

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

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Title: COMBINATIONAL HYBRID TURBO-MUD

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**PETITION FOR *INTER PARTES* REVIEW OF UNITED STATES PATENT  
NO. 7,593,492 PURSUANT TO 35 U.S.C. §§ 311–319, 37 C.F.R. § 42**

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**EXHIBITS**

|        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|--------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| EX1001 | U.S. Patent No. 7,593,492 to Robinson et al. (“the ’492 Patent”)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| EX1002 | Prosecution History of the ’492 Patent (“the Prosecution History”)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| EX1003 | Declaration of Dr. Paul S. Min                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| EX1004 | U.S. Publication No. 2004/0213360 (“McElwain”)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| EX1005 | International Publication No. WO2006/092090 (“Wang”)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| EX1006 | U.S. Publication No. 2007/0060061 (“Sampath”)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| EX1007 | U.S. Publication No. 2003/0193966 (“Mills”)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| EX1008 | U.S. Publication No. 2006/0188031 (“Liu”)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| EX1009 | Adaptive Modulation and Adaptive Antenna Array Assisted Network Performance of Multi-User Detection Aided UTRA-like FDD/CDMA Systems (2002), <i>available at</i> <a href="https://eprints.soton.ac.uk/257148/1/jsb-lh-vtcfall-2002.pdf">https://eprints.soton.ac.uk/257148/1/jsb-lh-vtcfall-2002.pdf</a>                                                                                                                                                                                                                                                                                                                                                                          |
| EX1010 | Single- and Multi-Carrier CDMA: Multi-User Detection, Space-Time Spreading, Synchronization and Standards (2003), <i>available at</i> <a href="https://eprints.soton.ac.uk/258485/3/sample-chaps1%252C2%252C9%252C17_singlepdf.pdf">https://eprints.soton.ac.uk/258485/3/sample-chaps1%252C2%252C9%252C17_singlepdf.pdf</a>                                                                                                                                                                                                                                                                                                                                                       |
| EX1011 | U.S. Publication No. 2002/0037061 (“Learned”)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| EX1012 | Adaptive Symbol and Parameter Estimation in Asynchronous Multiuser CDMA Detectors (1997), <i>available at</i> <a href="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">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</a> |

- EX1013      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>
- EX1014      Multi-User Detection for DS-CDMA Communications (1996), *available at* [http://cs-www.cs.yale.edu/homes/yyr/readings/wireless/wireless\\_readings/article16.pdf](http://cs-www.cs.yale.edu/homes/yyr/readings/wireless/wireless_readings/article16.pdf)
- EX1015      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>
- EX1016      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>
- EX1017      An Iterative Multiuser Receiver Using Partial Parallel Interference Cancellation for Turbo-Coded DS-CDMA Systems (2004), *available at* <https://ieeexplore.ieee.org/document/965116>
- EX1018      A Low-Complexity Iterative Multiuser Receiver for Turbo-Coded DS-CDMA Systems (2001), *available at* <https://core.ac.uk/download/pdf/61613862.pdf>
- EX1019      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-](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

- EX1020      Iterative Multiuser Interference Reduction: Turbo CDMA (1999), *available at* [https://www.researchgate.net/publication/3159939\\_Iterative\\_Multiuser\\_Interference\\_Reduction\\_Turbo\\_CDMA](https://www.researchgate.net/publication/3159939_Iterative_Multiuser_Interference_Reduction_Turbo_CDMA)
- EX1021      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](https://www.researchgate.net/profile/Yvonne-Anne-Pignolet/publication/221628472_Complexity_in_geometric_SINR/links/544129930cf2a6a049a56308/Complexity-in-geometric-SINR.pdf)
- EX1022      The Eigen-decomposition: Eigenvalues and Eigenvectors (2007), *available at* <https://malabdali.com/wp-content/uploads/2023/10/Abdi-EVD2007-pretty.pdf>
- EX1023      Harville, *Matrix Algebra From a Statistician's Perspective* (1997)
- EX1024      Direction of Arrival Estimation Using the Parameterized Spatial Correlation Matrix (2007), *available at* [https://www.wirelesslab.ca/File/pdf\\_files/journals/J015.pdf](https://www.wirelesslab.ca/File/pdf_files/journals/J015.pdf)
- EX1025      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>
- EX1026-1099      RESERVED
- EX1100      Claim Construction Order in *Collision Communications, Inc. v. Nokia Networks and Solutions Oy et al.*, 2-21-cv-00308 (EDTX) (Aug. 31, 2022)

- EX1101      *Samsung Electronics America, Inc. v. Collision Communications, Inc.*, Case No IPR2024-01247, Paper No. 14 (PTAB Feb. 7, 2025)
- EX1102      Memorandum, Interim Processes for PTAB Workload Management, March 26, 2025, *available at* <https://www.uspto.gov/sites/default/files/documents/InterimProcesses-PTABWorkloadMgmt-20250326.pdf>
- EX1103      Patent Trial and Appeal Board (PTAB) Boardside Chat: Interim processes relating to institution in AIA proceedings, April 17, 2025, *available at* [https://www.uspto.gov/sites/default/files/documents/boardside\\_chat\\_interim\\_process\\_for\\_aia\\_institution\\_decisions\\_.pdf](https://www.uspto.gov/sites/default/files/documents/boardside_chat_interim_process_for_aia_institution_decisions_.pdf)

## LISTING OF CLAIMS

| <u>Claim Element</u> | <u>Language</u>                                                                                                                                                                                                                                                                                                                                                                |
|----------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| [1pre]               | A hybrid Multi-User Detector System for processing received signals, comprising:                                                                                                                                                                                                                                                                                               |
| [1a]                 | a parameter estimator coupled to said received signals providing received data information;                                                                                                                                                                                                                                                                                    |
| [1b]                 | a multi-user detector decision unit coupled to said parameter estimator and said received signals;                                                                                                                                                                                                                                                                             |
| [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; |
| [1d]                 | a bank of decoders coupled to said plurality of information streams, wherein said decoders output a plurality of improved information streams.                                                                                                                                                                                                                                 |
| [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.                                                                                                                                         |
| [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.                                    |
| [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.                                                                  |

| <b><u>Claim Element</u></b> | <b><u>Language</u></b>                                                                                                                                                                                                           |
|-----------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| [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.                                                            |
| [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.                                                                           |
| [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.                                               |
| [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.                                                                                     |
| [10pre]                     | A hybrid receiver for processing a plurality of received signals, said receiver comprising:                                                                                                                                      |
| [10a]                       | a parameter estimation unit coupled to said received signals, wherein said parameter estimation unit extracts received signal information;                                                                                       |
| [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;               |
| [10c]                       | 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;          |
| [10d]                       | 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; |
| [10e]                       | 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   |

| <b><u>Claim Element</u></b> | <b><u>Language</u></b>                                                                                                                                                                                                                                                                                                                                                                                                |
|-----------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| [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.                                                                                                        |
| [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.                                                                                                                                                                                                                       |
| [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.                                                                                                               |
| [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. |
| [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.                                                                                                                                                                                                                                                                    |
| [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.                                                                                                                                                                                                                                                                |
| [17pre]                     | A method for processing signals from multiple users with raw digitized data, comprising:                                                                                                                                                                                                                                                                                                                              |
| [17a]                       | performing parameter estimation of said raw digitized data;                                                                                                                                                                                                                                                                                                                                                           |
| [17b]                       | grabbing a window of bits from said raw digitized data;                                                                                                                                                                                                                                                                                                                                                               |
| [17c]                       | subtracting any known bits from said window of bits;                                                                                                                                                                                                                                                                                                                                                                  |
| [17d]                       | selecting a multi-user detector;                                                                                                                                                                                                                                                                                                                                                                                      |
| [17e]                       | estimating unknown bits from said window of bits using said multi-user detector;                                                                                                                                                                                                                                                                                                                                      |

| <b><u>Claim Element</u></b> | <b><u>Language</u></b>                                                                                                                                |
|-----------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|
| [17f]                       | incrementing to a next window of bits;                                                                                                                |
| [17g]                       | repeating said steps of subtracting, selecting, estimating and incrementing until there are no more windows and outputting a set of symbol estimates. |

Petitioners Lenovo (United States) Inc. (“Lenovo”) and Motorola Mobility LLC (“Motorola”) (collectively “Petitioners”) petition for *Inter Partes* Review (“IPR”) of claims 1-3, 5-13, and 15-17 of U.S. Patent No. 7,593,492 (“the ’492 Patent”).

## **I. REQUIREMENTS FOR IPR**

### **A. Grounds for Standing**

Petitioners certify that the ’492 Patent is available for IPR, and Petitioners are not barred or estopped from requesting IPR.

### **B. Challenge and Relief Requested**

Petitioners request IPR on grounds 1A-2B listed below. An expert declaration from Dr. Paul S. Min supports each ground. *See* EX1003.

| <b><u>Ground</u></b> | <b><u>Claims</u></b> | <b><u>Basis for Rejection</u></b> |
|----------------------|----------------------|-----------------------------------|
| 1A                   | 1-3, 5-13, 15-17     | §103 –McElwain-Wang               |
| 1B                   | 1-3, 5-13, 15-17     | §103 –McElwain-Sampath            |
| 2A                   | 1-3, 5-13, 15-17     | §103 –Mills-Liu                   |
| 2B                   | 10-13, 15, 16        | §103 –Mills-Liu-Sampath           |

The ’492 Patent was filed September 15, 2006 (“Critical Date”). Grounds 1A-2B rely on publications that all qualify as prior art under 35 U.S.C. §102 as shown below:

| <b><u>Reference</u></b> | <b><u>Filed</u></b> | <b><u>Published</u></b> | <b><u>Pre-AIA Prior Art Status</u></b> |
|-------------------------|---------------------|-------------------------|----------------------------------------|
| McElwain                | 04/25/2003          | 10/28/2004              | §102(a)-(b), (e)                       |
| Wang                    | 12/29/2005          | 09/08/2006              | §102(a), (e)                           |

|         |            |            |                  |
|---------|------------|------------|------------------|
| Sampath | 08/08/2006 | 03/15/2007 | §102(e)          |
| Mills   | 04/11/2002 | 10/16/2003 | §102(a)-(b), (e) |
| Liu     | 02/22/2005 | 08/24/2006 | §102(a), (e)     |

Here, all but one of the prior art publications in Grounds 1A-2B were published before the Critical Date, thereby qualifying as prior art under pre-AIA §102(a). The only exception—Sampath—has an effective filing date prior to the Critical Date and qualifies as prior art under pre-AIA §102(e).

## **II. SUMMARY OF THE '492 PATENT**

### **A. Brief Description**

Generally, the '492 Patent describes a multi-user detection (MUD<sup>1</sup>) system implemented in a cellular base station to recover signals received from multiple cellular devices (e.g., multiple users). EX1001, 1:19-51, Abstract, 7:6-28; EX1003, ¶42. Because these signals sometimes share the same frequency (e.g. in Code Division Multiple Access (CDMA) systems), the signals can interfere with each other. EX1001, 2:6-14, 3:20-42, 4:4-14. The '492 patent describes using a specialized MUD system to remove interference and isolate the signal associated with each user. EX1001, 3:54-5:44, 7:40-44, 11:57-12:51; EX1003, ¶42.

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<sup>1</sup> Consistent with the '492 Patent, "MUD" refers herein to multi-user/multiuser *detection* or multi-user/multiuser *detector*. EX1001, 1:20-23, 4:56-61, 10:4-12.

The '492 Patent acknowledges that MUD systems were generally known in the prior art. For example, the '492 Patent describes a prior art MUD system that cycles “raw input data” between a multi-user detector 20 and a bank of decoders 40 through multiple iterations reaching 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; EX1003, ¶43.

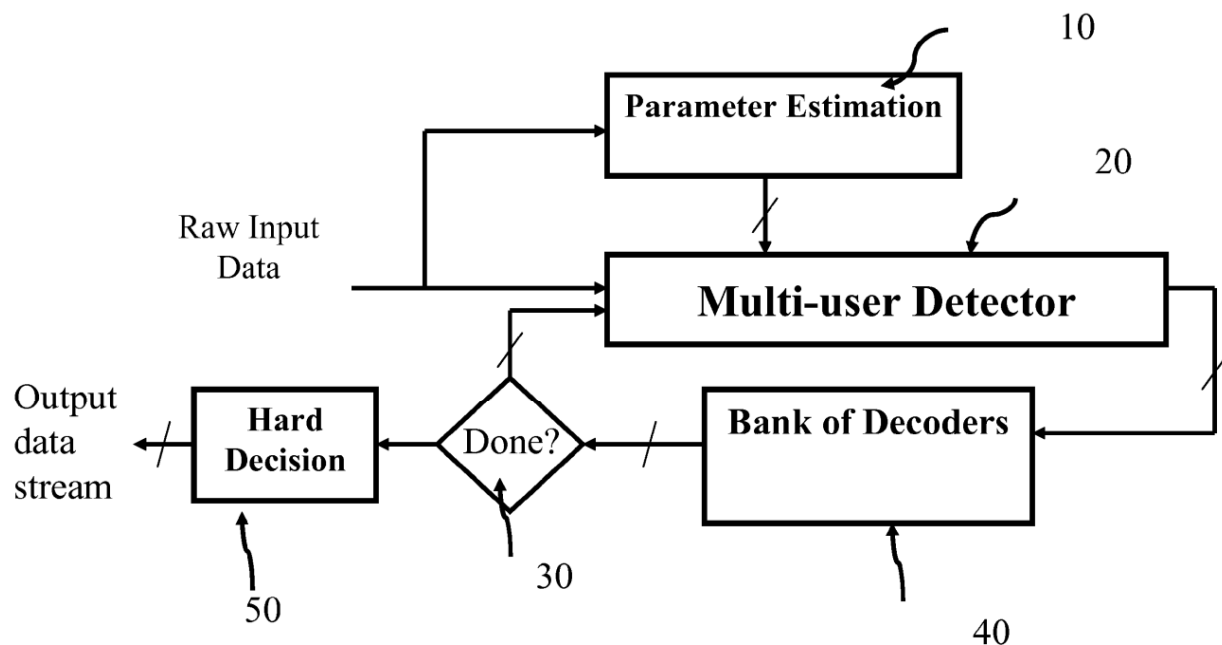


**Figure 1**  
**(Prior Art)**

EX1001, FIG. 1; *see id.*, 9:25-32 (iterative MUD procedures were “well known from published literature”). The '492 Patent acknowledges that “Prior Art” MUD system includes several elements recited in the claims of the '492 Patent, including:

- a parameter estimator (“parameter estimation unit 10,” 9:57-10:3),
- received signals (“many signals from many different transmitters,” 9:44-56),
- a bank of decoders (“bank of error correction decoders unit 40,” 10:13-11:10),
- a hard decision unit (“hard decision unit 50,” 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,” 10:47-50).

EX1001, 9:38-12:51; EX1003, ¶43. The purported point of novelty is instead “a multi-user detector decision unit” (“a MUD decision unit”) that can use specific “decision criteria to determine a selected multi-user detector” from a group of “at least two multi-user detectors.” EX1001, 12:52-67 (“decision block to choose the MUD”), 13:33-54 (“MUD decision unit 220”), FIG. 2; EX1003, ¶44. Figure 2 depicts the “MUD decision unit” and the “at least two” MUDs:

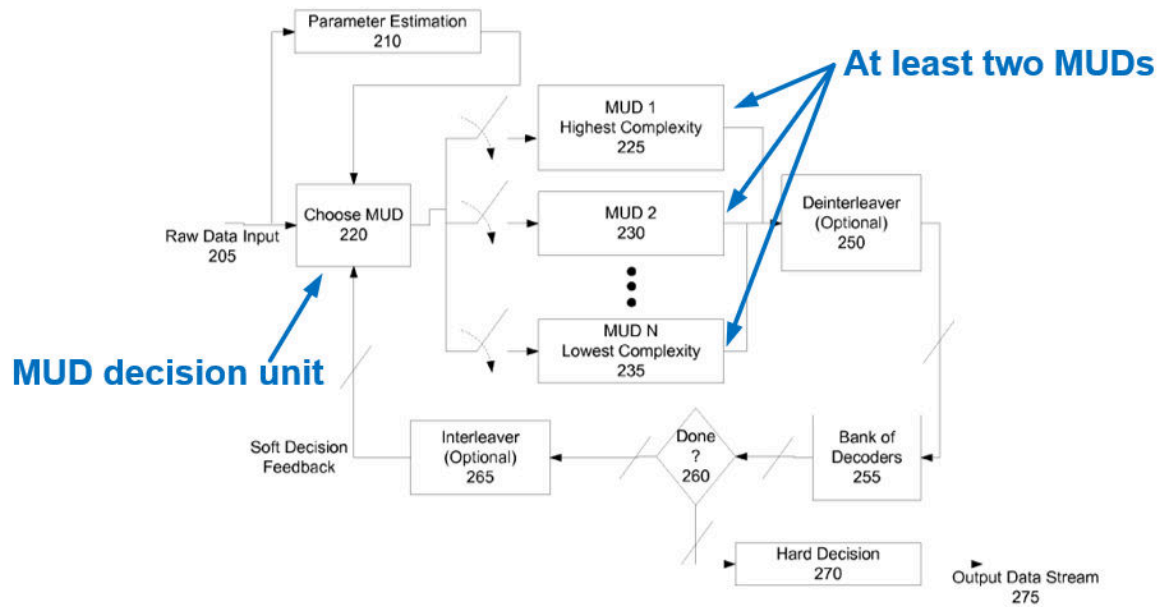


Figure 2

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

## B. Prosecution History

The '492 Patent issued after a brief prosecution that included no prior art rejections. *See, generally*, EX1002. In the reasons for allowance, the Examiner stated 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. However, this purported point of novelty was well-known in the art, e.g., as taught by Wang, Sampath, and Liu, which the Examiner did not consider. *Infra*, §V; EX1003, ¶45.

## III. LEVEL OF ORDINARY SKILL

A person of ordinary skill in the art at the Critical Date (“POSITA”) 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. EX1003, ¶33-38. More education can supplement practical experience and vice versa. EX1003, ¶33-38.

#### IV. CLAIM CONSTRUCTION

All claim terms should be construed according to the *Phillips* standard.

*Phillips v. AWH Corp.*, 415 F.3d 1303 (Fed. Cir. 2005); 37 C.F.R. §42.100.

Petitioners submit that other than the claim terms identified below, no claim term needs a formal construction for purposes of resolving controversies in this proceeding, especially in light of the noticeable overlap between the preferred embodiment of the '492 Patent and the prior art/predictable combinations articulated in Grounds 1A-2B. *Wellman, Inc. v. Eastman Chem. Co.*, 642 F.3d 1355, 1361 (Fed. Cir. 2011); *Google Inc. v. Intellectual Ventures II LLC*, 701 Fed. Appx. 946, 956 (Fed. Cir. 2017); EX1003, ¶39. A Federal District Court previously construed the element identified below in another litigation involving the '492 Patent. EX1100, 65-74.

##### A. A “multi-user detector decision unit” (claims 1 and 10)

The Court previously held that a “multi-user detector decision unit” that uses “decision criteria” to “determine a selected multi-user detector” recited by claim 10 is a means-plus-function term that must be interpreted under 35 U.S.C. §112, sixth

paragraph. EX1100, 72-74; EX1003, ¶40-41. 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: “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.

