

UNITED STATES PATENT AND TRADEMARK OFFICE

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**BEFORE THE PATENT TRIAL AND APPEAL BOARD**

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SAMSUNG ELECTRONICS CO., LTD.;  
SAMSUNG ELECTRONICS AMERICA, INC.,  
Petitioner

v.

EMPIRE TECHNOLOGY DEVELOPMENT LLC,  
Patent Owner.

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Case No. IPR2024-00896  
U.S. Patent No. 8,798,120

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**PETITION FOR *INTER PARTES* REVIEW  
OF U.S. PATENT NO. 8,798,120**

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**LIST OF EXHIBITS<sup>1</sup>**

| <b>Ex. No.</b> | <b>Description</b>                                                                                                                                                                                         |
|----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Ex-1001        | U.S. Patent No. 8,798,120 (“the ’120 Patent”)                                                                                                                                                              |
| Ex-1002        | Declaration of Dr. Matthew C. Valenti                                                                                                                                                                      |
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| Ex-1005        | U.S. Patent Publication No. 2006/0067263 (“Li”)                                                                                                                                                            |
| Ex-1006        | Mohammad Z. Siam et al., <i>Adaptive Multi-antenna Power Control in Wireless Networks</i> , International Conference on Wireless Communications and Mobile Computing 875-880 (2006) (“Siam”)               |
| Ex-1007        | Shuguang Cui et al., <i>Modulation Optimization Under Energy Constraints</i> , 4 Institute of Electrical and Electronic Engineers International Conference on Communications 2805-2811 (2003) (“Cui-2003”) |
| Ex-1008        | Esa Tirola and Juha Ylitalo, <i>Performance of a UMTS Uplink MIMO Scheme</i> , 1 Institute of Electrical and Electronic Engineers 58th Vehicular Technology Conference 657-661 (2003) (“Tirola”)           |
| Ex-1009        | U.S. Patent Publication No. 2007/0171808 (“Wu”)                                                                                                                                                            |
| Ex-1010        | INTENTIONALLY LEFT BLANK                                                                                                                                                                                   |
| Ex-1011        | INTENTIONALLY LEFT BLANK                                                                                                                                                                                   |
| Ex-1012        | INTENTIONALLY LEFT BLANK                                                                                                                                                                                   |
| Ex-1013        | INTENTIONALLY LEFT BLANK                                                                                                                                                                                   |

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<sup>1</sup> Four-digit pin citations that begin with 0 are to the branded numbers added by Samsung in the bottom right corner of the exhibits. All other pin citations are to original page, column, paragraph, or line numbers.

| Ex. No. | Description                                                                                                                                                                                                                        |
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| Ex-1014 | INTENTIONALLY LEFT BLANK                                                                                                                                                                                                           |
| Ex-1015 | INTENTIONALLY LEFT BLANK                                                                                                                                                                                                           |
| Ex-1016 | INTENTIONALLY LEFT BLANK                                                                                                                                                                                                           |
| Ex-1017 | INTENTIONALLY LEFT BLANK                                                                                                                                                                                                           |
| Ex-1018 | INTENTIONALLY LEFT BLANK                                                                                                                                                                                                           |
| Ex-1019 | INTENTIONALLY LEFT BLANK                                                                                                                                                                                                           |
| Ex-1020 | Claim Mapping Table                                                                                                                                                                                                                |
| Ex-1021 | <i>Empire Technology Development LLC v. Samsung Electronics Co., Ltd., et al.</i> , Case No. 2:23-cv-00427, Infringement Contentions (E.D. Tex. Jan. 4, 2024).                                                                     |
| Ex-1022 | Declaration of Scott Delman dated Mar. 8, 2024 (Association for Computing Machinery)                                                                                                                                               |
| Ex-1023 | Declaration of Gordon Macpherson dated Apr. 27, 2024 (Institute of Electrical and Electronics Engineers, Incorporated)                                                                                                             |
| Ex-1024 | Screenshot of ACM website (Siam)                                                                                                                                                                                                   |
| Ex-1025 | Shuguang Cui et al., <i>Energy-Constrained Modulation Optimization</i> , 4 Institute of Electrical and Electronic Engineers Transactions of Wireless Communications 2349-2360 (Sept. 2005) (“Cui-2005”)                            |
| Ex-1026 | Shuguang Cui et al., <i>Energy-Efficiency of MIMO and Cooperative MIMO Techniques in Sensor Networks</i> , 22 Institute of Electrical and Electronic Engineers Selected Areas in Communications 1089-1098 (Aug. 2004) (“Cui-2004”) |
| Ex-1027 | INTENTIONALLY LEFT BLANK                                                                                                                                                                                                           |
| Ex-1028 | U.S. Patent Publication No. 2008/0095263 (“Xu”)                                                                                                                                                                                    |
| Ex-1029 | Adam J. Tenenbaum et al., <i>Improved Sum-Rate Optimization in the</i>                                                                                                                                                             |

