

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

Samsung Electronics America, Inc.,
Samsung Electronics Co., Ltd.
Petitioners

v.

Cobblestone Wireless, LLC,
Patent Owner

Case No. IPR2024-00316
U.S. Patent No. 10,368,361

**DECLARATION OF JAMES A. PROCTOR IN SUPPORT OF
PETITION FOR INTER PARTES REVIEW OF
UNITED STATES PATENT NO. 10,368,361**

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I, James A. Proctor, declare as follows:

I. INTRODUCTION

1. I have been retained by Samsung Electronics America, Inc. and Samsung Electronics Co., Ltd. (“Petitioners”) as an independent expert consultant in this proceeding before the United States Patent and Trademark Office (“PTO”) against Cobblestone Wireless, LLC (“Patent Owner”) regarding U.S. Patent No. 10,368,361 (“the ’361 Patent”) (Ex. 1001).¹ I have been asked to submit this Declaration on behalf of Petitioners.

2. I have been asked to consider whether certain references disclose or render obvious the features recited in claims 10-13, 15, and 17 (“the challenged claims”) of the ’361 Patent.

3. My opinions are set forth below. Based on my experience and expertise, it is my opinion that the prior art renders obvious all limitations of the challenged claims, as I discuss in detail below.

4. I am being compensated at a rate of \$550 per hour for my work in this proceeding. My compensation is in no way contingent on the nature of my findings, the presentation of my findings in testimony, or the outcome of this or any other proceeding. I have no other interest in this proceeding.

¹ Where appropriate, I refer to exhibits that I understand are to be attached to the petition for *Inter Partes* Review of the ’361 patent.

5. All of my opinions stated in this Declaration are based on my own personal knowledge and professional judgment. I am over 18 years of age and, if I am called upon to do so, I would be competent to testify as to the matters set forth in this Declaration. My opinions in this Declaration are substantively identical as those given in my declaration in support of the Petition in *T-Mobile USA, Inc. et al. v. Cobblestone Wireless LLC*, IPR2024-00138.

II. BACKGROUND AND QUALIFICATIONS

6. My background and expertise that qualify me as an expert are described in detail in my *Curriculum Vitae* attached as **Attachment A**, which further includes an accurate list of all publications authored by me in the previous 10 years and a list of all cases in which I testified as an expert at trial or by deposition during the previous 4 years. Below I have summarized those qualifications, as well as any other background and expertise relevant to the technical issues in this case:

7. My educational background includes a Bachelor of Science in Electrical Engineering (BSEE) from the University of Florida in 1991 and Master of Science in Electrical Engineering (MSEE) from the Georgia Institute of Technology (“Georgia Tech”) in 1992 focusing on digital signal processing.

8. I have worked as an engineer and entrepreneur in the field of wireless communications for over 25 years and have been involved with various aspects of wireless communications for the duration of my career.

9. From 1986 to 1991, while at the University of Florida, I interned with Harris Corporation in various roles including mechanical design, software development, and digital design. From 1991 to 1992, while at Georgia Tech, I worked at the Georgia Tech Research Institute (GTRI) as a graduate research assistant, performing software development on classified government programs.

10. From 1993 to 1995, while working for Harris Corporation, I designed various cellular communication systems for voice, data, and tracking/location. Many of these systems I designed utilized advanced communications technologies, such as those utilized in the then-developing and future telecommunications (such as IS95, W-CDMA, and aspects of LTE).

11. From 1995 to 1998, I worked at Spectran in advanced development and technical marketing. At Spectrian, I interfaced with Nortel's and Qualcomm's product management and performed advanced technology development and systems analysis. In this role, I designed IS-95 CDMA and GSM base station power amplifiers and control electronics, and received several patents associated with advanced linearization techniques for the reduction of transmitted distortion. I note that the peak to average ratio of various waveforms was of particular concern in the design of the power amplifiers and associated linearization techniques with the designs I was involved with during my work at Spectrian.

12. From 1998 to 2002, I served as the Director of Strategic and Technical Marketing at Tantivy Communications, a venture capital-funded 3G cellular data and chip set company. At Tantivy, I helped to architect and standardize the I-CDMA Spread Spectrum Systems Air Interface Standard (T1P1.4). I also developed both wireless access terminals and base stations that complied with the standard. The base stations utilized various IP protocols, and interfaced with the wire line network utilizing IP over Ethernet. Additionally, I participated in and provided technical contributions to 3GPP/3GPP2 standardization efforts related to the development of CDMA2000 and 1xEV-DO. This work resulted in me being a named inventor on more than 150 pending or issued U.S. patents or applications.

13. From 2002 to 2007, as co-founder of WiDeFi, Inc., I served in various roles including President, CEO, CTO, and board member. As the CEO, my responsibilities included advanced development of platform technologies. I was a named inventor of wireless technology components, including a frequency translating TDD repeater, a same frequency repeater architecture for TDD/FDD-based systems, and physical layer multi-stream MIMO repeater technology. WiDeFi invented and provided wireless home networking products based on WiFi and cellular technologies. While at WiDeFi, I was a named inventor on over 25 issued U.S. patents or patent applications.

14. From 2007 to 2009, I consulted as a principal engineer for Qualcomm Inc. as part of the acquisition of WiDeFi's technology. While at Qualcomm, I worked with its corporate R&D division and developed consumer 3G and 4G cellular coverage enhancement systems utilizing WiDeFi's baseband interference cancellation technologies. My responsibilities included working with international cellular operators on product requirements, detailed W-CDMA simulations, Long Term Evolution ("LTE") systems analysis, and participation in prototype product realization. I am currently a named inventor on roughly 45 issued U.S. patents or patent applications assigned to Qualcomm.

15. From 2010 to the present, I have served as managing director and co-founder of Proxicom Wireless, LLC, which has developed and continues to develop cloud-based, mobile social networking and mobile payments technology based upon the proximity and location of mobile devices. Proxicom currently holds twelve issued U.S. patents and multiple pending patent applications, of which I am a named inventor. Significant aspects of Proxicom's technology involve a mobile device's use of short range wireless technologies (802.11, near field communications, Bluetooth) in combination with cellular data links (3G/WCDMA or 4G/LTE, for example) to facilitate frictionless interactions via a wireless networked central cloud server.

16. Since 2007, I have also been the principal of Proctor Consulting, LLC. In this role, I have been a consultant relating to wired, wireless, and cellular communication and technologies, start-up companies and intellectual property. I have also been involved with numerous patent infringement, patent validity, and patent analysis assignments for public and private companies in the wired, wireless, and cellular networking industries.

17. Additionally, I have worked and consulted for both cellular infrastructure and device focused companies (Spectrian, Qualcomm, Fastback Networks), and defense contractors (Harris Corporation), where I developed covert-tracking and location technologies involving CDMA and smart-antenna technologies.

18. In various of the above-detailed roles, I have been responsible for the development of business plans, product development plans, product development budgets, and product bill of materials estimations. I have been responsible for numerous product development teams, including schedule and costs of the development process at various stages of my career. For example, at Tantivy Communications, I ran a joint development of I-CDMA cellular base stations in Seoul, Korea that were used in a field trial in that country. Additionally, as founder and CEO of WiDeFi, Inc., I was responsible for similar such activities, as required to raise venture capital funding and reporting to the board of directors.

19. I am currently a named inventor on more than 325 issued U.S. patents, and more than 700 international patent publications in total. A substantial portion of my work has focused on wireless communication systems and products. A number of these patents and patent applications are related to the subject matter of the patents asserted in this matter. For example, the following patents, for which I am a named inventor, are examples of some of my experience relevant to the subject matter of this declaration:

U.S. Patent No.	Title	Priority Date
8,321,542	"Wireless channel allocation in a base station processor"	May 5, 2000
7,002,902	"Method and system for economical beam forming in a radio communication system"	Feb. 23, 2000
6,400,317	"Method and apparatus for antenna control in a communications network"	Feb. 2, 2001
8,259,687	"Dynamic bandwidth allocation for multiple access communications using buffer urgency factor"	June 31, 2001
11,443,344	"Efficient and secure communication using wireless service identifiers"	Sept. 8, 2008
8,477,665	"Method in a wireless repeater employing an antenna array for interference reduction"	July, 14, 2010
9,135,612	"Proximity detection, virtual detection, or location based triggering of the exchange of value and information"	Apr. 17, 2011
8,502,733	"Transmit co-channel spectrum sharing"	Feb. 10, 2012
8,422,540	"Intelligent backhaul radio with zero division duplexing"	Sept. 10, 2012

20. Based on my professional experience, I believe I am qualified to testify as an expert on matters related to the patent at issue.

21. I am currently consulting, working with and/or advising a number of companies and universities. For example, I currently serve on the external advisory

board to the University of Florida's Electrical and Computer Engineering department. I also perform expert consulting work, research, and development in the area of wireless communications with Proctor Consulting and Proxicom wireless. Finally, I perform conceptual and product development in the medical device field with Genesis Medical Devices.

III. MATERIALS REVIEWED

22. The opinions contained in this Declaration are based on the documents I reviewed, my professional judgment, as well as my education, experience, and knowledge.

23. In forming my opinions expressed in this Declaration, I also reviewed the following materials and information:

Exhibit No.	Description
1001	U.S. Patent No. 10,368,361 B2 ("the '361 Patent")
1002	Prosecution History of U.S. Patent No. 10,368,361 B2
1004	U.S. Patent Application Publication No. 2014/0341051 A1 ("Gaal")
1005	LTE-Advanced: A Practical Systems Approach to Understanding 3GPP LTE Releases 10 and 11 Radio Access technologies by Ahmadi ("Ahmadi")
1006	R1-142771, CR 0191 to TS 36.211, Inclusion of eIMTA, TDD-FDD CA, and coverage enhancements, 3GPP TSG-RAN WG1 Meeting #77, Ericsson (May 19-23, 2013) ("R1-142771")
1007	R1-142772, CR 0158 to TS 36.212, Introduction of Rel 12 features of TDD-FDD CA and eIMTA, 3GPP TSG-RAN WG1 Meeting #77, Huawei (May 19-23, 2014) ("R1-142772")
1008	3GPP TS 36.211 V12.2.0
1009	3GPP TS 36.213 V12.2.0

1010	Cobblestone Wireless, LLC v. T-Mobile USA, Inc., No. 2:22-cv-00447-JRG-RSP, Dkt. 62 (E.D. Tex. Apr. 8, 2023) (“Docket Control Order”)
1011	R1-132137, Signalling for flexible subframes and determination of their usage, 3GPP TSG-RAN WG1 Meeting #73, Panasonic (May 20-24, 2013) (“R1-132137”)
1012	Sesia, S. et al., <i>LTE—The UMTS Long Term Evolution</i> , 2d ed. (2011)
1013	Kreher, R. & Gaenger, K., <i>LTE Signaling, Troubleshooting and Optimization</i> , 1st ed. (2011)
1014	3GPP TS 36.214 V11.1.0
1015	IBM International Technical Support Organization, <i>An Introduction to Wireless Communications</i> , 2d ed. (October 1995)
1016	Taylor, M.S. et al., <i>Internet Mobility: The CDPD Approach</i> (June 11, 1996)
1017	Steele et al., <i>GSM, cdmaOne and 3G Systems</i> (2001)
1018	U.S. Patent No. 9,185,620 to Khoryaev (“Khoryaev”)

24. I also reviewed any other materials I refer to in this Declaration in support of my opinions.

25. My opinions contained in this Declaration are based on the documents I reviewed and my knowledge and professional judgment. My opinions have also been guided by my appreciation of how a person of ordinary skill in the art would have understood the state of the art, the prior art, and the claims and the specification of the ’361 patent at the time of the alleged invention.

IV. LEGAL STANDARDS

26. Petitioners’ attorneys have explained to me the legal standards that apply in this case. My understanding of those standards is described below. I am not

an attorney, and I do not have formal training in the law regarding patents. I have used my understanding of the following legal principles set forth in this section in reaching my opinions.

27. I understand that, in this proceeding, Petitioners have the burden of proving that the challenged claims are invalid by a preponderance of the evidence.

A. Obviousness

28. I have been informed that a claim is invalid as obvious under 35 U.S.C. § 103 (post-AIA) if the differences between the claimed subject matter and the prior art are such that the subject matter as a whole would have been obvious at the effective filing date to a person of ordinary skill in the art. I have been informed that the following matters are relevant to determining whether the claimed invention would have been obvious: (1) the scope and content of the prior art, (2) the difference or differences between the patent claim and the prior art, (3) the level of ordinary skill in the art at the time the invention of the patent, and (4) any secondary considerations or objective indicia of non-obviousness.

29. I have been informed that the combination of familiar elements according to known methods is likely to be obvious when it does no more than yield predictable results. When a claim simply arranges prior art elements with each performing the same function it had been known to perform and yields no more than one would expect from such an arrangement, then such a combination is obvious.

When a patent claims a structure already known in the prior art altered by the mere substitution of one element for another known in the field, the combination is likely to be obvious unless the combination yields an unpredictable result.

30. I have been informed that when a work is available in one field of endeavor, design incentives and other market forces can prompt variations of it, either in the same field or a different one. If a person of ordinary skill in the art can implement a predictable variation, such a variation is likely unpatentable. For the same reason, if a technique has been used to improve one device, and one of ordinary skill in the art would recognize that it would improve similar devices in the same way, using the technique is obvious unless its actual application is beyond his or her skill. One question to consider is whether the improvement is more than predictably using prior art elements according to their established functions.

31. I have been informed that it may often be necessary, in a validity analysis, to consider whether there was an apparent reason to combine the known elements in the fashion claimed by the patent at issue. This can be accomplished by looking to interrelated teachings of multiple patents or other publications or pieces of prior art; the effects of demands known to the design community or present in the marketplace; and the background knowledge possessed by one of ordinary skill in the art.

32. I have been informed that a validity analysis need not seek out precise teachings directed to the specific subject matter of the challenged claim; it is appropriate to take account of the inferences and creative steps that a person of ordinary skill in the art would employ. I have been informed that a person of ordinary skill in the art is a person of ordinary creativity, not an automaton.

33. I have been informed that a claim composed of several elements is not proved obvious merely by demonstrating that each element was, independently, known in the prior art. I have been informed that it can be important to identify a reason that would have prompted a person of ordinary skill in the art in the relevant field to combine the elements in the way the claimed new invention does. I am told that one way that subject matter can be proved obvious is by noting there existed at the time of the invention a known problem for which there was an obvious solution encompassed by the patent's claims. I have been informed that any need or problem known in the field of endeavor at the time of the claimed invention and addressed by the patent can provide a reason for combining the elements in the manner claimed.

34. I have been informed that one should not assume that a person of ordinary skill in the art attempting to solve a problem will be led only to those elements of prior art designed to solve the same problem. Instead, I have been informed that since familiar items may have obvious uses beyond their primary

purposes, in many cases a person of ordinary skill in the art will be able to fit the teachings of multiple prior art references together like pieces of a puzzle.

35. I have been informed that, when there is a design need or market pressure to solve a problem and there are a finite number of identified, predictable solutions, persons of ordinary skill in the art have good reason to pursue the known options within their technical grasp. If this leads to the anticipated success, the product was likely not accomplished by innovation but by using ordinary skill and common sense. I have been informed that, in such an instance, the fact that the combination was obvious to try may show that the combination was obvious.

36. I have been informed that, when determining whether a claimed combination would have been obvious, the correct analysis is not whether a person of ordinary skill in the art, writing on a blank slate, would have chosen the particular combination of elements described in the claim. Instead, I have been informed that the correct analysis considers whether one of ordinary skill, facing the wide range of needs created by developments in the field of endeavor, would have seen a benefit to selecting the combination claimed.

37. I have been informed that, when determining whether a claimed invention is obvious, any “secondary considerations” of non-obviousness identified by the patentee should also be considered. These secondary considerations can include:

- commercial success of the invention, causally related to the invention itself rather than to companion factors, such as advertising or attractive packaging;
- the invention taught away from the technical direction followed by those skilled in the art;
- a long-felt but unsatisfied need for the invention while the needed implementing arts and elements had long been available;
- the invention achieves results unexpected to those skilled in the art;
- copying of the invention by competitors as distinguished from their independent development
- unsuccessful attempts by those skilled in the art to make the invention;
- acquiescence by the industry to the patent's validity by honoring the patent through taking licenses or not infringing the patent, or both; and
- skepticism, disbelief in or incredulity by those skilled in the art that the patentee's approach worked.

38. I have been informed that, for the above information to impact the obviousness of a patent claim, there must be a nexus between the alleged secondary considerations and the claims. In addition, I have been informed that the burden of

introducing evidence of secondary considerations generally is on the Patent Owner. If the Patent Owner or its expert should assert secondary considerations of non-obviousness, I reserve the right to provide a Declaration addressing assertions of non-obviousness due to secondary considerations.

B. Claim Construction

39. I have been informed that claim terms are typically given their plain and ordinary meanings, as would have been understood by a person of ordinary skill in the art at the time of the earliest alleged priority date. I have further been informed that when considering the meaning of any terms in the challenged claims of the '888 patent, I should apply the plain and ordinary meaning of those terms. I have further been informed that in considering the meaning of the claims, one must consider the language of the claims, the specification, and the prosecution history of record.

40. I have been informed that in general, a preamble limits the invention if it recites essential structure or steps, or if it is necessary to give life, meaning, and vitality to the claim. I have further been informed that a preamble is not limiting where a patentee defines a structurally complete invention in the claim body and uses the preamble only to state a purpose or intended use for the invention. I have further been informed that dependence on a particular disputed preamble phrase for antecedent basis may limit claim scope because it indicates a reliance on both the preamble and claim body to define the claimed invention. I have further been

informed that clear reliance on the preamble during prosecution to distinguish the claimed invention from the prior art transforms the preamble into a claim limitation because such reliance indicates use of the preamble to define, in part, the claimed invention.

V. PERSON OF ORDINARY SKILL IN THE ART AND THE TIME OF THE ALLEGED INVENTION

41. I have been asked to assume that the '361 patent is entitled to its earliest alleged priority date of August 1, 2014. *See* Ex. 1001. Based on my knowledge and experience, I was a person of ordinary skill in the art as of August 1, 2014, and can provide opinions regarding the knowledge of a person of ordinary skill in the art as of that time. My opinions herein are, where appropriate, based on my understandings as to a person of ordinary skill in the art at that time.

42. Based on the materials and information I have reviewed and based on my experience in the technical areas relevant to the '361 patent, a person of ordinary skill in the art at the time of the alleged invention of the '361 patent would have had at least a bachelor's degree in electrical engineering, computer engineering, computer science, physics, or the equivalent, and at least two years of experience working in the field. Relevant working experience would include experience with cellular telecommunications and networking, radio-access networking architectures, protocols, and signal propagation in wireless networks. More education can supplement practical experience and vice versa. Based on my knowledge and

experience, including as discussed above in Section II, I was a person of ordinary skill in the art at the time of the alleged invention of the '361 patent and can provide opinions regarding the knowledge of a person of ordinary skill in the art as of that time. My opinions herein are, where appropriate, based on my understanding as to a person of ordinary skill in the art at that time. I myself had these capabilities at the time of the alleged invention of the '361 patent.

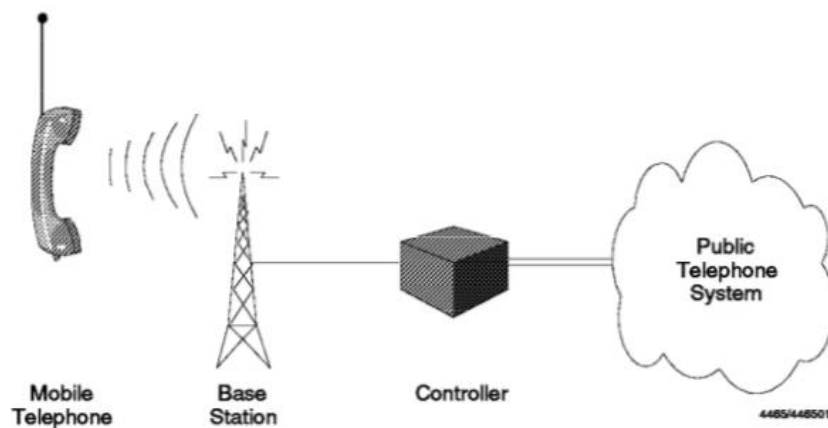
VI. TECHNICAL BACKGROUND

43. Below, I present a brief overview of certain technical concepts and features that would have been known to a person of ordinary skill in the art prior to and at the time of the earliest alleged priority date of the '361 patent. The technical concepts and features that I describe in this Technical Background section reflect the state of the art that a person of ordinary skill in the art would have had knowledge of and would have understood prior to and at the time of the '361 patent. I rely on, and incorporate as applicable (even if not expressly mentioned below in Section IX), the following disclosures to support my opinions in this Declaration, including those opinions relating to how the prior art discloses and/or suggests the challenged claims of the '361 patent and how (and why) a person of ordinary skill in the art would have been motivated to consider and combine the disclosures and suggestions from one or more prior art references.

A. A Brief History of Cellular Mobile Communications

44. The first mobile telephone system was deployed in St. Louis in 1946, having a 50-mile coverage range. This service was deployed in 25 states within the following year. See Ex. 1015 at 6. This system used a number of base stations, each having a frequency modulated transmitter, and was connected to the wired telephone network using a controller.

Ex. 1015, Fig. 1



45. This system was replaced in the 1960s with a system called the “Improved Mobile Telephone Systems” (IMTS), and was a precursor to the so-called cellular service. It used a larger number of smaller cells operating at lower power to increase the capacity of the system. Additionally, the system provided for a number of channels per base station.

46. Every cellular system must apportion some amount of over-the-air resources for user terminals, like cell phones, for some period of time to transmit communications to a base station. This communications link from user terminal to base station is referred to as the “uplink,” or “reverse link” (while the communications link from base station to user terminal is referred to as the “downlink,” or “Forward link”):

Ex. 1016 at 20

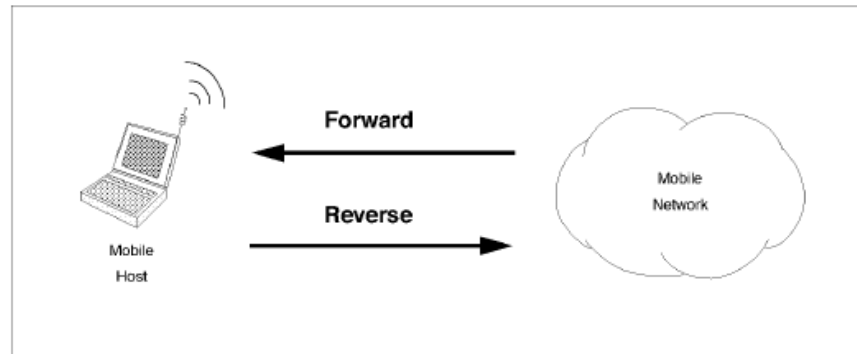


Figure 0.11: Directions of Mobile Transmission

47. Cellular mobile voice and/or data devices additionally must perform control operations with the cellular networks. These control operation may be grouped into some general categories: Radio Resource Management, Mobility Management, and Service (or Session) Management.

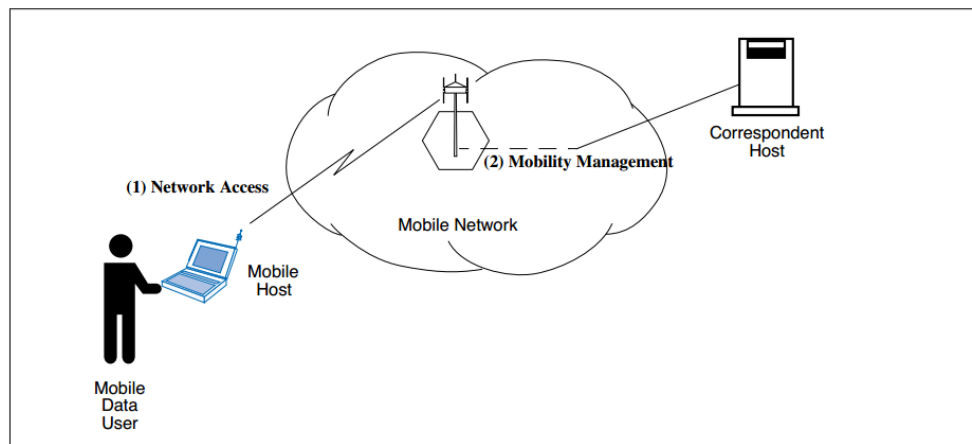


Figure 1.5: Two Basic Aspects of Mobile Communications

48. Radio Resource Management is typically concerned with assuring proper (effective and efficient) use of the RF medium and is part of accessing the mobile network. Ex. 1016 at 43. In many standards Radio Resource Management involves the mobile device exchanging messages and transmissions directly with the base station, or the controller of the base station.

Radio resource management functions Allocation and maintenance of radio communication channels are provided by these functions. The GSM radio resources are dynamically shared between the circuit mode and GPRS. The GPRS radio resource management is concerned with the allocation and release of timeslots for a GPRS channel; monitoring GPRS channel utilization; congestion control; and the distribution of GPRS channel configuration information that is broadcast on the common control channels.

Ex. 1017 at 418.

49. Mobility Management provides for the ability to send and receive communication wherever a mobile device is located. This category sometimes is referred to as, or otherwise includes, location management. At the least, it includes the location management aspects related to changing the point of attachment within one or more radio access networks.