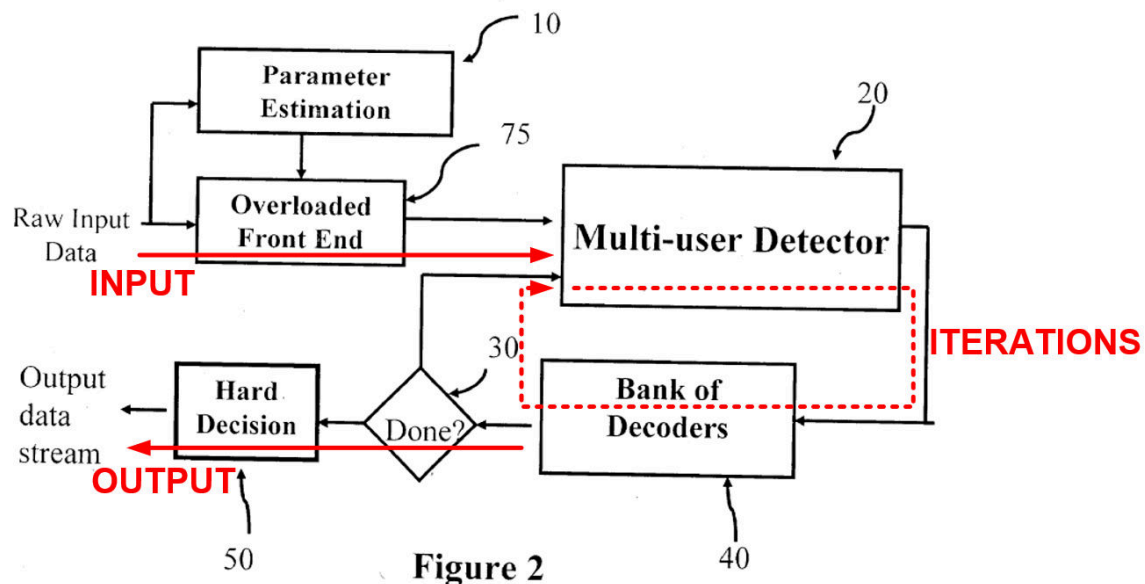
The Board in an earlier-filed petition, filed by another petitioner, found the District Court’s claim construction analysis of claim 1 to be persuasive and also made a similar construction of “multi-user detector decision unit” in claim 10, further in view of an agreement by the parties on claim construction. EX1101, 10-12. If the Board maintains the earlier construction here, per 37 C.F.R. §42.104(b)(3), Petitioners identify the “specific portions of the specification” that purportedly describe structures that correspond to the recited function of the element below. *Infra*, §V (Grounds 1A-2B). The analysis and prior art mapping presented herein apply regardless of whether §112, sixth paragraph is deemed to apply. EX1003, ¶40-41.

## V. THE CHALLENGED CLAIMS ARE UNPATENTABLE

### A. GROUND 1A: McElwain-Wang renders obvious claims 1-3, 5-13, and 15-17

#### 1. McElwain

Like the '492 Patent, McElwain discloses a cellular base station with a MUD system that removes interference from “raw input data” including signals from multiple users of a cellular network. EX1004, [0007], [0048]-[0064], [0073]-[0096], FIGS. 1-2; EX1003, ¶46. A MUD unit 20 can generate “a bit (or symbol) stream associated with each interfering [signal] present on the channel.” EX1004, [0084]; *see id.*, [0093], FIG. 2. These bit streams are passed to a bank of decoders 40, which generate “soft outputs” that are fed back to MUD unit 20. EX1004, [0085]-[0087], [0093]-[0096], FIG. 2. This process repeats until a hard decision unit 50 generates an output data stream. *Id.*



EX1004, FIG. 2 (annotated).

McElwain acknowledges a tradeoff between more complex MUDs that produce accurate results but consume large amounts of computing resources and less complex MUDs that consume fewer resources but are also less accurate, especially when the input data is “overloaded” with large numbers of interfering user signals. EX1004, [0007], [0022], [0025]-[0028], [0033]-[0037]; EX1003, ¶47-48. McElwain therefore acknowledges the importance of balancing MUD complexity with resource consumption to ensure accurate outputs with manageable processing demands. EX1003, ¶47-48.

2. *Wang*

As with McElwain and the '492 Patent, Wang describes a cellular base station that uses a MUD system to remove interference from multiple received signals. EX1005, FIG. 1 (depicting a base station that receives multiple signals from multiple mobile devices), 1:11-7:14, 9:3-24, 10:18-21, 11:14-12:3, 13:28-15:21. Wang discloses techniques for selecting an appropriate MUD algorithm based on a 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; EX1003, ¶49.

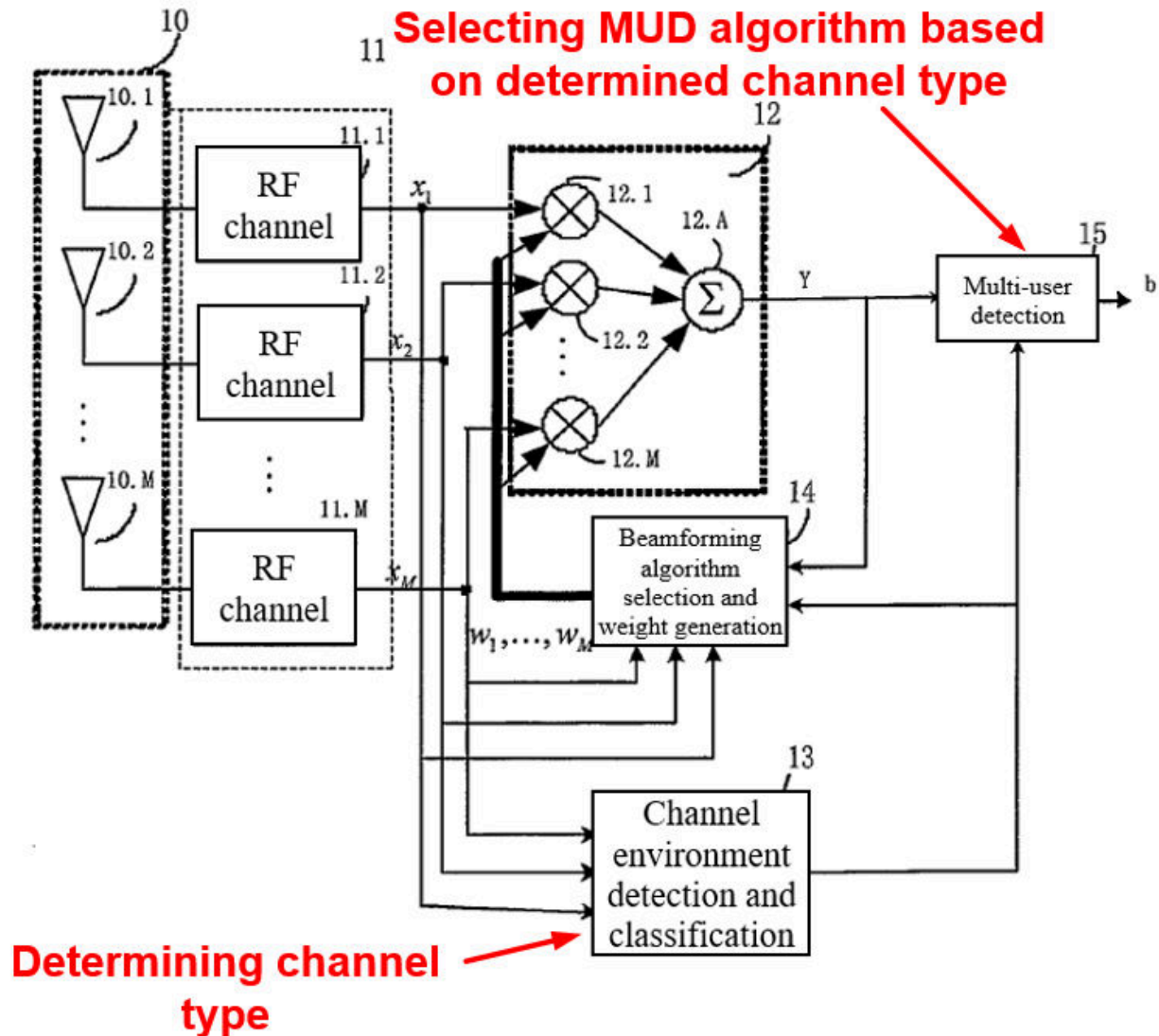


FIG. 2

EX1005, FIG. 2 (annotated).

Wang describes a process for determining a “channel type” based on interference characteristics of received signals and selecting a MUD algorithm having a complexity appropriate for the determined channel type. EX1005, 15:29-17:3, FIGS. 1, 4. More complex MUD algorithms are selected for greater interference and less complex MUD algorithms are selected for lesser interference.

EX1005, 9:7-30, 11:14-12:3, 16:14-17:3, FIG. 4; EX1003, ¶50-51. Wang therefore addresses the same accuracy/consumption tradeoff McElwain acknowledges.

EX1005, 10:22-12:3, 13:7-17, 15:29-17:3, Cls. 6, 7, FIGS. 2, 4; EX1003, ¶50-51.

### 3. *The McElwain-Wang Combination*

While McElwain does not expressly disclose a MUD decision unit that selects a MUD based on decision criteria, a POSITA would have been motivated to implement a system, per McElwain, to include MUD selection, per Wang, for multiple reasons. EX1004, [0048]-[0064], [0073]-[0096], FIGS. 1-2; *supra*, §V.A.1; EX1005, 10:22-12:3, 13:7-17, 15:29-17:3, FIGS. 2, 4; *supra*, §§V.A.1-V.A.2; EX1003, ¶52.

**First**, a POSITA implementing a MUD system, per McElwain would have incorporated 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, acknowledged by McElwain and Wang. EX1003, ¶53 (citing corroborating EX1013, 1). Based on McElwain's teaching, it was clear that channel overloading caused by large numbers of interfering signals could result in inaccurate MUD outputs, and a POSITA would have recognized from 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.

EX1003, ¶53.

**Second**, because the number of received signals and the interference level can change over time, a POSITA would have recognized benefits in dynamically changing MUDs in response to changing interference. EX1003, ¶54. For example, McElwain explains that MUD 20 processes raw input data according to a sequence of “data blocks” each representing a window of time, meaning that a POSITA would have been motivated to implement a MUD system, per McElwain, with MUD selection, per Wang, for each of the data blocks—allowing the system to change MUDs dynamically over time based on changing interference in the raw data. EX1004, [0087]-[0089], FIG. 2; EX1003, ¶54.

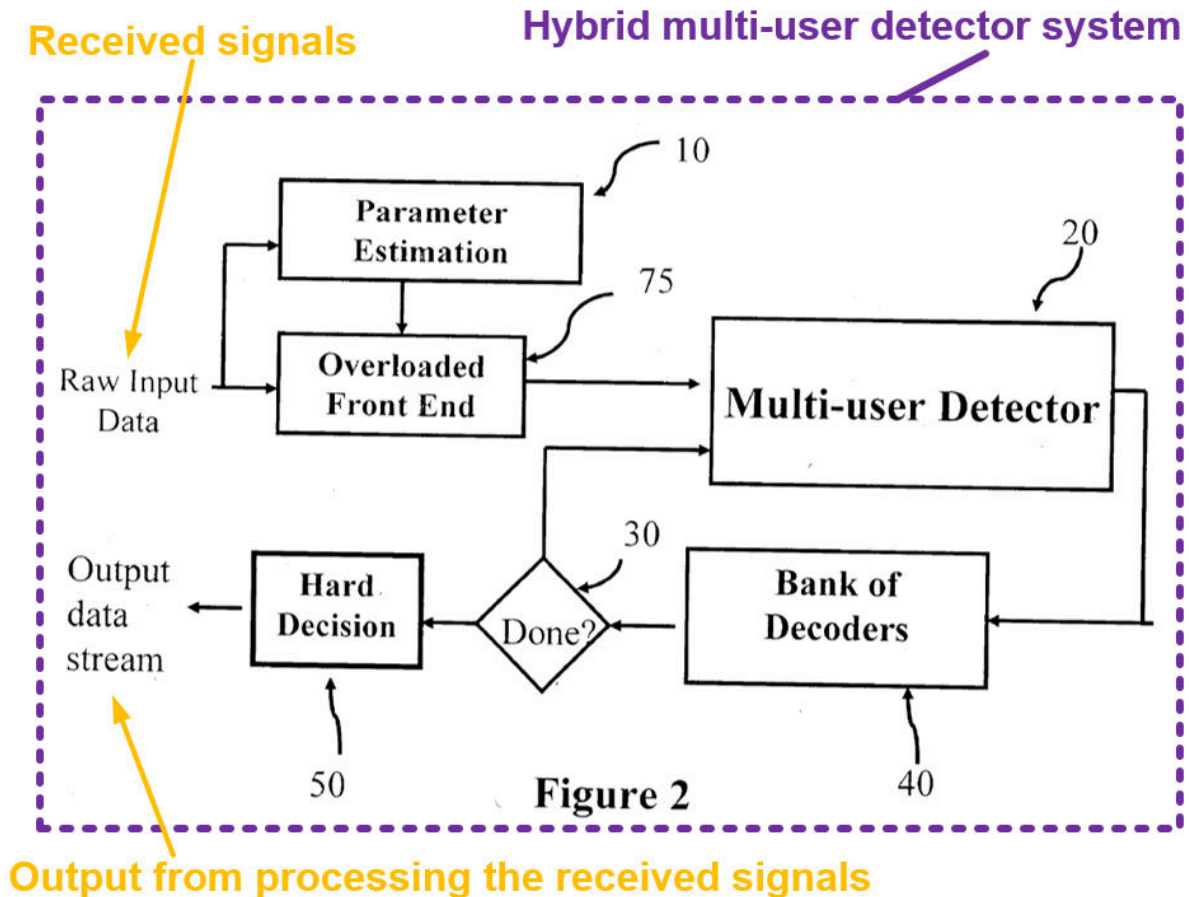
**Third**, performing an eigendecomposition of a correlation matrix of the raw data, per Wang, would have advantageously allowed the MUD system to identify interference characteristics of the raw input data in real time at a granular level, thus allowing the system to quickly select an appropriate MUD based on the real-time interference data. EX1003, ¶55. 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. EX1003, ¶55.

Finally, McElwain and Wang both describe base station receivers that remove interference from signals using MUDs. EX1003, ¶56. In this context, a POSITA would have possessed ample skill to successfully implement the combination. *KSR Int’l Co. v. Teleflex Inc.*, 550 U.S. 398, 417 (2007). 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. *KSR at 401*; EX1003, ¶56.

#### 4. *Claim-by-claim Analysis*

##### *[1pre]*

To the extent the preamble is limiting, the McElwain-Wang combination renders [1pre] obvious. EX1003, ¶82-83. For example, McElwain discloses a “**Hybrid Turbo-MUD**” *system* that can **receive** “raw input data.” EX1004, [0074], [0079]-[0080]; *see id.*, [0073], [0075]-[0078], [0090]-[0096], FIGS. 1-2. This raw input data includes multiple **received signals** “from many different transmitters.” EX1004, [0078]. The *system* includes a **MUD 20** and several other elements that **process** the **received signals**. EX1004, [0076]-[0096], FIGS. 1-2.



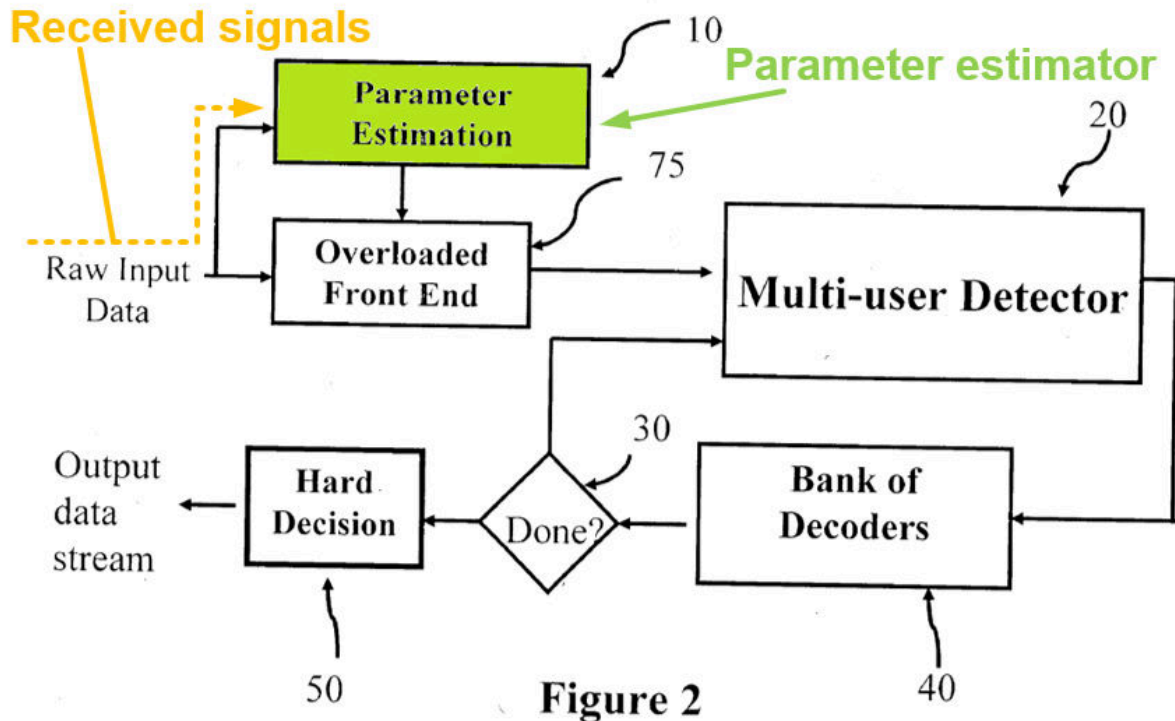
EX1004, FIG. 2 (annotated).

[1a]

The '492 Patent admits that the “parameter estimator” of [1a] was known in the prior art. EX1001, 9:57-10:3 (“parameter estimation unit is known in the art”); EX1003, ¶84 (citing EX1011, [0024]-[0035], EX1012). McElwain confirms this, disclosing a *parameter estimator* 10 that “processes the various parameters for the received raw data.” EX1004, [0080]; *see id.*, [0054], [0063], [0090], [0092], [0099], FIGS. 1-3. *Parameter estimator* 10 is *coupled* to the *received signals* because *parameter estimator* 10 directly receives the raw input data. EX1004,

FIG. 2; *see id.*, Cl. 1 (“parameter estimator coupled to a data stream”), [0099];

EX1003, ¶84.



EX1004, FIG. 2 (annotated).

McElwain explains that the *received signals* provide *received data information* indicating characteristics 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]; EX1003, ¶85-86.

[1b]

The McElwain-Wang combination includes a *MUD decision unit*. EX1003, ¶87-105; *supra*, §V.A.3. Wang describes a cellular base station receiver that

detects multiple *received signals* via an antenna array 10. EX1005, 13:7-14:11,

FIGS. 1-2. The receiver includes a channel environment detection and

classification module 13 that determines a “channel type” of the *received signals*

based on interference characteristics. EX1005, 7:26-8:22, 10:22-11:13, 13:7-24,

14:12-30, 15:12-21. Based on the determined channel type, a MUD module 15

selects “the appropriate multi-user detection algorithm” for processing the received

signals to remove interference. EX1005, 15:12-16; *see id.*, 11:14-12:3, 13:7-15:21,

FIG. 2; EX1003, ¶87-89.