| Ex. No. | Description                                                                                                                                                                                                                   |
|---------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|         | <i>Multiuser MIMO Downlink</i> , IEEE 984 (2008) (“Tenenbaum”)                                                                                                                                                                |
| Ex-1030 | Runhua Chen et al., <i>Uplink Power Control in Multi-Cell Spatial Multiplexing Wireless Systems</i> , 6 IEEE Transactions of Wireless Communications 2700 (July 2007) (“Chen”)                                                |
| Ex-1031 | U.S. Patent Publication No. 2005/0250452 (“Walton”)                                                                                                                                                                           |
| Ex-1032 | Screenshot of CD contents from Cui-2003 presentation                                                                                                                                                                          |
| Ex-1033 | Bruno Bougard et al., <i>SmartMIMO: An Energy-Aware Adaptive MIMO-OFDM Radio Link Control for Next-Generation Wireless Local Area Networks</i> , EURASIP Journal on Wireless Communications and Networking (2007) (“Bougard”) |
| Ex-1034 | Andreas F. Molisch et al., <i>MIMO Systems with Antenna Selection</i> , IEEE Microwave Magazine 46 (2004) (“Molisch”)                                                                                                         |
| Ex-1035 | Chan-Byoung Chae et al., <i>Adaptive Spatial Modulation for MIMO-OFDM</i> , IEEE Communications Society 87 (2004) (“Chae”)                                                                                                    |
| Ex-1036 | Kyeongjun Ko et al., <i>Low Complexity Multiuser MIMO Scheduling with Chordal Distance</i> , IEEE 80 (2008) (“Ko”)                                                                                                            |
| Ex-1037 | Alkan Soysal et al., <i>Optimizing the Rate of a Correlated MIMO Link Jointly over Channel Estimation and Data Transmission Parameters</i> , IEEE 74 (2008) (“Soysal”)                                                        |
| Ex-1038 | U.S. Patent Publication No. 2005/0289367 (“Clark”)                                                                                                                                                                            |
| Ex-1039 | U.S. Patent Publication No. 2008/0186918 (“Tinnakornsriruphap”)                                                                                                                                                               |
| Ex-1040 | Shuguang Cui et al., <i>Cross-Layer Energy and Delay Optimization in Small-Scale Sensor Networks</i> , 6 IEEE Transactions on Wireless Communications 3688 (2007) (“Cui-2007”)                                                |
| Ex-1041 | U.S. Patent No. 8,315,346 (“Kim”)                                                                                                                                                                                             |
| Ex-1042 | Karama Hamdi et al., <i>Low-Complexity Antenna Selection and User Scheduling in Cognitive MIMO Broadcast Systems</i> , IEEE 4038                                                                                              |

| Ex. No. | Description                                                                                                 |
|---------|-------------------------------------------------------------------------------------------------------------|
|         | (2008) (“Hamdi”)                                                                                            |
| Ex-1043 | Screenshot of CD contents from Tirola presentation                                                          |
| Ex-1044 | Chulhan Lee et al., <i>Adaptive Mode Switching in the MIMO Broadcast Channel</i> , IEEE 711 (2008) (“Lee”)  |
| Ex-1045 | Theodore S. Rappaport, <i>Wireless Communication, Principles and Practice</i> , Ch. 1, 1-24 (2nd ed., 2001) |

## I. INTRODUCTION

Samsung Electronics Co., Ltd. and Samsung Electronics America, Inc. (collectively, “Petitioner”) request *inter partes* review (“IPR”) of Claims 25-29 (“challenged claims”) of U.S. Patent No. 8,798,120 (“the ’120 Patent”) (Ex-1001), currently assigned to Empire Technology Development LLC (“PO”).

## II. MANDATORY NOTICES UNDER 37 C.F.R. §42.8

Real Parties-in-Interest: Petitioner identifies the following real parties-in-interest: Samsung Electronics Co., Ltd. and Samsung Electronics America, Inc.

Related Matters: PO has asserted the ’120 Patent against Samsung Electronics Co., Ltd. and Samsung Electronics America, Inc. in *Empire Technology Development LLC v. Samsung Electronics Co., Ltd., et al.*, Case No. 2:23-cv-00427 (E.D. Tex.) (“*Samsung* litigation”).

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### III. FEE AUTHORIZATION

The PTO is authorized to charge any fees due during this proceeding to Deposit Account No. LA50-0639.

### IV. GROUNDS FOR STANDING

Petitioner certifies that the '120 Patent is available for review, and Petitioner is not barred or estopped from requesting review.

### V. PRECISE RELIEF REQUESTED

Petitioner requests review and cancellation of Claims 25-29 as unpatentable based on the following grounds, supported by a declaration from Dr. Matthew Valenti. Ex-1002 ¶¶1-38, 47-58; Ex-1003.

| Ground | Summary                                                                          |
|--------|----------------------------------------------------------------------------------|
| 1      | Claims 25, 27, and 28 are obvious over Li (Ex-1005) combined with Siam (Ex-1006) |
| 2      | Claims 25, 27, and 28 are obvious over Li-Siam in view of Cui-2003 (Ex-1007)     |
| 3      | Claim 26 is obvious over Li-Siam in view of Wu (Ex-1009)                         |
| 4      | Claim 26 is obvious over Li-Siam-Cui-2003 in view of Wu                          |
| 5      | Claim 29 is obvious over Li-Siam in view of Tirola (Ex-1008)                     |

## VI. THE CHALLENGED PATENT

The '120 Patent describes a system that selects a multiple-input-multiple-output (MIMO) or single-input-multiple-output (SIMO) transmission mode for communicating data between a mobile station and a base station in a communications system based on certain parameters. Ex-1001, 2:12-24, 2:48-55, 7:44-46. In MIMO mode, multiple transmit antennas and multiple receive antennas are used to communicate data, while in SIMO mode, a single transmit antenna and multiple receive antennas are used to communicate data. Ex-1001, 1:1-18. Specifically, a controller in the mobile station receives a control signal that informs the controller whether to select a MIMO mode or a SIMO mode based on, for example, transmission circuitry power consumption of the mobile station, “idle power consumption of the mobile station,” and/or the “number of users of the communications system.” *Id.*, 7:29-36, Cls. 25, 29.

