

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

APPLE, INC.,

Petitioner

v.

APEX BEAM TECHNOLOGIES LLC,

Patent Owner

Case IPR2025-00901

U.S. Patent No. 11,374,721

**DECLARATION OF DR. ROBERT AKL, D.SC.
IN SUPPORT OF PETITION FOR *INTER PARTES* REVIEW**

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(c)	initiate a random access;	37
(d)	determine whether to select, for the random access, a first random access channel (RACH) procedure or a second RACH procedure based at least on a type of uplink data to be transmitted;.....	37
(e)	when the second RACH procedure is selected, the processor being further configured to: determine at least	

one physical random access channel (PRACH) resource associated with the second RACH procedure;.....	38
(f) determine a preamble sequence associated with the second RACH procedure;	38
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(c) receiving, by the first wireless communication device from a second wireless communication device in response to the first signal, a second signal.	50
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(b) [1.1] transmitting a first wireless signal; and.....	53
(c) [1.2] transmitting a second wireless signal;.....	56

- (d) [1.3] wherein the first wireless signal is generated by a first sequence; 58
- (e) [1.4] the first wireless signal is used to determine a first time interval; the first time interval is a time interval between a first time instant and a second time instant; the first time instant is a starting time instant at which a transmitter of the first wireless signal transmits the first wireless signal; the second time instant is a starting time instant at which a transmitter of the second wireless signal transmits the second wireless signal; the first time instant is earlier than the second time instant; 60
- (f) [1.5] the second wireless signal occupies a first wireless resource; the first wireless resource is one of J candidate wireless resources; the J is a positive integer; 69
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(c)	[3.3] the K candidate wireless resource(s) belongs (belong) to a first wireless resource pool; the first wireless resource pool is one of the Q wireless resource pool(s);	95
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(b)	[5.2] the first wireless signal occupies a target time-frequency resource;	107
(c)	[5.3] at least one of an index of the first sequence in the target sequence set, a location of the target time-frequency resource in time domain, a location of the target time-frequency resource in frequency domain, or a correspondence relationship between the location of the	

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I, Robert Akl, D.Sc., do hereby declare:

I. Introduction

1. I am over the age of 18 and am competent to make this Declaration. I have personal knowledge, or have developed knowledge, of the matters set forth herein based upon my education, training, and/or experience. If called upon to do so, I would testify competently thereto.

2. I have been retained by counsel for Petitioner Apple Inc. (“Petitioner” or “Apple”) as a technical expert in the above matter. I am submitting this Declaration to address the validity of claims 1-20 (“Challenged Claims”) in U.S. Patent No. 11,374,721 (“the ’721 patent”). For the purposes of this Declaration, I have not been asked to opine on any other issues not addressed below.

3. This Declaration explains the conclusions that I have formed based on my analysis. To summarize those conclusions:

- Ground 1: Based upon my knowledge and experience and my review of the prior art publications in this declaration, I believe that claims 1-20 are made obvious by Lee (APPLE-1005) in view of Freda (APPLE-1006) and Ly (APPLE-1007).

4. My opinions are based on my years of education, research and experience, as well as my investigation and study of relevant materials, including those identified in this Declaration. I may rely upon these materials, my knowledge

and experience, and/or additional materials in forming any necessary opinions. Further, I may also consider additional documents and information to rebut arguments raised by the Patent Owner Apex Beam Technologies LLC (“Patent Owner” or “Apex”). I reserve any right that I may have to supplement this Declaration if further information becomes available or if I am asked to consider additional information. Furthermore, I reserve any right that I may have to consider and comment on any additional expert statements or testimony of Apex’s expert(s) in this matter.

5. My analysis of the materials produced in this investigation is ongoing and I will continue to review any new material as it is provided. This Declaration represents only those opinions I have formed to date. I reserve the right to revise, supplement, and/or amend my opinions stated herein based on new information and on my continuing analysis of the materials already provided.

II. Documents and Materials Considered

6. In preparing my opinions, I have reviewed the ’721 patent and its prosecution history and have also reviewed the other documents and materials cited herein and the materials listed below. When citing from these references, all emphasis is added unless otherwise noted.

<u>Exhibit</u>	<u>Description</u>
APPLE-1001	U.S. Patent No. 11,374,721
APPLE-1002	U.S. Patent No. 11,374,721 File History

<u>Exhibit</u>	<u>Description</u>
APPLE-1004	Complaint, <i>Apex Beam Technologies LLC v. Apple Inc.</i> , 6:24-cv-00223, W.D. Tex., filed April 29, 2024
APPLE-1005	U.S. Patent Pub. No. 2017/0019930 A1 to Lee, et al. (“Lee”)
APPLE-1006	U.S. Patent Pub. No. 2019/0320467 A1 to Freda, et al. (“Freda”)
APPLE-1007	U.S. Patent Pub. No. 2018/0097590 A1 to Ly, et al. (“Ly”)
APPLE-1008	U.S. Prov. Patent App. No. 62/401,082 to Freda, et al. (“Freda Provisional 1”)
APPLE-1009	U.S. Prov. Patent App. No. 62/416,237 to Freda, et al. (“Freda Provisional 2”)
APPLE-1010	U.S. Prov. Patent App. No. 62/402,956 to Ly, et al. (“Ly Provisional”)
APPLE-1011	First Amended Complaint, <i>Apex Beam Technologies LLC v. Apple Inc.</i> , 6:24-cv-00223, W.D. Tex., filed May 2, 2024
APPLE-1012	Proof of Service of Complaint, <i>Apex Beam Technologies LLC v. Apple Inc.</i> , 6:24-cv-00223, W.D. Tex.

III. Background and Qualifications

7. I am an expert in the field of cellular networks. I have studied, taught, practiced, and researched this field for over 30 years. I have summarized in this section my educational background, work experience, and other relevant qualifications. A true and accurate copy of my *curriculum vitae* is attached in the Appendix.

8. I earned two Bachelor of Science degrees in Electrical Engineering and Computer Science summa cum laude with a grade point average of 4.0/4.0 and a ranking of first in my undergraduate class from Washington University in St. Louis

in 1994. In 1996, I earned my Master of Science degree in Electrical Engineering from Washington University in St. Louis with a grade point average of 4.0/4.0. I earned my Doctor of Science in Electrical Engineering from Washington University in St. Louis in 2000, again with a grade point average of 4.0/4.0, with my dissertation being on “Cell Design to Maximize Capacity in Cellular Code Division Multiple Access (CDMA) Networks.”

9. While a graduate student, from 1997 through 1999, I worked at MinMax Corporation in St. Louis, where I designed software packages that provided tools to flexibly allocate capacity in a CDMA communications network and maximize the number of subscribers. I also validated the hardware architecture for an Asynchronous Transfer Mode (ATM) switch capable of channel group switching, as well as performed logical and timing simulations, and developed the hardware architecture for the ATM switch. I also worked with Teleware Corporation in Seoul, South Korea, where I designed and developed algorithms that were commercially deployed in a software package suite for analyzing the capacity in a CDMA network implementing the IS-95 standard to maximize the number of subscribers.

10. After obtaining my Doctor of Science degree, I worked as a Senior Systems Engineer at Comspace Corporation from October of 2000 to December of 2001. At Comspace, I designed and developed advanced data coding and modulation methods for improving reliability and increasing the available data rates for cellular

communications. I coded and simulated different encoding schemes (including Turbo coding, Viterbi decoding, trellis coded modulation, and Reed- Muller codes) and modulation techniques using amplitude and phase characteristics and multilevel star constellations. This work further entailed the optimization of soft decision parameters and interleavers for additive white Gaussian and Rayleigh faded channels. In addition, I also extended the control and trunking of Logic Trunked Radio (LTR) to include one-to-one and one-to- many voice and data messaging.

11. In January of 2002, I joined the faculty of the University of New Orleans in Louisiana as an Assistant Professor in the Department of Electrical Engineering. While in this position, I designed and taught two new courses called “Computer Systems Design I and II.” I also developed a Computer Engineering Curriculum with a strong hardware-design emphasis, formed a wireless research group, and advised graduate and undergraduate students.

12. In September 2002, I received an appointment as an Assistant Professor in the Department of Computer Science and Engineering at the University of North Texas (UNT), in Denton, Texas. In May of 2008, I earned tenure and was promoted to the rank of Associate Professor. As a faculty member, I have taught courses and directed research in networking and telecommunications, including 2G, 3G, 4G, 5G, CDMA/WCDMA, GPS, GSM, UMTS, LTE, ad-hoc networks, antenna design and beamforming, Bluetooth, call admission control, channel coding, channel

estimation, communication interfaces and standards, compression, computer architecture, fault recovery, link aggregation, Internet Protocols, MIMO systems, multi-cell network optimization, network routing, network security, network self-test, packet-networks, ring networks, routing, telephony, VoIP, VPLS, Wi-Fi (802.11), 802.15.4, Zigbee, wireless communication, and wireless sensors. Between January 2015 and August 2022, I was appointed to Associate Chair of Graduate Studies in the Department of Computer Science and Engineering. In May of 2023, I was promoted to the rank of Professor.

13. I am also the director of the Wireless Sensor Lab (“WiSL”) at UNT. I am a member of the Center for Information and Cyber Security (CICS). It is the only program in the U.S. to be federally certified by the National Security Agency as a Center of Academic Excellence in Information Assurance Education and Research and Cyber Defense Research. I was also a member of the NSF Net-Centric & Cloud Software & Systems: Industry-University Cooperative Research Center (I/UCRC). Several of my research projects are funded by industry and the National Science Foundation and published in IEEE conference proceedings and journals.

14. In addition to advising and mentoring students at UNT, I was asked to join the faculty of the University of Arkansas in Little Rock as an Adjunct Assistant Professor from 2004 to 2008 in order to supervise the research of two Ph.D. graduate students who were doing research in wireless communications. At UNT, I have

advised and supervised more than 250 undergraduate and graduate students, several of whom received a master's or doctorate degree under my guidance.

15. Between 2005 and 2017, I have received over a million dollars in funding from the State of Texas, Texas Higher Education Coordination Board, the National Science Foundation, and industry to design and conduct robotics, video, and mobile gaming (*e.g.*, Xbox, PC, mobile device) programming summer camps for middle and high school students at UNT. By using video and mobile gaming as the backdrop, participants have learned coding and programming principles and developed an understanding of the role of physics and mathematics in video game design.

16. Between 2011 and 2013, I was director of the Bio-Com Project that was funded by Raytheon. The project evaluated the feasibility study using Surface Electromyography (EMG) and bend resistive sensors, which are attached to each of the five fingers of the hand, for hand gesture recognition. This approach is sometimes known as a "data glove." A prototype was developed and demonstrated at Raytheon, to help soldiers in close-combat situations communicate with hand gestures and hand signals that would be recognized and transmitted to other soldiers' Head Up Display (HUD) without breaking radio silence.

17. In addition to my academic work, I have remained active in the communication industry through my consulting work. In 2002, I consulted for

Input/Output Inc. and designed and implemented algorithms for optimizing the frequency selection process used by sonar for scanning the bottom of the ocean. In 2004, I worked with Allegiant Integrated Solutions in Ft. Worth, Texas to design and develop an integrated set of tools for fast deployment of wireless networks, using the 802.11 standard. Among other features, these tools optimize the placement of Access Points and determine their respective channel allocations to minimize interference and maximize capacity. I also assisted the Collin County Sheriff's Office (Texas) in a double homicide investigation, analyzing cellular record data to determine user location.

18. I have authored and co-authored over 100 journal publications, conference proceedings, technical papers, book chapters, and technical presentations in a broad array of communications-related technologies, including networking and wireless communication. I have also developed and taught over 100 courses related to communications and computer systems, switches and routers, including several courses on signals and systems, 4G/LTE and 5G/NR, OFDM, Internet Protocols, VoIP, VPLS, Wi-Fi (802.11), 802.15.4, Zigbee, wireless communication, antenna design and beamforming, communications systems, communication interfaces and standards, channel estimation, fault recovery, link aggregation, location management, sensor networks, source coding and compression, network security, network self-test, computer systems design, game and app design, and computer

architecture. These courses have included introductory courses on communication networks and signals and systems, as well as more advanced courses on wireless communications, networking and routing. A complete list of my publications and the courses I have developed and/or taught is also contained in my curriculum vitae.

19. My professional affiliations include services in various professional organizations and serving as a reviewer for a number of technical publications, journals, and conferences. I have also received a number of awards and recognitions, including the IEEE Professionalism Award (2008), UNT College of Engineering Outstanding Teacher Award (2008), and Tech Titan of the Future (2010) among others, which are listed in my curriculum vitae.

20. 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 (including those during the past four years) is provided in my curriculum vitae. Over the years, I have been retained by both patent owners and petitioners, as well as plaintiffs and defendants.

21. I am being compensated for my work in this case at my standard rate of \$995 per hour (plus reimbursement for expenses) in connection with my preparation of this declaration, as well as for each hour spent providing deposition or testimony. This compensation is not contingent upon my performance, the outcome of this case,

or any issues involved in or related to this case. I have no financial interest in this matter.

IV. Understanding of Legal Standards

22. I am not an attorney and have not been asked to offer an opinion on the law. I understand, however, that certain aspects of the law are relevant to my evaluation and opinions set forth herein. I have therefore been informed of and asked to apply the legal principles summarized below.

A. Priority Date

23. I understand that the “priority date” of a patent is the date on which it is filed. I further understand that a patent may be entitled to the filing date of an earlier-filed application or foreign patent filing. In this case I understand the ’721 patent claims priority to January 22, 2017.

B. Burden of Proof

24. I understand that Apple as the Petitioner bears the burden of proof in this proceeding and that that burden is to establish by a preponderance of the evidence that the claims are invalid.

C. Claim Construction

25. I understand that the words of a claim are generally given their ordinary and customary meaning, which I understand is the meaning that the term would have to a person of ordinary skill in the art in question at the time of the invention, *i.e.*, as of the effective filing date of the patent application. I understand the person of

ordinary skill in the art is deemed to read the claim term not only in the context of the particular claim in which the disputed term appears, but in the context of the entire patent, including the specification and prosecution history. Additionally, I understand other extrinsic evidence external to the patent and prosecution history, such as dictionaries and treatises, may also be useful in determining the meaning that the term would have to a person of ordinary skill in the art in question at the time of the invention. I understand that such extrinsic evidence, however, is generally afforded less weight than intrinsic evidence in determining the meaning of claim terms, and overall is unlikely to result in a reliable interpretation of a patent claim scope unless considered in the context of the intrinsic evidence.

D. Anticipation Under 35 U.S.C. § 102

26. I understand that a patent claim is invalid as anticipated if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference. I also understand that, to anticipate, the reference must teach all of the limitations arranged or combined in the same way as described in the claim. I do not rely on anticipation in this declaration.

27. With respect to inherency, I understand that the fact that a certain result or characteristic may occur or be present in the prior art is not sufficient to establish the inherency of that result or characteristic. Instead, the inherent characteristic must necessarily flow from the teaching of the prior art.

E. Obviousness Under 35 U.S.C. § 103

28. I understand that a claim is invalid if the invention recited in the claim would have been obvious to one of ordinary skill in the art at the time the invention was made. I understand this means that even if all the requirements of the claim cannot be found in a single prior art reference that would anticipate the claim, a person of ordinary skill in the field of the invention knowledgeable of the prior art would have come up with the claimed invention. In considering whether a claim is obvious, I have been asked to consider (a) the level of skill in the art at the time of the claimed invention, (b) the scope and content of the prior art, (c) any differences between the prior art and the claims of the patent-in-suit, and (d) any “secondary factors” tending to show non-obviousness of the claimed invention, including commercial success, long-felt but unresolved need, failure of others, copying, praise by others, unexpected results, and simultaneous invention by others.

29. I understand that a claim composed of several elements is not proved obvious merely by demonstrating that each of its elements was independently known in the prior art. I also understand that obviousness should not be analyzed using the benefit of hindsight. Instead, it must be analyzed from the standpoint of what was known and understood by a POSITA at the time of the claimed invention. I further understand demonstrating that a modification to a reference or the combination of multiple references is obvious requires providing a reason for why a POSITA would

modify a reference or combine multiple references and that reason must be supported with some rationale underpinning. Merely pointing out that two references are similar or in the same field of endeavor is not sufficient.

F. Secondary Considerations of Non-Obviousness

30. I understand that determining whether the claims are obvious also involves considering certain factors that may help determine that a particular concept was not obvious. These include practical factors relating to the concept, including (1) commercial success, (2) a long-felt need for a solution to the problem facing the inventors, (3) whether others tried and failed to solve the problem, (4) whether others copied the claimed invention, (5) whether the invention achieved unexpected results, (6) whether the prior art teaches away from combining certain known elements, and (7) whether others in the field praised the invention.

V. Person of Ordinary Skill in the Art

31. I understand there is a concept in patent law known as a person having ordinary skill in the art (POSITA). I understand that this concept refers to a person who is trained in the relevant technical field of a patent without possessing extraordinary or otherwise exceptional skill. I further understand that factors such as the education level of those working in the field, the sophistication of the technology, the types of problems encountered in the art, prior art solutions to those problems,

and the speed at which innovations are made may help establish the level of skill in the art.

32. Taking these factors into consideration, in my opinion, with regard to the '721 patent, a person of ordinary skill in the art would have a bachelor's degree in electrical engineering, computer engineering, computer science, or a similar field, along with two years of experience designing or developing wireless networks, including long-term evolution LTE/4G and 5G new radio (NR) cellular technology. Additional education might substitute for some of the experience, and additional substantial experience might substitute for some of the educational background.

33. Based at least on my educational and work experience, I was at least a person of ordinary skill in the art as of the effective filing date of the '721 patent. And while I note that my qualifications and experiences exceed this definition of a person of ordinary skill of the art, in arriving at the conclusions in this Declaration, I have considered the issues from the perspective of a person of ordinary skill of the art at the relevant time.

34. Unless otherwise stated, I have applied this level of ordinary skill in the art for the purposes of this Declaration.

VI. Overview of the Subject Patent US 11,374,721

A. Overview

35. The '721 patent is directed to “a transmission scheme in a wireless communication system, and in particular to a method and device related to uplink transmission.” APPLE-1001, 1:18-20.

36. FIG.1 of the '721 patent (reproduced below) depicts a user equipment (UE) transmitting two different signals to a base station. Initially, the UE transmits a “first wireless signal” to the base station over a Random Access Channel (RACH). *See id.*, FIG. 1 (S21). This first wireless signal is generated by a first sequence, which is a Zadoff-Chu (ZC) sequence. *Id.*, 3:7-8. Subsequently, the UE transmits a “second wireless signal” to the base station over a Physical Uplink Shared Channel (PUSCH). *See id.*, FIG. 1 (S24).

37. The '721 patent focuses on a scenario of “grant-free uplink transmission” where a “lack of centralized dynamic scheduling and resource coordination” can result in collisions between uplink transmissions of different UEs. *Id.*, 2:6-18. Further, the '721 patent describes reducing “the possibility of collision of the second wireless signals” and avoiding “ambiguity of uplink transmission between multiple uplink receiving nodes,” at least in part by adjusting various transmission properties of the second wireless signal, such as (i) the timing of the second wireless signal, (ii) the resource occupied by the second wireless signal, and

(iii) whether the second wireless signal is transmitted or not. *Id.*, 2:64-67, 11:27-28.

claim 1.

38. As an example, the '721 patent describes the ability to adjust the time interval ("first time interval") between the time at which the UE starts to transmit the first wireless signal ("first time instant") and the time at which the UE starts to transmit the second wireless signal ("second time instant"). *See id.*, 12:30-39, 49-67. Notably, the '721 patent describes that the first time interval is used to determine the first time interval, so as to adjust the transmission time of the second wireless signal to avoid collisions with similar transmissions by other UEs. *Id.*, *see also* 2:31-34.

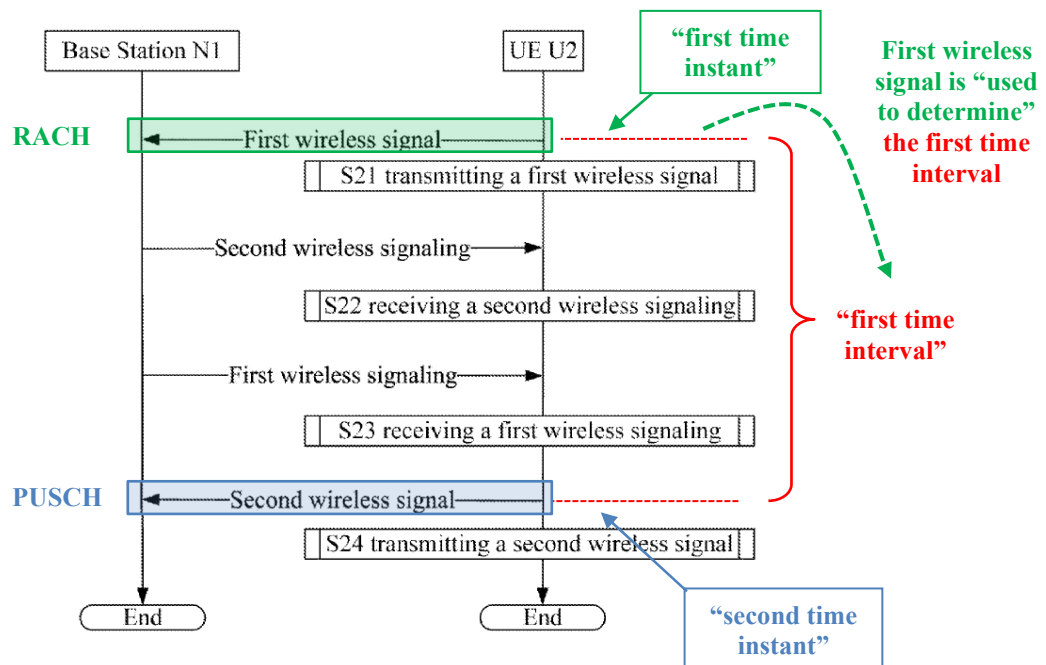
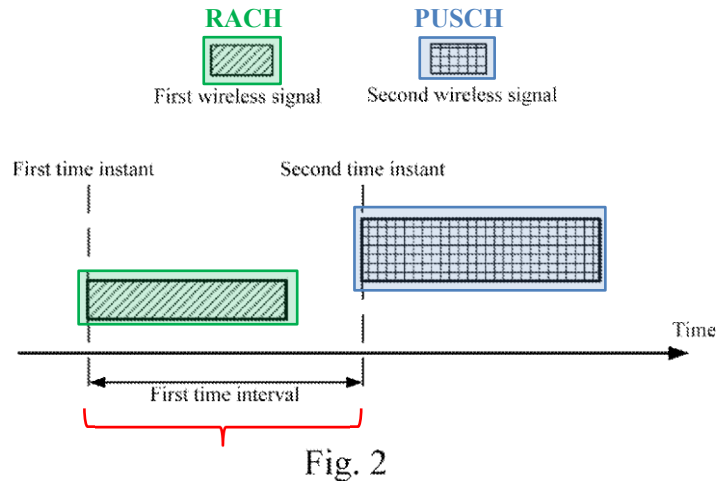


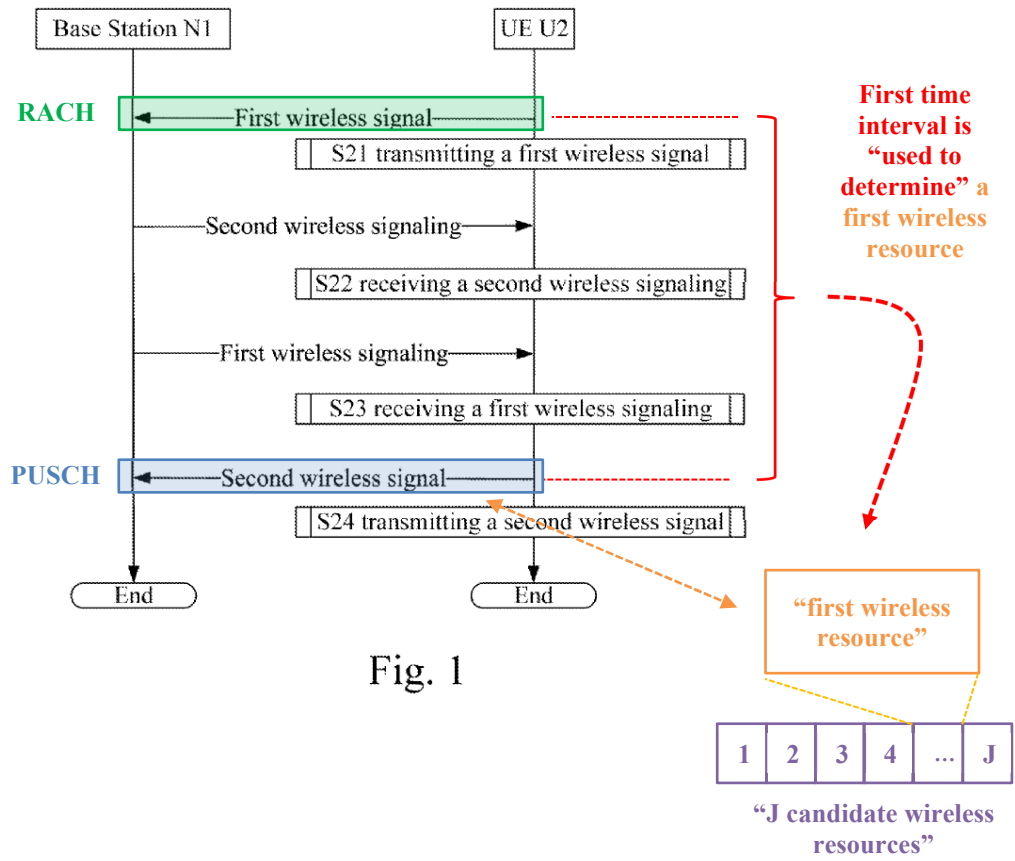
Fig. 1

APPLE-1001, FIG. 1 (annotated)

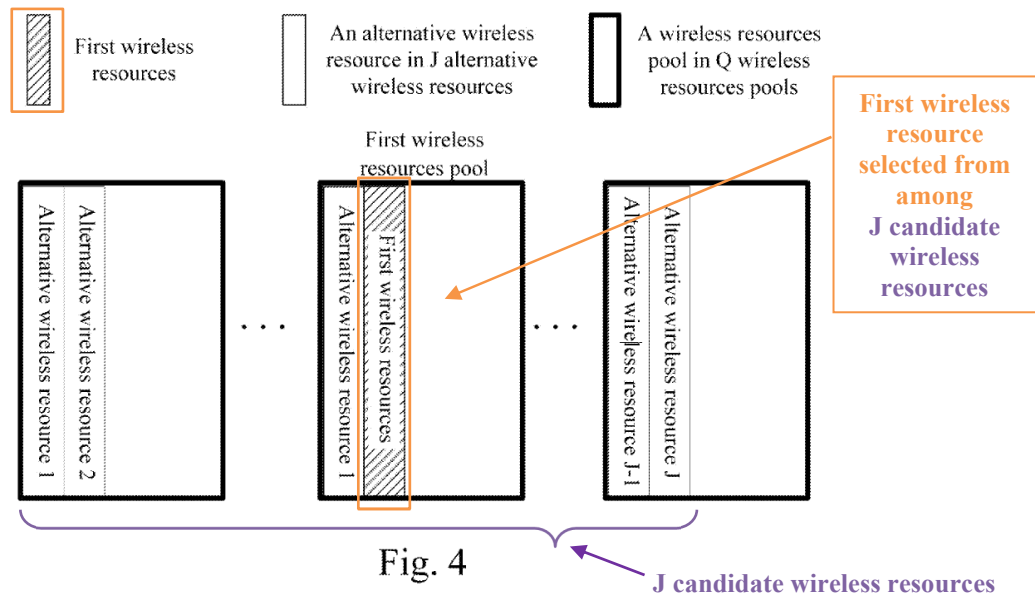


APPLE-1001, FIG. 2 (annotated)

39. The “second wireless signal” occupies a particular wireless resource (“first wireless resource”). *Id.*, 12:39-45. *See also id.*, 14:64-19:20. As the ’721 patent explains, a “wireless resource” can be a “time-frequency resource” occupying “one subcarrier in frequency domain” and “one OFDM symbol in time domain” (e.g., a “resource block”). *Id.*, 4:3-6, 4:15-19, 21:21-24. The “first wireless resource” is selected from among a group of “J candidate wireless resources” (where “J” is a positive integer). *Id.*, 12:39-45. *See also id.*, 14:64-19:20. Notably, the ’721 patent describes that the first wireless resource is determined by using the first time interval. *Id.* Thus, the ’721 patent describes the ability to adjust the time-frequency resource in which the second wireless signal is transmitted, to help avoid collisions. *Id.*, 2:31-34.



APPLE-1001, FIG. 1 (annotated)



APPLE-1001, FIG. 4 (annotated)

40. In addition, the '721 patent also describes the “first wireless signal” is used to determine whether the “second wireless signal is transmitted or not.” *Id.*, 10:9-11,13:4-6.

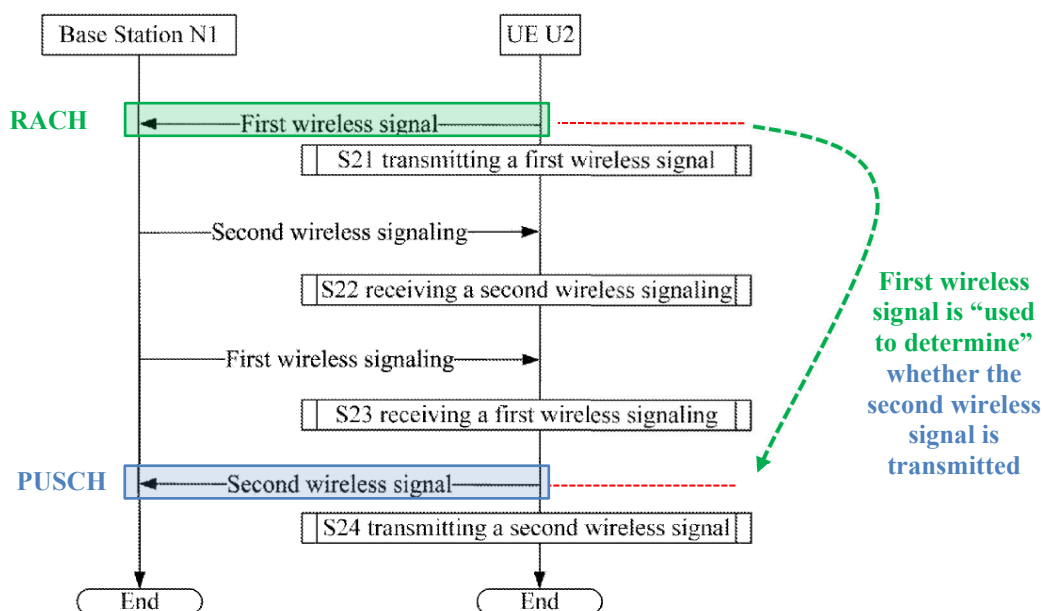


Fig. 1

APPLE-1001, FIG. 1 (annotated)

B. Prosecution History of the '721 Patent

41. The '721 patent issued on June 28, 2022 from U.S. Patent Application No. 17/095,767 (“the '767 application”), which was filed on November 12, 2020 with 20 claims. *See* APPLE-1002. This application claims priority to International Application No. PCT/CN2017/072131, filed January 22, 2017.

42. During prosecution of the '767 application, the Examiner did not issue any prior art rejections and there is no indication that the Examiner considered Lee, Freda, or Ly, which render the Challenged Claims obvious, as discussed below. *See generally*, APPLE-1002.

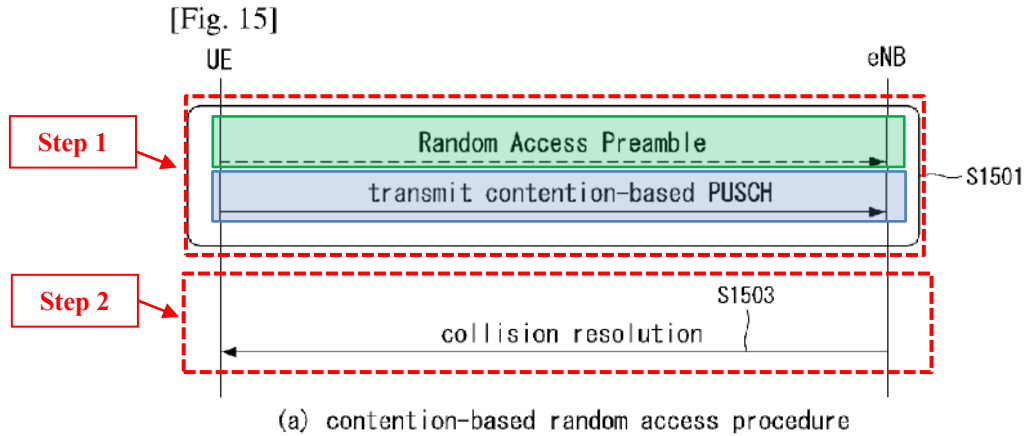
VII. Summary of '721 Prior Art

43. The following pieces of prior art render obvious the alleged invention of the '721 patent in the combinations addressed further below (Ground 1).

A. Overview of Lee

44. Lee is analogous art to the '721 patent because, like the '721 patent, Lee is directed to a random-access procedure in a wireless communication system with a goal of reducing collisions in unscheduled uplink transmissions. APPLE-1005, Abstract, [0041]-[0045]; APPLE-1001, 2:6-18, 2:64-67, 3:22-30, 11:27-28.

45. In particular, Lee describes a “2-step random access procedure” (“2-step RACH”). APPLE-1005, [0009]-[0011], [0019]-[0020], [0237]-[0241], [0315]-[0383], FIGS. 15(a) and 22-27. In the first step of this procedure (S1501 in FIG. 15(a), annotated “Step 1”), Lee’s UE transmits two signals, namely (i) “a RACH preamble sequence through the PRACH” (annotated in green below) and (ii) “simultaneously or sequentially ... an RRC message to an eNB” through the PUSCH (annotated in blue below). *Id.* In response, in the second step (step S1503, annotated “Step 2”), “[t]he eNB transmits a contention resolution” to the UE. *Id.*

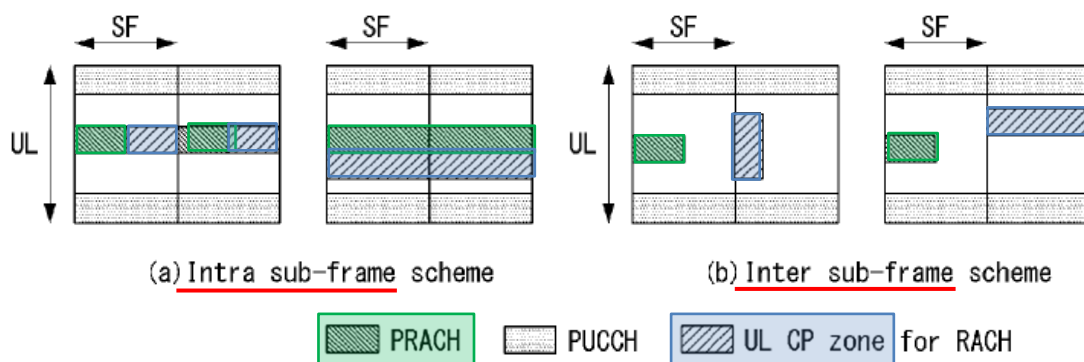


APPLE-1005, FIG. 15(a) (annotated)

46. As noted above, in Lee’s first step (S1501, “Step 1”), the UE transmits two signals, namely (i) the RACH preamble sequence (annotated in green) and (ii) the RRC message transmitted through the PUSCH (annotated in blue). *Id.* In the 2-step RACH, the UE transmits the RRC message “without separate UL grant.” *Id.*, [0241]. As Lee explains, transmitting the RRC message without having to receive a separate UL grant enables the UE to “shorten the time for transmitting the RRC message” as compared to a lengthier 4-step RACH procedure in which the transmission of the RRC message is predicated on the UE receiving a UL grant. *Id.* [0241], [0123], FIG. 8 (describing a lengthier 4-Step RACH procedure).

47. In this first step (S1501) of the 2-step RACH, Lee’s UE adjusts the timing between the RACH preamble transmission and the RRC message (PUSCH) transmission. For example, Lee explains that the “UE may transmit the RACH preamble message and the RRC message using the same time or a continuous time

resource.” APPLE-1005, [0212]. Lee refers to these two scenarios as “intra subframe” (in the same subframe) and “inter subframe”. *Id.*, [0203]-[0213], FIGS. 13-14. Lee provides examples of the “intra sub-frame scheme” in FIG. 14(a) (reproduced below, left) in which the resource for the RACH preamble (“PRACH,” annotated green) is allocated in the same subframe (“SF”) as the resource for the RRC message (“UL CP zone,” annotated blue). *Id.*, [0215], FIG. 14(a). By contrast, Lee provides examples of the “inter sub-frame scheme” in FIG. 14(b) (reproduced below, right) in which the RACH preamble resource (green) is allocated in a different subframe (“SF”) from the resource of the RRC message (UL CP zone, blue). *Id.*, [0216], FIG. 14(b). The term “CP zones” is an acronym for “contention-based PUSCH zones” which “signify resource regions in which a contention-based UL data transmission allocated within a subframe is available.” *Id.*, [0204].



APPLE-1005, FIG. 14 (annotated)

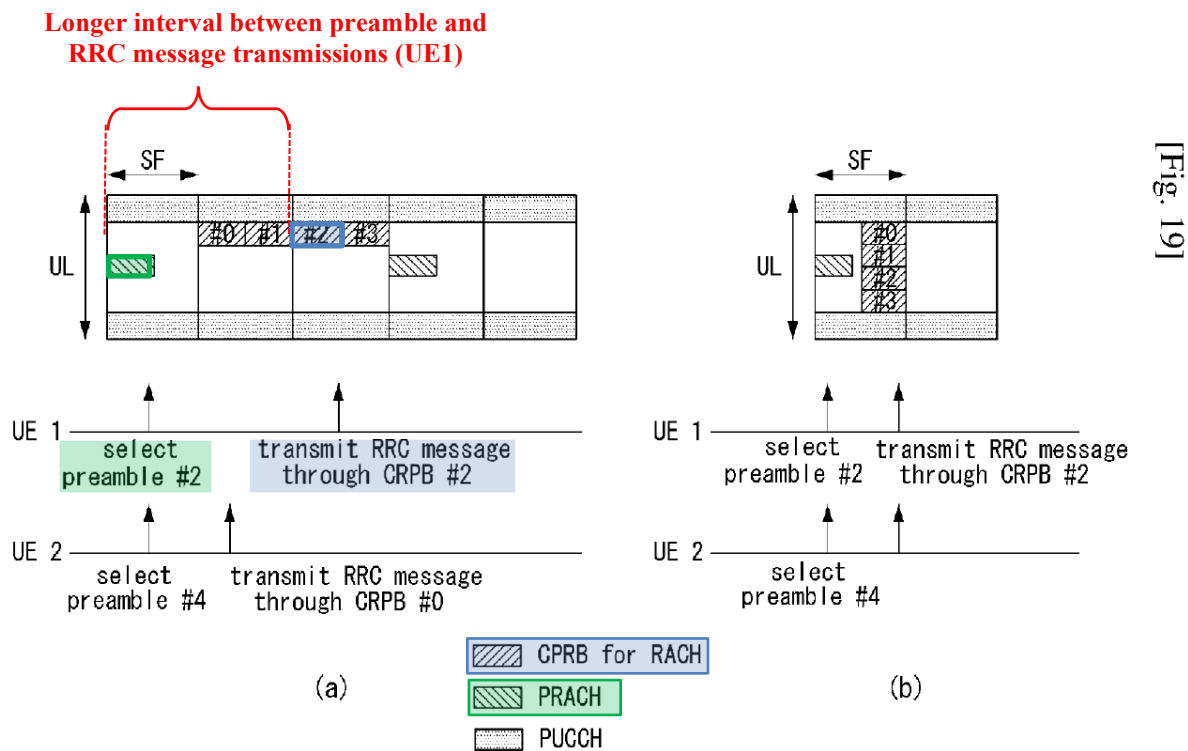
48. As such, Lee's UL CP zone (for the RRC PUSCH message) can be configured in the same subframe as the RACH preamble (intra-subframe scheme) or in a different subframe (inter-subframe scheme). The specific configuration (selection of scheme) is "predefined in a specific cell" and the base station associated with the cell "transmits the configuration information for the contention-based radio resource to a UE" where this information "signifies the information for time/frequency resource domain in which the CP zone is configured." APPLE-1005, [0213], [0218], [0220]. [0222]. Through the configuration of an intra- or inter-subframe scheme, the CP zone can be defined "in a relation to a PRACH region in which the RACH preamble is transmitted." *Id.*, [0213].

49. Each CP zone consists of multiple "contention-based PUSCH resource blocks" (CPRBs), where each CPRB is "a UL resource region that a UE may occupy (*e.g.*, use) for a specific procedure within the CP zone." *Id.*, [0205]. Thus, for a given CP zone configured for a UE (according to either the intra- or -inter-subframe scheme), the UE uses "one or more CPRB[s]" within that CP zone to transmit UL data in an RRC message. *Id.*, [0206], [0237].

50. In scenarios where multiple UEs share the same CP zone for their RRC message transmissions, Lee ensure the UEs use different CPRBs within the same CP zone, for example by selecting the "contention-based PUSCH resource block" ("CPRB") for the RRC message based on the RACH preamble. APPLE-1005,

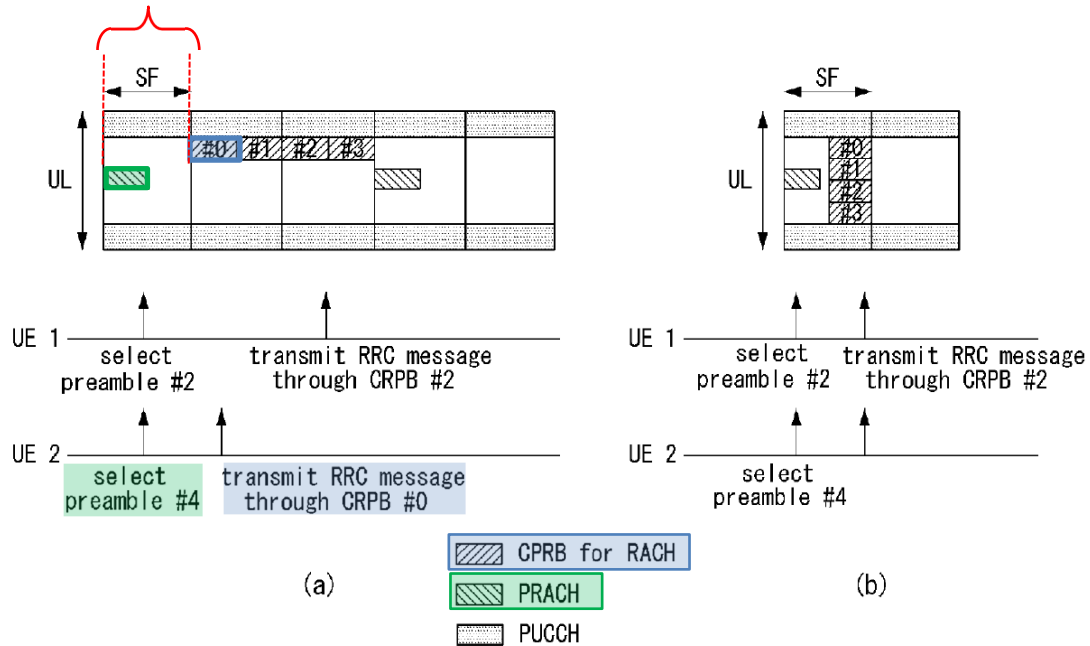
[0282]-[0287] (“minimizing failure of RRC message transmission through a CPRB by implicitly selecting a CPRB on the basis of a randomly selected preamble”).

