

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent of:	Lande	Attorney Docket No.: 55851-0028IP2
U.S. Patent No.:	7,593,492	
Issue Date:	September 22, 2009	
Appl. Serial No.:	11/532,125	
Filing Date:	September 15, 2006	
Title:	COMBINATIONAL HYBRID TURBO-MUD	

DECLARATION OF DR. PAUL S. MIN

I declare that all statements made herein on 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 under Section 1001 of Title 18 of the United States Code.

Date: April 24, 2025

By: 
Paul S. Min, Ph.D.

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DECLARATION OF DR. PAUL S. MIN

I, Paul S. Min, of Saint Louis, MO, declare that:

I. QUALIFICATIONS AND BACKGROUND INFORMATION

1. My name is Paul S. Min and I have been retained as an expert witness by Petitioners Lenovo (United States) Inc. (“Lenovo”) and Motorola Mobility LLC (“Motorola”) to provide assistance regarding U.S. Patent No. 7,593,492 (“the ’492 patent”). Specifically, I have been asked to consider the validity of claims 1-3, 5-13, and 15-17 of the ’492 patent (the “Challenged Claims”).

2. I have been retained by Petitioners, as an independent expert in this proceeding before the United States Patent and Trademark Office. Although I am being compensated at my usual and customary rate, no part of my compensation depends on the outcome of this proceeding, and I have no other interest in this proceeding.

3. I understand that this proceeding involves the ’492 Patent, and I have been asked to consider the validity of certain claims of the ’492 Patent based on certain prior art references. I have also been asked to consider the state of the art and prior art available as of September 15, 2006. Based on the prior art discussed in this declaration, it is my opinion that claims 1-3, 5-13, and 15-17 of the ’492 Patent are unpatentable for the reasons provided below.

4. I believe that I am well qualified to serve as a technical expert in this matter based upon my educational and work experience, and specifically, in the field of mobile networks and signal processing. My curriculum vitae (“CV”) is submitted with this declaration as Appendix A.

5. Of note, as shown in my CV, I have extensive experience design and implementation of receiver devices to be used in the cellular equipment and the WLAN equipment.

6. 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.

7. 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.

8. 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.

9. 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.

10. 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).

11. I have supervised numerous graduate students, many of whom received a doctoral degree under my guidance. A number of doctoral theses that I have supervised relate specifically to 4G LTE, 5G NR, and other cellular technologies. In particular, my students and I have published a number of peer-reviewed articles on resource allocation, scheduling, modulation, mobility management, and multiplexing. Several of these articles received accolades in the field. For example, in 2011, we received a best paper award in the category of cellular-standard related mobility and resource management at the prestigious Mobility 2011 international conference.

12. 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.

13. 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).

14. I am a named inventor on eleven U.S. patents, many of which are directly related to signal processing, 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. I have organized several international conferences and served as an international journal editor.

15. 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).

16. In my more than 35 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.

17. My CV includes a list of publications on which I am a named author. It contains further details regarding my experience, education, publications, and other qualifications to render an expert opinion in connection with this proceeding.

18. In writing this Declaration, I have considered the following: my own knowledge and experience, including my work experience in mobile systems and networks; my experience in teaching those subjects; and my experience in working with others involved in those fields. In addition, I have analyzed the following publications and materials, in addition to other materials I cite in my declaration:

- U.S. Patent No. 7,593,492 (EX1001), and excerpts of its accompanying prosecution history (EX1002)

- U.S. Publication No. 2004/0213360 (“McElwain”) (EX1004)
- International Publication No. WO2006/092090 (“Wang”) (EX1005)
- U.S. Publication No. 2007/0060061 (“Sampath”) (EX1006)
- U.S. Publication No. 2003/0193966 (“Mills”) (EX1007)
- U.S. Publication No. 2006/0188031 (“Liu”) (EX1008)
- Adaptive Modulation and Adaptive Antenna Array Assisted Network Performance of Multi-User Detection Aided UTRA-like FDD/CDMA Systems (2002), *available at* <https://eprints.soton.ac.uk/257148/1/jsb-lh-vtcfall-2002.pdf> (EX1009)
- Single- and Multi-Carrier CDMA: Multi-User Detection, Space-Time Spreading, Synchronization and Standards (2003), *available at* https://eprints.soton.ac.uk/258485/3/sample-chaps1%252C2%252C9%252C17_singlepdf.pdf (EX1010)
- U.S. Publication No. 2002/0037061 (“Learned”) (EX1011)
- Adaptive Symbol and Parameter Estimation in Asynchronous Multiuser CDMA Detectors (1997), *available at* https://www.researchgate.net/profile/Teng-Lim-3/publication/3159141_Adaptive_symbol_and_parameter_estimation_in_asynchronous_multiuser_CDMA_detectors/links/09e4150b595e286cbf000000

/Adaptive-symbol-and-parameter-estimation-in-asynchronous-multiuser-CDMA-detectors.pdf (EX1012)

- Hybrid Iterative Multiuser Detection for Channel Coded Space Division Multiple Access OFDM Systems (2006), *available at* <https://eprints.soton.ac.uk/262110/1/46-tvt06-jiang-ng-hanzo.pdf> (EX1013)
- Multi-User Detection for DS-CDMA Communications (1996), *available at* http://cs-www.cs.yale.edu/homes/yry/readings/wireless/wireless_readings/article16.pdf (EX1014)
- Hopfield Neural Network Implementation of the Optimal CDMA Multiuser Detector (1995), *available at* <https://citeseerx.ist.psu.edu/document?repid=rep1&type=pdf&doi=aff318a439822a7ab47683b1e604a03bce633d26> (EX1015)
- Application of Density Evolution in Turbo-MUD Design for Overloaded Coded CDMA Systems (2004), *available at* <https://flore.unifi.it/bitstream/2158/238224/1/Application%20of%20Density%20Evolution%20in%20Turbo-MUD%20Design%20for%20Overloaded%20Coded%20CDMA%20Systems.pdf> (EX1016)

- An Iterative Multiuser Receiver Using Partial Parallel Interference Cancellation for Turbo-Coded DS-CDMA Systems (2004), *available at* <https://ieeexplore.ieee.org/document/965116> (EX1017)
- A Low-Complexity Iterative Multiuser Receiver for Turbo-Coded DS-CDMA Systems (2001), *available at* <https://core.ac.uk/download/pdf/61613862.pdf> (EX1018)
- Computational Complexity and Performance of RAKE Receivers with Channel Estimation for DS-UWB (2005), *available at* https://www.researchgate.net/profile/Tomoaki-Ohtsuki/publication/220242734_Computational_Complexity_and_Performance_of_RAKE_Receivers_with_Channel_Estimation_for_DS-UWB/links/551d5c0a0cf2fcae4456d460/Computational-Complexity-and-Performance-of-RAKE-Receivers-with-Channel-Estimation-for-DS-UWB.pdf (EX1019)
- Iterative Multiuser Interference Reduction: Turbo CDMA (1999), *available at* https://www.researchgate.net/publication/3159939_Iterative_Multiuser_Interference_Reduction_Turbo_CDMA (EX1020)
- Complexity in Geometric SINR (2007), *available at* <https://www.researchgate.net/profile/Yvonne-Anne->

Pignolet/publication/221628472_Complexity_in_geometric_SINR/links/544129930cf2a6a049a56308/Complexity-in-geometric-SINR.pdf (EX1021)

- The Eigen-decomposition: Eigenvalues and Eigenvectors (2007), *available at* <https://malabdali.com/wp-content/uploads/2023/10/Abdi-EVD2007-pretty.pdf> (EX1022)
- Harville, *Matrix Algebra From a Statistician's Perspective* (1997) (EX1023)
- Direction of Arrival Estimation Using the Parameterized Spatial Correlation Matrix (2007), *available at* https://www.wirelesslab.ca/File/pdf_files/journals/J015.pdf (EX1024)
- Correlation Matrix Distance, a Meaningful Measure for Evaluation of Non-Stationary MIMO Channels (2005), *available at* <https://citeseerx.ist.psu.edu/document?repid=rep1&type=pdf&doi=d09aefac68ac3ef15829ef55e18b7fb166c559c5> (EX1025)
- Claim Construction Order in *Collision Communications, Inc. v. Nokia Networks and Solutions Oy et al.*, 2-21-cv-00308 (EDTX) (Aug. 31, 2022) (EX1100)
- *Samsung Electronics America, Inc. v. Collision Communications, Inc.*, Case No IPR2024-01247, Paper No. 14 (PTAB Feb. 7, 2025) (EX1101)

II. LEGAL PRINCIPLES

19. In forming my opinions and considering the subject matter of the '492 patent and its claims in light of the prior art, I am relying on certain legal principles that counsel in this case explained to me. My understanding of these concepts is summarized below.

20. I understand that the claims define the invention. I also understand that an unpatentability analysis is a two-step process. First, the claims of the patent are construed to determine their meaning and scope. Second, after the claims are construed, the content of the prior art is compared to the construed claims.

21. I understand that a claimed invention is only patentable when it is new, useful, and non-obvious in light of the “prior art.” That is, the invention, as defined by the claims of the patent, must not be anticipated or rendered obvious by the prior art.

A. Anticipation

22. I understand that under 35 U.S.C. § 102, a patent claim is invalid if its subject matter was patented or described in a printed publication before the effective filing date of the claimed invention. I have been told that this is referred to as invalidity by anticipation. I have been told that a patent claim is anticipated under § 102 if a single prior art reference discloses all limitations of the claimed invention.

B. Obviousness

23. I understand that a patent claim is invalid as obvious if the claimed invention would have been obvious to a person of ordinary skill in the art (“POSITA”) at the time the claimed invention was made. This means that even if all of the elements of the claim cannot be found in a single prior art reference that would anticipate the claim, a person of ordinary skill in the field who knew about all the prior art would have come up with the claimed invention. I understand that in an obviousness determination, the person of ordinary skill in the art is presumed to have knowledge of all material prior art. I understand that whether a claim is obvious is based upon the determination of several factual issues.

24. I understand that obviousness is a determination of law based on underlying determinations of fact. I understand that these factual determinations include the scope and content of the prior art, the level of ordinary skill in the art, the differences between the claimed invention and the prior art, and secondary considerations of non-obviousness.

25. In considering obviousness, I understand that one must determine the scope and content of the prior art. I understand that, in order to be considered as prior art to a patent being considered, a prior art reference must be reasonably related to the claimed invention of that patent. A reference is reasonably related if it is in the same field as the claimed invention or is from another field to which a person of ordinary skill in the art would look to solve a known problem.

26. I understand that one must determine what differences, if any, existed between the claimed invention and the prior art.

27. I understand that a patent claim composed of several elements is not proved obvious merely by demonstrating that each of its elements was independently known in the prior art. In evaluating whether such a claim would have been obvious, one may consider whether a reason has been identified that would have prompted a person of ordinary skill in the art to combine the elements or concepts from the prior art in the same way as in the claimed invention. There is no single way to define the line between true inventiveness on the one hand (which is patentable) and the application of common sense and ordinary skill to solve a problem on the other hand (which is not patentable). For example, market forces or other design incentives may be what precipitated a change, rather than true inventiveness.

28. I understand that whether a prior art reference renders a patent claim unpatentable as obvious is determined from the perspective of a person of ordinary skill in the art at the time of the alleged invention. I have been told that there is no requirement that the prior art contain an express suggestion to combine known elements to achieve the claimed invention, but a suggestion to combine known elements to achieve the claimed invention may come from the prior art, as filtered through the knowledge of one skilled in the art. In addition, I have been told that the

inferences and creative steps a person of ordinary skill in the art would employ are also relevant to the determination of obviousness.

29. I understand that there is no rigid rule that a reference or combination of references must contain a “teaching, suggestion, or motivation” to combine references. But I also understand that the “teaching, suggestion, or motivation” test can be a useful guide in establishing a rationale for combining elements of the prior art. I have been told that this test poses the question as to whether there is an express or implied teaching, suggestion, or motivation to combine prior art elements in a way that realizes the claimed invention, and that it seeks to counter impermissible hindsight analysis.

30. I understand that one may consider, e.g., whether (1) the change was merely the predictable result of using prior art elements according to their known functions, or whether it was the result of true inventiveness; (2) there is some teaching or suggestion in the prior art to make the modification or combination of elements claimed in the patent; (3) the claimed innovation applies a known technique that had been used to improve a similar device or method in a similar way; (4) the claimed invention would have been obvious to try, meaning that the claimed innovation was one of a relatively small number of possible approaches to the problem with a reasonable expectation of success by those skilled in the art; (5) the invention merely substituted one known element for another known element in order

to obtain predictable results; (6) the invention merely applies a known technique to a known device, method, or product to yield predictable results; or (7) known work in the field may have prompted variations of use of the same inventions in the same or different fields due to market forces or design incentives that would have been predictable to a person of ordinary skill in the art.

31. I understand that any assertion of secondary considerations of non-obviousness must be accompanied by a nexus between the merits of the invention and the evidence offered.

III. OVERVIEW OF CONCLUSIONS FORMED

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

- Based upon my knowledge and experience and my review of the prior art publications listed above, I believe that claims 1-3, 5-13, 15-17 of the '492 patent are obvious over McElwain in view of Wang.
- Based upon my knowledge and experience and my review of the prior art publications listed above, I believe that claims 1-3, 5-13, 15-17 of the '492 patent are obvious over McElwain in view of Sampath.
- Based upon my knowledge and experience and my review of the prior art publications listed above, I believe that claims 1-3, 5-13, 15-17 of the '492 patent are obvious over Mills in view of Liu.

- Based upon my knowledge and experience and my review of the prior art publications listed above, I believe that claims 10-13, 15, 16 of the '492 Patent are obvious over Mills, in view of Liu, and further in view of Sampath.

IV. BACKGROUND KNOWLEDGE ONE OF SKILL IN THE ART WOULD HAVE HAD PRIOR TO THE PRIORITY DATE OF THE '492 PATENT

33. I am informed that patentability must be analyzed from the perspective of “one of ordinary skill in the art” in the same field as the '492 patent at the time of the invention. As previously discussed, the relevant time of invention is the patent's priority date, which is no earlier than September 15, 2006. Moreover, I understand that whether or not a patent application provides “written description” support for patent claims must also be assessed from the perspective of a person of ordinary skill in the art.

34. I am also informed that several factors are considered in assessing the level of ordinary skill in the art, including (1) the types of problems encountered in the art; (2) the prior art solutions to those problems; (3) the rapidity with which innovations are made; (4) the sophistication of the technology; and (5) the education level of active workers in the field.

35. Based on the foregoing and upon my experience in this area, a person of ordinary skill in the art (“POSITA”) relating to the subject matter of the '492

patent by the Critical Date (Sep. 15, 2006) would have had a bachelor's degree in electrical engineering, computer engineering, computer science, or a related field, and at least two years of experience with cellular telecommunications, radio-access network architectures, protocols and signal propagation in wireless networks. A higher level of education or skill might make up for less experience, and vice versa.

36. Based on my experiences, I have a good understanding of the capabilities of a POSITA as I was such an individual at the time of the Critical Date. Moreover, I have taught, participated in organizations, and worked closely with many such persons over the course of my career.

37. Although I surpass this definition of one of ordinary skill in the art now and at the priority date of the '492 patent, my analysis regarding the '492 patent has been based on the perspective of one ordinary skill in the art as of the priority date of the '492 patent.

38. I am also familiar with the knowledge of the person of ordinary skill in the art as of the priority date of the '492 patent. I am able to opine on how the person of ordinary skill in the art would have understood the disclosure and claims of the '492 patent, the disclosures of the prior art, the motivation to combine the prior art, and what combinations would have been obvious to one of ordinary skill in the art.

V. INTERPRETATIONS OF THE '492 PATENT CLAIMS AT ISSUE

39. For purposes of my analysis in this IPR proceeding, I understand that the terms that appear in the claims of the '492 patent should be interpreted according to their “ordinary and customary meaning,” which is sometimes called the *Phillips* standard. In determining the ordinary and customary meaning, I understand that the words of a claim are first given their plain meaning that those words would have had to a POSITA at the time. I also understand that the structure of the claims, the specification, and the file history also may be used to better construe a claim insofar as the plain meaning of the claims cannot be understood. Moreover, I understand that even treatises and dictionaries may be used, albeit under limited circumstances, to determine the meaning attributed by a POSITA to a claim term at the time of filing. I have followed this approach in interpreting terms of the Challenged Claims herein.

40. One claim interpretation issue that I noticed in the claims of the '492 patent is that Claim 1 requires a “multi-user detector decision unit” that uses “decision criteria” to “determine a selected multi-user detector.” Counsel have informed me that this element has been previously construed by a Federal District Court in another litigation matter involving the '492 patent. EX1100, 65-74. I also understand that the Board in an earlier-filed petition, filed by another petitioner, found the District Court’s claim construction analysis to be persuasive, further in view of Patent Owner’s and the other petitioner’s agreement on claim construction. EX1101, 10-12.

41. I understand that the Court previously held that a “multi-user detector decision unit” is a means-plus-function term that must be interpreted under 35 U.S.C. §112, sixth paragraph. EX1100, 72-74. Specifically, I understand that the Court identified “MUD decision unit 220” and “decision logic unit 520” as corresponding structure and held that an alleged multi-user detector decision unit must be able to “perform one or more of the algorithms described at 8:12–18, 13:35–14:40, 15:3–21, 19:43–48, 19:56–62, and 20:41–49” of the ’492 patent to meet the corresponding structure. EX1100, 73-74. These algorithms include, for example, “at least one threshold selected from at least one of the group consisting of number of symbols, correlation matrix between users, expected bit error rate, eigendecomposition of correlation matrix, signal to interference plus noise ratio, and expected SINR.” EX1001, 8:12-18. Even if the Board maintains that the “multi-user detector decision unit” that uses “decision criteria” to “determine a selected multi-user detector” invokes §112, sixth paragraph, consistent with the requirements of 37 C.F.R. §42.104(b)(3), it is apparent that “specific portions of the specification” purportedly describing structures that correspond to the recited function of the element are identified below. *Infra*, §VII (Grounds 1A-2B). The analysis and prior art mapping presented in this Petition applies regardless of whether §112, sixth paragraph is deemed to apply.

VI. THE ’492 PATENT

A. Overview of the '492 patent

42. The '492 patent generally describes a multi-user detection (MUD¹) system. EX1001, 1:19-43, Abstract, 7:6-28. I noticed that the MUD system of the '492 patent is part of a cellular base station operating within a cellular network. EX1001, 1:44-51. This MUD system can receive signals from multiple cellular devices in communication with the base station. EX1001, 1:44-51. Each cellular device can be associated with a respective user, meaning that the received signals come from multiple users. EX1001, 1:44-51. Cellular networks can operate according to communication protocols such as Code Division Multiple Access (CDMA) protocols. EX1001, 2:6-14. One notable feature of CDMA is that multiple signals can share the same frequency at the same time. EX1001, 2:6-14. Such overlap can lead to interference between signals. EX1001, 2:6-14, 3:20-42, 4:4-14. It is clear that the MUD system of the '492 patent can process received signals to remove interference and isolate the signal associated with each user. EX1001, 3:54-5:44, 7:40-44, 11:57-12:51.

¹ I am using the acronym "MUD" in this declaration refer to (1) multi-user/multiuser *detection* or (2) multi-user/multiuser *detector*, and this is consistent with the acronym's usage in the '492 patent. EX1001, 1:20-23, 4:56-61, 10:4-12.

43. One thing that I noticed in my review of the '492 patent is that “raw input data” cycles between a multi-user detector 20 and a bank of decoders 40 through a number of iterations. EX1001, 1:14-24, 7:6-28, 8:7-11, 9:19-12:51. These iterations occur until the system reaches an “output data stream” including final decisions for each of the received signals. EX1001, 1:14-24, 7:6-28, 8:7-11, 9:19-12:51. The '492 patent acknowledges that this MUD system—including multi-user detector 20, the bank of decoders 40, and other elements—is “Prior Art” that was known by the September 15, 2006 Critical Date of the '492 patent.

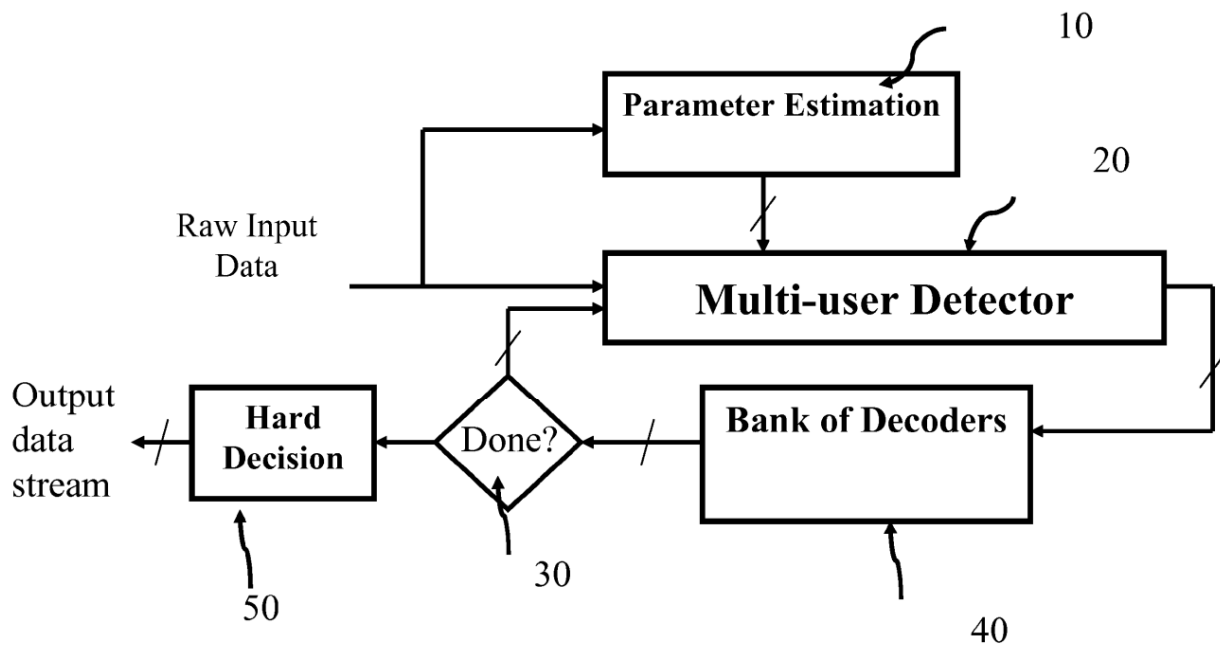


Figure 1
(Prior Art)

EX1001, FIG. 1; *see also id.*, 9:25-32 (iterative MUD procedures were “well known from published literature”). I noticed that FIG. 1, which the '492 patent

acknowledged as “Prior Art,” includes several elements that are also recited in the claims of the ’492 patent. These elements are described in the specification of the ’492 patent and include:

- a parameter estimator (“parameter estimation unit 10,” col. 9:57-10:3),
- received signals (“many signals from many different transmitters,” col. 9:44-56),
- a bank of decoders (“bank of error correction decoders unit 40,” col. 10:13-11:10),
- a hard decision unit (“hard decision unit 50,” col. 11:57-60), and
- an interleaver unit and a deinterleaver unit (“Deinterleavers and interleavers...are optional elements coupled between the MUD 20 and the decoders 40,” col. 10:47-50).

44. The ’492 patent acknowledges that each of the above-listed elements was known in the art by the Critical Date of the ’492 patent because these elements are part of the iterative MUD system of FIG. 1 acknowledged to be prior art. EX1001, 9:38-12:51. Based on this admitted prior art, it appears that one of the only purported points of novelty recited in the claims is “a multi-user detector decision unit” that can use “decision criteria to determine a selected multi-user detector” from a group of “at least two multi-user detectors.” EX1001, 12:52-67 (“a decision block to

choose the MUD”), 13:33-54 (“the MUD decision unit 220”), FIG. 2. The multi-user detector decision unit and the at least two MUDs are depicted below in FIG. 2:

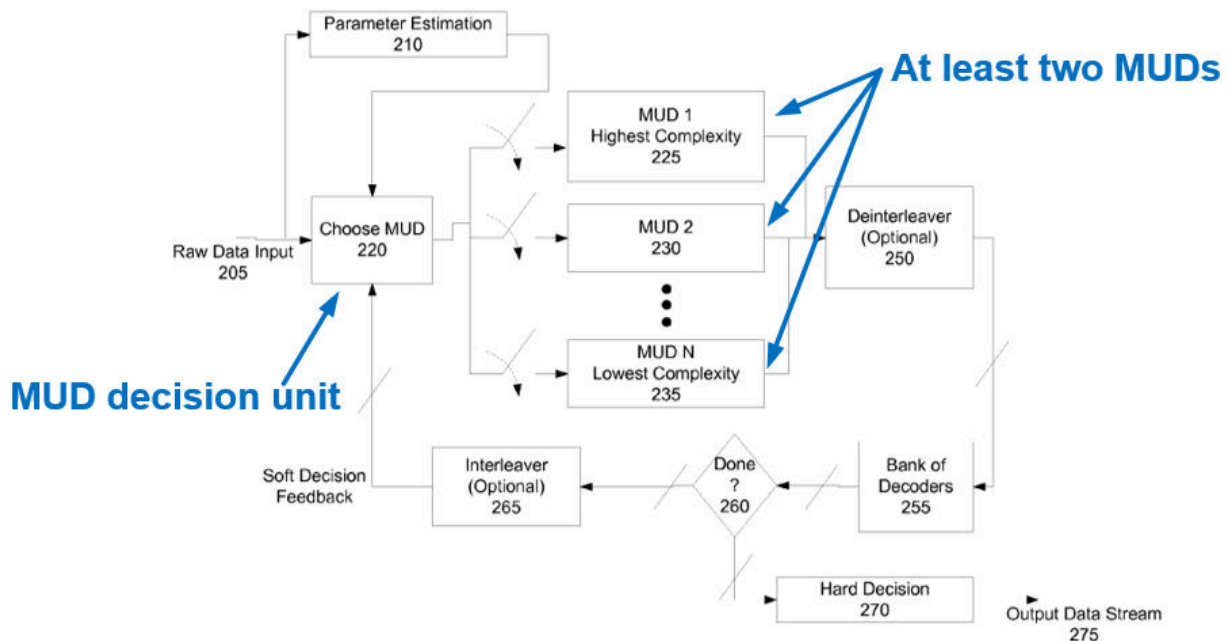


Figure 2

EX1001, 13:33-14:41, FIG. 2 (annotated).

B. Prosecution History of the ‘492 patent

45. I noticed that the ’492 patent issued after a prosecution that included no prior art rejections. *See, generally*, EX1002. The Examiner mailed a notice of allowance which allowed all claims as originally filed after Patent Owner filed the application and cited a few references. EX1002, 84-89. The Examiner provided reasons for allowance including an assertion that “[n]o prior art reference has been found to teach or suggest selecting one of a plurality of multi-user detectors based on a decision criteria.” EX1002, 88. Because multiple prior art references including

Wang, Sampath, and Liu describe selecting from a group of multi-user detectors, it is clear that the Examiner's finding was erroneous. *Infra*, §VII. It appears that none of these references was considered by the Examiner during prosecution.

VII. OVERVIEW AND COMBINATIONS OF PRIOR ART REFERENCES

A. Overview of McElwain

46. McElwain discloses a MUD system of a cellular base station that processes signals received from multiple users of a cellular network to remove interference, much like the '492 patent. EX1004, [0007] (“[t]he ability to extract the correct data from a given user is a difficult task, especially when the effects of interference and multipaths are considered”), *see also id.*, [0048]-[0064], [0073]-[0096], FIGS. 1-2. For example, I noticed McElwain explains that a MUD unit 20 can generate “a bit (or symbol) stream associated with each interfering [signal] present on the channel.” EX1004, [0084]; *see also id.*, [0093], FIG. 2. After generating these bit streams, MUD 20 passes the bit streams to a bank of decoders 40, which can generate “soft outputs.” EX1004, [0085]-[0087], [0093]-[0096]. The soft outputs are fed back to MUD unit 20. EX1004, [0087], [0093]. After continuing for several iterations, the process concludes when a hard decision unit 50 generates “hard outputs” for each signal and generates an output data stream including the hard outputs. EX1004, [0087]-[0089], [0094]-[0096], FIG. 2.

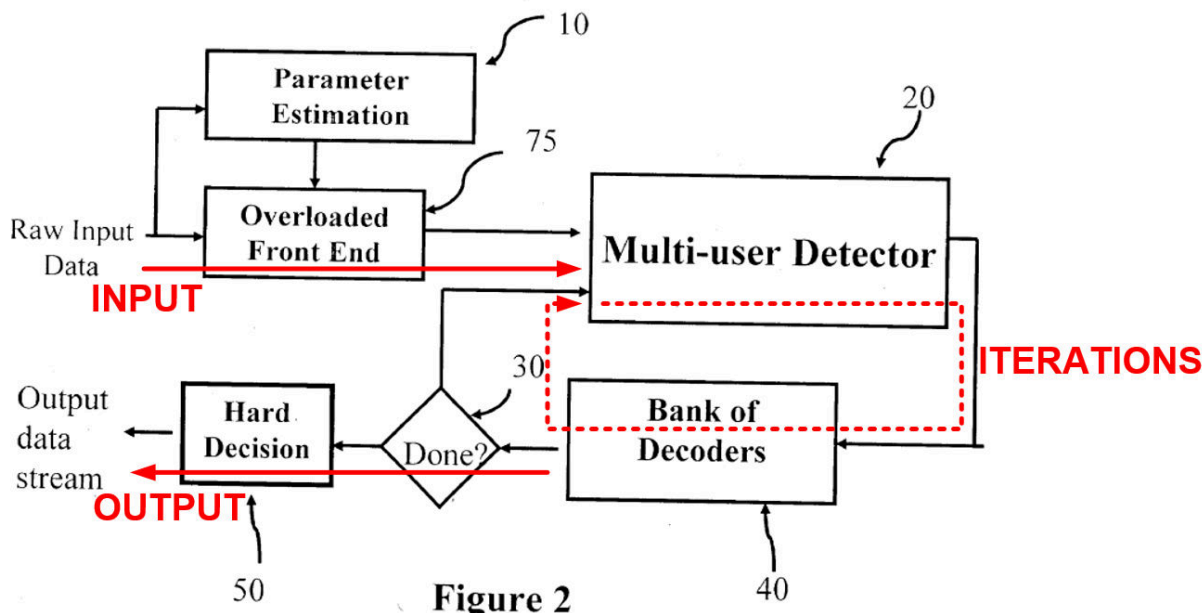


Figure 2

EX1004, FIG. 2 (annotated).

47. A common issue in MUD systems is ensuring that the system produces accurate outputs while limiting the amount of computing resources consumed to gain these results. McElwain acknowledges that a tradeoff exists between more complex MUDs that produce accurate results but consume large amounts of computing resources and less complex MUDs that consume fewer computing resources but are also less accurate. EX1004, [0022], [0060], [0061], [0074], [0076], [0078]. McElwain explains that this tradeoff is especially relevant when the input data is “overloaded” with large numbers of interfering user signals. EX1004, [0022], [0028], [0034], [0049]-[0051]. It is clear, therefore, that McElwain acknowledges an importance of balancing MUD complexity with resource consumption to ensure accurate outputs with manageable processing demands.

48. For example, I noticed that McElwain describes more complex MUDs as accommodating “the largest number of interfering signals” but also have “ a prohibitive computational complexity,” whereas “less complex” MUDs but “are not capable of operation when the number of signals is over a set threshold.” EX1004, [0022], *see also id.*, [0007], [0025]-[0028], [0033]-[0037]. I noticed that McElwain discloses at least two different ways to manage this tradeoff between accuracy and resource consumption. First, McElwain explains that an overloaded front end unit 75 can partially decouple co-channel interference and whiten noise in the raw data input mitigate the effects of overloading. EX1004, [0049]-[0051], [0090], [0091]. Second, McElwain describes techniques for “pruning” complex decision tree-based MUD algorithms can reduce an error rate in overloaded conditions while maintaining accurate outputs. EX1004, [0035]-[0037], [0060]-[0061]. This allows a complex “pruned” decision tree-based MUD algorithm (e.g., an M-algorithm) to process raw input data having large numbers of user signals at a low error rate. EX1004, [0035]-[0037], [0060]-[0061].

B. Overview of Wang

49. Wang describes a cellular base station including a MUD system that removes interference from received signals associated with multiple users, much like McElwain and the '492 patent. EX1005, FIG. 1 (depicting a base station that receives multiple signals from multiple mobile devices), 7:17-21 (“[t]he technical

problem to be solved...is to...achieve effective suppression of interference in various channel environments”), *see also id.*, 1:11-7:14, 9:3-24, 10:18-21, 11:14-12:3, 13:28-15:21. Although McElwain does not appear to describe a multi-user detector decision unit that can select between multiple MUDs, I noticed that Wang discloses techniques for determining a “channel type” and selecting an appropriate MUD algorithm based this determined “channel type.” EX1005, 8:4-22, 9:3-30, 10:18-12:3, 14:21-30, 15:12-16, 15:29-17:3, FIGS. 1-2, 4.

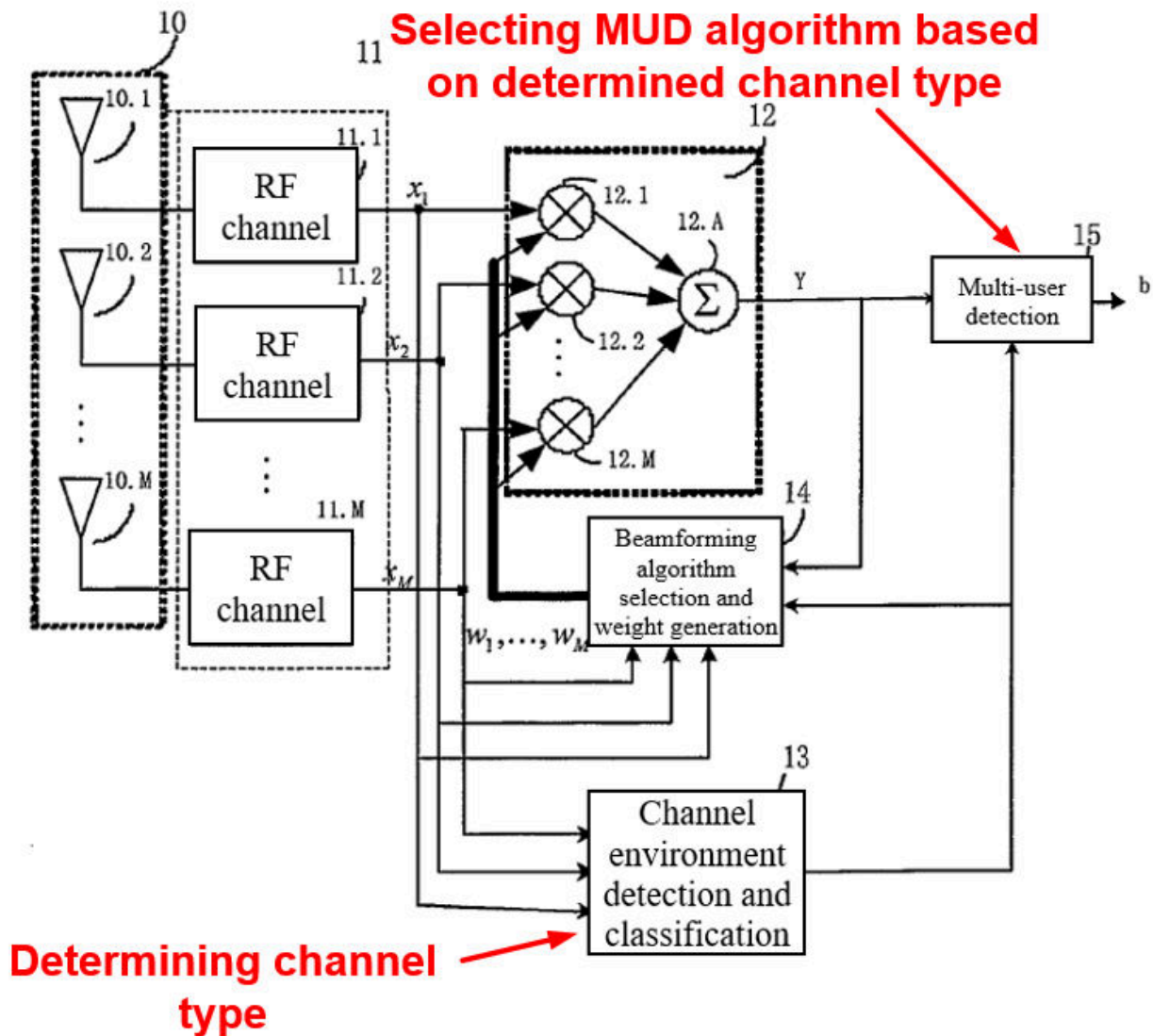


FIG. 2

EX1005, FIG. 2 (annotated).

