

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

HTC Corporation, and

HTC America, Inc.,
Petitioners

v.

INVT SPE LLC,
Patent Owner

IPR Case No. IPR2018-01556
Patent 6,760,590

DECLARATION OF PAUL S. MIN, PH.D

**IN SUPPORT OF
PETITION FOR *INTER PARTES* REVIEW
OF U.S. PATENT NO. 6,760,590**

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I, Paul Min, declare:

I. INTRODUCTION

1. My name is Paul S. Min, Ph.D. I have been retained as a technical expert and submit this declaration on behalf of HTC Corporation and HTC America, Inc. (collectively, “Petitioners” or “HTC”), which I understand are challenging the validity of claims 1-4 (“the challenged claims”) of U.S. Patent No. 7,206,587 (“the ’587 patent”) in a petition for *inter partes* review.

2. I have no financial interest in or affiliation with the Petitioners or the Patent Owner, which I understand is INVT SPE LLC. My compensation does not depend upon the outcome of, or my testimony in, this *inter partes* review proceeding or any litigation proceedings.

3. I have been asked to provide an opinion on the validity of the challenged claims. In my opinion, for the reasons in the following sections, the challenged claims are invalid on the following ground:

- (1) Claims 1- 4 are obvious under 35 U.S.C. § 103 by Padovani (PCT Application No. PCT/US98/23428) in view of Gils (W. van Gils, “Design of error-control coding schemes for three problems of noisy information transmission, storage and processing,” Ph.D. dissertation, Eindhoven Univ. of Technology, Eindhoven, the Netherlands, 1988).

4. (2) Claims 5-8 are obvious under 35 U.S.C. § 103 by Padovani (PCT Application No. PCT/US98/23428) in view of Gils (W. van Gils, “Design of error-control coding schemes for three problems of noisy information transmission, storage and processing,” Ph.D. dissertation, Eindhoven Univ. of Technology, Eindhoven, the Netherlands, 1988), and further in view of Olofsson et al. (US Patent No. 6,167,031).

5. I have been informed, and agree after reviewing Exhibits 1024-1052, that W. van Gils, “Design of error-control coding schemes for three problems of noisy information transmission, storage and processing,” Ph.D. dissertation, Eindhoven Univ. of Technology, Eindhoven, the Netherlands, 1988 (“Gils”) was available to members of the general public, including interested members of the public, without restriction as of January 6, 1988, was catalogued by no later than March 1998, and widely disseminated to other libraries by at least 1993.

II. BACKGROUND/QUALIFICATIONS

6. Appendix A to this declaration is my curriculum vitae, which sets forth my qualifications.

7. I received a B.S. degree in Electrical Engineering in 1982, an M.S. degree in Electrical Engineering in 1984, and a Ph.D. degree in Electrical Engineering in 1987 from the University of Michigan in Ann Arbor. I received several academic honors, including my B.S. degree with honors, a best graduate

student award and a best teaching assistant award during my M.S. study, and a best paper award from a major international conference for reporting results from my Ph.D. thesis.

8. After receiving my Ph.D., I worked at Bellcore in New Jersey from August 1987 until August 1990. At Bellcore, I was responsible for evolving the public switched telephone network (POTS) into a multi-services voice and data network that incorporated packet switches, optical technologies, and wireless technologies.

9. In September 1990, I joined the faculty at Washington University in St. Louis. In July 1996, I was promoted to an Associate Professor of Electrical Engineering with tenure. I am currently a Senior Professor at Washington University of the Electrical and Systems Engineering. I have also served as the Chair of the Graduate Curriculum (2000-2002) and the Chair of the Undergraduate Curriculum (2011-2014) for the Electrical and Systems Engineering department.

10. At Washington University, I have conducted research in communication, computing, and related electronic hardware and software. My research group has pioneered a new paradigm for designing electronic circuits that can alleviate the speed and performance mismatch against optical technology. I have received several grants from the U.S. Federal Agencies, including the National Science Foundation and the Defense Advanced Research Project Agency,

and numerous contracts from companies and organizations around the world. Specifically related to the technology matters in this Investigation, I have researched a variety of wireless communication technologies, including CDMA, WCDMA, OFDM, FDD, SC-FDMA, and TDD. I have an extensive background and experience in each of these technologies.

11. As a faculty member at Washington University, I have taught a number of courses in electronics, communication, and computing at both the undergraduate and graduate levels. For example, I have taught communication theory (Washington University ESE 471), transmission and multiplexing (Washington University ESE 571), and signaling and control of communication networks (Washington University ESE 572).

12. I have supervised nearly 100 graduate students, 12 of whom received a doctoral degree under my guidance. A number of doctoral theses that I have supervised relate specifically to wireless cellular communication involving base station and mobile terminals such as smart phones operating under the WCDMA and LTE standards. In particular, my students and I have published a number of peer-reviewed articles on resource allocation, scheduling, modulation, mobility management, power control, and multiplexing. Several of these articles received accolades in the field. For example, in 2011, we received a best paper award in 3G

WCDMA-related mobility and resource management at the prestigious Mobility 2011 international conference.

13. In addition to my responsibilities as a university faculty member, I have founded two companies. In May 1997, I founded MinMax Technologies, Inc., a fabless semiconductor company that developed switch fabric integrated circuit chips for the Internet. In March 1999, I founded Erlang Technology, Inc., a fabless semiconductor company that focused on the design and development of integrated circuit chips and software for the Internet. One of Erlang's products received a best product of the year award in 2004 from a major trade journal for the electronics industry.

14. Outside my own start-up companies, I have also served in various technology and business advisor roles for other companies and organizations around the world. I was the main technical author for one of two winning proposals to the Korean government for CDMA wireless service licenses (1996). I was responsible for designing a commercial scale IS-95 CDMA cellular network, which I understand to be one of the earliest such networks deployed in the world. I worked with numerous engineers and scientists around the world to implement this commercial-scale cellular network before IS-95 CDMA was widely accepted. This provided me with extensive insight into various components of CDMA technology, which by and large are used in WCDMA network. I have also been involved in a

semiconductor company that specializes in semiconductor memories such as flash EEPROMs as a board member and as a technical advisor (2007-2011).

15. I am a named inventor on nine U.S. patents, many of which are directly related to resource allocation, packet processing, and network designing. I have extensively published technical papers in international conferences and journals, technical memoranda and reports, and given a number of seminars and invited talks. Many of these papers are specifically within the context of the 3GPP standard, which is the preeminent governing standard for the cellular communication around the world. I have organized several international conferences and served as an international journal editor.

16. I am a member of and have been actively involved in a number of professional organizations. For example, I have served as the Chair of the Saint Louis Section of the IEEE with more than 3,000 members (2014), and a member of the Eta Kappa Nu Honor Society for electrical engineers. I have also been an Ambassador of the McDonnell International Scholars Academy (2007-2013).

17. In my 30+ years of experience with telecommunications technology, I have acquired significant knowledge about telecommunications systems industry standards, standard setting organizations such as 3GPP, and the rules and document policies that those organizations have in place to develop industry standards.

18. Further experience and a complete list of my publications are presented in my curriculum vitae, which is being submitted with this declaration as Appendix A.

19. Based on my above-described 3 decades of experience in communications technologies, and the acceptance of my publications and professional recognition by societies in my field, I believe that I am qualified to be an expert in wireless and mobile communications.

III. MATERIALS CONSIDERED

20. Appendix B to this declaration lists materials that I have considered in rendering the opinions that I express in this declaration. In forming my opinions, I have also relied on my experience and education.

IV. UNDERSTANDING OF THE LAW

21. I am not an attorney. I offer no opinions on the law. But counsel has informed me of legal standards that apply to the issue of patent validity. I have applied these standards in arriving at my conclusions.

22. I understand that in an inter partes review the petitioner has the burden of proving a proposition of unpatentability by a preponderance of the evidence. I understand this standard is different from the standard that applies in a district court, where I understand a challenger bears the burden of proving invalidity by clear and convincing evidence.

23. I understand that a patent claim is invalid based on anticipation if a single prior art reference discloses all of the features of that claim, and does so in a way that enables one of ordinary skill in the art to make and use the invention.

24. Each of the claim features may be expressly or inherently present in the prior art reference. I understand that if the prior art necessarily functions in accordance with, or includes a claim's feature, then that prior art inherently discloses that feature. I have relied on this understanding in expressing the opinions set forth below.

25. I understand that a prior art reference describes the claimed invention if it either expressly or inherently describes each and every feature set forth in the claim; i.e., in determining whether a single item of prior art anticipates a patent claim, one should take into consideration not only what is expressly disclosed in that item, but also what is inherently present as a natural result of the practice of the system or method disclosed in that item.

26. I understand that to establish inherency, the evidence must make clear that the missing descriptive matter is necessarily present in the item of prior art and that it would be so recognized by persons of ordinary skill in the art. I also understand that prior art use of the claimed patented invention that was accidental, unrecognized, or unappreciated at the time of filing can still be an invalidating anticipation.

27. I understand that although multiple prior art references may not be combined to show anticipation, additional references may be used to interpret the allegedly anticipating reference and shed light on what it would have meant to those skilled in the art at the time of the invention. These additional references must make it clear that the missing descriptive matter in the patent claim is necessarily present in the allegedly anticipating reference, and that it would be so recognized by persons of ordinary skill in the art.

28. I understand that a patent may not be valid even though the invention is not identically disclosed or described in the prior art if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious to a person having ordinary skill in the art in the relevant subject matter at the time the invention was made.

29. To determine if a claim is obvious, the following factors should be considered: (1) the level of ordinary skill in the art at the time the invention was made; (2) the scope and content of the prior art; (3) the differences between the claimed invention and the prior art; and (4) secondary considerations, including evidence of commercial success, long-felt but unsolved need, unsuccessful attempts by others, copying of the claimed invention, unexpected and superior results, acceptance and praise by others, independent invention by others, and the like.

30. For example, I understand that the combination of familiar elements according to known methods is likely to be obvious when it does no more than yield predictable results. I also understand that an obviousness analysis need not seek out precise teachings directed to the specific subject matter of the challenged claim because a court can take account of the inferences and/or creative steps that a person of ordinary skill in the art would employ.

31. I understand that the obviousness determination of an invention turns on whether a hypothetical person with ordinary skill and full knowledge of all the pertinent prior art, when faced with the problem to which the claimed invention is addressed, would be led naturally to the solution adopted in the claimed invention or would naturally view that solution as an available alternative. Facts to be evaluated in this analysis include:

- The scope and contents of the prior art;
- Differences between the prior art and the claims at issue;
- The level of ordinary skill in the pertinent art; and
- Evidence of objective factors suggesting or negating obviousness.

32. I understand that the following rationales may be used to determine whether a piece of prior art can be combined with other prior art or with other information within the knowledge of one of ordinary skill in the art:

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

33. I understand that when a work is available in one field of endeavor, design incentives and/or other market forces, for example, can prompt variations of it, either in the same field or a different one. Moreover, if a person of ordinary skill

can implement a predictable variation, I understand that that likely bars its patentability.

34. I understand that obviousness must be tested as of the time the invention was made. I understand that the test for obviousness is what the combined teachings of the prior art references would have suggested, disclosed, or taught to one of ordinary skill in the art. In particular, it is my understanding that a patent claim is invalid based upon obviousness if it does nothing more than combine familiar elements from one or more prior art references or products according to known methods to yield predictable results. For example, I understand that where a technique has been used to improve one device, and a person of ordinary skill in the art would have recognized that it would improve similar devices in the same way, using that technique is obvious. I understand that obviousness can be proved by showing that a combination of elements was obvious to try, i.e.: that it does no more than yield predictable results; implements a predictable variation; is no more than the predictable use of prior art elements according to their established functions; or when there is design need or market pressure to solve a problem and there are a finite number of identified, predictable solutions. I have been further informed that when a patent claim simply arranges old elements with each element performing the same function it had been known to

perform and yields results no more than one would expect from such an arrangement, the combination is obvious.

35. I understand that another factor to be considered is common sense. For example, I understand that common sense teaches that familiar items may have obvious uses beyond their primary purposes, and, in many cases, a person of ordinary skill will be able to fit the teachings of multiple patents together like pieces of a puzzle.

36. I understand that the Supreme Court articulated additional guidance for obviousness in its KSR decision. My understanding is that the Supreme Court said that technical people of ordinary skill look for guidance in other solutions to problems of a similar nature, and that the obviousness inquiry must track reality, and not legal fictions. I have relied on these understandings in expressing the opinions set forth below.

37. I understand that a new use of an old product or material cannot be claimed as a new product; the apparatus or system itself is old and cannot be patented. I further understand that, in general, merely discovering and claiming a new benefit to an old process cannot render the process newly patentable.

V. DOCUMENTS AND MATERIALS CONSIDERED

38. Appendix B to this declaration lists materials that I have considered in rendering the opinions that I express in this declaration. In forming my opinions, I have also relied on my experience and education.

VI. OVERVIEW OF THE '590 PATENT

39. The '590 Patent describes High Data Rate (HDR) communications as a method utilized in cellular communication systems whereby a base station (BS) uses time division to schedule the allocation of communication resources to communication terminals. *See, e.g., Ex. 1001, 1:14-26.* Additionally, a BS may set a transmission rate for each communication terminal in accordance with an estimated downlink channel quality relative to a particular communication terminal. *Id.*

40. In particular, the '590 Patent describes that a BS may transmit a pilot signal to each communication terminal with which the BS is communicating. *Id.*, 1:30-31. Each communication terminal, in turn, estimates the downlink channel quality between it and the BS “using a CIR (desired carrier to interference ratio) based on the pilot signal, etc.” and finds a transmission rate at which communications are possible. *Id.*, 1:31-35. Based on the identified transmission rate, “each communication terminal selects a communication mode,” described by the '590 Patent as “a combination of packet length, coding method, and modulation method.” *Id.*, 1:35-41. Each communication terminal informs the BS

of its respective, selected communication mode by transmitting a data rate control (DRC) signal to the BS. *Id.*

41. The '590 Patent indicates that DRC signals are generally “represented by numbers 1 to N, with a higher number indicating a proportionally better downlink channel quality.” *Id.*, 1:53-56. Based on each communication terminal’s indicated DRC, the BS sets a transmission rate for each communication terminal, and transmits a signal to each communication terminal indicating communication resource allocation to each communication terminal. *Id.*, 1:57-62.

42. The '590 Patent identifies problems with HDR communications, and purports solving those problems by transmitting information indicative of a communication terminal’s communication mode in a manner that is less susceptible to transmission error. See, e.g., *Id.*, 2:7-51.

43. In particular, the '590 Patent suggests that if the communication mode (determined by a communication terminal) is erroneously received by the BS due to, e.g., deterioration of uplink channel conditions, the communication terminal would be unable to demodulate/decode data transmitted to the communication terminal. *Id.*, 2:14-22. Additionally, the '590 Patent describes a scenario in which a BS transmits data to a particular communication terminal over some allocated time period (recalling that time division is used to schedule communication resource allocation). *Id.*, 2:24-33. If there is a mismatch in communication modes,

the allocated communication resources go unused, resulting in reduced downlink throughput. *Id.*

44. In accordance with various embodiments (referred to as Embodiments 2 and 5), the '590 Patent describes converting the DRC signal to a code word whose code word minimum distance with respect to other DRC signal code words varies in accordance with downlink channel quality between a communication terminal and BS (indicated by the DRC signal). *Id.*, 10:17-23, 18:24-29. That is, as downlink channel quality gets better, the code word minimum distance of a code word into which the DRC signal is converted correspondingly gets larger. *Id.* The '590 Patent defines the term “code word distance” as “the number of bits that differ between code words, and the term “code word minimum distance” as “the minimum number of bits by which a particular code word differs with respect to all other code words.” *Id.*, 10:60-63. See, also *Id.*, 10:63-11:4 and FIG. 7 (reproduced below).

DRC NUMBER	CODE WORD	CODE WORD MINIMUM DISTANCE
1	000000000	1
2	000000001	1
3	000000110	2
4	000111000	3
5	111111111	6

FIG.7

45. The '590 Patent suggests that the larger the code word minimum distance, the less likely the code word will be mistaken for another code word. *Id.*, 11:5-9. As previously noted, code word minimum distance is a function of the DRC number, and DRC numbers are indicative of downlink channel quality. *Id.*, 10:18-23, 10:60-11:4. Accordingly, a DRC signal corresponding to a communication mode that can be supported on a good quality downlink channel can be better protected by being converted to a code word with a greater code word minimum distance. *Id.*, 11:22-31.

46. The '590 Patent describes still another embodiment (referred to as Embodiment 6), in which a communication terminal may transmit with less susceptibility to errors in the propagation path in proportion to information for which the amount of change regarding CIR information is large. *Id.*, 19:35-43.

The '590 Patent defines “information for which the amount of change is large” with an example. *Id.*, 19:44-46. The example described in the '590 Patent is a CIR value with a decimal integer and a decimal fraction, e.g., 8.7 dB. *Id.*, 19:46-53. The phrase “information for which the amount of change is large,” in the given example, refers to the decimal integer “8.” That is, the amount of change in the decimal integer part of the CIR value can be 1dB. A change of 1dB is greater than the amount of change, i.e., 0.1dB per the decimal fraction portion of the CIR value (0.7dB). *Id.* In other words, if the decimal integer portion of the CIR value is received erroneously by a BS, the degree of error is large compared to a case where the decimal fraction portion of the CIR value is received erroneously. *Id.*, 19:53-58.

47. Accordingly, the '590 Patent describes converting a CIR value to a code word, where the code length of the code word is proportional to the value of the “upper” digit (in the above example, decimal integer portion “8”) making up the CIR value. *Id.*, 20:8-26. For example, the value of the upper digit (upon measuring) can be output to a 6-bit coding section, while the value of the lower digit (in the above example, decimal portion “0.7”) can be output to a 4-bit coding section. *Id.*, 20:33-45. The result is that the upper digit of the CIR value is converted into a 6-bit code word, and the lower digit of the CIR value is converted into a 4-bit code word, the total number of bits being used to indicate the complete

CIR value being 10 bits. *Id.*, 20:46-54, 21:7-10. Because the number of different code words that can be represented with 6 bits is 2^6 and the number of different code words that can be represented with 4 bits is 2^4 , the code word minimum distance between code words can be made larger for those represented with 6 bits. *Id.*, 21:11-17. The '590 Patent purports that the 6-bit code word (compared to the 4-bit code word) is less susceptible to errors. *Id.*, 21:20-33.

48. The '590 Patent concludes with eight independent claims directed to the following UEP coding schemes applied to (1) information comprising an upper digit and a lower digit indicative of a result of downlink channel quality estimation (claims 1 and 3); (2) information comprising an upper digit and a lower digit used for assignment of the downlink channel (claims 5 and 7); (3) encoding the information such that the upper digit has a larger code word minimum distance than the lower digit (claims 1 and 5); (4) encoding the information such that the upper digit is assigned a larger number of bits than the lower digit (claims 3 and 7); and the upper digit containing a most significant bit (MSB) of information (claims 2, 4, 6, and 8).

49. As demonstrated in detail below, these claimed UEP coding schemes were well known in the art, before the earliest claimed priority date of the '590 Patent. Moreover, a POSITA would have known to apply the well-known UEP coding schemes to error code a message indicative of a result of channel quality

estimation to achieve the well-known goal of protecting more important messages and/or more important part(s) of the message than other, less important parts of the message.

VII. CHALLENGED CLAIMS OF THE '590 PATENT

50. I understand that Petitioner is challenging the validity of claims 1-8 of the '590 patent in this proceeding. Those claims follow.

1. A communication terminal apparatus comprising:
 - a measurer that measures a downlink channel quality and outputs information that is generated in association with said downlink channel quality and composed of a plurality of digits including an upper digit and an lower digit;
 - a coder that encodes the information such that the upper digit has a larger code word minimum distance than the lower digit; and
 - a transmitter that transmits the encoded information to a base station apparatus.
2. The communication terminal apparatus according to claim 1, wherein: the upper digit contains a most significant bit of the information.
3. A communication terminal apparatus comprising:
 - a measurer that measures a downlink channel quality and outputs information that is generated in association with said downlink channel quality and composed of a plurality of digits including an upper digit and an lower digit;
 - a coder that encodes the information such that the upper digit is assigned a larger number of bits than the lower digit; and

a transmitter that transmits the encoded information to a base station apparatus.

4. The communication terminal apparatus according to claim 3, wherein: the upper digit contains a most significant bit of the information.