50. Service or Session Management provides for access to services within the radio access network. For example, in prior art cellular systems such as GSM (Global System for Mobile communications), GPRS (General Packet Radio Services), and UMTS (Universal Mobile Telecommunications System), services or sessions are invoked that are distinct from Mobility Management registration and authentication, and are related to a user device connecting and disconnecting from services within the network. For example, in GSM, connection management involves circuit-switched call control, so-called supplemental services, and SMS (short messaging services). The services connection management functions generally must determine which services the user (*e.g.*, based on the user's subscriber identification module (SIM)) is authorized to receive, and perform accounting and charging of the user related to use of those services. In GPRS and UMTS, access to circuit-switched voice connections and access to packet data services are invoked separately. In LTE, all communications are packet based both voice and data.

B. Cellular Standards and Standards Development Organizations

51. A standards setting organization (or standards development organization (“SDO”)) is any organization whose primary activity is producing technical standards to address the needs of companies that want to implement that technology. In particular, telecommunication SDOs promote cooperative standards for telecommunications equipment and systems through standards development, which provide manufacturers and vendors with a universal approach to develop products and compete in the marketplace. The existence of standards enhances the business environment by lowering development costs and by allowing diverse networks to communicate.

52. The 3rd Generation Partnership Project (“3GPP”) is a widespread SDO that is responsible for creating specifications that define 3GPP technologies that span from the first generation (1G) to the fourth generation (4G) as shown in the figure below:

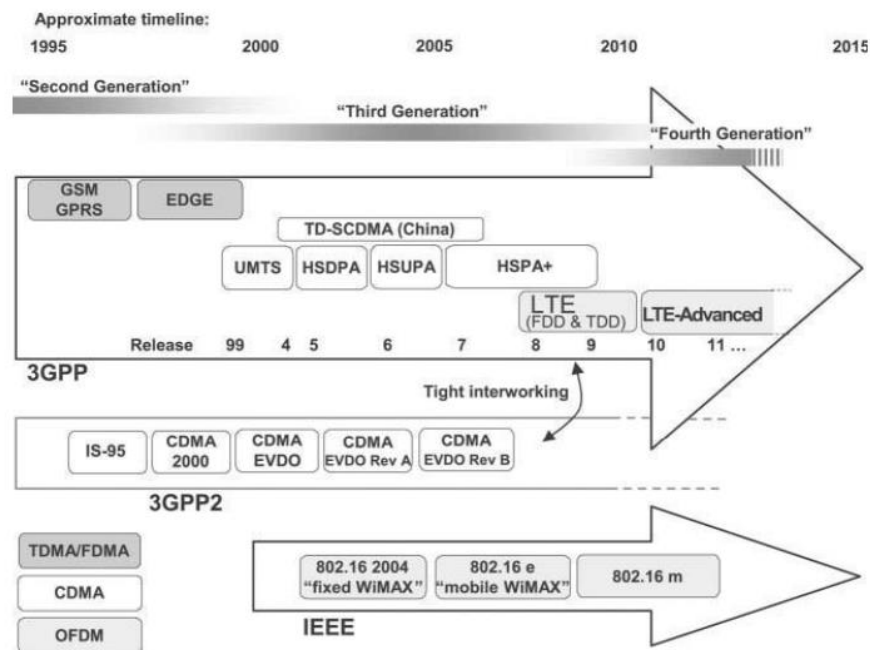
Ex. 1012, Fig. 1.1

Figure 1.1: Approximate timeline of the mobile communications standards landscape.

C. Wireless Communication Systems

53. At the time of effective filing date of the '361 patent, a POSITA would have been familiar with wireless communication networks. The 3GPP LTE, and LTE Advanced wireless communication networks involve multiple user equipment (UEs) attached to one or many base stations (eNB). As I discussed above in relation to radio resource allocation in GPRS, which was also developed by the 3GPP, radio resource allocation continued to be an important component of the “evolved” wireless standards produced by the same standards organization, resulting in LTE and LTE-A (LTE advanced). Therefore, one aspect of wireless communications networks involves how resources are allocated and scheduled.

54. Third Generation Partnership Project, or 3GPP, standardizes wireless cellular communication systems such as LTE and LTE-A networks. These standards are distributed in a form of “Releases” which provide developers with a stable platform for the implementation of features at a given point. New features can then be added in subsequent Releases.

55. For example, 3GPP releases 8 and 9 are referred generally to as Long Term Evolution (LTE) and releases 10, 11, and 12 are referred generally to as LTE Advanced (LTE-A), as mentioned above.

56. It was well-known at the time that in LTE and LTE-A, the resources used to transmit and receive data and control information are time-frequency resources which may be allocated in different ways in the network.

D. Frame Structure

57. Below, I show the basic structure of an LTE Radio frame annotated from a well-known textbook at the time. Ex. 1005 at 445.

Ex. 1005 at Fig. 9.31 (annotated)

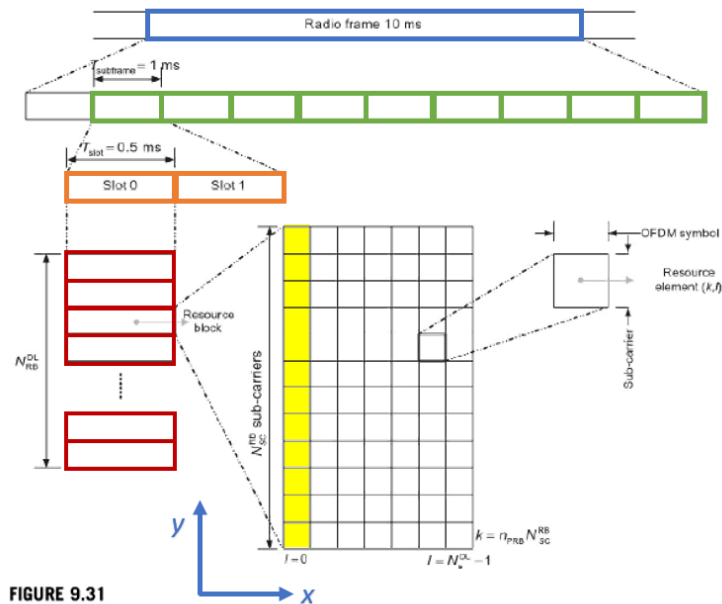


FIGURE 9.31

Resource block structure in time and frequency dimensions [3,162].

58. In the figure above, the time domain is represented in the x -direction, and the frequency domain is represented in the y -direction.

59. I have outlined the radio frame blue. The radio frame is a 10ms time-frequency resource.

60. I have outlined the radio subframes in green. These subframes consist of ten 1 ms subframes per radio frame.

61. I have outlined the two slots in each subframe in orange. These slots are 0.5 ms.

62. I have outlined the resource blocks (RBs) in red. For each slot, there are n resource blocks (RB). Resource blocks are the smallest units of resources that can

be allocated to a user. A resource block may be, for example, 180 kHz wide in frequency, including 12 subcarriers and are 1 slot long in time.

63. In yellow, I have outlined a plurality of subcarriers within a single resource block. In the figure above and in the prior art LTE system, the resource block is 12 subcarriers wide in frequency. It was well known at the time of the 361 patent that frequency units could be expressed in number of subcarriers or resource blocks.

E. Resource Allocation in TDD

64. As mentioned above, resources can be allocated to users for uplink and downlink transmission and reception. In wireless communications, the separation of the downlink communications, and uplink communications is referred to as duplexing. Two duplexing schemes were well known in the art and included within the first release of LTE: Frequency Division Duplexing (FDD) and Time Division Duplexing (TDD).

65. The FDD approach separates uplink and downlink transmissions by two different frequency ranges, as depicted in the following figure.

Ex. 1013 at Fig. 1.30

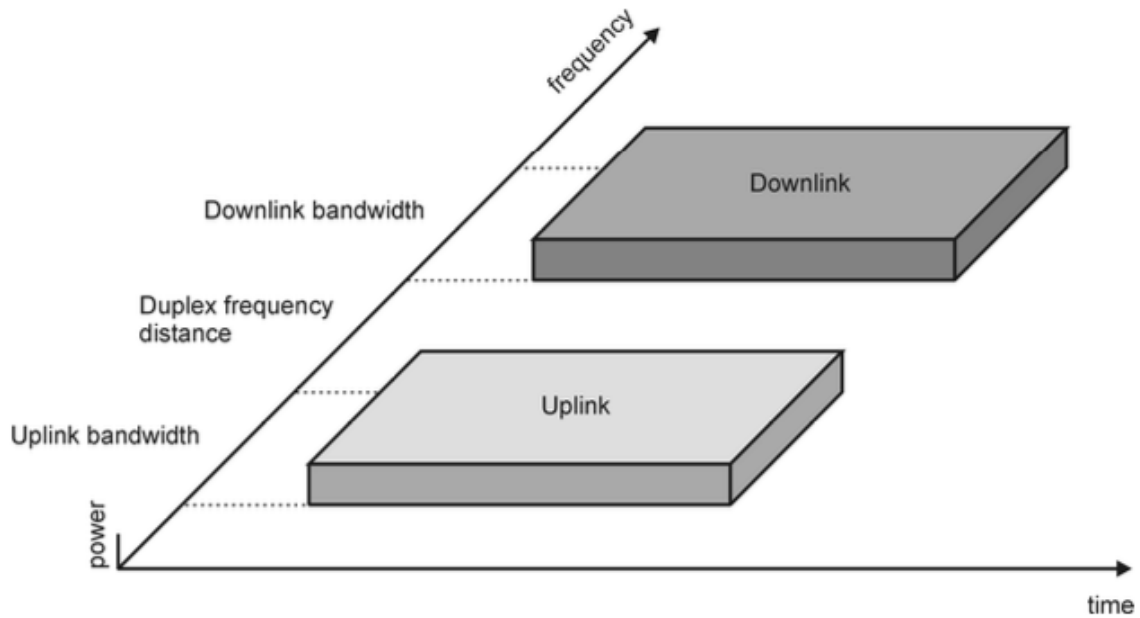


Figure 1.30 FDD system.

66. On the other hand, TDD separates the uplink and downlink communications by time, but uses the same frequency range, as shown in the figure below.

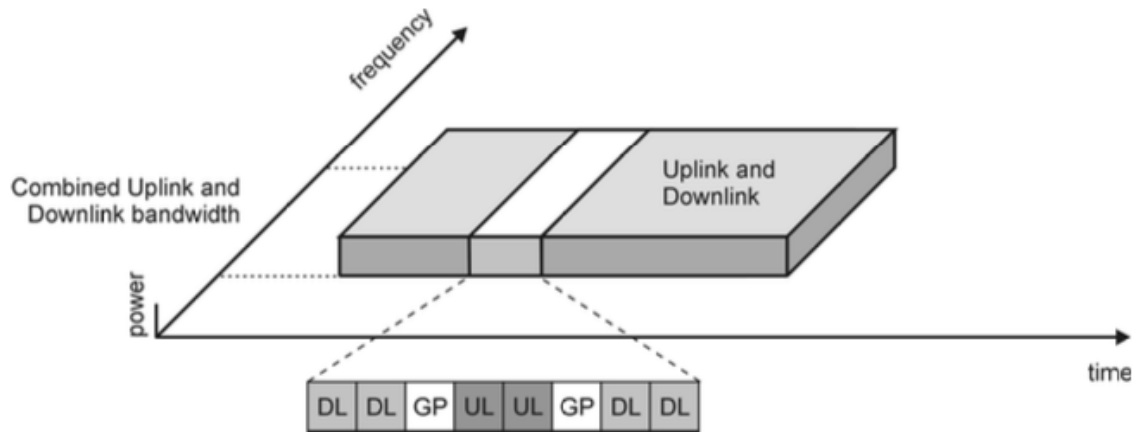


Figure 1.31 TDD system with example duplex slot structure.

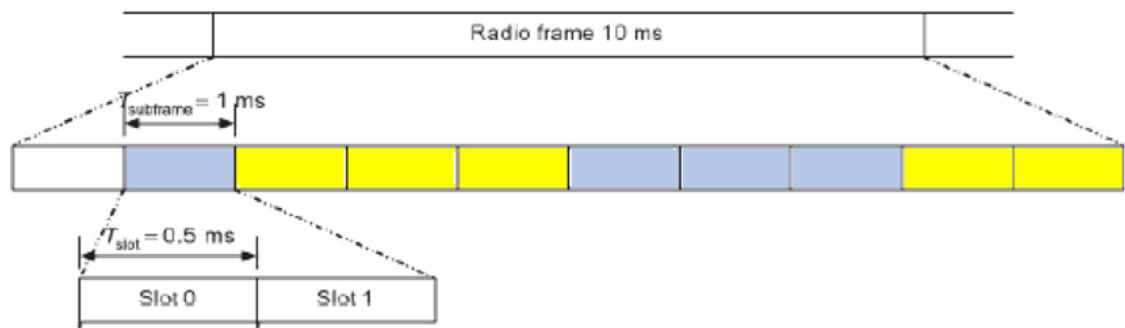
67. The figure above illustrates alternating downlink transmission periods (shown as “DL”), Guard Periods (GP), and uplink transmission periods (UL) utilizing the same uplink and downlink frequency bandwidth.

68. While the '361 patent discusses FDD and TDD embodiments, the '361 patent primarily is directed to TDD. Therefore, my discussion in this report is focused on TDD, as I explain in more detail below.

69. It was well known in the art at the time of the '361 patent that TDD resource allocation divides the available spectrum by time, and that the same frequency is used for both uplink and downlink, alternating in a time-sequential manner.

70. I have annotated the figure below to show one TDD allocation resource scheme. In the annotated figure below, the subframes in yellow could be allocated to uplink while the subframes in blue could be allocated to downlink:

Ex. 1005 at Fig. 9.31 (annotated) (partial)



71. At the time of the '361 Patent, 3GPP had standardized seven possible uplink-downlink (UL-DL) subframe configurations. “D” is downlink, the “U” is uplink, and the “S” is special, which is a frame that can be divided by slot between uplink and downlink. For the example, in the “S” subframe in subframe number (SFN) SFN 1, the first slot is of SFN 1 is downlink while the second slot is uplink. In this instance, a special guard interval is used.

Ex. 1008 at 12.

Table 4.2-2: Uplink-downlink configurations

Uplink-downlink configuration	Downlink-to-Uplink Switch-point periodicity	Subframe number									
		0	1	2	3	4	5	6	7	8	9
0	5 ms	D	S	U	U	U	D	S	U	U	U
1	5 ms	D	S	U	U	D	D	S	U	U	D
2	5 ms	D	S	U	D	D	D	S	U	D	D
3	10 ms	D	S	U	U	U	D	D	D	D	D
4	10 ms	D	S	U	U	D	D	D	D	D	D
5	10 ms	D	S	U	D	D	D	D	D	D	D
6	5 ms	D	S	U	U	U	D	S	U	U	D

72. A POSITA would have known at the time of the '361 patent that one problem for TDD resource allocation schemes is the possibility of inter-cell and intra-cell interference.

73. Interference in the subframes may occur due to collisions between uplink and downlink transmissions on the same frequency band. Likewise, interference may occur from neighboring cells using the same frequency band for transmissions. This is sometimes referred to as “other cell” interference. The following figure shows other cell interference between TDD deployments within a network.

Ex. 1012 at Fig. 23.4

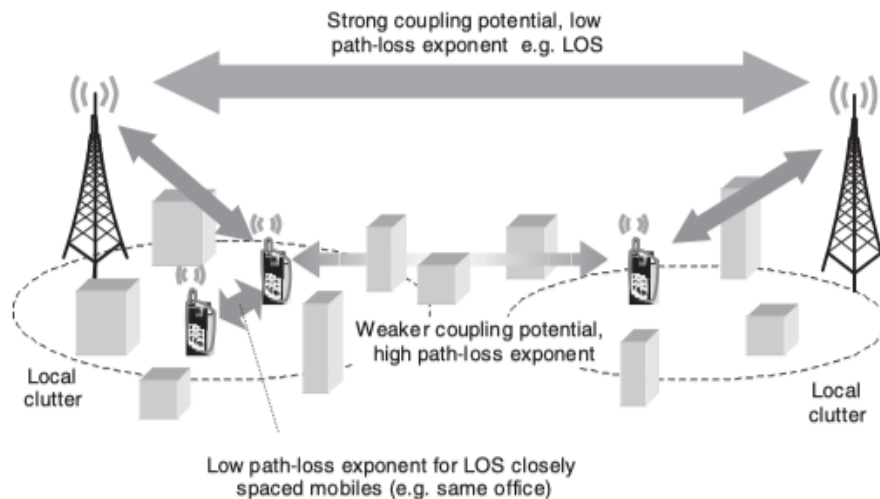


Figure 23.4: Typical RF interference scenario for a TDD system.

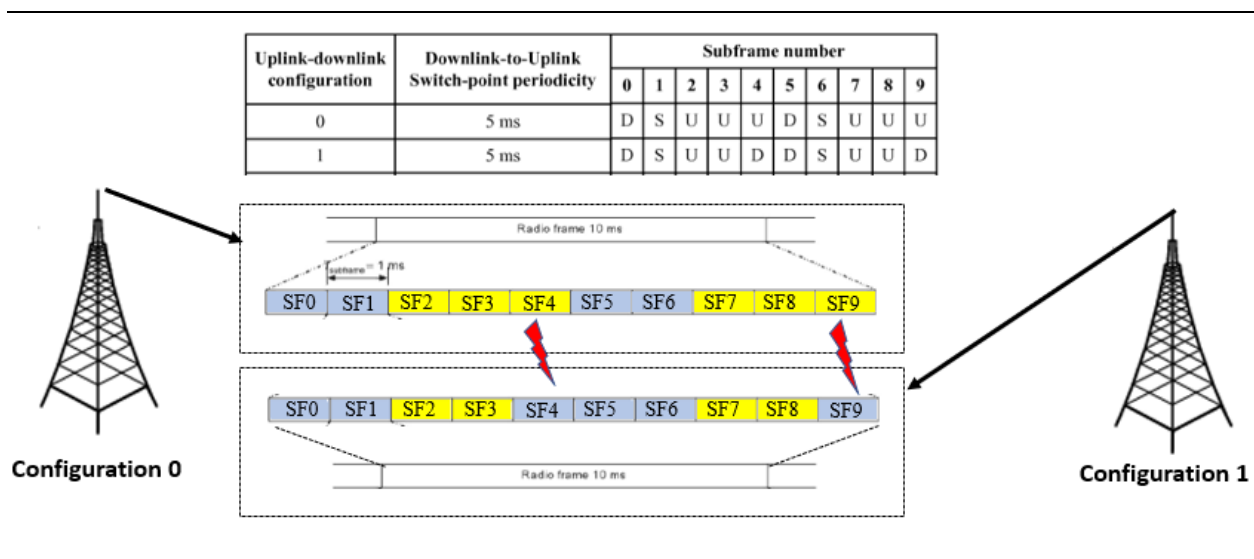
74. In the figure above, strong coupling is shown due to little signal loss between the two different base stations. This occurs because the antennas of the base stations are on top of a tower, and generally do not include obstructions between them allowing for one base station to receive a strong signal from the other base station. Strong transmission signal coupling also occurs when two cells are on the same tower using the same frequencies but operating on different “sectors” using directional antennas.

75. Additionally, in LTE, a UE’s transmission power is much less than that of a base station, and the desired signal received by a base station from a UE is relatively weak. When the TDD frame configuration between adjacent cells are not the same, a neighbor cell will be transmitting a strong signal while a “receiving” cell is attempting to receive the weaker signal from the UE. Because of this, the transmissions from the neighboring base stations can interfere with the reception of the desired UE signals.

76. For this reason, network operators at the time designed their network so that nearby cells (and sectors) would use the same TDD configuration. This prevents uplink and downlink inter-cell interference.

77. The reason it prevents interference is because both base stations transmit and receive at the same time when using the same TDD configuration, thus preventing one from transmitting while the other is receiving.

78. I have illustrated this interference below using TDD UL-DL configurations in Ex. 1008. In the Figure below, the base station on the left is operating in configuration 0 and the base station on right operating is operating in configuration 1. Because these configurations do not match, there's interference in subframes (SF) numbered SF4 and SF9 for a UE that was camped between them. The interference is shown by the red lightning bolt.



F. Interference Measurements

79. At the time of the 361 Patent, a POSITA would have known the techniques to measure inter-cell or crosslink interference in the network.

80. One measurement technique involves the use of channel state information (CSI) reference signals (CSI-RS). CSI-RS are known reference signals sent by the base station that the UE measures.

81. The UE sends the CSI information back to the base station in configured measurement reports so the base station can adjust its signal accordingly. The CSI reports are defined to include the CQI reported measurements, along with other feedback fields. Ex. 1009 at 58 (“The time and frequency resources that can be used by the UE ***to report CSI which consists of Channel Quality Indicator (CQI), precoding matrix indicator (PMI), precoding type indicator (PTI), and/or rank indication (RI)*** are controlled by the eNB.”) (emphasis added); *see also* Ex. 1009 at 69 (“A UE is semi-statically configured by higher layers to periodically feed back different ***CSI components (CQI, PMI, PTI, and/or RI)***[.]”) (emphasis added).

82. In addition to being defined in the prior art LTE standard documents (including Ex. 1008), the components of CSI were well known in prior art textbooks (Ex. 1012, Sesia). For example, Ex. 1012 describes the types of uplink control signaling information in LTE. This well-known reference textbook explains that CSI is a type of uplink control information, “which include Channel Quality Indicators (CQIs) as well as the MIMO-related feedback consisting of RIs and PMIs.” Ex. 1012 at 352.

83. As shown above, one CSI metric is called channel quality indicator (CQI). Ex. 1009 at 58; Ex. 1005 at 664. The CQI is a simple way to quantize the measured signal-to-interference-plus-noise ratio (SINR) for use by the base station (eNodeB) in determining which resources and modulation and coding for a given

resource to utilize in transmissions to the UE. Signal-to-Interference plus noise ratio (SINR) is a measure of the quality of the signal and is lower in the presence of interference.

84. A POSITA would have known that the CQI values were defined by the prior art LTE standard. The CQI values were defined as being between 0 and 15, with each value representing a different signal quality sufficient to support various modulation and coding schemes (MCS) resulting in more or less efficiency of each measured subframe. Ex. 1009. For example, Ex. 1012 states:

For the downlink data transmissions in LTE, the eNodeB typically selects the modulation scheme and code rate depending on a prediction of the downlink channel conditions. An important input to this selection process is the Channel Quality Indicator (CQI) feedback transmitted by the User Equipment (UE) in the uplink. CQI feedback is an indication of the data rate which can be supported by the channel, taking into account the Signal-to-Interference-Plus-Noise Ratio (SINR) and the characteristics of the UE's receiver.

Ex. 1012 at 215.

85. The following image is a table from the standard with the CQI index setting forth the values:

Ex. 1009, Table 7.2.3-1**Table 7.2.3-1: 4-bit CQI Table**

CQI index	modulation	code rate x 1024	efficiency
0	out of range		
1	QPSK	78	0.1523
2	QPSK	120	0.2344
3	QPSK	193	0.3770
4	QPSK	308	0.6016
5	QPSK	449	0.8770
6	QPSK	602	1.1758
7	16QAM	378	1.4766
8	16QAM	490	1.9141
9	16QAM	616	2.4063
10	64QAM	466	2.7305
11	64QAM	567	3.3223
12	64QAM	666	3.9023
13	64QAM	772	4.5234
14	64QAM	873	5.1152
15	64QAM	948	5.5547

86. A similar interference measurement at the base station is Received Interference Power (RIP), defined in LTE in prior art standard 3GPP TS 36.214 v11.1.0 (Ex. 1014), which is reproduced below.

Ex. 1014 at 11**5.2.2 Received Interference Power**

Definition	The uplink received interference power, including thermal noise, within one physical resource block's bandwidth of N_{sc}^{RB} resource elements as defined in TS 36.211 [3]. The reported value shall contain a set of Received Interference Powers of physical resource blocks $n_{PRB} = 0, \dots, N_{RB}^{UL} - 1$ as defined in TS 36.211 [3]. The reference point for the measurement shall be the RX antenna connector. In case of receiver diversity, the reported value shall be linear average of the power in the diversity branches.
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G. Dynamic Frame Configurations and 3GPP's eIMTA Functionality

87. Despite the known interference concerns, the 3GPP standards body at the time of the 361 Patent was discussing how resource allocation schemes could be designed to more efficiently allocate resources under changing traffic condition.

88. This was discussed in the concept of “dynamic” or “flexible” subframes. In these dynamic/flexible subframes, the network could change the uplink/downlink direction of certain subframes for short bursts.

89. For example, in May of 2013, the 3GPP standards body set forth a series of T-docs (which are technical contributions or proposals to the standard development work groups) discussing these flexible subframes. One such T-doc from Panasonic contained the table below:

Ex. 1011 (R1-132137) at 3.

Table 5: Additional Flexible Uplink-downlink configurations.

Uplink-downlink configuration	Subframe number									
	0	1	2	3	4	5	6	7	8	9
F0	D	S	U	F	F	D	S	U	F	F
F1	D	S	U	F	D	D	S	U	F	D
F2	D	S	U	D	D	D	S	F	D	D
F3	D	S	U	F	F	D	D	D	D	D
F4	D	S	U	F	D	D	D	D	D	D
F5	D	S	U	D	D	D	D	D	D	D
F6	D	S	U	F	F	D	S	U	F	D

90. This table is very similar to the table shown above from TS 36.211 (Ex. 1008) in section VI.D; except, this table includes flexible subframes as well. The flexible or dynamic subframes are designated using blue and green highlighting and

the letter “F.” According to the T-doc, these flexible subframe configurations (e.g., F0, F1, F2) allowed for “flexibility for the adaptation of the traffic.” Ex. 1011 (R1-132137) at 3.