50. According to one notable embodiment described by Wang , a “channel environment detection and classification module 13” performs several steps to determine the channel type which indicates characteristics of interference present in received signals. EX1005, 8:4-22, 9:7-24, 10:22-12:3, 13:7-17, 14:21-30, 15:12-16,

15:24-16:29, 19:7-20:7, FIG. 2, FIG. 4. Specifically, module 13 calculates a correlation matrix of signals received via antenna array 10, identifies one or more effective eigenvalues of the correlation matrix, determines an in-band power deviation of the received signals, and determines a channel type based on the number of effective eigenvalues and the in-band power deviation. EX1005, 15:29-17:3, FIGS. 1, 4.

51. By using the effective eigenvalues and the in-band power deviation which indicate characteristics of interference present in the received signals to select the appropriate MUD algorithm, Wang's MUD system addresses the same tradeoff between resource consumption and accuracy that is acknowledged by McElwain. EX1005, 10:22-12:3, 13:7-17, 15:29-17:3, Cl. 6, Cl. 7, FIGS. 2, 4. One way to do this is to include multiple hardware MUD decoders, each of which are configured to perform one of the available MUD algorithms, as described by Wang. I noticed that Wang's system selects a MUD algorithm based on complexity of interference, because Wang explains that different MUD algorithms can be selected based on whether the channel predominantly includes additive Gaussian white noise (AWGN) interference, co-channel interference, or inter-symbol interference. EX1005, 9:7-30, 11:14-12:3, 16:14-17:3, FIG. 4. Specifically, more complex MUD algorithms are selected to handle more complex interference, and less complex MUD algorithms are selected to handle less complex interference. EX1005, 16:14-29, 19:7-22.

C. Combination of McElwain and Wang

52. Based upon my knowledge and experience in the field and my review of McElwain and Wang, it is clear that McElwain discloses a MUD system processing received signals to remove interference between signals associated with different users. EX1004, [0048]-[0064], [0073]-[0096], FIGS. 1-2; *supra*, §VII.A. Although McElwain does not disclose selecting a multi-user detector using a multi-user detector decision unit based on decision criteria Wang provides this feature. One technique that Wang discloses involves selecting a MUD algorithm based on a “channel type” determined from characteristics of channel interference. EX1005, 10:22-12:3, 13:7-17, 15:29-17:3, FIGS. 2, 4; *supra*, §VII.B. A POSITA would have been motivated to implement McElwain’s system to include Wang’s MUD selection teachings because it is beneficial to select MUD algorithms for specific channel conditions. It is clear that multiple reasons would have motivated a POSITA to make this implementation, for reasons that I will discuss in further detail below.

53. As a *first* reason, a POSITA would have been prompted to implement McElwain’s MUD system with Wang’s suggestion to select a MUD algorithm based on channel interference characteristics because doing so would efficiently manage the tradeoff between computing resource consumption and accuracy that is acknowledged by McElwain and Wang. My opinion here is corroborated by academic studies published before the Critical Date of the ’492 patent which confirm

that accuracy comes at a cost of complexity, and vice versa. EX1013, 1 (explaining that “the maximum likelihood detection (MLD) arrangement was found to attain the best performance, although this was achieved at the cost of a computational complexity, which increases exponentially both with the number of users and with the number of bits per symbol transmitted by higher order modulation schemes. By contrast, the minimum mean-square error (MMSE) SDMA-MUD exhibits a lower complexity at the cost of a performance loss.”). It was clear based on McElwain’s disclosure that channel overloading caused by large numbers of interfering signals could result in inaccurate MUD outputs. This means that, a POSITA would have recognized based on the teachings of Wang that identifying interference present in received signals and selecting more complex MUD algorithms to handle more complex interference would have advantageously avoided errors in MUD outputs. Similarly, a POSITA would have recognized based on the teachings of Wang that identifying interference present in received signals and selecting less complex MUD algorithms to handle less complex interference would have advantageously decreased the amount of computing resources consumed while maintaining an accurate output.

54. As a *second* reason, a POSITA would have recognized that it would be beneficial to dynamically change MUDs in response to changing interference characteristics of the received signals because the number of received signals and

the level of interference can change over time. For example, because McElwain explains that MUD 20 processes raw input data according to a sequence of “data blocks” each representing a window of time, a POSITA would have been motivated to implement McElwain’s system with Wang’s MUD selection teachings for each of the data blocks—thus allowing the system to change MUDs dynamically over time based on changing interference in the raw data. EX1004, [0087]-[0089], FIG. 2.

55. As a *third* reason, performing an eigendecomposition of a correlation matrix of the raw data as taught by Wang would have advantageously allowed McElwain’s MUD system to identify interference characteristics of the raw input data in real time at a granular level, thus allowing McElwain’s system to quickly select an appropriate MUD based on the real-time interference data. It is apparent that a POSITA would have known that the eigendecomposition was a widely used technique for determining power levels associated with various signal components. Further, a POSITA would have understood from Wang’s teachings that performing an eigendecomposition of the correlation matrix is a straightforward way to measure interference, meaning that a POSITA would have been motivated to select an appropriate MUD using this process.

56. Finally, McElwain and Wang are each directed to MUD systems that remove interference from signals received by a base station in a cellular network. In

light of these similarities, a POSITA would have possessed ample skill to successfully implement the combination as described above. Based upon the predictable electrical components and software involved in the combination and the state of the art at the time, a POSITA would have reasonably expected success achieving the combination before the Critical Date.

D. Overview of Sampath

57. Much like McElwain and the '492 patent, Sampath describes a receiver including that processes raw data to remove interference between multiple input signals, much like the systems of McElwain and the '492 patent. EX1006, [0004] (“Multiple-access communication systems allow using multiple access terminals with a single base station.”), [0006] (“the present disclosure provides a multiple-input receiver”); *see also id.*, [0024]-[0027], [0039]-[0048], FIG. 3A. I noticed that Sampath expressly discloses a set of demodulators for removing interference from multiple signals in the raw data and a demodulator selector for selecting one of the set of demodulators. EX1006, [0039]-[0049], FIG. 3A.

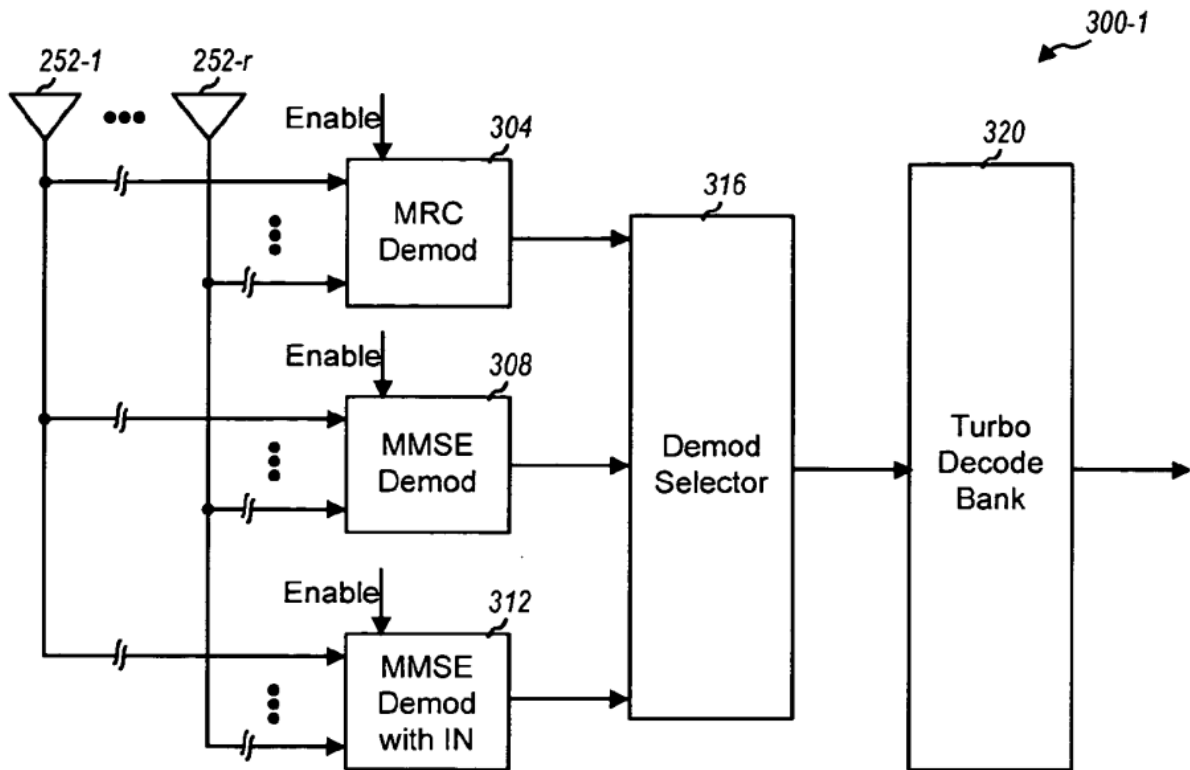


Fig. 3A

EX1006, FIG. 3A.

58. Sampath explains that demodulators 304, 308, 312 can “each demodulate the received signals,” and “demodulator selector 316 in this embodiment determines the demodulator 304, 308, 312 that is likely to produce the most accurate demodulated signal.” EX1006, [0039], [0041]. Demodulators that are not likely to produce the best result “can be disabled and powered-down,” and the output from the demodulator that is likely to produce the most accurate result can be “passed to the turbo decoding 320 for decoding.” EX1006, [0041]-[0043]. The “turbo decoder” of Sampath can decode an output from the selected one of the set of

demodulators to generate estimated values for “multiple signals.” EX1006, [0039]-[0042], FIG. 3A. Therefore, Sampath’s system can demodulate multiple signals using a selected demodulator and decode the output from the selected demodulator, much like the MUD systems of McElwain and the ’492 patent in which a bank of decoders processes an output from a MUD. EX1006, [0039]-[0048], FIG. 3A.

E. Combination of McElwain and Sampath

59. It is clear that McElwain describes a MUD system of a cellular base station receiver that uses a MUD unit 20 and a bank of decoders 40 to remove interference from raw data including signals from multiple users. EX1004, [0076]-[0096], FIGS. 1-3; *supra*, §VII.A. McElwain does not, however, disclose a “a multi-user detector decision unit” that selects a multi-user detector based on decision criteria. Sampath nonetheless describes a conventional solution that would have been obvious to apply to McElwain’s MUD system to achieve its goals of conserving resources and providing accurate estimates. Multiple reasons would have prompted a POSITA to implement McElwain’s MUD system with Sampath’s suggestion to select one of a set of demodulators for removing signal interference before the Critical Date.

60. As a *first* matter, a POSITA would have understood that implementing McElwain’s MUD system to select one of a plurality of demodulators to demodulate raw data for output to a bank of decoders, per Sampath, would predictably provide

a simple way to implement McElwain's MUD system with multiple MUDs that each are capable of providing outputs to the bank of decoders 40. Because Sampath discloses that "demodulator selector 316 uses a metric to decide which of the demodulators...to pass to...a bank of decoders," and because Sampath discloses different kinds of demodulators (e.g., maximum ratio combining (MRC) demodulators and minimum mean squared error (MMSE) demodulators), a POSITA would have been motivated to implement McElwain's MUD unit 20 with multiple MUDs and a multi-user detector decision unit that selects one of the MUDs to provide an output to a bank of decoders. EX1006, [0039], *see also id.*, [0040]

61. As a *second* matter, as I discussed above in my analysis of the McElwain-Wang combination (*supra*, §VII.C), a POSITA would have been prompted to implement McElwain's system with the demodulator selection teachings of Sampath because doing so would result in McElwain's system more effectively managing the tradeoff between using more complex detectors that produce more accurate results but consume more resources and less complex detectors that produce less accurate results but consume fewer resources. For example, because Sampath discloses at least three different kinds of demodulators including an MRC demodulator 304 an MMSE demodulator 308, and an MMSE demodulator with Interference Nulling 312 that have varying complexity, a POSITA would have been motivated to implement McElwain's system with multiple

demodulators, per Sampath, so that the resulting system can select less complex detectors to handle less complex interference and select more complex detectors to handle more complex interference.

62. As a *third* matter, as I discussed above in my analysis of the McElwain-Wang combination (*supra*, §VII.C), because the number of received signals and the level of interference can change over time, a POSITA would have recognized that it would be beneficial to dynamically change detectors in response to changing interference of the received signals.

63. As a *fourth* matter, it is clear that using expected signal to interference-plus-noise ratio (SINR) as a decision metric for selecting a MUD would advantageously allow McElwain's MUD system to determine SINR in real-time, because using SINR would allow McElwain's MUD system to quickly determine a decision metric used to select an appropriate MUD.

64. Considering the predictable electrical/network and software components involved in the combination and the relatively advanced state of the art at the time, it is clear that a POSITA would have reasonably expected success achieving the combination before the Critical Date.

F. Overview of Mills

65. Mills describes a cellular base station receiver including a MUD system that can remove interference from multiple signals travelling on the same channel

that “are purposely allowed to interfere with one another.” EX1007, [0004]; *see also id.*, [0002]-[0003], [0021]-[0023], [0028]-[0039], FIG. 1. For example, I noticed that the MUD system of Mills includes a multi-user decoder 14 and a bank of single user decoders 16 that cycle the input data through a series of iterations until final estimates for each of the received signals are output from the bank of single user decoders 16. EX1007, [0028]-[0039], FIG. 1.

66. For example, Mills discloses that “[t]ogether, MUD 14 and the single user decoders 16 work in concert to estimate the transmitted Sequence of Symbols from all users within a time frame.” EX1007, [0029]. Mills also explains that “[i]f the received signals had been interleaved at the transmitter, the signals output from MUD 14 are...passed on...to a bank of single user decoders 16” and “the symbol estimates output from MUD 14 are input to each of a plurality of single-user decoders 16, with there being one single-user decoder used for each signal to be decoded, that decodes all symbols/bits in a particular signal.” EX1007, [0033], [0034]. I noticed that in Mills’s system, “[t]he Single-user decoders 16 each calculate ‘probability estimates’ from their respective signals and output them for use by MUD 14 which uses them as apriori information during the next iteration of MAP decoding by MUD 14.” EX1007, [0036]. Mills discloses that “[t]he passing of information between MUD 14 and the single-user decoders 16 is repeated a predefined number of times, until the desired bit error rate performance is attained,

or until further iterations result in insignificant changes in the channel symbol estimates.” EX1007, [0038].

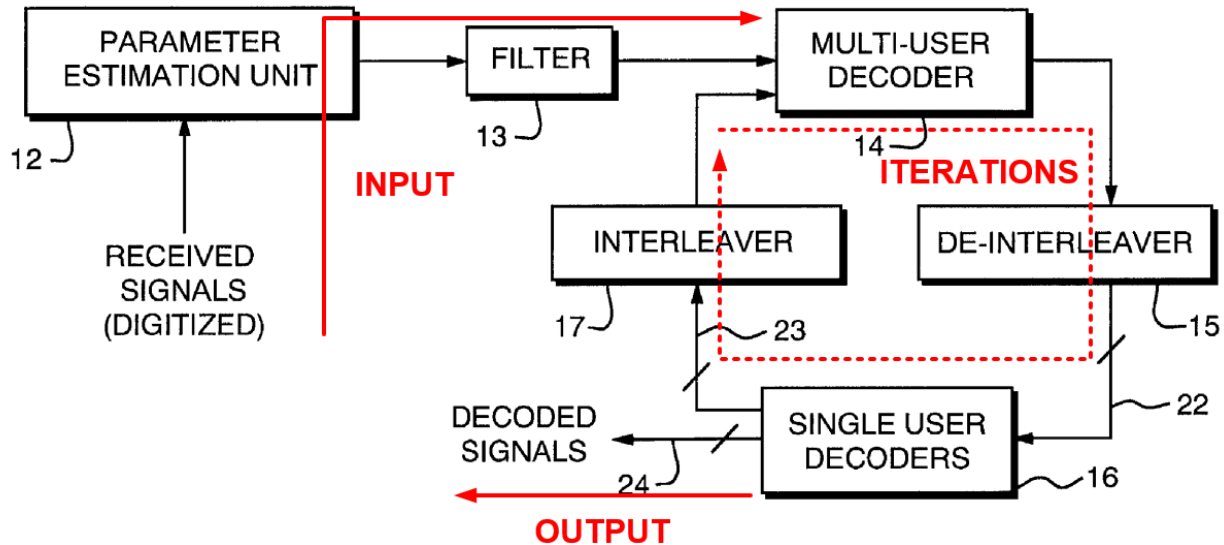


FIG. 1
(PRIOR ART)

EX1007, FIG. 1 (annotated).

67. I noticed that Mills recognizes a tradeoff between high complexity MUDs that are accurate in high-interference situations but have a “prohibitively high” complexity and low complexity MUDs that have “lower computational demands” but perform poorly in “high-interference situations.” EX1007, [0006]. Mills explains that this tradeoff can be managed by using a single complex decision tree-based MUD (e.g., an M-algorithm MUD) that uses “pruning” techniques to reduce the number of calculations made while maintaining accuracy in high-interference situations and rearranges bits in each iteration to focus computing resources on

solving the lowest confidence soft estimates. EX1007, [0006], [0007], [0013], [0021]-[0023], [0028]-[0039], FIG. 1.

G. Overview of Liu

68. Liu discloses a receiver that removes interference from multiple signals that simultaneously occupy the same frequency, much like Mills and the '492 patent. EX1008, [0002]-[0012], [0021]-[0023], FIGS. 1-2. For example, Liu discloses describes “demodulation logic” that includes three separate decoders including a single user decoder 404, a linear multi-user decoder 406, and a non-linear multi-user decoder 407. EX1008, [0024]-[0029], FIG. 4. The non-linear multi-user decoder 407 of Liu is described as being “more powerful” than the nonlinear multi-user decoder 406. EX1008, [0026]. Thus, Liu expressly discloses that the demodulation logic includes at least three decoders, of which at least two are multiuser decoders of varying complexity.

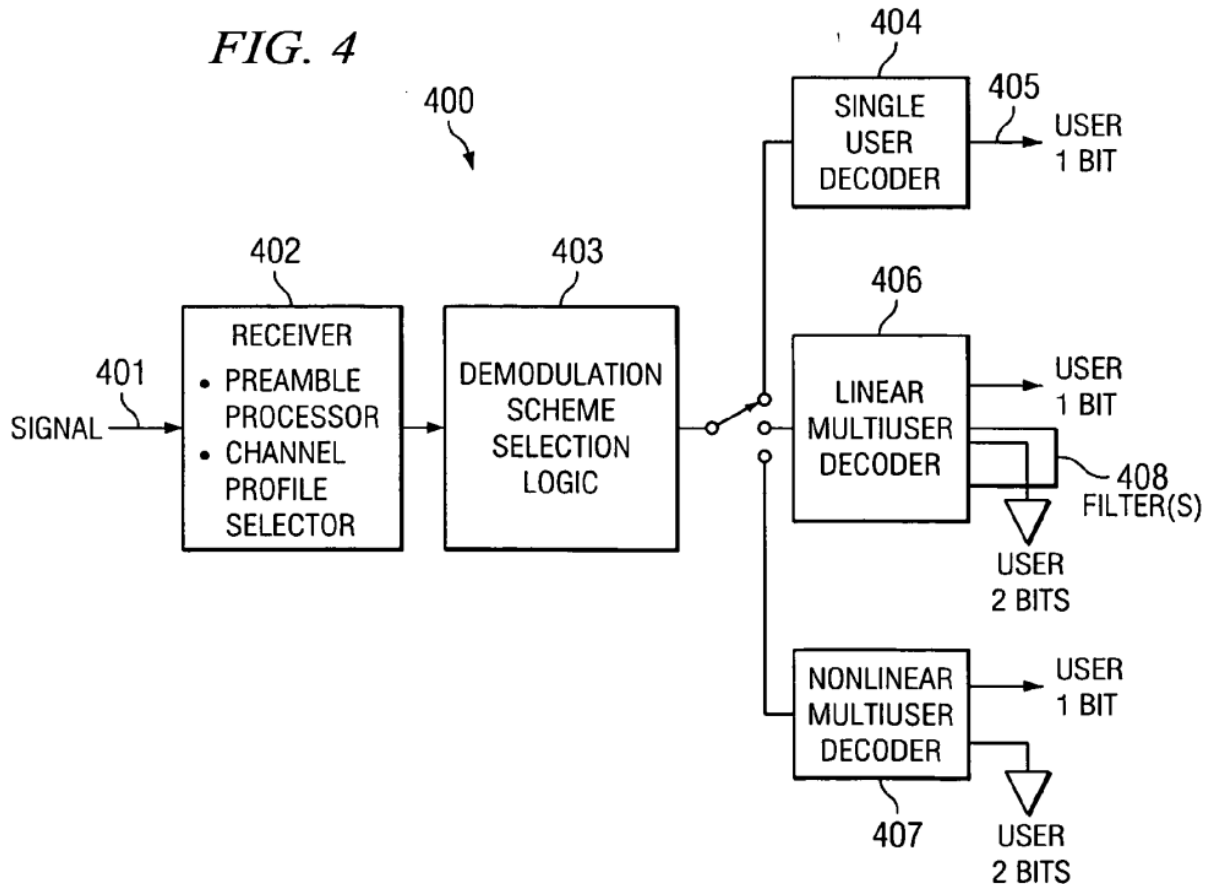
69. I noticed that Liu describes “demodulation scheme selection logic 403” for selecting one of the single user decoder 404, the linear multi-user decoder 406, and the non-linear multi-user decoder 407 for processing received signals. EX1008, [0007]-[0009], [0025]-[0029], FIG. 4. Liu explains that demodulation scheme selection logic 403 uses certain metrics to select one of decoders 403, 406, 407 that is most appropriate for a given situation. EX1007, [0025] (“[i]f the neighboring interference is very low, so as to be considered trivial, such as below a lower

threshold or of insufficient strength to provide code information to the terminal, terminal demodulation scheme selection logic 403 may select to use single user decoder 404 to decode the signal intended for the user terminal”), [0026] (“[o]n the other hand, if the interference from the preamble estimation of the interference signal strength provided by channel profile selector 402 is significant or strong, such as strong enough to provide code information, multiuser decoder 405 or 406 is preferably selected by demodulation scheme selection logic 403”). Liu also explains that “[i]f the interference is above the aforementioned lower threshold, but not above an upper threshold, linear multi-user decoder 406 may be selected by demodulation scheme selection logic 403” and “[i]f the interference is above the aforementioned upper threshold demodulation scheme selection logic 403 preferably chooses to employ non-linear multi-user decoder 407.” EX1007, [0027], [0028].

70. Liu explains that characteristics such as signal strength, signal-to-noise ratio (SNR), and bit error rate can be used by logic 403 to select one of the single user decoder 404, the linear multi-user decoder 406, and the non-linear multi-user decoder 407. EX1008, [0007], [0022], [0025], [0026], [0029]. For example, Liu explains that non-linear multi-user decoder 407 is more computationally intensive and therefore more accurate, but “it may drain more battery power of a terminal, generate more heat.” EX1008, [0029]. Liu’s system therefore solves the accuracy-resource tradeoff acknowledged by Mills by selecting a more complex detector when

interference is high and selecting a less complex detector when interference is low.

EX1008, [0025]-[0029]; FIG. 4.



EX1008, FIG. 1.

H. Combination of Mills and Liu

71. To the extent that Mills does not expressly disclose a multi-user detector decision unit that uses decision criteria to select a multi-user detector, Liu provides this feature. For example, Liu discloses demodulation scheme selection logic 403 that can select between a lower complexity linear MUD and a higher complexity nonlinear MUD based on characteristics of the received signals and one

or more thresholds associated with each MUD. EX1008, [0025]-[0029]; FIG. 4; *supra*, §VII.G. Multiple reasons would have motivated a POSITA to implement Mills's system to include Liu's MUD selection teachings.

72. As a ***first*** reason, a POSITA would have been prompted to implement Mills's MUD system with Liu's suggestion to select a multi-user detector having an appropriate complexity because doing so would ensure that resources are conserved by selecting the least complex multi-user detector that is likely to generate a satisfactory output. For example, because Liu discloses that demodulation scheme selection logic 403 can determine a likelihood that each available MUD will adequately decode received signals, a POSITA would have understood that implementing Mills's system to select a MUD based on predicted performance would yield high accuracy while conserving resources—effectively managing the very tradeoff that Mills acknowledged as being an issue for MUD systems. EX1008, [0029].

73. As a ***second*** reason, selecting a MUD based on a predicted performance (e.g., an expected error rate and/or an expected output SNR) of available decoders would have advantageously allowed Mills's MUD system to tailor a MUD selection that consistently ensures accurate outputs. Because Mills acknowledges accurately decoding multiple received signals is an important consideration in MUD systems, a POSITA would have understood that implementing Mills's system with Liu's

suggestion to determine an expected accuracy of available decoders is advantageous. EX1007, [0013], [0050].

74. As a *third* reason, as discussed *supra*, §VII.C, because the number of received signals and the level of interference can change over time, a POSITA would have understood that it would be beneficial to dynamically change detectors in response to changing interference of the received signals.

75. As a *fourth* reason, A POSITA would have understood that selecting an appropriate detector among multiple decoders, per Liu, would reduce resource consumption and thus lead the receiver to consume a lower amount of power.

76. Considering the predictable electrical/network and software components involved in the combination and the relatively advanced state of the art at the time, a POSITA would have reasonably expected success achieving the combination before the Critical Date.

I. Combination of Mills, Liu, and Sampath

77. To the extent that the Mills-Liu combination would not have rendered obvious low, medium, and high complexity multi-user detectors, Sampath expressly describes three different multi-user detectors having varying complexity. EX1006, [0039]-[0043], [0047], [0048], FIG. 3A. Multiple reasons would have prompted a POSITA to implement the MUD system of the Mills-Liu combination in accordance

with Sampath's suggestion for a demodulator selector 316 to select between low, medium, and high complexity multi-user detectors.

78. As a **first** reason, a POSITA would have understood that implementing the MUD system of the predictable Mills-Liu combination to include three different multi-user detectors as suggested by Sampath would improve an ability of the system to balance between resource consumption and accuracy as compared with Liu's suggested technique for selecting between two multi-user detectors. For example, Sampath explains that having multiple (e.g., three) separate decoders can help to ensure that "the optimum demodulator is selected." EX1006, [0022].

79. As a **second** reason, because Liu discloses that linear multi-user decoder 406 can include an MMSE detector, a POSITA would have been motivated to implement Liu's system to include two MMSE detectors of differing complexity or implement Liu's system to include a maximum ratio combining (MRC) decoder in addition to the linear MMSE multiuser decoder 406 and the nonlinear maximum likelihood multiuser decoder 407. EX1006, [0026], [0027], [0036], [0039], [0040], FIG. 3A. Doing so would provide additional linear decoders that can handle lower amounts of interference.

80. As a **third** reason, as discussed above (*supra*, §VII.C), because the number of received signals and the level of interference can change over time, a

POSITA would have recognized that it would be beneficial to dynamically change detectors in response to changing interference of the received signals.

81. Considering the predictable electrical/network and software components involved in the combination and the relatively advanced state of the art at the time, a POSITA would have reasonably expected success achieving the combination before the Critical Date.

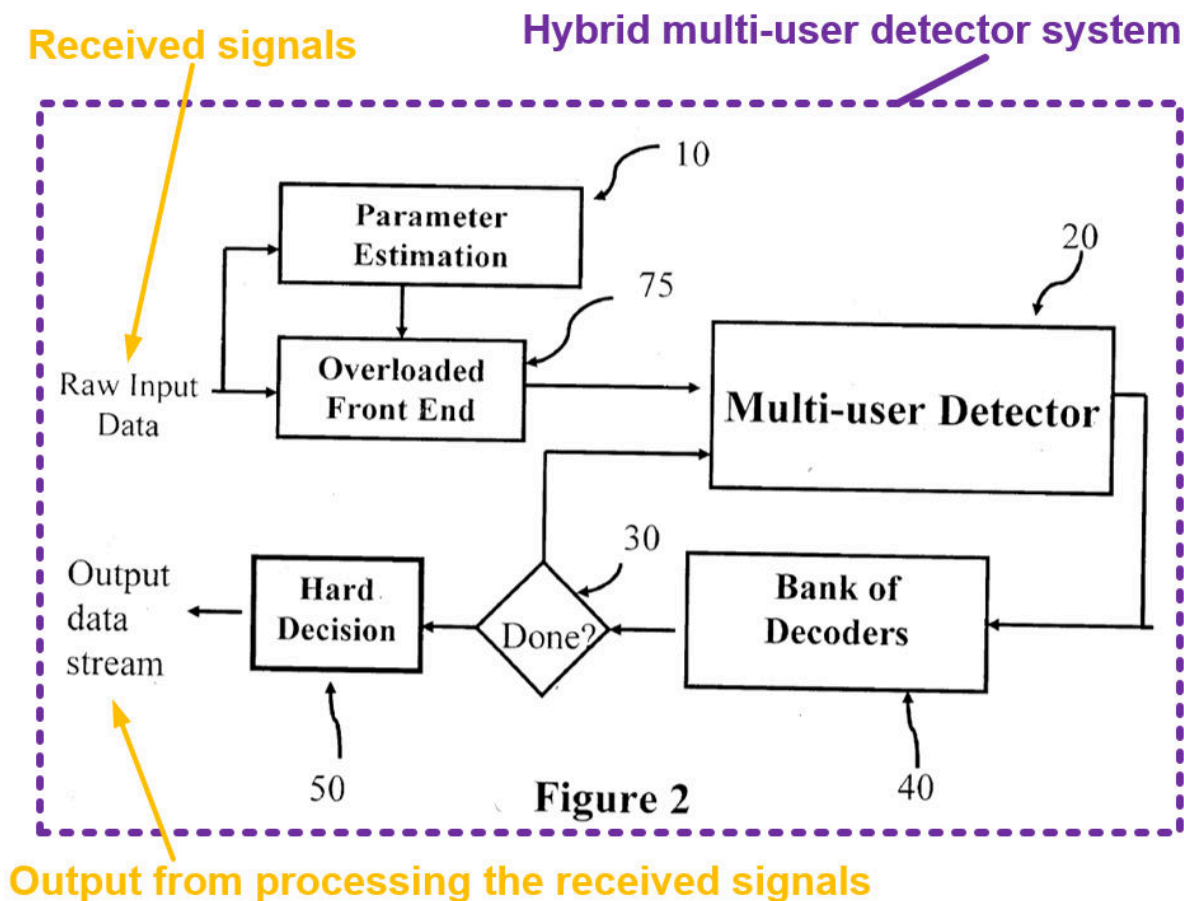
VIII. MANNER IN WHICH THE PRIOR ART REFERENCES RENDER THE '492 CLAIMS UNPATENTABLE

A. GROUND 1A: The McElwain-Wang Combination Renders Claims 1-3, 5-13, and 15-17 Obvious

Element [1pre]: A hybrid Multi-User Detector System for processing received signals, comprising:

82. To the extent that the preamble is treated as a limitation, my review of McElwain and Wang confirms that the McElwain-Wang combination renders Element [1pre] obvious. One reason is that McElwain expressly discloses a “**Hybrid Turbo-MUD**” *system* that can *receive* “raw input data.” EX1004, [0074], [0079]-[0080]; *see also id.*, [0073], [0075]-[0078], [0090]-[0096], FIGS. 1-2. It is clear that the MUD system of McElwain is a “**hybrid**” *multi-user detector system*, because the system includes multiple components that work together to remove interference from raw input data including a multiuser detector (MUD) 20 and a bank of decoders 40. EX1004, [0076]-[0096], FIGS. 1-2.

83. I noticed that McElwain describes the raw input data as including “the aggregate of many signals from many different transmitters.” EX1004, [0078]. It is apparent therefore that the raw input data input to the system of McElwain includes multiple *received signals* corresponding to multiple users. EX1004, [0078]-[0081], [0087], [0090]. Because the system includes a multiuser detector 20, it is apparent that McElwain describes a *multi-user detector system*. EX1004, [0079]-[0085], [0087]-[0090], [0093]-[0096], FIGS. 1-2. McElwain describes several components that can *process* the *received signals*, including but not limited to parameter estimator 10, MUD 20, the bank of decoders 40, hard decision unit 50, and overloaded front end 75. EX1004, [0076]-[0096], FIGS. 1-2.

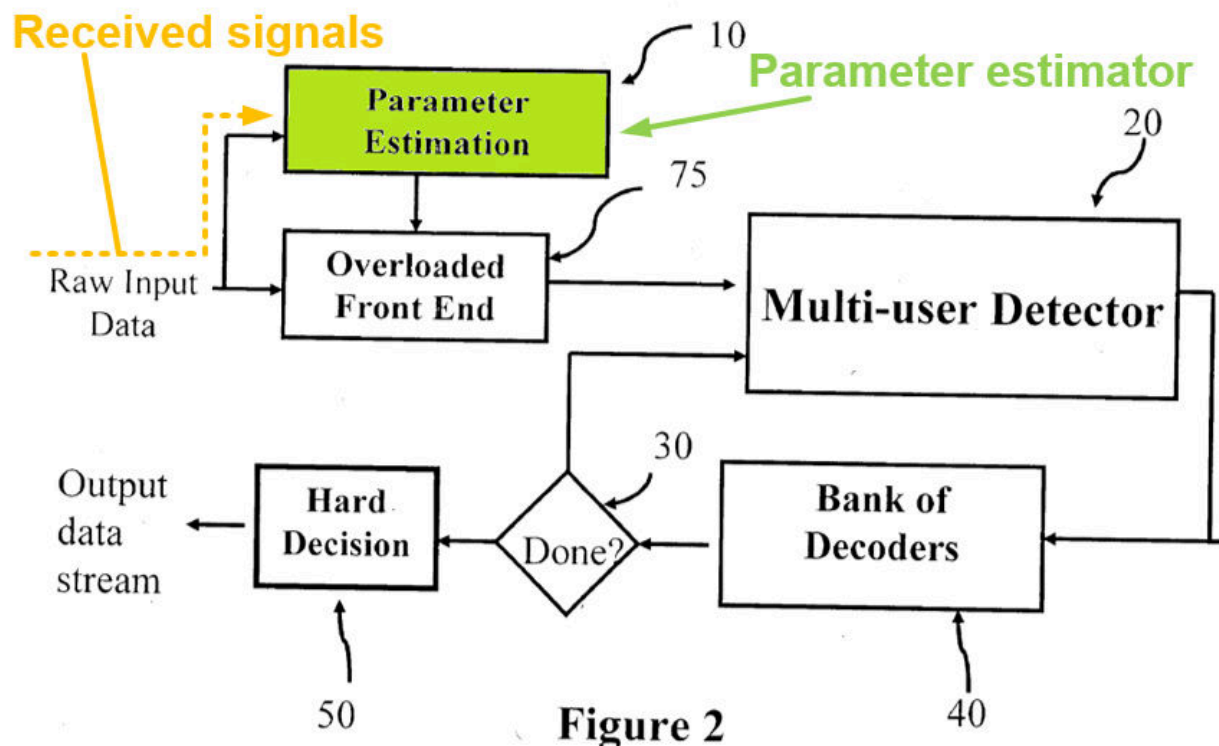


EX1004, FIG. 2 (annotated).

Element [1a]: a parameter estimator coupled to said received signals providing received data information;

84. In my review of the '492 patent, I noticed that the '492 patent admits the “parameter estimator” of element [1a] was well-known available and known in the prior art. EX1001, 9:57-10:3 (“[t]he parameter estimation unit is known in the art”). The fact that parameter estimators were known in the art before the Critical Date of the '492 patent is corroborated by multiple references which describe parameter estimation in the context of cellular networks and multiuser detectors. EX1011, [0024]-[0035] (describing a parameter estimator for a base station receiver);

EX1012 (describing a multiuser detector system capable of parameter estimation for received signal energy, carrier phase, and propagation delay). McElwain also confirms that parameter estimators were known in the art by the Critical Date of the '492 patent. For example, I noticed that McElwain describes a *parameter estimator* that is sometimes referred to by McElwain as “parameter estimator 10” or “parameter estimation unit 10.” EX1004, [0054], [0063], [0080], [0090], FIGS. 1-2. Specifically, the parameter estimator 10 of McElwain “processes the various parameters for the received raw data.” EX1004, [0080], [0090], [0092]; *see also id.*, [0054] (“[p]arameter estimation is used”), [0063] (“[t]he parameter estimator”), [0099] (“received measurement from the parameter estimation unit 110”), FIGS. 1-3. Furthermore, it is clear that the *parameter estimator* 10 is *coupled* to the *received signals* because parameter estimator 10 directly receives the raw input data. EX1004, FIG. 2, *see also id.*, Cl. 1 (“a parameter estimator coupled to a data stream”), [0099].