51. Lee’s FIG. 19(a) illustrates a CP zone consisting of 4 CPRBs (#0 through #3) in which two UEs transmit RRC messages in different CPRBs, based on their different respective preambles. *See also* APPLE-1005, [0281]-[0290]. On two annotated versions of FIG. 19, presented in sequence, variations in the interval lengths of various CPRBs are highlighted.



APPLE-1005, FIG. 19 (annotated)

Shorter interval between preamble and RRC message transmissions (UE2)



[Fig. 19]

APPLE-1005, FIG. 19 (annotated)

52. Lee also describes techniques where a UE can abandon its RRC message transmission when too many UEs attempt to utilize a CP zone. *Id.*, [0305]-[0311], FIG. 21. For example, in scenarios of full-duplex relay (FDR) where each UE is able to simultaneously transmit its own RACH preamble while also recognizing which RACH preamble a neighbor UE has selected, Lee describes a technique to ensure the simultaneously transmitting UEs do not collide in a CP zone. *Id.* Specifically, *e.g.*, preamble sequences can be numbered such that “a UE which selects a preamble sequence having a smaller value may always have priority.” *Id.*, [0306]. For a UE that selects a preamble sequence with lower priority, if “there is

no available CPRB” then “a CPRB is not allocated thereto” and the UE “abandons RRC message transmission to the eNB.” *Id.*, [0309], [0310].

B. Overview of Freda

53. Freda is analogous art to the '721 patent because, like the '721 patent, Freda is directed to a wireless communication system having a random-access procedure for reducing collisions in scenarios where uplink transmissions are performed without receiving a grant from the network. APPLE-1006, Title, Abstract, [0128], [0280], [0364]; APPLE-1008, Title, Abstract, [0113], [0240], [0296]; APPLE-1009, Title, Abstract, [0113], [0263], [0321]; APPLE-1001, 2:6-18, 2:64-67, 3:22-30, 11:27-28.

54. In particular, Freda describes an “enhanced random access procedure” (“2-step RACH”). APPLE-1006, [0127]; APPLE-1008, [0112]; APPLE-1009, [0112]. In the first step (604-610 in FIG. 6, “Step 1”) of Freda’s 2-step RACH procedure, a UE (also referred to as a “WTRU”) transmits, to a base station, a “first message (*e.g.*, eMSG1)” which “may include a transmission of data combined with a preamble sequence.” APPLE-1006, [0129]; APPLE-1008, [0114]; APPLE-1009, [0114]. In response, in the second step (612, “Step 2”), the UE receives a “second message (*e.g.*, eMSG2)” (also referred to as “eRAR”) which may include “contention resolution information.” APPLE-1006, [0290], [0335]; APPLE-1008, [0249], [0294]; APPLE-1009, [0273], [0318].

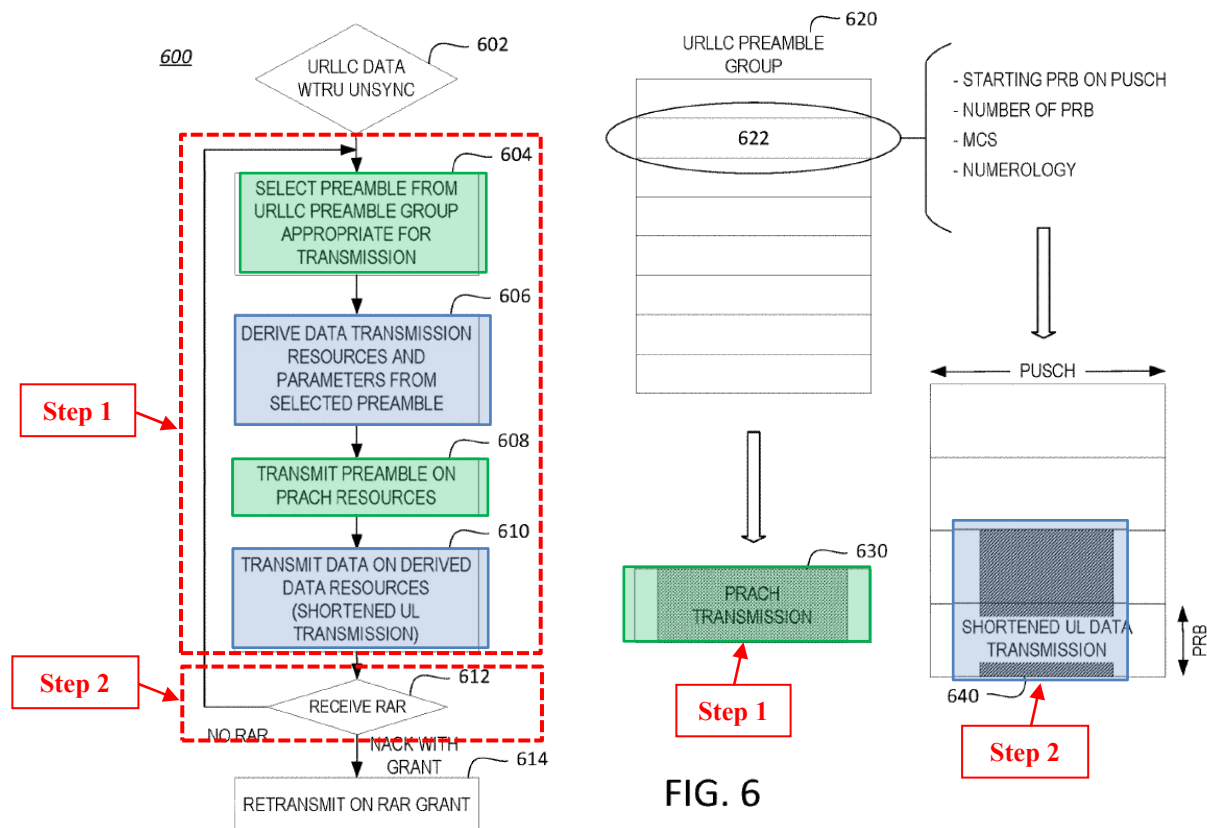


FIG. 6

APPLE-1006, FIG. 6 (annotated)

55. In Freda’s first step (annotated “Step 1” above), as with Lee, the UE transmits two signals, namely (i) a preamble transmitted through a “PRACH” and (ii) data transmitted through a “PUSCH.” APPLE-1006, FIG. 6, [0132]; APPLE-1008, FIG. 6, [0117]; APPLE-1009, FIG. 6, [0117]. As Freda explains, its 2-step RACH “enable[s] a WTRU to send data before receiving a grant from the network” which can “reduce latency for an initial transmission of a data burst.” APPLE-1006, [0128]; APPLE-1008, [0113]; APPLE-1009, [0113].

56. In this first step (Step 1) of the 2-step RACH, the UE’s preamble transmission and the UE’s data transmission can be related through “association

rules between preamble resources and data resources, such as ... a time and/or frequency offset between them.” APPLE-1006, [0206]; APPLE-1008, [0181]; APPLE-1009, [0189]. For example, “[a] relationship between preamble and data may be in a **time domain**” such that “a start time of a transmission of a preamble and a start time of a transmission of a data portion may be offset from each other by a specific amount of time.” APPLE-1006, [0209]; APPLE-1008, [0184]; APPLE-1009, [0192]. Freda explains that the “start time may correspond to ... [a] first symbol of a corresponding PRB region.” APPLE-1006, [0209]; APPLE-1008, [0184]; APPLE-1009, [0192]. As another example, “[a] relationship between preamble and data may be in a **frequency domain**” such that “a first PRB of a transmission of a preamble and a first PRB of a transmission of a data portion may be offset from each other by a specific amount of PRBs.” APPLE-1006, [0210]; APPLE-1008, [0185]; APPLE-1009, [0193]. Notably, Freda discloses that both the time-domain offset and frequency-domain offset can be determined based on the selected RACH preamble (*e.g.*, “a preamble may be associated with a specific offset to be used”). APPLE-1006, [0209], [0211]; APPLE-1008, [0184], [0186]; APPLE-1009, [0192], [0194].

1. At Least One of Freda’s Claims Is Supported by Freda’s Provisional Applications

57. Freda claims priority to U.S. Prov. 62/401,082 filed September 28, 2016 (“Freda Provisional 1”) and U.S. Prov. Patent App. No. 62/474,762 filed

November 2, 2016 (“Freda Provisional 2”). APPLE-1006, Cover. Freda Provisional 1 and Freda Provisional 2 are incorporated in their entirety in/by Freda. APPLE-1006, [0001].

58. Freda Provisional 1 and Freda Provisional 2 both include the relevant prior art disclosure and supports at least one of Freda’s claims (claim 1), as shown below.

(a) A wireless transmit/receive unit (WTRU) comprising:

59. APPLE-1008, [0015]-[0016], [0026]-[0035], FIGS. 1A-1E; APPLE-1009, [0015]-[0016], [0026]-[0035], FIGS. 1A-1E.

(b) a processor configured to:

60. APPLE-1008, [0027]-[0028], [0032]-[0035], FIG. 1B; APPLE-1009, [0027]-[0028], [0032]-[0035], FIG. 1B.

(c) initiate a random access;

61. APPLE-1008, [0118]-[0122], [0131], FIG. 6; APPLE-1009, [0118]-[0122], [0131], FIG. 6.

(d) determine whether to select, for the random access, a first random access channel (RACH) procedure or a second RACH procedure based at least on a type of uplink data to be transmitted;

62. APPLE-1008, [0130]-[0168] (e.g., [0157] “WTRU may determine that it should perform an eRACH procedure, for example, based on the type of data/transmission”); APPLE-1009, [0130]-[0176].

- (e) *when the second RACH procedure is selected, the processor being further configured to: determine at least one physical random access channel (PRACH) resource associated with the second RACH procedure;***

63. APPLE-1008, [0129], [0132]-[0133], [0149], [0159], [0180], [0186], [0210], [0213]; APPLE-1009, [0129], [0132]-[0133], [0149], [0164], [0188], [0194], [0232], [0236].

- (f) *determine a preamble sequence associated with the second RACH procedure;***

64. APPLE-1008, [0002], [0132], [0149], [0193], [0197]-[0212], FIG. 6; APPLE-1009, [0002], [0132], [0149], [0211], [0215]-[0235], FIG. 6.

- (g) *determine a data resource for the uplink data based on one or more of the at least one PRACH resource, the preamble sequence, the type of uplink data, or a size of the uplink data; and***

- (h) *send, to a network device using the at least one PRACH resource and the data resource, a RACH transmission that comprises the preamble sequence and the uplink data.***

65. APPLE-1008, [0158], [0178]-[0192], FIG. 6; APPLE-1009, [0163], [0185]-[0200], FIG. 6.

C. The Combination of Lee and Freda

66. As I explained above, both Lee and Freda describe 2-step random access procedures for reducing collisions in unscheduled uplink transmissions, where, in the first step, a UE transmits both a RACH preamble and PUSCH data to a base station. APPLE-1005, [0009]-[0011], [0019]-[0020], [0041]-[0045], [0237]-

[0241], [0315]-[0383], FIGS. 15(a) and 22-27; APPLE-1006, FIG. 6, [0128], [0132] [0238], [364]; APPLE-1008, FIG. 6, [0113], [0117], [0240], [0296]; APPLE-1009, FIG. 6, [0113], [0117], [0263], [0321]. And, Lee and Freda both disclose a scenario where the PUSCH data is transmitted without a separate grant/scheduling from the base station, which can result in collisions of PUSCH data transmissions between different UEs. APPLE-1005, [0241], [0123], FIG. 8; APPLE-1006, [0128]; APPLE-1008, [0113]; APPLE-1009, [0113]. Both recognize and offer suggestions for processes designed to avoid this potential issue. For instance, to avoid such collisions, broadly speaking, Lee discloses adaptively allocating resources for a UE's PUSCH data depending on the UE's selection/assignment of the RACH preamble. APPLE-1005, [0281]-[0290], FIG. 19. Freda complements this broad disclosure with details that inform implementation of an adaptive resource allocation scheme having a 2-step random access procedure, notably suggesting the use of time and/or frequency offsets between the RACH preamble and PUSCH data, where the offsets depend on the selection of the RACH preamble. APPLE-1006, [0209], [0211]; APPLE-1008, [0184], [0186]; APPLE-1009, [0192], [0194].

67. As I explained above, Lee discloses a collision-avoidance resource allocation in which (i) a CP zone for PUSCH data can be configured in either the same subframe or a different subframe relative to the RACH preamble ("intra-subframe" or "inter-subframe"), and (ii) within that CP zone, , and (ii) within that

CP zone, a particular “resource block” can be selected, depending on the UE’s RACH preamble. APPLE-1005, [0203]-[0213], [0281]-[0290], FIGS. 13-14, 19.

68. A POSITA would have naturally looked to Freda and its “association rules between preamble resources and data resources, such as ... a time and/or frequency offset between them” for further details of how to implement collision-avoidance resource allocation as described in Lee. APPLE-1005, [0282]; APPLE-1006, [0206]; APPLE-1008, [0181]; APPLE-1009, [0189]. A POSITA implementing the supplemental teachings of Freda into the existing disclosure of Lee would have created the Lee-Freda combination.

69. In the Lee-Freda combination, Lee’s UE device would implement collision-avoidance resource allocation for PUSCH data by using dynamically configurable time and frequency “offsets” between PRACH preamble and PUSCH data resources, as taught by Freda. Specifically, the Lee-Freda device would determine both (i) a configurable offset “in a time domain” between the starting time of Lee’s RACH preamble transmission and the starting time of Lee’s PUSCH data transmission, and (ii) a configurable offset “in a frequency domain” between a first CPRB of Lee’s RACH preamble transmission and a first CPRB of Lee’s PUSCH data transmission. These time-domain and frequency-domain offsets would indicate a specific PUSCH resource (*e.g.*, Lee’s CPRB) in which the Lee-Freda device would transmit the RRC (PUSCH data) message. Diagrams A and B, below, illustrates at

a high-level an example of how a POSITA would implement a Lee-Freda combination. APPLE-1005, FIG. 19(a). As shown, the modification simply applies Freda's time-domain offset and frequency-domain offset to enable an indication of which of Lee's CPRBs should be used for PUSCH data transmission (RRC message).

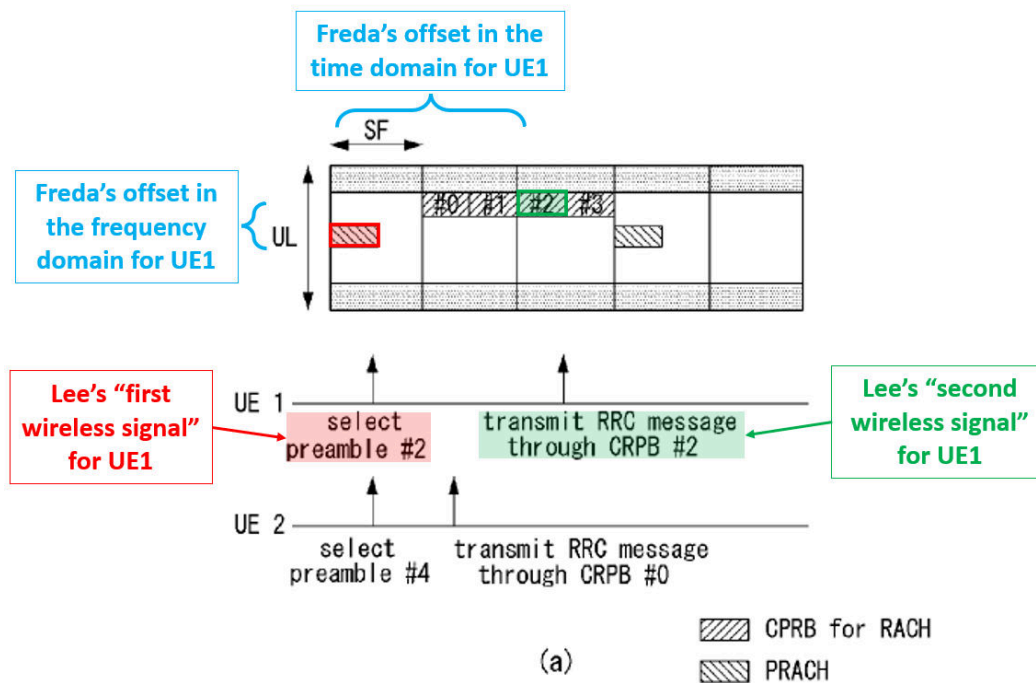


Diagram A (Determining an Offset for UE1)

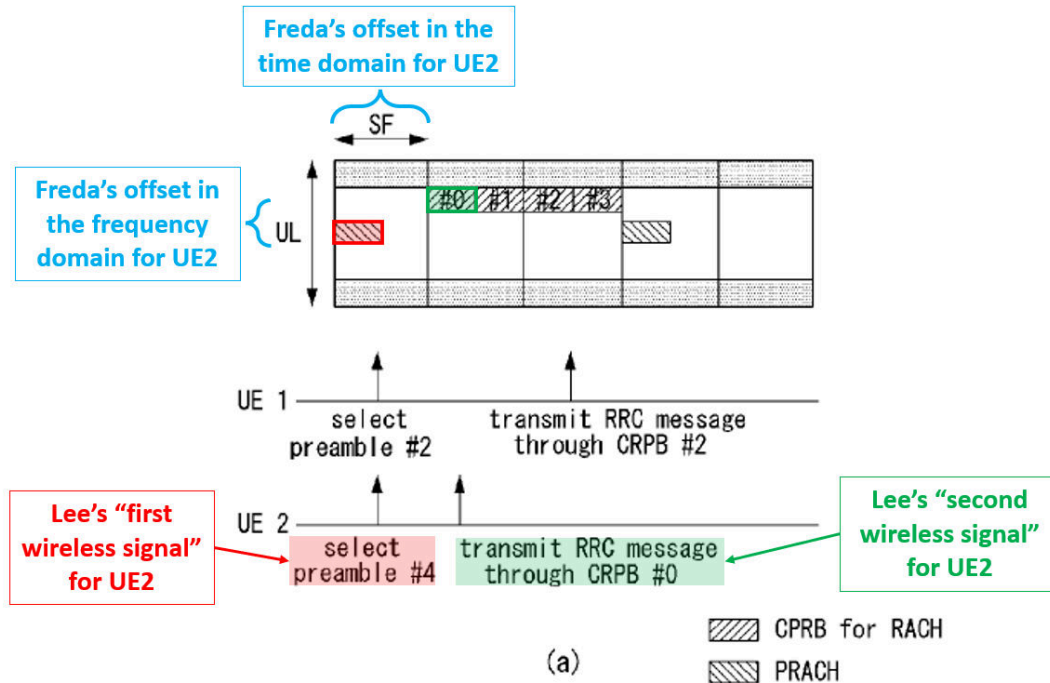


Diagram B (Determining an Offset for UE2)

70. Further, as taught by Freda, the Lee-Freda device would determine both the time-domain offset and frequency-domain offset, at least in part, based on the RACH preamble. For example, the Lee-Freda device would determine that the RACH preamble indicates that a particular time-frequency “offset” should be used (*e.g.*, based on an association that is “fixed or configured by a network”). APPLE-1006, [0209], [0211]; APPLE-1008, [0184], [0186]; APPLE-1009, [0192], [0194].

71. A POSITA would have understood that the Lee-Freda system would implement Lee's intra-subframe and inter-subframe scheme by setting appropriate values of a time-domain offset, as taught by Freda. In one example, the Lee-Freda system would involve implementing Lee's *intra*-subframe scheme (as shown in Lee's FIG. 14(a)) by setting Freda's time-domain offset equal to zero. APPLE-1006,

[0209] (the time-domain offset “may be equal to zero, for example, when transmission of a preamble and a data portion may be continuous in time”); *see also* [0211] (an “association may be valid for a given transmission time duration (or for a specific overlap in time of the respective transmission duration), for example, for a given slot, mini-slot, subframe”); APPLE-1008, [0184]; APPLE-1009, [0192]. As another example, the Lee-Freda system would implement Lee’s *inter*-subframe scheme by controlling Freda’s time-domain offset so that the RACH preamble and PUSCH data are transmitted in different subframes. APPLE-1006, [0210] (the “association may (*e.g.* alternatively) be applicable over non=overlapping (*e.g.* disjointed in time) time intervals”); APPLE-1008 [0185], APPLE-1009, [0193].

72. In addition, a POSITA would have understood Lee’s collision-avoidance techniques can be implemented using Freda’s configurable time-frequency offset. For example, as I explained in Section VII.A, Lee discloses that CPRB collisions can be avoided by “implicitly selecting a CPRB on the basis of a randomly selected preamble.” APPLE-1005, [0282]. Freda discloses details of how this would be implemented, explaining that “resources used for a preamble and the resources used for data may have some association, such as an implicit association” and that these association rules can be a “time and/or frequency offset” between preamble resources and data resources. APPLE-1006, [0147], [0206]; APPLE-1008, [0132], [0181], APPLE-1009, [0132], [0189]. In particular, Freda explains that the

time/frequency offset can be determined “based on explicit indication (*e.g.* explicitly indicated in DCI, or in a downlink control message)” or “based on a selected preamble (*e.g.* a preamble may be associated with a specific offset to be used, where an association may be fixed or configured by a network).” APPLE-1006, [0211]; APPLE-1008, [0186]; APPLE-1009, [0194].

73. As I explain below in more detail, combining Lee and Freda would have been obvious at least because such a combination would have merely involved (1) combining prior art elements according to known methods to yield predictable results; and (2) use of a known technique to improve similar devices (methods, or products) in the same way.

74. Indeed, Lee describes a similar 2-step random access procedure as Freda, and the combination would have simply involved adding Freda’s teachings into the compatible teachings of Lee, thus, for at least this reason, making the Lee-Freda combination predictable and foreseeable with a reasonable expectation of success. APPLE-1005, [0237]-[0241]; APPLE-1006, [0127], [0290]; APPLE-1008, [0112], [0114], [0249], [0249]; APPLE-1009, [0112], [0114], [0273], [0318]. Specifically, a POSITA would have recognized that, as with Lee, Freda describes a random access procedure in which a wireless communications device can communicate with a base station without first receiving a separate uplink grant from the base station. *See, e.g.*, APPLE-1005, Abstract (“As such, the UE transmits the

RRC message from the eNB through the CP zone without separate UL grant”); APPLE-1006, [0128] (“an enhanced random access procedure may enable a WTRU to send data before receiving a grant from the network”); APPLE-1008, [0113]; APPLE-1009, [0113].

75. In both Lee and Freda, a UE’s RACH preamble can be either assigned by the base station or self-selected by the UE. APPLE-1005, [0242], [0283]; APPLE-1006, [0116], [0132], [0138]-[0139], [0141], [0145], [0228], [0383]; APPLE-1008, [0101], [0117], [0123]-[0124], [0126], [0130], [0193], [0337]; APPLE-1009, [0101], [0117], [0123]-[0124], [0126], [0130], [0203], [0211], [0366]. In both Lee and Freda, the selected/assigned RACH preamble is then used to determine resources for subsequently transmitting the PUSCH data. *See, e.g.*, APPLE-1005, [0282]-[0287] (describing “implicitly selecting a CPRB on the basis of a randomly selected preamble when a RACH procedure is performed using a CP zone”); APPLE-1006, [0209], [0211] (describing that a wireless communications device “may determine an offset in time [between a start time of a transmission of a preamble and a start time of a transmission of a data portion] based on a selected PRACH resource”); APPLE-1008, [0184], [0186]; APPLE-1009, [0192], [0194]. Both Lee and Freda disclose that one or multiple resource blocks can be assigned to the PUSCH data. APPLE-1005, [0206] (“UE may uses one or more CPRB[s]” to transmit data and that “a different number of CPRBs may be used for each of UEs”);

APPLE-1006, [0213] (“relationship between preamble and data may be in a length/size/duration of transmission” for example, “the number of resource blocks ... may be associated with properties of the preamble.”); APPLE-1008, [0189]; APPLE-1009, [0196].

76. Both Lee and Freda are also compatible in duplexing and relaying capabilities of their devices. For example, Lee describes an example involving “full duplex relay (FDR) UEs.” APPLE-1005, [0305] (referring to FIG. 21 of Lee). Likewise, Freda discloses that its techniques are applicable to “relay” devices and devices that “include a full duplex radio.” APPLE-1006, [0021], [0041]; APPLE-1008, [0018]; APPLE-1009, [0018].

77. A POSITA would have also recognized that Freda improves upon Lee’s system in several ways, providing further motivation to combine. For example, Freda’s teachings allow the base station to dynamically configure the resource allocation for PUSCH data, by using “DCI [downlink control information] that may include dynamically scheduled system-specific ePRACH parameters.” APPLE-1006, [0144]; APPLE-1008, [0129]; APPLE-1009, [0129]. Freda explains that its DCI can include “association rules between preamble resources and data resources ... such as a time and/or frequency offset between them.” APPLE-1006, [0144]; APPLE-1008, [0181]; APPLE-1009, [0189]. A POSITA would have understood that implementing Freda’s DCI-based configuration would have been

straightforward in Lee's system. Indeed, both Lee and Freda disclose that the UE receives a DCI signal prior to initiating the random access procedure. APPLE-1006, [0135] ("initiate an eRACH procedure, for example, ... upon reception of downlink control signaling (*e.g.*, a DCI on NR-PDCCH)"); APPLE-1005, [0092] (the UE can "receive a Physical Downlink Control Channel (PDCCH) ... and acquire more detailed system information ... Thereafter, the UE may perform a random access procedure"); APPLE-1008, [0120]; APPLE-1009, [0120]. Lee further explains that resource allocation information can be conveyed to a UE via "configuration information" such as "a broadcasting message" or using "a unicast scheme through a new control message." APPLE-1005, [0225], [0229].

78. Furthermore, Freda's teachings allow both the wireless communications device and the base station to identify the specific time and specific frequency (resource block) at which the wireless communications device transmits the data to the base station (*e.g.*, by determining "offsets" in both time and frequency between the transmission of the preamble and the transmission of the data, based on the preamble). Through such techniques, Freda discloses that a wireless communication device can use the time-domain offset and the frequency-domain offset in order to "facilitate blind decoding of data" by the receiving node (*e.g.*, base station) by using "a priori knowledge" of the start time and the first PRB of the

transmission of a data portion, *e.g.*, “as may be indicated by a preamble.” APPLE-1006, [0207]-[0210]; APPLE-1008, [0182]-[0185]; APPLE-1009, [0190]-[0193].

79. Accordingly, the wireless communications device and the base station can better synchronize communications between them, without requiring that the base station first transmit an uplink grant to the wireless network device (which may delay the transmission of data by the wireless communications device). Further, Freda provides more flexibility by allowing the time offset and/or frequency offset to implement a range of offset values including being “equal to zero” (to provide joint transmission) and by allowing the “start time” of data transmission to be first symbol of subframe or any “specific symbol thereof.” APPLE-1006, [0209]; APPLE-1008, [0184]; APPLE-1009, [0192].

D. Overview of Ly

80. Ly is analogous art to the '721 patent because, like the '721 patent, Ly is directed to a random-access procedure in a wireless communication system. APPLE-1007, Abstract, [0030]; APPLE-1010, Abstract, [0026]; APPLE-1001, 3:22-30.

81. Indeed, Ly is directed to “[w]ireless communications systems and methods related to random access and uplink (UL)-based mobility.” APPLE-1007, Abstract; APPLE-1010, Abstract. And like Lee, Freda and the '721 patent, Ly describes “2-step random access mechanisms,” which it offers to facilitate

communications between a UE and a base station, including (i) transmitting “a random access preamble” over a PRACH and (ii) transmitting additional data over a PUSCH. *See, e.g.*, APPLE-1007, [0069], [0083], FIG. 9; APPLE-1010, [0065], [0079], FIG. 9.

82. Specifically, Ly describes that a network “may employ two sets of random access preamble sequences with cyclic shifts, one set for random access procedure and the other set for UL mobility,” and that “each set may include 64 Zadoff-Chu sequences.” APPLE-1007, [0083]-[0085]; APPLE-1010, [0079]-[0081]. As Ly explains, this configuration “may be suitable for use in large-cell deployment.” APPLE-1007, [0085]; APPLE-1010, [0081]. In particular, “Zadoff-Chu [sequences] with cyclic shifts” can be used as “preamble sequences,” and the “cyclic shifts [can be dimensioned] such that delay spread and/or Doppler shift have minimal impacts on the RACH sequence cross-correlation.” APPLE-1007, [0085]; APPLE-1010, [0081].

1. At Least One of Ly’s Claims Is Supported by Ly’s Provisional Application

83. Ly claims priority to U.S. Prov. 62/402,956 filed September 30, 2016 (“Ly Provisional”). APPLE-1007, Cover. The Ly Provisional is incorporated in its entirety in Ly. APPLE-1007, [0001].

84. Ly Provisional includes the relevant prior art disclosure and supports at least one of Ly’s claims (claim 1), as shown below.

(a) *A method of wireless communication in a network, comprising:*

85. APPLE-1010, [0065], [0068]-[0070], [0082]-[0087], FIGS. 9, FIG. 15-16, claim 1.

(b) *transmitting, by a first wireless communication device, a first signal carrying a random access sequence and a data; and*

86. APPLE-1010, [0065], [0068]-[0070], [0082]-[0087], FIGS. 9, FIG. 15-16, claim 1.

(c) *receiving, by the first wireless communication device from a second wireless communication device in response to the first signal, a second signal.*

87. APPLE-1010, [0066], [0082]-[0087], FIG. 9, FIG. 15, claim 1.

E. The Combination of Lee, Freda, and Ly

88. In view of Ly, a POSITA would have found it obvious to implement the RACH preamble sequence in the Lee-Freda system using a well-known ZC sequence, as taught by Ly. Combining Lee-Freda and Ly would have been obvious at least because such a combination would have merely involved (1) combining prior art elements according to known methods to yield predictable results; and (2) use of a known technique to improve similar devices (methods, or products) in the same way. Further, a POSITA would have had a reasonable expectation of success in making such a combination.

89. In particular, a POSITA would have recognized that Ly, like Lee and Freda, describes “2-step random access mechanisms” for facilitating

communications between a UE and a base station, including (i) transmitting “a random access preamble” over a PRACH and (ii) transmitting additional data over a PUSCH. *See, e.g.*, APPLE-1005, [0237]-[0241], [0315]-[0383], FIG. 15(a); APPLE-1007, [0069], [0083], FIG. 9; APPLE-1010, [0065], [0079], FIG. 9. Further, in view of Ly, a POSITA would have understood that a network can utilize a set of preamble sequence for random access, for example by employing “two sets of random access preamble sequences with cyclic shifts, one set for random access procedure and the other set for UL mobility,” and that “each set may include 64 Zadoff-Chu sequences.” APPLE-1007, [0083]-[0085]; APPLE-1010, [0079]-[0081].

90. In view of Ly, a POSITA would have found it obvious to configure Lee’s system that such that the “RACH preamble sequence” is implemented using a “Zadoff-Chu [sequence]” (*e.g.*, with specifically dimensioned “cyclic shifts”) such that “delay spread and/or Doppler shift have minimal impacts on the RACH sequence cross-correlation,” thereby improving the reliability of the communications. APPLE-1007, [0085]; APPLE-1010, [0081]. Such a modification would have been predictable and within an ordinary artisan’s skill without undue experimentation, and would have been one known option that would lead to predictable results.

VIII. Ground 1 – Claims 1-20 are Obvious under 35 U.S.C. § 103 based on Lee, Freda, and Ly

A. Analysis

91. In my opinion, a person of ordinary skill in the art would have found claims 1-20 of the '721 patent to have been obvious based on Lee, Freda, and Ly. Lee provides a foundational teaching for many of the claim features of the '721 patent with the goal of addressing the same technical problems as the '721 patent, namely adaptively adjusting when, where, and whether a UE transmits its PUSCH (second wireless signal) to reduce collisions with PUSCH transmissions of other UEs. Freda provides additional details for implementing the type of adaptive allocation of PUSCH resources as described in Lee. Ly merely provides disclosure of the notoriously well-known feature that the RACH (first wireless signal) is a Zadoff-Chu (ZC) sequence.

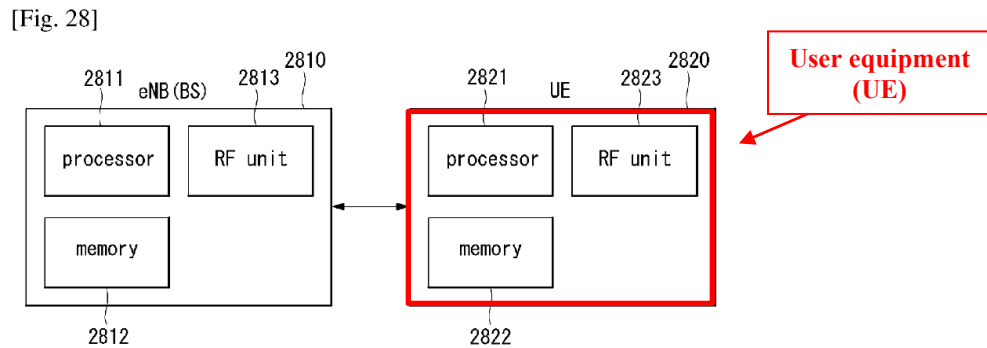
1. Claim 1

92. In my opinion, for the reasons discussed below, the combination of Lee, Freda, and Ly renders obvious claim 1.

(a) *[1.pre] A method for wireless communication in a user equipment (UE), comprising:*

93. To the extent that the preamble is limiting, Lee discloses or renders obvious [1.pre].

94. Lee describes a “*user equipment (UE)*” for communicating in a “wireless communications system” (... *for wireless communication*). APPLE-1005, Abstract, [0385]-[0389], FIG. 28 (2820).



APPLE-1005, FIG. 28 (annotated)

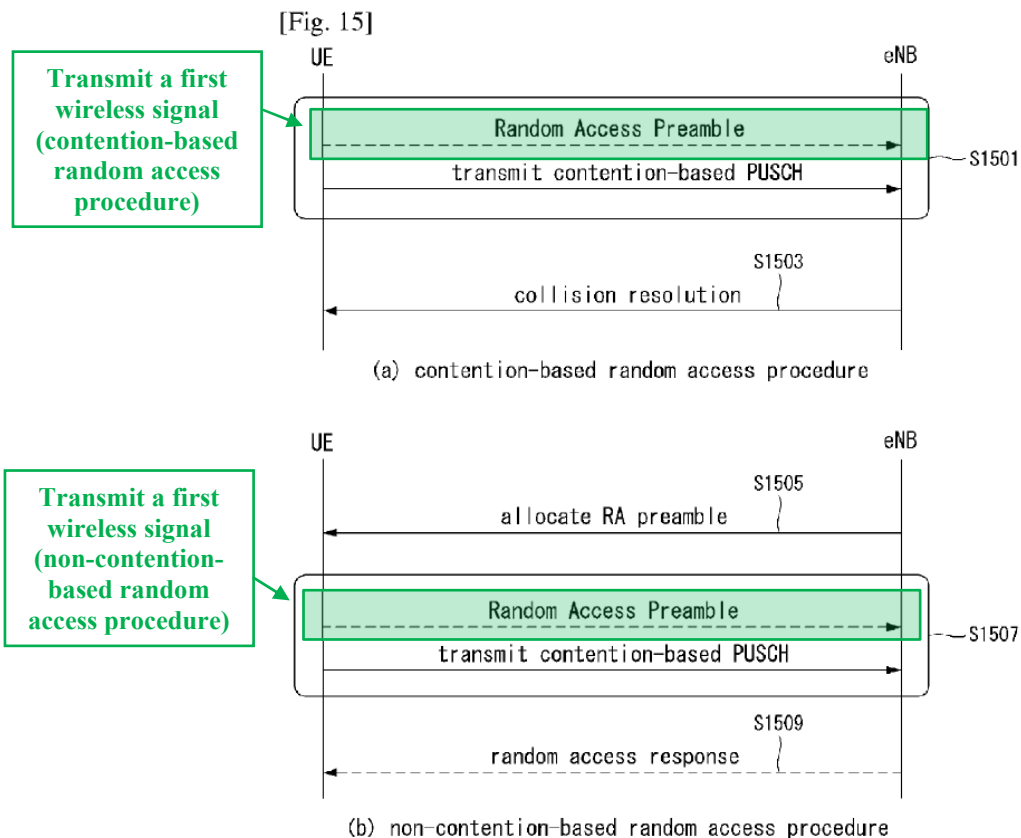
95. Further, in view of Lee, Freda, and Ly, it would have been obvious to configure Lee’s UE to perform *a method for wireless communication* including each of the operations recited in claim 1, as I explain in further detail below. Therefore, a POSITA would have understood the combination of Lee-Freda-Ly to render obvious [1.pre].

(b) [1.1] transmitting a first wireless signal; and

96. Lee discloses or renders obvious [1.1].

97. As I explained in Section VII.A, above, Lee describes a 2-step random access procedure where, in the first step (Step 1 as described in Section VII.A), a UE “transmit[s] ... a *random access preamble* to a base station (BS)” (*transmitting a first wireless signal*). APPLE-1005, Abstract.

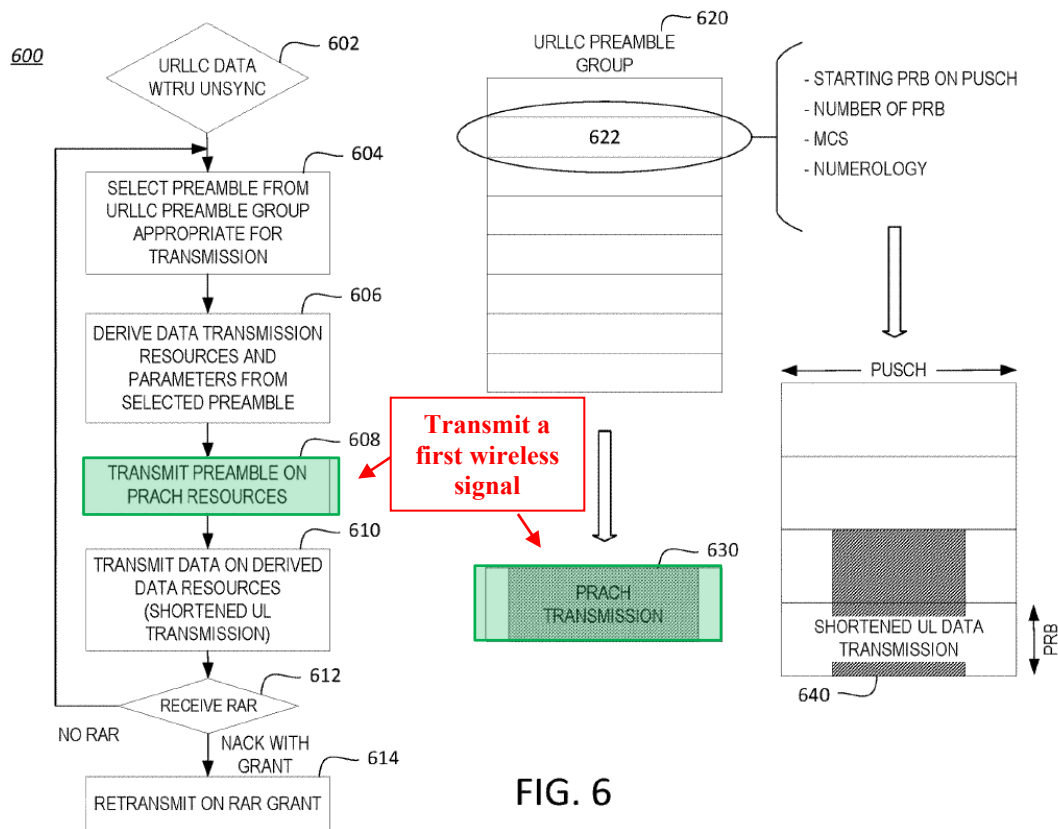
98. Specifically, in a “contention-based random access procedure,” Lee’s UE “*transmits a RACH preamble* sequence through the PRACH” to an “eNode B” (eNB). APPLE-1005, [0237]-[0241], FIG. 15(a) (S1501, top)). Alternatively, in a “non-contention-based random access procedure,” Lee’s UE “*transmits a RACH preamble* sequence through the PRACH” to the eNB after the UE has been “allocated with the RACH preamble sequence from [the] eNB.” APPLE-1005, [0242]-[0244], FIG. 15(b) (S1507, top)), [0266]-[0276], FIG. 17.



APPLE-1005, FIG. 15 (annotated)

99. Lee further discloses that the RACH preamble is transmitted by the UE's "radio frequency (RF) unit" through a "radio signal" (*transmitting a first wireless signal*) APPLE-1005, [0010], [0388].

100. Similarly, as described in section IV.A.2, Freda discloses a 2-step RACH procedure. In Freda's first step, as with Lee, the UE transmits a preamble transmitted through a "PRACH" (*transmitting a first wireless signal*). APPLE-1006, FIG. 6, [0132]; APPLE-1008, FIG. 6, [0117]; APPLE-1009, FIG. 6, [0117].



