

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

GOOGLE LLC, CELLCO PARTNERSHIP D/B/A VERIZON WIRELESS, T-MOBILE USA, INC., AT&T SERVICES, INC., NOKIA OF AMERICA, CORP.,
AND ERICSSON INC.

Petitioners

v.

KT CORPORATION (Patent Owner) and
PEGASUS WIRELESS INNOVATION LLC (Exclusive Licensee)

Case No. IPR2025-00292

Patent 9,894,644

**DECLARATION OF SUMIT ROY IN SUPPORT OF PETITION FOR
INTER PARTES REVIEW OF U.S. PATENT NO. 9,894,644**

**Petitioners' Exhibit 1008
Google et al. v. KT Corporation et al.
IPR2025-00292**

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Exhibit No.	Description
1001	U.S. Patent No. 9,894,644, issued on February 13, 2018 (“the ’644 Patent”)
1002	File History of U.S. Patent Application No. 15/024,862, filed on March 25, 2016 (“the ’862 Application”)
1006	PCT International Publication No. WO 2014/055878, published on April 10, 2014 (“Lee”)
1007	U.S. Patent Publication No. 2016/0353420, published on December 1, 2016 (“You”)
1009	<i>Curriculum Vitae</i> of Sumit Roy
1010	U.S. Provisional Patent Application No. 61/863,223, filed August 7, 2013 (“Lee Priority Application”)
1011	U.S. Provisional Patent Application No. 61/807,945 filed April 3, 2013
1012	U.S. Provisional Patent Application No. 61/753,263 filed January 16, 2013
1013	U.S. Provisional Patent Application No. 61/710,315 filed October 5, 2012
1014	Plaintiff and Counterclaim-Defendant Pegasus Wireless Innovation LLC’s Initial Proposed Constructions dated December 4, 2024, <i>Pegasus Wireless Innovation LLC v. Verizon Communications Inc., et al.</i> , Civ. Action No. 2:23-cv-00640 (E.D. Tex.)
1015	Defendants and Intervenor’s P.R. 4-2 Preliminary Claim Constructions and Extrinsic Evidence dated December 4, 2024, <i>Pegasus Wireless Innovation LLC v. Verizon Communications Inc., et al.</i> , Civ. Action No. 2:23-cv-00640 (E.D. Tex.)

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Exhibit No.	Description
1016	PCT International Publication No. WO 2015/018075, filed August 9, 2013 and published on February 12, 2015 (“Zhuang”)
1019	Certified Translation of U.S. Provisional Patent Application No. 61/862,518 (“You Priority Application”)
1021	3GPP TS 36.213 v11.1.0 (2012-12) 3rd Generation Partnership Project; Technical Specification Group Radio Access Network; Evolved Universal Terrestrial Radio Access (E-UTRA); Physical layer procedures; (Release 11) (“3GPP 36.213”)
1022	3GPP TR 36.888 v12.0.0 (2013-06) 3rd Generation Partnership Project; Technical Specification Group Radio Access Network; Study on provision of low-cost MTC UEs based on LTE; (Release 12) (“3GPP 36.888”)

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I, Sumit Roy, hereby state as follows:

1. I have been retained by GOOGLE LLC , CELLCO PARTNERSHIP D/B/A VERIZON WIRELESS, T-MOBILE USA, INC., AT&T SERVICES, INC., NOKIA OF AMERICA, CORP., AND ERICSSON INC. (“Petitioners”) as an independent expert consultant in this *inter partes* review (“IPR”) proceeding before the United States Patent and Trademark Office (“PTO”).

2. I have been asked by Counsel for Petitioners (“Counsel”) to consider whether certain references teach or suggest the features recited in Claims 1-3 (“the Challenged Claims”) of U.S. Patent No. 9,894,644 (“the ’644 Patent”) (EX1001). My opinions and the bases for my opinions are set forth below.

3. I understand that the ’644 Patent is assigned to KT Corporation, which has given an exclusive license to Pegasus Wireless Innovation LLC.

4. I have been asked to provide an independent analysis of the ’644 Patent in view of the asserted prior art publications cited in the Petition. This Declaration is limited to those issues.

5. I am not, and never have been, an employee of KT Corporation, Pegasus Wireless Innovation LLC, or Petitioners. I am not receiving compensation for this Declaration beyond my normal hourly fees based on my time actually spent analyzing and documenting my opinions herein on the ’644 Patent, the asserted prior art publications cited in this Declaration and in the Petition, and the issues related

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thereto. My compensation is not related to the outcome of this proceeding, and I will not receive any additional compensation based on the outcome of any IPR or other proceeding involving the '644 Patent.

6. I am being compensated at my ordinary and customary consulting rate for my work, which is \$625 per hour. My compensation is in no way contingent on the nature of my findings, the presentation of my findings in testimony, or the outcome of this or any other proceeding. I have no other financial interest in this proceeding.

7. I have personal knowledge of the facts and opinions stated herein and, if called as a witness, could and would testify competently to them under oath.

I. BACKGROUND AND QUALIFICATIONS

8. All of my opinions stated in this declaration are based on my own personal knowledge and professional judgment. In forming my opinions, I have relied on my knowledge and experience in the field of wireless networks.

9. I am an expert in the field of wireless networks (both commercial licensed cellular and unlicensed technologies) – having studied, taught, practiced, and researched this field for over thirty years. I summarize in this section my educational background, work experience, and other relevant qualifications. I understand that my curriculum vitae (CV) is being filed as EX1009 in this proceeding. I certify that EX1009 is a true and correct copy and sets forth the details

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of my educational history, work history, patents, and other related professional experience.

10. I earned my Bachelor of Technology degree in Electrical Engineering from Indian Institute of Technology in Kanpur, India in 1983. Subsequently, I earned my Master of Science and Doctor of Philosophy degrees in Electrical & Computer Engineering from University of California in Santa Barbara – with my dissertation being on “Estimation Strategies for a Network of Distributed Sensors.” I also simultaneously was awarded a Master of Arts in Statistics & Applied Probability from University of California in Santa Barbara in 1988.

11. While a graduate student (1983 through 1988), I worked on various projects related to wireless communication and radar systems using a mix of analytical modeling and computer simulation. This initial exposure to 3G cellular systems initiated a career pathway that traversed network evolution through 4G and current 5G systems, giving me a working knowledge of 3GPP technology standards governing these systems. In July 1988, I joined the faculty of the University of Pennsylvania as an Assistant Professor in the Department of Electrical Engineering, where I taught an upper level undergraduate course on “Communication Systems” and graduate level courses on “Advanced Digital Signal Processing” and “Digital Communications” and conducted research in my specialization.

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12. In January 1995, I became a tenured Associate Professor in the Division of Engineering at the University of Texas at San Antonio, in San Antonio, Texas. In April 1998, I transferred to a tenured Associate Professor position in the Department of Electrical Engineering, University of Washington (“UW”) in Seattle, Washington and was promoted to Professor in September 2002. As a faculty member at UW, I have taught courses and directed research in networking and telecommunications, including 802.11 WLAN and cellular technologies. From September 2014 to September 2019, I was awarded Integrated Systems Term Professorship at UW in recognition of my leadership and national stature in this area.

13. I took full-time leave from UW to serve as a Senior Staff Researcher at Intel Labs, Hillsboro, OR from September 2001 to December 2003. In that role, I served as Wireless Systems Architect researching IEEE 802.15.3a Ultra-Wideband PHY layer for Wireless Personal Area Networks and pre-802.11n (MIMO WiFi). I also represented Intel at IEEE Standards meetings and coordinated with other industry partners. My research resulted in several patents relating to the above, including design implementation of MIMO WiFi transceivers. More recently (July 2020 – Aug. 2022), I served as Program Lead for the U.S. Department of Defense, Office of the Under Secretary of Defense’s Innovate Beyond 5G program for research and experimentation within the 5G-to-xG (now renamed FutureG) initiative,

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where I had responsibility for monitoring commercial 5G evolution via 3GPP standardization.

14. As a result of my academic teaching, research, industry, and federal government experience, I have significant knowledge of wireless networking technologies. Since 1988, I have served as Principal Investigator for multiple competitively awarded research projects (in excess of \$10 M net funding) from various national organizations (both federal government and private industry sources) to support my research, as listed in my CV. I have authored and co-authored over 200 journal publications, conference proceedings, technical papers, book chapters, and technical presentations in a broad array of communications-related technologies, including networking and wireless communication. My work on Radar-WiFi Spectrum Sharing was recognized as the best paper published in IEEE Trans. Aerosp. Elect. Systems with annual Barry Carlton Award in 2016.

15. My professional affiliation with IEEE include serving in various professional societies as a reviewer for a number of technical publications, journals, and conferences. I have also received multiple awards and recognitions, most notably, elevation to IEEE Fellow in 2007 for “contributions to multi-user communications theory and cross-layer design of wireless networking standards.” By IEEE bylaws, only 0.1% of IEEE membership is elevated to Fellow annually. See <https://www.ieee.org/membership/fellows/steps.html>. In addition, I was

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selected as IEEE Communications Society's Distinguished Lecturer (2014-15, 2017-18), which are listed in my curriculum vitae.

16. In addition to advising and mentoring students at UW, I have served as an external dissertation reviewer for several reputed international universities (e.g., McGill Univ., Montreal, CA; National University of Singapore, and Australia National University). During my career, I have advised and supervised over 35 Ph.D. students and numerous visiting scholars.

17. I have also served as an expert in certain legal proceedings. A list of cases in which I have testified at trial, hearing, or by deposition is provided in Appendix 1. Over the years, I have been retained by both patent owners as well as petitioners.

II. INFORMATION CONSIDERED

18. In preparation for this declaration, I have considered the materials discussed in this declaration, including, for example, the '644 Patent, the references cited by the '644 Patent, the prosecution histories of the '644 Patent and applications from which it derives (including the references cited therein), various background articles and materials referenced in this declaration, and the prior art references identified in this declaration. In addition, my opinions are further based on my education, training, experience, and knowledge in the relevant field.

III. RELEVANT LEGAL STANDARDS

19. I am not an attorney and offer no legal opinions. For the purposes of this Declaration, I have been informed about certain aspects of the law that are relevant to my analysis, as summarized below.

A. Claim Interpretation

20. I have been informed that during an *inter partes* review proceeding, claims are to be construed in light of the specification as would be read by a person of ordinary skill in the relevant art at the time the application was filed. I have been informed that claim terms are given their ordinary and customary meaning as would be understood by a person of ordinary skill in the relevant art in the context of the entire disclosure. A claim term, however, will not receive its ordinary meaning if the patentee acted as his own lexicographer and clearly set forth a definition of the claim term in the specification. In that case, the claim term will receive the definition set forth in the patent.

21. I have been informed that certain patent claim terms may be interpreted as “means-plus-function” claim terms. I have been informed that terminology is part of the U.S. Patent Law in 35 USC §112, paragraph 6 (pre-AIA) / 35 USC §112(f) (post-AIA), which states the following: “An element in a claim for a combination may be expressed as a means or step for performing a specified function without the recital of structure, material, or acts in support thereof, and such claim shall be

construed to cover the corresponding structure, material, or acts described in the specification and equivalents thereof.”

B. Perspective of One of Ordinary Skill in the Art

22. I have been informed that a patent is to be understood from the perspective of a hypothetical “person of ordinary skill in the art” (“POSITA”). Such an individual is considered to possess normal skills and knowledge in a particular technical field (as opposed to being a genius). I have been informed that in considering what the claims of a patent require, what was known prior to that patent, what a prior art reference discloses, and whether an invention is obvious or not, one must use the perspective of such a POSITA.

C. Anticipation

23. I have been informed that a claim is not patentable if it is anticipated. I have been informed that anticipation of a claim requires that every element of a claim is disclosed expressly or inherently in a prior art reference, arranged as in the claim, when considered from the perspective of a person of ordinary skill in the relevant art. I have been informed that when the structure recited in a reference is substantially identical to that of the claims, claimed properties or functions are presumed to be inherent. I have been informed that extrinsic evidence may be used to explain but not expand the meaning of terms and phrases used in the reference relied upon as anticipatory of the claimed subject matter.

D. Obviousness

24. I have been informed that a patent claim is obvious under 35 U.S.C. §103, and therefore invalid, if the claimed subject matter, as a whole, would have been obvious to a POSITA as of the priority date of the patent based on one or more prior art references and/or the knowledge of a POSITA.

25. I have been informed that an obviousness analysis must consider (1) the scope and content of the prior art, (2) the differences between the claims and the prior art, (3) the level of ordinary skill in the pertinent art, and (4) secondary considerations, if any, of non-obviousness (such as unexpected results, commercial success, long- felt but unmet need, failure of others, copying by others, and skepticism of experts).

26. I have been informed that a prior art reference may be combined with other references to disclose each element of the invention under 35 U.S.C. § 103. I have been informed that a reference may also be combined with the knowledge of a POSITA, and that this knowledge may be used to combine multiple references. I have been informed that a POSITA is presumed to know the relevant prior art. I have been informed that the obviousness analysis may take into account the inferences and creative steps that a POSITA would employ.

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27. In determining whether a prior art reference would have been combined with other prior art or other information known to a POSITA, I have been informed that the following principles may be considered:

- whether the references to be combined involve non-analogous art;
- whether the references to be combined are in different fields of endeavor than the alleged invention in the Patent;
- whether the references to be combined are reasonably pertinent to the problems to which the inventions of the Patent are directed;
- whether the combination is of familiar elements according to known methods that yields predictable results;
- whether a combination involves the substitution of one known element for another that yields predictable results;
- whether the combination involves the use of a known technique to improve similar items or methods in the same way that yields predictable results;
- whether the combination involves the application of a known technique to a prior art reference that is ready for improvement, to yield predictable results;
- whether the combination is “obvious to try”;
- whether the combination involves the known work in one field of endeavor prompting variations of it for use in either the same field or a different one based on design incentives or other market forces, where the variations are predictable to a POSITA;
- whether there is some teaching, suggestion, or motivation in the prior art that would have led one of ordinary skill in the

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art to modify the prior art reference or to combine prior art reference teachings to arrive at the claimed invention;

- whether the combination requires modifications that render the prior art unsatisfactory for its intended use;
- whether the combination requires modifications that change the principle of operation of the reference;
- whether the combination is reasonably expected to be a success; and
- whether the combination possesses the requisite degree of predictability at the time the invention was made.

28. I have been informed that in determining whether a combination of prior art references renders a claim obvious, it is helpful to consider whether there is some teaching, suggestion, or motivation to combine the references and a reasonable expectation of success in doing so. I have been informed, however, that a teaching, suggestion, or motivation to combine is not required.

IV. SUMMARY OF OPINIONS

29. It is my opinion that Claims 1-3 of the '644 Patent are unpatentable under 35 U.S.C. §§102 and 103 on the following grounds:

Ground	Reference(s)	Basis	Claims
1	WO 2014/055878 to Lee et al. ("Lee") (EX1006)	§102	1-3
2	Lee	§103	1-3

Ground	Reference(s)	Basis	Claims
3	Lee in view of U.S. Patent App. Pub. No. 2016/0353420 to You et al. (“You”) (EX1007) and optionally Zhuang (EX1016)	§103	1-3

V. TECHNOLOGY BACKGROUND

30. The ’644 Patent describes transmitting signals from a base station to a terminal including downlink control channels repeatedly allocated in a plurality of subframes. EX1001, 1:66-2:45. The ’644 Patent states “[a]n MTC terminal may be installed in a place having a bad electric wave environment as compared with a normal terminal. Therefore, the coverage of the MTC terminal should be improved to about 20 dB or higher as compared with the coverage the normal terminal.” *Id.*, 1:39-43. The ’644 Patent suggests improving MTC terminal coverage by “receiv[ing] downlink control channels through a plurality of subframes and acquir[ing] scheduling information of downlink data channel and/or uplink data channel transmission resources.” *Id.*, 1:59-62.