EX1004, FIG. 2 (annotated).

85. Because parameter estimator 10 processes the received signals of the raw input data to provide an output to overloaded front end 75 and MUD 20, it is clear that the *received signals* provide *received data information* indicating certain aspects of the *received signals*. EX1004, Cl. 1 (“data stream providing estimation values of said data stream”), [0070] (“MUD systems generally require some raw data parameters”), [0080] (“various parameters for the received raw data”), [0108] (“A data stream 100, potentially complex, is received from some a source.”).

86. Furthermore, I noticed that McElwain incorporates by reference US 2002/0037061 (EX1011). EX1004, [0080] (“The parameter estimation unit is known in the art, and a detailed description is available in published patent application U.S.

2002/0037061 A1 entitled ‘System for Parameter Estimation and Tracking of Interfering Digitally Modulated Signals’, which is incorporated by reference.”). The parameter estimation unit of this incorporated reference extracts ***received data information*** from ***received signals*** including “the received power 22, the phase 24 of the oscillator for each of the transmitted signals, the timing offset 26 relative to the base station clock and transmission distance, the carrier frequency offset 28 and the multipath structure 29.” EX1011, [0029].

Element [1b]: a multi-user detector decision unit coupled to said parameter estimator and said received signals;

87. For at least the reasons I described above in my analysis of Element [1pre], *supra*, it is clear that McElwain discloses a MUD 20 for processing raw input data including multiple ***received signals*** to generate “a bit (or symbol) stream associated with each interfering signal[] present on the channel.” EX1004, [0084]; *see also id.*, [0079]-[0083], [0093]-[0095]. One thing that I noticed in my review of the ’492 patent is that many varieties of MUD are acknowledged as known in the art. These include more complex detectors such as maximum a posteriori (MAP) decoders and maximum likelihood detectors, and less complex detectors such as decorrelators, minimum mean square error (MMSE) detectors, and zero forcing bock linear equalizers. EX1001, 5:14-29; 10:13-16. McElwain discloses several other kinds of MUDs such as M-algorithm detectors, T-algorithm detectors, Fano algorithm detectors, and Viterbi decoders In addition to the decoders that the ’492

patent admits as being known. EX1004, [0027], [0036]-[0037], [0079], [0085]-[0086]. Therefore, it is clear that multi-user detectors were generally known in the art by the Critical Date of the '492 patent including many different detectors of varying complexity.

88. Even if McElwain does not expressly disclose a *multi-user detector decision unit*, a POSITA would have found it obvious based on the teachings of Wang to implement the MUD system of McElwain with a *multi-user detector decision unit*. *Supra*, §VII.C. I noticed that Wang describes a cellular base station receiver that detects multiple signals via an antenna array 10. EX1005, 13:7-14:11, FIGS. 1-2. As depicted below in FIG. 1 of Wang, the base station receives these signals from multiple different mobile devices, and the received signals include both “desired” signals and “interference” signals. EX1005, 13:7-27, FIG. 1.

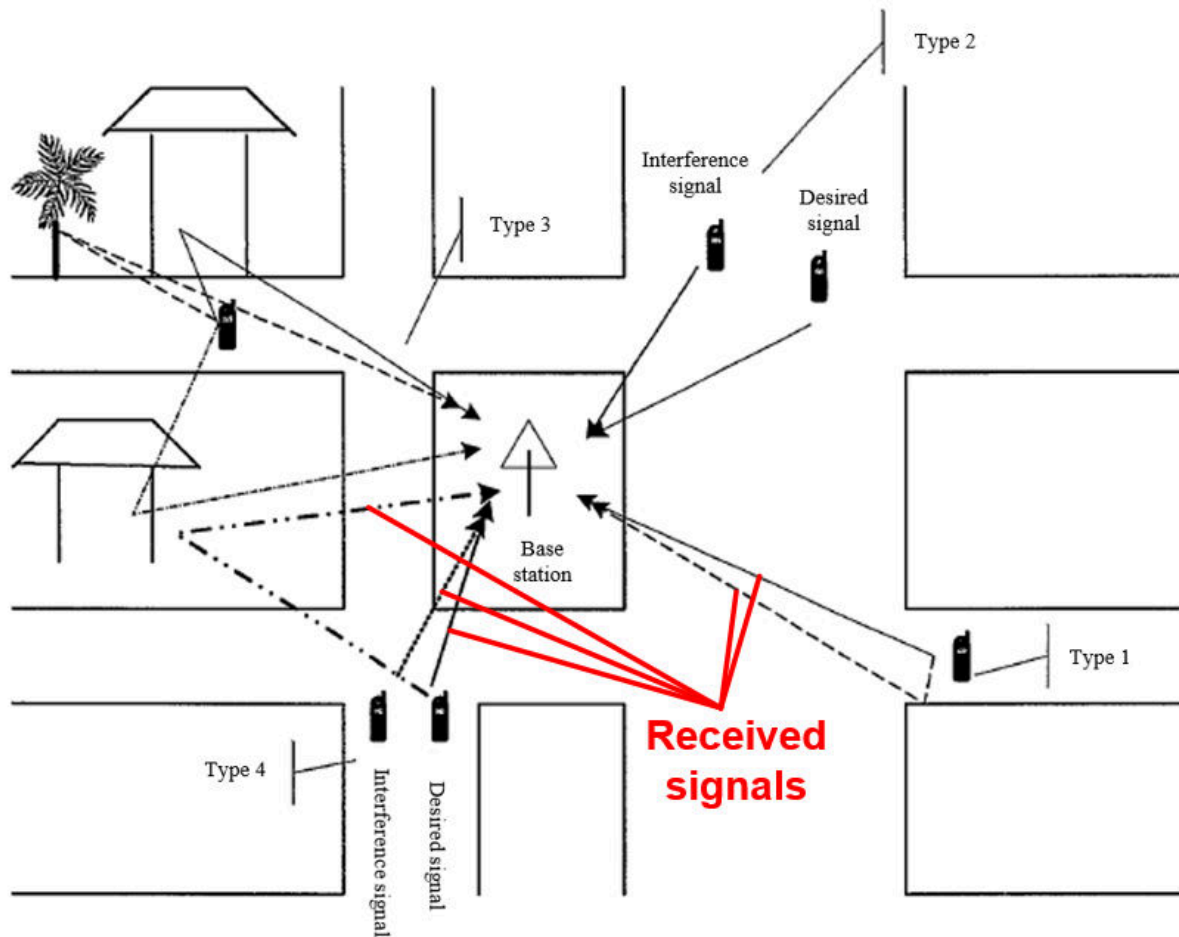


FIG. 1

89. Another thing I noticed in my review of Wang is that the base station receiver includes a channel environment detection and classification module 13 for determining a “channel type” of received signals. EX1005, 7:26-8:22, 10:22-11:13, 13:7-24, 14:12-30, 15:12-21. Wang explains that this channel type can be determined based on a nature of interference present in the received signals. EX1005, 7:26-8:22, 10:22-11:13, 13:7-24, 14:12-30, 15:12-21. For example, Wang explains that a first channel type corresponds to “additive white Gaussian noise,” a second

channel type corresponds to “co-channel interference,” a third channel type corresponds to “inter-symbol interference,” and a fourth channel type corresponding to “multiple interferences and noise.” EX1005, 13:7-17, 14:21-30, 16:17-29. Wang also explains that a multi-user detection module 15 selects “the appropriate multi-user detection algorithm” for processing the received signals to remove interference, and this selection is made based on the determined channel type. EX1005, 15:12-16, *see also id.*, 11:14-12:3, 13:7-15:21, FIG. 2. For example, module 15 selects a “minimum mean square” detection method for the first channel type, selects a “decorrelation” detection method for the second channel type, selects a “parallel interference cancellation” detection method for the third channel type, and selects a “partial multiple access interference cancellation” detection method for the fourth channel type. EX1005, 9:7-30, 11:18-31, 19:7-22, Cls.6, 8.

Received signals

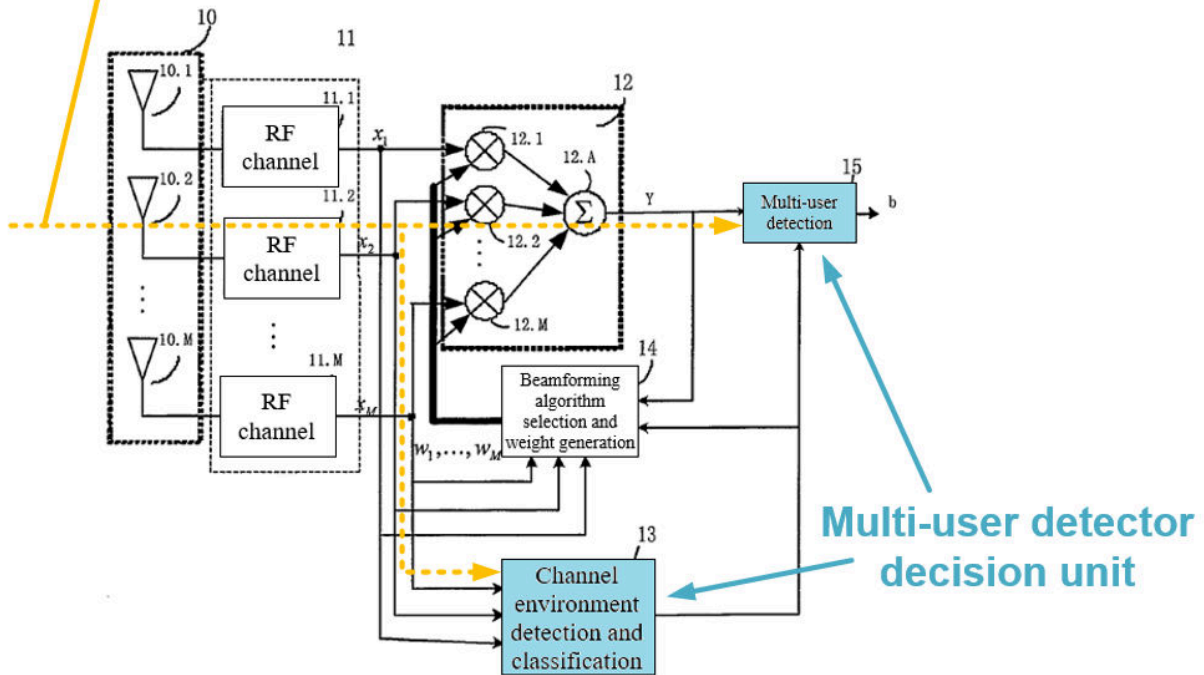


FIG. 2

EX1005, FIG. 2 (annotated).

90. It is apparent that modules 13, 15 therefore represent a *multi-user detector decision unit* that (1) determines a channel type based on interference characteristics of *received signals* and (2) selects a MUD algorithm based on the channel type. EX1005, 9:3-30, 10:18-12:3, 3:28-15:21, 19:7-22, Cl. 6, 8, FIG. 2. Because module 13 determines the channel type based on characteristics of the interference within received signals and module 15 selects the MUD algorithm based on the determined channel type, modules 13, 15 address the tradeoff between MUD complexity and resource consumption that is acknowledged by McElwain. EX1005,

13:7-17, 14:21-30, 15:12-16, 15:26-17:3. Namely, modules 13, 15 select more complex MUD algorithms to handle more complex interference and select less complex MUD algorithms to handle less complex interference, thus ensuring accurate outputs while conserving resources. EX1005, 13:7-17, 14:21-30, 15:12-16, 15:26-17:3; 19:7-22.

91. Furthermore, it is clear that the *multi-user detector decision unit* is *coupled* to the *received signals* because modules 13, 15 each process the *received signals* to determine the channel type. EX1005, 14:21-30, 15:12-16. For example, Wang expressly discloses that antenna array 10 “is composed of M elements 10.1, 10.2 ... 10.M, used for receiving wireless signals” and radio frequency channel module 11 processes these wireless signals to generate a baseband signal “referred to as array data X.” EX1005, 14:6-20, FIG. 4. The “array data X” is subsequently processed by a beamforming module 12 to generate an “output signal Y.” EX1005, 15:7-11, FIG. 4. Module 13 processes this “array data X” to determine a channel type and outputs the channel type to module 15 for selecting a MUD algorithm, and MUD 15 uses the selected MUD algorithm to process the “output signal Y” to generate “demodulated output bits ‘b.’” EX1005, 15:7-16, FIG. 4. Because both of the modules 13, 15 rely on array data X or outputs generated based on array data X, the *multi-user detector decision unit* is *coupled* to the *received signals* corresponding to array data X.

92. It is clear that to determine the channel type of received signals, module 13 performs an *eigendecomposition* of *correlation matrix* as described in the specification of the '492 patent. EX1005, 14:21-30; 15:22-16:29, FIG. 4; cf. EX1001, 14:7-18. This means that modules 13, 15 represent a “*multi-user detector decision unit*” even if this term is interpreted to require structure that performs one of the MUD algorithms expressly described by the '492 patent. For example, I noticed that the '492 patent provides the following explanation of an algorithm that involves performing an *eigendecomposition* of *correlation matrix*:

As indicated, the MUD decision unit 220 that selects from among at least one MUD 225, 230, 235 represents one of the inventive aspects of the present invention. There are many different ways that the decision can be made...

...The decision can be made by taking the eigendecomposition of the correlation matrix and looking at all the eigenvalues that are above the noise floor. If the first N eigenvalues are very close to one another and the eigenvectors associated with those eigenvalues all have the same N entries terms then use a lower complexity MUD. If there are any other regions of the eigenvalues that are basically equal and the eigenvalues have the same dominant terms or if there is any one eigenvector that has a dominant term and its eigenvector² is above the noise floor then

² I believe that when the '492 patent explains that “if there is any one eigenvector that has a dominant term and its *eigenvector* is above the noise floor,” this is an error and the '492 patent means to explain that “if there is any one eigenvector that has a dominant term and its *eigenvalue* is above the noise floor.”

use a lower complexity MUD. If the eigenvalues and eigenvectors of the correlation matrix do not have these characteristics then use the highest complexity MUD.

EX1001, 13:33-37, 14:7-18.

93. The *eigendecomposition* of *correlation matrix* algorithm described by the '492 patent therefore involves several steps. Each of the steps described by the '492 patent are present in the *eigendecomposition* of *correlation matrix* algorithm described by Wang. For example, it is apparent that module 13 performs an *eigendecomposition* of *correlation matrix* to determine a channel type for selecting a MUD algorithm, because module 13 both (1) calculates a *correlation matrix* based on array data of received signals, and (2) performs an *eigendecomposition* of this *correlation matrix* by determining eigenvalues and eigenvectors corresponding to the *correlation matrix*. EX1001, 14:7-18; EX1005, 10:22-11:13, 14:21-30, 15:29-17:3, FIGS. 2, 4.

This is because the same paragraph of the '492 patent earlier refers to “looking at all the *eigenvalues* that are above the noise floor.” Furthermore, because it is commonly known that each eigenvector corresponds to an eigenvalue, it would make sense for the '492 patent to refer to an eigenvector by “its eigenvalue” instead of “its eigenvector.”

94. First, it is clear that module 13 calculates a **correlation matrix** ($R = X \cdot X^H$) of the received signals (referred to by Wang as “array data X ”). EX1005, 14:12-20, 16:1; *see also id.*, 10:22-29, 13:18-24, 14:21-30, FIG. 4. The **eigendecomposition** of **correlation matrix** algorithm described by the ’492 patent does not involve any specific equation or method for calculating the **correlation matrix**, instead the ’492 patent generally references correlation matrices and does not describe how correlation matrices are determined or calculated. EX1001, 14:7-18. My opinion here is supported by the fact that the equation $R = X \cdot X^H$ involves the product of a matrix with the conjugate transpose of the matrix, which is a commonly known technique for calculating a correlation matrix. EX1024, 3 (describing an equation for calculating a correlation matrix R involving the product of a matrix $x[n]$ with the conjugate transpose $x^H[n]$); EX1025, 2 (describing an equation for calculating a correlation matrix $\hat{R}_{R_x}$ involving the product of a matrix H with the conjugate transpose H^H of the matrix). The equation $R = X \cdot X^H$ described by Wang for calculating the **correlation matrix** therefore is consistent with the ’492 patent’s general description of determining a correlation matrix. EX1005, 16:1, FIG. 4.

95. I noticed that Wang describes techniques for using module 13 to perform an **eigendecomposition** of the **correlation matrix** R by identifying one or more eigenvectors (V) and calculating one or more eigenvalues (λ) with respect to each eigenvector. EX1005, 16:2-4, FIG. 4. This means that the **eigendecomposition**

performed by module 13 involves calculating both eigenvalues and eigenvectors just like the *eigendecomposition* of the '492 patent yields both eigenvalues and eigenvectors used for selecting an appropriate MUD. EX1005, 14:21-30, 16:2-4, FIG. 4; *cf.* EX1001, 14:7-18. Wang explains that these eigenvalues and eigenvectors are computed using the equation $R \cdot V = \lambda \cdot V$, which represents a well-known equation for calculating eigenvalues and eigenvectors. EX1005, 16:2-4, FIG. 4. My opinion here is corroborated by multiple references that describe a similar equation for calculating eigenvalues and eigenvectors. EX1022, 2 (describing an equation $A \cdot u = \lambda \cdot u$, where λ represents eigenvalues, u represents eigenvectors, and A is a matrix subject to an eigendecomposition); EX1023, 2 (describing an equation $A \cdot x = \lambda \cdot x$, where λ represents eigenvalues, x represents eigenvectors, and A is a matrix subject to an eigendecomposition).

96. Furthermore, I noticed that module 13 determines a noise power (σ_N^2) based on the one or more eigenvalues (λ) according to the equation $\lambda_1 \geq \lambda_2 \geq \dots = \lambda_M = \sigma_N^2$. EX1005, 16:5, FIG. 4. In the equation $\lambda_1 \geq \lambda_2 \geq \dots = \lambda_M = \sigma_N^2$, the smallest eigenvalue is equal to the noise power (σ_N^2), meaning that the noise power is exceeded or equaled by every eigenvalue. EX1005, 16:5, FIG. 4. The '492 patent does not describe equations or techniques for calculating the “noise floor” of the *eigendecomposition* of *correlation matrix* algorithm described by the '492 patent. EX1001, 14:7-18. Wang does describe a process that involves comparing a “noise

floor” value based on the noise power (σ_N^2) to each of one or more eigenvalues (λ) that is calculated by module 13 using the equation $R \cdot V = \lambda \cdot V$. EX1005, 16:2-9, FIG. 4.

97. Specifically, module 13 identifies “effective” eigenvalues according to the equation $\lambda \geq \sigma_N^2 + \delta_\lambda$, where δ_λ is a specific parameter. EX1005, 16:5-9, FIG. 4. To apply the equation $\lambda \geq \sigma_N^2 + \delta_\lambda$, module 13 compares every one of the one or more eigenvalues (λ) that is calculated by module 13 using the equation $R \cdot V = \lambda \cdot V$ with the value $\sigma_N^2 + \delta_\lambda$ representing the noise power (σ_N^2) plus the specific parameter δ_λ and identifies effective eigenvalues as those that exceed the value $\sigma_N^2 + \delta_\lambda$. EX1005, 16:5-9, FIG. 4. Because the noise power plus the specific parameter ($\sigma_N^2 + \delta_\lambda$) involves a noise value and represents a threshold against which eigenvalues are compared, $\sigma_N^2 + \delta_\lambda$ can therefore be considered a “noise floor.” EX1005, 16:5-9, FIG. 4. Module 13 compares every single one of the one or more eigenvalues (λ) with $\sigma_N^2 + \delta_\lambda$ to identify effective eigenvalues, and in so doing identifies every single effective eigenvalue greater than the noise floor. EX1005, 16:5-9, FIG. 4; *cf.* EX1001, 8-9 (“looking at all the eigenvalues that are above the noise floor”)

98. Furthermore, Wang explains that effective eigenvalues are eigenvalues that exceed the noise power by at least the specific parameter δ_λ . EX1005, 16:5-9, FIG. 4. Because the equation $\lambda_1 \geq \lambda_2 \geq \dots = \lambda_M = \sigma_N^2$ guarantees that the smallest

eigenvalue is equal to the noise power σ_N^2 , this means that at least one eigenvalue will not be an effective eigenvalue provided that δ_λ is greater than zero. In other words, it is likely that at least one of the eigenvalues identified by module 13 using the equation $R \cdot V = \lambda \cdot V$ will not exceed the noise floor, meaning that in addition to looking at all the eigenvalues that are above the noise floor, module 13 also looks at all the eigenvalues that are *not* above the noise floor. EX1005, 16:5-9, FIG. 4. The process performed by module 13 involves looking at all eigenvalues, regardless of being above, equal to, or below the noise floor, and in so doing identifies which eigenvalues are above the noise floor and which are not. EX1005, 16:5-9, FIG. 4.

99. Wang's process of identifying effective eigenvalues as eigenvalues greater than a noise floor of $\sigma_N^2 + \delta_\lambda$ is therefore the same as the step of "looking at all the eigenvalues that are above the noise floor" as described by the '492 patent. 16:5-9, *cf.* EX1001, 14:8-9, FIG. 4. The '492 patent does not describe how the step of "looking at all the eigenvalues that are above the noise floor" is performed, but as I have described above, Wang's equation $\lambda \geq \sigma_N^2 + \delta_\lambda$ satisfies this step especially given the fact that that noise power σ_N^2 is equal to the smallest eigenvalue and at least one eigenvalue is likely not to exceed $\sigma_N^2 + \delta_\lambda$. EX1005, 16:5-9, FIG. 4. Module 13 also determines a power of each channel ($P_1, P_2, \dots P_M$) corresponding to the antenna array 10. EX1005, 16:5-6, FIG. 4.

100. Furthermore, it is clear that module 13 determines a total number of effective eigenvalues associated with the correlation matrix for the received signals. EX1005, 16:5-9, FIG. 4. Module 13 determines a channel type of the *received signals* based on the number of effective eigenvalues. EX1005, 16:14-29. Because the multi-user detection module 15 selects an “appropriate multi-user detection algorithm” based on the channel type that is determined by determining the number of effective eigenvalues for a *correlation matrix*, it is clear that the modules 13, 15 represent a *multi-user detector decision unit* that performs an *eigendecomposition* of *correlation matrix* to select an appropriate multi-user detector. EX1005, 15:12-16, 15:29-16:29. This supports my opinion that Wang’s algorithm for determining the number of effective eigenvalues is the same algorithm described by the ’492 patent for determining the *eigendecomposition* of the *correlation matrix*.

101. Furthermore, Wang explains that when the number of effective eigenvalues is equal to one, module 13 selects the first channel type or the second channel type and when the number of effective eigenvalues is greater than one, module 13 selects the third channel type or the fourth channel type. EX1005, 8:12-22, 9:7-24, 10:30-11:31, 16:14-29, FIG. 4. In general, because Wang explains that effective eigenvalues are determined to be eigenvalues greater than a threshold (e.g., a noise floor), a greater number of effective eigenvalues corresponds to a greater number of large eigenvalues which indicates a greater amount of interference. This

is confirmed by the fact that the first channel type and the second channel type correspond to “additive Gaussian white noise interference” and “co-channel interference,” which are less complex as compared with the “inter-symbol interference” and the “multiple interferences and noise” corresponding to the third and fourth channel types, respectively. EX1005, 8:4-11, 9:7-24, 10:30-11:31.

102. This means that when only one eigenvalue is above the noise power threshold (as is the case when module 13 selects the first channel type or the second channel type based on identifying a single effective eigenvalue), module 13 selects a lower complexity MUD just as the '492 patent explains that a lower complexity MUD is selected “if there is any one eigenvector that has a dominant term” and the eigenvalue corresponding to that eigenvector is above the noise floor. EX1005, 8:12-22, 9:7-24, 10:30-11:31, 16:14-29, FIG. 4; *cf.* EX1001, 14:7-18. In this case, the eigenvector corresponding to the effective eigenvalue has a “dominant term,” because this eigenvector must be different from eigenvectors for the other eigenvalues in a way that causes this eigenvector to correspond to the only eigenvalue that exceeds the noise floor. EX1005, 8:12-22, 9:7-24, 10:30-11:31, 16:14-29, FIG. 4.

103. It is also clear that when module 13 identifies only one effective eigenvalue, every other eigenvalue of the one or more eigenvalues λ is less than the noise floor $\sigma_N^2 + \delta_\lambda$ and greater than the noise power σ_N^2 . EX1005, 16:2-9, FIG. 4.

Aside from the single effective eigenvalue, every other eigenvalue is within the range from the noise power σ_N^2 to the noise floor $\sigma_N^2 + \delta_\lambda$, meaning that “the first N eigenvalues” corresponding to every eigenvalue other than the single effective eigenvalue are “very close to one another,” just as described by the ’492 patent, leading to module 13 identifying the first or second channel type which results in module 15 selecting a “lower complexity MUD.” EX1005, 16:2-29, 19:7-22, FIG. 4; *cf.* EX1001, 14:7-18. In this scenario, it is clear that “the first N eigenvalues” other than the single effective eigenvalue would correspond to eigenvectors that “all have the same N entries,” because when eigenvalues are similar this means that eigenvectors corresponding to those eigenvalues have similar entries. EX1005, 16:2-29, 19:7-22, FIG. 4; *cf.* EX1001, 14:7-18.

104. Furthermore, it is clear that when more than one eigenvalue is above the noise floor (as is the case when module 13 selects the third channel type or the fourth channel type), module 13 selects a high complexity MUD just as the ’492 patent explains that the highest complexity MUD is selected when the eigenvalues and eigenvectors do not have the characteristics for selecting a lower complexity MUD. EX1005, 8:12-22, 9:7-24, 10:30-11:31, 16:14-29, FIG. 4; *cf.* EX1001, 14:7-18. In other words, it is clear that when module 13 identifies more than one effective eigenvalue, this is the same as the condition described by the ’492 patent where “the eigenvalues and eigenvectors of the correlation matrix do not have *these*

characteristics.” EX1001, 14:7-18. The ’492 patent explains that “these characteristics” include “any one eigenvector that has a dominant term and its eigenvector is above the noise floor,” and “the first N eigenvalues are very close to one another and the eigenvectors associated with those eigenvalues all have the same N entries terms,” meaning that Wang explains when there is more than one effective eigenvalue the characteristics for selecting a lower complexity MUD are not present and “the highest complexity MUD is selected.” EX1005, 16:2-29, 19:7-22, FIG. 4; *cf.* EX1001, 14:7-18.

105. Because the *eigendecomposition* of the *correlation matrix* algorithm that Wang uses to select a MUD algorithm is the same *eigendecomposition* of the *correlation matrix* algorithm described by the ’492 patent, the modules 13, 15 of Wang represent a multi-user detector decision unit even if the District Court’s prior interpretation is applied. It would have been obvious for a POSITA to implement the MUD system of McElwain so that *parameter estimator* 10 and the *received signals* are coupled to the *multi-user detector decision unit*, because Wang explains that module 13 selects a multi-user detection algorithm based on parameters of the received signals. EX1004, [0076]-[0096], FIGS. 1-2; EX1005, 15:29-16:16, FIG. 4, *supra*, §VII.C.

Element [1c]: at least two multi-user detectors coupled to said parameter estimator and said multi-user detector decision unit, said multi-user detector decision unit using decision criteria to determine a selected multi-user detector,

wherein said selected multi-user detector outputs a plurality of information streams, one stream corresponding to each of said received signals;

106. As I described above in my analysis of Elements [1pre] and [1b], *supra*, McElwain discloses a single MUD 20 that is *coupled* to a *parameter estimator* 10. EX1004, [0080]-[0085], [0090]-[0093], FIGS. 1-2. This MUD 20 is *coupled* to a *parameter estimator* 10 either directly as depicted in FIG. 1 or through an overloaded front end 75 as depicted in FIG. 2. EX1004, [0080]-[0085], [0090]-[0093], FIGS. 1-2. In my review of McElwain, I noticed that McElwain expressly describes MUD 20 as outputting a *plurality of information streams* each corresponding to one of the *received signals* present in raw input data. EX1004, [0084] (“multiuser detection unit 20 outputs a bit (or symbol) stream associated with each interfering signal[] present on the channel”); *see also id.*, [0093], FIGS. 1-2.

107. As I discussed above in my analysis of Element [1b], *supra*, it is clear that a POSITA would have been motivated to implement the MUD system of McElwain with a *multi-user detector decision unit* as suggested by Wang, because doing so would enable MUD system of the predictable McElwain-Wang combination to select a *multi-user detector* based on characteristics of interference in the raw input data. *Supra*, §VII.C. This would allow the system to select a more complex detector to ensure accuracy when the received signals include greater amounts of interference and select a less complex detector to conserve resources when the received signals include lower amounts of interference.

108. I noticed that Wang provides *at least two multi-user detectors*, even if McElwain does not expressly describe this feature. My opinion here is supported by the fact that Wang describes at least four different multi-user detection algorithms. EX1005, 9:7-30, 10:30-11:17, 19:8, Cl. 6, 8, 15, 16. Wang sometimes refers to these algorithms to as “methods,” and discloses that module 15 uses these multi-user detection algorithms to remove interference from *received signals*. EX1005, 9:7-30, 10:30-11:17, 19:8, Cl. 6, 8, 15, 16. For example, I noticed that the multi-user detection algorithms described by Wang achieve “user differentiation” and cause module 15 to output “the demodulated bits...to other subsequent conventional processing modules.” EX1005, 15:12-16.

109. These multi-user detection algorithms include a “minimum mean square” detection method, a “decorrelation” detection method, a “parallel interference cancellation” detection method, and a “partial multiple access interference cancellation” detection method. EX1005, 11:14-12:3, 19:8-22, Cl. 6, 8. Minimum mean square error (MMSE) detectors, decorrelators, and interference cancellation detectors are each acknowledged by the ’492 patent as being known in the art, which supports my opinion that a POSITA would have been motivated to modify the system of McElwain with MUD selection teachings of Wang.

110. Because Wang describes four different multi-user detection algorithms that are used by multi-user detection module 15, it is apparent that module 15

includes *at least two multi-user detectors* each corresponding to one of these algorithms. EX1005, 9:3-30, 11:14-12:3, 13:28-14:5, 15:12-21, 19:8-22, FIGS. 2, 4. My opinion here is supported by the fact that Wang expressly discloses an embodiment where module 15 is a hardware module. EX1005, 15:17-21 (“multi-user detection module 15...can also be hardware modules...implemented in an...ASIC...or an FPGA”). Each multi-user detection algorithm is applied by dedicated hardware when module 15 is a hardware module, because each of the multi-user detection algorithms described by Wang involves a different mathematical operation. EX1005, 15:17-21. Processing hardware is comprised of circuit elements that define logic gates, which means that different arrangements of hardware are necessary to apply different mathematical operations.

111. The fact each individual MUD is associated with separate hardware is corroborated by multiple references published before the Critical Date of the '492 patent that describing MUD hardware. EX1014, 10 (describing two kinds of nonlinear multiuser detectors and explaining that one “requires more hardware” than the other); EX1015, 9 (describing a multiuser detector having “low hardware complexity”). This means that the multi-user detection module 15 described by Wang includes *at least two multi-user detectors*, each detector including dedicated hardware for applying a respective multi-user detection algorithm. EX1005, 15:17-21.

112. As I described above in connection with Element [1b], *supra*, it is clear that Wang discloses a module 13 that identifies a “channel type” corresponding to the received signals and a module 15 that selects a multi-user detection algorithm based on the identified channel type. EX1005, 14:21-30 (“channel environment detection and classification module 13 further includes...a channel type determination unit, used to identify the current channel type based on the number of effective eigenvalues and the in-band power spectrum deviation according to preset determination rules”), 15:17-21 (“[t]he multi-user detection module 15 is used to select the appropriate multi-user detection algorithm based on the channel type result output by the channel environment detection and classification module 13”). Wang therefore discloses a ***multi-user detector decision unit*** that uses ***decision criteria*** to select a multi-user detection algorithm, the algorithm applied by one of the ***at least two multi-user detectors*** corresponding to the selected algorithm. EX1005, 8:4-22, 9:3-30, 10:22-12:3, 14:21-30, 15:12-21; FIG. 2.

Received signals

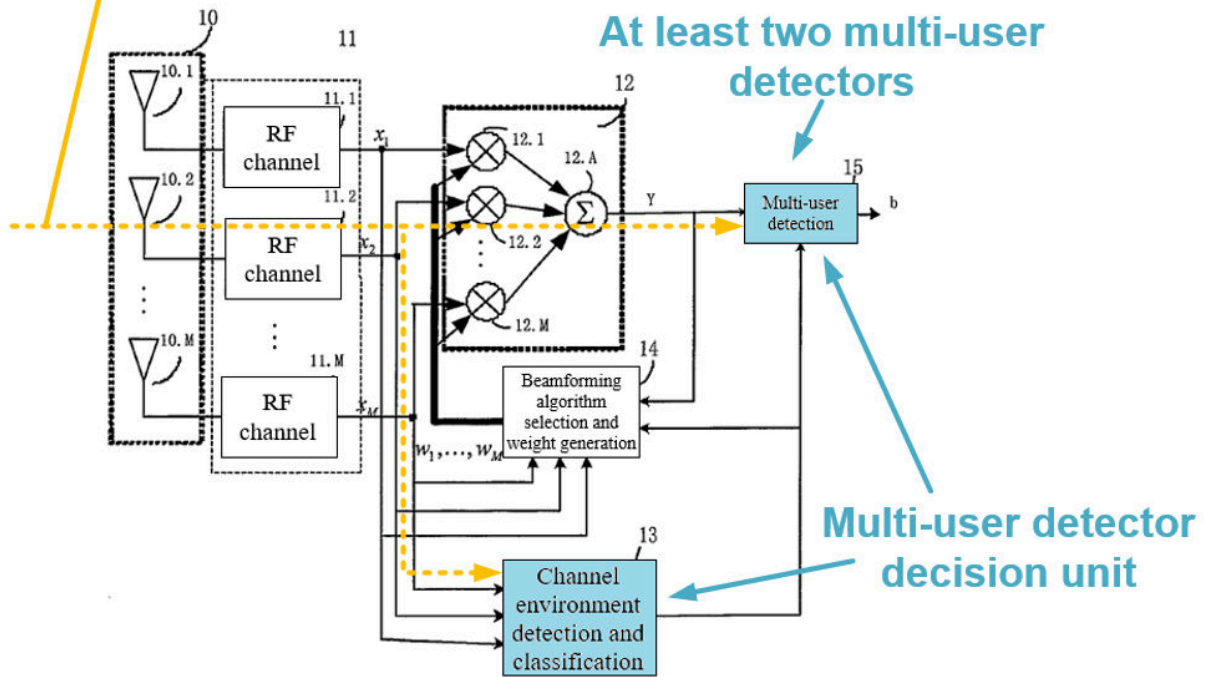


FIG. 2

EX1005, FIG. 2 (annotated).