91. As part of this discussion on “dynamic” subframes, 3GPP was also working to solve the known interference problem that the use of dynamic subframes described above would cause. 3GPP called this the Enhanced Interference Mitigation & Traffic Adaptation (eIMTA) feature. *See, e.g.*, Ex. 1010 at 87 (listing agreement for the inclusion of eIMTA as discussed in TD# R1-142771 and R1-142772); Ex. 1006 (entitled “Inclusion of eIMTA, TDD-FDD CA, and coverage enhancements); Ex. 1007 (entitled “Introduction of Rel 12 features of TDD-FDD CA and eIMTA). eIMTA allows the network to consider interference considerations in the dynamic reconfiguration of UL-DL configuration of time slots.

92. At the time of the ’361 Patent, the allocation and scheduling of frequency spectrum resources for uplink and downlink transmission based on channel condition and traffic needs—the subject of the challenged claims—was known.

VII. THE ’361 PATENT

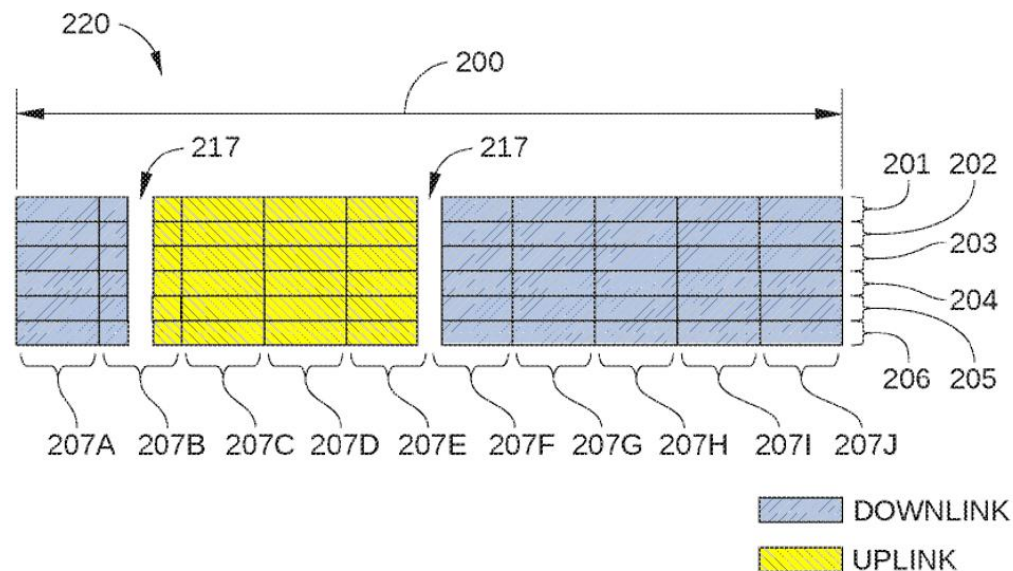
A. Description of the ’361 Patent’s Specification

93. The 361 Patent describes both FDD and TDD resource allocation schemes, though the challenged claims are more relevant to TDD configurations as

FDD systems typically are not reconfigured for the modification between uplink and downlink resources.

94. Figure 2B illustrates frequency spectrum resource allocation employing TDD. Ex. 1001, 5:11-14.

Ex. 1001, Fig. 2B (annotated).



95. Like the figures addressed above, the blue resource blocks and subframes are allocated for downlink and the yellow ones for uplink.

96. The '361 patent states that it seeks to address a challenge of “efficient use of available wireless communication spectrum.” Ex. 1001, 1:19-24, 32-34. The '361 patent acknowledges existing “communication schemes commonly used” “time-division duplex (TDD)” but this scheme “may typically be unable to employ all available frequency spectrum resources when uplink and downlink traffic is

constantly changing.” Ex. 1001, 3:23-38. The 361 Patent notes the limited number of options described above (seven configurations in the table).

97. The process to solve the purported identified problem is described in Figure 4:

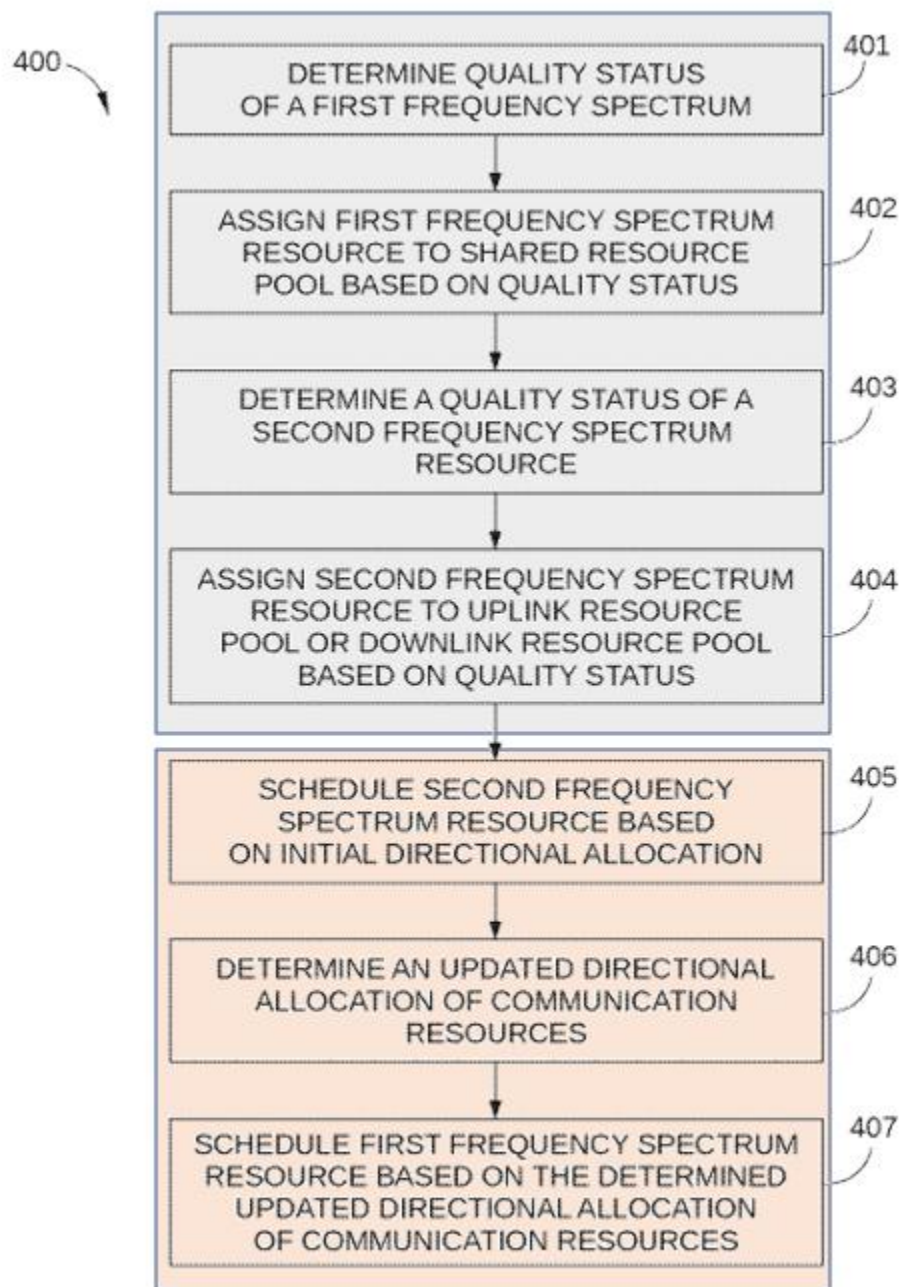


FIG. 4

98. The process occurs in two phases, which I have annotated in grey and orange.

99. In phase one (shaded in grey on top), the resources are measured and assigned based on their quality. In phase two (shaded on orange on bottom), the resources are scheduled based on “allocation determinations” (e.g., traffic needs or interference measurements) in the network. Ex. 1001, Fig. 4, 10:55-13:4.

100. Starting with phase one, in steps 401 & 403 shown in Figure 4, the method “obtain[s] the quality status of the current uplink and downlink frequency spectrum resources available (e.g., subcarriers 201-206) using quality status module 113.” Ex. 1001, 8:50-53. To obtain the quality of the signal, the ’361 Patent states “that *determination of quality status*, as described above, can be performed *using information typically already measured by LTE and LTE-Advanced wireless communication systems*.” Ex. 1001, 8:53-64; 8:64-9:2. Two of the known measurement types already in use in LTE and LTE-A include measuring CQI on the downlink and RIP on the uplink. Ex. 1001, 8:60-9:2. *See also id.*, 10:55-11:46.

101. Still in phase one, *in steps 402 and 404*, the method describes using “the quality status measured” to sort the resources into “pools.” Ex. 1001, 9:3-5 (emphasis added); *see also id.* 10:8-28. The first pool (identified in step 402) is labeled as the “shared resource pool.” This pool is where the first frequency resource is assigned. Ex. 1001, 11:28-32 (emphasis added). The 361 Patent describes how this shared pool is filled with resources that are measured to be “sub-optimal” for both downlink and uplink. Ex. 1001, 11:28-32 (emphasis added). The second and

third pools (identified in step 404) are labeled the (i) “downlink resource pool” and (ii) the “uplink resource pool.” These pools are filled with resources that are measured to be most suitable for either the downlink (e.g., “high CQI”) or uplink (e.g., “low RIP”), respectively. Ex. 1001, 9:9-13, 11:4-38, 11:47-12:7.

102. In phase two *in step 405*, a scheduler schedules resources. The scheduler performs an “initial allocation” by scheduling the downlink resources from the downlink resource pool and the uplink resources from the uplink pool. Ex. 1001, 9:30-40, 12:8-34.

103. *In step 406*, the scheduler performs an “updated directional allocation of frequency spectrum resources” based on the number of current resources requests, the current scheduling of uplink channels and downlink channels, and remaining resources not yet scheduled. Ex. 1001, 9:47-63, 12:35-54.

104. *In step 407*, the resources are scheduled from the shared resource pool in either the uplink or downlink direction depending on what kind of resource is needed. Ex. 1001, 12:55-62. “Consequently, frequency spectrum resources may be dynamically allocated to satisfy resource requests for node 110, so that very few or no frequency spectrum resources are idle” Ex. 1001, 10:1-6, 12:55-13:4.

105. The 361 Patent also makes clear that “each individual [physical resource block] PRB” may constitute a frequency resource. Ex. 1001, 10:29-38.

B. Claim Construction of the '361 Patent

106. I understand in an *inter partes* review, claims are “construed using the same claim construction standard that would be used to construe the claim in a civil action under 35 U.S.C. 282(b).” 37 C.F.R. 42.100(b) §42.100(b). This means claim terms must be given their plain ordinary and customary meaning as understood by a POSITA during the relevant timeframe considering the specification and the prosecution history.

i. “quality status module”

107. I understand that Claim 10 of the 361 Patent contains a means plus function term. The means plus function claim term is italicized below:

a quality status module configured to determine a respective quality status of a first frequency spectrum resource and a second frequency spectrum resource, wherein each of the first frequency spectrum resource and the second frequency spectrum resource are associated with an air interface that is available for use by the wireless base station for an uplink channel or a downlink channel.

108. The prefix “quality status” does not impart structure into the term “module” and does not describe a sufficiently definite structure to a POSITA. I have reviewed the specification and file history and nothing in the specification and prosecution history convey additional structure. For example, the “quality status

module 113” is described as “suitably configured software , firmware , or logic circuit entity , etc.” Ex. 1001, 10:56-58.

109. A POSTIA would understand that the function of the quality status module is to “to determine a respective quality status of a first frequency spectrum resource and a second frequency spectrum resource” as stated in the claim. The structure disclosed in the specification is a general purpose processor. Ex. 1001, 10:56-58. The algorithm executed by the processor to determine the quality status is to measure the “channel quality indicator (CQI), received interference power (RIP), and/or any other suitable quality metric or key performance indicator, such as RSSI, acknowledgement/negative acknowledgement (ACK/NACK) frequency, dropping rate, block error rate, bit error rate, signal-to-interference-plus-noise ratio (SINR), etc.” Ex. 1001, 4:28-34.

ii. “sub-optimal”

110. Claims 10 and 17 require “determin[ing] based on the quality status of the first frequency spectrum resource, that the first frequency spectrum resource is a *sub-optimal* resource, for the uplink channel and the downlink channel, relative to other frequency spectrum resources that are available for use by the wireless base station. Ex. 1001, cl. 10, 17.

111. “Sub-optimal” is a term of degree and is indefinite. The only example of how to determine whether a resource is sub-optimal described in the ’361 Patent

is the “suitability” based on “RIP and CQI values.” According to the implications of the ’361 Patent, the resources that are not “high CQI” or “low RIP” are sub-optimal. Ex. 1001, 9:21-29. Based on this disclosure, a POSITA would not be able to determine whether a resource is “sub-optimal,” as it does not restrict the test to those parameters and does not define what is “high” and what is “low.” The test is purely subjective. However, as described below, the prior art discloses an example consistent with how the ’361 Patent describes the term.

VIII. SUMMARY OF PRIOR ART

A. Gaal (Ex. 1004)

112. U.S. Patent Application Publication No. US 2014/0341051 A1 (“Gaal”) is titled “Channel State Information (CSI) Measurement and Reporting for Enhanced Interference Management for Traffic Adaptation (EIMTA) in LTE.”

113. Based on the face of Gaal, it was published on November 20, 2014, based on an application filed on May 13, 2014. Ex. 1004, Cover. I understand Gaal is therefore prior art under at least 35 U.S.C. § 102(a) (AIA).

114. Gaal states that it “generally relate[s] to wireless communications and, more particularly, to techniques for channel state information (CSI) measurement and reporting for enhanced interference management for traffic adaptation (eIMTA) in long term evolution (LTE)” Ex. 1004, *Abstract* at ¶[0003].

115. Gaal discloses a method that “identif[ies], within a set of subframes, one or more flexible subframes that may be dynamically managed for either uplink or downlink communications.” Ex. 1004 at Abs.; *see also* ¶[0009].

116. Gaal discloses techniques that can be used for many different types of radio technologies described in documents from 3GPP, including in exemplary LTE/LTE-A systems. Ex. 1004, ¶¶[0033]-[0034].

117. In an exemplary LTE & LTE-A system, Gaal discloses TDD mode where the transmissions travel in both the downlink and uplink direction on the same frequency band. Ex. 1004, ¶[0069]).

118. Gaal discloses the same TDD configuration table from the 3GPP standard, which as explained above shows seven possible downlink and uplink subframe configurations:

Ex. 1004, Fig. 6

Uplink-downlink configurations											
Uplink-downlink configuration	Downlink-to-Uplink Switch-point periodicity	Subframe number									
		0	1	2	3	4	5	6	7	8	9
0	5 ms	D	S	U	U	U	D	S	U	U	U
1	5 ms	D	S	U	U	D	D	S	U	U	D
2	5 ms	D	S	U	D	D	D	S	U	D	D
3	10 ms	D	S	U	U	U	D	D	D	D	D
4	10 ms	D	S	U	U	D	D	D	D	D	D
5	10 ms	D	S	U	D	D	D	D	D	D	D
6	5 ms	D	S	U	U	U	D	S	U	U	D

119. Gaal also discloses the 3GPP concept of “fixed” and “dynamic” subframes discussed above in section VI.E. Like the discussion from 3GPP, Gaal discloses how subframes are classified as dynamic if the direction can be dynamically changed (e.g., managed as UL and DL subframes), rather than having a fixed direction (e.g., as either a DL subframe or an UL subframe). Ex. 1004, ¶[0071].

120. Referring to FIG. 6, Gaal discloses the base station could be configured in TDD “subframe configuration 0 (DSUUUDSUUU).” Ex. 1004, ¶[0077]. “In this example, subframes 0/1/2/5/6/7 may be fixed subframes, while subframes 3/4/8/9 may be flexible subframes.” Ex. 1004, ¶[0007].

121. I’ve illustrated this configuration below, where downlink subframes are shown in blue and uplink subframes are shown in yellow, while the flexible subframes are shown in pink. For simplicity, the special subframes are assumed to be downlink subframes:

Ex. 1004, FIG. 6 (partial, annotated).

Uplink-downlink configurations											
Uplink-downlink configuration	Downlink-to-Uplink Switch-point periodicity	Subframe number									
		0	1	2	3	4	5	6	7	8	9
0	5 ms	D	S	U			D	S	U		

Flexible Subframes

122. For *fixed* subframes, Gaal states, “[d]ifferent cells may share a common set of fixed subframes such that there is generally no DL-to-UL interference or UL-to-DL interference in the fixed subframes.” Ex. 1004, ¶[0076].

123. For *flexible* subframes, Gaal states, “[f]lexible subframes, on the other hand, may be subject to interference” (e.g., DL-to-UL interference or UL-to-DL interference). Ex. 1004, ¶[0076].

124. In other words, as described above, Gaal discloses the known problem that flexible subframes may be subject to interference.

125. Gaal discloses that “[t]he direction of flexible subframes may change in a dynamic manner, for example, due to scheduler decisions based on traffic needs,” or “due to inter-cell and/or intra cell interference considerations” Ex. 1004, ¶[0075].

B. Khoryaev (Ex. 1018)

126. U.S. Patent No. 9,185,620 (“Khoryaev”) is titled “Adaptive UL-DL Configurations in a TDD heterogeneous Network.”

127. Based on the face of Khoryaev, it was filed at least as early as November 29, 2012 based on Application No. 13/688,417 and issued on November 10, 2015. Ex. 1018, Cover. I understand Khoryaev is therefore prior art under at least 35 U.S.C. § 102(a) (AIA).

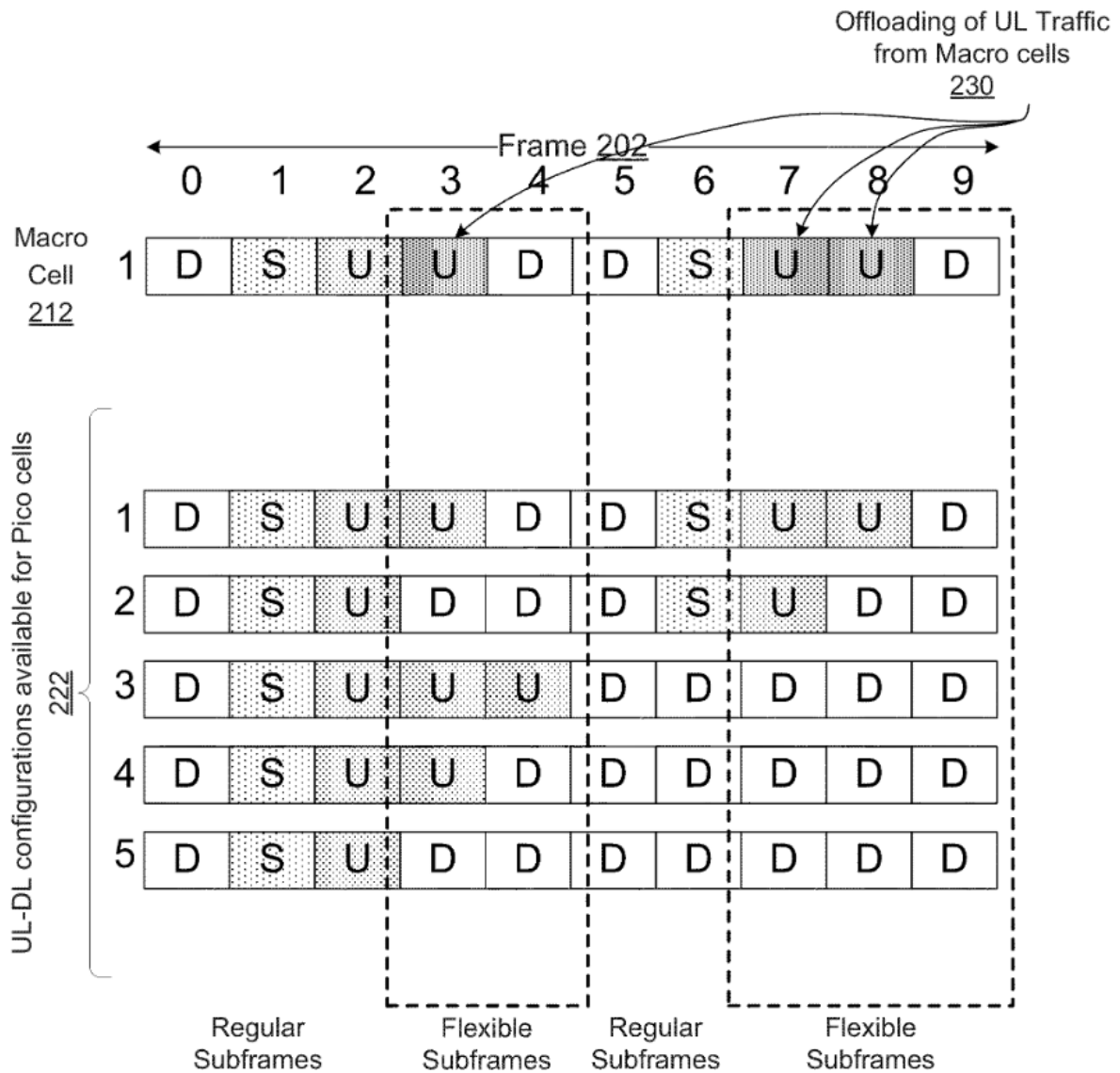
128. Khoryaev is generally directed to “technology for traffic offloading to generate a low interference flexible subframe (FlexSF) of an adaptive uplink-downlink (UL-DL) time-division duplexing (TDD) subframe configuration[.]” Ex. 1018, Abstract.

129. Khoryaev describes a problem of strong inter-cell (BS-to-BS) interference between macro and pico nodes, which can make dynamic adaptation of UL-DL transmission configuration difficult to implement. Ex. 1018, 5:11-19. Khoryaev teaches methods for mitigating or resolving this kind of interference by (i) converting the pico subframe from fixed to flexible, and (ii) muting or traffic offloading the macro subframe. Ex. 1018, 8:20-9:15. According to Khoryaev, these methods “can take into account inter-cell interference from macro cells” (which is measured “using path-gains”) resulting in “effective implementation of adaptive change of UL-DL configuration at pico cells.” Ex. 1018, 7:26-35, 6:34-35.

130. For example, Khoryaev teaches that in response to inter-cell interference in UL macro subframes 3, 7, and 8, those subframes can be designated as flexible subframes for the pico cell. Ex. 1018, Fig. 7, 9:30-33. As a result, those subframes can now be “used for the DL transmission of the pico cells without affecting uplink performance of the macro UEs.” Ex. 1018, Fig. 7, 9:30-33. In particular, the pico cell is no longer limited to subframes 4, 5, and 9 for download but now also use subframes 3, 7 and 8. At the same time, “the macro UE can still

serve some of the UL traffic in a remaining UL subframe #2 (using a legacy LTE UL-DL configuration).” Ex. 1018, 9:39-41. This is illustrated in Figure 7 below.

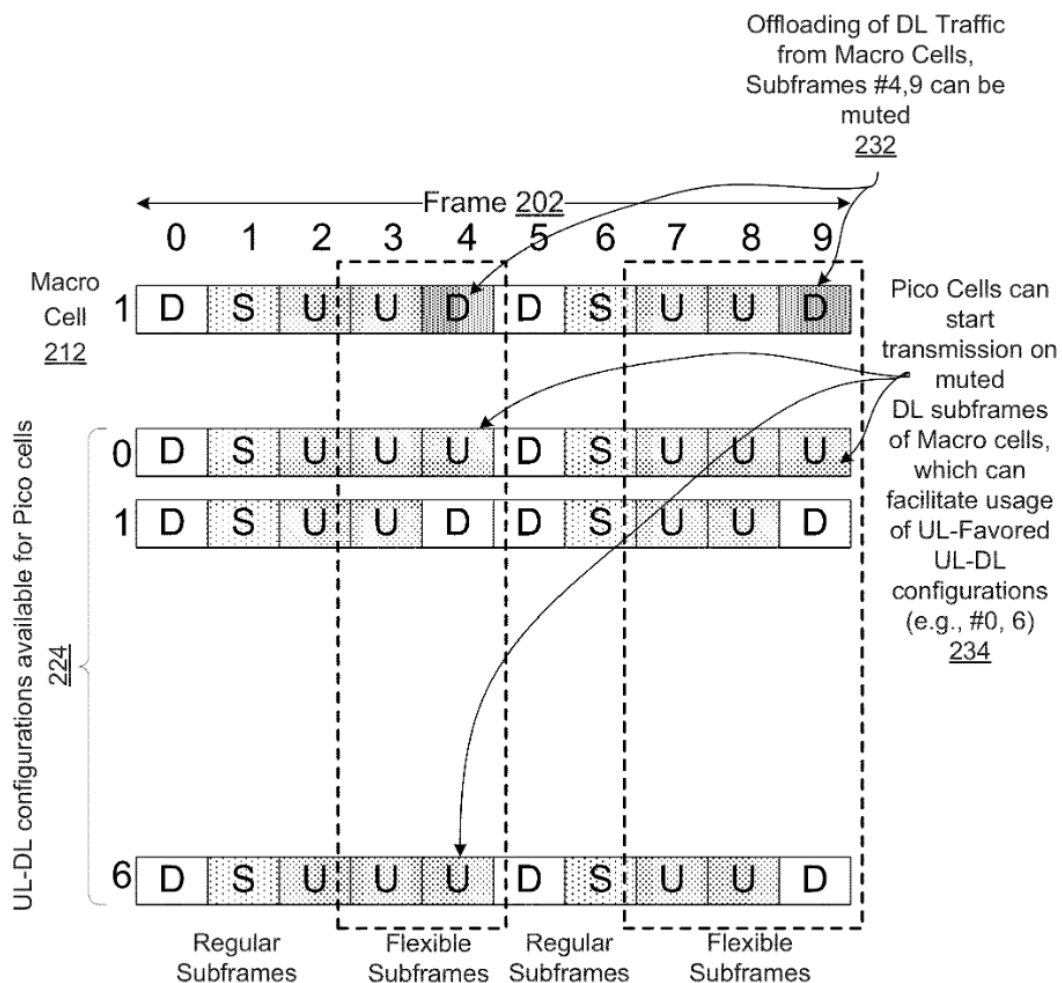
Ex. 1018, FIG. 7



131. Illustrated in Figure 8 is “an opposite example” where “the macro cells can restrict or mute their DL transmissions on flexible subframes #4 and 9,” which results in “[t]he reduction of the DL inter-cell interference from the macro cells on

those subframes 4 and 9” and “facilitate the usage of UL favored UL-DL configurations” for the pico cell, thereby “substantially improv[ing] UL packet throughput at the pico cells.” Ex. 1018, 9:45-55. Moreover, DL throughput is improved because those subframes are flexible. Ex. 1018, 9:55-58.

