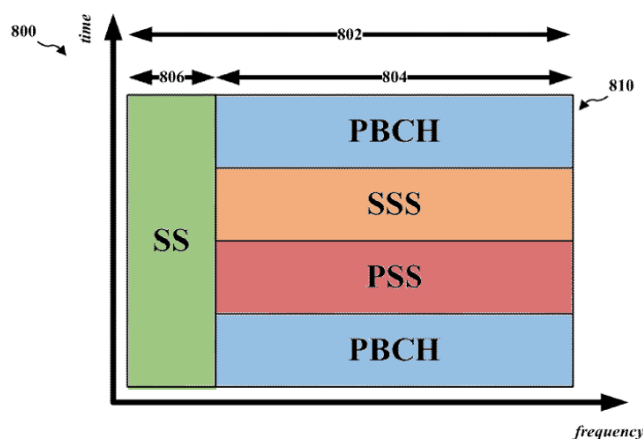
112. I also note that Luo and Ly were filed by the same applicant and are assigned to the same assignee (Qualcomm, Inc.), and that both share a common named inventor, Tao Luo. Further, Ly '973 Provisional was filed on February 16, 2017, just several days before the Luo Provisional was filed on February 23, 2017. It should also be noted that Luo and Ly share certain common Figures and portion of the specification (*e.g.*, figures 1-3 and portions of the background section). It is also my opinion, therefore, that a POSITA would have been motivated to consult the specific teaching by the same common inventor of Luo and Ly, that were filed at the same timeframe by the same applicant, to improve the scheme described in Luo with the generally familiar technique of multiplexing SS signals in SS block, described in Ly, for accomplishing such an improvement.

**1. Independent Claims 1, 7, 13, and 25**

113. As I explained in section X.A above, it is my opinion that Luo renders obvious independent claims 1, 7, 13 and 25. To the extent Patent Owner contends that Luo does not render obvious the limitation “wherein the system information is multiplexed with information providing a time index” of independent claims 1, 7, and 13, and the limitation “the scrambled system information multiplexed with the information providing the time index” of claim 25, it is my opinion that Luo in combination with Ly renders them obvious.

114. Specifically, similar to Luo, Ly discloses multiplexing of synchronization signals PSS, SSS and PBCH in a SS block. Ex. 1006, 6:64-66 (“multiplex[ing] a plurality of synchronization signals, including a PSS, a SSS, or a PBCH, for transmission in a SS block”); Ex. 1007 ¶ 0006. Ly also discloses that the multiplexed PBCH in the SS block carries system information to support the initial access and synchronization procedure of the UE with the wireless network. Ex. 1006, 16:22-24 (“the PBCH may be used to signal minimum system information to support a UE in initial access procedures.”); Ex. 1007 ¶ 0075. Ly further teaches that a SS block index is carried in one or more of the synchronization signals. Ex. 1006, at 16:39-40 (“SS block index which may be carried in one or more synchronization signals.”); Ex. 1007 ¶¶ 0036, 0076, 00159. Specifically, Ly teaches that the SS block index may be carried by a synchronization signal called TSS (as

described in the '722 Patent), or by another generic synchronization signal referred to as SS. Ex. 1006, 16:44-46 (“SS block index may be carried in a synchronization signal (*e.g.*, the TSS or other SS)”).; Ex. 1007 ¶ 00100. Ly also teaches that the SS signal “may be used to signal SS block indices.” Ex. 1006, 16:18-19; Ex. 1007 ¶ 0075. Ly further discloses that the PBCH (as well as PSS and SSS) may be time/frequency division multiplexed with the SS (that carries the SS block time index) in an SS block, as shown, for example, in annotated Figure 8 below. Ex. 1006, 16:44-48, Ex. 1007 ¶ 00100; *see also* Ex. 1006, 16:6-9 (“a plurality of synchronization signals that are multiplexed together... may include one or more of a PSS, an SSS, a TSS, or a PBCH.”). Annotated Figure 8 shows PBCHs (in blue), a PSS (in red), a SSS (in orange), and a SS signal that carries the SS block time index (in green) multiplexed on time and frequency domains in a SS block.

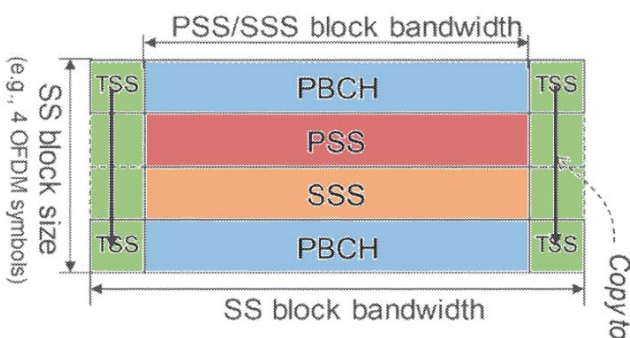


115. Thus, Ly discloses that the information providing a time index is conveyed through a separate SS signal in the SS block (shown in green in annotated Figure 8 above), which is consistent with Luo’s teaching that “[t]he SS block may

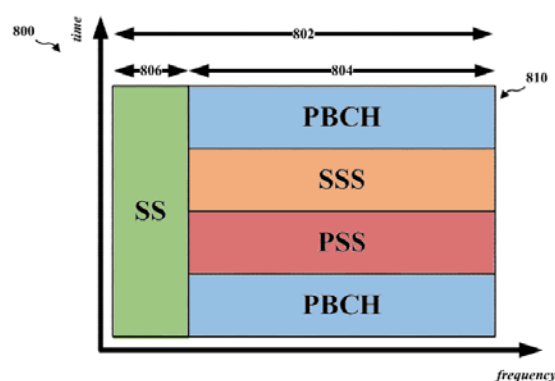
include other signals/channels, and therefore other signals/channels other than the PSS, SSS, and PBCH may be multiplexed into the SS block.” Ex. 1004, 10:54-65; Ex. 1005 ¶ 0046.

116. Ly also teaches that the information providing a time index may be a TSS signal, as described in the ’722 Patent. Ex. 1006, 16:44-46; Ex. 1007 ¶ 00100; Ex. 1001, Fig. 2a. In other embodiments, Ly teaches that the information providing a time index could be other SS signals. Ex. 1006, 16:42-44 (“the one or more synchronization signals in the SS block may include a PBCH, a PSS, an SSS, a TSS, and/or other SS. Different ones of the synchronization signals may convey some or all of the SS block index.”); Ex. 1007 ¶¶ 0076-77. In another embodiment, and consistent with the teaching of Luo, Ly discloses that the SS signal that conveys the time index could be, for example, a DMRS signal for PBCH. Ex. 1006, 31:3-4 (“In an aspect, the SS comprises a DMRS for a physical broadcast channel PBCH.”); Ex. 1007 ¶ 0040; Ex. 1008 ¶ 00118; *see also* Ex. 1006, 22:7-8.

117. A side-by-side comparison of Figure 8 of Ly (below right, annotated) and Figure 2a of the ’722 Patent (below left, annotated) shows that Ly discloses the same concept of multiplexing system information (*e.g.*, information within MIB carried by PBCH) with information providing a time index (*e.g.*, SS, such as TSS, or a DMRS), as described by the ’722 Patent:



**'722 Patent (Ex. 1001), Fig. 2a**



**'410 Ly (Ex. 1006), Fig. 8**

118. As I explained above, a POSITA would have been motivated to combine the teachings of Luo with the teachings of Ly. Specifically, Ly provides specific details on *how* to multiplex the information providing the time index (by using a SS, TSS, or DMRS signals), which adds to the disclosure of Luo that the information providing the time index is included in the SS block. A POSITA would also have been motivated to combine the teachings of Luo with the teachings of Ly to improve the disclosure of Luo. In particular, as explained above, a POSITA would have recognized the benefit of multiplexing another signal (*e.g.*, SS, TSS or DMRS) in the SS block (in addition to PSS, SSS, and the PBCH) to convey information providing a time index with the synchronization signals in the SS block. Such benefit would have been achieved by applying a known technique (*e.g.*, multiplexing multiple synchronization signals in an SS block) to improve similar devices (*e.g.*, wireless 5G NR devices) in the same way (time/frequency division multiplexing) to

yield predictable results (*e.g.*, conveying of information providing a time index in an SS block).

## 2. **Dependent Claim 11**

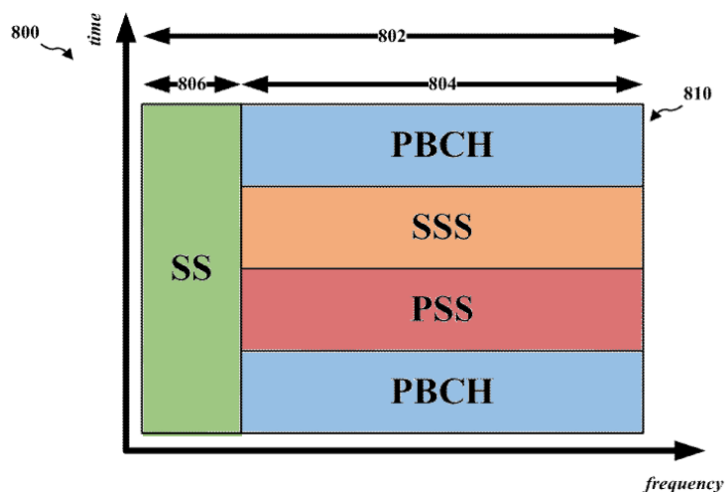
### a) *Preamble 11: “The method of claim 7”*

119. Luo teaches the method of claim 7, as I explained above in Section X.A.2.

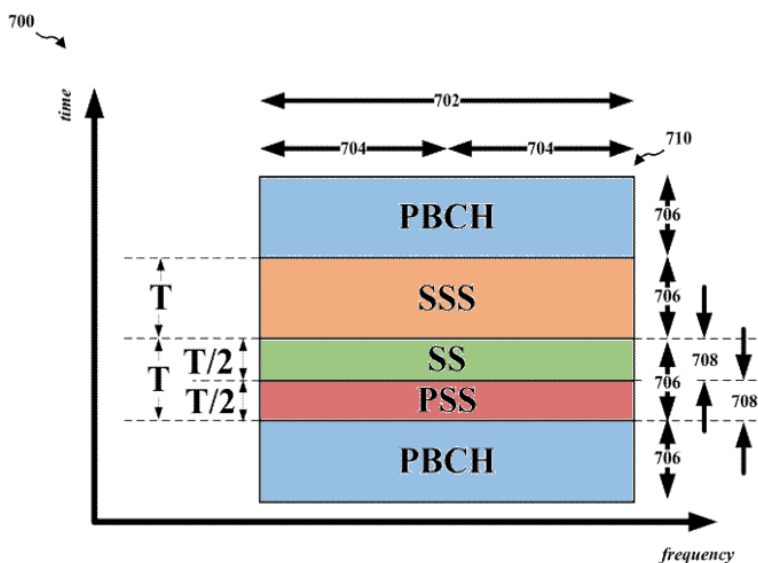
### b) *Element [11.1]: “wherein the SS block has a certain size in the time dimension during which synchronization signals, the information providing the time index, and system information are transmitted.”*

120. Ly teaches that the SS block has a certain size in the time dimension during which synchronization signals (*e.g.*, PSS and SSS), the information providing the time index (*e.g.*, SS, TSS or DMRS), and system information (*e.g.*, information carried by PBCH) are transmitted. Specifically, Ly discloses an SS block 810 that has a certain size in the time dimension (shown by the time axis), during which synchronization signals (*e.g.*, PSS and SSS), the information providing the time index (*e.g.*, SS), and system information (*e.g.*, in PBCH) are transmitted, as shown by annotated Figure 8 below. Ex. 1006, 19:51-60 (“FIG. 8 is a diagram illustrating an example of frequency-division multiplexing 800 of a SS with other SS in an SS block 810 ... [t]he time/frequency diagram illustrates an example placement of the PSS, the SSS, the SS, the PSS, and the PBCH (two PBCHs) in time and frequency. The PSS, the SSS, the SS, the PSS, and the PBCH (two PBCHs) may be transmitted as part of an SS block 810.”); Ex. 1007 ¶ 0056. Annotated Figure 8 shows PBCHs

(in blue), a PSS (in red), a SSS (in orange), and a SS signal that carries the SS block time index (in green) multiplexed on time and frequency domains in a SS block.



121. In another embodiment, Ly further discloses that the SS signal (shown in green in annotated Figure 7 below) is time-division multiplexed (*i.e.*, multiplexed on the time domain) with PBCHs (in blue), a PSS (in red), and a SSS (in orange), as shown in annotated Figure 7. Ex. 1006, 18:18-20.



122. As I explained above, a POSITA would have been motivated to combine the teachings of Luo with the teachings of Ly. In particular, a POSITA would have recognized the benefit of transmitting synchronization signals (such as PSS and SSS), the information providing the time index (*e.g.*, SS, TSS or DMRS) and system information (*e.g.*, in PBCH) in the SS block having a certain size in the time dimension to convey information providing a time index with the synchronization signals in the SS block, because simultaneous transmission of this information in the same SS block is more efficient, reduces latencies and delays, and provides a way for the accuracy of the time index to be checked early in the synchronization process. Thus, a POSITA would have been motivated to apply the teaching of Ly to the disclosure of Luo and time multiplex the scrambled DMRS (or other SS) with the PSS, SSS and PBCH in the SS block to arrive at the claimed invention, and would also have a reasonable expectation of success in doing so, as I explained in Section X.B.1 above.

### **3. Dependent Claim 12**

a) *Preamble 12: “The method of claim 7”*

123. Luo teaches the method of claim 7, as I explained above in Section X.A.2.

b) *Element [12.1]: “wherein the information providing the time index is a tertiary synchronization signal (TSS) in the SS block.”*

124. Ly teaches that the information providing the time index is a tertiary synchronization signal (TSS) in the SS block. Specifically, Ly discloses an SS block index that is carried by a synchronization signal. Ex. 1006, at 16:39-40 (“SS block index which may be carried in one or more synchronization signals.”); Ex. 1007 ¶ 0036, 0076, 00159. Ly teaches that the SS block index may be carried in a TSS signal. Ex. 1006, 16:44-48 (“SS block index may be carried in a synchronization signal (*e.g.*, the **TSS** or other SS) which may be frequency division multiplexed with the other synchronization signals of the SS block.”) (emphasis added), Figure 8; Ex. 1007 ¶ 00100; *see also* Ex. 1006, 16:6-9 (“[t]he plurality of synchronization signals may include one or more of a PSS, an SSS, **a TSS**, or a PBCH”) (emphasis added). The TSS signal disclosed in Ly is a *Tertiary Synchronization Signal*, *i.e.*, a third synchronization signal in addition to PSS and SSS. *See, e.g.*, Ex. 1007 (Ly’s ’973 Provisional titled “**Tertiary Synchronization Signal** Design Consideration”) (emphasis added).

#### **4. Dependent Claims 8, 9, 17, 18, 24, 26 and 27**

125. As I explained in section X.A above, Luo renders obvious claims 8, 9, 17, 18, 24, 26 and 27.

## **XI. SECONDARY CONSIDERATIONS**

126. I have seen no evidence of, and I am not aware of any, secondary considerations that would tend to show non-obviousness of the Challenged Claims of the '722 Patent, including commercial success, long-felt need, failure of others, skepticism, praise, teaching away, recognition of a problem or copying by competitors. However, should Patent Owner assert any secondary considerations of non-obviousness, I reserve the right to respond at that time.