**Received signals**

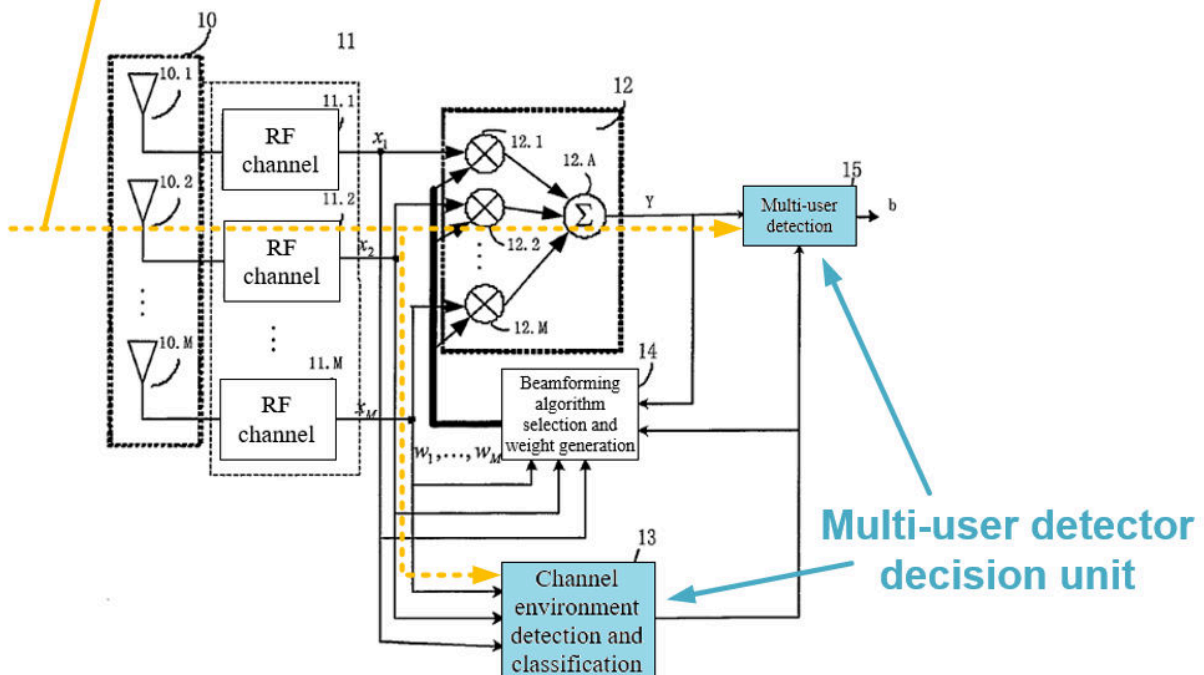


FIG. 2

EX1005, FIG. 2 (annotated).

Modules 13, 15 therefore represent a ***MUD decision unit*** that determines a channel type based on interference characteristics of ***received signals*** and selects a MUD algorithm based on the channel type. EX1005, 9:3-30, 10:18-12:3, 3:28-15:21, 19:7-22, Cls. 6, 8, FIG. 2; EX1003, ¶90. The ***MUD decision unit*** is ***coupled*** to the ***received signals*** because modules 13, 15 process the ***received signals*** to determine the channel type. EX1005, 14:21-30, 15:12-16; EX1003, ¶91.

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; EX1003, ¶92. For example, the '492 Patent explains that “taking the eigendecomposition of the correlation matrix” involves computing a correlation matrix, calculating eigenvalues and eigenvectors based on the correlation matrix, and “looking at all the eigenvalues that are above the noise floor.” EX1001, 14:7-18. The '492 Patent also explains that “[i]f 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,” “[i]f 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 eigenvector is above the noise floor then use a lower complexity MUD,”

and “[i]f the eigenvalues and eigenvectors of the correlation matrix do not have these characteristics then use the highest complexity MUD.” EX1001, 14:7-18.

Module 13 performs an *eigendecomposition* of *correlation matrix* to determine the channel type for selecting a MUD algorithm that involves each of the steps described by the ’492 Patent. EX1001, 14:7-18; EX1005, 10:22-11:13, 14:21-30, 15:29-17:3, FIGS. 2, 4; EX1003, ¶93. First, 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 id.*, 10:22-29, 13:18-24, 14:21-30, FIG. 4; EX1003, ¶94. Using this *correlation matrix*  $R$ , module 13 performs an *eigendecomposition* to identify one or more eigenvectors ( $V$ ) and calculate one or more eigenvalues ( $\lambda$ ) with respect to each eigenvector, meaning that the *eigendecomposition* performed by module 13 involves calculating both eigenvalues and eigenvectors just like the *eigendecomposition* of the ’492 Patent. EX1005, 16:2-4, FIG. 4; *cf.* EX1001, 14:7-18; EX1003, ¶95. These eigenvalues and eigenvectors are computed using the equation  $R \cdot V = \lambda \cdot V$ . EX1005, 16:2-4, FIG. 4.

Based on the one or more eigenvalues ( $\lambda$ ), module 13 determines a noise power ( $\sigma_N^2$ ) according to the equation  $\lambda_1 \geq \lambda_2 \geq \dots = \lambda_M = \sigma_N^2$ . EX1005, 16:5, 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. Comparing the

noise power to each eigenvalue, module 13 identifies “effective” eigenvalues according to the equation  $\lambda \geq \sigma_N^2 + \delta_\lambda$ , where  $\delta_\lambda$  is a specific parameter. EX1005, 16:5-9, FIG. 4. The process described by Wang of identifying eigenvalues greater than the noise power is the same as “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; EX1003, ¶96-99.

Module 13 determines a total number of effective eigenvalues associated with the correlation matrix for the received signals. EX1005, 16:5-9, FIG. 4. Based on the number of effective eigenvalues, module 13 determines a channel type of the *received signals*. EX1005, 16:14-29; EX1003, ¶100. Because the MUD module 15 selects an “appropriate multi-user detection algorithm” based on the channel type, the modules 13, 15 represent a ***MUD decision unit*** that performs an *eigendecomposition* of *correlation matrix* to select an appropriate MUD. EX1005, 15:12-16, 15:29-16:29. This algorithm for determining the number of effective eigenvalues is therefore the same algorithm described by the ’492 Patent for determining the *eigendecomposition* of the *correlation matrix*.

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; EX1003, ¶101. 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.

Therefore, 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), 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 its 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; EX1003, ¶102-103.

Furthermore, when more than 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), module 13 selects a higher 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; EX1003, ¶104.

Because Wang explains that module 13 selects a MUD algorithm based on parameters of the received signals, it would have been obvious for a POSITA to

implement the MUD system per McElwain so that *parameter estimator* 10 and the *received signals* are coupled to the *MUD decision unit*. EX1004, [0076]-[0096], FIGS. 1-2; EX1005, 15:29-16:16, FIG. 4; EX1003, ¶105, *supra*, §V.A.3.

[1c]

McElwain discloses a single MUD 20 that is *coupled* to a *parameter estimator* 10. EX1004, [0080]-[0085], [0090]-[0093], FIGS. 1-2; [1pre], [1b], *supra*; EX1003, ¶106. Even if McElwain does not expressly describe *at least two MUDs*, Wang provides this feature. EX1003, ¶107. For example, Wang describes several MUD algorithms—sometimes referred to as detection “methods”—that MUD module 15 uses to remove interference from *received signals*. EX1005, 9:7-30, 10:30-11:17, 19:8, Cls. 6, 8, 15-16; EX1003, ¶108. The MUD 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. These MUD 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, Cls. 6, 8; EX1003, ¶109.

Module 15 includes *at least two MUDs* each corresponding to one of the detection algorithms described by Wang. EX1005, 9:3-30, 11:14-12:3, 13:28-14:5,

15:12-21, 19:8-22, FIGS. 2, 4; EX1003, ¶110. For example, Wang discloses that module 15 is a hardware module in some embodiments. EX1005, 15:17-21. In these embodiments, module 15 uses dedicated hardware to apply each of the MUD algorithms, per Wang, because each of these the algorithms involves a different mathematical operation. EX1005, 15:17-21; EX1003, ¶111 (citing EX1014, 10, EX1015, 9).

As discussed for [1b], *supra*, it would have been obvious for a POSITA to implement the MUD system described by McElwain with a ***MUD decision unit*** that selects a MUD algorithm based on ***decision criteria*** (e.g., performing an ***eigendecomposition of correlation matrix***) as suggested by Wang. EX1003, ¶112, *supra*, §V.A.3. The McElwain-Wang combination therefore provides a ***MUD decision unit*** that uses ***decision criteria*** to determine a ***selected MUD*** from the ***at least two MUDs***. EX1005, 8:4-22, 9:3-30, 10:22-12:3, 14:21-30, 15:12-21; FIG. 2.

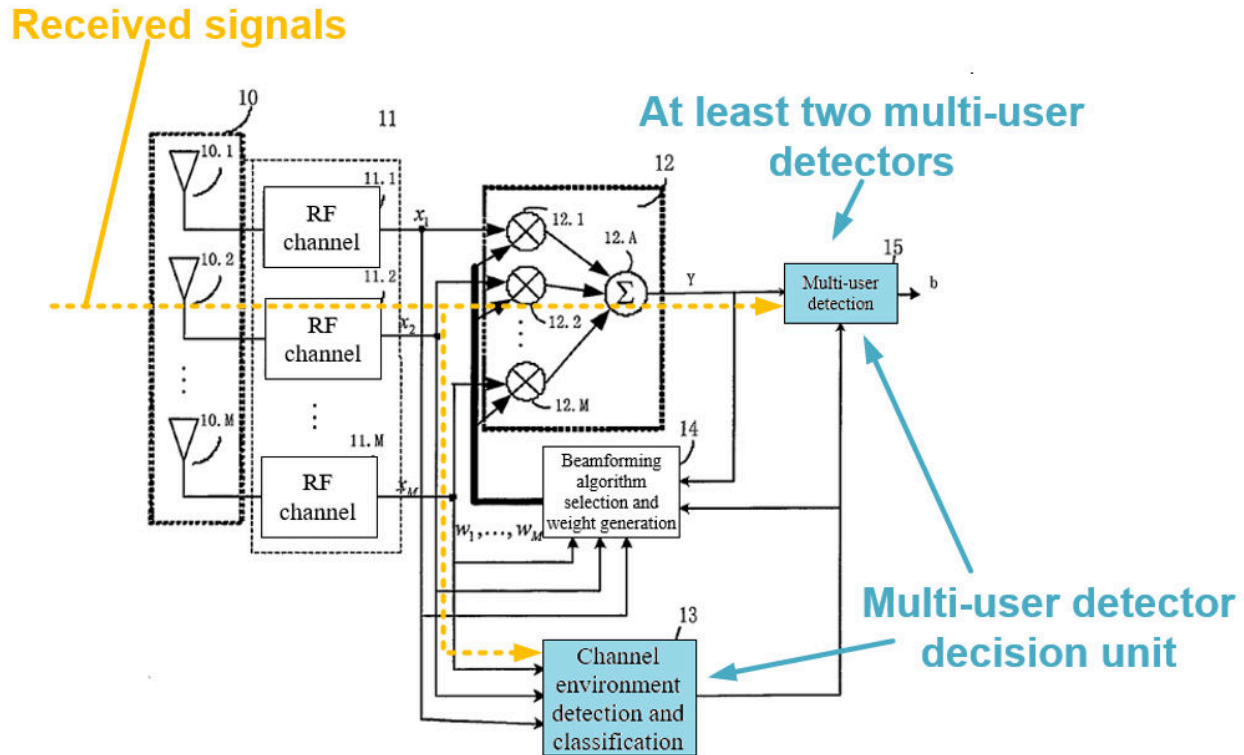


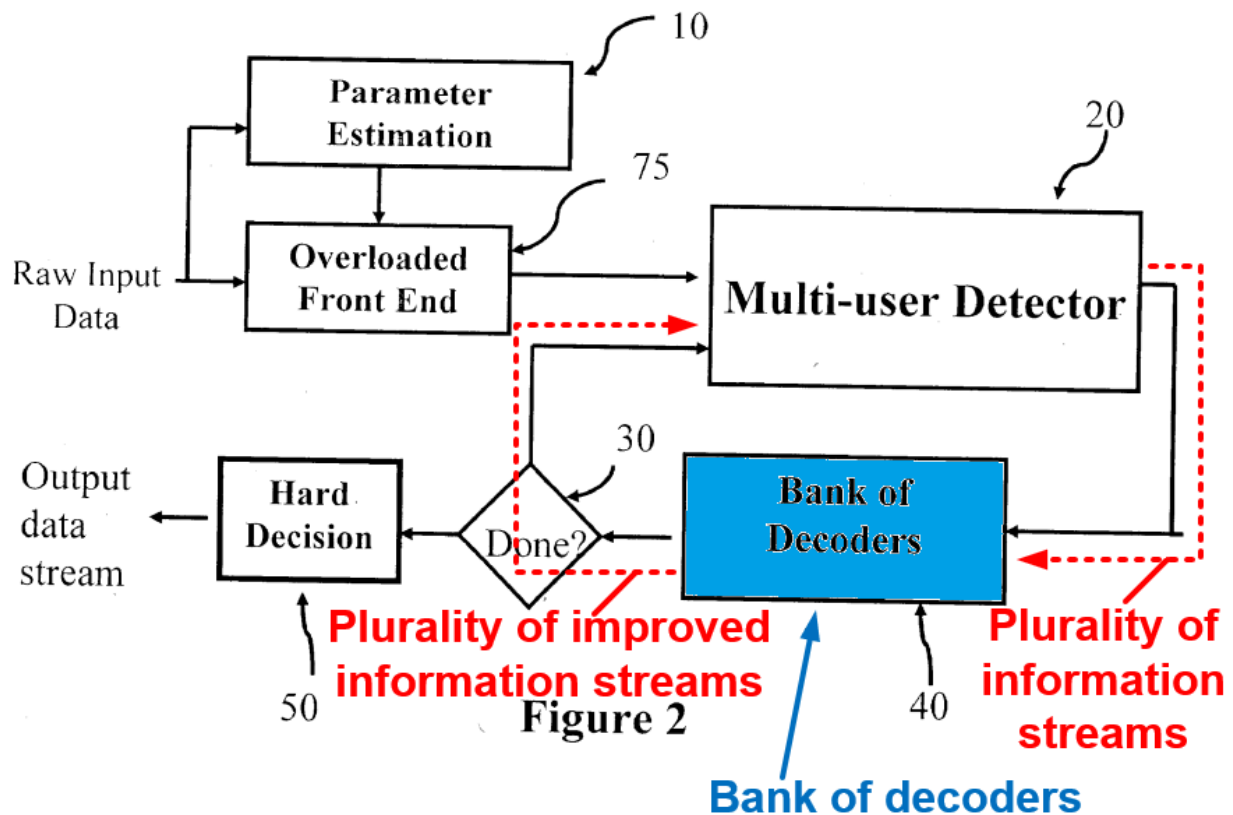
FIG. 2

EX1005, FIG. 2 (annotated).

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 id.*, [0093], FIGS. 1-2. Because McElwain discloses that MUD 20 is *coupled* to a *parameter estimator* 10, the *at least two MUDs* of the McElwain-Wang combination are therefore coupled to a *parameter estimator* and the *selected MUD* outputs a *plurality of information streams*. EX1004, [0080], [0084], [0090], [0093]; EX1003, ¶113; *supra*, §V.A.3.

[1d]

The '492 Patent admits that the “bank of decoders” of [1d] was known in the prior art. EX1001, 10:66-11:10, FIG. 1. McElwain confirms this by disclosing that a *bank of decoders* 40 are *coupled* to the *plurality of information streams* output by MUD 20. EX1004, [0081], [0083]-[0085], [0087]-[0089], [0093]-[0096], FIGS. 1-2. The McElwain-Wang combination therefore provides a *bank of decoders* 40 coupled to a *plurality of information streams* generated by a *selected MUD*. EX1004, [0076]-[0096], FIGS. 1-2; EX1005, 13:28-17:3, FIGS. 2, 4; *supra*, §V.A.3; EX1003, ¶114.

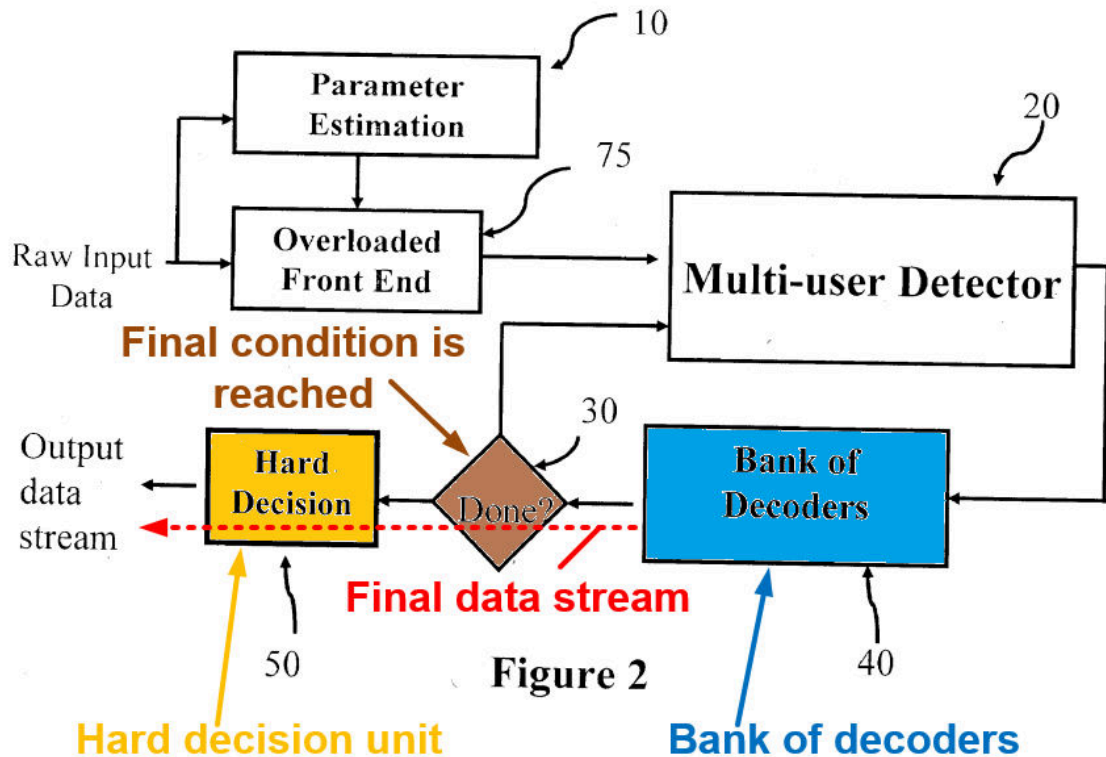


EX1004, FIG. 2 (annotated).

McElwain discloses that the *bank of decoders* 40 can generate a signal including “soft outputs for each bit of each user,” and that these soft outputs can be “fed back to the MUD 20 for each iteration.” EX1004, [0087]; *see id.*, [0095]; EX1003, ¶115. One result of this iterative process is “to calculate an *improved*, less corrupted bit stream for each user.” *Id.* Consequently, the *bank of decoders* 40 of the McElwain-Wang combination outputs a *plurality of improved information streams* just as the bank of decoders 40 described by the ’492 Patent generates improved bit streams. *Cf.* EX1001, 11:34-43; EX1003, ¶116.

[2]

In the McElwain-Wang combination, the *bank of decoders* 40 feeds the plurality of improved information streams back to the *MUD decision unit*, resulting in further improvements for each iteration. EX1004, [0088] (describing “changes to the data from the last iteration”); *see id.*, [0087], [0093]-[0096]; FIGS. 1-2; *supra*, §V.A.3; EX1003, ¶117. Specifically, McElwain 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 is reached.” EX1004, [0087]. Decision block 30 determines whether a *final condition is reached*, at which point the iterations conclude. EX1004, [0094] (“output of the decoders 40 is checked to determine if processing is completed”); *see id.*, [0088]-[0089], [0095]-[0096]; EX1003, ¶118.



EX1004, FIG. 2 (annotated).

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. EX1004, [0088]; *see id.*, [0089], [0094]-[0096], FIGS. 1-2; EX1003, ¶119. The process for using the *bank of decoders* 40 to output a *final data stream* when a *final condition is reached* is nearly identical to the process of the '492 Patent. *Cf.* EX1001, 11:44-56, 11:57-61; EX1003, ¶120. [3]

As described for [1b]-[1c], *supra*, the *MUD decision unit* of the McElwain-Wang combination is configured to determine a *selected MUD* of at *least two MUDs* based on *decision criteria* such as the *eigendecomposition* of a *correlation*

*matrix*. EX1005, 9:7-30, 10:18-12:3, 13:28-14:5, 15:12-16:13, 19:8-22, FIG. 2, FIG. 4; EX1003, ¶121-123. Specifically, module 13 applies *thresholds* to identify a channel type based on the *eigendecomposition* of the *correlation matrix*. EX1005, 14:21-30, 15:17-21, 16:14-17:3, 19:8-22, FIG. 4; *supra*, [1b]-[1c].