Ex. 1018, Fig. 8



132. Therefore, upon detecting that a fixed macro subframe is resulting in inter-cell interference with a fixed pico cell subframe, Khoryaev teaches that the

macro subframe can be muted or offloaded and the pico cell subframe can be converted to a flexible subframe, allowing the pico cell subframe to flexibly adapt to traffic.

IX. GROUND 1: GAAL RENDERS OBVIOUS CLAIMS 10-13, 15, AND 17 OF THE '361 PATENT

133. It's my opinion that Claims 10-13, 15, and 17 of the '361 Patent are obvious based on U.S. Patent Application Publication No. US 2014/0341051 A1 ("Gaal").

134. Independent claim 10 implements many of the limitations recited in independent claim 17. Therefore, the substantively similar limitations of claims 10 and 17 are discussed together.

A. Independent claim 10

[10.pre]: A wireless base station for a wireless communication network, the wireless base station comprising:

135. To the extent the preamble is limiting, Gaal renders obvious claim elements [10.pre].

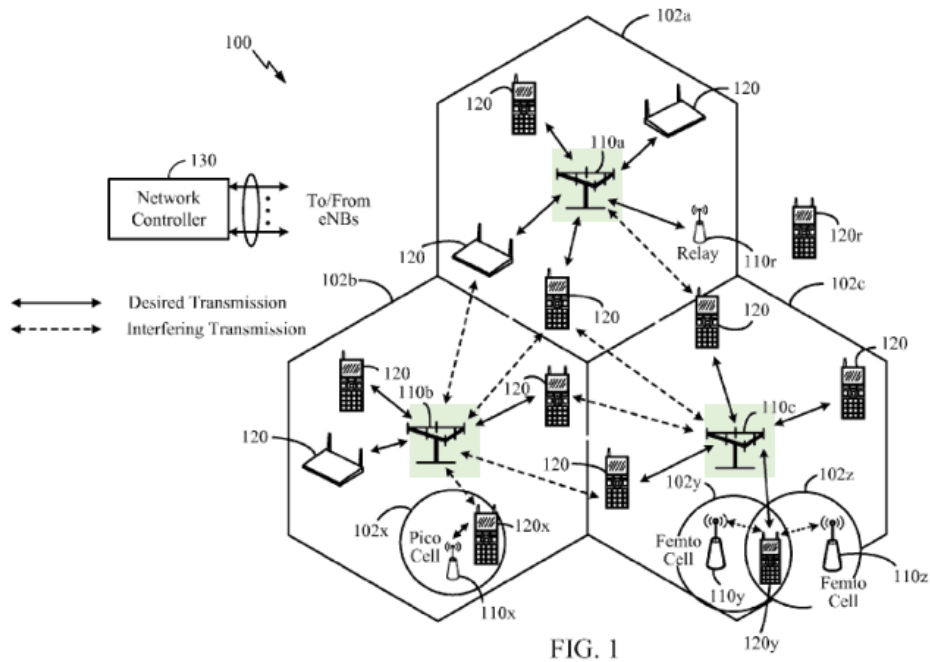
136. Gaal states that its "disclosure generally relate[s] to wireless communications and, more particularly, to techniques for channel state information (CSI) measurement and reporting for enhanced interference management for traffic adaptation (eIMTA) in long term evolution (LTE)" Ex. 1004, ¶[0003].

137. Gaal discloses a "Background" with multiple examples of wireless communication network standards and that a "wireless communication network may

include a number of base stations that can support communication for a number of user equipment (UEs)” Ex. 1004, ¶¶[0005]-[0006].

138. Further, Gaal illustrates “an example of a wireless communication network” in FIG. 1. Ex. 1004, FIG. 1, ¶[0021].

Ex. 1004, Fig. 1 (annotated).



139. In Figure 1, there are multiple wireless base stations (*e.g.*, eNBs) that I have highlighted in green and that Gaal labeled 110. Ex. 1004, FIG. 1, ¶¶[0034]-[0041] (describing FIG. 1); *see also* Ex. 1004, FIG. 3; ¶¶[0054]-[0062].

[10.1]: a quality status module configured to determine a respective quality status of a first frequency spectrum resource and a second frequency spectrum resource, wherein each of the first frequency spectrum resource and the second frequency spectrum resource are associated with an air interface that is available for use by the wireless base station for an uplink channel or a downlink channel;

140. Gaal renders obvious claim element [10.1].

141. I discuss this limitation in three parts. (i) a first frequency spectrum resource and a second frequency spectrum resource, (ii) each of the first frequency spectrum resource and the second frequency spectrum resource are associated with an air interface that is available for use by the wireless base station for an uplink channel or a downlink channel, and (iii) a quality status module configured to determine a respective quality status of a first frequency spectrum resource and a second frequency spectrum resource.

i. A first frequency spectrum resource and a second frequency spectrum resource.

142. Gaal discloses frequency spectrum resources, including a first frequency spectrum resource and a second frequency spectrum resource.

143. As explained in the background section, Gaal discloses subcarriers and resource blocks in an LTE radio frame. Ex. 1004, ¶[0075]. I have shown the LTE radio frame in red in Figure 2, which Gaal describes as “a frame structure in a wireless communications network.” Ex. 1004, ¶[0022]. As described in Section

VI.D above, each radio frame comprises ten (10) subframes, which I’ve illustrated in blue and yellow for downlink and uplink respectively. Ex. 1004, ¶[0042].

Ex. 1004, Fig. 2 (annotated)

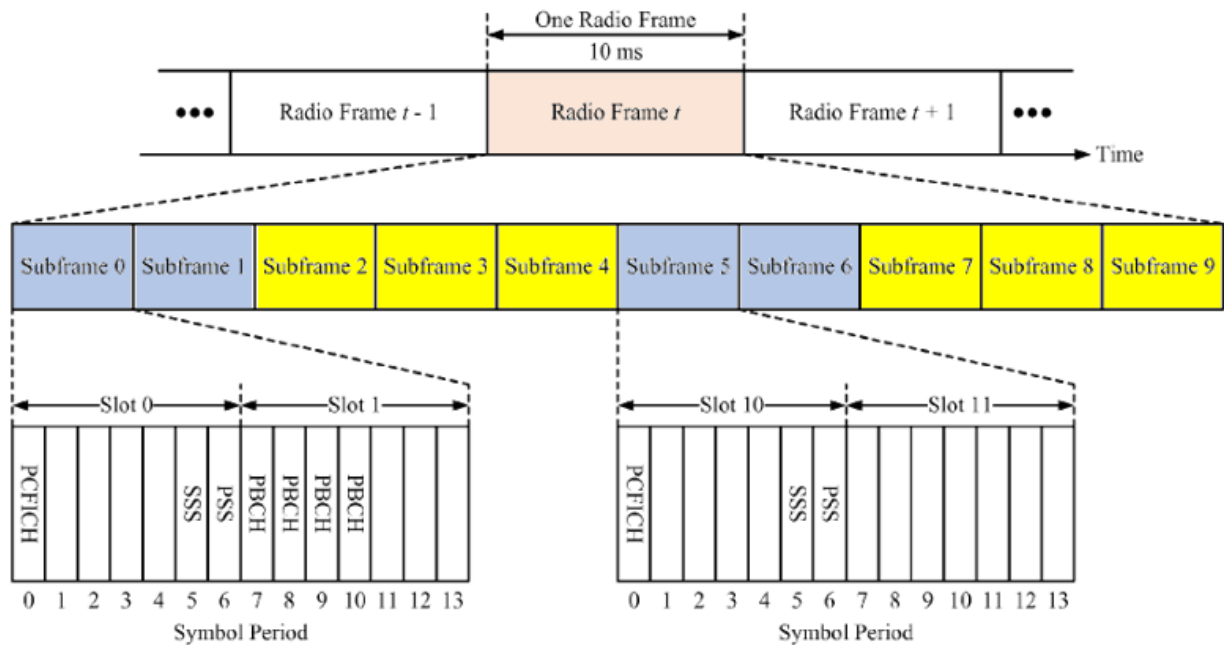
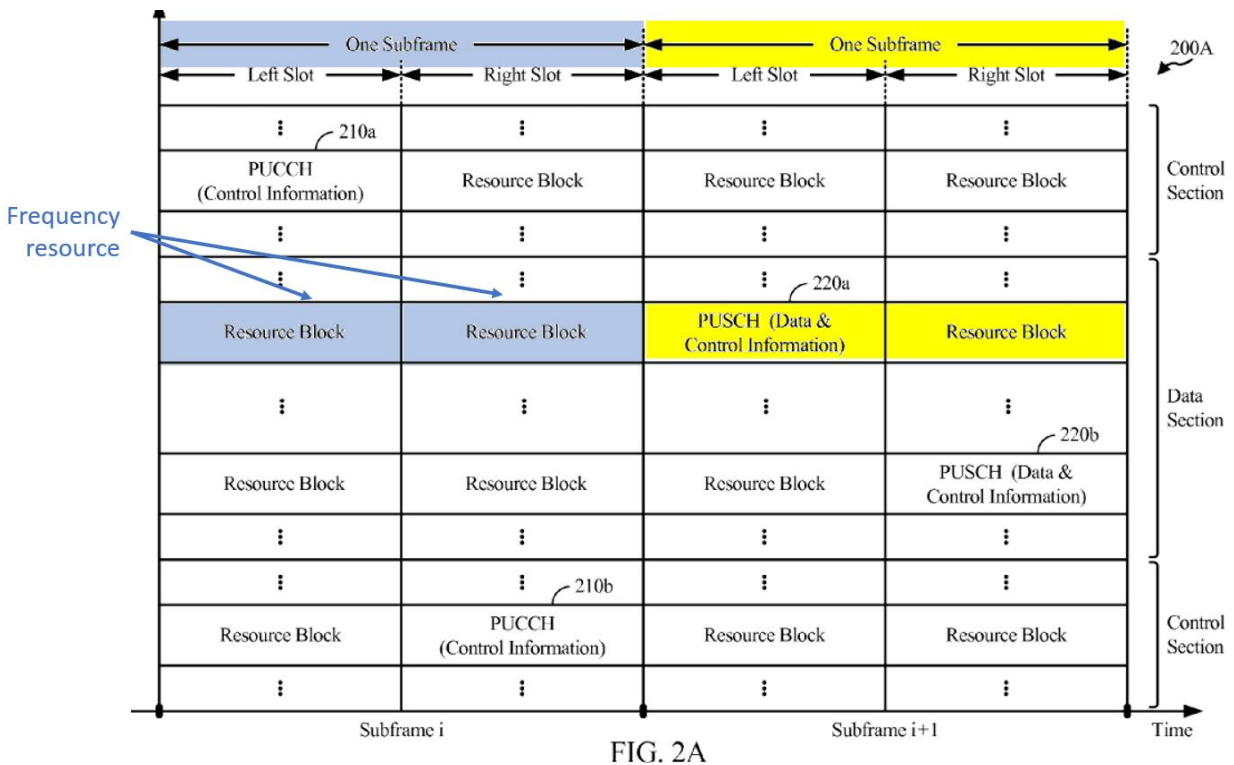


FIG. 2

144. As described above, each subframe may include two slots and those “may be partitioned into *resource blocks*.” Ex. 1004, ¶[0042] (emphasis added). “Each resource block may cover N subcarriers (*e.g.*, 12 subcarriers)” in the frequency domain in one slot in the time domain. E.g., Ex. 1004, ¶[0042]. The resource blocks are shown below. As shown, one subframe (in either blue or yellow) is divided into a left slot and a right slot and there are resource blocks associated with those slots.

Ex. 1004, Fig. 2A (annotated)



145. The resource blocks in Gaal are the first and second frequency resources of the claims of the 361 Patent. Ex. 1001, cl. 9 (“assigning *the first frequency spectrum resource* to the shared resource pool comprises assigning a *physical resource block that includes multiple subcarriers*”).

- ii. **Each of the first frequency spectrum resource and the second frequency spectrum resource are associated with an air interface that is available for use by the wireless base station for an uplink channel or a downlink channel.**

146. The frequency resources described above are associated with an air interface that is available for use by the base station for an uplink channel or a downlink channel. Ex. 1004, ¶[0075].

147. Gaal discloses TDD systems that allow for communication in the uplink and downlink: “TDD is a mode of the common LTE standard that is specified for the unpaired spectrum where the *transmissions travel in both the downlink and uplink directions* on the same frequency band.” Ex. 1004, ¶[0069].

148. Gaal discloses the same table that’s disclosed in the 3GPP standard with seven (7) possible downlink (DL) and uplink (UL) subframe configurations are supported:

Ex. 1004, Fig. 6 (annotated)

600 ↘

Uplink-downlink configurations

Uplink-downlink configuration	Downlink-to-Uplink Switch-point periodicity	Subframe number									
		0	1	2	3	4	5	6	7	8	9
0	5 ms	D	S	U	U	U	D	S	U	U	U
1	5 ms	D	S	U	U	D	D	S	U	U	D
2	5 ms	D	S	U	D	D	D	S	U	D	D
3	10 ms	D	S	U	U	U	D	D	D	D	D
4	10 ms	D	S	U	U	D	D	D	D	D	D
5	10 ms	D	S	U	D	D	D	D	D	D	D
6	5 ms	D	S	U	U	U	D	S	U	U	D

149. Gaal discloses that the subframes may be categorized as “fixed” subframes or “flexible (dynamic)” subframes. Ex. 1004, ¶[0075].

150. “*Fixed* subframes are not expected to change in a dynamic or semi-static manner, but only when a cell determines to change the subframe configurations (*e.g.*, from one of the seven TDD UL/DL subframe configurations shown in FIG. 6 to another of the seven TDD UL/DL subframe configurations) in a static manner.” Ex. 1004, ¶[0075].

151. On the other hand, “[t]he direction of flexible subframes may change in a dynamic manner, for example, due to scheduler decisions based on traffic needs. As another example, *the direction of a subframe may change due to inter-cell and/or intra-cell interference considerations.*” Ex. 1004, ¶[0075].

152. Gaal provides an example. Referring to FIG. 6, the base station could be configured in TDD “subframe configuration 0 (DSUUUDSUUU).” Ex. 1004, ¶[0077]. “In this example, subframes **0/1/2/5/6/7** may be fixed subframes, while subframes **3/4/8/9** may be flexible subframes.” Ex. 1004, ¶[0007]. As I show below, I have used blue to indicate downlink (with special subframes assumed to be downlink) and yellow to indicate uplink, while flexible subframes are pink.

Ex. 1004, FIG. 6 (partial, annotated).

Uplink-downlink configurations

Uplink-downlink configuration	Downlink-to-Uplink Switch-point periodicity	Subframe number									
		0	1	2	3	4	5	6	7	8	9
0	5 ms	D	S	U			D	S	U		


Flexible Subframes

iii. A quality status module configured to determine a respective quality status of a first frequency spectrum resource and a second frequency spectrum resource

153. Last, Gaal discloses a quality status module that determines the quality status of the frequency resources. As noted above, this term is a means-plus-function term. Regardless of whether the term is a means plus function term, the limitation is disclosed by Gaal.

154. In describing the enhanced interference management for traffic adaptation (eIMTA) method of its LTE network, Gaal states that the “direction of flexible subframes may change in a dynamic manner, for example, due to scheduler decisions based on traffic needs” and that “the *direction of a subframe may change due to inter-cell and/or intra-cell interference considerations.*” Ex. 1004, ¶[0075].

155. A POSITA would have understood and known that—as described in the 361 Patent—there were known ways to measure channel conditions such as inter-cell and intra-cell interference. Ex. 1001, 10:61-11:3. Channel state information

(CSI) reference signals (CSI-RS), measured by the UE in each subframe, will provide a simplified measurement of interference. Ex. 1001, 8:60-64. By measuring the CSI-RS, the UE provides information to the base station, including quality status, about the radio channel conditions of an air interface available for use between a wireless base station and a UE.

156. Gaal discloses the use of CSI and that a wireless base station that can “receive CSI feedback from a UE” and “process the CSI feedback” (*E.g.*, Ex. 1004, ¶[0109], [0110]. Receiving and processing CSI feedback is one way in which the base station can determine a quality status of a subframe. Ex. 1004, ¶[0057]. Claim 28 of Gaal likewise discloses the use of a processor process the CSI feedback. Ex. 1004 at cl. 28.

157. A POSTIA would have known about CSI feedback in the art. As described above in Section VI.F, a POSITA would have known CSI consists of multiple indicators. Once such indicator is Channel Quality Indicator (CQI)—which as its name implies, is a measurement of quality. The 361 Patent describes CQI as an “existing” “quality status” indicator “typically [] in place in wireless network[s].” Ex. 1001, 10:61-64 (“In some embodiments, quality status module 113 may *determine this quality status by determining at least one of a channel quality indicator (CQI) value and a received interference power (RIP) of the first frequency spectrum resource, CQI and RIP are each existing channel performance measures*

that may already typically be in place in wireless network.” (emphasis added)).

Thus, a POSITA would have understood (or at least found it obvious) that the CQI may be provided in a CSI feedback report provided by a UE and then used by the base station to determine a quality status of the subframes. Ex. 1004, ¶[0022]; Ex. 1001, 8:60-64.

158. I reach the same conclusion under the means plus function construction of the term as well. A POSITA would have recognized that accounting for interference considerations is the same as the function of the claim (determining a respective quality status of a first frequency spectrum resource and a second frequency spectrum resource). The structure disclosed in Gaal is likewise a general purpose processor. Ex. 1004 at cl. 28 (reciting “at least one processor configured to” perform “process[ing] the CSI feedback.”). Finally, as described above, a POSITA would have recognized (or at least found it obvious) that the algorithm executed by the processor to measure and process the CSI feedback could be through a “channel quality indicator (CQI),” or more broadly “and/or any other suitable quality metric or key performance indicator,” as described in 361 Patent specification. Ex. 1001, 4:28-34.

159. Gaal discloses that the quality status is measured on the frequency resources. Gaal states “[c]hannel state information reference signals (CSI-RS) may be transmitted in the flexible subframes.” Ex. 1004, ¶[0081]; [0084]; Ex. 1001, 8:60-

64. A POSITA would have understood (or at least found it trivially obvious) to use the CSI-RS in the flexible subframe in its intended manner and send a CSI report containing quality status such as CQI back to the base station.

[10.2]: a processor coupled to the quality status module and configured to:

160. Gaal renders obvious claim element [10.2].

161. The processor and controller in Gaal is shown in in FIG. 3. Ex. 1004, FIG. 3. I have highlighted the processor and controller in green below. The two components are shown as connected. Ex. 1004, FIG. 3, ¶[0058].

Ex. 1004 Fig. 3

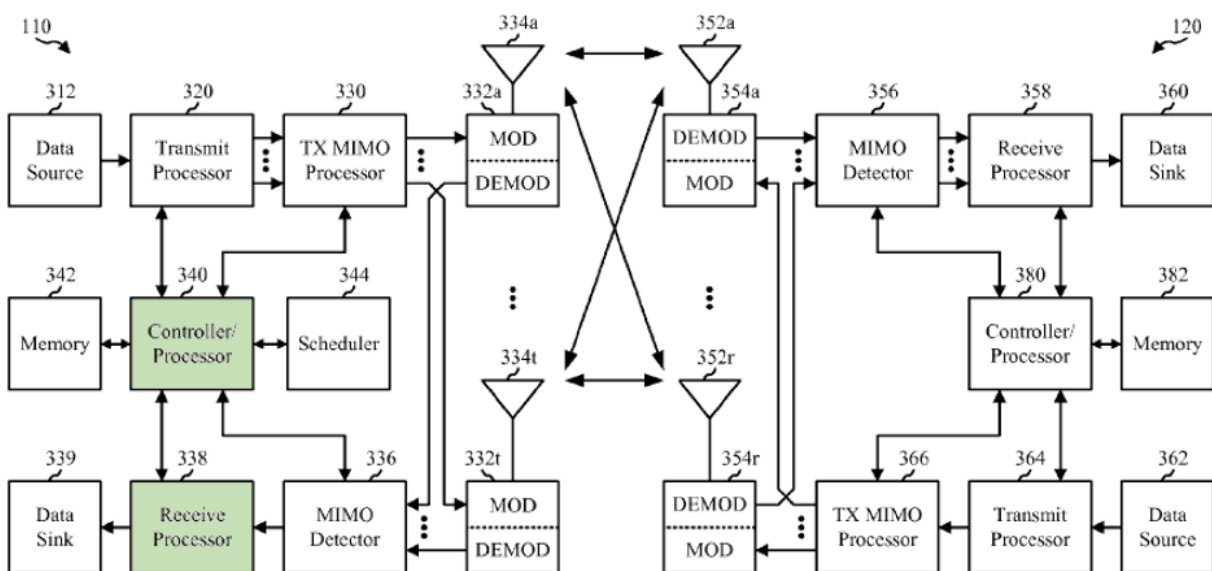


FIG. 3

162. Gaal discloses that “[t]he controller/processor 340, receive processor 338, and/or other processors and modules at the eNB 110 may perform or direct operations 800 in FIG. 8 and/or other processes for the techniques described herein.”

Ex. 1004, ¶[0058]; Ex. 1004 at cl. 28 (reciting “at least one processor configured to” perform “process[ing] the CSI feedback.”). This means the processor and controller would perform the quality status check using the CSI feedback.

[10.3]: determine, based on the quality status of the first frequency spectrum resource, that the first frequency spectrum resource is a sub-optimal resource, for the uplink channel and the downlink channel, relative to other frequency spectrum resources that are available for use by the wireless base station; and

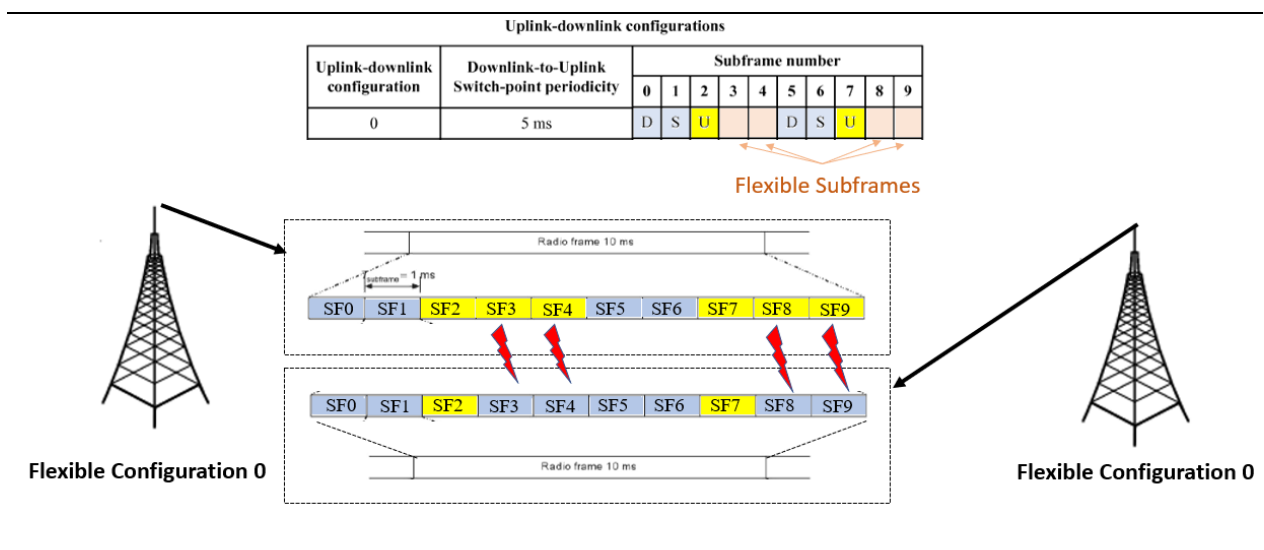
163. Gaal renders obvious claim element [10.3].

164. I incorporate my discussion for claim element [10.1] above. Gaal discloses determining a quality status of a first frequency spectrum resource. Gaal discloses that the first frequency spectrum resource of a subframe may be flexible and that the directionality of a flexible subframe is dynamic and changes based on “traffic needs” or on “inter-cell and/or intra-cell interference considerations.” Ex. 1004, ¶[0075]; *see also* Ex. 1004, FIG. 6 (illustrating configurations of subframes with dynamic subframes), ¶¶[0071]-[0074] (describing classifying subframes as dynamic or fixed).