The alleged improvement is a system that selects a transmission mode from either a MIMO or SIMO mode based “on which mode provides a lower energy per bit for transmission in the communications system.” *Id.*, 4:47-50. But the claims are directed to predictable combinations of well-known prior-art elements in wireless communication technologies as reflected, for example, in challenged independent Claim 25, which recites:

25. A mobile station for use in a communications system comprising:

- [a] a first antenna and a second antenna;
- [b] first circuitry coupled to the first antenna and configured to process signals for transmission by the first antenna;  
second circuitry coupled to the second antenna and configured to process signals for transmission by the second antenna; and
- [c] a controller coupled to the first and second circuitry, wherein the controller is configured to receive a control signal and,
- [d] in accordance with the control signal, to select between a multiple-input multiple-output (MIMO) mode wherein both the first and second antennas transmit data over a communications channel and a single-input multiple-output (SIMO) mode wherein only one of the first and second antennas transmit data over a communications channel,
- [e] wherein the control signal is based, at least in part, on a power consumption of the first and second circuitry,
- [f] wherein the control signal is based, at least in part, on an idle power consumption of the mobile station.

Ex-1001, 19:1-20. Challenged dependent Claims 26-28 depend from Claim 25 and further limit the control signal of Claim 25. *Id.*, 19:21-20:2. Challenged independent Claim 29 is identical, except for the last limitation, replacing “idle power consumption of the mobile station” with “a number of users of the communications system.” *Id.*, 20:3-24.

As claimed, a controller in the mobile station receives a control signal and accordingly selects either a MIMO (multiple transmitting antennas) or SIMO (single transmitting antenna) transmission mode, where the control signal is based on circuit

power consumption and other parameters. Annotated Figure 4, below, and the accompanying description, depicts the components of the claimed system<sup>2</sup>:

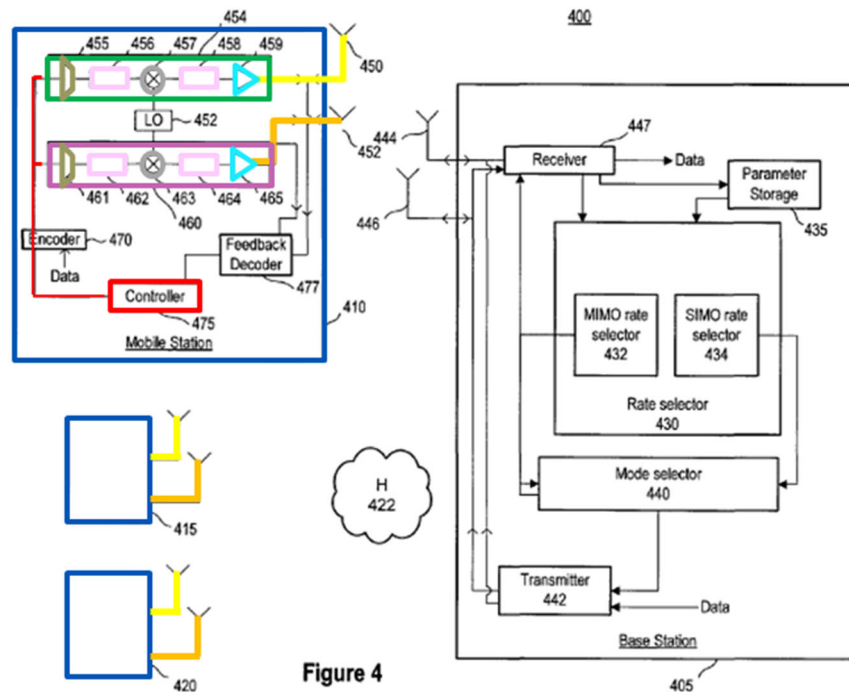


Figure 4

Mobile station 410 (blue) includes two antennas 450 and 452. Ex-1001, 7:17-18. First antenna 450 (yellow) is coupled to first circuitry 454 (green), which processes signals for transmission from antenna 450 and includes additional processing components indicated in various colors. *Id.*, 7:18-22. Second antenna 452 (orange) is coupled to second circuitry 460 (purple), which processes signals from antenna 452 and includes the same additional processing components indicated with the same colors as the first circuitry. *Id.*, 7:23-27. Controller 475 (red), which is coupled to the first and second circuitry via encoder 470, provides “a signal to the

<sup>2</sup> All annotations and emphases are added herein unless otherwise noted.

encoder 470 to operate in a MIMO mode or a SIMO mode.” *Id.*, 7:29-33. Feedback decoder 477, which is coupled to antennas 450 and 452 and controller 475, decodes “received data and provide[s] a signal to the controller 475 corresponding to [the] selected mode.” *Id.*, 7:33-36; *see also id.*, 11:36-38 (Controller 475 receives “a signal indicative of the selected mode, selected rate, selected antenna, or combinations thereof.”). The control signal for selecting a MIMO mode or a SIMO mode may be based on certain parameters, including “idle power consumption of one or more mobile stations, transmission circuitry power consumption of one or more mobile stations,” and “number of users of the communications system.” *Id.*, 8:34-41; Ex-1002 ¶¶39-43.

## **VII. PROSECUTION HISTORY OF THE ’120 PATENT**

The ’120 Patent was filed March 18, 2010 and claims priority to provisional application 61/161,166, filed March 18, 2009.