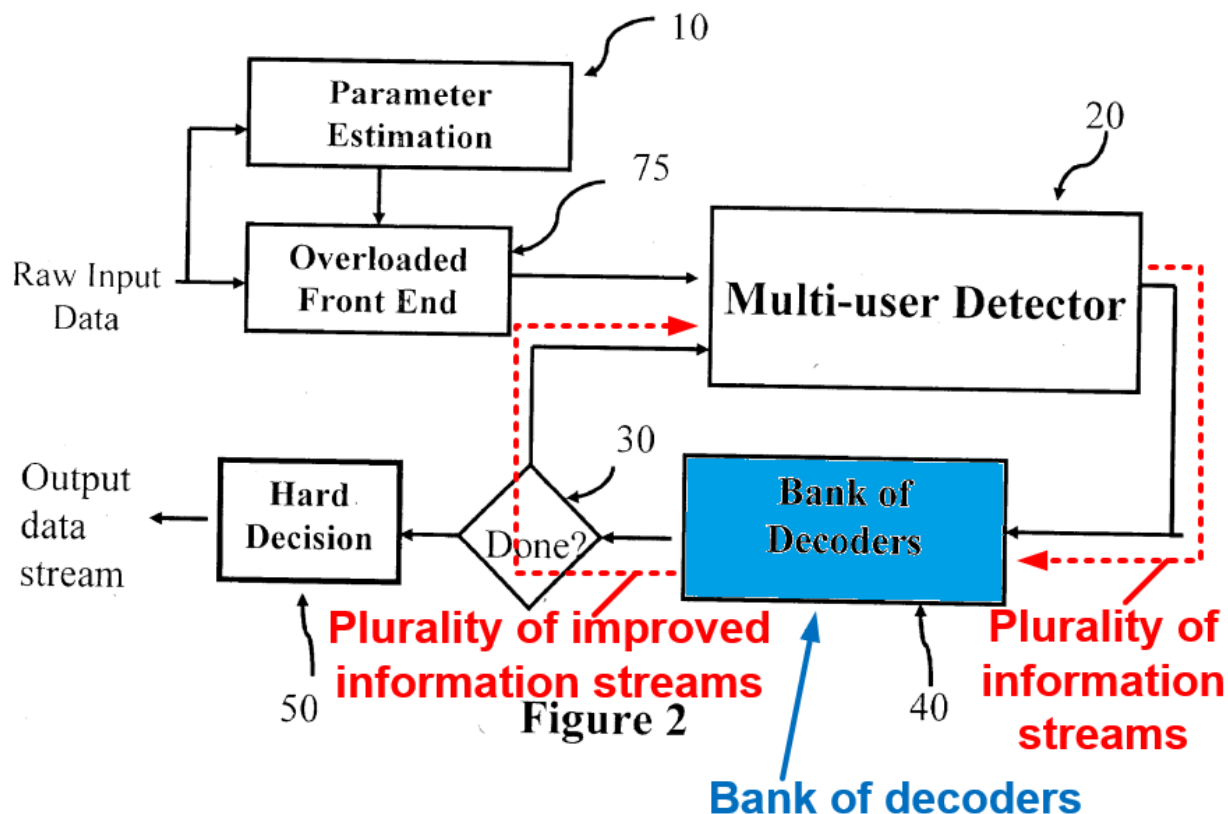
113. I noticed McElwain explains that MUD 20 outputs a *plurality of information streams* each corresponding to a *received signal* present in raw input data. EX1004, [0084] (“multiuser detection unit 20 outputs a bit (or symbol) stream associated with each interfering signal[] present on the channel”); *see also id.*, [0093], FIGS. 1-2. The *at least two multi-user detectors* of the predictable McElwain-Wang combination are therefore coupled to a *parameter estimator* and the *selected multi-user detector* outputs a *plurality of information streams* because McElwain

expressly discloses that MUD 20 is *coupled* to a *parameter estimator* 10,. EX1004, [0080], [0084], [0090], [0093]; *supra*, §VII.C.

Element [1d]: a bank of decoders coupled to said plurality of information streams, wherein said decoders output a plurality of improved information streams.

114. In my review, I noticed that the '492 patent acknowledges the “bank of decoders” to be well-known available and known in the prior art by the Critical Date. EX1001, 10:66-11:10 ([i]n one known variation, there is a bank of error correction decoders 40 that provide soft output or restore values associated with prior probabilities...[s]oft input soft output decoders, such as MAP or soft-output Viterbi algorithm (SOVA) decoders are examples known in the art”), FIG. 1 (depicting a “bank of decoders 40” in a figure labeled “Prior Art”). This is confirmed by McElwain, which describes a MUD system including a *bank of decoders* 40 that are *coupled* to the *plurality of information streams* output by MUD 20. EX1004, [0081] (“The bit streams from the MUD 20 are passed to a bank of error correction decoders unit 40.”); *see also id.*, [0083]-[0085], [0087]-[0089], [0093]-[0096], FIGS. 1-2. Because Wang describes a *multi-user detector decision unit* for determining a *selected multi-user detector* from *at least two multi-user detectors* and McElwain discloses that MUD 20 can generate a *plurality of information streams* for output to a *bank of decoders* 40, a POSITA would have been motivated to implement the MUD system of McElwain so that the *bank of decoders* 40 are coupled to a *plurality*

of *information streams* generated by the *selected multi-user detector*. EX1004, [0076]-[0096], FIGS. 1-2; EX1005, 13:28-17:3, FIGS. 2, 4; *supra*, §VII.A.



EX1004, FIG. 2 (annotated).

115. I noticed that McElwain describes the *bank of decoders* 40 as generating “soft outputs for each bit of each user.” EX1004, [0087]; *see also id.*, [0093]. These soft outputs are “fed back to the MUD 20 for each iteration” to be processed again so that the soft estimates become more accurate after each iteration. EX1004, [0087]; *see also id.*, [0093]. One result of this iterative process is “to calculate an *improved*, less corrupted bit stream for each user.” EX1004, [0087]; *see also id.*, [0095]. It is clear, therefore, that McElwain’s *bank of decoders* 40 output a

plurality of improved information streams including the soft outputs that are fed back into MUD 20.

116. In the predictable McElwain-Wang combination, the bank of decoders 40 therefore receives a *plurality of information streams* from a *selected multi-user detector* and outputs a *plurality of improved information streams* through a series of iterations. *Supra*, §VII.C. This iterative process is substantially the same as the iterative process performed by MUD 20 and the bank of decoders 40 in the '492 patent generates improved bit streams. *Cf.* EX1001, 11:34-43 (“soft outputs for each bit of each user from the bank of decoders 40 are fed back to the MUD 20...multiuser detector 20 takes these soft inputs along with the original raw input signal to calculate an improved, less corrupted bit stream for each user.”).

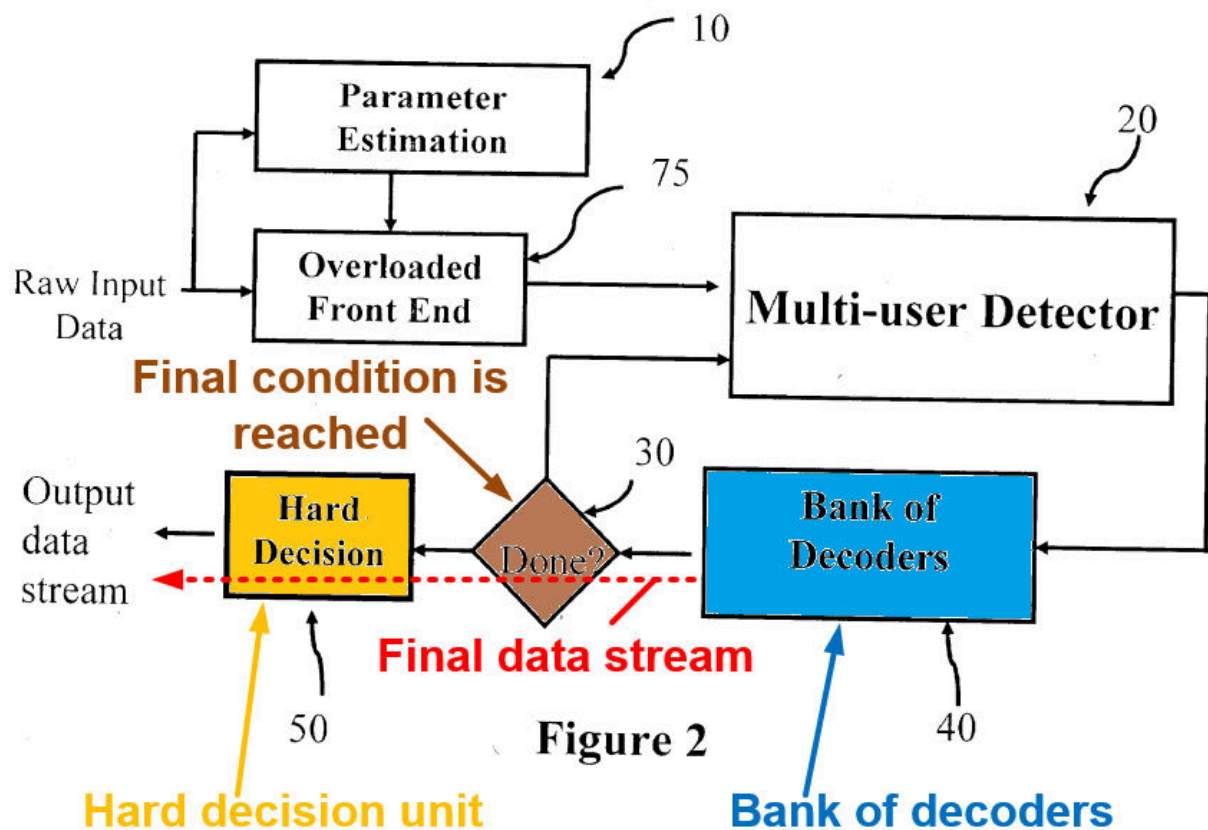
Claim [2]: The System according to claim 1 wherein said plurality of improved information streams are fed back to said multi-user detector decision unit until a final condition is reached and said bank of decoders output a final data stream.

117. As I described above in connection with my analysis of Element [1d], *supra*, McElwain expressly discloses that “soft outputs for each bit of each user from the bank of decoders 40 are fed back to the MUD 20 for each iteration.” EX1004, [0087]; *see also id.*, [0093], FIG. 2. McElwain also explains that MUD 20 uses these soft values to calculate improved bit streams for each user and the values are improved through several iterations. EX1004, [0087]; *see also id.*, [0093], FIG. 2. Based on my review of McElwain and Wang, it is apparent that in the predictable

McElwain-Wang combination the *bank of decoders* 40 therefore feeds the plurality of improved information streams back to the *multi-user detector decision unit* for each iteration so the selected multi-user detector can process the improved information streams resulting in further improvements. EX1004, [0087] (“soft outputs for each bit of each user from the bank of decoders 40 are fed back to the MUD 20 for each iteration”), [0088] (describing “changes to the data from the last iteration”), *see also id.*, [0087], [0093]-[0096]; FIGS. 1-2. For example, in the McElwain-Wang combination, it would have been obvious to implement the MUD system of Mills so that the *bank of decoders* 40 feed the *plurality of improved information streams* into a *multi-user detector decision unit*, because doing so would allow the *multi-user detector decision unit* to direct the signals to the appropriate *selected multi-user detector*. For example, because nodule 14 of Wang selects the appropriate detection algorithm and applies the selected detection algorithm, a POSITA would have been motivated to implement decoders 40 to feed the *plurality of improved information streams* back into a *multi-user detector decision unit* so this unit can apply the correct detection algorithm to the improved streams. EX1005, 15:12-16, FIG. 4.

118. McElwain also explains that the bit streams are passed between MUD 20 and the bank of decoders 40 through several iterations, “until the desired quality is reached” or a fixed number of iterations “is reached.” EX1004, [0087].

Specifically, McElwain explains that a decision block 30 can determine whether a *final condition is reached*. EX1004, [0094] (“the output of the decoders 40 is checked to determine if processing is completed”); *see also id.*, [0088]-[0089], [0095]-[0096]. I noticed that the *final condition* in the system of McElwain is reached “once the data is no longer being altered or reaches a certain iteration counter limit” or “[a]lternatively,...until an asymptote is reached or the desired performance level is attained.” EX1004, [0088], *see also id.*, [0094] (“[d]epending upon the number of fixed iterations or desired accuracy, the output of the decoders 40 is checked to determine if processing is completed”).



EX1004, FIG. 2 (annotated).

119. McElwain explains that the bank of decoders 40 pass along soft outputs to a hard decision unit 50 when decision block 30 determines that the *final condition is reached*, the *bank of decoders* 40 pass a *final data stream* including “final estimates of what the user sent” to a *hard decision unit* 50 to output a *final data stream*. EX1004, [0089] (“[w]hen processing is completed...the soft output of the bank of error decoders 40 is passed to a hard decision unit 50 which outputs the final...output data stream for each interfering user”); *see also id.*, [0088], [0094]-[0096], FIGS. 1-2. That is, output of the bank of decoders 40 corresponding to the last iteration represents the *final data stream* that is output to the hard decision unit 50 which generates the output data stream for each user. EX1004, [0089], [0094].

120. In my review, I noticed that the process of using a *bank of decoders* to output a *final data stream* when a *final condition is reached* described by McElwain is nearly identical to the final output process of the '492 patent. *Cf.* EX1001, 11:44-56 (“[o]nce the data is no longer being altered or reaches a certain iteration counter limit, the data from the decoder 40 can be output as final estimates of what the user sent), 11:57-61 (“[w]hen processing is completed 30, the soft output of the bank of error decoders 40 is passed to a hard decision unit 50 which outputs the final...output data stream for each interfering user for the current data block.”). Indeed, the '492 patent itself cites an academic article that describes an “iterative” MUD system

where “the iterative process continues until further iterations yield minimal improvement.” EX1020, 4.

Claim [3]: The System according to claim 1 wherein said design criteria is based upon at least one threshold selected from at least one of the group consisting of number of symbols, correlation matrix between users, expected bit error rate, eigendecomposition of correlation matrix, signal to interference plus noise ratio, and expected SINR.

121. As I described above in my analysis of Elements [1b]-[1c], *supra*, the ***multi-user detector decision unit*** of the predictable McElwain-Wang combination is configured to ***determine a selected multi-user detector*** of at ***least two multi-user detectors*** based on ***decision criteria***. EX1005, 9:7-30, 10:18-12:3, 13:28-14:5, 15:12-21, 19:8-22, FIG. 2, FIG. 4. For example, I noticed that Wang describes a technique for performing an ***eigendecomposition*** of a ***correlation matrix*** of signals received via antenna array 10 as one way that the ***multi-user detector decision unit*** can ***determine a selected multi-user detector***. EX1005, 15:29-16:13, FIG. 4; *supra*, Elements [1b]-[1c]. In fact, Wang specifically describes this technique as involving a channel environment detection and classification module 13 that includes a channel type decision unit for applying ***thresholds*** to identify a channel type. EX1005, 14:21-30, 15:17-21, 16:14-17:3, 19:8-22, FIG. 4; *supra*, Elements [1b]-[1c]. These ***thresholds*** include a threshold number of effective eigenvalues which can be determined by performing the ***eigendecomposition*** of the ***correlation matrix***,

as I discussed in connection with Elements [1b]-[1c], *supra*. EX1005, 14:21-30, 15:17-21, 16:14-17:3, 19:8-22, FIG. 4.

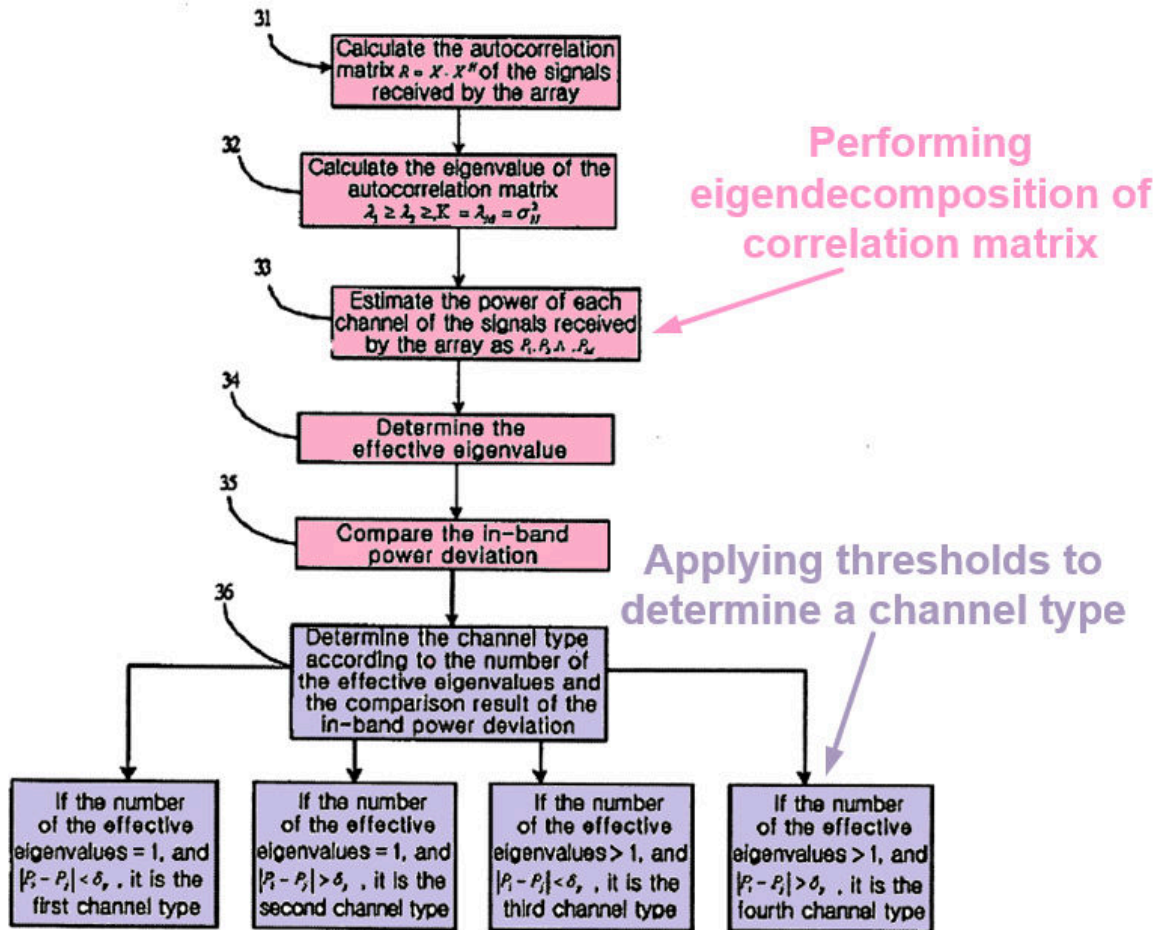


fig. 4

EX1005, FIG. 4 (annotated).

122. For example, I noticed that that channel environment detection and classification module 13 of the *multi-user detector decision unit* described by Wang identifies a number of effective eigenvalues corresponding to a *correlation matrix* of the received signals by performing a series of mathematical operations. EX1005, 16:1 (“calculating the autocorrelation matrix $R = X \cdot X^H$ ”), 16:2-4 (“calculating the

eigenvalue λ with respect to the eigenvector V according to the equation: $R \cdot V = \lambda \cdot V$ ”), 16:5 (describing an equation to determine a noise power (σ_N^2)), 16:6 (“estimating the power of each channel...as $P_1, P_2, \dots P_M$ ”), 16:7-9 (“determining the effective eigenvalue, if $\lambda \geq \sigma_N^2 + \delta_\lambda$, λ is the effective eigenvalue”). Next, Wang explains that the *multi-user detector decision unit* of Wang compares the number of effective eigenvalues identified from the *eigendecomposition* of the *correlation matrix* to a *threshold* number of effective eigenvalues to identify a channel type. EX1005, 16:17-19 (“if the number of the effective eigenvalues is 1, and the in-band power deviation is small...then it is the first channel type”), 16:20-23 (“if the number of the effective eigenvalues is 1, and the in-band power deviation is large...then it is the second channel type”), 16:24-26 (“if the number of the effective eigenvalues is larger than 1, and the in-band power deviation is small...then it is the third channel type”), 16:27-29 (“if the number of the effective eigenvalues is larger than 1, and the in-band power deviation is large...then it is the fourth channel type”), FIG. 4.

123. I noticed that the process described by Wang for performing the *eigendecomposition* of the *correlation matrix* itself involves comparing eigenvalues of the correlation matrix with a *threshold* noise power value (σ_N^2) to determine whether each eigenvalue represents an effective eigenvalue. EX1005, 16:5, 16:7-9. Indeed, Wang explains that if an eigenvalue is greater than a *threshold* of $\sigma_N^2 + \delta_\lambda$, where δ_λ is a specific parameter, the eigenvalue is considered an effective

eigenvalue. EX1005, 16:5, 16:7-9. Alternatively, if an eigenvalue is not greater than a **threshold** of $\sigma_N^2 + \delta_\lambda$, the eigenvalue is not considered an effective eigenvalue. EX1005, 16:5, 16:7-9. Because the **eigendecomposition** of **correlation matrix** described by Wang involves applying a **threshold** noise floor to determine effective eigenvalues and applying a **threshold** number of effective eigenvalues to determine a channel type, the predictable McElwain-Wang combination provides **a multi-user detector decision unit** that determines a **selected multi-user detector** using **decision criteria**³ based on at least one threshold relating to an **eigendecomposition** of **correlation matrix**. *Supra*, §VII.C.

Claim [5]: The System according to claim 1 wherein said at least two multiuser detectors are selected from the group consisting of M-algorithm, sphere decoder, T-algorithm, FANO, reduced state Viterbi, Maximum Likelihood, matched filter, minimum mean squared error (MMSE), decorrelator, and combinations thereof.

124. As I described in my analysis of Element [1c], *supra*, Wang describes a multi-user detection module 15 that can apply at least four different multi-user detection algorithms each corresponding to a respective multiuser detector. EX1005, 9:7-30, 10:30-11:17, 19:8, Cl. 6, 8, 15, 16. I noticed that these multiuser detection

³ I noticed that claim 3 uses the term “design criteria,” whereas independent claim 1 uses the term “design criteria.” I have analyzed Claim 3 as referring to the same “design criteria” that is referred to by claim 1.

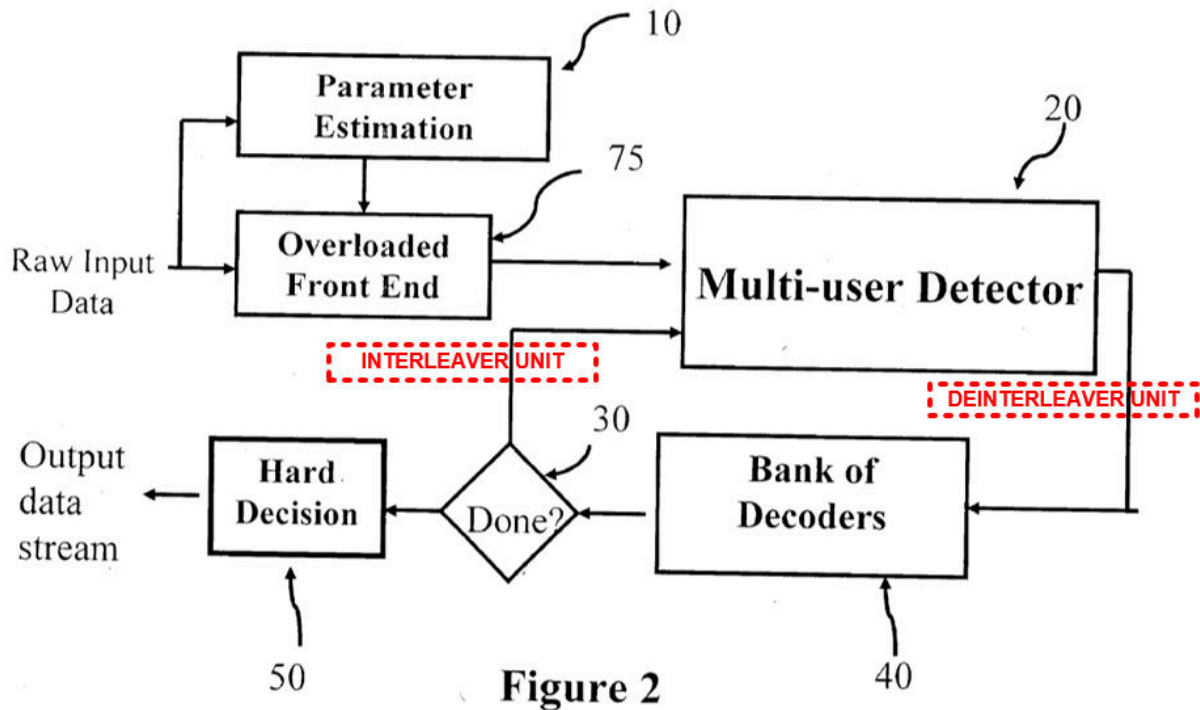
algorithms include a “minimum mean square based multi-user detection method” and a “de-correlation detection method.” EX1005, 9:11-13, 11:18-21, 19:11-13, Cl. 6, Cl. 15; FIG. 2; *supra*, Element [1c]. As I explained in connection with Element [1c], *supra*, separate hardware would be needed to apply each individual MUD algorithm in the case where multi-user detection module 15 includes hardware components,. EX1005, 15:17-21. This means that the module 15 described by Wang would include first hardware for applying the “minimum mean square based multi-user detection method” and second hardware for applying the “de-correlation detection method” that is separate from the first hardware. Consequently, when McElwain’s system is implemented with Wang’s suggestion to include *at least two multiuser detectors*, these detectors can be selected from a group consisting of minimum *mean squared error (MMSE)* detectors and *decorrelator* detectors. *Supra*, §VII.C.

Claim [6]: The System according to claim 1, further comprising an interleaver unit and a deinterleaver unit coupled between said bank of decoders and said multi-user detectors.

125. In my review, I noticed that the ’492 patent explains that “deinterleavers” and “interleavers” are coupled between the MUD 20 and bank of decoders 40 of FIG. 1, which the ’492 patent acknowledges as “Prior Art.” EX1001, 10:45-65, FIG. 1. I also noticed that an academic article cited by the ’492 patent confirms that it was known in the art as of the Critical Date of the ’492 patent for an

interleaver and a deinterleaver to be coupled between a multi-user decoder and a bank of single-user decoders in an iterative MUD system. EX1020, FIG. 2 (depicting an interleaver and a deinterleaver).

126. McElwain explains that “[d]einterleavers and interleavers (not shown) are optional elements coupled between the MUD 20 and the decoders 40 that are used if the transmitted signals are interleaved.” EX1004, [0084]; *see also id.*, [0093], Claim 14. It is apparent, therefore, that McElwain’s MUD system includes both an *interleaver unit* and a *deinterleaver unit* that are coupled between the *bank of decoders* 40 and MUD 20 described by McElwain. My opinion here is supported by the fact that McElwain expressly discloses an embodiment where an interleaver is coupled to the output of the bank of decoders 40 and a deinterleaver is coupled to the output of MUD 20. For example, McElwain discloses that “[i]f the signals were transmitted with interleaving, the reliability measures from the MUD 20 are first passed through a deinterleaver (not shown) and passed on in shuffled form to the decoder 40.” EX1004, [0084]; *see also id.*, [0093], Claim 14. McElwain also explains that an “interleaver unit performs interleaving” prior to signals being fed back into MUD 20. EX1004, [0084]; *see also id.*, [0093], Claim 14.



EX1004, FIG. 2 (annotated).

127. As depicted above in FIG. 2, this means that an interleaver unit can be coupled between an output of the bank of decoders 40 and an input of MUD 20 and a deinterleaver unit can be connected between an output of MUD 20 and an input of the bank of decoders 40. When McElwain's MUD system is implemented with *two or more multi-user detectors* as Wang suggests, the *interleaver unit* and the *deinterleaver unit* described by McElwain are therefore coupled between *the bank of decoders* 40 and the *two or more multi-user detectors*. *Supra*, §VII.C.

Claim [7]: *The System according to claim 2, wherein said final condition is determined by one of a fixed number of iterations and an allowable performance level.*

128. It is apparent that MUD 20 and bank of decoders 40 of McElwain pass signals between each other through a series of iterations until a ***final condition*** is reached, as I described above in my analysis of Claim [2], *supra*. EX1004, [0087]-[0088], [0094]-[0096], FIGS. 1-2. McElwain explains that in some embodiments, these iterations continue until a ***fixed number*** of iterations is reached. EX1004, [0087] (“[t]his iterative process continues until...a fixed number is reached”); *see also id.*, [0088] (“[a] fixed number of iterations”), [0094]-[0096], FIGS. 1-2, Claim 12. In these embodiments, the decision block 30 feeds soft outputs from the bank of decoders 40 back into the MUD 20 in each iteration until decision block 30 determines that a ***final condition*** is satisfied when the ***fixed number*** of iterations is reached. EX1004, [0087], [0088], [0094]-[0096]. At this point, I noticed that decision block 30 delivers the output of the bank of decoders 40 to the hard decision unit 50. EX1004, [0089], [0094].

129. According to another embodiment described by McElwain, decision unit 30 can allow iterations to continue until an ***allowable performance level*** is reached, at which point the decision unit 30 determines that the ***final condition*** is satisfied. EX1004, [0088] (“information between the...MUD...and the decoders...repeats in subsequent iterations until...the desired performance level is attained”); *see also id.*, [0096], Claim 13. I noticed that McElwain describes how the ***allowable performance level*** can be determined. For example, McElwain discloses

that “[a] buffer can store the previous values and compare them to the latter processed values during the iterative process,” which means that the system can determine whether the *allowable performance level* is reached by determining whether additional iterations are likely to produce further improvement in the output. EX1004, [0088], *see also id.*, [0096]. McElwain describes this process as “checking if there were significant changes to the data from the last iteration” and determining whether an “asymptote is reached.” EX1004, [0088], *see also id.*, [0096].

130. Therefore, the MUD system of the predictable McElwain-Wang combination can determine a *final condition* based on a *fixed number* of iterations or an *allowable performance level*. *Supra*, §VII.C.

Claim [8]: The System according to claim 1, further comprising a filter unit coupled to said received signals, wherein said filter unit is coupled to said multi-user detector decision unit.

131. I noticed that McElwain describes at least one embodiment where an overloaded front end 75 receives the raw input data including the *received signals*. EX1004, [0090] (explaining that “one embodiment...uses an overloaded front end 75 in cooperation with MUD 20” and “[t]he raw input data is coupled to...the overloaded front end 75”), *see also id.*, [0091], [0095], [0097]-[0100], FIGS. 2-3. Based on my review of McElwain, it is apparent that the overloaded front end 75 represents a *filter unit* because overloaded front end 75 includes a filter 120 that is *coupled* to the *received signals* of raw data 100 and the *parameter estimator* 10.

EX1004, [0099] (“The raw data 100 is coupled to the parameter estimation module 110 and to the filter 120.”), *see also id.*, [0090]-[0091], [0095], [0097], [0098], [0100], FIGS. 2-3.

132. McElwain also explains that filter 120 can be “a whitening matched filter, whitened-M algorithm filter, or matched filter,” which further supports my opinion that overloaded front end 75 represents a ***filter unit***. EX1004, [0099]; *see also id.*, [0100], [0109], [0145], FIG. 3. My opinion here is supported by the fact that matched filters were known in the art by the Critical Date of the ’492 patent. EX1018, 2 (depicting matched filter providing input to a multiuser detector). Overloaded front end 75 also includes an “asynchronous whitener designer 130” and a “whitener unit 135” that both serve as ***filters*** and confirm the status of overloaded front end 75 as a ***filter unit***. EX1004, [0099]-[0100], [0109], [0147]-[0150], [0152], [0154], FIG. 3. I also noticed that McElwain explains that the front end unit 75 “partially decouples the co-channel interference and partially whitens the noise,” therefore confirming that front end unit 75 filters the raw input data for delivery to MUD 20. EX1004, [0091].

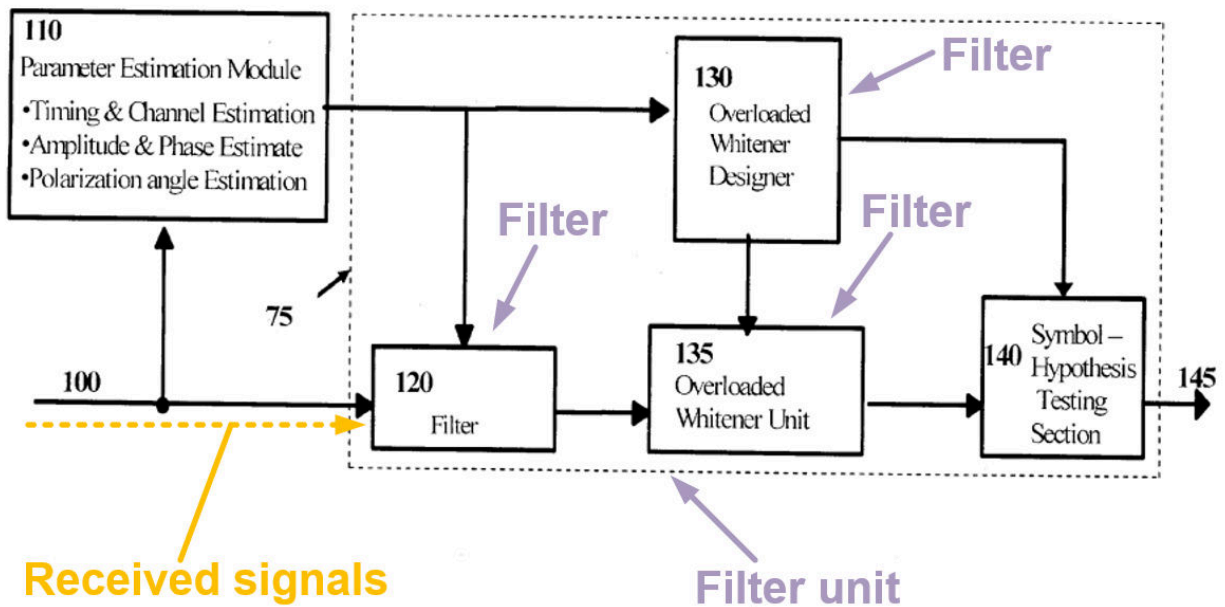


Figure 3

EX1004, FIG. 3 (annotated).

133. It is clear that when McElwain’s MUD system is implemented with a *multi-user detector decision unit* that can determine a *selected multi-user detector* from *at least two multi-user detectors* as suggested by Wang, the *filter unit* of the predictable McElwain-Wang combination is *coupled* to the *multi-user detector decision unit*. EX1005, 14:21-15:6, 15:12-21, 15:29-17:3, FIGS. 2, 4; *supra*, §VII.C. My opinion here is supported by the fact that the *filter unit* of McElwain including front end unit 75 can “allow overloaded processing of more users than available dimensions...to pass the proper parameters” prior to delivering the filtered signals to MUD 20 for processing. EX1005, [0049]. It would have been obvious for a POSITA to implement McElwain’s MUD system so that the output of front end unit

75 is coupled to a ***multi-user detector decision unit*** as taught by Wang because this would allow the front end unit 75 to “pre-process” the raw data before ***multi-user detector decision unit*** selects an appropriate MUD. *Supra*, §VII.C.

Claim [9]: The System according to claim 1, further comprising a hard decision unit coupled to said bank of decoders and producing a final data stream.

134. In my review, I noticed that the ’492 patent acknowledges FIG. 1 as “Prior Art,” and that FIG. 1 includes a “***hard decision unit*** 50.” EX1001, 11:57-60, FIG. 1. Specifically, I noticed that the ’492 patent describes the ***hard decision unit*** 50 of FIG. 1 as outputting “the ***final stream*** of decisions or output data stream for each interfering user for the current data block” based on a soft output received from the ***bank of decoders*** 40. EX1001, 11:57-60. This means that the ’492 patent acknowledges “a hard decision unit coupled to said bank of decoders and producing a final data stream” as being known in the art prior to the Critical Date of the ’492 patent.

135. My opinion here is strengthened by the fact that McElwain discloses a ***hard decision unit*** 50. EX1004, [0089], [0094]. Specifically, McElwain discloses that “[w]hen processing is completed...the soft output of the ***bank of error decoders*** 40 is passed to a ***hard decision unit*** 50 which outputs the ***final stream*** of decisions or ***output data*** stream for each interfering user for the current data block.” EX1004, [0089]; *see also id.*, [0094], FIG. 2; *supra*, Claim [2]. Consequently, McElwain

discloses that a *hard decision unit* 50 is *coupled to* a *bank of decoders* 40 and produces *a final data stream*.

Element [10pre]: A hybrid receiver for processing a plurality of received signals, said receiver comprising:

136. The McElwain-Wang combination provides this claim element for at least the same reasons I described above in connection with Element [1pre]. *See supra*, Element [1pre]. McElwain expressly discloses that “[t]he present invention is an improvement on a multiuser detection processing procedure that allows for real time implementation in *receivers* designed for typical and high data rate multiple access communication, without causing degradation in quality of service or decreasing the total throughput,” therefore indicating that the system represents a *hybrid receiver* that can process a plurality of *received signals*. EX1004, [0061], *see also id.*, [0074] (“the *Hybrid* Turbo-MUD disclosed herein enable implementations of advanced *receiver* processing”), [0075], [0078]. I noticed that Wang discloses a similar base station *receiver* that processes *received signals*. EX1004, FIG. 2.

Element [10a]: a parameter estimation unit coupled to said received signals, wherein said parameter estimation unit extracts received signal information;

137. As I described above in my analysis of Element [1a], *supra*, McElwain explains that *parameter estimator* 10 receives raw input data including *received signals* that provide *received data information*, meaning that parameter estimator 10 is *coupled* to the *received signals*. EX1004, [0054], [0063], [0080], [0090],

[0092], [0099], FIGS. 1-3. I noticed that McElwain also explains that the *parameter estimator* 10 *extracts* the *received data information* from the *received signals*. EX1004, [0080] (“A parameter estimation unit 10 processes the various parameters for the received raw data, and provides certain data to the MUD 20.”), [0099] (“received measurement from the parameter estimation unit 110”), FIG. 2. My opinion here is confirmed by the fact that McElwain incorporates by reference another patent application (EX1011), which describes several different parameters that can be extracted by a parameter estimator including “the received power 22, the phase 24 of the oscillator for each of the transmitted signals, the timing offset 26 relative to the base station clock and transmission distance, the carrier frequency offset 28 and the multipath structure 29.” EX1011, [0029].