## **XII. CONCLUSION**

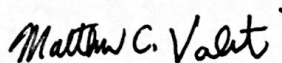
127. For the aforementioned reasons, in my opinion, to a person of ordinary skill in the art as of the alleged Priority Date of the '722 Patent, the Challenged Claims of the '722 Patent are invalid as rendered obvious by the prior art.

Declaration of Dr. Valenti for *Inter Partes* Review of U.S. Patent No. 10,476,722

128. I hereby declare under penalty of perjury under the laws of the United States of America that the foregoing is true and correct, and that all statements made of my own knowledge are true and that all statements made on information and belief are believed to be true. I understand that willful false statements are punishable by fine or imprisonment or both. *See* 18 U.S.C. § 1001.

Date: January 29, 2021

Respectfully submitted,



---

Matthew C. Valenti, Ph.D.

## MATTHEW C. VALENTI

---

Lane Dept. of Comp. Sci. & Electrical Engineering  
West Virginia University  
Morgantown, WV 26506-6109  
Web: <http://www.csee.wvu.edu/~mvalenti>

Phone: (304) 293-9139  
Fax: (304) 293-8602  
Email: [Matthew.C.Valenti@gmail.com](mailto:Matthew.C.Valenti@gmail.com)

---

### I. PROFESSIONAL BACKGROUND

#### A. EDUCATION

##### Virginia Tech

**Ph.D., Electrical Engineering**, August 1999  
**B.S., Electrical Engineering**, May 1992

##### Johns Hopkins University

**M.S., Electrical Engineering**, May 1995

#### B. EMPLOYMENT AND APPOINTMENTS

##### West Virginia University, *Lane Department of Computer Science and Electrical Engineering*

**Raymond J. Lane Department Chair**, July 1, 2020 to present  
**Interim Chair**, July 1, 2019 to June 30, 2020  
**Professor**, 2010 to present  
**Associate Professor**, 2005 to 2010  
**Assistant Professor**, August 1999 to 2005

##### Center for Identification Technology Research (CITeR), *an NSF I/UCRC*

**Director, WVU Site**, Aug. 2014 to present.

##### Virginia Tech, *Bradley Department of Electrical and Computer Engineering*

**Bradley Fellow, Graduate Research Assistant, and Instructor**, Aug. 1995-July 1999

##### U.S. Naval Research Laboratory, *Naval Center for Space Technology*

**Electronics Engineer**, Summer 1991, May 1992-August 1995

#### C. HONORS AND AWARDS

##### IEEE MILCOM Award for Sustained Technical Achievement (2019)

##### Fellow, Institute of Electrical and Electronics Engineers (IEEE)

Student Member 1992, Member 1999, Senior Member 2007, Fellow 2018

##### WVU Foundation Outstanding Teaching Award (2013)

##### Outstanding Teacher (2012, 2009, 2006, 2003, and 2001)

##### Outstanding Advisor (2012, 2004)

##### Outstanding Researcher (2008, 2001, and 2000)

*West Virginia University, Statler College of Engineering and Mineral Resources*

##### Bradley Fellow, August 1995-May 1998

*Virginia Tech, Bradley Department of Electrical Engineering*

#### D. PROFESSIONAL REGISTRATION

##### Professional Engineer (P.E.)

Registered in the state of West Virginia since 2011

## II. TECHNICAL CONSULTING BACKGROUND

### A. PATENT LITIGATION SUPPORT AND EXPERT WITNESS EXPERIENCE

1. Kirkland & Ellis for Lenovo  
Dates: 2020-2021  
Venue: UK High Court  
Cases: InterDigital Technology Corporation and others v Lenovo Group Limited and others (Claim No. HP-2019 000032)  
Technology: Wireless technology including control signaling for LTE  
Activity: Expert Report (Invalidity, non-essentiality), Rebuttal Report
2. Fish & Richardson for LG  
Dates: 2019  
Venue: United States Patent and Trademark Office  
Cases: Petition for *Inter Partes* Review (IPR) of United States Patent No. 7,039,435 (held by Bell Northern Research)  
Technology: Wireless technology including power control of wireless transmissions  
Activity: Expert Declaration (in support of IPR Petition)
3. Fish & Richardson for Apple  
Dates: 2017-2019  
Venue: United States District Court; Southern District of California  
Cases: Apple Inc. v. Qualcomm Inc., Civil Action No. 3:17-cv-00108  
Technology: LTE wireless technology.  
Activity: Expert Report (Patent portfolio technical evaluation). Deposition (Oct. 17, 2018). *Testimony before jury was scheduled for April 22, 2019, but case settled after opening arguments.*
4. Quinn Emanuel Urquhart & Sullivan for Samsung  
Dates: 2017-2019  
Venue: United States District Court; Northern District of California (San Francisco Division)  
Cases: Samsung Electronics Co., LTD., et al. (counterclaim-plaintiffs) v. Huawei Technologies Co., LTD., et al. (counterclaim-defendants), Case No. 16-cv-02787-WHO  
Huawei Technologies Co., LTD vs. Samsung Electronics Co., LTD, Case IPR2017-01974 (US Patent 8,457,588)  
Huawei Technologies Co., LTD vs. Samsung Electronics Co., LTD, Case IPR2017-01982 (US Patent 8,228,827)  
Technology: LTE wireless technology.  
Activity: Declarations (Claim Construction, 2 Patent Owner's Responses to Petition for IPR); Expert Report (Infringement); Rebuttal Report (Validity). Depositions (June 20, 2018, Aug. 10, 2018, Aug. 11, 2018).
5. Baker Botts for AT&T; Gibson, Dunn & Crutcher for T-Mobile  
Dates: 2016-2017  
Venue: United States District Court; District of Delaware  
Cases: (a) Intellectual Ventures I LLC v. AT&T Mobility LLC et al., Civil Action No. 12-CV-193-LPS (D. Del.); Intellectual Ventures I LLC v. AT&T Mobility LLC et al., Civil Action No. 1:15-CV-00799-LPS.  
(b) Intellectual Ventures I LLC v. T-Mobile USA Inc. et al. D. Del. Case No. 1:13-cv-1632-LPS.  
Technology: HSDPA wireless technology.  
Activity: Expert Report; Declaration; Sur-Reply Report. Deposition (Mar. 23, 2017).

**MATTHEW C. VALENTI**

---

6. Rothwell Figg for LG; Paul Hastings for Samsung; Mayer Brown for Motorola Mobility  
Dates: 2016  
Venue: United States District Court; Southern District of California  
Cases: (a) Odyssey Wireless Inc. v. LG Electronics USA, Inc. et al., Civil Action No. 3:15-cv-01746-H-RBB (S.D. Cal.).  
(b) Odyssey Wireless Inc. v. Samsung Electronics Co. et al., Civil Action No. 3:15-cv-01738-H-RBB (S.D. Cal.).  
(c) Odyssey Wireless Inc. v. Motorola Mobility, Civil Action No. 3:15-cv-01741-H-RBB (S.D. Cal.).  
Technology: LTE wireless technology.  
Activity: Expert Report (noninfringement). Deposition (Aug. 24, 2016).
7. Sheppard Mullin for Samsung; Gibson Dunn and Wilmer Hale for Intel; Boies Schiller for Apple  
Dates: 2016  
Case: Various regulatory agencies' investigations of Qualcomm Incorporated ("Qualcomm"), including the Korean Fair Trade Commission (the "KFTC") and the United States Federal Trade Commission (the "FTC").  
Technology: LTE wireless technology.  
Activity: Declaration (technical analysis of patent portfolio).
8. Boies, Schiller & Flexner for Apple; Sheppard, Mullin, Richter & Hampton for HTC; Kilpatrick Townsend & Stockton for Lenovo and Motorola Mobility; Quinn Emanuel Urquhart & Sullivan for Samsung; McDermott Will & Emery for ZTE; SidleyAustin for Microsoft  
Dates: 2016  
Venue: United States District Court; District of Delaware  
Cases: (a) Evolved Wireless, LCC, v. Apple Inc., Civil Action No. 1:15-cv-00542-SLR.  
(b) Evolved Wireless, LCC, v. HTC Corporation and HTC America, Inc., Civil Action No. 1:15-cv-00543-SLR. (c) Evolved Wireless, LCC, v. Lenovo Group Ltd., Lenovo (United States) Inc., and Motorola Mobility, Civil Action No. 1:15-cv-00544-SLR.  
(d) Evolved Wireless, LCC v. Samsung Electronics Co., Ltd. and Samsung Electronics America, Inc., Civil Action No. 1:15-cv-00545-SLR. (e) Evolved Wireless, LCC v. ZTE Corporation, ZTE (USA) Inc., and ZTE Solutions Inc., Civil Action No. 1:15-cv-00546-SLR. (f) Evolved Wireless, LCC v. Microsoft Corporation, Microsoft Mobile OY and Nokia Inc., Civil Action No. 1:15-cv-00547-SLR.  
Technology: LTE wireless technology.  
Activity: Declaration (claim construction).
9. Williams & Connolly  
Dates: 2015  
Case: Confidential Parties (Leading Global Wireless Communication Companies)  
Consolidated Arbitrations Under the International Chamber of Commerce Rules.  
Technology: LTE wireless technology.  
Activity: Expert Report (patent portfolio technical evaluation).
10. Kirkland & Ellis for Samsung  
Dates: 2013  
Case: Samsung Electronics and Samsung Telecommunications America v. Ericsson Inc.  
In the Matter of Certain Wireless Communications Equipment and Articles Therein  
US. International Trade Commission (ITC) Investigation No. 337-TA-866  
Technology: LTE wireless technology.  
Activity: Expert Report (infringement, domestic industry practice), rebuttal report (validity).  
Court testimony (ITC bench trial): direct (Oct. 23, 2013) and rebuttal (Oct. 30, 2013).

11. Quinn Emanuel Urquhart & Sullivan, LLP for Samsung  
Dates: 2013  
Case: Samsung Electronics GmbH v. Apple Inc.  
German Patent Court, Case Number 5 Ni 49/11  
Technology: Turbo codes; LTE wireless technology.  
Activity: Declaration (validity).
12. Kirkland & Ellis for DIRECTV  
Dates: 2009  
Case: Rembrandt Data Technologies v. DIRECTV, Inc. et al.  
Eastern District of Virginia, Case No. 1:08cv1009  
Technology: Telephone modems; set-top boxes.  
Activity: Rebuttal Expert Report (non-infringement). Deposition (May 20, 2009).
13. Kirkland & Ellis for Samsung  
Dates: 2006  
Case: Samsung Electronics and Samsung Telecommunications America v. Ericsson Inc.  
In the Matter of Certain Wireless Communications Equipment, Articles Therein, and  
Products Containing the Same  
ITC Investigation No. 377-TA-577  
Technology: WCDMA/UMTS wireless technology; mobile phone handsets.  
Activity: Declaration (domestic industry practice). Deposition (Nov. 17, 2006).

#### B. TECHNICAL CONSULTING OF A NON-LEGAL NATURE OVER PAST TEN YEARS

1. 4D Tech Solutions, Morgantown, WV  
*Nonorthogonal Frequency Division Multiplexing*  
July 2017 to Dec 2018.

#### C. DESCRIPTION TECHNICAL AREA OF EXPERTISE

Dr. Valenti's area of expertise is communication technology, with an emphasis on wireless and cellular networks. This includes physical-layer technology; i.e., modulation, error-control coding, and receiver design, as well as issues related to cellular network call processing (e.g., control signal formats and protocols). Dr. Valenti has a working knowledge of several current standards, including UMTS/WCDMA (3-G Cellular), LTE (4-G Cellular), 5G NR, WiMAX, and DVB-S2 (Satellite Television).

### III. RESEARCH

#### A. PUBLICATIONS

##### *Journal Papers*

- J1. V. Talreja, **M.C. Valenti** and N. M. Nasrabadi, "Deep hashing for secure multimodal biometrics," *IEEE Transactions on Information Forensics and Security*, vol. 16, pp. 1306-1321, 2021.
- J2. F. Taherkhani, V. Talreja, **M.C. Valenti**, and N.M. Nasrabadi "Error-corrected margin-based deep cross-modal hashing for facial image retrieval," *IEEE Transactions on Biometrics, Behavior, and Identity Science*, vol. 2, no. 3, pp. 279-293, July 2020.
- J3. E. Hriba and **M.C. Valenti**, "Correlated blocking in mmwave cellular networks: Macrodiversity, outage, and interference," *Electronics (Special Issue on Millimeter-Wave (mmWave) Communications)*, vol. 8, no. 10, article number 1187, Oct. 2019.
- J4. T. Ferrett and **M.C. Valenti**, "Noncoherent LDPC-coded physical-layer network coding using multitone FSK," *IEEE Transactions on Communications*, vol. 66, no. 6, pp. 2384-2395, June 2018.

- J5. D. Torrieri, S. Talarico, and **M.C. Valenti**, "Analysis of a frequency-hopping millimeter-wave cellular uplink," *IEEE Transactions on Wireless Communications*, vol. 15, no. 10, pp. 7089-7098, Oct. 2016.
- J6. K. Venugopal, **M.C. Valenti**, and R. W. Heath, Jr., "Device-to-device millimeter wave communications: Interference, coverage, rate, and finite topologies," *IEEE Transactions on Wireless Communications*, vol. 15, no. 9, pp. 6175-6188, Sept. 2016.
- J7. D. Torrieri, S. Talarico, and **M.C. Valenti**, "Performance comparisons of geographic routing protocols in mobile ad hoc networks," *IEEE Transactions on Communications*, vol. 63, no. 11, pp. 4276-4286, Nov. 2015.
- J8. P. Rost, S. Talarico, and **M.C. Valenti**, "The complexity-rate tradeoff of centralized radio access networks," *IEEE Transactions on Wireless Communications*, vol. 14, no. 11, pp. 6164-6176, Nov. 2015.
- J9. **M.C. Valenti**, D. Torrieri, and S. Talarico, "A direct approach to computing spatially averaged outage probability," *IEEE Communications Letters*, vol. 18, no. 7, pp. 1103-1106, July 2014.
- J10. S. Talarico, N.A. Schmid, M. Alkhweldi, and **M.C. Valenti**, "Distributed estimation of a parametric field: Algorithms and performance analysis," *IEEE Transactions on Signal Processing*, vol. 62, no. 5, pp. 1041-1053, Mar 1, 2014.
- J11. D. Torrieri, **M.C. Valenti**, and S. Talarico, "An analysis of the DS-CDMA cellular uplink for arbitrary and constrained topologies," *IEEE Transactions on Communications*, vol. 61, no. 8, pp. 3318-3326, Aug. 2013.
- J12. D. Torrieri and **M.C. Valenti**, "Exclusion and guard zones in DS-CDMA ad hoc networks," *IEEE Transactions on Communications*, vol. 61, no. 6, pp. 2468-2476, June 2013.
- J13. D. Torrieri and **M.C. Valenti**, "The outage probability of a finite ad hoc network in Nakagami fading," *IEEE Transactions on Communications*, vol. 60, pp. 3509-3518, Nov. 2012.
- J14. **M.C. Valenti** and X. Xiang, "Constellation shaping for bit-interleaved LDPC coded APSK," *IEEE Transactions on Communications*, vol. 60, pp. 2960-2970, Oct. 2012.
- J15. **M.C. Valenti**, D. Torrieri, and T. Ferrett, "Noncoherent physical-layer network coding with FSK modulation: Relay receiver design issues," *IEEE Transactions on Communications*, vol. 59, no. 9, pp. 2595-2604, Sept. 2011.
- J16. D. Torrieri and **M.C. Valenti**, "Rapidly-converging series representations of a mutual-information integral," *ISRN Communications and Networking*, vol. 2011, Article ID 546205, 6 pages, 2011.
- J17. **M.C. Valenti**, S. Cheng, and D. Torrieri "Iterative multisymbol noncoherent reception of coded CPFSK," *IEEE Transactions on Communications*, vol. 58, no. 7, pp. 2046-2054, July 2010.
- J18. D. Torrieri and **M.C. Valenti**, "Efficiently decoded full-rate space-time block codes," *IEEE Transactions on Communications*, vol. 58, no. 2, pp. 480-488, Feb. 2010.
- J19. S. Cheng, **M.C. Valenti**, and D. Torrieri, "Coherent continuous-phase frequency-shift keying: Parameter optimization and code design," *IEEE Transactions on Wireless Communications*, vol. 8, no. 4, pp. 1792-1802, Apr. 2009.
- J20. D. Torrieri and **M.C. Valenti**, "Constellation labeling maps for low error floors," *IEEE Transactions on Wireless Communications*, vol. 7, no. 12, pp. 5401-5407, Dec. 2008.
- J21. D. Torrieri, S. Cheng, and **M.C. Valenti**, "Robust frequency hopping for interference and fading channels," *IEEE Transactions on Communications*, vol. 56, no. 8, pp. 1343-1351, Aug. 2008.
- J22. K. Vardhe, D. Reynolds, and **M.C. Valenti**, "The performance of multi-user cooperative diversity in an asynchronous CDMA uplink," *IEEE Transactions on Wireless Communications*, vol. 7, no. 5, pp. 1930-1940, May 2008.