APPLE-1006, FIG. 6 (annotated)

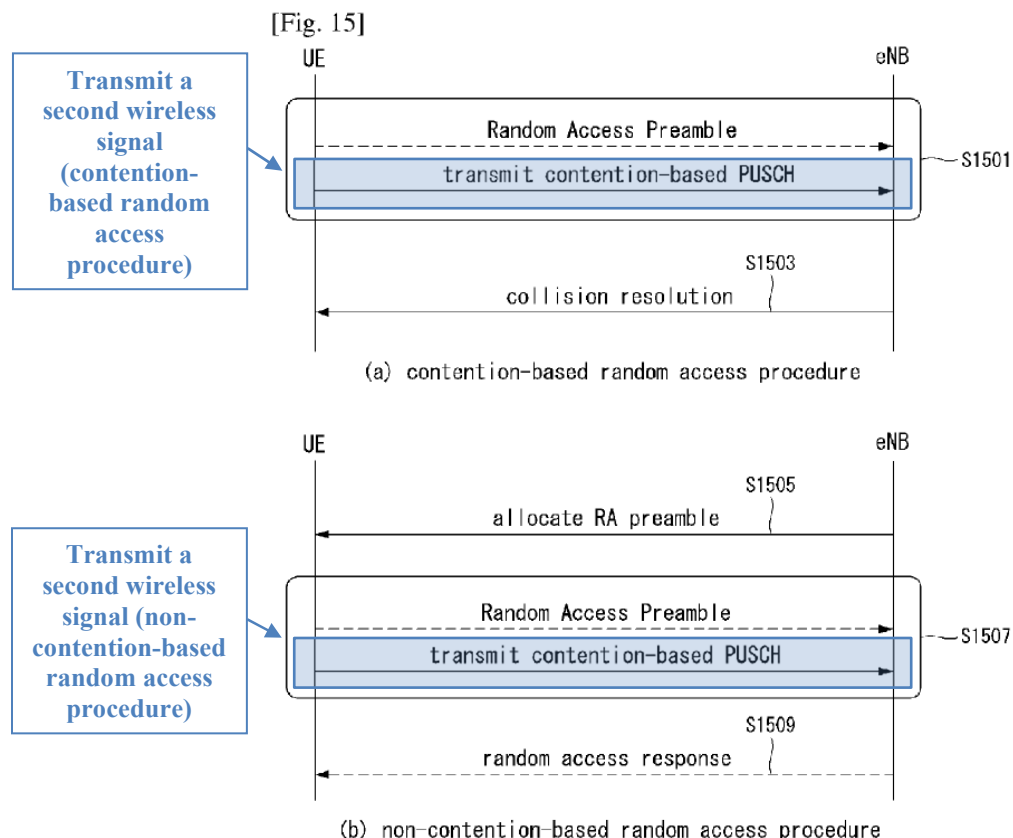
101. Therefore, a POSITA would have understood the combination of Lee-Freda-Ly to render obvious [1.1].

(c) *[1.2] transmitting a second wireless signal;*

102. Lee discloses or renders obvious [1.2].

103. As I explained in Section VII.A, above, Lee describes a 2-step random access procedure where, in the first step (Step 1 as described in Section VII.A), the UE additionally “*transmit[s] ... a radio resource control (RRC) request message* to the BS through a contention-based physical uplink shared channel (PUSCH) resource block in which uplink data can be transmitted without uplink resource allocation scheduling” (*transmitting a second wireless signal*). APPLE-1005, Abstract.

104. Specifically, in the “contention-based random access procedure,” Lee’s UE “*transmits an RRC message* to an eNB through the CP zone” to the eNB (*e.g.*, either simultaneously with or sequentially after transmits a RACH preamble sequence through the PRACH). APPLE-1005, [0237]-[0241], FIG. 15(a) (S1501, bottom)). Alternatively, in the “non-contention-based random access procedure,” Lee’s UE “*transmits ... the RRC message ...* through the PRACH” to the eNB (*e.g.*, either simultaneously with or sequentially after transmitting the RACH preamble sequence allocated by the eNB). APPLE-1005, [0242]-[0244], FIG. 15(b) (S1507, top)), [0266]-[0276], FIG. 17.



APPLE-1005, FIG. 15 (annotated)

105. Lee further discloses that the RRC message (PUSCH) is transmitted by the UE's "radio frequency (RF) unit" through a "radio signal" (*transmitting a second wireless signal*) APPLE-1005, [0010], [0388]. Therefore, a POSITA would have understood the combination of Lee-Freda-Ly to render obvious [1.2].

106. Similarly, as described in section IV.A.2, Freda discloses a 2-step RACH procedure. In Freda's first step, as with Lee, the UE additionally transmits) data through a "PUSCH" (*transmitting a second wireless signal*). APPLE-1006, FIG. 6, [0132]; APPLE-1008, FIG. 6, [0117]; APPLE-1009, FIG. 6, [0117].

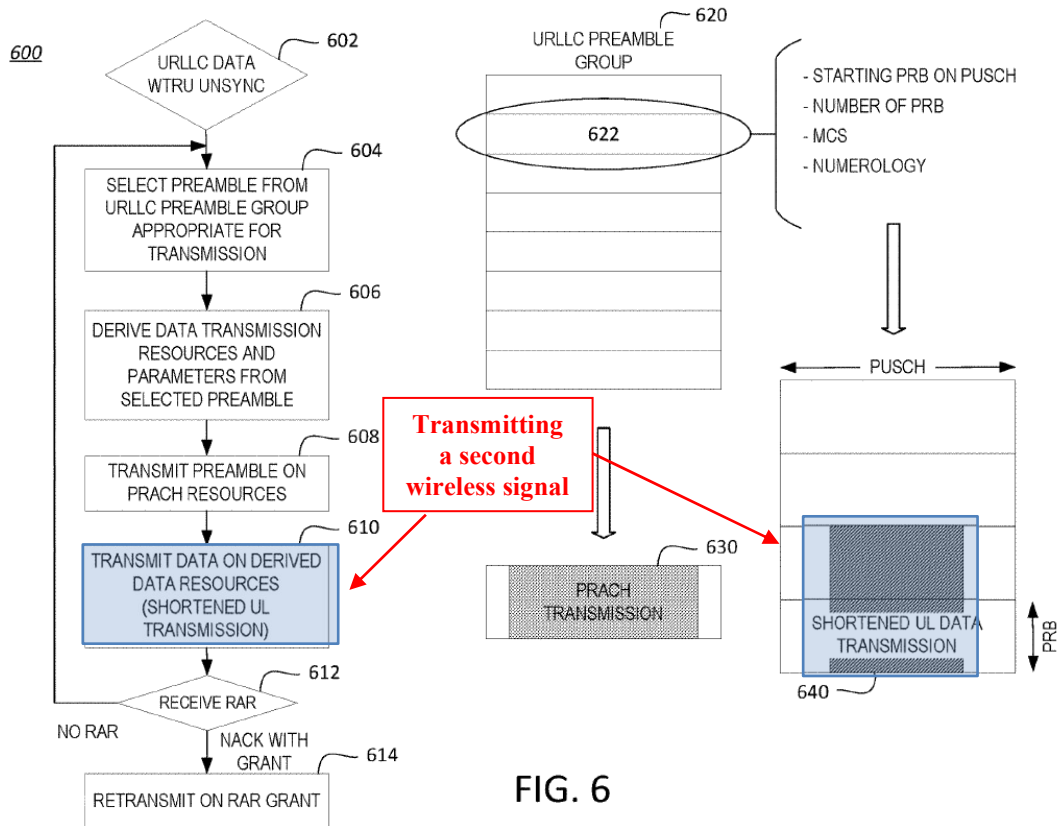


FIG. 6

APPLE-1006, FIG. 6 (annotated)

(d) [1.3] wherein the first wireless signal is generated by a first sequence;

107. Lee discloses or renders obvious [1.3].

108. As I explained with respect to [1.1], above, Lee's UE transmits, via a radio signal, "a *random access preamble* to a base station (BS)" (*the first wireless signal*). APPLE-1005, Abstract, [0010]. The transmitted "random access preamble" includes, and thus is generated at least in part by, a "*RACH preamble sequence*" determined by the UE (*...is generated by a first sequence*). APPLE-1005, [0211]-[0214].

109. Specifically, each of Lee's UEs determines a different respective "RACH preamble sequence" (*first sequence*) and transmits a wireless signal including that RACH preamble sequence (*first wireless signal*) to the eNB. See APPLE-1005, [0277] ("the UE 1 and the UE 2 transmit different RACH preamble sequences to the BS through the PRACH region allocated to the first subframe"), [0288] ("the UE 1 selects an RACH preamble sequence # 2 and the UE 2 selects an RACH preamble sequence # 4"), [0307] ("the UE 1 selects preamble sequence # 2 and the UE 2 selects preamble sequence # 4, and UE 3 selects preamble sequence # 8"), FIGS. 17, 19, 21.

110. Lee describes that, in some cases, the UE selects the RACH preamble sequence (*first sequence*) itself, such as by randomly selecting a RACH preamble or monitoring the RACH preamble sequences selected by neighboring UEs and selecting a RACH preamble to avoid collisions. See, e.g., APPLE-1005, [0283], [0304]-[0311], FIG. 21. In other cases, the UE "is allocated with the RACH preamble sequence from an eNB." APPLE-1005, [0242]-[0244], [0266]-[0276], [0286], [0300]. In either scenario, a POSITA would have found obvious that Lee's radio signal carrying the RACH preamble is generated by a RACH preamble sequence.

111. Similarly, as described in section VII.B, Freda discloses a 2-step RACH procedure. In Freda's first step, as with Lee, the UE transmits a preamble transmitted

through a “PRACH.” APPLE-1006, FIG. 6, [0132]; APPLE-1008, FIG. 6, [0117]; APPLE-1009, FIG. 6, [0117]. Further, Freda discloses the use of “[a] Preamble index (*e.g.*, in a DCI and/or an RRC message)” to “indicate a specific preamble sequence (*e.g.*, for dedicated signaling)” and/or to “indicate a specific preamble group and/or range (*e.g.*, for shared signaling).” APPLE-1006, [0141]; APPLE-1008, [0126]; APPLE-1009, [0126]. The transmitted “preamble” (*the first wireless signal*) is thus generated at least in part by, a “preamble sequence” indicated by a “preamble index.” (*...is generated by a first sequence*).

112. Therefore, a POSITA would have understood the combination of Lee-Freda-Ly to render obvious [1.3].

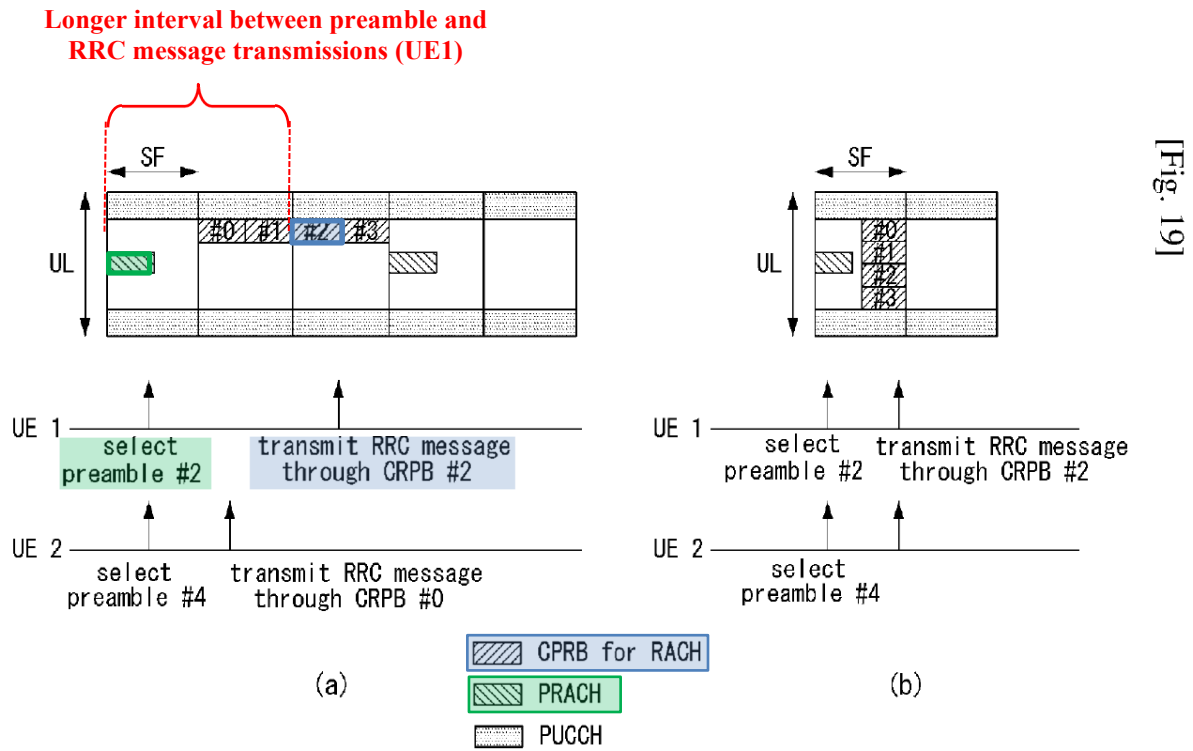
- (e) *[1.4] the first wireless signal is used to determine a first time interval; the first time interval is a time interval between a first time instant and a second time instant; the first time instant is a starting time instant at which a transmitter of the first wireless signal transmits the first wireless signal; the second time instant is a starting time instant at which a transmitter of the second wireless signal transmits the second wireless signal; the first time instant is earlier than the second time instant;*

113. Lee and Freda render obvious [1.4].

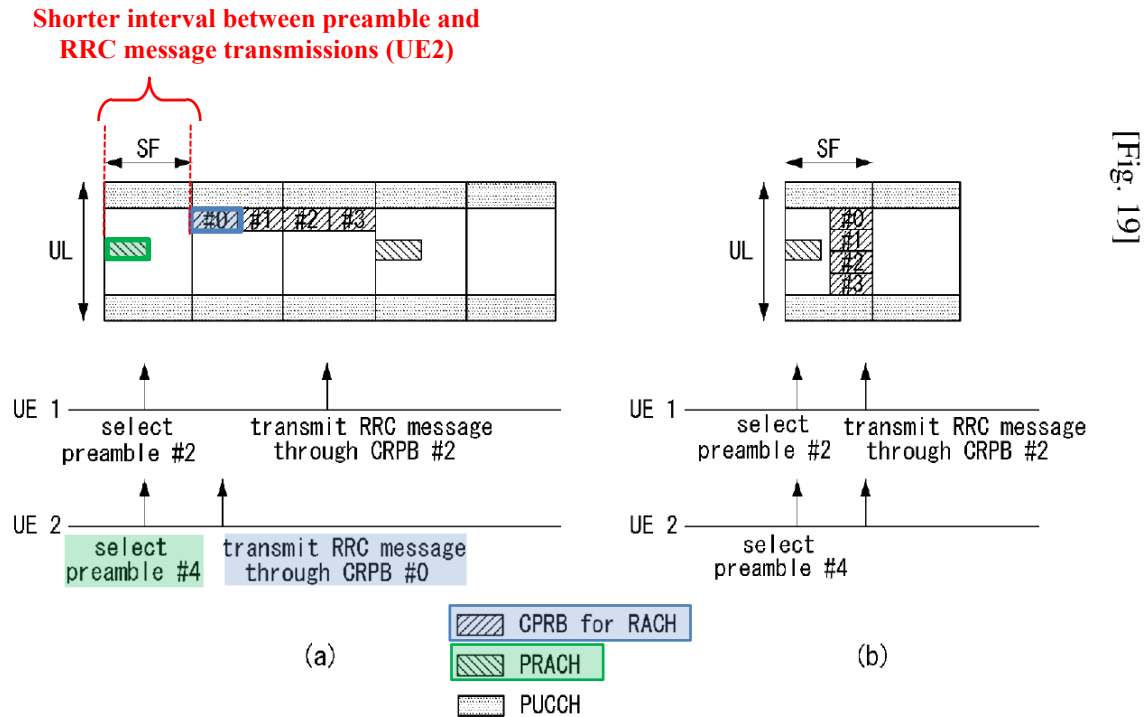
114. As I explained with respect to [1.1] and [1.2] and in Section VII.A, in the first step (Step 1) of Lee’s 2-step random access procedure, the UE transmits two signals, namely, (i) Lee’s UE transmits “a *random access preamble* to a base station (BS)” through the PRACH (*the first wireless signal*) and (ii) Lee’s UE subsequently

transmits “a *radio resource control (RRC) request message* to the BS” through the PUSCH (*the second wireless signal*). APPLE-1005, Abstract.

115. Furthermore, as I explained in Section VII.A, above, Lee UE adjusts the timing between the PRACH preamble transmission and the RRC message (PUSCH) transmission, by first allocating a CP zone for the RRC PUSCH transmission in the same subframe or in different subframes (intra-subframe or inter-subframe) as the PRACH preamble, and then by adaptively selecting a particular CPRB for the RRC PUSCH transmission within the CP zone depending on the PRACH preamble. APPLE-1005, [0206], [0213], [0218], [0220], [0222], [0237], [0282]-[0287], FIG. 19(a) (reproduced below, annotated).



APPLE-1005, FIG. 19 (annotated)



APPLE-1005, FIG. 19 (annotated)

116. Therefore, Lee itself discloses or renders obvious that the PRACH preamble is used to determine the time interval between the PRACH preamble transmission and the RRC (PUSCH) transmission (“*the first wireless signal is used to determine a first time interval*”).

117. Additionally, in combination, Freda provides details that inform designation of the time interval between (i) the starting time instant of the transmission of the RACH preamble and (ii) the starting time instant of the transmission of the RRC message, as I explained in Section VII.C. Specifically, as discussed, the Lee-Freda system would implement Lee’s adaptive PUSCH resource

allocation using Freda's time-domain offset, which is determined using the PRACH preamble as taught by Freda.

118. For example, as I explained in Sections VII.B and C, *supra*, Freda defines an "offset" (***first time interval***) between "start times" of transmissions of the RACH preamble and the RRC message (PUSCH), and Freda further discloses that the UE can determine this offset using the selected RACH preamble (***first wireless signal***). The Lee-Freda device would implement Freda's teaching of "[a] relationship between preamble and data ... in a time domain," and specifically, "a start time of a transmission of a preamble and a start time of a transmission of a data portion may be *offset* from each other by a specific amount of time" (***a first time interval between the first time instant and the second time instant***). APPLE-1006, [0209]; APPLE-1008, [0184]; APPLE-1009, [0193]. Further, as taught by Freda, this "offset" can be "indicated by a preamble." APPLE-1006, [0209]; APPLE-1008, [0184]; APPLE-1009, [0193]. For instance, the Lee-Freda system "may determine an *offset in time* ... based on a selected preamble (*e.g.* a preamble may be associated with a specific offset to be used, where an association may be fixed or configured by a network)" as taught by Freda (***the first wireless signal is used to determine a first time interval***). APPLE-1006, [0211]; APPLE-1008, [0186]; APPLE-1009, [0194].

119. An example of this is shown in Diagrams C and D, below, which are annotated versions of Lee's FIG. 19(a) showing two different UEs using two different time-domain offsets (as taught by Freda) based on the UE's selection of its preamble. APPLE-1005, FIG. 19(a).

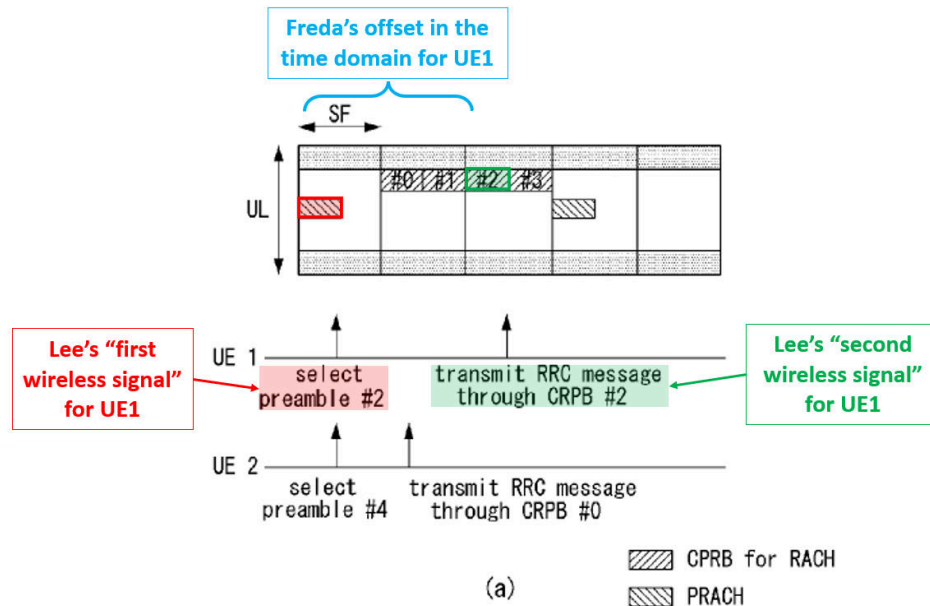


Diagram C

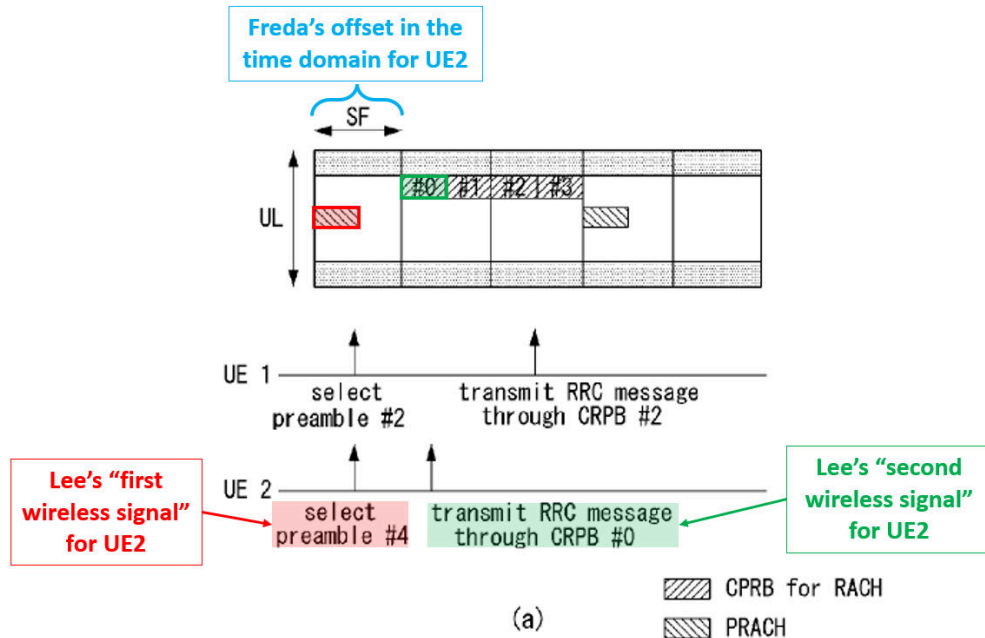
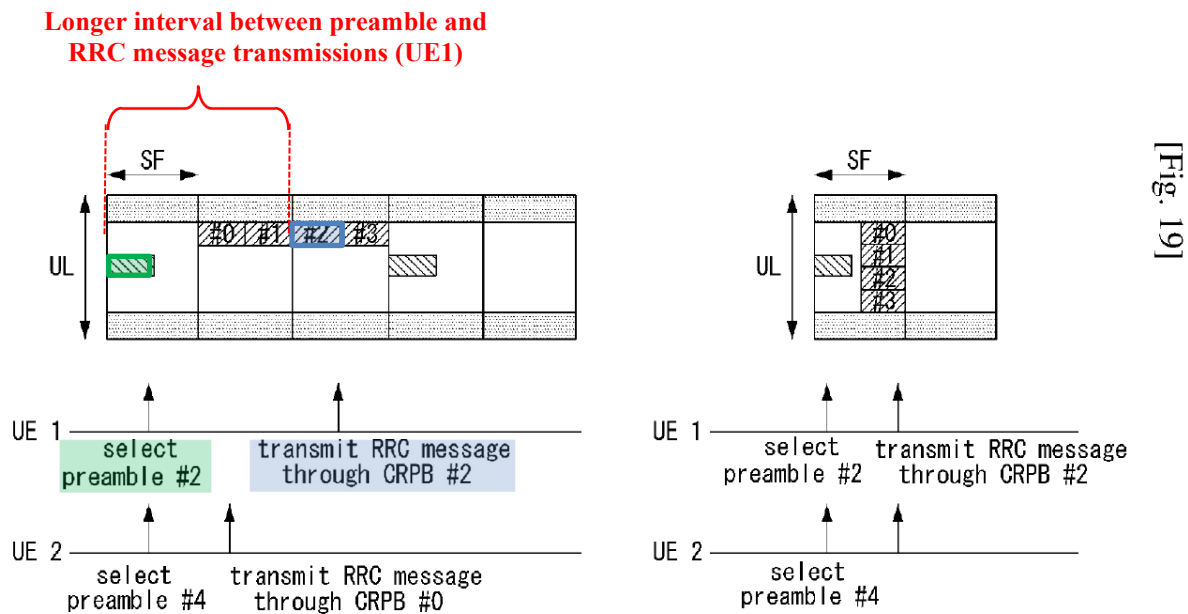


Diagram D

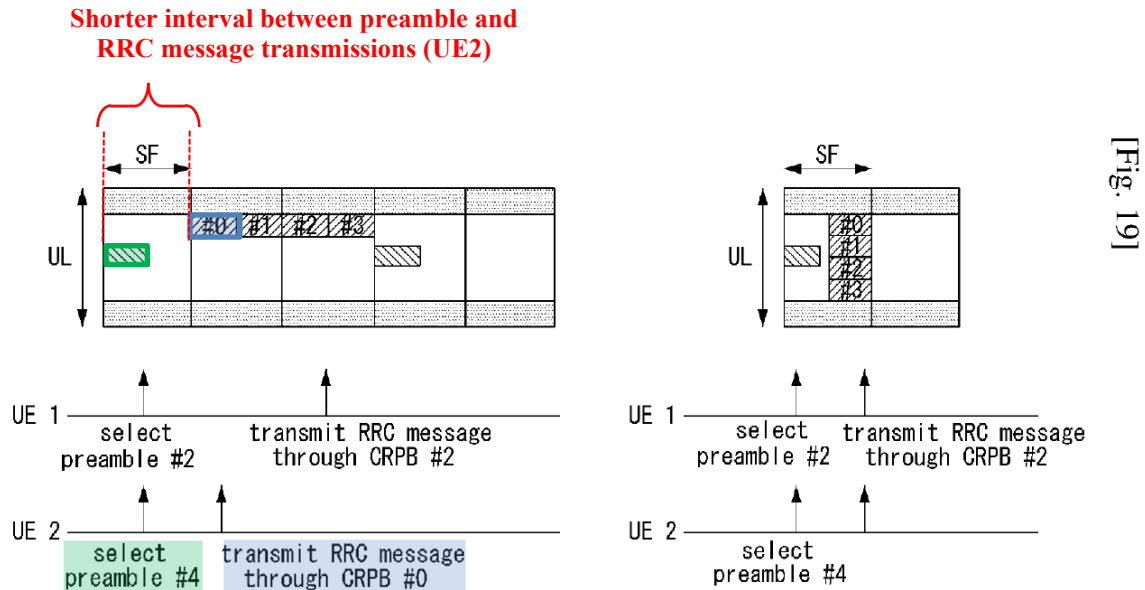
120. Furthermore, the starting time instant at which the Lee-Freda UE transmits the random access preamble (*the first time instant...*) occurs prior to (*...is earlier than...*) the starting time instant at which the UE transmits the RRC request message (*... the second time instant*). See, e.g., APPLE-1005, Abstract; [0237]-[0244], FIGS. 15, 17, 19.

121. In addition to Freda's explicit designation of a time-domain "offset" discussed above, Lee itself also teaches that its UE adjusts the timing between the PRACH preamble transmission and the RRC message (PUSCH) transmission. For example, as discussed in section IV.A.1, above Lee discloses allocating a CP zone for the RRC PUSCH transmission either in the same subframe or in different subframes (intra-subframe or inter-subframe) as the PRACH preamble, and then

selecting a particular CPRB for the RRC PUSCH transmission within the CP zone depending on the PRACH preamble. APPLE-1005, [0206], [0213], [0218], [0220], [0222], [0237], [0282]-[0287], FIG. 19(a) (reproduced below, annotated).



APPLE-1005, FIG. 19(a) (annotated, showing the time interval for UE1)



APPLE-1005, FIG. 19 (annotated, showing the time interval for UE2)

122. Therefore, Lee itself dictates the *first time interval* by establishing when the RRC (PUSCH) message (*second wireless signal*) will be transmitted relative to the PRACH preamble (*first wireless signal*). In particular, as discussed in section IV.A.1, above, Lee's designation of a resource block (CPRB) for the RRC message (*second wireless signal*) depends on the selection of the PRACH preamble (*first wireless signal*), and this renders obvious a determination of the time interval between the PRACH preamble and the RRC message, by using the PRACH preamble (*"the first wireless signal is used to determine a first time interval"*).

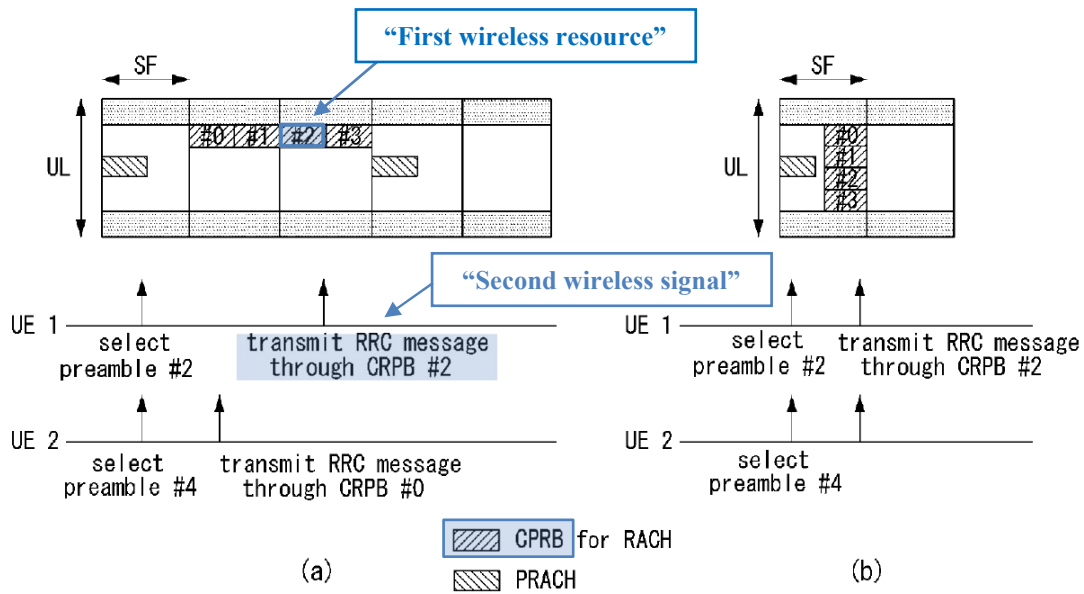
123. Therefore, a POSITA would have understood the combination of Lee-Freda-Ly to render obvious [1.4].

(f) ***[1.5] the second wireless signal occupies a first wireless resource; the first wireless resource is one of J candidate wireless resources; the J is a positive integer;***

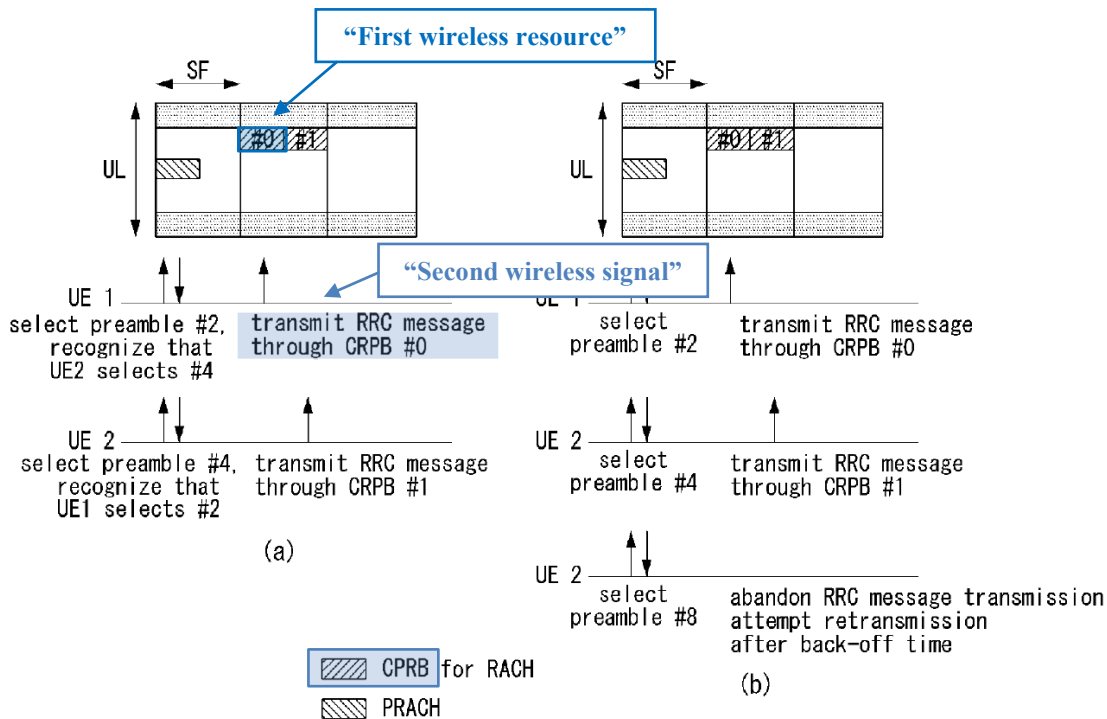
124. Lee discloses or renders obvious [1.5].

125. As I explained in Sections VII.A and C, *supra*, Lee's UE transmits the RRC message (***second wireless signal***) using a "contention-based PUSCH resource block" ("CPRB") (***...occupies a first wireless resource***) that is selected based the RACH preamble. APPLE-1005, [0282]-[0287], [0203]. Specifically, "[e]ach of the CP zones (1301, 1303) may include N contention-based PUSCH resource blocks (hereinafter, referred to as 'CPRB') (1305) that may occupy one or more UE(s). The CPRB (1305) signifies a UL resource region that a UE may occupy (*e.g.*, use) for a specific procedure within the CP zone."). I note that word "first" here is used in the '721 patent merely as a label, rather than a limiting expression. *See, e.g.*, APPLE-1001, FIGS. 4 and 5 (showing the "first wireless resource" as an arbitrary resource among the J wireless resources).

126. For example, as shown in Lee's FIG. 19(a), below, the RRC message of UE1 (***second wireless signal***) occupies a resource "CPRB #2" (***...occupies a first wireless resource***). APPLE-1005, [0281]-[0290]. As another example, as shown in Lee's FIG. 21(a), below, the RRC message of UE1 (***second wireless signal***) occupies a resource "CPRB #0" (***...occupies a first wireless source***). APPLE-1005, [0304]-[0311].



APPLE-1005, FIG. 19 (annotated)



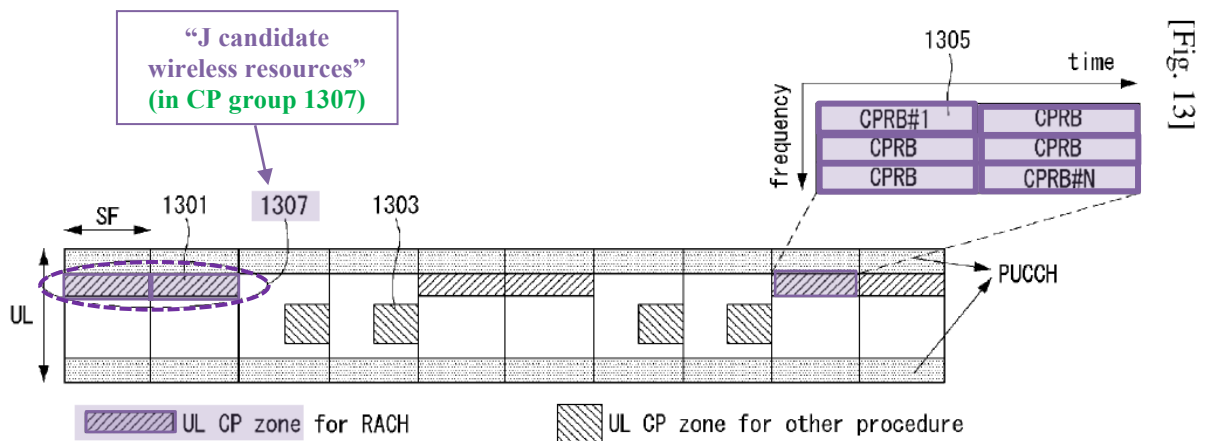
APPLE-1005, FIG. 21 (annotated)

127. Each of these examples are therefore compatible with FIG. 14.

128. Further, Lee describes that “[a] contention-based PUSCH group (hereinafter, referred to as ‘CP group’) (1307) may be comprised of one or more CP zone(s) (1301), and signifies a resource region in which the UEs that occupy the CPRB resources may contend in an arbitrary time, that is, a set of candidate CPRB(s) that an arbitrary UE may occupy.” APPLE-1005, [0209]. Further, Lee describes that each of the M “CP zones” in the group has N CPRBs. APPLE-1005, [0223]. Thus, Lee’s CPRB (*first wireless resource*) is selected from among $N \cdot M$ individual CPRBs (*...is one of J candidate wireless resources*) in the “CP group.” APPLE-1005, [0223]. For example, Lee explains “in case that one CP zone is comprised of

four CPRBs, and one CP group is comprised of two CP zones, a UE has candidate CPRBs as many as $N \times M = 8$ ” (*J candidate wireless resources*). APPLE-1005, [0223], [0355], [0365], [0367], [0376], FIGS. 22, 23, 25-27.

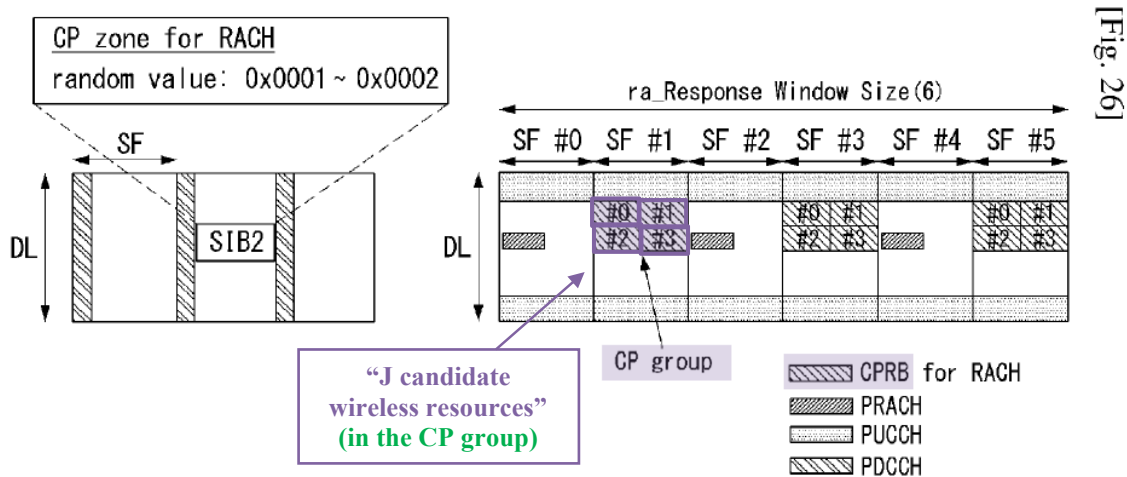
129. FIG. 13 shows an example of Lee's hierarchical resource structure for RRC message transmission. In this example, CP group 1307 includes two CP zones 1301, and each CP zone 1301 includes N CPRBs 1305, such that the CP group 1307 has a total of $2 \times N$ CPRBs (thus, $J = 2 \times N$ for this example's *J candidate wireless resources*). See also APPLE-1005, [0203]-[0212]. Lee explains that the example of FIG. 13 can be used with either the intra- or inter-subframe scheme, and is thus compatible with FIG. 14. APPLE-1005, [0209]-[0213].



APPLE-1005, FIG. 13 (annotated)

130. FIG. 26 (reproduced below, annotated) shows another example of Lee's hierarchical resource structure. In this example, the CP group includes four CPRBs (thus, $J = 4$ for this example's *J candidate wireless resources*). See also APPLE-

1005, [0351]-[0361]. The example of FIG. 26 shows an inter-subframe scheme, and is thus compatible with FIG. 14.



APPLE-1005, FIG. 26 (annotated)

131. Here and elsewhere, Lee contemplates an RRC message (*the second wireless signal*) occupying a CPRB (*a first wireless resource*), which is one of $N \times M$ CPRBs (*one of J candidate wireless resources*) in a CP group, where $N \times M$ can be, for example, equal to 4 (*the J is a positive integer*), as taught by Lee. Therefore, a POSITA would have understood the combination of Lee-Freda-Ly to render obvious [1.5].

(g) [1.6] *the first time interval is used to determine the first wireless resource out of the J candidate wireless resources;*

132. Lee and Freda render obvious [1.6].

133. As I explained with respect to [1.4], Lee and Freda render obvious determining the time interval between (i) the starting time instant of the transmission

of the random access preamble through the PRACH and (ii) the start time instant of the transmission of the RRC request message through the PUSCH (*the first time interval*).

134. Further, as I explained with respect to [1.5], Lee describes that the RRC request message is transmitted using a corresponding CPRB (*the first wireless resource*) that is selected from among a set of $M \times N$ CPRBs (*J candidate wireless resources*) in a CP group.

135. Moreover, the Lee-Freda system further renders obvious using the time interval to determine the CPRB for transmitting the RRC request message from among the set of $M \times N$ CPRBs. As I explained in Sections VII.B and C, above, the Lee-Freda system uses a time-domain “offset” (*first time interval*) as well as its frequency-domain offset to select a time-frequency resource block (*first wireless resource*) for the PUSCH data (*second wireless signal*), as taught by Freda. For example, in the Lee-Freda system, “resources used for a preamble and the resources used for data may have some association, such as an implicit association” and that these association rules can be a “time and/or frequency offset” between preamble resources and data resources, as taught by Freda. APPLE-1006, [0147], [0209]; APPLE-1008, [0132], [0184]; APPLE-1009, [0132], [0192].

136. Specifically, in a Lee-Freda system, a time-domain offset would be used with respect to a “start time” that “may correspond to ... [a] first symbol of a

corresponding PRB region” of the PUSCH data (Lee’s RRC message). APPLE-1006, [0209]; APPLE-1008, [0184]; APPLE-1009, [0192]. In addition, the Lee-Freda system would use a frequency-domain offset in which “a first PRB of a transmission of a preamble and a *first PRB of a transmission of a data portion* may be offset from each other by a specific amount of PRBs,” as taught by Freda. APPLE-1006, [0210]; APPLE-1008, [0185]; APPLE-1009, [0193]. As such, the Lee-Freda system uses Freda’s time-domain offset (*first time interval*) to determine a “PRB region” for transmitting the PUSCH data (Lee’s RRC message), and further uses Freda’s frequency-domain offset to determine a specific PRB (*the first wireless resource*) within the PRB region for transmitting the PUSCH data. APPLE-1006, [0209], [0211]; APPLE-1008, [0184], [0186]; APPLE-1009, [0192], [0194].

137. Through such techniques, Freda discloses that a wireless communication device can use the time-domain offset and the frequency-domain offset in order to “facilitate blind decoding of data” by the receiving node (*e.g.*, base station) by using “a priori knowledge” of the start time and the first PRB of the transmission of a data portion, *e.g.*, “as may be indicated by a preamble.” APPLE-1006, [0207]-[0210]; APPLE-1008, [0182]-[0185]; APPLE-1009, [0190]-[0193].