31. The ’644 Patent indicates that the terminal should be aware of both (1) a start subframe of the plurality of a subframes; and (2) a number of subframes of the plurality of subframes. EX1001, 9:51-59. The DCI carries the information on the number of the plurality of subframes while information on the start subframe is received via higher layer signaling:

the DCI includes the information on the number of the plurality of subframes where the DCI is repeatedly transmitted. The terminal can know subframes where the DCI is repeatedly transmitted, on the basis of the information, which is received through higher layer signaling, on the start subframe of a plurality of subframes where the DCI is repeatedly transmitted and the information, which is included in the DCI, on the number of a plurality of subframes where the DCI is repeatedly transmitted. Therefore, the terminal can predict transmission subframes of the PDSCH/PUSCH.

EX1001, 12:15-26. The Challenged Claims purport to enhance coverage of an MTC terminal by repeating DCI in a plurality of subframes, where the information on a start subframe and the information on the number of the plurality of subframes is received by the terminal via different signaling mechanisms, e.g., the DCI versus higher layer signaling. *See* EX1002, pp.68-69.

32. To enhance coverage of MTC UEs a base station sends repeating transmissions (e.g., repeating subframes including downlink control channels carrying DCI) to the UE. EX1001, 1:25-62; 8:1-7. To receive the DCI, the UE combines the DCI in view of (1) the start subframe of the plurality of a subframes; and (2) a number of subframes of the plurality of subframes. *Id.*, 10:28-32. Figure 9

illustrates repeatedly allocating downlink control channels (Physical Downlink Control Channels, “PDCCHs”) in a plurality of subframes:

FIG.9

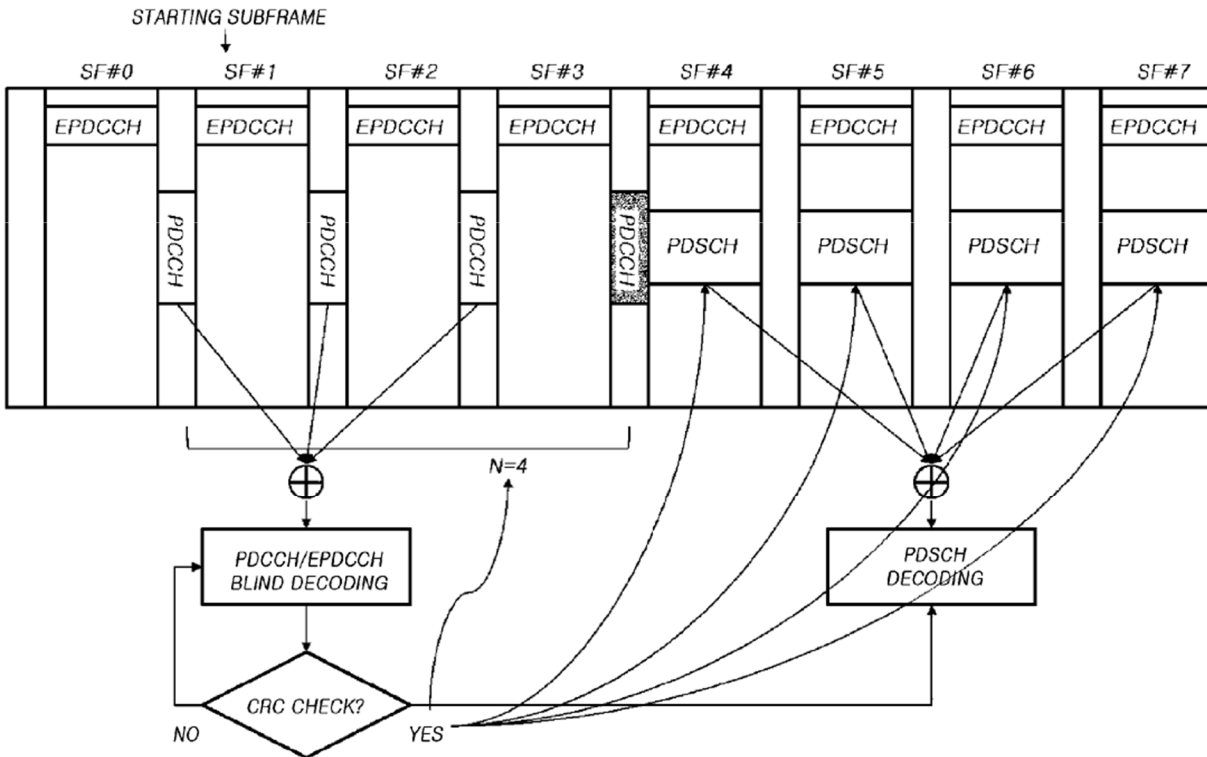


Fig. 9 of '644 Patent

33. These allegedly novel techniques of the Challenged Claims were well known before the filing of the '644 Patent. The prior art (Lee, You) had already addressed MTC terminal coverage enhancement by providing enhanced coverage modes for MTC UEs using repeated subframes where (1) the start subframe of the plurality of subframes; and (2) the number of subframes of the plurality of subframes are received through different operations (e.g., high layer signaling and DCI). The

exact same techniques contemplated in the '644 Patent for coverage enhancement of MTC UEs are fully disclosed in the prior art.

VI. THE CHALLENGED '644 PATENT

34. The '644 Patent contains 3 claims. I have been asked to opine on the validity of Claims 1-3.

VII. THE '644 PATENT PROSECUTION HISTORY

35. I have reviewed the file history of the '644 Patent.

36. The application that was issued as the '644 Patent was first rejected in a first Office Action dated August 8, 2017 under 35 U.S.C. §102 as anticipated by You. EX1002, p.73.

37. You discloses that a subframe bundle is a plurality of subframes. EX1007, ¶[0146]; EX1019, p.43. “[A] set of subframes in which PDCCHs carrying the same DCI can be transmitted may be a subframe bundle for PDCCH transmission.” EX1007, ¶[0046]; *see* EX1019, pp.43-44. In the rejection, the Examiner cited You’s subframe bundle at paragraph [0146] of You as disclosing the downlink control channels repeatedly allocated in the plurality of subframes. EX1002, p.76 (“plurality of downlink control channels are transmitted in a bundle”). This was not disputed by Applicant in any response. *See id.*, pp.67-70.

38. In response to the first Office Action, Applicant cancelled all claims except for the three independent claims. *Id.*, pp.64-66. Applicant also amended the

three independent claims to recite “wherein: the configuration information comprises information on a start subframe of the plurality of subframes; and the downlink control information comprises information on the number of the plurality of subframes.” *Id.*, p.64. Applicant only disputed that You “do[es] **not** disclose that the start subframe information and the information on the number of subframes are **separately** obtained **through different operations.**” *Id.*, p.68 (emphasis in original).

39. The Examiner issued a Notice of Allowance in response to Applicant’s amendments and arguments over You. *Id.*, p.53.

VIII. LEVEL OF ORDINARY SKILL IN THE ART

40. A POSITA would have had a bachelor’s degree in electrical engineering, computer engineering, or a related discipline, knowledge of the relevant 3GPP standards as of this time, and at least 2 years of experience working in a field involving wireless communications. A person with a different degree but with additional relevant experience could still qualify if the additional experience compensates for the different educational background. A person with less than 2 years of experience working in a field involving wireless communications could still qualify if the person has additional education that compensates for their lesser experience.

41. I have been informed that the “priority date” or “earliest effective filing date” of a patent is the date on which it is filed, or the date on which an earlier-filed U.S. or international patent application was filed if the patentee claims the benefit of priority to that earlier-filed U.S. or international patent application. For purposes of this declaration, I have assumed that the ’644 Patent is entitled to a priority date of September 26, 2013, and I have not evaluated or formed an opinion on whether the claims of the ’644 Patent are actually entitled to that date.

IX. CLAIM CONSTRUCTION

42. For purposes of my analysis in this IPR proceeding, I have been informed that terms that appear in the claims of the ’644 Patent should be interpreted according to their plain and ordinary meaning under the *Phillips* standard. In determining the ordinary and customary meaning, I have been informed that the words of a claim are first given their plain meaning that those words would have had to a POSITA at the time of the alleged invention. I also have been informed that the claims, specification, and file history may be used to better construe a claim insofar as the plain meaning of the claims cannot be understood. I have been informed that even treatises and dictionaries may be used under limited circumstances to determine the meaning attributed by a POSITA to a claim term at the time of filing.

43. I also understand that, for terms that evoke a means plus function construction, “the construction of the claim must identify the specific portions of the

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specification that describe the structure, material, or acts corresponding to each claimed function.” 37 C.F.R. §42.104(b)(3). I understand from counsel that construing a means-plus-function claim term is a two-step process that includes (1) identifying the claimed function and (2) then determining what structure, if any, disclosed in the specification corresponds to the claimed function.

44. I have reviewed the '644 Patent and its prosecution history as well as additional documents to construe the claims for performing my validity analysis. It is my understanding that some terms of the '644 Patent are in dispute in a related litigation.

45. I understand that in Related Litigation, the parties proposed that certain claim terms should be given their plain and ordinary meaning. *See* EX1014, pp.13-14 (Plaintiff's initial proposed constructions); EX1015, pp.40-43 (Defendants' preliminary claim constructions). Defendants proposed that the plain and ordinary meaning of “configured to” in claim 3 means “actually configured to and not merely capable of performing the claimed function”. EX1015, p.42. Defendants also proposed that the preambles are limiting. *See id.*, pp.40-43. I understand that Defendants and Plaintiffs agreed the preambles of the Challenged Claims are limiting. I apply the constructions proposed in Related Litigation for purposes of this Expert Declaration.

46. While the proper metes and bounds of the claims are disputed in the Related Litigation, the cited prior art falls within these bounds whatever they may be.

47. The Challenged Claims are unpatentable under all potential constructions.

X. OVERVIEW OF THE PRIOR ART REFERENCES

A. Lee (EX1006)

48. Lee discloses enhancing coverage of MTC UE devices. *See* EX1006, Title, ¶¶[0003]-[0005]; EX1010, Title, ¶¶[0001], [0076]. Lee describes techniques including subframe bundling (e.g., TTI bundling) for (E)PDCCHs for coverage enhancement. EX1006, ¶¶[0092], [0111]-[0127], [0139]-[0152]; EX1010, ¶¶[0086], [0105]-[0121], [0134]-[0145]. Lee discloses that subframe bundling is repeatedly transmitting consecutive subframes with the same data to a UE [to effectively extend the transmission, thereby enhancing coverage]. EX1006, ¶¶ [0103]-[0104], [0107], [0111], [0145]-[0153]; EX1010, ¶¶[0097]-[0098], [0101], [0105], [0141]-[0145]. According to Lee, “subframe, TTI and ms may be used interchangeably.” *Id.*, ¶[0106].

49. Lee discloses transmitting a plurality of subframes for downlink transmission including repeatedly allocated downlink control channels (Physical Downlink Control Channels, “PDCCHs”) carrying DCI. *See* EX1006, ¶¶[0113]-

[0115]. Lee's DCI includes information on the number of the plurality of subframes (N_{TTI}). *Id.*, ¶[0114]. Lee's N_{TTI} refers to a number of repetitions of a single subframe to constitute a plurality of subframes. *Id.*

50. Lee discloses additional mechanisms for a coverage enhancement mode, including repeatedly transmitting the plurality of subframes. That is, Lee discloses an additional layer of coverage enhancement by repeatedly transmitting the entire plurality of subframes over time defined by a repetition rate (N_{rep}). *Id.*, ¶[0104]. Effectively, Lee demonstrates that a subframe including a PDCCH that is repeatedly allocated in a plurality of subframes can be defined by a first number of a plurality of subframes (N_{TTI}), and further defined by a number of repetitions (N_{rep}) of the first number of the plurality subframes, resulting in a total number of subframes (e.g., a plurality of subframes). *Id.* Lee teaches that both the first number of the plurality of subframes and the number of repetitions of the plurality of subframes are transmitted through DCI. *Id.*, ¶[0104]. Lee's N_{TTI} is a subset of the number of repetitions N_{rep} because Lee demonstrates that applying the number of repetitions for the plurality of subframes further enhances coverage of an MTC UE. *Id.*

B. You (EX1007)

51. You discloses enhancing coverage of MTC UE devices. *See* EX1007, ¶[0150]; EX1019, pp.43-48. You discloses repeatedly transmitting a PDCCH in a

subframe bundle comprising a plurality of subframes (EX1007, Abs.; EX1019, p.43) where multiple subframes are bundled and transmitted to a UE for the UE to successfully receive repeatedly transmitted PDCCH signals. EX1007, ¶[0150]; EX1019, pp.43-44. You discloses repeatedly allocated PDCCHs in a plurality of subframes. You expressly states that a subframe bundle is a plurality of subframes. EX1007, ¶[0146]; EX1019, p.43. “[A] set of subframes in which PDCCHs carrying the same DCI can be transmitted may be a subframe bundle for PDCCH transmission.” EX1007, ¶[0146]; *see* EX1019, pp.43-44.

52. You demonstrates that the PDCCH is repeatedly transmitted over a bundle of N subframes (e.g., a number of the repeated subframes). EX1007, ¶[0146]; *see* EX1019, pp.43-44. You’s UE successfully receives the PDCCH using at least a subset n of the N subframes (e.g., $1 \leq n \leq N$). *Id.* You indicates that “a transmission start subframe location of a PDCCH” is defined as a fixed value transmitted to the UE through higher layer signaling. EX1007, ¶[0153]; EX1019, p.44.

53. You’s plurality of subframes including repeatedly allocated PDCCHs apply directly to enhanced coverage modes for MTC UE devices. You specifically discloses:

A PDCCH for an MTC UE may be repeatedly transmitted over numerous subframes for coverage enhancement. The UE may repeatedly receive the PDCCH in a subframe

bundle in which multiple subframes are bundled and successfully receive the PDCCH using repeatedly received PDCCH signals in the multiple subframes.

EX1007, ¶¶[0150]; *see* EX1019, p.43. *See also* EX1007, ¶¶[0147]-[0180]; EX1019, pp.43-48.

C. Zhuang (EX1016)

54. Zhuang is directed to MTC or M2M communications:

Machine-to-Machine (M2M) applications required low-cost devices and improved coverage other than current cellular communication system. For example, some smart-metering devices suffer a significantly larger path-loss (e.g., 20dB path loss) than that in the typical operation condition of normal devices, which are often installed in the basements of residential buildings or locations shielded by foil-backed insulation, metalized windows, or traditional thick-walled building construction.

EX1016, 1:9-14. Zhuang describes standardization work directed to coverage improvement and cost reduction for MTC devices, noting that “some potential solutions have been identified such as repetition of the physical channels to improve coverage.” *Id.*, 1:14-17; *see also id.*, 4:20-24.

55. Zhuang explains that “the data channel is downlink data channel (e.g., PDSCH in LTE system)” and “[t]he control channel is PDCCH or EPDCCH in LTE

system.” *Id.*, 4:29-32. Zhuang further explains that the mobile station “gets the downlink of uplink scheduling information from a physical downlink control channel (PDCCH) or enhanced physical downlink control channel (EPDCCH).” *Id.*, 3:27-30. “The downlink or uplink scheduling information and the other control information, carried by the PDCCH, is referred to as downlink control information (DCI).” *Id.*, 3:30-31.

56. Zhuang is directed to “[a] method for a mobile station to determine the starting subframe of a data channel.” *Id.*, 1:26-27. Zhuang teaches that, “[t]he repetitions number (or the number of subframes occupied by data channel or control channel) may or may not be the same” and therefore “a method to determine the starting subframe of data channel reception or transmission is necessary.” *Id.*, 4:20-24.