- J23. R. Iyer Seshadri and **M.C. Valenti**, "Capacity-based parameter optimization of bit-interleaved coded CPM with differential detection," *IEEE Transactions on Vehicular Technology*, vol. 57, no. 1, pp. 345-353, Jan. 2008.
- J24. S. Cheng, **M.C. Valenti**, and D. Torrieri, "Robust iterative noncoherent reception of coded FSK over block fading channels," *IEEE Transactions on Wireless Communications*, vol. 6, no. 9, pp. 3142-3147, Sept. 2007.
- J25. S. Wei, D.L. Goeckel, and **M.C. Valenti**, "Asynchronous cooperative diversity," *IEEE Transactions on Wireless Communications*, vol. 5, no. 6, pp. 1547-1557, June 2006.
- J26. B. Zhao and **M.C. Valenti**, "Position-based relaying with hybrid-ARQ for efficient ad hoc networking," *EURASIP Journal on Wireless Communications and Networking*, vol. 5, no. 5, pp. 610-624, Dec. 2005.
- J27. **M.C. Valenti** and S. Cheng, "Iterative demodulation and decoding of turbo coded M-ary noncoherent orthogonal modulation," *IEEE Journal on Selected Areas in Communications*, vol. 23, no. 9, pp. 1738-1747, Sept. 2005.
- J28. J. Sun and **M.C. Valenti**, "Joint synchronization and SNR estimation for turbo codes in AWGN channels," *IEEE Transactions on Communications*, vol. 53, no. 7, pp. 1136-1144, July 2005.
- J29. B. Zhao and **M.C. Valenti**, "Practical relay networks: A generalization of hybrid-ARQ," *IEEE Journal on Selected Areas in Communications*, vol. 23, no. 1, pp. 7-18, Jan. 2005.
- J30. B. Zhao and **M.C. Valenti**, "Distributed turbo coded diversity for the relay channel," *IEEE Electronics Letters*, vol. 39, no. 10, pp. 786-787, May 15, 2003.
- J31. **M.C. Valenti** and J. Sun, "The UMTS turbo code and an efficient decoder implementation suitable for software defined radios," *International Journal on Wireless Information Networks*, vol. 8, no. 4, pp. 203-216, Oct. 2001.
- J32. **M.C. Valenti** and B.D. Woerner, "Pilot symbol assisted detection of turbo codes over flat-fading channels," *IEEE Journal on Selected Areas in Communications*, vol. 19, pp. 1697-1705, Sept. 2001.
- J33. **M.C. Valenti** and B.D. Woerner, "Iterative multiuser detection, macrodiversity combining and decoding for the TDMA cellular uplink," *IEEE Journal on Selected Areas in Communications*, vol. 19, pp. 1570-1583, Aug. 2001.
- J34. **M.C. Valenti** and B.D. Woerner, "Distributed multiuser detection for the TDMA cellular uplink," *IEEE Electronics Letters*, vol. 35, no. 21, pp. 1803-1804, Oct. 21, 1999.
- J35. **M.C. Valenti** and B.D. Woerner, "Refined channel estimation for coherent detection of turbo codes over flat-fading channels," *IEEE Electronics Letters*, vol. 34, no. 17, pp. 1648-1649, Aug. 20, 1998.

#### Magazine Articles

- A1. P. Rost, I. Berberana, A. Maeder, H. Paul, V. Suryaprakash, **M.C. Valenti**, D. Wubben, A. Dekorsy, and G. Fettweis, "Benefits and challenges of virtualization in 5G radio access networks," *IEEE Communications Magazine*, vol. 53, no. 12, *Communications Standards Supplement*, pp. 75-82, Dec. 2015.
- A2. N. Chandran and **M.C. Valenti**, "Cellular communication systems: Three generations of evolution in wireless technology," *IEEE Potentials*, vol. 20, no. 1, pp. 32-35, Feb./March 2001.

#### Book Chapters

- B1. E. Hriba and **M.C. Valenti**, "Correlated blocking in mmwave cellular networks: Macrodiversity, outage, and interference," in *Millimeter-Wave (mmWave) Communications*, MDPI, 2020, pp. 137-153.
- B2. V. Talreja, T. Ferrett, **M.C. Valenti**, and A. Ross, "A framework for secure selfie-based biometric authentication in the cloud," Chapter 14 of *Selfie Biometrics: Advances and Challenges*, Springer, 2019, pp. 275-297.

- B3. P. Rost, **M.C. Valenti**, S. Talarico, and A. Maeder, “The tradeoff of computational complexity and achievable rates in C-RANs,” Chapter 3 of *Cloud Radio Access Networks: Principles, Technologies, and Applications*, Cambridge University Press, 2017.
- B4. **M.C. Valenti** and M. Fanaei, “The interplay between modulation and channel coding,” Chapter 5 of *Transmission Techniques for Digital Communications*, Elsevier, 2016.
- B5. **M.C. Valenti** and D. Reynolds, “Distributed space-time block codes,” chapter 6 in *Cooperative Cellular Wireless Networks*, Edited by E. Hossain, D.I. Kim, and V.K. Bhargava, Cambridge University Press, 2011, pp. 153-175.
- B6. **M.C. Valenti**, S. Cheng, and R. Iyer Seshadri, “Turbo and LDPC codes for digital video broadcasting,” in *Turbo Code Application: A Journey from a Paper to Realization*, Edited by K. Sripimanwat, Springer, 2005.
- B7. **M.C. Valenti** and J. Sun, “Turbo codes,” in *Handbook of RF and Wireless Technologies*, Edited by F. Dowla Editor, Newnes Press, 2004, pp. 375-399.

*Refereed Conference Papers*

- C1. F. Taherkhani, V. Talreja, J. Dawson, **M.C. Valenti**, and N.M. Nasrabadi, “PF-cpGAN: Profile to frontal coupled GAN for face recognition in the wild” in *Proc. IEEE Int. Joint Conf. on Biometrics (IJCB)*, (Houston, TX), Sept. 2020. Best Biometric Student Paper Award.
- C2. T. Ketseoglou, **M.C. Valenti**, and E. Ayanoglu “Millimeter wave massive MIMO downlink per group communications with hybrid linear precoding,” in *Proc. Asilomar Conf. on Signals, Sys., & Computers*, (Pacific Grove, CA), Nov. 2019
- C3. E. Hriba and **M.C. Valenti**, “The potential gains of macrodiversity in mmwave cellular networks with correlated blocking,” in *Proc. IEEE Military Commun. Conf. (MILCOM)*, (Norfolk, VA), Nov. 2019.
- C4. V. Talreja, F. Taherkhani, **M.C. Valenti**, and N.M. Nasrabadi, “Attribute-guided coupled GAN for cross-resolution face recognition,” in *Proc. IEEE Int. Conf. on Biometrics: Theory, Applications, & Systems (BTAS)*, (Tampa, FL), Sept. 2019.
- C5. V. Talreja, **M.C. Valenti**, and N.M. Nasrabadi, “Zero-shot deep hashing and network based error correction for face template protection,” in *Proc. IEEE Int. Conf. on Biometrics: Theory, Applications, & Systems (BTAS)*, (Tampa, FL), Sept. 2019.
- C6. V. Talreja, S. Soleymani, **M.C. Valenti**, and N.M. Nasrabadi, “Learning to authenticate with deep multibiometric hashing and neural network decoding,” in *Proc. IEEE Int. Conf. on Commun. (ICC)*, (Shanghai, China), May 2019.
- C7. V. Talreja, F. Taherkhani, **M.C. Valenti**, and N.M. Nasrabadi, “Using deep cross-modal hashing and error-correcting codes for improving the efficiency of attribute-guided facial image retrieval,” in *Proc. IEEE Global Conf. on Signal and Information Processing (GlobalSIP)*, (Anaheim, CA), Nov. 2018.
- C8. E. Hriba and **M.C. Valenti**, “The impact of correlated blocking on millimeter-wave personal networks,” in *Proc. IEEE Military Commun. Conf. (MILCOM)*, (Los Angeles, CA), Oct. 2018.
- C9. S. Talarico, **M.C. Valenti**, and M. DiRenzo, “Outage correlation in finite and clustered wireless networks,” in *Proc. IEEE Int. Symp. on Personal, Indoor, & Mobile Radio Commun. (PIMRC)*, (Bologna, Italy), Sept. 2018.
- C10. V. Talreja, T. Ferrett, **M.C. Valenti**, and A. Ross, “Biometrics-as-a-Service: A framework to promote innovative biometric recognition in the cloud,” in *Proc. IEEE Int. Conf. on Consumer Electronics (ICCE)*, (Las Vegas, NV), Jan. 2018
- C11. E. Hriba, **M.C. Valenti**, K. Venugopal, and R. W. Heath, Jr., “Accurately accounting for random blockage in device-to-device mmwave networks,” in *Proc. IEEE Global Commun. Conf. (GLOBECOM)*, (Singapore), Dec. 2017.

- C12. V. Talreja, **M.C. Valenti**, and N.M. Nasrabadi, “Multibiometric secure system based on deep learning,” in *Proc. IEEE Global Conf. on Signal and Information Processing (GlobalSIP)*, (Montreal, Canada), Nov. 2017.
- C13. T. Ferrett and **M.C. Valenti**, “Noncoherent analog network coding using LPDC-coded FSK,” to appear in *Proc. IEEE Int. Conf. on Commun. (ICC)*, (Paris), May 2017.
- C14. K. Whetzel and **M.C. Valenti**, “Complexity-aware scheduling for an LDPC encoded C-RAN uplink,” in *Proc. Conf. on Info. Sci. and Sys. (CISS)*, (Baltimore, MD), Mar. 2017.
- C15. S. Talarico, **M.C. Valenti**, and T.R. Halford, “Controlled barrage regions: Stochastic modeling, analysis, and optimization,” in *Proc. IEEE Military Commun. Conf. (MILCOM)*, (Baltimore, MD), Nov. 2016.
- C16. P. Rost, A. Maeder, **M.C. Valenti**, and S. Talarico, “Computationally aware sum-rate optimal scheduling for centralized radio access networks,” in *Proc. IEEE Global Commun. Conf. (GLOBECOM)*, (San Diego, CA), Dec. 2015.
- C17. S. Talarico and **M.C. Valenti**, “Frequency hopping on a 5G millimeter uplink,” in *Proc. Asilomar Conf. on Signals, Sys., & Computers*, (Pacific Grove, CA), Nov. 2015. [invited paper](#).
- C18. K. Venugopal, **M.C. Valenti**, and R. W. Heath, Jr., “Analysis of millimeter-wave networked wearables in crowded environments,” in *Proc. Asilomar Conf. on Signals, Sys., & Computers*, (Pacific Grove, CA), Nov. 2015. [invited paper](#).
- C19. T. Ferrett and **M.C. Valenti**, “Reduced complexity detection for network-coded slotted ALOHA using sphere decoding,” in *Proc. Asilomar Conf. on Signals, Sys., & Computers*, (Pacific Grove, CA), Nov. 2015.
- C20. D. Torrieri, S. Talarico, and **M.C. Valenti**, “Performance analysis of a fifth-generation cellular uplink,” in *Proc. IEEE Military Commun. Conf. (MILCOM)*, (Tampa, FL), Oct. 2015.
- C21. D. Torrieri, S. Talarico, and **M.C. Valenti**, “Optimization of an adaptive frequency-hopping networks,” in *Proc. IEEE Military Commun. Conf. (MILCOM)*, (Tampa, FL), Oct. 2015.
- C22. T. Ferrett and **M.C. Valenti**, “LDPC Code Design for Noncoherent Physical Layer Network Coding,” in *Proc. IEEE Int. Conf. on Commun. (ICC)*, (London), June 2015.
- C23. K. Venugopal, **M.C. Valenti**, and R. W. Heath, Jr., “Interference in finite-sized highly dense millimeter wave networks,” in *Proc. Information Theory and Applications (ITA) Workshop*, (San Diego, CA), Feb. 2015. [invited paper](#).
- C24. **M.C. Valenti**, S. Talarico, and P. Rost, “The role of computational outage in dense cloud-based centralized radio access networks,” in *Proc. IEEE Global Commun. Conf. (GLOBECOM)*, (Austin, TX), Dec. 2014.
- C25. D. Torrieri, S. Talarico, and **M.C. Valenti**, “Performance analysis of geographic routing protocols in ad hoc networks,” in *Proc. IEEE Military Commun. Conf. (MILCOM)*, (Baltimore, MD), Oct. 2014.
- C26. S. Talarico, **M.C. Valenti**, and T.R. Halford, “Unicast barrage relay networks: Outage analysis and optimization,” in *Proc. IEEE Military Commun. Conf. (MILCOM)*, (Baltimore, MD), Oct. 2014.
- C27. A.S. Bommagani, **M.C. Valenti**, and A. Ross, “A framework for secure cloud-empowered mobile biometrics,” in *Proc. IEEE Military Commun. Conf. (MILCOM)*, (Baltimore, MD), Oct. 2014.
- C28. M. Fanaei, A. Tahmasbi-Sarvestani, Y.P. Fallah, G. Bansal, **M.C. Valenti**, and J. Kenny, “Adaptive content control for communication amongst cooperative automated vehicles,” in *Proc. IEEE International Symposium on Wireless Vehicular Communications (WIVEC)*, (Vancouver, Canada), Sept. 2014.
- C29. M. Fanaei, **M.C. Valenti**, and N. Schmid, “Effects of spatial randomness on locating a point source with distributed sensors,” in *Proc. IEEE Int. Conf. on Commun. (ICC) Workshop on Advances in Network Localization and Navigation (ANLN)*, (Sydney), June 2014, [invited paper](#).