138. Therefore, in view of Freda, a POSITA would have found it obvious to use Freda’s time-domain offset (*first time interval*) and Freda’s frequency-domain offset to determine a CPRB (*the first wireless resource*) out of Lee’s M*N CPRBs

in a CP group (*out of the J candidate wireless resources*). Accordingly, a POSITA would have understood the combination of Lee-Freda-Ly to render obvious [1.6].

(h) [1.7] *the first sequence is a Zadoff-Chu (ZC) sequence,*

139. Lee-Freda in combination with Ly renders obvious [1.7].

140. A POSITA would have understood, as of the Critical Date, that it was notoriously well-known to generate a RACH preamble (*the first sequence*) using a Zadoff-Chu sequence. Indeed, such knowledge is evidenced by Ly, as discussed in Sections VII.D and E, above. As I explained, a POSITA would have found to obvious to implement Lee's "RACH preamble sequence" (*the first sequence*) using *a Zadoff-Chu (ZC) sequence* as taught by Ly. For example, like Lee and Freda, Ly describes "2-step random access mechanisms" for facilitating communications between a UE and a base station, including (i) transmitting "a random access preamble" over a PRACH and (ii) transmitting additional data over a PUSCH. *See, e.g.,* APPLE-1005, [0237]-[0241], [0315]-[0383], FIG. 15(a); APPLE-1007, [0069], [0083], FIG. 9; APPLE-1010, [0065], [0079], FIG. 9. Further, in view of Ly, a POSITA would have understood that a network can employ a set of "random access preamble sequences with cyclic shifts" for a "random access procedure," and that this set "may include 64 Zadoff-Chu sequences." APPLE-1007, [0083]-[0085]; APPLE-1010, [0079]-[0081].

141. Ly discloses that using “a Zadoff-Chu [sequence] with cyclic shifts” can improve communication reliability because “delay spread and/or Doppler shift have minimal impacts on the RACH sequence cross-correlation.” APPLE-1007, [0085]; APPLE-1010, [0081]. This would encourage and enable the POSITA to use a Zadoff-Chu sequence for Lee’s “RACH preamble sequence” (*the first sequence is a ZC sequence*). Therefore, a POSITA would have understood the combination of Lee-Freda-Ly to render obvious [1.7].

(i) ***[1.8] a transport channel corresponding to the first wireless signal is a Random Access Channel (RACH), a physical channel corresponding to the second wireless signal is a Physical Uplink Shared Channel (PUSCH);***

142. Lee discloses or renders obvious [1.8].

143. As I explained in Section VII.A and with respect to [1.1], Lee describes that the UE “transmit[s] ... a random access preamble to a base station (BS)” (*first wireless signal*). APPLE-1005, Abstract. Specifically, in a “contention-based random access procedure,” Lee’s UE “transmits a RACH preamble sequence through the PRACH” to an “eNode B” (eNB) (*a transport channel corresponding to the first wireless signal is a Random Access Channel (RACH)*). APPLE-1005, [0237]-[0241], FIG. 15(a) (S1501, top)). Alternatively, in a “non-contention-based random access procedure,” Lee’s UE “transmits a RACH preamble sequence through the PRACH” to the eNB after the UE has been “allocated with the RACH preamble sequence from [the] eNB” (*a transport channel corresponding to the first*

wireless signal is a Random Access Channel (RACH)). APPLE-1005, [0242]-[0244], FIG. 15(b) (S1507, top)), [0266]-[0276], FIG. 17.

144. Further, as I explained in Section VII.A and with respect to [1.2], Lee describes that the UE “transmit[s] ... a radio resource control (RRC) request message” (*second wireless signal*) to the BS through a “contention-based physical uplink shared channel (PUSCH) resource block” (*a physical channel corresponding to the second wireless signal is a Physical Uplink Shared Channel (PUSCH)*). APPLE-1005, Abstract. Specifically, in both of Lee’s “contention-based random access procedure” and in Lee’s “non-contention-based random access procedure,” Lee’s UE transmits a “contention-based PUSCH” to the eNB (*a physical channel corresponding to the second wireless signal is a Physical Uplink Shared Channel (PUSCH)*). APPLE-1005, [0237], [0241]-[0244], FIG. 15(a) (S1501, bottom), FIG. 15(b) (S1507, bottom)), [0266]-[0276], FIG. 17. Therefore, a POSITA would have understood the combination of Lee-Freda-Ly to render obvious [1.8].

(j) *[1.9] the first wireless signal is used to determine whether the second wireless signal is transmitted or not.*

145. Lee discloses or renders obvious [1.9].

146. As I explained in Section VII.A and in further detail below, Lee’s UE uses its RACH preamble (*first wireless signal*) to determine whether (and which) resources are available for Lee’s RRC message (*second wireless signal*), and if no resources are available then the UE abandons the RRC message.

147. Thus, Lee resolves to abandon some instances of RRC message (*second wireless signal*) transmission, particularly when a relatively high number of RRC messages compete for a relatively limited number of CPRBs. In so abandoning, Lee determines that the implicated RRC messages (*second wireless signals*) are **not** transmitted, and by implication, those RRC message not abandoned have been determined by Lee to be transmitted.

148. In particular, as I explained with respect to [1.4], Lee's UE minimizes failure and/or collision of the RRC message (*second wireless signal*) transmission by selecting the "contention-based PUSCH resource block" ("CPRB") for the RRC message based on the RACH preamble (*first wireless signal*). APPLE-1005, [0282]-[0287].

149. Further, Lee's describes implementations of "full duplex relay (FDR) UEs" in which CPRBs are allocated to each of several UEs "in order of preamble sequences" (e.g., "according to descending order or ascending order of the transmitted RACH preamble sequence number"), such that UEs are prioritized for CPRB allocation. APPLE-1005, [0306]. Further, if there are an insufficient number of CPRBs to allocate to all of the UEs, then UEs with larger-valued RACH preamble sequence numbers are configured to "abandon[] RRC message transmission to the eNB at the corresponding point in time (subframe). APPLE-1005, [0307]-[0310].

After a “back-off time” has elapsed, those UEs may “transmit[] the RRC message to the eNB by using an available CPRB.” APPLE-1005, [0310].

150. For example, referring to FIG. 21, Lee describes a scenario in which three UEs are prioritized for allocation of two CPRBs based on their transmitted preamble sequences. APPLE-1005, [0304]-[0311]. As only two CPRBs are available for allocation, there are no CPRBs available for allocation of the UE having the highest-valued RACH preamble sequence number (UE 3 which selected “preamble sequence #8”), and that UE “abandons RRC message transmission to the eNB at the corresponding point in time.” APPLE-1005, [0309]-[0310].

151. Therefore, Lee’s discloses that the RACH preamble sequence (*first wireless signal*) is used to determine whether to transmit the RRC (PUSCH) message (*...is used to determine whether the second wireless signal is transmitted or not*). Therefore, a POSITA would have understood the combination of Lee-Freda-Ly to render obvious [1.9].

2. Claim 2

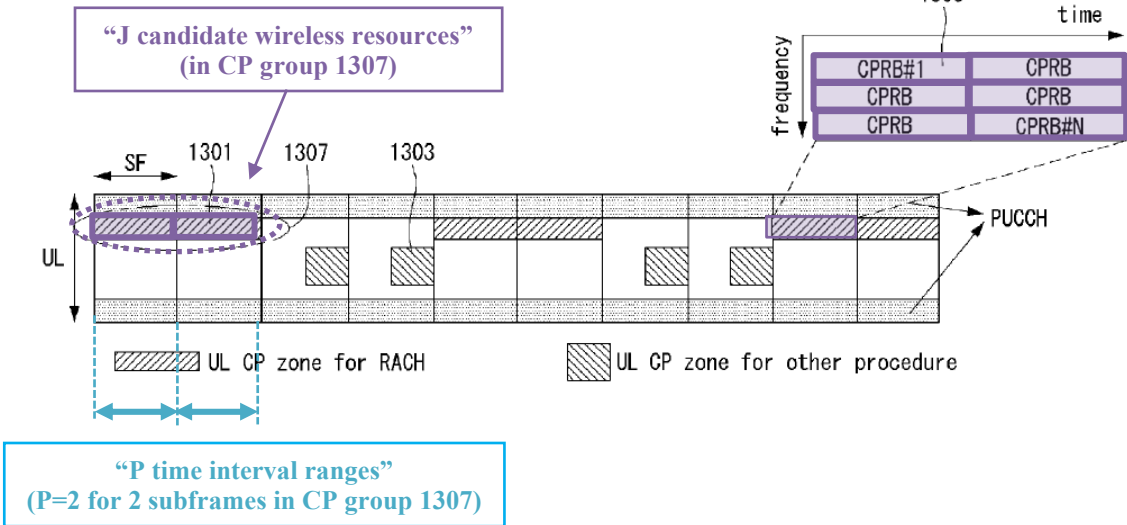
152. In my opinion, for the reasons discussed below, the combination of Lee, Freda, and Ly renders obvious claim 2.

- (a) *[2.1] The method of claim 1, wherein the J candidate wireless resources correspond to P time interval ranges; any two time interval ranges of the P time interval ranges do not overlap; the P is a positive integer greater than 1;*

153. Lee discloses or renders obvious [2.1].

154. As I explained with respect to [1.5], Lee's CPRB (*first wireless resource*) is selected from among $M \times N$ individual CPRBs (*J candidate wireless resources*) in the "CP group" (where each CP group has M CP zones, and each CP zone has N CPRBs). "For example, in case that one CP zone is comprised of four CPRBs, and one CP group is comprised of two CP zones, a UE has candidate CPRBs as many as $N \times M = 8$." APPLE-1005, [0223], [0355], [0365], [0367], [0376], FIGS. 22, 23, 25-27.

155. An example of Lee's hierarchical resource structure is shown in FIG. 13. In this example, CP group 1307 includes two CP zones (e.g., CP zone 1301), and each CP zone includes N CPRBs (e.g., CPRB 1305). See also APPLE-1005, [0203]-[0212]. The time duration of each CP zone can be configured to comprise "n ($n \geq 1$) subframes." APPLE-1005, [0204]. In the example of FIG. 13, shown below, CP group 1307 (including the claimed "*J candidate wireless resources*") corresponds to 2 subframes (*P time interval range*). APPLE-1005, FIG. 13.



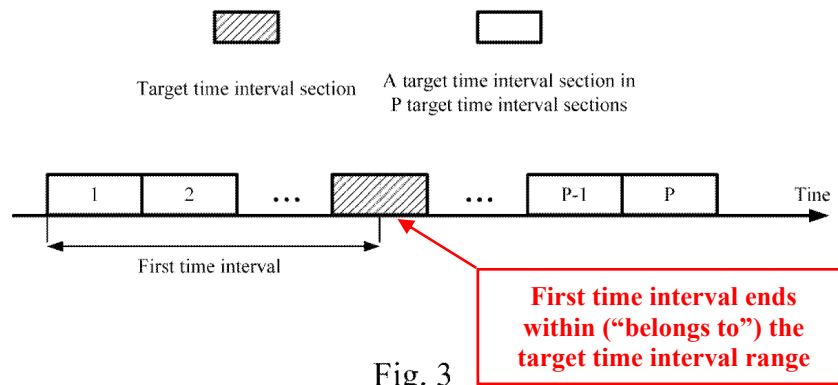
APPLE-1005, FIG. 13 (annotated)

156. Therefore, according to Lee, each “CP group” (e.g., CP group 1307) having $M \times N$ individual CPRBs (***J candidate wireless resources***) includes an integer number (M) of “CP zones” (e.g., $M=2$ CP zones in CP group 1307) where each CP zone can include “ $n \geq 1$ ” subframes (***time interval ranges***). APPLE-1005, FIG. 13, [0204]. Furthermore, as evident from FIG. 13, the subframes (“SF”) in Lee do not overlap with each other. APPLE-1005, FIG. 13, *see also* FIGS. 4, 14, 17-19, 21-24. Therefore, the $M \times N$ CPRBs (***J candidate wireless resources***) in a CP group correspond to $n \times M$ non-overlapping subframes, where $n \geq 1$ and M can be, for example, equal to 2 (***...correspond to P time interval ranges, where any two time interval ranges of the P time interval ranges do not overlap, and where the P is a positive integer greater than 1***). Therefore, a POSITA would have understood the combination of Lee-Freda-Ly to render obvious [2.1].

(b) *[2.2] the first time interval belongs to a target time interval range; the target time interval range is a time interval range of the P time interval ranges;*

157. Lee in combination with Freda renders obvious [2.2].

158. In regard to the claim language “*the first time interval belongs to a target time interval range*” of [2.2], the ’721 patent describes “belongs to” as the ending point of the first time interval falling within the target time interval range. For example, the ’721 patent shows an example of “a relationship between the first time interval and the target time interval” in FIG. 3, where “the unfilled rectangle represents one time interval range in P time interval ranges, and the rectangle filled by slashes represents the target interval range.” APPLE-1001, 14:30-35.



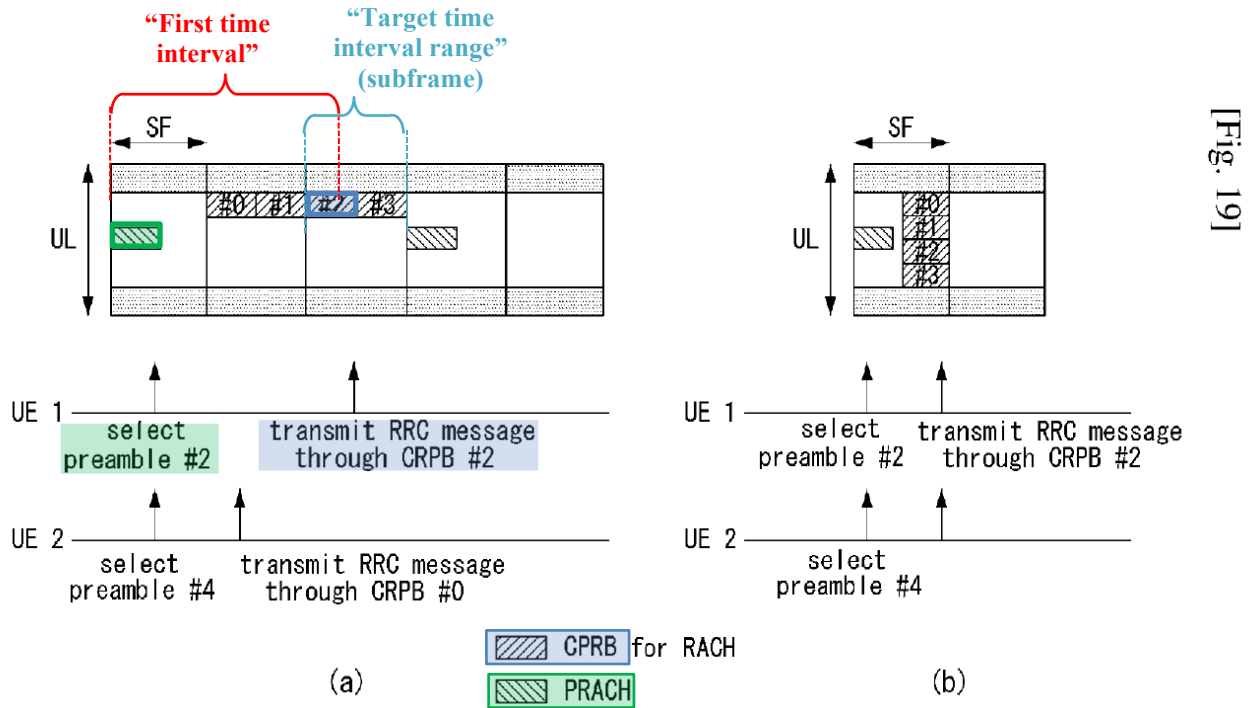
APPLE-1001, FIG. 3 (annotated)

159. The ’721 patent characterizes FIG. 3 as showing “[t]he first time interval belongs to a target time interval range.” APPLE-1001, 14:38-39. Given

this description, a POSITA would have understood that according to the '721 patent, the first time interval “belongs to” the target time interval range if the first time interval ends within the target time interval range. APPLE-1001, 14:35-40, FIG. 3. In particular, the '721 patent explains that “one time interval range refers to a continuous range of one time interval.” APPLE-1001, 14:41-42. As such, a POSITA would have understood the '721 describes a “*time interval range*” as a continuous range of possible end points of a time interval.

160. Lee in combination with Freda discloses exactly such a relationship between a *first time interval* and a *target time interval range*. As discussed with respect to [1.4], Lee in combination with Freda renders obvious determining the time interval between (i) the starting time instant of the transmission of the random access preamble through the PRACH and (ii) the start time instant of the transmission of the RRC request message through the PUSCH (*the first time interval*).

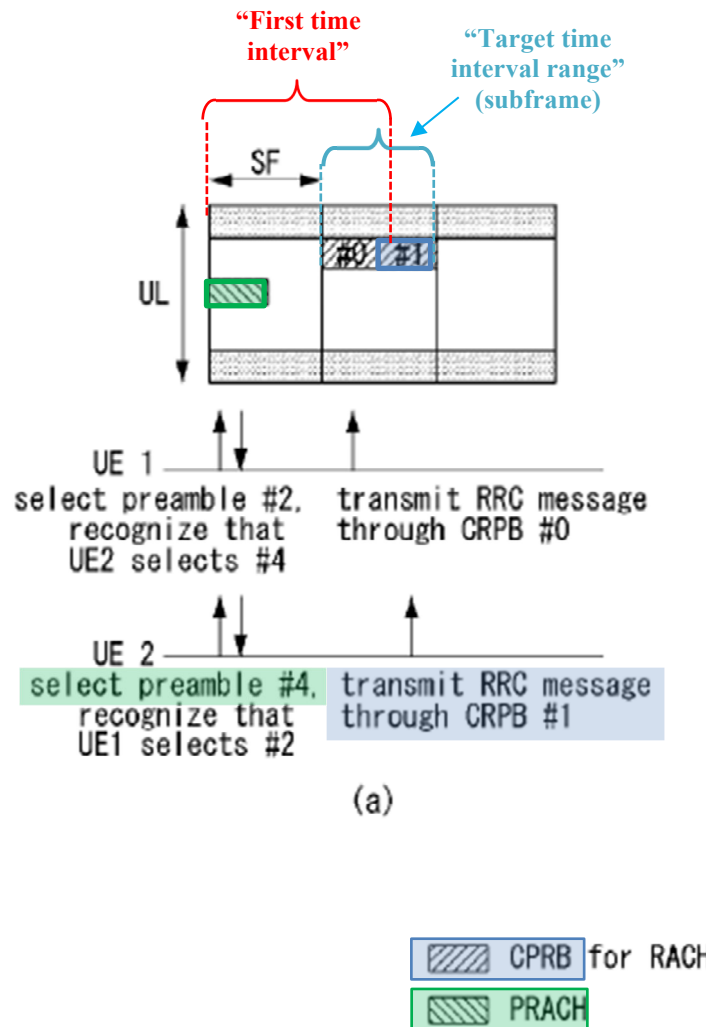
161. Further, in view of the discussion in [2.1], a POSITA would have understood that this first time interval “belongs to” (*i.e.*, ends within) one of the $n \times M$ subframes (*P time interval ranges*) in Lee’s CP group (*...belongs to a target time interval range, where the target time interval range is a time interval range of the P time interval ranges*). In particular, when the UE transmits an RRC message over the PUSCH, Lee discloses that the transmission is performed using a particular subframe (*target time interval range*) within a CP zone from among the CP group.



APPLE-1005, FIG. 19 (annotated)

162. For example, FIG. 19 shows a CP zone with four CPRBs (#0 through #3) spanning two subframes. The "UE 1" transmits a RRC message using "CPRB #2" in the second subframe (which spans "CPRB #2" and "CPRB #3") of the CP zone. APPLE-1005, [0287]-[0291]. Therefore, because the RRC message is transmitted in CPRB #2, a POSITA would have understood that in the Lee-Freda combination, the time interval between the starting time of the PRACH preamble transmission and the starting time of the RRC message transmission (*first time interval*) ends in the second subframe (*belongs to a target time interval range*) of Lee's CP zone.

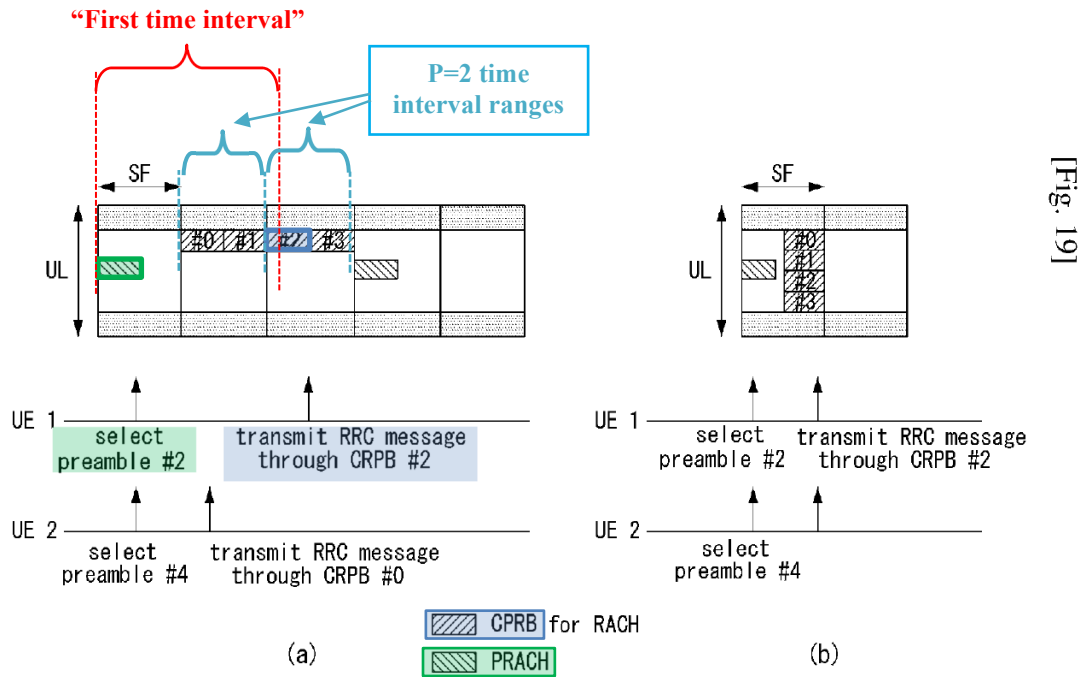
163. As another example, FIG. 21 shows a CP zone with two CPRBs (#0 and #1) in a single subframe. The “UE 2” transmits a RRC message using “CPRB #1” which is the second CPRB in this single subframe of the CP zone. APPLE-1005, [0309]. Therefore, because the RRC message is transmitted in CPRB #1, a POSITA would have understood that in the Lee-Freda combination, the time interval between the starting time of the PRACH preamble transmission and the starting time of the RRC message transmission (*first time interval*) ends in the single subframe (*belongs to a target time interval range*) of the CP zone.



APPLE-1005, FIG. 19(a) (annotated)

164. That is, each of Lee’s CP zones in the Lee-Freda combination has a particular subframe corresponding to a range of possible times where the time interval between the starting time instant of the PRACH preamble transmission and starting time instant of the RRC message transmission (*first time interval*) can end, and this time interval “belongs to” a particular subframe (*target time interval range*) within the CP zone by virtue of the time interval ending within that subframe.

165. Further, a POSITA would have understood that the particular subframe in which the RRC message is transmitted (*target time interval range*) is one of the time interval ranges from among the multiple subframes (*... is a time interval range of the P time interval ranges*) corresponding to a CP group. For example, Lee's FIG. 19 depicts a CP group have a single CP zone spanning 2 subframes (*P time interval ranges*), where each subframe has two CPRBs and CPRB #2 (in the second subframe) is used for transmitting the RRC message.



APPLE-1005, FIG. 19 (annotated)

166. Therefore, a POSITA would have understood the combination of Lee-Freda-Ly to render obvious [2.2].

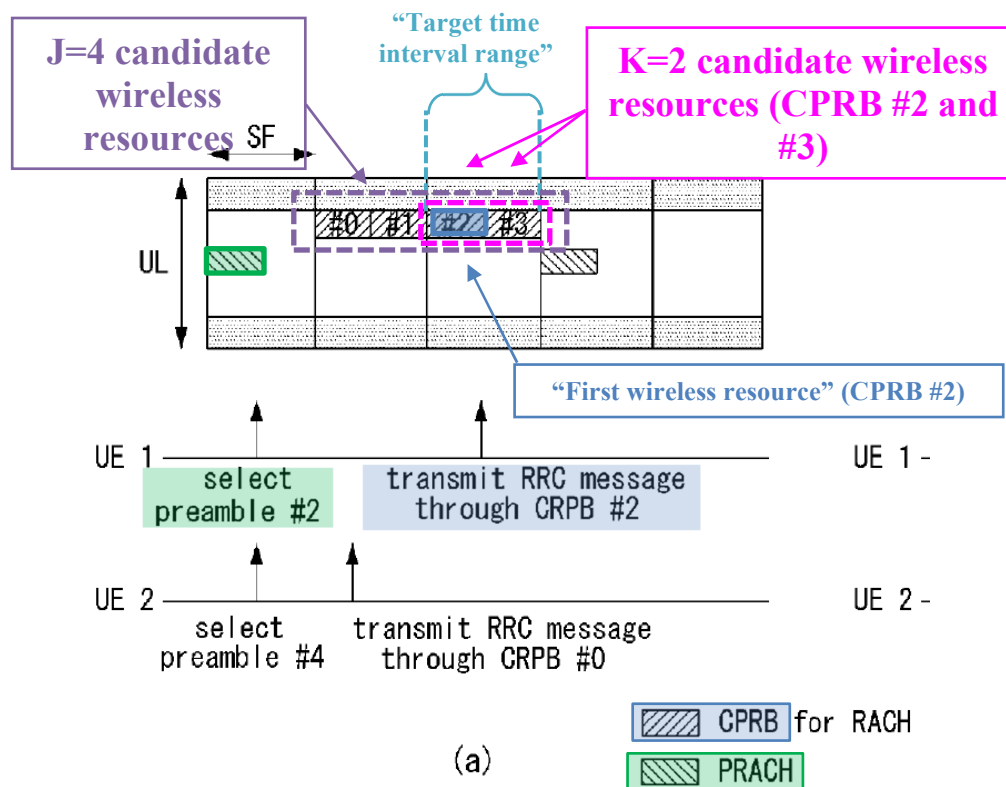
(c) [2.3] the target time interval range corresponds to K candidate wireless resource(s) out of the J candidate wireless resources;

the first wireless resource is one of the K candidate wireless resource(s); the K is a positive integer smaller than or equal to the J ;

167. Lee discloses or renders obvious [2.3].

168. As I explained with respect to [2.2], a POSITA would have recognized that Lee's *first time interval* "belongs to" one of the subframes (*target time interval range*) among Lee's subframes in a CP group.

169. For instance, in the example shown in Lee's FIG. 19, the "UE1" transmits a RRC message using "CPRB #2," which falls within the second "CP zone" or subframe spanning "CPRB #2" and "CPRB #3." APPLE-1005, [0287]-[0291], FIG. 13 (depicting each "CP group" as having two "CP zone" or subframes).



APPLE-1005, FIG. 19 (annotated)

170. That is, in this example, Lee's second subframe (*the target time interval range*) in the CP zone corresponds to two CPRBs, *i.e.*, CPRB #2 and CPRB #3 (*...corresponds to K candidate wireless resource(s)*) from among the set of four CPRBs, *i.e.*, CPRBs #0, #1, #2, #3, in the CP group (*...out of the J candidate wireless resources*) and the number of CPRBs in the second subframe ($K=2$) of the CP group is a positive integer smaller than or equal to the total number of CPRBs in the CP group ($J=4$) (*the K is a positive integer smaller than or equal to the J*). APPLE-1005, FIG. 19(a). Further, CPRB #2 in which the RRC message is transmitted (*the first wireless resource*) is one of the two CPRBs of the second subframe (*...is one of the K candidate wireless resource(s)*) of the CP zone in the CP group. APPLE-1005, FIG. 19(a).

171. Therefore, a POSITA would have understood the combination of Lee-Freda-Ly to render obvious [2.3].

(d) [2.4] P is configured by network.

172. Lee discloses or renders obvious [2.4].

173. As I explained with respect to [2.1], a POSITA would have understood that Lee's RRC message is transmitted within a particular subframe (*target time interval range*) which is one of multiple subframes corresponding to a CP group (*... is a time interval range of the P time interval ranges*).

174. Further, as I explain below, Lee discloses that each of the “CP zones” and “CP groups” is configured by the eNB. Thus, it would have been obvious to a POSITA that Lee specifically configures the number of subframes (time interval ranges) spanned by a CP group (***P is configured by network***). Specifically, Lee discloses that “[t]he CP zone, the CPRB and the CP group described above are predefined in a specific cell” and that “an eNB of the corresponding cell **transmits the configuration information** for the contention-based radio resource to a UE in order to notify that the contention-based radio resource is **configured**.” APPLE-1005, [0220]. For example, this configuration information can include “the UL resource information in which the CP zone is configured,” “information for time/frequency resource domain in which the CP zone is configured,” “the number (N) of CPRBs constructing one CP zone,” and “the number (M) of CP zones that attempt to occupy resources by an arbitrary UE.” APPLE-1005, [0220]-[0223]. Further, Lee explains that “CP zones (1301, 1303) may be **configured** to be comprised of the same pattern **within n (n $\geq$ 1) subframes** (or m (m $\geq$ 1) radio frames).” APPLE-1005, [0204].

175. In view of Lee, a POSITA would have understood that a network can provide “predefined” configurations to a UE regarding each of the CP groups, CP zones, and subframes for the CP zones for communicating with the eNB, and that such configuration can signal at least “information for time/frequency resource

domain in which the CP zone is configured (*e.g.*, the number of “CP zones” or subframes in each “CP group”) (*P is configured by network*). Therefore, a POSITA would have understood the combination of Lee-Freda-Ly to render obvious [2.4].

3. Claim 3

176. In my opinion, for the reasons discussed below, the combination of Lee, Freda, and Ly renders obvious claim 3.

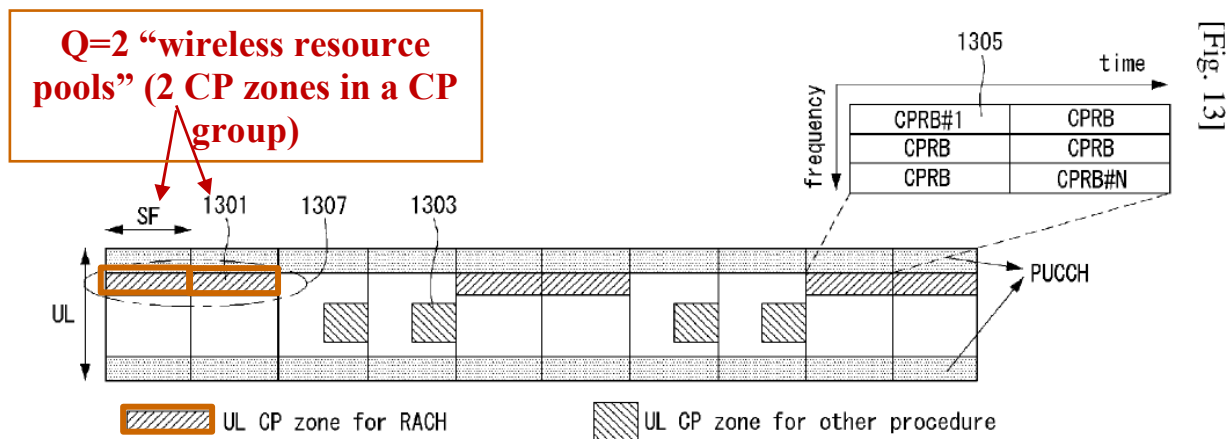
(a) ***[3.1] The method of claim 2, further comprising: receiving a first signaling; wherein the first wireless signaling is used to determine Q wireless resource pool(s); the Q is a positive integer;***

177. Lee discloses or renders obvious [3.1].

178. Lee describes that the UE receives, from the eNB “configuration information” (*receiving a first signaling*) for a “contention-based radio resource,” such as configuration information regarding “[t]he CP zone, the CPRB and the CP group.” APPLE-1005, [0220]. Lee discloses that the UE can receive this configuration information through various types of signaling, such as “a broadcasting message, transmitted with a unicast message for a specific UE, or transmitted with a multicast message” (APPLE-1005, [0225]) or “through a master information block (MIB)” (APPLE-1005, [0226]) or “through the existing system information block (SIB)-x” (APPLE-1005, [0227]) or “using a unicast scheme through a new control message” (APPLE-1005, [0228]).

179. This configuration information (*the first signaling*) can include “the UL resource information in which the CP zone is configured,” “information for time/frequency resource domain in which the CP zone is configured,” “the number (N) of CPRBs constructing one CP zone,” and “the number (M) of CP zones that attempt to occupy resources by an arbitrary UE” (*... is used to determine Q wireless resource pool(s), where the Q is a positive integer*). APPLE-1005, [0220]-[0223], [0226]-[0229].

180. For instance, in the example shown in FIG. 13, a “CP group” has two “CP zones” (*Q=2 wireless resource pools*) in a CP group, each CP zone having respective frequency and time components. APPLE-1005, [0203]-[0212].



APPLE-1005, FIG. 13 (annotated)

181. Therefore, a POSITA would have understood the combination of Lee-Freda-Ly to render obvious [3.1].

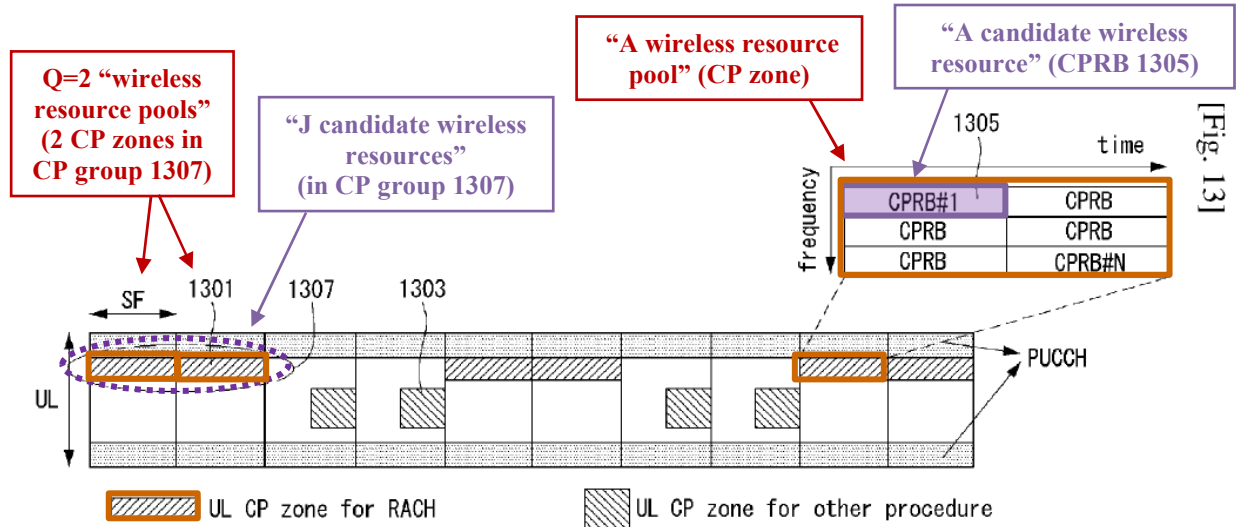
(b) *[3.2] each candidate wireless resource of the J candidate wireless resources belongs to one of the Q wireless resource pool(s);*

182. Lee discloses or renders obvious [3.2].

183. As I explained with respect to [3.1], Lee's UE device receives configuration information (*the first signaling*) can include, among other parameters, "the number (M) of CP zones that attempt to occupy resources by an arbitrary UE" (*... is used to determine Q wireless resource pool(s)*).

184. Further, a POSITA would have understood each of Lee's M*N CPRBs (*each candidate wireless resource of the J candidate wireless resources*) belongs to one of the "CP zones" (*...belongs to one of the Q wireless resource pool(s)*).

185. For instance, in the example shown in FIG. 13, CP group 1307 has two CP zones (*Q=2 wireless resource pools*), and each CP zone includes one or more respective CPRBs, *e.g.*, CPRBs #1 through #N (*candidate wireless resources*).
APPLE-1005, [0203]-[0212].



APPLE-1005, FIG. 13 (annotated)

186. In general, Lee describes a CP group having "M" CP zones where each CP zone has "N" CPRBs, such that the CP group has a total of $N \times M$ CPRBs. APPLE-1005, [0223]. In this case, each CPRB (*each candidate wireless resource*) of the total $M \times N$ CPRBs (*of the J candidate wireless resources*) in the CP group belongs to one of the M CP zones (*...belongs to one of the Q wireless resource pool(s)*) in the CP group.

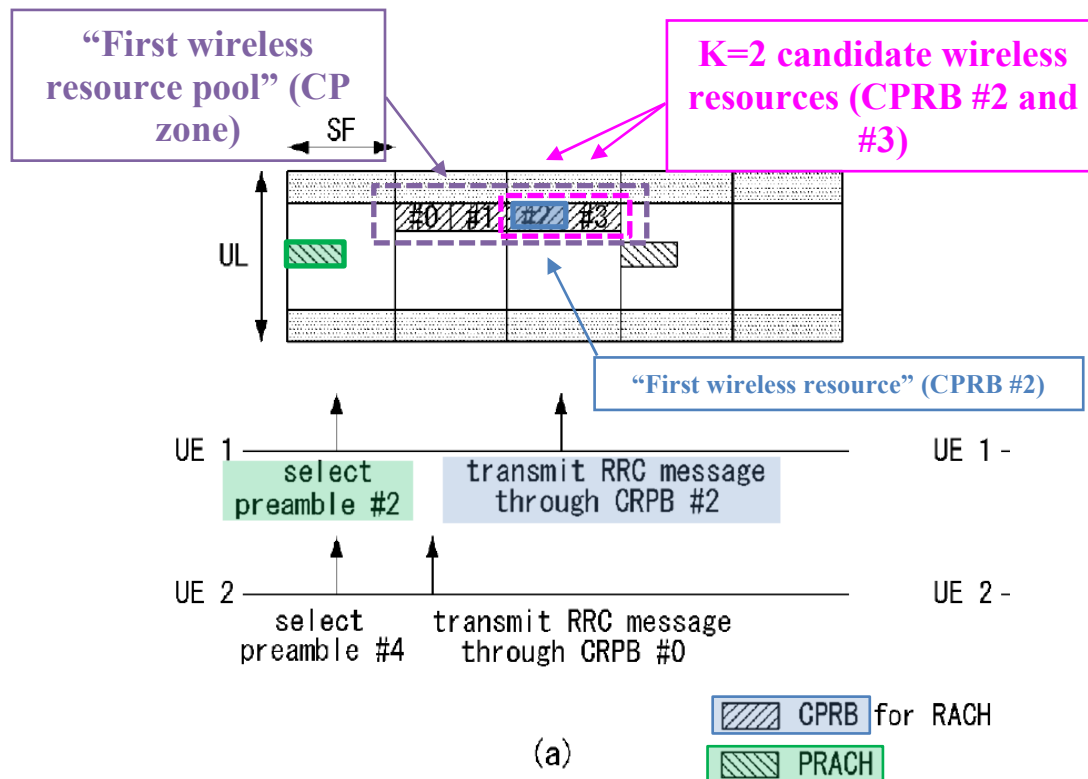
187. Therefore, a POSITA would have understood the combination of Lee-Freda-Ly to render obvious [3.2].

(c) [3.3] the K candidate wireless resource(s) belongs (belong) to a first wireless resource pool; the first wireless resource pool is one of the Q wireless resource pool(s);

188. Lee discloses or renders obvious [3.3].

189. As I explained discussed with respect to [2.3], Lee's *first time interval* "belongs to" a particular subframe (*the target time interval range*) within a CP group.

190. For instance, in the example shown in Lee's FIG. 19(a), Lee discloses that the two CPRBs, *i.e.*, CPRBs #2 and #3 (*K candidate wireless resource(s)*) in the second subframe belong to a CP zone (*a first wireless resource pool*) consisting of the four CPRBs #0, #1, #2, and #3. APPLE-1005, FIG. 19(a), [0288]. In particular, as shown in FIG. 19(a), Lee's "UE1" transmits a RRC message using "CPRB #2" of the CP zone including CPRBs #0 through #3. APPLE-1005, [0287]-[0291], *see also* FIG. 13 (depicting CP group 1307 as having two CP zones).



APPLE-1005, FIG. 19 (annotated)

191. That is, the RRC message is transmitted in CPRB #2 (*the first wireless resource*) which is one of two CPRBs, *i.e.*, CPRBs #2 and #3 (*...is one of the K candidate wireless resource(s)*) in the second subframe which belongs to the CP zone (*...belong to a first wireless resource pool*). APPLE-1005, [0287]-[0291].

192. Further, in the example of FIG. 19(a), the CP zone (*the first wireless resource*) consisting of CPRBs #0 through #3 is the only CP zone (*...is one of the Q wireless resource pool(s)* in the singular) in the CP group. APPLE-1005, [0287]-[0291]. In general, Lee discloses that a CP group can include “M” CP zones, *e.g.*, M=2 as in FIG. 13, (*...is one of the Q wireless resource pool(s)* in the plural). APPLE-1005, [0223], FIG. 13.

193. Therefore, a POSITA would have understood the combination of Lee-Freda-Ly to render obvious [3.3].

(d) [3.4] *the first time interval is used to determine the first wireless resource pool out of the Q wireless resource pool(s).*

194. Lee in combination with Freda renders obvious [3.4].

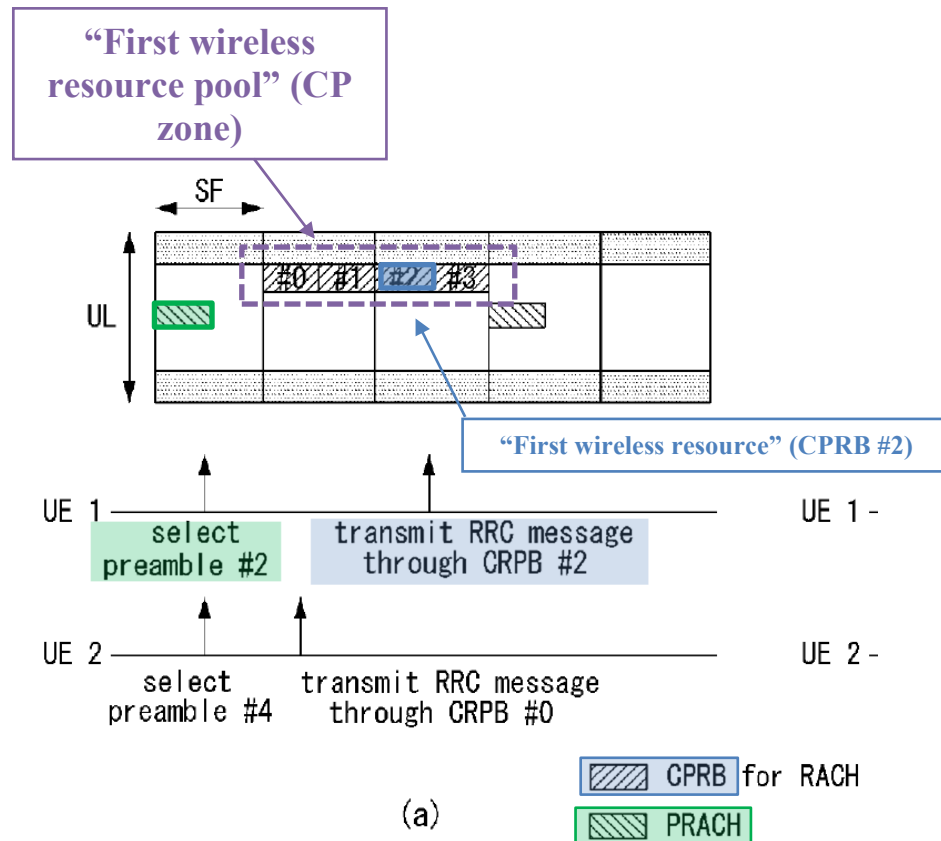
195. As I explained with respect to [1.4], the Lee-Freda system uses a time-domain “offset” (*the first time interval*) and a frequency-domain offset, as taught by Freda, to determine a resource block (*i.e.*, Lee’s CPRB) for Lee’s RRC message transmission. As explained below, a POSITA would have understood that the Lee-Freda system would also determine the particular CP zone (*the first wireless*

resource pool out of the Q wireless resource pool(s)) in which the CPRB is allocated for the RRC message (PUSCH) transmission.