57. Specifically, Zhuang discloses “detecting number of subframes occupied by the decoded control channel; and determining the starting subframe of the data channel based on the detected number of subframes occupied by the decoded control [channel] and a known gap from the starting subframe of the data channel to the end subframe of the decoded control channel.” *Id.*, 2:3-7; *see also id.*, Fig. 4.

58. Zhuang discloses that “[t]he number of the plurality of subframes occupied by [] each control channel candidate may be unknown to the mobile station

before successfully decoded one or more of the control channel candidates (i.e., the decoded control channel intended for the mobile station).” *Id.*, 5:28-30. Zhuang further discloses that the “the number of subframes occupied by the decoded control channel needs to be pre-defined or configured.” *Id.*, 6:17-18.

59. In one disclosed embodiment, Zhuang discloses “the number of subframes occupied is indicated in the decoded control channel.” *Id.*, 6:19-20.

60. In another embodiment, Zhuang discloses that a “subframe indicator in the decoded control channel” that “signal[s] the number of subframes occupied by the control channel that contains the subframe indicator.” *Id.*, 6:21-7:6; *see also id.*, 10:22-11:13, Figs. 5, 7, Table 1. Zhuang discloses that the “subframe indicator can be carried in control information in the decoded control channel.” *Id.*, 12:4-10; *see also id.*, Fig. 8.

XI. DETAILED EXPLANATION OF THE UNPATENTABILITY GROUNDS

61. In my opinion, the Challenged Claims are unpatentable over the prior art.

A. Claims 1-3 Are Anticipated By Lee (Ground 1)

62. The following sections reference where elements of Claims 1-3 are anticipated by Lee.

1. Claim 1 (Preamble): “A method for receiving, by a terminal, downlink control information through downlink control channels repeatedly allocated in a plurality of subframes, the method comprising:”

63. To the extent the Preamble is limiting, Lee discloses the Preamble of Claim 1.

64. Lee discloses a method for receiving, by a terminal (e.g., a UE), downlink control information (DCI) through downlink control channels (e.g., PDCCHs) repeatedly allocated in a plurality of subframes.

65. Lee discloses a method for enhancing coverage of MTC devices such as wireless transmit/receive units (“WTRUs”). Lee’s WTRU constitutes a terminal. EX1006, ¶¶[0005], [0033]-[0042]; EX1010, ¶¶[0031]-[0039]. Lee’s WTRUs are configured to receive DCI through downlink control channels (e.g., PDCCHs)). EX1006, ¶[0096]; EX1010, ¶[0090]. The ’644 Patent indicates that downlink control channels include “PDCCHs or EPDCCHs”. EX1001, 2:1-2.

66. Lee recognizes that “[i]n order to improve the coverage of channels such as the enhanced PDCCH (EPDCCH) ... repetitive transmission may be considered as a coverage enhancement technique.” EX1006, ¶[0092]; EX1010, ¶[0086].

67. Lee's WTRUs "transmit/receive data N_{TTI} times" where N_{TTI} is a number indicating a plurality of subframes. EX1006, ¶¶[0104]-[0114]; EX1010, ¶¶[0098]-[0108].

68. Lee's WTRUs also transmit/receive "repeatedly transmitted" pluralities of subframes. *See* EX1006, ¶¶[0104]-[0105]; EX1010, ¶¶[0098]-[0099].

69. Thus, Lee's WTRU receiving a single subframe repeated N_{TTI} times within a subframe bundle and Lee's WTRU receiving repeatedly transmitted bundled subframes each constitute methods for receiving, by a terminal, downlink control information through downlink control channels repeatedly allocated in a plurality of subframes.

70. Repeated allocation is accomplished through "TTI bundling", "where the number of subframes for TTI bundling may be predefined or configured." EX1006, ¶[0104]; EX1010, ¶[0098].

71. According to Lee, using TTI bundling, the same data may be transmitted in multiple consecutive TTIs (e.g., subframes) where "all TTIs within a TTI bundle may be treated as a single resource". EX1006, ¶[0001]; EX1010, ¶[0001]. *See* EX1006, ¶¶[0051], [0106]-[0107]; EX1010, ¶¶[0001], [0100]-[0101].

72. Lee's multiple consecutive TTIs (e.g., subframes) carrying the same data constitute a plurality of subframes with repeatedly allocated downlink control channels.

73. Additionally, Lee's "bundled subframes may be repetitively transmitted over the time" to achieve further coverage enhancement. EX1006, ¶[0104], EX1010, ¶[0098]. Lee's WTRUs "transmit/receive the same data in consecutive N_{TTI} subframes". EX1006, ¶[0107]; EX1010, ¶[0101]. Lee's WTRU receives consecutive N_{TTI} subframes that are "repeatedly transmitted (N_{rep})" resulting in " $N_{TTI} \times N_{rep}$ subframes [] used, effectively, in total." EX1006, ¶[0104], EX1010, ¶[0098].

74. Thus, Lee's group (e.g., bundle) of N_{TTI} subframes is repeated to produce a plurality of subframe groups (e.g., a plurality of subframe bundles). Lee's N_{TTI} subframes (e.g., a single subframe repeated N_{TTI} times to constitute a plurality of subframes) that are repeatedly transmitted N_{rep} times (e.g., a group of repeated subframes further repeated N_{rep} times) also constitutes a plurality of subframes.

75. Lee discloses DCI transmitted through (E)PDCCHs repeatedly allocated in Lee's plurality of subframes. EX1006, ¶¶[0139], [0143], [0182]-[0186] ("In order to improve the coverage, the DCI format-x may be transmitted repetitively for multiple subframes which may, for example, be consecutive DL [downlink] subframes."), [0290]-[0292]; EX1010, ¶¶[0134], [0139], [0160]-[0164], [0276]-[0278]. *See also* EX1006, ¶[0114], Fig. 13; EX1010, ¶[0108], Fig. 13.

76. Thus, Lee discloses both repeatedly allocating PDCCHs including DCI in consecutive N_{TTI} subframes as well as repeatedly allocating (e.g., repeatedly transmitting N_{rep} times) groups of N_{TTI} subframes (e.g., bundles).

77. Lee discloses that both control channels (e.g., PDCCHs) and data channels (e.g., physical downlink shared channels (“PDSCHs”)) benefit from the coverage enhancement method. EX1006, ¶[0087]; EX1010, ¶[0081].

a. [1.1]: “receiving configuration information relating to the plurality of subframes through higher layer signaling;”

78. Lee discloses Element [1.1].

79. Lee discloses that a “set of TTI bundling cases may be defined via higher layer signaling”. EX1006, ¶¶[0115], *see id.*, ¶¶[0051], [0394]; EX1010, ¶[0109]; *see id.*, ¶[0122].

80. Lee discloses that a “window size (N_{window}) may be defined and/or the subset of subframes for TTI bundling may be indicated by using a bitmap within the window, and the bitmap may be informed via higher layer signaling.” EX1006, ¶[0111]; EX1010, ¶[0105].

81. At least Lee’s set of TTI bundling cases, window size, subset of subframes for TTI bundling, and bitmap each constitute “configuration information relating to the plurality of subframes” that are received through higher layer signaling.

82. Thus, Lee discloses the WTRU receiving configuration information relating to a plurality of subframes through higher layer signaling. *Id.*

b. [1.2]: “receiving downlink control channels repeatedly allocated in the plurality of subframes and combining the received downlink control channels on the basis of the configuration information; and”

83. Lee discloses Element [1.2].

84. Lee discloses PDCCHs repeatedly allocated N_{TTI} times in a plurality of subframes (e.g., repeated subframes). *See* EX1006, ¶¶[0103]-[0107], *see id.*, ¶[0107] (“WTRU may transmit/receive the same data in consecutive N_{TTI} consecutive subframes”); *See* EX1010, ¶¶[0097]-[0101], *see id.*, ¶[0101].

85. Lee’s repeated consecutive subframes, repeated N_{TTI} times, where the repeated subframes include PDCCHs, constitute the WTRU receiving downlink control channels repeatedly allocated in the plurality of subframes. *See* EX1006, ¶¶[0139]-[0151]; EX1010, ¶¶[0133]-[0145].

86. Lee also discloses repeatedly allocating repeated consecutive subframes, repeating N_{TTI} times, including PDCCHs (e.g., repeating a subframe bundle N_{rep} number of times). *See* EX1006, ¶¶[0104]-[0107]; EX1010, ¶¶[0098]-[0101].

87. Thus, Lee discloses PDCCHs repeatedly allocated in a plurality of subframes in three ways.

88. Lee discloses (1) a subframe bundle, where the single subframe bundle (e.g., defined by N_{TTI}) constitutes repeatedly allocating downlink control channels in the plurality of subframes. EX1006, ¶¶[0104]-[0117], EX1010, ¶¶[0098]-[0111].

89. Lee also discloses (2) PDCCHs repeatedly allocated in the single subframe bundle where the single subframe bundle itself is also repeated (e.g., defined by N_{rep}) to transmit multiple subframe bundles for reception by the WTRU. EX1006, ¶¶[0104]-[0117], EX1010, ¶¶[0098]-[0111]. This also constitutes repeatedly allocated downlink control channels in the plurality of subframes.

90. Finally, Lee discloses (3) the total amount of subframes defined by $N_{TTI} \times N_{rep}$, which also constitutes a repeated allocation of downlink control channels in a plurality of subframes. EX1006, ¶[0104]; EX1010, ¶[0098]. *See* EX1006, ¶[0151]; EX1010, ¶[0145] (“The subframes may be bundled for an (E)PDCCH transmission in the (E)PDCCH coverage extension mode.”).

91. Lee discloses combining (e.g., soft combining) the received repeatedly allocated PDCCHs on the basis of configuration information. *See* EX1006, ¶¶[0208]-[0212], [0224]-[0225]; EX1010, ¶¶[0186]-[0211].

92. Lee discloses that the WTRU “attempt[s] to receive and/or decode the signal in one or more subframes of a frame” and “***combine[s]*** (e.g., integrate) signals ***from multiple such subframes*** within a frame in which the signal was transmitted”.

EX1006, ¶[0208]; EX1010 ¶[0189] (emphasis added). *See also* EX1006, ¶¶[0208]-[0212], [0224]-[0225], [0295]; EX1010, ¶¶[0189]-[0193], [0210]-[0212], [0281].

93. Lee's WTRU combines the PDCCHs received in the plurality of subframes on the basis of the configuration information (e.g., from multiple subframes in which the signal was transmitted) and based on at least Lee's set of TTI bundling cases, window size, subset of subframes, the start subframe, and/or a bitmap which each constitute "configuration information relating to the plurality of subframes" that are received through higher layer signaling. EX1006, ¶[0111]; EX1010, ¶[0105]. EX1006, ¶[0208]; EX1010 ¶[0189].

94. Lee discloses combining PDCCHs in a plurality of subframes repeatedly allocated. EX1006, ¶¶[0105], [0208]; EX1006, ¶¶[0099], [0189] ("The WTRU may combine (e.g., integrate)", on the basis of a bitmap defining the subframe bundle (*see* EX1006, ¶[0111]; EX1010, ¶[0105]), and on the basis of the control channel element ("CCE") number.). *See also* EX1006, ¶[0152]; EX1010, ¶[0145].

95. At least each of the bitmap, and the CCE number constitute "configuration information" that is configured via higher layer signaling. *See* EX1006, ¶¶[0105]-[0140]; EX1010, ¶¶[0099]-[0134]. *See also id.*, EX1006, ¶[0185]; EX1010, ¶[0163].

c. [1.3]: “extracting the downlink control information from the combined downlink control channels, wherein:”

96. Lee discloses Element [1.3].

97. Lee discloses that, once the PDCCHs are combined, the WTRU “use[s] that combination to *successfully receive and/or decode* the signal”. EX1006, ¶[0208]; EX1010, ¶[0189].

98. Lee *successfully receiving and/or decoding* DCI from combined PDCCHs constitutes extracting the DCI from the combined PDCCHs. EX1006, ¶¶[0208]-[0212], [0224]-[0225], [0321]; EX1010, ¶¶[0189]-[0193], [0210]-[0212], [0307].

99. Lee expressly discloses combining downlink control channels (*see* §XI.A.1.b., *supra*) and “successfully receiving and decoding the DCI”. *Id.*

100. The '644 Patent describes that “the terminal performs soft combining and then blind decoding on a DCI value” and “[i]f the blind decoding is successful, the terminal extracts, from DCI, information on the number of subframes”. EX1001, 12:34-39. “When the terminal *succeeds* in the blind decoding, the terminal acquires scheduling information”. *Id.*, 10:35-36 (emphasis added).

101. Lee discloses that DCI is extracted because Lee describes the data that is successfully received (and thus extracted) by the WTRU: “the DCI for a DL transmission transmitted in the (E)PDCCH window may include the subframe

information as well as the frequency resource information”. EX1006, ¶[0311]; EX1010, ¶[0298].

102. Thus, Lee discloses that the DCI is extracted from the combined (e.g., integrated) (E)PDCCHs in the plurality of subframes by successfully receiving and/or decoding the DCI. *See also* EX1006, ¶¶[0183]-[0186]; EX1010, ¶¶[0161]-[0164].

d. [1.4]: “the configuration information comprises information on a start subframe of the plurality of subframes; and”

103. Lee discloses Element [1.4].

104. Each of Lee’s bitmap, and the CCE number constitute “configuration information”. *See* §§XI.A.1.a-XI.A.1.b., *supra*. At least Lee’s bitmap includes information on a start subframe of the plurality of subframes.

105. Lee discloses downlink control channels (e.g., (E)PDCCHs) repeatedly allocated in the plurality of subframes within a subframe window 905 in Figure 9. Lee’s Figure 9 shows that the repeated subframes within the window 905 include subframes #0, #1, #2, #3, #6 and #7.

106. In Lee’s Figure 9, both subframe #0 and subframe #6 constitute “start subframes” because these subframes include a subframe index (or subframe number) indicating a start point of a plurality of subframes (repeated subframes #0 starting at a first subframe #0) or a subset of the plurality of subframes (repeated subframes #0

starting at a second subframe #6). EX1006, Fig. 9, ¶¶[0111]-[0122]; EX1010, Fig. 9, ¶¶[0105]-[0116]. The '644 Patent discloses that information on a start subframe is “a value of a particular subframe index (or subframe number) indicating a start point”. EX1001, 10:2-6.

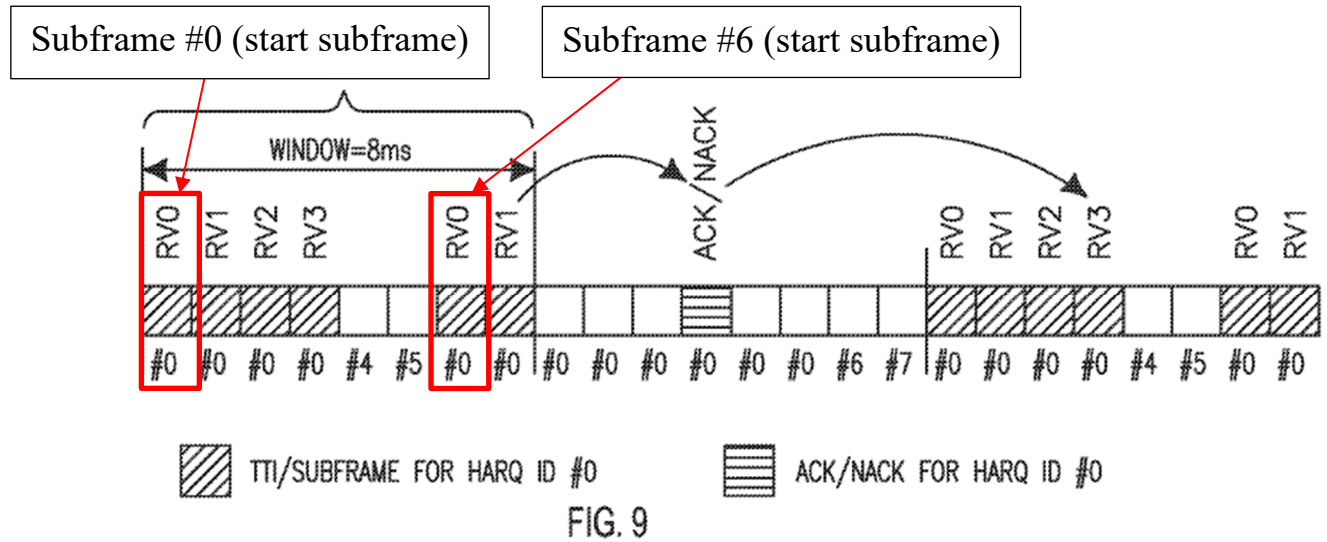


Fig. 9 of Lee (Annotated)

107. As disclosed in Lee, Figure 9 uses a “bitmap indication” where a subset of the plurality of subframes are indicated by using a bitmap. EX1006, ¶¶[0111]-[0122]; EX1010, ¶¶[0105]-[0116].