- C30. S. Talarico and **M.C. Valenti**, “An accurate and efficient analysis of an MBSFN network,” in *Proc. IEEE Int. Conf. on Acoustics, Speech, and Signal Processing (ICASSP)*, (Florence, Italy), May 2014.
- C31. M. Fanaei, **M.C. Valenti**, A. Jamalipour, and N. Schmid, “Optimal power allocation for distributed BLUE estimation with linear spatial collaboration,” in *Proc. IEEE Int. Conf. on Acoustics, Speech, and Signal Processing (ICASSP)*, (Florence, Italy), May 2014.
- C32. D. Torrieri, **M.C. Valenti**, and S. Talarico, “Analysis of multi-cell downlink cooperation with a constrained spatial model,” in *Proc. IEEE Global Commun. Conf. (GLOBECOM)*, (Atlanta, GA), Dec. 2013.
- C33. D. Torrieri, S. Talarico, and **M.C. Valenti**, “Multihop routing in ad hoc networks,” in *Proc. IEEE Military Commun. Conf. (MILCOM)*, (San Diego, CA), Nov. 2013.
- C34. M. Fanaei, **M.C. Valenti**, and N.A. Schmid, “Power allocation for distributed BLUE estimation with full and limited feedback of CSI,” in *Proc. IEEE Military Commun. Conf. (MILCOM)*, (San Diego, CA), Nov. 2013.
- C35. M. Fanaei, **M.C. Valenti**, and N.A. Schmid, “Limited-feedback-based channel-aware power allocation for linear distributed estimation,” in *Proc. Asilomar Conf. on Signals, Sys., & Computers*, (Pacific Grove, CA), Nov. 2013.
- C36. D. Torrieri, **M.C. Valenti**, and S. Talarico, “A new analysis of the DS-CDMA cellular uplink under spatial constraints,” in *Proc. IEEE Int. Conf. on Commun. (ICC)*, (Budapest, Hungary), June 2013.
- C37. **M.C. Valenti**, D. Torrieri, and S. Talarico, “Adjacent-channel interference in frequency-hopping ad hoc networks,” in *Proc. IEEE Int. Conf. on Commun. (ICC)*, (Budapest, Hungary), June 2013.
- C38. T. Ferrett, **M.C. Valenti**, and D. Torrieri, “An iterative noncoherent relay receiver for the two-way relay channel,” in *Proc. IEEE Int. Conf. on Commun. (ICC)*, (Budapest, Hungary), June 2013.
- C39. **M.C. Valenti**, D. Torrieri, and S. Talarico, “A new analysis of the DS-CDMA cellular downlink under spatial constraints,” in *Proc. Int. Conf. on Computing, Networking, and Commun. (ICNC)*, (San Diego, CA), Jan. 2013.
- C40. X. Xiang and **M.C. Valenti**, “Closing the gap to the capacity of APSK: Constellation shaping and degree distributions,” in *Proc. Int. Conf. on Computing, Networking, and Commun. (ICNC)*, (San Diego, CA), Jan. 2013.
- C41. D. Torrieri and **M.C. Valenti**, “Guard zones and the near-far problem in DS-CDMA ad hoc networks,” in *Proc. IEEE Military Commun. Conf. (MILCOM)*, (Orlando, FL), Nov. 2012, pp. 86-91.
- C42. **M.C. Valenti**, D. Torrieri, and S. Talarico, “Optimization of a finite frequency-hopping ad hoc network in Nakagami fading,” in *Proc. IEEE Military Commun. Conf. (MILCOM)*, (Orlando, FL), Nov. 2012, pp. 192-197.
- C43. N. Schmid, M. Alkhweldi, and **M.C. Valenti**, “Distributed estimation of a parametric field using sparse noisy data,” in *Proc. IEEE Military Commun. Conf. (MILCOM)*, (Orlando, FL), Nov. 2012.
- C44. S. Talarico, **M.C. Valenti**, and D. Torrieri, “Analysis and optimization of a frequency hopping ad hoc network in Rayleigh fading,” in *Proc. Virginia Tech Symp. on Wireless Personal Commun.*, (Blacksburg, VA), May 2012.
- C45. T. Ferrett, H. Ochiai, and **M.C. Valenti**, “Physical-layer network coding using FSK modulation under frequency offset,” in *Proc. IEEE Vehicular Tech. Conf. (VTC)*, (Yokohama, Japan), May 2012.
- C46. M. Fanaei, **M.C. Valenti**, and N. Schmid, “Distributed parameter estimation in wireless sensor networks using fused local observations,” in *Proc. SPIE Wireless Sensing, Localization, and Processing VII*, (Baltimore, MD), Apr. 2012.
- C47. T. Ferrett, **M.C. Valenti**, and D. Torrieri, “Noncoherent digital network coding using multi-tone CPFSK,” in *Proc. IEEE Military Commun. Conf. (MILCOM)*, (Baltimore, MD), Nov. 2011.

- C48. X. Xiang and **M.C. Valenti**, “Improving DVB-S2 performance through constellation shaping and iterative demapping,” in *Proc. IEEE Military Commun. Conf. (MILCOM)*, (Baltimore, MD), Nov. 2011.
- C49. **M.C. Valenti** and X. Xiang, “Constellation shaping for bit-interleaved coded APSK,” in *Proc. IEEE Int. Conf. on Commun. (ICC)*, (Kyoto, Japan), June 2011.
- C50. **M.C. Valenti**, “An information-theoretic approach to accelerated simulation of hybrid-ARQ systems,” in *Proc. IEEE Int. Conf. on Commun. (ICC)*, (Kyoto, Japan), June 2011.
- C51. M. Fanaei, **M.C. Valenti**, N. Schmid and V. Kulathumani, “Channel-aware distributed classification using binary local decisions,” in *Proc. SPIE Signal Processing, Sensor Fusion, and Target Recognition XX*, (Orlando, FL), Apr. 2011.
- C52. C. Nannapaneni, **M.C. Valenti**, and X. Xiang, “Constellation shaping for communication channels with quantized outputs,” in *Proc. Conf. on Info. Sci. and Sys. (CISS)*, (Baltimore, MD), Mar. 2011.
- C53. T. Ferrett, **M.C. Valenti**, and D. Torrieri, “Receiver design for Noncoherent digital network coding,” in *Proc. IEEE Military Commun. Conf. (MILCOM)*, (San Jose, CA), Nov. 2010.
- C54. **M.C. Valenti**, S. Cheng, and D. Torrieri, “Iterative multisymbol noncoherent reception of coded CPFSK,” in *Proc. IEEE Military Communications Conference (MILCOM)*, (Boston, MA), Oct. 2009.
- C55. **M.C. Valenti**, D. Torrieri, and T. Ferrett, “Noncoherent Physical-Layer Network Coding Using Binary CPFSK Modulation,” in *Proc. IEEE Military Communications Conference (MILCOM)*, (Boston, MA), Oct. 2009.
- C56. D. Torrieri and **M.C. Valenti**, “Efficient space-time block codes designed by a genetic algorithm,” in *Proc. IEEE Military Commun. Conf. (MILCOM)*, (San Diego, CA), Nov. 2008.
- C57. **M.C. Valenti**, R. Doppalapudi, and D. Torrieri, “A genetic algorithm for designing constellations with low error floors,” in *Proc. Conf. on Info. Sci. and Sys. (CISS)*, (Princeton, NJ), Mar. 2008.
- C58. D. Buckingham and **M.C. Valenti**, “The information-outage probability of finite-length codes over AWGN channels,” in *Proc. Conf. on Info. Sci. and Sys. (CISS)*, (Princeton, NJ), Mar. 2008.
- C59. S. Cheng, **M.C. Valenti**, and D. Torrieri, “Coherent and multi-symbol noncoherent CPFSK: Capacity and code design,” in *Proc. IEEE Military Commun. Conf. (MILCOM)*, (Orlando, FL), Oct. 2007.
- C60. D. Torrieri and **M.C. Valenti**, “Constellation labeling maps for low error floors,” in *Proc. IEEE Military Commun. Conf. (MILCOM)*, (Orlando, FL), Oct. 2007.
- C61. Rohit Iyer Seshadri, S. Cheng, and **M.C. Valenti**, “The BICM capacity of coherent continuous-phase frequency shift keying,” in *Proc. IEEE Vehicular Tech. Conf. (VTC)*, (Baltimore, MD), Oct. 2007.
- C62. X. Chen, S. Gong, N.A. Schmid, and **M.C. Valenti**, “UAV based distributed ATR under realistic simulated environmental effects,” in *Proc. SPIE Signal Processing, Sensor Fusion, and Target Recognition XVI*, (Orlando, FL), Apr. 2007.
- C63. D. Torrieri, S. Cheng, and **M.C. Valenti**, “Robust frequency-hopping system for channels with interference and frequency-selective fading,” in *Proc. IEEE Int. Conf. on Commun. (ICC)*, (Glasgow, Scotland), June 2007.
- C64. R. Rajagopalan, D. Reynolds, **M.C. Valenti**, B.D. Woerner, “The impact of an antenna array in a relay network,” in *Proc. IEEE Int. Conf. on Commun. (ICC)*, (Glasgow, Scotland), June 2007.
- C65. S. Cheng, R. Iyer Sehshadri, **M.C. Valenti**, and D. Torrieri, “The capacity of noncoherent continuous-phase frequency shift keying,” in *Proc. Conf. on Info. Sci. and Sys. (CISS)*, (Baltimore, MD), Mar. 2007.
- C66. S.A. Ahmad and **M.C. Valenti**, “A practical hybrid-ARQ protocol using noncoherent orthogonal modulation,” in *Proc. Conf. on Info. Sci. and Sys. (CISS)*, (Baltimore, MD), Mar. 2007.

- C67. K.G. Vardhe, D. Reynolds, and **M.C. Valenti**, “Outage probability of a multi-user cooperation protocol in an asynchronous CDMA cellular uplink,” in *Proc. Conf. on Info. Sci. and Sys. (CISS)*, (Baltimore, MD), Mar. 2007.
- C68. S. Cheng and **M.C. Valenti**, “Union bound analysis of bit interleaved coded orthogonal modulation with differential precoding,” in *Proceedings of the International Symposium on Information Theory (ISIT)*, (Seattle, WA), July 2006.
- C69. R. Iyer Seshadri and **M.C. Valenti**, “A capacity-based approach for designing bit-interleaved coded GFSK with noncoherent detection,” in *Proceedings of the International Symposium on Information Theory (ISIT)*, (Seattle, WA), July 2006.
- C70. R. Iyer Seshadri and **M.C. Valenti**, “A capacity-based search for energy and bandwidth efficient bit-interleaved coded noncoherent GFSK,” in *Proceedings of the Virginia Tech Symp. on Wireless Personal Commun.*, (Blacksburg, VA), June 2006.
- C71. R. Iyer Seshadri and **M.C. Valenti**, “Soft-in/soft-out noncoherent sequence detection for Bluetooth: Capacity, error rate and throughput analysis,” in *Proceedings of the IEEE Wireless Commun. & Networking Conf. (WCNC)*, (Las Vegas, NV), Apr. 2006, pp. 1354-1359.
- C72. T. Ghanim and **M.C. Valenti**, “The throughput of hybrid-ARQ in block fading under modulation constraints,” in *Proceedings of the Conference on Information Sciences and Systems (CISS)*, (Princeton, NJ), Mar. 2006.
- C73. S. Cheng, **M.C. Valenti**, and D. Torrieri, “Turbo-NFSK: Iterative estimation, noncoherent demodulation, and decoding for fast fading channels,” in *Proc. IEEE Military Commun. Conf. (MILCOM)*, (Atlantic City, NJ), Nov. 2005, pp. 3193-3199.
- C74. S. Cheng and **M.C. Valenti**, “Macrodiversity packet combining for the IEEE 802.11a uplink,” in *Proc. IEEE Wireless Commun. & Networking Conf. (WCNC)*, (New Orleans, LA), Mar. 2005, pp. 88-93.
- C75. B. Zhao, R. Iyer Seshadri, and **M.C. Valenti**, “Geographic random forwarding with hybrid-ARQ for ad hoc networks with rapid sleep cycles,” in *Proc. IEEE Global Telecommun. Conf. (GLOBECOM)*, (Dallas, TX), Dec. 2004, pp. 3047-3052.
- C76. S. Cheng and **M.C. Valenti**, “Bit-interleaved turbo-coded noncoherent orthogonal modulation with iterative demodulation and decoding: Capacity limits and convergence analysis,” in *Proc. Asilomar Conference on Signals, Systems, and Computers*, (Pacific Grove, CA), Nov. 2004, pp. 2020-2024.
- C77. J. Sun and **M.C. Valenti**, “Optimum frame synchronization for preamble-less packet transmission of turbo codes,” in *Proc. Asilomar Conference on Signals, Systems, and Computers*, (Pacific Grove, CA), Nov. 2004, pp. 1126-1130.
- C78. **M.C. Valenti** and B. Zhao, “Hybrid-ARQ based intra-cluster geographic relaying,” in *Proc. IEEE Military Commun. Conf. (MILCOM)*, (Monterey, CA), Nov. 2004, pp. 805-811, invited paper.
- C79. **M.C. Valenti**, E. Hueffmeier, B. Bogusch, and J. Fryer, “Towards the capacity of noncoherent orthogonal modulation: BICM-ID for turbo coded NFSK,” in *Proc. IEEE Military Commun. Conf. (MILCOM)*, (Monterey, CA), Nov. 2004, pp. 1549-1555.
- C80. S. Wei, D. Goeckel, and **M. Valenti**, “Asynchronous cooperative diversity,” in *Proc. Conf. on Info. Sci. and Sys. (CISS)*, (Princeton, NJ), Mar. 2004, 6 pages.
- C81. G.J. Raux, A. Feliachi, and **M.C. Valenti**, “Telecommunication of stabilizing signals in power systems,” in *Proc. North American Power Symposium (NAPS)*, (Rolla, MO), Oct. 2003, 5 pages.
- C82. B. Zhao and **M.C. Valenti**, “Some new adaptive protocols for the wireless relay channel,” in *Proc. Allerton Conf. on Commun., Control, and Comp.*, (Monticello, IL), Oct. 2003, pp. 1588-1589.
- C83. **M.C. Valenti** and B. Zhao, “Distributed turbo codes: Towards the capacity of the relay channel,” in *Proc. IEEE Vehicular Tech. Conf. (VTC)*, (Orlando, FL), Oct. 2003, pp. 6-9.