165. Gaal therefore at least renders obvious the fact that the flexible subframes are determined to be sub-optimal relative to other frequency spectrum resources. The reason Gaal shows a “sub-optimal” resource is a flexible subframe is due to the interference. Gaal identifies that *fixed* subframes do not have the same interference concerns as the flexible subframes: “Different cells may share a

common set of *fixed* subframes such that there is generally *no* DL-to-UL interference or UL-to-DL interference in the fixed subframes.” Ex. 1004, ¶[0076] (emphasis added). “Flexible subframes, on the other hand, may be subject to interference (e.g., DL-to-UL interference or UL-to-DL interference).” Ex. 1004, ¶[0076].

166. I have included an illustration below showing how inter-cell uplink downlink interference is created in flexible subframes in Gaal when one base station chooses uplink and another base station chooses downlink for the flexible subframe.



167. In the above illustration, the interference is caused by uplink communications and downlink communications in the same timeslot on nearby base stations. I have discussed this in more detail above in Section VI.D.

168. Thus, the flexible subframe is the first frequency resource and, due to the interference caused by its flexibility, is sub-optimal compared to the fixed

subframes where there “is generally no DL-to-UL interference or UL-to-DL interference.” Ex. 1004, ¶[0076].

169. Moreover, a POSITA would have understood Gaal’s disclosure of inter-cell and/or intra-cell interference would include the use of CSI/CQI to measure such interference, or at least that it would be obvious to do so. (*e.g.*, Ex. 1004, ¶¶[0068]-[0075].

170. Gaal dedicates an entire subsection to “Example CSI Measurement and Reporting for EIMTA in LTE.” Ex. 1004, ¶¶[0069]-[0110]. A POSITA would have understood that LTE CSI reports include the defined CQI measurements. Ex. 1009 at 58 (“The time and frequency resources that can be used by the UE **to report CSI which consists of Channel Quality Indicator (CQI), precoding matrix indicator (PMI), precoding type indicator (PTI), and/or rank indication (RI)** are controlled by the eNB.”) (emphasis added); *see also* Ex. 1009 at 69 (“A UE is semi-statically configured by higher layers to periodically feed back different **CSI components (CQI, PMI, PTI, and/or RI)**[.]”) (emphasis added).

171. CQI indicates how well the signal is received, considering factors like signal strength, interference, and noise. A POSITA would have known (and it is defined by the LTE standard), that CQI values are ranked 0 to 15, and that the CQI is included within the CSI reports. A POSITA would have known that when two

CQI for two resource blocks are compared that the lower CQI value would be sub-optimal due to it representing a lower quality status.

172. Using the CQI to rank resources is also how the 361 Patent describes the determination of a sub-optimal resource. “For example, in some embodiments, subcarriers with high CQI, which may indicate that the subcarrier is well-suited for a downlink channel, may be assigned” Ex. 1001, 9:8-11. “In such embodiments, the assigned subcarriers may be ranked in order of suitability.” Ex. 1001, 9:14-16.

[10.4]: in response to the determination that the first frequency spectrum resource is the sub-optimal resource, assign the first frequency spectrum resource to a shared resource pool; and

173. Gaal renders obvious claim elements [10.4].

174. As described above, Gaal discloses that time division duplexing (TDD) frame structures are supported that allow for transmissions in both the downlink and uplink directions on the same frequency band and the use of flexible subframes that can be scheduled for uplink or downlink based on traffic needs or interference considerations. Ex. 1004, ¶[0069].

175. As described above, these flexible subframes are “sub-optimal” compared to the fixed subframes because the flexible subframes are subject to interference: “*Flexible* subframes, on the other hand, may be subject to interference (e.g., DL-to-UL interference or UL-to-DL interference).” Ex. 1004, ¶[0076]. A

POSITA would have understood that this disclosure means (or it would have been trivially obvious to modify this disclosure to mean) that these sub-optimal flexible subframes are allocatable to either uplink or downlink and therefore constitute the claimed shared resources in the shared resource pool.

176. This interpretation is consistent with how the 361 Patent describes the shared resource pool. “Furthermore, in some embodiments, a particular frequency spectrum resource *assigned to shared resource pool 118* may be scheduled by scheduler module 114 of node 110 *for an uplink or a downlink channel based on suitability of* the particular frequency spectrum resource for an uplink or a downlink channel, respectively.” Ex. 1001, 10:8-13. This description is consistent with, or at least obvious in view of, Gaal’s disclosure about the use of interference considerations using the enhanced interference management technique.

[10.5]: a scheduler module coupled to the processor and configured to:

177. Gaal renders obvious claim element [10.5].

178. Gaal discloses an eNB with a scheduler 344 and illustrates the scheduler 344 in FIG. 3. Ex. 1004, Fig. 3, ¶[0024].

Ex. 1004, Fig. 3

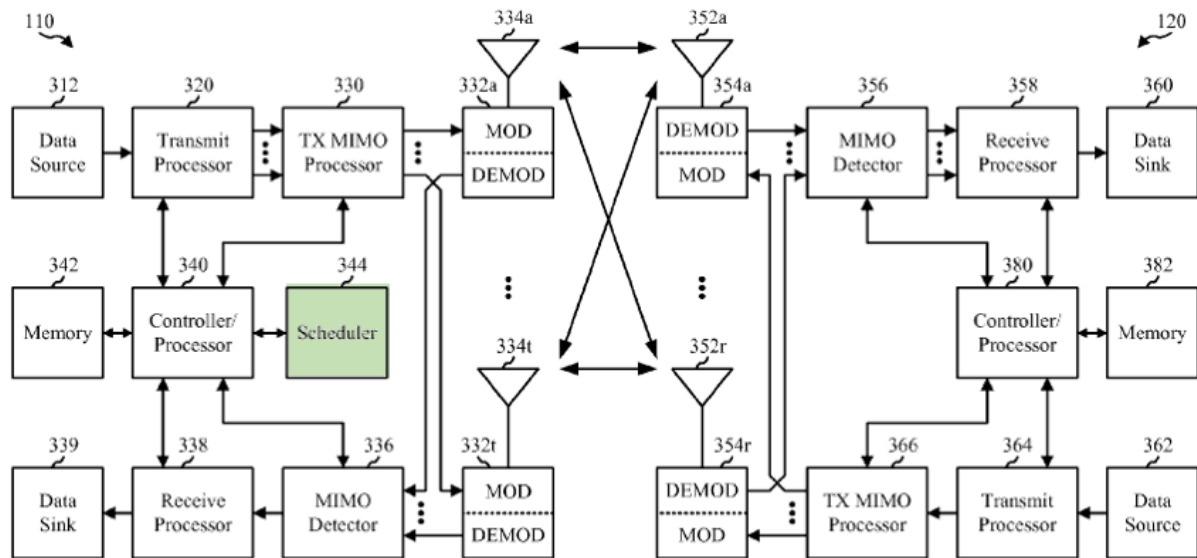


FIG. 3

179. As shown above, the scheduler 344 is connected to (e.g., coupled to) the controller/processor 340 of the eNB 110. Ex. 1004, Fig 3.

180. As described above, Gaal discloses that the controllers/processors 340 may direct the operations of the scheduler 344 described by Gaal, and the “scheduler 344 may schedule UEs for data transmission on the downlink and/or uplink.” Ex. 1004, ¶[0058].

[10.6]: schedule the second frequency spectrum resource for the uplink channel or the downlink channel based on an initial directional allocation of frequency spectrum resources for the wireless base station;

181. Gaal renders obvious claim element [10.6].

182. Gaal discloses the initial directional allocation of communication resources. The initial directional allocation is the directional allocation given in the

table in FIG. 6. Ex. 1004, Fig. 6. A POSITA reading this table would have known that this table gives the initial configuration and thus teaches or renders obvious an initial allocation.

183. The initial directional allocation of an eNB with configuration 0—which is the example I have used above—is shown below:

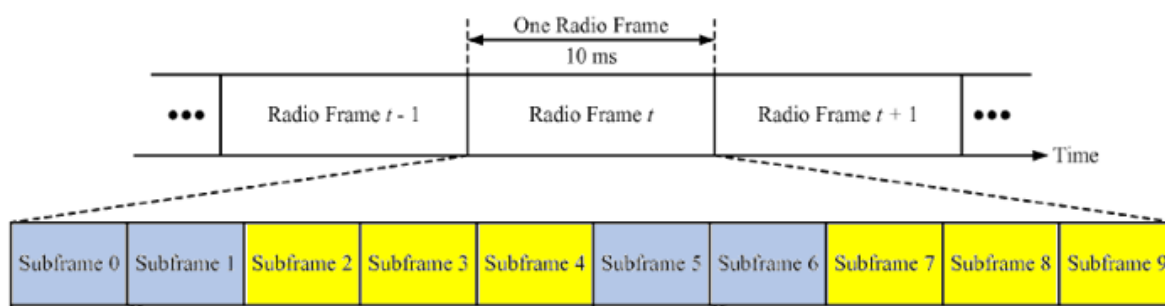
Ex. 1004, Fig 6

Uplink-downlink configurations											
Uplink-downlink configuration	Downlink-to-Uplink Switch-point periodicity	Subframe number									
		0	1	2	3	4	5	6	7	8	9
0	5 ms	D	S	U	U	U	D	S	U	U	U

184. For the purposes of below, I have annotated the “special” subframe as a regular downlink subframe. This is consistent with how Gaal discloses “special” subframes. “Each of the special subframes 706 and 708 *may include* a Downlink Pilot Time Slot (DwPTS), a Guard Period (GP), and an Uplink Pilot Time Slot (UpPTS).” Ex. 1004, ¶[0070]. This is also consistent with how a POSITA would have understood special subframes at the time of the ’361 Patent.

185. In this example, I illustrated the initial direction allocation of the radio frame with blue subframes representing downlink and yellow subframes representing uplink subframes.

Ex. 1004, Fig. 2 (annotated).



[10.7]: determine an updated directional allocation of frequency spectrum resource for the wireless base station after the second frequency spectrum resource is scheduled for the uplink channel or the downlink channel; and

186. Gaal renders obvious claim elements [10.7].

187. Gaal discloses or at least renders obvious the use of flexible subframes that can be scheduled after the initial directional allocation is scheduled above, based on traffic needs. The flexible subframes are shown below:

Ex. 1004, Fig. 6 (annotated)

Uplink-downlink configurations											
Uplink-downlink configuration	Downlink-to-Uplink Switch-point periodicity	Subframe number									
		0	1	2	3	4	5	6	7	8	9
0	5 ms	D	S	U			D	S	U		


Flexible Subframes

188. As stated in Gaal, “In this example, subframes **0/1/2/5/6/7** may be fixed subframes, while subframes **3/4/8/9** may be flexible subframes.” Ex. 1004, ¶[0077].

189. A POSITA would have understood that after the uplink and downlink subframes are assigned, these flexible subframes would have been assigned to fill traffic needs or other factors such as interference mitigation. Ex. 1004, ¶[0075]. A POSITA would have understood this disclosure as part of the “updated directional allocation” or at least render and updated direction allocation obvious.

190. The ’361 Patent also describes that an updated directional allocation may be based on based on one or more of a plurality of factors:

In some embodiments, the updated directional allocation of frequency spectrum resources may be based on *the number of current resource requests from wireless devices 120, on the number of current resource requests from node 110, [etc.] . . .*

Ex. 1001, 9:49-58; *see also id.* at 12:35-48 (describing the same updated directional allocation for block 406 of FIG. 4).

191. Like in Gaal, a POSITA would have understood these factors are based on, e.g., traffic needs.

192. In the case of Gaal, the flexible subframes will be scheduled based on similar factors, such as traffic needs: “The direction of flexible subframes may change in a dynamic manner, for example, due to scheduler *decisions based on traffic needs.*” Ex. 1004, ¶[0075].

193. Gaal discloses one reason to change the flexible subframes would be “As an illustrative example of eIMTA, if during a short duration a large data burst

on downlink is desired, the configuration may be changed to *a more downlink heavy subframe configuration*.” Ex. 1004, ¶[0072].

194. To illustrate what Gaal is disclosing, I have shown a “more downlink heavy subframe configuration” in the updated allocation in the figure below, where the traditional uplink subframes of configuration 0 (highlighted in pink in the top figure) have been dynamically allocated to downlink (in the bottom figure):

Ex. 1004, Fig 6 (annotated)

Initial Allocation

Uplink-downlink configurations

Uplink-downlink configuration	Downlink-to-Uplink Switch-point periodicity	Subframe number									
		0	1	2	3	4	5	6	7	8	9
0	5 ms	D	S	U	U	U	D	S	U	U	U

Updated Allocation

Uplink-downlink configurations

Uplink-downlink configuration	Downlink-to-Uplink Switch-point periodicity	Subframe number									
		0	1	2	3	4	5	6	7	8	9
0	5 ms	D	S	U	D	D	D	S	U	D	D

195. As shown, the updated allocation has six downlink subframes while the initial allocation had two.

196. A POSITA would have been obvious to schedule the flexible subframes after scheduling the fixed subframes. As disclosed in Gaal, “fixed subframes”

generally have no risk of “DL-to-UL interference or UL-to-DL interference.” Ex. 1004, ¶[0076]. A POSITA would have understood that, in determining updated allocation based on traffic needs, the fixed downlink subframes would be first assigned to downlink resource needs and then the fixed uplink subframes would be first assigned to uplink resource needs. After this, a POSITA would have understood or found it obvious that the scheduler will determine interference and traffic in the network and allocate the direction of the flexible subframe accordingly. Ex. 1004, ¶[0075].

[10.8]: schedule the first frequency spectrum resource based on the updated directional allocation of frequency spectrum resources for the wireless base station.

197. Gaal renders obvious claim elements [10.8].

198. I incorporate my analysis of claim element [10.5] above. Gaal discloses a schedule module of scheduler 344 for scheduling UL-DL subframes. Gaal disclosed that the scheduling of UL-DL subframes included flexible subframes that are dynamically changed due to scheduler decisions based on traffic needs. Ex. 1004, ¶[0075].

199. Since the flexible subframes were allocated to the shared resource pool and available for either uplink or downlink allocation, a POSITA would have understood from Gaal’s disclosure those subframes must be scheduled for the uplink or downlink based on the updated allocation. That is, a POSITA would have

understood that Gaal discloses the directional resources are scheduled for uplink or downlink transmission based on the directional needs that are updated due to traffic and channel conditions. Ex. 1004, ¶[0075]

200. Thus, a POSITA would have understood Gaal to renders obvious claim elements [10.8].

B. Dependent claim 11

11: The base station of claim 10, further comprising: a memory coupled to the processor and configured to store an uplink resource pool, a downlink resource pool, and the shared resource pool, wherein the processor is further configured to assign, based on the determined quality status of the second frequency spectrum resource, the second frequency spectrum resource to one of the uplink resource pool or downlink resource pool.

201. I incorporate my analysis of claim 10. Gaal renders obvious claim 11.

202. Gaal discloses a base station with memory: “The memories 342 and 382 may store data and program codes for the eNB 110 and the UE 120, respectively.” Ex. 1004, ¶[0058].

203. FIG. 3 illustrates that memory coupled to controller/processor 340, as shown below. Ex. 1004, FIG. 3.

Ex. 1004, Fig. 3 (annotated)

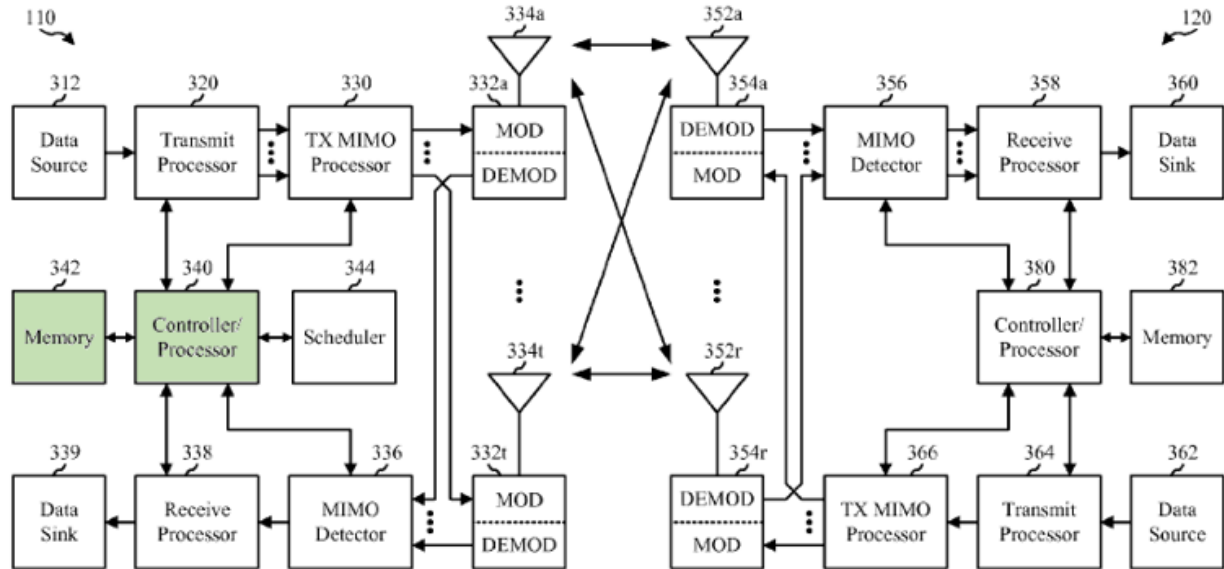


FIG. 3

204. At the time of the 361 Patent, a POSITA would have understood that the memory would have been the component storing information about the available resources, including their respective quality status, and assigned pool. That is the purpose of memory to store information.

205. Moreover, a POSITA would have found it obvious to use the memory to store the information.

206. A POSITA would have understood the processor would have been responsible for executing steps like the assignment of resources to the different pools in the memory. This is because the processor is the only entity attached to the memory. As such, a POSITA would have found it obvious to use the processor for this purpose.

C. Dependent claim 12

12: The wireless base station of claim 10, wherein the updated directional allocation of frequency spectrum resources is based on one or more of: current resource requests from a wireless device serviced by the wireless base station, current resource requests from the wireless base station, a number of frequency spectrum resources scheduled from an uplink resource pool for uplink channels, and a number of frequency spectrum resource scheduled from a downlink resource pool for downlink channels.

207. I incorporate my analysis of claim 10. Gaal renders obvious claim 12.

208. Gaal discloses that “[t]he direction of flexible subframes may change in a dynamic manner, for example, due to scheduler *decisions based on traffic needs*.” Ex. 1004, ¶[0075].

209. Gaal discloses one reason to change the flexible subframes would be “As an illustrative example of eIMTA, if during a short duration a large data burst on downlink is desired, the configuration may be changed to *a more downlink heavy subframe configuration*.” Ex. 1004, ¶[0072].

210. A POSITA would have understood that Gaal’s disclosure of “traffic needs” is the same as the 361 Patent claim element describing “current resource requests from a wireless device serviced by the wireless base station” and “current resource requests from the wireless base station.” A POSITA would have understood these factors are based on, e.g., traffic needs.

D. Dependent claim 13

13: The wireless base station of claim 10, wherein the initial directional allocation of frequency spectrum resources is based on current resource requests from a wireless device serviced by the wireless base station, and current resource requests from the wireless base station.

211. I incorporate my analysis of claim 10. Gaal renders obvious claim 13.

212. Gaal discloses that the scheduling of subframes is performed dynamically, including based on traffic needs. Ex. 1004, ¶[0075].

213. A POSITA would have understood that Gaal's disclosure of scheduling subframes based on traffic needs discloses (or at least renders obvious) that the initial directional allocation of frequency spectrum resources is based on current resource requests from a wireless device (e.g., traffic needs) serviced by the wireless base station, and current resource requests (e.g., traffic needs) from the wireless base station.

E. Dependent claim 15

15: The wireless base station of claim 10, wherein the first frequency spectrum resource includes multiple subcarriers and multiple resource elements associated with each of the multiple subcarriers.

214. I incorporate my analysis of claim 10. Gaal renders obvious claim 15.

215. As described above, Gaal discloses a frequency spectrum resource of a subframe or a resource block: "The available time frequency resources may be partitioned into resource blocks." Ex. 1004, ¶[0042].

216. Gaal further discloses: “Each resource block may cover N subcarriers (e.g., 12 subcarriers) in one slot.” Moreover, Gaal discloses that “a number of resource elements may be available in each symbol period”:

Each resource element may cover one subcarrier in one symbol period and may be used to send one modulation symbol, which may be a real or complex value. Resource elements not used for a reference signal in each symbol period may be arranged into resource element groups (REGs). Each REG may include four resource elements in one symbol period.

217. This arrangement of multiple resource elements is also shown in Figure 4 below. Ex. 1004, ¶[0063].

Ex. 1004, Fig. 4

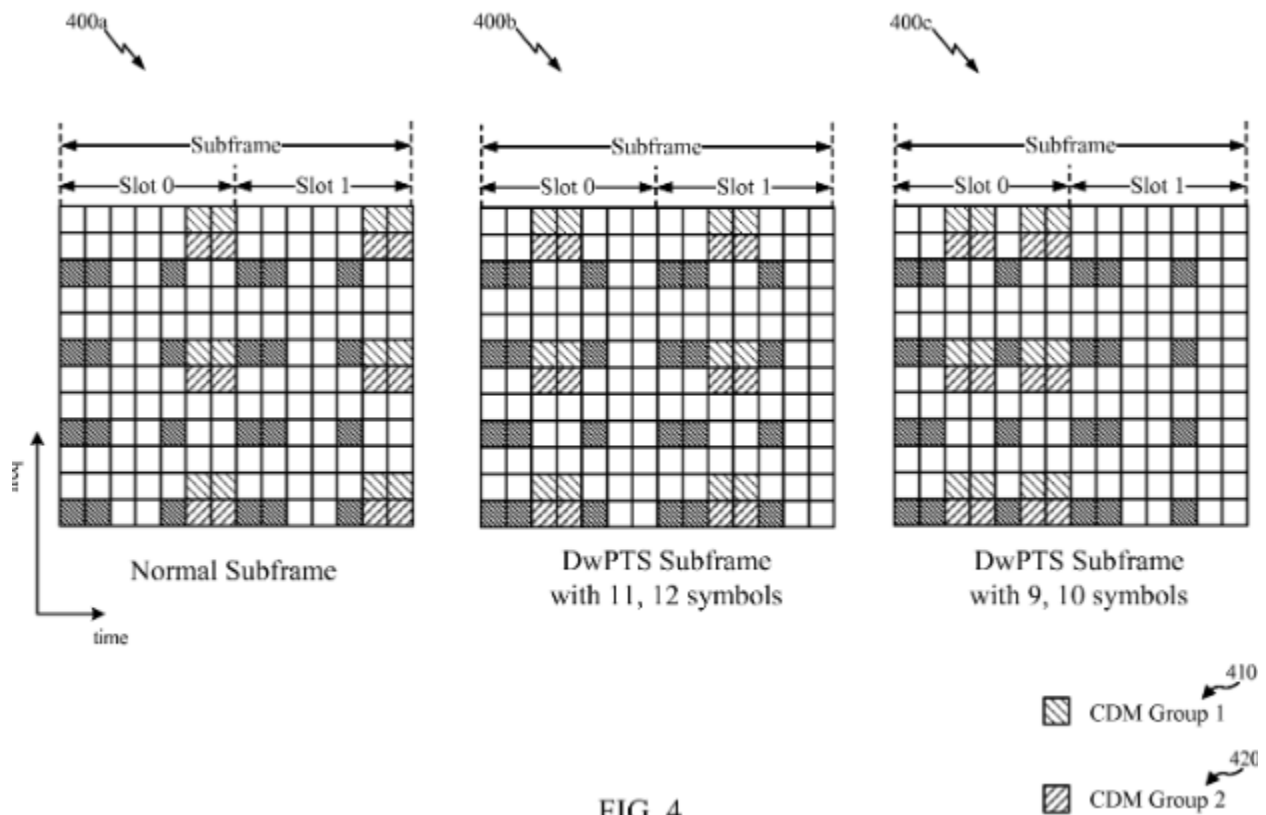


FIG. 4

218. Gaal also renders this limitation obvious because a POSITA would have understood the subframe in Gaal to be (or obviously could be) a subframe set forth in LTE standards. A POSITA would have known that LTE subframes include multiple subcarriers and multiple resource elements associated with each of the multiple subcarriers.

F. Independent claim 17

[17.pre]: A non-transitory computer-readable medium that includes computer-executable instructions stored thereon, which in response to execution by a processor, cause the processor to perform or control performance of operations that comprise:

219. To the extent the preamble is limiting, Gaal renders obvious claim element [17.pre].

220. Gaal discloses that its operations are contained in computer-executable instructions are executed by a processor:

In one or more exemplary designs, the functions described may be implemented in hardware, software/firmware or combinations thereof. If implemented in software/firmware, the functions may be stored on or transmitted over as one or more instructions or code on a computer-readable medium. . . . A storage media may be any available media that can be accessed by a general purpose or special purpose computer.

Ex. 1004, ¶[0117].

[17.1]: determine a quality status of a first frequency spectrum resource that is available for use by a base station for an uplink channel or a downlink channel;

221. I incorporate my analysis of claim element [10.1].

222. Gaal renders obvious claim element [17.1].

223. Gaal discloses that “the *direction of a subframe may change due to inter-cell and/or intra-cell interference considerations.*” Ex. 1004, ¶[0075]. A POSITA would have known that there were known (and standardized) ways to

measure channel conditions such as inter-cell and intra-cell interference prior to the '361 Patent.