108. Thus, Lee’s information on a start subframe (e.g., each of subframe #0 and subframe #6 in Figure 9) are included as a bitmap indication in Lee’s bitmap. According to Lee, “the bitmap may be informed by higher layer signaling.” EX1006, ¶¶[0111]; EX1010, ¶¶[0105]. Thus, Lee’s bitmap is configuration information

including information on a start subframe of the plurality of subframes. *See* EX1006, ¶¶[0111]-[0115]; EX1010, ¶¶[0105]-[0109].

109. Lee's bitmap includes an indication at least for the starting subframe (subframe #6) of the subset of the plurality of subframes.

110. Lee discloses information on a start subframe equivalent to information on a start subframe disclosed by the '644 Patent. EX1001, 10:7-22 ("the information indicating the subframe index [*e.g., of a start subframe*] may be a bitmap").

e. [1.5]: "the downlink control information comprises information on the number of the plurality of subframes."

111. Lee discloses Element [1.5].

112. Lee discloses the number of the plurality of subframes in at least three ways. *See* §XI.A.1.b., *supra*.

113. Lee discloses the number of the plurality of subframes as (1) the number of subframes in a subframe bundle of multiple subframes (N_{TTI}); (2) the N_{TTI} subframes in a bundle that are repeated subframes (N_{rep}), where a subframe bundle includes a single subframe (N_{rep} = the information on the number of the plurality of subframes, where $N_{TTI} = 1$, such that $N_{TTI} \times N_{rep} = N_{rep}$); and (3) the total number of subframes where multiple subframes in a bundle (N_{TTI}) are repeatedly transmitted N_{rep} number of times, resulting in the total number of subframes being equal to N_{TTI}

$\times N_{\text{rep}}$ ($N_{\text{TTI}} \times N_{\text{rep}}$ = the information on the number of the plurality of subframes).

EX1006, ¶[0104]; EX1010, ¶[0098].

114. Lee discloses that N_{TTI} is transmitted via the DCI.

115. Lee discloses that (1) N_{TTI} is transmitted via the DCI. “In the new DCI format, indication bits for TTI bundling may be included so that, for each DL/UL [downlink/uplink] data transmission, *the N_{TTI} may be defined so that a WTRU may transmit/receive data N_{TTI} times according to the indication.*” EX1006, ¶[0114]; EX1010, ¶[0108] (emphasis added). Lee discloses information on the number of the plurality of subframes as “indication bits” defining N_{TTI} that are included in the DCI. Lee’s “indication bits” can be included in DCI in any of Lee’s disclosed embodiments. EX1006, ¶¶[0139], [0302]; EX1010, ¶[0135].

116. Where Lee discloses that (1) N_{TTI} is transmitted via the DCI and (2) N_{rep} is transmitted via higher layer signaling, the total number of subframes $N_{\text{TTI}} \times N_{\text{rep}}$ is informed at least in part by N_{TTI} transmitted via the DCI. EX1006, ¶¶[0104]-[0105].

117. Thus, at least some of Lee’s information on the number of plurality of subframes (e.g., N_{TTI}) is transmitted via the DCI where there is a total number of subframes defined by $N_{\text{TTI}} \times N_{\text{rep}}$. *Id.*

118. Lee's discloses that the information for N_{TTI} is transmitted via the DCI, because Lee expressly describes the coverage enhancement mode with regard to N_{TTI} . See EX1006, ¶¶[0105], [0128]; EX1010, ¶¶[0099], [0122].

119. Lee discloses:

a default value of ***bundling size*** [N_{TTI}] and/or repetition rate [N_{rep}] for coverage enhancement mode may be defined, and the default value may be used if a WTRU is configured for or falls under coverage enhancement mode until the WTRU receives ***WTRU-specific configuration of a bundling size and/or a repetition rate***.

EX1006, ¶[0105]; EX1010, ¶[0099] (emphasis added).

120. Lee describes that a default value for N_{TTI} and/or N_{rep} is used by the WTRU to receive/decode the plurality of subframes until the WTRU receives WTRU-specific configuration for N_{TTI} and/or N_{rep} .

121. Lee is clear that at least " N_{TTI} may be configured by an eNB in a dynamic manner." EX1006, ¶[0114]; EX1010, ¶[0108]. Lee's dynamic configuration of N_{TTI} uses "indication bits" for N_{TTI} transmitted in a new DCI format. *Id.* Lee also provides an example of how the "indication bits" are used in the new DCI format. See EX1006, ¶[0115]; EX1010, ¶[0109]. Lee discloses that a set of default values is defined by higher layer signaling and "***the indication bits in the***

DCI format may indicate one of the bundling sizes within the set” of default values. *Id.* (emphasis added). In this way, Lee’s “indication bits” transmitted via DCI serve as the WTRU-specific configuration. *Id.* See also EX1006, ¶¶[0128]; EX1010, ¶[0122].

122. Because Lee discloses: (1) “indication bits” transmitted via DCI for dynamically configuring N_{TTI} (EX1006, ¶¶[0114]-[0115]; EX1010, ¶¶[0108]-[0109]), (2) that bundling size and/or repetition rate can be configured via higher layers with the transmission mode configuration, and (3) coverage enhancement mode including dynamically configuring both N_{TTI} and N_{rep} (EX1006, ¶¶[0104]-[0105]; EX1010, ¶¶[0098]-[0099]), a POSITA would have understood that Lee contemplates transmitting “indication bits” via DCI for dynamically configuring N_{rep} (a number of repetitions) as evidenced by a POSITA’s understanding of “indication bits” based on the operation of well-known techniques of transmitting dynamic configuration indications for a UE via DCI. This is because throughout Lee’s description, Lee describes details of dynamic configuration for various types of information evidencing that transmitting information relating to repetition rate, *e.g.*, N_{rep} , would have been understood by the POSITA. See, *e.g.*, EX1006, ¶¶[0060], [0114]-[0115], [0128]-[0154]; EX1010, ¶¶[0056], [0108]-[0109], [0122]-[0147]).

2. Claim 2 (Preamble): “A method of transmitting, by a base station, downlink control information through downlink control channels repeatedly allocated in a plurality of subframes, the method comprising:”

123. To the extent the Preamble is limiting, Lee discloses the Preamble of claim 2. *See* §XI.A.1., *supra*.

124. Lee discloses the method of receiving the DCI through downlink control channel repeatedly allocated in a plurality of subframes is performed by the WTRU while the method of transmitting is performed by a base station. EX1006, ¶¶[0024]-[0030], [0034]-[0036], [0105]-[0115], [0189], [0206], Figs. 1A, 1C.; EX1010, ¶¶[0021]-[0027], [0031]-[0033], [0099]-[0109], [0187], Figs. 1A, 1C.

a. [2.1]: “transmitting configuration information relating to the plurality of subframes through higher layer signaling; and”

125. Lee discloses Element [2.1]. *See* §XI.A.1.a., *supra*; EX1006, ¶¶[0036], [0105]-[0106] (“the N_{TTI} subframes may be configured by an eNB”); EX1010, ¶¶[0033], [0099]-[0100], [0105].

b. [2.2]: “transmitting the downlink control information through the downlink control channels repeatedly allocated in the plurality of subframes, wherein”

126. Lee discloses Element [2.2]. *See* §XI.A.1.b., §§XI.A.2.-XI.A.2.a., *supra*.

- c. [2.3]: “the configuration information comprises information on a start subframe of the plurality of subframes; and”**

127. Lee discloses Element [2.3]. *See* §XI.A.1.d., *supra*.

- d. [2.4]: “the downlink control information comprises information on the number of the plurality of subframes.”**

128. Lee discloses Element [2.4]. *See* §XI.A.1.e., *supra*.

- 3. Claim 3 (Preamble): “A terminal for receiving downlink control information through downlink control channels repeatedly allocated in plurality of subframes, the terminal comprising:”**

129. To the extent the Preamble is limiting, Lee discloses the Preamble of claim 3. *See* §XI.A.1., *supra*.

130. Lee discloses a LC-MTC [*low-cost machine-type-communication*] WTRU [*wireless transmit/receive unit*] that is “configured to transmit and/or receive wireless signals” including “user equipment (UE), a mobile station, a fixed or mobile subscriber unit, a pager, a cellular telephone, a personal digital assistant (PDA), a smartphone, a laptop, a netbook, a personal computer, a wireless sensor, consumer electronics, and the like.” EX1006, ¶¶[0023]-[0042]; EX1010, ¶¶[0020]-[0039]. *See id.*, Figs. 1A-1C.

- a. [3.1]: “a receiver configured to receive configuration information comprising information on a start subframe of the plurality of subframes through higher layer signaling, to receive the downlink control channels repeatedly allocated in the plurality of subframes, and to combine the received downlink control channels based on the configuration information; and”

131. Lee discloses Element [3.1]. *See* §§XI.A.1.a.-XI.A.1.b., *supra*.

132. Lee discloses the WTRU including a transceiver 120 and a transmit/receive element 122. EX1006, ¶[0034], Fig. 1B; EX1010, ¶[0031], Fig. 1B.

133. Lee’s transmit/receive element 122 is “configured to transmit signals to, or receive signals from, a base station” including “any combination of wireless signals.” EX1006, ¶[0036]; EX1010, ¶[0033]. *See also* EX1006, ¶¶[0149], [0156] (“DL signal reception at a WTRU receiver”), EX1010, ¶[0149], claim 37 (“The WTRU of claim 36, further comprising a receiver”).

134. Lee’s WTRU includes a receiver that is configured to perform the functions recited in Element [3.1] at least because Lee discloses a WTRU including a receiver where the WTRU performs the claimed functions. *See* §§XII.A.1.a.-XI.a.1.b., *supra*.

135. Thus, Lee discloses a receiver “configured to” under Petitioners’ construction which means “actually configured to and not merely capable of performing the claimed function”. EX1015, p.37.

136. Lee also discloses a WTRU including a receiver configured to perform the functions of Element [3.1] under a plain and ordinary meaning of “configured to”.

b. [3.2]: “a controller configured to extract downlink control information from the combined downlink control channels,”

137. Lee discloses Element [3.2]. *See* §XI.A.1.c., *supra*.

138. Lee discloses the WTRU including processor 118 that includes “a controller” that is configured to “perform signal coding, data processing, power control, input/output processing, and/or any other functionality that enables the WTRU 102 to operate in a wireless environment.” EX1006, ¶[0035]; EX1010, ¶[0032]. *See id.*, Fig. 1B.

139. Such functionality disclosed in Lee includes extracting DCI from combined PDCCHs. *See* §XI.A.1.c., *supra*.

140. Thus, Lee discloses a WTRU including a controller configured to extract DCI from the combined downlink control channels.

141. Lee’s WTRU includes a controller that is configured to extract DCI at least because Lee discloses a WTRU including a controller where the WTRU performs the extracting. *See* §§XI.A.1.c., *supra*.

142. Thus, Lee discloses a controller “configured to” under Petitioners’ construction which means “actually configured to and not merely capable of performing the claimed function”. EX1015, p.37.

143. Lee also discloses a WTRU including a controller configured to perform the functions of Element [3.2] under a plain and ordinary meaning of “configured to”.

c. [3.3]: “wherein the downlink control information comprises information on the number of the plurality of subframes.”

144. Lee discloses Element [3.3]. *See* §XI.A.1.e., *supra*.

B. Claims 1-3 Would Have Been Obvious Over Lee (Ground 2)

1. Unpatentability of Claims 1-3 is Supported by POSITA Knowledge

145. The Challenged Claims are anticipated by Lee. *See* §XI.A., *supra*.

146. To the extent there are any minor differences between Lee and the features of the Challenged Claims, any such minor differences would have been obvious. Further, to the extent any expert testimony is interpretive of Lee, any minor differences would have been obvious to a POSITA to be taught by Lee.

147. Thus, the Challenged Claims are obvious over Lee.

148. To the extent it is argued that Lee does not constitute an anticipation because Lee does not disclose a single specific embodiment containing all elements of the Challenged Claims, such an assertion is untenable.

a. Preambles and Elements [1.2], [2.2], and [3.1]

149. Lee discloses “applications for using a coverage enhancement mode. *A WTRU may apply all embodiments and examples herein individually or in combination as part of a coverage enhancement mode of operation.*” EX1006, ¶[0302] (emphasis added). *See also id.*, ¶¶[0082], [0106], [0139], [0145]. *See* EX1010, ¶[0287]. *See also id.*, ¶¶[0077], [0100], [0134], [0141].

150. A POSITA would have been motivated to apply Lee’s techniques of “coverage enhancement” at least to a MTC UE because Lee discloses coverage enhancement solutions for MTC UEs. EX1006, ¶¶[0004], [0081]; EX1010, ¶[0076].

151. Lee discloses applicability of coverage enhancement techniques to MTC devices. EX1006, ¶[0093]; EX1010, ¶[0087].

152. A POSITA would have been motivated to use Lee’s repetitive transmission (e.g., using N_{TTI} and N_{rep}) as a solution for coverage enhancement of downlink control channels like the (E)PDCCH (or other downlink channels), because Lee tells one to do so. EX1006, ¶¶[0092]-[0093], [0103]-[0105], [0145]; EX1010, ¶¶[0086], [0098]-[0099], [0141], [0295].

153. Lee discloses that “subframes may be bundled for an (E)PDCCH transmission in the (E)PDCCH coverage enhancement mode” where “(E)PDCCH coverage enhancement mode may be used irrespective of the transmission.” EX1006, ¶[0152]; EX1010, ¶[0145].

154. Lee informs a POSITA to use repetitive transmission of downlink control channels for coverage enhancement mode, and that this mode can be used irrespective of the transmission. EX1006, ¶¶[0146], [0152]; EX1010, ¶¶[0142], [0145].

155. Lee discloses that “[i]n order to improve the coverage of channels such as the enhanced PDCCH (EPDCCH) . . . repetitive transmission may be considered as a coverage enhancement technique.” EX1006, ¶[0092]; *see* EX1010, ¶[0086].

156. A POSITA would have been motivated to apply Lee’s coverage enhancement mode, using repetitive transmission of EPDCCH subframes, to enhance coverage of downlink control channels in order to improve signal reception of MTC UEs.

157. A POSITA would have had a reasonable expectation of success given Lee’s details for implementing coverage enhancement mode and Lee’s indication of MTC UE requirements, including supporting of low data rates and relaxed throughput requirements. *See* EX1006, ¶¶[0082], [0087], [0093], [0099], [0194]; EX1010, ¶¶[0077], [0081], [0087], [0093], [0175].

b. Elements [1.4]-[1.5], [2.3]-[2.4], [3.1], and [3.3]

158. Lee’s disclosure teaches that one or both of the information for N_{TTI} and N_{rep} is transmitted via DCI, because Lee expressly describes the coverage

enhancement mode with regard to N_{TTI} and N_{rep} . See EX1006, ¶¶[0105], [0128]; EX1010, ¶¶[0099], [0122]. See also §XI.A.1.e., *supra*.