To determine the channel type, module 13 identifies a number of effective eigenvalues of a *correlation matrix* and compares the number of effective eigenvalues to a *threshold*. EX1005, 15:22- 17:3, FIG. 4. Furthermore, to identify these effective eigenvalues, module 13 compares each eigenvalue of the *correlation matrix* to a *threshold* noise power value ( $\sigma_N^2$ ). EX1005, 16:5, 16:7-9. Consequently, the McElwain-Wang combination provides a *MUD decision unit* that determines a *selected MUD* using *decision criteria*<sup>2</sup> based *on at least one threshold* relating to an *eigendecomposition* of *correlation matrix*. EX1003, ¶121-123; *supra*, §V.A.3.

[5]

Wang explains that MUD module 15 can apply multiple MUD algorithms including a “minimum mean square based multi-user detection method” and a

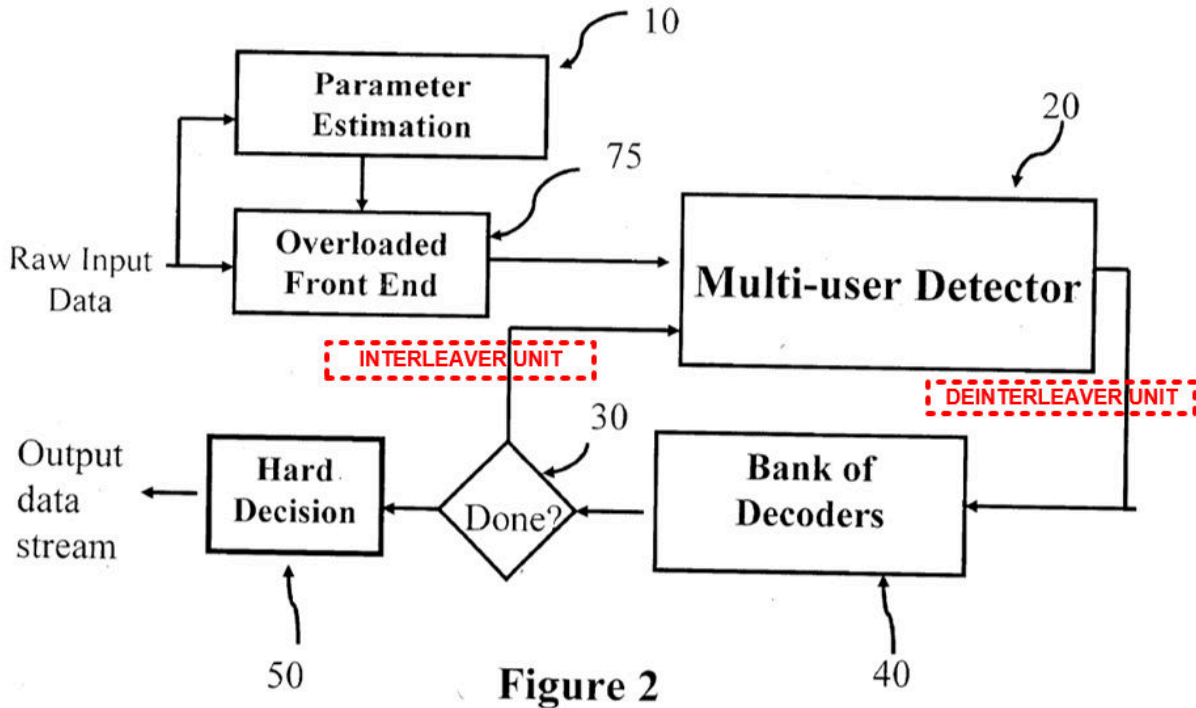
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<sup>2</sup> Claim 3 uses the term “design criteria,” whereas Claim 1 uses the term “decision criteria.” Petitioners interpret Claim 3 as referring to the “decision criteria” recited by claim 1.

“decorrelation detection method.” EX1005, 9:11-13, 11:18-21, 19:11-13, Cls. 6, 15; FIG. 2; *supra*, [1c]. The McElwain-Wang combination therefore includes *at least two MUDs* selected from a group including minimum *mean squared error (MMSE)* detectors and *decorrelator* detectors. EX1003, ¶124; *supra*, §V.A.3.

[6]

McElwain explains that in some embodiments, “[d]einterleavers and interleavers...are...coupled between the MUD 20 and the decoders 40.” EX1004, [0084]; *see id.*, [0093], Claim 14. This means that an *interleaver unit* and a *deinterleaver unit* can be coupled between the *bank of decoders* 40 and MUD 20. EX1003, ¶125-126. McElwain explains that “the reliability measures from the MUD 20 are first passed through a deinterleaver...and passed on in shuffled form to the decoder 40” and that an “interleaver unit performs interleaving” prior to signals being fed back into MUD 20. EX1004, [0084]; *see id.*, [0093], Claim 14.



EX1004, FIG. 2 (annotated).

Consequently, the McElwain-Wang combination provides an *interleaver unit* and a *deinterleaver unit* coupled between the bank of decoders 40 and *two or more MUDs*. EX1003, ¶127; *supra*, §V.A.3.

[7]

The McElwain-Wang combination provides a *bank of decoders* 40 that feed a *plurality of information streams* back into a *MUD decision unit* until a *final condition* is reached. EX1004, [0087]-[0088], [0094]-[0096], FIGS. 1-2; *supra*, [2]. These iterations can continue until a “*fixed number*” of iterations is reached. EX1004, [0087]-[0088], [0096]; *see id.*, [0089], [0094]-[0095], FIGS. 1-2, Cl. 12; EX1003, ¶128-130. In other embodiments, these iterations continue until an

*allowable performance level* is reached. EX1004, [0088] (“desired performance level is attained”); *see id.*, [0096], Cl. 13; EX1003, ¶128-130.

[8]

McElwain includes an overloaded front end 75 that is coupled to the *received signals* of the raw input data. EX1004, [0090]-[0091], [0095], [0097]-[0100], FIGS. 2-3; EX1003, ¶131-132. For example, the overloaded front end 75 includes a filter 120 that is *coupled* to the *received signals* of raw data 100 and the parameter estimation module 110. *Id.* Filter 120 includes “a whitening matched filter, whitened-M algorithm filter, or matched filter.” EX1004, [0099]; *see id.*, [0100], [0109], [0145], FIG. 3. Overloaded front end 75 also includes an “asynchronous whitener designer 130” and a “whitener unit 135” that both serve as filters. EX1004, [0099]-[0100], [0109], [0147]-[0150], [0152], [0154], FIG. 3.

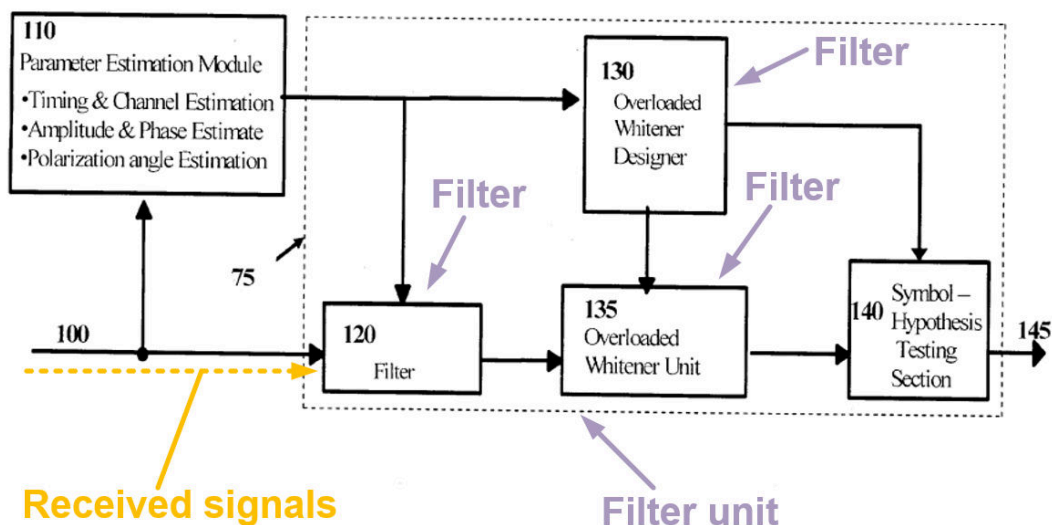


Figure 3

EX1004, FIG. 3 (annotated).

The McElwain-Wang combination provides a ***filter unit*** that is ***coupled*** to the ***MUD decision unit***. EX1005, 14:21-15:6, 15:12-21, 15:29-17:3, FIGS. 2, 4; EX1003, ¶133; *supra*, §V.A.3. Because front end unit 75 allows “overloaded processing of more users than available dimensions...to pass the proper parameters,” a POSITA would have been motivated to implement the MUD system described by McElwain so that front end unit 75 is coupled to a ***MUD decision unit***. *Supra*, §V.A.3. This would allow the front end unit 75 to “pre-process” the raw data before ***MUD decision unit*** selects an appropriate MUD. *Supra*, §V.A.3.

[9]

McElwain explains 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 id.*, [0094], FIG. 2; *supra*, [2]; EX1003, ¶134-135.

[10pre]

*Supra*, [1pre]; EX1003, ¶136. Furthermore, McElwain discloses that the “Hybrid Turbo-MUD” enables “advanced ***receiver*** processing” for processing ***received signals***. EX1004, [0074]-[0075]; *see id.*, [0078]; EX1003, ¶136.

**[10a]**

*Supra*, [1a]; EX1003, ¶137. Furthermore, McElwain explains that the *parameter estimator 10 extracts the received data information* from the *received signals*. EX1004, [0080], [0099], FIG. 2; EX1003, ¶137.

**[10b]**

*Supra*, [1b]-[1c], [3]; EX1003, ¶138. The *MUD decision unit* of the McElwain-Wang combination selects a *MUD* based upon *at least one threshold* (e.g., a threshold number of effective eigenvalues and a threshold noise power). EX1005, 15:26-17:3; EX1003, ¶138.

**[10c]-[10e]**

*Supra*, [1b]-[1c], [3]; EX1003, ¶139. One MUD described by Wang is a “minimum mean square” detector representing a *low complexity MUD*. EX1005, 9:11-12, 11:18-19, 19:11-12, Cl. 6; EX1003, ¶139. McElwain confirms that MMSE detectors were “known in the art” by the Critical Date and explains that MMSE detectors are “less computationally complex” because MMSE detectors are linear as opposed to nonlinear. EX1004, [0034].

The minimum mean square is selected to process *received signals* of a “first channel type.” EX1005, 11:3-6, 11:18-19, 16:17-19, 19:11-12, FIG. 4. Interference is lower for the first channel type as compared with the other channel types because the second, third, and fourth channel types each correspond to a correlation matrix having more effective eigenvalues or a greater in-band power

spectrum deviation as compared with the first channel type. EX1005, 10:22-11:31, 16:14-17:3, 19:8-22, FIG. 4. Because the minimum mean square detector is selected to process signals associated with the least interference, the minimum mean square detector represents a *low complexity MUD*. EX1003, ¶140.

Another MUD disclosed by Wang is a “decorrelation” detector that serves as a *medium complexity MUD*. EX1005, 9:13-14, 11:20-21, 19:13, Cl. 6. McElwain confirms that decorrelation detectors, like minimum mean square detectors, are “less computationally complex” and “known in the art.” EX1001, 5:25-29; EX1004, [0034]. Wang teaches that the decorrelation detector is more complex than the minimum mean square detector because the decorrelation detector is selected for the second channel type which includes more interference than the first channel type. EX1005, 10:30-11:31, 16:14-17:3, 19:8-22, FIG. 4; EX1003, ¶141. For example, the second channel type corresponds to received signals “dominated by co-channel interference” and the first channel type corresponds to received signals “dominated by additive white Gaussian noise interference.” EX1005, 9:7-14; *see id.*, 11:3-9, 16:14-23; EX1003, ¶142.

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. Furthermore, Wang discloses 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. *Id.* 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. EX1003, ¶143.

Wang also describes two examples of a **high complexity MUD** including a “parallel interference counteraction” detector selected for a third channel type and a “partial multi-access interference cancellation” detector selected for a fourth channel type. EX1005, 9:15-16, 11:22-23, 12:1-3, 19:14-15, 19:20-21, Cl. 6, FIG. 4; EX1003, ¶144. Parallel interference counteraction and partial multi-access interference cancellation detectors are more complex than minimum mean square and decorrelator detectors because the third channel type and the fourth channel type include more complex interference as compared with the first channel type and the second channel type. EX1005, 9:7-30, 10:30-12:3, 19:8-22, Cl. 6, FIG. 4. For example, the third and fourth channel correspond to more than one effective eigenvalue and the first and second channel types correspond to less than one effective eigenvalue. *Id.*

The **low**, **medium**, and **high complexity MUDs** are each switchably coupled to the **MUD decision unit** because “[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. Because modules 13, 15 represent “hardware modules” in some embodiments, the *low*, *medium*, and *high complexity MUDs* of the McElwain-Wang combination each include dedicated hardware that is *switchably coupled* by the *MUD decision unit*. EX1005, 15:17-21; EX1003, ¶145.

The McElwain-Wang combination provides *low, medium and high complexity MUDs* that each output a *plurality of information streams*. EX1004, [0084], [0093]; *supra*, [1c]; EX1003, ¶146; *supra*, §V.A.3. The *low complexity MUD* of the McElwain-Wang combination outputs a *plurality of low complexity processed information streams*, because lower complexity MUDs generate lower complexity outputs. *Id.* Similarly, the medium complexity *MUD* outputs a plurality of *medium complexity processed information streams*, and the high complexity *MUD* outputs a plurality of *high complexity processed information streams*. *Id.* [10f]

*Supra*, [1d]; EX1003, ¶147. In the McElwain-Wang combination, the *low, medium and high complexity processed information streams* each are coupled to the *bank of decoders* just as McElwain’s single MUD 20 is coupled to a *bank of decoders* 40. EX1004, [0076]-[0096], FIGS. 1-2; EX1005, 13:28-17:3, FIG. 4; EX1003, ¶147; *supra*, §V.A.3.

**[11]**

As described for [8], *supra*, 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; EX1003, ¶148.

**[12]-[13], [15]-[16]**

*Supra*, [2]-[3], [7], [9], respectively; EX1003, ¶149-152.

**[17pre]**

*Supra*, [1pre]; EX1003, ¶153. McElwain further describes a **method** for processing **signals** from **multiple users** by a **receiver**. EX1004, [0047] (“a **method**...for allowing **multiple users** to operate in the same channel”), [0074] (“enable...advanced **receiver** processing”), [0078]. McElwain discloses that **raw data** collected by the receiver is “**digitized**.” EX1004, [0078]; *see id.*, [0079], [0156], EX1003, ¶153.

**[17a]**

*Supra*, [1a]; EX1003, ¶154. Furthermore, the **parameter estimator** 10 performs a **parameter estimation** of the **raw digitized data**. EX1004, [0080] (“parameter estimation unit 10 processes the various parameters for the received raw data”); *see id.*, [0099]-[0100], [0108]-[0109], FIGS. 1-3; EX1003, ¶154.

**[17b]**

McElwain explains that the *raw digitized data* is split into a sequence of “data blocks” each corresponding to *bits* received during a *window* of time. EX1004, [0084], [0087]-[0089], [0093]-[0096]; EX1003, ¶155. Specifically, MUD 20 and the bank of decoders 40 process each data block through a series of iterations until hard decision unit 50 generates an output data stream. *Id.* When the iterations are complete for the current data block, “[t]he process is repeated for all subsequent data blocks.” EX1004, [0089]; *see id.*, [0094]. Thus, McElwain discloses a process for *grabbing a window of bits* from the *raw digitized data*. EX1003, ¶155.

**[17c]**

McElwain describes an iterative process for reaching an output data stream for a *window of bits*. EX1004, [0084], [0087]-[0089], [0093]-[0096]; *supra*, [1b]; EX1003, ¶156. To reach an output data stream, the bank of decoders 40 generates “soft outputs” for each iteration “until an asymptote is reached or the desired performance level is attained,” leading the system to produce hard outputs. EX1004, [0088]; *see id.*, [0096]. Soft outputs are improved each iteration. EX1004, [0076]-[0096], FIGS. 1-3.

According to McElwain, hard outputs “are discrete values” and soft outputs “indicate both [a] discrete estimate and [a] probability that the estimate is correct.”

EX1004, [0039]; *see id.*, [0085]. Because soft outputs are improved each iteration, soft outputs with higher conditional probabilities are removed from analysis during each iteration and McElwain's MUD system therefore ***subtracts any known bits*** from the respective ***window of bits*** as part of the iterative process to improve soft outputs. EX1003, ¶157 (citing EX1016, 2, EX1017, 3). McElwain's process of ***subtracting any known bits*** from the respective ***window of bits*** based on estimates and conditional probabilities for each bit is similar to the '492 Patent's process for subtracting known bits. EX1004, [0076]-[0096], FIGS. 1-2; *Cf.* EX1001, 19:66-20:12; EX1003, ¶157.

[17d]

*Supra*, [1b]-[1c]; EX1003, ¶158.

[17e]

McElwain discloses that a MUD system can ***subtract any known bits*** from the respective ***window of bits*** as part of an iterative process to improve soft outputs from a bank of decoders 40 until a hard decision is reached. EX1004, [0076]-[0096], FIGS. 1-2; *supra*, [17c]. Furthermore, the McElwain-Wang combination provides a MUD system that can ***estimate unknown bits*** from a respective ***window of bits*** using a selected ***MUD***. *Supra*, [1b]-[1c]; EX1003, ¶159.

[17f]

McElwain discloses that “[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 id.*, [0094]. This means that when hard outputs are generated for a respective window of bits, the MUD system of the McElwain-Wang combination proceeds to *increment* to a *next window of bits*. EX1004, [0076]-[0096], FIGS. 1-2; EX1003, ¶160.

**[17g]**

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,” the MUD system of the McElwain-Wang combination repeats the steps of *subtracting, selecting, estimating* and *incrementing* for each window of bits *until there are no more windows* and hard decision unit 50 outputs a *set of symbol estimates*. EX1004, [0076]-[0096], FIGS. 1-2; EX1005, 9:3-30, 11:14-12:3, 15:12-21, 19:8-22; EX1003, ¶161.

**B. GROUND 1B: McElwain-Sampath renders obvious claims 1-3, 5-13, and 15-17**

*1. Sampath*

Sampath describes a receiver that processes raw data to remove interference between multiple input signals, much like the systems of McElwain and the ’492 Patent. EX1006, [0004], [0006]; *see id.*, [0024]-[0027], [0039]-[0043], [0047], [0048], FIG. 3A. Sampath describes a set of demodulators 304, 308, 312 for removing interference from multiple signals in the raw data and a demodulator

selector 316 for selecting one of the demodulators. EX1006, [0039]; *see id.*,

[0040]-[0043], [0047]-[0048], FIG. 3A; EX1003, ¶57.