- C84. B. Zhao and **M.C. Valenti**, "Cooperative diversity using distributed turbo codes," in *Proc. Virginia Tech Symp. on Wireless Personal Commun.*, (Blacksburg, VA), June 2003, pp.143-152.
- C85. J. Sun and **M.C. Valenti**, "Synchronization of turbo codes based on online statistics," in *Proc. IEEE Int. Conf. on Commun. (ICC)*, (Anchorage, AK), May 2003, pp. 2733-2737.
- C86. B. Zhao and **M.C. Valenti**, "Convergence analysis of a new class of flexible hybrid concatenated codes," in *Proc. Southeastern Symp. Sys. Theory (SSST)*, (Morgantown, WV), Mar. 2003, pp. 283-287.
- C87. **M.C. Valenti** and N. Correal, "Exploiting Macrodiversity in Dense Multihop Networks and Relay Channels," in *Proc. IEEE Wireless Commun. & Networking Conf. (WCNC)*, (New Orleans, LA), Mar. 2003, pp. 1877-1882.
- C88. **M.C. Valenti**, "Improving uplink performance by macrodiversity combining packets from adjacent access points," in *Proc. IEEE Wireless Commun. & Networking Conf. (WCNC)*, (New Orleans, LA), Mar. 2003, pp. 636-641.
- C89. **M.C. Valenti** and M. Robert, "Improving the QoS of Bluetooth through turbo coding," in *Proc. IEEE Military Commun. Conf. (MILCOM)*, (Los Angeles, CA), Oct. 2002, pp. 1057-1061.
- C90. **M.C. Valenti** and M. Robert, "Custom coding, adaptive rate control, and distributed detection for Bluetooth," in *Proc. IEEE Vehicular Tech. Conf. (VTC)*, (Vancouver, BC), Sept. 2002, pp. 918-922.
- C91. S. Krishnamoorthy, M. Robert, S. Srikanteswara, **M.C. Valenti**, C. Anderson, and J.H. Reed, "Channel frame error rate for Bluetooth in the presence of microwave ovens," in *Proc. IEEE Vehicular Tech. Conf. (VTC)*, (Vancouver, BC), Sept. 2002, pp. 927-931.
- C92. N.S. Correal, J. Heck, and **M.C. Valenti**, "An analog turbo decoder for an (8,4) product code," in *Proc. IEEE Midwest Symp. on Circuits & Sys. (MWSCAS)*, (Tulsa, OK), Aug. 2002, pp. 632-635.
- C93. N. Chandran and **M.C. Valenti**, "Bridging the gap between parallel and serial concatenated codes," in *Proc. Virginia Tech Symp. on Wireless Personal Commun.*, (Blacksburg, VA), June 2002, pp. 145-154.
- C94. B. Naduvathuparambil, **M.C. Valenti**, and A. Feliachi, "Communication delays in wide area measurement systems," in *Proc. Southeastern Symp. Sys. Theory (SSST)*, (Huntsville, AL), Mar. 2002, pp. 118-122.
- C95. **M.C. Valenti**, M. Robert, and J.H. Reed, "On the throughput of Bluetooth data transmissions," in *Proc. IEEE Wireless Commun. & Networking Conf. (WCNC)*, (Orlando, FL), Mar. 2002, pp. 119-123.
- C96. B. Zhao and **M.C. Valenti**, "Per-survivor based detection of DPSK modulated high rate turbo codes over Rayleigh fading channels," in *Proc. Asilomar Conference on Signals, Systems, and Computers*, (Pacific Grove, CA), Nov. 2001, pp. 1026-1030, [invited paper](#).
- C97. **M.C. Valenti**, "An efficient software radio implementation of the UMTS turbo codec," in *Proc. IEEE International Symposium on Personal, Indoor, and Mobile Radio Communications (PIMRC)*, (San Diego, CA), Oct. 2001, pp. 108-113.
- C98. B. Zhao and **M.C. Valenti**, "Iterative demodulation and decoding of DPSK modulated turbo codes over Rayleigh fading channels," in *Proc. Virginia Tech Symposium on Wireless Personal Communications*, (Blacksburg, VA), June 2001, pp. 259-270.
- C99. D. Baker and **M.C. Valenti**, "The impact of channel estimation errors on space time block codes," in *Proc. Virginia Tech Symposium on Wireless Personal Communications*, Blacksburg, VA, June 2001, pp. 175-186.
- C100. Y. Tang and **M.C. Valenti**, "Coded transmit macrodiversity: Block space-time codes over distributed antennas," in *Proc. IEEE Vehicular Technology Conference (VTC)*, (Rhodes, Greece), May 2001, pp. 1435-1438.

- C101. N. Chandran and **M.C. Valenti**, “Hybrid ARQ using Serial Concatenated Convolutional Codes over Fading Channels” in *Proc. IEEE Vehicular Technology Conference (VTC)*, (Rhodes, Greece), May 2001, pp. 1410-1414.
- C102. **M.C. Valenti**, “Inserting turbo code technology in the DVB satellite broadcasting system,” in *Proc. Military Communications International Symposium (MILCOM)*, Los Angeles, CA, Nov. 2000, pp. 650-654.
- C103. **M.C. Valenti**, “Iterative channel estimation and decoding of turbo codes over flat-fading channels,” in *Proc. IEEE Wireless Communications and Networking Conference (WCNC)*, Chicago, IL, Sept. 2000, pp. 1019-1024, [invited paper](#).
- C104. **M.C. Valenti**, “An optimal soft-output multiuser detection algorithm and its applications,” in *Proc. Second International Symposium of Turbo Codes and Related Topics*, Brest, France, Sept. 2000, pp. 177-180.
- C105. Y. Wu and **M.C. Valenti**, “An ARQ technique using related parallel and serial concatenated convolutional codes,” in *Proc. Int. Conf. on Commun. (ICC)*, New Orleans, LA, June 2000, pp. 1390-1394.
- C106. **M.C. Valenti** and B.D. Woerner, “A bandwidth efficient pilot symbol technique for coherent detection of turbo codes over fading channels,” in *Proc. Military Communications International Symposium (MILCOM)*, Atlantic City, NJ, Nov. 1999, pp. 81-85.
- C107. **M.C. Valenti**, “Turbo codes and iterative processing,” in *Proc. IEEE New Zealand Wireless Commun. Symp.*, (Auckland, New Zealand), Nov. 1998.
- C108. **M.C. Valenti** and B.D. Woerner, “Combined multiuser detection and channel decoding with receiver diversity,” in *Proc. IEEE Global Telecommun. Conf. (GLOBECOM), Commun. Theory Mini-Conf.*, (Sydney, Australia), Nov. 1998, pp. 137-142.
- C109. **M.C. Valenti** and B.D. Woerner, “Multiuser detection with base station diversity,” in *Proc. IEEE Int. Conf. on Universal Personal Commun. (ICUPC)*, (Florence, Italy), Oct. 1998, pp. 1189-1194.
- C110. **M.C. Valenti** and B.D. Woerner, “Iterative multiuser detection for convolutionally coded asynchronous DS-CDMA,” in *Proc. IEEE Int. Symp. on Personal, Indoor, & Mobile Radio Commun. (PIMRC)*, (Boston, MA), Sept. 1998, pp. 213-217.
- C111. **M.C. Valenti** and B.D. Woerner, “Performance of turbo codes in interleaved flat fading channels with estimated channel state information,” in *Proc. IEEE Vehicular Tech. Conf. (VTC)*, (Ottawa, ON), May 1998, pp. 66-70.
- C112. **M.C. Valenti** and B.D. Woerner, “Combined multiuser reception and channel decoding for TDMA cellular systems,” in *Proc. IEEE Vehicular Tech. Conf. (VTC)*, (Ottawa, ON), May 1998, pp. 1915-1919.
- C113. **M.C. Valenti** and B.D. Woerner, “Variable latency turbo codes for wireless multimedia applications,” in *Proc. Int. Symp. on Turbo Codes & Related Topics*, (Brest, France), Sept. 1997, pp. 216-219.

## B. PRESENTATIONS

### *Invited Research Seminars and Tutorial Presentations*

1. “Cloud radio access networks for 5G communications,” [invited seminar](#), *Hughes Network Systems* (Germantown, MD), June 8, 2018.
2. “Cloud radio access networks for 5G communications,” [invited seminar](#), *Michigan Technological University* (Houghton, MI), April 13, 2018.
3. “Centralized radio access networks: Moving baseband to the Cloud,” a half-day [tutorial](#) presented at the *IEEE International Conference on Communications* (Kuala Lumpur, Malaysia), May 27, 2016.

4. “The computational requirements of centralized RAN,” invited presentation, *Communication Theory Workshop* (Nafplio, Greece), May 16, 2016.
5. “Research challenges in biometrics”, invited seminar, *Biometrics Institute meeting* (Australian Embassy, Washington, DC), Sep. 15, 2015.
6. “Computational outage: A new KPI for C-RAN,” invited seminar, *University of Southampton* (Southampton, UK), June 12, 2015.
7. “Centralized radio access networks: Moving baseband to the Cloud,” a half-day tutorial presented at the *Virginia Tech Symposium on Wireless Personal Communications and Annual Wireless Summer School*, (Blacksburg, VA), May 28, 2015.
8. “Coverage and rate in finite-sized device-to-device millimeter wave networks,” invited seminar, *McGill University* (Montreal, Quebec), Mar. 23, 2015.
9. “Centralized radio access networks: The case for baseband in the cloud,” invited seminar, *University of Toronto* (Toronto, ON), Nov. 12, 2014.
10. “Centralized radio access networks: The case for baseband in the cloud,” invited seminar, *University of New Mexico* (Albuquerque, NM), Oct. 31, 2014.
11. “Mobile biometrics in the cloud,” invited presentation, *Smart Card Alliance Government Conference* (Washington, DC), Oct. 30, 2014.
12. “Computational communication theory: A modern tool for engineering future wireless networks,” invited seminar, *Motorola Labs* (Plantation, FL), May 23, 2014.
13. “Interference and spatial modeling in wireless networks,” invited seminar, *University at Buffalo, The State University of New York* (Buffalo, NY), May 15, 2014.
14. “Interference and spatial modeling in wireless networks,” invited seminar, *University of Pisa* (Pisa, Italy), May 5, 2014.
15. “A day in the life of an LTE handset,” a half-day tutorial presented at the *Virginia Tech Symposium on Wireless Personal Communications and Annual Wireless Summer School*, (Blacksburg, VA), May 30, 2013.
16. “Interference and spatial modeling in wireless networks,” invited seminar, *Clemson University*, May 28, 2013
17. “Constellation shaping for LDPC-coded APSK,” invited seminar, *Hughes Network Systems* (Germantown, MD), Mar. 14, 2013.
18. “The LTE physical layer,” a half-day tutorial presented at the *Virginia Tech Symposium on Wireless Personal Communications*, (Blacksburg, VA), June 1, 2012.
19. “A high-performance computing approach to wireless network optimisation,” invited seminar, *University of Auckland* (Auckland, New Zealand), Feb. 3, 2012.
20. “Communication theory in the cloud: The transformative power of cheap utility computing,” plenary, *Australian Communication Theory Workshop* (Wellington, New Zealand), Jan. 30, 2012.
21. “Modern digital satellite television: How it works,” invited seminar, *United States Naval Academy*, Nov. 7, 2011.
22. “Modern digital satellite television: How it works,” invited seminar, *Georgia Institute of Technology*, Nov. 1, 2011.
23. “The transmission capacity of frequency-hopping ad hoc networks,” invited seminar, *Osaka University*, June 13, 2011.
24. “LDPC codes: Achieving the capacity of the binary erasure channel,” invited talk, *Math/CS Colloquium* (West Virginia University, Morgantown, WV), Nov. 30, 2009.
25. “Communication theory in the cloud,” invited seminar, *University of Toronto*, Oct. 30, 2009.

26. "Channel coding for IEEE 802.16e mobile WiMAX," a half-day tutorial presented at the *IEEE International Conference on Communications* (Dresden, Germany), June 18, 2009.
27. "Channel coding for IEEE 802.16e mobile WiMAX," a half-day tutorial presented at the *Virginia Tech Symposium on Wireless Personal Communications* (Blacksburg, VA), June 4, 2009.
28. "Mutual information as a tool for the design, analysis, and testing of modern communication systems," invited seminar presented to *Hughes Network Systems*, (Germantown, MD), June 8, 2007.
29. "Turbo and LDPC codes: Implementation, simulation, and standardization," a half-day tutorial presented at the *16<sup>th</sup> Virginia Tech/MPRG Symposium on Wireless Personal Communications and 2<sup>nd</sup> Annual Wireless Summer School*, (Blacksburg, VA), June 2006.
30. "Distributed Simulation of Modern Communication Systems Using the Global Grid Exchange," invited presentation, *Teaming to Win Conference*, Stonewall Jackson Resort (Walkersville, WV), June 1, 2006.
31. "Distributed Simulation of Modern Communication Systems Using the Global Grid Exchange," invited presentation, *West Virginia University Computing & Technology Symp.*, Apr. 12, 2006.
32. "Modern wireless network design based on constrained capacity," invited seminar, *Pittsburgh Signal Processing Society Seminar*, University of Pittsburgh, April 20, 2005.
33. "Coded-protocols for implementing cooperative diversity," invited research colloquium, *Motorola Corporate Research Labs*, (Schaumburg, IL), June 30, 2004.
34. "Bluetooth: Throughput analysis and tricks to improve performance," invited seminar, *Ohio University*, (Athens, OH), May 15, 2002.
35. "Bluetooth: Link and physical layer," invited research colloquium, *Motorola Florida Research Labs*, (Plantation, FL), Mar. 25, 2002.
36. "Turbo codes and iterative processing," invited research colloquium, *Motorola Florida Research Labs*, (Plantation, FL), Mar. 22, 2002.
37. "Emerging wireless standards," invited presentation, *Second YAS Broadband Venture Seminar*, West Virginia University, (Morgantown, WV), Sept. 7, 2001.
38. "Wireless communications research at West Virginia University," invited research colloquium, *National Radio Astronomy Observatory (NRAO)*, (Green Bank, WV), June 13, 2000.

*Oral Conference Presentations*

1. "Learning to authenticate with deep multibiometric hashing and neural network decoding," *IEEE Int. Conf. on Commun. (ICC)*, (Shanghai, China), May 21, 2019.
2. "The impact of correlated blocking on millimeter-wave personal networks," *IEEE Military Commun. Conf. (MILCOM)*, (Los Angeles, CA), Oct. 29, 2018.
3. "Outage correlation in finite and clustered wireless networks," *IEEE Int. Symp. on Personal, Indoor, & Mobile Radio Commun. (PIMRC)*, (Bologna, Italy), Sept. 12, 2018.
4. "Accurately accounting for random blockage in device-to-device mmwave networks," *Global Commun. Conf. (GLOBECOM)*, (Singapore), Dec. 5, 2017.
5. "Controlled barrage regions: Stochastic modeling, analysis, and optimization," *IEEE Military Commun. Conf. (MILCOM)*, (Baltimore, MD), Nov. 2016.
6. "Frequency hopping on a 5G millimeter uplink," in *Proc. Asilomar Conf. on Signals, Sys., & Computers*, (Pacific Grove, CA), Nov. 2015
7. "Optimization of an adaptive frequency-hopping networks," in *Proc. IEEE Military Commun. Conf. (MILCOM)*, (Tampa, FL), Oct. 2015.