196. Lee explains that “zones signify a region in which a UE may transmit UL data competitively without UL resource allocation scheduling” and a “CPRB ... signifies a UL resource region that a UE may occupy (*e.g.*, use) for a specific procedure within the CP zone.” APPLE-1005, [0204], [0205]. In particular, “[e]ach of the CPRBs that constructs the CP zone has its own unique index (*e.g.*, CPRB #1, CPRB #2, etc.).” APPLE-1005, [0205]. Furthermore, “UL resource information in which the CP zone is configured signifies the information for time/frequency resource domain in which the CP zone is configured.” *Id.*, [0222].

197. A POSITA also would have found it obvious to determine a particular CP zone out of Lee’s “M” CP zones (*the first wireless resource pool out of the Q wireless resource pool(s))* in a CP group to transmit the RRC message. APPLE-1005, [0223]. For example, a POSITA would have recognized that upon determining that the RRC message is to be transmitted at a particular time (*e.g.*, based on Freda’s teaching regarding an “offset” in time), the UE would determine that the transmission time falls within a particular one of Lee’s “CP zones.” Accordingly, a POSITA would have found it obvious to select that “CP zone” to transmit the RRC message.

198. For instance, referring to example in Lee's FIG. 19(a), the RRC message is transmitted in CPRB #2 within the CP zone ($Q=1$ wireless resource pool) which includes four CPRBs #0, #1, #2, and #3. APPLE-10065, [0203]-[0212]. Upon determining that the "offset" in time (as taught by Freda) for transmitting the RRC message points to CPRB #2, the UE would determine that the CP zone (*the first wireless pool*) including CPRB #2 should be used for transmitting the RRC message. APPLE-10065, [0203]-[0212].



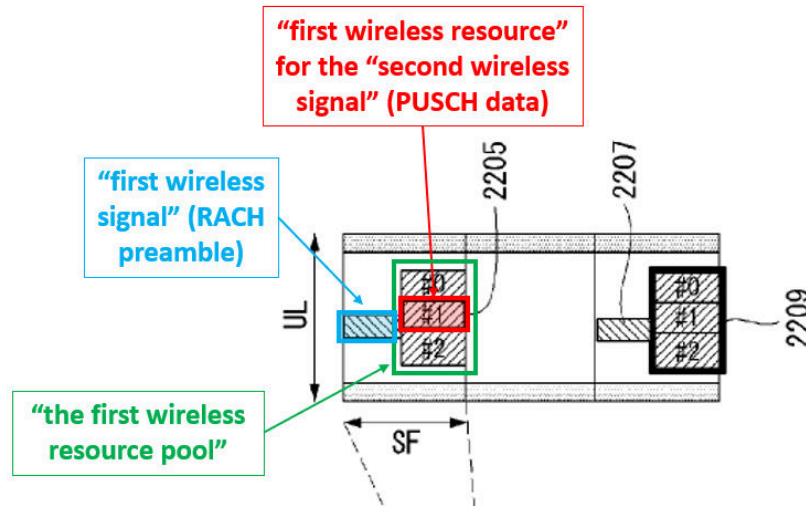
APPLE-1005, FIG. 19 (annotated)

199. As another example, it would have been obvious to use Freda's time-domain offset (*the first time interval*) to determine one of Lee's CP zones and further

use Freda's frequency-domain offset to determine one of Lee's CPRB (*the first wireless resource*) within the CP zone for transmitting Lee's RRC message. In particular, as I explained in Sections VII.B and C and in [1.6], the Lee-Freda system uses Freda's time-domain offset (*the first time interval*) to determine a "PRB region" for transmitting the PUSCH data, and further uses Freda's frequency-domain offset to determine a specific PRB (*the first wireless resource*) within the PRB region for transmitting the PUSCH data. APPLE-1006, [0209], [0211]; APPLE-1008, [0184], [0186]; APPLE-1009, [0192], [0194]. Based on this teaching, a POSITA would have found it obvious that the Lee-Freda system would use Freda's time-domain offset (*the first time interval*) to determine one of Lee's "M" CP zones (*the first wireless resource pool out of the Q wireless resource pool(s)*) in a CP group and further use Freda's frequency-domain offset to determine one of Lee's CPRBs (*the first wireless resource*) within the CP zone for transmitting Lee's RRC message. APPLE-1005, [0223].

200. An illustration of this is shown below with reference to Lee's FIG. 22 (reproduced below, annotated). In this example, the Lee-Freda system would use Freda's time-domain offset (*first time interval*) between the radio signal for the RACH preamble ("first wireless signal") and radio signal for the RRC message (PUSCH) ("second wireless signal") (along the horizontal distance in the figure below) to determine the CP zone ("the first wireless resource pool" annotated in

green) in which to transmit the PUSCH data. The Lee-Freda system would then use Freda's frequency-domain offset (along the vertical direction in the figure below) to determine CPRB #1 (*the first wireless resource*, red box) within the CP zone (along the vertical axis) for transmitting Lee's RRC message.



APPLE-1005, FIG. 22 (annotated)

201. Therefore, as shown in this example, a POSITA would have found it obvious that the Lee-Freda system could use Freda's time-domain offset (*the first time interval*) to determine one of Lee's CP zones (*the first wireless resource pool out of the Q wireless resource pool(s)*) for transmitting Lee's RRC message.

202. Therefore, a POSITA would have understood the combination of Lee-Freda-Ly to render obvious [3.4].

4. Claim 4

203. In my opinion, for the reasons discussed below, the combination of Lee, Freda, and Ly renders obvious claim 4.

- (a) ***[4] The method of claim 1, further comprising: receiving a second wireless signaling; wherein the second wireless signaling is used to determine the first time interval; the second wireless signaling indicates a portion of the first time interval, the second wireless signaling is a Radio Resource Control (RRC) signaling.***

204. The combination of Lee, Freda, and Ly renders obvious claim 4.

205. As I explained with respect to [1.4], the Lee-Freda system would use the RACH preamble to determine Freda's time-domain offset (*the first time interval*) between (i) the starting time instant of the transmission of the RACH preamble and (ii) the starting time instant of the transmission of the PUSCH data.

206. Furthermore, as I explain below, Freda also discloses that a "guard period" (*a portion of the first time interval*) can be configured prior to the data transmission, and that the UE can receive its guard period configuration from the network (*receiving a second wireless signaling, ... the second wireless signaling indicates a portion of the first time interval*).

207. Freda discloses that "[a] guard period may be used *prior* and/or after *data transmission*." APPLE-1006, [0275]; APPLE-1008, [0235]; APPLE-1009, [0258]. In particular, there may be "a known sequence within a portion of a guard period" where the "sequence may consist of a cyclic prefix." APPLE-1006, [0277]; APPLE-1008, [0237]; APPLE-1009, [0260]. As such, Freda discloses that a guard period (including a cyclic prefix) can be implement prior to the data transmission

210. Furthermore, Freda discloses that the UE can “receive its guard period configuration from the network” (*receiving a second wireless signaling, ... the second wireless signaling indicates a portion of the first time interval*). APPLE-1006, [0276], [0287] (the UE “may (*e.g.* further) modify a guard interval configuration for retransmission of preamble+data”). Furthermore, a POSITA would have found it obvious that the UE would receive this guard period configuration through RRC signaling (*the second wireless signaling is a Radio Resource Control (RRC) signaling*). See also APPLE-1008, [0236], [0246]; APPLE-1009, [0259], [0270]. For example, both Lee and Freda disclose using RRC signaling to configure various aspects of the network, and using RRC signaling would have been one of a finite number of predictable solutions to receive a guard period configuration. APPLE-1005, [0073] (“Radio Resource Control (RRC) layer ...is responsible for control of logical, transport, and physical channels in association with configuration, reconfiguration, and release of Radio Bearers (RBs)”); APPLE-1006, [0407].

211. Therefore, a POSITA would have understood the combination of Lee-Freda-Ly to render obvious claim 4.

5. Claim 5

212. In my opinion, for the reasons discussed below, the combination of Lee, Freda, and Ly renders obvious claim 5.

(a) [5.1] The method of claim 1, wherein the first sequence belongs to a target sequence set;

213. Lee in combination with Freda and Ly renders obvious [5.1].

214. As I explained with respect to [1.3], Lee discloses that the “random access preamble” (*the first wireless signal*) includes, and thus is generated at least in part by, a “RACH preamble sequence” (*the first sequence*).

215. Further, Lee discloses that the “RACH preamble sequence” (*the first wireless signal*) can be identified by a “preamble sequence number,” which implies that the “RACH preamble sequence” is selected from a finite set of enumerated preamble sequences (*...belongs to a target sequence set*). See, e.g., APPLE-1005, [0301], [0306], [0311], [0156] (referring to a “preamble index/identifier” that can be the “same as the random access preamble”), [0367] (referring to a “preamble index,” such as “preamble index #1”).

216. Nevertheless, even if Lee were to not expressly disclose that “RACH preamble sequence” is selected from among a particular set, a POSITA nevertheless would have found it obvious to configure Lee’s system to do so in view of Freda.

217. For example, Freda describes that a wireless communications device “may select a preamble 622 from a group 620 of preambles.” APPLE-1006, [0132]; APPLE-1008, [0194]; APPLE-1009, [0212]. Further, Freda describes that “[a] set of eRACH resource(s) may include one or more of a set of preambles.” APPLE-1006, [0164], [0229] (describing a “selection of one or more preambles from a set

of configured preambles”), [0239] (describing “random selection of a preamble from a configured set of preambles, or from a set of preambles that may meet one or more (e.g. a combination of) other rules for preamble association”), [0248] (“describing “receiv[ing] multiple preambles from a network (e.g. through RRC signaling) and ... select[ing] a provided preamble, e.g., based on one or more properties”), APPLE-1006, [0251] (describing “select[ing] from a different set of preamble sequences, for example, based on the type of procedure. A first set of preambles (e.g. preamble group C) may be associated with ePRACH while one or more sets of preambles (e.g. preamble group A and B) may be associated with PRACH transmission”); APPLE-1008, [0149], [0194], [0204], [0208], [0211]; APPLE-1009, [0149], [0212], [0222], [0231], [0234].

218. In view of Freda, a POSITA would have understood that a random access preamble sequence (e.g., as described by both Lee and Freda) (*the first wireless signal*) can be selected from a specific set of preambles (*...belongs to a target sequence set*), such as a set of configured preambles (e.g., as expressly described by Freda). This selection process would allow a UE and a base station to select and use random access preamble sequences in a more consistent and predictable manner (e.g., by limiting random access preamble sequences to a known set of sequences), thereby improving the reliability of communications between them.

219. A POSITA also would have found it obvious in view of Ly to configure Lee's system to select a "RACH preamble sequence" from among a particular set. For example, as I explained with respect to [1.7], in view of Lee and Ly, a POSITA would have found it obvious to implement the "RACH preamble sequence" (*the first wireless signal*) as a *Zadoff-Chu (ZC) sequence*. Further, Ly expressly discloses that a "network ... may employ two sets of random access preamble sequences," and that "each set may include 64 Zadoff-Chu sequences" (*a target sequence set*). APPLE-1007, [0083]; APPLE-1010, [0079]. As above, this selection process would allow a UE and a base station to select and use random access preamble sequences in a more consistent and predictable manner, thereby improving the reliability of communications between them.

220. Therefore, a POSITA would have understood the combination of Lee-Freda-Ly to render obvious [5.1].

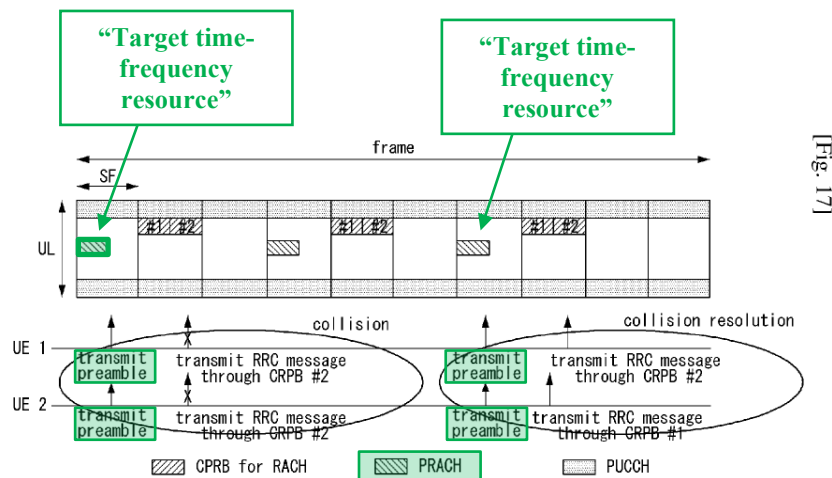
(b) *[5.2] the first wireless signal occupies a target time-frequency resource;*

221. Lee discloses or renders obvious [5.2].

222. As I explained with respect to [1.1], Lee discloses that a UE "transmit[s] ... a random access preamble to a base station (BS)" (*the first wireless signal*).

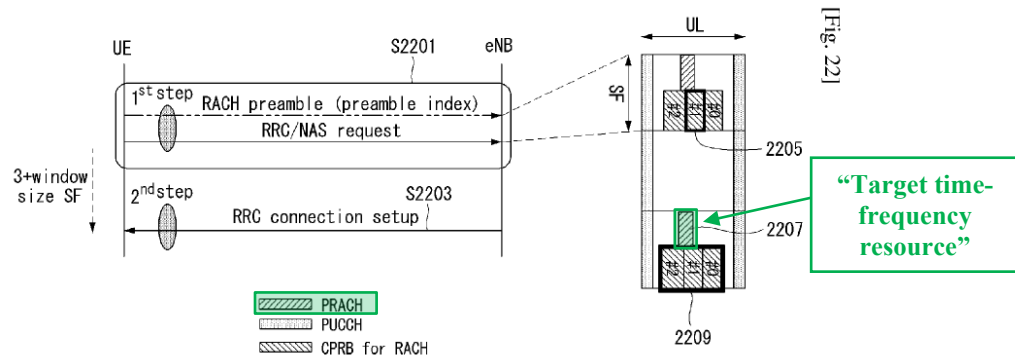
223. Further, the random access preamble (*the first wireless signal*) occupies a particular PRACH region (*...occupies a target time-frequency resource*).

224. For example, as shown in Lee's FIG. 17, "[t]he UE 1 and UE 2 transmit different RACH preamble sequences in a PRACH region of a first subframe to a BS," which includes a frequency component (vertical axis) and a time-component (horizontal axis).



APPLE-1005, FIG. 17 (annotated)

225. Further, Lee's FIG. 22 depicts a "PRACH region 2207 in which a preamble is transmitted," which includes a frequency component (horizontal axis) and a time-component (vertical axis.) APPLE-1005, [0317].



APPLE-1005, FIG. 22 (annotated)

226. Therefore, a POSITA would have understood the combination of Lee-Freda-Ly to render obvious [5.2].

(c) *[5.3] at least one of an index of the first sequence in the target sequence set, a location of the target time-frequency resource in time domain, a location of the target time-frequency resource in frequency domain, or a correspondence relationship between the location of the target time-frequency resource in time domain and the location of the target time-frequency resource in frequency domain is used to determine the first wireless resource out of the J candidate wireless resources through a pre-defined mapping relationship;*

227. Lee, either alone in in combination with Freda, renders obvious [5.3].

228. As I explained with respect to [1.3], Lee discloses that the “random access preamble” (*the first wireless signal*) includes, and thus is generated at least in part by, a “RACH preamble sequence” (*the first sequence*).

229. In addition, Lee discloses that the index of the “RACH preamble sequence” (*index of the first sequence in the target sequence set*) can be used to determine the CPRB (*first wireless resource*) from among M*N individual CPRBs

in the “CP group” (*...is used to determine the first wireless resource out of the J candidate wireless re-sources through a pre-defined mapping relationship*). APPLE-1005, [0355] (“the UE may select a random value by using a certain value (e.g., ... a preamble index selected by the UE)” and “the UE may select one CPRB of the CP group with respect to a PRACH, on the basis of the preamble selected by the UE”), [0358] (“the CPRB may be selected on the basis of a transmitted preamble index”), [0367] (“the RRC/NAS request message is transmitted through CPRB selected based on ... a preamble index within the contention-based PUSCH group (namely, in the CP group)),” [0375] (“the CPRB can be selected on the basis of the transmitted preamble index”). *See also* [1.5] (regarding “first wireless resource” and “j candidate wireless resources”, [5.1] (regarding “first sequence”), [5.2] (regarding “target time-frequency resource”).

230. Further, as I explained in Section VII.B and VII.C and in [1.6], the Lee-Freda system uses Freda’s time-domain offset relative to “a start time of a transmission of a preamble” (*a location of the target time-frequency resource in time domain*) to determine a “PRB region” for transmitting the PUSCH data, and further uses Freda’s frequency-domain offset relative to “a first PRB of a transmission of a preamble”(*a location of the target time-frequency resource in frequency domain*) to determine a specific RB (*the first wireless resource*) within

the PRB region for transmitting the PUSCH data. APPLE-1006, [0209], [0211]; APPLE-1008, [0184], [0186]; APPLE-1009, [0192], [0194].

231. Therefore, a POSITA would have understood the combination of Lee-Freda-Ly to render obvious [5.3].

(d) [5.4] the index of the first sequence in the target sequence set is an index for which the sequence in the target sequence set are sorted by a specific order.

232. Lee discloses or renders obvious [5.4].

233. Lee discloses that the index of the “RACH preamble sequence” (*index of the first sequence in the target sequence set*) are sorted on the basis of its “preamble sequence numbers,” such as in “descending order or ascending order” (*...is an index for which the sequence in the target sequence set are sorted by a specific order*). APPLE-1005, [0306]-[0307], [0311]. For example, “a UE which selects a preamble sequence having a smaller value may always have priority.” APPLE-1005, [0306], [0307] (describing an example determination of priority based on preamble sequence numbers).

234. Therefore, a POSITA would have understood the combination of Lee-Freda-Ly to render obvious [5.4].

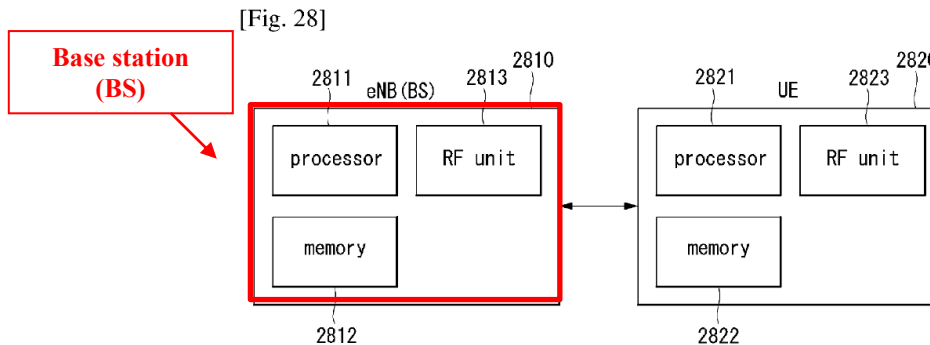
6. Claim 6

235. In my opinion, for the reasons discussed below, the combination of Lee, Freda, and Ly renders obvious claim 6.

(a) [6.pre] *A method for wireless communication in a base station, comprising:*

236. To the extent that the preamble is limiting, Lee discloses or renders obvious [1.pre].

237. Lee describes a “base station (BS) or “eNode B” (eNB) (*base station*) for communicating in a “wireless communications system” (... *for wireless communication*). APPLE-1005, Abstract, [0055]-[0056], [0385]-[0389], FIG. 28 (2810).



APPLE-1005, FIG. 28 (annotated)

238. Further, in view of Lee, Freda, and/or Ly, it would have been obvious to configure Lee’s base station or eNB to perform *a method for wireless communication* including each of the operations recited in claim 6, as I explain in further detail below.

239. Therefore, a POSITA would have understood the combination of Lee-Freda-Ly to render obvious [6.pre].

(b) [6.1] *receiving a first wireless signal; and*

240. Lee discloses or renders obvious [6.1].

241. Lee describes a “method for allocating a temporary radio network temporary identifier (T-RNTI) to a user equipment (UE) within a random access procedure in a wireless communication system,” in which a UE “transmit[s] ... a random access preamble to a base station (BS)” (*receiving a first wireless signal*). APPLE-1005, Abstract. *See also* [1.1].

242. Therefore, a POSITA would have understood the combination of Lee-Freda-Ly to render obvious [6.1].

(c) [6.2] receiving a second wireless signal;

243. Lee discloses or renders obvious [6.2].

244. Lee describes that, as a part of the “method for allocating a temporary radio network temporary identifier (T-RNTI) to a user equipment (UE) within a random access procedure in a wireless communication system,” the UE additionally “transmit[s] ... a radio resource control (RRC) request message to the BS through a contention-based physical uplink shared channel (PUSCH) resource block in which uplink data can be transmitted without uplink resource allocation scheduling” (*receiving a second wireless signal*). APPLE-1005, Abstract. *See also* [1.2].

245. Therefore, a POSITA would have understood the combination of Lee-Freda-Ly to render obvious [6.2].

(d) [6.3]-[6.9]

246. *See* [1.3]-[1.9], *supra*, based on which a POSITA would have understood the combination of Lee-Freda-Ly to render obvious [6.3]–[6.9].

7. Claims 7-10

247. *See* Claims 2-5, *supra*, based on which a POSITA would have understood the combination of Lee-Freda-Ly to render obvious claims 7–10

8. Claim 11

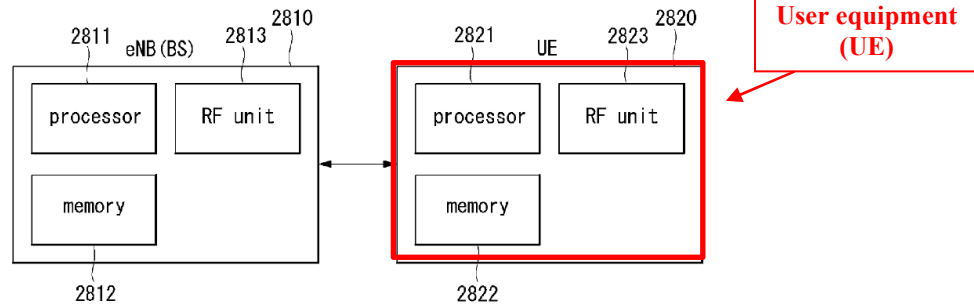
248. Claim 11 and dependent claims 12-15 are directed to a “user equipment” and recite limitations that are analogous to claims 1-5. To the extent [11.3], [11.4], [11.6], [11.9], [13.4] and claim 14 (which recite features of how signals are intended to be used) are deemed limiting, these features are rendered obvious for reasons similar to those discussed in regard to claims 1-5.

(a) [11.pre] A user equipment for wireless communication, comprising:

249. To the extent that the preamble is limiting, Lee discloses or renders obvious [11.pre].

250. Lee describes a “*user equipment (UE)*” for communicating in a “wireless communications system” (... *for wireless communication*). APPLE-1005, Abstract, [0385]-[0389], FIG. 28 (2820). *See also* [1.pre].

[Fig. 28]



APPLE-1005, FIG. 28 (annotated)

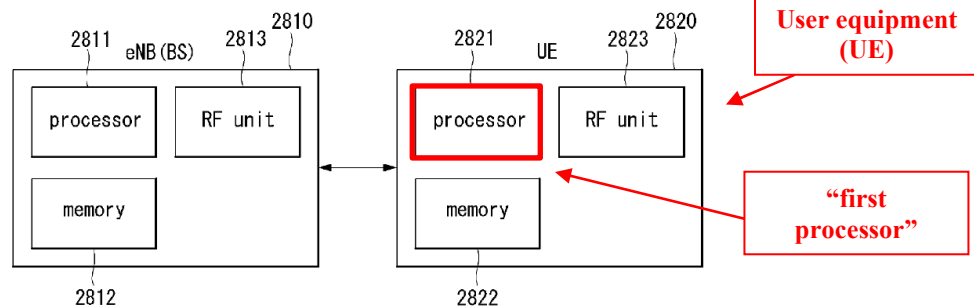
251. Therefore, a POSITA would have understood the combination of Lee-Freda-Ly to render obvious [11.pre].

(b) [11.1] a first processor transmitting a first wireless signal; and

252. Lee discloses or renders obvious [11.1].

253. Lee discloses that a “UE 2820 includes a processor 2821” (*a first processor*), which “may be configured to implement the functions, procedures and/or methods proposed by the present invention as described in FIG. 1-27.”
APPLE-1005, [0388], FIG. 28 (2821).

[Fig. 28]



APPLE-1005, FIG. 28 (annotated)

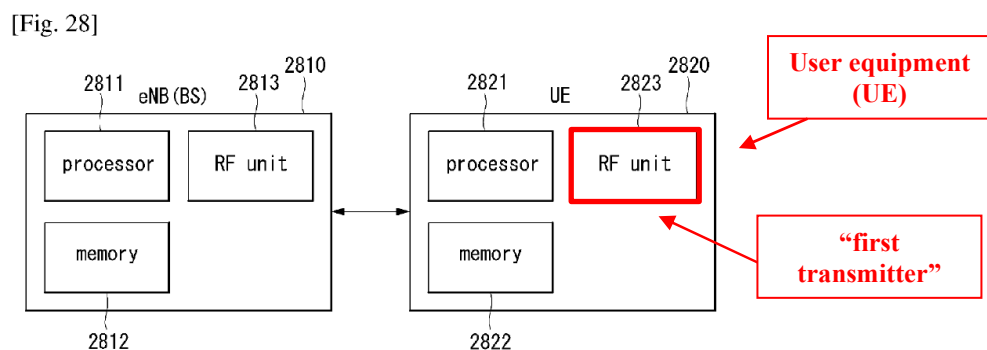
254. Among these “functions, procedures, and/or methods” includes a “method for allocating a temporary radio network temporary identifier (T-RNTI) to a user equipment (UE) within a random access procedure in a wireless communication system,” in which a UE “transmit[s] ... a random access preamble to a base station (BS)” (*transmitting a first wireless signal*). APPLE-1005, Abstract. *See also* [1.1].

255. Therefore, a POSITA would have understood the combination of Lee-Freda-Ly to render obvious [11.1].

(c) [11.2] *a first transmitter transmitting a second wireless signal;*

256. Lee discloses or renders obvious [11.2].

257. Lee discloses that a “UE 2820 includes ... an RF unit 2823” (*a first transmitter*), which “is connected to the processor 2811, transmits and/or receives an RF signal.” APPLE-1005, [0388], FIG. 28 (2823).



APPLE-1005, FIG. 28 (annotated)

258. Lee further discloses that the UE can transmit various RF signals, including “transmitting ... a radio resource control (RRC) request message to the BS through a contention-based physical uplink shared channel (PUSCH) resource block in which uplink data can be transmitted without uplink resource allocation scheduling” (*transmitting a second wireless signal*). APPLE-1005, Abstract. *See also* [1.2].

259. Therefore, a POSITA would have understood the combination of Lee-Freda-Ly to render obvious [11.2].

(d) [11.3]-[11.9]

260. *See* [1.3]-[1.9] , *supra*, based on which a POSITA would have understood the combination of Lee-Freda-Ly to render obvious [11.3]–[11.9].

9. Claims 12-15

261. *See* Claims 2–5, *supra*, based on which a POSITA would have understood the combination of Lee-Freda-Ly to render obvious claims 12–15.

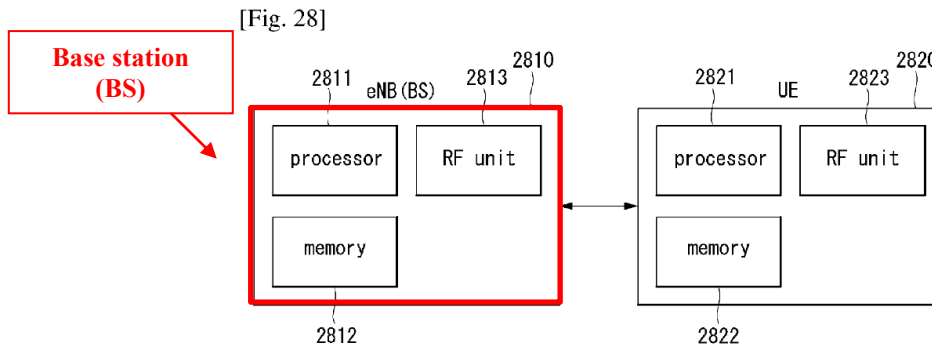
10. Claim 16

262. Claim 16 and dependent claims 17-20 are directed to a “base station” and recite limitations that are analogous to method claims 6-10. To the extent [16.3], [16.4], [16.6], [16.9], [18.4] and claim 19 (which recite features of how signals are intended to be used) are deemed limiting, these features are rendered obvious for reasons similar to those discussed in regard to claims 6-10.

(a) *[16.pre] A base station for wireless communication, comprising:*

263. To the extent that the preamble is limiting, Lee discloses or renders obvious [16.pre].

264. Lee describes a “base station (BS) or “eNode B” (eNB) (*base station*) for communicating in a “wireless communications system” (*... for wireless communication*). APPLE-1005, Abstract, [0055]-[0056], [0385]-[0389], FIG. 28 (2810).



APPLE-1005, FIG. 28 (annotated)

265. Therefore, a POSITA would have understood the combination of Lee-Freda-Ly to render obvious [16.pre].

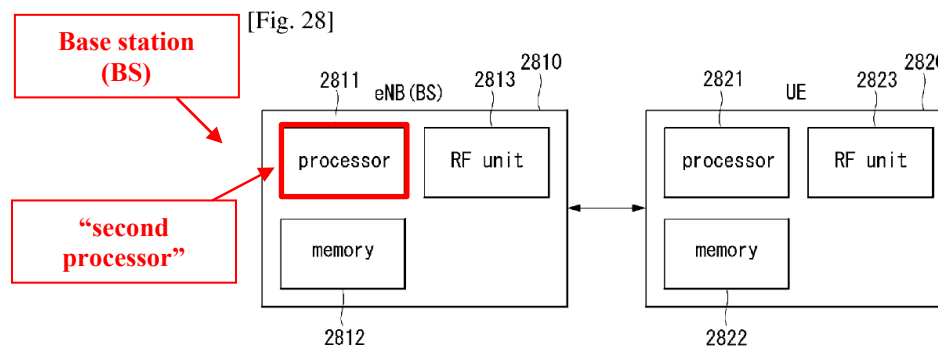
(b) *[16.1] a second processor transmitting a first wireless signal; and*

266. Lee renders obvious [16.1], either alone in combination with Ly.

267. The word “transmitting” in [16.1] appears to be a typographical error, as the corresponding method claim ([6.1]) refers to the base station “receiving” the

first wireless signal. As explained for [6.1], Lee discloses the base station “receiving” the first wireless signal. In addition, as discussed here, Lee-Freda-Ly renders obvious claim [16.1] even with the “transmitting” language.

268. Lee discloses that an “eNB 2810 includes a processor 2811” (*a second processor*), which “may be configured to implement the functions, procedures and/or methods proposed by the present invention as described in FIG. 1-27.” APPLE-1005, [0387], FIG. 28 (2811).



APPLE-1005, FIG. 28 (annotated)

269. Further, Lee discloses a “method for allocating a temporary radio network temporary identifier (T-RNTI) to a user equipment (UE) within a random access procedure in a wireless communication system,” in which a UE “transmit[s] ... a random access preamble to a base station (BS)” (*transmitting a first wireless signal*). APPLE-1005, Abstract. *See also* [1.1].

270. To the extent that Lee does not expressly disclose that a base station or eNB transmits a random access preamble, a POSITA nevertheless would have found

it obvious to configure Lee's base station to transmit a random access preamble in view of Ly's teaching that base stations "may ... communicate with one another, directly or indirectly, over wired and/or wireless connections." APPLE-1007, [0032]; APPLE-1010, [0028]. In view of Ly, a POSITA would have found it obvious that, in the same way that Lee's UE communicates wirelessly with a base station, Lee's base station can also communicate wirelessly with another base station. Accordingly, a POSITA would have found to obvious to configure the Lee's base station transmit a random access preamble to another base station (*transmit a first wireless signal*) when two base stations are communicating wirelessly with another.

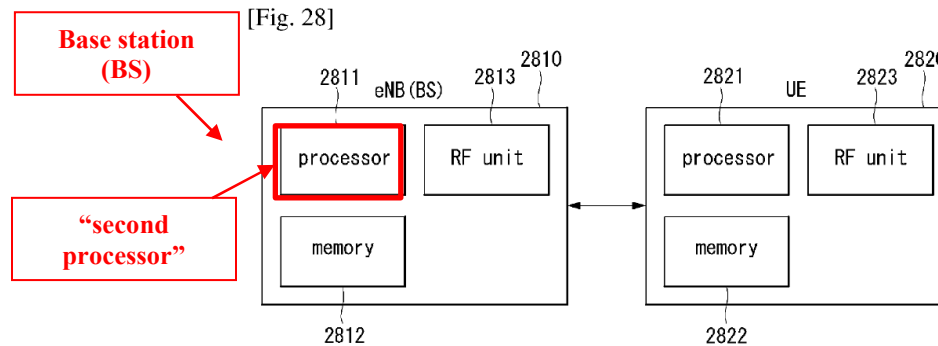
271. Therefore, a POSITA would have understood the combination of Lee-Freda-Ly to render obvious [16.1].

(c) [16.2] a first receiver transmitting a second wireless signal;

272. Lee renders obvious [16.1], either alone in combination with Ly.

273. I note that the word "transmitting" in [16.2] appears to be a typographical error, as the corresponding method claim (claim 6) refers to the base station "receiving" the second wireless signal. As explained for claim 6, Lee discloses the base station receiving the second wireless signal. In addition, as I explain here, Ly renders obvious claim [16.2] even with the "transmitting" language.

274. Lee discloses that an “eNB 2810 includes a processor 2811” (*a second processor*), which “may be configured to implement the functions, procedures and/or methods proposed by the present invention as described in FIG. 1-27.” APPLE-1005, [0387], FIG. 28 (2811).



APPLE-1005, FIG. 28 (annotated)

275. Further, Lee discloses a “method for allocating a temporary radio network temporary identifier (T-RNTI) to a user equipment (UE) within a random access procedure in a wireless communication system,” in which a UE “transmit[s] ... a random access preamble to a base station (BS)” (*transmitting a first wireless signal*). APPLE-1005, Abstract. *See also* [1.1].

276. Even if Lee were to not expressly disclose that a base station or eNB transmits a random access preamble, a POSITA nevertheless would have found it obvious to configure Lee’s base station to transmit a random access preamble in view of Ly’s teaching that base stations “may ... communicate with one another, directly or indirectly, over wired and/or wireless connections.” APPLE-1007,

[0032]; APPLE-1010, [0028]. In view of Ly, a POSITA would have found it obvious that, in the same way that Lee's UE communicates wirelessly with a base station, Lee's base station can also communicate wirelessly with another base station. Accordingly, a POSITA would have found to obvious to configure the Lee's base station transmit a random access preamble to another base station (*transmit a first wireless signal*) when two base stations are communicating wirelessly with another.

277. Therefore, a POSITA would have understood the combination of Lee-Freda-Ly to render obvious [16.2].

(d) [16.3]-[16.9]

278. See [1.3]-[1.9] , *supra*, based on which a POSITA would have understood the combination of Lee-Freda-Ly to render obvious [16.3]-[16.9].

11. Claims 17-20

279. See Claims 2-5, *supra*, based on which a POSITA would have understood the combination of Lee-Freda-Ly to render obvious claims 17-20.

IX. Conclusion

280. For the reasons I explain above, all of the Challenged Claims of the '721 patent are rendered obvious by the prior art at issue.

X. Additional Remarks

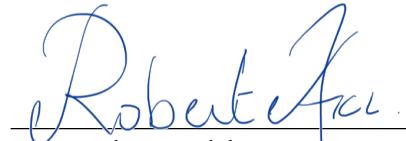
281. In signing this declaration, I recognize that the declaration will be filed as evidence in a contested case before the Patent Trial and Appeal Board of the

United States Patent and Trademark Office. I also recognize that I may be subject to cross examination in the case and that cross examination will take place within the United States. If cross examination is required of me, I will appear for cross examination within the United States during the time as mutually agreed between the parties.

282. I currently hold the opinions expressed in this declaration. But my analysis may continue, and I may acquire additional information and/or attain supplemental insights that may result in added observations. Therefore, I reserve the right to revise, supplement, and/or amend my opinions stated herein based on new information that becomes available to me and on my continuing analysis of the materials already provided.

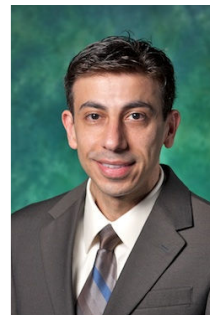
I hereby declare that all statements made are of my own knowledge are true and that all statements made on information and belief are believed to be true. I further declare that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or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

Executed on April 28, 2025 in Dallas, Texas.


Dr. Robert Akl, D.Sc.

APPENDIX A

Professor Robert Akl, D.Sc.



Professional Summary

Dr. Akl has over three decades of industry and academic experience. He is currently a Tenured Professor at the University of North Texas and a Senior Member of *IEEE*. He has designed, implemented, and optimized both hardware and software aspects of several wireless communication systems for CDMA, Wi-Fi, and sensor networks. Dr. Akl has broad expertise in wireless communication, Bluetooth, CDMA/WCDMA network optimization, GSM, LTE, VoIP, telephony, computer architecture, and computer networks. He is a very active researcher and is well published and cited. He has been awarded many research grants by leading companies in the industry and the National Science Foundation. He has developed and taught over 100 courses in his field. Dr. Akl has received several awards and commendations for his work, including the 2008 *IEEE* Professionalism Award and was the winner of the 2010 Tech Titan of the Future Award.

Dr. Akl has extensive experience with patents in the wireless and networking industry. In the past ten years, he has worked as a technical expert in dozens of patent related matters, involving thousands of hours of research, investigation, and study. He has repeatedly been qualified as an expert by Courts, and has provided numerous technology tutorials to Courts, and given testimony by deposition and at trial. He has worked with companies large and small, both for and against the validity and infringement of patents, and has also helped counsel and Courts to understand technology that often seems complex. In doing so, he has become familiar with, and actively worked with, the legal principles that underlie patentability and validity and claim interpretation in the wireless and networking industries.

Areas of Expertise

2G, 3G, 4G, 5G, 6G, CDMA/WCDMA, GPS, GSM, UMTS, LTE, Ad-hoc Networks, Antenna Design, Bluetooth, Call Admission Control, Channel Coding, Channel Estimation, Communication Interfaces and Standards, Compression, Computer Architecture, Internet protocols, MIMO Systems, Multi-cell Network Optimization, Network Security, Packet-networks, Ring-networks, Switches and Routers, Telephony, VoIP, VPLS, Wi-Fi, Wireless Communication, Wireless Sensors.

Education

<u>Year</u>	<u>College/University</u>	<u>Degree</u>	<u>GPA</u>
2000	Washington University in Saint Louis	D.Sc. in Electrical Engineering	4.0 / 4.0
1996	Washington University in Saint Louis	M.Sc. in Electrical Engineering	4.0 / 4.0
1994	Washington University in Saint Louis	B.Sc. in Electrical Engineering	4.0 / 4.0
1994	Washington University in Saint Louis	B.Sc. in Computer Science	4.0 / 4.0

Graduated *summa cum laude* and ranked first in undergraduate class.

Dissertation: “Cell Design to Maximize Capacity in Cellular Code Division Multiple Access (CDMA) Networks.” Advisors: Dr. Manju Hegde and Dr. Paul Min.