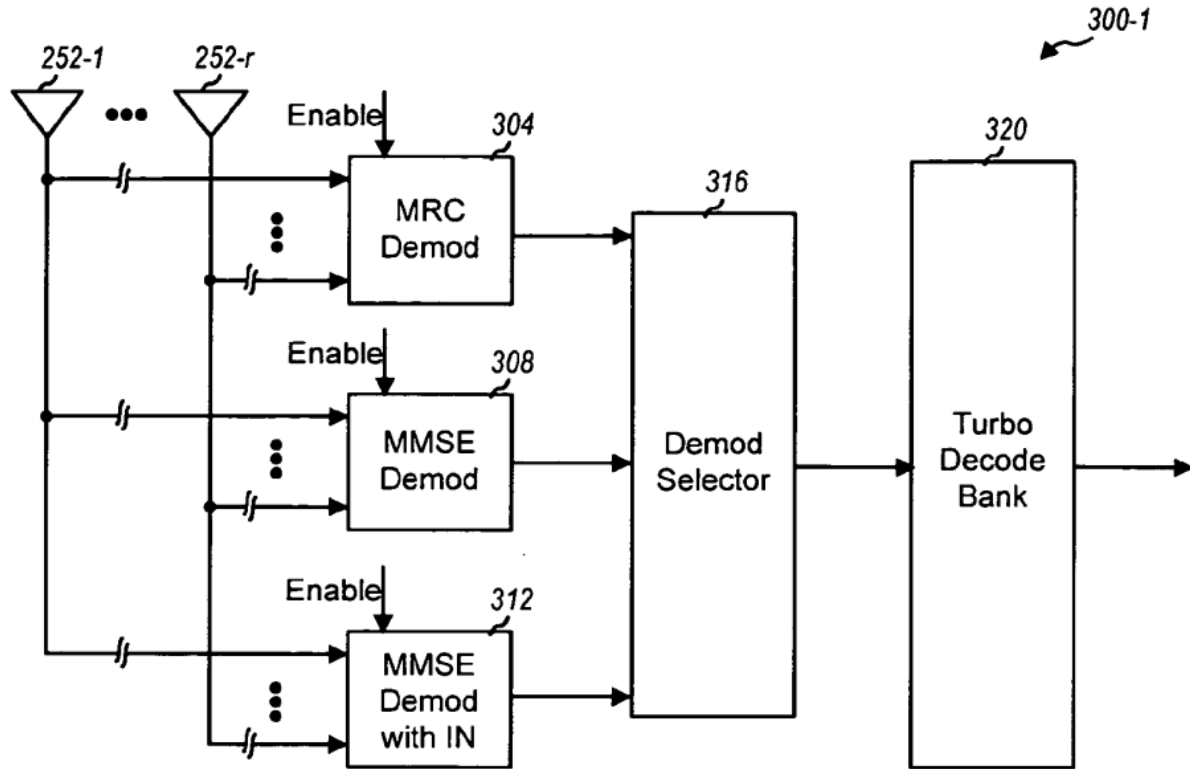


**Fig. 3A**

EX1006, FIG. 3A.

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]; EX1003, ¶58. The output from the demodulator that is likely to produce the most accurate result is “passed to the turbo decoding 320 for decoding.” EX1006, [0041]-[0043]. The “turbo

decoder” of Sampath decodes an output from the selected demodulator to generate estimated values for “multiple signals.” EX1006, [0039]-[0042], FIG. 3A.

## 2. *The McElwain-Sampath Combination*

To the extent that McElwain does not disclose a MUD decision unit that determines a selected MUD, the McElwain-Sampath combination provides this feature. EX1006, [0039]-[0042], FIG. 3A. Multiple reasons would have prompted a POSITA to implement a MUD system, per McElwain, with MUD selection, per Sampath. EX1003, ¶59.

**First**, a POSITA would have understood that implementing a MUD system, per McElwain, with a system for selecting between different kinds of demodulators that provide input to a bank of decoders, per Sampath, would predictably provide a simple way to implement the system with multiple MUDs of varying complexity. EX1003, ¶60. For example, because Sampath discloses that “demodulator selector 316 uses a metric to decide which of the demodulators...to pass to...a bank of decoders,” a POSITA would have been motivated to implement the system with multiple MUDs that each provide output to the bank of decoders 40. EX1006, [0039], EX1003, ¶60.

**Second**, as discussed (*supra*, §V.A.3), a POSITA would have been prompted to implement the system, per McElwain, with the demodulator selection teachings

of Sampath because the resulting system would more effectively manage the tradeoff between complexity and resource consumption. EX1003, ¶61.

*Third*, as discussed (*supra*, §V.A.3), because the number of received signals and the level of interference can change over time, a POSITA would have recognized benefits of dynamically changing detectors in response to changing interference conditions. EX1003, ¶62.

*Fourth*, using signal to interference-plus-noise ratio (SINR) as a decision metric for selecting a MUD would advantageously allow the MUD system to determine SINR in real-time, thus allowing the MUD system to quickly determine the decision metric used to select an appropriate MUD. EX1003, ¶63.

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. *KSR at 401*; EX1003, ¶64.

### 3. *Claim-by-claim Analysis*

#### **[1pre]-[1a]**

*Supra*, Ground 1A (§V.A.4) at [1pre]-[1a]. EX1003, ¶162.

#### **[1b]**

McElwain describes a system that processes *received signals* through a series of iterations so that a single MUD 20 generates bit streams for each of the received signals for input to a *bank of decoders* 40 which generates soft outputs

for feeding back into the MUD 20. EX1004, [0076]-[0096], FIGS. 1-2; *supra*, Ground 1A (§V.A.4) at [1pre]-[1b], §V.A.1, §V.A.3; EX1003, ¶163. To the extent McElwain does not expressly disclose a **MUD decision unit**, this feature would have been obvious and provided in the McElwain-Sampath combination. *Supra*, §V.B.2 For example, Sampath describes a demodulator selector 316 representing a **MUD decision unit** for selecting one of three demodulators 304, 308, and 312 likely to produce the most accurate demodulated signal. EX1006, [0039]-[0043], [0047]-[0048], FIG. 3A; EX1003, ¶164. Outputs from the selected demodulator are “passed to the turbo decoding 320” for decoding. EX1006, [0041]; *see id.*, [0039], [0042], [0047]-[0048], FIG. 3A. Sampath 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 to the turbo decode bank 320. EX1006, [0043]; EX1003, ¶165.

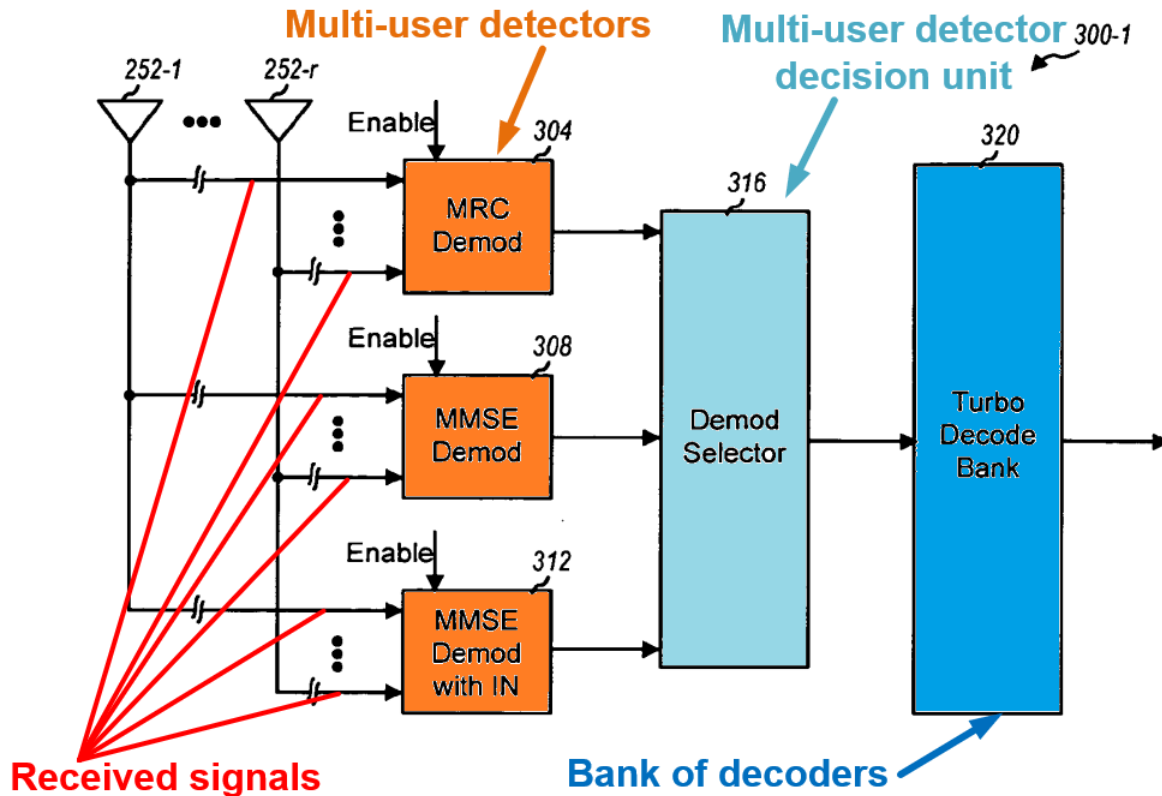


Fig. 3A

EX1006, FIG. 3A (annotated).

The three demodulators 304, 308, and 312 are each *coupled* to raw input data including multiple “*received signals*.” EX1006, [0039]; *see id.*, [0040], FIG. 3A. The selected one of demodulators 304, 308, and 312 processes the multiple *received signals* to detect “transmitted symbol streams,” EX1006, [0034]. Because each of demodulators 304, 308, and 312 can remove interference from multiple *received signals*, demodulators 304, 308, and 312 represent *MUDs* and demodulator selector 316 represents a *MUD decision unit* for selecting one of these *MUDs*. EX1003, ¶166.

Even if Sampath does not expressly disclose that demodulators 304, 308, and 312 are *MUDs*, a POSITA would have been motivated to implement the MUD system of McElwain with a *MUD decision unit* in view of Sampath's teachings for selecting between three different demodulators 304, 308, and 312. EX1006, [0039]-[0043], [0047], [0048], FIG. 3A; *supra*, §V.B.2. For example, because McElwain discloses a MUD unit 20, a POSITA would have been motivated to implement the MUD 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. The McElwain-Sampath combination therefore provides a *MUD decision unit* coupled to a *parameter estimator* and *received signals*. EX1004, [0080]; EX1003, ¶167.

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], Cls. 8-9. In doing so, demodulator selector 316 performs one of the MUD selection algorithms described by the '492 Patent. EX1003, ¶168. For example, the '492 Patent explains that "[t]he decision can be made by calculating the signal to interference plus noise ratio (SINR) for each symbol." The '492 Patent also explains that "[i]f the SINR for any symbols is above a threshold set for a specific lower complexity MUD technique then use that technique," and "[i]f none of the

SINR values are above any of the lower complexity MUD thresholds then use the highest complexity MUD.” EX1001, 14:19-25.

Sampath discloses that demodulator selector 316 can use “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; EX1003, ¶169-170. Sampath explains that “decision logic” (demodulator selector 316) can choose a demodulator based upon “signal to interference-plus-noise ratio (SINR)” thresholds associated with different demodulators. EX1006, Cl. 9; *see id.*, Cls. 14, 24; EX1003, ¶171-172. The demodulator selector 316 uses a SINR threshold for a first demodulator and a SINR threshold for a second demodulator to choose between selecting the first demodulator or the second demodulator for processing received signals. EX1006, Cls. 1, 8-9.

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. EX1003, ¶173 (citing EX1021, 8). Demodulator selector 316 therefore 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 demodulators 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, Cls. 1, 8 (“decision logic is configured to choose based upon a metric”), 9 (“metric is a signal to interference-plus-noise ratio (SINR) for the first or second demodulator”); EX1003, ¶174. On the other hand, if the *expected SINR* for processing the received signals using demodulator 304 is *not greater* than the SINR threshold, thus indicating that demodulator 304 cannot handle the interference level, demodulator selector 316 can select one of demodulators 308, 312 for processing the received signals. *Id.*

Consequently, Sampath explains that demodulator selector 316 uses an algorithm for selecting one of the three demodulators 304, 308, and 312 that is the same as the *expected SINR* MUD selection algorithm the ’492 Patent discloses. EX1003, ¶174. Even if the Board applies the District Court’s prior construction of the “a multi-user detector decision unit,” the McElwain-Sampath combination provides a *MUD decision unit* coupled to a *parameter estimator* and *received signals*. EX1006, [0039]-[0043], [0047], [0048]; *supra*, §V.B.2; EX1003, ¶174.

[1c]

To the extent that McElwain does not expressly disclose *at least two MUDs* coupled to a *parameter estimator* and *MUD decision unit*, such features would have been obvious and provided in the McElwain-Sampath combination. EX1003, ¶175; *supra*, §V.B.2. Sampath discloses three different demodulators 304, 308, 312

that represent *at least two MUDs*. EX1004, [0079]-[0088], [0090], [0093]-[0096], FIGS. 1-2; EX1006, [0039]-[0048], FIG. 3A. For example, 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). EX1006, [0039], [0040], FIG. 3A. Even if Sampath does not expressly disclose that the demodulators 304, 308, 312 are *MUDs*, it would have been obvious to implement demodulators 304, 308, 312 as *MUDs* in view of McElwain's MUD 20. EX1004, [0076]-[0096], FIGS. 1-2; EX1006, [0039]-[0048], FIG. 3A; *supra*, [1b], §V.B.2; EX1003, ¶176.

The *MUD decision unit* of the McElwain-Sampath combination is configured to determine a *selected MUD* based on *decision criteria*. EX1006, [0039] (“decide which of the demodulators 304, 308, 312 to pass to a turbo decoder 320”); *see id.*, [0040]-[0043], [0047], [0048], FIG. 3A, Cls. 1, 8, 9; *supra*, [1b]; EX1003, ¶177. 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 described for [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.

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 id.*, [0079], [0090], [0093], FIGS. 1-2. The McElwain-Sampath combination therefore provides *two or more MUDs* (including the *selected MUD*) 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]; EX1003, ¶178; *supra*, §V.B.2.

*[1d]*

*Supra*, Ground 1A (§V.A.4[1d]). EX1003, ¶179. Furthermore, because Sampath discloses a turbo decoder bank 320 that processes a demodulator output just as McElwain’s bank of decoders 40 processes an output from MUD 20, a POSITA would have been motivated to implement the MUD system of McElwain with Sampath’s MUD selection teachings. EX1004, [0076]-[0096], FIGS. 1-2; EX1006, [0039]-[0043], [0047], [0048]; EX1003, ¶179; *supra*, §V.B.2.

*[3]*

Sampath describes *a MUD decision unit* (demodulator selector 316) that uses *decision criteria* to select an appropriate demodulator, the *decision criteria* including *expected SINR*. EX1006, [0039], [0041], [0043], Cls. 8, 9, 13, 14, 23, 24; *supra*, [1b]-[1c]; EX1003, ¶180. A POSITA would have understood that to use

*expected SINR* as *decision criteria* for selecting a demodulator, a SINR for received signals must be compared to *at least one threshold*. *Supra*, §V.B.2; EX1003, ¶180 (citing EX1009, 1, EX1010, 44).

[5]

Sampath 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; EX1003, ¶181; *supra*, [1b]-[1c]. Therefore, the McElwain-Sampath combination includes *at least two MUDs* selected from a group including *MMSE* detectors. EX1003, ¶181; *supra*, §V.B.2.

[10pre]-[10a]

*Supra*, Ground 1A (§V.A.4) at [10pre]-[10a]. EX1003, ¶182.

[10b]

As described for [1b]-[1c] and [3], *supra*, the McElwain-Sampath combination provides a *MUD 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*, §V.B.2; EX1003, ¶183.

[10c]-[10e]

Sampath discloses three separate demodulators including an MRC demodulator 304, an MMSE demodulator 308, and an MMSE demodulator with

interference nulling 312. EX1006, [0039]-[0041], [0043], [0047], [0048], FIG. 3A; EX1003, ¶184; *supra*, [1b]-[1c] and [3]. Demodulator 304 represents a *low complexity detector*, demodulator 308 represents a *medium complexity detector*, and a demodulator 312 represents a *high complexity detector*. *Id.*

For example, demodulator 304 uses the equation  $G = H^*$  to demodulate the *received signals*,  $H$  representing the channel matrix corresponding to the *received signals*, and  $G$  representing the transpose of the channel matrix. EX1006, [0026], [0031], [0040]; EX1003, ¶185. Demodulator 308 uses the equation  $G = H^*(HH^* + \sigma^2 I)^{-1}$  to demodulate the *received signals*, and the demodulator 312 uses the equation  $G = H^*(HH^* + R_{nn})^{-1}$  to demodulate the *received signals*—both of these equations are significantly more complex than the  $G = H^*$  equation used by demodulator 304. EX1006, [0026], [0027], [0031], [0040]; EX1003, ¶184-185 (citing EX1019, 4-5). Furthermore, 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; EX1003, ¶185.

McElwain's MUD 20 "outputs a bit (or symbol) stream associated with each interfering signal present on the channel." EX1004, [0084]; *see id.*, [0093], FIGS. 1-2. Therefore, when the MUD system of McElwain is implemented with

Sampath's suggested demodulator selector 316 and multiple demodulators 304, 308, 312, the MUD system includes *low*, *medium*, and *high complexity MUDs* that each output respective *processed information streams*. EX1003, ¶186; *supra*, §V.B.2.

**[10f]**

*Supra*, [1d]; EX1003, ¶187. In the McElwain-Sampath combination, the *low*, *medium and high complexity processed information streams* are each be coupled to a *bank of decoders* because in McElwain 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; EX1003, ¶187; *supra*, §V.A.3.

**[13]**

*Supra*, [3]; EX1003, ¶188.

**[17pre]-[17c]**

*Supra*, Ground 1A (§V.A.4) at [17pre]-[17c]. EX1003, ¶189.

**[17d]**

*Supra*, [1b]-[1c]; EX1003, ¶190.

**[17e]-[17g]**

*Supra*, Ground 1A (§V.A.4) at [17e]-[17g]. EX1003, ¶191.

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

The McElwain-Sampath combination renders obvious [2], [6]-[9], [11]-[12], and [15]-[16] for at least the reasons described for the McElwain-Wang combination (Ground 1A (§V.A.4) at [2], [6]-[9], [11]-[12], [15]-[16], *supra*); EX1003, ¶192.

**C. GROUND 2A: Mills-Liu renders obvious claims 1-3, 5-13, and 15-17**

*1. Mills*

Mills describes a cellular base station receiver that removes interference from multiple signals travelling on the same channel that “are purposely allowed to interfere with one another.” EX1007, [0004]; *see id.*, [0002]-[0003], [0021]-[0023], [0028]-[0039], FIG. 1; EX1003, ¶65-66. For example, Mills includes a multi-user decoder 14 and a bank of single user decoders 16 that cycle input data through a series of iterations until final estimates are reached.