5. A coding and transmission method for use in a communication system where a base station apparatus assigns a downlink channel to each of a plurality of communication terminal apparatuses on a time division basis, wherein said each of a plurality of communication terminal apparatuses:

encodes information that is used for the assignment of the downlink channel and composed of a plurality of digits including an upper digit and a lower digit such that the upper digit has a larger code word minimum distance than the lower digit; and

transmits the encoded information to said base station apparatus.

6. The coding and transmission method according to claim 5, wherein: the upper digit contains a most significant bit of the information.

7. A coding and transmission method for use in a communication system where a base station apparatus assigns a downlink channel to each of a plurality of communication terminal apparatuses on a time division basis, wherein said each of a plurality of communication terminal apparatuses:

encodes information that is used for the assignment of the downlink channel and composed of a plurality of digits including an upper digit and a lower digit such that the upper digit is assigned a larger number of bits than the lower digit; and

transmits the encoded information to said base station apparatus.

8. The coding and transmission method according to claim 7, wherein: the upper digit contains a most significant bit of the information.

VIII. EFFECTIVE FILING DATE OF THE '590 PATENT

51. I understand that the '590 patent issued on July 6, 2004 from Application No. PCT/JP01/06654 filed on August 2, 2001 (Ex.1002, 136-205), and filed as U.S. Application No. 10/089,605 (the “ '605 application”) on April 1, 2002. The earliest claimed priority date of the '590 patent is August 2, 2000. *Id.*, 134-135.

IX. PERSON OF ORDINARY SKILL IN THE ART (“POSITA”)

52. As discussed above, I have been advised that the claims of a patent are reviewed from the point of view of a person of ordinary skill in the art.

53. The person of ordinary skill in the art of the subject matter of the '590 patent at the time of the alleged invention would have had at least a bachelor's degree in electrical engineering, computer engineering, mathematics, or a related field, and one to two years of experience in wireless/mobile communications or equivalent education and experience. This represents the level of skill a person of ordinary skill in the art would have possessed on August 2, 2000, the alleged priority date of the '590 Patent. Such a person would have had the capability of

understanding the scientific and engineering principles applicable to the pertinent art.

54. This opinion is based on my understanding of the state of the art at the priority date of the '590 patent, the typical education level of the workers in the field of the '590 patent, and the sophistication of the related technology. Personally, I have trained and hired a number of such persons in my professional effort, both as an academic professor and as an entrepreneur who managed companies in the related field.

X. TECHNOLOGY BACKGROUND

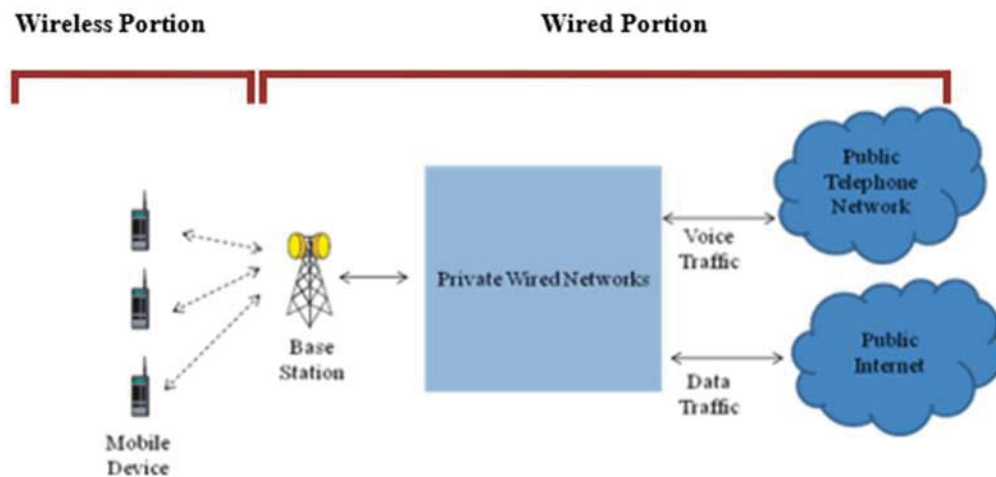
55. To aid the discussions presented in this declaration, I provided a brief technology background below.

A. Wireless Cellular Networks

56. The technology at issue for the '590 patent relates to mobile communication systems, in particular cellular wireless communication systems. Wireless telephones, more commonly known as cell phones or mobile phones, are the most ubiquitous form of mobile communication system today. In the '590 patent, the mobile devices are referred to as the user equipment or the UE, borrowing this terminology from the 3rd Generation Partnership Project ("3GPP") organization, which is the preeminent standard governing body for the wireless cellular industry around the world. The subscribers of the cellular communication

systems use the mobile phones or the UEs that communicate with cell towers by transmitting and receiving signals at a radio frequency (“RF”).

57. There are various forms of wireless networks, such as paging networks (e.g., Skytel network), cellular networks (e.g., AT&T and Verizon networks), and wireless LANs (e.g., WiFi). Certain types of wireless networks, with which the 590 patent is concerned, are those owned and operated by service providers such as AT&T and Verizon, who in exchange for providing access to their networks, charge and collect usage fees from the subscribers. While the specifics regarding architecture and technology can vary, the wireless networks owned and operated by service providers consist of a wireless portion and a wired portion, as depicted in the figure below.



58. With reference to the above illustration, the “base station,” more commonly known as a cell tower, communicates with the “mobile devices”

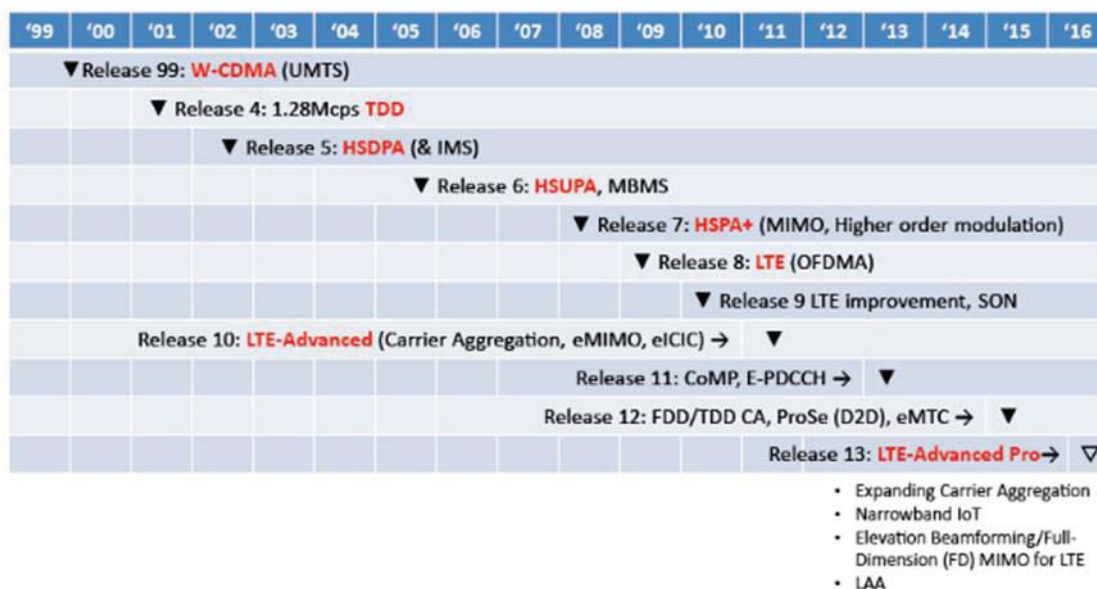
wirelessly by transmitting and receiving the RF signals, which gives the “wireless” portion to the name wireless networks. This wireless portion is referred to as the radio access network (or “RAN”).

59. In the illustration shown above, there are two types of wireless communications: the communications from a base station to the mobile device, and the communications from the mobile device to a base station. The communications from the base station to the mobile device are referred to as the downlink communications or the forward link communication, and the communications from the mobile devices to the base station are referred to as the uplink communications or the reverse link communication. In both downlink communications and uplink communications, a wireless mobile device utilizes a transmitter and receiver to send and receive RF signals containing data and control information.

60. Radio access networks are telecommunications systems, which provide services, including voice calls, video, Internet access, and more, to mobile devices such as cell phones (also called user equipment, UE, mobile terminals, mobile stations or terminals) through transmission of data over radio frequencies. Radio access networks operate through a variety of radio access technologies (“RATs”), which are standardized through standard-setting organizations such as ETSI (European Telecommunications Standards Institute – www.etsi.org) and

3GPP (3rd Generation Partnership Project – www.3gpp.org). Typically, a radio access network architecture involves a mobile device or UE, which connects via radio bearers to/from a base station, for access to/from a network providing data and/or voice communications.

61. To this date, 3GPP has published numerous standard documents for various RATs. The following is a figure from a 3GPP website, which shows various generations of the RATS governed by 3GPP.



62. (Downloaded from <http://www.3gpp.org/about-3gpp> on August 8, 2018.)

63. The above figure shows that 3GPP first published the Release 99 standard, which is based on the W-CDMA (“Wideband- Code-Division Multiple Access”) radio access technology, and is synonymously known as the UMTS

(“Universal Mobile Telecommunications Service”). The cellular networks based on the UMTS or the W-CDMA standard are commonly known as the 3G networks. With regard to the Release 99 standard, 3GPP states that “[t]he first Release of the third generation specifications was essentially a consolidation of the underlying GSM specifications and the development of the new UTRAN radio access network. The foundations were laid for future high-speed traffic transfer in both circuit switched and packet switched modes.” ([http://www.3gpp.org/specifications/3GPP releases/77-release-1999](http://www.3gpp.org/specifications/3GPP_releases/77-release-1999).)

64. The UMTS network architecture can be broken down into two basic networks: the UMTS terrestrial Radio Access Network (“UTRAN”), which provided the functionality allowing radio transmission of information to and from mobile terminals; and the Core Network that connects the UTRAN to the rest of the public land-based network, and controls various service and mobility related functions for the UTRAN.

65. Following Release 99, 3GPP has published 3GPP releases 4, 5, 6, and 7, which improved different aspects of the original UMTS standard in Release 99. This included the addition of so-called High Speed Uplink Packet Access (“HSUPA”) in release 6. HSUPA was designed to increase uplink packet data rate transmission in a 3G/UMTS system.

66. After various 3GPP releases of the UMTS standard were published, 3GPP began work on evolving the existing UTRAN standard, which became known as the “Evolved UTRAN” (or E-UTRAN) standard. The E-UTRAN standard is intended to increase service provisioning and simplify network architecture, among other goals. Today, the E-UTRAN RAT is commonly known as the Long Term Evolution (or “LTE”). Release 8 was the first release of what is known as the LTE standard. LTE is considered a fourth generation (“4G”) technology, and a cellular system that implements features of 3GPP release 8 and later 3GPP releases are known as a 4G/LTE system.

B. Channel Quality

67. In communication theory, a “channel” is a medium of communication. Since any communication involves at least two distinct entities (e.g., a sender and a receiver), a medium between them comprises some distance, which can be very small (e.g., inches) or can be very large (e.g., thousands of miles). No matter what the actual distance between the communicating parties, the signals carrying the information associated with the communication are attenuated while traversing over the channel. Moreover, the communication channels are susceptible to interferences coming from other signal sources (e.g., different communicating parties) and noises (i.e., unpredictable electrical signals from natural causes).

Together, there is a limit as to how much of the information can be reliably transmitted over a given channel.

68. A classical textbook titled “Communication Systems” by A. Bruce Carlson was published in 1968 (“Carlson”) (Ex.1055). In fact, as an Electrical Engineering undergraduate student at the University of Michigan in Ann Arbor, I learned the fundamentals of the communication theory from Carlson.

69. In Carlson, referring to Claude Shannon, a pioneer in the modern communication theory, “Shannon’s work is more nearly akin to what we think of as communication, where signal processing can take place at both transmitter and receiver.” (Ex.1055 at 341.) Carlson acknowledges that “Shannon’s approach was soon rechristened information theory.” (Ex.1055 at 341.)

70. Carlson formalizes the fundamental theorem of information theory, as follows. Given an information source and a communication channel, there exists a coding technique such that the information can be transmitted over the channel at any rate less than the channel capacity and with arbitrarily small frequency of errors despite the presence of noise. (Ex.1055 at 341.)

71. Applying Shannon’s theorem to an ideal communication system, Carlson illustrates that “[a] communication system capable of transmitting without errors at a rate of $B \log(1 + S/N)$ bits/s, where B and S/N are the channel parameters, is called an ideal system.” (Ex.1055 at 357.) In this equation, channel

parameter, B , is the bandwidth of the channel in hertz, and channel parameter, S/N , is the ratio of the signal power to the noise power in the channel (or simply the signal to noise ratio).

72. This equation specifies the maximum data bit rate that the information can be transmitted and received across the channel without errors. Formally, equation “ $C = B \log (1 + S/N)$ bits/s” is frequently referred to as Shannon’s Channel Capacity Theorem, whereby parameter C is the maximum data bit rate that the information can be transmitted and received across the channel without errors.

73. From Shannon’s Channel Capacity Theorem, for a given channel with a fixed bandwidth B , the channel capacity C is a function of the signal to noise ratio, S/N , in the channel. As such, the quality of a channel is determined by the signal to noise ratio, S/N – the higher the value of S/N , the higher the data bit rate, C bits/sec, that the information can be transmitted and received without error.

74. In the context of the ’590 Patent, the communication channel is a wireless medium, as the ’590 Patent relates to radio-frequency communications. (Ex. 1001 at 2:37-43.) The signal to noise ratio, with which the ’590 Patent is concerned, is the CIR, which stands for the carrier to interference ratio. (Ex. 1001 at 1:28-41.)

C. Error Correction Coding (ECC)

75. Carlson explains that “[i]n a nutshell, error-control coding is the calculated use of redundancy. Taking a hint from information theory, one systematically adds extra digits to the transmitted message, digits which themselves convey no information but make it possible for the receiver to detect or even correct errors in the information-bearing digits. Theoretically, near-errorless transmission is possible; more practically, there is the inevitable trade-off between transmission reliability, efficiency, and complexity of terminal equipment. Reflecting this factor, a multitude of error-detecting and error-correcting codes have been devised to suit various applications.” (Ex.1055 at 406.)

76. Carlson further explains that “consider a repeated code in which each binary message digit is repeated three times-roughly analogous to repeating your words when you are trying to talk to someone on the other side of a noisy room. The allowed code words are then 000 and 111, so any other received work such as 101 clearly indicates the presence of errors. To correct single errors, one might use a majority-rule decision and the following decoding table:” (Ex. 1055 at 407.)

Decoded digit	0	1
Received words	000 001 010 100	111 110 101 011

77. The example above from Carlson is an error correcting code that can correct a single bit error. For example, if one bit of information “1” needs be transmitted, then this information bit “1” is encoded into code word “111,” which repeats the information bit “1” three times. Code word “111” is transmitted over a channel. The above decoding table from Carlson shows that if the three received bits at the receiver is any of “111,” “110,” “101,” and “011,” the received bits are decoded into information bit “1.” As such, up to any one bit of error in the received bits can be corrected and the information bit is decoded correctly.

78. If, however, when code word “111” is transmitted, two bits of this codeword is corrupted by noise and the receiver receives three bits, for example, “100.” In this case, last two bits of the transmitted code word “111” are changed from “1” to “0.” According to the decoding table above, the received bits “100” are now decoded into “0.” Thus, there is a maximum number of errors that this error correcting code can correct.

79. Carlson illustrates that “the difference between any two binary words is measured in terms of the Hamming distance d , defined simply as the number of places in which the words have different digits; thus, it takes d errors (in the right places) to change one word into the other.” (Ex.1055 at 407.) In the example above, the Hamming distance between the two code words “000” and “111” is 3.

In the context of 90the'590 Patent, the Hamming distance is the “code word distance.” (Ex. 1001 at 10:62-65.)

80. Carlson further explains that “code that detects up to K errors per word or corrects up to K errors per word must consist of code words having

$$d_{\min} = \begin{cases} K+1 & \text{error detection} \\ 2K+1 & \text{error correction} \end{cases} \quad (3)$$

an assertion left for the student to ponder. The triple-repetition code clearly has $d = 3$ so, as we have seen, it can detect $K = 2$ errors or correct $K = 1$ error per word.”

(Ex. 1055 at 408.) In equation (3) shown above, d_{\min} is the minimum among all the Hamming distances between any two codewords. Parameter d_{\min} is known as the minimum Hamming distance (or simply the minimum distance in the context of 90the'590 Patent). Often equation (3) from Carlson shown above is translated to K

$$= \left\lfloor \frac{d_{\min} - 1}{2} \right\rfloor \text{ where } \lfloor x \rfloor \text{ is the largest integer less than or equal to } x. \text{ This translation}$$

is based on the fact that K must be an integer.

81. The decoding table above from Carlson is sometimes referred to as the nearest neighbor decoding because any received bits (e.g., “101”) are decoded into the valid code word, which is the smallest Hamming distance away from the received bits. Since there are only two valid code words “000” and “111,” the Hamming distance of the received bits “101” to the code word “000” is 2 and the

Hamming distance to the code word “111” is 1. Thus, the received bits “101” are decoded to the code word “111,” which has a smaller Hamming distance away than the code word “000.”

82. Error correcting codes are often characterized by two parameters, n and k . When an error correcting code is specified as an (n, k) code, it implies that this error correcting code encodes k information bits in an n -bit codeword. The above example of tripling each information bit into a 3-bit codeword (i.e., “0” to “000” and “1” to “111”) is a $(3, 1)$ code.

D. Unequal Error Protection (“UEP”) Coding

83. As explained above, error-correction coding is a process of adding redundant data to a message (e.g., “0” becomes “000” and “1” becomes “111”), such that it can be recovered by a receiver even when a number of errors (up to the capability of the code being used) were introduced. Error-correction codes/coding have been known as early as 1940’s, attributed to Richard W. Hamming and Claude E. Shannon. Initially, most error-correcting codes and capabilities were described in terms of the correct reception of the entire message. Ex. 1010, 6.

84. However, many applications exist in which some message positions are more important than others. Ex. 1010, 6. For example, in transmitting numerical data, errors in the sign or high-order digits are more serious than are errors in the low-order digits. *Id.*, 14; *see also* Ex. 1023, 293. To solve this

problem, unequal error protection (UEP) codes that protect some positions in a message word against a larger number of errors than other ones were developed.

85. UEP codes refer to a class of error-correction codes that allow certain digits of a message to be protected against a greater number of errors than other digits in the message. Ex. 1012, 600. UEP codes have been known since at least 1967. Ex. 1012 (published in 1967).

86. Various UEP coding schemes have been applied to different technology areas before August 2, 2000, the earliest alleged priority date of the '587 Patent. For example, UEP coding schemes have been used to solve the problem "concern[ed] with the transmission and storage of messages in which different parts are of mutually different importance." Ex. 1010, v. This can be done by using different coding schemes for the different parts, but more elegantly by using a single so-called Unequal Error Protection coding scheme. Id. As another example, a European patent application filed in 1982 discloses applying UEP codes to the "transmission of information of a television picture." Ex. 1011, 1:1-25. Most pertinently, UEP coding schemes were applied to digital wireless communication systems before August 2, 2000.

87. Regarding wireless digital communications, channel characteristics, such as downlink channel/forward link quality, were and are still used to determine information rates or levels of service that can be supported on those downlink

channels/forward links. Ex. 1009, 4:3-13; Ex. 1013, 2:52-64. Signal-to-noise-and-interference ratio (SNIR), sometimes referred to as signal-to-interference-plus-noise ratio (SINR) or carrier-to-interference ratio (CIR or C/I) is an indicator of the downlink channel/forward link quality. Ex. 1009, 4:3-13; Ex. 1013, 2:52-64. Generally, a mobile station or access terminal measures the downlink channel/forward link quality based on a signal, such as a paging or pilot signal received from a network relay point (e.g., base station, access point, or similar network element). Ex. 1009, 9:34-38; Ex. 1013, 5:51-58. The mobile station/access terminal then informs the network relay point of the downlink channel/forward link quality by transmitting a signal containing or indicative of the downlink channel/forward link quality (e.g., a data rate control (DRC) message) to the network relay point. Ex. 1009, 9:28-10:9; Ex. 1013, 5:64-6:6.

88. For example, a mobile station/access terminal may include an SNIR estimation component that outputs an SNIR measurement to a DRC component for generating a DRC message that ultimately is transmitted to an access point. Ex. 1013, 12:29-50; FIG. 6 (reproduced below).