8. "Effects of spatial randomness on locating a point source with distributed sensors," *IEEE Int. Conf. on Commun. (ICC) Workshop on Advances in Network Localization and Navigation (ANLN)*, (Sydney), June 2014.
9. "An iterative noncoherent relay receiver for the two-way relay channel," in *Proc. IEEE Int. Conf. on Commun. (ICC)*, (Budapest, Hungary), June 2013.
10. "Closing the gap to the capacity of APSK: Constellation shaping and degree distributions," in *Proc. Int. Conf. on Computing, Networking, and Commun. (ICNC)*, (San Diego, CA), Jan. 2013.
11. "Analysis and optimization of a frequency hopping ad hoc network in Rayleigh fading," *Virginia Tech Symp. on Wireless Personal Commun.*, (Blacksburg, VA), May 30, 2012.
12. "Iterative multisymbol noncoherent reception of coded CPFSK," presented at the *IEEE Military Communications Conference (MILCOM)*, (Boston, MA), Oct. 19, 2009.
13. "Robust frequency-hopping system for channels with interference and frequency-selective fading," *IEEE Int. Conf. on Commun. (ICC)*, (Glasgow, Scotland), June 2007.
14. "The impact of an antenna array in a relay network," *IEEE Int. Conf. on Commun. (ICC)*, (Glasgow, Scotland), June 2007.
15. "Macrodiversity packet combining for the IEEE 802.11a uplink," *IEEE Wireless Commun. & Networking Conf. (WCNC)*, (New Orleans, LA), Mar. 2005.
16. "Bit-interleaved turbo-coded noncoherent orthogonal modulation with iterative demodulation and decoding: Capacity limits and convergence analysis," *Asilomar Conference on Signals, Systems, and Computers*, (Pacific Grove, CA), Nov. 2004.
17. "Hybrid-ARQ based intra-cluster geographic relaying," in *Proc. IEEE Military Commun. Conf. (MILCOM)*, (Monterey, CA), Nov. 2004, [invited presentation](#).
18. "Towards the capacity of noncoherent orthogonal modulation: BICM-ID for turbo coded NFSK," *IEEE Military Commun. Conf. (MILCOM)*, (Monterey, CA), Nov. 2004.
19. "Some new adaptive protocols for the wireless relay channel," *Allerton Conf. on Commun., Control, and Comp.*, Monticello, IL, Oct. 3, 2003.
20. "Cooperative diversity using distributed turbo codes," *Virginia Tech Symp. on Wireless Personal Commun.*, Blacksburg, VA, June 6, 2003.
21. "Exploiting Macrodiversity in Dense Multihop Networks and Relay Channels," *IEEE Wireless Commun. & Networking Conf. (WCNC)*, New Orleans, LA, Mar. 20, 2003.
22. "Improving uplink performance by macrodiversity combining packets from adjacent access points," *IEEE Wireless Commun. & Networking Conf. (WCNC)*, New Orleans, LA, Mar. 19, 2003.
23. "Improving the QoS of Bluetooth Through Turbo Coding," *IEEE Military Commun. Conf. (MILCOM)*, Los Angeles, CA, Oct. 8, 2002.
24. "Custom coding, adaptive rate control, and distributed detection for Bluetooth," *IEEE Vehicular Tech. Conf. (VTC)*, Vancouver, BC, Sept. 26, 2002.
25. "An analog turbo decoder for an (8,4) product code," *IEEE Midwest Symp. on Circuits & Sys. (MWSCAS)*, Tulsa, OK, Aug. 7, 2002.
26. "Bridging the gap between parallel and serial concatenated codes," *Virginia Tech Symp. on Wireless Personal Commun.*, Blacksburg, VA, June 7, 2002.
27. "On the throughput of Bluetooth data transmissions," *IEEE Wireless Commun. & Networking Conf. (WCNC)*, (Orlando, FL), Mar. 18, 2002.
28. "Per-survivor based detection of DPSK modulated high rate turbo codes over Rayleigh fading channels," *Asilomar Conference on Signals, Systems, and Computers*, Pacific Grove, CA, Nov. 2001, [invited presentation](#).

29. "An efficient software radio implementation of the UMTS turbo codec," *IEEE International Symp. on Personal, Indoor, and Mobile Radio Communications (PIMRC)*, San Diego, CA, Oct. 2001.
30. "The impact of channel estimation errors on space time block codes," *Virginia Tech Symposium on Wireless Personal Communications*, Blacksburg, VA, June 2001.
31. "Coded transmit macrodiversity: Block space-time codes over distributed antennas," in *Proc. IEEE Vehicular Technology Conference (VTC)*, Rhodes, Greece, May 2001.
32. "Hybrid ARQ using Serial Concatenated Convolutional Codes over Fading Channels" *IEEE Vehicular Technology Conference (VTC)*, Rhodes, Greece, May 2001.
33. "Inserting turbo code technology in the DVB satellite broadcasting system," *Military Communications International Symposium (MILCOM)*, Los Angeles, CA, Nov. 2000.
34. "Iterative channel estimation and decoding of turbo codes over flat-fading channels," *Wireless Communications and Networking Conference (WCNC)*, Chicago, IL, Sept. 2000, invited presentation.
35. "An optimal soft-output multiuser detection algorithm and its applications," *Second International Symposium of Turbo Codes and Related Topics*, Brest, France, Sept. 2000.
36. "An ARQ technique using related parallel and serial concatenated convolutional codes," *Int. Conf. on Commun. (ICC)*, New Orleans, LA, June 2000.
37. "A bandwidth efficient pilot symbol technique for coherent detection of turbo codes over fading channels," *Military Communications International Symp. (MILCOM)*, Atlantic City, NJ, Nov. 1999.

*Poster Presentations*

1. "Multibiometric secure system based on deep learning," *poster presentation, IEEE Global Conf. on Signal and Information Processing (GlobalSIP)*, (Montreal, Canada), Nov. 2017
2. "Interference correlation in fixed and finite networks," *poster presentation, 2015 Communication Theory Workshop*, (Laguna Beach, CA), May 11, 2015.
3. "The role of computational outage in dense cloud-based centralized radio access networks," *poster presentation, IEEE Global Commun. Conf. (GLOBECOM)*, (Austin, TX), Dec. 2014
4. "A direct approach to spatial averaging: Revisiting Baccelli's Result," *poster presentation, 2014 IEEE Communication Theory Workshop*, (Curacao), May 26, 2014.
5. "An information-theoretic approach to accelerated simulation of hybrid-ARQ systems," *poster presentation, IEEE Int. Conf. on Commun. (ICC)*, (Kyoto, Japan), June 2011.
6. "Optimum frame synchronization for preamble-less packet transmission of turbo codes," *poster presentation, Asilomar Conference on Signals, Systems, and Computers*, (Pacific Grove, CA), Nov. 2004.
7. "Scaling cooperative diversity to large networks," *poster presentation, NATO Workshop on Cross-Layer Issues in the Design of Tactical Mobile Ad Hoc Wireless Networks*, (US Naval Research Laboratory, Washington, DC), June 2-3, 2004.
8. "Iterative demodulation and decoding of DPSK modulated turbo codes over Rayleigh fading channels," *poster presentation, Virginia Tech Symposium on Wireless Personal Communications*, (Virginia Tech, Blacksburg, VA), June 2001.

**C. RESEARCH FUNDING**

Research Title	Granting Agency	Dates of Award	Agency Funding	Role
I/UCRC Phase II: I/UCRC for Identification Technology Research	National Science Foundation (and Federal Affiliate Members)	3/15/2017 to 2/28/2022	\$3,167,536	PI
CITeR Affiliation Membership: Athena Sciences	Athena Sciences	6/1/2019 to 2/28/2022	\$10,000	PI

Declaration of Matthew C. Valenti  
Appendix A

**MATTHEW C. VALENTI**

CITeR Affiliation Membership: Incadence Membership	Incadence Strategic Solutions Corporation	6/1/2017 to 2/28/2022	\$30,000	PI
CITeR Affiliation Membership: FBI Membership	US Department of Justice: FBI	6/1/2017 to 2/28/2022	\$210,000	PI
CITeR Affiliation Membership: Northrop Grumman Corporation	Northrop Grumman Corporation	6/1/2017 to 2/28/2022	\$170,000	PI
CITeR Affiliation Membership: MorphoTrak	MorphoTrak	6/1/2017 to 8/15/2018	\$40,000	PI
CITeR Affiliation Membership: Stereovision Imaging, Inc.	Stereovision Imaging, Inc.	1/1/2019 to 12/31/2019	\$50,000	PI
Deep Hashing for Secure Multimodal Biometrics	Center for Identification Technology Research <i>an NSF I/UCRC</i>	1/1/2018 to 12/31/2018	\$50,000	PI
Survivable, Secure, and Dependable Wireless Communications	WPL, Inc.	1/1/2018 to 12/31/2019	\$124,650	PI (Sole)
Collaborative Research: I/UCRC for Identification Technology (CITeR)	National Science Foundation (and Industrial Affiliates)	3/15/2011 to 2/29/2017	\$3,363,384	PI
Iris Liveness Detection	MorphoTrak	9/1/2016 to 8/31/2017	\$50,000	PI
A Forensic Approach to Iris Analysis	Center for Identification Technology Research <i>an NSF I/UCRC</i>	8/16/2015 to 8/15/2016	\$34,400	PI
A Cloud-based Biometric Service Model for Iris and Ocular Recognition Using a Smartphone	Center for Identification Technology Research <i>an NSF I/UCRC</i>	1/2/2015 to 1/1/2016	\$29,000	Co-PI
I/UCRC FRP: Collaborative Research: Enabling Biometrics Research in the Cloud: Design and Demonstration	National Science Foundation	8/1/2013 to 7/31/2014	\$65,000	Co-PI
Cloud-Empowered Mobile Biometrics	Center for Identification Technology Research <i>an NSF I/UCRC</i>	4/15/2013 to 5/15/2014	\$34,400	PI
Intelligent Camera Networks for the Recognition of Human Activities in Urban Environments	Office of Naval Research	9/3/2009 to 9/2/2013	\$604,505	Co-PI
CRI: CRD: A Web-Accessible Grid-Computing Resource for the Telecommunications Research Community	National Science Foundation	5/01/2008 to 4/30/2013	\$578,351	PI (Sole)
Advanced Communications for Wireless Sensor Networks	US Army Research Laboratory	9/29/2010 to 12/31/2012	\$2,720,000	Investigator
Radiation Hardened Interceptor Communications, Phase II.	Welkin Sciences, LLC (Subcontract of phase II STTR award from MDA)	6/15/2009 to 5/31/2011	\$225,000	PI (sole)
Initiatives in Computational-Based Discovery	WVU Research Corporation (PSCoR)	1/7/2009 to 12/31/2009	\$28,784	PI
Evolutionary Design of Near-Optimal Space Links	Parabon Computation (Subcontract of a NASA award)	2/12/2007 to 2/28/2008	\$59,177	PI (Sole)
Phase II of Development of a	Augusta Systems	9/1/2005 to	\$277,498	PI

**MATTHEW C. VALENTI**

Concept for Swarmed mini-UAVs for Automatic Target Recognition	(Subcontract of phase II STTR award from US Navy)	8/31/2007		
Retrieval and Reconstruction of Magnetic Data Using Scanning Probe Microscopy	Federal Government (classified agency)	8/31/2004 to 8/30/2007	\$683,168	Co-PI
Multiterminal Relaying Strategies	Welkin Sciences, LLC (Subcontract of phase I STTR award from MDA)	10/1/2007 to 3/28/2007	\$30,000	PI (Sole)
Proximity Based Protocols for Highly Mobile Large Scale Ad Hoc Networks	Augusta Systems (Subcontract of US Navy award)	2/1/2006 to 12/31/2006	\$75,000	PI
Improved Code and Receiver Design for IFICS	Xenotran (Subcontract of phase II SBIR award from MDA)	4/15/2005 to 8/15/2006	\$87,585	PI (Sole)
Efficient and Reusable Framework for Deep Space Mission Communication Applications	NASA	7/1/2005 to 6/30/2006	\$20,000	PI (Sole)
Development of a Concept for Swarmed mini-UAVs for Automatic Target Recognition	Augusta Systems (Subcontract of phase I STTR award from ONR)	7/1/2004 to 9/15/2005	\$42,000	PI
Software Radio Architectures for Deep Space Communication	NASA	7/1/2004 to 6/30/2005	\$20,000	PI (Sole)
Advanced Packet-Based Communications: Turbo Coding, Synchronization, and Automatic Repeat Request	Office of Naval Research	4/1/2000 to 6/30/2004	\$345,000	PI (Sole)
Macrodiversity-Reception for the Wireless LAN Uplink: Feasibility Study and Application to IEEE 802.11a	Cisco Systems (University Research Program)	1/1/2003 to 12/31/2003	\$39,900 <i>no overhead</i>	PI (Sole)
Integrated Computing, Communication and Distributed Control of Deregulated Electric Power Systems	Department of Energy (DOE EPSCoR)	10/1/2000 to 9/30/2003	\$900,000	Co-PI
Development of Modules for VisSim/Comm	Eritek, Inc.	5/15/2001 to 12/31/2001	\$9,216	PI (Sole)
Turbo Space-Time Codes for High Data Rate Wireless Communications	NASA	5/15/2000 to 5/14/2001	\$13,333	PI (Sole)
Turbo Code Consulting	Coleman Research Corporation (now L3)	2/1/2000 to 7/31/2000	\$14,475	PI (Sole)

#### IV SERVICE

##### A. SERVICE TO THE PROFESSION

###### 1. Journal Editorship

**Editor-in-Chief, IEEE Communications Society Best Readings, 2015-present.**

Best Readings is an online repository of curated content. It publishes four issues per year, with each issue devoted to a particular technology. Examples include *Massive MIMO*, *Nanoscale Communication Networks*, *Cloud Communications and Networking*, and *Device-to-Device Communications*.

**Executive Editorial Committee, IEEE Transactions on Wireless Communications,**

Member: 2014-2017. Chair: 2016-2017.

*This committee assists the Editor-in-Chief with the screening of submissions, providing early reject decisions and assignment to Area Editors.*

**Editor**, *IEEE Transactions on Communications*, 2013-2017.

**Associate Editor**, *IEEE Wireless Communications Letters*, 2011-2014.

**Associate Editor**, *IEEE Transactions on Wireless Communications*, 2007-2011.

**Associate Editor**, *IEEE Transactions on Vehicular Technology*, 2003-2007.

2. Conference Organizer or Member of Technical Program Committee (TPC)

*IEEE Globecom/ICC Technical Content (GITC) Committee*

**Chair**, 2018-2021

**Vice Chair**, 2016-2017

**Member**, 2015-2019

This is the (technical) steering committee for Globecom and ICC, the flagship conferences on communication technology sponsored by the IEEE Communications Society.

*IEEE Military Communications Conference (MILCOM) Board*

**Member**, 2014-2020

This is the steering committee for MILCOM, the flagship IEEE/AFCEA conference on military conference.

**Technical Program Co-Chair**, *IEEE International Conference on Communications (ICC) 2021*, Montreal, Canada, June 2021.

**Technical Program Chair**, *IEEE Military Communications Conference (Milcom) 2017*, Baltimore, MD, Oct. 2017

**Unclassified Technical Program Chair**, *IEEE Military Communications Conference (Milcom) 2016*, Baltimore, MD, Oct. 2016

**Technical Program Vice Chair**, *IEEE Military Communications Conference (Milcom) 2015*, Tampa, FL, Oct. 2015

**Technical Program Vice Chair**, *IEEE Global Communications Conference (Globecom) 2013*, Atlanta, GA, Dec. 2013

**Workshop Co-Chair**, *4<sup>th</sup> International Workshop on 5G Architecture, 2017 International Conference on Communications (ICC) Workshops*, Paris, France, May 2017.