224. One way to measure channel conditions is through the measurement of channel state information (CSI) reference signals (CSI-RS) in each subframe. Ex. 1001, 8:60-64. CSI-RS is a standardized way to measure channel quality and state on the downlink.

225. A second way to measure channel conditions is on the uplink. Received Interference Power is a standardized way to measure interference on the uplink.

226. Gaal also discloses that a wireless base station that can “receive CSI feedback from a UE” and “process the CSI feedback.” *E.g.*, Ex. 1004, ¶[0109], [0110]. Receiving and processing CSI feedback is one way in which the base station can determine a quality status of a subframe. Ex. 1004, ¶[0057].

[17.2]: determine, based on the quality status, that the first frequency spectrum resource is a sub-optimal resource, for the uplink channel and the downlink channel, relative to other frequency spectrum resources that are available for use by the base station,

227. I incorporate my analysis of claim element [10.3].

228. Gaal renders obvious claim element [17.2].

229. Gaal discloses (or at least renders obvious) the fact that the flexible subframes are sub-optimal relative to other frequency spectrum resources due to interference on those subframes.

230. A POSITA would have also understood that the base station would have made a determination as to which resources are sub-optimal relative to other frequency spectrum resources when determining which resources to use as flexible subframes.

[17.3]: wherein to determine that the first frequency spectrum resource is the sub-optimal resource, the computer-executable instructions, in response to execution by the processor, cause the processor to perform or control performance of at least one operation that comprises: determine that a channel quality indicator (CQI) of the first frequency spectrum resource is less than a respective CQI of one or more other frequency spectrum resources that are available for use by the base station; and determine that a received interference power (RIP) of the first frequency spectrum resources is greater than a respective RIP of the one or more other frequency spectrum resources that are available for use by the base station;

231. I incorporate my analysis of claim element [10.3].

232. Gaal renders obvious claim element [17.3].

233. I have broken down this claim element into the following parts: (i) to determine the first frequency resource is sub-optimal, cause the processor to perform at least one operation that comprises either (ii.a) determine that a channel quality indicator (CQI) of the first frequency spectrum resource is less than a respective CQI of one or more other frequency spectrum resources that are available for use by the base station, or (ii.b) determine that a received interference power (RIP) of the first frequency spectrum resources is greater than a respective RIP of the one or more other frequency spectrum resources that are available for use by the base station.

234. The phrase “at least one operation that comprises” means that either (ii.a) or (ii.b) must be disclosed or rendered obvious.

235. Regardless, a POSITA would have known of both operations as they were well known in the art.

- i. **The element “to determine the first frequency resource is sub-optimal, cause the processor to perform at least one operation that comprises either”**

236. I incorporate my analysis of claim elements [10.2], [10.3] and [17.pre].

237. Gaal discloses a controller/processor 340 connected to receive processor 338. Ex. 1004, FIG. 3, ¶[0058].

Ex. 1004 Fig. 3

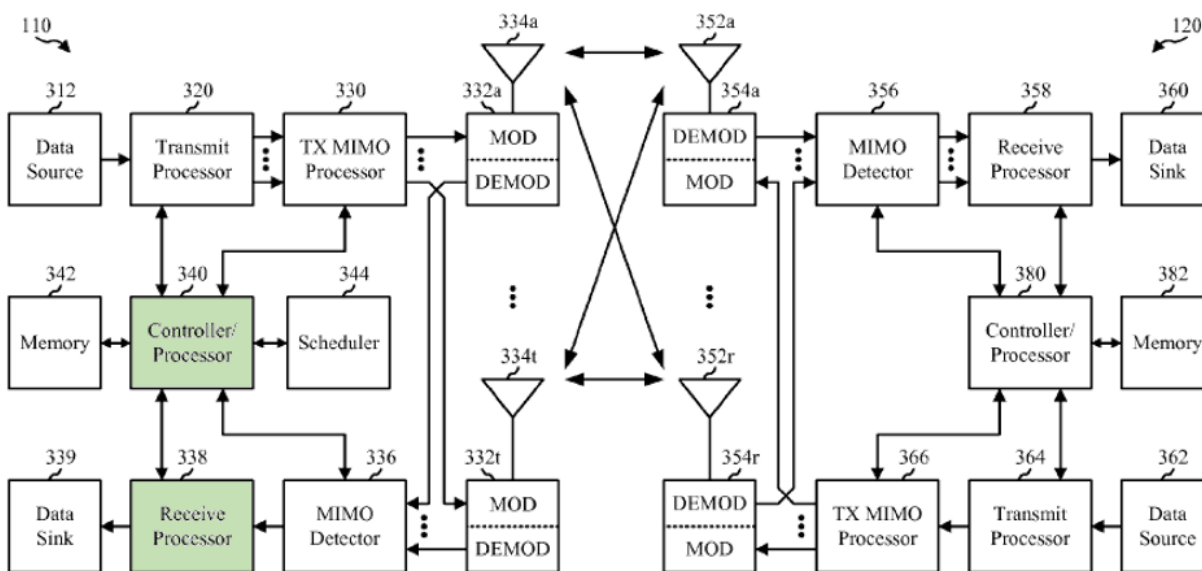


FIG. 3

238. Gaal states: “[t]he controller/processor 340, receive processor 338, and/or other processors and modules at the eNB 110 may perform or direct

operations 800 in FIG. 8 and/or other processes for the techniques described herein.”

Ex. 1004, ¶[0058].

239. Claim 28 also states “at least one processor configured to” perform “process[ing] the CSI feedback.” Ex. 1004 at cl. 28.

- ii. **The element “determine that a channel quality indicator (CQI) of the first frequency spectrum resource is less than a respective CQI of one or more other frequency spectrum resources that are available for use by the base station.”**

240. I incorporate my analysis of claim element [10.3].

241. A POSITA would have understood Gaal’s disclosure of inter-cell and/or intra-cell interference to include the use of CSI/CQI to measure such interference, or at least that it would be obvious to do so. Ex. 1004, ¶¶ [0068]-[0075]. As noted above, a POSITA would have understood that CQI was a well-known CSI metric that indicates how well the signal is received, considering factors like signal strength, interference, and noise. A POSITA would have known (and it is defined by the LTE standard), that CQI values are ranked 0 to 15. A POSITA would have known that when two CQI for two resource blocks are compared that the lower CQI value would be sub-optimal due to it representing a lower quality status.

242. Gaal has an entire subsection dedicated to “Example CSI Measurement and Reporting for EIMTA in LTE.” Ex. 1004, ¶¶ [0069]-[0110].

- iii. **The element “determine that a received interference power (RIP) of the first frequency spectrum resources is greater than**

a respective RIP of the one or more other frequency spectrum resources that are available for use by the base station.”

243. The use of other known measurements such as Received Interference Power (RIP) would also have been well known to a POSITA at the time of the 361 Patent.

244. Received Interference Power was also a known uplink interference tool available to a POSITA. A POSITA would have recognized that RIP is measured on the uplink signal.

245. The choice to use RIP or CQI was simply one of two available design choices to a POSITA. A POSITA would have chosen between one of these two design choices to measure interference on the flexible subframe.

[17.4]: in response to the determination that the first frequency spectrum resource is the sub-optimal resource, assign the first frequency spectrum resource to a shared resource pool;

246. I incorporate my analysis of claim element [10.4].

247. Gaal renders obvious claim element [17.4] for the same reasons as stated in claim element [10.4].

[17.5]: schedule, based on an initial directional allocation of communication resources for the base station, a second frequency spectrum resource that is available for use by the base station for the uplink channel or the downlink channel;

248. I incorporate my analysis of claim element [10.6].

249. Gaal renders obvious claim element [17.5] for the same reasons as stated in claim element [10.6].

[17.6]: after the second frequency spectrum resource is scheduled for use by the base station, determine an updated directional allocation of communication resources for the base station; and

250. I incorporate my analysis of claim element [10.7].

251. Gaal renders obvious claim element [17.6].

252. Gaal discloses “The direction of flexible subframes may change in a dynamic manner, for example, due to scheduler *decisions based on traffic needs.*” Ex. 1004, ¶[0075]. Gaal discloses one reason to change the flexible subframes would be “[a]s an illustrative example of eIMTA, if during a short duration a large data burst on downlink is desired, the configuration may be changed to *a more downlink heavy subframe configuration.*” Ex. 1004, ¶[0072].

253. The exact timing of scheduling the sub-optimal subframes after the second frequency resource would have been obvious to a POSITA. As disclosed in Gaal, “fixed subframes” generally have no risk of “DL-to-UL interference or UL-to-DL interference.” Ex. 1004, ¶[0076]. A POSITA would have understood that, in determining updated allocation based on traffic needs, the fixed downlink subframes would be first assigned to downlink resource needs and then the fixed uplink subframes would be first assigned to uplink resource needs. After this, a POSITA would have understood that the scheduler will determine interference and traffic in the network and allocate the direction of the flexible subframe accordingly. Ex. 1004, ¶[0075].

[17.7]: select the first frequency spectrum resource from the shared resource pool, and schedule the first frequency spectrum resource for either the uplink channel or the downlink channel based on the determined updated directional allocation of communication resources for the base station.

254. I incorporate my analysis of claim element [10.8].

255. Gaal renders obvious claim element [17.7].

256. A POSITA would have understood from Gaal's disclosure that there is a need to actually schedule the subframe for the uplink or downlink based on the updated allocation. A POSITA would have understood that Gaal discloses the directional resources are scheduled for uplink or downlink transmission based on changing traffic needs. Ex. 1004, ¶[0075].

X. GROUND 2: GAAL IN VIEW OF KHORYAEV RENDERS OBVIOUS CLAIMS 10-13, 15, AND 17 OF THE '361 PATENT

257. I incorporate my analysis for Ground 1 above, and it is my opinion that Gaal alone renders obvious claims 1-13, 15, and 17 of the '361 Patent. To the extent Patent Owner argues that claim limitations [10.3] and [10.4] set forth above are not disclosed or rendered obvious by Gaal, then these limitations reciting determining that a first frequency spectrum resource is sub-optimal relative to other resources and assigning the first resource to a shared resource pool in response to that determination, are rendered obvious by Gaal in view of Khoryaev. Gaal in combination with Khoryaev teaches that, in order to mitigate measured interference for a particular subframe, the subframe can be allocated from fixed to flexible.

A. Motivation to Combine

258. A POSITA would have been motivated to combine the system for assigning subframes as either fixed or flexible disclosed in Gaal with Khoryaev's configuration of a subframe as a flexible subframe based on other cell interference. For example, as I explained above in Ground 1, Gaal teaches that subframes "may be generally categorized as 'fixed' subframes and 'flexible' (dynamic) subframes," where "[f]ixed subframes are not expected to change in a dynamic or semi-static manner[.]" Ex. 1004, ¶[0075]. However, Gaal further discloses that "[t]he direction of flexible subframes may change in a dynamic manner," based on certain network conditions, such as "inter-cell and/or intra-cell interference considerations." Ex. 1004, ¶[0075]. Further, Gaal discloses that a base station can "indicate[]" to a user equipment (UE) via some signaling" that a subframe is "designate[ed]" as a "fixed subframe" or a "flexible subframe." Ex. 1004, ¶[0077]. This is illustrated by Gaal's disclosure that a base station can configure a subframe, such as "TDD UL/DL subframe configuration 0 (DSUUUDSUUU)" to communicate to UEs that "subframes 0/1/2/5/6/7 may be fixed subframes, while subframes 3/4/8/9 may be flexible subframes." Ex. 1004, ¶[0077].

259. However, a POSITA would recognize that even though Gaal discloses that the direction of a subframe can change "due to interference considerations," Gaal does not expressly disclose that a subframe can be configured from fixed to

flexible responsively to those interference considerations. A POSITA would look to Khoryaev's teachings to incorporate into Gaal to determine the criteria and process for designating a subframe as flexible because, although Gaal teaches that the direction of flexible subframes may change in a dynamic manner, Gaal does not expressly provide the criteria for designating a flexible subframe. A POSITA deciding what criteria to use when designating a fixed subframe as flexible, would have looked to Khoryaev because it teaches designating a subframe as flexible based on a determination that the subframe is subject to inter-cell interference.

260. In addition, Khoryaev discloses that its methods "can be used both to mitigate the impact of macro DL inter-cell interference on UL pico reception and to mitigate the impact of DL inter-cell interference from pico cells on macro UL performance." Ex. 1018, 8:20-24. Gaal expressly teaches that "the direction of a subframe may change due to inter-cell . . . interference consideration," and a POSITA would be motivated to use Khoryaev's teachings for designating the direction of a subframe to address the inter-cell interference considerations disclosed in Gaal. Ex. 1004, ¶[0075].

261. A POSITA would be motivated to combine Gaal and Khoryaev for other reasons. For example, both Gaal and Khoryaev teach that flexible subframes are used for adaptation to traffic conditions. Ex. 1004, ¶[0075]; Ex. 1018, 6:54-60. Both Gaal and Khoryaev are directed, in part, to configuring and implementing

flexible subframes to adapt to changing uplink-downlink traffic conditions. Thus, the solutions provided in Gaal and Khoryaev are compatible with one another, as they are directed to solving the same problem. In particular, Khoryaev's teachings of assigning frames as flexible frames based on inter-cell interference to allow for traffic adaptation is compatible with Gaal's methods of using flexible subframes for traffic adaptation. Gaal and Khoryaev are further compatible because Gaal discloses "a heterogeneous network (HetNet) that includes eNBs of different types, e.g., macro eNBs [and] pico eNBs," (Ex. 1004, ¶[0037]), and Khoryaev's methods are directed to inter-cell interference between macro and pico cells.

262. In addition, a POSITA would have been motivated to combine Gaal and Khoryaev because they are analogous art to each other and the '361 patent. Gaal, Khoryaev, and the '361 patent each are directed to the allocation of frequency resources (subframes) in a wireless communication network. For example, the '361 patent states that "[f]requency spectrum resources . . . may be allocated for either an uplink or downlink channel," (Ex. 1001, Abstract) Gaal states that its "method generally includes identifying, within a set of subframes, one or more flexible subframes that may be dynamically managed for either uplink or downlink communications," (Ex. 1004, Abstract) and Khoryaev states that it is directed to "[t]echnology for traffic offloading to generate a low interference flexible subframe

(FlexSF) of an adaptive uplink-downlink (UL-DL) . . . subframe configuration.” Ex. 1018, Abstract.

263. Finally, a POSITA would have had a reasonable expectation of success combining Gaal and Khoryaev because both are directed to assigning subframes as flexible subframes that can be used for either uplink or downlink transmissions for adaptation to changing network conditions. While Gaal does not expressly state the criteria to be used to determine which subframes should be designated as flexible, Gaal does state that subframe directionality would change based on “inter-cell . . . interference considerations.” Ex. 1004, ¶[0075]. A POSITA would understand that Khoryaev provides the details missing in Gaal in its disclosure that, in response to a determination that a subframe is subject to inter-cell interference, that subframe can be designated as flexible. A POSITA would have a reasonable expectation of success to combine Gaal and Khoryaev because the teachings in Khoryaev could be seamlessly implemented within Gaal using the knowledge and skill of a POSITA.

B. Independent claim 10

[10.3]: determine, based on the quality status of the first frequency spectrum resource, that the first frequency spectrum resource is a sub-optimal resource, for the uplink channel and the downlink channel, relative to other frequency spectrum resources that are available for use by the wireless base station; and

264. This limitation is rendered obvious in view of Gaal and in further view of Khoryaev.

265. As I explained in Ground 1 for claim limitation [10.3], Gaal discloses measuring the interference for a subframe using CSI-RS measurements, which a POSITA would understand to include a Channel Quality Indicator (CQI) measurement. Similarly, Khoryaev discloses that its methods for configuring a subframe as a flexible subframe “can take into account inter-cell interference from macro cells” using “path-gains,” which results in “effective implementation of adaptive change of UL-DL configuration at pico cells.” Ex. 1018, 7:26-6:34-35. Thus, a POSITA would understand Khoryaev to teach determining that a subframe is sub-optimal for the uplink and downlink channel due to the inter-cell interference measurement for that subframe. Considering Gaal in combination with Khoryaev, Gaal’s use of CSI/CQI would be the measurement used to determine inter-cell interference, which is expressly disclosed by Khoryaev. For example, Khoryaev discloses that a “UE can measure a channel quality for different interference environments (e.g., regular or ABS subframes) and report a corresponding channel quality indicator (CQI) feedback for both macro and pico cells.” Ex. 1018, 12:35-40.

266. Moreover, a POSITA would understand that Khoryaev teaches that there is a determination as to whether the inter-cell interference for a subframe is sub-optimal in comparison to inter-cell interference for other subframes. This is illustrated by Khoryaev’s description in Figure 2 that a pico UL subframe against a

macro DL subframe has significantly worse SINR than a pico UL subframe against a macro UL subframe. Ex. 1018, 5:59-6:5, 7:32-35, 8:20-24.

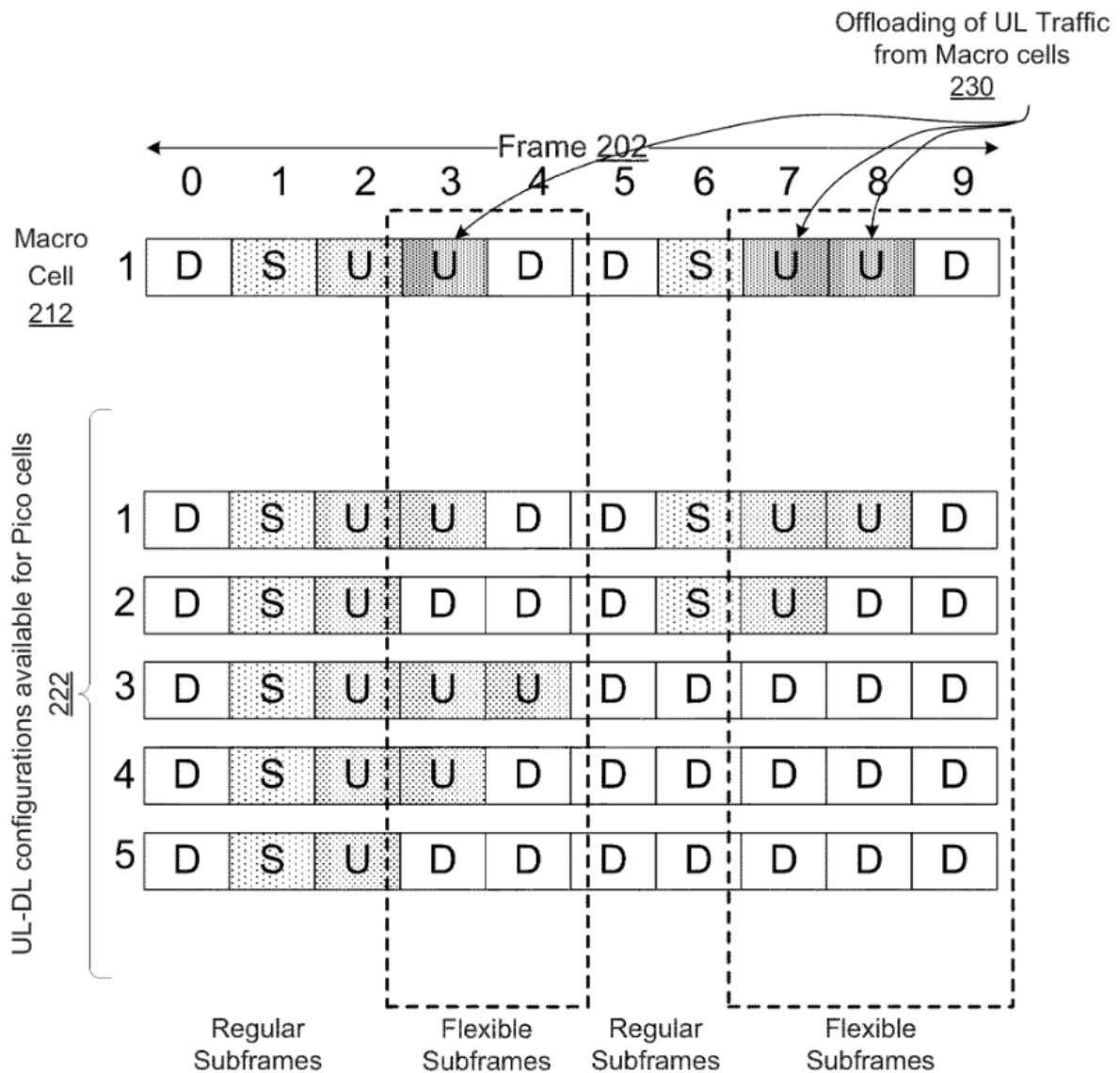
267. Thus, Gaal in view of Khoryaev renders obvious this claim limitation

[10.4]: in response to the determination that the first frequency spectrum resource is the sub-optimal resource, assign the first frequency spectrum resource to a shared resource pool; and

268. Gaal in view of Khoryaev renders obvious limitation 10.4.

269. Khoryaev teaches that a subframe will be assigned as a flexible subframe in response to determining that the subframe's inter-cell interference is sub-optimal. Specifically, Khoryaev discloses that in response to "tak[ing] into account inter-cell interference from macro cells," then either (i) the pico subframe will be converted from a fixed to a flexible subframe, and (ii) the macro subframe will be muted or have traffic offloaded. Ex. 1018, 7:26-35, 8:20-9:15.

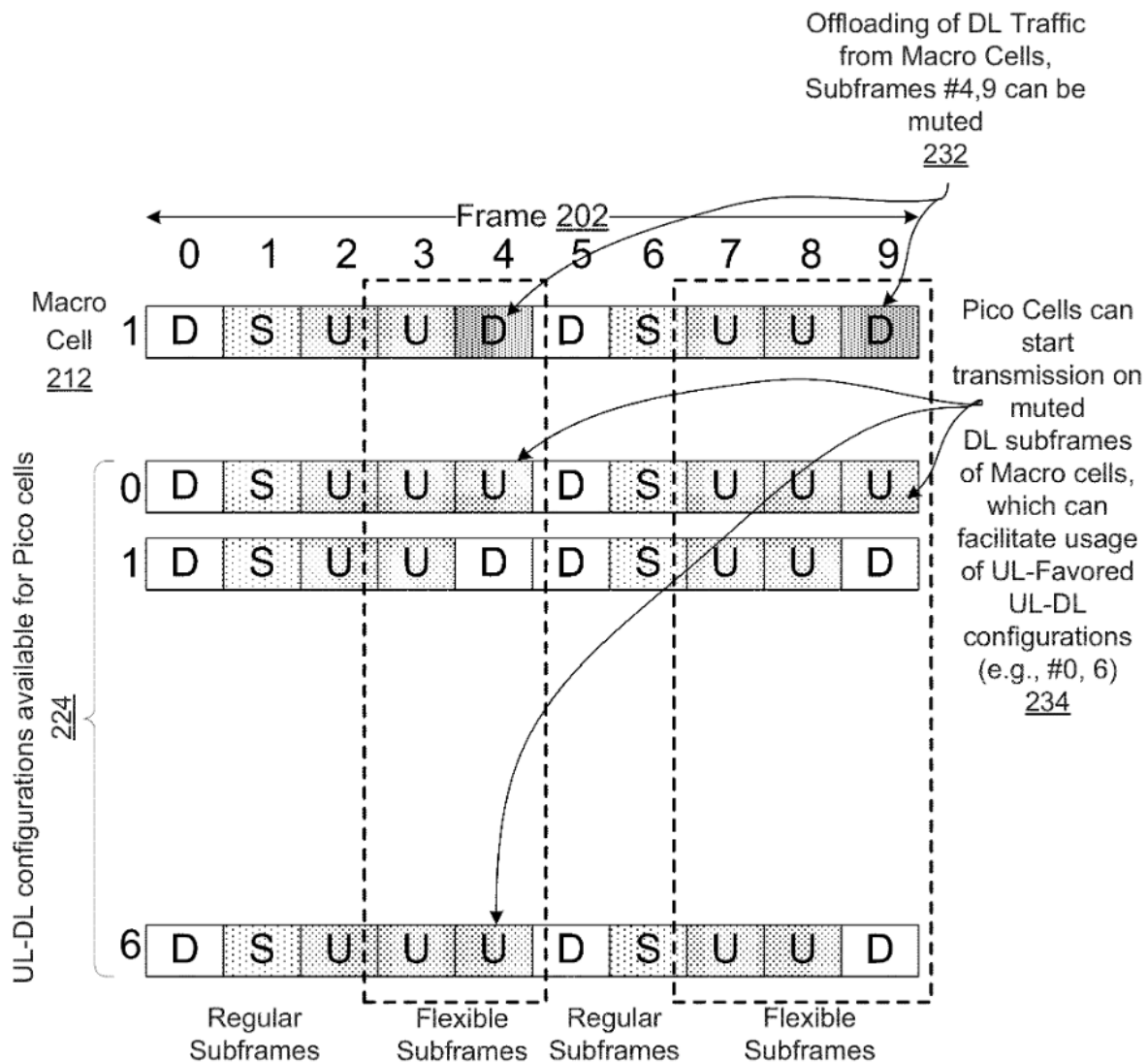
270. This concept is illustrated in Figure 7. Inter-cell interference in UL macro subframes 3, 7, and 8 causes those subframes to be designated as flexible subframes for the pico cell. Ex. 1018, Fig. 7, 9:30-33.