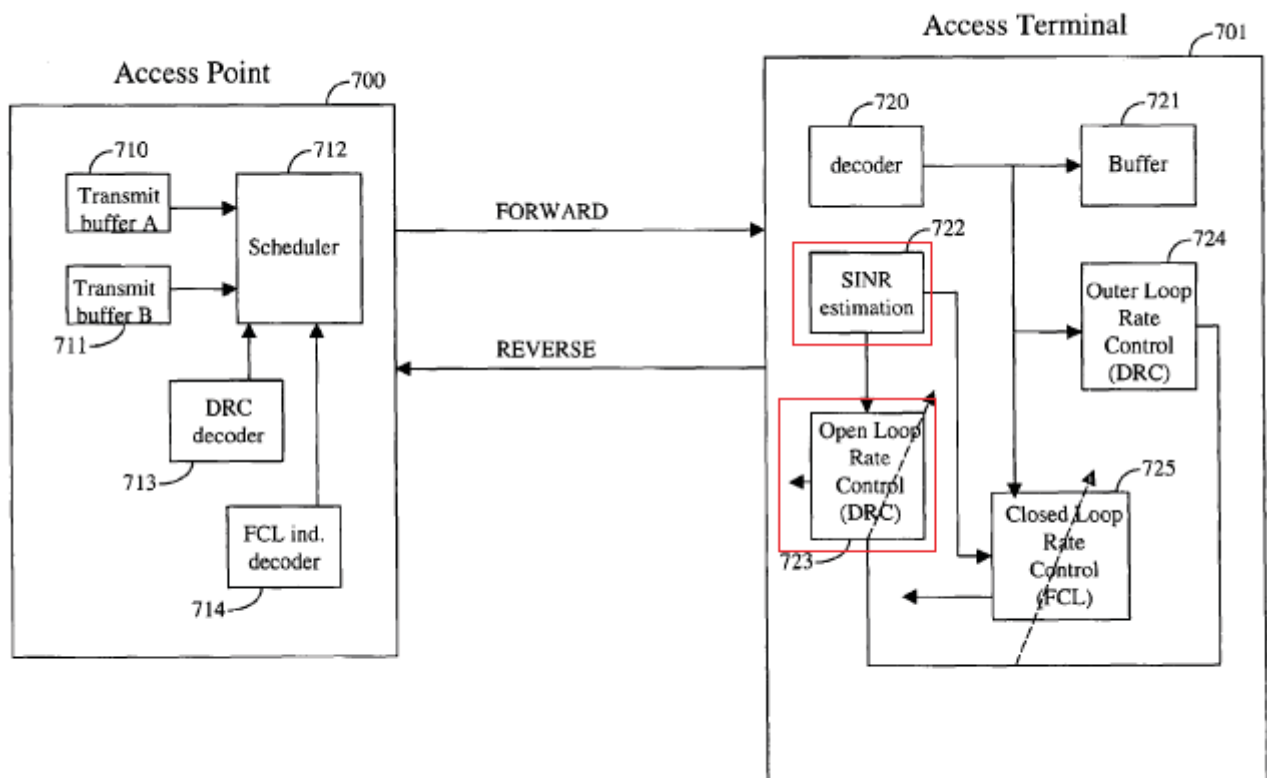


FIG. 6

89. As explained above, based on the nearest neighbor decoding, error correction coding can detect and correct up to $\left\lfloor \frac{d_{\min} - 1}{2} \right\rfloor$ bit errors where $\lfloor x \rfloor$ is the largest integer less than or equal to x and d_{\min} is the minimum distance of error correcting code. In this regard, the error correction capability does not depend on the positions of error in the received bits. For example, suppose arbitrary k bits of information is encoded into a codeword of n bits using an (n, k) error correction coding with the minimum distance of $d(n, k)$. The n -bit codeword corresponding to this arbitrary k bits of information is transmitted over the noisy channel.

Supposed that a certain number m bits among the received k bits are in error. The error correction coding based on the nearest neighbor decoding can correct the m bit error as long as $m \leq \left\lfloor \frac{d(n,k)-1}{2} \right\rfloor$, regardless of the positions of error in the received k bit string.

90. Unequal error protection (“UEP”) coding is a field of error correction coding that take into consideration of the positions of error within the received bit string. The UEP coding had been widely known and practiced for several decades before the priority date of the ’590 patent. For example, Burt Masnick wrote a widely cited paper entitled “On Linear Unequal Error Protection Code,” in IEEE Transactions on Information Theory, vol. IT-3, No. 4, pp. 600-607, in October 1967 (“Masnick”) (Ex. 1012). With regard to integer M , where $M = m_{\beta-1}2^{\beta-1} + m_{\beta-2}2^{\beta-2} + \dots + m_0$, Masnick explains that “[i]f an error changed the coefficient $m_{\beta-1}$, the magnitude of M would be changed to $2^{\beta-1}$. On the other hand, if an error changed the digit m_0 , the magnitude of M would be changed by 1. Thus if errors of large magnitude are more important (costly) than errors of small magnitude, it may be desirable to seek a coding scheme that provides more protection for the high-order digits than for the low-order digits.” (Ex. 1012, 600.) Masnick further explains that “[t]his paper contains an analysis of the problem of linear code^[1] for which the protection afforded each digit or set of digits can be different from the protection afforded some other digit or set of digits.” (Ex. 1012, 600.) Masnick

has extensive discussions regarding properties of UEP codes (see Theorems 1-4 in Masnick, 601-604), and also gives specific numerical examples of UEP coding scheme. For example, Masnick illustrates how 5 bits of information is UEP coded to generate a 20 bit codeword using H matrix shown in Fig. 2. (Ex. 1012, 603-604.) For this exemplary UEP coding, Masnick explains that:

Digit m1 is protected against up to 1 error
Digit m2 is protected against up to 2 errors
Digit m3 is protected against up to 3 errors
Digit m4 is protected against up to 4 errors
Digit m5 is protected against up to 5 errors
(Ex. 1012 at p. 604.)

91. Another article entitled “Optimal Encoding of Linear Block Codes for Unequal Error Protection” by Larry A. Dunning and W. E. Robbins (“Dunning”) (Ex.1054) was published in Information and Control, 37 in 1978. Dunning states that “[i]t is possible for a linear block code to provide more protection for selected message positions than is guaranteed by the minimum distance of the code. The protection provided a message position can be measured by associating number with that position called its separation. The separation of a message position measure the protection provided to that position in a manner analogous to that in which the minimum distance of a code measure the protection provided the entire message. This paper proves that any fixed linear block code has an encoding which is optimal with respect to the error protection provided the individual message position. More precisely, among those encodings of the code for which

the separations associated with the message positions are arranged in nondecreasing order, there is at least one which simultaneously maximizes all the separations associated with the message positions.” (Ex. 1054, 150.) As the “separations associated with the message positions are arranged in nondecreasing order,” the message positions are protected against errors in non-decreasing order, which translates to the non-decreasing number of errors that successive message positions are protected. That is to say, any message position can tolerate a number of errors at least as many as those tolerated in any of the preceding message positions. Dunning provides a comprehensive treatment for the UEP encoding and provides optimal encoding procedures in Section 3.

92. Another example of UEP study is given in an article entitled “On an Infinite Series of $[4n, 2n]$ Binary Codes” by Léon M. H. E. Driessen (“Driessen”) (Ex.1056), which was published in IEEE Transactions on Information Theory, Vol. IT-30, No. 2, in March 1984. Driessen states that “[i]n many applications not all message bits are equally important and errors in more important bits are more serious than errors in less important bits. The question arises to what extent error patterns of weight greater than $\lfloor (d-1)/2 \rfloor$ can be decoded such that the most important message bits are correctly retrieved. This is the same as asking for an $[n, k, d]$ binary unequal error protection (UEP) code which is optimal [2], [3].” (Ex.1011, 392.)

93. Driessen further states that “[i]n an experimental digital recorder we have implemented an optimal [12,6,4] binary UEP code [4], which guarantees the two most important message bits to be protected against two bit errors in the corresponding codeword. This code is a member of an infinite class of $[4n, 2n, 4]$ binary UEP codes which will be defined and studied in the next section. The [12,6,4] UEP code is used as an example throughout the correspondence.” (1011, 392.)

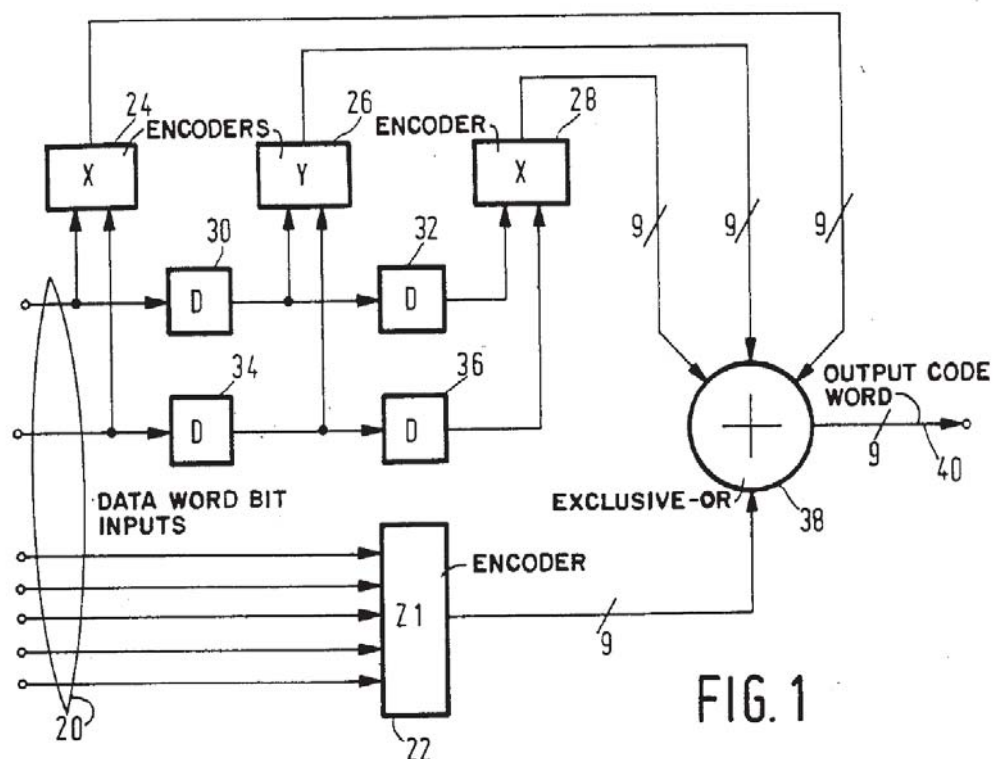
94. Driessen defines a generator matrix G_{4n} as a specific form of $2n$ by $4n$ matrix (Ex.1011, 392), and provides the UEP property of the code F_{4n} generated from G_{4n} with $n \geq 3$ (392-393).

95. Yet another example of UEP coding is U.S. Patent No. 4,747,104 to Philippe M. O. A. Piret (“Piret”) (Ex.1021). Piret is entitled “Data Transmission System Employing a Combination of Block Encoding and Convolution Encoding for Error Protection,” and was issued on May 24, 1988.

96. Piret states that “[a] data transmission system for providing error protection of transmitted data words. The less significant bits of a data word are, by means of matrix multiplication, encoded into a first redundant proto-code word and the more significant bits are, by means of further matrix multiplication and delay by different word recurrence intervals encoded in a set of further redundant proto-code words. A composite of the proto-code word is formed by means of a

modulo-2-addition of code words, so that for the less significant data bits a block code is realized, while for the more significant data bits a convolutional encoding is realized.” (Ex.1021, Abstract.)

97. The following is a figure from Piret, which shows “an element[ary] block diagram of an encoder system.” (Ex.1021, 2:44-45.)



(Ex.1021, FIG. 1.)

98. With regard to the figure above, Piret states that “FIG. 1 is an elementary block diagram of an encoder system for a (9, 7) convolutional code. Input 20 receives the seven data bits of a data word in parallel. Element 22 is an encoder for deriving a block protocode word, which becomes part of a convolutional code word. In this block code, the five less significant bits of the

input seven bit data word are encoded by means of matrix multiplication to form a nine bit proto-code word. In itself, matrix multiplication is a conventional technique. Moreover, there are only $32=2^5$ different values of the five data bits and therefore, a five bit input, nine bit output programmable logic array would be sufficient. Other types of read-only storage arrays would function equally well. The two most significant bits are entered into encoder 24 which has a two bit wide input, nine bit wide output. Similar technology can be used as for encoder 22.” (Ex.1021 at 2:65-3:14.)

99. Based on the encoding scheme shown in Figure 1, Piret explains that “[n]ext the minimum distance profile is presented, which for the less significant bits is (3 0 . . .). The first integer should be always be non-zero and represents the minimum distance for the individual code word. Thus, the code is single bit error correcting. The further zeroes indicate that upon erasure of a code word, no further information on these less significant bits exists. The minimum distance profile for the more significant bits is (6 4 2 0 . . .). The first integer is the minimum distance if no erased code word occurs in a sequence of three successive code words. Thus the code is double bit error correcting and triple bit error detecting.” (Ex. 1021, 3:65-4:8.)

100. Piret further states that “[t]he improved error protection of the more significant bits allows for an additional feature to be realized by the invention in

that these more significant bit positions may be used to transfer data bits, for example as derived from calculations or digital coding of characters. In that case the less significant bits are preferably represented by trailing zeroes or other valued non-significant bits.” (Ex.1021, 4:16-23.)

101. These examples clearly show that UEP coding, which protects against higher numbers of bit errors for more important bits, was well known and widely practiced in the field of error correction coding for decades prior to the priority date of the ’590 patent.

102. Moreover, not only was UEP coding well known as a general tool for error correction coding, UEP coding was specifically applied to wireless communication as exemplified in Masnick’s satellite communication (Ex. 1012, 600) and Piret’s broadcast communication (Ex.1021, 1:33-36). When a wireless channel is used (as in the case of satellite communication and broadcast communication), transmitted bits are highly susceptible to errors due to noise and interference-prone ambient characteristics. As such, when some of the transmitted bits convey magnitude information (as opposed to simple binary meaning such as “yes” or “no”), the bit positions carrying large magnitude information must be protected, more so than the bit positions carrying small magnitude information. This was a well-known fact among the professionals working in the wireless communication field before the priority date of the ’590 patent.

XI. CLAIM CONSTRUCTION

103. I have been asked to offer my opinion about the understanding of a person of ordinary skill in the art regarding certain claim terms in the '590 patent. I understand that, in an inter partes review, the Patent Trial and Appeal Board construes claim terms in an unexpired patent according to their broadest reasonable construction in light of the specification. Under this standard, claim terms are given their ordinary and accustomed meaning as would have been understood by a person of ordinary skill in the art in the context of the entire disclosure. I also understand that a special definition for a claim term must be set forth in the specification with reasonable clarity, deliberateness, and precision. I further understand that the claims themselves and the prosecution history can provide insight into how the claims should be construed.

104. Because the standard of claim construction used in an IPR differs than that used in litigation, I reserve the right to present different constructions of terms in litigation under claim construction standards appropriate for such cases.

105. I have been asked to offer my opinion about the understanding of a person of ordinary skill in the art under the broadest reasonable construction regarding the following terms in the claims of the '590 Patent. In my opinion, any claim terms that are not defined below have their plain and ordinary meaning.

A. “code word minimum distance” (Claims 1 and 5)

106. This term is used in claims 1 and 5, which recites encoding “such that the upper digit has a larger code word minimum distance than the lower digit.” Ex. 1001 at 25:31-32;26:28-29.

107. The specification of the ’590 Patent, then goes on to describe that “‘code word minimum distance’ is the minimum number of bits by which a particular code word differs with respect to all other code words.” *Id.*, 10:61-63.

108. Accordingly, a POSITA would find, in light of the specification and the claim language, the meaning of the term “code word minimum distance” to include “the minimum number of bits by which a particular code word differs with respect to all other code words.”

XII. BASIS FOR INVALIDITY

A. Padovani in View of Driessen Invalidates Claims 1, 2, 5 and 6.

1. Overview Of Padovani

109. I am informed that Padovani issued on July 31, 2003, and has an effective filing date of November 3, 1997, making it prior art under at least 35 U.S.C. § 102(e).

110. Padovani discloses a Code Division Multiple Access (CDMA) system, in which a mobile station transmits a data request message to a base station containing an indication of the forward link channel quality. See, e.g., Ex. 1009, Abstract and 9:8-10:6. Moreover, Padovani discloses encoding a data request

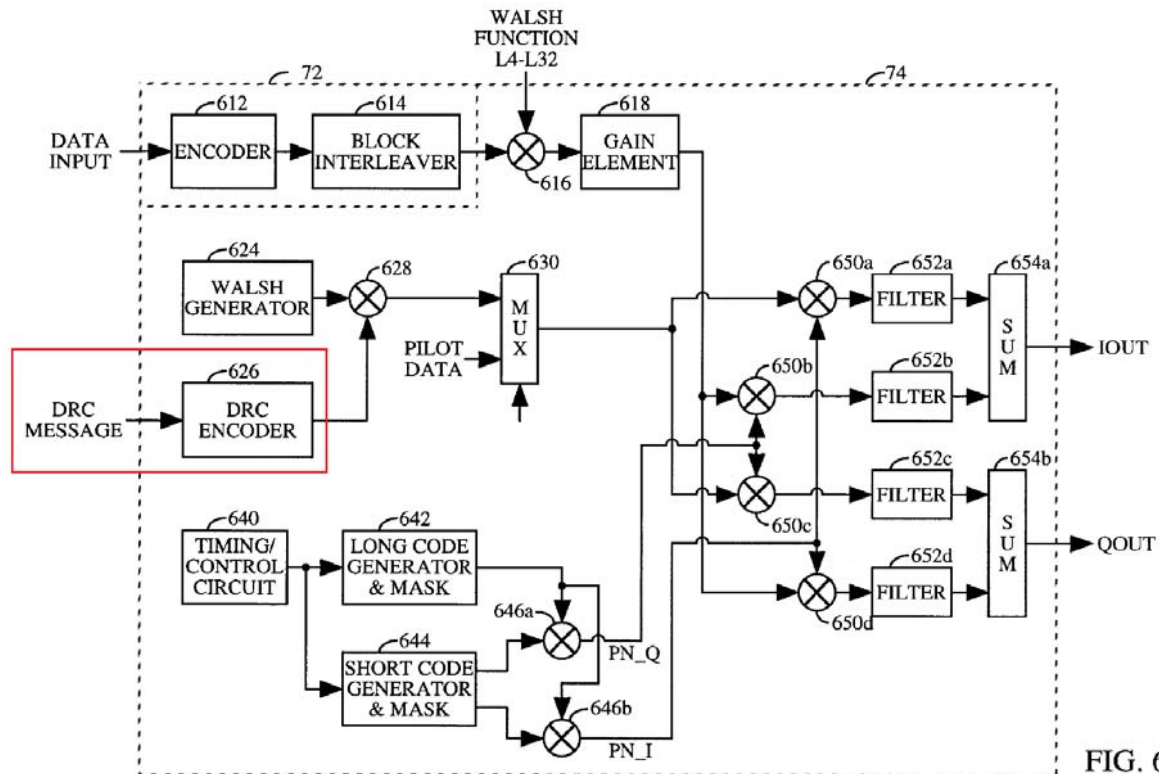
channel/data rate control (DRC) message using an error correcting code. *Id.* at 45:15-25.

111. In particular, Padovani seeks to “improve[] the efficiency of a CDMA system by providing for means for transmitting data on the forward and reverse links” for high rate packet data transmission. *Id.* at 5:22-24. Padovani’s goal of increasing efficiency in at least the forward link for high rate packet data transmission is akin to that of the ’590 Patent which purports providing systems and method for “preventing downlink throughput from decreasing” in the HDR context. Ex. 1001 at 2:50-51. It should be noted that the ’590 Patent describes downlink transmissions as going from a BS to a communication terminal (Ex. 1001 at 1:19-22). This comports with Padovani’s description of the forward link. Ex. 1009 at 2:1-4, 8:37-38.