During prosecution, challenged independent Claim 25 was amended twice to overcome prior art rejections—first to add the limitation reciting “wherein the control signal is based, at least in part, on a power consumption of the first and second circuitry” from a dependent claim and second to add the limitation reciting “wherein the control signal is based, at least in part, on an idle power consumption of the mobile station” from a dependent claim. Ex-1004, 85-101, 120-131, 136-154, 165-175. Challenged independent Claim 29, originally a dependent claim reciting

“wherein the control signal is based, at least in part, on a number of users of the communications system,” was changed to independent form and amended to include most of the other limitations of Claim 25 to overcome prior art rejections. Ex-1004, 136-154, 165-175. The Notice of Allowance recited the “idle power consumption” and “number of users” wherein clauses as the reasons for allowance. Ex-1004, 184-190.

This Petition presents new arguments and prior art not considered during prosecution, and nothing precludes considering them in the first instance under 35 U.S.C. §325(d). All challenged claims are invalid as obvious. Ex-1002 ¶¶44-46.

#### **VIII. LEVEL OF ORDINARY SKILL IN THE ART**

A person of ordinary skill in the art at the relevant time (“POSITA”) would have had a bachelor’s degree in electrical engineering, computer science, computer engineering, or a related field, and two-to-three years of experience in the research, design, development, or testing of wireless data communication systems at the physical and media access control (MAC) layer, with additional education substituting for experience and vice versa. Ex-1002 ¶¶30-34.

#### **IX. PRIORITY DATE**

The ’120 Patent is entitled to a priority date no earlier than March 18, 2009 (the filing date of provisional application 61/161,166). PO has asserted in the pending district court litigation between the parties that the challenged claims were

“conceived as of October 1, 2007,” “reduced to practice with reasonable diligence,” and are “entitled to a priority date of [] October 1, 2007.” Ex-1021, 24. Petitioner disputes this priority date; however, even assuming a priority date of October 1, 2007, all references relied upon in this petition are prior art.

## **X. CLAIM CONSTRUCTION**

Petitioner interprets the claims according to *Phillips*. 37 C.F.R. §42.100(b). To resolve this Petition, Petitioner does not believe that any term requires construction.<sup>3</sup> Ex-1002 ¶¶35-37, 83-84.

## **XI. BRIEF DESCRIPTION OF THE APPLIED PRIOR ART**

### **A. Li (Ex-1005)**

Li (U.S. Pat. Pub. 2006/0067263) was filed September 30, 2004 and published March 30, 2006. Li is prior art under pre-AIA 35 U.S.C. §102(b) based on its publication date. Ex-1002 ¶¶47-51, 59-63.

Li teaches a wireless communication system 100, depicted in Figure 1, which includes multiple “nodes” that communicate information, such as data or control information. Ex-1005 ¶¶9-10, Fig. 1. A “node” could include a server, access point, or cellular phone. *Id.* ¶9. Exemplary nodes also include wireless access point AP 110

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<sup>3</sup> District court claim construction procedures have not yet begun. Petitioner respectfully reserves all rights to raise claim construction and other arguments in district court. Additionally, Petitioner will request leave to submit the district court’s claim construction as soon as it becomes available.

(pink) and mobile stations STA 120 and STA 150 (blue), which may be implemented as high throughput (HT) wireless devices and “may each include a MIMO system” having multiple transceivers and multiple antennas. Ex-1005 ¶¶12-13, 15, Fig. 1.

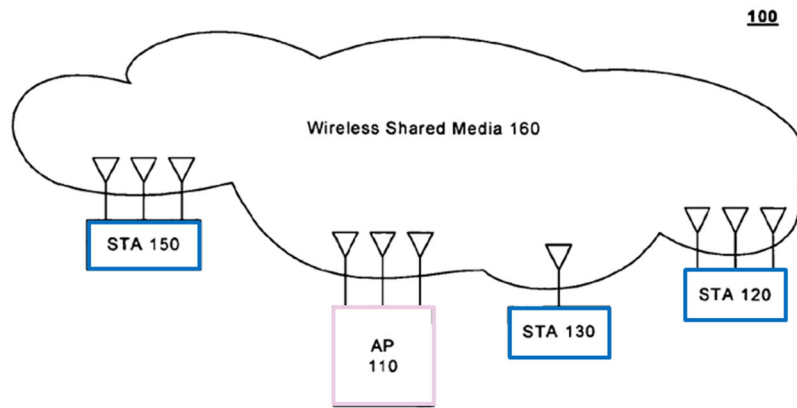
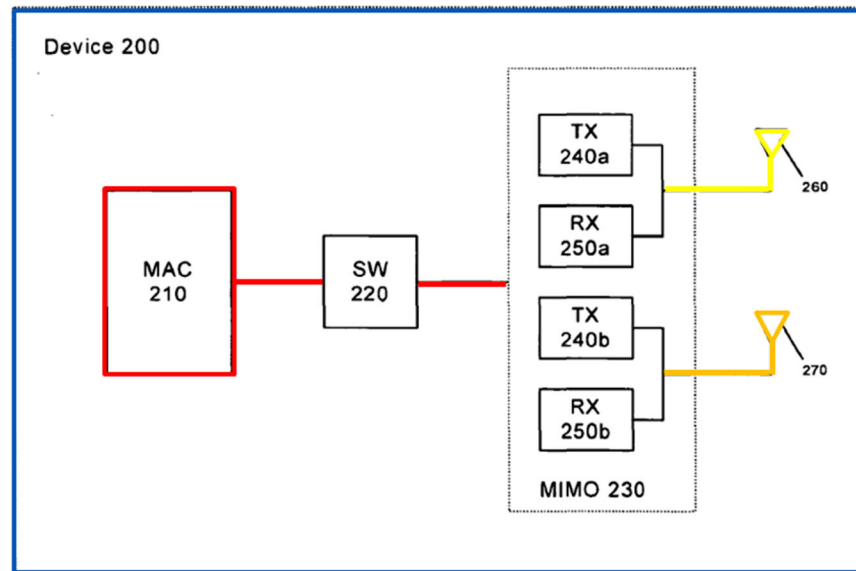


FIG. 1

Li’s Figure 2, below, depicts exemplary node 200 (blue), which may represent any one of AP 110, STA 120 or STA 150 of Figure 1. Ex-1005 ¶20, Fig. 2. Node 200 includes multiple elements, such as media access control (MAC) processor 210 (red), switch (SW) 220, and transceiver array 230. Ex-1005 ¶20, Fig. 2. Li further teaches that transceiver array 230 includes a first transmitter 240a/receiver 250a pair, which are coupled to antenna 260 (yellow), and a second transmitter 240b/receiver 250b pair, which are coupled to antenna 270 (orange). Ex-1005 ¶23, Fig. 2.