159. As discussed above, Lee discloses:

a default value of ***bundling size*** [N_{TTI}] ***and/or repetition rate*** [N_{rep}] for coverage enhancement mode may be defined, and the default value may be used if a WTRU is configured for or falls under coverage enhancement mode until the WTRU receives ***WTRU-specific configuration of a bundling size and/or a repetition rate***.

EX1006, ¶[0105]; EX1010, ¶[0099] (emphasis added).

160. Lee describes that a default value for N_{TTI} and/or N_{rep} is used by the WTRU to receive/decode the plurality of subframes until the WTRU receives WTRU-specific configuration for N_{TTI} and/or N_{rep} . Lee is clear that at least “ N_{TTI} may be configured by an eNB in a dynamic manner.” EX1006, ¶[0114]; EX1010, ¶[0108].

161. Lee’s dynamic configuration of N_{TTI} uses “indication bits” for N_{TTI} transmitted in a new DCI format. *Id.* Lee also provides an example of how the “indication bits” are used in the new DCI format. See EX1006, ¶[0115]; EX1010, ¶[0109].

162. Lee discloses that a set of default values is defined by higher layer signaling and “*the indication bits in the DCI format* may indicate one of the bundling sizes within the set” of default values. *Id.* (emphasis added). In this way, Lee’s “indication bits” transmitted via DCI serve as the WTRU-specific configuration. *Id.* See also EX1006, ¶[0128]; EX1010, ¶[0122]. At a minimum, Lee teaches and suggests transmitting N_{rep} via DCI because throughout Lee’s description, Lee turns to details of 3GPP (including Release 11) to further articulate specific implementations of Lee’s process (see, e.g., EX1007, ¶¶[0072], [0234], [0263], [0303], [0310]-[0311]; EX1010, ¶¶[0221], [0288]-[0289], [0295], [0297]-[0298]), and the transmission of N_{rep} via the DCI is no different. See EX1021, pp.34-39, §7.1.6; p.36 (DCI includes “a resource indication value (RIV) corresponding to a starting resource block (RB_{start}) and a length in terms of virtually contiguously allocated resource blocks”). See also *id.*, pp.122-123; EX1022, pp.42-43, §9.4.

163. A POSITA would have been motivated in view of Lee to transmit the start of the subframe repetitions (e.g., a bitmap) via higher layer signaling in the configuration information and to transmit N_{TTI} and/or N_{rep} via the DCI.

164. A POSITA would have been motivated to transmit information on the start subframe in the configuration information so that the UE knows where/when to find the repeated (E)PDCCHs. EX1006, ¶[0128]; EX1010, ¶[0122].

165. A POSITA would have been motivated to transmit the information on the number of plurality of subframes in the DCI (such that the information on the number of plurality of subframes is transmitted implicitly and decoded at the UE) in order to reduce the amount of data transmitted by configuration information and to further enhance coverage where throughput of configuration information may be reduced due to reduced coverage for an MTC UE.

166. Where coverage is reduced for an MTC UE, signals transmitted via higher layers are not repeated, whereas signals including PDCCHs carrying DCI are repeated in view of Lee.

167. A POSITA would understand that, in a reduced coverage scenario, it would be beneficial to transmit some information (e.g., the information on the number of the plurality of subframes) via the DCI in the coverage enhancement mode so that information is more likely to be received by the MTC UE. A POSITA would recognize that repetitively transmitting N_{TTI} and/or N_{rep} may provide more reliable reception of the number of the plurality of subframes than if the same information were transmitted via higher layer signaling. A POSITA would have also understood that an MTC UE would use the information on the number of subframes to skip decoding (e.g., blind decoding) of redundant repeated subframes and locate when/where different data signals are transmitted.

168. A POSITA would have had a reasonable expectation of success given Lee's details for implementing coverage enhancement mode and Lee's indication of MTC UE requirements, including supporting of low data rates and relaxed throughput requirements. *See* EX1006, ¶¶[0082], [0087], [0093], [0099], [0194]; EX1010, ¶¶[0077], [0081], [0087], [0093], [0175].

169. Given such express disclosure and the fact that the components and functionalities of Lee discussed in §XI.A. are all clearly compatible and applicable to each another.

170. It would have been immediately apparent to a POSITA that Lee discloses the combined use of such components and functionalities. Furthermore, it would have been obvious to employ the components and functionalities of Lee discussed in §XI.A. together in the same implementation given Lee's express suggestion and teaching to combine its embodiments. EX1006, ¶[0302]; EX1010, ¶[0287].

171. Such a modification would have been predictable, and a POSITA would have had a reasonable expectation of success, given that Lee suggests and teaches such modifications, and given the fact that the components and functionalities are all applicable to base station transmission (e.g., signals transmitted on the DL) and MTC UE operation for enhancing coverage of a MTC UE. EX1006, ¶¶[0093], [0103]-[0118]; EX1010, ¶¶[0097]-[0112].

2. Lee’s Number of Subframes in a “Subframe Bundle” and Number of Repetitions of a “Subframe Bundle” Read on the Plain and Ordinary Meaning of Elements [1.5], [2.4], and [3.3]

a. Preambles and Elements [1.2], [2.2], and [3.1]

172. Ground 1 reads on the plain and ordinary meaning of the Challenged Claims where Lee includes information on the number of plurality of subframes (N_{TTI}) in a “subframe bundle” within the DCI.¹

173. It would have been obvious to a POSITA that Lee’s repetitions of “subframe bundles” (N_{rep}) constitute “downlink control channels repeatedly allocated in a plurality of subframes” under the plain and ordinary meaning of the claim term.

b. Elements [1.4]-[1.5], [2.3]-[2.4], [3.1], and [3.3]

174. A POSITA reading Lee’s disclosure regarding “a default value of bundling size [N_{TTI}] and/or repetition rate [N_{rep}]” (EX1006, ¶[0105]; EX1010, ¶[0099]) and Lee’s example disclosure regarding dynamic configuration using

¹ In the prosecution history of the ’644 Patent, the Examiner cited to You’s (EX1007) “subframe bundle” as disclosing “downlink control channels repeatedly allocated in the plurality of subframes”. Applicant did not dispute this in its response. *See* EX1002, pp.67-76.

“indication bits” for N_{TTI} would have fully appreciated that the dynamic configuration and “indication bits” transmitted via DCI would be used for not only N_{TTI} , but also N_{rep} .

175. Lee discloses that N_{TTI} and/or N_{rep} use default values (configured by higher layer signaling) and WTRU-specific values that are transmitted in DCI as “indication bits” to configure the WTRU dynamically in a coverage enhancement mode. EX1006, ¶¶[0105]-[0115]; EX1010, ¶¶[0099]-[0109]. *See also* EX1006, ¶[0302]; EX1010, ¶[0287]; §XI.A.1.e.

176. A POSITA viewing Lee would have understood that the transmission of dynamic “indication bits” within DCI would have been used to signal N_{rep} .

177. In view of Lee’s disclosure on dynamic configuration of both N_{TTI} and N_{rep} , a POSITA would have understood that, not only can N_{TTI} be transmitted via Lee’s “new DCI format,” but also that N_{rep} would also be transmitted via the “new DCI format” for dynamic configuration of the number of repetitions of subframe bundles. EX1006, ¶[0114]; EX1010, ¶[0108].

178. A POSITA would also have understood both N_{TTI} and N_{rep} would be transmitted via the DCI simultaneously. Therefore, Lee teaches that (1) N_{TTI} alone, (2) N_{rep} alone, and (3) both N_{TTI} and N_{rep} where total number of subframes = $N_{\text{TTI}} \times N_{\text{rep}}$ would have been transmitted via the DCI, and a POSITA would have fully appreciated this.

179. A POSITA would have a reasonable expectation of success of transmitting N_{rep} via the DCI given Lee's disclosure of dynamic configuration of N_{TTI} . EX1006, ¶[0114]; EX1010, ¶[0108].

180. Dynamic configuration of N_{rep} would use a same or similar operation because N_{rep} could also be represented as an integer, and could be dynamically indicated using Lee's "indication bits" In the DCI. EX1006, ¶¶[0104]-[0115]; EX1010, ¶[0098]-[0109]. *See also* EX1006, ¶¶[0140]-[0144]; EX1010, ¶¶[0136]-[0140].

C. Claims 1-3 Would Have Been Obvious Over Lee in View of You and Zhuang (Ground 3)

181. The Challenged Claims would have been obvious over Lee in view of You and Zhuang.

182. Lee discloses the claimed subject matter and thus anticipates and renders obvious each of the Challenged Claims as explained in Grounds 1 and 2 (*see* §§XI.A., XII.B.).

183. Further, to the extent any minor differences are alleged between the Challenged Claims and Lee, such minor differences would have been obvious in view of the details and disclosure provided in You and Zhuang.

184. For example, You discloses at least the Preamble and Elements [1.1] to [1.4] (and similar elements of claims 2 and 3).

185. Zhuang discloses at least the Preamble and Elements [1.2], [1.3], and [1.5] (and similar elements of claims 2 and 3).

186. You was considered by the Examiner in the prosecution history of the '644 Patent. *See* §XI., *supra*. Applicant amended the Challenged Claims to recite Element [1.5] and asserted patentability over You based on Element [1.5]. EX1002, pp.68-69. Applicant did not dispute that You discloses the Preamble and Elements [1.1] to [1.4] (and corresponding elements of claims 2 and 3). *See* EX1002, pp.53-79.

187. A POSITA would have had been motivated to turn to You to provide specific teachings for implementing Lee's processes/techniques with repeatedly allocated (E)PDCCHs in a plurality of subframes.

188. For example, Lee generally discloses that "[i]n order to improve the coverage of channels such as the enhanced PDCCH (EPDCCH), the PDSCH, and the PUCCH, *repetitive transmission* may be considered as a coverage enhancement technique." EX1006, ¶[0092] (emphasis added); *see* EX1010, ¶[0086].

189. Thus, to the extent Lee is found to lack express disclosure of specific details for at least each of Element [1.1] to Element [1.4] as applied to the (E)PDCCH, a POSITA would have been motivated to combine You's disclosure of subframe repetition for the (E)PDCCH to the subframe repetition techniques disclosed by Lee.

190. Such combination would have been a routine combination of prior art elements according to known methods of subframe repetition to yield predictable results of repeatedly allocating (E)PDCCHs in a plurality of subframes.

191. A POSITA would have had a reasonable expectation of success, especially given that You's techniques and Lee's techniques are both solutions for enhancing coverage of an MTC UE.

192. Lee recognizes applicability of You's disclosure of repeated transmission of downlink control channels in a plurality of subframes to its techniques and Lee adopts similar subframe repetition implementations as those described in You. EX1006, ¶¶[0092], [0145]; EX1010, ¶¶[0086], [0141]; *see* EX1007, ¶[0150]; EX1019, pp.43-44.

193. Lee recognizes a need for enhancing coverage of MTC UE devices, including by enhancing coverage up to 20dB (e.g., *see* EX1006, Title, ¶¶[0003]-[0005]; *see* EX1010, ¶¶[0076], [0078], [0084]), while You describes a mechanism for enhancing coverage of MTC devices, for example, by repeatedly allocating downlink control channels (PDCCHs) in a plurality of subframes:

[T]he present invention proposes that the eNB apply a coverage enhancement scheme such as subframe repetition (repetition of a subframe with a signal) or subframe bundling upon transmission of a signal to the MTC UE having a coverage issue so that the MTC UE can

effectively receive a signal transmitted by the eNB. For example, the PDCCH and PDSCH may be transmitted to the MTC UE having the coverage issue in a plurality of subframes (e.g. about 100 subframes).

EX1007, ¶[0145]; *see* EX1019, p.43. *See* EX1007, ¶¶[0147]-[0180]; EX1019, pp.43-48.

194. You's implementation accords improved "efficiency to reduce production cost and battery consumption of UEs for MTC [] according to data transmission rate" recognizing that for MTC UEs, "the amount of transmission data is small". EX1007, ¶[0144]; *see* EX1019, p.43.

195. You's systems are applied to a MTC UE "operating in a coverage enhancement mode." EX1007, ¶[0145]; EX1019, p.43.

196. Because both Lee and You provide methods for enhancing coverage of an MTC UE device using repeated PDCCHs in a plurality of subframes, a POSITA would have been motivated to apply express teachings of You's repeated PDCCHs in plural subframes to the disclosure of Lee in order to further refine techniques for enhancing coverage of MTC devices using repeated subframes. *See* EX1006, ¶¶[0092]-[0114]; EX1010, ¶¶[0086]-[0108]; EX1007, ¶¶[0147]-[0180]; EX1019, pp.43-48.

197. Applying You’s teachings to Lee would have been a straightforward combination of prior art elements according to known methods taught by both Lee and You such that combining elements of Lee and You would have yielded predictable results.

198. The ’644 Patent, like Lee and You, also seeks to provide enhanced coverage of MTC devices. The ’644 Patent, as identical to Lee, suggests “coverage of the MTC terminal should be improved to about 20 dB or higher as compared with the coverage the normal terminal.” EX1001, 1:41-43.

199. The ’644 Patent provides the same solution as Lee and You, in that “control information and/or data of each physical channel transmitted in a unit of only one subframe may be required to be repeatedly transmitted in a plurality of subframes.” *Id.*, 1:44-9.

200. A POSITA would have been similarly motivated to turn to Zhuang for additional details on subframe repetition for the PDCCH.

201. Like Lee and You, Zhuang also discloses “coverage improvement and cost reduction for [] MTC devices in coverage hole scenario[s],” including “repetition of the physical channels to improve the coverage.” EX1016, 1:14-16. Specifically, Zhuang teaches repetition of the PDCCH or EPDCCH. *Id.*, 4:20-21 (“For coverage hole devices, PDCCH or EPDCCH may need repetitions across multiple subframes.”).

202. A POSITA would have understood subframe repetition to be a known technique in the field of telecommunications for improvement of coverage of MTC devices, and subframe repetition would have yielded predictable results.

203. As described herein, Lee teaches dynamic configuration of N_{TTI} and N_{rep} using “indication bits” transmitted via DCI.

204. A POSITA would have been motivated to turn to Zhuang for additional details on implementing the “indication bits.”

205. Zhuang confirms that “[t]he number of the plurality of subframes occupied by [] each control channel candidate may be unknown to the mobile station before successfully decod[ing] one or more of the control channel candidates (i.e., the decoded control channel intended for the mobile station).” EX1016, 5:28-30.

206. Zhuang discloses that information on the number of subframes occupied by the decoded control channel ((E)PDCCH) can be transmitted as a “subframe indicator in the decoded control channel.” *Id.*, 2:3-11.

207. Zhuang teaches that the information in a “subframe indicator” can be used to find the start subframe of the data channel (PDSCH). *Id.* Zhuang teaches that this would improve the function of MTC UE’s because “there may be misunderstanding between base station and mobile station on the start time of the transmission of some physical channels” and “it is important to have a method to determine the start subframe of the physical channels.” *Id.*, 1:21-22.

208. The combination of Lee, You, and Zhuang would have been a straightforward combination of prior art elements (e.g., repeated subframes, PDCCHs, and DCI) according to known methods such that combining elements of Lee, You, and Zhuang would have yielded predictable results of transmitting information on a start subframe and information on the number of the plurality of subframes through different operations.

209. To the extent it is asserted that Lee lacks specific details of elements of the Challenged Claims, You expressly discloses specific details of the same features of the Challenged Claims as applied to PDCCHs and DCI.

210. While Lee anticipates the Challenged Claims and render the Challenged Claims obvious, Lee in combination with You also render the Challenged Claims obvious.