112. Like the ’590 Patent, Padovani describes a mobile station “measur[ing] the signal-to-noise-and-interference ratio (C/I) of the forward link pilot from the base stations in the active set, as received at the mobile station.” Ex. 1099, at 9:12-14. A POSITA would understand that the signal-to-noise-and-interference ratio is also known as the carrier-to-interference ratio (CIR). Like the ’590 Patent, Padovani describes transmitting “to the selected base station a data request message (hereinafter referred to as the DRC message) on the data request channel (hereinafter referred to as the DRC channel).” *Id.*, 10:3-6. The DRC as

defined in Padovani is the same DRC in the '590 Patent [expand on this]. Again like the '590 Patent, Padovani indicates that the DRC message can contain “an indication of the quality of the forward link channel (e.g., the C/I measurement itself, the bit-error rate, or the packet-error rate).” *Id.*, 10:6-9.

113. Padovani teaches providing the DRC message to a DRC encoder “which encodes the message in accordance with a predetermined coding format.” *Id.* at FIG. 6, 45:15-17.



114. Drawing further parallels to the '590 Patent, Padovani notes the importance of coding the DRC message, i.e., “since the error probability of the DRC message needs to be sufficiently low because incorrect forward link data rate

determination impacts the system throughput performance.” Ex. 1009 at 45:17-20. As an example, Padovani describes using a “rate (8,4) CRC block encoder that encodes the 3-bit DRC message into an 8-bit code word. *Id.* at 45:20-22. A POSITA would have understood that Padovani’s (8,4) CRC block encoder would incorporate one bit (in addition to the 3-bit DRC message) to effectuate the cyclical redundancy check.

2. Overview Of Gils

115. Gils was published January 1, 1988. I am informed that this makes the Gils reference prior art under at least 35 U.S.C. § 102 (a), (b). At a high level, Gils discloses the design of error-control coding schemes for different problems including noisy information transmission. Ex. 1010, v. Gils describes that in “the transmission and storage of messages in which different parts are of mutually different importance,” “it is natural to give parts of mutually different importance different protection against errors.” *Id.*

116. Like the ‘590 Patent, Gils recognizes that “many applications exist in which some message positions are more important... [f]or example in transmitting numerical data, errors in the sign or in the high-order digits are more serious than the errors in the low-order digits.” *Id.* at 14; *see also* Ex. 1023, 293. Gils also considers scenarios involving “the transmission of message words from different sources simultaneously... where the different sources have different demands

concerning the protection against errors,” as a scenario in which unequal error protection may be useful. *Id.*

117. Gils describes the generation and use of linear unequal protection (LUEP) codes to “protect some positions in a message word against a larger number of errors than other ones,” (crediting Masnick and Wolf with the introduction of unequal error protection (UEP) codes by considering single position error protection). *Id.*; *see also* Ex. 1023, 293. In coding theory, “[a] linear $[n,k]$ block code C of length n and dimension k ($k < n$) over the alphabet $GF(q)$, the Galois field containing q elements, is a k -dimensional subspace of the n -dimensional vector space $GF(q)^n$. *Id.* at 1 (emphasis in original). Additionally, Gils notes that “(linear) encoding of the message set... is a linear mapping from M onto the code space C ; a message $m = (m_1, m_2, \dots, m_k) \in M$ is mapped onto the codeword $c = mG$,” where the matrix G is referred to as a generator matrix. *Id.* (emphasis in original).

118. Further still, Gils describes that if a message is to be transmitted, “the codeword attached to it” is transmitted, and that “[d]uring transmission... the codeword can be corrupted,” where “[t]he nature of the corruption depends on the specific channel used.” *Id.* Gils indicates that it is up to the decoder “at the receiving end of the channel” to estimate the original message “as good as possible,” which is based on Hamming weight and distance. *Id.* at 2. Hamming

distance can be defined as “the number of positions in which x and y differ, and can be characterized in terms of a separation vector $s(G)$. *Id.* at 2, 16. See also, *Id.* at 3 (“the minimum (Hamming) distance is defined as the minimum distance between two different codewords....”).

119. Gils explores various possibilities for LUEP codes, examples of which are listed in Table II (reproduced below), where the separation vectors of the LUEP codes have lengths equal to or less than 15. *Id.* at 24-26; *see also* Ex. 1023, 295-296..

n	k	$d(n, k)$	separation vector
4	2	2	A 32
5	2	3	A 42
5	3	2	A 322
6	2	4	A 52
6	3	3	A 422
6	4	2	A 3222
7	2	4	A 62, I 54
7	3	4	A 522
7	4	3	A 4222
7	5	2	A 32222
8	2	5	A 72, I 64
8	3	4	A 622, C 544
8	4	4	A 5222
8	5	2	A 42222, J 33332
8	6	2	A 322222
9	2	6	A 82, I 74
9	3	4	A 722, C 644, G 554
9	4	4	A 6222, C 5444
9	5	3	A 52222, J 44442, B 43333
9	6	2	A 422222, J 333322
9	7	2	A 3222222
10	2	6	A 92, I 84, I 76
10	3	5	A 822, C 744, L 664
10	4	4	A 7222, C 6444, G 5544
10	5	4	A 62222, C 54444
10	6	3	A 522222, J 444422, J 433332
10	7	2	A 4222222, J 3333222
10	8	2	A 32222222
11	2	7	A 10.2, I 94, I 86
11	3	6	A 922, C 844, K ₁ 764
11	4	5	A 8222, C 7444, E 6644
11	5	4	A 72222, C 64444, G 55444

Table I: The separation vectors of all binary optimal LUEP codes of length less than or equal to 15.

n	k	$d(n, k)$	separation vector
11	6	4	A 622222, J 544442, B 533333
11	7	3	A 5222222, J 4444222, J 4333322
11	8	2	A 42222222, J 33332222
11	9	2	A 322222222
12	2	8	A 11.2, I 10.4, I 96
12	3	6	A 10.22, C 944, E 864, K ₂ 774, K ₁ 766
12	4	6	A 9222, C 8444, K ₁ 7644
12	5	4	A 82222, C 74444, E 66444, M 55554
12	6	4	A 722222, C 644444, G 554444
12	7	4	A 6222222, J 5444422, J 5333332
12	8	3	A 52222222, J 44442222, J 43333222
12	9	2	A 422222222, J 333322222
12	10	2	A 3222222222
13	2	8	A 12.2, I 11.4, I 10.6, I 98
13	3	7	A 11.22, C 10.44, K ₁ 964, E 884, L 866
13	4	6	A 10.222, C 9444, L 8644, F 7744, K ₁ 7666
13	5	5	A 92222, C 84444, K ₁ 76444, L 66664, H 66555
13	6	4	A 822222, C 744444, D 664444, M 555544
13	7	4	A 7222222, J 6444442, B 6333333, J 5544442, K ₁ 5444444
13	8	4	A 62222222, J 54444222, J 53333322
13	9	3	A 522222222, J 444422222, J 433332222
13	10	2	A 4222222222, J 3333222222
13	11	2	A 32222222222
14	2	9	A 13.2, I 12.4, I 11.6, I 10.8
14	3	8	A 12.22, C 11.44, L 10.64, K ₁ 984, K ₁ 966
14	4	7	A 11.222, C 10.444, K ₁ 9644, L 8844, L 8666
14	5	6	A 10.2222, C 94444, L 86444, F 77444, N 76666

Table I(continued): The separation vectors of all binary optimal LUEP codes of length less than or equal to 15.

120. As explained in Gils, “ n denotes the length of the code, k denotes the dimension [the length of the data input or data word], and $d(n, k)$ denotes the maximal minimum distance of a binary linear code of length n and dimension k . 1010 at 24; see also Ex. 1023, 294. It should be noted that the separation vectors

in Table I are identified with particular (n,k) codes generated using different generator matrices (denoted by “A”, “C”, “I”, “J”, etc.), constructions of which are described in the Appendix of Gils. *Id.* at 56-64; *see also* Ex. 1023, 297-304.

3. Motivation To Combine Padovani and Gils

121. Padovani discloses a CDMA system where a mobile station transmits a request based on a channel quality measurement to a BS. Ex. 1009, 5:21-22. The mobile station measures the C/I (signal-to-noise-and-interference-ratio) of the forward link channel. *Id.*, 5:32-38, 47:17-36. It then transmits a DRC (data request) message to the BS. *Id.*, 5:38-6:3.

122. The DRC message carries the C/I measurement or another indication of quality of the forward link channel. *Id.*, 9:39-10:9. Padovani also discloses a DRC encoder that encodes a DRC message with an error correcting code prior to transmission to the BS. *Id.*, 45:16-33.

123. Gils discloses error coding message words for transmission using LUEP codes. See, e.g., Ex. 1010, 14. Gils further discloses various LUEP codes (Table I) with unequal protection against errors in which a first column of the table (denoted “n”) gives the length of a code word, a second column (denoted “k”) gives the length of a data word to be converted into the code word, a third column (denoted “d(n,k)”) gives a maximal minimum distance of the code word relative to other code words in a code word set, and a fourth column (denoted “separation

vector”) gives the degree(s) of error protection for each bit of the data word as a Hamming distance. *Id.*, 14 and 24-28.

124. Each row of Table I reflects different (n,k) coding schemes that result in protecting certain part(s) of the message better than other parts of the message. For example, the (n,k) coding scheme (8,3) results in the encoding of 3 bits into a plurality of 8 bit codewords, where according to a first construction (A), one bit (which can be considered a most significant bit) is more important than two other bits. The resulting code words have a Hamming distance of 6 and the other bits each have Hamming distances of 4, indicating unequal error protection for different bits.

n	k	$d(n, k)$	separation vector
4	2	2	A 32
5	2	3	A 42
5	3	2	A 322
6	2	4	A 52
6	3	3	A 422
6	4	2	A 3222
7	2	4	A 62, I 54
7	3	4	A 522
7	4	3	A 4222
7	5	2	A 32222
8	2	5	A 72, I 64
8	3	4	A 622, C 544
8	4	4	A 5222
8	5	2	A 42222, J 33332
8	6	2	A 322222
9	2	6	A 82, I 74
9	3	4	A 722, C 644, G 554
9	4	4	A 6222, C 5444
9	5	3	A 52222, J 44442, B 43333
9	6	2	A 422222, J 333322
9	7	2	A 3222222
10	2	6	A 92, I 84, I 76
10	3	5	A 822, C 744, L 664
10	4	4	A 7222, C 6444, G 5544
10	5	4	A 62222, C 54444
10	6	3	A 522222, J 444422, J 433332
10	7	2	A 4222222, J 3333222
10	8	2	A 32222222
11	2	7	A 10.2, I 94, I 86
11	3	6	A 922, C 844, K ₁ 764
11	4	5	A 8222, C 7444, E 6644
11	5	4	A 72222, C 64444, G 55444

Table I: The separation vectors of all binary optimal LUEP codes of length less than or equal to 15.

125. It would have been obvious for a POSITA to have modified the DRC encoder of Padovani by using an encoder configured to implement a coding scheme, like those disclosed by Gils, in order to ensure that error probability of the encoded DRC message is sufficiently low. Moreover, POSITA would have understood that the use of one coding scheme versus another would depend on, e.g., the type of data to be encoded and/or the amount of error protection desired.

126. Both Padovani and Gils contemplate transforming or converting data into a code word prior to transmission using an encoder. As noted above, Padovani describes converting DRC data prior to transmission from a mobile station to a BS in a CDMA system, while Gils discusses, generally, LUEP in any context where a message is to be transmitted and where unequal error protection may be beneficial to protect the message. Thus, both references are in the same general field of endeavor (error coding data prior to transmission of that data). As recognized by the Supreme Court, known work in one field of endeavor may prompt variations of it for use in either the same field or a different one based on design incentives or other market forces if the variations are predictable to one of ordinary skill in the art. *See KSR Int'l co. v. Teleflex Inc.*, 550 U.S. 398, 417 (2007).

127. Gils also recognizes the need for an error coding scheme that provides improved error correction when transmitting data. For example, Gils recognizes that greater error protection may be needed for certain bits, e.g., one or more higher order or more significant bits. Ex. 1010, 6. Inasmuch as Padovani contemplates encoding a DRC message that can include actual C/I measurements which may be represented in terms of a decimal integer and decimal fraction (like the '590 Patent), POSITA would have been motivated to provide greater protection for the decimal integer portion (an error in which would be magnified versus an error in the decimal fraction portion). Ex. 1009, 23:29-24:02.

128. In other words, and as described above, Padovani contemplates transmitting an actual C/I measurement, e.g., 3.5 dB, as a DRC message or within a DRC message. A POSITA would have understood that an error with respect to the decimal integer portion of the C/I measurement, i.e., 3 would have greater consequences than an error with respect to the decimal fraction portion of the C/I measurement, i.e., 5. Accordingly, the decimal integer portion of the C/I measurement is of greater significance than the decimal fraction portion, The '590 Patent admits as much. Ex. 1001, 19:43-58. It is an elementary fact that the relative positions of digits in a string of digits implies weight (a power of 10 for a decimal digit and a power of 2 for a binary digit, for example).

129. As I have discussed above, Gils provides different coding schemes where code words derived from the different coding schemes provide better error protection for some portion(s) of a data or input word and less error protection for another portion(s) of the data or input word. For example, Gils describes that in “the transmission and storage of messages in which different parts are of mutually different importance,” “it is natural to give parts of mutually different importance different protection against errors.” Ex. 1010, v. Based on this understanding of the premise of Gils, a POSITA would have known to extrapolate and apply this portion-wise error protection to the context of data inputs composed of more/less significant digits. Indeed, Gils recognizes that “many applications exist in which

some message positions are more important... [f]or example in transmitting numerical data, errors in the sign or in the high-order digits are more serious than the errors in the low-order digits.” *Id.*, 14. Moreover, Gils discloses many UEP coding scheme choices that can be applied in many situations – Gils could be used like any coding textbook as a reference for finding different ways of error coding data. Thus, a POSITA would have been motivated to derive code words based on one or more coding schemes of Gils to protect different portions of a C/I measurement.

130. Further still, Padovani recognizes that “the difference between the highest and lowest [C/I] value can be as large as 10,000,” resulting in “information bit rates that can vary by as much as a factor of 100.” Ex. 1009, 4:25-34. Moreover, Table 1 of Padovani (reproduced below) illustrates a plurality of data rates ranging from 38.4 Kbps to 2457.6 Kbps, each corresponding to a particular rate index (0 – 6).

TABLE 1

Traffic Channel Parameters								
Parameter	Data Rates							Units
	38.4	76.8	153.6	307.2	614.4	1228.8	2457.6	Kbps
Data bit/packet	1024	1024	1024	1024	1024	2048	2048	bits
Packet length	26.67	13.33	6.67	3.33	1.67	1.67	0.83	msec
Slots/packet	16	8	4	2	1	1	0.5	slots
Packet/transmission	1	1	1	1	1	1	2	packets
Slots/transmission	16	8	4	2	1	1	1	slots
Walsh symbol rate	153.6	307.2	614.4	1228.8	2457.6	2457.6	4915.2	Kcps
Walsh channel/ QPSK phase	1	2	4	8	16	16	16	channels
Modulator rate	76.8	76.8	76.8	76.8	76.8	76.8	76.8 ¹	kps
PN chips/data bit	32	16	8	4	2	1	0.5	chips/bit
PN chip rate	1228.8	1228.8	1228.8	1228.8	1228.8	1228.8	1228.8	Kcps
Modulation format	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QAM ¹	
Rate index	0	1	2	3	4	5	6	

Note:

¹16-QAM modulation

131. Better quality channels, i.e., those having higher C/I values can support the higher data rates, e.g., 2457.6 Kbps. *Id.*, 4:18-21. A POSITA would have understood that in order to support the range of potential C/I values /data rates, a non-linear distribution would be needed (or at least preferable) – hence the supported data rates reflected in Table 1 that double at each step.

132. A result of this non-linear distribution is that the effect of errors in data rates at the upper range is more pronounced, e.g., an error in coding a data rate of 2457.6 Kbps could potentially drop the data rate by half (down to 1228.8 Kbps), whereas an error in coding a data rate of 76.8 Kbps could also drop the data rate by half, but the result is only a drop of 38.4 Kbps. Accordingly, in view of this teaching of Padovani, a POSITA would have understood that although Gils is directed to protecting certain portions of a data word, the codes disclosed in Gils

can be used for protecting an entire data word. That is, protecting an entire data word, such as an index (e.g., 6) for a data rate (e.g., 1228.8 Kbps) disclosed in Padovani, could be important in addition to protecting, e.g., a most significant bit of that data word. As shown below, e.g., with respect to Claim 1, a POSITA would have been motivated to use the teachings of Gils to protect entire data words (e.g., indices for data rates disclosed in Padovani) with code words having some desired code word minimum distance from other code words rather than or in addition to one or more portions of a code word. Therefore, in order to better protect a forward link having better quality, an error to which would have more negative consequences (with respect to a decrease in data rate), a POSITA would have been motivated to combine the teachings of Padovani and Gils for the purpose of encoding a higher-valued DRC message from the mobile station to the base station with a code word having a stronger error protection.

133. Moreover, Gils is agnostic as to the context in which LUEP codes may be used. That is, Gils describes designing “error-control coding schemes for... problems of noisy information transmission” without limiting the use of LUEP to any particular application or environment. Ex. 1010, v. Indeed, Gils notes that “[t]hese problems... are of interest from a practical, industrial point of view....” Ex. 1010, v. Because a variety of systems and situations were known to experience noisy transmissions, a POSITA would have understood that Gils’

LUEP codes could be used to combat noisy transmissions in any of these systems and/or situations, including the transmission of DRC messages as is the case in Padovani.

4. Padovani in View of Gils Renders Claim 3 Obvious

Claim 3 pre recites “[a] communication terminal apparatus[.]”

134. Padovani teaches a communication terminal apparatus. Ex. 1009, FIG. 2 (element 6).

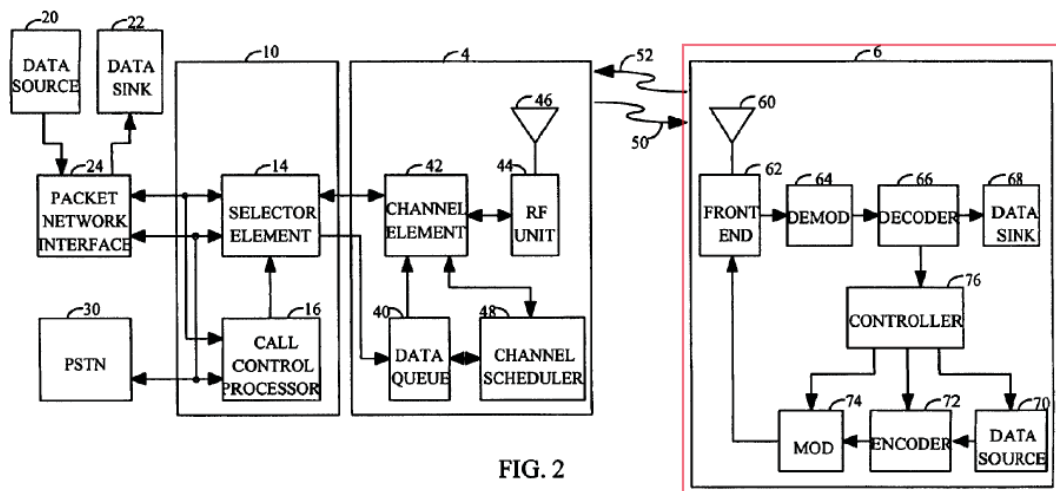


FIG. 2

135. In particular, Padovani describes a data communication system in which embodiments may be implemented as follows:

Base station controller 10 interfaces with packet network interface 24, PSTN 30, and all base stations 4 in the data communication system (only one base station 4 is shown in FIG. 2 for simplicity). Base station controller 10 coordinates the communication between *mobile stations* 6 in the data communication system and other users connected to packet network interface 24 and PSTN 30.

Id., 12:13-19. (emphasis added).

136. Accordingly, Padovani teaches Claim 3pre.

Claim 3a recites “a measurer that measures a downlink channel quality and outputs information that is generated in association with said downlink channel quality and composed of a plurality of digits including an upper digit and an lower digit[.]”

137. Padovani teaches a measurer that measures a downlink channel quality and outputs information that is generated in association with said downlink channel quality and composed of a plurality of digits including an upper digit and a lower digit.

138. In particular, Padovani describes that “[u]pon decoding the paging messages, and for each time slot until the data transmission is completed, the mobile station measures the C/I of the forward link signals from the base stations in the active set, as received at the mobile station.” (emphasis added). Ex. 1009, 9:34-37. Moreover, Padovani teaches transmitting to a base station “a data request message (hereinafter referred to as the DRC message) on the data request channel (hereinafter referred as the DRC channel). The DRC message can contain the requested data rate or, alternatively, an indication of the quality of the forward link channel (e.g., the C/I measurement itself, the bit-error rate, or the packet error-rate).” Id., 10:3-9. Additionally still, Padovani describes that as noted above, the

C/I of the forward link (as taught by Padovani) is analogous to the downlink channel quality of the '590 Patent.