Element [10b]: a multi-user detector decision unit coupled to said parameter estimator and said received signals, wherein said multi-user detector decision unit selects a multi-user detector based upon at least one threshold;

138. The predictable McElwain-Wang combination renders obvious a *multi-user detector decision unit* that can select a *multi-user detector* from two or more multi-user detectors, the *multi-user detector decision unit* being coupled to *parameter estimator* 10 and *received signals* of the raw input data as I described above in my analysis of Elements [1b]-[1c] and Claim [3], *supra*. EX1005, 10:22-12:3, 14:21-30, 15:12-16, 15:23-17:3, 19:8-22, FIG. 2, FIG. 4, *supra*, Elements [1b]-[1c]. As I also described in my analysis of Elements [1b]-[1c] and Claim [3], *supra*,

it is clear that the *multi-user detector decision unit* described by Wang can perform an *eigendecomposition* of a *correlation matrix* corresponding to the *received signals* of the raw input data. EX1005, 10:22-12:3, 14:21-30, 15:12-16, 15:29-17:3, 19:8-22. Furthermore, it is apparent that the *multi-user detector decision unit* of Wang can apply *at least one threshold* to identify a channel type corresponding to the *received signals* for selecting a *multi-user detector*. EX1005, 10:22-12:3, 14:21-30, 15:12-16, 15:29-17:3, 19:8-22. The *at least one threshold* can include, for example, a threshold number of effective eigenvalues for identifying the channel type and a threshold noise power (σ_N^2) for determining whether an identified eigenvalue is an effective eigenvalue. EX1005, 10:22-12:3, 16:5, 16:7-9, 16:14-29, FIG. 4.

Elements [10c]-[10e]: a low complexity multi-user detector switchably coupled by said multi-user detector decision unit, wherein said low complexity multi-user detector outputs a plurality of low complexity processed information streams; a medium complexity multi-user detector switchably coupled by said multi-user detector decision unit, wherein said medium complexity multi-user detector outputs a plurality of medium complexity processed information streams; a high complexity multi-user detector switchably coupled by said multi-user detector decision unit, wherein said high complexity multi-user detector outputs a plurality of high complexity processed information streams; and;

139. As I described in my analysis of Element [1c], *supra*, the predictable McElwain-Wang combination discloses a MUD system that includes several multi-user detectors. EX1005, 11:14-12:3, 19:8-22, Cl. 6. It is clear that these multi-user detectors disclosed by Wang vary in computational complexity such that some

detectors have more computational complexity than other detectors and vice versa. I noticed that one of the multi-user detectors described by Wang is a “minimum mean square” detector. EX1005, 9:11-12, 11:18-19, 19:11-12, Cl. 6. This “minimum mean square” detector serves as a *low complexity multi-user detector* because a “minimum mean square” detector is a linear MUD that involves a relatively low level of computational complexity. EX1005, 9:11-12, 11:18-19, 19:11-12, Cl. 6. My opinion here is supported by the fact that the ‘492 patent describes “less computationally complex” MUDs including minimum mean square error (MMSE) detectors are “known in the art,” meaning that the ‘492 patent acknowledges MMSE detectors as being *low complexity*. EX1001, 5:25-29. McElwain also explains that that MMSE detectors are “less computationally complex and known in the art,” and one reason that McElwain cites to in support of this statement is that MMSE detectors are linear as opposed to nonlinear. EX1004, [0034].

140. The channel types of Wang are determined based on applying at least two different factors—the number of effective eigenvalues identified from the correlation matrix and the in-band power spectrum deviation. EX1005, 8:12-22, 16:14-29, FIG. 4. These factors indicate a level of interference present in the received signals, thus guiding module 13 to select a multi-user detector having the appropriate complexity. EX1005, 8:12-22, 16:14-29, 19:11-20:7, FIG. 2, FIG. 4. For example, I noticed that Wang explains that the minimum mean square detector is

selected to process received signals corresponding to “first channel type” where there is one effective eigenvalue and the in-band power spectrum deviation is less than a power spectrum deviation threshold. EX1005, 11:3-6, 11:18-19, 16:17-19, 19:11-12, FIG. 4. The first channel type corresponds to lower amounts of interference as compared with Wang’s second, third, and fourth channel types. EX1005, 10:30-11:31, 16:14-17:3, 19:8-22, FIG. 4. I noticed that each of the second, third, and fourth channel types, for example, correspond to correlation matrices with more than one effective eigenvalue and/or in-band power spectrum deviations being greater than the power spectrum deviation threshold. EX1005, 10:22-11:2, 16:14-17:3, 19:8-22, FIG. 4. It is apparent therefore that the minimum mean square detector is selected to process signals associated with the lowest amount of interference, meaning that the minimum mean square detector represents a *low complexity multi-user detector*. As I described above in my analysis of Element [1c], *supra*, it would have been obvious for a POSTA to modify McElwain’s system to include two or more MUDs as taught by Wang such that each of the MUDs—including a *low complexity multi-user detector*—outputs a *plurality of information streams*. EX1004, [0084], [0093]; *supra*, §VII.C.

141. I noticed that Wang discloses another multi-user detector that Wang refers to as a “decorrelation” detector. EX1005, 9:13-14, 11:20-21, 19:13, Cl. 6. It is clear that the decorrelation detector of Wang serves as a *medium complexity*

multi-user detector that is more complex than the minimum mean square detector serving as the *low complexity multi-user detector*. EX1005, 9:13-14, 11:20-21, 19:13, Cl. 6. One thing I noticed in my review is that The '492 patent acknowledges and McElwain confirms that decorrelators, like MMSE detectors, are “less computationally complex” and “known in the art.” EX1001, 5:25-29; EX1004, [0034]. Furthermore, it is apparent that decorrelators are more complex than MMSE detectors, meaning that a decorrelator can be considered a *medium complexity multi-user detector* in a spectrum where an MMSE detector is a *low complexity multi-user detector*.

142. My opinion here is supported by the fact that the “decorrelation” detector of Wang is selected for the second channel type and the “minimum mean square” detector of Wang is selected for the first channel type, the second channel type including a greater amount of interference as compared with the first channel type. EX1005, 10:30-11:31, 16:14-17:3, 19:8-22, FIG. 4. For example, because the in-band power deviation is “large” for the second channel type and “small” for the first channel type, the second channel type includes a greater amount of interference as compared to the first channel type. EX1005, 8:12-22, 9:7-24, 10:30-11:31, 16:14-17:3, 19:8-22, FIG. 4. Furthermore, Wang explains that the first channel type is associated with “additive Gaussian white noise interference” and the second channel type is associated with “co-channel interference” that introduces additional

complexity. EX1005, 10:30-11:31, 16:14-17:3, 19:8-22, FIG. 4. To handle the additional complexity of co-channel interference, Wang's module 13 selects the "decorrelation" detector (*medium complexity multi-user detector*) to handle the interference of the second channel type, whereas module 13 selects the "minimum mean square" detector (*low complexity multi-user detector*) to handle the lower interference of the first channel type. EX1005, 10:30-11:31, 16:14-17:3, 19:8-22, FIG. 4.

143. It is also clear that co-channel interference (CCI) is more complex than additive white Gaussian noise (AWGN) interference, because CCI includes interference between signals themselves, whereas AWGN includes general noise introduced by outside sources. EX1005, 8:4-11, 13:7-17. I noticed that Wang explains that module 13 identifies the first channel type when the in-band power deviation is small and identifies the second channel type when the in-band power deviation is large. EX1005, 8:4-11, 13:7-17. This confirms that the decorrelation detector selected for the second channel type is more complex than the minimum mean square detector selected for the first channel type.

144. Wang also explains that a "parallel interference counteraction" detector or a "partial multi-access interference cancellation" detector can serve as a *high complexity multi-user detector* that is more complex than the "decorrelation" *medium complexity multi-user detector* and the minimum mean square *low*

complexity multi-user detector. EX1005, 9:15-16, 11:22-23, 12:1-3, 19:14-15, 19:20-21, Cl. 6, FIG. 4. My opinion here is supported by the fact that parallel interference counteraction detectors and partial multi-access interference cancellation are selected for channel types including more interference than the channel types corresponding to the minimum mean square and de-correlation detectors. EX1005, 9:7-30, 10:30-12:3, 19:8-22, Cl. 6, FIG. 4. For example, the interference counteraction and interference cancellation detectors are selected for channel types corresponding to a correlation matrix having a number of effective eigenvalues being greater than one, which signifies greater amounts of interference in the respective channels. EX1005, 9:7-30, 10:30-12:3, 19:8-22, Cl. 6, FIG. 4.

145. Wang's *low complexity multi-user detector*, *medium complexity multi-user detector*, and *high complexity multi-user detector* are each switchably coupled to the *multi-user detector decision unit* because Wang explains that "[t]he multi-user detection module 15 is used to select corresponding multi-user detection algorithm according to the result of channel type output by the channel environment detection and classification module 13." EX1005, 15:12-16. In an embodiment where the multi-user detection module 15 and the channel environment detection and classification module 13 of Wang comprise "hardware," a POSITA would have understood that hardware corresponding to each of Wang's MUDs is *switchably*

coupled by the *multi-user detector decision unit* to allow selection between the MUDs. EX1005, 15:17-21.

146. As I described in connection with my analysis of Element [1c], *supra*, it would have been obvious for a POSTA to modify McElwain's system with two or more MUDs as taught by Wang such that each of the MUDs—including *low, medium and high complexity multi-user detectors*—output a *plurality of information streams*. EX1004, [0084], [0093]; *supra*, §VII.C. It is apparent that the *low complexity multi-user detector* of the predictable McElwain-Wang combination would output a *plurality of low complexity processed information streams*, because lower complexity MUDs generate lower complexity outputs. It is similarly apparent that the medium complexity *multi-user detector* would output a plurality of *medium complexity processed information streams*, and the high complexity *multi-user detector* would output a plurality of *high complexity processed information streams*.

Element [10f]: a bank of decoders coupled to said plurality of low complexity processed information streams, said plurality of medium complexity processed information streams, and said plurality of high complexity processed information streams, wherein said decoders output a plurality of refined information streams.

147. The McElwain-Wang combination provides this claim element for at least the same reasons I described above in connection with Element [1d]. *See supra*, Element [1d]. Furthermore, it is clear that in the predictable McElwain-Wang combination, the *low, medium and high complexity processed information streams*

would each be coupled to the *bank of decoders* 40 because a POSITA would have been motivated to implement the *bank of decoders* 40 to be coupled to outputs from the *low, medium and high complexity multi-user detectors* just as McElwain describes the *bank of decoders* 40 as being coupled to McElwain's MUD 20. EX1004, [0076]-[0096], FIGS. 1-2; EX1005, 13:28-17:3, FIG. 4; *supra*, §VII.C.

Claim [11]: The hybrid receiver according to claim 10, further comprising a front end section coupled to said received signals and to said received signal information which filters said received signals.

148. The McElwain-Wang combination provides this claim element for at least the same reasons I described above in connection with Claim [8]. *See supra*, Claim [8]. As I described above in my analysis of Claim [8], McElwain includes a *front end section* including an overloaded front end 75 that *filters received signals* that are *coupled* to the *front end section*. EX1004, [0090]-[0093], [0095], [0097]-[0100], FIGS. 2-3.

Claim [12]: The hybrid receiver according to claim 10, wherein said plurality of refined information streams are fed back to said multi-user detector decision unit for iterative processing until a final condition is reached and said bank of error correction decoders output a final plurality of bit streams.

149. The McElwain-Wang combination provides this claim element for at least the same reasons I described above in connection with Claim [2]. *See supra*, Claim [2].

Claim [13]: The hybrid receiver according to claim 10, wherein said multi-user detector decision unit makes a selection determined by design criteria based upon at least one threshold selected from at least one of the group consisting of

number of symbols, correlation matrix between users, expected bit error rate, eigendecomposition of correlation matrix, signal to interference plus noise ratio, and expected SINR.

150. The McElwain-Wang combination provides this claim element for at least the same reasons I described above in connection with Claim [3]. *See supra*, Claim [3].

Claim [15]: The hybrid receiver according to claim 12, wherein said final condition is one of a fixed number of iterations and an allowable performance level.

151. The McElwain-Wang combination provides this claim element for at least the same reasons I described above in connection with Claim [7]. *See supra*, Claim [7].

Claim [16]: The hybrid receiver according to claim 10, further comprising a hard decision unit coupled to said bank of decoders and producing a final data stream.

152. The McElwain-Wang combination provides this claim element for at least the same reasons I described above in connection with Claim [9]. *See supra*, Claim [9].

Claim [17pre]: A method for processing signals from multiple users with raw digitized data, comprising:

153. As I described above in my analysis of Element [1pre], *supra*, it is clear that McElwain discloses a hybrid **multi-user** detector system for processing received signals. EX1004, [0074]-[0085], [0087]-[0096], FIGS. 1-2. I noticed, for example, that McElwain discloses a **method** for processing **signals** from **multiple users** by a

receiver. EX1004, [0047] (“[w]hat is needed...is a **method** and apparatus for allowing **multiple users** to operate in the same channel”), [0074] (“[t]he **methods** and embodiments of the Hybrid Turbo-MUD disclosed herein enable implementations of advanced receiver processing providing high quality real-time processing for multiple access systems,” [0078] (“[a]n input signal...is comprised of the aggregate of many signals from many different transmitters”). Another thing I noticed is that McElwain expressly discloses the **raw data** collected by the receiver as being “**digitized**.” EX1004, [0078]; *see also id.*, [0062] (“[t]he present invention is directed to any other form of digital communication or signal storage methods”), [0074] (“separate co-channel interfering digitally modulated signals”), [0079], [0156]. This means that McElwain provides a **method** for **processing signals** from **multiple users** with raw **digitized data**. EX1004, [0076]-[0096], FIGS. 1-2.

Claim [17a]: performing parameter estimation of said raw digitized data;

154. McElwain discloses a **parameter estimator** 10 that is coupled to the received **signals** from **multiple users**, as I discussed in my analysis of Element [1a], *supra*. EX1004, [0054], [0063], [0080], [0090], [0092], [0099], FIGS. 1-3. This parameter estimator 10 can perform a **parameter estimation** of the raw digitized data that includes **signals** from **multiple users**. EX1004, [0080] (“[a] parameter estimation unit 10 processes the various parameters for the received raw data, and provides certain data to the MUD 20”); *see also id.*, [0099]-[0100], [0108]-[0109],

FIGS. 1-3. Furthermore, as I described above in my analysis of Element [1a], *supra*, McElwain incorporates by reference another patent application (EX1011), which describes discloses that “any digital communication system can make use of the subject parameter estimation system so that interfering signals can be separated.” EX1011, [0017].

Claim [17b]: grabbing a window of bits from said raw digitized data;

155. I noticed that in the iterative process performed by McElwain’s MUD system, the *raw digitized data* is split into a sequence of “data blocks” that each correspond to *bits* of the signals received during a *window* of time. EX1004, [0084], [0087]-[0089], [0093]-[0096];. For example, McElwain explains that each data block is processed by MUD 20 and the bank of decoders 40 through a series of iterations until hard decision unit 50 generates an output data steam for the respective data block. EX1004, [0084], [0087]-[0089], [0093]-[0096]. McElwain explains that “[t]he process is repeated for all subsequent data blocks” when McElwain’s iterative process is completed for the current data block. EX1004, [0089]; *see also id.*, [0094]. Based on my review, it is therefore clear that McElwain discloses a process for *grabbing a window of bits* from the *raw digitized data* to perform the iterative process for the respective *window of bits*.

Claim [17c]: subtracting any known bits from said window of bits;

156. As I described in connection with Element [17b], *supra*, it is clear that McElwain describes a MUD system that performs an iterative process to reach an output data stream for a selected window of bits. EX1004, [0084], [0087]-[0089], [0093]-[0096]; The iterative process described by McElwain involves the bank of decoders 40 generating “soft outputs” for each iteration, with iterations continuing “until an asymptote is reached or the desired performance level is attained.” EX1004, [0088]; *see also id.*, [0096]. Consequently, it is clear that McElwain’s iterative MUD system generates soft outputs that are continuously improved through subsequent iterations until these soft outputs reach a performance standard at which the soft outputs become hard decisions. EX1004, [0076]-[0096], FIGS. 1-3;.

157. I noticed that that McElwain describes hard outputs as being “discrete values” and describes soft outputs as indicating “both [a] discrete estimate and [a] probability that the estimate is correct.” EX1004, [0039]; *see also id.*, [0085] (“The single user decoders calculate conditional probabilities, one for each decoded symbol of each user, and output them as confidence values back to the MUD 20.”). Each iteration therefore focuses on soft outputs that are associated with lower conditional probabilities while removing soft outputs with higher conditional probabilities from analysis because McElwain’s iterative process involves improving soft outputs until a performance standard is reached. My opinion here is corroborated by multiple references that describe improvements to soft estimates

through a series of iterations. EX1016, 2 (explaining that performance improvement is more remarkable in the first iterations and more negligible in the second iterations); EX1017, 3 (describing an iterative MUD system that can “use the reliability information from turbo decoders’ output” in subsequent iterations to focus on less reliable soft estimates). It is clear, therefore, that McElwain’s MUD system ***subtracts any known bits*** from the respective ***window of bits*** as part of the iterative process to improve soft outputs until a hard decision is reached. McElwain’s system of ***subtracting any known bits*** from the respective ***window of bits*** based on estimates and conditional probabilities for each bit is very similar to the ’492 patent’s process for subtracting known bits, which is a well-known way of improving the accuracy of successive outputs from the iterative MUD decoding. EX1004, [0076]-[0096], FIGS. 1-2; *Cf.* EX1001, 19:66-20:12 (disclosing that “known symbols are subtracted,” and one way to determine whether a symbol is “known” is based on “symbol estimates and probabilities of error for each symbol” determined by a bank of decoders).

Claim [17d]: selecting a multi-user detector;

158. The McElwain-Wang combination provides this claim element for at least the same reasons I described above in connection with Elements [1a]-[1b]. *See supra*, Elements [1a]-[1b].

Claim [17e]: estimating unknown bits from said window of bits using said multi-user detector;

159. As I described above in my analysis of Element [17c], *supra*, McElwain explains that as part of an iterative process to improve soft outputs from a bank of decoders 40 until a hard decision is reached, a MUD system can ***subtract any known bits*** from the respective ***window of bits***. EX1004, [0076]-[0096], FIGS. 1-2. Furthermore, it is apparent that the predictable McElwain-Wang combination provides a MUD system that can ***estimate unknown bits*** from a respective ***window of bits*** using a selected ***multi-user detector***. *Supra*, Elements [1b]-[1c].

Claim [17f]: incrementing to a next window of bits;

160. I noticed that McElwain expressly discloses “[w]hen processing is completed... hard decision unit 50... outputs the final stream of decisions or output data stream for each interfering user for the current data block” and that “[t]he process is repeated for all subsequent data blocks.” EX1004, [0089]; *see also id.*, [0094]. Consequently, the MUD system of the predictable McElwain-Wang combination proceeds to ***increment*** to a ***next window of bits*** when hard outputs are generated for a respective window of bits. EX1004, [0076]-[0096], FIGS. 1-2.

Claim [17g]: repeating said steps of subtracting, selecting, estimating and incrementing until there are no more windows and outputting a set of symbol estimates.

161. It is clear that the MUD system of the predictable McElwain-Wang combination repeats the steps of ***subtracting***, ***selecting***, ***estimating*** and ***incrementing***, for each window of bits until hard decision unit 50 outputs a ***set of***

symbol estimates for each *window of bits* because McElwain discloses that the iterative process for identifying hard outputs is performed for a current data block and “repeated for all subsequent data blocks.” EX1004, [0076]-[0096], FIGS. 1-2; EX1005, 9:3-30, 11:14-12:3, 15:12-21, 19:8-22.

B. GROUND 1B: The McElwain-Sampath Combination Renders Claims 1-3, 5-13, and 15-17 Obvious

Element [1pre]-[1a] A hybrid Multi-User Detector System for processing received signals, comprising: a parameter estimator coupled to said received signals providing received data information;

162. McElwain discloses and renders obvious Elements [1pre]-[1a] for at least the same reasons that I addressed above in connection with Ground 1A (§VIII.A) at Elements [1pre]-[1a]. *See supra*, Ground 1A (§VIII.A) at Elements [1pre]-[1a].

Element [1b]: a multi-user detector decision unit coupled to said parameter estimator and said received signals;

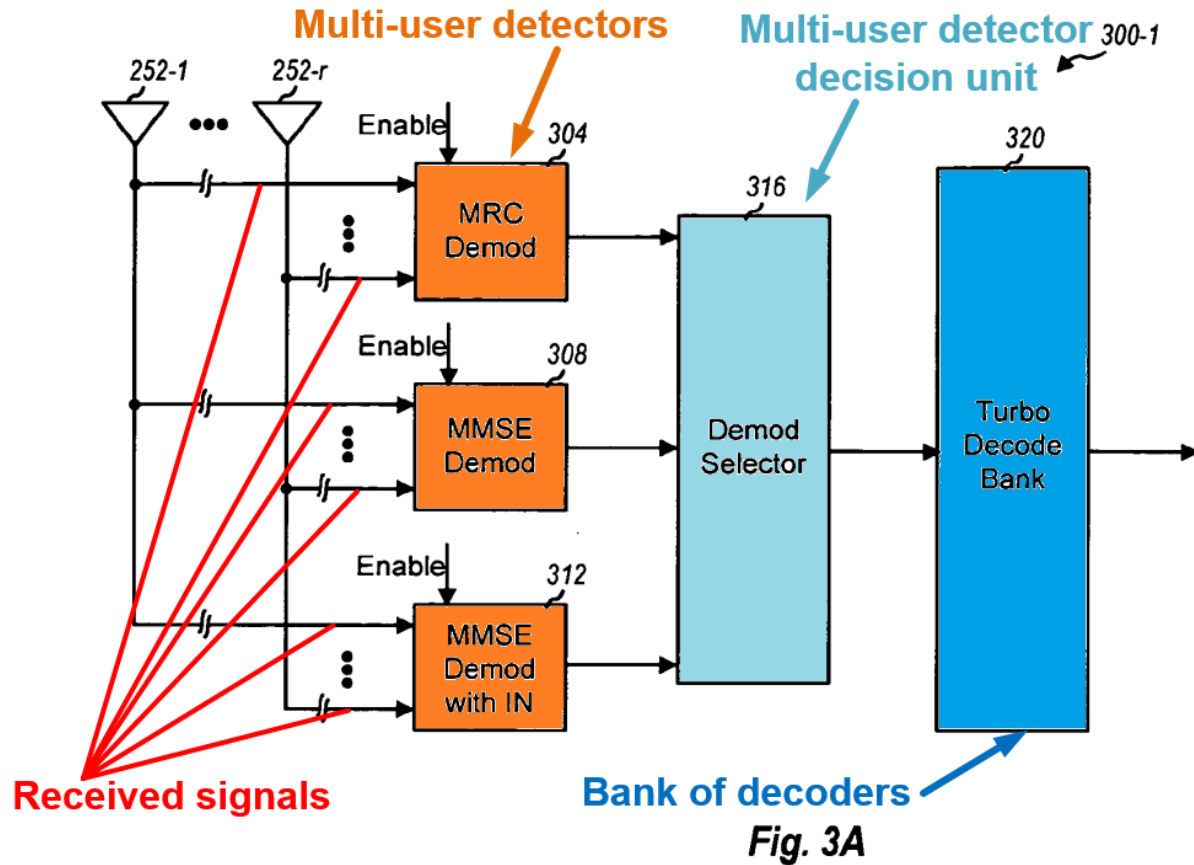
163. As I described in my analysis of Ground 1A (§VIII.A), Elements [1pre]-[1b], McElwain describes a *multi-user detector* system that processes *received signals* through a series of iterations so that a MUD 20 generates bit streams for each of the received signals for input to a *bank of decoders* 40. EX1004, [0076]-[0096], FIGS. 1-2; \. This *bank of decoders* 40 generates soft outputs that can be fed back into the MUD 20. EX1004, [0087], [0095]. Even if McElwain does not expressly disclose a *multi-user detector decision unit* that can select a MUD from a

group of two or more MUDs, it is clear that such features would have been obvious and provided in the McElwain-Sampath combination. *Supra*, §VII.E.

164. My opinion here is supported by the fact that Sampath describes a demodulator selector 316 that can select one of a group of three demodulators 304, 308, and 312 that is most likely to produce the most accurate demodulated signal. EX1006, [0039]-[0043], FIG. 3A. This demodulator selector 316 represents a ***multi-user detector decision unit*** selects a demodulator—from a group of three demodulators 304, 308, and 312—that is most likely to produce the most accurate demodulated signal. EX1006, [0039] (“[a] demodulator selector 316 uses a metric to decide which of the demodulators 304, 308, 312 to pass to a turbo decoder 320...for decoding”), *see also id.*, [0040]-[0043], FIG. 3A. When demodulator selector 316 chooses one of the three demodulators, the selected demodulator outputs demodulated signals to turbo decode bank 320. EX1006, [0039]-[0043], [0047], [0048], FIG. 3A.

165. Furthermore, in my review, I noticed that Sampath expressly discloses an embodiment where demodulators not selected by demodulator selector 316 are disabled and powered down so that only the selected demodulator provides an output the turbo decode bank 320. EX1006, [0043] (“[t]he demodulator 304,308, 312 unlikely to produce the best result can be disabled and powered-down”). This supports my opinion that demodulator selector 316 represents a ***multi-user detector***

decision unit for selecting one of demodulators 304, 308, and 312, because demodulator selector 316 can control the selected demodulator to generate an output for delivery to turbo decode bank 320 and control the non-selected demodulators to power down to conserve resources. EX1006, [0041]-[0043], FIG. 4A.



EX1006, FIG. 3A (annotated).

166. It is apparent that each of the three demodulators 304, 308, and 312 represent a *detector* that is *coupled* to raw input data including multiple *received signals*. EX1006, [0039] (“[t]he...received signals (corresponding to the receive antennas 252) are passed to three different demodulators 304, 308, 312”). Because

each *detector* is configured to process “received signals” in order to detect “transmitted symbol streams,” these *detectors* represent *multi-user detectors*. EX1006, [0034]. It is clear that demodulators 304, 308, and 312 each represent a *multi-user detector* in cases where the received signals include multiple interfering signals. EX1006, [0021] (“the present disclosure provides a multiple-input receiver for processing one or more communication signals”), [0032] (“[a]t the access terminal 132, the transmitted modulated signals are received by NR antennas 252 and the received signal from each antenna 252 is provided to a respective receiver/transmitter (RCVR/TMTR) 254”), [0039] (“[t]he N_R received signals”).

167. As I described above in my analysis of the McElwain-Sampath combination (*supra*, §VII.E), even if the three demodulators 304, 308, and 312 described by Sampath do not represent *multi-user detectors*, a POSITA would have been motivated to implement McElwain’s MUD system with three separate *multi-user detectors* and a *multi-user detector decision unit* for selecting between these three separate *multi-user detectors* based on Sampath’s suggestion of using three separate demodulators 304, 308, and 312. EX1006, [0039]-[0043], FIG. 3A. Because McElwain discloses a multiuser detection unit 20 that outputs “a bit (or symbol) stream” associated with each user, a POSITA would have been motivated to implement multiuser detection unit 20 with three separate MUDs that each generate streams for signals present in the raw data, as Sampath suggests. EX1004,

[0084], [0093], FIGS. 1-2. Consequently, it is apparent that the MUD system of the predictable McElwain-Sampath combination includes a *multi-user detector decision unit* coupled to a *parameter estimator* and *received signals*. EX1004, [0080].

168. I noticed that demodulator selector 316 uses an expected signal-to-interference-plus-noise ratio (*expected SINR*) to select one of the three demodulators 304, 308, and 312 for processing the received signals. EX1006, [0021], [0039], [0041], [0043], Cl. 8, Cl. 9. In doing so, demodulator selector 316 performs the same *expected SINR* MUD selection algorithm that is also described by the '492 patent. For example, I noticed that the '492 patent explains that:

The decision can be made by calculating the expected SINR value for each symbol after filtering with one of the lower complexity MUDs. If the SINR is above a threshold set for a specific lower complexity MUD technique then use that technique. If none of the post filtering SINR values are above any of the lower complexity MUD thresholds then use the highest complexity MUD.

EX1001, 14:25-31.

169. For example, I noticed that Sampath describes demodulator selector 316 as using “a metric” for deciding which of demodulators 304, 308, and 312 to select. EX1006, [0021], [0039], [0041], [0043], Cls. 8, 9, 13, 14, 23, 24. This metric can include several different parameters relating to each of the available demodulators 304, 308, and 312, including “power consumption” and “turbo-decoder resources available” in a turbo decoder bank based on the forward link (FL)

data rate. EX1006, [0041], *see also id.*, [0021]. I noticed that Sampath describes the “turbo-decoder resources available” metric is based on the forward link (FL) data rate, where smaller FL data rates correspond to demodulators with more available computing resources and larger FL data rates correspond to demodulators with fewer available computing resources. EX1006, [0041]. I also noticed that that Sampath discloses that :

In one embodiment, the present disclosure provides a multiple-input receiver for processing one or more communication signals. The receiver includes a decoder, which may be implemented as a bank of demodulators and a bank of decoders, and a decision logic that routes the signals from appropriate demodulators to the decoders. Each demodulator can implement a different demodulator algorithm. In one embodiment, the first demodulator algorithm can incorporate interference nulling, whereas the second demodulator algorithm can assume no knowledge of interference. The decoder may include multiple decoders, for example, turbo-decoders. The turbo-decoders can be used to decode symbols from one or more demodulators. ***The decision logic determines which demodulator outputs need to be routed to turbo-decoders, based upon one or more metrics. These metrics can be for example, the available turbo-decoder resources and/or power consumption considerations.***

EX1006, [0021].

170. This confirms that demodulator selector 316 can select one of demodulators 304, 308, and 312 by considering the amount of power consumed to decode the received signals and the amount of computing resources available for turbo decode bank 320 to process the output of the selected one of demodulators 304, 308, and 312. This indicates that when more resources are available for turbo decode

bank 320 to process an output, a less complex one of demodulators 304, 308, and 312 can be selected to demodulate the received signals and when more resources are available for turbo decode bank 320 to process an output, a less complex one of demodulators 304, 308, and 312 can be selected to demodulate the received signals.

171. Sampath expressly discloses that demodulator selector 316 uses an expected signal-to-interference-plus-noise ratio (*expected SINR*) algorithm to select one of the three demodulators 304, 308, and 312. EX1006, Cl. 8, 9. For example, Sampath explains that “decision logic” (demodulator selector 316) can choose a demodulator based upon “signal to interference-plus-noise ratio (SINR)” thresholds associated with multiple different demodulators. EX1006, Cl. 9, *see also id.*, Cls. 14, 24. It is clear that for decision logic to choose a demodulator based upon a metric including SINR “for [a] first or second demodulator,” demodulator selector 316 applies a SINR threshold for a using first demodulator and a SINR threshold for using a second demodulator to choose between selecting the first demodulator or the second demodulator for processing received signals. EX1006, Cl. 1, Cl. 8, Cl. 9.

172. Specifically, it is clear that demodulator selector 316 determines a SINR that is expected to result from using each of the three demodulators 304, 308, and 312 to process the received signals (“expected SINR”). EX1006, Cl. 1, Cl. 8, Cl. 9. The *expected SINR* for each of the three demodulators 304, 308, and 312 is then compared to one or more threshold SINR values for using each of the detectors, so

that when the expected SINR for a demodulator is lower than a threshold SINR for that demodulator, that demodulator is not selected and a more complex demodulator is instead selected. EX1006, Cl. 1, Cl. 8, Cl. 9. Performing this process ensures that demodulator selector 316 choose a demodulator “based on a SINR for the first or second demodulator” exactly as disclosed by Sampath. EX1006, Cl. 9.

173. SINR is a ratio where the signal power is part of the numerator and interference is part of the denominator, meaning that greater SINR corresponds to lower relative interference and lower SINR corresponds to greater relative interference. My opinion here is corroborated by references that describe equations for SINR where signal power is in the numerator and interference is in the denominator. EX1021, 8 (describing an equation for SINR)). Consequently, it is clear that demodulator selector 316 performs the expected SINR algorithm described by the '492 patent by comparing an *expected SINR* for processing the received signal with demodulator 304 with a SINR threshold and selecting demodulator 304 if the *expected SINR* is *greater* than the SINR threshold for the demodulator 304, thus indicating that demodulator 304 can handle the level of interference present in the received signals. EX1006, Cl. 1, Cl. 8 (“wherein the decision logic is configured to choose based upon a metric”), Cl. 9 (“wherein the metric is a signal to interference-plus-noise ratio (SINR) for the first or second demodulator”). This is equivalent to “[i]f the SINR is above a threshold set for a specific lower complexity

MUD technique then use that technique,” as described by the ’492 patent, because if the expected SINR for using the demodulator 304 is not sufficient for using that demodulator, Sampath indicates that another demodulator (e.g., demodulator 308, 312) is selected to process the received signals. EX1006, Cl. 1, Cl. 8, Cl. 9; *cf.* EX1001, 14:25-31.

174. For example, it is clear that if the expected SINR for using demodulator 304 to process the received signals is *not greater* than the SINR threshold for the demodulator 304, thus indicating that demodulator 304 cannot handle the interference level of the received signals, demodulator selector 316 can select one of the more complex demodulators 308, 312 for processing the received signals. EX1006, Cl. 1, Cl. 8, Cl. 9. This is equivalent to “[i]f none of the post filtering SINR values are above any of the lower complexity MUD thresholds then use the highest complexity MUD,” because when the expected SINR for using the demodulator 304 is not greater than the threshold SINR, then an MMSE detector (e.g., the “highest complexity MUD”) is selected. EX1006, Cl. 1, Cl. 8, Cl. 9; *cf.* EX1001, 14:25-31.

It is therefore clear that Sampath explains demodulator selector 316 can use an algorithm for selecting one of the three demodulators 304, 308, and 312 that is the same as the *expected SINR* MUD selection algorithm expressly disclosed by the ’492 patent. Even if the Board applies the District Court’s prior construction of the “a multi-user detector decision unit,” the predictable McElwain-Sampath

combination therefore provides a ***multi-user detector decision unit*** coupled to a ***parameter estimator*** and ***received signals***. EX1006, [0039]-[0043], [0047], [0048]; *supra*, §VII.E.

Element [1c]: at least two multi-user detectors coupled to said parameter estimator and said multi-user detector decision unit, said multi-user detector decision unit using decision criteria to determine a selected multi-user detector, wherein said selected multi-user detector outputs a plurality of information streams, one stream corresponding to each of said received signals;

175. Even if McElwain does not expressly disclose ***at least two multi-user detectors*** coupled to a ***parameter estimator*** and a ***multi-user detector decision unit***, such features would have been obvious and provided in the McElwain-Sampath combination. *Supra*, §VII.E. Sampath discloses three different demodulators 304, 308, 312 representing ***at least two multi-user detectors***. EX1004, [0079]-[0088], [0090], [0093]-[0096], FIGS. 1-2; EX1006, [0039]-[0048], FIG. 3A. For example, Sampath expressly discloses that “[t]he N received signals (corresponding to the receive antennas 252) are passed to three different demodulators 304, 308, 312 in this embodiment, which each demodulate the received signals in parallel.” EX1006, [0039]. Sampath also discloses that “[t]his embodiment uses MRC and MMSE demodulators 304, 308 that use an equalization technique and a MMSE demodulator with IN 312 that uses a successive cancellation technique.” EX1006, [0040].

176. Thus, it is clear that demodulator 304 includes a maximum ratio combining (MRC) demodulator, demodulator 308 includes a minimum mean

squared error (MMSE) demodulator, and demodulator 312 includes an MMSE demodulator with interference nulling (IN), indicating that Sampath provides *at least two multi-user detectors*. EX1006, [0039], [0040], FIG. 3A. As I described above in my analysis of the McElwain-Sampath combination (§VII.E), even if Sampath does not expressly disclose that the demodulators 304, 308, 312 are *multi-user detectors*, it would have been obvious to implement demodulators 304, 308, 312 as *multi-user detectors* in view of McElwain's MUD 20. EX1004, [0076]-[0096], FIGS. 1-2; EX1006, [0039]-[0048], FIG. 3A.