211. The following sections reference where elements of Claims 1-3 are rendered obvious by the prior art.

1. Claim 1 (Preamble)

212. To the extent the Preamble is limiting, Lee discloses the Preamble. *See* §XI.A.1., *supra*.

213. To the extent Lee does not disclose the preamble, You expressly discloses a method for receiving, by a terminal, downlink control information through downlink control channels repeatedly allocated in a plurality of subframes.

214. You discloses a method for receiving, by a user equipment (“UE”), a physical downlink control channel (PDCCH) during a first subframe bundle comprising a plurality of subframes, and [receiving] a PDSCH related to the PDCCH. EX1007, Abs. 11.2-6; *see* EX1019, pp.43-47. A PDCCH carries DCI. EX1007, ¶¶[0053], [0081]; EX1019, p.4.

215. Figure 10 of You shows the method for transmitting/receiving DCI through a plurality of subframes. EX1007, Fig. 10; EX1019, p.44, Fig. 11. *See also* EX1007, ¶[0150]; EX1019, pp.43-44.

216. You states that a “subframe bundle” is “a set of subframes in which PDCCHs carrying the same DCI can be transmitted” to a UE. EX1007, ¶[0146]; EX1019, pp.43-44.

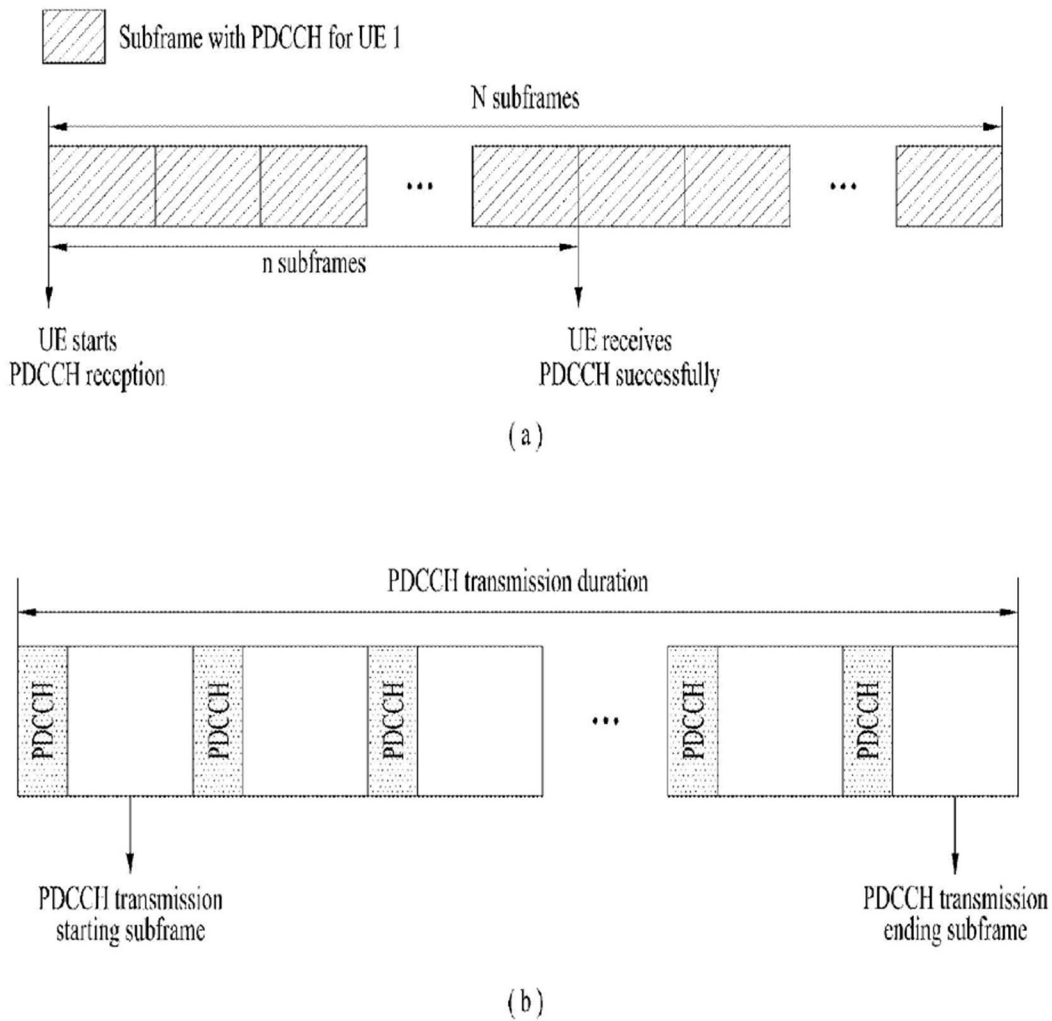


Fig. 10 of You

217. Zhuang discloses a method for receiving, by a terminal, downlink control information through downlink control channels repeatedly allocated in a plurality of subframes. Zhuang discloses that “PDCCH or EPDCCH may need repetitions across multiple subframes.” EX1016, 4:20-21; *see also id.*, 7:24-25. Zhuang discloses that “the downlink or uplink scheduling information and the other control information, carried by PDCCH, is referred to as downlink control

information (DCI).” *Id.*, 3:30-31. Zhuang confirms the teachings of Lee and You regarding the Preamble.

a. Element [1.1]

218. Lee discloses Element [1.1]. *See* §XI.A.1.a., *supra*.

219. To the extent Lee does not expressly disclose Element [1.1], You discloses receiving configuration information relating to the plurality of subframes through higher layer signaling.

220. You discloses that the “eNB [*base station*] processor may control the eNB RF [*radio frequency*] unit so that ***configuration information of a subframe bundle***” such as a start subframe “may be transmitted for repetitive transmission of the PDCCH”. EX1007, ¶[0238] (emphasis added); EX1019, p. 44 (“the information about the subframe location in which transmission of PDCCH bundle may start may be configured via higher-layer signals such as RRC.”).

221. You discloses configuration information relating to the plurality of subframes including at least a start subframe.

222. Thus, You discloses transmitting configuration information relating to the plurality of subframes (at least the start subframe) through higher layer signaling.

223. For the reasons discussed, it would have been obvious to combine You with Lee to arrive at Element [1.1].

b. Element [1.2]

224. Lee discloses Element[1.2]. *See* §XI.A.1.b., *supra*.

225. To the extent Lee does not disclose Element [1.2], You discloses receiving downlink control channels repeatedly allocated in the plurality of subframes and combining the received downlink control channels on the basis of the configuration information.

226. You discloses that the UE “repeatedly receive[s] the PDCCH [*downlink control channels*] in a subframe bundle [*in the plurality of subframes*] in which multiple subframes are bundled and successfully receive[s] the PDCCH using repeatedly received PDCCH signals [*repeatedly allocated*] in the multiple subframes.” EX1007, ¶[0150], Fig. 10; *see* EX1019, pp.43-44, Figs. 1, 11.

227. As shown in Figure 10 of You, the UE “successfully receive[s] the PDCCH using n ($1 < n < N$) subframes among the N subframes.” *Id.* Figure 10 of You shows the downlink control channels repeatedly allocated in the plurality of subframes.

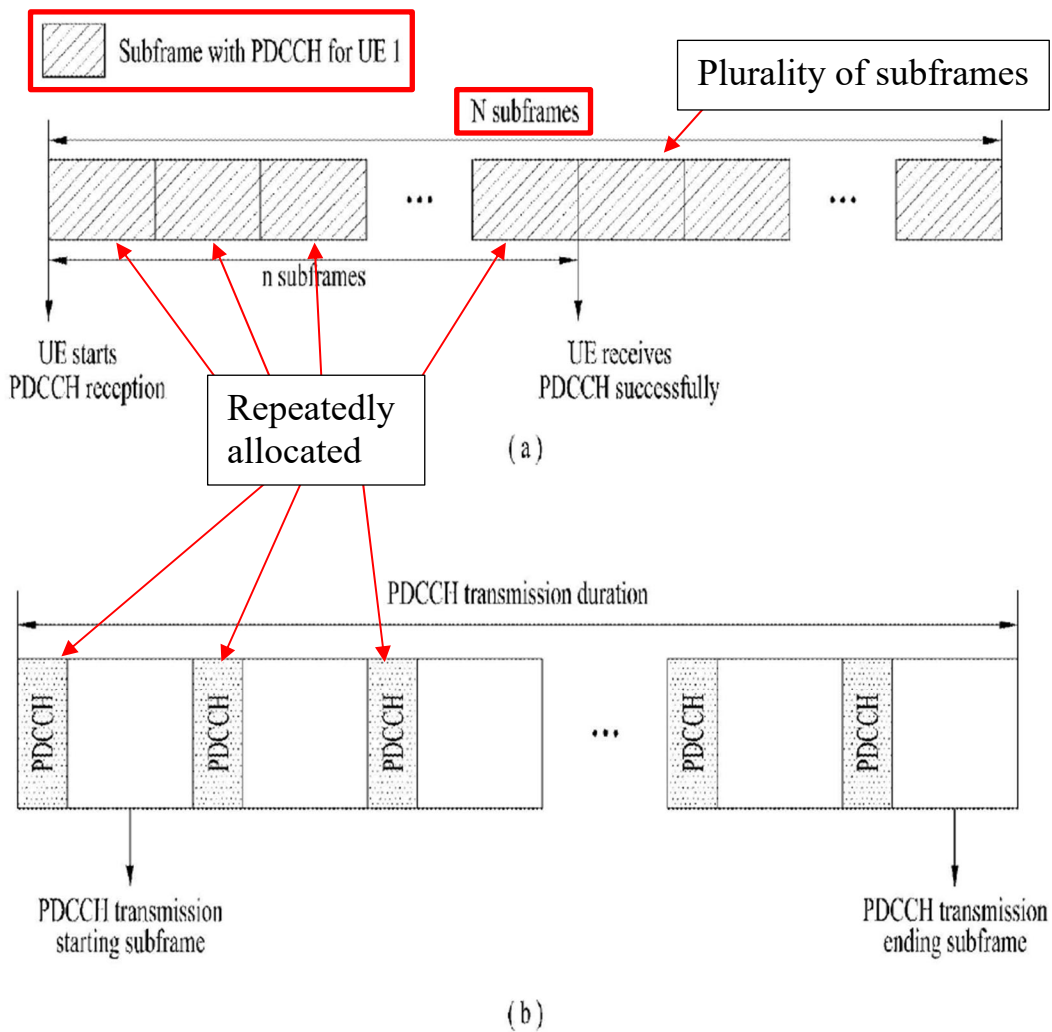


Fig. 10 of You (Annotated)

228. You discloses combining the received PDCCHs on the basis of the configuration information. EX1007, ¶[0239]; EX1019, pp.16, 46.

229. You discloses that when transmitting a subframe bundle of PDCCHs, “physical channels of multiple subframes in a corresponding bundle carry information/data/content that are identical or *can be combined*” and that the “UE

processor may (*combine* and) decode the repeatedly received PDCCH and/or PDSCH.” EX1007, ¶¶[0146], [0239]; *see* EX1019, p.43, Fig. 1.

230. According to You, decoding of the received PDCCHs occurs once the PDCCHs in multiple subframes are combined. EX1007, ¶[0146]; EX1019, p.16.

231. You discloses that configuration information of a subframe bundle (e.g., a plurality of subframes) includes at least a start subframe. EX1007, ¶[0239]; EX1019, p.43; XI.C.1.b., *supra*.

232. You’s UE “attempt[s] to receive and/or decode a corresponding PDCCH during N subframes starting from a transmission start subframe of the PDCCH bundle based on the information (e.g. offset and/or N) about the transmission start subframe location of the PDCCH bundle.” EX1007, ¶[0153]; *see* EX1019, pp.43-44, Fig. 1.

233. Thus, You discloses combining the received downlink control channels on the basis of the configuration information.

234. Zhuang also discloses Element [1.2]. *See* §XI.C.1., *supra*.

c. Element [1.3]

235. Lee discloses Lee discloses Element [1.3]. *See* §XI.A.1.c., *supra*.

236. To the extent Lee does not disclose Element [1.3], You discloses extracting the DCI from the combined downlink control channels.

237. You discloses that the repeated PDCCHs in a subframe bundle are combined and then “decoded together and restored into one piece of information/data.” EX1007, ¶[0146]; *see* EX1019, pp.43-47. Once the PDCCHs are combined, You’s UE uses “decodes and demodulates the radio signals [*e.g., including PDCCHs*] received through the receive antennas and **restores** [*e.g., extracts*] data [*DCI*] that the transmitting device 10 intended to transmit.” EX1007, ¶[0129]; EX1019, pp.43-47.

238. You discloses the UE receiving the repeated PDCCHs, combining the repeated PDCCHs, and receiving and/or decoding the combined PDCCHs to extract and obtain the information/data/content (*e.g., DCI*) that are carried by the PDCCHs. *See* EX1007, ¶¶[0146], [0153]; ¶[0053] (“a physical downlink control channel (PDCCH) . . . refer[s] to a set of time-frequency resources or resource elements (REs) carrying downlink control information (DCI)”); *see* EX1019, pp.43-48.

239. Zhuang discloses Element [1.3].

240. Zhuang discloses “decod[ing] a control channel intended for the mobile station” and extracting information “from the decoded control channel.” *Id.*, 1:28-31. Zhuang discloses that the “decoded control channel” can include “the number of subframes occupied by the decoded control channel” (*id.*, 2:3-7) and “a subframe indicator in the decoded control channel” (*id.*, 2:8-11). Zhuang discloses that the

MTC UE “attempts to decode the control channel and it may early successfully decode the control channel.” *Id.*, 10:34-11:1; *see also id.*, Fig. 7.

241. Zhuang confirms the teachings of Lee and You regarding Element [1.3].

d. Element [1.4]

242. Lee discloses Lee discloses Element[1.4]. *See* §XI.A.1.d., *supra*.

243. To the extent Lee does not disclose Element [1.4], You discloses the configuration information comprising information on a start subframe of the plurality of subframes.

244. You discloses that “information about the subframe location at which transmission of the PDCCH bundle may be started may be preconfigured through *a higher layer signal* [e.g., including configuration information] such as an RRC signal.” EX1007, ¶[0153]; EX1019, p.44. *See* §XI.C.1.b., *supra*.

245. Thus, You discloses configuration information transmitted to the UE through higher layer signaling includes information on a start subframe of the subframe bundle. *See* EX1007, ¶¶[0153], [0175], claim 3; EX1019, pp.43-48.

246. Zhuang confirms that “it is important to have a method to determine the start subframe of physical channels.” EX1016, 1:21:22. Zhuang itself does not disclose a method for determining the start subframe of the PDCCH or EPDCCH, but that would have been within the skill of a POSITA.

247. It would have been obvious to a POSITA to transmit information on a start subframe in configuration information (e.g., higher layer signaling) ahead of the PDCCH or EPDCCH. *Id.* This is confirmed by Lee and You. EX1006, ¶¶[0111]-[0113], Fig. 9; EX1010, ¶¶[0105]-[0107], Fig. 9; EX1007, ¶[0153]; EX1019, pp.43-44.

e. Element [1.5]

248. Lee discloses Element [1.5]. *See* §XI.A.1.e., *supra*.

249. In the prosecution history of the '644 Patent, the Examiner rejected the Challenged Claims over You. EX1002, pp.76-79. Applicant amended the Challenged Claims to recite Element [1.5] (from a rejected dependent claim) and argued in favor of Element [1.5] over You. *Id.*, pp.68-69. Applicant did not dispute the rejection over You for each of the preamble and Elements [1.1] to [1.4] (and corresponding elements of claims 2 and 3). *See* EX1002, pp.53-79. Applicant asserted that You “merely disclose[s] typical information included in downlink control information (DCI)” including “‘resource allocation information’ such as DL scheduling information (or DL grant) and UL scheduling information (or UL grant).” *Id.*, p.68.