139. As would have been recognized by a POSITA, by virtue of Padovani's teaching that a mobile station measures the downlink channel quality (i.e., C/I of the forward link), the mobile station of Padovani includes a measuring device that measures downlink channel quality and outputs information, or at the least, it would have been obvious to include such a measuring device in the mobile station that outputs information.

140. Moreover as discussed above, it was known for a mobile station/access terminal to have an SNIR estimation component that outputs an SNIR measurement to a DRC component for generating a DRC message that ultimately is transmitted to an access point. Ex.1013, 12:29-50; FIG. 6.

141. Additionally, a CIR value may have decimal integer and decimal fraction portions. In other words, a data word may include a decimal integer portion and a decimal fraction portion, e.g., "X.Y," where "X" refers to the decimal integer portion and "Y" refers to a decimal fraction portion. In the case of the '590 Patent example, the decimal integer portion of the CIR value may be the decimal integer "8," where the amount of change in the decimal integer part of the CIR value can be on the order of a single digit decimal integer, i.e., 1 dB. Ex. 1001, 19:43-52. A change of 1dB is greater than the amount of change, i.e., 0.1 dB

per the decimal fraction portion of the CIR value (0.7 dB). *Id.* In other words, if the decimal integer portion of the CIR value is received erroneously by a BS, the degree of error is large compared to a case where the decimal fraction portion of the CIR value is received erroneously. *Id.*, 19:52-57. The decimal integer portion of the CIR value can be interpreted as being an “upper digit,” while the decimal fraction portion of the CIR value can be interpreted as being a “lower digit.” *Id.*, 20:33-45.

142. Similarly, Padovani indicates that the DRC message can contain “an indication of the quality of the forward link channel (e.g., the C/I measurement itself, the bit-error rate, or the packet-error rate).” Ex. 1009 at 10:6-9. An actual C/I measurement may comprise a value that includes a decimal integer portion and a decimal fraction portion, e.g., 3.5 dB. *Id.*, 23:34-24:2. Thus, when transmitting actual C/I measurements, a POSITA would have recognized that the decimal integer portion of the actual C/I measurement is an upper digit and the decimal fraction portion of the actual C/I measurement is a lower digit. More broadly, any one of ordinary skill would know that any string of digits that represent a quantitative value such as the C/I measurement would have different weights associated with the different digits. The relative positions of each digits in the string of digits are therefore significant since the relative positions implies the weights (a power of 10 for the decimal digit and a power of 2 for the binary digit)

assigned to the digits. As such a digit at a higher weight position would be an upper digit than a digit at a lower weight position. A POSITA would have known this elementary fact.

143. Accordingly, Padovani teaches Claim 3a.

Claim 3b recites “a coder that encodes the information such that the upper digit is assigned a larger number of bits than the lower digit[.]”

144. Padovani in combination with Gils teaches a coder that encodes the information such that the upper digit is assigned a larger number of bits than the lower digit. As explained above, a digit is a representation of value and can have, for example, a weight in the power of 10 (i.e., a decimal digit), a weight in the power of 2 (i.e., a binary digit), or a weight in the power of 16 (i.e., a hexadecimal digit).

145. As discussed above, Padovani contemplates transmitting information (C/I measurements transmitted as/in DRC messages) represented by a plurality of digits that include an upper digit (e.g., 3) and a lower digit (e.g., 5). Ex. 1009, 23:34-24:2. Padovani also contemplates encoding binary representations of such information. *Id.*, 45:15-22. Gils derives a plurality of LUEP (n,k) coding schemes that when applied to a k-bit (binary) data word, result in n-bit code words. Ex. 1010, 24-27, and as admitted by the '590 Patent,.

146. As described above, it would have been obvious to a POSITA to have combined Padovani and Gils such that the DRC encoder of Padovani could be configured to encode the C/I measurement in accordance with one or more of the coding schemes set forth in Gils, which are directed to providing unequal error protection for portions of a data word. Moreover, although Gils seeks to provide unequal error protection for one or more portions of a data message, different coding schemes provided by Gils also result in code words that have different lengths (i.e., n-bit code words where n can vary). A POSITA would have readily understood that greater error protection (vis-a-via longer code word length) should or could have been provided to a digit the greater the significance a digit has.

147. In particular, the '590 Patent describes encoding a decimal integer portion 8 using a coding scheme that results in a first code word having a first code word length, and encoding a decimal fraction portion 7 using a coding scheme that results in a second code word having a second code word length, where the first code word is longer than the second code word. Ex. 1001, 20:36-49. A POSITA would have understood that encoding or converting a digit, such as decimal integer 8, into a code word having a certain length results in "assigning" a number of bits to that digit.

148. Similarly, Padovani indicates that the DRC message can contain "an indication of the quality of the forward link channel (e.g., the C/I measurement

itself, the bit-error rate, or the packet-error rate).” Ex. 1009, 10:6-9. An actual C/I measurement may comprise a value that includes a decimal integer portion and a decimal fraction portion, e.g., 3.5 dB. *Id.*, 23:34-24:2. Thus, when transmitting actual C/I measurements, a POSITA would have recognized that the DRC encoder of Padovani would benefit from the improved error protection provided by Gils.

149. Gils seeks to solve the very same issue set forth in the ’590 Patent, and solves the issue in a very similar way. For example, by encoding a data word (in the case of Padovani, the DRC message) that comprises, e.g., a decimal integer portion and a decimal fraction portion (3 and 5, respectively), wherein errors with the decimal integer portion would be more significant than errors with the decimal fraction portion, one or more of Gils’ coding schemes would afford the decimal integer portion (i.e., a digit having more significance than the digit representative of the decimal fraction portion) greater protection.

150. As an example, Gils provides a table of binary optimal LUEP codes having lengths less than or equal to 15. Ex. 1010, 25.

n	k	$d(n, k)$	separation vector
4	2	2	A 32
5	2	3	A 42
5	3	2	A 322
6	2	4	A 52
6	3	3	A 422
6	4	2	A 3222
7	2	4	A 62, I 54
7	3	4	A 522
7	4	3	A 4222
7	5	2	A 32222
8	2	5	A 72, I 64
8	3	4	A 622, C 544
8	4	4	A 5222
8	5	2	A 42222, J 33332
8	6	2	A 322222
9	2	6	A 82, I 74
9	3	4	A 722, C 644, G 554
9	4	4	A 6222, C 5444
9	5	3	A 52222, J 44442, B 43333
9	6	2	A 422222, J 333322
9	7	2	A 3222222
10	2	6	A 92, I 84, I 76
10	3	5	A 822, C 744, L 664
10	4	4	A 7222, C 6444, G 5544
10	5	4	A 62222, C 54444
10	6	3	A 522222, J 444422, J 433332
10	7	2	A 4222222, J 3333222
10	8	2	A 32222222
11	2	7	A 10.2, I 94, I 86
11	3	6	A 922, C 844, K ₁ 764
11	4	5	A 8222, C 7444, E 6644
11	5	4	A 72222, C 64444, G 55444

Table I: The separation vectors of all binary optimal LUEP codes of length less than or equal to 15.

151. Table II of Gils shows a plurality of possible (n,k) coding schemes for encoding data words represented by k number of bits into sets of possible code words having n bits. *Id.* For example, in the case of an $(8,4)$ coding scheme, a data word (e.g., decimal integer 3 of Padovani's C/I measurement) represented by 4 bits can be encoded into a code word having a bit length of 8. *Id.* Because use of the $(8,4)$ coding scheme results in an 8-bit code word, a POSITA would have understood this to be assigning 8 bits to the upper digit 3. Likewise, a data word

(e.g., decimal fraction 5 of Padovani's C/I measurement) represented by 4 bits can be encoded into a code word having a bit length of 6 using a (6,4) coding scheme. *Id.* Because use of the (6,4) coding scheme results in a 6-bit code word, a POSITA would have understood this to be assigning 6 bits to the lower digit 5. And 8 being larger than 6, a larger number of bits is assigned to the upper digit.

152. A POSITA would have known to select the two coding schemes that could be used to derive code words for a 4-bit data word. By selecting an (8,4) coding scheme to encode the digit representing the decimal integer portion of a C/I measurement, and a (6,4) coding scheme to encode the digit representing the decimal fraction portion of the C/I measurement, each of the digits representing the C/I measurement would have code words whose code word minimum distance is larger for the decimal integer portion (i.e., upper digit) compared to that of the decimal fraction portion (i.e., lower digit). This is seen by the fact that Table 1 of Padovani shows a large range of data rate (a factor of 64 from the highest to the lowest), which corresponds to a large range of C/I values. As shown in Table 1 of Padovani, these data rates are incremented in a non-uniform manner – each successive data rate being twice of the once preceding, and as such an error in the upper digit would have more serious impact in representing the data rate being requested. A POSITA would have known that assigning a coding scheme that

provides a larger number of bits to the upper digit than the lower digit would be highly beneficial.

153. Thus, based on the teaching set forth by Gils, a POSITA would have known to encode different portions of data to be encoded in accordance with coding schemes that result in different code word minimum distances. Indeed, Gils describes that “it is natural to give parts of mutually different importance different protection against errors. This can be done by using “different coding schemes for the different parts,” albeit a single UEP coding scheme could also be used depending upon how a POSITA would have wanted to implement unequal error protection. Ex. 1010, v; Ex. 1012, 600.

154. Accordingly, Padovani in combination with Gils teaches Claim 3b.

Claim 3c recites “a transmitter that transmits the encoded information to a base station apparatus.”

155. Padovani teaches a transmitter that transmits the encoded information to a base station apparatus.

156. In particular, Padovani describes transmitting “to the selected base station a data request message (hereinafter referred to as the DRC message) on the data request channel (hereinafter referred to as the DRC channel).” Ex. 1009, 10:3-6. Padovani further indicates that the DRC message can contain “an indication of the quality of the forward link channel (e.g., the C/I measurement

itself, the bit-error rate, or the packet-error rate).” *Id.*, 10:6-9; *see also id.*, 46:16-18 indicating “the DRC message carries an indication of the forward link quality (e.g., the C/I information as measured by the mobile station 6).

157. Moreover, Padovani describes that “the DRC message is provided to DRC encoder 626, which encodes the message in accordance with a predetermined coding format.” Ex. 1009, 45:15-17. Padovani further describes that “the DRC message is [then] transmitted to the selected base station 4,” after being covered with a Walsh code. *Id.*, 45:20-33. In order to transmit the DRC message to the selected BS, Padovani uses a transmitter, i.e., “the interleaved data is covered with Walsh codes, spread with a long PN code, and further spread with the short PN codes. The spread data is provided to a *transmitter* within front end 62 [of the mobile station 6].” *Id.*, 14:39. (emphasis added).

158. Accordingly, Padovani teaches Claim 3c.

5. Padovani in View of Gils Renders Claim 1 Obvious

1 pre recites “[a] communication terminal apparatus[.]”

159. As discussed above regarding Claim 3 pre, Padovani teaches a communication terminal apparatus.

160. Accordingly, Padovani teaches Claim 1pre.

Claim 1a recites “a measurer that measures a downlink channel quality and outputs information that is generated in association with said downlink

channel quality and composed of a plurality of digits including an upper digit and an lower digit[.]”

161. As described above regarding Claim 3a, Padovani teaches a measurer that measures a downlink channel quality and outputs information that is generated in association with said downlink channel quality and composed of a plurality of digits including an upper digit and a lower digit.

162. Accordingly, Padovani teaches Claim 1a.

Claim 1b recites “a coder that encodes the information such that the upper digit has a larger code word minimum distance than the lower digit[.]”

163. Padovani in combination with Gils teaches a coder that encodes the information such that the upper digit has a larger code word minimum distance than the lower digit.

164. As discussed in Section XII.A.I above, Padovani contemplates transmitting information (C/I measurements transmitted as/in DRC messages) represented by a plurality of digits that include an upper digit (e.g., 3) and a lower digit (e.g., 5). Ex. 1009, 10:3-9. Padovani also contemplates encoding binary representations of such information. *Id.*, 27:35-36. Gils derives a plurality of LUEP (n,k) coding schemes that when applied to a k-bit (binary) data word, result in n-bit code words. Ex. 1010, 24-27, and as admitted by the '590 Patent, .

165. As described above, it would have been obvious to a POSITA to have combined Padovani and Gils such that the DRC encoder of Padovani could be configured to encode the C/I measurement in accordance with one or more of the coding schemes set forth by Gils directed to providing unequal error protection for portions of a data word. Moreover, although Gils seeks to provide unequal error protection for one or more portions of a data message, different coding schemes provided by Gils also result in code words that have different lengths (i.e., n-bit code words where n can vary). As admitted by the '590 Patent, the longer the length of a code word, the greater the code word minimum distance, and a POSITA would have naturally understood that greater error protection should or could have been provided to a digit the greater the significance a digit has.

166. In particular, the '590 Patent describes encoding a decimal integer portion 8 using a coding scheme that results in a first code word having a first code word length, and encoding a decimal fraction portion 7 using a coding scheme that results in a second code word having a second code word length, where the first code word is longer than the second code word. Ex. 1001 at 19:43-20:45. When that upper digit is encoded or converted into a code word having some number of bits, one of those bits may be the MSB. In order to achieve error protection such that the upper digit is converted into a code word whose length is proportional to the digit's degree of significance, the '590 Patent describes encoding an upper digit

using a 6-bit encoder, and encoding a lower digit using a 4-bit encoder. *Id.*, 20:46-54. The '590 Patent describes that “the code word minimum distance between code words can be made larger for code words represented by 6 bits... [making it] less susceptible to being mistaken for another code word than a code word represented by 4 bits.” *Id.*, 21:11-17.

167. Similarly, Padovani indicates that the DRC message can contain “an indication of the quality of the forward link channel (e.g., the C/I measurement itself, the bit-error rate, or the packet-error rate).” Ex. 1009, 10:6-9. An actual C/I measurement may comprise a value that includes a decimal integer portion and a decimal fraction portion, e.g., 3.5 dB, 3 being the decimal integer portion and 5 being the decimal fraction portion. *Id.*, 23:34-24:2. Thus, when transmitting actual C/I measurements, a POSITA would have recognized that the DRC encoder of Padovani would benefit from the improved error protection provided by Gils. This is seen by the fact that Table 1 of Padovani shows a large range of data rate (a factor of 64 from the highest to the lowest), which corresponds to a large range of C/I values. As shown in Table 1 of Padovani, these data rates are incremented in a non-uniform manner – each successive data rate being twice of the once preceding, and as such an error in the upper digit would have more serious impact in representing the data rate being requested. A POSITA would have known that

assigning a coding scheme that provides a larger code word minimum distance to the upper digit than the lower digit would be highly beneficial.

168. Gils seeks to solve the very same issue set forth in the '590 Patent, and solves the issue in a very similar way. For example, by encoding a data word (in the case of Padovani, the DRC message) having, e.g., a decimal integer portion and a decimal fraction portion, one or more of Gils' coding schemes would afford the decimal integer portion (i.e., a digit having more significance than the digit representative of the decimal fraction portion) greater protection. A POSITA would have understood that errors with the decimal integer portion would be more significant than errors with the decimal fraction portion.

169. As an example, Gils provides a table of binary optimal LUEP codes having lengths less than or equal to 15. Ex. 1010, 25.

n	k	$d(n,k)$	separation vector
4	2	2	A 32
5	2	3	A 42
5	3	2	A 322
6	2	4	A 52
6	3	3	A 422
6	4	2	A 3222
7	2	4	A 62, I 54
7	3	4	A 522
7	4	3	A 4222
7	5	2	A 32222
8	2	5	A 72, I 64
8	3	4	A 622, C 544
8	4	4	A 5222
8	5	2	A 42222, J 33332
8	6	2	A 322222
9	2	6	A 82, I 74
9	3	4	A 722, C 644, G 554
9	4	4	A 6222, C 5444
9	5	3	A 52222, J 44442, B 43333
9	6	2	A 422222, J 333322
9	7	2	A 3222222
10	2	6	A 92, I 84, I 76
10	3	5	A 822, C 744, L 664
10	4	4	A 7222, C 6444, G 5544
10	5	4	A 62222, C 54444
10	6	3	A 522222, J 444422, J 433332
10	7	2	A 4222222, J 3333222
10	8	2	A 32222222
11	2	7	A 10.2, I 94, I 86
11	3	6	A 922, C 844, K ₁ 764
11	4	5	A 8222, C 7444, E 6644
11	5	4	A 72222, C 64444, G 55444

Table I: The separation vectors of all binary optimal LUEP codes of length less than or equal to 15.

170. Table II of Gils shows a plurality of possible (n,k) coding schemes for encoding data words represented by k number of bits into sets of possible code words having n bits. *Id.* For example, in the case of an $(8,4)$ coding scheme, a data word (e.g., decimal integer 3 of Padovani's C/I measurement) represented by 4 bits can be encoded into a code word having a bit length of 8 and a maximal minimum code word distance ($d(n,k)$) of 4. *Id.* Likewise, a data word (e.g., decimal fraction 5 of Padovani's C/I measurement) represented by 4 bits can be

encoded into a code word having a bit length of 6 and a maximal minimum code word distance of 2 using a (6,4) coding scheme. *Id.*

171. A POSITA would have known to select the two coding schemes that could be used to derive code words for a 4-bit data word. By selecting an (8,4) coding scheme to encode the digit representing the decimal integer portion of a C/I measurement, and a (6,4) coding scheme to encode the digit representing the decimal fraction portion of the C/I measurement, each of the digits representing the C/I measurement would have code words whose code word minimum distance is larger for the decimal integer portion (i.e., upper digit) compared to that of the decimal fraction portion (i.e., lower digit). Clearly, Gils discloses many possible choices of UEP encoding schemes that can be applied to a wide variety of applications. A POSITA would have looked at Gils to figure which particular UEP encoding schemes to apply to encode DRC messages, just the way such a person may have looked at any coding textbooks.

172. As another example, Gils describes coding schemes, such as the (12,4) coding scheme, where a 4-bit data word could be encoded into at least one resulting 12-bit code word derived using a K_1 generator matrix has separation vectors 7,6,4,4. Ex. 1010, 25.

n	k	$d(n, k)$	separation vector
11	6	4	A 622222, J 544442, B 533333
11	7	3	A 5222222, J 4444222, J 4333322
11	8	2	A 42222222, J 33332222
11	9	2	A 322222222
12	2	8	A 11.2, I 10.4, I 96
12	3	6	A 10.22, C 944, E 864, K ₂ 774, K ₁ 766
12	4	6	A 9222, C 8444, K ₁ 7644
12	5	4	A 82222, C 74444, E 66444, M 55554
12	6	4	A 722222, C 644444, G 554444
12	7	4	A 6222222, J 5444422, J 5333332
12	8	3	A 52222222, J 44442222, J 43333222
12	9	2	A 422222222, J 333322222
12	10	2	A 3222222222
13	2	8	A 12.2, I 11.4, I 10.6, I 98
13	3	7	A 11.22, C 10.44, K ₁ 964, E 884, L 866
13	4	6	A 10.222, C 9444, L 8644, F 7744, K ₁ 7666
13	5	5	A 92222, C 84444, K ₁ 76444, L 66664, H 66555
13	6	4	A 822222, C 744444, D 664444, M 555544
13	7	4	A 7222222, J 6444442, B 6333333, J 5544442, K ₁ 544444
13	8	4	A 62222222, J 54444222, J 53333322
13	9	3	A 522222222, J 444422222, J 433332222
13	10	2	A 4222222222, J 3333222222
13	11	2	A 32222222222
14	2	9	A 13.2, I 12.4, I 11.6, I 10.8
14	3	8	A 12.22, C 11.44, L 10.64, K ₁ 984, K ₁ 966
14	4	7	A 11.222, C 10.444, K ₁ 9644, L 8844, L 8666
14	5	6	A 10.2222, C 94444, L 86444, F 77444, N 76666

Table I(continued): The separation vectors of all binary optimal LUEP codes of length less than or equal to 15.