Litigation Support and Expert Witness Experience

- L1. 2025 **Fish & Richardson, P.C.**
Case: Apple Inc. v. Apex Beam Technologies LLC
IPR2025-00896; IPR2025-00909; IPR2025-00910; IPR2025-00911;
IPR2025-*To be Assigned*
Matter: *Inter Partes* Review, multi-antenna transmission
Project: Eight declarations to support eight IPR Petitions
- L2. 2025 **Milbank LLP**
Case: Samsung Electronics Co, LTD., Samsung Electronics America, Inc v.
Empire Technology Development LLC
IPR2024-00896
Matter: *Inter Partes* Review, MIMO wireless communication, energy
consumption
Project: Declaration to support Patent Owner’s response
- L3. 2025 **Bayes PLLC**
Case: OnePlus Technology (Shenzhen) Co. Ltd. v. Pantech Corporation
IPR2025-00637; IPR2025-00783
Matter: *Inter Partes* Review, radio link failure
Project: Two declarations to support two IPR Petitions
- L4. 2025 **Folio Law Group PLLP**
Case: K.Mizra LLC v. Ciena Corporation
Northern district of Georgia, Atlanta division, Case No. 1:24-cv-
05442-SDG
Matter: Patent infringement, telecommunication systems, switches and routers
Project: Declaration in support of plaintiff’s amended complaint
- L5. 2025 **Carter Arnett**
Case: Katana Silicon Technologies, LLC v. GlobalFoundries, Inc, et al.
Western district of Texas, Austin division, Case No. 1:22-cv-00852-
RP
Matter: Patent infringement, telecommunication systems
Project: Declaration
- L6. 2025 **Bunsow De Mory LLP**
Case: Secure Wi-Fi, LLC v. Samsung Electronics Co, LTD., Samsung
Electronics America, Inc.
Eastern district of Texas, Marshall division, Case No. 2:24-cv-00047-
JRG-RSP
Matter: Patent infringement, Wi-Fi access and security

- Project: Declaration regarding claim construction
- L7. 2024 **Steptoe LLP**
Case: Corrigent Corporation and Nahum Communication NTB LTD v. Dell Technologies Inc. and Dell Inc.; Corrigent Corporation and Nahum Communication NTB LTD v. Arista Networks Inc.
District of Delaware, Case No. 1:22-cv-496-RGA; Case No. 1:22-cv-497-RGA
Matter: Patent infringement, telecommunication systems, switches and routers
Project: Source code review, two expert reports regarding infringement, two rebuttal expert reports regarding validity, two reply expert reports, two supplemental rebuttal expert reports, two depositions
- L8. 2024 **Kilpatrick Townsend & Stockton LLP**
Case: Intellectual Ventures I LLC and Intellectual Ventures II LLC v. Lenovo Group Limited; Intellectual Ventures I LLC and Intellectual Ventures II LLC v. Zebra Technologies Corporation
Western district of Texas, Waco division, Case No. 6:23-cv-000307-ADA; Case No. 6:23-cv-00292-ADA
Matter: Patent infringement, cyclic diversity methods
Project: Source code review, expert report regarding invalidity
- L9. 2024 **Perkins Coie LLP**
Case: ParkerVision, Inc. v. MediaTek Inc and MediaTek USA Inc.
Western district of Texas, Waco division, Case No. 6:22-cv-01163-ADA
Matter: Patent infringement, frequency translation
Project: Non-infringement consulting
- L10. 2024 **Steptoe LLP**
Case: Stingray IP Solutions v. Leedarson IOT Technology, Inc. et al.
Eastern district of Texas, Marshall division, Case No. 2:23-cv-00499-JRG-RSP
Matter: Patent infringement, mobile ad-hoc networks
Project: Declaration regarding claim construction
- L11. 2024 **Milbank LLP**
Case: Empire Technology Development LLC v. Samsung Electronics Co, LTD., Samsung Electronics America, Inc.
Eastern district of Texas, Marshall division, Case No. 2:23-cv-00427-JRG-RSP
Matter: Patent infringement, MIMO wireless communication, energy consumption
Project: Source code review, declaration regarding claim construction, expert report regarding infringement, expert report regarding validity, deposition

- L12. 2024 **Folio Law Group PLLP**
Case: Valve Corporation v. Immersion Corporation
IPR2024-00477; IPR2024-00478; IPR2024-00557; IPR2024-00582;
IPR2024-00714
Matter: *Inter Partes* Review, virtual reality and augmented reality
Project: Five declarations to support five Patent Owner's responses, deposition
- L13. 2024 **Hicks Johnson PLLC**
Case: Cardtek International, Inc. v. The Kroger Co.
Eastern district of Texas, Marshall division, Case No. 2:23-cv-0045-
JRG-RSP
Matter: Patent infringement, payment convergence system
Project: Expert report regarding infringement, rebuttal expert report regarding
validity, deposition
- L14. 2024 **Kilpatrick Townsend & Stockton LLP**
Case: PLR Worldwide Sales Limited v. Flip Phone Games Inc.
IPR2024-00132; IPR2024-00171; IPR2024-00200; IPR2024-00209;
IPR2024-00133
Matter: *Inter Partes* Review, mobile gaming
Project: Four declarations to support four Patent Owner's responses,
deposition
- L15. 2024 **K & L Gates LLP**
Case: STA Group, LLC v. Motorola Solutions, Inc.
Eastern district of Texas, Marshall division, Case No. 2:23-cv-00300-
JRG-RSP
Matter: Patent infringement, emergency communication networks
Project: Expert report regarding licenses, rebuttal expert report regarding
validity, deposition
- L16. 2024 **K & L Gates LLP**
Case: Motorola Solutions, Inc. v. STA Group, LLC
IPR2023-01292; IPR2023-01295 ; IPR2024-00511; IPR2024-00207
Matter: *Inter Partes* Review, emergency communication networks
Project: Four declarations to support four Patent Owner's responses
- L17. 2024 **K & L Gates LLP**
Case: STA Group, LLC v. Motorola Solutions, Inc.
Eastern district of Texas, Marshall division, Case No. 2:22-cv-00381-
JRG-RSP
Matter: Patent infringement, emergency communication networks
Project: Declaration regarding claim construction, deposition, expert report
regarding infringement, rebuttal expert report regarding validity

- L18. 2024 **White & Case, LLP**
Case: Wangs Alliance Corporation d/b/a WAC Lighting. v. Minka Lighting, LLC
In the Matter of Certain Smart Ceiling Fans, Components Thereof, and Associated Systems and Software Thereof, ITC Investigation No. 337-TA-1374
Matter: Patent infringement, smart ceiling fans
Project: Expert report regarding invalidity, expert rebuttal report, two-day depositions
- L19. 2024 **Folio Law Group PLLP**
Case: Immersion Corporation v. Valve Corporation.
Western district of Washington, Seattle, Case No. 2:23-CV-00712-TL
Matter: Patent infringement, virtual reality and augmented reality
Project: Declaration regarding claim construction
- L20. 2024 **Latham & Watkins LLP**
Case: AX Wireless LLC v. Dell Inc., et al.; AX Wireless LLC, v. HP Inc.
Eastern district of Texas, Marshall division, Case No. 2:22-cv-277-RWS-RSP; Case No. 2:22-cv-279-JRG-RSP
Matter: Patent infringement, Wi-Fi networks
Project: Source code review, expert report regarding infringement, rebuttal expert report regarding validity, deposition
- L21. 2024 **Perkins Coie LLP**
Case: Wi-LAN Inc. et al. v. Huizhou TCL Mobile Communication Co. Ltd., et al.
Central district of California, Southern division, Case No. 8:19-cv-00870-JVS-ADS
Matter: Patent infringement, QoS enhancements for wireless IP networks
Project: Declaration regarding claim construction
- L22. 2024 **Kilpatrick Townsend & Stockton LLP**
Case: Flip Phone Games Inc. v. PLR Worldwide Sales Limited
Eastern district of Texas, Marshall division, Case No. 2:23-cv-00139-JRG
Matter: Patent infringement, mobile gaming
Project: Declaration regarding claim construction, deposition
- L23. 2024 **K & L Gates LLP**
Case: STA Group, LLC v. Motorola Solutions, Inc.
Eastern district of Texas, Marshall division, Case No. 2:22-cv-00381-JRG-RSP
Matter: Patent infringement, emergency communication networks
Project: Declaration regarding claim construction, deposition, expert report regarding infringement, rebuttal expert report regarding validity

- L24. 2024 **Alston & Bird LLP**
Case: Stingray IP Solutions v. Snap One Holdings Corp., et al.
Eastern district of Texas, Marshall division, Case No. 2:23-cv-00003-JRG-RSP
Matter: Patent infringement, mobile ad-hoc networks
Project: Declaration regarding claim construction, deposition
- L25. 2024 **Kilpatrick Townsend & Stockton LLP**
Case: Askeladden LLC v. Calabrese Stemer LLC
IPR2024-00367; IPR2024-00368; IPR2024-00369
Matter: *Inter Partes* Review, secure transactions and payments
Project: Declaration to support three IPR petitions
- L26. 2023 **McGuireWoods LLP**
Case: VoIP-Pal.com, Inc. v. Huawei Technologies Co., Ltd., et al.
Northern district of Texas, Dallas division, Case No. 3:23-cv-0151-X
Matter: Patent infringement, call routing
Project: Declaration regarding 101 Motion
- L27. 2023 **Steptoe LLP**
Case: Corrigent Corporation v. Cisco Systems, Inc.
Western district of Texas, Waco division, Case No. 6:22-cv-00396-ADA
Matter: Patent infringement, telecommunication systems, switches and routers
Project: Source code review, expert report regarding infringement, expert report regarding validity, two-day depositions, supplemental expert report, jury trial testimony
- L28. 2023 **Latham & Watkins LLP**
Case: Netgear Inc. v. TP-Link Technologies Co., Ltd., TP-Link Corporation Limited, TP-Link USA Corporation, and TP-Link Research America Corp.
In the Matter of Certain Wi-Fi Routers, Wi-Fi Devices, Mesh Wi-Fi Network Devices, and Hardware and Software Components Thereof, ITC Investigation No. 337-TA-1361
Matter: Patent infringement, Wi-Fi and mesh networks
Project: Source code review, expert report regarding infringement and domestic industry, expert report regarding validity, supplemental expert report, deposition, ITC hearing testimony
- L29. 2023 **Winston & Strawn LLP**
Case: Google, LLC. v. Flypsi, Inc.
IPR2023-00357; IPR2023-00358; IPR2023-00359;
IPR2023-00360; IPR2023-00361
Matter: *Inter Partes* Review, primary and secondary call processing

- Project: Five declarations to support five Patent Owner's responses, deposition
- L30. 2023 **Carter Arnett**
Case: Correct Transmission, LLC v. Nokia Corporation, et al.
Eastern district of Texas, Marshall division, Case No. 2:22-cv-00343-JRG-RSP
Matter: Patent infringement, telecommunication systems, switches and routers
Project: Declaration regarding claim construction
- L31. 2023 **Carter Arnett**
Case: Smart Path Connections, LLC v. Nokia Corporation, et al.
Eastern district of Texas, Marshall division, Case No. 2:22-cv-00296-JRG
Matter: Patent infringement, network communication systems, switches and routers
Project: Two declarations regarding claim construction
- L32. 2023 **Devlin Law Firm**
Case: Google, LLC. v. Motion Offense, LLC
IPR2022-01311; IPR2022-01312; IPR2022-01313
Matter: *Inter Partes* Review, cloud storage and file requests
Project: Three declarations to support three Patent Owner's responses, deposition
- L33. 2023 **Carter Arnett**
Case: Cisco Systems, Inc. v. Zilkr Cloud Technologies, LLC
IPR2023-00553; IPR2023-00663; IPR2023-00822
Matter: *Inter Partes* Review, integration of communication services
Project: Two declarations to support two Patent Owner's preliminary responses
- L34. 2023 **Friedman, Suder & Cooke; Kane Russell Coleman Logan PC**
Case: Q Technologies, Inc. v. Walmart Inc.
Western district of Texas, Waco division, Case No. 4W-21-CV-00321-ADA
Matter: Patent infringement, content sharing and payment systems
Project: Validity expert report, deposition
- L35. 2023 **K & L Gates LLP**
Case: Entropic Communications, LLC v. DirectTV, LLC, Dish Network Corporation et al.
Central district of California, Southern division, Case No. 2:22-cv-07775-JWH-JEM, 2:22-cv-07959
Matter: Patent infringement, satellite and cable receivers and systems
Project: Declaration regarding claim construction, deposition, tech tutorial testimony

- L36. 2023 **Folio Law Group PLLP**
Case: Immersion Corporation v. Meta Platforms, Inc., f/k/a Facebook, Inc.
Western district of Texas, Waco division, Case No. 6:22-cv-00541-
ADA
Matter: Patent infringement, virtual reality and augmented reality
Project: Source code review, expert report regarding infringement,
supplemental expert report regarding infringement, rebuttal expert
report regarding validity, two depositions
- L37. 2023 **Cole Schotz P.C.**
Case: SB IP Holdings, Inc. v. Vivint Smart Home, Inc., Vivint, Inc.
Eastern district of Texas, Sherman division, Case No. 4:20-cv-00886-
ALM
Matter: Patent infringement, wireless telecommunication systems
Project: Source code review, expert report regarding infringement, expert
report regarding validity, two-day depositions, rebuttal expert report
regarding non-infringing alternatives, 2 additional depositions, jury
trial testimony
- L38. 2023 **Cole Schotz P.C.**
Case: Vivint Inc. v. SB IP Holdings LLC
IPR2022-00812; IPR2022-01449
Matter: *Inter Partes* Review, wireless telecommunication systems
Project: Two declarations to support Patent Owner's responses, deposition
- L39. 2023 **Carter Arnett**
Case: Samsung Electronics Co., LTD v. G+ Communications, LLC
IPR2022-01598; IPR2023-00171; IPR2023-00665
Matter: *Inter Partes* Review, 4G/5G cellular systems
Project: Three declarations to support three Patent Owner's preliminary
responses, two declarations to support Patent Owner's responses, two
depositions
- L40. 2023 **Fish & Richardson, P.C.**
Case: Neo Wireless, LLC v. General Motors Co. et al.;
Neo Wireless, LLC v. Tesla Inc.
Eastern district of Michigan, Southern division, Case No. 2:22-cv-
11407-TGB; Case No. 2:22-cv-11408-TGB
Matter: Patent infringement, 4G/LTE wireless communication
Project: Tech tutorial testimony, declaration regarding claim construction

- L41. 2023 **Carter Arnett**
Case: G+ Communications v. Samsung Electronics Co., LTD et al.
Eastern district of Texas, Marshall division, Case No. 2:22-cv-00078-JRG
Matter: Patent infringement, 4G/5G cellular systems
Project: Source code review, declaration regarding claim construction, supplemental declaration regarding claim construction, infringement expert report, rebuttal expert report regarding validity, deposition, two supplemental reports, second deposition, jury trial testimony, jury retrial testimony (for damages)
- L42. 2022 **Kilpatrick Townsend & Stockton LLP**
Case: TP-Link Technologies Co., Ltd. and TP-Link Corporation Limited v. Stingray IP Solutions
IPR2022- *To be Assigned*; IPR2022-*To be Assigned*
Matter: *Inter Partes* Review, security and intrusion detection in wireless systems
Project: Two declarations to support two IPR petitions
- L43. 2022 **Devlin Law Firm**
Case: CDN Innovations, LLC v. Mediacom Communication Corporation
Middle district of Georgia, Columbus division
Matter: Patent infringement, telecommunication systems
Project: Declaration to support infringement contentions
- L44. 2022 **Jenner & Block LLP**
Case: WSOU Investments, LLC v. Netgear, Inc.
District of Delaware, Case No. 21-cv-01117-MN-CJB, 21-cv-01119-MN-CJB, 21-cv-01120-MN-CJB
Matter: Patent infringement, adaptive antennas, routers
Project: Declaration regarding claim construction
- L45. 2022 **Simpson Thacher & Bartlett LLP**
Case: XR Communications, LLC. v. Ubiquiti Networks, Inc.
Central district of California, Case No. 2:21-cv-1065-DOC(JDE)
Matter: Patent infringement, Wi-Fi and adaptive antennas
Project: Non-infringement expert report, deposition
- L46. 2022 **Ropes & Gray LLP**
Case: Speir Technologies Ltd. v. Apple Inc.
Western district of Texas, Waco division, Case No. 6:22-cv-00077-ADA
Matter: Patent infringement, channel estimation
Project: Declaration regarding claim construction

- L47. 2022 **Fish & Richardson, P.C.**
Case: Constellation Designs, LLC v. LG Electronics, Inc. et al.
Eastern district of Texas, Marshall division, Case No. 2:21-cv-448
Matter: Patent infringement, channel coding
Project: Source code review, invalidity expert report, non-infringement expert report, two-day depositions, jury trial testimony
- L48. 2022 **Calfee, Halter & Griswold LLP**
Case: Resi Media LLC v. BoxCast Inc.
IPR2022-00066; IPR2022-00067
Matter: *Inter Partes* Review, autonomous broadcasting
Project: Combined declaration to support Patent Owner's response, declaration to support Patent Owner's sur-reply, deposition
- L49. 2022 **Fish & Richardson, P.C.**
Case: FedEx Corporation v. Transcend Shipping Systems, LLC
IPR2022-01117; IPR2022-01219; IPR2022-01252;
IPR2022-01261; IPR2022-01314
Matter: *Inter Partes* Review, location management
Project: Five declarations to support five IPR petitions
- L50. 2022 **Finnegan Henderson Farabow Garrett & Dunner LLP**
Case: Toyota Motor Corp and Continental Automotive Systems. v. Intellectual Ventures II, LLC
IPR2022-00971; IPR2022-00972; IPR2022-00973; IPR2022-00974;
IPR2022-01130
Matter: *Inter Partes* Review, multicarrier communication
Project: Five declarations to support five IPR petitions, four depositions, three supplemental declarations, two depositions
- L51. 2022 **Fenwick & West LLP**
Case: TrackThings LLC v. Amazon.com, Inc. et al.
Western district of Texas, Waco division, Case No. 6:21-cv-00720
Matter: Patent infringement, mobile ad-hoc networks
Project: Invalidity consulting
- L52. 2022 **Fenwick & West LLP**
Case: Stingray IP Solutions v. Amazon.com, Inc. et al.
Eastern district of Texas, Marshall division, Case No. 2:21-cv-00193-JRG; Case No. 2:21-cv-00194-JRG
Matter: Patent infringement, mobile ad-hoc networks
Project: Noninfringement consulting

- L53. 2022 **Fitch, Even, Tabin & Flannery**
Case: L2 Mobile Technologies LLC v. Ford Motor Company
District of Delaware, Case No. 1:21-cv-01409-JLH
Matter: Patent infringement, wireless communication systems
Project: Standard essentiality consulting
- L54. 2022 **Susman Godfrey LLP**
Case: California Institute of Technology v. Samsung Electronics Co., Ltd. et al.
Eastern district of Texas, Marshall division, Case No. 2:21-cv-00446-JRG
Matter: Patent infringement, low-density parity-check codes
Project: Source code review, infringement expert report, deposition, supplemental infringement expert report
- L55. 2022 **Devlin Law Firm**
Case: Dropbox, Inc. v. Motion Offense, LLC; Motion Offense, LLC v. Dropbox, Inc.
Western district of Texas, Waco division, Case No. 6:20-cv-00251-ADA; 6:21-cv-00758-ADA
Matter: Patent infringement, telecommunication systems and networking
Project: Source code review, infringement expert report, supplemental infringement expert report, validity expert report, supplemental validity expert report, deposition, jury trial testimony
- L56. 2022 **Bayes PLLC**
Case: Guangdong OPPO Mobile Telecommunications Corp., Ltd. v. Nokia Solutions and Networks Oy
IPR2022-00632
Matter: *Inter Partes* Review, PDU and SDU
Project: Declaration to support IPR petition, deposition, supplemental declaration, second deposition
- L57. 2022 **Finnegan Henderson Farabow Garrett & Dunner LLP**
Case: NetApp, Inc. v. Proven Networks, LLC
IPR2022-00644
Matter: *Inter Partes* Review, allocating resources
Project: Declaration to support IPR petition
- L58. 2022 **Devlin Law Firm**
Case: Motion Offense, LLC v. Google, LLC
Western district of Texas, Waco division, Case No. 6:21-cv-00514-ADA
Matter: Patent infringement, telecommunication systems and networking
Project: Declaration regarding claim construction

- L59. 2022 **Jenner & Block LLP**
Case: Netgear, Inc. v. WSOU Investments, LLC
IPR2022-00516; IPR2022-00606
Matter: *Inter Partes* Review, telecommunication systems
Project: Two declarations to support two IPR petitions
- L60. 2022 **Calfee, Halter & Griswold LLP**
Case: BoxCast Inc. v. Resi Media LLC
Eastern district of Texas, Marshall division, Case No. 2:21-cv-00217-JRG
Matter: Patent infringement, autonomous broadcasting
Project: Source code review, declaration regarding claim construction, declaration regarding validity, declaration regarding infringement, deposition
- L61. 2022 **Fish & Richardson, P.C.**
Case: Apple Inc. v. Ericsson Inc.
IPR2022-00341; IPR2022-00346;
IPR2022-*To be assigned*; IPR2022-*To be assigned*;
IPR2022-*To be assigned*
Matter: *Inter Partes* Review, wireless communication systems
Project: Five declarations to support five IPR petitions, deposition
- L62. 2022 **Ropes & Gray LLP**
Case: Godo Kaisha IP Bridge 1 v. Nokia Corporation, Ericsson Inc. et al.
Eastern district of Texas, Marshall division, Case No. 2:21-CV-213-JRG; Case No. 2:21-CV-215-JRG
Matter: Patent infringement, wireless communication systems
Project: Declaration regarding claim construction
- L63. 2022 **Fish & Richardson, P.C.**
Case: Apple Inc. and HP Inc. v. XR Communication Inc
IPR2022-00367; IPR2022-01155; IPR2022-01362
Matter: *Inter Partes* Review, adaptive antennas
Project: Two declarations to support two IPR petitions, deposition, declaration to support petitioners' reply
- L64. 2021 **Mayer Brown LLP**
Case: Pantech Corp. v. Coolpad Group Ltd.
Eastern district of Texas, Texarkana division, Case No. 5:21-cv00065
Matter: Patent infringement, LTE wireless communication systems
Project: Infringement consulting

- L65. 2021 **Fitch, Even, Tabin & Flannery**
Case: L2 Mobile Technologies LLC v. Google LLC
Western district of Texas, Waco division, Case No. 6:21-cv-00358-
ADA
Matter: Patent infringement, wireless communication systems
Project: Claim construction consulting
- L66. 2021 **Morgan Lewis & Bockius LLP**
Case: Intellectual Tech LLC v. Zebra Technologies Corporation
Western district of Texas, Waco division, Case No. 6:19-cv-00628-
ADA
Matter: Patent infringement, RFID tags
Project: Source code review, claim construction consulting, invalidity expert
report
- L67. 2021 **Carter Arnett**
Case: Correct Transmission LLC v. Adtran, Inc.
Northern district of Alabama, Northeastern division, Case No. 5:21-
cv-00690-LCB
Matter: Patent infringement, telecommunication systems, switches and routers
Project: Declaration regarding claim construction
- L68. 2021 **Carter Arnett**
Case: Juniper Networks, Inc. v. Correct Transmission, LLC
IPR2021-00463; IPR2021-00682; IPR2022-00815
Matter: *Inter Partes* Review, network communication systems, switches and
routers
Project: Two declarations to support 2 Patent Owner's responses, two
depositions; declaration to support Patent Owner's preliminary
response
- L69. 2021 **King & Wood Mallesons LLP**
Case: ToT Power Control, S.L. v. AT&T Mobility et al.; ToT Power
Control, S.L. v. T-Mobile USA, Inc. et al.
Western district of Texas, Waco division, Case No. 6:21-CV-00107-
ADA; 6:21-CV-00109-ADA
Matter: Patent infringement, WCDMA cellular systems
Project: Declaration regarding claim construction
- L70. 2021 **Finnegan Henderson Farabow Garrett & Dunner LLP**
Case: Xiaomi Communications Co., Ltd. v. Koninklijke KPN N.V.
IPR2022-00025
Matter: *Inter Partes* Review, network communication systems
Project: Declaration to support IPR petition

- L71. 2021 **Carter Arnett**
Case: Juniper Networks, Inc. v. Smart Path Connections, LLC
IPR2021-001170; IPR2021-01356; IPR2022-00240; IPR2022-00815
Matter: *Inter Partes* Review, network communication systems, switches and routers
Project: Declaration to support Patent Owner's preliminary response, three declarations to support three Patent Owner's responses, two depositions
- L72. 2021 **Devlin Law Firm**
Case: Dyfan LLC v. Target Corporation
District of Delaware, Case No. 6:19-cv-00179-ADA
Matter: Patent infringement, network communications
Project: Declaration to support summary judgement, deposition
- L73. 2021 **Alston & Bird LLP**
Case: Stingray IP Solutions v. Signify N.V., et al.
Eastern district of Texas, Marshall division, Case No. 2:21-cv-00043-JRG; Case No. 2:21-cv-00044-JRG
Matter: Patent infringement, mobile ad-hoc networks
Project: Declaration regarding claim construction
- L74. 2021 **Cole Schotz P.C.**
Case: SkyBell Technologies, Inc. v. Vivint Smart Home, Inc., SimpliSafe, Inc., and Arlo Technologies Inc
In the Matter of Certain IP Camera Systems Including Video Doorbells and Components Thereof, ITC Investigation No. 337-TA-1242
Matter: Patent infringement, wireless telecommunication systems
Project: Source code review, expert report infringement and domestic industry, rebuttal expert report, three-day depositions
- L75. 2021 **Axinn, Veltrop & Harkrider LLP**
Case: Koninklijke Philips N.V. v. Thales DIS AIS USA, LLC et al.
In the Matter of Certain UMTS and LTE Cellular Communication Modules and Products Containing the Same, ITC Investigation No. 337-TA-1240
Matter: Patent infringement, wireless communication systems
Project: Expert report regarding non-infringement and no domestic industry, deposition, ITC hearing testimony
- L76. 2021 **Morgan Lewis & Bockius LLP**
Case: SIPCO, LLC v. Aruba Networks, LLC and Hewlett Packard Enterprise Company
District of Delaware, Case No. 1:20-cv-00537-MN
Matter: Patent infringement, wireless communication systems

- Project: Declaration regarding claim construction
- L77. 2021 **Ropes & Gray LLP**
Case: Palo Alto Networks Inc. v. Centripetal Networks, Inc.
IPR2021-01150, IPR2021-01151, IPR2021-01155, IPR2021-01156,
IPR2021-01270, PGR2021-00108, IPR2021-01520, IPR2021-01521
Matter: *Inter Partes* Review, network security systems
Project: Seven declarations to support seven IPR petitions, declaration to
support post grant review, deposition
- L78. 2021 **Devlin Law Firm**
Case: CDN Innovations, LLC v. Grande Communications Networks, LLC
Eastern district of Texas, Sherman division, Case No. 4:20-cv-653-
SDJ
Matter: Patent infringement, telecommunication systems
Project: Declaration to support infringement contentions
- L79. 2021 **Banner Witcoff**
Case: Sisvel International S.A., 3G Licensing S.A. v. ZTE (USA) Inc. et al.
Northern district of Texas, Case No. 3:20-cv-01289-M
Matter: Patent infringement, wireless communication systems
Project: Declaration regarding claim construction, deposition
- L80. 2021 **Paul Hastings LLP**
Case: G. Holdings Ltd. v. Samsung Electronics Co., et al.
Eastern district of Texas, Marshall division, Case No. 2:20-cv-00342-
JRG
Matter: Patent infringement, electronic payment systems
Project: Declaration regarding claim construction
- L81. 2021 **Morgan Lewis & Bockius LLP**
Case: Aruba Networks, LLC and Hewlett Packard Enterprise Company v.
SIPCO, LLC
IPR2021-00787
Matter: *Inter Partes* Review, wireless communication systems
Project: Declaration to support IPR petition
- L82. 2021 **Jenner & Block LLP**
Case: Virentem Ventures LLC D/B/A Enounce v. TiVo Corp and Xperi
Holding Corporation
District of Delaware, Case No. 20-787-MN
Matter: Patent infringement, telecommunication systems
Project: Declaration regarding claim construction

- L83. 2021 **Carter Arnett**
Case: Correct Transmission LLC v. Adtran, Inc. and Juniper Networks, Inc.
Western district of Texas, Waco division, Case No. 6:20-cv-669-ADA
Matter: Patent infringement, telecommunication systems
Project: Source code review, declaration regarding claim construction
- L84. 2021 **Fish & Richardson, P.C.**
Case: Quectel Wireless Solutions Co. Ltd. v. Koninklijke Philips N.V.
IPR2021-00558, IPR2021-00559, IPR2021-00561
Matter: *Inter Partes* Review, wireless communication systems
Project: Three declarations to support three IPR petitions, declaration to support reply, two depositions
- L85. 2021 **Goldberg Kohn Ltd**
Case: United States ex. rel. Todd Heath v. Wisconsin Bell, Inc
District of Columbia, Case No. 11-cv-01897
Matter: Networking systems
Project: Technology consulting
- L86. 2021 **Fish & Richardson, P.C.**
Case: Samsung Electronics Co. Ltd. v. Ericsson Inc.
IPR2021-00447, IPR2021-00588, IPR2021-00613, IPR2021-00614,
IPR2021-00643, IPR2021-00645, IPR2021-00684
Matter: *Inter Partes* Review, wireless communication systems
Project: Seven declarations to support seven IPR petitions
- L87. 2020 **Kilpatrick Townsend & Stockton LLP**
Case: GREE Inc. v. Supercell Oy
Eastern district of Texas, Marshall division, Case No. 2:19-cv-00413-JRG-RSP
Matter: Patent infringement, mobile gaming
Project: Source code review, infringement expert report, supplemental expert report, validity expert report, deposition
- L88. 2020 **Banner Witcoff**
Case: Sisvel International S.A., 3G Licensing S.A. v. ZTE (USA) Inc. et al.
Northern district of Texas, Case No. 3:19-cv-01694-N
Matter: Patent infringement, wireless communication systems
Project: Declaration regarding claim construction, deposition
- L89. 2020 **Fish & Richardson, P.C.**
Case: Cellco Partnership D/B/A Verizon Wireless v. Huawei Technologies Co., Ltd
IPR2020-01352, IPR202-01356, IPR2020-01357
Matter: *Inter Partes* Review, network communication systems
Project: Three declarations to support 3 Patent Owner' responses

- L90. 2020 **Kilpatrick Townsend & Stockton LLP**
Case: GREE Inc. v. Supercell Oy
Eastern district of Texas, Marshall division, Case No. 2:20-cv-00113-JRG-RSP
Matter: Patent infringement, mobile gaming
Project: Source code review, declaration supporting claim construction, infringement expert report, validity expert report, supplemental report, deposition
- L91. 2020 **Kilpatrick Townsend & Stockton LLP**
Case: GREE Inc. v. Supercell Oy
Eastern district of Texas, Marshall division, Case No. 2:19-cv-00200-JRG-RSP, Case No. 2:19-cv-00237-JRG-RSP, Case No. 2:19-cv-00310-JRG-RSP; Case No. 2:19-cv-00311-JRG-RSP
Matter: Patent infringement, mobile gaming
Project: Source code review, four infringement expert reports, two supplemental infringement expert reports, four validity expert reports, two supplemental expert reports, two second supplemental expert reports, three-day depositions, jury trial testimony
- L92. 2020 **Sheridan Ross P.C.**
Case: Justservice.net LLC v. Dropbox, Inc.
Western district of Texas, Waco division, Case No. 6:20-CV-00070-ADA
Matter: Patent infringement, computer systems and networking
Project: Source code review, declaration regarding claim construction
- L93. 2020 **Perkins Coie LLP**
Case: Huizhou TCL Mobile Communication Co. Ltd., TCT Mobile (US) Inc., and TCL Mobile Communication (HK) Co., Ltd. v. Wi-LAN Inc.
Matter: *Ex Partes* Reexamination, QoS enhancements for wireless IP networks
Project: Declaration to support Requesters
- L94. 2020 **Perkins Coie LLP**
Case: Intel Corporation v. UNM Rainforest Innovations
IPR2020-01576, IPR2020-01578, IPR2020-*to be assigned*
Matter: *Inter Partes* Review, wireless broadband
Project: Three declarations to support three IPR petitions
- L95. 2020 **Calfee, Halter & Griswold LLP**
Case: Motorola Solutions, Inc. v. Hytera Communications Corp. Ltd. et al.
Northern district of Illinois, Case No. 1:17-cv-01972
Matter: Patent infringement, two-way radios

- Project: Declaration regarding claim construction, deposition, expert report regarding invalidity, rebuttal expert report regarding non-infringement, three-day depositions
- L96. 2020 **Fish & Richardson, P.C.**
Case: Huawei Technologies Co., Ltd et al. v. Verizon Communications, Inc. et al.
Western district of Texas, Waco division, Case No. 6-20-cv-00090
Matter: Patent infringement, video communication
Project: Source code review, declaration regarding claim construction, infringement expert report, validity expert report, deposition
- L97. 2020 **Kilpatrick Townsend & Stockton LLP**
Case: GREE Inc. v. Supercell Oy
Eastern district of Texas, Marshall division, Case No. 2:19-cv-00070-JRG-RSP, Case No. 2:19-cv-00071-JRG-RSP
Matter: Patent infringement, mobile gaming
Project: Source code review, two infringement expert reports, two supplemental infringement expert reports, two second supplemental infringement expert reports, two rebuttal expert reports on validity, two-day depositions, seven declarations supporting Gree's opposition to Supercell's motions for summary judgement, jury trial testimony
- L98. 2020 **Cooley LLP**
Case: Saint Lawrence Communications, LLC v. Amazon.com, Inc., et al.
Eastern district of Texas, Marshall division, Case No. 2:19-cv-00027-JRG
Matter: Patent infringement, AMR-WB, speech compression, coding and decoding
Project: Invalidity expert report
- L99. 2020 **Prince Lobel Tye LLP**
Case: Intellectual Ventures I and II LLC v. VMware, Inc.
Western district of Texas, Austin division, Case No. 1:19-cv-01075-ADA
Matter: Patent infringement, networking systems
Project: Declaration regarding claim construction
- L100. 2020 **Gibson, Dun & Crutcher LLP**
Case: Cellular Evolution LLC v. T-Mobile US, Inc. et al.
Eastern district of Texas, Marshall division, Case No. 2:19-cv-232-JRG
Matter: Patent infringement, cellular systems
Project: Invalidity consulting

- L101. 2020 **Faegre Baker Daniels LLP**
Case: CommScope, Inc. v. Rosenberger Technology, et al.
District of New Jersey, Case No. 19-cv-15962-MCA-LDW
Matter: Trade secret software, base station antenna design
Project: Declaration, deposition
- L102. 2020 **Ropes & Gray LLP**
Case: Canon, Inc. v. TCL Electronics Holdings Ltd., et al.
Eastern district of Texas, Marshall division, Case No. 2:18-cv-546-JRG
Matter: Patent infringement, communication interfaces
Project: Source code review, declaration regarding claim construction, deposition
- L103. 2019 **Perkins Coie LLP**
Case: Huizhou TCL Mobile Communication Co. Ltd., TCT Mobile (US) Inc., and TCL Mobile Communication (HK) Co., Ltd. v. Wi-LAN Inc.
IPR2020-00302, IPR2020-00303
Matter: *Inter Partes* Review, QoS enhancements for wireless IP networks
Project: Two declarations to support two IPR petitions
- L104. 2019 **Fish & Richardson**
Case: Bell Northern Research v. Huawei, et al.
Southern district of California, Case No. 3:18-cv-1784-CAB-BLM
Matter: Patent infringement, wireless networks
Project: Invalidity consulting
- L105. 2019 **K & L Gates LLP**
Case: EVS CODEC Technologies, LLC and Saint Lawrence Communications, LLC v. ZTE Corporation, et al.
Northern district of Texas, Dallas division, Case No. 3:19-cv-00385-MBH
Matter: Patent infringement, EVS, speech compression, coding and decoding
Project: Invalidity expert report
- L106. 2019 **Feinberg Day Alberti Lim & Belloli LLP**
Case: Uniloc 2017 LLC v. AT&T Mobility LLC, et al.
Eastern district of Texas, Marshall division, Case No. 2:18-cv-00514-JRG
Matter: Patent infringement, wireless frequency bands and devices
Project: Two declarations regarding claim construction, deposition

- L107. 2019 **Susman Godfrey LLP**
Case: Sol IP, LLC v. AT&T Mobility LLC, et al.
Eastern district of Texas, Marshall division, Case No. 2:18-cv-00526;
2:18- cv-00527; and 2:18-cv-00528
Matter: Patent infringement, Wi-Fi and LTE
Project: Validity consulting
- L108. 2019 **Ropes & Gray LLP**
Case: Huawei Technologies Co. Ltd. v. Harris Global Communications, Inc.
IPR2019-01512, IPR2019-01631
Matter: *Inter Partes* Review, routing and security in wireless networks
Project: Two declarations to support two IPR petitions
- L109. 2019 **Ropes & Gray LLP**
Case: Harris Corporation v. Huawei Device USA, Inc. et al.
Eastern district of Texas, Marshall division, Case No. 2:18-cv-00439-
JRG
Matter: Patent infringement, routing and security in wireless networks
Project: Declaration regarding claim construction
- L110. 2019 **Erise IP**
Case: Semcon IP Inc. v. ASUSTeK Computer Inc.
Eastern district of Texas, Marshall division, Case No. 2:18-cv-00193-
JRG
Matter: Patent infringement, adaptive power control
Project: Non-infringement expert report
- L111. 2019 **Cooley LLP**
Case: Facebook Inc. v. BlackBerry Corp. et al.
Northern District of California, Oakland division, Case No. 4:18-cv-
05434-JSW
Matter: Patent infringement, mobile computing
Project: Declaration regarding claim construction
- L112. 2019 **Sidley Austin LLP**
Case: Semcon IP Inc. v. Amazon.com, Inc.
Eastern district of Texas, Marshall division, Case No. 2:18-cv-00192-
JRG
Matter: Patent infringement, adaptive power control
Project: Expert report regarding patent marking, rebuttal report regarding
patent marking, deposition
- L113. 2019 **Oblon, McClelland, Maier & Neustadt, LLP**
Case: MV3 Partners LLC v. Roku, Inc.
Western district of Texas, Waco division, Case No. 6:18-cv-308-ADA
Matter: Patent infringement, mobile set top box

- Project: Declaration regarding claim construction, deposition, Markman hearing and tech tutorial testimony
- L114. 2019 **Banner & Witcoff, LTD.**
Case: Kathrein USA, Inc. v. Fractus S.A.
IPR2019-00954, IPR2019-00955, IPR2019-00956, IPR2019-00957
Matter: *Inter Partes* Review, multiband antenna arrays
Project: Four declarations to support four IPR petitions
- L115. 2019 **Fish & Richardson, P.C.**
Case: LG Electronics Inc. v. Saint Lawrence Communications LLC
Southern district of New York, Case No. 1:18-cv-11082-DLC
Matter: Patent infringement, EVS, speech compression, coding and decoding
Project: Declaration relating to motion for summary judgment, expert report, deposition
- L116. 2019 **Ropes & Gray LLP**
Case: SIPCO, LLC v. Emerson Electric Co.
In the Matter of Certain Wireless Mesh Networking Products and Related Components Thereof, ITC Investigation No. 337-TA-1131
Matter: Patent infringement, links in wireless networks and remote monitoring
Project: Source code review, declaration regarding claim construction, invalidity expert report, rebuttal expert report regarding non-infringement and no domestic industry
- L117. 2019 **Fish & Richardson, P.C.**
Case: Maxell Ltd. v. Huawei Technologies Co. Ltd., ZTE, et al.
Eastern district of Texas, Texarkana division, Case No. 5:18-cv-0033-RWS
Matter: Patent infringement, portable computing devices
Project: Declaration regarding claim construction
- L118. 2019 **Ropes & Gray LLP**
Case: Emerson Electric Co. v. SIPCO, LLC
IPR2019-00548, IPR2019-00549
Matter: *Inter Partes* Review, routing in wireless networks
Project: Two declarations to support two IPR petitions
- L119. 2018 **Mishcon de Reya New York LLP; King & Wood Mallesons LLP**
Case: ChanBond, LLC v. Cox Communications, Inc.
District of Delaware, Case No. 1:15-cv-00849-RGA
Matter: Patent infringement, wideband signal distribution system
Project: Validity expert report, deposition, sur-reply expert report, second sur-reply expert report, second deposition, jury trial with settlement mid-trial

- L120. 2018 **Fish & Richardson, P.C.**
Case: In re: Qualcomm Antitrust Litigation (Client: Apple)
Southern district of California, Case No. 3:17-cv-00108-GPC-MDD
Matter: Qualcomm antitrust litigation
Project: Two expert rebuttal reports, deposition
- L121. 2018 **Susman Godfrey LLP**
Case: In re: Qualcomm Antitrust Litigation (Client: Class Action)
Northern district of California, Case No. 5:17-md-02773-LHK
Matter: Qualcomm antitrust litigation
Project: Expert declaration on standard essential patents, expert report on
deemed essential patents, rebuttal expert report, deposition
- L122. 2018 **284 Partners**
Case: Federal Trade Commission. v. Qualcomm Incorporated
Northern district of California, Case No. 5:17-cv-00220
Matter: Qualcomm antitrust litigation
Project: Expert report on standard essential patents, expert rebuttal report,
deposition
- L123. 2018 **Vorys, Sater, Seymour and Pease LLP**
Case: Route1 Inc. v. Airwatch LLC
District of Delaware, Case No. 17-331-RGA
Matter: Patent infringement, remote access
Project: Source code review, declaration regarding claim construction,
infringement expert report, validity expert report, reply expert report,
deposition, three declarations regarding re-exam
- L124. 2018 **Sidley Austin LLP**
Case: Samsung Electronics Co., Ltd v. Huawei Technologies Co., Ltd.
IPR2017-01471, IPR2017-01474, IPR2017-01475
Matter: *Inter Partes* Review, 4G/LTE
Project: Three declarations to support three Patent Owner's responses,
supplemental declaration, deposition
- L125. 2018 **Fitzpatrick Cella Harper & Scinto**
Case: IPC Systems, Inc. v. Cloud9 Technologies, LLC
District of Delaware, Case No. 16-cv-443-GMS
Matter: Patent infringement, telephone stations and trading turrets
Project: Source code review, declaration regarding claim construction,
supplemental declaration regarding claim construction

- L126. 2018 **Haynes and Boone, LLP**
Case: LG Electronics Inc., et al. v. Wi-LAN Inc., et al.
IPR2018-00673, IPR2018-00674, IPR2018-00704, IPR2018-00705,
IPR2018-00709, IPR2018-00710
Matter: *Inter Partes* Review, bandwidth allocation
Project: Six declarations to support six IPR petitions, two depositions, two
reply declarations
- L127. 2018 **Pillsbury Winthrop Shaw Pittman LLP**
Case: Cellular Communications Equipment v. ZTE, HTC Corporation, et al.
Eastern district of Texas, Case No. 6:16-cv-475-RWS
Matter: Patent infringement, LTE, power control, emergency notification
Project: Invalidity expert report, deposition
- L128. 2018 **Finnegan Henderson Farabow Garrett & Dunner LLP**
Case: FanDuel, Inc. DraftKings, Inc., and Bwin.Party Digital Entertainment
PLC. v. CG Technology Development, LLC
IPR2017-00902, IPR2017-01333, IPR2017-01491, IPR2017-01532
Matter: *Inter Partes* Review, location-based gaming
Project: Four declarations to support four Patent Owner's responses, two
supplemental declarations, four depositions
- L129. 2018 **Calfee, Halter & Griswold LLP**
Case: Hytera Communications Corp. Ltd. v. Motorola Solutions, Inc.
Northern district of Ohio, Case No. 1:17-cv-01794-DNC
Matter: Patent infringement, two-way radios
Project: Source code review, declaration regarding claim construction, rebuttal
declaration regarding claim construction, deposition, infringement
expert report, validity expert report, two-day depositions
- L130. 2017 **Covington & Burling LLP**
Case: Sharp Corporation, et al. v. Hisense Co., Ltd., et al.
In the Matter of Certain Wi-Fi Enabled Electronic Devices and
Components Thereof, ITC Investigation No. 337-TA-1072
Matter: Patent infringement, Wi-Fi, OFDMA
Project: Declaration regarding claim construction
- L131. 2017 **Vorys, Sater, Seymour and Pease LLP**
Case: Airwatch LLC and VMWare Inc. v. Route1 Inc.
IPR2017-02145
Matter: *Inter Partes* Review, remote access
Project: Declaration to support Patent Owner's response