Li's MAC processor 210 "may be arranged to receive a physical layer convergence procedure (PLCP) protocol data unit (PPDU)." Ex-1005 ¶24.<sup>4</sup> After receiving the PPDU message, "MAC 210 may output a receiver control signal in response to the received PPDU." Ex-1005 ¶24. The "receiver control signal may cause MIMO system 230 to switch between a first operating mode and a second operating mode in response to the receiver control signal." *Id.* The first and second operating modes are selected from SISO, SIMO, MISO, and MIMO communication modes. *Id.* The operating modes define how many antennas are used for transmitting (TX)<sup>5</sup> (i.e., input to wireless shared media 160) and receiving (RX) signals (i.e.,

<sup>4</sup> In a packet-based network, a PPDU is just a message with particular headers and a data payload that is sent to a node. Ex-1002 ¶65.

<sup>5</sup> TX is an abbreviation for transmitter. RX is the corresponding abbreviation for receiver.

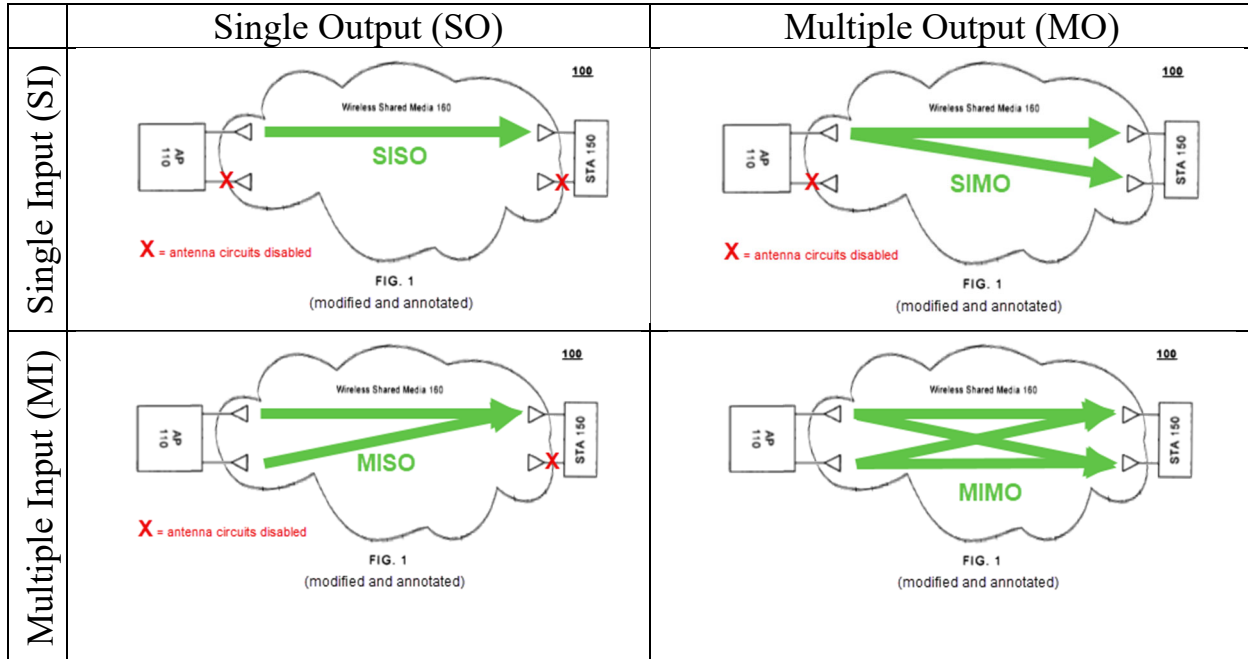
output from the wireless shared media 160). *See id.* ¶17. Thus, SISO refers to single input single-output and can be depicted in Dr. Valenti's diagram below (adapted from Li, Figure 1), where AP 110 is transmitting and STA 150 is receiving:



FIG. 1  
(modified and annotated)

Ex-1002 ¶¶64-65; Ex-1005 ¶17 (“In a SISO operating mode, a single transmitter and a single receiver may be used to communicate information signals....”).

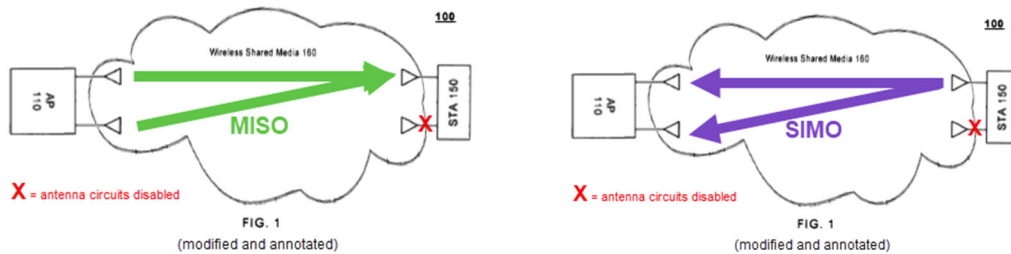
Together, all four modes, SISO, SIMO, MISO, and MIMO, modes can be respectively depicted as follows, assuming AP 110 is transmitting:



Ex-1002 ¶65; Ex-1005 ¶17. While this table depicts the four modes when AP 110 is transmitting and STA 150 is receiving (called the “downlink”), mobile STA 150 also transmits and AP 110 also receives (called the “uplink”). Ex-1005 ¶13 (“STA 120 and STA 150 may each include a MIMO system having *at least two transceivers* and two antennas.”); Ex-1002 ¶¶47, 65.