173. A POSITA would have understood that an upper digit, e.g., Padovani's decimal integer 3, could have been converted into a 2-bit data word, while a lower digit, e.g., Padovani's decimal fraction value 5 could have been converted into another 2-bit data word. For example, the integer portion 3 can be represented as two bits "11," while the decimal fraction 5 (i.e., 0.5) can be represented as "10" assuming the fractional value is divided into 4 equal

quantization steps – decimal fraction 0.0 is represented as “00,” decimal fraction 0.25 is represented as “01,” decimal fraction 0.5 is represented as “10,” and decimal fraction 0.75 is represented as “11.” If more bits are available to represent the decimal fraction values, then the quantization step will be smaller. This type of quantization is widely used in an analog-to-digital (A/D) conversion, which is commonly known to any one of ordinary skill in the art. Using the (12,4) coding scheme, as reflected by the corresponding separation vectors, the upper digit could have been protected with at least a 6 bit minimum code word distance, i.e., the separation vectors for the two most significant bits is 7,6. Ex. 1010, 25, 62. The lower digit could have been protected with at least a 4-bit minimum code word distance, i.e., the separation vectors for the two least significant bits is 4,4. Ex. 1010, 25, 62.

174. Thus, based on the teaching set forth by Gils, a POSITA would have known to encode different portions of a data word in accordance with one or more coding schemes that result in different code word minimum distances. Indeed, Gils describes that “it is natural to give parts of mutually different importance different protection against errors. This can be done by using “different coding schemes for the different parts,” albeit a single UEP coding scheme could also be used depending upon how a POSITA would have wanted to implement unequal error protection. Ex. 1010, v; Ex. 1012, 600.

175. Accordingly, Padovani in combination with Gils teaches Claim 1b.

Claim 1c recites “a transmitter that transmits the encoded information to a base station apparatus.”

176. As described with respect to Claim 3c, Padovani teaches a transmitter that transmits the encoded information to a base station apparatus.

177. Accordingly, Padovani teaches Claim 1c.

6. Padovani in View of Gils Renders Claim 2 Obvious

Claim 2 recites “the upper digit contains a most significant bit of the information.”

178. Padovani teaches that the upper digit contains a most significant bit of the information.

179. Padovani describes using a “rate (8,4) CRC block encoder that encodes the 3-bit DRC message into an 8-bit code word. *Id.*, 45:20-22. A POSITA would have understood that Padovani’s (8,4) CRC block encoder incorporates one bit (in addition to the 3-bit DRC message) to effectuate the cyclical redundancy check. A bit refers to a binary digit, e.g., 0 or 1. For a group of n bits, it is possible to represent 2^n values. Therefore, in the case of a 3-bit word, it is possible to represent 2^3 values. In a binary number, a bit’s value depends on its position, starting from the right (similar to ones, tens, hundreds, and

thousands in a decimal number. A bit's value grows by a power of two as it goes from right to left as shown below.

Binary number	1	1	1
Value	2^2	2^1	2^0

180. For example, a 3-bit representation of the decimal value 5 is 101, a 3-bit representation of the decimal value 7 is 111. In a 3-bit representation of a value, the most significant value would be that of 2^2 , in other words, the leftmost bit. As described above with respect to Claim 1a and 1b, Padovani in combination with Gils describes encoding, e.g., a decimal integer (the upper digit of the information). Inasmuch as the decimal integer or upper digit portion of the information is, prior to encoding, represented as a binary representation, e.g., a 3-bit representation, the leftmost bit of the 3-bit representation is a most significant bit of the information.

181. Accordingly, Padovani teaches the additional limitation of Claim 2.

7. Padovani in View of Gils Renders Claim 4 Obvious

Claim 4 recites “the upper digit contains a most significant bit of the information.”

182. As described with respect to Claim 2, Padovani teaches that the upper digit contains a most significant bit of the information.

183. Accordingly, Padovani teaches the additional limitation of Claim 4.

8. Padovani in View of Gils and Olofsson Invalidates Claims 5-8

1. Overview of Olofsson

184. Olofsson was published December 26, 2000 and filed on August 29, 1997 making it prior art under at least 35 U.S.C. § 102 (e). At a high level, Olofsson discloses a method for selecting a combination of modulation and channel coding schemes in a digital communication system. Selection of this combination is made by “select[ing an] optimum RF link by measuring link quality parameters, such as C/I ratio.” Ex. 1053, Abstract.

185. Olofsson describes that “depending on the modulation and channel coding schemes, grades of service deteriorates more rapidly as link quality decreases.” *Id.* at 2:35-39. Accordingly, Olofsson describes that “link adaptation methods, which provide the ability to dynamically change modulation scheme, channel coding, and/or the number of used times slots, based on the channel conditions, are used to balance the user bit rate against link quality. *Id.*, 2:47-51. In particular, Olofsson describes that “these methods dynamically adapt a system’s combination of channel coding, modulation, and a number of assignable time slots to achieve optimum performance over a broad range of C/I conditions.” *Id.*, 2:51-54. The combination of at least channel coding and assigned time slots corresponds to a downlink channel. Moreover, Olofsson contemplates that “[t]he

present invention may also be used in CDMS or a hybrid of CDMA and TDMA communication systems. *Id.*, 6:14-16.

2. Motivation to Combine Olofsson with Padovani and Gils

186. As discussed above, Padovani discloses a CDMA system in which a mobile station transmits a data request message to a base station containing an indication of the forward link channel quality. See, e.g., Ex. 1009, Abstract and 9:8-10:6. Moreover, Padovani describes that “[D]ata is partitioned into data packets, with each data packet being transmitted over one or more time slots (or slots),” and that “[a]t each time slot, the base station can direct data transmission to any mobile station which is in communication with the base station.” *Id.*, 9:1-4. See, also *Id.*, 6:17-19 describing “[i]t is yet another object of the present invention to enhance efficiency by allowing the base stations to transmit data packets to each mobile station for a variable number of time slots.”

187. Whether Padovani is characterized as being a CDMA system or a hybrid CDMA system (inasmuch as Padovani transmits data packets over one or more time slots), Padovani is the type of communications system that a POSITA would have understood could have been improved by the methods of Olofsson. Indeed, both Padovani and Olofsson seek to improve efficiency/achieve optimal operation of a digital communications system through at least the assignment of time slots for data transmission purposes. Ex. 1009, 6:17-19; Ex. 1053, 2:51-54.

Moreover, because Padovani already teaches measuring the C/I of a forward link/downlink channel (See, e.g., Ex. 1009, 4:44-56) and Oloffson teaches basing at least channel coding and time slot(s) assignment on C/I conditions, a POSITA would have been motivated to assign a downlink channel per the teachings of Oloffson based on the C/I measurements contemplated by Padovani while relying on the teachings of Gils' LUEP coding schemes for encoding the DRC messages of Padovani as previously discussed. Indeed, while Padovani teaches the control of downlink data transmission rates, both Gils and Oloffson teach particular techniques that can be used to implement specific aspects of controlling the downlink data transmission rates taught in Padovani. As such, the techniques taught in Gils and Oloffson are directly applicable to and compatible with Padovani's controlling of the downlink data transmission rates.

3. Padovani in View of Gils and Oloffson Renders Claim 5

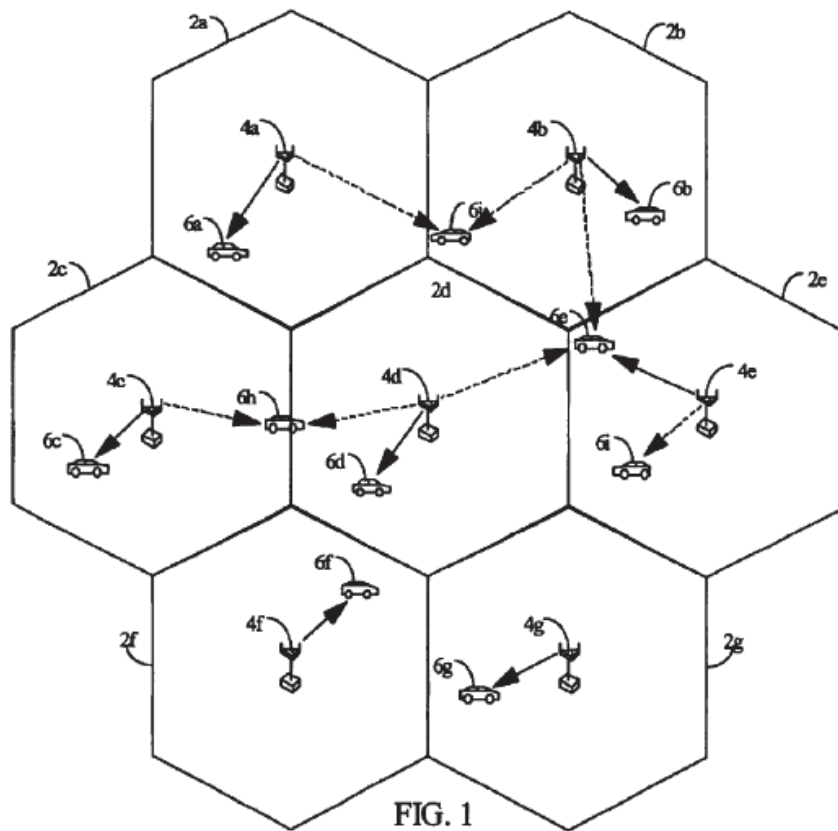
Obvious

Claim 5 pre recites “A coding and transmission method for use in a communication system where a base station apparatus assigns a downlink channel to each of a plurality of communication terminal apparatuses on a time division basis.”

188. Padovani teaches a coding and transmission method for use in a communication system where a base station apparatus assigns a downlink channel

to each of a plurality of communication terminal apparatuses on a time division basis.

189. Padovani describes that “[i]t is an object of the present invention to improve utilization of the forward and reverse link capacity in the data **communication system.**” (emphasis added). Ex. 1009, 5:32-33. FIG. 1 of Padovani (reproduced below) illustrates this communication system.



190. Padovani’s communication system includes a plurality of communication terminals, referred to as mobile stations (6). *Id.*, 15:6-16:3. Each cell 2 of the communication system is serviced by a corresponding base station 4,

e.g., “base station 4a transmits data...to mobile station 61, base station 4b transmits data...to mobile station 6b [and so on] **on the forward link at time slot n.**” (emphasis added). *Id.* Additionally, Padovani describes that “[d]ata is partitioned into data packets, with each data packet being transmitted over one or more time slots (or slots),” and that “[a]t each time slot, the base station can direct data transmission to any mobile station which is in communication with the base station.” *Id.*, 9:1-4.

191. In order to “improve utilization of the forward and reverse link capacity in the data communication system,” a mobile station “measures the signal-to-noise interference ration (C/I) of the forward link signals... at every time slots[sic].” *Id.*, 5:32-38. Moreover, “[t]he mobile station transmits to the selected base station on a dedicated data request (DRC) channel a request for transmission at the highest data rate which the measured C/I can reliably support.” *Id.*, 5:38-6:3.

192. Padovani further describes that “[t]he DRC message is provided to DRC encoder 626, which **encodes the message in accordance with a predetermined coding format,**” where “[c]oding of the DRC message is important since the error probability of the DRC message needs to be sufficiently low because incorrect forward link data rate determination impacts the system throughput performance.” (emphasis added). (emphasis added). *Id.*, 45:15-20.

193. As noted above, it would have been obvious for a POSITA to have combined the teachings of Padovani and Olofsson such that a base station assigns a downlink channel to each of a plurality of communication terminal apparatuses on a time division basis.

194. Accordingly, Padovani teaches Claim 5pre.

Claim 5a recites “[wherein said each of a plurality of communication terminal apparatuses] encodes information that is used for the assignment of the downlink channel and composed of a plurality of digits including an upper digit and a lower digit such that the upper digit has a larger code word minimum distance than the lower digit[.]”

195. As described above with respect to Claim 5pre, Padovani in combination with Gils teaches that each of a plurality of communication terminal apparatuses encodes information used for the assignment of the downlink channel.

196. Additionally, Padovani in combination with Gils teaches that the information is composed of a plurality of digits including an upper digit and a lower digit such that the upper digit has a larger code word minimum distance than the lower digit.

197. As described above, it would have been obvious to a POSITA to have combined Padovani and Gils such that the DRC encoder of Padovani could be configured to encode the C/I measurement in accordance with one or more of the

coding schemes set forth Gils directed to providing unequal error protection for portions of a data word.

198. The '590 Patent describes encoding a decimal integer portion 8 using a coding scheme that results in a first code word having a first code word length, and encoding a decimal fraction portion 7 using a coding scheme that results in a second code word having a second code word length, where the first code word is longer than the second code word. Ex. 1001, at 20:36-49. When that upper digit is encoded or converted into a code word having some number of bits, one of those bits may be the MSB. In order to achieve error protection such that the upper digit is converted into a code word whose length is proportional to the digit's degree of significance, the '590 Patent describes encoding an upper digit using a 6-bit encoder, and encoding a lower digit using a 4-bit encoder. *Id.*, 20:46-54. The '590 Patent describes that "the code word minimum distance between code words can be made larger for code words represented by 6 bits... [making it] less susceptible to being mistaken for another code word than a code word represented by 4 bits." *Id.*, 21:11-17.

199. Similarly, Padovani indicates that the DRC message can contain "an indication of the quality of the forward link channel (e.g., the C/I measurement itself, the bit-error rate, or the packet-error rate)." Ex. 1009, 10:6-9. An actual C/I measurement may comprise a value that includes a decimal integer portion and a

decimal fraction portion, e.g., 3.5 dB. *Id.*, 23:34-24:2. Thus, when transmitting actual C/I measurements, a POSITA would have recognized that the DRC encoder of Padovani would benefit from the improved error protection provided by Gils.

200. Gils seeks to solve the very same issue set forth in the '590 Patent, and solves the issue in a very similar way. For example, by encoding a data word (in the case of Padovani, the DRC message) that comprises, e.g., a decimal integer portion and a decimal fraction portion (3 and 5, respectively), wherein errors with the decimal integer portion would be more significant than errors with the decimal fraction portion, one or more of Gils' coding schemes would afford the decimal integer portion (i.e., a digit having more significance than the digit representative of the decimal fraction portion) greater protection.

201. As an example, Gils provides a table of binary optimal LUEP codes having lengths less than or equal to 15. Ex. 1010, 25.

n	k	$d(n, k)$	separation vector
4	2	2	A 32
5	2	3	A 42
5	3	2	A 322
6	2	4	A 52
6	3	3	A 422
6	4	2	A 3222
7	2	4	A 62, I 54
7	3	4	A 522
7	4	3	A 4222
7	5	2	A 32222
8	2	5	A 72, I 64
8	3	4	A 622, C 544
8	4	4	A 5222
8	5	2	A 42222, J 33332
8	6	2	A 322222
9	2	6	A 82, I 74
9	3	4	A 722, C 644, G 554
9	4	4	A 6222, C 5444
9	5	3	A 52222, J 44442, B 43333
9	6	2	A 422222, J 333322
9	7	2	A 3222222
10	2	6	A 92, I 84, I 76
10	3	5	A 822, C 744, L 664
10	4	4	A 7222, C 6444, G 5544
10	5	4	A 62222, C 54444
10	6	3	A 522222, J 444422, J 433332
10	7	2	A 4222222, J 3333222
10	8	2	A 32222222
11	2	7	A 10.2, I 94, I 86
11	3	6	A 922, C 844, K ₁ 764
11	4	5	A 8222, C 7444, E 6644
11	5	4	A 72222, C 64444, G 55444

Table I: The separation vectors of all binary optimal LUEP codes of length less than or equal to 15.

202. Table II of Gils shows a plurality of possible (n,k) coding schemes for encoding data words represented by k number of bits into sets of possible code words having n bits. *Id.* For example, in the case of an $(8,4)$ coding scheme, a data word (e.g., decimal integer 3 of Padovani's C/I measurement) represented by 4 bits can be encoded into a code word having a bit length of 8 and a maximal minimum code word distance ($d(n,k)$) of 4. *Id.* Likewise, a data word (e.g.,

decimal fraction 5 of Padovani's C/I measurement) represented by 4 bits can be encoded into a code word having a bit length of 6 and a maximal minimum code word distance of 2 using a (6,4) coding scheme. *Id.*

203. A POSITA would have known to select the two coding schemes that could be used to derive code words for a 4-bit data word. By selecting an (8,4) coding scheme to encode the digit representing the decimal integer portion of a C/I measurement, and a (6,4) coding scheme to encode the digit representing the decimal fraction portion of the C/I measurement, each of the digits representing the C/I measurement would have code words whose code word minimum distance is larger for the decimal integer portion (i.e., upper digit) compared to that of the decimal fraction portion (i.e., lower digit). This is seen by the fact that Table 1 of Padovani shows a large range of data rate (a factor of 64 from the highest to the lowest), which corresponds to a large range of C/I values. As shown in Table 1 of Padovani, these data rates are incremented in a non-uniform manner – each successive data rate being twice of the once preceding, and as such an error in the upper digit would have more serious impact in representing the data rate being requested. A POSITA would have known that assigning a coding scheme that provides a larger code word minimum distance to the upper digit than the lower digit would be highly beneficial.

204. Thus, based on the teaching set forth by Gils, a POSITA would have known to encode different portions of a data word in accordance with coding schemes that result in different code word minimum distances. Indeed, Gils describes that “it is natural to give parts of mutually different importance different protection against errors. This can be done by using “different coding schemes for the different parts,” albeit a single UEP coding scheme could also be used depending upon how a POSITA would have wanted to implement unequal error protection. Ex. 1010, v; Ex. 1012, 600.

205. Accordingly, Padovani in combination with Gils teaches Claim 5a.

Claim 5b recites “[wherein said each of a plurality of communication terminal apparatuses] transmits the encoded information to said base station apparatus.”

206. Padovani teaches that each of a plurality of communication terminal apparatuses transmits the encoded information to a base station apparatus.

207. In particular, Padovani describes transmitting “to the selected base station a data request message (hereinafter referred to as the DRC message) on the data request channel (hereinafter referred to as the DRC channel).” *Id.*, 10:3-6 Padovani further indicates that the DRC message can contain “an indication of the quality of the forward link channel (e.g., the C/I measurement itself, the bit-error rate, or the packet-error rate).” *Id.*, 10:6-9; *see, also Id.*, 17:16-18; 46:16-18

indicating “the DRC message carries an indication of the forward link quality (e.g., the C/I information as measured by the mobile station 6).

208. Moreover, Padovani describes that “the DRC message is provided to DRC encoder 626, which encodes the message in accordance with a predetermined coding format.” *Id.*, 45:15-17. Padovani further describes that “the DRC message is [then] transmitted to the selected base station 4,” after being covered with a Walsh code. *Id.*, 45:32-33. In order to transmit the DRC message to the selected BS, Padovani uses a transmitter, i.e., “the interleaved data is covered with Walsh codes, spread with a long PN code, and further spread with the short PN codes. The spread data is provided to a *transmitter* within front end 62 [of the mobile station 6].” (emphasis added). *Id.*, 14:36-39.

209. Accordingly, Padovani teaches Claim 5b.

4. Padovani in View of Gils and Olofsson Renders Claim 6

Obvious

Claim 6 recites “the upper digit contains a most significant bit of the information.”

210. As described with respect to Claim 2, Padovani teaches that the upper digit contains a most significant bit of the information.

211. Accordingly, Padovani teaches the additional limitation of Claim 6.

5. Padovani in View of Gils and Olofsson Renders Claim 7

Obvious

Claim 7 pre recites “[a] coding and transmission method for use in a communication system where a base station apparatus assigns a downlink channel to each of a plurality of communication terminal apparatuses on a time division basis.”

212. As described with respect to Claim 5pre, Padovani in combination with Olofsson teaches a coding and transmission method for use in a communication system where a base station apparatus assigns a downlink channel to each of a plurality of communication terminal apparatuses on a time division basis.

213. Accordingly, Padovani teaches Claim 7pre.

Claim 7a recites “[wherein said each of a plurality of communication terminal apparatuses] encodes information that is used for the assignment of the downlink channel and composed of a plurality of digits including an upper digit and a lower digit such that the upper digit is assigned a larger number of bits than the lower digit[.]”

214. As discussed above regarding Claim 7pre, Padovani teaches that each of plurality of communication terminal apparatuses encodes information used for the assignment of the downlink channel.

215. Padovani in combination with Gils teaches that encoded information is composed of a plurality of digits including an upper digit and a lower digit such that the upper digit is assigned a larger number of bits than the lower digit.

216. As described above, it would have been obvious to a POSITA to have combined Padovani and Gils such that the DRC encoder of Padovani could be configured to encode the C/I measurement in accordance with one or more of the coding schemes set forth Gils directed to providing unequal error protection for portions of a data word.