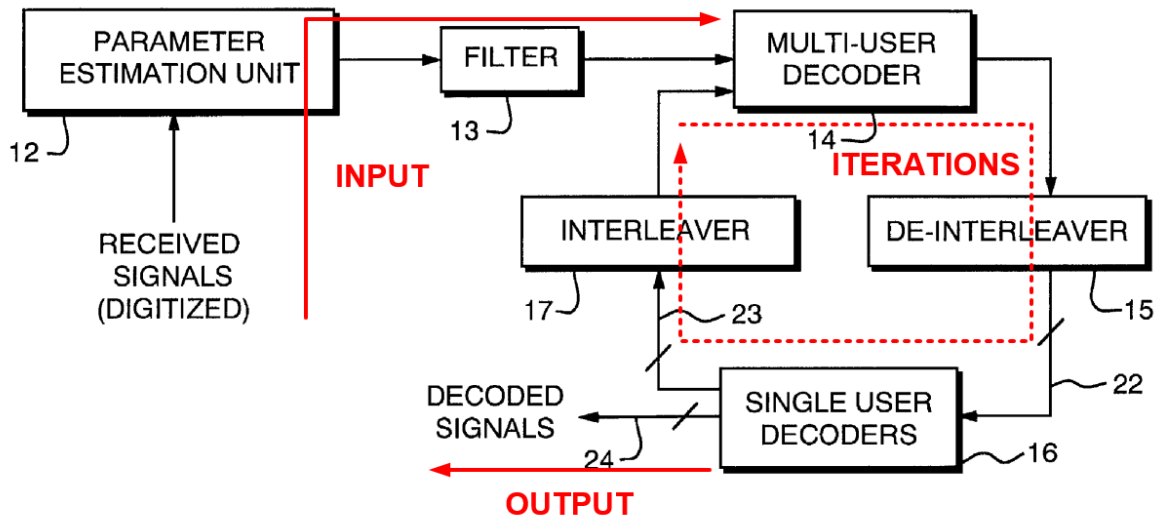


FIG. 1  
(PRIOR ART)

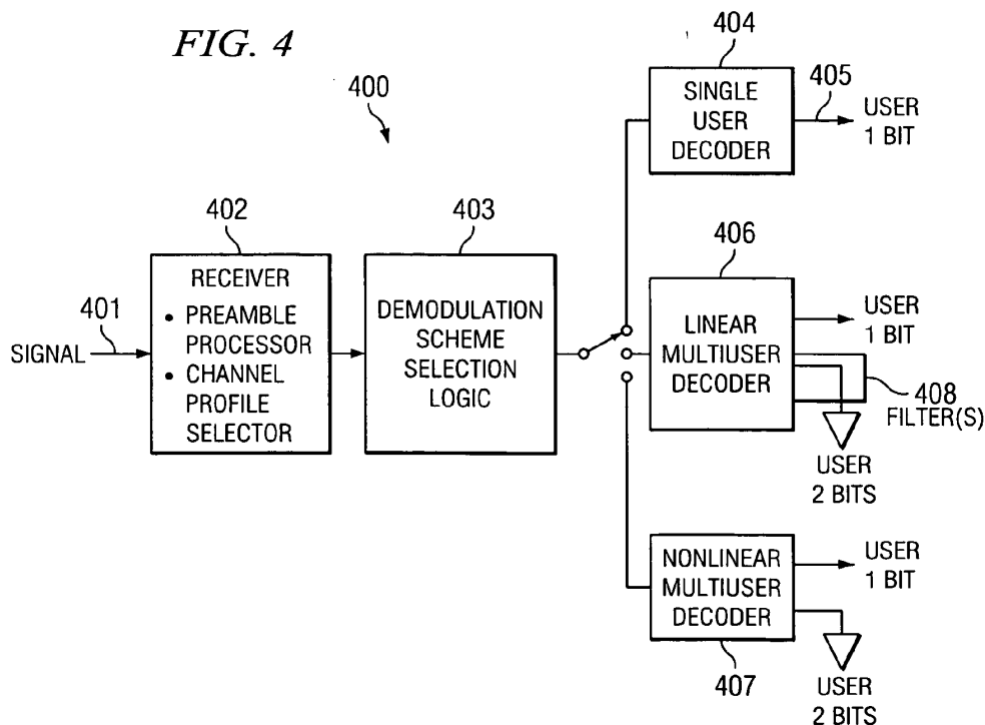
EX1007, FIG. 1 (annotated); *see id.*, [0028]-[0039], FIG. 1; EX1003, ¶66.

Mills acknowledges a tradeoff between low complexity MUDs that have “lower computational demands” but perform poorly in “high-interference situations” and high complexity MUDs that are accurate in high-interference situations but have a “prohibitively high” complexity. EX1007, [0006]; EX1003, ¶67.

## 2. *Liu*

Much like Mills and the '492 Patent, Liu discloses a receiver that removes interference from multiple signals that simultaneously occupy the same frequency. EX1008, [0002]-[0012], [0021]-[0023], FIGS. 1-2; EX1003, ¶68. Liu describes “demodulation logic” including a single user decoder 404, a linear multi-user decoder 406, and a “more powerful” nonlinear multi-user decoder 407. EX1008, [0024]-[0029], FIG. 4. A “demodulation scheme selection logic 403” selects one of

the three decoders to process the received signals. EX1008, [0007]-[0009], [0025]-[0029], FIG. 4; EX1003, ¶69. This selection can be made based on signal strength, signal-to-noise ratio (SNR), or expected bit error rate. EX1008, [0007], [0022], [0025], [0026], [0029]. Liu explains that nonlinear multi-user decoder 407 is more computationally intensive than linear multi-user decoder 406 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; EX1003, ¶70.



EX1008, FIG. 1.

3. *The Mills-Liu Combination*

To the extent that Mills does not expressly disclose a MUD decision unit using decision criteria to select a MUD, Liu provides this feature. EX1008, [0025]-[0029]; FIG. 4; *supra*, §V.C.2; EX1003, ¶71. Multiple reasons would have motivated a POSITA to implement a system, per Mills, to include MUD selection, per Liu. EX1003, ¶71.

**First**, a POSITA would have been prompted to implement a MUD system, per Mills, with Liu's suggestion to select a MUD having an appropriate complexity because doing so would ensure that resources are conserved by selecting the least complex MUD that is likely to generate a satisfactory output. EX1003, ¶72. For example, because Liu discloses that demodulation scheme selection logic 403 can determine a likelihood that each available MUD will produce an accurate output, a POSITA would have understood that implementing the system to select a MUD based on predicted performance would yield high accuracy while conserving resources. EX1008, [0029]; EX1003, ¶72.

**Second**, 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 the MUD system to tailor a MUD selection that consistently ensures accurate outputs. EX1003, ¶73. Because Mills acknowledges accurately decoding multiple received signals is an important consideration in

MUD systems, a POSITA would have understood that implementing the system, per Mills, with Liu's suggestion to determine an expected accuracy of available decoders, is advantageous. EX1007, [0013], [0050]; EX1003, ¶73.

**Third**, as discussed (*supra*, §V.A.3), because the number of received signals and the level of interference can change over time, a POSITA would have recognized benefits in dynamically changing detectors in response to changing interference of the received signals. EX1003, ¶74.

**Fourth**, A POSITA would have understood that selecting an appropriate detector among multiple decoders, per Liu, would reduce resource consumption and thus lead to lower power consumption in the receiver. EX1003, ¶75.

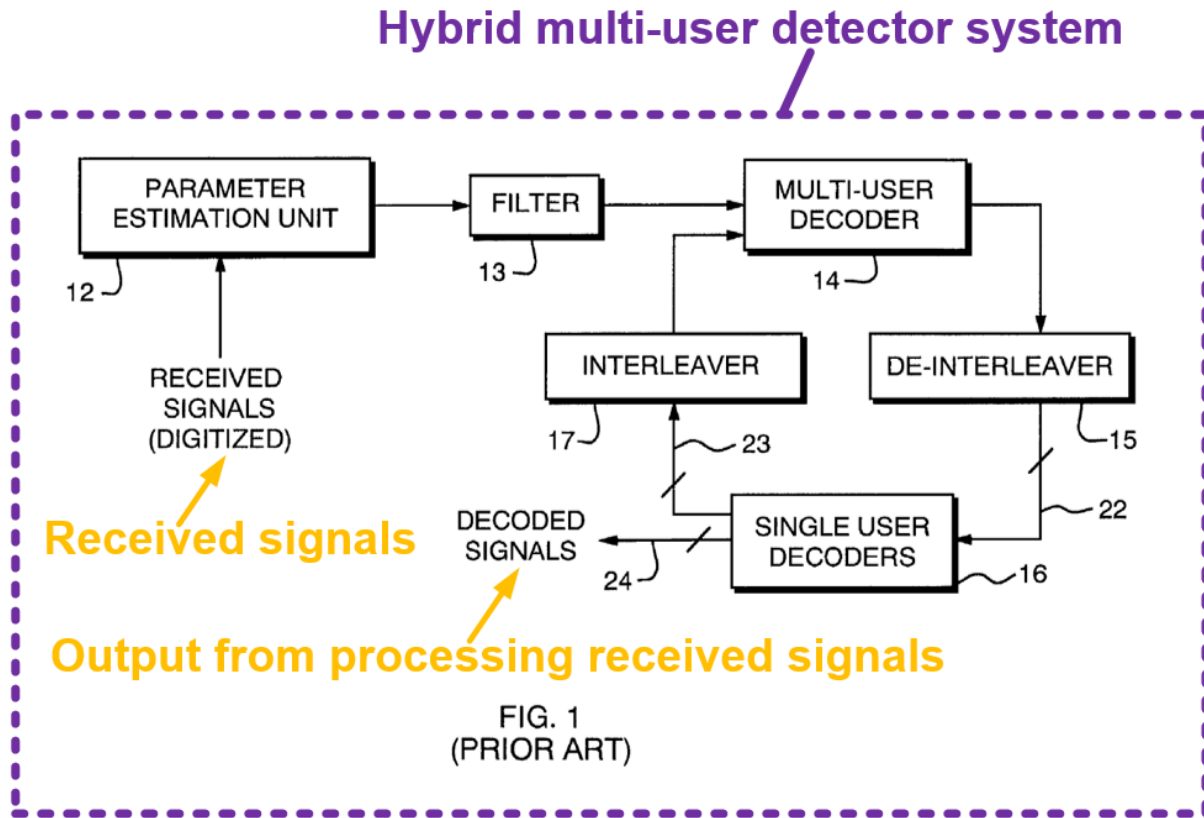
Considering the predictable electrical/network and software components involved in the combination and the relatively advanced state of the art at the time, a POSITA would have reasonably expected success achieving the combination before the Critical Date. *KSR at 401*; EX1003, ¶76.

#### 4. *Claim-by-claim Analysis*

[1pre]

To the extent the preamble is limiting, the Mills-Liu combination renders [1pre] obvious. EX1003, ¶193. For example, Mills discloses a **system** including a **MUD** that **processes received signals**. EX1007, [0028]-[0039], FIG. 1; EX1003, ¶193. This **MUD system** of Mills represents a **hybrid** system because the system is

a combination of multiple elements including, for example, a parameter estimation unit 12, a MUD 14, and a bank of single user decoders 16. *Id.*



EX1007, FIG. 1 (annotated).

[1a]

Mills describes a *parameter estimator* (parameter estimation unit 12) that identifies “parameters for each” of the *received signals*. EX1007, [0030]; *see id.*, [0005], [0029], [0041], FIGS. 1-2; EX1003, ¶194-195. These *received signals* provide *received data information*. EX1007, [0029] (“various parameters...such as relative received timing offsets, carrier phase, frequency offsets, received amplitudes, and multi-path structure”); *see id.*, [0030].

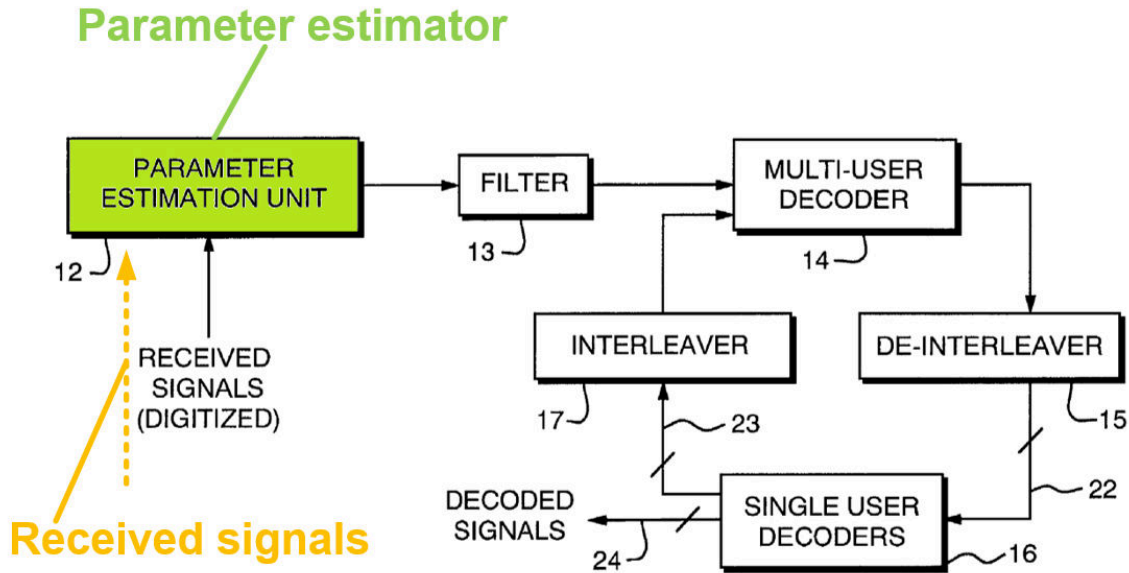
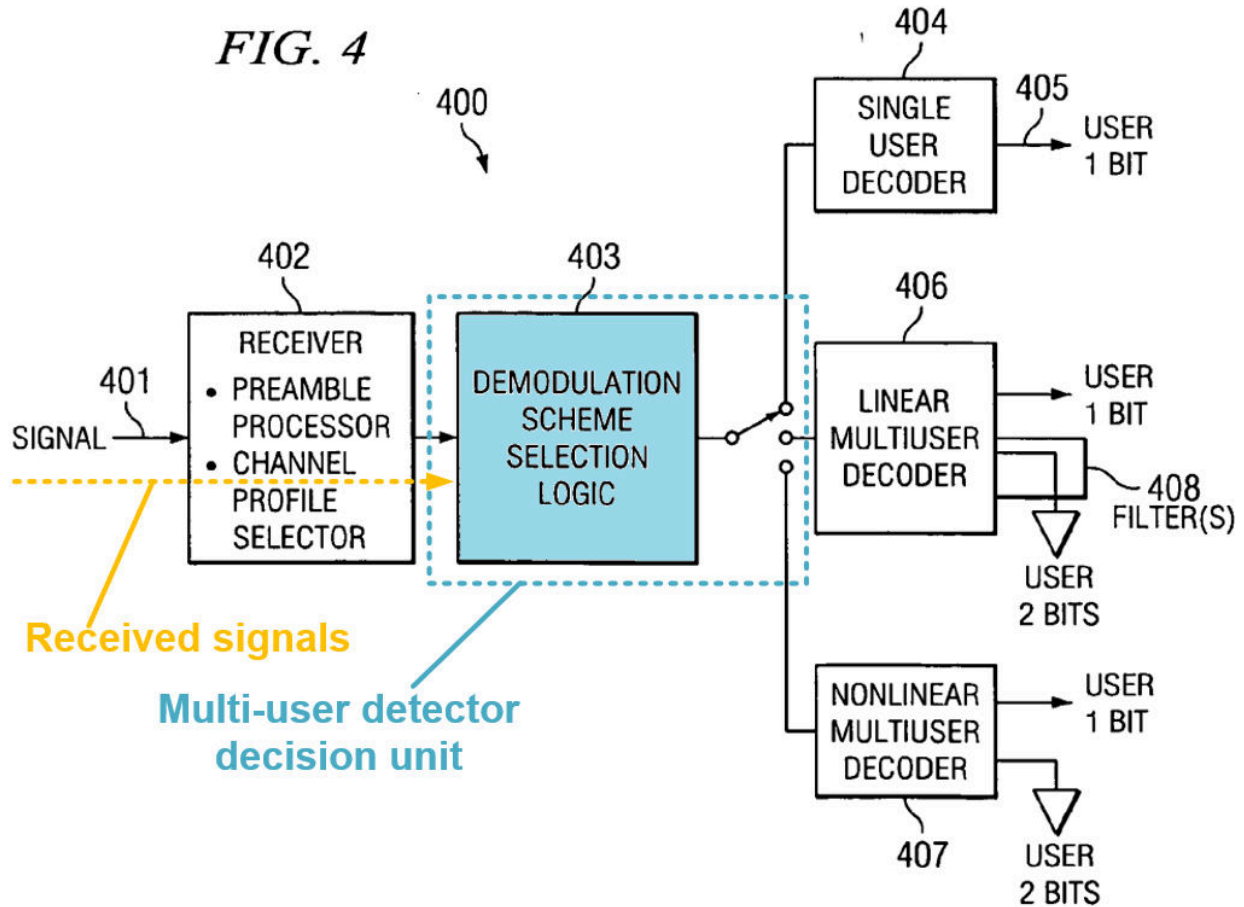


FIG. 1  
(PRIOR ART)

EX1007, FIG. 1 (annotated).

[1b]

To the extent Mills does not expressly disclose a MUD decision unit that uses decision criteria to select a MUD, Liu provides this feature. EX1003, ¶196; *supra*, §V.C.3. For example, Liu describes a receiver including demodulation scheme selection logic 403 for selecting one of single user decoder 404, linear multi-user decoder 406, or nonlinear multi-user decoder 407 to process *received signals*. EX1008, [0024]-[0029], FIG. 4. Logic 403 therefore represents a *MUD decision unit* coupled to *received signals*. EX1008, [0024]-[0029], FIG. 4; EX1003, ¶196.



EX1008, FIG. 4 (annotated).

Logic 403 selects one of the decoders 404, 406, 407 using an *expected bit error rate* algorithm equivalent to the *expected bit error rate* algorithm of the '492 Patent. EX1008, [0024]-[0029], FIG. 4; EX1003, ¶197. According to the '492 Patent, “[t]he decision can be made by calculating the expected bit error rate (BER) of each user based on all the lower complexity MUD techniques” and comparing these rates with threshold BERs for each detector. EX1001, 13:63-14:6. Furthermore, the '492 Patent explains that “[i]f 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,” and “[i]f 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.

Liu explains that logic 403 selects one of decoders 404, 406, 407 for processing received signals according to several different parameters. EX1008, [0025], [0029]-[0031]; EX1003, ¶198. These parameters include signal strength, signal-to-noise ratio (SNR), and *bit error rate*. *Id.* To select one of decoders 404, 406, 407, logic 403 compares a parameter value for the received signals with 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.” EX1008, [0029]; EX1003, ¶198. These “other threshold factors” include *bit error rate*. EX1008, [0029] (“unacceptable error rate”).

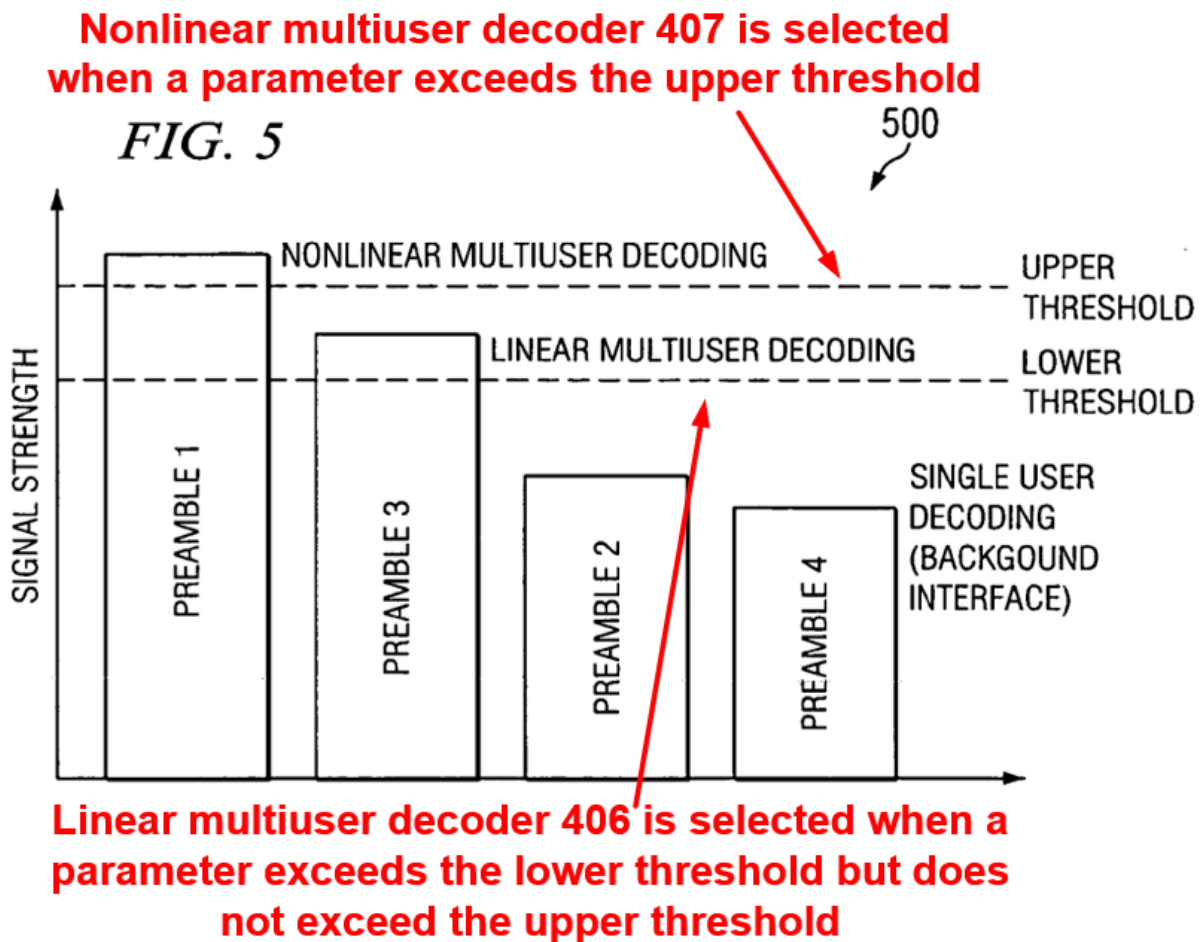
Therefore, logic 403 of Liu selects linear MUD 406 if any of the users present in the received signals have an *expected bit error rate* greater than the threshold *bit error rate* for linear MUD 406. EX1008, [0029]. Between the two MUDs described by Liu, the linear MUD 406 is the lowest complexity MUD EX1008, [0026]-[0029]; EX1003, ¶199. Logic 403 thus 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,” just like the *expected bit error rate* algorithm of the '492 Patent. EX1008, [0026]-[0029]; FIG. 4; *cf.* EX1001, 13:63-14:6. EX1003, ¶200-201.