- L132. 2017 **Arnold & Porter Kaye Scholer**
Case: Uniloc USA, Inc. v. Google, Inc.
Eastern district of Texas, Marshall division, Case No. 2:17-cv-0214-JRG, 2:17-cv-0224-JRG, 2:17-cv-0231-JRG, 2:17-cv-0465-JRG, 2:17-cv-0466-JRG, 2:17-cv-0467JRG
Matter: Patent infringement, VoIP messaging
Project: Invalidity consulting
- L133. 2017 **Simpson Thacher & Bartlett LLP**
Case: XR Communications, LLC. v. Ubiquiti Networks, Inc.
Central district of California, Case No. 2:17-cv-02968-AG(JCGx)
Matter: Patent infringement, Wi-Fi and adaptive antennas
Project: Declaration regarding claim construction, deposition
- L134. 2017 **Covington & Burling LLP**
Case: Huawei Device USA Inc. v. Hitachi Maxell, Ltd.
IPR2018-00209, IPR2018-00210
Matter: *Inter Partes* Review, base station selection, GPS/Cellular location
Project: Two declarations to support two IPR petitions
- L135. 2017 **Calfee, Halter & Griswold LLP**
Case: Hytera Communications Corp. Ltd. v. Motorola Solutions, Inc.
IPR2018-00128, IPR2017-02183
Matter: *Inter Partes* Review, two-way radios
Project: Declaration to support IPR petition, deposition, two supplemental declarations, two depositions
- L136. 2017 **Finnegan Henderson Farabow Garrett & Dunner LLP**
Case: Hytera Communications Corp. Ltd. v. Motorola Solutions, Inc.
IPR2017-02179, IPR2017-02183
Matter: *Inter Partes* Review, two-way radios
Project: Two declarations to support two IPR petitions, deposition
- L137. 2017 **Mayer Brown LLP**
Case: Silver Spring Networks, Inc. v. Sunrise Technologies, Inc.
Silver Spring Networks, Inc. v. Weatherproof Wireless, LLC
IPR2017-*To Be Assigned*, IPR2017-*To Be Assigned*
Matter: *Inter Partes* Review, power meter
Project: Two declarations to support two IPR petitions
- L138. 2017 **Covington & Burling LLP**
Case: Hitachi Maxell, Ltd. v. Huawei Device USA Inc. et al.
Eastern district of Texas, Texarkana division, Case No. 5:16-cv-00178-RWS
Matter: Patent infringement, 3G/4G

- Project: Source code review, declaration regarding claim construction, invalidity expert report, non-infringement expert report, non-infringing alternatives expert report, two depositions
- L139. 2017 **Finnegan Henderson Farabow Garrett & Dunner LLP**
Case: LG Electronics, Inc. et al. v. BLU Products, Inc. and CT Miami, LLC
In the Matter of Certain LTE Wireless Communication Devices and Components Thereof, ITC Investigation No. 337-TA-1051
Matter: Patent infringement, 4G/LTE
Project: Declaration regarding claim construction, second declaration regarding claim construction
- L140. 2017 **Sidley Austin LLP**
Case: Huawei Technologies Co., Ltd. v. Samsung Electronics Co., Ltd.
IPR2017-01979, IPR2017-01980, IPR2017-01986
Matter: *Inter Partes* Review, 4G/LTE
Project: Three declarations to support three IPR petitions, deposition
- L141. 2017 **Finnegan Henderson Farabow Garrett & Dunner LLP**
Case: Motorola Solutions, Inc. v. Hytera Communications Corp. Ltd. et al.
In the Matter of Certain Two-way Radio Equipment Systems, Related Software and Components Thereof, ITC Investigation No. 337-TA-1053
Matter: Patent infringement, two-way radio
Project: Source code review, declaration regarding claim construction, invalidity expert report, non-infringement expert report, deposition, ITC hearing testimony
- L142. 2017 **Haynes and Boone, LLP**
Case: Rackspace US, Inc. v. Realtime Data LLC
IPR2017-01691
Matter: *Inter Partes* Review, data compression
Project: Declaration to support IPR petition
- L143. 2017 **Pillsbury Winthrop Shaw Pittman LLP**
Case: ZTE (USA), HTC Corporation, et al. v. Cellular Communications Equipment
IPR2017-01508, IPR2017-01509
Matter: *Inter Partes* Review, LTE, power control, emergency notification
Project: Two declarations to support two IPR petitions, two depositions
- L144. 2017 **Alston & Bird LLP; Womble Carlyle Sandridge & Rice LLP**
Case: Itron, Inc. and Duke Energy Corp. v. Smart Meter Technologies
IPR2017-01199
Matter: *Inter Partes* Review, power meter
Project: Declaration to support IPR petition, deposition

- L145. 2017 **Haynes and Boone, LLP**
Case: Ericsson Inc. v. Regents of the University of Minnesota
IPR2017-01186, IPR2017-01200, IPR2017-01213
Matter: *Inter Partes* Review, OFDM and MIMO
Project: Three declarations to support three IPR petitions
- L146. 2017 **Quinn Emanuel Urquhart & Sullivan, LLP**
Case: GENBAND US, LLC v. Metaswitch Networks Ltd, et al.
Eastern district of Texas, Marshall division, Case No. 2:16-cv-582-
JRG-RSP
Matter: Patent infringement, Internet protocols and VoIP, switches and routers
Project: Expert report regarding essentiality
- L147. 2017 **Mayer Brown LLP**
Case: Uniloc USA, Inc. et al. v. Avaya Inc., ShoreTel, Inc., et al.
Eastern district of Texas, Tyler division, Case Nos. 6:15-cv-1168-JRG
Matter: Patent infringement, instant messaging and conference calling
Project: Source code review, non-infringement consulting
- L148. 2017 **Fish & Richardson P.C.**
Case: Nokia Solutions and Networks US LLC, et al. v. Huawei
Technologies Co. Ltd., et al.
Eastern district of Texas, Marshall division, Case Nos. 2:16-cv-753-
JRG-RSP, 2:16-cv-754
Matter: Patent infringement, 4G/LTE
Project: Claim construction, two declarations
- L149. 2017 **Rothwell Figg Ernst & Manbeck, PC; Pepper Hamilton LLP**
Case: Samsung Electronics, et al. v. Rembrandt Wireless Technologies, LP
IPR2015-00555
Matter: *Ex Parte* Reexamination, Bluetooth
Project: Two declarations to support two Patent Owner's responses,
supplemental declaration to support Patent Owner's reply
- L150. 2016 **Sidley Austin LLP**
Case: Huawei Technologies Co., et al. v. Samsung Electronics Co, et al. and
Samsung Research America v. Hisilicon Technologies Co, LTD
Northern district of California, San Francisco division, Case No. 3:16-
cv-2787-WHO
Matter: Patent infringement, 3G/4G/LTE
Project: Source code review, declaration regarding claim construction,
declaration opposing summary judgement, infringement expert report,
invalidity expert report, non-infringement expert report, validity
expert report, two depositions

- L151. 2016 **Bragalone Conroy PC**
Case: Securus Technologies, Inc. v. Global Tel*Link Corporation
CBM2017-00034
Matter: Covered Business Method Review, call monitoring and recording
Project: Declaration to support CBM petition, deposition
- L152. 2016 **Braxton, Hilton & Perrone PLLC**
Case: Biosonix, LLC. v. Hydrowave, LLC et al.
Eastern district of Texas, Case No. 2:16-cv-139-RC
Matter: Patent infringement, underwater transceivers
Project: Claim construction, Markman hearing and tech tutorial testimony
- L153. 2016 **Gray Reed & McGraw**
Case: Optis Cellular Technology, LLC and PanOptis Patent Management, LLC. v. Blackberry Corporation, et al.
Eastern district of Texas, Marshall division, Case No. 2:16-cv-59-JRG-RSP, Case No. 2:16-cv-61-JRG-RSP, Case No. 2:16-cv-62-JRG-RSP
Matter: Patent infringement, LTE
Project: Claim construction, three declarations regarding claim construction, deposition
- L154. 2016 **Ropes & Gray LLP; Davidson Berquist Jackson & Gowdey**
Case: SIPCO, LLC et al v. Emerson Electric Co. et al
Eastern district of Texas, Tyler division, Case No. 6:15-cv-907
Emerson Electric Co. et al v. SIPCO, LLC et al.
Northern district of Georgia, Atlanta division, Case No. 1:15-cv-00319-AT
Matter: Patent infringement, links in wireless networks and remote monitoring
Project: Source code review, invalidity consulting
- L155. 2016 **McKool Smith**
Case: Regents of University of Minnesota v. AT&T Mobility LLC, et al.
District of Minnesota, Case No. 0:14-cv-04666-JRT-TNL
Matter: Patent infringement, LTE and MIMO
Project: Invalidity consulting
- L156. 2016 **EIP US LLP**
Case: GENBAND US, LLC et al. v. Metaswitch Networks Ltd
IPR2015-01456, IPR2015-01457
Matter: *Inter Partes* Review, media gateways, switches and routers
Project: Two declarations to support Patent Owner's responses, two depositions

- L157. 2016 **Haynes and Boone, LLP**
Case: Cox Communications, Inc. v. AT&T Intellectual Property I, II, LP
IPR2015-01187, IPR2015-01227, IPR2015-01273, IPR2015-01536
Matter: *Inter Partes* Review, cable networks
Project: Four declarations to support Patent Owner's responses, four
depositions
- L158. 2016 **Mayer Brown LLP**
Case: Odyssey Wireless v. Motorola Mobility LLC
Eastern district of North Carolina, Western division, Case No. 5:14-
cv-491-D
Southern district of California, Case No. 3:15-cv-01741-H-RBB
Matter: Patent infringement, LTE
Project: Source code review, non-infringement consulting
- L159. 2016 **Cooley LLP; Finnegan LLP**
Case: Saint Lawrence Comm. LLC v. Motorola Mobility LLC, ZTE (USA)
Inc., et al.
Eastern district of Texas, Marshall division, Case No. 2:15-cv-
000351-JRG, Case No. 2:15-cv-000349-JRG
Matter: Patent infringement, speech compression, coding and decoding
Project: Invalidity expert report, expert report regarding AMR-WB standard,
expert report regarding Opus and Silk, supplemental expert report
regarding invalidity, two-day depositions, jury trial testimony for
Motorola
- L160. 2015 **Sidley Austin LLP**
Case: Evolved Wireless, LLC v. Microsoft Corp., et al.
District of Delaware, Case No. 15-cv-546
Matter: Patent infringement, LTE
Project: Prior art and invalidity consulting
- L161. 2015 **McKool Smith**
Case: Optis Wireless Technology, LLC and PanOptis Patent Management,
LLC. v. ZTE Corporation and ZTE (USA) Inc.
Eastern district of Texas, Marshall division, Case No. 2:15-cv-300-
JRG-RSP
Matter: Patent infringement, cellular messages and multimedia attachments
Project: Source code review, claim construction, declaration
- L162. 2015 **Fish & Richardson, P.C.**
Case: Saint Lawrence Comm. LLC v. LG Elec., Inc. et al.
Eastern district of Texas, Marshall division, Case No. 2:14-cv-1055-
JRG
Matter: Patent infringement, speech compression, coding and decoding
Project: Invalidity expert report

- L163. 2015 **Finnegan Henderson Farabow Garrett & Dunner LLP**
Case: LG Electronics, Inc. v. Cellular Communications Equipment LLC
IPR2016-00178
Matter: *Inter Partes* Review, LTE
Project: Declaration to support IPR petition
- L164. 2015 **McKool Smith**
Case: AT&T, et al. v. Cox Communication, Inc., et al.
District of Delaware, Case No. 14-1106-GMS
Matter: Patent infringement, cable networks
Project: Claim construction, declaration
- L165. 2015 **McKool Smith**
Case: Ericsson Inc., et al. v. TCL Communication, et al.
Eastern district of Texas, Marshall division, Case No. 2:15-cv-00011-RSP
Matter: Patent infringement, wireless devices and systems
Project: Source code review, claim construction, declaration, infringement expert report, validity expert report, two-day depositions
- L166. 2015 **Foley & Lardner LLP**
Case: Kyocera Communications, Inc. v. Cellular Communications Equipment LLC
IPR2015-01559, IPR2015-01564
Matter: *Inter Partes* Review, LTE, power control, emergency notification
Project: Two declarations to support two IPR petitions
- L167. 2015 **Fish & Richardson, P.C.**
Case: Fairfield Industries Inc. v. Wireless Seismic, Inc.
Southern district of Texas, Case No. 4:14-cv-02972-KPE
Matter: Patent infringement, wireless sensor networks
Project: Non-infringement expert report
- L168. 2015 **Quinn Emanuel Urquhart & Sullivan, LLP**
Case: GENBAND US, LLC v. Metaswitch Networks Ltd, et al.
Eastern district of Texas, Marshall division, Case No. 2:14-cv-33-JRG-RSP
Matter: Patent infringement, Internet protocols and VoIP, switches and routers
Project: Expert report regarding essentiality, non-infringement expert report, rebuttal expert report regarding non-practice, supplemental rebuttal expert report, three-day depositions, jury trial testimony

- L169. 2015 **Duane Morris LLP; Foley & Lardner LLP**
Case: Mobile Telecommunications Technologies, LLC v. Leap Wireless International, Cricket Communications, Inc.
Eastern district of Texas, Marshall division, Case No. 2:13-cv-00885-RSP
Matter: Patent infringement, OFDM and MIMO
Project: Non-infringement expert report, deposition
- L170. 2015 **Hogan Lovells US LLP; Kenyon & Kenyon LLP**
Case: One-E-Way v. Beats Electronics, LLC, Sony Corporation, et al.
In the Matter of Certain Wireless Headsets, ITC Investigation No. 337-TA-943
Matter: Patent infringement, wireless communication
Project: Claim construction, declaration
- L171. 2015 **McKool Smith**
Case: Solocron Media, LLC v. AT&T Inc., et al.
Eastern district of Texas, Marshall division, Case No. 2:13-cv-1059-JRG
Matter: Patent infringement, ringtone download
Project: Claim construction, invalidity expert report
- L172. 2015 **EIP US LLP**
Case: Good Technology Software, Inc. v. Mobile Iron, Inc.
IPR2015-00833, IPR2015-00836, IPR2015-01090
Matter: *Inter Partes* Review, software management in wireless devices
Project: Three declarations to support three IPR petitions
- L173. 2015 **McKool Smith**
Case: AirWatch LLC v. Good Technology Corp
Northern district of Georgia, Case No. 1:14-cv-02281-SCJ
Matter: Patent infringement, software management in wireless devices
Project: Claim construction, declaration
- L174. 2015 **Simpson Thacher & Bartlett LLP**
Case: IXI Mobile (R&D) Ltd. et al. v. Apple Inc.
Southern district of New York, Case No. 14-cv-7594-RJS
Matter: Patent infringement, PDA and Bluetooth
Project: Invalidity consulting
- L175. 2014 **Bragalone Conroy PC**
Case: Global Tel*Link Corporation v. Securus Technologies, Inc.
IPR2014-00785, IPR2014-00810, IPR2014-00824, IPR2014-00825, IPR2014-01278, IPR2014-01282, IPR2014-01283
Matter: *Inter Partes* Review, VoIP call monitoring and recording, allocating telecommunication resources and information systems

- Project: Seven declarations to support seven Patent Owner's responses, five depositions
- L176. 2014 **Orrick, Herrington & Sutcliffe LLP**
Case: Shopkick, Inc. v. Novitaz, Inc.
IPR2015-00277, IPR2015-00278
Matter: *Inter Partes* Review, wireless customer service management
Project: Two declarations to support two IPR petitions
- L177. 2014 **Paul Hastings LLP**
Case: Cellular Communications Equipment LLC v. AT&T, et al.
Eastern district of Texas, Tyler division, Case No. 6:13-cv-507-LED
(Lead Case for Consolidation)
Matter: Patent infringement, 3G cellular communication
Project: Claim construction, declaration
- L178. 2014 **Baker Botts LLP**
Case: Orlando Communications LLC v. AT&T, et al.
M.D. Florida, Case No. 6:14-cv-01021
Matter: Patent infringement, 3G/4G cellular communication
Project: Non-infringement and claim construction consulting
- L179. 2014 **EIP US LLP**
Case: Good Technology Software, Inc. v. AirWatch, LLC
IPR2015-00248, IPR2015-00875
Matter: *Inter Partes* Review, software management in wireless devices
Project: Two declarations to support two IPR petitions
- L180. 2014 **Bragalone Conroy PC**
Case: Securus Technologies, Inc. v. Global Tel*Link Corporation
IPR2015-00153, IPR2015-00155, IPR2015-00156
Matter: *Inter Partes* Review, VoIP call monitoring and recording
Project: Three declarations to support three IPR petitions, two depositions
- L181. 2014 **Andrews Kurth LLP**
Case: Sony Mobile Communications (USA) v. Adaptix Inc.
IPR2014-01524, IPR2014-01525
Matter: *Inter Partes* Review, subcarrier selection in LTE
Project: Two declarations to support two IPR petitions, deposition
- L182. 2014 **Steptoe & Johnson LLP; Baker & McKenzie LLP**
Case: VTech Communications, Inc. and Uniden America Corporations v. Spherix Incorporated
IPR2014-01432
Matter: *Inter Partes* Review, IP telephony

- Project: Declaration to support IPR petition, deposition, reply declaration, deposition
- L183. 2014 **Steptoe & Johnson LLP; Baker & McKenzie LLP**
Case: Spherix Inc. v. VTech Telecommunications Ltd., et al.
Spherix Inc. v. Uniden Corp, et al.
Northern district of Texas, Dallas division, Case No. 3:13-cv-3494 and 3:13-cv-3496
Matter: Patent infringement, IP telephony
Project: Claim construction, declaration, deposition
- L184. 2014 **McKool Smith**
Case: Good Technology Corp. v. MobileIron, Inc.
Northern district of California, Case No. 5:12-cv-05826-PSG
Matter: Patent infringement, software management in wireless devices
Project: Claim construction, three declarations, claim invalidity expert report, non-infringement expert report, deposition, jury trial testimony
- L185. 2014 **Lee & Hayes**
Case: Broadcom Corp. v. Ericsson, Inc.
IPR2013-00601, IPR2013-00602, and IPR2013-00636
Matter: *Inter Partes* Review, ARQ protocols
Project: Three declarations to support Patent Owner's responses, two declarations to support Patent Owner's Motion to Amend, deposition, two reply declarations
- L186. 2014 **Sidley Austin LLP**
Case: Adaptix, Inc. v. Huawei Technologies Co., et al.
Eastern district of Texas, Case No. 6:13-cv-00438, 439, 440 and 441
Matter: Patent infringement, subcarrier selection in LTE
Project: Source code review, non-infringement consulting
- L187. 2014 **Finnegan Henderson Farabow Garrett & Dunner LLP**
Case: Cell and Network Selection LLC v. Huawei Technologies Co., et al.
Eastern district of Texas, Case No. 6:13-cv-00404-LED-JDL
Matter: Patent infringement, base station selection in LTE
Project: Non-infringement consulting
- L188. 2014 **Feinberg Day Alberti & Thompson LLP**
Case: DSS Technology Management, Inc. v. Apple Inc.
Eastern district of Texas, Tyler division, Case No. 6:13-cv-00919-JDL
Matter: Patent infringement, PDA and Bluetooth
Project: Claim construction and invalidity consulting
- L189. 2014 **Sheppard Mullin Richter & Hampton LLP**
Case: Digcom Inc. v. ZTE (USA), Inc.

- District of Nevada, Case No. 3:13-cv-00178-RCJ-WGC
Matter: Patent infringement, cellular communication
Project: Claim construction consulting
- L190. 2014 **Lott & Fischer**
Case: Zenith Electronics, LLC, et al. v. Craig Electronics, Inc.
Southern district of Florida, Case No. 9:13-cv-80567-DMM/DLB
Matter: Patent infringement, HDTV transmission and reception
Project: Opening expert report regarding nonessentiality
- L191. 2013 **McKool Smith**
Case: Zenith Electronics, LLC, et al. v. Curtis International Ltd.
Southern district of Florida, Case No. 9:13-cv-80568-DMM/DLB
Matter: Patent infringement, HDTV transmission and reception
Project: Claim construction, declaration, deposition
- L192. 2013 **Gibson Dunn**
Case: Straight Path IP Group v. Sharp Corp. and Sharp Electronics Corp.
In the Matter of Certain Point-to-Point Network Communication
Devices and Products Containing Same, ITC Investigation No. 337-
TA-892
Matter: Patent infringement, point-to-point network communication
Project: Non-infringement consulting
- L193. 2013 **Kilpatrick Townsend & Stockton LLP; Cooley LLP**
Case: Monec Holding AG v. Motorola Mobility LLC, HTC, et al.
District of Delaware, Case No. 1:11-cv-798-LPS-SRF
Matter: Patent infringement, displaying books on tablets
Project: Non-infringement expert report for Motorola, non-infringement expert
report for HTC, deposition
- L194. 2013 **Gartman Law Group**
Case: Lone Star WiFi LLC v. Legacy Stonebriar Hotel, Ltd; et al.
Eastern district Of Texas, Tyler, Case No. 6:12-cv-957
Matter: Patent infringement, levels of access in Wi-Fi networks
Project: Claim validity consulting
- L195. 2013 **White & Case, LLP**
Case: Nokia Corp and Nokia, Inc. v. HTC Corp and HTC America, Inc. and
Google, Inc.
In the Matter of Certain Portable Electronic Communication Devices,
Including Mobile Phones and Components Thereof, ITC Investigation
No. 337-TA-885
Matter: Patent infringement, App download and installation
Project: Non-infringement consulting

- L196. 2013 **Heim, Payne & Chorush, LLP**
Case: Rembrandt Wireless v. Samsung Electronics Co., et al.
Eastern district of Texas, Marshall, Case No. 2:13-cv-213-JRG-RSP
Matter: Patent infringement, Bluetooth
Project: Expert report regarding validity, deposition, jury trial testimony
- L197. 2013 **Baker Hostetler; Davis Polk & Wardwell LLP**
Case: Comcast v. Sprint; and Nextel Inc.
Eastern district of Pennsylvania, Case No. 2:12-cv-00859-JD
Matter: Patent infringement, SMS/MMS in Cellular Networks
Project: Infringement expert report, validity expert report, reply expert report, declaration, two-day depositions, jury trial testimony
- L198. 2013 **McKool Smith**
Case: Samsung Electronics America v. Ericsson Inc.
In the Matter of Certain Wireless Communications Equipment and Articles Therein, ITC Investigation No. 337-TA-866
Matter: Patent infringement, LTE uplink and downlink
Project: Source code review, prior art research, claim construction, claim invalidity expert report, non-infringement expert report, ITC hearing testimony
- L199. 2012 **DLA Piper US LLP**
Case: CSR Technology Inc. v. Freescale Semiconductor, Inc.
USDC-San Francisco, Case No. 3:12-cv-02619-RS
Matter: Patent infringement, radio transceivers
Project: Claim construction, declaration
- L200. 2012 **Fish & Richardson P.C.**
Case: GPNE Corp. v. Apple, Inc.; et al.
USDC-ND California, Case No. 5:12-cv-02885-LHK
Matter: Patent infringement, resource allocation in wireless networks
Project: Prior art research consulting
- L201. 2012 **Polsinelli Shughart PC**
Case: Single Touch Interactive, Inc. v. Zoove Corporation
Northern district of California, Case No. 3:12-cv-00831-JSC
Matter: Patent infringement, abbreviated dialing, information delivery
Project: Claim construction, Markman hearing and tech tutorial testimony, two declarations
- L202. 2012 **K & L Gates**
Case: EON Corp. IP Holdings, LLC v. Novatel Wireless, Inc.; et al.
DC-Tyler, Texas, Case No. 6:11-cv-00015-LED-JDL
Matter: Patent infringement, wireless modem and 3G services
Project: Non-infringement expert report, deposition

- L203. 2012 **Simpson Thacher & Bartlett LLP**
Case: CSR Technology, Inc. v. Bandspeed, Inc.
Western district of Texas, Case No. 1:12-cv-297-LY
Matter: Patent infringement, packet identification in 2.4 GHz and 5 GHz
Project: Source code review, Markman hearing and tech tutorial testimony,
infringement expert report
- L204. 2012 **Sheppard Mullin Richter & Hampton LLP**
Case: Wi-LAN v. HTC America, Inc., et al.
Eastern district of Texas, Case No. 6:10-cv-521-LED
Matter: Patent infringement, CDMA, Orthogonal Codes
Project: Source code review, non-infringement expert report, deposition, jury
trial testimony
- L205. 2012 **Dechert LLP**
Case: Hitachi v. TPV and Vizio, Inc.; and Vizio v. Hitachi, LTD.
Eastern district of Texas, Case No. 2:10-cv-260
Matter: Patent infringement, HD television transmission and reception
Project: Prior art research, claim invalidity consulting
- L206. 2012 **Fish & Richardson P.C.; Covington & Burling; Alston & Bird;
Brinks Hofer Gilson & Lione**
Case: InterDigital Commc'n, LLC v. Huawei Tech. Co. LTD; LG
Electronics, Inc.; Nokia, Inc.; and ZTE (USA) Inc.
Certain Wireless Devices With 3G Capabilities and Components
Thereof, ITC Investigation No. 337-TA-800
Matter: Patent infringement, channel coding in UMTS, HSDPA
Project: Non-infringement consulting
- L207. 2012 **Fish & Richardson P.C.; Covington & Burling; Alston & Bird;
Brinks Hofer Gilson & Lione**
Case: InterDigital Commc'n, LLC v. Huawei Tech. Co. LTD; LG
Electronics, Inc.; Nokia, Inc.; and ZTE (USA) Inc.
District of Delaware, Case No. 1:11-cv-00654-UNA
Matter: Patent infringement, channel coding in UMTS, HSDPA
Project: Non-infringement consulting
- L208. 2011 **O'Melveny & Myers LLP**
Case: MobileMedia Ideas, LLC v. Apple, Inc.
District of Delaware, Case No. 1:10-cv-00258-SLR-MPT
Matter: Patent infringement, voice control, call rejection in mobile phones
Project: Source code review, prior art research, declaration, claim invalidity
expert report, non-infringement expert report, deposition, jury trial
testimony

- L209. 2011 **Wilmer Cutler Pickering Hale and Dorr**
Case: Apple, Inc. v. Samsung Electronics Co.
Northern district of California, Case No. 5:11-cv-01846-LHK
Matter: Patent infringement, channel coding in CDMA, E-AGCH, TFCI
Project: Prior art research, claim construction consulting
- L210. 2011 **Weil, Gotshal & Manges LLP**
Case: Vizio, Inc. v. Renesas Electronics America, Inc.
ITC Investigation No. 337-TA-789
Matter: Patent infringement, HD television transmission and reception
Project: Claim invalidity consulting
- L211. 2011 **Shapiro Cohen**
Case: TenXc Wireless Inc. v. Andrew LLC
TenXc Wireless Inc. v. Mobi Antenna Technologies Ltd.
Matter: Patent infringement, antenna design, sectorized cellular network
Project: Claim validity consulting
- L212. 2010 **Fish & Richardson P.C.**
Case: Vizio, Inc., v. LG Electronics, Inc.
ITC Investigation No. 337-TA-733
Matter: Patent infringement, HD television transmission and reception
Project: Claim charts, claim construction expert report, deposition
- L213. 2010 **Fish & Richardson P.C.**
Case: Vizio, Inc., v. LG Electronics, Inc.
District of Maryland, Case No. 1:09-cv-1481-BEL
Matter: Patent infringement, HD television transmission and reception
Project: Claim charts, claim construction expert report, deposition
- L214. 2008 **Kaye Scholer LLP**
Case: eBay Inc. v. IDT.
Western district of Arkansas, Case No. 4:08-cv-4015-HFB
Matter: Patent infringement, long distance communication using Internet
Project: Prior art research, claim construction consulting
- L215. 2008 **Simpson Thacher & Bartlett LLP**
Case: Commil USA, LLC v. Cisco Systems, Inc.
Eastern district of Texas, Case No. 2:07-cv-00341-DF-CE
Matter: Patent infringement, two-level wireless protocol
Project: Prior art research
- L216. 2006 **Woodfill and Pressler**
Case: Charles Russell v. Interinsurance Exchange of the Auto Club
Harris County, Texas, Case No. 2005-19706
Matter: House fire and insurance claim

Project: Determining user location using cellular phone records, expert report, deposition, jury trial testimony

Consulting History

From:	11/2022	Abe, Ikubo & Katayama (Client: ASUS Japan K.K.)
To:	12/2022	Japan
Duties:		Analyze 3GPP standards contribution.
From:	8/2022	JLP Enterprise Holdings LLC
To:	8/2022	Dallas, TX
Duties:		Analyze patents for essentiality to 5G standards.
From:	5/2022	Washington Utilities and Transportation Commission DOCKET UT-181051
To:	12/2022	Olympia, WA
Duties:		Analyze cause(s) of network failure, provide testimony on behalf of Staff, deposition, hearing testimony
From:	8/2021	Carter Arnett (Client: G+ Communications)
To:	5/2022	Dallas, TX
Duties:		Analyze patents for essentiality to 4G and 5G standards.
From:	2/2021	ExpertsDirect Pty Ltd
To:	3/2021	Australia
Duties:		Analyze antenna arrays.
From:	11/2020	Licks Attorneys
To:	1/2021	Brazil
Duties:		Analyze patents for essentiality to 4G standards.
From:	6/2019	Fish & Richardson, P.C. (Client: Huawei)
To:	5/2022	Dallas, TX
Duties:		Analyze patents for essentiality to 3G, 4G, and 5G standards.
From:	1/2013	Heim, Payne & Chorush, LLP
To:	3/2013	Houston, TX
Duties:		Analyze patents on wireless technologies.
From:	4/2007	Collin County Sheriff's Office
To:	5/2007	McKinney, TX
Duties:		Analyzed cellular record data and determined user location in a double-homicide investigation.
From:	4/2004	Allegiant Integrated Solutions
To:	5/2004	Fort Worth, TX

Duties: Designed and developed an integrated set of tools for fast deployment of wireless networks. The tools optimize the placement of Access Points and determine their respective channel allocations to minimize interference and maximize capacity.

From: 3/2002 **Input/Output Incorporated**
 To: 4/2002 New Orleans, LA
 Duties: Designed and implemented an algorithm in MATLAB for optimizing the frequency selection process used by sonar for scanning the bottom of the ocean.

From: 6/1998 **Teleware Corporation**
 To: 7/1998 Seoul, South Korea
 Duties: Designed and developed a software package for analyzing the capacity in a CDMA network to maximize the number of subscribers.

Employment History

From: 5/2023 **University of North Texas**
 To: Present Denton, TX
 Position: *Tenured Professor Department of Computer Science and Engineering*
 Conducting research on MIMO and 5G cellular networks. Teaching telecommunication courses. Advising graduate and undergraduate students.

From: 1/2015 **University of North Texas**
 To: 8/2021 Denton, TX
 Position: *Associate Chair of Graduate Studies Department of Computer Science and Engineering*
 In charge of all administrative duties related to the Master's and Ph.D. programs in the department.

From: 5/2008 **University of North Texas**
 To: 5/2023 Denton, TX
 Position: *Tenured Associate Professor Department of Computer Science and Engineering*
 Conducting research on cellular networks and wireless sensor networks. Teaching wireless communication courses. Advising graduate and undergraduate students.

From: 9/2002 **University of North Texas**
 To: 5/2008 Denton, TX
 Position: *Assistant Professor Department of Computer Science and Engineering*
 Conducting research on WCDMA/UMTS wireless networks. Teaching wireless communication and computer architecture courses. Advising graduate and undergraduate students.

From: 1/2002 **University of New Orleans**
To: 8/2002 New Orleans, LA
Position: *Assistant Professor Department of Electrical Engineering*
Designed and taught two new courses “Computer Systems Design I and II”. Developed a Computer Engineering Curriculum with strong hardware-design emphasis. Formed a wireless research group. Advised graduate and undergraduate students.

From: 10/2000 **Comspace Corporation**
To: 12/2001 Coppell, TX
Position: *Senior Systems Engineer*
Designed, coded (in MATLAB), and simulated Viterbi decoding, Turbo coding, trellis coded modulation (TCM), and Reed-Muller codes. Optimized soft decision parameters and interleavers for additive white Gaussian and Rayleigh faded channels. Extended the control and trunking of push-to-talk Logic Trunked Radio (LTR) to include one-to-one and one-to-many voice and data messaging.

From: 8/1997 **MinMax Corporation**
To: 5/1999 Saint Louis, MO
Position: *Research Associate*
Designed software packages that provide the tools to flexibly allocate capacity in a CDMA network and maximize the number of subscribers. Analyzed and simulated different audio compression schemes. Validated, simulated (logical and timing), and developed the hardware architecture for an ATM switch capable of channel group switching.

From: 8/1994 **Washington University**
To: 8/2000 Saint Louis, MO
Position: *Research and Teaching Assistant*
Taught, consulted, and graded Circuit Analysis at the undergraduate level and Network Design at the graduate level.

Publications

Conference Proceedings

- C1. R. Chataut, **R. Akl**, “An Adaptive User Scheduling Algorithm for 6G Massive MIMO Systems,” *26th IEEE International Conference on Advanced Communications Technology (IEEE ICACT 2024)*, February 2024, pp. 1475-1482.
- C2. R. Chataut, **R. Akl**, U.K. Dey, “An Adaptive User Scheduling Algorithm for 6G Massive MIMO Systems,” *25th IEEE International Conference on Advanced Communications Technology (IEEE ICACT 2023)*, February 2023, pp. 158-163.

- C3. U.K. Dey, **R. Akl**, R. Chataut, “Performance Improvement in Cellular V2X (CV2X) by Using Massive MIMO Jacobi Detector,” *2022 IEEE 19th International Conference on Smart Communities: Improving Quality of Life Using ICT, IoT and AI (HONET)*, December 2022, pp. 122-127.
- C4. U.K. Dey, **R. Akl**, R. Chataut, “Performance Improvement in Cellular V2X (CV2X) by Using Low Density Parity Check (LDPC) Code,” *2022 IEEE 13th Annual Ubiquitous Computing, Electronics & Mobile Communication Conference (UEMCON)*, October 2022, pp. 296-302.
- C5. M. Robaei, **R. Akl**, “Distributed Compressed Sensing Karhunen-Loève Expansion - Application to Millimeter-Wave Resource Allocation Through Group Beamforming,” *2022 IEEE International Workshop Technical Committee on Communications Quality and Reliability (CQR)*, September 2022, pp. 7-12.
- C6. R. Chataut, **R. Akl**, U.K. Dey, “Massive MIMO Uplink Signal Detector for 5G and Beyond Networks,” *2022 IEEE Texas Symposium on Wireless and Microwave Circuits and Systems (WMCS)*, April 2022, 7 pgs.
- C7. M. Robaei, **R. Akl**, R. Chataut, U.K. Dey, “Adaptive Millimeter-Wave Channel Estimation and Tracking,” *2022 24th International Conference on Advanced Communication Technology (ICACT)*, February 2022, pp. 23-28.
- C8. U.K. Dey, **R. Akl**, R. Chataut, “Throughput Improvement in Vehicular Communication by Using Low Density Parity Check (LDPC) Code,” *IEEE CCWC 2022 The 12th Annual Computing and Communication Workshop and Conference*, January 2022, pp. 836-843.
- C9. U.K. Dey, **R. Akl**, R. Chataut, M. Robaei, “Selective MIMO in Vehicular Communication for Reliable Safety Services and High Speed Non-Safety Services,” *2021 IEEE 12th Annual Ubiquitous Computing, Electronics & Mobile Communication Conference (UEMCON)*, 2021, pp. 785-790, 6 pgs.
- C10. R. Chataut, **R. Akl**, U.K. Dey, “An Efficient and Fast-convergent Detector for 5G and Beyond Massive MIMO Systems,” *2021 IEEE 12th Annual Ubiquitous Computing, Electronics & Mobile Communication Conference (UEMCON)*, 2021, pp. 866-872, 7 pgs.
- C11. M. Robaei, **R. Akl**, “Millimeter-Wave Blockage Modeling And Mitigation,” *2021 IEEE International Workshop Technical Committee on Communications Quality and Reliability (CQR 2021)*, 2021, 6 pgs.
- C12. M. Robaei, **R. Akl**, “Characterizing Non-Stationary Millimeter-Wave Communication Using Fuzzy Entropy,” *2021 55th Annual Conference on Information Sciences and Systems (CISS)*, 2021, 6 pgs.

- C13. M. Robaei, **R. Akl**, R. Chataut, U.K. Dey, “Adaptive Millimeter-Wave Channel Estimation and Tracking,” *2021 23rd International Conference on Advanced Communication Technology (ICACT)*, February 2021, pp. 23-28, 6 pgs.
- C14. U.K. Dey, **R. Akl**, R. Chataut, M. Robaei, “Modified PHY Layer for High Performance V2X Communication using 5G NR,” *IEEE UEMCON 11th IEEE Annual Ubiquitous Computing, Electronics & Mobile Communication Conference*, October 2020, pp. 137-142, 6 pgs.
- C15. R. Chataut, **R. Akl**, “An Efficient and Fair Scheduling for Downlink 5G Massive MIMO Systems,” *IEEE Texas Symposium on Wireless and Microwave Circuits and Systems*, June 2020, paper no.TSWMCS2020-39, 8 pgs.
- C16. R. Chataut, **R. Akl**, “Efficient and Low-Complexity Iterative Detectors for 5G Massive MIMO Systems,” *IEEE DCOSS 2020 International Conference on Distributed Computing in Sensor Systems*, May 2020, pp. 442-449, 8 pgs.
- C17. U.K. Dey, **R. Akl**, R. Chataut, “High Throughput Vehicular Communication Using Spatial Multiplexing MIMO,” *IEEE CCWC 2020 The 10th Annual Computing and Communication Workshop and Conference*, January 2020, paper no. 1570613408, 6 pgs.
- C18. R. Chataut, **R. Akl**, M. Robaei, “Accelerated and Preconditioned Refinement of Gauss-Seidel Method for Uplink Signal Detection in 5G Massive MIMO Systems,” *IEEE CCWC 2020 The 10th Annual Computing and Communication Workshop and Conference*, January 2020, paper no. 1570605343, 7 pgs.
- C19. M. Robaei, **R. Akl**, “Examining Spatial Consistency for Millimeter-Wave Massive MIMO Channel Estimation in 5G-NR,” *IEEE ICCE 2020 The 38th International Conference on Consumer Electronics*, January 2020, paper no. 1570596880, 6 pages.
- C20. R. Chataut, **R. Akl**, “Channel Gain Based User Scheduling for 5G Massive MIMO Systems,” *IEEE HONET-ICT 2019 The 16th International Conference on Smart Cities: Improving Quality of Life Using ICT & IoT and AI*, October 2019, paper no. 1570565594, 5 pgs.
- C21. M. Robaei, **R. Akl**, “Time-Variant Broadband mmWave Channel Estimation Based on Compressed Sensing,” *IEEE UEMCON 2019 The 10th Annual Ubiquitous Computing, Electronics & Mobile Communication Conference*, October 2019, paper no. 1570577430, 7 pages.
- C22. R. Chataut, **R. Akl**, U. Dey, “Least Square Regressor Selection Based Detection for Uplink 5G Massive MIMO Systems,” *IEEE WAMICON 2019 The 20th Annual IEEE Wireless and Microwave Technology Conference*, April 2019, paper no. 1570524727, 6 pgs.

- C23. R. Chataut, **R. Akl**, "Huber Fitting Based ADMM Detection for Uplink 5G Massive MIMO Systems," *IEEE UEMCON 2018 The 9th Annual Ubiquitous Computing, Electronics & Mobile Communication Conference*, November 2018, paper no. 1570492416, 5 pgs.
- C24. R. Chataut, **R. Akl**, "Efficient and Low Complex Uplink Detection for 5G Massive MIMO Systems," *IEEE WAMICON 2018 The 19th Annual Wireless and Microwave Technology Conference*, April 2018, paper no. 1570431593, 6 pgs.
- C25. R. Chataut, **R. Akl**, "Optimal Pilot Reuse Factor Based on User Environments in 5G Massive MIMO," *IEEE CCWC 2018 The 8th Annual Computing and Communication Workshop Conference*, January 2018, paper no. 1570413394, 6 pgs.
- C26. S. Alotaibi, **R. Akl**, "Radio Resource Management in LTE Femtocell Networks," *IEEE NCA '17 International Symposium on Network Computing and Applications*, November 2017, paper no. 117, 5 pgs.
- C27. U. Sawant, **R. Akl**, "Subcarrier Allocation in LTE Network Deployment with Mobility," *IEEE UEMCON 2017 8th Annual Ubiquitous Computing, Electronics and Mobile Communication Conference*, October 2017, paper no. 1570349184, 8 pgs.
- C28. S. Alotaibi, **R. Akl**, "Packet Scheduling Bandwidth Type-Based Mechanism for LTE," *IEEE UEMCON 2017 8th Annual Ubiquitous Computing, Electronics and Mobile Communication Conference*, October 2017, paper no. 1570394639, 6 pgs.
- C29. S. Alotaibi, **R. Akl**, "Dynamic Fractional Frequency Reuse (FFR) Scheme for Two-Tier Network in LTE," *IEEE UEMCON 2017 8th Annual Ubiquitous Computing, Electronics and Mobile Communication Conference*, October 2017, paper no. 1570394969, 6 pgs.
- C30. U. Sawant, **R. Akl**, "Evaluation of Adaptive and Non Adaptive LTE Fractional Frequency Reuse Mechanisms," *IEEE WOCC 2017 The 26th Annual Wireless and Optical Communications Conference*, April 2017, paper no. 1570341174, 6 pgs.
- C31. S. Alotaibi, **R. Akl**, "Range-Based Scheme for Adjusting Transmission Power for Femtocells in Co-Channel Deployment," *IEEE WTS 2017 The 16th Annual Wireless Telecommunications Symposium*, April 2017, paper no. 1570334744, 5 pgs.
- C32. U. Sawant, **R. Akl**, "A Novel Metric to Study the Performance of Sectorized Fractional Frequency Reuse Techniques in LTE," *IEEE WTS 2017 The 16th Annual Wireless Telecommunications Symposium*, April 2017, paper no. 1570338498, 7 pgs.