217. The '590 Patent describes encoding a decimal integer portion 8 using a coding scheme that results in a first code word having a first code word length, and encoding a decimal fraction portion 7 using a coding scheme that results in a second code word having a second code word length, where the first code word is longer than the second code word. Ex. 1001, 19:43-20:45. A POSITA would have understood that encoding or converting a digit, such as decimal integer 8, into a code word having a certain length results in “assigning” a number of bits to that digit.

218. Similarly, Padovani indicates that the DRC message can contain “an indication of the quality of the forward link channel (e.g., the C/I measurement itself, the bit-error rate, or the packet-error rate).” Ex. 1009, 10:6-9. An actual C/I measurement may comprise a value that includes a decimal integer portion and a

decimal fraction portion, e.g., 3.5 dB. *Id.*, 23:34-24:2. Thus, when transmitting actual C/I measurements, a POSITA would have recognized that the DRC encoder of Padovani would benefit from the improved error protection provided by Gils.

219. Gils seeks to solve the very same issue set forth in the '590 Patent, and solves the issue in a very similar way. For example, by encoding a data word (in the case of Padovani, the DRC message) that comprises, e.g., a decimal integer portion and a decimal fraction portion (3 and 5, respectively), wherein errors with the decimal integer portion would be more significant than errors with the decimal fraction portion, one or more of Gils' coding schemes would afford the decimal integer portion (i.e., a digit having more significance than the digit representative of the decimal fraction portion) greater protection.

220. As an example, Gils provides a table of binary optimal LUEP codes having lengths less than or equal to 15. Ex. 1010, 25.

n	k	$d(n, k)$	separation vector
4	2	2	A 32
5	2	3	A 42
5	3	2	A 322
6	2	4	A 52
6	3	3	A 422
6	4	2	A 3222
7	2	4	A 62, I 54
7	3	4	A 522
7	4	3	A 4222
7	5	2	A 32222
8	2	5	A 72, I 64
8	3	4	A 622, C 544
8	4	4	A 5222
8	5	2	A 42222, J 33332
8	6	2	A 322222
9	2	6	A 82, I 74
9	3	4	A 722, C 644, G 554
9	4	4	A 6222, C 5444
9	5	3	A 52222, J 44442, B 43333
9	6	2	A 422222, J 333322
9	7	2	A 3222222
10	2	6	A 92, I 84, I 76
10	3	5	A 822, C 744, L 664
10	4	4	A 7222, C 6444, G 5544
10	5	4	A 62222, C 54444
10	6	3	A 522222, J 444422, J 433332
10	7	2	A 4222222, J 3333222
10	8	2	A 32222222
11	2	7	A 10.2, I 94, I 86
11	3	6	A 922, C 844, K ₁ 764
11	4	5	A 8222, C 7444, E 6644
11	5	4	A 72222, C 64444, G 55444

Table I: The separation vectors of all binary optimal LUEP codes of length less than or equal to 15.

221. Table II of Gils shows a plurality of possible (n,k) coding schemes for encoding data words represented by k number of bits into sets of possible code words having n bits. *Id.* For example, in the case of an $(8,4)$ coding scheme, a data word (e.g., decimal integer 3 of Padovani's C/I measurement) represented by 4 bits can be encoded into a code word having a bit length of 8. *Id.* Because use of the $(8,4)$ coding scheme results in an 8-bit code word, a POSITA would have

understood this to be assigning 8 bits to the upper digit 3. Likewise, a data word (e.g., decimal fraction 5 of Padovani's C/I measurement) represented by 4 bits can be encoded into a code word having a bit length of 6 using a (6,4) coding scheme. *Id.* Because use of the (6,4) coding scheme results in a 6-bit code word, a POSITA would have understood this to be assigning 6 bits to the lower digit 5. And 8 being larger than 6, a larger number of bits is assigned to the upper digit.

222. A POSITA would have known to select the two coding schemes that could be used to derive code words for a 4-bit data word. By selecting an (8,4) coding scheme to encode the digit representing the decimal integer portion of a C/I measurement, and a (6,4) coding scheme to encode the digit representing the decimal fraction portion of the C/I measurement, each of the digits representing the C/I measurement would have code words whose code word minimum distance is larger for the decimal integer portion (i.e., upper digit) compared to that of the decimal fraction portion (i.e., lower digit). This is seen by the fact that Table 1 of Padovani shows a large range of data rate (a factor of 64 from the highest to the lowest), which corresponds to a large range of C/I values. As shown in Table 1 of Padovani, these data rates are incremented in a non-uniform manner – each successive data rate being twice of the once preceding, and as such an error in the upper digit would have more serious impact in representing the data rate being requested. A POSITA would have known that assigning a coding scheme that

provides a larger number of bits to the upper digit than the lower digit would be highly beneficial.

223. Thus, based on the teaching set forth by Gils, a POSITA would have known to encode different portions of data to be encoded in accordance with coding schemes that result in different code word minimum distances. Indeed, Gils describes that “it is natural to give parts of mutually different importance different protection against errors. This can be done by using “different coding schemes for the different parts,” albeit a single UEP coding scheme could also be used depending upon how a POSITA would have wanted to implement unequal error protection. Ex. 1010, v; Ex. 1012, 600.

224. Accordingly, Padovani in combination with Gils teaches Claim 7a.

Claim 7b recites “[wherein said each of a plurality of communication terminal apparatuses] transmits the encoded information to said base station apparatus.”

225. As described with respect to Claim 1c, Padovani teaches that each communication terminal apparatus comprises a transmitter that transmits the encoded information to said base station apparatus.

226. Accordingly, Padovani teaches Claim 7b.

6. Padovani in View of Gils and Olofsson Renders Claim 8

Obvious

Claim 8 recites “the upper digit contains a most significant bit of the information.”

227. As described with respect to Claim 2, Padovani teaches that the upper digit contains a most significant bit of the information.

228. Accordingly, Padovani teaches Claim 8.

XIII. CONCLUSION

229. Based on the forgoing, I submit that:

- i. Claims 1, 2, 3, and 4 are obvious under 35 U.S.C. § 103(a) over Padovani in view of Gils.
- ii. Claims 5, 6, 7, and 8 are obvious under 35 U.S.C. § 103(a) over Padovani in view of Gils and Olofsson.

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

Respectfully submitted,

Dated: August 22, 2018

A handwritten signature in cursive script, appearing to read "Paul S. Min".

Paul S. Min, Ph.D.

APPENDIX A

Paul S. Min, Ph.D.
Washington University in Saint Louis
(Webpage : <https://ese.wustl.edu/faculty/Pages/Paul-Min.aspx>)

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St. Louis, MO 63130

Education

<u>Year</u>	<u>College or University</u>	<u>Degree</u>
1987	The University of Michigan	Ph.D. in Electrical Engineering
1984	The University of Michigan	M.S. in Electrical Engineering
1982	The University of Michigan	B.S. in Electrical Engineering

Professional Experience

From: 1990
To: Present
Organization: Washington University, St. Louis

Summary:

2015 - Senior Professor - Department of Electrical Systems Engineering

2011 – 2014 Chair – Undergraduate Curriculum, Department of Electrical and Systems Engineering

2000 – 2002 Chair – Graduate Curriculum, Department of Electrical and Systems Engineering

2002 - 2014 Associate Professor - Department of Electrical and Systems Engineering

1997 - 2008 On leave from full-time duty at Washington University – as Presidents of MinMax Technologies and Erlang Technology.)

1996 - 2002 Associate Professor - Department of Electrical Engineering

1996 Promoted with Tenure

1990 - 1996 Assistant Professor - Department of Electrical Engineering

- Teaching Experience
- “Transmission System and Multiplexing,” Washington University, ESE 571
 - “Electrical Laboratory I,” Washington University, EE 250.
 - “Communication Theory,” Washington University, ESE 471.
 - “Reliability and Quality Control,” Washington University, ESE 405/505
 - “Signaling and Control of Communications Networks,” Washington University, ESE 572.
 - “Introduction to Electronic Circuits,” Washington University, ESE232
 - “Queueing Systems and Discrete Stochastic Processes,” Washington University, EE 536 / CS 567.
 - “Digital Computer,” Washington University, EE 260M / CS 260.
 - “Data Networks,” Washington University, EE 530.
 - “Electrical Circuit Analysis,” Washington University, ESE 230.
 - “Computer/Communications System Analysis I,” Washington University, EE 557/ CS 557.
 - “Computer/Communications System Analysis II,” Washington University, EE558 / CS 558.
 - “Digital Systems Laboratory,” Washington University, EE 455 / CS 455.

From: 1999
To: 2008
Organization: Erlang Technology, Inc., St. Louis, Missouri
Title: Founder and President
Summary: Up to 70 employees, \$40M in total capital raised from 5 VCs and 3 Corporations
Received “Product of Year” Award from Analog Zone Magazine in 2004

From: 1997
To: 1999
Organization: MinMax Technologies, Inc., St. Louis, Missouri
Title: Founder and President
Summary: Fabless semiconductor company, designing high performance switching ASICs

From: September 1987
To: August 1990
Organization: Bellcore, New Jersey
Title: Member of Technical Staff
Summary: Member of New Network Architecture Development Group

From: 1983
To: 1987

Organization: Department of Electrical Engineering, The University of Michigan
Title: Graduate Instructor
Summary: Instructor for senior level Electrical Engineering Laboratory Class. Received a Best “Best Graduate Instructor Award” from the Department of Electrical Engineering

Professional Affiliations, Achievements & Awards

- Technical Program Committee, COMCAS 2015, Tel Aviv, November 2017.
- Technical Program Committee, COMCAS 2015, Tel Aviv, October 2015.
- Past-Chair, Saint Louis Section of the Institute of Electrical and Electronics Engineers (IEEE), 2015
- Member of Executive Committee, Saint Louis Section of the IEEE, 2010-2015
- Chair, Saint Louis Section of the IEEE, 2014
- Technical Program Committee, COMCAS 2013, Tel Aviv, October 2013.
- Vice Chair, Saint Louis Section of the IEEE, 2013
- Treasurer, Saint Louis Section of the IEEE, 2012
- The Best Paper Award at MOBILITY 2011, October 2011, Barcelona, Spain
- Counselor, Student Chapter of the Year, the Institute of Electrical and Electronics Engineers, 2011
- Award of Appreciation, Saint Louis Section of the Institute of Electrical and Electronics Engineers, 2011, for contribution to various activities of the Saint Louis Section the Institute of Electrical and Electronics Engineers
- Secretary, Saint Louis Section of the IEEE, 2010
- Counselor, Student Chapter of the Year, the Institute of Electrical and Electronics Engineers, 2010
- Wall Street Journal Businessmen of Year, 2003.
- American Men and Women of Science, listed in 1997.
- Outstanding Achievement Award, Bellcore, 1990.
- 18th ISATA Award of Technical Excellence, the best paper award at ISATA 1988.
- Rockwell Fellow, Rockwell International, 1985, 1986.
- Outstanding Graduate Student Award, the University of Michigan, 1985.
- Outstanding Teaching Award, the University of Michigan, 1984, 1986.
- Member of Honor's College, the University of Michigan, 1979, 1980.
- Honor's Convocation, the University of Michigan, 1979.
- Outstanding Freshman Award, the University of Michigan, 1979.
- Woodhaven Rotary Club Scholarship, Woodhaven Rotary Club, 1978.

- Second Place Winner, the State of Michigan Mathematics Prize Competition, 1977.
- International Program Committee, *IASTED International Conference on Communications, Internet and Information Technology (CIIT 2005)*, Cambridge, Massachusetts from October 31-November 2, 2005
- International Program Committee, *IASTED International Conference on Communications 2003*, Scottsdale, Arizona, 2003
- International Program Committee, *Wireless and Optical Communications 2003*, Banff, Canada, 2003.
- International Program Committee, Session Chair, *Wireless and Optical Communications 2002*, Banff, Canada, 2002.
- Invited participant, *NSF Workshop on Enhancing International Cooperation in CS/CE Research and Education*, Portland, 1997.
- Session Chair, *the 1993 Conference on Information Sciences and Systems*, Baltimore, March 1997.
- Member, Board of Editors, *Journal of Network and Systems Management*, 1996-1998.
- Program Committee, *International Symposium on Integrated Network Management*, San Diego, 1997.
- Guest Editor, *Journal of Network and Systems Management, Special Issue on Routing in Broadband Networks*, December 1995 and June 1996.
- Invited participant, *ARPA Workshop on Survivability of Large Scale Systems*, Washington D.C., 1996.
- Special Event Organizer, *International Symposium on Integrated Network Management*, Santa Barbara, 1995.
- Organizing Committee, *International Symposium on Integrated Network Management*, Santa Barbara, 1995.
- Local Arrangements Chair, *IEEE Information Theory Workshop on Information Theory Multiple Access and Queueing*, St. Louis, 1995.
- Chair, *Communications Chapter, St. Louis Section of the IEEE*, 1995.
- Participant, *IEEE Information Theory Workshop on Information Theory, Multiple Access and Queueing*, St. Louis, 1995.
- Participant, *ARPA/AFOSR Non-Linear Optics and Communication Workshop*, Denver, 1994.
- Participant, *CNRI Giga Bit Network Workshop*, Washington D.C., 1993.
- Participant, *IFIP/IEEE International Workshop on Distributed Systems*, New Jersey, 1993.
- Program Committee, *International Conference on Computer Communications and Networks*, San Diego, 1992.
- Session Chair, *ISMM International Conference*, New Orleans, 1990.
- Senior Member, *IEEE*.
- Member, *IEEE Committee on Network Operations and Management*.
- Member, *IEEE Committee on Computer Communications*.
- Registered Specialist, *Hong Kong Research Grant Council*.

- Reviewer, *IEEE Transactions on Communications*.
- Reviewer, *IEEE Transactions on Networking*.
- Reviewer, *IEEE Journal on Selected Areas in Communications*.
- Reviewer, *Journal of Network and Systems Management*.
- Reviewer, *Telecommunication Systems*.
- Reviewer, Computers and Electrical Engineering.
- Reviewer, *ETRI Journal*.
- Reviewer, *IEEE Transactions on Automatic Control*.
- Reviewer, *IEEE Communications*.
- Book Reviewer, *Prentice Hall*.
- Book Reviewer, *Morgan Kaufmann Publishers, Inc.*
- Book Reviewer, *Irwin Publishing Co.*

University Activities:

- Undergraduate Studies Committee, School of Engineering and Applied Science (2012 – Present)
- Faculty Advisor for IEEE Student Chapter (2009 – Present)
- Ambassador for McDonnell International Scholar Academy (2007 – 2013)
- Web Development Committee (2006 – 2008)
- University Judicial Board (1998 - 2000)
- Resource Generation Committee (1994 - 1995)
- Top 20 Committee (1992 - 1995)
- Telecommunications Committee, Chair (1991 - 1997)
- Library Planning Committee (1991 - 1992)
- Computer Engineering Committee (1990 - 1996)
- Communications Curriculum Committee (1990 - 1992)
- Resources Committee (1990 - 1992)

Patents

<u>Patent No.</u>	<u>Date</u>	<u>Title</u>
7,110,411	09/19/06	Method of and Apparatus for WFQ Scheduling Using a Plurality of Scheduling Queues to Provide Fairness, High Scalability, and Low Computational Complexity
7,106,738	09/12/06	Method of and Apparatus for High Speed Packet Switching Using Train Packet Queuing and Providing High Scalability
6,859,455	02/22/05	Method of and Apparatus for Building and Using Multi-Dimensional

		Index Trees for Multi-Dimensional Data Objects
6,614,789	09/02/03	Method of and Apparatus for Matching Strings of Different Lengths
6,359,885	3/19/02	Multi-Channel Packet Switching Apparatus Having Traffic Flow Controlling and Checking Functions
6,128,292	10/03/00	Packet Switching Apparatus with Multi-Channel and Multi-Cast Switching Functions and Packet Switching System Using the Same
5,788,161	12/13/98	Network Designer for Communication Networks
5,526,352	06/11/95	Integrable Low Complexity Multi-Channel Switch
5,440,549	08/08/95	Nonblocking Multi-Channel Switching with Multicasting Capability

Publications

- Yu, Qixiang, Luo, Z., and Min, P.S., “Intrusion Detection in Wireless Sensor Networks for Destructive Intruders.” Proceedings of the APSIPA 2015 conference. December 16-19, 2015.
- Hung, C.P., and Min, P.S., “Simple Web Application Framework.” Submitted for publication in the IEEE Transactions on Cloud Computing.
- Luo, Z., and Min, P.S., “Parallel Implementation of Energy-Based Target Localization Methods in Wireless Sensor Networks.” Proceeding of the 2014 IEEE SOUTHEASTCON.
- Yu, Q., Luo, Z., and Min, P.S., “Intrusion Detection in Wireless Sensor Networks for Destructive Intruder.” Proceeding of 2014 International Conference on Smart Computing (SMARTCOMP 2014).
- Luo, Z., and Min, P.S., “Survey of Target Localization Methods in Wireless Sensor Networks,” 19th IEEE International Conference on Networks (ICON 2013), Singapore, December 11-13, 2013.
- Hung, C.P., and Min, P.S., “Deriving and Visualizing the Lower Bounds of Information Gain for Prefetch Systems,” 19th IEEE International Conference On Networks (ICON 2013), Singapore, December 11-13, 2013.
- Hung, C.P., and Min, P.S., “Access LUT without CAM - Improved Pearson Hashing for Collision Reduction,” 19th IEEE International Conference On Networks (ICON 2013), Singapore, December 11-13, 2013.
- Luo, Z and Min, P.S., “Target Localization in Wireless Sensor Networks for Industrial Control with Selected Sensors.” International Journal of Distributed Sensor Networks, Volume 2013 (2013), Article ID 304631.
- Hung, C.P., and Min, P.S. “Performance Evaluation of Distributed Mobile Application Virtualization Services,” International Journal on Advances in Internet Technology, Vol. 5, no. 3&4, 2012, pp. 65-83.
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- Hung, C.P. and Min, P.S., "Service Area Optimization For Application Virtualization Using UMTS Mobility Model," International Conference on Internet Computing, pp. 128-134, Las Vegas, July 18-21, 2011.
- Hung, C.P. and Min, P.S., "Application Virtualization Using UMTS Mobility Model," ICOMP'11, September, 2011.
- Hung, C.P. and Min, P.S., "Infrastructure Arrangement for Application Virtualization Service," the 9th International Information and Telecommunication Technologies Symposium, Vol.1, pp. 78-85, Rio de Janeiro, December 2010.
- Hung, C.P. and Min, P.S., "Probabilistic Approach to Network-Based Virtual Computing," the 9th International Information and Telecommunication Technologies Symposium, Vol.1, pp. 117-124, Rio de Janeiro, December 2010.
- Shiravi, A. and Min, P. S., "On the Latency Bound of Proportional Nested-DRR with Credit Adjusting," *2007 Workshop on High Performance Switching and Routing HPSR 2007*, July 2007.
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- Min, P.S., "Diagnosis of On-Board Sensors in Internal Combustion (IC) Engines," *Proceedings of the 1989 American Control Conference*, Pittsburgh, pp. 1065-1070, June 1989.
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Testimony Provided or Expected to Provide as Expert Witness

Matter: Patent Infringement for Mobile Devices
Law Firm: Quinn Emanuel

Case Name: Qualcomm v. Apple, Case No. 3:17-cv-00108-GPC-MDD (U.S.D.C.S.D. Cal.)
Testifying Expert for Qualcomm.
Retained in April 2017.
(Expert reports submitted.)

Matter: Patent Infringement for Communication Devices

Law Firm: Alston Bird

Case Name: Sycamore IP Holdings LLC v. Verizon Communications Inc, Case No. 2:16-cv-591-JRG-RSP (U.S.D.C. E.D. Texas)
Testifying Expert for Verizon and Level 3.
Retained in May 2017.
(Expert reports submitted, and deposed.)

Matter: Patent Infringement for Mobile Devices

Law Firm: Alston Bird

Case Name: Huawei Technologies Co. Ltd. V. Nokia Solutions and Networks, Case No. 2:16-cv-0056-JRG-RSP (U.S.D.C. E.D. Texas)
Testifying Expert for Nokia.
Completed in December 2017.
(Expert reports submitted.)

Matter: Patent Infringement for Mobile Devices

Law Firm: Quinn Emanuel

Case Name: Huawei Technologies Co. Ltd. V. Samsung Electronics C. Ltd, Case No. 3:16-cv-02787 (U.S.D.C. N.D. Cal)
Testifying Expert for Samsung.
Retained in August 2016.
(Expert reports submitted.)