177. As I described above in my analysis of Element [1b], the *multi-user detector decision unit* of the predictable McElwain-Sampath combination is configured to determine a *selected multi-user detector* based on *decision criteria*. EX1006, [0039] (“decide which of the demodulators 304, 308, 312 to pass to a turbo decoder 320”), *see also id.*, [0040]-[0043], [0047], [0048], FIG. 3A, Cls. 1, 8, 9. Specifically, demodulator selector 316 “determines the demodulator 304, 308, 312 that is likely to produce the most accurate demodulated signal” and uses “a metric” to make this determination. EX1006, [0041]. As I described above in my analysis of Element [1b], *supra*, demodulator selector 316 uses the *expected SINR* selection algorithm disclosed by the '492 patent to select one of the demodulators 304, 308, 312. EX1006, [0039]-[0043], [0047], [0048], FIG. 3A, Cls. 1, 8, 9.

178. It is clear that McElwain discloses a MUD 20 that outputs a ***plurality of information streams*** including “a bit (or symbol) stream” associated with each of the interfering signals present in raw input data. EX1004, [0084], *see also id.*, [0079], [0090], [0093], FIGS. 1-2. This supports my opinion that the predictable McElwain-Sampath combination provides ***two or more multi-user detectors*** (including the ***selected multi-user detector***) that each output ***a plurality of information streams***, one stream corresponding to each of the ***received signals***. EX1004, [0076]-[0096], FIGS. 1-2; EX1006, [0039]-[0043], [0047], [0048]; *supra*, §VII.E.

Element [1d]: a bank of decoders coupled to said plurality of information streams, wherein said decoders output a plurality of improved information streams.

179. McElwain discloses and renders obvious Element [1d] for at least the same reasons that I addressed above in connection with Ground 1A (§VIII.A) at Element [1d]. *See supra*, Ground 1A (§VIII.A) at Element [1d]. Additionally, Sampath discloses that a turbo decoder bank 320 can process signals output from the demodulator selected by demodulator selector 316. EX1006, [0039], [0041]-[0045], [0047], [0048], FIG. 3A. A POSITA would have been motivated to implement Sampath’s MUD selection teachings with the MUD system of McElwain in which MUD 20 passes signals to a bank of decoders 40 because Sampath discloses a turbo decoder bank 320 that processes signals output from a selected demodulator.

EX1004, [0076]-[0096], FIGS. 1-2; EX1006, [0039]-[0043], [0047], [0048]; *supra*, §VII.E.

Claim [3]: The System according to claim 1 wherein said design criteria is based upon at least one threshold selected from at least one of the group consisting of number of symbols, correlation matrix between users, expected bit error rate, eigendecomposition of correlation matrix, signal to interference plus noise ratio, and expected SINR.

180. As I described in my analysis of Elements [1b]-[1c], *supra*, Sampath explains that the demodulator selector 316 representing *a multi-user detector decision unit* can use *decision criteria* including “a metric” to select an appropriate demodulator, and that this metric can be *SINR* or *expected SINR*. EX1006, [0039], [0041], [0043], Cl. 8, 9, 13, 14, 23, 24. A POSITA would have understood that SINR is a determined value, and to use SINR as a metric for selecting a demodulator, the determined SINR must be compared to *at least one threshold* that defines which detector is selected. My opinion here is corroborated by multiple references indicating that expected SINR is one metric that can be used to evaluate a performance of various different kinds of MUDs. EX1009, 1 (explaining that certain SINRs are “required” by certain varieties of MUD); EX1010, 44 (describing cellular systems as being designed to balance voice quality for multiple users while maintaining SINR above a “desired target”).

Claim [5]: The System according to claim 1 wherein said at least two multiuser detectors are selected from the group consisting of M-algorithm, sphere decoder, T-algorithm, FANO, reduced state Viterbi, Maximum Likelihood, matched filter, minimum mean squared error (MMSE), decorrelator, and combinations thereof.

181. As I described above in my analysis of Elements [1b]-[1c], *supra*, Sampath expressly discloses that demodulators 304, 308, 312 include an **MMSE** demodulator 308 and an **MMSE** demodulator with interference nulling 312. EX1006, [0039]-[0041], [0047], [0048], FIG. 3A. This means that when McElwain's MUD system is implemented with the multiple demodulators, as disclosed by Sampath, the resulting system would include *at least two multiuser detectors* selected from a group including **MMSE** detectors.

Elements [10pre]-[10a]: A hybrid receiver for processing a plurality of received signals, said receiver comprising: a parameter estimation unit coupled to said received signals, wherein said parameter estimation unit extracts received signal information;

182. McElwain discloses and renders obvious Elements [10pre]-[10a] for at least the same reasons that I addressed above in connection with Ground 1A (§VIII.A) at Elements [10pre]-[10a]. *See supra*, Ground 1A (§VIII.A) at Elements [10pre]-[10a].

Element [10b]: a multi-user detector decision unit coupled to said parameter estimator and said received signals, wherein said multi-user detector decision unit selects a multi-user detector based upon at least one threshold;

183. As I described for Elements [1b]-[1c] and Claim [3], *supra*, The McElwain-Sampath combination provides a **multi-user detector decision unit** (demodulator selector 316) coupled to a **parameter estimator** 10 that applies *at least one threshold* relating to **expected SINR** to select a demodulator for processing **received signals**. EX1004; [0076]-[0096], FIGS. 1-2; EX1006, [0039]-[0043],

[0047], [0048], Cls. 8-9, 13-14, 23-24, FIG. 3A; *supra*, §VII.E. For example, because Sampath discloses that “the metric is a signal to interference-plus-noise ratio (SINR) *for the first or second demodulator*,” this means that Sampath discloses evaluating a threshold corresponding to one demodulator and a threshold corresponding to another demodulator. EX1006, C. 9.

Elements [10c]-[10e]: a low complexity multi-user detector switchably coupled by said multi-user detector decision unit, wherein said low complexity multi-user detector outputs a plurality of low complexity processed information streams; a medium complexity multi-user detector switchably coupled by said multi-user detector decision unit, wherein said medium complexity multi-user detector outputs a plurality of medium complexity processed information streams; a high complexity multi-user detector switchably coupled by said multi-user detector decision unit, wherein said high complexity multi-user detector outputs a plurality of high complexity processed information streams; and

184. Sampath describes three separate demodulators including an MRC demodulator 304, an MMSE demodulator 308, and an MMSE demodulator with interference nulling 312, as I described above in my analysis of Elements [1b]-[1c] and Claim [3], *supra*. EX1006, [0039]-[0041], [0043], [0047], [0048], FIG. 3A. The three demodulators described by Sampath represent three separate complexities, with demodulator 304 being a *low complexity multi-user detector*, demodulator 308 being a *medium complexity multi-user detector*, and a demodulator 312 being a *high complexity multi-user detector*. EX1006, [0039]-[0041], [0043], [0047], [0048], FIG. 3A. References published by the Critical Date confirm that MMSE detectors are more complex than MRC detectors. My opinion here is corroborated

by a reference published before the Critical Date of the '492 patent. EX1019, 4-5 (explaining that MMSE detectors have a greater computational complexity than MRC detectors).

185. My opinion here is also supported by the fact that demodulator 304 uses a low complexity equation to process signals, demodulator 308 uses a medium complexity equation to process signals, and demodulator 312 uses a high complexity equation to process signals. EX1006, [0039]-[0043], [0047], [0048], FIG. 3A. Specifically, I noticed that demodulator 304 uses the equation $G = H^*$ to demodulate the *received signals*, where H represents the channel matrix corresponding to the *received signals*, and G represents the transpose of the channel matrix. EX1006, [0026], [0031], [0040];. I also noticed that the demodulator 308 uses the equation $G = H^*(HH^* + \sigma^2 I)^{-1}$ to demodulate the *received signals*, and demodulator 312 uses the equation $G = H^*(HH^* + R_{nn})^{-1}$ to demodulate the *received signals*. EX1006, [0026], [0027], [0031], [0040]. The equations used by demodulators 308, 312 are both more complex than the equation used by demodulator 304, because The equations used by demodulators 308, 312 both involve mathematical operations in addition to the H^* operation used by demodulator 304. EX1006, [0026], [0027], [0031], [0040]. Because demodulators 308 and 312 are both MMSE demodulators, with demodulator 312 adding the additional feature of interference nulling, this means that demodulator 312 is more

complex than demodulator 308. EX1006, [0026]-[0027], [0031], [0036], [0040], FIG. 3A.

186. It is clear that MUD 20 of McElwain “outputs a bit (or symbol) stream associated with each interfering signal present on the channel.” EX1004, [0084]; *see also id.*, [0093], FIGS. 1-2. Therefore, when the MUD system of McElwain is implemented with Sampath’s suggested demodulator elector 316 and multiple demodulators 304, 308, 312, the MUD system includes *low, medium, and high complexity multi-user detectors* that each output respective *processed information streams*. *Supra*, §VII.E.

Claim [10f]: a bank of decoders coupled to said plurality of low complexity processed information streams, said plurality of medium complexity processed information streams, and said plurality of high complexity processed information streams, wherein said decoders output a plurality of refined information streams.

187. McElwain discloses and renders obvious Element [10f] for at least the reasons I addressed above in my analysis of Element [1d]. In the predictable McElwain-Sampath combination, the *low, medium and high complexity processed information streams* are each coupled to a *bank of decoders* because McElwain explains that the bank of decoders 40 is coupled to MUD 20 and Sampath explains that demodulators 304, 308, 312 are coupled to turbo decoder bank 320. EX1004, [0076]-[0096], FIGS. 1-2; EX1006, [0041], [0042], [0047], [0048], FIG. 4; *supra*, §VII.E.

Claim [13]: The hybrid receiver according to claim 10, wherein said multi-user detector decision unit makes a selection determined by design criteria based upon at least one threshold selected from at least one of the group consisting of number of symbols, correlation matrix between users, expected bit error rate, eigendecomposition of correlation matrix, signal to interference plus noise ratio, and expected SINR.

188. The McElwain-Sampath combination provides this claim element for at least the same reasons I described above in connection with Claim [3]. *See supra*, Claim [3].

Elements [17pre]-[17c]: A method for processing signals from multiple users with raw digitized data, comprising: performing parameter estimation of said raw digitized data; grabbing a window of bits from said raw digitized data; subtracting any known bits from said window of bits;

189. The McElwain-Sampath combination discloses and renders obvious Elements [17pre]-[17c] for at least the same reasons that I addressed above in connection with Ground 1A (§VIII.A) at Elements [17pre]-[17c]. *See supra*, Ground 1A (§VIII.A) at Elements [17pre]-[17c].

Element [17d]: selecting a multi-user detector;

190. The McElwain-Sampath combination discloses and renders obvious Element [17d] for at least the same reasons that I addressed above in connection with Elements [1b]-[1c]. *See supra*, Elements [1b]-[1c].

Elements [17e]-[17g]: estimating unknown bits from said window of bits using said multi-user detector; incrementing to a next window of bits; repeating said steps of subtracting, selecting, estimating and incrementing until there are no more windows and outputting a set of symbol estimates.

191. The McElwain-Sampath combination discloses and renders obvious Elements [17e]-[17g] for at least the same reasons that I addressed above in connection with Ground 1A (§VIII.A) at Elements [17e]-[17g]. *See supra*, Ground 1A (§VIII.A) at Elements [17e]-[17g].

Claims [2], [6]-[9], [11]-[12], and [15]-[16]

Claim [2]: The System according to claim 1 wherein said plurality of improved information streams are fed back to said multi-user detector decision unit until a final condition is reached and said bank of decoders output a final data stream.

Claim [6]: The System according to claim 1, further comprising an interleaver unit and a deinterleaver unit coupled between said bank of decoders and said multi-user detectors.

Claim [7]: The System according to claim 2, wherein said final condition is determined by one of a fixed number of iterations and an allowable performance level.

Claim [8]: The System according to claim 1, further comprising a filter unit coupled to said received signals, wherein said filter unit is coupled to said multi-user detector decision unit.

Claim [9]: The System according to claim 1, further comprising a hard decision unit coupled to said bank of decoders and producing a final data stream.

Claim [11]: The hybrid receiver according to claim 10, further comprising a front end section coupled to said received signals and to said received signal information which filters said received signals.

Claim [12]: The hybrid receiver according to claim 10, wherein said plurality of refined information streams are fed back to said multi-user detector decision unit for iterative processing until a final condition is reached and said bank of error correction decoders output a final plurality of bit streams.

Claim [15]: The hybrid receiver according to claim 12, wherein said final condition is one of a fixed number of iterations and an allowable performance level.

Claim [16]: The hybrid receiver according to claim 10, further comprising a hard decision unit coupled to said bank of decoders and producing a final data stream.

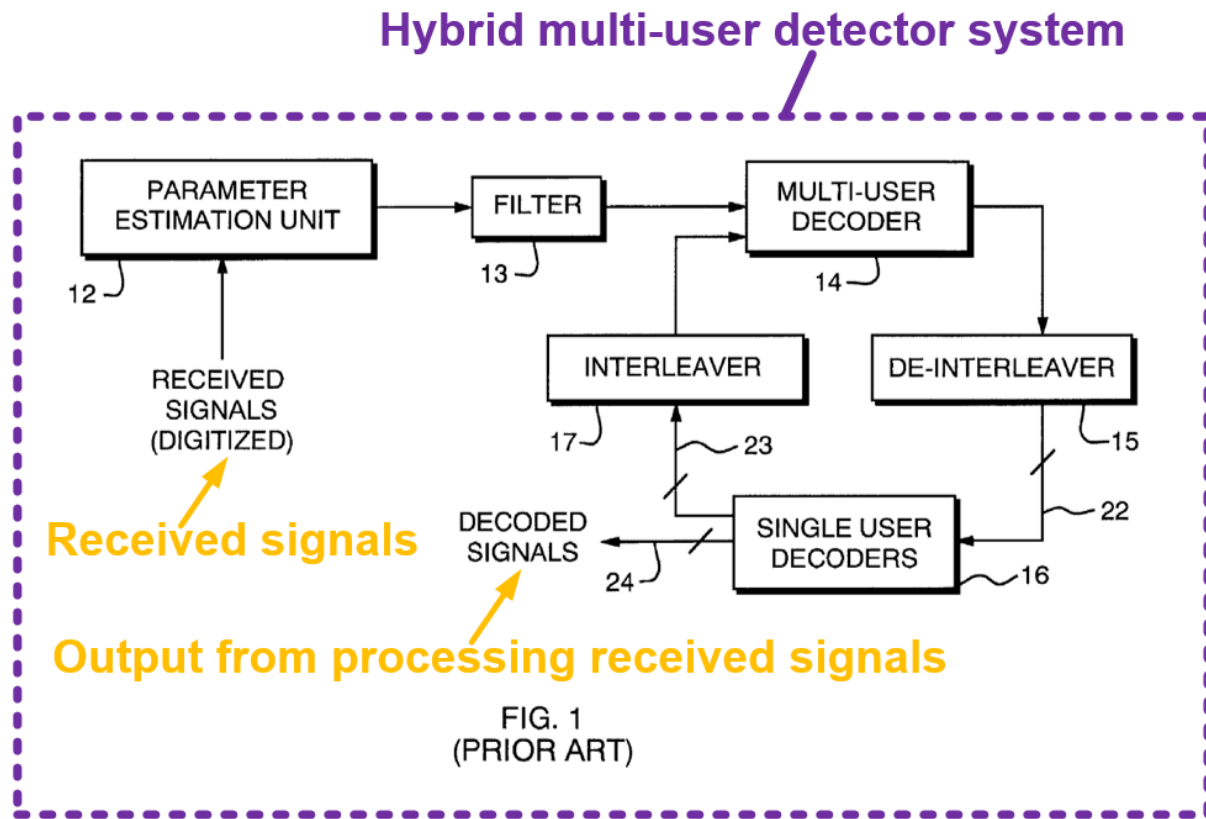
192. The McElwain-Sampath combination renders obvious Claims [2], [6]-[9], [11]-[12], and [15]-[16] for at least the same reasons that I addressed above in connection with Ground 1A (§VIII.A) at Claims [2], [6]-[9], [11]-[12], and [15]-[16]. *See supra*, Ground 1A (§VIII.A) at Claims [2], [6]-[9], [11]-[12], and [15]-[16].

C. GROUND 2A: The Mills-Liu Combination Renders Claims 1-3, 5-13, and 15-17 Obvious

Element [1pre]: A hybrid Multi-User Detector System for processing received signals, comprising:

193. Even if the preamble is limiting, it is clear that the Mills-Liu combination renders Element [1pre] obvious. For example, Mills discloses a ***system*** that including a ***multi-user detector*** that ***processes received signals***. EX1007, [0028]-[0039], FIG. 1. For example, Mills discloses that “[i]n a turboMUD system decoding, probability estimate and channel symbol estimate information is repeatedly passed between a multi-user decoder (MUD) 14 and a plurality of single-user decoders 16.” EX1007, [0029], *see also id.*, [0032]-[0034] (describing ***multi-user decoder*** 14), FIG. 1. The ***multi-user detector system*** of Mills represents a ***hybrid*** system because the system is a combination of multiple elements including and in addition to the multi-user decoder 14, for example, a parameter estimation

unit 12, filter 13, a de-interleaver 15, and a bank of single user decoders 16, and an interleaver 17. EX1007, [0028]-[0039], FIG. 1. Each of these elements can *process* the *received signals*. EX1007, [0028]-[0039], FIG. 1.



EX1007, FIG. 1 (annotated).

Element [1a]: a parameter estimator coupled to said received signals providing received data information;

194. I noticed that Mills discloses that the MUD system includes a *parameter estimator* (referred to by Mills as “parameter estimation unit 12”) that can “identify parameters for each interfering signal” of the *received signals*. EX1007, [0030]; *see also id.*, [0005], [0029], [0041], FIGS. 1-2. Mills explains that the received signals provide *received data information* that can be extracted by the

parameter estimation unit 12. EX1007, [0029] (“turbo multi-user detector (turboMUD) assumes knowledge of various parameters about received signals such as relative received timing offsets, carrier phase, frequency offsets, received amplitudes, and multi-path structure for each of the interfering signals present in the received signal”); *see also id.*, [0030]. Mills also expressly discloses that “[t]he purpose of the parameter estimation unit is to identify and determine parameters associated with each signal that may later be used by the multi-user detector (MUD) to separate each signal from the other interfering signals, regardless of the fact that the signals exist in the same communications bandwidth and at the same instant in time.” EX1007, [0005]

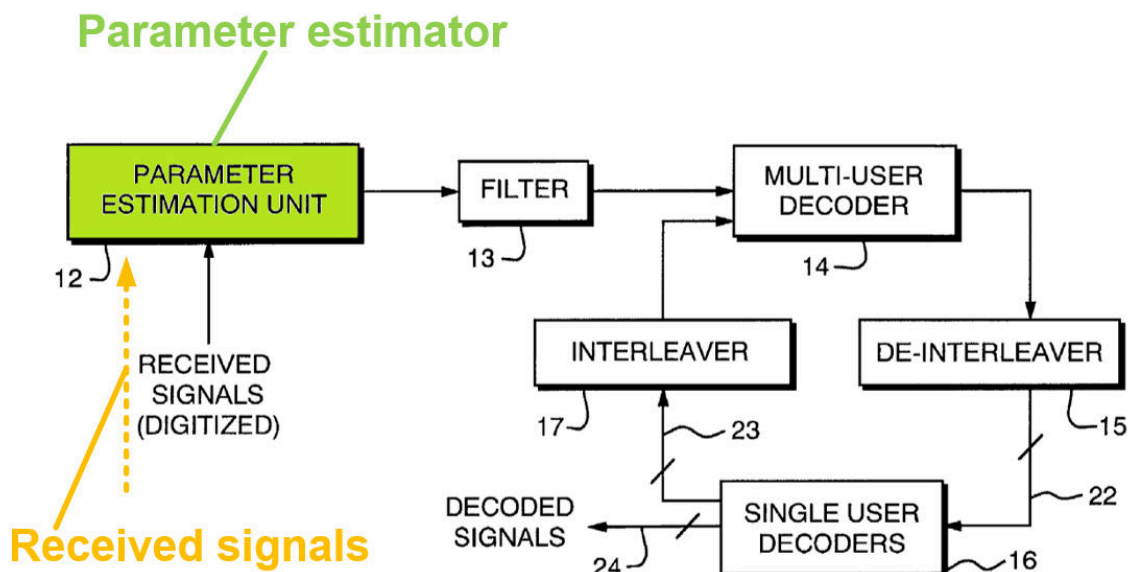


FIG. 1
(PRIOR ART)

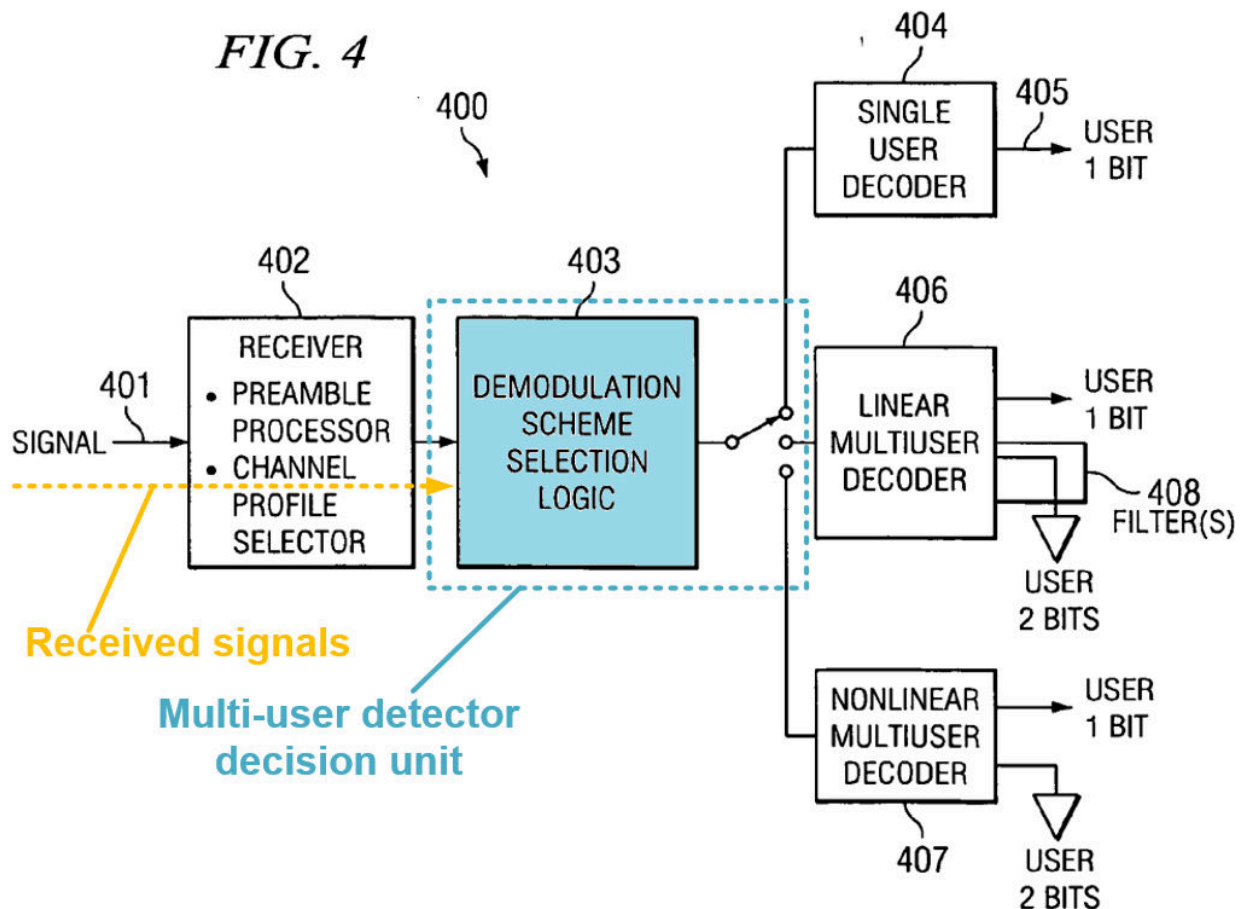
EX1007, FIG. 1 (annotated).

195. Furthermore, I noticed that Liu incorporates by reference US 2002/0037061 (EX1011). EX1004, [0080] (“The parameter estimation unit is known in the art, and a detailed description is available in published patent application U.S. 2002/0037061 A1 entitled ‘System for Parameter Estimation and Tracking of Interfering Digitally Modulated Signals’, which is incorporated by reference.”). The parameter estimation unit of this incorporated reference extracts *received data information* from *received signals* including “the received power 22, the phase 24 of the oscillator for each of the transmitted signals, the timing offset 26 relative to the base station clock and transmission distance, the carrier frequency offset 28 and the multipath structure 29.” EX1011, [0029].

Element [1b]: a multi-user detector decision unit coupled to said parameter estimator and said received signals;

196. Liu provides a multi-user detector decision unit that uses decision criteria to select a multi-user detector, to the extent that Mills does not expressly disclose this feature. EX1008, [0024]-[0029], FIG. 4; *supra*, §VII.H. I noticed that Liu describes, for example, receiver including demodulation scheme selection logic 403 for selecting one of single user decoder 404, linear multi-user decoder 406, or non-linear multi-user decoder 407 to process *received signals*. EX1008, [0024]-[0029], FIG. 4. Specifically, I noticed that logic 403 selects between the two multiuser detectors 406, 407 based on comparing characteristics of the *received signals* with one or more thresholds associated with each of the multiuser detectors

406, 407. EX1008, [0027] (“[i]f the interference is above the aforementioned lower threshold, but not above an upper threshold, linear multi-user decoder 406 may be selected by demodulation scheme selection logic 403”), [0028] (“[i]f the interference is above the aforementioned upper threshold demodulation scheme selection logic 403 preferably chooses to employ non-linear multi-user decoder 407”). Because logic 403 selects between at least two different multiuser decoders based on interference characteristics of *received signals*, it is clear that logic 403 represents a *multi-user detector decision unit* coupled to *received signals*. EX1008, [0024]-[0029], FIG. 4.



EX1008, FIG. 4 (annotated).

197. I noticed that Liu explains that in some embodiments, logic 403 uses an *expected bit error rate* algorithm to select between the two multiuser detectors 406, 407 for processing *received signals*. EX1008, [0026]-[0029]. The *expected bit error rate* algorithm that logic 403 uses to select one of the decoders 404, 406, 407 is the same as the *expected bit error rate* algorithm described by the '492 patent, or it would have been obvious to implement the Mills-Liu combination per the *expected bit error rate* performed by logic 403 to arrive at the *expected bit error rate* algorithm described by the '492 patent. EX1008, [0024]-[0029], FIG. 4. For example, I noticed that the '492 patent discloses:

The decision can be made by calculating the expected bit error rate (BER) of each user based on all the lower complexity MUD techniques. If any of the users have an expected BER that is acceptable, or above a threshold, for any of the lower complexity MUD techniques, then use the lowest complexity MUD possible that meets that criteria. As users are removed through the turbo iteration the expected BER of the remaining users changes. If none of the users in a specific window have an expected BER below the threshold for any of the lower complexity MUD techniques then the highest complexity MUD technique should be used.

EX1001, 13:63-14:6.

198. Several different parameters can be used by the logic 403 of Liu to select one of decoders 404, 406, 407 for processing received signals. EX1008, [0025]-[0031]. I noticed that these parameters include signal strength, signal-to-noise ratio (SNR), and *bit error rate*. EX1008, [0025]-[0031]. As I described above,

to select one of decoders 404, 406, 407, logic 403 compares a parameter value for the *received signals* with one or more threshold parameter values for each detector. EX1008, [0024]-[0029], FIG. 4. For example, Liu explains that “if linear multi-user decoder 406 demodulation can provide a certain Signal-to Noise Ratio (SNR) strength threshold and/or meet other threshold factors, the simpler linear multi-user decoder 406 will be used,” and Liu also explains that “if linear multi-user decoder 406 cannot satisfactorily decode the intended signal, such as failing to provide a threshold SNR strength and/or other threshold factors, resulting in an *unacceptable error rate* or other performance, non-linear multi-user decoder 407 is preferably used for decoding.” EX1008, [0029]. Therefore, Liu explains that in some cases, *bit error rate* is a threshold factor that logic 403 uses to evaluate whether to select linear multi-user decoder 406 or non-linear multi-user decoder 407 by comparing an *expected bit error rate* for using each of decoders 406, 407 to process *received signals* with threshold bit error rates corresponding to each decoder. EX1008, [0029].

199. Because Liu explains that logic 403 selects decoder 407 when selecting decoder 406 would result in an “unacceptable error rate,” it is clear that logic 403 evaluates the *expected bit error rate* for each user (e.g., for each signal that is decoded by multiuser decoders 406, 407), just as the *expected bit error rate* algorithm described by the ’492 patent calculates the expected bit error rate for each user. EX1008, [0007], [0024], [0029]. For example, Liu discloses that *received*

signals (signal 401) include “a signal intended for receipt by the terminal and interfering one or more...signals using a same subchannel.” EX1008, [0024]. To remove this interference from the *received signals*, multiuser decoders 406, 407 each output separate bit streams for each user corresponding to one of the *received signals*. EX1008, [0026]-[0029], FIG. 4 (depicting linear multi-user decoder 406 and non-linear multi-user decoder 407 outputting at least two bit streams including “user 1 bit” and “user 2 bits”). It is clear that to determine whether decoder 406 would result in an “unacceptable error rate,” logic 403 determines an *expected bit error rate* for the bit streams corresponding to each user and determines that decoder 406 would result in an unacceptable error rate if the expected bit error rate for any of the users is too high. EX1008, [0026]-[0029], FIG. 4.

200. Furthermore, McElwain explains that “MUD 14 and the single user decoders 16 work in concert to estimate the transmitted sequence of symbols from all users within a time frame” EX1007, [0029]. Consequently, in the Mills-Liu combination, it would have been obvious to implement the MUD system described by Mills with a *multi-user detector decision unit* for selecting a decoder without producing an unacceptable error rate for the sequence of symbols corresponding to any of the users as suggested by Liu. EX1007, [0029], [0032]-[0039]; EX1008, [0026]-[0029]; *supra*, §VII.H. The Mills-Liu combination therefore provides a *multi-user detector decision unit* that calculates the expected bit error rate for each

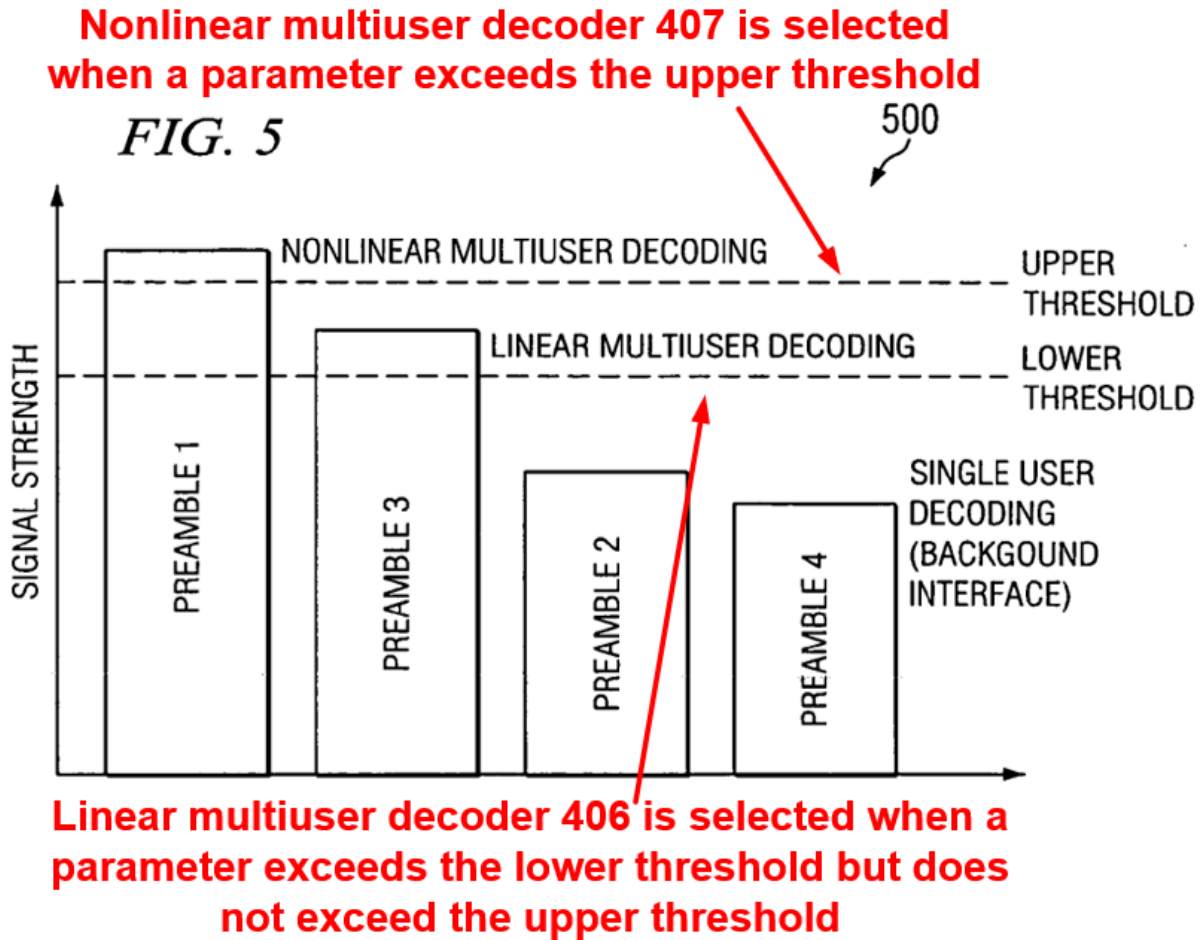
user, just as the '492 patent describes calculating the expected bit error rate for each user. *cf.* EX1001, 13:63-14:6.

201. As I described above, if any of the users associated with the received signals correspond to an *expected bit error rate* greater than the threshold *bit error rate* for linear multi-user decoder 406, logic 403 of Liu selects linear multi-user decoder 406. EX1008, [0026]-[0029]. Between linear multi-user decoder 406 and non-linear multi-user decoder 407, linear multi-user decoder 406 is the lowest complexity MUD. EX1008, [0026]-[0028], [0029] (referring to “the simpler” linear multi-user decoder 406). My opinion here is supported by the fact that in some embodiments, decoder 406 is an MMSE decoder and decoder 407 is a maximum likelihood decoder and an academic article confirms that maximum likelihood decoders are more complex than MMSE decoders. EX1013, 1 (explaining that nonlinear maximum likelihood detectors attain the best performance but are computationally complex, whereas linear MMSE detectors have lower complexity at the cost of performance). This means that just like the *expected bit error rate* algorithm of the '492 patent, logic 403 uses “the lowest complexity MUD possible” when “any of the users have an expected BER that is...above a threshold, for any of the lower complexity MUD techniques.” EX1008, [0026]-[0029]; FIG. 4; *cf.* EX1001, 13:63-14:6.

202. Liu also explains that “if linear multi-user decoder 406 cannot satisfactorily decode the intended signal, such as failing to provide a threshold SNR strength and/or other threshold factors, resulting in an unacceptable error rate or other performance, non-linear multi-user decoder 407 is preferably used for decoding.” Because nonlinear decoders are more complex than linear decoders and Liu expressly refers to decoder 406 as being “simpler” than decoder 407, the non-linear multi-user decoder 407 is the highest complexity MUD described by Liu. EX1008, [0029]. Therefore, it is clear that the step of using “the highest complexity MUD possible” when “none of the users in a specific window have an expected BER below the threshold for any of the lower complexity MUD techniques” described by the ’492 patent is performed by logic 403 of Liu. EX1008, [0026]-[0029]; FIG. 4; *cf.* EX1001, 13:63-14:6.

203. Liu describes a technique for comparing a signal strength of incoming received signals with threshold signal strength values to select one of decoders 404, 406, 407 to process the received signals. EX1008, [0030], [0031], FIG. 5. For example, I noticed that Liu expressly discloses that that some received signals (e.g., “preamble 1”) have “[s]ufficient signal strength, above an upper signal strength threshold, to warrant...nonlinear multi-user decoding.” EX1008, [0030]. That is, logic 403 selects the most complex MUD in response to the signal strength exceeding the upper threshold. EX1008, [0030], *see id.*, [0028] (“[i]f the interference

is above the aforementioned upper threshold demodulation scheme selection logic 403 preferably chooses to employ non-linear multi-user decoder 407”). I also noticed that Liu discloses that other received signals (e.g., “preamble 3”), have “only sufficient strength, above the lower signal strength threshold, but below the upper signal strength threshold, to warrant linear multi-user decoding.” EX1008, [0030]. That is, when the signal strength is between the upper and the lower thresholds, the linear multiuser decoder is selected. EX1008, [0030], *see id.*, [0027] (“[i]f the interference is above the aforementioned lower threshold, but not above an upper threshold, linear multi-user decoder 406 may be selected by demodulation scheme selection logic 403”).