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.” The non-linear multi-user decoder 407 is the highest complexity MUD described by Liu because nonlinear decoders are more complex than linear decoders and Liu expressly refers to decoder 406 as being “simpler” than decoder 407. EX1008, [0029]. Therefore, logic 403 uses “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,” just like the '492 Patent's *expected bit error rate* algorithm. EX1008, [0026]-[0029]; FIG. 4; *cf.* EX1001, 13:63-14:6. EX1003, ¶202.

In the context of signal strength, 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 for processing the received signals. EX1008, [0030]-[0031], FIG. 5; EX1003, ¶203. For example, Liu 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]. Liu also 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].



EX1008, FIG. 5 (annotated).

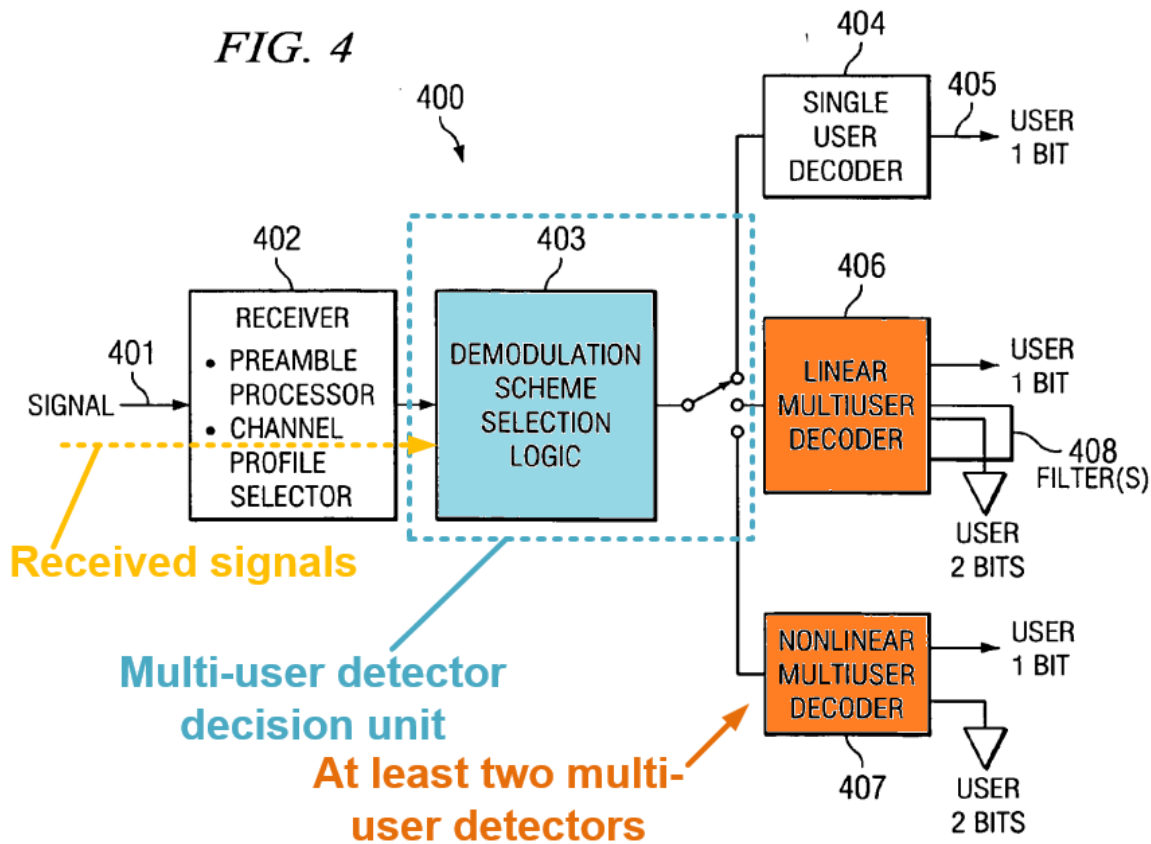
Even though FIG. 5 is described in the context of signal strength as opposed to bit error rate, it would have been obvious for a POSITA to implement the technique of FIG. 5 with the *bit error rate* of received signals and *bit error rate* thresholds corresponding to each of decoders 406, 407. EX1008, [0024]-[0031], FIGS. 4-5; *supra*, §V.C.3; EX1003, ¶204. 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,” meaning that a POSITA would have been motivated to use Liu’s threshold teachings in the context of *bit error rate*. EX1008, [0029], FIGS. 4-5; *supra*, §V.C.3; EX1003, ¶204.

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, Liu provides the *MUD decision unit* of claim 1 even when this term is interpreted according to the to the District Court’s prior construction. EX1008, [0024]-[0031], FIGS. 4-5; *supra*, §V.C.3; EX1003, ¶205. In the Mills-Liu combination, the *MUD 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*, §V.C.3; EX1003, ¶205. 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 *MUD decision unit* receives input from the *parameter estimator* 10 and the received signals. *Id.*

[1c]

Mills describes a MUD system including a MUD 14 that is *coupled* to a *parameter estimator* 12 through a filter 13. EX1007, [0029]-[0031], FIG. 1; EX1003, ¶206. To the extent MUD 14 includes only a single MUD, Liu describes *at least two MUDs* including a linear multi-user decoder 406 and a nonlinear multi-user decoder 407. EX1007, [0026]-[0029], FIG. 4. Although decoders 406, 407 are referred to as “multiuser decoders,” Liu explains that “decoders may also be referred to as ‘detectors.’” EX1008, [0007]. Therefore, decoders 406, 407, represent *multi-user detectors*.



EX1008, FIG. 4 (annotated).

Liu describes a *MUD 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; *supra*, [1b]; EX1003, ¶207. As described for [1b], *supra*, logic 403 applies the same *expected bit error rate* algorithm to select one of multiuser decoders 406, 407 that is described by the '492 Patent for selecting a MUD, meaning that logic 403 represents a *MUD decision unit* that is coupled to the *at least two MUDs* and

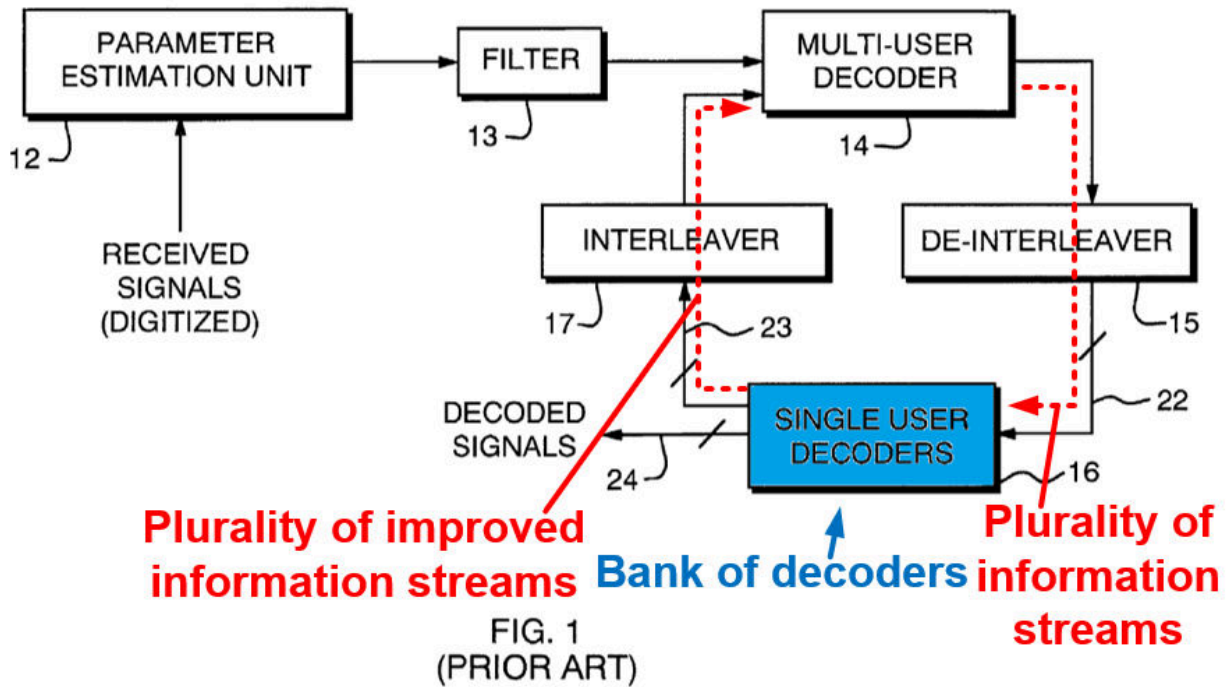
uses *decision criteria* to determine a *selected MUD*. EX1008, [0024]-[0031];

FIGS. 4-5; *cf.* EX1001, 13:63-14:6; EX1003, ¶207.

Because Mills discloses that MUD 14 is coupled to parameter estimation unit 12, a POSITA would have been motivated to implement the Mills-Liu combination so that each of the *at least two MUDs* are coupled to a *parameter estimator*. EX1007, [0029]-[0031], FIG. 1; EX1008, [0024]-[0029], FIG. 4; *supra*, §V.C.3; EX1003, ¶208. 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 id.*, [0033]-[0038]. Consequently, in the Mills-Liu combination, the *selected MUD* outputs a *plurality of information streams*, one information stream corresponding to each of the *received signals*. EX1007, [0028]-[0039], FIG. 1; *supra*, §V.C.3; EX1003, ¶208.

[1d]

Mills discloses a *bank of* single-user *decoders* 16 that are *coupled* to the *plurality of information streams* output from MUD 14. EX1007, [0034] (“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 id.*, [0029], [0033], [0035]-[0038], [0040], [0044], [0046]-[0054], FIGS. 1-2; EX1003, ¶209.



EX1007, FIG. 1 (annotated).

*Decoders* 16 and MUD 14 pass information between each other for a number of iterations “until further iterations will result in insignificant changes...and therefore will not significantly improve the...performance.” EX1007, [0054]; *see id.*, [0036]-[0038], [0053], FIGS. 1-2. This means that in the Mills-Liu combination, the **bank of** single user *decoders* 16 outputs a **plurality of improved information streams**. EX1007, [0036]-[0038], [0053]-[0054], FIGS. 1-2; EX1008, [0024]-[0029], FIG. 4; *supra*, §V.C.3; EX1003, ¶210.

[2]

Mills discloses that the **bank of** single user *decoders* 16 calculates soft outputs for each of the received signals which include “probability estimates” that

each soft output is correct. EX1007, [0034]-[0037]; *see id.*, [0032], [0038], [0046], [0053]-[0054], FIGS. 1-2; EX1003, ¶211. These soft outputs represent a **plurality of improved information streams** that are fed back into MUD 14 for multiple 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 id.*, [0054]; EX1003, ¶212.

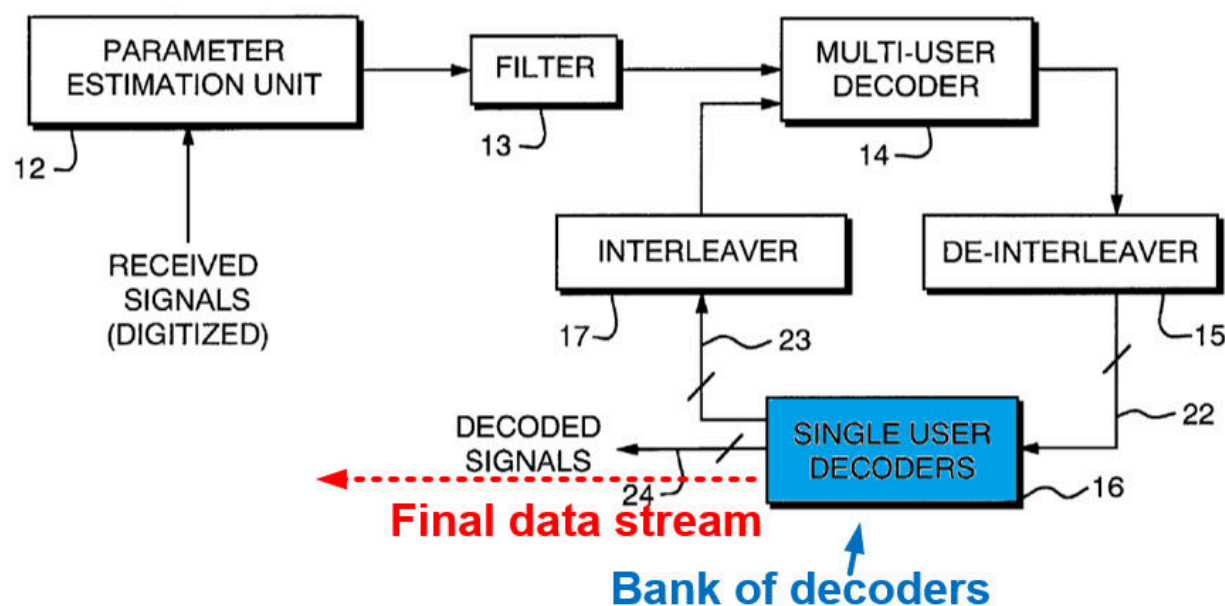


FIG. 1  
(PRIOR ART)

EX1007, FIG. 1 (annotated).

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 *MUD decision unit*, because doing so would allow the *MUD decision unit* to direct the signals to the appropriate *selected MUD*. EX1008, [0025]-[0029], FIG. 4; *supra*, §V.C.3; EX1003, ¶213-214.

[3]

The *decision criteria* logic 403 uses to determine a *selected MUD* include *at least one threshold* selected from a group including *expected bit error rate*.

EX1008, [0029] (“*unacceptable error rate*”); *see id.*, [0024]-[0028], FIG. 4; *supra*, [1b]-[1c]. A POSITA would have understood and found obvious that determining whether an error rate corresponding to decoder 406 is acceptable involves determining an *expected bit error rate* for using decoder 406 to process *received signals* and comparing this rate with *at least one threshold* that defines an “acceptable” bit error rate and an “unacceptable” bit error rate. EX1008, [0024]-[0029], FIG. 4; *supra*, [1b]-[1c], §V.C.3; EX1003, ¶215-216.

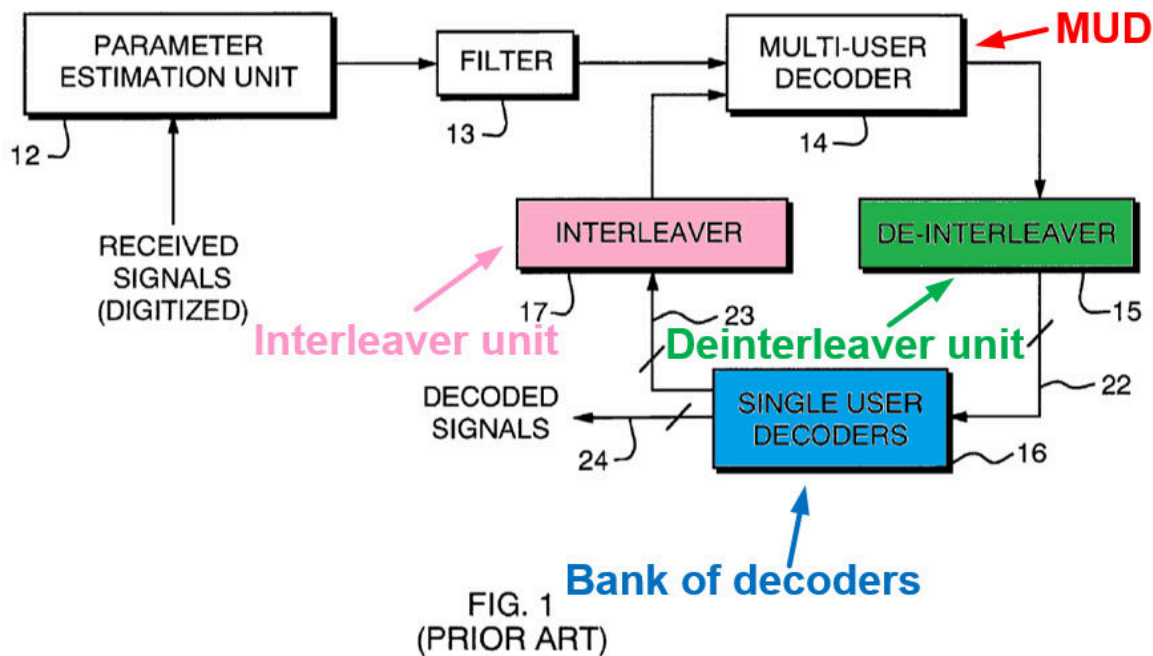
[5]

The *at least two MUDs* described by Liu include linear multi-user decoder 406 and nonlinear multi-user decoder 407. EX1008, [0026]-[0029], FIG. 4; *supra*, [1b]-[1c]. Liu discloses that “linear multi-user decoding is commonly referred to as *Minimum Mean Squared Error* 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 Mills-Liu combination includes *at least two MUDs* selected from a group consisting of *maximum likelihood* detectors and *MMSE* detectors. *Supra*, §V.C.3; EX1003, ¶217.

[6]

Mills explains 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]-[0034], [0037], [0040], FIG. 1. This means that the predictable Mills-Liu combination includes an *interleaver unit* and a *deinterleaver unit* coupled between *two or more MUDs* and the *bank of* single user *decoders* 16. EX1003, ¶218; *supra*, §V.C.3.



EX1007, FIG. 1 (annotated).

[7]

Mills explains that MUD 14 and a bank of single user decoders 16 perform a “predefined number” of iterations, until a “desired...performance is attained, or until further iterations result in insignificant changes in the channel symbol estimates.” EX1007, [0038]; *see id.*, [0054] *supra*, [2]. When this occurs, 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. *Id.*; EX1003, ¶219-220.

[8]

Mills discloses that a *filter unit* represented by filter 13 is *coupled* to the *received signals* through parameter estimation unit 12. EX1007, [0030] (“digitized signal passes through conventional receiver circuitry (not shown) and is then input to parameter estimation unit 12”), [0031] (“digitized signal is then passed through a whitening matched filter 13”), [0041]-[0042], FIGS. 1-2; EX1003, ¶221.