**Symposium Co-Chair**, Communication Theory Symposium, *IEEE International Conference on Communications (ICC) 2019*, Shanghai, China, June 2019.

**Symposium Co-Chair**, Wireless Communications Symposium, *IEEE Global Communications Conference (Globecom) 2015*, San Diego, CA, Dec. 2015.

**Track Chair**, Waveforms and Signal Processing Track, *IEEE Military Communications Conference (Milcom) 2014*, San Diego, CA, Oct. 2014.

**Track Co-Chair**, Waveforms and Signal Processing Track, *IEEE Military Communications Conference (Milcom) 2012*, Orlando, FL, Oct./Nov. 2012.

**Symposium Co-Chair**, Communication Theory Symposium, *IEEE International Conference on Communications (ICC) 2011*, Kyoto, Japan, June 2011.

**Track Co-Chair**, Waveforms and Signal Processing Track, *IEEE Military Communications Conference (Milcom) 2010*, San Jose, California, Oct./Nov. 2010.

**Symposium Co-Chair**, Wireless Communications Symposium, *IEEE International Conference on Communications (ICC) 2009*, Dresden, Germany, May 2009.

**Track Co-Chair**, Transmission Technologies, *IEEE Vehicular Technology Conference (VTC) Fall-2007*, Baltimore, MD, Oct. 2007.

**Member, Technical Program Committee, IEEE Global Telecommunications Conference (Globecom)** for the following symposia and years:

- Communication Theory Symposium 2019, Hawaii, Dec. 2019.
- Communication Theory Symposium 2018, Abu Dhabi, Dec. 2018.
- Communication Theory Symposium 2017, Singapore, Dec. 2017.
- Communication Theory Symposium 2016, Washington, DC, Dec. 2016.
- Communication Theory Symposium 2014, Austin, TX, Dec. 2014.
- Communication Theory Symposium 2012, Anaheim, CA, Dec. 2012.
- Communication Theory Symposium 2011, Houston, TX, Dec. 2011.
- Wireless Communications Symposium 2010, Miami, FL, Dec. 2010.
- Wireless Communications Symposium 2009, Honolulu, HI, Nov/Dec. 2009.
- Wireless Communications Symposium 2008, New Orleans, LA, Dec. 2008.
- Communication Theory Symposium 2007, Washington, DC, Nov. 2007.
- Next Generation Networks Symposium 2006, San Francisco, Dec. 2006.
- Wireless Communications Symposium 2005, St. Louis, Nov.-Dec. 2005.

**Member, Technical Program Committee, IEEE International Conference on Communications (ICC)** for the following symposia and years:

- Communication Theory Symposium 2020, Dublin, Ireland, May 2020.
- Communication Theory Symposium 2018, Kansas City, MO, May 2018.
- Communication Theory Symposium 2017, Paris, France, May 2017.
- Communication Theory Symposium 2016, Kuala Lumpur, May 2016.  
*Also Member of ICC-2016 Best Paper Award Committee*
- Wireless Communications Symposium 2016, Kuala Lumpur, May 2016.
- Communication Theory Symposium 2015, London, England, June 2015.
- Communication Theory Symposium 2014, Sydney, Australia, June 2014.
- Communication Theory Symposium 2013, Budapest, Hungary, June 2013.  
*Also Member of ICC-2013 Best Paper Award Committee*
- Communication Theory Symposium 2012, Ottawa, Canada, June 2012.
- Wireless Communications Symposium 2008, Beijing, China, May 2008.
- Wireless Communications Symposium 2007, Glasgow, Scotland, May 2007.
- General Conference 2005, Seoul, Korea, May 2005.

**Member, Technical Program Committee, IEEE Wireless Communications & Networking Conference (WCNC)** for the following years:

- 2018, Barcelona, Spain, Mar. 2018.
- 2017, San Francisco, CA, Mar. 2017.
- 2015, New Orleans, LA, Mar. 2015.
- 2014, Istanbul, Turkey, Apr. 2014.
- 2010, Sydney, Australia, Apr. 2010.
- 2009, Budapest, Hungary, Apr. 2009.
- 2008, Las Vegas (NV), Mar.-Apr. 2008.
- 2007, Hong Kong, Mar. 2007.
- 2006, Las Vegas (NV), Apr. 2006.

**Member, Technical Program Committee, IEEE Vehicular Technology Conference (VTC)** for the following tracks and years:

- Satellite Networks, Positioning Technologies, Localization and Navigation, Fall 2014, Vancouver, Sept. 2014.
- Cooperative Communication, Distributed MIMO and Relaying Track, Spring 2013, Dresden, Germany, June 2013.
- Transmission Technologies Track, Spring 2012, Yokohama, Japan, May 2012.

**Member, Technical Program Committee, IEEE Military Communications Conference (Milcom)** for the following tracks and years:

- Waveforms and Signal Processing Track 2013, San Diego, CA, Nov. 2013.
- Waveforms and Signal Processing Track 2011, Baltimore, MD, Nov. 2011.

**Member, Technical Program Committee**, *Wireless Telecommunications Symposium (WTS) 2015*, New York, NY, Apr. 2015.

**Member, Technical Program Committee, Member, Technical Program Committee**, *Wireless Telecommunications Symposium (WTS) 2015*, New York, NY, Apr. 2015.

**Member, Technical Program Committee**, *7<sup>th</sup> International Symposium on Turbo Codes & Iterative Processing*, Gothenburg, Sweden, Aug. 2012.

**Member, Technical Program Committee**, *European Wireless Conference 2008*, Prague, Czech Republic, June 2008.

**Member of Technical Program Committee**, Symposium on Cooperative Networks, *IEEE WirelessCom*, Maui, Hawaii, June 2005.

**Session Organizer**, *IEEE Military Communications Conference (Milcom)* for the following years:

- “Interference and Fading I,” Boston, MA, Oct. 2009.
- “Coding and Modulation for Noncoherent Channels,” Atlantic City, NJ, Nov. 2005.
- “Advanced Coding Techniques,” Monterey, CA, Nov. 2004.

**Workshop Co-chair**, “Infrastructure and Applications for the Mobile Internet,” *IEEE Int. Workshops on Enabling Technologies: Infrastructure for Collaborative Enterprises (WETICE)*, Cambridge, MA, June 2001.

### 3. Session Chair

**Session Chair**, “Energy Management Strategies,” *IEEE Int. Symp. on Personal, Indoor, & Mobile Radio Commun. (PIMRC)*, (Bologna, Italy), Sept. 10, 2018.

**Session Organizer and Chair**, “5G Cellular Networks,” *Asilomar Conference on Signals, Systems, and Computers*, (Pacific Grove, CA), Nov. 2015.

**Session Chair**, “Cooperative Communications,” *IEEE Global Communications Conference (Globecom)*, Austin, TX, Dec. 11, 2014.

**Session Chair**, “Cooperative Communications (session 1),” *IEEE Military Communications Conference (Milcom)*, (San Diego, CA), Nov. 18, 2013.

**Session Chair**, “Relay Channels II (session CT-11),” *IEEE International Conference on Communications (ICC)*, (Budapest, Hungary), June 12, 2013.

**Session Chair**, “Cooperative Networks (session WSP-20),” *IEEE Military Communications Conference (Milcom)*, (San Jose, CA), Nov. 3, 2010.

**Session Chair**, “Interference and Fading I (session U116),” *IEEE Military Communications Conference (Milcom)*, (Boston, MA), Oct. 20, 2009.

**Session Chair**, “CDMA (session WCS-19),” *IEEE International Conference on Communications (ICC)*, (Dresden, Germany), June 16, 2009.

**Session Chair**, “Topics in Networking (session FA2),” *Conf. on Info. Sci. and Sys. (CISS)*, (Baltimore, MD), Mar. 2007.

**Session Chair**, “Modulation and Coding (session 4C),” *IEEE Vehicular Tech. Conf. (VTC)*, (Baltimore, MD), Oct. 2, 2007.

**Session Chair**, “Space-time Communication (session MCS-10),” *IEEE Military Communications Symposium (MILCOM)*, (Orlando, FL), Oct. 31 2007.

**Session Chair**, “Phy 22: Space Time Codes I,” *IEEE Wireless Communications & Networking Conference (WCNC) 2005*, (New Orleans, LA), Mar. 2005.

**Session Chair**, “Phy 23: Space Time Codes II,” *IEEE Wireless Communications & Networking Conference (WCNC) 2005*, (New Orleans, LA), Mar. 2005.

**Session Chair**, “FEC,” *Asilomar Conference on Signals, Systems, and Computers*, (Pacific Grove, CA), Nov. 2004.

**Session Chair**: “Performance Analysis 8,” *IEEE Vehicular Tech. Conf. (VTC)*, (Vancouver, BC), Sept. 2002.

**Session Chair**: “High Data Rate Modulation and Coding Techniques,” *IEEE Midwest Symposium on Circuits and Systems (MWSCAS)*, (Tulsa, OK), Aug. 2002.

4. Reviewer/Panelist: Funding Agencies

**National Research Foundation**, *Panelist and Reviewer for Enhanced Access to the Radio Spectrum (EARS) Program (2016), BigData Program (2015), CyberSEES Program (2014), Communications Research Program (2002 and 2005), Integrative, Hybrid and Complex Systems (IHCS) Program (2007), Communications and Information Foundations (CIF) Program (2010 and 2012), Accelerating Innovation Research (AIR) Program (2011), Industry & University Cooperative Research Program (IUCRC) Program (2012, 2016, and 2018), and Spectrum Energy Efficiency, and Security (SpecEES) Program (2017).*

**Air Force Office of Scientific Research**, *Proposal reviewer for Dynamics & Controls Program, 2007*

**Army Research Office**, *Proposal reviewer for Wireless Communications and Networks program, 2004, 2005, 2008, 2011, 2013, 2014, and 2017.*

**Tennessee EPSCoR State Committee**, *Reviewed Pre-Proposal for DoD EPSCoR Competition, 2004.*

5. Reviewer: Journals

*ACM Mobile Communications Review*, 1 paper (2004).

*Arabian Journal of Science and Engineering*, 1 paper (2005).

*EURASIP Journal on Applied Signal Processing*, 1 paper (2003).

*IASTED International Journal of Computers and Applications (IASTED)*, 1 paper (2004).

*IEE Electronics Letters*, 16 papers (2000-2003).

*IEEE Trans. on Aerospace and Electronic Systems*, 1 paper (2007-2008).

*IEEE Communications Letters*, 26 papers (2000-2016).

*IEEE Journal on Selected Areas of Communications*, 19 papers (1999-2017).

*IEEE Signal Processing Letters*, 3 papers (2009-2012).

*IEEE Trans. on Broadcasting*, 1 paper (2017).

*IEEE Trans. on Circuits and Systems*, 1 paper (2002).

*IEEE Trans. on Communications*, 58 papers (1998-2016).

*IEEE Trans. on Education*, 3 papers (1999-2010).

*IEEE Trans. on Information Theory*, 1 paper (2005-2007).

*IEEE Trans. on Networking*, 2 papers (2005-2006, 2013).

*IEEE Trans. on Mobile Computing*, 1 paper (2012).

*IEEE Trans. on Signal Processing*, 3 papers (2001-2005).

*IEEE Trans. on Vehicular Tech.*, 13 papers (2002-2018).

*IEEE Trans. on Wireless Communications*, 34 papers (2001-2018).

*IEEE Vehicular Technology Magazine*, 1 paper (2016).

*IEEE Wireless Communications Magazine*, 1 paper (2011).

*IEEE Communications*, 1 paper (2010).

*Wireless Communications & Mobile Computing (Wiley)*, 1 paper (2001).

6. Reviewer: Books and Book Proposals

*Cambridge University Press*, 1 book proposal (2010).

*Springer*, 3 books (2011, 2014, 2017).

*Wiley & Sons*, 13 book proposals (1999-2014).

*Kluwer*, 1 book proposal (2003).

7. Reviewer: Conferences

*IEEE Global Communications Conference (Globecom)*, 2000-2020.

*IEEE Int. Conf. on Communications (ICC)*, 2001-2021.

*IEEE Int. Symp. on Information Theory (ISIT)*, 2003-2017.

*IEEE Int. Symp. on Information Theory and its Applications (ISITA)*, 2004.

*IEEE Int. Symp. on Personal, Indoor and Mobile Radio Communications (PIMRC)*, 2008-2013.

*IEEE Int. Symp. on Spread Spectrum Techniques and Applications (ISSSTA)*, 2004.

*IEEE Int. Symp. on Wireless Communication Systems (ISWCS)*, 2008.

*IEEE Int. Workshop on Computational Advances in Multi-Sensor Adaptive Processing (CAMSAP)*, 2015.

*IEEE Int. Workshop on Signal Processing Advances in Wireless Communications (SPAWC)*, 2005.

*IEEE Military Communications Conf. (MILCOM)*, 2003-2018.

*IEEE Vehicular Tech. Conf. (VTC)*, 2002-2014.

*IEEE Wireless Commun. & Networking Conf. (WCNC)*, 2004-2018.

*Int. Conf. on Commun. Systems (ICCS)*, 2004.

*Int. Symp. on Turbo Codes & Iterative Processing*, 2012.

*Int. Symp. on Modeling & Optimization in Mobile, Ad Hoc, and Wireless Networks*, 2017.

8. Professional Offices

**Chair**, Communication Theory Technical Committee (IEEE Communications Society), 2015-2016.

**Vice Chair**, Communication Theory Technical Committee (IEEE Communications Society), 2013-2014.

**President**, IEEE Upper Monongahela Subsection (under Pittsburgh Section), 2003.

**Treasurer**, IEEE Upper Monongahela Subsection, 2002.

**Delegate at Large**, IEEE Upper Monongahela Subsection, 1999-2001.

9. Professional membership

**Fellow**, Institute of Electrical and Electronics Engineers  
Student Member 1992, Member 1999, Senior Member 2007, Fellow 2018.