250. Applicant further argued:

the cited part ([0153]) of **You** merely discloses that information (e.g., a transmission start subframe location,

the number of subframes) on a subframe bundle associated with a PDCCH transmission is transmitted to user equipment and is used to receive a PDCCH. However, the cited parts ([0081], [0082], [0153]) of ***You*** do **not** disclose that the start subframe information and the information on the number of subframes are **separately** obtained **through different operations**.

Id.

251. Effectively, Applicant admitted that *You* discloses information on a start subframe and information on the number of plurality of subframes as information on a subframe bundle. Applicant only argued that these pieces of information must be obtained through separate operations: higher layer signaling and DCI. *Id.*

252. A POSITA would have recognized the teachings of *You* would have been directly applicable to the disclosure of Lee.

253. *You* and Lee both set out to improve coverage enhancement of MTC devices. *See* EX1007, ¶¶[0145], [0150]; EX1019, p.43; EX1006, ¶¶[0004]-[0005]; EX1010, ¶[0002]. Additionally, both *You* and Lee arrive at the same solution of applying subframe repetition and/or subframe bundling. *See* EX1007, ¶[0145]; EX1019, p.43; EX1006, ¶¶[0084], [0103]; EX1010, ¶¶[0078], [0097].

254. Lee discloses the UE receiving information on the number of the plurality of subframes via the DCI, particularly using a “new DCI (e.g., DCI format 1E)”. EX1006, ¶[0114]; EX1010, ¶[0108].

255. Lee’s new DCI format includes “indication bits for TTI bundling ... for each DL/UL data transmission” where “the N_{TTI} may be defined so that a WTRU [e.g., UE] may transmit/receive data N_{TTI} times according to the indication.” *Id.* You recognizes that different DCI formats can be used for PDCCH transmission to a UE:

The size and usage of the DCI carried by one PDCCH are varied depending on DCI formats. The size of the DCI may be varied depending on a coding rate. In the current 3GPP LTE system, various formats are defined, wherein formats 0 and 4 are defined for a UL, and formats 1, 1A, 1B, 1C, 1D, 2, 2A, 2B, 3 and 3A are defined for a DL.

EX1007, ¶[0081]; EX1019, pp.17, 41.

256. You does not disclose using a new DCI format 1E. A POSITA would recognize that You does not include the new DCI format 1E and would have been motivated to improve upon You by using the new DCI format 1E disclosed by Lee.

257. Lee’s new DCI format is described as being used to carry “indication bits” for dynamic configuration of a UE (e.g., WTRU) using dynamic subframe bundling. EX1006, ¶[0114]; EX1010, ¶[0108].

258. You does not disclose the use of dynamic bundling for its subframe bundles. Thus, A POSITA would have been motivated to combine You with Lee in order apply Lee's dynamic bundling (and use of DCI to transmit subframe information) to You's subframe bundling methods for further enhancing coverage of MTC UEs, by providing a dynamic coverage enhancement mode in situations where You recognizes it would be difficult for a UE to successfully receive data over PDCCH/PDSCH. EX1007, ¶[0228]; EX1019, pp.43-44.

259. A POSITA would have had a reasonable expectation of success in combining You with the disclosure of Lee to apply You's related methods for subframe bundling to Lee's TTI bundling methods with Lee's new DCI format, such that the information on the number of the plurality of subframes disclosed in You (EX1007, ¶¶[0151]-[0152]; EX1019, pp.43-44) is included in Lee's new DCI format. EX1006, ¶[0114]; EX1010, ¶[0108].

260. A POSITA would have been motivated to apply You's teaching of information on the number of the plurality of subframes to Lee's new DCI format for indicating the number of subframes in a subframe bundle to a UE.

261. A POSITA would have had a reasonable expectation of success given that Lee had applied the new DCI format and "indication bits" in the DCI for indicating the number of subframes in its application of coverage enhancement using

repeated/bundled subframes transmitted to the UE. EX1006, ¶¶[0092]-[0114]; EX1010, ¶¶[0086]-[0108].

262. The new DCI format disclosed in Lee would have benefited from combining the detailed subframe bundling techniques for PDCCHs described in You, and would have been a simple modification, combining elements of subframe bundling in the prior art according to known subframe bundling methods disclosed in both Lee and You to yield predictable results of transmitting the information for the number of plurality of subframes included in the DCI (e.g., the new DCI format disclosed by Lee) rather than via higher layer signaling.

263. Zhuang discloses Element [1.5].

264. Zhuang discloses that “the number of subframes occupied [by the control channel] is indicated in the decoded control channel.” EX1016, 6:11-20. Zhuang discloses a “subframe indicator in the decoded control channel” where “the subframe indicator can be some information field in downlink control information (DCI) format.” *Id.*, 12:5-6; *see id.*, 6:24-26.

265. Zhuang’s subframe indicator “signal[s] the number of subframes occupied by the control channel that contains the subframe indicator.” *Id.*, 6:21-7:6. Zhuang’s UE obtains the subframe indicator after decoding the control channel and extracting the DCI (including the subframe indicator) in the decoded control channel. *Id.*, 1:28-31, 2:3-11, 10:34-11:1; *see also id.*, Fig. 7; *see* §XI.C.1.c., *supra*.

266. Zhuang's Figure 7 shows "obtain[ing] the subframe indicator 731 in the decoded control channel 723." *Id.*, 10:22-28. Zhuang discloses that "the subframe indicator 731 signals the number of subframes 701 occupied by the control channel 721 intended for the mobile station." *Id.*, 10:29-30. Zhuang explains that "[t]he control channel [is] repeated in multiple subframes and each subframe carries full information of the control channel." *Id.*, 10:30-34.

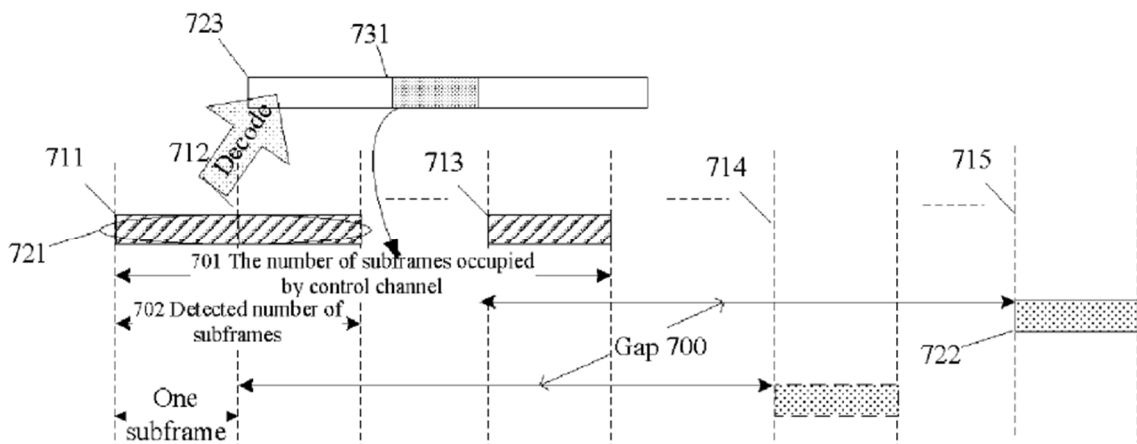


Fig. 7 of Zhuang

267. Zhuang explains that "[a]fter the mobile station decode[s] the control channel, the mobile station knows the number 701 of subframes occupied by the control channel via the subframe indicator in the decoded control channel" and "[t]herefore, the mobile station can calculate the end subframe of the decoded control channel, e.g., subframe 713 shown in Figure 7." *Id.*, 11:6-7.

268. Zhuang discloses: (1) “some original field 811 in DCI format 801 can be redefined as the subframe indicator 821” or (2) “the subframe indicator 822 in new field 812 is added to a new DCI format 802.” *Id.*, 12:8-10.

269. Zhuang is further evidence that Lee and Lee in combination with You disclose Element [1.5].

270. Lee discloses “indication bits” transmitted via DCI, similar to Zhuang’s “subframe indicator.” EX1006, ¶[0114]; EX1010, ¶[0108]. *See* EX1016, 12:4-10. Transmitting the number of the plurality of subframes in the DCI would have been obvious over Lee and You in combination, as further evidenced by Zhuang.

Claim 2 (Preamble)

271. To the extent the Preamble is limiting, Lee discloses the Preamble. *See* §XI.A.2.

272. To the extent Lee does not disclose the preamble of claim 2, You and Zhuang disclose a method for receiving, by a UE, downlink control information through downlink control channels repeatedly allocated in a plurality of subframes. *See* §XI.B.1., *supra*.

273. You and Zhuang contemplate the method of receiving being performed by the UE while the method of transmitting is performed by a base station. EX1007, Abs., ¶¶[0045]-[0046], claims 1, 5, 9, 13, Fig. 8; EX1019, p.43; EX1016, Abs., 3:8-4:4.

a. Element [2.1]

274. Lee discloses Element [2.1]. *See* §XI.A.2.a.

275. To the extent Lee does not disclose Element [1.2], You discloses the base station transmitting configuration information relating to the plurality of subframes through higher layer signaling. *See* §XI.B.1.a., *supra*; EX1007, ¶¶[0152]-[0154], claim 6 (“transmitting, by the base station, a higher layer signal including information on a maximum number of repetitions for the PDCCH”); *see* EX1019, pp.43-48.

b. Element [2.2]

276. Lee discloses Element [2.2]. *See* §XI.A.2.b.

277. To the extent Lee does not disclose Element [2.2], You and Zhuang disclose the base station transmitting the downlink control information through the downlink control channels repeatedly allocated in the plurality of subframes. *See* §XI.C.1.b., §§XI.C.2.-XI.C.2.a., *supra*.

c. Element [2.3]

278. Lee discloses Element [2.3]. *See* §XI.A.2.c.

279. To the extent Lee does not disclose Element [2.3], You discloses Element [2.3]. *See* §XI.B.1.d., *supra*.

d. Element [2.4]

280. Lee discloses Element [2.4]. *See* §XI.A.2.d.

281. To the extent Lee does not disclose Element [2.4], Zhuang discloses Element [2.4]. *See* §XI.C.1.e., *supra*.

Claim 3 (Preamble)

282. To the extent the Preamble is limiting, Lee discloses the Preamble. *See* §XI.A.3.

283. To the extent Lee does not disclose the Preamble, You discloses a terminal for receiving downlink control information through downlink control channels repeatedly allocated in a plurality of subframes. *See* §XI.B.1., *supra*.

284. Lee discloses a MTC [*low-cost machine-type-communication*] UE [*user equipment*] that is configured to “transmit and receive data and/or control information scheduled on a prescribed time unit basis, e.g. on a subframe basis.”

285. You’s UE includes “a terminal equipment (TE), a mobile station (MS), a mobile terminal (MT), a user terminal (UT), a subscriber station (SS), a wireless device, a personal digital assistant (PDA), a wireless modem, a handheld device, etc.” *Id.*, ¶[0045], ¶¶[0144]-[0146]. *See id.*, Fig. 8, ¶[0131] (“a UE operates as the transmitting device 10 in UL and as the receiving device 20 in DL” and “an eNB operates as the receiving device 20 in UL and as the transmitting device 10 in DL.”).

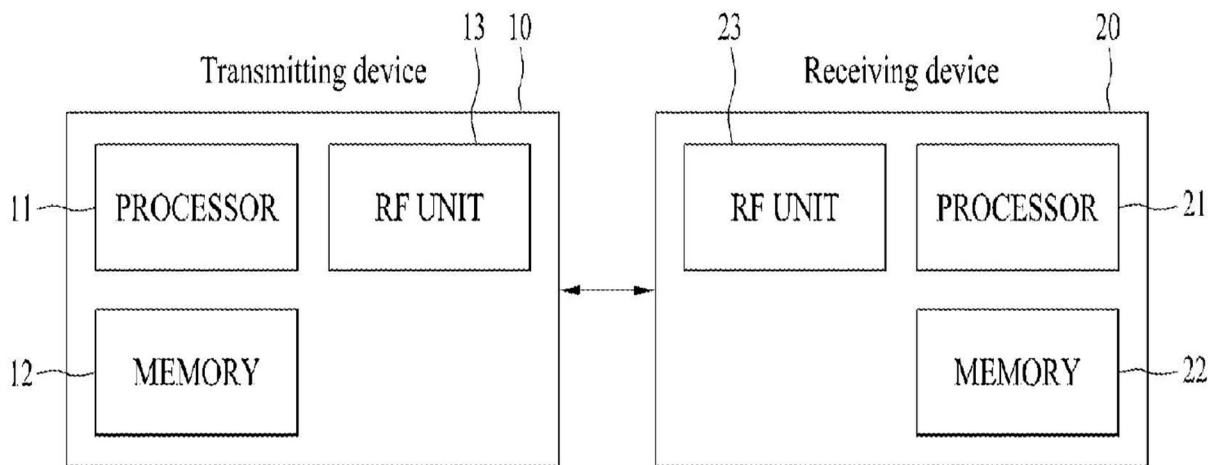


Fig. 8 of You

286. Zhuang discloses the Preamble. *See* §XI.C.1., *supra*.

287. Zhuang discloses “mobile station 911” that “may be fixed or mobile user terminals” or “may also be referred to as subscriber units, users, terminals, remote units, subscriber stations, user equipment (UE), user terminals, or by other terminology used in the art.” EX1016, 12:14-17.

288. A POSITA would have understood Zhuang’s “mobile stations” to be a terminal.

a. Element [3.1]:

289. Lee discloses Element [3.1]. *See* §XI.A.3.a.

290. To the extent Lee does not disclose Element [3.1], You and Zhuang disclose a terminal including a receiver configured to receive configuration information comprising information on a start subframe of the plurality of subframes through higher layer signaling, to receive the downlink control channels repeatedly

allocated in the plurality of subframes, and to combine the received downlink control channels based on the configuration information. *See* §§XI.B.1.a.-XI.B.1.b., *supra*.

291. You discloses the UE (e.g., as receiving device 20 in Figure 8) including a RF unit 23 for “transmitting and receiving radio signals carrying information, data, signals, and/or messages” and configured to “receive[] radio signals transmitted by the transmitting device 10” including configuration information and PDCCHs repeatedly transmitted in a plurality of subframes. EX1007, ¶¶[0125], [0129], Fig. 8; EX1019, pp.5, 43-48, Fig. 5.

292. Zhuang discloses Element [3.1].

293. Zhuang’s “mobile station 911” includes “antenna 917 [that] transmits and receives RF signals.” EX1016, 12:28-29. “RF transceiver module 916, coupled with the antenna, receives RF signals from the antenna, converts them to baseband signals and sends them to processor 913.” *Id.*, 12:29-29. Zhuang further discloses that “[m]obile station 911 receives the control channels and data channels by transceiver 916 via antenna 917.” *Id.*, 13:14-15.

294. You’s UE and Zhuang’s UE include a receiver that is configured to perform the functions recited in Element [3.1] at least because You and Zhuang disclose a UE including a receiver where the UE performs the claimed functions. Thus, You and Zhuang each disclose a receiver “configured to” under Petitioners’ construction which means “actually configured to and not merely capable of

performing the claimed function”. EX1015, p.37. You and Zhuang also each disclose a UE including a receiver configured to perform the functions of Element [3.1] under a plain and ordinary meaning of “configured to”. EX1007, ¶¶[0125], [0129], Fig. 8; EX1019, p.5, 43-48, Fig. 5.

b. Element [3.2]

295. Lee discloses Element [3.2]. *See* §XI.A.3.a.

296. To the extent it is argued Lee does not disclose Element [3.2], You and Zhuang disclose a terminal including a controller configured to extract downlink control information from the combined downlink control channels. *See* §XI.B.1.c., *supra*.