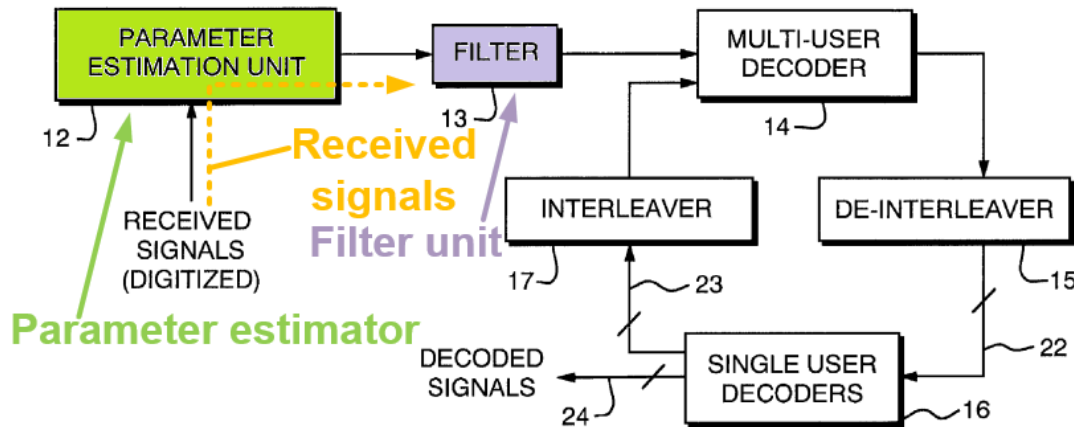


FIG. 1  
(PRIOR ART)

EX1007, FIG. 1 (annotated).

In the Mills-Liu combination, it would be obvious for a POSITA to implement the *filter unit* to also be coupled to the *MUD decision unit* because this would allow filter 13 to process the received signals before the *MUD decision unit* selects an appropriate MUD. EX1003, ¶222. For example, because filter 13 “serves to cancel some inter-symbol (ISI) interference” or “reduces the correlation between symbols of interfering users,” it would be advantageous for filter 13 to be connected to the *MUD 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. EX1007, [0031]; EX1003, ¶222.

[9]

Because explains that MUD 14 and decoders 16 exchange information for a number of iterations until the *bank of* single user *decoders* 16 outputs a *final data*

*stream*, this means that the Mills-Liu combination provides a ***hard decision unit*** coupled to the ***bank of*** single user ***decoders*** 16 that produces the ***final data stream***. EX1007, [0014], [0028]-[0055], FIGS. 1-2; *supra*, [1d], [2], [7]; EX1003, ¶223.

**[10pre]**

*Supra*, [1pre]; EX1003, ¶224.

**[10a]**

*Supra*, [1a]; EX1003, ¶225. Mills's parameter estimation unit 12 coupled to the ***received signals*** can extract the ***received data information*** including different kinds of parameters from the ***received signals***. EX1007, [0030] ("parameter estimation unit 12...utilizes unique apriori knowledge of each of the received signals to help identify parameters for each interfering signal"); *see id.*, [0005], [0029]; EX1003, ¶225.

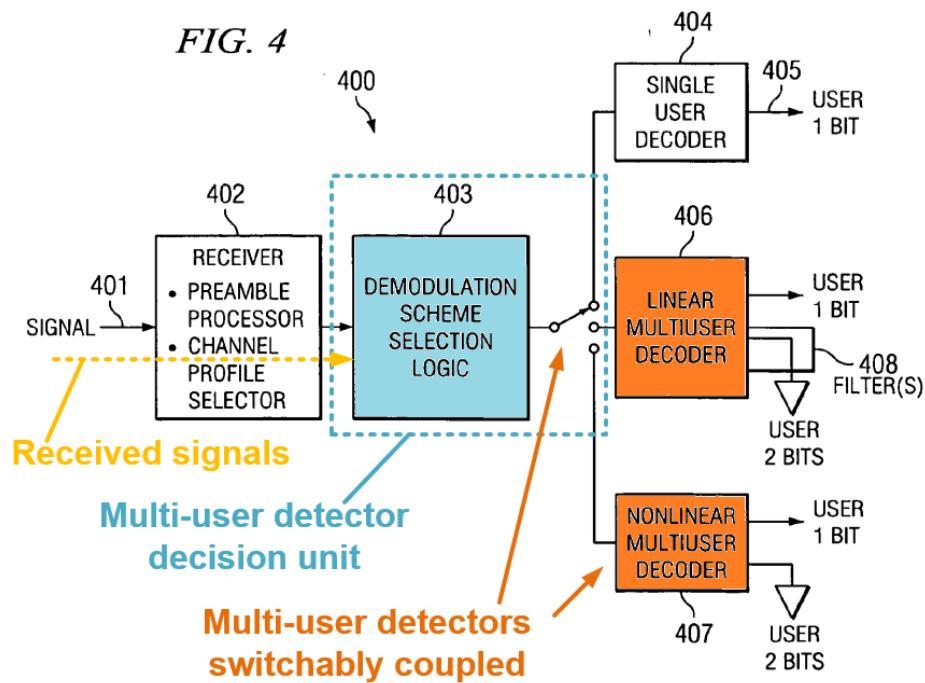
**[10b]**

*Supra*, [1b]-[1c] and [3]; EX1003, ¶226. Logic 403 of Liu represents a ***MUD decision unit*** that selects a ***MUD*** (e.g., decoder 406 or 407) based upon ***at least one threshold*** using the ***expected bit error rate threshold*** described by the '492 Patent. EX1007, [0024]-[0031], FIGS. 4-5 *cf.* EX1001, 13:63-14:6; EX1003, ¶226. Examples of the ***at least one threshold*** include signal strength thresholds, expected SNR thresholds, and expected bit error rate thresholds. EX1008, [0029] ("failing to provide a ***threshold*** SNR strength and/or ***other threshold factors***, resulting in an ***unacceptable error rate***"), *see id.*, [0030], [0031].

*[10c]-[10e]*

*Supra*, [1b]-[1c] and [3]; EX1003, ¶227. The logic 403 described by Liu can select between a linear multi-user decoder 406 and a non-linear multi-user decoder 407. EX1008, [0024]-[0029], FIG. 4. Liu describes an embodiment where linear multi-user decoder 406 is an MMSE detector and non-linear multi-user decoder 407 is a maximum likelihood detector. EX1007, [0027]-[0028]; EX1003, ¶227. Nonlinear maximum likelihood detectors are more complex than linear MMSE detectors. EX1008, [0029] (referring to “the simpler” decoder 406); EX1003, ¶228 (citing corroborating EX1013, 1).

Liu explains that more complex detectors “may drain more battery power of a terminal, generate more heat and/or the like.” EX1008, [0029]; EX1003, ¶229. It is therefore 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. *Id.* To the extent that Liu only discloses two MUDs—linear MUD 406 and nonlinear MUD 407—a POSITA would have found it obvious to implement the MUD system per Mills with a *low complexity MUD*, a *medium complexity MUD*, and a *high complexity MUD* to provide a broader menu of options for tailoring complexity to interference levels. *Supra*, §V.C.3. EX1003, ¶229.



EX1008, FIG. 4 (annotated).

As depicted above, multiuser decoders 406, 407 are each *switchably coupled* to logic 403. EX1008, [0024]-[0029], FIG. 4; EX1003, ¶230. 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 low, medium, or high complexity processed information streams*. EX1007, [0029]-[0031], FIG. 1; EX1008, [0024]-[0029], FIG. 4; *supra*, [1c], §V.C.3; EX1003, ¶230.

[10f]

*Supra*, [1d]; EX1003, ¶231. In the Mills-Liu combination, the *low, medium and high complexity processed information streams* are each coupled to the *bank*

of single user *decoders* 16 which outputs a *plurality of refined information streams*. EX1007, [0029]-[0031], [0034], FIG. 1; EX1008, [0028]-[0039], FIG. 4; EX1003, ¶231.

[11]

Mills discloses a filter 13 representing a *front end section* that is coupled to *received signals* through parameter estimation unit 12. EX1007, [0030] (“digitized signal...input to parameter estimation unit 12”), [0031] (“digitized signal...passed through...filter 13”), *see id.*, [0028], [0029], [0040]-[0042], FIGS. 1-2; EX1003, ¶232. This *front end section* is also coupled to *received signal information* generated by the parameter estimator 12. EX1007, [0028]-[0031], [0040]-[0042], FIGS. 1-2; *supra*, [10a]. The *front end section* filters the *received signals*. EX1007, [0031] (“reduces the correlation between symbols of interfering users”).

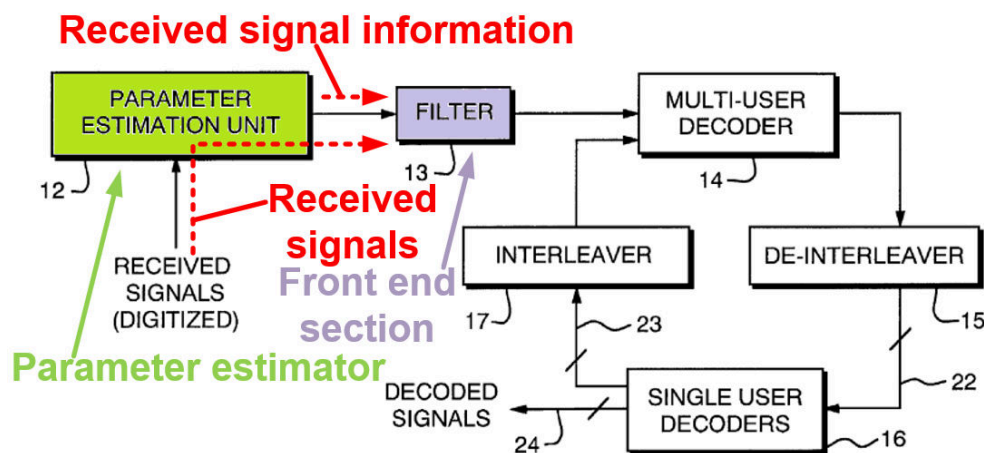


FIG. 1  
(PRIOR ART)

EX1007, FIG. 1 (annotated).

**[12]-[13], [15]-[16]**

*Supra*, [2]-[3], [7], [9], respectively; EX1003, ¶233-236.

**[17pre]**

*Supra*, [1pre], [10pre]; EX1003, ¶237. Mills discloses a **method** for processing **signals** from **multiple users**. EX1007, [0001] (“**method**...in a receiver for iterative turbo multi-user detection”), [0021] (“**method**...for processing simultaneously occurring, interfering signals”); *see id.*, [0028]-[0039], FIG. 1. Mills also discloses that **signals** corresponding to **multiple users** can be **processed** as **raw digitized data**. EX1007, [0030] (“**digitized** signal...is then input to parameter estimation unit 12”); *see id.*, [0031], [0042], FIG. 1 (“digitized”); EX1003, ¶237.

**[17a]**

*Supra*, [1a], [10a]; EX1003, ¶238. Mills discloses that a parameter estimation unit 12 performs a **parameter estimation** of the **raw digitized data**. EX1007, [0030] (“digitized signal...is then input to parameter estimation unit 12...to...identify parameters for each interfering signal”). EX1007, [0030]; *see id.*, [0005], [0029], FIG. 1; EX1003, ¶238.

**[17b]**

Mills explains that 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] (“turbo decoder operates on one block of coded data bits, or

symbols, at a time”); *see id.*, [0029], [0039], [0054]; EX1003, ¶239. Specifically, each of these data blocks are 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 id.*, [0054].

**[17c]**

Mills explains that for each iteration, soft output decoders 16 generate “conditional probabilities” indicating a confidence that symbol estimates output from MUD 14 are correct. EX1007, [0034], *see id.*, [0014]-[0017], [0029], [0035]-[0039], [0043], [0046], [0050]; EX1003, ¶240. These 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 symbol estimates are continuously improved throughout these iterations until final decoded signals are reached. EX1007, [0038], *see id.*, [0014]-[0017], [0039], [0040], [0054], FIG. 1; EX1003, ¶240. For example, Mills describes one embodiment where a MUD system determines whether each conditional probability has exceeded a “minimal absolute probability value” and terminates the decoding process if this occurs. EX1007, [0014]-[0017].

For each iteration, symbol estimates associated with lower conditional probabilities are therefore improved to reach the desired level of performance, while symbol estimates with higher conditional probabilities remain completely or largely unchanged, because these symbol estimates represent **known bits** that are estimated with high confidence. EX1007, [0014]-[0017], [0029]-[0039], FIG. 1; EX1003, ¶241. Because each iteration involves improving low confidence estimates while leaving high confidence estimates unchanged, Mills'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. *Id.* 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, [0014]-[0017], [0028]-[0055], FIGS. 1-2; *cf.* EX1001, 19:66-20:12; EX1003, ¶241.

[17d]

*Supra*, [1b]-[1c]; EX1003, ¶242.

[17e]

As described for [17c], *supra*, Mills describes techniques for generating conditional probabilities indicating a confidence that symbol estimates output from MUD 14 are correct and discloses techniques for comparing these conditional probabilities to a threshold to determine whether the symbol estimates represent

*known bits* or *unknown bits*. EX1007, [0014]-[0017], [0029]-[0039], FIG. 1; EX1003, ¶243. The Mills-Liu combination therefore provides a MUD system that *estimates unknown bits* from a respective *window of bits* using a selected *MUD*. *Supra*, [1b]-[1c], [17c]; EX1003, ¶244.

**[17f]**

Mills 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 id.*, [0054]; EX1003, ¶244. This means that when hard outputs are generated for a respective *window of bits*, the MUD system of the Mills-Liu combination *increments* to a *next window of bits*. EX1007, [0028]-[0055], FIGS. 1-2; EX1003, ¶244.

**[17g]**

Because Mills explains that the iterative process proceeds to “the next block of received data bits, repeating the process,” the MUD system of the 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; EX1003, ¶245.

**D. GROUND 2B: Mills-Liu-Sampath renders obvious claims 10-13 and 15-16**

*1. The Mills-Liu-Sampath Combination*

To the extent that the Mills-Liu combination would not have rendered obvious low, medium, and high complexity MUDs, Sampath provides this feature. EX1006, [0039]-[0043], [0047]-[0048], FIG. 3A; *supra*, §V.B.1, Ground 1B (§V.B.3) at [1b]-[1c]; EX1003, ¶77. Multiple reasons would have prompted a POSITA to implement the MUD system of the Mills-Liu combination in accordance with Sampath's suggestion for selecting between low, medium, and high complexity MUDs. EX1003, ¶77.

*First*, a POSITA would have understood that implementing the MUD system of the Mills-Liu combination to include three different MUDs 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 MUDs. EX1003, ¶78. For example, Sampath explains that having multiple (e.g., three) separate decoders can help to ensure that "the optimum demodulator is selected." EX1006, [0022]; EX1003, ¶78.

*Second*, 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” multi-user decoder 406 and the non-linear “maximum likelihood” multi-user decoder 407. EX1006, [0026]-[0027], [0036], [0039]-[0040], FIG. 3A; EX1003, ¶79. Doing so would provide additional linear decoders that can handle lower amounts of interference while consuming low amounts of resources. EX1003, ¶79.

*Third*, as discussed above (*supra*, §V.A.3), 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. EX1003, ¶80.

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. *KSR at* 401; EX1003, ¶81.

## 2. *Claim-by-claim Analysis*

### *[10pre]-[10a]*

*Supra*, Ground 2A (§V.C.3) at [10pre]-[10a]) EX1003, ¶246.

### *[10b]*

*Supra*, Ground 2A (§V.C.3) at [1b]-[1c], [3], and [10b]. EX1003, ¶247.

Furthermore, Sampath discloses a demodulator selector 316 that can select one of demodulators 304, 308, 312 based upon *at least one threshold*. EX1006, [0039], [0041], [0043], Cls. 8-9; EX1003, ¶247.

**[10c]-[10e]**

*Supra*, Ground 2A (§V.C.3) at [1b]-[1c], [3], and [10c]-[10e]. EX1003, ¶248. The demodulator selector 316 described by Sampath selects between ***low***, ***medium***, and ***high complexity MUDs*** represented by MRC demodulator 304, MMSE demodulator 308, and MMSE demodulator with IN 312, respectively. EX1006, [0039]-[0043], FIG. 3A. This means that the Mills-Liu-Sampath combination includes ***low***, ***medium***, and ***high complexity MUDs***—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. EX1003, ¶248; *supra*, §V.D.1. 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,” meaning that a POSITA would have found it obvious to implement Liu’s MUD system with additional MUDs. EX1007, [0028]; EX1003, ¶248.

**[10f]**

*Supra*, Ground 2A (§V.C.3) at [1d]. EX1003, ¶249. The Mills-Liu-Sampath combination provides ***low***, ***medium***, and ***high complexity processed information streams*** 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; EX1003, ¶249; *supra*, §V.D.1.

[13]

*Supra*, Ground 2A (§V.C.3) at [13]. EX1003, ¶250. Furthermore, Sampath explains that the demodulator selector 316 representing *a MUD decision unit* uses *decision criteria* including “a metric” to select an appropriate demodulator, and that this metric includes *at least one threshold* selected from a group including *expected SINR*. EX1006, [0039], [0041], [0043], Cls. 8-9, 13-14, 23-24; EX1003, ¶250.

[11]-[12] and [15]-[16]

The Mills-Liu-Sampath combination renders obvious [11]-[12] and [15]-[16] for at least the reasons described for the Mills-Liu combination (Ground 2A (§V.C.3) at [11]-[12], [15]-[16], *supra*); EX1003, ¶251.

## VI. INSTITUTION SHOULD NOT BE DENIED ON DISCRETION

Petitioner believes that discretionary denial is unwarranted, and yet, Petitioner intends to utilize the bifurcated briefing process contemplated by the March 26, 2025, Stewart Memorandum to rebut contentions if offered by Patent Owner to the contrary. *See* EX1102; EX1103; Video at <https://uspto.coso-cloud.com/p9xpz6s4jn75/>.

## **VII. CONCLUSION AND PAYMENT OF FEES**

The Challenged Claims are unpatentable. Petitioners authorize charge of fees to Deposit Account 06-1050.

## **VIII. MANDATORY NOTICES UNDER 37 C.F.R. § 42.8(a)(1)**

### **A. Real Party-In-Interest Under 37 C.F.R. § 42.8(b)(1)**

Lenovo and Motorola are real parties-in-interest, and, solely because it is named as a defendant in a co-pending district court case listed below, Lenovo Group Ltd., is also a real party-in-interest.

### **B. Related Matters Under 37 C.F.R. § 42.8(b)(2)**

The '492 Patent is the subject of civil actions *Collision Communications, Inc. v. Samsung Electronics Co. Ltd et al.*, 2-23-cv-00587 (E.D. Tex.) filed December 12, 2023 (pending) and *Collision Communications, Inc. v. Lenovo Group Ltd*, 2-23-cv-00594 (E.D. Tex.) filed December 12, 2023 (pending). The '492 patent was also the subject of IPR2024-01247, filed August 1, 2024 (denied) and civil actions *Collision Communications, Inc. v. Telefonaktiebolaget LM Ericsson et al.*, 2-21-cv-00327 (E.D. Tex.) filed August 27, 2021 (settled) and *Collision Communications, Inc. v. Nokia Corporation et al.*, 2-21-cv-00308 (E.D. Tex.) filed August 10, 2021 (settled).

Petitioners are not aware of any other disclaimers, reexamination certificates, or IPR petitions addressing the '492 Patent.

### **C. Lead And Back-Up Counsel Under 37 C.F.R. § 42.8(b)(3)**

Petitioners provides the following designation of counsel.

| Lead Counsel                                                                                                                                                                                                                                       | Backup counsel                                                                                                                                                                                                                                                                          |
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**D. Service Information**

Please address all correspondence and service to the address listed above.

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Respectfully submitted,

Dated April 25, 2025

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**CERTIFICATION UNDER 37 CFR § 42.24**

Under the provisions of 37 CFR § 42.24(d), the undersigned hereby certifies that the word count for the foregoing Petition for *Inter partes* Review totals 13,880 words, which is less than the 14,000 allowed under 37 CFR § 42.24.

Dated April 25, 2025

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**CERTIFICATE OF SERVICE**

Pursuant to 37 CFR §§ 42.6(e)(4)(i) *et seq.* and 42.105(b), the undersigned certifies that on April 25, 2025, a complete and entire copy of this Petition for *Inter partes* Review, Power of Attorney, and all supporting exhibits were provided via Express Mail, to the Patent Owner by serving the correspondence address of record as follows:

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