271. Thus, those subframes would then be “used for the DL transmission of the pico cells without affecting uplink performance of the macro UEs.” Ex. 1018, 9:30-33. The pico cell is therefore not limited to using subframes 4, 5, and 9 for DL, but can also use subframes 3, 7, and 8. At the same time, “the macro UE can still

serve some of the UL traffic in a remaining UL subframe #2 (using legacy LTE UL-DL configuration).” Ex. 1018, 9:39-41.

272. An opposite example is shown in Figure 8. In connection with Figure 8, Khoryaev explains that “the macro cells can restrict or mute their DL transmissions on flexible subframes #4 and 9,” resulting in “[t]he reduction of the DL inter-cell interference from the macro cells on those subframes 4 and 9,” and “facilitat[ing] the usage of UL favored favored UL-DL configurations” for the pico cell. Ex. 1018, 9:45-52. This “substantially improve[s] UL packet throughput at the pico cells.” Ex. 1018, 9:54-55. Downlink throughput is also improved as a result because the subframes are flexible. Ex. 1018, 9:55-60. This example is illustrated in Figure 8 below.



273. Thus, a POSITA would have known that Gaal's system deciding whether or not to convert a fixed subframe to a flexible subframe would be modified using the above disclosure of Khoryaev to mitigate inter-cell interference. As I explained in Ground 1, the flexible subframes described herein satisfy the "shared resource pool" recited in the '361 patent challenged claims.

C. Independent claim 17

[17.2]: determine, based on the quality status, that the first frequency spectrum resource is a sub-optimal resource, for the uplink channel and the downlink channel, relative to other frequency spectrum resources that are available for use by the base station,

274. Gaal in view of Khoryaev renders obvious claim element [17.2] for the reasons I explained above for claim element [10.3].

[17.4]: in response to the determination that the first frequency spectrum resource is the sub-optimal resource, assign the first frequency spectrum resource to a shared resource pool;

275. Gaal in view of Khoryaev renders obvious claim element [17.4] for the reasons I explained above for claim element [10.4].

D. Remaining Limitations of Independent claim 10 and claims 11-13, 15, and 17

276. Gaal in view of Khoryaev render obvious the remaining limitations of the challenged claims for the same reasons I explained above in Ground 1.

XI. CONCLUSION

277. I hereby declare that all statements made of my own knowledge are true and that all statements made on information and belief are believed to be true. I 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 December 18, 2023 by:



James A. Proctor

XII. CLAIM LISTING

Cl. No.	Elem.	Claim Language
10	[10.pre]	A wireless base station for a wireless communication network, the wireless base station comprising:
	[10.1]	a quality status module configured to determine a respective quality status of a first frequency spectrum resource and a second frequency spectrum resource, wherein each of the first frequency spectrum resource and the second frequency spectrum resource are associated with an air interface that is available for use by the wireless base station for an uplink channel or a downlink channel;
	[10.2]	a processor coupled to the quality status module and configured to:
	[10.3]	determine, based on the quality status of the first frequency spectrum resource, that the first frequency spectrum resource is a sub-optimal resource, for the uplink channel and the downlink channel, relative to other frequency spectrum resources that are available for use by the wireless base station; and
	[10.4]	in response to the determination that the first frequency spectrum resource is the sub-optimal resource, assign the first frequency spectrum resource to a shared resource pool; and
	[10.5]	a scheduler module coupled to the processor and configured to:
	[10.6]	schedule the second frequency spectrum resource for the uplink channel or the downlink channel based on an initial directional allocation of frequency spectrum resources for the wireless base station;
	[10.7]	determine an updated directional allocation of frequency spectrum resource for the wireless base station after the second frequency spectrum resource is scheduled for the uplink channel or the downlink channel; and
	[10.8]	schedule the first frequency spectrum resource based on the updated directional allocation of frequency spectrum resources for the wireless base station.
11	[11]	The base station of claim 10, further comprising: a memory coupled to the processor and configured to store an uplink resource pool, a downlink resource pool, and the shared

		resource pool, wherein the processor is further configured to assign, based on the determined quality status of the second frequency spectrum resource, the second frequency spectrum resource to one of the uplink resource pool or downlink resource pool.
12	[12]	The wireless base station of claim 10, wherein the updated directional allocation of frequency spectrum resources is based on one or more of: current resource requests from a wireless device serviced by the wireless base station, current resource requests from the wireless base station, a number of frequency spectrum resources scheduled from an uplink resource pool for uplink channels, and a number of frequency spectrum resource scheduled from a downlink resource pool for downlink channels.
13	[13]	The wireless base station of claim 10, wherein the initial directional allocation of frequency spectrum resources is based on current resource requests from a wireless device serviced by the wireless base station, and current resource requests from the wireless base station.
15	[15]	The wireless base station of claim 10, wherein the first frequency spectrum resource includes multiple subcarriers and multiple resource elements associated with each of the multiple subcarriers.
17	[17.pre]	A non-transitory computer-readable medium that includes computer-executable instructions stored thereon, which in response to execution by a processor, cause the processor to perform or control performance of operations that comprise:
	[17.1]	determine a quality status of a first frequency spectrum resource that is available for use by a base station for an uplink channel or a downlink channel;
	[17.2]	determine, based on the quality status, that the first frequency spectrum resource is a sub-optimal resource, for the uplink channel and the downlink channel, relative to other frequency spectrum resources that are available for use by the base station,
	[17.3]	wherein to determine that the first frequency spectrum resource is the sub-optimal resource, the computer-executable instructions, in response to execution by the processor, cause the processor to perform or control performance of at least

		one operation that comprises: determine that a channel quality indicator (CQI) of the first frequency spectrum resource is less than a respective CQI of one or more other frequency spectrum resources that are available for use by the base station; and determine that a received interference power (RIP) of the first frequency spectrum resources is greater than a respective RIP of the one or more other frequency spectrum resources that are available for use by the base station;
	[17.4]	in response to the determination that the first frequency spectrum resource is the sub-optimal resource, assign the first frequency spectrum resource to a shared resource pool;
	[17.5]	schedule, based on an initial directional allocation of communication resources for the base station, a second frequency spectrum resource that is available for use by the base station for the uplink channel or the downlink channel;
	[17.6]	after the second frequency spectrum resource is scheduled for use by the base station, determine an updated directional allocation of communication resources for the base station; and
	[17.7]	select the first frequency spectrum resource from the shared resource pool, and schedule the first frequency spectrum resource for either the uplink channel or the downlink channel based on the determined updated directional allocation of communication resources for the base station.

James A. Proctor Jr.

1680 North Riverside Drive, Indialantic, FL 32903 - (321) 271-8411 - jproctor@ieee.org

EDUCATION

Georgia Institute of Technology, Atlanta, Georgia M.S. Electrical Engineering
Graduated: September 1992
Interests: Digital Signal Processing, Communications, Optics

The University of Florida, Gainesville, Florida B.S. Electrical Engineering
Graduated: May 1991
Minor Studies: Business
Honors & Activities: PI ETA SIGMA Honor Society
ALPHA LAMBDA DELTA Freshman Honor Society
ETA KAPPA NU National Electrical Engineering Fraternity

Skills & Achievements

- Successfully led Qualcomm / WiDeFi integration efforts resulting in a new product effort within Qualcomm related to the 3G/4G Market
- Co-founded WiDeFi and successfully raised >\$14M of venture funding
- Generated intellectual property and product strategy leading to the acquisition of two companies (WiDeFi, and Tantivy Communications), contributing to > \$100M of revenue
- Performed extensive customer and industry business development to provide support for innovative product definition, requirement definition, and customer support for business plan and forecasts (Qualcomm, WiDeFi, and Tantivy Communications)
- Led and coached many R&D teams to refine and de-risk innovative wireless concepts
- Led cross functional product teams to deliver high volume ready prototypes
- Ability to balance market, programmatic, and technical concerns and refine clear strategy and actionable plans
- Generated >320 issued US Patents Currently and >700 international patent publications
- Have spoken at numerous public events: industry, venture, and technical
- Strong communication and technical skills

Work Experience

Proctor Consulting, LLC **December 2008 - Present**

- Early stage market and technology strategy
 - o Interim CTO/Team Member, business development/validation
 - o Roadmap / IP development
 - o Advisory Board Member
- Technical / Market Consultant
 - o Fastback Networks, Audigence, Peregrine Semiconductor
- Intellectual property portfolio analysis within the communications market space
 - o Market / Product Applicability, Claims Chart Development and Analysis, Valuation
 - o Expert Witness Consulting in Wireless Communications (WiFi, 2G-GSM, 3G-C2K/WCDMA, 4G/LTE and associated networks)

Proximcom Wireless. Co-Founder, Managing Director **November 2011 – Present**

- Proximity based mobile technology utilizing a centralized trusted third party
- Development of foundational Intellectual Property (12+ US Patents)
- Enabling technology applicable to a variety of proximity based applications including highly secure: Mobile Payments, Electronic Coupons and Loyalty, Rating and Reviews, Social Commerce

Qualcomm Inc., Principal Engineer (Consulting)**October 2007 - October 2009**

- Technical and Business development leadership of a consumer level 3G wireless repeater product concept based upon WiDeFi's technology during the integration
- Provided technical leadership in architecture development
 - o Defined initial architecture approach for the wireless repeater concept based upon WiDeFi's technology
 - o Worked with technical team to refine approach and achieve "key proof points"
- Performed Business Development with International Wireless Operators
 - o Worked closely with business development from ESG and QCT divisions
 - o Developed bottoms up forecast with the top international wireless operators for consumer repeater products.
 - o Refined product features to meet carrier's requirements
- Market Analysis to estimate Market Size and Competitive Landscape
- Named inventor on 44+ Issued or pending patents for Qualcomm on wireless repeater concepts

WiDeFi, Inc., EVP/CTO, and Co-Founder, Director**August 2005 - October 2007**

- Focused on aligning WiDeFi's technology and product roadmaps to customer and market drivers
 - o Strategic and Technical Marketing, Product Definition
 - o Market Analysis to estimate Market Size and Competitive Landscape
 - o Collaborated with customers and internal team to define and pursue product/customer opportunities (Retail Wi-Fi, Mesh Repeater, VoiP over Wi-Fi Repeater, Cellular Repeaters, Wi-Max Repeaters, In-Building Distribution Systems)
 - o Customer Development from initial contact, joint testing, first purchase order, to new product introduction
 - o Contributed to and managed WiDeFi's IP portfolio
 - o Pursued fund raising from corporate and venture capital communities

WiDeFi, Inc., President, CEO, and Co-Founder, Director**July 2002 - August 2005**

- Led WiDeFi from inception to the recruitment of an expansion-stage CEO.
- Principal duties:
 - o Direct Fundraising of initial seed and Series A Venture Capital
 - o General Management (Finance, Business Administration, Legal/Contracts and Organizational Development/Recruiting)
 - o Coordination of Board of Directors and Investors
 - o Sales (WiDeFi was Cash Flow positive prior to venture investment)

Tantivy Communications**April 1998 - June 2002****Director of Strategic and Technical Marketing**

- Business Development/Technical Due Diligence
- Represented Tantivy in a wide range of Wireless Broad Band Industry Conferences
- Intellectual Property Management and Strategy
 - o Represented Tantivy's Patents and their value to External Companies
 - o Performed Validity, Infringement, and Value Analysis of Tantivy Patents for non-Tantivy products
- Industry Standards Representation for 3G Technologies
 - o TIA/3GPP2, Over 15 Technical Contributions/Papers
 - o T1P1 (3GPP Member)
- Project Management of an International Technology Transfer Team (S Korea)
- Performed System Architecture and Analysis

Spectrian, Advanced Development and Technical Marketing**1995 - April 1998**

- Interfaced with NORTEL/Qualcomm's Product Management
- Performed Advanced Technology Development/Systems Analysis

**Harris Corp. GCSD,
Senior Engineer Signal Processing Section, Modems Group**

September 1992 - 1995

Georgia Tech Research Institute, CSITL

June 1991 - August 1992

Harris Corp.. ISD, Electro-optics, Co-op

May 1990 - August 1990

- Acousto-optic signal processing

Standards Development

- Participated in architecting "Internet CDMA" (I-CDMA)
- Jointly led establishment of the Committee T1, working group T1P1.4 "WWINA" standardization effort, which stands for "Wireless Wideband Internet Access"
 - o T1 Approved this system as the T1.723-2002 standard
- ATIS approved as **ATIS0700723-2002 I-CDMA Spread Spectrum Systems Air Interface Standard**
- Participated in 3GPP2 Standards Developments (including 15+ technical contributions)

Intellectual Property

- More than 320 Issued U.S. Patents
- More than 700 Issued or Pending International Patent Applications (WIPO)
- Patents Cited at the USPTO more than 6000 times
- 55+ Patents Assigned to Intel
- 45+ Patents Assigned to Qualcomm
- 16+ Patents designated as "Standards Essential" for UMTS (WCDMA)
- 6+ Patents designated as "Standards Essential" for LTE

Testifying Expert Experience

SPH Am., LLC v. Acer, Inc., 09CV02535-CAB MDD, 2012 WL 1344515 (S.D. Cal. Apr. 18, 2012).

Testifying Expert offering opinions on validity for the defense. The technology related to WCDMA modulation techniques. Resulted in settlement prior to trial.

WI-LAN USA, INC. and WI-LAN INC. v. ELEFONAKTIEBOLAGET LM ERICSSON and ERICSSON INC., Case No. 1:12-23569-Civ (S.D. FL)

Testifying expert offering opinions on infringement for the defense. The technology involved LTE "contention free" handover (CFRA), and Media Access Control (MAC) layer messaging for Quality of Service (QOS). Resulted in a summary judgement finding of non-infringement for the defense, and settlement after appeal.

U.S. ETHERNET INNOVATIONS, LLC. V. STMICROELECTRONICS, INC., Civil Action No. 6:12-cv-4181-MHS-JDL

Testifying expert offering opinions on both validity and infringement for the defense. The technology related to Ethernet devices. Resulted in settlement prior to trial.

UNWIRED PLANET. V. SQUARE, INC.,

Case No. 3:13-CV-00579-RCJ-WGC, DISTRICT OF NEVADA,
Case CBM2014-00156, Case IPR2014-01164, Case IPR2014-01165, UNITED STATES PATENT TRIAL AND APPEAL BOARD,

Provided testimony related to claim construction, and validity for the defense. The technology was related to location based services (LBS). The case resulted in a finding by the Patent Trial and Appeal Board of unpatentability of all asserted claims.

PRISM TECHNOLOGIES LLC. V. T-MOBILE USA, INC., Case No. 12-CV-124

Testifying expert at trial, and deposition offering opinions on both validity and infringement for the defense. The technology was related to SIM/USIM/ISIM based authentication in UMTS, LTE, and IMS networks. The case resulted in a jury verdict of non-infringement.

FASTVDO LLC. V. AT&T Mobility LLC, AT&T Services, Inc., and Apple Inc.,
Case No. 3:16-cv-00385-H-WVG

Engaged by Apple as the testifying expert offering opinions on infringement for the defense. The technology was related to Forward Error Correction (FEC) and voice codecs in GSM and WCDMA standards, including detailed FEC performance simulations. The case was concluded based upon an IPR outcome finding unpatentable subject matter by the PTAB.

BLACKBERRY LIMITED V. BLU PRODUCTS, INC.,
Case No.: 16-23535-CIV-MORENO

Engaged by Blackberry as the testifying expert offering opinions on infringement for the plaintiff. The technology involved WCDMA and battery saving techniques in Radio Resource Control (RRC) states. The case was settled between the parties prior to trial.

CELLULAR COMMUNICATIONS EQUIPMENT LLC V. AT&T Inc., and Apple Inc.
Case No.: 2:15-cv-00576-RWS-RSP

Engaged engaged by Apple as the testifying expert offering opinions on validity and benefits of the alleged inventions for the defense. The technology involved Media Access Control (MAC) messaging for LTE (Power Headroom Reporting) and LTE Advanced (CSI reporting for Carrier Aggregation). The case resulted in summary judgement for the defense.

GENERAL ACCESS SOLUTIONS, LTD. v. Sprint Corporation et al.
Civil Action No. 2:16-cv- 00465 (E.D. Tex.) and PTAB Proceedings (IPR2017-01885 (Patent 7,173,916 B2) IPR2017-01887 (Patent 6,891,810 B2) IPR2017-01889 (Patent 7,230,931 B2),

Engaged by Sprint to provide expert testimony relating to claim construction, and validity for the defense before the Patent Trial and Appeal Board (PTAB) relating to an Inter Partes Review petition, providing multiple expert declarations, and deposition testimony. The technology related to Adaptive Modulation and Coding (AMC) in a wireless system; Adaptive Beamforming, Sectorization, and Multi-Input Multi-Output (MIMO). All trials were instituted by the PTAB Board, with a finding of all petitioned claims unpatentable for two of the three patents.

TC TECHNOLOGY LLC. V., Sprint Corporation and Sprint Spectrum, L.P
Case 1:16-cv-00153-RGA

Engaged by Sprint to provide expert testimony relating to validity and infringement by the defense, in the district of Delaware. The technology related to OFDMA and SC-FDMA use in the LTE uplink, for multiplexing transmissions from different UEs utilizing mutually exclusive OFDM subcarriers. The matter was resolved.

Mobility Workx, LLC v T-Mobile US, Inc.
Civil Action No. 4:17-cv-00567-ALM

Retained by the defendant, and provided declarations and deposition for claim construction, engaged for both invalidity and non-infringement analysis and testimony. This matter relates to LTE handover, and Mobile IP. The case was settled between the parties prior to trial.

Mobility Workx, LLC v Cellco Partnership d/b/a Verizon Wireless

Case No. 4:17-cv-872-ALM

Retained by the defendant, engaged for both invalidity and non-infringement analysis and testimony. This matter relates to LTE handover, and Mobile IP. The case further related to 3GPP compliance testing techniques. This matter was resolved during trial preparation.

Uniloc USA, Inc., et al. v. Apple Inc.

No. 18-cv-158 and 18-cv-161, engaged by Apple as a technical and testifying expert. This matter relates to Quality of Service aspect of 3G UMTS (WCDMA), and the request and allocation of uplink resources in LTE. The matter was stayed, pending result of PTAB IPR Trial.

Wi-LAN v. LG.

Case No. Case No.: 3:18-cv-01577-H-BGS

Engaged by LG as a technical and testifying expert. The technology involved LTE “contention free” handover (CFRA), Media Access Control (MAC) layer messaging for bandwidth management and Quality of Service (QOS). This matter was resolved.

Fractus, S.A. v. Sprint Communications Company, L.P. et al.

Civil Action No. 2:18-cv-00135 (E.D. Tex.), Engaged by Sprint and Verizon Wireless as a technical and testifying expert for invalidity. The technology involved design aspects of antenna element placement in multiband antenna arrays for use at cellular base stations. This matter was resolved.

Wilson Electronics, LLC v. Cellphone-Mate, Inc. dba SureCall.

Case No. 2:17-cv- 00305-DB (District of Utah)

Retained by the Wilson Electronics, and engaged for both invalidity and non-infringement analysis and testimony in both district court and in ITU proceedings. This matter relates to cellular multi-band wireless signal boosters / repeaters. This matter was resolved.

Sol IP, LLC v Joint Defense Group (AT&T, Ericsson, Nokia, Sprint, Verizon)

Civil Action No. 2:18-cv-00526 (E.D. Tex.)

Retained by each of the defendants, and engaged to provide testimony relating to infringement of the asserted claims for 8 of the asserted patents. The subject matter related to random access, paging, resource allocation, and carrier aggregation in LTE. The matter was resolved.

Polaris PowerLED Technologies, LLC v. TCL Corporation, et al., C.D. California Civil Action No.: 8:20-cv-00127-JVS-DFMBGL Ref. No.: 16725-7 and 16725-8

Engaged by TCL and Hisense to provide expert testimony in district court and to provide a declaration as an expert in an Inter Party Review (IPR) proceeding before the U.S Patent Trial and Appeals Board. The subject matter related to power supply circuitry for use in backlight displays and U.S. Pat. No 11,011,752. The IPR was instituted, and the proceedings were terminated following settlement.

SmartSky Networks v. Wireless Systems Solutions, LLC; DAG Wireless Solutions, et al., M.D. North Carolina (Case No. 1:20-cv-00834-NCT-LPA), and related arbitration proceedings

Engaged by SmartSky to provide expert testimony related to a trade secret dispute in district court, and an arbitration proceeding. The technology related to air to ground internet service for aircraft using a proprietary LTE derived system including airborne radios and ground stations allowing for increased range and velocity beyond that which can be provided by standards based LTE systems. The system includes advanced UE and eNodeB architectures, and modified LTE protocols. I provided expert reports and declarations in both district court and arbitration. I further provided live testimony before an arbitration panel. The arbitration panel found in favor of SmartSky, achieving a successful injunction against WSS/DAG.

Dali Wireless v. JMA Wireless, Civil Action 1:99-mc-09999

Engaged by JMA Wireless to provide several declarations as an expert in an Inter Party Review (IPR) proceeding before the U.S Patent Trial and Appeals Board, and further testimony relating to the district court cases. The subject matter related to in-building wireless signal distribution systems utilizing digital network (CPRI / IP packetized) interfaces and as well as LTE eNodeB architectures. This matter was resolved pending expert discovery.

Dali Wireless v. Corning Optical Communications LLC, No. 3:20-cv-06469 (N.D. Cal.) and Dali Wireless, Inc. v. Corning Incorporated et al., No. 6:20-cv-00827 (W.D. Tex.)

Engaged by Corning to provide several declarations as an expert in an Inter Party Review (IPR) proceeding before the U.S Patent Trial and Appeals Board and further testimony relating to the district court cases. The subject matter related to distributed antenna systems for in-building wireless signal distribution as well as intercell frequency reuse and interference management techniques. This matter was resolved pending expert discovery.

Flexiworld Technologies, Inc. v. Amazon.com, Inc., et al., Case No. 6:20-cv-00553-ADA (W.D. Texas), and Case No. 2:21-cv-01055-DGE (W.D. Washington, Tacoma)

Engaged by Amazon to provide testimony for district court matter in the Western District of Texas. The matter related to approaches for mobile devices to utilize Bluetooth to interface with smart speakers and servers, allowing for the request of content to be played by an output device (speaker) based upon specific requests, including in some cases voice requests. This matter was transferred to Western District of Washington, Tacoma Division and remains pending.

WSOU Investments, LLC d/b/a Brazos Licensing and Development v. Huawei Technologies Co., Ltd. et al., 6:20-cv-00544 (W.D. Tex.)

Engaged by Huawei to provide expert testimony in district court. The matter related to LTE protocols and signaling, Hybrid ARQ, and scheduling of retransmissions relative to new transmissions from a UE to an eNodeB. I provided a claim construction declaration, prior to the matter being resolved.

Ericsson, Inc. IPR petition of 7,532,865, (TOT Power Control, S.L. Patent Owner)

Engaged by Ericsson, Inc. to provide a declaration as an expert in an Inter Party Review (IPR) proceeding before the U.S Patent Trial and Appeals Board, relating to US. Pat. No. 7,532,865. The matter involved "outer loop" power control techniques in WCDMA systems or other mobile devices.

Sierra Wireless et al. IPR petition of 7,215,653 (Sisvel, Patent Owner).

Engaged by Sierra Wireless to provide a declaration as an expert in an Inter Party Review (IPR) proceeding before the U.S. Patent Trial and Appeals Board, relating to US. Pat. No. 7,215,653. This matter involved the control of uplink data rates and power control in a CDMA system called 1xEV-DO developed within the 3GPP2 standards, in which I personally participated. The IPR was instituted by the PTAB, and all claims were found unpatentable.

KAIFI LLC v. T-Mobile US, Inc. et al., Case No. 2:20-cv-281-JRG (E.D. Tex.)

Engaged by T-Mobile to provide expert testimony for both (in)validity and (non)infringement for a district court matter in the Eastern District of Texas. The matter involved a mobile device's roaming between an outdoor cellular / LTE networks and an indoor Wi-Fi network. It further included approaches for the LTE core network to perform the selection of transmission paths of VoLTE and VoWiFi signals involving the LTE core (EPC), including the ePDG, and IMS networks. This matter settled.

KAIFI LLC v. Verizon Wireless, et al., Civil Action No. 2:20-cv-00280-JRG (E.D. Tex.)

Engaged by Verizon to provide expert testimony relating to (in)validity for a district court matter in the Eastern District of Texas. The matter involved a mobile device's roaming between an outdoor cellular / LTE networks and an indoor Wi-Fi network. It further included approaches for the LTE core network to perform the selection of transmission paths of VoLTE and VoWiFi signals involving the LTE core (EPC), including the ePDG, and IMS networks. This matter settled.

NEO Wireless, LLC v. DELL Technologies Inc. and DELL Inc., Case No. 6:21-cv-024-ADA (W.D. Tex.)

Engaged by Dell to provide expert testimony relating to claim construction, (in)validity and (non)infringement in the Western District of Texas, Waco Division. The matter involved LTE and 5G devices and standards aspects including signaling aspect associated with: OFDM/OFDMA, resource scheduling and frame structures, random access and ranging, transmit diversity and beamforming signaling. This matter was settled by the parties.

American Patents v. Xerox., Case No. 6:21- cv-636-ADA, (W.D. Tex.)

Engaged by Xerox to provide expert testimony relating to claim construction, (in)validity and (non)infringement in the Western District of Texas, Waco Division. The matter involved IEEE802.11 (WiFi) based systems relating to a number of patents, including Time and frequency synchronization in multi-input, multi-output (MIMO) systems, the assessment and management of interference in 802.11 systems. This matter was resolved.

TurboCode, v. Dell Technologies Inc. and Dell Inc., Case No. Civil Action No. 6:21-cv-359 (W.D. of Tex.)