297. You discloses the UE (e.g., as receiving device 20) including processor 21 that includes “controllers, microcontrollers, microprocessors, or microcomputers.” EX1007, ¶[0127], Fig. 8; EX1019, pp.5, 43-48, Fig. 5.

298. You’s processor 21 is configured to “control the overall operation of various modules in the transmitting device and the receiving device” including “perform[ing] various control functions to implement” You’s teachings. *Id.* Such control functions disclosed in You include extracting DCI from combined PDCCHs. *See* §XI.B.1.c., *supra*.

299. Zhuang discloses Element [3.2].

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300. Zhuang discloses “[p]rocessor 913 [that] processes the received baseband signals and invokes different functional modules to perform features in mobile station 911.” *Id.*, 12:32-33.

301. Zhuang discloses that “different functional modules can be implemented by software, firmware, hardware, or any combination thereof.” *Id.*, 13:4-5.

302. Zhuang discloses that “[m]obile station 911 monitors the control channel candidates, decodes a control channel intended for mobile station 911.” *Id.*, 13:15-16.

303. Zhuang’s “mobile station 911 obtains the [subframe] indicator in the decoded control channel via processors 913.” *Id.*, 13:18-20. Zhuang therefore discloses a controller configured to extract downlink control information.

304. You’s UE and Zhuang’s UE include a controller that is configured to extract DCI at least because You and Zhuang each disclose a UE including a controller where the UE performs the extracting.

305. Thus, You and Zhuang each disclose a controller “configured to” under Petitioners’ construction which means “actually configured to and not merely capable of performing the claimed function”. EX1015, p.37.

306. You and Zhuang also each disclose a UE including a controller configured to perform the functions of Element [3.2] under a plain and ordinary meaning of “configured to”. EX1007, ¶[0127], Fig. 8; EX1019, pp.5, 43-48, Fig. 5.

c. Element [3.3]

307. Lee discloses Element [3.3]. *See* §XI.A.3.b.

308. Lee in combination with You discloses DCI comprising information on the number of the plurality of subframes, and Zhuang discloses DCI including information on the number of the plurality of subframes. *See* §XI.C.1.e., *supra*.

XII. SECONDARY CONSIDERATIONS

309. As discussed herein, all elements of the Challenged Claims were known in the art, and any differences would have been obvious to a POSITA based on the disclosures of the applied references and the knowledge in the art.

310. I am not aware of any secondary considerations that would alter my opinion. For instance, there was no long felt need as techniques for enhancing coverage of MTC UE’s using repeated subframes were known and used before the effective filing date of the ’644 Patent.

311. As another example, the ’644 Patent and its techniques are not widely used in the art or incorporated into any commercially successful enhanced coverage

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systems for MTC UEs. I am not aware of an enhanced coverage system that is commercially successful marked with the '644 Patent.

312. Any secondary considerations evidence Owner may offer in this proceeding would be insufficient to overcome the strong evidence that the Challenged Claims are obvious.

XIII. CONCLUSION

313. For the reasons set forth above, it is my opinion that all elements of the Challenged Claims of the '644 Patent are disclosed or suggested by the prior art. In my opinion, the Challenged Claims of the '644 Patent are anticipated by and/or would have been obvious over the prior art.

314. In signing this Declaration, I understand that the Declaration will be filed as evidence in a contested case before the Patent Trial and Appeal Board of the United States Patent and Trademark Office. I acknowledge that I may be subject to cross-examination in the case and that cross-examination will take place within the United States. If cross-examination is required of me, I will appear for cross-examination within the United States during the time allotted for cross-examination.

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

Date: 12-29-2024



Sumit Roy

APPENDIX 1

SUMIT ROY, Ph.D.

RESUME ADDENDUM

LITIGATION RELATED EXPERIENCE

Dr. Roy has served as an expert witness on the matters disclosed below (underlined denotes party represented).

Case:	<u>Marvell Semiconductor</u> et al. vs. Commonwealth Scientific and Industrial Research Organization
Jurisdiction:	United States District Court Eastern District of Texas Civil Action No. 6:2007-CV-00204
Nature of Case/Notes:	Patent infringement US Patent 5487069
Work Product:	On Behalf of plaintiff Marvell Semiconductor. Wrote expert Report on Non-Infringement, deposed before opposing attorney.
Counsel:	Retained by White & Case LLP (lead: Warren Heit wheit@paloalto.whitecase.com)
Date:	2009. <u>Status -closed.</u>
Case:	<u>X10</u> vs. Guardian Technologies
Jurisdiction:	United States District Court Northern District of Texas Civil Action No. 3:2009-CV-00649
Nature of Case/Notes:	Patent infringement US Patent 5657076
Work Product:	Wrote expert report on behalf of X10
Counsel:	Retained by Black Lowe & Graham (lead: Larry Graham; graham@blacklaw.com)
Date:	2010. <u>Status - closed.</u>
Case:	Commonwealth Scientific and Industrial Research Organization vs. <u>Sony Corporation</u> et al.
Jurisdiction:	United States District Court Eastern District of Texas Civil Action No. 6:2009-CV-00400-LED
Nature of Case/Notes:	Patent infringement US Patent 5487069.
Work Product:	On behalf of defendant Sony Corporation. Conducted independent technical analysis of claims, wrote rebuttal expert report against motion for infringement, deposed before opposing attorney.
Counsel:	Retained by White & Case LLP (lead: Warren Heit wheit@paloalto.whitecase.com)
Date:	2011. <u>Status -closed.</u>

Case: **Certain Electronic Devices, Including Mobile Phones and Tablet Computers, and Components Thereof**
Complainant- Nokia Corporation and Intellisync vs. HTC (Respondent) & Google (Intervenor)

Jurisdiction: United States International Trade Commission
Investigation No. 337-TA-847

Nature of Case/Notes Expert on behalf of Google (Intervenor) & HTC (Respondent)
Counsel: Retained by White & Case LLP on behalf of Google
(Lead: Shamita D. Etienne-Cummings
setienne@paloalto.whitecase.com)
Coordinated with
Counsel Barrington Dyer, McDermott, Will & Emery for HTC

Work Product Wrote Expert Witness report for Invalidity on behalf of Google. Deposed before opposing counsel.
Testified @ trial before ITC Judge Hon. Robert Pender (Jun. 2013)

Date: Aug. 2012 – July 2013. **Status- completed.**

Case: **In the Matter of Certain Wireless Communications Equipment and Articles Therein**
Complainant: Samsung Electronics Co. vs LM Ericsson

Jurisdiction: United States International Trade Commission
Investigation No. 337-TA-2126

Nature of Case/Notes Expert on behalf of respondents LM Ericsson
Counsel: McKool Smith LLP (Counsel:
Geoffrey Smith; gsmith@mckoolsmith.com)

Date: Feb. 2013 – July 2013

Work Product: Assisted Counsel for discovery of relevant prior art as part of non-infringement. **Status- closed.**

Case: **Intellectual Ventures LLC vs Motorola Mobility/Google**

Jurisdiction: US District Court – Southern District Florida
Case No. 13-CV-61358

Nature of Case/Notes Expert on behalf of respondents Motorola Mobility/Google
Counsel: Kilpatrick Townsend LLP (Counsels: Theodore Brown,
Jonathan Olinger, Rob Curylo, Akarsh Belagodu;
tbrown@kilpatricktownsend.com)

Date: Aug. 2013 – Sep. 2015.

Work Product: Assisting Counsel for Inter-Partes Review (IPR) for 3 patents.

Status IPR Declaration Filed, **Status – completed.**

Case: **C-Cation vs. Cisco**
Jurisdiction: Patent Trial & Appeals Board IPR 2014-00454
Nature of Case/Notes: Expert on behalf of respondents Cisco
Counsel: Kilpatrick Townsend LLP (Counsels: Patrick Njeim, Mike Pavento; pjneim@kilpatricktownsend.com)
Date: Jan 2014 – present
Work Product: Assisted Counsel for IPR
Status: IPR Declaration filed; **Status - Closed.**

Case: **DirectTV vs. ViXS**
Jurisdiction:
Nature of Case/Notes: Expert on behalf of respondents DirectTV
Counsel: Quinn Emanuel LLP (Counsels: Alan Whitehurst alanwhitehurst@quinnemanuel.com)
Date: Apr- Aug. 2014
Work Product: Assisted in discovery of prior art
Status: **Status: Closed (case settled)**

Case: **Commonwealth Scientific and Industrial Research Organization vs. Mediatek, Amazon et al.**
Jurisdiction: United States District Court Eastern District of Texas
Civil Action No. 6:2012-CV-578-LED
Nature of Case/Notes: Patent infringement US Patent 5487069.
Work Product: On behalf of defendant Amazon Corporation. Wrote expert report on non-infringement, deposed before opposing attorney.
Counsel: Retained by White & Case LLP (lead: Warren Heit wheit@paloalto.whitecase.com)
Date: Jan- Aug. 2015. **Status – Completed (case settled)**

Case: **NFC Tech. vs. Samsung Electronics Ltd. & Samsung Electronics America Inc.**
Jurisdiction: United States District Court Eastern District of Texas
Civil Action No. 2:15-cv-283-JRG-RSP
Nature of Case/Notes: Patent infringement US Patent 7905419.
Work Product: On behalf of defendant Samsung Electronics. Assisted with Claim Construction, wrote Invalidity Expert report.
Counsel: Retained by O'Melveny & Myers LLP (lead: Brian Cook, John Kappos, [bkook](mailto:bkook@omm.com), jkappos@omm.com)
Date: Oct. 2015- May 2016. **Status – Completed (case settled)**

Case:	<u>TCL Commn. Tech.</u> v. Ericsson
Jurisdiction:	U.S. Central District Court, CA Southern District Case 8:14-CV-00341-JVS-AN
Nature of Case/Notes:	Expert consultant for TCL on a set of 4G LTE patents for a FRAND case
Work Product:	Read Claim Charts and evaluated for potential infringement
Counsel:	Retained by Sheppard, Mullin, Richter & Hampton (lead: Nam Kim, nkim@sheppardmullin.com)
Date:	Sep. 2015- Dec. 2015.
Case:	<u>Barco NV</u> vs. Display Ten Tech. (via IMS Expert Services)
Nature of Case/Notes:	Potential US patent infringement
Work Product:	Visited Barco, examined product and wrote report exploring possible patent infringement strategy
Counsel:	Retained by Barnes & Thornburg LLP on behalf of Barco NV (lead: Jeffrey Morgan, jeff.morgan@btlaw.com)
Date:	Dec. 2015- Mar. 2016.
Nature of Work	Expert Consultant - Review of Wireless Patent Porfolio
Work Product:	Reviewed lapsing patents, provided expert opinion
Counsel:	Retained by Perkins Coie (Chris J. Daley-Watson, CDaleyWatson@perkinscoie.com)
Date:	Feb. 2017- Apr. 2017.
Case	<u>SIPCO</u> v Emerson 337-TA-1131
Jurisdiction	ITC
Nature of Case/Notes	Infringement of SIPCO patents re IEEE 802.15.4, Wireless HART, Zigbee standards
Work Product:	Assisted with review of products, patents, assisted with claim construction; Testified at ITC Trial (Judge Lord)
Counsel:	Retained by Finnegan, Henderson, Farabow, Garrett & Dunner (Greg Gramenopoulos, c.gregory.gramenopoulos@finnegan.com ; Karthik Kumar, Karthik.kumar@finnegan.com)
Date:	May 2018 – Sep. 2019 (completed)
Case	Sol IP LLC vs AT&T Mobility 2:18-cv-00526
Jurisdiction	Eastern District TX
Nature of Case/Notes	Retained on behalf of Ericsson NA
Work Product:	Assisted with review of patents, assisted with claim construction;

Counsel:	Retained by Winston & Strawn (M. Ruckheim, MRuckheim@winston.com; J. C. Masullo, JMasullo@winston.com)
Date:	May 2019 – Mar. 2020 <u>(completed)</u>
Case	UNM Rainforest Innovations vs Dell/ZyXEL Comm.
Jurisdiction	IPR2021-00375 before PTAB
Nature of Case/Notes	Retained on behalf of defendants (Dell/ZyXel)
Work Product:	Contributed to multiple expert declarations (3 patents)
Counsel:	Reed Smith (Peter Chassman, Jonathan Detrixhe@reedsmith.com)
Date:	Oct. 2021 – May 2022 <u>(completed)</u>
Case	NXP USA vs <u>MediaTek</u>
Jurisdiction	IPR2022-00911/00912 before PTAB
Nature of Work	Retained on behalf of plaintiff (MediaTek)
Work Product:	Contributed to expert declarations (2 patents)
Counsel:	Finnegan Henderson Farabow Garrett & Dunner (Houtan.Esfahani, Jason.Stach, Christopher.Johns@finnegan.com)
Date:	Mar. 2022 – Jun 2022 <u>(completed)</u>
Case:	Apple v <u>Ericsson</u> (Certain Mobile Phones and Tablet Computers, All With Switchable Connectivity)
Jurisdiction:	United States International Trade Commission 337-TA-1301
Nature of Work	Retained on behalf of Ericsson (plaintiff)
Counsel	Winston and Strawn, Fisher Broyles Louis Campbell (llcampbell@winston.com), Michael Murray (mike.murray@fisherbroyles.com)
Work Description:	multiple declarations (claim construction, expert report) deposition, Trial Testimony @ ITC before ALJ Hon. Cameron Elliott
Date	May – Nov 2022 <u>(completed)</u>
Case	Atlas Global vs <u>Sercomm/Asustek Inc</u>
Jurisdiction	6:21-cv-818 (WDTX) & IPR 2022-01519/01520
Work on Case	Retained on behalf of defendants (Sercomm/Asustek)
Counsel:	Steptoe & Johnson Christopher Suarez (csuarez@steptoe.com), Matthew Bathon (matthew.bathon@steptoe.com)
Work Description:	Assisted with multiple declarations (claim construction brief, expert declaration) for 2 patents
Date:	Mar 2022 – Mar 2023 <u>(completed)</u>

Case:	Panasonic v <u>Broadcomm</u> (6:22-cv-00755, 6:22-cv-00756)
Jurisdiction:	WDTX
Nature of Work	Retained on behalf of Broadcomm (defendant)
Counsel/Firm	Kilpatrick Townsend Ted Mayle (TMayle@kilpatricktownsend.com)
Work Description:	Assisted with Claim Construction, review infringement contentions
Date	Sep. 2022- Nov. 2023 (<u>completed</u>)
Case:	XR Communications v <u>Samsung</u> (6:21-cv-626)
Jurisdiction:	WDTX
Nature of Work	Retained on behalf of Samsung (defendant)
Counsel/Firm	Arnold Porter Ruifeng Pu(Ruifeng.Pu@arnoldporter.com), Atanas Baitchev (Atanas.Baitchev@arnoldporter.com), Michael Shamouilian (Michael.Shamouilian@arnoldporter.com)
Work Description:	Review Infringement contentions, help with Invalidity charts Invalidity Prior art review, Draft Invalidity Report
Date	Aug. 2022 – Feb. 2023 (<u>completed</u>)
Case:	AX Wireless v <u>Lenovo</u> (6:22-cv-280)
Jurisdiction:	EDTX
Nature of Work	Retained on behalf of Lenovo (defendant)
Counsel/Firm	Kilpatrick Townsend Ted Mayle (TMayle@kilpatricktownsend.com)
Work Description:	Review infringement contentions
Date	Mar. 2023- Jul 2023 (<u>completed</u>)
Case:	Neo Wireless v <u>VW Group America</u> (2:22-cv-11404)
Jurisdiction:	EDTN
Nature of Work	Retained on behalf of VW Group (defendant)
Counsel/Firm	Sterne, Kessler, Goldstein & Fox Timothy Tang (TTang@sternekessler.com) Ryan Richardson (RRichardson@sternekessler.com)
Work Description:	Assisted with Non-infringement Contentions
Date	Apr-May 2023 (<u>completed</u>)