EX1008, FIG. 5 (annotated).

204. It would have been obvious for a POSITA to implement the technique of FIG. 5 with the *bit error rate* of received signals and *bit error rate* thresholds corresponding to each of decoders 406, 407 even though FIG. 5 is described in the context of signal strength as opposed to bit error rate. EX1008, [0024]-[0031], FIGS. 4-5; *supra*, §VII.H. Liu discloses, for example, that “if linear multi-user decoder 406 demodulation can provide a certain Signal-to Noise Ratio (SNR) strength threshold *and/or meet other threshold factors*, the simpler linear multi-user decoder 406 will

be used” and “if linear multi-user decoder 406 cannot satisfactorily decode the intended signal, such as failing to provide a threshold SNR strength *and/or other threshold factors*, resulting in an *unacceptable error rate or other performance*, non-linear multi-user decoder 407 is preferably used for decoding.” EX1008, [0029], FIGS. 4-5. Because Liu expressly discloses that threshold factors resulting in an unacceptable error rate can be used to select between decoders 406, 407 and an *expected bit error rate* is one of these threshold factors, a POSITA would have been motivated to implement the MUD system of Mills with use Liu’s suggestion to select between decoders 406, 407 based on comparing *expected bit error rate* for each of decoders 406, 407 with threshold *bit error rates*. EX1008, [0029], FIGS. 4-5; *supra*, §VII.H.

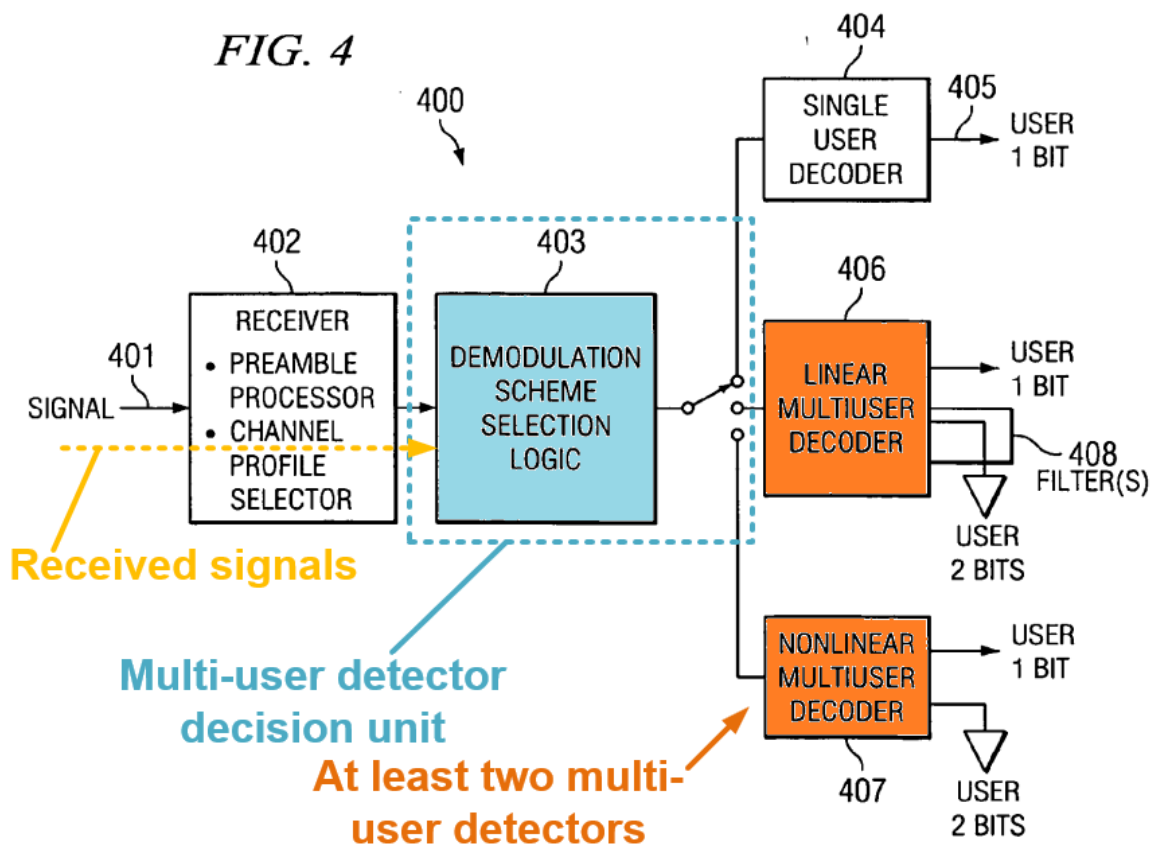
205. It is therefore clear that Liu provides the *multi-user detector decision unit* of claim 1 even when this term is interpreted according to the to the District Court’s prior construction, because the logic 403 selects one of the decoders 404, 406, 407 by applying an algorithm that is the same as the *expected bit error rate* algorithm described by the ’492 patent. EX1008, [0024]-[0031], FIGS. 4-5; *supra*, §VII.H. It is clear that in the predictable Mills-Liu combination, the *multi-user detector decision unit* is coupled to the *parameter estimator* 10 and the *received signals*. EX1007, [0028]-[0055], FIGS. 1-2; EX1008, [0024]-[0031], FIGS. 4-5; *supra*, §VII.H. Liu discloses, for example, that logic 403 selects one of the decoders

404, 406, 407 based on parameters of received signals, meaning that a POSITA would have been motivated to implement Mills's MUD system so that the *multi-user detector decision unit* receives input from the *parameter estimator* 10 and the received signals. EX1007, [0028]-[0055], FIGS. 1-2; EX1008, [0024]-[0029], FIG. 4; *supra*, §VII.H.

Element [1c]: at least two multi-user detectors coupled to said parameter estimator and said multi-user detector decision unit, said multi-user detector decision unit using decision criteria to determine a selected multi-user detector, wherein said selected multi-user detector outputs a plurality of information streams, one stream corresponding to each of said received signals;

206. Mills describes a MUD system including a MUD 14 that is *coupled* to a *parameter estimator* 12 through a filter 13. EX1007, [0029]-[0032], FIG. 1. For example, Liu expressly discloses that “[a] digitized signal passes through conventional receiver circuitry (not shown) and is then input to parameter estimation unit 12,” “[t]he digitized signal is then passed through a whitening matched filter 13,” and “[t]he whitened signal is input to multi-user decoder (MUD) 14.” EX1007, [0030]-[0032], FIG. 1. Liu describes *at least two multi-user detectors* including a linear multi-user decoder 406 and a non-linear multi-user decoder 407, to the extent MUD 14 includes only a single multiuser detector. EX1007, [0026]-[0029], FIG. 4. One thing I noticed is that linear multi-user decoder 406 and non-linear multi-user decoder 407 both generate multiple output bit streams, each of these bit streams corresponding to a different user. EX1007, FIG. 4 (depicting linear multi-user

decoder 406 and non-linear multi-user decoder 407 outputting at least two bit streams including “user 1 bit” and “user 2 bits”). Although Liu refers to decoders 406, 407 as “multiuser decoders” in FIG. 4 and other places in the specification, Liu explains that “decoders may also be referred to as ‘detectors.’” EX1008, [0007]. Therefore, it is clear that decoders 406, 407, represent *multi-user detectors*.



EX1008, FIG. 4 (annotated).

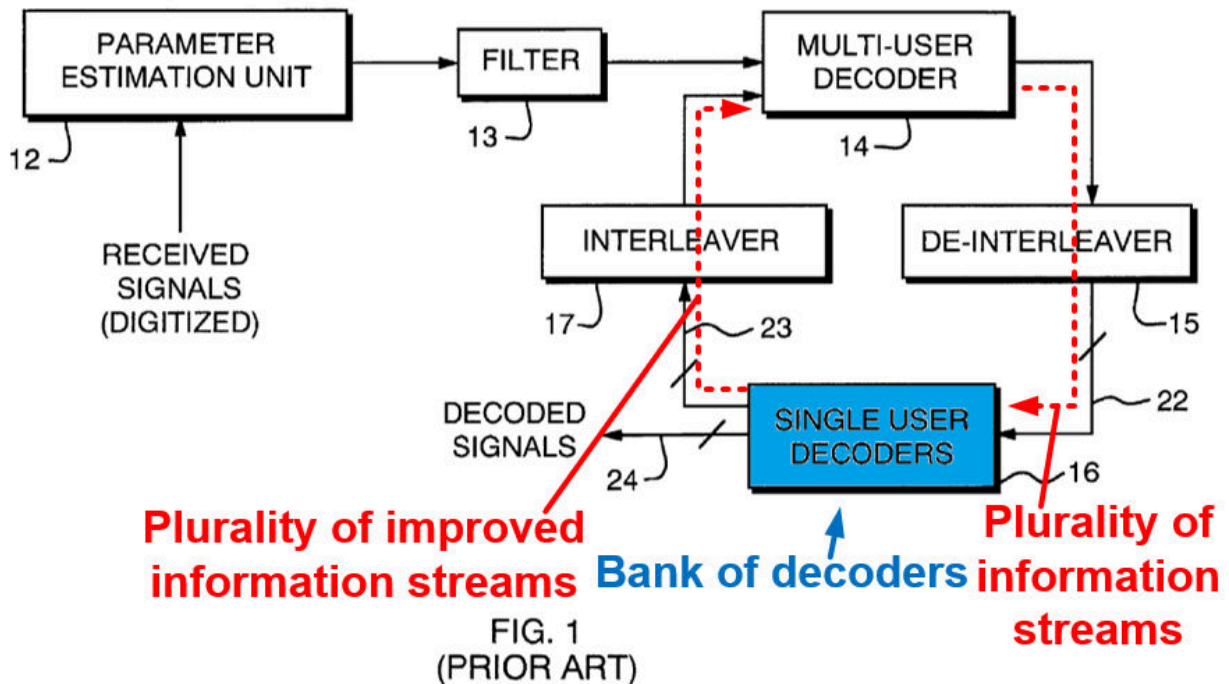
207. As I described in my analysis of Element [1b], *supra*, Liu describes a *multi-user detector decision unit* including demodulation scheme selection logic 403 that uses *decision criteria* to select one of multiuser decoders 406, 407 for

processing *received signals*. EX1008, [0024]-[0031]; FIGS. 4-5. I also described in my analysis of Element [1b], *supra*, that logic 403 applies an *expected bit error rate* algorithm to select one of multiuser decoders 406, 407 that is the same as the *expected bit error rate* algorithm described by the '492 patent for selecting a multi-user detector. EX1008, [0024]-[0031]; FIGS. 4-5; *cf.* EX1001, 13:63-14:6. This means that logic 403 represents a “*multi-user detector decision unit*” that is coupled to the *at least two multi-user detectors* and uses *decision criteria* to determine a *selected multi-user detector*. EX1008, [0024]-[0031]; FIGS. 4-5.

208. A POSITA would have been motivated to implement the Mills-Liu combination so that each of the *at least two multi-user detectors* are coupled to a *parameter estimator* because Mills discloses that MUD 14 is coupled to parameter estimation unit 12. EX1007, [0029]-[0031], FIG. 1; EX1008, [0024]-[0029], FIG. 4; *supra*, §VII.E. I noticed that Mills explains that MUD 14 and single user decoders 16 “work in concert to estimate the transmitted sequence of symbols from all users within a time frame, also called a block, that is under consideration”; EX1007, [0029], *see also id.*, [0033]-[0038]. Consequently, it is apparent that the *selected multi-user detector* outputs a *plurality of information streams* including one information stream corresponding to each of the *received signals*, in the predictable Mills-Liu combination. EX1007, [0028]-[0039], FIG. 1; *supra*, §VII.E.

Element [1d]: a bank of decoders coupled to said plurality of information streams, wherein said decoders output a plurality of improved information streams.

209. Mills discloses a plurality of single-user decoders 16 (also referred to by Mills as a “**bank** of single user **decoders** 16”). EX1007, [0029], [0033]-[0038], [0040], [0044], [0046]-[0054], FIGS. 1-2. I noticed that this **bank of** single user **decoders** 16 receives an output of the MUD 14 and is therefore **coupled** to the **plurality of information streams** output from MUD 14. EX1007, [0034] (“the symbol estimates output from MUD 14 are input to each of a plurality of single-user decoders 16, with there being one single-user decoder used for each signal to be decoded”); *see also id.*, [0038], [0044], [0049]-[0051].



EX1007, FIG. 1 (annotated).

210. Mills discloses that the **bank of** single user **decoders** 16 and the MUD 14 pass information between each other for a number of iterations “until further iterations will result in insignificant changes in the probability estimates output from single user decoders 16 and therefore will not significantly improve the turboMUD bit error rate performance.” EX1007, [0054]; *see also id.*, [0036]-[0038], [0053], FIGS. 1-2. This means that over each iteration, the **bank of** single user **decoders** 16 outputs a **plurality of improved information streams** based on the plurality of information streams received from MUD 14. In implementing Mills’s MUD system with Liu’s **multi-user detector decision unit** for determining a **selected multi-user detector** from **two or more multi-user detectors**, a POSITA would have found it obvious for the bank of single user decoders 16 to be coupled to the **plurality of information streams** output from the selected multi-user detector so that Mills’s MUD system can function as depicted in FIG. 1 with the **selected multi-user detector**. EX1007, [0024]-[0029], FIG. 4; EX1008, [0024]-[0029], FIG. 4; *supra*, §VII.H.

Claim [2]: The System according to claim 1 wherein said plurality of improved information streams are fed back to said multi-user detector decision unit until a final condition is reached and said bank of decoders output a final data stream.

211. Mills discloses that the **bank of** single user **decoders** 16 calculates soft outputs for each of the received signals which include “probability estimates” indicating a confidence that each soft output estimate is correct. EX1007, [0032], [0034]-[0036], [0038], [0046], [0053], [0054], FIGS. 1-2. For example, I noticed

that Mills explains that “[t]he output from MUD 14 are typically soft signal symbol estimates called ‘channel symbol estimates’ in this description. EX1007, [0032]. Mills also explains that “[t]he single user decoders 16 calculate conditional probabilities called ‘probability estimates’...one for each decoded symbol of each user, and output them as probability estimates” and explains that the decoders 16 output these probability estimates “for use by MUD 14 which uses them...during the next iteration of...decoding by MUD 14.” EX1007, [0034], [0036].

212. The probability estimates calculated by the *bank of* single user *decoders* 16 therefore represent a *plurality of improved information streams* that are fed back into MUD 14 for a number of iterations until the *bank of* single user *decoders* 16 outputs final estimates for each of the received signals (referred to as “decoded signals”). EX1007, [0036]-[0038], [0053], [0054], FIGS. 1-2. For example, when a *final condition* is reached at which “the desired bit error rate performance is attained” or “further iterations result in insignificant changes in the channel symbol estimates,” this is when the *bank of* single user *decoders* 16 outputs the *final data stream* including the decoded signals. EX1007, [0038]; *see also id.*, [0054].

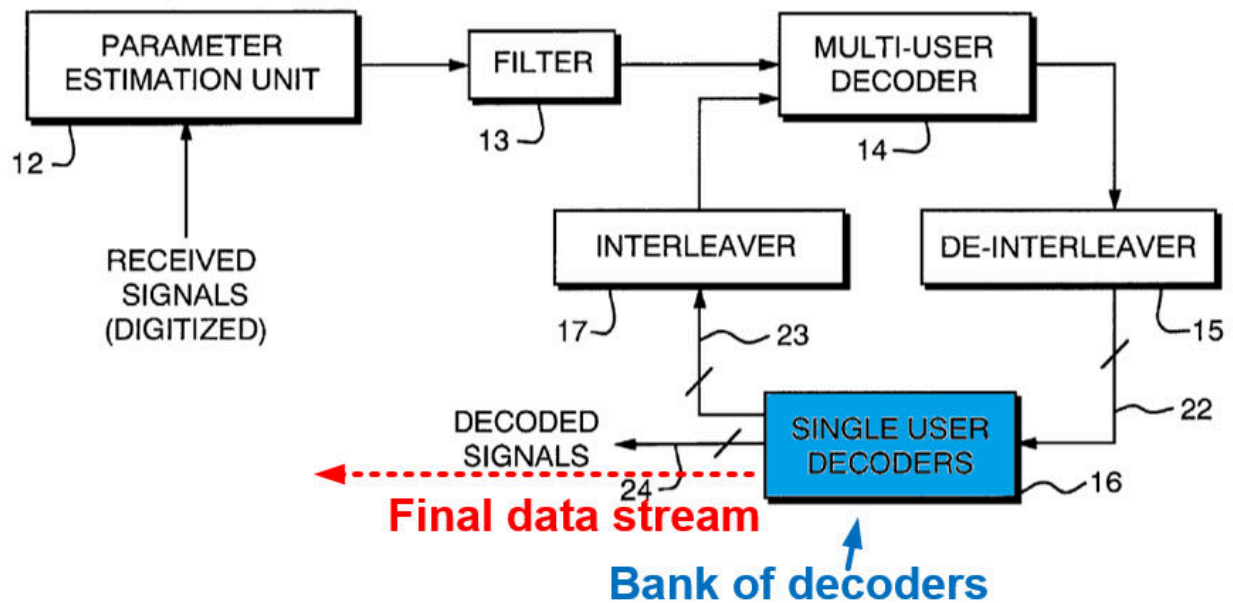


FIG. 1
(PRIOR ART)

EX1007, FIG. 1 (annotated).

213. I noticed that Mills also discloses that “[t]urbo decoding involves an iterative algorithm in which probability estimates of the code information bits that are derived by one decoder for the coded information bits being processed in that decoder are fed back to the other decoder,” that “[e]ach iteration of decoding of the code information bits through the two decoders generally increases the reliability of the probability estimates,” and that “[t]his iterative feedback and decoding process continues, decoding the code information bits a finite number of times, and a decision is made based on the final probability estimates that the bits represent the transmitted data and can be used to make reliable decoding decisions.” EX1007, [0014]. Mills expressly discloses one embodiment where a final condition is reached

when “[w]hen the minimal absolute probability value is above a predetermined threshold, indicating that all of the bits have been assigned either the value ‘-1’ or ‘0’ with relatively high probability.” EX1007, [0015]. Consequently, it is apparent that the probability estimates generated by the decoders 16 represent a *plurality of improved information streams* that are fed back into MUD 14 until a *final condition* is reached.

214. In the Mills-Liu combination, it would have been obvious to implement the MUD system of Mills so that the *bank of* single user *decoders* 16 feed the *plurality of improved information streams* into a *multi-user detector decision unit*, because doing so would allow the *multi-user detector decision unit* to direct the signals to the appropriate *selected multi-user detector*. For example, because Liu depicts logic 403 as being switchably connected to each of single user decoder 404, linear multi-user decoder 406, and non-linear multi-user decoder 407, a POSITA would have been motivated to implement decoders 16 to feed the *plurality of improved information streams* back into a *multi-user detector decision unit* such as logic 403 that can subsequently output the *plurality of improved information streams* to the *selected multi-user detector* (e.g., the selected one of decoders 406, 407). EX1008, [0025]-[0029], FIG. 4.

Claim [3]: The System according to claim 1 wherein said design criteria is based upon at least one threshold selected from at least one of the group consisting of number of symbols, correlation matrix between users, expected bit error rate,

eigendecomposition of correlation matrix, signal to interference plus noise ratio, and expected SINR.

215. Liu describes a *multi-user detector decision unit* including “demodulation scheme selection logic 403” that can use *decision criteria* to determine a selected multi-user detector. EX1008, [0024]-[0029], FIG. 4; *supra*, Elements [1b]-[1c]. These *decision criteria* can include at least one threshold selected from at least one of a group consisting of expected bit error rate for one or both of the linear multi-user decoder 406 and the non-linear multi-user decoder 407. EX1008, [0029] (explaining that “if linear multi-user decoder 406 demodulation can...meet other threshold factors, the simpler linear multi-user decoder 406 will be used” and “if linear multi-user decoder 406 cannot satisfactorily decode the intended signal, such as failing to provide a threshold SNR strength and/or other threshold factors, resulting in an unacceptable error rate or other performance, non-linear multi-user decoder 407 is preferably used for decoding”).

216. A POSITA would have understood and found obvious that determining whether an error rate of a given *multi-user detector* is acceptable involves determining an *expected bit error rate* for one or more available detectors and comparing these expected bit error rates with one or more thresholds that define an “acceptable” bit error rate and an “unacceptable” bit error rate. EX1008, [0024]-[0029], FIG. 4; *supra*, §VII.H. My opinion here is confirmed by the fact that Liu expressly discloses that that some received signals (e.g., “preamble 1”) have

“[s]ufficient signal strength, above an upper signal strength **threshold**, to warrant...nonlinear multi-user decoding” and that some received signals (e.g., “preamble 3”), have “only sufficient strength, above the lower signal strength **threshold**, but below the upper signal strength threshold, to warrant linear multi-user decoding.” EX1008, [0030], FIG. 5. Consequently, even if Liu does not expressly disclose comparing expected bit error rates to bit error rate thresholds, a POSITA would have found it obvious to do so just as Liu expressly discloses that upper and lower signal strength thresholds can be used to select between decoders 406, 407. EX1008, [0024]-[0030], FIGS. 4-5; *supra*, §VII.H.

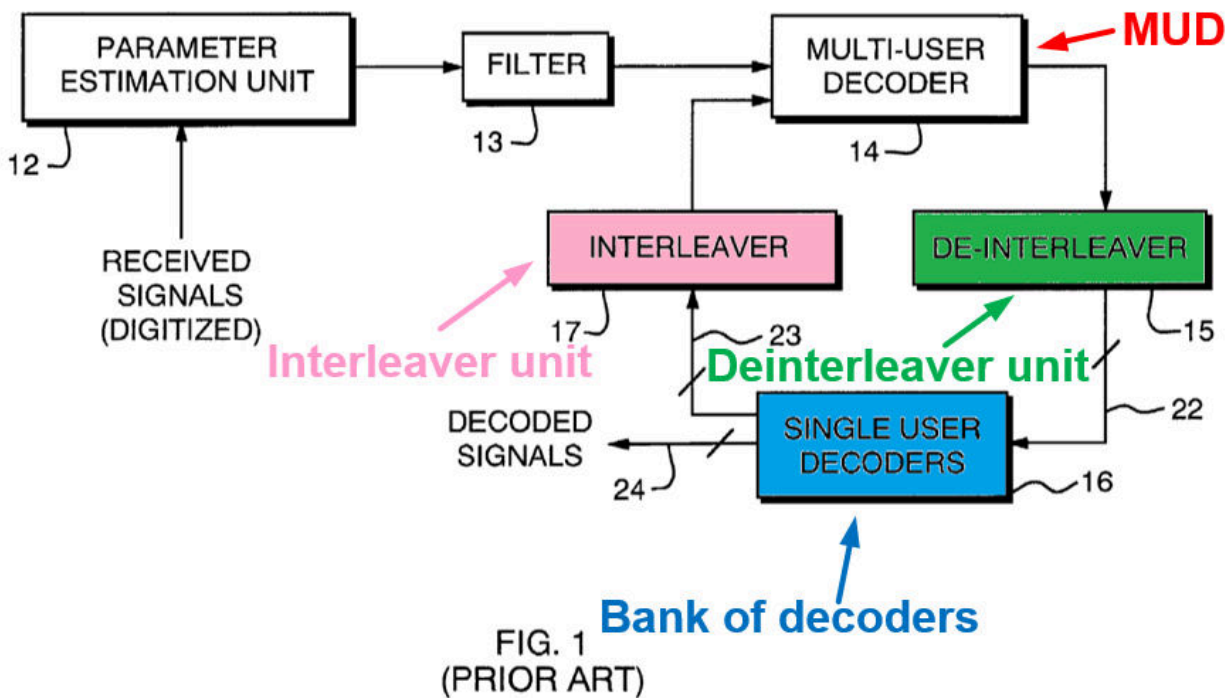
Claim [5]: The System according to claim 1 wherein said at least two multiuser detectors are selected from the group consisting of M-algorithm, sphere decoder, T-algorithm, FANO, reduced state Viterbi, Maximum Likelihood, matched filter, minimum mean squared error (MMSE), decorrelator, and combinations thereof.

217. The ***at least two multi-user detectors*** described by Liu include linear multi-user decoder 406 and non-linear multi-user decoder 407. EX1008, [0026]-[0029], FIG. 4; *supra*, Elements [1b]-[1c]. Liu expressly discloses that “[o]ne often-used scheme of linear multi-user decoding is commonly referred to as ***Minimum Mean Squared Error*** Multi-user Decoding (***MMSE*** multi user decoding)” and “[a] typical example of a non-linear multi-user decoder is the so-called ‘***maximum likelihood*** multi-user decoder.’” EX1008, [0027]. Therefore, the predictable Mills-Liu combination includes ***at least two multiuser detectors*** selected from a group consisting of Maximum Likelihood detectors and MMSE detectors; *supra*, §VII.H.

Liu also explains that “as will be appreciated by one of ordinary skill in the art, any number of multi-user decoders may be used in accordance with the present invention.” EX1008, [0028]. This means that a POSITA would have been motivated to modify a system that does not include MMSE and maximum likelihood decoders (e.g., Mills’s M-algorithm) with Liu. *Supra*, §VII.H.

Claim [6]: The System according to claim 1, further comprising an interleaver unit and a deinterleaver unit coupled between said bank of decoders and said multi-user detectors.

218. Mills expressly discloses that an ***interleaver unit*** (interleaver 17) and a ***deinterleaver unit*** (de-interleaver 15) are coupled between the MUD 14 and the ***bank of*** single user ***decoders*** 16. EX1007, [0033] (“[i]f the received signals had been interleaved at the transmitter, the signals output from MUD 14 are first passed through a de-interleaver 15 and passed on...to a bank of single user decoders 16”), [0037] (“[i]nterleaving of the signals output from single user decoders 16 on leads 23 is performed at interleaver 17 to restore the received signals to their original received order”), *see id.*, [0034], [0040], FIG. 1. It is apparent, therefore, that when Mills’s MUD system is implemented with the multi-user decoders 406, 407 as Liu suggests, the resulting system would include an ***interleaver unit*** and a ***deinterleaver unit*** coupled between ***two or more multi-user detectors*** and the ***bank of*** single user ***decoders*** 16. *Supra*, §VII.H.



EX1007, FIG. 1 (annotated).

Claim [7]: *The System according to claim 2, wherein said final condition is determined by one of a fixed number of iterations and an allowable performance level.*

219. According to Mills, MUD 14 and a bank of single user decoders 16 can pass information between each other for a “predefined number” of iterations, until a “desired...performance is attained, or until further iterations result in insignificant changes in the channel symbol estimates” which represents a ***final condition***. EX1007, [0038]; *see also id.*, [0054] *supra*, [2]. Mills also explains an embodiment where “iterative feedback and decoding process continues, decoding the code information bits a finite number of times, and a decision is made based on the final probability estimates that the bits represent the transmitted data and can be used to

make reliable decoding decisions” and another embodiment where “the minimal absolute probability value is above a predetermined threshold, indicating that all of the bits have been assigned either the value “-1” or “0” with relatively high probability,” leading the iterative turbo decoding process to be “terminated.” EX1007, [0014], [0015].

220. When this ***final condition*** occurs, it is clear that the bank of single user decoders 16 output estimates for the decoded signals. EX1007, [0038], [0054]. Thus, a ***final condition*** is determined based on a ***fixed number of iterations*** or an ***allowable performance level*** being reached. EX1007, [0038], [0054].

Claim [8]: The System according to claim 1, further comprising a filter unit coupled to said received signals, wherein said filter unit is coupled to said multi-user detector decision unit.

221. Mills expressly discloses that a ***filter unit*** represented by filter 13 is ***coupled*** to the ***received signals*** through parameter estimation unit 12. EX1007, [0030] (“[a] digitized signal passes through conventional receiver circuitry (not shown) and is then input to parameter estimation unit 12”), [0031] (“[t]he digitized signal is then passed through a whitening matched filter 13”), [0041], [0042], FIGS. 1-2. Filter 13 clearly represents a filter unit, because Mills expressly refers to filter 13 as a “whitening matched filter” that “reduces the correlation between symbols of interfering users. EX1007, [0031].

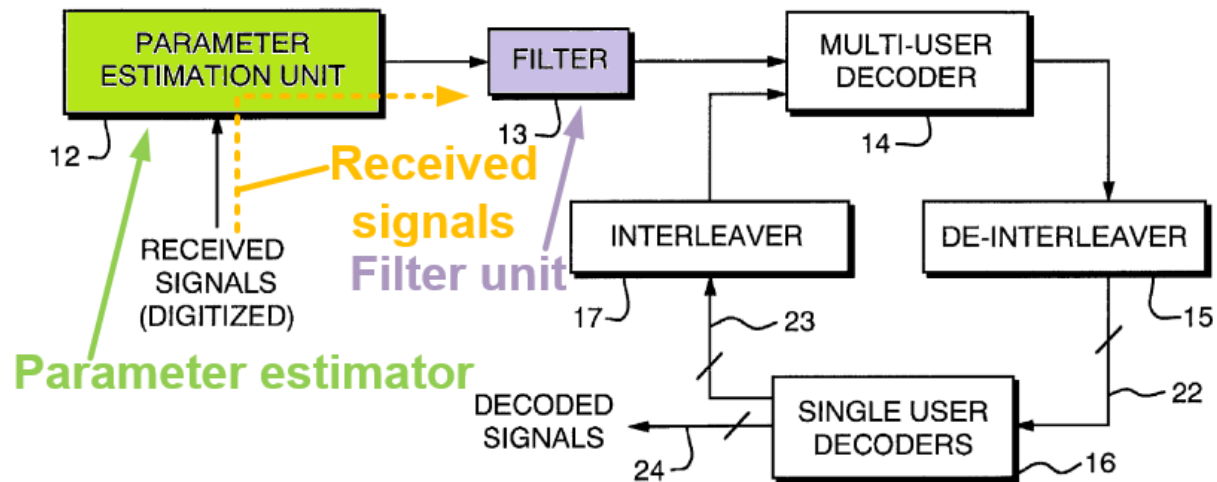


FIG. 1
(PRIOR ART)

EX1007, FIG. 1 (annotated).

222. In the predictable Mills-Liu combination, it would be obvious for a POSITA to implement the *filter unit* to also be coupled to the *multi-user detector decision unit* because this would allow filter 13 to process the received signals before the *multi-user detector decision unit* selects an appropriate MUD. For example, it would be advantageous for filter 13 to be connected to the *multi-user detector decision unit* so that a decision of whether to use the linear MUD 406 or the nonlinear MUD 407 can be made based on interference characteristics of the filtered signal because filter 13 “serves to cancel some inter-symbol (ISI) interference” or “reduces the correlation between symbols of interfering users,”. EX1007, [0031].

Claim [9]: The System according to claim 1, further comprising a hard decision unit coupled to said bank of decoders and producing a final data stream.

223. As described for Element [1d] and Claims [2] and [7], *supra*, Mills describes a system where MUD 14 and the bank of single user decoders 16 can exchange information for a number of iterations to improve soft estimates for a number of interfering signals, until a final condition is reached at which point the ***bank of*** single user ***decoders*** 16 output a set of decoded signals. EX1007, [0028]-[0055], FIGS. 1-2. Specifically, Mills discloses that “[t]he passing of information between MUD 14 and the single-user decoders 16 is repeated a predefined number of times, until the desired bit error rate performance is attained, or until further iterations result in insignificant changes in the channel symbol estimates. At that point, the estimates of the decoded signals (i.e. estimates of the data sequences) are output from the single user decoders 16 over path 28.” EX1007, [0038]. This means that the Mills-Liu combination provides system provides or would have rendered obvious ***a hard decision unit*** coupled to the ***bank of*** single user ***decoders*** 16 that is responsible for outputting a ***final data stream*** including the estimates of the decoded signals when the appropriate conditions are met. EX1007, [0014], [0028]-[0055], FIGS. 1-2; *supra*, [1d], [2], [7].

Element [10pre]: A hybrid receiver for processing a plurality of received signals, said receiver comprising.

224. The Mills-Liu combination provides this claim element for at least the same reasons I described above in connection with Element [1pre]. *See supra*, Element [1pre]. Furthermore, Mills expressly discloses “receiver circuitry utilizing iterative turbo decoding to separate multiple interfering signals on the same communication channel,” therefore indicating a **hybrid receiver** that can process a plurality of **received signals**. EX1007, [0028], *see also id.*, [0030] (“[a] digitized signal passes through conventional receiver circuitry (not shown) and is then input to parameter estimation unit 12”), [0040].

Element [10a]: a parameter estimation unit coupled to said received signals, wherein said parameter estimation unit extracts received signal information;

225. The Mills-Liu combination provides this claim element for at least the same reasons I described above in connection with Element [1a]. *See supra*, Element [1a]. Furthermore, Mills’s parameter estimation unit 12 that is coupled to the **received signals** can extract the **received data information** including multiple different kinds of parameters from the **received signals**. EX1007, [0030] (“[a] digitized signal passes through conventional receiver circuitry (not shown) and is then input to parameter estimation unit 12 which utilizes unique apriori knowledge of each of the received signals to help identify parameters for each interfering signal...[t]hese parameters includes the received power, the phase of the oscillator which generated each received signal, the timing offset relative to the base station

clock, carrier frequency, any frequency offset of the carrier (phase difference), and the structure of multi-path replicas.”); *see also id.*, [0005], [0029].

Element [10b]: a multi-user detector decision unit coupled to said parameter estimator and said received signals, wherein said multi-user detector decision unit selects a multi-user detector based upon at least one threshold;

226. As described for Elements [1b]-[1c] and Claim [3], *supra*, Liu describes a demodulation scheme selection logic 403 representing a multi-user detector decision unit that selects a multi-user detector—e.g., selects between linear multi-user decoder 406 and a non-linear multi-user decoder 407—based upon at least one threshold. EX1008, [0025]-[0029], FIG. 4. Examples of thresholds that Liu’s multi-user detector decision unit can use to select a multi-user detector include signal strength thresholds of the incoming signal 401, expected SNR thresholds of the decoders 406, 407, and expected bit error rate thresholds of the decoders 406, 407. EX1008, [0029] (“However, if linear multi-user decoder 406 cannot satisfactorily decode the intended signal, such as failing to provide a threshold SNR strength and/or other threshold factors, resulting in an unacceptable error rate or other performance, non-linear multi-user decoder 407 is preferably used for decoding.”). This means that even if the “multi-user detector decision unit” of claim 10 is construed as a means-plus-function term according to the District Court’s prior ruling, the predictable Mills-Liu combination includes a multi-user detector decision

unit that can select a multi-user detector based upon an expected bit error rate threshold as described in the '492 patent. EX1008, [0029]; cf. EX1001, 13:63-14:6.