Matter: Arbitration for Licensing

Law Firm: Alston Bird

Case Name: Nokia v. LG Electronics, International Chamber of Commerce Arb. No. 21326
Testifying Expert for Nokia.
Completed in October 2016.
(Expert reports submitted.)

Matter: Patent Infringement for Mobile Devices

Law Firm: Ropes and Gray

Case Name: Godo Kaisha IP Bridge 1 v. TCL Communication Technology Holdings, Case No. 15-634-SLR-SRF (U.S.D.C.S.D. Delaware.)
Testifying Expert for IP Bridge.
Retained in April 2016.
(Expert reports submitted.)

Matter: Patent Infringement for Mobile Devices
Law Firm: Paul Hastings
Case Name: Odyssey Wireless, Inc., v. Samsung Electronics Co., Ltd., et al, Case No. 3:15-cv-1738-H-RBB (U.S.D.C.S.D. Cal.)
Testifying Expert for Samsung.
Completed in October 2016.
(Expert reports submitted.)

Matter: Patent Infringement for Mobile Devices
Law Firm: Greenberg Traurig
Case Name: Mobile Telecommunications Technologies LLC v. Amazon.com, Inc., 2:13-cv-883-JRG-RSP (U.S.D.C. E.D. Texas)
Testifying Expert for Amazon.
Completed in April 2015.
(Expert reports submitted, and deposited.)

Matter: Patent Infringement for Mobile Devices
Law Firm: Mayer Brown
Case Name: Mobile Telecommunications Technologies LLC v. LG Electronics Mobilecomm U.S.A., Inc., 2:13-cv-947-JRG-RSP (U.S.D.C. E.D. Texas)
Testifying Expert for LG Electronics Mobilecomm.
Completed in February 2016.
(Expert reports submitted, and deposited.)

Matter: Patent Infringement for Semiconductor Devices
Law Firm: Mayer Brown
Case Name: Inter Parte Reexamination for U.S. Patent Nos. 6,895,520 and 6,899,332
Expert for LG Electronics.
Completed in February 2016.
(Expert declaration submitted, and deposited.)

Matter: Patent Infringement in Vehicular Electronics
Law Firm: Gardner, Linn, Burkhardt & Flory, L.L.P
Case Name: *Magna Electronics Inc. v. TRW Automotive Holdings Corp. et al.*, Civil Action No. 1:12-cv-00654 (Western District of Michigan), and relating to the action styled *Magna Electronics Inc. v. TRW Automotive Holdings Corp. et al.*, Civil Action No. 1:13-cv-00324 (Western District of Michigan).
Testifying Expert for Magna Electronics
Completed in February 2016.
(Expert reports submitted, and deposited.)

Matter: Patent Infringement in Electronic Circuits
Law Firm: Ropes and Gray
Case Name: Certain Devices Containing Non-Volatile Memory and Products Containing the Same (USITC Inv. Nos. 337-TA-922)
Testifying Expert for Spansion Inc.
Completed in February 2015.
(Expert reports submitted.)

Matter: Trade Secret Misappropriation in Software Method for Cable Television Advertisement
Law Firm: Brownstein Hyatt Farber Schreck
Case Name: Cross MediaWorks v. EMT Holdings, USDC Southern District of New York, Case No. 1:14-cv-00561-VSB
Testifying Expert for Cross MediaWorks.
Completed in April 2015.
(Testified during injunction hearing.)

Matter: Patent Infringement in Vehicular Electronics
Law Firm: Steptoe and Johnson
Case Name: Certain Vision-Based river Assistance System Cameras and Components Thereof (USITC Inv. Nos. 337-TA-899 and 907)
Testifying Expert for Magna Electronics
Completed in February 2015.
(Expert reports submitted, deposed, and testified during trial.)

Matter: Patent Infringement for Vehicular System
Law Firm: Susman Godfrey
Case Name: Eagle Harbor Holdings, LLC, and Mediustech, LLC, v. Ford Motor Company, 3:11-cv-05503-BHS (U.S.D.C. Western District of Washington at Tacoma)
Testifying Expert for Mediustech.
Completed in March 2015.
(Expert reports submitted, deposed, and testified during trial.)

Matter: Patent Infringement for Communication Networks
Law Firm: Davis Polk & Wardwell LLP
Case Name: Sprint Communications Company L.P., v. Comcast Cable Communications, LLC, Comcast IP Phone, LLC, and Comcast Phone of Kansas, LLC. 2:11-cv-02684-KHV-DJW (U.S.D.C. Kansas)
Testifying Expert for Comcast.
Retained in March 2012.
(Expert reports submitted, and deposed.)

Matter: Patent Infringement for Communication Networks
Law Firm: Quinn Emanuel
Case Name: France Telecom S.A. v. Marvell Semiconductor, Inc., 12-Civ-4986 (S.D.N.Y.)

Testifying Expert for Marvell.
Completed in September 2014.
(Expert reports submitted, deposed, and testified during trial.)

Matter: Wireless Image Distribution
Law Firm: Jones Day
Case Name: *Inter Partes* Review of U.S. Patent No. 8,437,797
Expert for Google Inc.
Completed in November 2014.
(Expert declaration submitted.)

Matter: Nonvolatile Semiconductor Memories
Law Firm: Jones Day
Case Name: *Inter Partes* Review of U.S. Patent Nos. 8,301,833 and 8,516,187
Expert for SanDisk.
Completed in May 2014.
(Expert declaration submitted.)

Matter: Communication Protocols for Wireless Device
Law Firm: Dorsey & Whitney, LLP
Case Name: Certain Point-To-Point Network Communication Devices and Products
Containing Same (USITC Inv. No. 337-TA-892)
Testifying Expert for Toshiba
Completed in May 2014.
(Expert reports submitted, and deposed.)

Matter: Patent Infringement for Wireless Networks
Law Firm: Ropes and Gray
Case Name: In the Matter of Certain Wireless Devices With 3G and/or 4G Capabilities and
Components Thereof (USITC Inv. No. 337-TA-868) InterDigital Comms., Inc. v.
Huawei Techs. Co., Ltd., No. 13-00008 (D. Del., filed January 2, 2013),
InterDigital Comms., Inc. v. ZTE Corp., No. 13-00009 (D. Del., filed January 2,
2013), InterDigital Comms., Inc. v. Nokia Corp., No. 1:13-cv-00010 (D. Del.,
filed January 2, 2013), InterDigital Comms., Inc. v. Samsung Elec. Co., Ltd., No.
13-00011 (D. Del., filed January 2, 2013)
Testifying Expert for Joint Defense Group.
Completed in February 2014.
(Expert reports submitted, deposed, and testified during trials.)

Matter: Patent Infringement for Mobile Communication
Law Firm: Finnegan, Henderson, Farabow, Garrett & Dunner, L.L.P.
Case Name: Certain Digital Media Devices, Including Televisions, Blu-Ray Disc Players,
Home Theater Systems, Tablets and Mobile Phones, Components Thereof and
Associated Software (USITC Inv. No. 337-TA-882)
Testifying Expert for LG Electronics, Inc.
Completed in February 2014.

(Expert reports submitted, deposed, and testified during trial.)

Matter: Patent Infringement for Wireless Networks
Law Firm: Vinson & Elkins LLP
Case Name: Wi-LAN USA, Inc. and Wi-LAN, Inc. v. Telefonaktiebolaget LM Ericsson and Ericsson, Inc. (USDC: Southern District of FL - Case #1: 12-cv-23569), Wi-LAN USA, Inc. and Wi-LAN, Inc. v. Alcatel-Lucent USA, Inc. (USDC: Southern District of FL - Case #1: 12-cv-23568-Altonaga/Simonton)
Testifying Expert for Wi-LAN.
Completed in May 2015.
(Expert reports submitted, and deposed.)

Matter: Patent Infringement for Data Storage
Law Firm: Ropes and Gray, Weil Gotshal
Case Name: Summit Data Systems, LLC v. EMC Corporation., et al. 1:10-cv-00749-GMS (U.S.D.C. Delaware)
Testifying Expert for EMC Corporation and Netapp, Inc.
Completed in December 2012.
(Expert reports submitted, and deposed.)

Matter: Patent Infringement for Wireless Mobile Device
Law Firm: Ashurst Australia
Case Name: Samsung v. Apple, Australian Federal Court Proceeding No. NSD 1243 of 2011
Testifying Expert for Samsung Electronics.
Completed in December 2012.
(Expert reports submitted, deposed, and testified during trial.)

Matter: Patent Infringement for Wireless Mobile Devices
Law Firm: Quinn Emanuel
Case Name: Apple Inc. v. Samsung Electronics Co., Ltd., et al., 4:11-cv-01846-LHK (N.D. Cal.) and Samsung Electronics Co., Ltd., et al. v. Apple Inc., 4:11-cv-02079 (N.D. Cal.)
Testifying Expert for Samsung Electronics.
Completed in July 2012.
(Expert reports submitted, and deposed.)

Matter: Patent Infringement for Wireless Mobile Device
Law Firm: Quinn Emanuel
Case Name: Certain Electronic Devices, Including Wireless Communication Devices, Portable Music And Data Processing Devices, And Tablet Computer, U.S.I.T.C. Inv. No. 337-TA-794
Testifying Expert for Samsung Electronics.
Completed in June 2012.
(Expert reports submitted, deposed, and testified during trial.)

Matter: Patent Infringement for Portable Storage Device

Law Firm: White and Case
Case Name: CERTAIN UNIVERSAL SERIAL BUS (“USB”) PORTABLE STORAGE DEVICES, INCLUDING USB FLASH DRIVES AND COMPONENTS THEREOF, US International Trade Commission Investigation No. 337-TA-788
Testifying Expert Witness for Trek
Completed in May 2012.
(Expert reports submitted, and deposited.)

Matter: Copyright Infringement for Petroleum Processing Software
Law Firm: Osha Liang LLP
Case Name: Aspen Technology, Inc. v. Tekin A. Kunt and M3 Technology, Inc., Case Number: H-10-1127, US District Court, Texas, Houston Division.
Testifying Expert for M3 Technology, Inc.
Completed in May 2012.
(Expert reports submitted, deposited, and testified during trial.)

Matter: Trade Secret Misappropriation for DC-DC converter
Law Firm: Covington & Burling, Haynes Boone
Case Name: Certain DC—DC Controllers and Products Containing Same, US International Trade Commission Investigation No. 337-TA-698
Testifying Expert for UPI.
Completed in March 2012.
(Expert reports submitted, deposited, and testified during trial.)

Matter: Patent Infringement for Parallel Processor
Law Firm: Orrick, Herrington, & Sutcliffe. Kirkland and Ellis.
Case Name: BIAx Corporation v. Nvidia and Sony Civil Action No. 09-cv-01257-PAB-MEH
Testifying Expert for Nvidia and Sony
Completed in March 2012.
(Expert reports submitted, and deposited.)

Matter: Patent Infringement for Call Center Technology
Law Firms: Duffy, Sweeney, and Scott. Foley Lardner.
Case Name: Ronald Katz Technology Licensing v. Citizens Financial Group 7-ML-1816-C RGK (FFM)
Testifying Expert Witness for Citizens Financial Group.
Completed in 2011.
(Expert reports submitted, and deposited.)

Matter: Patent Infringement for Storage Area Network
Law Firm: DLA Piper
Case Name: Network Appliance, Inc., v. Sun Microsystems, Inc., Case Number: C-07-06053 EDL, US District Court, Northern District of California, San Francisco Division.
Testifying Expert for Sun Microsystems, Inc.
Completed in 2010.
(Expert reports submitted, and deposited.)

Matter: Patent Infringement for Flat Panel Display Controller
Law Firm: Jones Day
Case Name: Certain Video Displays, Components Thereof, and Products Containing Same, US International Trade Commission Investigation No. 337-TA-687
Testifying Expert for Vizio, Inc.
Completed in 2010.
(Expert reports submitted, deposed, and testified during trial.)

Matter: Patent Infringement for Call Center Technology
Law Firms: Foley Lardner
Case Name: Ronald Katz Technology Licensing v. US Bank 7-ML-1816-C RGK (FFM)
Testifying Expert Witness for US Bank
Completed in May 2009.
(Expert reports submitted, and deposed.)

Matter: Patent Infringement for USB to VGA Converter
Law Firm: Wang Hartmann, Gibbs, & Cauley, P.C.
Case Name: Displaylink Corporation v. Magic Control Technology Corporation, Case No. 5:07-CV-01998-RMW, US District Court, Northern District of California, San Francisco Division.
Testifying Expert for Magic Control Technology Corporation
Completed in 2009.
(Expert reports submitted, and deposed.)

Matter: Patent Infringement for Flash Memory
Law Firm: Jones Day and Wilson Sansini
Case Name: Certain Flash Memory Controllers, Drives, Memory Card, and Media Players and Products Containing Same. US International Trade Commission Investigation No. 337-TA-619
Testifying Expert for SanDisk Corporation.
Completed in 2008.
(Expert reports submitted, deposed, and testified during trial.)

Matter: Patent Infringement for Semiconductor Packaging
Law Firm: Jones Day
Case Name: Certain Semiconductor Chips with Minimized Chip Package Size and Products Containing the Same. US International Trade Commission Investigation No. 337-TA-605
Testifying Expert for Freescale Semiconductor
Completed in 2008.
(Expert reports submitted, deposed, and testified during trial.)

Matter: Patent Infringement for Automatic Switching System
Law Firms: Jones Day, and Heller Ehrman, LLP.

Case Name: ATEN International Co., Ltd and ATEN Technology, Inc. v. Belkin Corporation, Belkin Logistics, Inc. and Emine Technology Co., Ltd. US International Trade Commission Investigation No. Ltd 337-TA-589
Testifying Expert for Belkin Corporation, Belkin Logistics, Inc., and Emine Technology Co., Ltd.
Completed in 2007.
(Expert reports submitted, deposed, and testified during trial.)

Matter: Patent Infringement for Dual Mode Communication
Law Firm: Wilmer Cutler Pickering Hale and Dorr, LLP
Case Name: Broadcom Corporation v. Qualcomm Incorporated SACV05-467-JVS (RNBx)
Testifying Expert Witness for Broadcom Corporation
Completed in 2007.
(Expert reports submitted, deposed, and testified during trial.)

APPENDIX B

Exhibit No.	Description	Date	Identifier
1001	U.S. Patent No. 6,760,590 to Miyoshi et al.	April 1, 2002 (Priority Date)	'590 Patent
1002	File History for the '590 Patent	n/a	'590 Patent File History
1009	PCT Application No. PCT/US98/23428 to Padovani et al.	November 3, 1997 (Priority Date)	Padovani
1010	W. van Gils, "Design of error-control coding schemes for three problems of noisy information transmission, storage and processing," Ph.D., dissertation, Eindhoven Univ. of Technology, Eindhoven, the Netherlands, 1988.	January 1, 1988 (Publication date)	Gils
1011	European Patent No. 0083127 B1 to Driessen	December 14, 1982 (Filing Date)	Driessen
1012	B. Masnick and J. Wolf, "On Linear Unequal Error Protection Codes," IEEE Transactions on Information Theory, vol. IT 13, no. 4, pp. 600-607, July 1967.	October of 1967 (Publication Date)	Masnick
1013	United States Patent No. 7,245,594 to Esteves et al.	May 12, 2000 (Filing Date)	Esteves
1014	United States Patent No. 7,079,550 to Padovani et al.	Dec. 12, 2002 (Filing Date)	Padovani 550
1015	United States Patent No. 6,975,611 to Balachandran et al.	Mar. 3, 2000 (Filing Date)	Balachandran

Exhibit No.	Description	Date	Identifier
1016	K. Balachandran, R. Ejzak, S. Nanda, S. Vitebskiy, S. Seth, "GPRS- 136: High-Rate Packet Data Service for North American TDMA Digital Cellular Systems," IEEE Personal Communications, vol. 6, pp. 34-47, June 1999.		Balachandran 136
1017	Corrected Declaration of Paul Min, Ph.D. and Curriculum Vitae	n/a	Min
1018	A.O. Mabogunje, P.G. Farrell, "Construction of Unequal Error Protection Codes," Lecture Notes in Computer Science, vol. 514, Eurocode '90, pp. 87-93, November 1990.	June of 1991 (Publication Date)	Mabogunje
1019	U.S. Patent No. 5,691,992 to Molnar et al	October 12, 1995 (Filing Date)	Molnar
1020	United States Patent 6,665,831 to Yoshida et al.	January 6, 2000 (Filing Date)	Yoshida
1021	United States Patent No. 4,747,104 to Piret	June 5, 1986 (Filing Date)	Piret
1022	United States Patent 6,292,917 to Sinha et al.	September 30, 1998 (Filing Date)	Sinha
1023	Philips Journal of Research, Vol. 39, no. 6, 1984		1984 Philips Journal
1024	Declaration of Ximena Solano	n/a	Solano
1025	Webpages from WorldCat.org database re Gils Dissertation	July 27, 2018	
1026	Correspondence with University of South Wales re Gils Dissertation	July 29, 2018 – August 7, 2018	

Exhibit No.	Description	Date	Identifier
1027	Webpages from the German National Library of Science and Technology (“TIB - Leibniz Information Centre for Science and Technology and University Library”)		
1028	Correspondence with TIB re Gils Dissertation	July 30, 2018 – July 31, 2018	
1029	Correspondence with Karlsruher Institute of Technology (KIT)	July 28, 2018 – July 31, 2018	
1030	Correspondence with Hamburg University of Technology (TUHH)	July 28, 2018 – July 31, 2018	
1031	Correspondence with Saxon State and University Library Dresden (SLUB)	July 28, 2018 – August 13, 2018	
1032	Correspondence with Eindhoven University of Technology (TU/e)	July 28, 2018 – July 29, 2018	
1033	Correspondence with Tilburg University	July 28, 2018 – July 30, 2018	
1034	Philips Technical Review 1988 (downloadable today)	August 14, 2018	
1035	Screenshot from Stanford University Library website displaying Philips Tech. Rev.	August 20, 2018	
1036	Screenshot from Stanford University Library website displaying Philips Journal	August 21, 2018	
1037	Declaration of Oliver Heinisch	n/a	Heinisch

Exhibit No.	Description	Date	Identifier
1038	Certified translated copy of Correspondence with Hamburg University of Technology (TUHH)	July 31, 2018 – August 2, 2018	
1039	Certified translated copy of Correspondence with TIB	August 1, 2018 – August 15, 2018	
1040	Certified translated copy of Correspondence with the Universitätsbibliothek Stuttgart	August 1, 2018 – August 14, 2018	
1041	Certified translated copy of Correspondence with Karlsruher Institut für Technologie (KIT)	August 1, 2018 – August 14, 2018	
1042	Declaration of Otto Steinbusch	n/a	Steinbusch
1043	Certified translated copy of correspondence with Eindhoven University of Technology	July 30, 2018 – August 2, 2018	
1044	Certified translated copy of correspondence with Bibliotheek UvA/HvA (AMSTERDAM)	July 30, 2018 – August 1, 2018	
1045	Certified translated copy of correspondence with the KB National Library of The Netherlands	July 30, 2018 – August 1, 2018	
1046	Declaration of Bruce Liebman	n/a	Liebman
1047	Correspondence with University of California Riverside (UCR) re the 1984 Philips Journal	August 15, 2018	
1048	Correspondence with California State University, Sacramento (CSU) re the 1988 Philips Tech. Rev.	August 15, 2018	

Exhibit No.	Description	Date	Identifier
1049	Online Catalog Records for the 1984 Philips Journal	August 16, 2018	
1050	Online Catalog Records for the Philips Tech. Rev.	August 16, 2018	
1051	Declaration of Gerard P. Grenier (“IEEE Declaration”)	n/a	Grenier
1052	Declaration of Steve Wasserman (“Retriev-it Declaration”)	n/a	Wasserman
1053	United States patent 6,167,031 to Oloffson et al.	August 29, 1997	Olofsson
1054	L. Dunning and W.E. Robbins, “Optimal Encodings of Linear Block Codes for Unequal Error Protection,” Information and Control vol. 37, pp. 150-177 (1978).	1978	Dunning
1055	A. B. Carlson, “Communication Systems An Introduction to Signals And Noise in Electrical Communication,” McGraw-Hill, Inc., 1975.	1975	Carlson
1056	Léon M. H. E. Driessen, “On an Infinite Series of $[4n, 2n]$ Binary Codes,” IEEE Transactions on Information Theory, Vol. IT-30, No. 2 (March 1984)	March 1984	Driessen II