When STA 150 becomes the transmitter, its active antennas can become the input(s), and AP 110’s active antennas can become the output(s), and correspondingly its mode would change. For example, when AP 110 is transmitting in MISO mode, it is transmitting two inputs to one output received at STA 150 (below, left), but when STA 150 responds it may transmit on one input to two outputs received at AP 110 (below, right), and in such case STA 150 is in SIMO mode. Ex-1005 ¶17 (“two or more transmitters may transmit ... over

wireless shared media 160, ... and [] be received ... by a single receiver”); Ex-1002 ¶¶66.



This is only exemplary. The transmission mode could be MISO on the downlink and any of the four modes (SISO, MISO, SIMO, MIMO) on the uplink. Ex-1002 ¶¶47-51, 66-68.

## B. Siam (Ex-1006)

Siam (“Adaptive Multi-antenna Power Control in Wireless Networks”) was presented at a symposium held on July 3-6, 2006 in Vancouver, British Columbia, Canada, made available to the conference attendees on July 3, 2006, and published by the Association for Computing Machinery on July 11, 2006. Ex-1022 (declaration); Ex-1024 (screenshot of website). Siam is prior art under at least pre-AIA 35 U.S.C. §102(b) because both its presentation date and its ACM publication date are more than a year before the earliest priority date of the ’120 Patent.

Siam presents a protocol, called “E-BASIC,” which “is an extension of BASIC, a power-controlled MAC protocol that was originally developed for SISO-

based ad-hoc networks.” Ex-1006, 876. The protocol dynamically adjusts “on a per-packet basis” the transmission power and transmission mode (e.g., SISO, SIMO, MISO, or MIMO) of data packets in a MIMO-capable wireless network having “two antennas per node,” in order to reduce the total energy consumption. Ex-1006, 875. Siam explains that “[w]hile the MIMO mode requires less RF transmission energy than the other three modes, it also incurs the highest circuit energy consumption.” Ex-1006, 875. Depending on conditions, any of the four modes could be “optimal” for “minimizing the total energy consumption.” Ex-1006, 875.

Accordingly, Siam develops a power model in which the “total power consumption consists of transmission and circuit powers.” Ex-1006, 876. Circuit power,  $P_c$ , is given by:

$$P_c \approx M_t(P_{DAC} + P_{mix} + P_{filt}) + 2P_{syn} + M_r(P_{LNA} + P_{mix} + P_{IFA} + P_{filr} + P_{ADC}) \quad (2)$$

Here,  $P_{DAC}$ ,  $P_{mix}$ ,  $P_{LNA}$ ,  $P_{IFA}$ ,  $P_{filt}$ ,  $P_{filr}$ ,  $P_{ADC}$ , and  $P_{syn}$  are power consumption values for the digital-to-analog converter (DAC), the mixer, the low noise amplifier (LNA), the intermediate frequency amplifier (IFA), the active filters, the analog-to-digital converter (ADC) and the frequency synthesizers. Ex-1006, 877. This circuit power model is folded into Siam’s E-BASIC protocol, which seeks to determine “an optimally chosen multi-antenna scheme (among SISO, SIMO, MISO, or MIMO) according to the total power consumption that each scheme results.” Ex-1006, 877;

Ex-1002 ¶¶69-72.

**C. Cui-2003 (Ex-1007)**

Cui-2003 (“Modulation Optimization Under Energy Constraints”) was presented at a symposium held on May 11-15, 2003 in Anchorage, Alaska, USA, and published by the Institute of Electrical and Electronic Engineers (“IEEE”) on June 11, 2003. Ex-1023 (declaration attaching a screenshot of IEEE’s website as Exhibit A); Ex-1032 (screenshots from Dr. Valenti’s CD). Cui-2003 is prior art under at least pre-AIA 35 U.S.C. §102(b) because both its presentation date and its IEEE publication date are more than a year before the earliest priority date of the ’120 Patent.

Cui-2003 teaches methods for selecting “the best modulation strategy to minimize the total energy consumption” in a wireless transceiver network while meeting data throughput and delay requirements. Ex-1007, 2805. For example, Cui-2003 teaches that “to find the optimal transmission scheme, the overall energy consumption including both transmission and circuit energy consumption needs to be considered.” Ex-1007, 2805.

Cui-2003’s Figures 1 and 2 depict “signal paths on the transmitter and receiver sides.” Ex-1007, 2806, Figs. 1-2. Cui-2003 considers the power consumption of the circuitry coupled to the antennas in active mode, sleep mode, and during transitions back to active mode. Ex-1007, 2806.