Engaged by Dell to provide expert testimony relating to claim construction, (in)validity and (non)infringement in the Western District of Texas, Waco Division. The matter involved 3G / WCDMA use and implementations of Turbo Coding in wireless transmission and reception. This matter was settled by the parties.

XR Communications d/b/a Vivato Technologies v. Microsoft Corporation, Case No: 6:21-cv-695 (WDTX)

Engaged by Microsoft to provide expert testimony relating to claim construction, (in)validity and (non)infringement in the Western District of Texas. The matter involved the use of transmit beamforming, channel estimation and diversity techniques in IEEE802.11n, 802.11AC, and 802.11AX systems (WiFi). This matter was settled by the parties.

Finesse Wireless, LLC v. AT&T Mobility LLC; Cellco Partnership d/b/a Verizon Wireless; Nokia of America Corporation; Ericsson Inc., Case No. 2:21-CV-00063-JRG (E.D. TX).

Engaged by Nokia to provide expert testimony relating to claim construction, (in)validity and (non)infringement in the Eastern District of Texas. The matter involved aspects of LTE and 5G infrastructure relating to the cancelation of radio frequency intermodulation distortion produced in a transmitter from the receiver of the same base station, and involving both passive intermodulation (PIM) and active intermodulation from Power amplifiers (PA). This matter remains pending.

GODO KAISHA IP BRIDGE v Ericsson and Nokia Case No. 2:21-CV-213-JRG, Case No. 2:21-CV-215-JRG (E.D. TX).

Engaged by Nokia and Ericsson to provide expert testimony relating to claim construction, (in)validity and (non)infringement in the Eastern District of Texas. The matter involved aspects of LTE and 5G infrastructure relating to the channel state information (CSI/CQI) configuration and triggering for periodic and aperiodic, wideband and sub-band reports from LTE/NR UEs. This matter was settled prior to trial.

Microsoft Corporation, IPR petition of '414, '763, '988, '890 (Lemco Corporation, Patent Owner).

Engaged by Microsoft Corporation to provide several declarations as an expert in Inter Party Review (IPR) proceedings before the U.S. Patent Trial and Appeals Board, relating to US. Pat. Nos. 7,653,414, 7,548,763, 7,855,988, and 9,191,980. These matters involved distributed cellular network infrastructure architectures. The patents relate to software implementations of cellular network infrastructure, including a distributed mobile architecture server and a distributed mobile architecture gateway. This matter remains pending.

Ozmo v. Dell, Case No: 6:22-cv-00642-ADA (WDTX)

Engaged by Dell to testimony related to claim construction, (in)validity and (non)infringement relating to U.S Pat. Nos. 8,599,814; 9,264,991; 10,873,906; 11,012,934; 11,122,504; and 11,252,659 and share common provisional applications. The subject matter of the patents relate to seamlessly integrating short-range wireless personal area networks ("WPANs") into longer-range wireless local area networks ("WLANs").

XR Communications d/b/a Vivato Technologies v. ASUSTek Computer Inc., Computer Inc.

Case No: 6:21-cv-00622-ADA (WDTX)

Engaged by ASUSTek to provide expert testimony relating to claim construction, (in)validity and (non)infringement in the Western District of Texas. The matter involved the use of transmit beamforming, channel estimation and diversity techniques in IEEE802.11n, 802.11AC, and 802.11AX systems (WiFi). This matter remains pending.

List of Issued U.S. Patents

United States Pat. No.	Title
5,550,549	Transponder system and method
5,687,196	Range and bearing tracking system with multipath rejection
5,898,338	Adaptive digital predistortion linearization and feed-forward correction of RF power amplifier
5,929,704	Control of RF error extraction using auto-calibrating RF correlator
5,949,283	Adaptive digital predistortion linearization and feed-forward correction of RF power amplifier
5,960,047	System and method for transmitting information signals
6,078,216	Aliased wide band performance monitor for adjusting predistortion and vector modulator control parameters of RF amplifier
6,100,843	Adaptive antenna for use in same frequency networks
6,212,220	Method and apparatus for creating non-interfering signals using non-orthogonal techniques
6,222,832	Fast Acquisition of traffic channels for a highly variable data rate reverse link of a CDMA wireless communication system
6,239,756	Antenna array with housing
6,301,291	Pilot symbol assisted modulation and demodulation in wireless communication systems
6,304,215	Method of use for an adaptive antenna in same frequency networks
6,362,790	Antenna array structure stacked over printed wiring board with beamforming components
6,388,999	Dynamic bandwidth allocation for multiple access communications using buffer urgency factor
6,396,456	Stacked dipole antenna for use in wireless communications systems
6,400,317	Method and apparatus for antenna control in a communications network
6,404,386	Adaptive antenna for use in same frequency networks
6,421,336	Variable rate orthogonally coded reverse link structure
6,448,938	Method and apparatus for frequency selective beam forming
6,452,913	Fast acquisition of traffic channels for a highly variable data rate reverse link of a CDMA wireless communication system
6,456,835	Arbitration method for high power transmissions in a code division multiple access system
6,473,036	Method and apparatus for adapting antenna array to reduce adaptation time while increasing array performance
6,515,635	Adaptive antenna for use in wireless communication systems
6,518,920	Adaptive antenna for use in same frequency networks
6,542,481	Dynamic bandwidth allocation for multiple access communication using session queues
6,545,990	Method and apparatus for a spectrally compliant cellular communication system
6,545,994	Access probe acknowledgment including collision detection to avoid oversetting initial power level
6,563,809	Subscriber-controlled registration technique in a CDMA system
6,600,456	Adaptive antenna for use in wireless communication systems
6,614,776	Forward error correction scheme for high rate data exchange in a wireless system
6,678,260	System and method for maintaining wireless channels over a reverse link of a CDMA wireless communication system
6,707,804	Fast acquisition of traffic channels for a highly variable data rate reverse link of a CDMA wireless communication system
6,785,323	Variable rate coding for forward link
6,788,268	Method and apparatus for frequency selective beam forming
6,792,290	Method and apparatus for performing directional re-scan of an adaptive antenna
6,801,564	Reverse link correlation filter in wireless communication systems
6,804,223	Reverse link pilot integrated with block codes
6,873,293	Adaptive receive and omnidirectional transmit antenna array
6,888,504	Aperiodic array antenna
6,888,807	Applying session services based on packet flows
6,894,653	Low cost multiple pattern antenna for use with multiple receiver systems
6,904,079	Access channel structure for wireless communication system
6,911,879	Electronic phase shifter with enhanced phase shift performance
6,917,581	Use of orthogonal or near orthogonal codes in reverse link

6,917,642	Method for using a non-orthogonal pilot signal with data channel interference cancellation
6,925,070	Time-slotted data packets with a preamble
6,928,064	Fast acquisition of traffic channels for a highly variable data rate reverse link of a CDMA wireless communication system
6,933,887	Method and apparatus for adapting antenna array using received predetermined signal
6,937,562	Application specific traffic optimization in a wireless link
6,940,842	System and method for maintaining wireless channels over a reverse link of a CDMA wireless communication system
6,941,152	Wireless subscriber network registration system for configurable services
6,954,448	Alternate channel for carrying selected message types
6,956,840	Power control protocol for highly variable data rate reverse link of a wireless communication system
6,973,140	Maximizing data rate by adjusting codes and code rates in CDMA system
6,989,797	Adaptive antenna for use in wireless communication systems
6,992,546	Electronic phase shifter with enhanced phase shift performance
7,002,902	Method and system for economical beam forming in a radio communication system
7,006,428	Method for allowing multi-user orthogonal and non-orthogonal interoperability of code channels
7,006,483	Qualifying available reverse link coding rates from access channel power setting
7,009,559	Method and apparatus for adapting antenna array using received predetermined signal
7,015,773	Electronic phase shifter with enhanced phase shift performance
7,034,759	Adaptive receive and omnidirectional transmit antenna array
7,072,316	Subscriber-controlled registration technique in a CDMA system
7,079,523	Maintenance link using active/standby request channels
7,092,430	Method for using a non-orthogonal pilot signal with data channel interference cancellation
7,113,786	Antenna adaptation to manage the active set to manipulate soft hand-off regions
7,145,964	Maximizing data rate by adjusting codes and code rates in CDMA system
7,176,844	Aperiodic array antenna
7,184,417	Power control protocol for highly variable data rate reverse link of a wireless communication system
7,187,904	Frequency translating repeater with low cost high performance local oscillator architecture
7,200,134	Wireless area network using frequency translation and retransmission based on modified protocol messages for enhancing network coverage
7,215,297	Adaptive antenna for use in wireless communication systems
7,218,623	Coded reverse link messages for closed-loop power control of forward link control messages
7,221,664	Transmittal of heartbeat signal at a lower level than heartbeat request
7,224,685	Method of detection of signals using an adaptive antenna in a peer-to-peer network
7,227,907	Antenna adaptation comparison method for high mobility
7,230,935	Physical layer repeater with selective use of higher layer functions based on network operating conditions
7,233,627	Method for searching pilot signals to synchronize a CDMA receiver with an associated transmitter
7,233,771	Non-frequency translating repeater with downlink detection for uplink and downlink synchronization
7,253,783	Low cost multiple pattern antenna for use with multiple receiver systems
7,272,169	Reverse link correlation filter in wireless communication systems
7,289,827	Method and apparatus for performing directional re-scan of an adaptive antenna
7,308,285	Antenna adaptation in a time division duplexing system
7,366,154	Forward error correction scheme for high rate data exchange in a wireless system
7,394,791	Multi-detection of heartbeat to reduce error probability
7,425,928	Method and apparatus for frequency selective beam forming
7,426,241	Variable rate coding for forward link
7,428,263	Method for using a non-orthogonal pilot signal with data channel interference cancellation
7,433,340	Staggering forward and reverse wireless channel allocation timing
7,447,187	Reverse link pilot integrated with block codes
7,463,200	Directional antenna configuration for TDD repeater

7,463,201	Aperiodic array antenna
7,480,280	Fast acquisition of traffic channels for a highly variable data rate reverse link of a CDMA wireless communication system
7,483,473	Access channel structure for wireless communication system
7,496,072	System and method for controlling signal strength over a reverse link of a CDMA wireless communication system
7,502,351	Alternate channel for carrying selected message types
7,502,424	Maximizing data rate by adjusting codes and code rates
7,528,789	Adaptive antenna for use in wireless communication systems
7,529,264	Use of orthogonal or near orthogonal codes in reverse link
7,551,663	Use of correlation combination to achieve channel detection
7,580,674	Intelligent interface for controlling an adaptive antenna array
7,586,880	Method of detection of signals using an adaptive antenna in a peer-to-peer network
7,592,969	Multiple-antenna device having an isolation element
7,593,380	Variable rate forward error correction for enabling high performance communication
7,602,749	Fast acquisition of traffic channels for a highly variable data rate reverse link of a CDMA wireless communication system
7,613,227	Reverse link correlation filter in wireless communication systems
7,701,903	Power control protocol for highly variable data rate reverse link of a wireless communication system
7,733,285	Integrated, closely spaced, high isolation, printed dipoles
7,746,830	System and method for maintaining wireless channels over a reverse link of a CDMA wireless communication system
7,773,566	System and method for maintaining timing of synchronization messages over a reverse link of a CDMA wireless communication system
7,787,408	Wireless repeater with master/slave configuration
7,826,437	Variable rate coding for enabling high performance communication
7,889,702	Time-slotted data packets with a preamble
7,893,889	Multiple-antenna device having an isolation element
7,907,513	Superimposed composite channel filter
7,907,891	Physical layer repeater utilizing real time measurement metrics and adaptive antenna array to promote signal integrity and amplification
7,911,985	Automatic gain control and filtering techniques for use in on-channel repeater
7,911,993	Method and apparatus for allowing soft handoff of a CDMA reverse link utilizing an orthogonal channel structure
7,916,772	Method for searching pilot signals to synchronize a CDMA receiver with an associated transmitter
7,936,728	System and method for maintaining timing of synchronization messages over a reverse link of a CDMA wireless communication system
7,936,736	Enforcing policies in wireless communication using exchanged identities
7,944,845	Application specific traffic optimization in a wireless link
7,990,904	Wireless network repeater
8,023,885	Non-frequency translating repeater with downlink detection for uplink and downlink synchronization
8,027,642	Transmission canceller for wireless local area network
8,045,536	Forward error correction scheme for high rate data exchange in a wireless system
8,059,727	Physical layer repeater configuration for increasing MIMO performance
8,060,009	Wireless local area network repeater with automatic gain control for extending network coverage
8,068,474	Variable rate coding for enabling high performance communication
8,072,944	Staggering forward and reverse wireless channel allocation timing
8,072,958	Reverse link pilot integrated with block codes
8,078,100	Physical layer repeater with discrete time filter for all-digital detection and delay generation
8,089,913	Physical layer repeater with selective use of higher layer functions based on network operating conditions
8,090,359	Exchanging identifiers between wireless communication to determine further information to be exchanged or further services to be provided
8,090,616	Visual identification information used as confirmation in a wireless communication
8,095,067	Frequency translating repeater with low cost high performance local oscillator architecture
8,111,645	Wireless local area network repeater with detection

8,116,239	Use of a filterbank in an adaptive on-channel repeater utilizing adaptive antenna arrays
8,116,749	Protocol for anonymous wireless communication
8,121,535	Configuration of a repeater
8,122,134	Reducing loop effects in a wireless local area network repeater
8,134,980	Transmittal of heartbeat signal at a lower level than heartbeat request
8,139,546	System and method for maintaining wireless channels over a reverse link of a CDMA wireless communication system
8,155,096	Antenna control system and method
8,175,120	Minimal maintenance link to support synchronization
8,194,783	Variable rate coding for a forward and reverse link
8,204,140	Subscriber unit and method for variable forward error correction (FEC) decoding
8,238,912	Non-intrusive detection of enhanced capabilities at existing cellsites in a wireless data communication system
8,259,687	Dynamic bandwidth allocation for multiple access communications using buffer urgency factor
8,259,744	Use of orthogonal or near orthogonal codes in reverse link
8,265,630	Antenna adaptation to manage the active set to manipulate soft hand-off regions
8,274,954	Alternate channel for carrying selected message types
8,285,201	Wideband echo cancellation in a repeater
8,315,294	Method for searching pilot signals to synchronize a CDMA receiver with an associated transmitter
8,321,542	Wireless channel allocation in a base station processor
8,358,969	Feedback delay control in an echo cancellation repeater
8,363,590	Physical layer repeater with roaming support based on multiple identifiers
8,369,277	Signaling for wireless communications
8,369,842	Exchanging identifiers between wireless communication to determine further information to be exchanged or further services to be provided
8,370,955	Enforcing policies in wireless communication using exchanged identities
8,374,592	Exchanging identifiers between wireless communication to determine further information to be exchanged or further services to be provided
8,385,305	Hybrid band intelligent backhaul radio
8,385,818	Delay control to improve frequency domain channel estimation in an echo cancellation repeater
8,385,896	Exchanging identifiers between wireless communication to determine further information to be exchanged or further services to be provided
8,385,913	Using a first wireless link to exchange identification information used to communicate over a second wireless link
8,422,540	Intelligent backhaul radio with zero division duplexing
8,437,329	Variable rate coding for enabling high performance communication
8,437,330	Antenna control system and method
8,463,255	Method and apparatus for a spectrally compliant cellular communication system
8,467,353	Time-slotted data packets with a preamble
8,467,363	Intelligent backhaul radio and antenna system
8,477,665	Method in a wireless repeater employing an antenna array for interference reduction
8,498,234	Wireless local area network repeater
8,502,733	Transmit co-channel spectrum sharing
8,503,926	IQ imbalance compensation in interference cancellation repeater using a zero-IF radio architecture
8,509,268	Minimal maintenance link to support synchronization
8,509,835	Reverse link initial power setting using effective radiated power message to compute path loss
8,521,862	Wireless channel allocation in a base station processor
8,526,401	Power control protocol for highly variable data rate reverse link of wireless communication system
8,537,656	Method for compensating for multi-path of a CDMA reverse link utilizing an orthogonal channel structure
8,542,623	Use of RF reference in a digital baseband interference cancellation repeater
8,553,610	Interference cancellation repeater incorporating a non-linear element
8,559,379	Method and apparatus for mitigating oscillation between repeaters
8,576,805	Subscriber-controlled registration technique in a CDMA system

8,582,552	Maintaining a maintenance channel in a reverse link of a wireless communications system
8,599,906	Closed form calculation of temporal equalizer weights used in a repeater transmitter leakage cancellation system
8,605,702	Maintaining a maintenance channel in a reverse link of a wireless communications system
8,619,837	Use of adaptive antenna array in conjunction with an on-channel repeater to improve signal quality
8,630,211	Hybrid radio architecture for repeaters using RF cancellation reference
8,638,839	Intelligent backhaul radio with co-band zero division duplexing
8,638,877	Methods, apparatuses and systems for selective transmission of traffic data using orthogonal sequences
8,649,418	Enhancement of the channel propagation matrix order and rank for a wireless channel
8,676,131	Method and apparatus for allowing soft handoff of a CDMA reverse link utilizing an orthogonal channel structure
8,687,606	Alternate channel for carrying selected message types
8,709,092	Periprosthetic fracture management enhancements
8,737,343	Coded reverse link messages for closed-loop power control of forward link control messages
8,755,360	Method and apparatus for a spectrally compliant cellular communication system
8,755,473	Method and apparatus for detecting rapid changes in signaling path environment
8,774,079	Repeater techniques for multiple input multiple output utilizing beam formers
8,787,248	Method in a wireless repeater employing an antenna array including vertical and horizontal feeds for interference reduction
8,790,321	Apparatus, system, and method for harvesting improved bone graft material with reamer-irrigator-aspirator (RIA) device
8,792,458	System and method for maintaining wireless channels over a reverse link of a CDMA wireless communication system
8,811,367	Qualifying available reverse link coding rates from access channel power setting
8,824,442	Intelligent backhaul radio with adaptive channel bandwidth control
8,830,977	Reverse link pilot integrated with block codes
8,842,642	Transmitting acknowledgement messages using a staggered uplink time slot
8,849,186	Repeater communication using inserted low power sequences
8,849,698	Exchanging identifiers between wireless communication to determine further information to be exchanged or further services to be provided
8,861,429	Selective carrier amplification in a wireless repeater
8,885,688	Control message management in physical layer repeater
8,897,340	Enhancement of the channel propagation matrix order and rank for a wireless channel
8,908,654	Dynamic bandwidth allocation for multiple access communications using buffer urgency factor
8,937,874	Adjusting repeater gains based upon received downlink power level
8,942,216	Hybrid band intelligent backhaul radio
8,948,235	Intelligent backhaul radio with co-band zero division duplexing utilizing transmitter to receiver antenna isolation adaptation
8,958,457	Channel structure for a wireless communication system
8,964,909	Maximizing data rate by adjusting codes and code rates
8,989,762	Advanced backhaul services
9,014,118	Signaling for wireless communications
9,019,930	Coded reverse link messages for closed-loop power control of forward link control messages
9,020,009	Inserted pilot construction for an echo cancellation repeater
9,020,621	Network based media enhancement function based on an identifier
9,038,129	Enforcing policies in wireless communication using exchanged identities
9,042,400	Multi-detection of heartbeat to reduce error probability
9,135,612	Proximity detection, virtual detection, or location based triggering of the exchange of value and information
9,161,164	Exchanging identifiers between wireless communication to determine further information to be exchanged or further services to be provided
9,179,240	Transmit co-channel spectrum sharing
9,185,604	Qualifying available reverse link coding rates from access channel power setting
9,210,616	Application specific traffic optimization in a wireless link
9,225,395	Antenna control system and method
9,226,295	Hybrid band radio with data direction determined by a link performance metric

9,237,209	Time-slotted data packets with a preamble
9,247,510	Use of correlation combination to achieve channel detection
9,252,857	Embedded control signaling for wireless systems
9,294,222	Variable rate coding for forward and reverse link
9,301,274	Minimal maintenance link to support synchronization
9,306,658	Method and apparatus for a spectrally compliant cellular communication system
9,306,703	Variable rate coding for enabling high performance communication
9,307,532	Signaling for wireless communications
9,325,398	Method for installing a backhaul radio with an antenna array
9,325,477	Alternate channel for carrying selected message types
9,345,523	Periprosthetic fracture management enhancements
9,363,759	Power control protocol for highly variable data rate reverse link of a wireless communication system
9,369,235	Maximizing data rate by adjusting codes and code rates
9,374,822	Method for installing a hybrid band radio
9,397,808	Reverse link pilot integrated with block codes
9,398,120	Time-slotted data packets with a preamble
9,456,376	Subscriber-controlled registration technique in a CDMA system
9,456,428	Method and apparatus for allowing soft handoff of a CDMA reverse link utilizing an orthogonal channel structure
9,460,433	Proximity detection, virtual detection, or location based triggering of the exchange of value and information
9,490,918	Zero division duplexing MIMO backhaul radio with adaptable RF and/or baseband cancellation
9,496,915	Use of orthogonal or near orthogonal codes in reverse link
9,497,761	Qualifying available reverse link coding rates from access channel power setting
9,522,066	Periprosthetic fracture management enhancements
9,525,923	Multi-detection of heartbeat to reduce error probability
9,554,061	Smart hub
9,555,169	Apparatus for harvesting improved bone graft material utilizing an implantable biodegradable filter
9,572,163	Hybrid band radio with adaptive antenna arrays
9,577,733	Method for installing a backhaul link with multiple antenna patterns
9,655,062	System and method for coordination of wireless maintenance channel power control
9,661,583	Reverse link initial power setting using effective radiated power message to compute path loss
9,686,713	Application specific traffic optimization in a wireless link
9,686,790	Signaling for wireless communications
9,713,019	Self organizing backhaul radio
9,713,157	Method for installing a backhaul link with alignment signals
9,775,115	Antenna control system and method
9,780,930	Communicating reference and data information in a wireless network
9,781,626	Wireless channel allocation in a base station processor
9,807,714	Minimal maintenance link to support synchronization
9,832,664	Receiving and transmitting reverse link signals from subscriber units
9,867,101	Method and apparatus for allowing soft handoff of a CDMA reverse link utilizing an orthogonal channel structure
9,872,196	Subscriber-controlled registration technique in a CDMA system
9,876,530	Advanced backhaul services
9,913,271	Qualifying available reverse link coding rates from access channel power setting
9,913,722	Periprosthetic fracture management enhancements
9,924,468	Antenna control system and method
9,936,500	Transmitting acknowledgement messages using a staggered uplink time slot
9,954,635	Variable rate coding for enabling high performance communication
9,974,116	Handoff to base station having enhanced capabilities

10,057,700	Smart hub
10,063,363	Zero division duplexing MIMO radio with adaptable RF and/or baseband cancellation
10,064,144	Use of correlation combination to achieve channel detection
10,129,888	Method for installing a fixed wireless access link with alignment signals
10,153,885	Alternate channel for carrying selected message types
10,204,357	Proximity detection, virtual detection, or location based triggering of the exchange of value and information
10,211,940	Use of orthogonal or near orthogonal codes in reverse link
10,237,760	Self organizing backhaul radio
10,284,253	Advanced backhaul services
10,286,123	Removable biocompatible substrate filter for a reaming and collection device
10,299,218	System and method for coordination of wireless maintenance channel power control
10,306,635	Hybrid band radio with multiple antenna arrays
10,356,782	Embedded control signaling for self-organizing wireless backhaul radio and systems
10,357,370	Periprosthetic fracture management enhancements
10,390,311	Maintaining a maintenance channel in a reverse link of a wireless communications system
10,638,468	Qualifying available reverse link coding rates from access channel power setting
10,687,161	Smart hub
10,687,950	Periprosthetic shoulder fracture repair
10,700,733	Advanced backhaul services
10,708,918	Electronic alignment using signature emissions for backhaul radios
10,735,979	Self organizing backhaul radio
10,736,110	Method for installing a fixed wireless access link with alignment signals
10,762,532	Proximity detection, virtual detection, or location based triggering of the exchange of value and information
10,805,887	Maintaining a maintenance channel in a reverse link of a wireless communications system
10,821,030	Apparatus and method for a temperature released adhesive structure for use with bandages
10,874,520	Combination intra-medullary and extra-medullary fracture stabilization with aligning arm
10,932,267	Hybrid band radio with multiple antenna arrays
10,966,201	Embedded control signaling for self-organizing wireless backhaul radio and systems
11,000,380	Combination intra-medullary and extra medullary fracture stabilization with aligning arm
11,013,605	Combination intra-medullary and extra medullary fracture stabilization with aligning arm
11,074,615	Efficient and secure communication using wireless service identifiers
11,219,527	Combination intra-medullary and extra-medullary fracture stabilization with aligning arm
11,238,499	Proximity detection, virtual detection, or location based triggering of the exchange of value and information
11,260,164	Negative pressure wound therapy dressing and related apparatus
11,303,322	Advanced backhaul services
11,310,614	Smart Hub
11,334,918	Exchanging identifiers between wireless communication to determine further information to be exchanged or further services to be provided
11,343,060	Zero division duplexing MIMO radio with adaptable RF and/or baseband cancellation
11,343,684	Self organizing backhaul radio
11,437,740	Removable biocompatible substrate filter for a reaming and collection device
11,443,344	Efficient and secure communication using wireless service identifiers
11,6333,217	Reduction and fixation apparatus for calcaneal fracture
11,684,518	Apparatus and method for a temperature released adhesive structure for use with bandages
11,687,971	Efficient and secure communication using wireless service identifiers
11,723,776	Periprosthetic shoulder fracture repair
D532780	Wireless repeater housing