**Member**, Radio Club of America, 1999-present.

**Member**, Phi Beta Phi, 1991-present.

**Member**, Eta Kappa Nu, 1990-present.

**B. SERVICE TO THE UNIVERSITY**

**Member**, WVU Board of Governors, 2017-2019.

**Senator**, WVU Faculty Senate, 2006-2009, 2012-2018.

**Secretary**, 2018-2019.

**Chair**, 2017-2018.

**Chair-elect**, 2016-2017.

**Member**, WVU Faculty Senate Executive Committee, 2015-2019.

**Chair**, 2017-2018.

**Member**, Faculty Senate Curriculum Committee, 2012-2017.

**Chair**, 2015-2017.

**Chair-elect**, 2014-2015.

**Member**, Faculty Senate Committee on Committees, 2016-2019.

**Member**, Faculty Senate Faculty Welfare Committee, 2016-2018.

**Member**, Faculty Senate General Education Committee, 2016-2017.

**Member**, Presidential Search Committee, 2014.

*One of the three faculty members selected to participate in the search for the 24<sup>th</sup> president of WVU*

**Member**, Faculty Senate Library Committee, 2005-2008.

**Chair**, 2007-2008.

**Member**, WVU Educational Responsibility Roundtable, 2012-2014.

*Roundtable charged with developing a plan for meeting Goal 1 of WVU's Strategic Plan: "Engage undergraduate, graduate, and professional students in a challenging academic environment."*

**Member**, Heebink Award Selection Committee, 2014-2016.

**Member**, Committee to Conduct 5-year Review of the Dean of Libraries, 2008-2009.

**Member**, Wireless Task Force, 2001-2002.

*An Ad Hoc University Committee charged to study the impact and implementation of a campus-wide wireless network.*

**Associate Member**, Mountain, 2004-present.

**Faculty Co-Advisor**, WVU Amateur Radio Club, 1999-present.

**C. SERVICE TO THE COLLEGE**

**Member**, Statler Promotion and Tenure Committee, 2015-2019.

**Chair**, 2017-2018.

**Member**, Undergraduate Academic Affairs Committee, Statler College, 2010-2019.

**Chair**, 2011-2014.

**Member**, ABET Leadership Team, Statler College of Eng. & Mineral Res., 2012-2021.

*Committee charged with preparing for 2015 and 2021 ABET visits.*

**Member**, Freshman Engineering Faculty Promotion Committee, 2013.

*Charged with evaluating a teaching assistant professor up for a 3-year renewal.*

**Member**, Outstanding Advisor Selection Committee, College of Engineering and Mineral Resources, 2010 and 2012.

**Member**, Library Committee, College of Engineering and Mineral Resources, 2004-2008.

**Chair**, 2006-2007.

**Member**, Teaching Award Committee, College of Engineering and Mineral Resources, 2008.

**D. SERVICE TO THE DEPARTMENT**

**Faculty Advisor**, WVU chapter of Eta Kappa Nu (HKN), the EE honor society, 2002-2017.

**Member**, CSEE Promotion and Tenure Committee, 2000-2002, 2005-2007, 2010-2012, and 2013-2015.  
**Chair**, 2014-2015.

**Member**, CSEE Faculty Search Committee, 2001-2002, 2002-2003, and 2014-2015.  
**Chair**, 2013-2015.

**Member**, EE Curriculum Committee, 1999-present.  
**Chair**, 2010-present.

**Chair**, EE Graduate Curriculum Committee, 2007-2010.

**Chair**, CSEE Computer Systems Committee, 2004-2006.

**Chair**, Lane Fellowship Committee, 2000-2003.

**Member**, CSEE Graduate Affairs Committee, 2010-present.

**Member**, CSEE Computer Systems Committee, 2004-2015.  
**Chair**, 2004-2006.

**MATTHEW C. VALENTI**

**V. INSTRUCTION**

**A. COURSES TAUGHT**

**UNDERGRADUATE COURSES**

Course Number	Title	Semester	Number of Students
EE 329	Signals & Systems II	Spring 2005	43
		Spring 2004	63
		Spring 2002	38
EE 461	Introduction to Communication Systems	Fall 2002	44
		Fall 2001	36
		Fall 2000	14
		Fall 1999	16
EE 463	Digital Signal Processing Fundamentals	Spring 2010	25
		Spring 2009	34
		Spring 2008	35
		Spring 2007	44
		Spring 2006	36
CPE 462	Wireless Networking	Fall 2019	14
		Fall 2018	14
		Fall 2017	6
		Fall 2016	13
		Fall 2015	10
		Fall 2013	24
		Fall 2012	30
		Fall 2010	15
		Fall 2008	22
		Fall 2005	30
		Fall 2004	43
		Fall 2003	34
EE/CPE 495	Independent Study: <i>Wireless Networking</i>	Spring 2003	4

**GRADUATE COURSES**

Course Number	Title	Semester	Number of Students
EE 513	Stochastic Systems Theory	Fall 2014	33
		Fall 2011	27
		Fall 2009	35
		Fall 2006	63
		Fall 2004	51
		Fall 2002	39
		Fall 2001	27
EE 561	Communication Theory	Spring 2019	4
		Spring 2017	11
		Spring 2015	24
		Spring 2013	18
		Spring 2011	25
		Spring 2009	27
EE 562	Wireless Communication Systems	Fall 2007	8

**MATTHEW C. VALENTI**

EE 567	Coding Theory	Spring 2018	4
		Spring 2016	19
		Spring 2014	28
		Spring 2012	16
		Spring 2010	29
		Spring 2008	24
		Spring 2006	19
		Spring 2004	27
EE/CPE 695	Independent Study: <i>Wireless Networking</i>	Fall 2004	1
	Independent Study: <i>Wireless Application Protocol</i>	Summer II 2000	1
	Independent Study: <i>DSP Implementation of Communication Systems</i>	Spring 2001	4
	Independent Study: <i>Wireless Communication Systems</i>	Summer II 2001	4
CS/EE/CPE 796	Graduate Seminar	Fall 2016	CS 796: 25 / CPE 796: 1 / EE 796: 18
		Spring 2016	CS 796: 12 / CPE 796: 0 / EE 796: 25
		Fall 2015	CS 796: 28 / CPE 796: 2 / EE 796: 35
		Spring 2015	CS 796: 11 / CPE 796: 5 / EE 796: 27
		Fall 2014	CS 796: 23 / CPE 796: 5 / EE 796: 31
		Spring 2014	CS 796: 20 / CPE 796: 1 / EE 796: 35
		Fall 2013	CS 796: 17 / CPE 796: 1 / EE 796: 42
		Spring 2013	CS 796: 18 / CPE 796: 3 / EE 796: 37
		Fall 2012	CS 796: 31 / CPE 796: 2 / EE 796: 40
		Spring 2012	CS 796: 18 / CPE 796: 3 / EE 796: 30
		Fall 2011	CS 796: 29 / CPE 796: 4 / EE 796: 32
		Spring 2011	CS 796: 11 / CPE 796: 2 / EE 796: 32
		Fall 2010	CS 796: 18 / CPE 796: 1 / EE 796: 27
		Spring 2010	CS 796: 17 / CPE 796: 3 / EE 796: 19
		Fall 2009	CS 796: 25 / CPE 796: 2 / EE 796: 37
		Spring 2009	CS 796: 8 / CPE 796: 1 / EE 796: 39
		Fall 2008	CS 796: 9 / EE 796: 48
		Spring 2008	EE 796: 38
		Fall 2007	EE/CPE 796: 40
		Spring 2007	EE/CPE 796: 66
		Fall 2006	EE/CPE 796: 67
		Spring 2006	CPE 796: 4 / EE 796: 48
		Fall 2005	CPE 796: 1 / EE 796: 47 / CS 696: 2
		Spring 2004	CPE 796: 6 / EE 796: 80
		Fall 2003	CPE 796: 14 / EE 796: 36
		Spring 2003	CPE 796: 10 / EE 796: 70

**B. GRADUATE STUDENTS**

1. Major Professor

*Completed Ph.D. Students*

1. **Shi Cheng**, *Coded Continuous-phase FSK: Information Theoretic Limits and Receiver Design*, Nov. 12, 2007.
2. **Mohammad Fanaei**, *Distributed Detection and Estimation in Wireless Sensor Networks*, July 22, 2016.
3. **Terry Ferrett**, *Receiver Design for Physical-Layer Network Coding in the Two-Way Relay Channel*, July 21, 2017.
4. **Rohit Iyer Seshadri**, *Capacity-Based Parameter Optimization of Bandwidth Constrained CPM*, Aug. 31, 2007.
5. **Jian Sun**, *Synchronization for Capacity-Approaching Coded Systems*, Oct. 25, 2004.
6. **Salvatore Talarico**, *Role of Interference and Computational Complexity in Modern Wireless Networks: Analysis, Optimization and Design*, Sept. 10, 2015.
7. **Xingyu Xiang**, *Optimization of a Coded-Modulation System with Shaped Constellation*, Apr. 12, 2013.
8. **Bin Zhao**, *Multiterminal Relay Networks: Performance Bounds, Protocol Design, and Channel Coding Strategies*, Apr. 19, 2004.

*Completed M.S. Students (Thesis or Problem Report students only)*

1. **Syed Amaar Ahmad**, *A Robust Hybrid-ARQ Protocol for Relay Networks*, Apr. 4, 2007.
2. **Naga Gopi Krishna Alapati**, *Green Cellular Networks: When Should a Base Station Be Turned Off?*, Dec. 2, 2015.
3. **Deepthi Ancha**, *Implementation of Tail-Biting Convolutional Codes*, Nov. 7, 2008.
4. **Geetanjalee Athavale**, *Enabling Wireless Data Applications on Mobile Devices*, Oct. 28, 2002.
5. **Dirk Baker**, *Space-Time Block Coding with Imperfect Channel Estimates*, Apr. 10, 2001.
6. **Sri Lakshmi Balineni**, *Stochastic Geometry Analysis of a Class of Cooperative Relaying Protocols*, Apr. 18, 2017.
7. **Anupama Battula**, *Implementation of Extrinsic Information Transfer Charts*, Oct. 24, 2008.
8. **Aruna Sri Bommagani**, *Distributed Monte Carlo Simulation*, Nov. 3, 2011.
9. **David Buckingham**, *Information Outage Analysis of Finite-Length Codes*, Apr. 7, 2008.
10. **Naveen Chandran**, *Hybrid ARQ with Parallel and Serial Concatenated Convolutional Codes for Next Generation Wireless Communications*, June 19, 2001.
11. **Sheetu Dasari**, *Implementation & Analysis of a Hybrid-ARQ Based Cooperative Diversity Protocol Using Reed-Solomon Codes*, Nov. 14, 2005.
12. **John Deal**, *Fractal Analysis of Fingerprints*, Nov. 12, 2007.
13. **Raghu Doppalapudi**, *Optimization of Bit Interleaved Coded Modulation Using Genetic Algorithms*, Oct. 20, 2008.
14. **Terry Ferrett**, *Data Recovery from Magnetic Media Using Magnetic Force Microscopy*, Apr. 25, 2008.
15. **Ramesh Gali**, *A Tool for the Statistical Analysis and Post-Processing of Distributed Sensor Network Data*, Mar. 31, 2003.
16. **Anusha Gangadi**, *Object-Oriented Implementation of LTE Turbo Codes*, Nov. 5, 2010.

17. **Timothy Gerkin**, *Implementation of LDPC Codes Using the IEEE 802.16e Standard*, Apr. 9, 2008.
18. **Tarik Ghanim**, *Analysis of Hybrid-ARQ Based Relaying Protocols under Modulation Constraints*, Apr. 26, 2006.
19. **Ruthika Gunda**, *Simulation of the Physical Link Layer of GSM*, July 8, 2004.
20. **Sai Deepthi Katragunta**, *Simulation of the Performance of IEEE 802.16-2004 Fixed Broadband Wireless Access Technology*, Jan. 17, 2007.
21. **Raja Katuri**, *Efficient Simulation of Communication Systems on a Desktop Grid*, Aug. 25, 2006.
22. **Haranath Madineni**, *A Diagnostic Tool for Performance Assessment of Bluetooth Data Transmissions*, Dec. 4, 2003.
23. **Sushma Mamidipaka**, *Implementation of Block Turbo Codes from IEEE 802.16 Standard*, Oct. 27, 2008.
24. **Gopal Manchikanti**, *A Framework for Developing Wireless Applications*, May 1, 2001.
25. **Mamatha Mannava**, *Simulation of the Performance of IEEE 802.16-2004 Wireless MAN-OFDM PHY Layer*, Apr. 11, 2008.
26. **Sundara Ram Matta**, *Visualizing Outage Performance in Wireless Networks in the Presence of Rayleigh Fading*, Dec. 4, 2015.
27. **Brianna Maze**, *Analysis of Hamming and Bernard's Patent and the Bluetooth Standard*, Apr. 25, 2016.
28. **John Mazzie**, *Relay Communications Over Frequency-Selective Fading Channels*, Apr. 11, 2008.
29. **Lokesh Merupula**, *Simulation of IEEE 802.11a PHY Layer*, Sept. 9, 2004.
30. **Biju Naduvathuparambil**, *Telecommunications for a Deregulated Power Industry*, July 12, 2002.
31. **Chandana Nannapaneni**, *Constellation Shaping for Communication Channels with Quantized Outputs*, Nov. 11, 2010.
32. **Nisha Narasimhan**, *Data Synchronization for Bluetooth Networks*, Dec. 4, 2003.
33. **Senthil Ramamurthy**, *Multiple Quantum Filtered Localized Spectroscopy at 3T*, Apr. 14, 2004.
34. **Vasavi Rangammagari**, *Optical-Based ATR Algorithms for Applications in Swarmed UAVs*, Aug. 4, 2006.
35. **Guillaume Raux**, *Telecommunication of Stabilizing Signals in Power Systems*, Apr. 18, 2003.
36. **Sumit Sharma**, *Optimization of an iDEN Cellular Network*, Feb. 18, 2005.
37. **Yipeng Tang**, *DSP Implementation of Trellis Coded Modulation and Distributed Space Time Coding*, Jan. 25, 2001.
38. **Sujay Telang**, *Wireless Streaming Multimedia Applications*, Oct. 2, 2000.
39. **Srinivas Vemury**, *Comparison of Decoding Algorithms for LDPC Codes*, April 16, 2004.
40. **Kyle Whetzel**, *Complexity Aware C-RAN Scheduling for LDPC Codes over BEC*, Dec. 21, 2016.

2. Member of Research and Advisory Committees

*Served on the committee of 59 completed M.S. students (thesis or problem report), and 16 completed Ph.D. students. Additionally, served as an external examiner or dissertation committee member for 9 students outside of WVU.*

#### UNDERGRADUATE STUDENTS

*Faculty advisor for 15 completed senior design projects.*

*Supervised and supported undergrad researchers during summers of 2002, 2003, 2006, 2010, and 2013.*

*Academic advisor to approximately 25 EE, CPE, and dual (CPE/EE and CPE/BIOM) majors per semester.*

#### C. INSTRUCTIONAL ACTIVITIES

##### 1. Course Development

Developed the following courses, which were new to WVU (permanent course numbers indicated):

*Wireless Networking (CPE 462)*

*Wireless Communication Systems (EE 562)*

*Coding Theory (EE 567)*

##### 2. Independent Study

Led undergraduate and graduate students in the following asynchronous learning experiences:

*DSP Implementation of Communication Systems*

*Wireless Application Protocol*

*Wireless Networking*

*Wireless Communication Systems*

##### 3. Preparation of General Pedagogical Material

- M.C. Valenti, The Wireless Networking Workbook, 2013; revised 2018.  
*A 33-page companion for CPE 462 (Wireless Networking) used during the Fall 2013 semester.*
- M.C. Valenti, The Coding Theory Workbook, 2012.  
*A 56-page companion for EE 567 (Coding Theory) used during the Spring 2012 semester.*
- M.C. Valenti, The DSP Workbook, 2011  
*A 113-page companion text for EE 463 used by Prof. Brian Woerner during the Spring 2011 semester and Prof. Reynolds during the Spring 2012 and 2013 semesters. An “instructor edition” was also created, which contains worked out exercises (which are blank in the student edition).*
- M.C. Valenti, Solutions Manual for the DSP Workbook, 2011.  
*A 63-page solutions manual for the end-of-chapter exercises.*
- M.C. Valenti, The Signals and Systems Workbook, 2002, revised 2005.  
*A 75-page companion text for EE 329 developed during the Spring 2002 semester and used during from Spring 2003 to Spring 2013 by myself, Prof. Jerabek, Prof. Reynolds, Prof. Woerner, and Prof. Schmid.*
- M.C. Valenti, Solutions Manual for the Signals and Systems Workbook, 2002, revised 2005.  
*A 75-page solutions manual for the end-of-chapter exercises.*