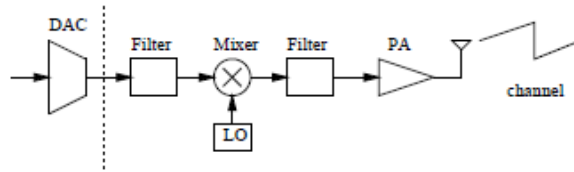


Fig. 1. Transmitter Circuit Blocks (Analog)

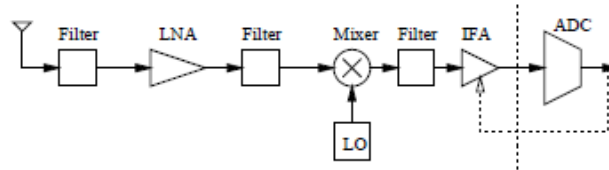


Fig. 2. Receiver Circuit Blocks (Analog)

Specifically, Cui-2003 “assume[s] that the transceiver circuitry works on a multimode basis” such that “when there is a signal to transmit all circuits work in active mode, when there is no signal to transmit they work in sleep mode, and when switching from sleep mode to active mode there is a transient mode.” Ex-1007, 2806. This “multi-mode operation” allows significant energy to be saved when the sleep mode is used. Ex-1007, 2806; Ex-1002 ¶¶73-76.

#### D. Tiirola (Ex-1008)

Tiirola (“Performance of a UMTS Uplink MIMO Scheme”) was presented at a symposium held on October 6-9, 2003 in Orlando, Florida, USA, and published by the IEEE on May 4, 2004. Ex-1023 (declaration attaching a screenshot of IEEE’s website as Exhibit B); Ex-1043 (screenshots from Dr. Valenti’s CD). Tiirola is prior art under at least pre-AIA 35 U.S.C. §102(b) because both its presentation date and its IEEE publication date are more than a year before the earliest priority date of the ’120 Patent.

Tiirola studies uplink (UL) performance in a mobile telecommunications system assuming different SIMO and MIMO transmission approaches from mobile stations having a maximum of two transmit antennas to base stations having up to four antennas. Ex-1008, 657. Figure 1 depicts a “block diagram of the considered SIMO [] and MIMO transmission schemes.” Ex-1008, 657, Fig. 1.

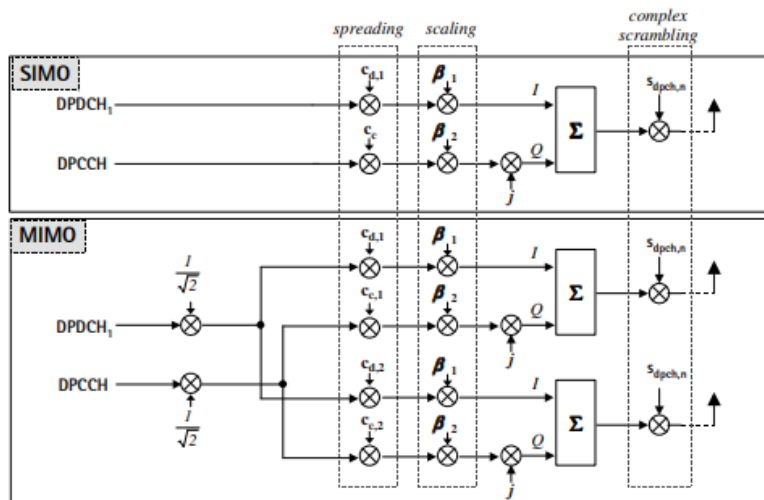
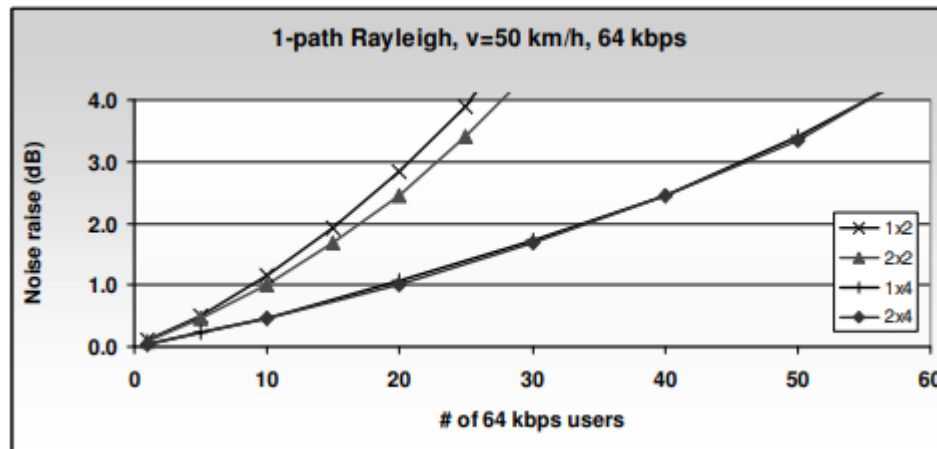


Figure 1. Block diagram of the considered transmission schemes.

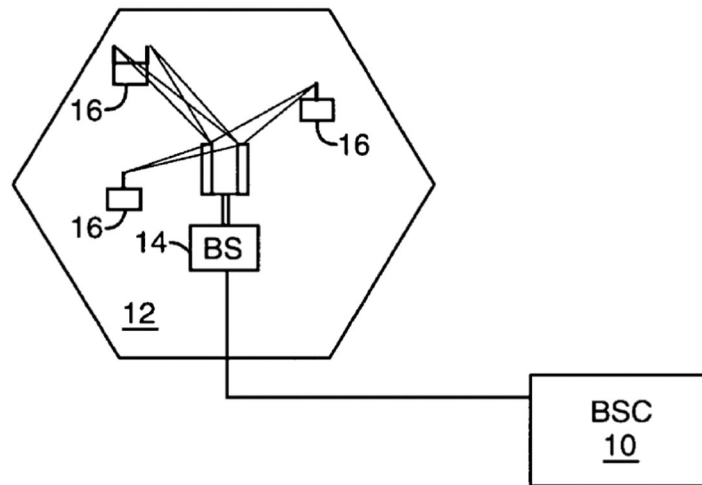
Tiirola calculates and simulates the effects of the number of users ( $J$ ) on uplink performance. Ex-1008, 658. Tiirola also calculates the increase in noise from the UL load factor based on the number of users for various antenna configurations. Ex-1008, 658. Tiirola's simulation of noise rise, depicted in Figure 4(b), demonstrates that noise rise is larger for a 1x2 (SIMO) mode than for a 2x2 (MIMO) mode and the advantage of a MIMO mode increases with increasing number of users. Ex-1008, 659-61, Fig. 4(b); Ex-1002 ¶¶77-79.