Elements [10c]-[10e]: a low complexity multi-user detector switchably coupled by said multi-user detector decision unit, wherein said low complexity multi-user detector outputs a plurality of low complexity processed information streams; a medium complexity multi-user detector switchably coupled by said multi-user detector decision unit, wherein said medium complexity multi-user detector outputs a plurality of medium complexity processed information streams; a high complexity multi-user detector switchably coupled by said multi-user detector decision unit, wherein said high complexity multi-user detector outputs a plurality of high complexity processed information streams; and

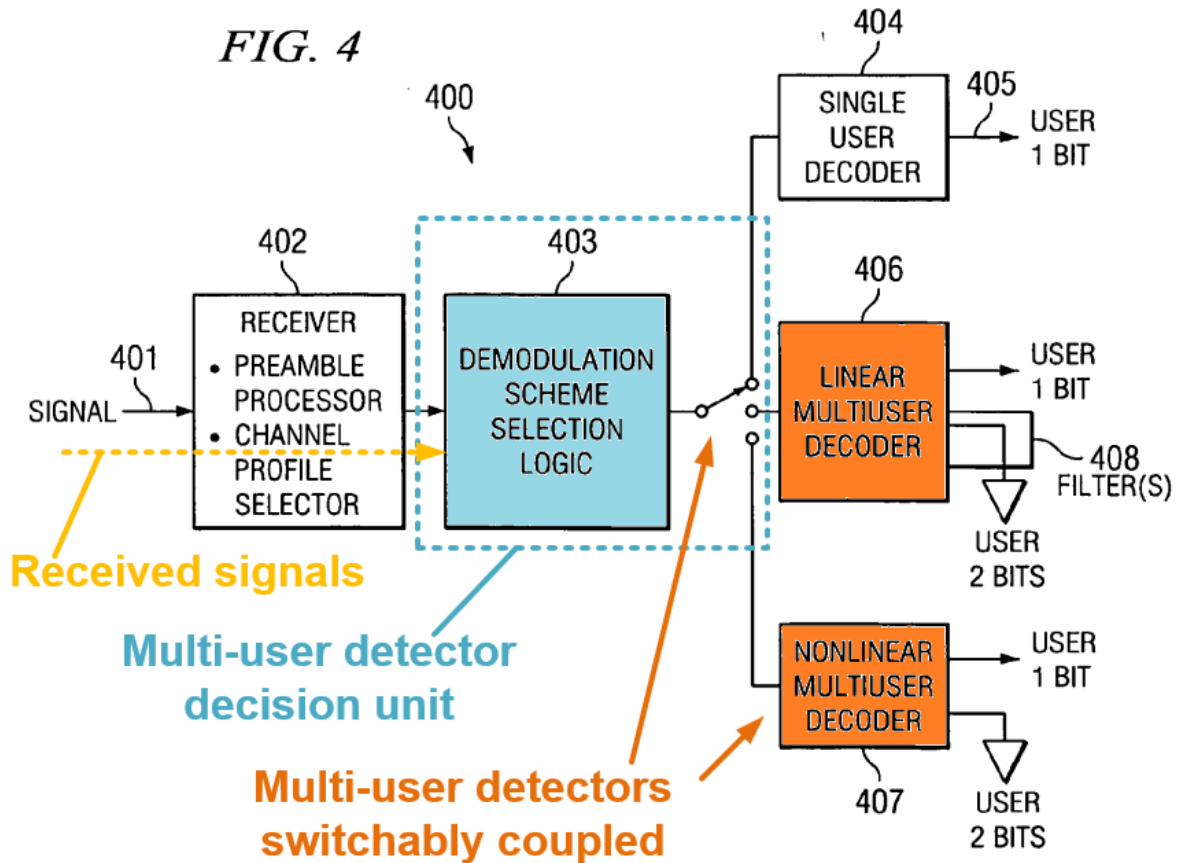
227. The Mills-Liu combination provides these claim elements for at least the same reasons I described above in connection with Elements [1b]-[1c] and Claim [3]. *See supra*, Elements [1b]-[1c] and Claim [3]. Liu discloses demodulation scheme selection logic 403 that can select between three decoders of varying complexity including a single user decoder 404, a linear multi-user decoder 406 that is more complex than decoder 404, and a non-linear multi-user decoder 407 that is more complex than decoder 406. EX1008, [0024]-[0029], FIG. 4; *supra*, Elements [1b]-[1c]. Logic 403 selects a decoder based on characteristics indicating an amount of interference within received signals. EX1008, [0026] (“if the interference from the preamble estimation of the interference signal strength provided by channel profile selector 402 is significant or strong...multi user decoder...is preferably selected by...logic 403”), [0027] (“[i]f the interference is above the aforementioned lower threshold, but not above an upper threshold, linear multi-user decoder 406

may be selected”), [0028] (“[i]f the interference is above the aforementioned upper threshold demodulation scheme selection logic 403 preferably chooses to employ non-linear multi-user decoder 407”).

228. Liu expressly discloses that a linear multi-user decoder 406 represents an MMSE detector and non-linear multi-user decoder 407 represents a maximum likelihood detector. EX1007, [0027], [0028]. Nonlinear maximum likelihood detectors are more complex than linear MMSE detectors. EX1013, 1 (explaining that nonlinear maximum likelihood detectors attain the best performance but are computationally complex, whereas linear MMSE detectors have lower complexity at the cost of performance).

229. One reason that more complex detectors are selected for higher levels of interference is that more complex detectors “may drain more battery power of a terminal, generate more heat and/or the like.” EX1008, [0029]. Liu explains that it is beneficial to select a higher complexity detector when necessary to handle higher levels of interference, but when a lower complexity detector will suffice it is better to use that detector to conserve resources. EX1008, [0029]. Therefore, to the extent that Liu only discloses two multiuser detectors – linear multi-user decoder 406 and non-linear multi-user decoder 407 – a POSITA would have found it obvious to implement the MUD system of Mills with a *low complexity multi-user detector*, a *medium complexity multi-user detector*, and a *high complexity multi-user detector*.

Supra, §VII.H. Liu's **multi-user detectors** are each switchably coupled to a **multi-user detector decision unit**.



EX1008, FIG. 4 (annotated).

230. As depicted above, multiuser decoders 406, 407 are each *switchably coupled* to logic 403, the **multi-user detector decision unit**. EX1008, [0024]-[0029], FIG. 4. The Mills-Liu combination therefore provides *low, medium and high complexity multi-user detectors* that are each *switchably coupled* by a **multi-user detector decision unit** and output a respective *plurality of information streams*.

EX1007, [0029]-[0031], FIG. 1; EX1008, [0024]-[0029], FIG. 4; *supra*, Element [1c], §VII.H.

Claim [10f]: a bank of decoders coupled to said plurality of low complexity processed information streams, said plurality of medium complexity processed information streams, and said plurality of high complexity processed information streams, wherein said decoders output a plurality of refined information streams.

231. The Mills-Liu combination provides this claim element for at least the same reasons I described above in connection with Element [1d]. *See supra*, Element [1d]. In the predictable Mills-Liu combination, the ***low, medium and high complexity processed information streams*** would each be coupled to the ***bank of single user decoders*** 16 because a POSITA would have recognized that Mills's ***bank of single user decoders*** 16 would be coupled to these outputs from the ***low, medium and high complexity multi-user detectors*** just as ***bank of single user decoders*** 16 are coupled to Mills's MUD 14. EX1008, [0028]-[0039], FIG. 1.

Claim [11]: The hybrid receiver according to claim 10, further comprising a front end section coupled to said received signals and to said received signal information which filters said received signals.

232. Mills discloses a filter 13 representing a ***front end section*** that is ***coupled to received signals*** through the ***parameter estimator*** (e.g., parameter estimation unit 12). EX1007, [0028]-[0031], [0040]-[0042], FIGS. 1-2. For example, the ***received signals*** of Mills pass through parameter estimation unit 12 to reach filter 13. EX1007, [0030] (“[a] digitized signal...is then input to parameter estimation unit

12”), [0031] (“[t]he digitized signal is then passed through a whitening matched filter 13”). Because the filter 13 receives the output of parameter estimation unit 12 including parameters generated based on the received signal, Mills’s *front end section* is also coupled to *received signal information* generated by the parameter estimator. EX1007, [0028]-[0031], [0040]-[0042], FIGS. 1-2; *supra*, Element [10a]. The *front end section* described by Mills clearly filters the *received signals*. EX1007, [0031] (explaining that filter 13 “serves to cancel some inter-symbol (ISI) interference or which reduces the correlation between symbols of interfering users”).

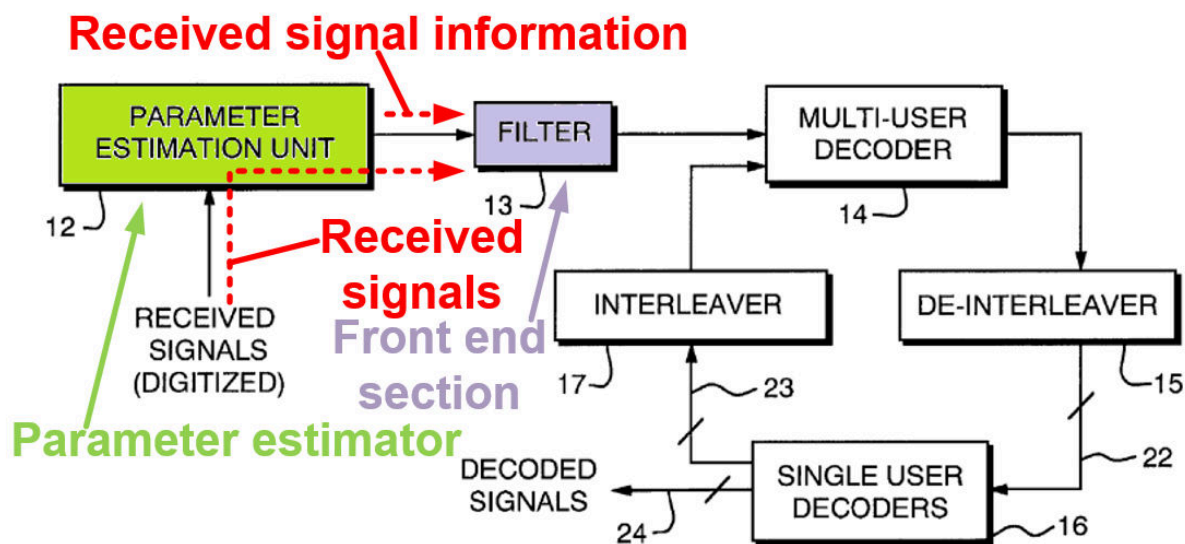


FIG. 1
(PRIOR ART)

EX1007, FIG. 1 (annotated).

Claim [12]: The hybrid receiver according to claim 10, wherein said plurality of refined information streams are fed back to said multi-user detector decision unit

for iterative processing until a final condition is reached and said bank of error correction decoders output a final plurality of bit streams.

233. The Mills-Liu combination provides this claim element for at least the same reasons I described above in connection with Claim [2]. *See supra*, Claim [2].

Claim [13]: The hybrid receiver according to claim 10, wherein said multi-user detector decision unit makes a selection determined by design criteria based upon at least one threshold selected from at least one of the group consisting of number of symbols, correlation matrix between users, expected bit error rate, eigendecomposition of correlation matrix, signal to interference plus noise ratio, and expected SINR.

234. The Mills-Liu combination provides this claim element for at least the same reasons I described above in connection with Claim [3]. *See supra*, Claim [3].

Claim [15]: The hybrid receiver according to claim 12, wherein said final condition is one of a fixed number of iterations and an allowable performance level.

235. The Mills-Liu combination provides this claim element for at least the same reasons I described above in connection with Claim [7]. *See supra*, Claim [7].

Claim [16]: The hybrid receiver according to claim 10, further comprising a hard decision unit coupled to said bank of decoders and producing a final data stream.

236. The Mills-Liu combination provides this claim element for at least the same reasons I described above in connection with Claim [9]. *See supra*, Claim [9].

Claim [17pre]: A method for processing signals from multiple users with raw digitized data, comprising:

237. Mills discloses a ***method*** for processing ***signals*** from ***multiple users***.

EX1007, [0001] (“[t]his invention relates to...an improved method...in a receiver

for iterative turbo multi-user detection”), [0021] (“[t]he present invention provides an improved method and apparatus for processing simultaneously occurring, interfering signals using a turboMUD detector”), *see also id.*, [0028]-[0039], FIG. 1; *supra*, Element [1pre]. Mills also discloses that received signals corresponding to multiple users can be *processed* as *raw digitized data*. EX1007, [0030] (“[a] digitized signal...is then input to parameter estimation unit 12...to help identify parameters for each interfering signal”), *see also id.*, [0031], [0042], FIG. 1 (referring to received signals as “digitized”).

Claim [17a]: performing parameter estimation of said raw digitized data;

238. Mills discloses that a parameter estimation unit 12 can perform a *parameter estimation* of the *raw digitized data*. EX1007, [0030] (“[a] digitized signal...is then input to parameter estimation unit 12 which utilizes unique apriori knowledge of each of the received signals to help identify parameters for each interfering signal”). EX1007, [0030], *see also id.*, [0005], [0029], FIG. 1; *supra*, Element [1a]. Mills expressly discloses that estimated parameters can include “the received power, the phase of the oscillator which generated each received Signal, the timing offset relative to the base Station clock, carrier frequency, any frequency offset of the carrier (phase difference), and the structure of multi-path replicas.” EX1007, [0030].

Claim [17b]: grabbing a window of bits from said raw digitized data;

239. In the iterative process Mills's MUD system performs, the *raw digitized data* is split into a sequence of "data blocks" that each correspond to *bits* of the signals received during a *window* of time. EX1007, [0014] ("[t]he turbo decoder operates on one block of coded data bits, or symbols, at a time, passing the revised estimates between the component decoders until processing of that block is complete."), *see also id.*, [0029], [0039], [0054]. Specifically, each of Mills's data blocks is processed by MUD 14 and the bank of decoders 16 through a series of iterations until final outputs are determined. EX1007, [0038], [0039], [0054]. When Mills's iterative process is completed for the current data block, "[t]he operation then commences using the next block of received data bits, repeating the process." EX1007, [0039], *see also id.*, [0054].

Claim [17c]: subtracting any known bits from said window of bits;

240. Mills's MUD 14 and soft output decoders 16 can each generate soft outputs for each iteration of the received signals where data is passed between MUD 14 and decoders 16. EX1007, [0029], [0035], [0036], [0043], [0046], [0050]. Mills explains that the iterations continue "a predefined number of times, until the desired bit error rate performance is attained, or until further iterations result in insignificant changes in the channel symbol estimates," meaning that the soft outputs are continuously improved throughout these iterations until final decoded signals are reached. EX1007, [0038]-[0040], [0054], FIG. 1. Specifically, the bank of soft

output decoders 16 generates “conditional probabilities” indicating a confidence that each soft output from the bank of soft output decoders 16 is correct. EX1007, [0034], *see also id.*, [0035]-[0039], [0046].

241. Because Mills’s iterative process involves improving soft outputs until a performance standard is reached, each iteration focuses on soft outputs that are associated with lower conditional probabilities while removing soft outputs with higher conditional probabilities from analysis. EX1007, [0014]-[0017], [0029]-[0039], FIG. 1. Mills’s MUD system therefore ***subtracts any known bits*** from the respective ***window of bits*** as part of the iterative process to improve soft outputs until a hard decision is reached. Mills’s system of ***subtracting any known bits*** from the respective ***window of bits*** based on estimates and conditional probabilities for each bit is very similar to the ’492 patent’s process for subtracting known bits. EX1004, [0028]-[0055], FIGS. 1-2; *cf.* EX1001, 19:66-20:12 (disclosing that “known symbols are subtracted,” and one way to determine whether a symbol is “known” is based on “symbol estimates and probabilities of error for each symbol” determined by a bank of decoders).

Claim [17d]: selecting a multi-user detector;

242. The Mills-Liu combination provides this claim element for at least the same reasons I described above in connection with Elements [1b]-[1c]. *See supra*, Elements [1b]-[1c].

Claim [17e]: estimating unknown bits from said window of bits using said multi-user detector;

243. As I described in my analysis of Element [17c], *supra*, Mills discloses that a MUD system ***subtracts any known bits*** from the respective ***window of bits*** as part of an iterative process to improve soft outputs from a bank of soft output decoders 16 until final decoded signals are reached. EX1007, [0028]-[0055], FIGS. 1-2. Furthermore, the predictable Mills-Liu combination provides a MUD system that ***estimates unknown bits*** from a respective ***window of bits*** using a selected ***multi-user detector***. *Supra*, Elements [1b]-[1c].

Claim [17f]: incrementing to a next window of bits;

244. Mills expressly discloses that, when a final condition is reached, “the estimates of the decoded signals (i.e. estimates of the data sequences) are output from the single user decoders 16” and that “[t]he operation then commences using the next block of received data bits, repeating the process.” EX1007, [0038], [0039], *see also id.*, [0054]. This means that when hard outputs are generated for a respective ***window of bits***, the MUD system of the predictable Mills-Liu combination proceeds to ***increment*** to a ***next window of bits***. EX1007, [0028]-[0055], FIGS. 1-2.

Claim [17g]: repeating said steps of subtracting, selecting, estimating and incrementing until there are no more windows and outputting a set of symbol estimates.

245. Because Mills discloses that the iterative process for identifying hard outputs is performed for a current data block and “the next block of received data

bits, repeating the process,” the MUD system of the predictable Mills-Liu combination therefore repeats the steps of *subtracting*, *selecting*, *estimating* and *incrementing*, for each *window of bits* until the bank of single user decoders 16 outputs a *set of symbol estimates* for each *window of bits*. EX1007, [0028]-[0055], FIGS. 1-2; EX1008, [0024]-[0029], FIG. 4.

D. GROUND 2B: The Mills-Liu-Sampath Combination Renders Claims 10-13, 15, and 16 Obvious

Elements [10pre]-[10a]: A hybrid receiver for processing a plurality of received signals, said receiver comprising: a parameter estimation unit coupled to said received signals, wherein said parameter estimation unit extracts received signal information;

246. Mills discloses and renders obvious Elements [10pre]-[10a] for at least the same reasons that I addressed above in connection with Ground 2A (§VIII.C) at Elements [10pre]-[10a]. *See supra*, Elements [10pre]-[10a].

Element [10b]: a multi-user detector decision unit coupled to said parameter estimator and said received signals, wherein said multi-user detector decision unit selects a multi-user detector based upon at least one threshold;

247. As I described my analysis of Ground 2A (§VIII.C) at Element [10b], *supra*, the predictable Mills-Liu combination includes a ***multi-user detector decision unit*** (e.g., demodulation scheme selection logic 403) that selects a ***multi-user detector*** based upon ***at least one threshold*** (e.g., a threshold ***expected bit error rate***). EX1008, [0025]-[0029], FIG. 4. Furthermore, Sampath discloses a demodulator selector 316 that can select one of demodulators 304, 308, 312 based upon ***at least one threshold*** for a metric such as ***signal to interference-plus-noise***

ratio (SINR). EX1006, [0039], [0041], [0043], Cls. 8, 9. Consequently, the predictable Mills-Liu-Sampath combination includes a ***multi-user detector decision unit*** that can use ***one or more thresholds*** for various metrics to select a ***multi-user detector***.

Elements [10c]-[10e]: a low complexity multi-user detector switchably coupled by said multi-user detector decision unit, wherein said low complexity multi-user detector outputs a plurality of low complexity processed information streams; a medium complexity multi-user detector switchably coupled by said multi-user detector decision unit, wherein said medium complexity multi-user detector outputs a plurality of medium complexity processed information streams; a high complexity multi-user detector switchably coupled by said multi-user detector decision unit, wherein said high complexity multi-user detector outputs a plurality of high complexity processed information streams; and

248. As I described in my analysis of the Mills-Liu-Sampath combination (§VII.I, *supra*), a POSITA would have been prompted to implement the MUD system of the Mills-Liu combination with Sampath's suggestion to include two separate MMSE multi-user detectors of different complexities and/or implement the MUD system of the Mills-Liu combination with Sampath's suggestion to include an MRC multi-user detector in addition to at least two more complex multi-user detectors. EX1007, [0026]-[0029], FIG. 4; EX1006, [0039]-[0043], [0047], [0048], FIG. 3A. This would result in a predictable Mills-Liu-Sampath combination including a ***low, medium, and high complexity multi-user detectors***—such as Sampath's MRC detector in addition to Liu's MMSE and maximum likelihood detectors, or Liu's maximum likelihood detector in addition to Sampath's two

MMSE detectors having different complexities. *Supra*, §VII.I. A POSITA would have found it obvious to implement Liu's MUD system with additional multi-user detectors because Liu explains that "as will be appreciated by one of ordinary skill in the art, any number of multi-user decoders may be used in accordance with the present invention." EX1007, [0028].

Claim [10f]: a bank of decoders coupled to said plurality of low complexity processed information streams, said plurality of medium complexity processed information streams, and said plurality of high complexity processed information streams, wherein said decoders output a plurality of refined information streams.

249. Mills discloses and renders obvious Elements [1d] for at least the same reasons that I addressed above in connection with Ground 2A (§VIII.C) at Elements [1d]. *See supra*, Element [1d]. In the predictable Mills-Liu-Sampath combination, the *low, medium and high complexity processed information streams* would each be coupled to a *bank of decoders* because Mills explains that the bank of single decoders 16 is coupled to MUD 14 and Sampath explains that demodulators 304, 308, 312 are coupled to turbo decoder bank 320. EX1004, [0028]-[0039], FIG. 1; EX1006, [0041], [0042], [0047], [0048], FIG. 4; *supra*, §VII.I.

Claim [13]: The hybrid receiver according to claim 10, wherein said multi-user detector decision unit makes a selection determined by design criteria based upon at least one threshold selected from at least one of the group consisting of number of symbols, correlation matrix between users, expected bit error rate, eigendecomposition of correlation matrix, signal to interference plus noise ratio, and expected SINR.

250. The Mills-Liu-Sampath combination provides Claim [13] for at least the same reasons that I addressed above in connection with Ground 2A (§VIII.C) at Claim [13]. *See supra*, Ground 2A (§VIII.C) at Claim [13]. Furthermore, as I described in my analysis of Ground 1B (§VIII.B) at Elements [1b]-[1c] and Claim [3], *supra*, it is clear that Sampath describes a demodulator selector 316 representing a ***multi-user detector decision unit*** that a metric to determine a ***selected multi-user detector***, the metric based upon ***at least one threshold*** selected from a group including ***expected SINR***. EX1006, [0039], [0041], [0043], Cls. 8, 9, 13, 14, 23, 24. Therefore, the Mills-Liu-Sampath combination provides a ***multi-user detector decision unit*** that uses ***decision criteria*** based upon at least one of a group that includes ***expected SINR***. *Supra*, §VII.I.

Claims [11], [12], [15], and [16]

Claim [11]: The hybrid receiver according to claim 10, further comprising a front end section coupled to said received signals and to said received signal information which filters said received signals.

Claim [12]: The hybrid receiver according to claim 10, wherein said plurality of refined information streams are fed back to said multi-user detector decision unit for iterative processing until a final condition is reached and said bank of error correction decoders output a final plurality of bit streams.

Claim [15]: The hybrid receiver according to claim 12, wherein said final condition is one of a fixed number of iterations and an allowable performance level.

Claim [16]: The hybrid receiver according to claim 10, further comprising a hard decision unit coupled to said bank of decoders and producing a final data stream.

251. The Mills-Liu-Sampath combination renders obvious Claims [11], [12], [15], and [16] for at least the same reasons that I addressed above in connection with Ground 2A (§VIII.C) at Claims [11], [12], [15], and [16]. *See supra*, Ground 2A (§VIII.C) at Claims [11], [12], [15], and [16].

IX. CONCLUSION

252. For all the reasons I have noted in the foregoing paragraphs, claims 1-3, 5-13, and 15-17 of the '492 patent are obvious in view of the references discussed above.

253. I currently hold the opinions set expressed in this declaration. But my analysis may continue, and I may acquire additional information and/or attain supplemental insights that may result in added observations.

APPENDIX A

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

psm@wustl.edu
+1 (314) 853-6200 (phone)

Campus Box 1223
Academy Building Room 218A
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 2021, Tel Aviv, November 2021.
- Technical Program Committee, COMCAS 2019, Tel Aviv, November 2019.
- Technical Program Committee, COMCAS 2017, 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.
- Member, Eta Kappa Nu (Honor Society for Electrical Engineers), inducted in 1992
- 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>
10,623,323	04/14/20	Network Devices and a Method for Signature Pattern Detection
10,284,476	05/07/19	Hierarchical Pattern Matching Devices and Methods

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
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- 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).
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- 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.
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- Hung, C.P. and Min, P.S., “Performance evaluation of distributed application virtualization services using the UMTS mobility model,” *MOBILITY 2011 The First International Conference on Mobile Services, Resources, and Users*, 23-29 Oct. 2011.
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Testimony Provided or Expected to Provide as Expert Witness

Matter: Patent Infringement for Wireless Local Area Networks
Law Firm: Quinn Emanuel Urquhard & Sullivan LLP

Case Name: Certain Audio Players and Components thereof (II). U.S.I.T.C. Inv. No. 337-TA-1330.

Testifying Expert for Google Inc.

Completed in June 2023.

(Expert reports submitted and deposited.)

Matter: Patent Infringement for Wireless Communications

Law Firm: Alston & Bird

Case Name: Atlas Global Technologies LLC v. ASUSTek Computers Inc. USDC WD TX
Civil Action No. 6:21-cv-820

Testifying Expert for ASUSTek

Completed in November 2023

(Expert report submitted.)

Matter: Patent Infringement for Wireless Communications

Law Firm: Perkins Coie

Case Name: Bell Northern Research, LLC v. HMD AMERICA, INC. et al., Case No.: 1:22-cv-22706-SCOLA/GOODMAN (S.D. Fla.)

Testifying Expert for HMD

Completed in December 2023

(Expert report submitted. Deposited.)

Matter: Patent Infringement for Wireless Communications

Law Firm: LAW OFFICES S. J. CHRISTINE YANG

Case Name: Atlas Global Technologies LLC v. ZyXEL Communications Corp. et al.,
U.S.D.C., W.D.T.X., Waco Div., Case No. 6:22-cv-00355 Atlas Global
Technologies LLC v. D-Link Corp. U.S.D.C., W.D.T.X., Waco Div., Case No.
6:22-cv-00520

Testifying Expert for ZyXel

Retained in March 2023.

(Expert report submitted.)

Matter: Patent Infringement for Wireless Communications

Law Firm: Finnegan, Henderson, Farabow, Garrett & Dunner, LLP

Case Name: Bell Northern Research v. MeidaTek Inc.

Testifying Expert for MediaTek Inc.

Retained in August 2023.

Matter: Patent Infringement for Home Security System

Law Firm: Foley and Lardner LLP

Case Name: Alarm.com v. Vivint, Inc., AAA Arbitration Case. No. 01-22-0004-5525 and
U.S.D.C. Case No. 2:23-cv-00004-JRG-RSP (E.D. Tex.),

Testifying Expert for Vivint, Inc.

Completed in 2023.

Matter: Patent Infringement for Wireless Communications and Electronics

Law Firm: Perkins Coie
Case Name: Bell Northern Research, LLC v. HMD AMERICA, INC. et al., Case No.: 1:22-cv-22706-SCOLA/GOODMAN (S.D. Fla.)
Testifying Expert for HMD
Completed in December 2023.

Matter: Patent Infringement for Network Switches
Law Firm: Charhon Callahan Robson & Garza, PLLC
Case Name: Sable Networks, Inc. and Sable IP, LLC v. CouldFlare, Inc. U.S.D.C. WD Tx
Case No. 6:21-cv-261
Testifying Expert for CloudFlare, Inc.
Completed in January 2024.
(Expert report submitted and deposited.)

Matter: Patent Infringement for Network Security
Law Firm: Fish and Richardson
Case Name: Finjan LLC v. Palo Alto Networks, Inc. – Case No. 4:14-cv-04908-PJH. USDC
ND CA, Oakland Division.
Testifying Expert for Finjan LLC.
Retained in September 2022.
(Expert report submitted and deposited.)

Matter: Patent Infringement for Network Management
Law Firm: Irell & Manella LLP
Case Name: SNMP Research, Inc. & SNMP Research International, Inc. v. Broadcom Inc.,
Brocade Communications Systems LLC, & Extreme Networks, Inc. U.S.D.C.
E.D. Tennessee at Knoxville Case No. 3:20-CV-451
Testifying Expert for SNMP Research.
Retained in May 2022.

Matter: Inter Parte Reexamination for Wireless Communications
Law Firm: Finnegan, Henderson, Farabow, Garrett & Dunner, LLP
Case Name: Patent reexamination in front of the U.S.P.T.O.
Testifying Expert for MediaTek
Retained in March 2023.

Matter: Patent Infringement for Network Switching
Law Firm: Baker Botts
Case Name: Corrigent Corp. v. Arista Networks, Inc., Case No. 1:22-cv-00497-UNA. USDC
Delaware
Testifying Expert for Arista
Retained in October 2022.

Matter: Patent Infringement for Mobile Devices
Law Firm: Fish and Richardson
Case Name: GComm v. Samsung, U.S.D.C. ED. TX. Case No.:2:22-cv-0078-JRG

Testifying Expert for Samsung
Completed in January 2024.

Matter: Patent Infringement for Wireless Networks
Law Firm: McKool Smith
Case Name: Certain Mobile Telephones, Tablet Computers with Cellular Connectivity, and Smart Watches with Cellular Connectivity, Components Thereof, and Products Containing Same. U.S.I.T.C. Inv. No. 337-TA-1299
Testifying Expert for Ericsson
Completed in July 2022.
(Expert report submitted and deposed.)

Matter: Patent Infringement for Semiconductor Manufacturing
Law Firm: Kramer Levin
Case Name: Oasis Tooling, Inc. v. Siemens Indus. Software, Inc., 1:22-cv-151 (D. Del.), Oasis Tooling, Inc. v. GlobalFoundries U.S. Inc., 1:22-cv-312 (D. Del.)
Testifying Expert for Oasis Tooling
Retained in June 2022.
(Expert reports submitted.)

Matter: Patent Infringement for Optical Networks
Law Firm: Duane Morris
Case Name: NextGen Innovations, LLC v. Infinera Corporation. U.S.D.C. ED. TX (Marshall)
Case No. 2:22-cv-00306-JRG-RSP / IPR
Testifying Expert for Infinera
Retained in April 2023.

Matter: Patent Infringement for Wireless Devices
Law Firm: King and Spalding LLP
Case Name: Intellectual Ventures, et. al. v. General Motors Company and General Company Motors, LLC, Case No. 6:21-CV-1088 pending in the Western District of Texas, Waco Division
Testifying Expert for General Motors
Completed in January 2023.
(Expert report submitted.)

Matter: Patent Infringement for Wireless Devices
Law Firm: Sterne Kessler
Case Name: Neo Wireless LLC v. Volkswagen Group of America, Inc. and Volkswagen Group of America Chattanooga Operations, LLC and related matters
Testifying Expert for Volkswagen
Completed in September 2023.
(Expert report submitted and deposed. IPR declarations submitted)

Matter: Patent Infringement for Wireless Networks
Law Firm: Covington & Burling LLP

Case Name: XR Communications, LLC v. D-Link Systems, Inc., No. 8:17-cv-00596
(Consolidated) (C.D. Cal.)
Testifying Expert for Hewlett Packard Enterprise
Completed
(Expert report submitted and deposited.)

Matter: Patent Infringement for USB Charging System
Law Firm: Orrick, Herrington & Sutcliffe LLP
Case Name: Fundamental Innovation Systems International LLC v. TCT Mobile (US), TCT
Mobile (US) Holdings, Inc., et al. U.S.D.C. Delaware No. 20-552-RGA-CJB
Testifying Expert for TCL
Completed in June 2022.
(Expert report submitted and deposited.)

Matter: Inter Parte Reexamination for Wireless Communications
Law Firm: Alston & Bird
Case Name: Patent reexamination in front of the U.S.P.T.O.
Testifying Expert for Nokia
Retained in May 2022.
(Expert report submitted.)

Matter: Patent Infringement for Network Management System
Law Firm: Morgan, Lewis & Bockius, LLP
Case Name: Certain Routers, Access Points, Controllers, Network Management Devices,
Other Networking Products, and Hardware and Software Components Thereof,
U.S.I.T.C. Inv. No. 337-TA-1227
Testifying Expert for Hewlett Packard, Netgear, and CommScope
Completed in August 2021.
(Expert report submitted, deposited, and testified during trial.)

Matter: Patent Infringement for Security Systems
Law Firm: Forley and Lardner LLP
Case Name: Certain Residential Premises Security Monitoring and Automation Control
Panels, and Components Thereof (ITC Inv. No. 337-TA-1273) and ADT LLC et
al v. Vivint, Inc., Case No. 6:21-cv-00687 (W.D. Tex.)
Testifying Expert for Vivint, Inc.
Completed in April 2022.
(Expert report submitted, deposited, and testified during trial.)

Matter: Inter Parte Reexamination for Internet Communications
Law Firm: Perkins Coie
Case Name: Patent reexamination in front of the U.S.P.T.O.
Testifying Expert for Twitter
Retained in June 2020.
(Expert report submitted.)

- Law Firm: Fisher Broyles
Case Name: Vaxcel International Co., Ltd. v. Heathco LLC, U.S.D.C. Delaware No. 20-224-LPS
Testifying Expert for Vaxcel
Retained in February 2021.
(Expert report submitted and deposed.)
- Matter: Patent Infringement for Network Communication System
Law Firm: Charhon Callahan Robson & Garza, PLLC
Case Name: Sable Networks, Inc. and Sable IP, LLC, v. ClouFlare, Inc. U.S.D.C. WDTX, Civil Action No. 6:21-cv-261
Testifying Expert for CloudFlare, Inc.,
Completed in January 2024.
- Matter: Patent Infringement for Mobile Wireless Device
Law Firm: Pearl Cohen
Case Name: In the Matter Of Certain UMTS And LTE Cellular Communications Modules And Products Containing The Same, U.S.I.T.C. Inv. No. 337-TA-1240
Testifying Expert for Telit Wireless Communication, Quectel, and Thales
Completed in March 2023.
(Expert reports submitted and deposed.)
- Matter: Transactional Taxes for Internet Application
Law Firm: Ryan Rapp & Underwood, PLC
Case Name: ADP, LLC v. Arizona Department of Revenue (TX2018-000246),
Testifying Expert for ADP, LLC.
Completed in June 2020.
(Expert report submitted.)
- Matter: Trade Secret Misappropriation in Digital Electronics
Law Firm: Goodwin Proctor LLP
Case Name: Guzik Technical Enterprises versus Keysight Technologies, Inc. Superior Court of the State of California for the County of Santa Clara, Case No.: 19CV355879
Testifying Expert for Keysight Technologies, Inc.
Retained in August 2020.
- Matter: Patent Infringement for Fiber Optic Devices
Law Firm: Cooley
Case Name: Certain High-Density Fiber Optic Equipment and Components Thereof, U.S.I.T.C. Inv. No. 337-TA-1194
Testifying Expert for AFL Communications, Panduit, FS.Com, Wirewerk, and Siemon
Completed in October 2020.
(Expert reports submitted, deposed, and testified during trial.)
- Matter: Patent Infringement for Optical Transport Networks

Law Firm: Venerble
Case Name: Huawei Technologies Co. Ltd v Verizon Communications, Inc., et. al., 2:20-cv-0030
Testifying Expert for Verizon.
Retained in March 2020.
(IPR declarations submitted.)

Matter: Patent Infringement for Lighting System
Law Firm: Fisher Broyles
Case Name: Vaxcel International Co., Ltd., v. Jasco Products Company, LLC., (Case No. USDC Western District of Oklahoma, 5:19-CV-00154-JD
Testifying Expert for Vaxcel.
Retained in August 2020.

Matter: Patent Infringement for Wireless Communication
Law Firm: McDermott Will & Emery
Case Name: Bell Northern Research LLC v. ZTE. (Case No. 3:18-cv-01786 - S.D. Cal)
Testifying Expert for ZTE.
Retained in July 2019.
(IPR declarations submitted.)

Matter: Patent Infringement for Wireless Communication
Law Firm: Jones Day
Case Name: Bell Northern Research LLC v. Kyocera Corp. (Case No. 3:18-cv-1785 - S.D. Cal)
Testifying Expert for Kyocera.
Completed in May 2019.
(Claim construction declaration submitted, and deposed.)

Matter: Patent Infringement for Electronic Payment Systems
Law Firm: Paul Hastings
Case Name: ID Tech Corp. v. Samsung Electronics Co., Ltd., et al. (Case No. No. 8:17-cv-1748-DOC-JDE (C.D. Cal))
Testifying Expert for Samsung.
Retained in January 2019.
(Expert reports submitted, and deposed.)

Matter: Patent Infringement for Internet Switching
Law Firm: Maynard Cooper
Case Name: Parity Networks, LLC v. Juniper Networks, Inc., Case No. 6:17-CV-00495-RWS-KNM (U.S.D.C.E.D. Tx.)
Testifying Expert for Juniper.
Retained in April 2018.
(IPR declarations submitted.)

Matter: Patent Infringement for Internet Switching

Law Firm: Morgan Lewis
Case Name: Parity Networks, LLC v. Hewlett Packard Enterprise Company, Case No. 6:17-CV-00682 (U.S.D.C.E.D. Tx.)
Testifying Expert for Hewlett Packard Enterprise Company.
Retained in September 2018.
(IPR declarations submitted.)

Matter: Inter Parte Examination for Covered Business Method
Law Firm: Reed Smith LLP
Case Name: NASDAQ v. Miami International
Expert for Miami International.
Retained in February 2018.
(Expert declarations submitted, and deposited.)

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.
Completed in April 2019.
(Expert reports submitted, and deposited.)

Matter: Patent Infringement for Communication Devices
Law Firm: Venable
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.
Completed in September 2017.
(Expert reports submitted, and deposited.)

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.
Completed in March 2019.
(Expert reports submitted, and deposited.)

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.
Completed in October 2018.
(Expert reports submitted, and deposited.)

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 deposed.)

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 deposed.)

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, deposed, 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, deposed, 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 deposed.)

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, deposited, 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 deposited.)

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 deposited.)

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, deposited, 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.)