- C33. S. Alotaibi, **R. Akl**, “Dynamic Frequency Partitioning Scheme for LTE HetNet Networks Using Fractional Frequency Reuse,” *IEEE WCNC '17 Wireless Communications and Networking Conference*, March 2017, paper no. 1570332420, 5 pgs., demo and poster.
- C34. U. Sawant, **R. Akl**, “Performance Evaluation of Network Productivity for LTE Heterogenous Networks with Reward-Penalty Weights Assessment,” *IEEE CCWC 2017 The 7th Annual Computing and Communication Workshop Conference*, January 2017, paper no. 1570328396, 6 pgs.
- C35. S. Alotaibi, **R. Akl**, “Self-Adjustment Downlink Transmission Power for Femtocells in Co-Channel Deployment in Heterogeneous Networks,” *IEEE CCWC 2017 The 7th Annual Computing and Communication Workshop Conference*, January 2017, paper no. 1570326815, 6 pgs.
- C36. U. Sawant, **R. Akl**, “Performance Evaluation of Sectorized Fractional Frequency Reuse Techniques Using Novel Metric,” *IEEE ISCC 2016 The Twenty-First IEEE Symposium on Computers and Communications*, June 2016, paper no. 1570275270, 7 pgs.
- C37. R. Tidwell, S. Akumalla, S. Karlaputi, **R. Akl**, K. Kavi, and D. Struble, “Evaluating the Feasibility of EMG and Bend Sensors for Classifying Hand Gestures,” *1st International Conference on Multimedia and Human Computer Interaction*, July 2013, paper no. 63, 8 pgs.
- C38. **R. Akl**, K. Pasupathy, and M. Haidar, “Anchor Nodes Placement for Effective Passive Localization,” *2011 IEEE International Conference on Selected Topics in Mobile and Wireless Networks (iCOST)*, October 2011, paper no. 1569490799, pp. 127 - 132.
- C39. **R. Akl**, P. Kadiyala, and M. Haidar, “Non-Uniform Grid-Based Routing in Sensor Networks,” *9th IEEE Malaysia International Conference on Communications*, December 2009, paper no. 1569243649, pp. 536 - 540.
- C40. M. Haidar, M. Al-Rizzo, Y. Chan, **R. Akl**, M. Bouharras, “Throughput Validation of an Advanced Channel Assignment Algorithm in IEEE 802.11 WLAN,” *ICCSN 2009 – International Conference on Communication Software and Networks*, February 2009, paper no. P385, pp. 801 - 806.
- C41. **R. Akl** and D. Keathly, “Robocamp: Encouraging Young Women to Embrace STEM,” 4th Annual TETC Best Practices Conference, February 2009, 13 pgs.
- C42. M. Haidar, R. Ghimire, M. Al-Rizzo, **R. Akl**, Y. Chan, “Channel Assignment in an IEEE 802.11 WLAN Based on Signal-to-interference Ratio,” *IEEE CCECE* –

Canadian Conference on Electrical and Computer Engineering: Communications and Networking, May 2008, paper no. 1569092894, pp. 1169 - 1174.

- C43. H. Al-Rizzo, M. Haidar, **R. Akl**, and Y. Chan, "Enhanced Channel Assignment and Load Distribution in IEEE 802.11 WLANs," *IEEE International Conference on Signal Processing and Communication*, November 2007, paper no. 1569042132, pp. 768 - 771.
- C44. **R. Akl** and Y. Saravanos, "Hybrid Energy-Aware Synchronization Algorithm in Wireless Sensor Networks," *18th Annual IEEE International Symposium on Personal, Indoor and Mobile Radio Communications*, September 2007, paper no. 692, 5 pgs.
- C45. M. Haidar, **R. Akl**, and H. Al-Rizzo, "Channel Assignment and Load Distribution in a Power-Managed WLAN," *18th Annual IEEE International Symposium on Personal, Indoor and Mobile Radio Communications*, September 2007, paper no. 463, 5 pgs.
- C46. D. Keathly and **R. Akl**, "Attracting and Retaining Women in Computer Science and Engineering: Evaluating the Results," *Proceedings of American Society for Engineering Education: ASEE Annual Conference*, June 2007, paper no. AC 2007-1229, 10 pgs.
- C47. M. Haidar, **R. Akl**, H. Al-Rizzo, Y. Chan, R. Adada, "Optimal Load Distribution in Large Scale WLAN Networks Utilizing a Power Management Algorithm," *Proceedings of IEEE Sarnoff Symposium*, May 2007, 5 pgs.
- C48. R. Dantu, P. Kolan, **R. Akl**, and K. Loper, "Classification of Attributes and Behavior in Risk Management Using Bayesian Networks," *Proceedings of IEEE Intelligence and Security Informatics Conference*, May 2007, pp. 71-74.
- C49. **R. Akl** and A. Arepally, "Dynamic Channel Assignment in IEEE 802.11 Networks," *Proceedings of IEEE Portable 2007: International Conference on Portable Information Devices*, March 2007, pp 309-313.
- C50. **R. Akl** and U. Sawant, "Grid-based Coordinated Routing in Wireless Sensor Networks," *Proceedings of IEEE CCNC 2007: Consumer Communications and Networking Conference*, January 2007, pp. 860-864.
- C51. **R. Akl** and A. Arepally, "Simulation of Throughput in UMTS Networks with Different Spreading Factors," *Proceedings of IEEE VTC Fall 2006: Vehicular Technology Conference*, September 2006, pp. C1-5.
- C52. A. Alhabsi, H. Al-Rizzo, and **R. Akl**, "Parity Assisted Decision Making for QAM Modulation," *International Conference on Mobile Computing and Wireless Communications*, September 2006, paper no. 1568988776, 5 pgs.

- C53. **R. Akl** and R. Garlick, "Retention and Recruitment of Women in Computer Engineering," *ICEE 2006: International Conference on Engineering Education*, July 2006, paper no. 3318, 5 pgs.
- C54. R. Garlick and **R. Akl**, "Intra-Class Competitive Assignments in CS2: A One-Year Study," *ICEE 2006: International Conference on Engineering Education*, July 2006, paper no. 3325, 5 pgs.
- C55. **R. Akl**, D. Tummala, and X. Li, "Indoor Propagation Modeling at 2.4 GHz for IEEE 802.11 Networks," *WNET 2006: Wireless Networks and Emerging Technologies*, July 2006, paper no. 510-014, 6 pgs.
- C56. P. Chen, K. Kavi, and **R. Akl**, "Performance Enhancement by Eliminating Redundant Function Execution," *Proceedings of IEEE: 39th Annual Simulation Symposium*, April 2006, pp. 143-150.
- C57. **R. Akl** and S. Nguyen, "Capacity Allocation in Multi-cell UMTS Networks for Different Spreading Factors with Perfect and Imperfect Power Control," *Proceedings of IEEE CCNC 2006: Consumer Communications and Networking Conference*, January 2006, vol. 2, pp. 928-932.
- C58. W. Li, K. Kavi, and **R. Akl**, "An Efficient Non-Preemptive Real-Time Scheduling," *18th International Conference on Parallel and Distributed Computing Systems*, Las Vegas, NV, September 2005, pp. 154-160.
- C59. S. Nguyen and **R. Akl**, "Approximating User Distributions in WCDMA Networks Using 2-D Gaussian," *CCCC20T 05: International Conference on Computing, Communications, and Control Technologies*, July 2005, 5 pgs.
- C60. **R. Akl** and S. Park, "Optimal Access Point Selection and Traffic Allocation in IEEE 802.11 Networks," *Proceedings of 9th World Multiconference on Systemics, Cybernetics and Informatics (WMSCI 2005): Communication and Network Systems, Technologies and Applications*, July 2005, vol. 8, pp. 75-79.
- C61. **R. Akl**, M. Naraghi-Pour, M. Hegde, "Throughput Optimization in Multi-Cell CDMA Networks," *IEEE WCNC 2005 - Wireless Communications, and Networking Conference*, March 2005, vol. 3, pp. 1292-1297.
- C62. **R. Akl**, "Subscriber Maximization in CDMA Cellular Networks," *Proceedings of CCCT 04: International Conference on Computing, Communications, and Control Technologies*, August 2004, vol. 3, pp. 234-239.
- C63. **R. Akl** and A. Parvez, "Global versus Local Call Admission Control in CDMA Cellular Networks," *Proceedings of CITSA 04: Communications, Information and Control Systems, Technologies and Applications*, July 2004, vol. 2, pp. 283-288.

- C64. **R. Akl** and A. Parvez, "Impact of Interference Model on Capacity in CDMA Cellular Networks," *Proceedings of SCI 04: Communication and Network Systems, Technologies and Applications*, July 2004, vol. 3, pp. 404-408. Selected as **best paper** of those presented in the session: Tele-Communication Systems, Technologies and Application II.
- C65. **R.G. Akl**, M.V. Hegde, M. Naraghi-Pour, P.S. Min, "Call Admission Control Scheme for Arbitrary Traffic Distribution in CDMA Cellular Systems," *IEEE Wireless Communications and Networking Conference*, September 2000, vol. 1, pp. 465-470.
- C66. **R.G. Akl**, M.V. Hegde, M. Naraghi-Pour, P.S. Min, "Cell Placement in a CDMA Network," *IEEE Wireless Communications and Networking Conference*, September 1999, vol. 2, pp. 903-907.
- C67. **R.G. Akl**, M.V. Hegde, P.S. Min, "Effects of Call Arrival Rate and Mobility on Network Throughput in Multi-Cell CDMA," *IEEE International Conference on Communications*, June 1999, vol. 3, pp. 1763-1767.
- C68. **R.G. Akl**, M.V. Hegde, M. Naraghi-Pour, P.S. Min, "Flexible Allocation of Capacity in Multi-Cell CDMA Networks," *IEEE Vehicular Technology Conference*, May 1999, vol. 2, pp. 1643-1647.

Journal Publications

- J1. R. Chataut, M. Nankya, **R. Akl**, "6G Networks and the AI Revolution – Exploring Technologies, Applications, and Emerging Challenges," *Sensors 2024*, March 2024, 29 pgs.
- J2. R. Chataut, **R. Akl**, "An Adaptive User Scheduling Algorithm for 6G Massive MIMO Systems," *IEEE Transactions on Advanced Communications Technology*, November 2023, 8 pgs.
- J3. M. Nankya, R. Chataut, **R. Akl**, "Securing Industrial Control Systems: Components, Cyber Threats, and Machine Learning-Driven Defense Strategies," *Sensors 2023*, October 2023, 41 pgs.
- J4. R. Chataut, A. Phoummalayvane, **R. Akl**, "Unleashing the Power of IoT: A Comprehensive Review of IoT Applications and Future Prospects in Healthcare, Agriculture, Smart Homes, Smart Cities, and Industry 4.0," *Sensors 2023*, August 2023, 19 pgs.
- J5. M. Robaei, **R. Akl**, "Quadratic Displacement Operators—Theory and Application to Millimeter-Wave Channel Tracking," *IEEE Transactions on Wireless Communications*, January 2023, Vol. 22, No. 1, 15 pgs.

- J6. M. Robaei, **R. Akl**, “Continuous Compressed Sensing Hilbert-Schmidt Integral Operator,” *IEEE Access*, August 2022, pp. 80264-80276.
- J7. R. Chataut, **R. Akl**, U.K. Dey, M. Robaei, “SSOR Preconditioned Gauss-Seidel Detection and Its Hardware Architecture for 5G and beyond Massive MIMO Networks,” *Electronics 2021 ISSN 2079-9292*, 10(5), 578, *Special Issue MIMO for Next Generation Wireless Systems*, March 2021, 17 pgs.
- J8. R. Chataut, **R. Akl**, “Massive MIMO Systems for 5G and Beyond Networks – Overview, Recent Trends, Challenges, and Future Research Direction,” *Sensors* 2020, 20(10), 2753, May 2020.
- J9. R. Chataut, **R. Akl**, “Massive MIMO Systems for 5G,” *Encyclopedia* 2020, doi:10.32545, 2020, (ISSN 2309-3366).
- J10. S. Alotaibi, **R. Akl**, “Range-Based Scheme for Adjusting Transmission Power of Femtocell in Co-Channel Deployment,” *International Journal of Interdisciplinary Telecommunications and Networking*, IJITN Vol. 10, No. 4, pgs. 14-24, 2018.
- J11. U. Sawant, **R. Akl**, “Adaptive and Non Adaptive LTE Fractional Frequency Reuse Mechanisms Mobility Performance,” *Advances in Science, Technology and Engineering Systems Journal*, ASTES Vol. 3, No. 3, 02-11, 11 pgs., 2018.
- J12. M. Haidar, H.M. Al-Rizzo, **R. Akl**, and Z. Elbazzal, “The Effect of an Enhanced Channel Assignment Algorithm in an IEEE 802.11 WLAN,” *World Scientific and Engineering Academy and Society Transactions on Communications*, WSEAS, Vol. 8, Issue 12, December 2009.
- J13. **R. Akl**, P. Kadiyala, and M. Haidar, “Non-Uniform Grid-Based Coordinated Routing in Wireless Sensor Networks,” *Journal of Sensors*, article ID 491349, volume 2009, 11 pages.
- J14. M. Haidar, M. Al-Rizzo, Y. Chan, **R. Akl**, “User-Based Channel Assignment Algorithm in a Load-Balanced IEEE 802.11 WLAN,” *International Journal of Interdisciplinary Telecommunications & Networking (IJITN)*, April-June 2009, 1(2), pp. 66-81.
- J15. **R. Akl**, D. Keathly, and R. Garlick, “Strategies for Retention and Recruitment of Women and Minorities in Computer Science and Engineering,” *iNEER Special Volume: Innovations 2007- World Innovations in Engineering Education and Research*, 9 pgs., 2007.
- J16. R. Garlick and **R. Akl**, “Motivating and Retaining CS2 Students with a Competitive Game Programming Project,” *iNEER Special Volume: Innovations 2007- World Innovations in Engineering Education and Research*, 9 pgs., 2007.

- J17. **R. Akl** and S. Nguyen, "UMTS Capacity and Throughput Maximization for Different Spreading Factors," *Journal of Networks*, July 2006, vol. 1, issue 3, pp. 40-49. ISSN: 1796-2056
- J18. W. Li, K. Kavi, and **R. Akl**, "A Non-preemptive Scheduling Algorithm for Soft Real-time Systems," *Journal of Computer and Electrical Engineering*, 2006, vol. 32, 18 pgs. ISSN: 0045-7906
- J19. **R. Akl**, A. Parvez, and S. Nguyen, "Effects of Interference on Capacity in Multi-Cell CDMA Networks," *Journal of Systemics, Cybernetics and Informatics*, 2006, vol. 3, no. 1, p825612, 7 pgs. ISSN: 1690-4524
- J20. **R.G. Akl**, M. Hegde and M. Naraghi-Pour, "Mobility-based CAC Algorithm for Arbitrary Traffic Distribution in CDMA Cellular Systems," *IEEE Transactions on Vehicular Technology*, March 2005, vol. 54, no. 2, pp. 639-651.
- J21. **R.G. Akl**, M.V. Hegde, M. Naraghi-Pour, P.S. Min, "Multi-Cell CDMA Network Design," *IEEE Transactions on Vehicular Technology*, May 2001, vol. 50, no. 3, pp. 711-722.

Technical Papers

- T1. J. Williams, **R. Akl**, et al, "Flight Control Subsystem," *The Eagle Feather*, Special Section: Undergraduate Research Initiative in Engineering, University of North Texas, Vol. 7, 2010.
- T2. **R.G. Akl**, M.V. Hegde, A. Chandra, P.S. Min, "CDMA Capacity Allocation and Planning," Technical Document, Washington University Department of Electrical Engineering WUEE-98, April 1998.

Book Chapters

- B1. R. Akl, Y. Saravanos, and M. Haidar, "Chapter 18: Hybrid Approach for Energy-Aware Synchronization in Sensor Networks," *Sustainable Wireless Sensor Networks*, December 2010, pgs. 413-429, ISBN: 978-953-307-297-5.
- B2. K. Kavi, **R. Akl** and A. Hurson, "Real-Time Systems: An Introduction and the State-of-the-Art," *Encyclopedia of Computer Science and Engineering*, John Wiley & Sons, Volume 4, January 2009, pgs. 2369-2377.
- B3. **R. Akl** and K. Kavi, "Chapter 12: Modeling and Analysis using Computational Tools," *Introduction to Queuing Theory: Modeling and Analysis*, Birkhauser Boston, December 2008, pgs. 295-320.

Technical Presentations

- P1. “Bio-Com Project,” Raytheon, Richardson TX, May 2012, (invited).
- P2. “Bio-Com Project,” Net-Centric Software and Systems I/UCRC Meeting, Denton TX, December 2011, (invited).
- P3. “Student Outreach Report: Robocamp,” College of Engineering Advisory Board Meeting, Denton TX, May 2011, (invited).
- P4. “Robocamp: Encouraging Young Women to Embrace STEM,” 4th Annual TETC Best Practices Conference, Austin TX, February 2009, (invited).
- P5. “Self-Configuring Wireless MEMS Network (demo),” Southern Methodist University, Dallas TX, January 2008, (invited).
- P6. “Energy-aware Routing and Hybrid Synchronization in Sensor Networks,” *Southern Methodist University*, Dallas TX, September 2007, (invited).
- P7. “Retention and Recruitment of Women in Computer Engineering,” *ICEE 2006: International Conference on Engineering Education*, Puerto Rico, July 2006, (refereed).
- P8. “Capacity Allocation in Multi-cell UMTS Networks for Different Spreading Factors with Perfect and Imperfect Power Control,” *IEEE CCNC 2006: Consumer Communications and Networking Conference*, Las Vegas, NV, January 2006, (refereed).
- P9. “Research, Teaching, and Outreach,” CSE Advisory Council Meeting, *UNT Research Park*, Denton, TX, December 2005, (invited).
- P10. “Wi-Fi and WCDMA Network Design,” *University of Arkansas*, Little Rock, AR, April 2005, (invited).
- P11. “Wi-Fi and WCDMA Network Design,” *Southern Methodist University*, Dallas, TX, March 2005, (invited).
- P12. “Current Research in Wireless at UNT,” *Nortel Networks*, Richardson, TX, October 2004, (invited).
- P13. “Subscriber Maximization in CDMA Cellular Networks,” *International Conference on Computing, Communications, and Control Technologies*, Austin, TX, August 2004, (refereed).
- P14. “Global versus Local Call Admission Control in CDMA Cellular Networks,” *International Conference on Cybernetics and Information Technologies, Systems*

and Applications, Orlando, FL, July 2004, (refereed).

- P15. "Impact of Interference Model on Capacity in CDMA Cellular Networks," *8th World Multi-Conference on Systemics, Cybernetics, and Informatics*, Orlando, FL, July 2004, (refereed).
- P16. "CDMA Network Design," IEEE Communications Society – New Orleans Chapter, New Orleans, LA, May 2002, (invited).
- P17. "Cell Design to Maximize Capacity in CDMA Networks," Louisiana State University, Baton Rouge, LA, April 2002, (invited).
- P18. "Call Admission Control Scheme for Arbitrary Traffic Distribution in CDMA Cellular Systems," *IEEE Wireless Communications and Networking Conference*, Chicago, IL, September 2000, (refereed).
- P19. "Cell Placement in a CDMA Network," *IEEE Wireless Communications and Networking Conference*, September 1999, (refereed).
- P20. "Effects of Call Arrival Rate and Mobility on Network Throughput in Multi-Cell CDMA," *IEEE International Conference on Communications*, June 1999, (refereed).
- P21. "Flexible Allocation of Capacity in Multi-Cell CDMA Networks," *IEEE Vehicular Technology Conference*, May 1999, (refereed).
- P22. "CCAP: A Strategic Tool for Managing Capacity of CDMA Networks," Teleware Co. Ltd., Seoul, South Korea, 1998, (invited).

Courses Developed

- CSCE 5933: LTE Physical Layer Using MATLAB.
Research issues in the design of LTE physical layer and simulate using MATLAB. Topics include modulation and coding, OFDM, channel modeling, MIMO, and link adaption.
- CSCE 6590: Advanced Topics in Wireless Communications & Networks: 4G/LTE.
Research issues in the design of next generation wireless networks: cellular systems, medium access techniques, signaling, mobility management, control and management for mobile networks, wireless data networks, Internet mobility, quality-of-service for multimedia applications, caching for wireless web access, and ad hoc networks.
- CSCE 5933: Fundamentals of VoIP.

Fundamentals of VoIP, with emphasis on network infrastructure implementation and security. Topics include IP protocol suite, SS7, speech-coding techniques, quality of service, session initiation protocol, and security issues.

- CSCE 5540: Introduction to Sensor Networks.
Topics include: design implications of energy (hardware and software), and otherwise resource-constrained nodes; network self-configuration; services such as routing under network dynamics, localization, time-synchronization and calibration; distributed data management, in-network aggregation and collaborative signal processing, programming tools and language support.
- CSCE 5510. Wireless Communication.
Point-to-point signal transmission through a wireless channel, channel capacity, channel encoding, and multi-user transmissions. First, second, and third generation cellular systems, and mobility management.
- CSCE 3510. Introduction to Wireless Communication.
Fundamentals of wireless communications and networking, with emphasis on first, second, and third generation cellular systems. Topics include point-to-point signal transmission through a wireless channel, cellular capacity, multi-user transmissions, and mobility management.
- CSCE 3020. Communications Systems.
Introduction to the concepts of transmission of information via communication channels. Amplitude and angle modulation for the transmission of continuous-time signals. Analog-to-digital conversion and pulse code modulation. Transmission of digital data. Introduction to random signals and noise and their effects on communication. Optimum detection systems in the presence of noise.
- ENEE 3583. Computer Systems Design I (UNO).
The design process of digital computer systems is studied from the instruction set level, system architecture level, and digital logic level. Topics include machine organization, register transfer notation, processor design, memory design, and input/output considerations. Includes semester project.
- ENEE 3584. Computer Systems Design II (UNO).
The design and evaluation of contemporary computer systems are analyzed to compare the performance of different architectures. Topics include performance metrics, computer arithmetic, pipelining, memory hierarchies, and multiprocessor systems.
- ENEE 3514. Computer Architecture Laboratory (UNO).
Selected experiments examining programmable logic, VHDL and logic synthesis, and including a final design project, to accompany and complement the lecture course ENEE 3584. Three hours of laboratory.

Courses Taught

Spring 2025

- CSCE 3020.1: Communication Systems (no evaluation yet)

Spring 2024

- CSCE 3020.1: Communication Systems (4.0 / 5.0)

Fall 2023

- CSCE 3010.1: Signals and Systems (3.6 / 5.0)

Spring 2023

- CSCE 3020.1: Communication Systems (4.5 / 5.0)

Fall 2022

- CSCE 3010.1: Signals and Systems (4.4 / 5.0)
- CSCE 6950.743: Dissertation (no evaluation done)

Spring 2022

- CSCE 3020.1: Communication Systems (4.2 / 5.0)
- CSCE 6950.743: Dissertation (no evaluation done)

Fall 2021

- CSCE 3010.1: Signals and Systems (4.2 / 5.0)
- CSCE 5933.1: LTE Physical Layer Using MATLAB (5.0 / 5.0)
- CSCE 6950.743: Dissertation (no evaluation done)

Spring 2021

- CSCE 2610.2: Computer Organization (4.0 / 5.0)
- CSCE 3020.1: Communication Systems (4.2 / 5.0)
- CSCE 6950.743: Dissertation (no evaluation done)

Fall 2020

- CSCE 3010.1: Signals and Systems (4.1 / 5.0)
- CSCE 6940.743: 5G MIMO Systems (no evaluation done)
- CSCE 6950.743: Dissertation (no evaluation done)

Spring 2020

- CSCE 6940.743: 5G MIMO Systems (no evaluation done)
- CSCE 6950.743: Dissertation (no evaluation done)

Fall 2019

- CSCE 5933.3: LTE Physical Layer Using MATLAB (4.3 / 5.0)
- CSCE 6940.743: 5G MIMO Systems (no evaluation done)
- CSCE 6950.743: Dissertation (no evaluation done)

Spring 2019

- CSCE 6940.743: 5G MIMO Systems (no evaluation done)
- CSCE 6940.743: Software Defined Radios (no evaluation done)
- CSCE 6950.743: Dissertation (no evaluation done)

Fall 2018

- CSCE 5933.3: LTE Physical Layer Using MATLAB (4.8 / 5.0)
- CSCE 6940.743: 5G MIMO Systems (no evaluation done)
- CSCE 6950.743: Dissertation (no evaluation done)

Spring 2018

- CSCE 6940.743: 5G MIMO Systems (no evaluation done)
- CSCE 6940.743: Jitter-buffer Management and Interference in VoIP (no evaluation done)
- CSCE 6950.743: Dissertation (no evaluation done)

Fall 2017

- CSCE 5933.3: LTE Physical Layer Using MATLAB (4.9 / 5.0)
- CSCE 6940.743: 5G MIMO Systems (no evaluation done)
- CSCE 6940.743: VoLTE and VoWiFi (no evaluation done)
- CSCE 6950.743: Dissertation (no evaluation done)

Spring 2017

- CSCE 6950.743: Dissertation (no evaluation done)

Fall 2016

- CSCE 5933.3: LTE Physical Layer Using MATLAB (4.7 / 5.0)
- CSCE 6950.743: Dissertation (no evaluation done)

Spring 2016

- CSCE 5950.743: Thesis (no evaluation done)
- CSCE 6950.743: Dissertation (no evaluation done)

Fall 2015

- CSCE 3010.1: Signals and Systems (5.7 / 7.0)
- CSCE 5950.743: Thesis (no evaluation done)
- CSCE 6950.743: Dissertation (no evaluation done)

Spring 2015

- CSCE 5934.743: Directed Study (no evaluation done)
- CSCE 5950.743: Thesis (no evaluation done)
- CSCE 6950.743: Dissertation (no evaluation done)

Fall 2014

- CSCE 3010.1: Signals and Systems (3.32 / 4.00)
- CSCE 5950.743: Thesis (no evaluation done)
- CSCE 6950.743: Dissertation (no evaluation done)
- CSCE 6590.1: Advanced Topics in Wireless Communications & Networks: 4G/LTE (3.79 / 4.00)

Spring 2014

- CSCE 3510.1: Intro to Wireless Communication (808 – Highly Effective)
- CSCE 5510.1: Wireless Communications (808 – Highly Effective)
- CSCE 5950.743: Thesis (no evaluation done)
- CSCE 6950.743: Dissertation (no evaluation done)

Fall 2013

- CSCE 5950.743: Thesis (no evaluation done)
- CSCE 6950.743: Dissertation (no evaluation done)
- CSCE 6590.1: Advanced Topics in Wireless Communications & Networks: 4G/LTE (804 – Highly Effective)

Spring 2013

- CSCE 4890.743: Directed Study (no evaluation done)
- CSCE 5950.743: Thesis (no evaluation done)

- CSCE 6940.743: Individual Research (no evaluation done)
- CSCE 6950.743: Dissertation (no evaluation done)

Fall 2012

- CSCE 3010.1: Signals and Systems (793 – Highly Effective)
- CSCE 5540.1: Intro to Sensor Networks (814 – Highly Effective)
- CSCE 5950.743: Thesis (no evaluation done)
- CSCE 6950.743: Dissertation (no evaluation done)

Spring 2012

- CSCE 3020.1: Communication Systems (809 – Highly Effective)
- CSCE 3510.1: Intro to Wireless Communication (811 – Highly Effective)
- CSCE 5510.1: Wireless Communications (817 – Highly Effective)
- EENG 3810.1: Communication Systems (801 – Highly Effective)

Fall 2011

- CSCE 3010.1: Signals and Systems (793 – Highly Effective)
- CSCE 5540.1: Intro to Sensor Networks (824 – Highly Effective)

Spring 2011

- CSCE 3020.1: Communication Systems (820 – Highly Effective)
- CSCE 3510.1: Intro to Wireless Communication (812 – Highly Effective)
- CSCE 5510.1: Wireless Communications (812 – Highly Effective)
- EENG 3810.1: Communication Systems (826 – Highly Effective)

Fall 2010

- CSCE 3010.1: Signals and Systems (857 – Highly Effective)
- CSCE 5540.1: Intro to Sensor Networks (831 – Highly Effective)

Spring 2010

- CSCE 3020.1: Communication Systems (792 – Highly Effective)
- CSCE 3510.1: Intro to Wireless Communication (793 – Highly Effective)
- CSCE 5510.1: Wireless Communications (834 – Highly Effective)
- EENG 3810.1: Communication Systems (854 – Highly Effective)

Fall 2009

- CSCE 3010.1: Signals and Systems (4.40 / 5.00)
- CSCE 5540.1: Intro to Sensor Networks (4.70 / 5.00)
- EENG 2620.1: Signals and Systems (4.40 / 5.00)

Spring 2009

- CSCE 3020.1: Communication Systems (4.87 / 5.00)
- CSCE 3510.1: Intro to Wireless Communication (4.65 / 5.00)
- CSCE 5510.1: Wireless Communications (4.79 / 5.00)

Fall 2008

- CSCE 3010.1: Signals and Systems (4.91 / 5.00)
- CSCE 5540.2: Intro to Sensor Networks (4.10 / 5.00)
- EENG 2620.3: Signals and Systems (4.91 / 5.00)

Spring 2008

- CSCE 3020.1: Communication Systems (4.68 / 5.00)
- CSCE 3510.1: Intro to Wireless Communication (3.96 / 5.00)
- CSCE 5510.1: Wireless Communications (4.75 / 5.00)

Fall 2007

- CSCE 3010.1: Signals and Systems (4.57 / 5.00)
- CSCE 5540.2: Intro to Sensor Networks (4.01 / 5.00)

Summer 2007

- CSCE 3020.1: Fund. of Communication Theory (no evaluation done)
- EENG 3810.1: Communication Systems (no evaluation done)

Spring 2007

- CSCE 5510.2: Wireless Communications (4.75 / 5.00)
- CSCE 5933.6: Fundamentals of VoIP (4.70 / 5.00)

Fall 2006

- CSCE 3010.1: Signals and Systems (4.58 / 5.00)
- CSCE 5540.1: Intro to Sensor Networks (4.70 / 5.00)
- EENG 2620.1: Signals and Systems (4.58 / 5.00)

Summer 2006

- CSCE 3020.1: Fund. of Communication Theory (no evaluation done)
- CSCE 3510.21: Intro to Wireless Communications (no evaluation done)
- CSCE 5510.21: Intro to Wireless Communications (no evaluation done)
- EENG 3810.1: Communication Systems (no evaluation done)

Spring 2006

- CSCE 2610.2: Computer Organization (3.69 / 5.00)
- CSCE 3010.1: Signals and Systems (4.41 / 5.00)
- EENG 2620.1: Signals and Systems (4.41 / 5.00)

Fall 2005

- CSCE 3510.1: Intro to Wireless Communications (4.52 / 5.00)
- CSCE 5510.1: Wireless Communications (4.46 / 5.00)
- CSCE 5933.6: Intro to Sensor Networks (4.60 / 5.00)

Summer 2005

- CSCE 3010.21: Signals and Systems (no evaluation done)
- CSCE 3510.21: Intro to Wireless Communications (no evaluation done)

Spring 2005

- CSCE 3510.02: Intro to Wireless Communications (4.46 / 5.00)
- CSCI 3100.02: Computer Organization (4.14 / 5.00)

Fall 2004

- CSCE 3510.01: Intro to Wireless Communications (4.15 / 5.00)
- CSCI 4510.01: Machine Structures (4.55 / 5.00)
- CSCI 5330.02: Intro to Wireless Communications (4.05 / 5.00)

Summer 2004

- CSCI 4330.22: Intro to Wireless Communications (no evaluation done)
- CSCI 4330.23: Intro to Wireless Communications (no evaluation done)
- CSCI 5330.22: Intro to Wireless Communications (no evaluation done)

Spring 2004

- CSCI 3100: Computer Organization (4.64 / 5.00)
- CSCI 4330: Intro to Wireless Communications (4.22 / 5.00)

Fall 2003

- CSCI 4510: Machine Structures (4.49 / 5.00)
 - CSCI 5330: Intro to Wireless Communications (4.83 / 5.00)
- Summer 2003
- CSCI 3100: Computer Organization (no evaluation done)
- Spring 2003
- CSCI 3100: Computer Organization (3.84 / 5.00)
- Fall 2002
- CSCI 4510: Machine Structures (4.38 / 5.00)

Funded Proposals

- R1. “I/UCRC Industrial Membership - Ashum Corp,” 2020. Krishna Kavi (PI), Robert Akl (co-PI), **\$52,000.**
- R2. “I/UCRC Industrial Membership - Ashum Corp,” 2019. Krishna Kavi (PI), Robert Akl (co-PI), **\$60,900.**
- R3. “I/UCRC Industrial Membership - Ashum Corp,” 2018. Krishna Kavi (PI), Robert Akl (co-PI), **\$57,700.**
- R4. “Robotics and App Design Summer Camp” under Texas Higher Education Coordinating Board: Engineering Summer Program. Requested amount is \$11,727. Submitted 5/5/17. Robert Akl (PI), **\$11,727.**
- R5. “I/UCRC Industrial Membership - Ashum Corp,” 2017. Krishna Kavi (PI), Robert Akl (co-PI), **\$50,000.**
- R6. “UNT GenCyber Summer Program: Inspiring the Next Generation of Cyber Stars in North Texas,” National Security Agency (NSA). Requested amount is \$85,000. Submitted 11/4/2016. Robert Akl (co-PI), **\$85,000.**
- R7. “App Design Summer Camp” under Texas Higher Education Coordinating Board: Engineering Summer Program. Requested amount is \$12,900. Submitted 5/6/16. Robert Akl (PI), **\$12,900.**
- R8. “I/UCRC Industrial Membership - Ashum Corp,” 2016. Krishna Kavi (PI), Robert Akl (co-PI), **\$65,000.**
- R9. “Robotics, Game and App Programming Summer Camps” under Texas Workforce Commission: Summer Merit Program. Requested amount is \$63,000. Submitted 11/16/15. Robert Akl (PI), **\$63,000.**
- R10. “App Design Summer Camp” under Texas Higher Education Coordinating Board: Engineering Summer Program. Requested amount is \$13,998. Submitted 5/1/15. Robert Akl (PI), **\$13,988.**

- R11. "I/UCRC Industrial Membership - Ashum Corp," 2015. Krishna Kavi (PI), Robert Akl (co-PI), **\$40,000.**
- R12. "App Design Summer Camp" under Texas Higher Education Coordinating Board: Engineering Summer Program. Requested amount is \$12,500. Submitted 5/2/14. Robert Akl (PI), **\$12,500.**
- R13. "I/UCRC Industrial Membership - Ashum Corp," 2014. Krishna Kavi (PI), Robert Akl (co-PI), **\$46,000.**
- R14. "I/UCRC Industrial Membership - Ashum Corp," 2013. Krishna Kavi (PI), Robert Akl (co-PI), **\$38,500.**
- R15. "Robotics, Game and App Programming Summer Camps" under Texas Workforce Commission: Summer Merit Program. Requested amount is \$63,000. Submitted 12/14/12. Robert Akl (PI), **\$63,000.**
- R16. "Bio-Com Project," funded by Raytheon under Net-Centric Software and Systems I/UCRC 2nd year. Requested amount is \$30,000. Submitted 5/12/12. Krishna Kavi (PI), Robert Akl (co-PI), **\$30,000.**
- R17. "Bio-Com Project," funded by Raytheon under Net-Centric Software and Systems I/UCRC. Requested amount is \$30,000. Submitted 5/12/11. Krishna Kavi (PI), Robert Akl (co-PI), **\$30,000.**
- R18. "Game Programming for Xbox 360 Summer Camp" under Texas Higher Education Coordinating Board: Engineering Summer Program. Requested amount is \$20,000. Submitted 3/21/11. Robert Akl (PI), **\$20,000.**
- R19. "RoboCamps and Game Programming Summer Camps" under Texas Workforce Commission: Summer Merit Program. Requested amount is \$63,000. Submitted 2/17/11. Robert Akl (PI), **\$63,000.**
- R20. "Game Programming for Xbox 360 Summer Camp" under Texas Higher Education Coordinating Board: Engineering Summer Program. Requested amount is \$13,000. Submitted 2/22/10. Robert Akl (PI), **\$18,000.**
- R21. "Robotics and Game Programming Summer Camps" under Texas Workforce Commission: Summer Merit Program. Requested amount is \$63,000. Submitted 10/16/09. Robert Akl (PI), **\$63,000.**
- R22. "Micro Air Vehicle Design: A Collaborative Undergraduate Project for Electrical Engineering, Computer Engineering, and Computer Science Students," under UNT Undergraduate Research Initiative. Submitted 9/25/2009. Robert Akl (co-PI), **\$8,000.**

- R23. “Summer Merit Program” under Texas Workforce Commission. Requested amount is \$42,000. Submitted 3/20/09. Robert Akl (PI), **\$42,000**.
- R24. “Robocamp at Stewpot” under Dallas Women's Foundation. Requested amount is \$20,000. Submitted 2/23/09. Robert Akl (PI), **\$18,600**.
- R25. “Robocamp Jump Start” under Motorola Foundation Innovation Generation Grant. Requested amount is \$29,852. Submitted 2/12/09. Robert Akl (PI), **\$30,700**.
- R26. “Engineering Summer Program” under Texas Higher Education Coordinating Board. Requested amount is \$7,944. Submitted 2/13/09. Robert Akl (PI), **\$11,111**.
- R27. “Texas Youth in Technology” under Texas Workforce Commission. Requested amount is \$152,393. Submitted 11/10/08. Robert Akl (PI), **\$152,393**.
- R28. “I/UCRC Center Proposal: Net-Centric Software and Systems,” under NSF-07-537: Industry/University Cooperative Research Centers. Requested amount is \$349,482. Submitted 9/26/08. Krishna Kavi (PI), Robert Akl (co-PI), **\$60,000 per year for 5 years**.
- R29. “Robocamp and Beyond” under Motorola Foundation Innovation Generation Grant. Requested amount is \$30,000. Submitted 6/20/08. Robert Akl (PI), **\$30,000**.
- R30. Texas Youth in Technology” under Texas Workforce Commission. Requested amount is \$30,000. Submitted 2/27/08. Robert Akl (PI), **\$31,500**.
- R31. “Robocamp Program for Young Women” under RGK foundation. Requested amount is \$30,000. Submitted 11/5/07. Robert Akl (PI), **\$15,000**.
- R32. “Texas Youth in Technology” under Texas Workforce Commission. Requested amount is \$102,514. Submitted 10/22/07. Robert Akl (PI), **\$102,514**.
- R33. “Women Art Technology” under Hispanic and Global Studies Initiatives Fund. Requested amount is \$14,125. Submitted 9/30/07. Jennifer Way (PI), Robert Akl (co-PI), **\$12,785**.
- R34. “Robocamp Mobile Unit” under Motorola Foundation Innovation Generation Grant. Requested amount is \$35,000. Submitted 6/20/07. Robert Akl (PI), **\$30,000**.
- R35. “ICER: UNT Engineering Challenge Camps” under NSF 0547299. Requested amount is \$35,000. Submitted 4/27/07. Oscar Garcia (PI), Robert Akl (senior personnel), **\$32,792**.

- R36. "I/UCRC-Planning Proposal: UNT Research Site Proposal to join Embedded Systems I/UCRC," under NSF-01-116: Industry/University Cooperative Research Centers. Requested amount is \$10,000. Submitted 3/31/07. Krishna Kavi (PI), Robert Akl (co-PI), **\$10,000**.
- R37. "High-assurance NCCS: Ultra Dependability Integration Engineering," Department of Defense. Requested amount is \$20,000. Submitted 3/12/07. Krishna Kavi (PI), Robert Akl (co-PI), **\$20,000**.
- R38. "Recruiting and Retention Strategies for Computer Science at UNT" under Texas Technology Workforce Development Grant Program – 2005. Requested amount is \$163,322. Submitted 3/17/05. Robert Akl (PI), **\$125,322**.
- R39. UNT Faculty Research Grant for Fall 2003, Robert Akl (PI), \$5,000, **\$4,000**.
- R40. UNT Junior Faculty Summer Research Fellowship for Summer 2003, Robert Akl (PI), \$5,000, **\$5,000**.

Professional Associations and Achievements

Membership in Professional Organizations

- Senior Member IEEE
- Member, Federation Council of North Texas Universities
- Member, Eta Kappa Nu Electrical Engineering Honor Society
- Member, Golden Key National Honor Society
- Member, Tau Beta Pi Engineering Honor Society

Offices and Committee Assignments in Professional Organizations

- Technical Program Committee Member, IEEE Wireless Communications and Networking Conference, IEEE WCNC
- Technical Program Committee Member, International Wireless Symposium, IWS
- Technical Program Committee Member, IEEE International Conference on Computational Science, IEEE ICCS
- Technical Program Committee Member, IASTED International Conference on Wireless Communications, WC
- Technical Program Committee Member, WTS Wireless Telecommunications Symposium
- Technical Program Committee Member, Mosharaka International Conference on Computer Science and Engineering, Amman
- Invitation to serve as an NSF reviewer/panelist for Engineering Research Centers (ERC) proposals
- Technical Program Committee Member, 18th IEEE International Symposium on Personal, Indoor and Mobile Radio Communication, Greece

- International Program Committee, IASTED International Conference on Wireless and Optical Communication, Canada
- Program Committee Member, Fifth Annual Wireless Telecommunications Symposium, CA
- Technical Publications Chair, IEEE Vehicular Technology Conference, Dallas TX
- Session Chair, International Conference on Computing, Commun. and Control Tech., Austin TX
- Session Chair, International Conference on Cybernetics and Information Technologies, Orlando FL
- Session Chair, 8th World Multi Conference on Systemics, Cybernetic, and Informatics, Orlando FL

Additional Responsibilities and Activities

- Reviewer, *Wireless Communications and Mobile Computing*, 2012 – present
- Reviewer, *Journal of Sensor and Actuator Networks*, 2012 – present
- Reviewer, *IEEE Transactions on Vehicular Technology*, 2011 – present
- Reviewer, *Elsevier Journal of Computers & Electrical Engineering*, 2008 – present
- Reviewer, *IEEE Globecom*, 2007 – present
- Reviewer, *IEEE International Conference on Advanced Networks and Telecommunication Systems (ANTS)*, 2008 – present
- Reviewer, *The International Wireless Communications and Mobile Computing Conference*, 2007 – present
- Reviewer, *Journal on Wireless Communications and Networking*, 2007 – present
- Reviewer, *IEEE Transactions on Communications*, 2007 - present
- Reviewer, *International Journal of Communication Systems*, 2007 – present
- Reviewer, *IEEE Communications Magazine*, 2005 – present
- Reviewer, *Journal of Wireless Networks*, 2004 – present
- Reviewer, *IEEE Transactions on Mobile Computing*, 2004 – present
- Reviewer, *IEEE Transactions on Wireless Communications*, 2004 – present
- Reviewer, *ACM Crossroads*, 2004 – present

Honors and Awards

- Who's Who in America, 2012 Edition
- Winner of Tech Titan of the Future – University Level Award for UNT Robocamps for Girls, Metroplex Technology Business Council, 2010 with **\$15,000 cash prize**.
- IEEE Professionalism Award, Ft Worth Chapter, 2008
- UNT College of Engineering Outstanding Teacher Award, 2008
- Certificate of Appreciation: IEEE Vehicular Technology Conference, Dallas, TX, 2005
- Certificate of Appreciation: Denton County Boosting Engineering, Science and Technology (BEST) Robotics Competition, 2004
- Summa Cum Laude Graduate, Ranked First in Undergraduate Class

- The Computer Science Departmental Award for Academic Excellence, Washington University, 1993
 - The Dual Degree Engineering Award for Outstanding Senior, Washington University, 1993
 - The 1992 Technical Writing Competition Award, The Society for Technical Communication
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