#### E. Wu (Ex-1009)

Wu (U.S. Pat. Pub. 2007/0171808) was filed January 20, 2006 and published July 26, 2007. Wu is prior art under at least pre-AIA 35 U.S.C. §102(b).

Wu teaches a scheduling algorithm for a virtual cooperative MIMO system. Ex-1009, Abstract, ¶5. Figure 1 depicts Wu's "wireless communication environment," which includes a base station BS 14 and a number of mobile terminals 16 that have one or more antennas. Ex-1009 ¶¶11, 24.



Wu's system evaluates several factors to determine how the mobile terminals will communicate with the base station. *See, e.g.,* Ex-1009 ¶71. If the mobile terminals are moving very quickly, Wu's base station assumes that the channel is changing too rapidly and randomly schedules the mobile stations to a Random User Scheduling (RUS) group. Ex-1009 ¶73. But if the mobile terminals are moving more slowly, Wu's base station picks one mobile device and then looks for another one such that their channels are the most orthogonal and organizes them into a virtual MIMO system to communicate with the base station in a MIMO mode (this is called channel aware orthogonal scheduling, or CAOS). Ex-1009 ¶74. It then proceeds to the next device and finds its most orthogonal pair device and sets up another MIMO link with them. Ex-1009 ¶76. Wu further teaches that if a certain device has poor channel quality because of high channel correlation, the system instead just sets up a SIMO link for that device to communicate to the base station individually. Ex-

1009 ¶75. Wu explains the well-known relationship that channels that are highly orthogonal to one another have very low correlation. Ex-1009 ¶56. A channel exhibiting high correlation results in “poor channel quality” that results in selection of a SIMO mode. Ex-1009 ¶75, Fig. 12 (flowchart illustrating this concept); Ex-1002 ¶¶80-82.

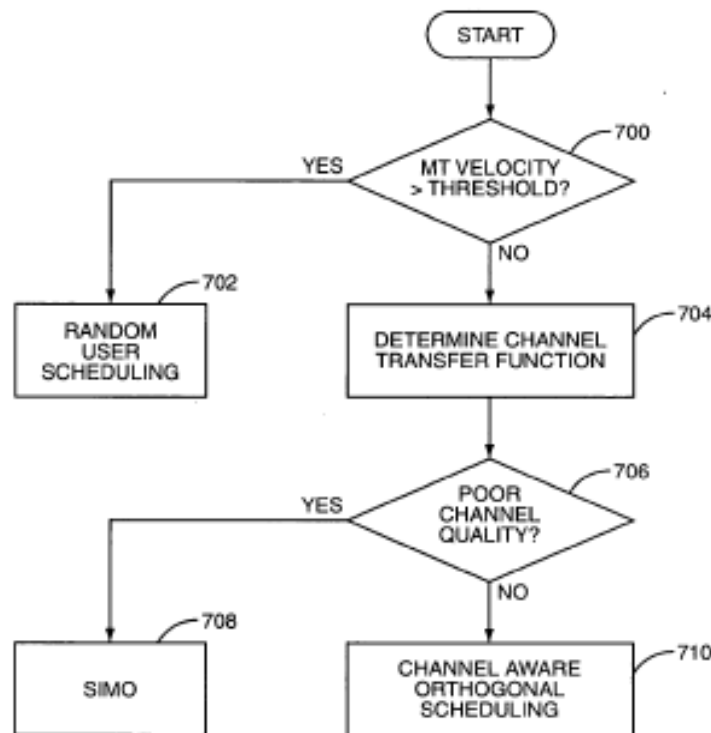


**FIG. 12**

**XII. THE BOARD SHOULD NOT EXERCISE ITS DISCRETION UNDER §325(D) TO DENY HEARING THESE INVALIDITY ISSUES FOR THE FIRST TIME IN THIS PETITION**

In considering its discretion under §325(d), “the Board uses the following two-part framework: (1) whether the same or substantially the same art previously

was presented to the Office or whether the same or substantially the same arguments previously were presented to the Office; and (2) if either condition of first part of the framework is satisfied, whether the petitioner has demonstrated that the Office erred in a manner material to the patentability of challenged claims.” *Advanced Bionics, LLC v. MED-EL Elektromedizinische Geräte GmbH*, IPR2019-01469, Paper 6 at 8 (PTAB Feb. 13, 2020) (precedential).

Here, the first *Advanced Bionics* prong is not met. None of the references relied upon in this petition (Li, Siam, Cui-2003, Wu, and Tirola) was cited or discussed by the examiner. There were two other references authored by Cui (Ex-1026 (“Cui-2004”)) and Ex-1025 (“Cui-2005”)) of record during prosecution but, even if cumulative to Cui-2003,<sup>6</sup> this would not be sufficient to satisfy the first prong of *Advanced Bionics*, because it applies only to the second and fourth grounds (Li-Siam-Cui-2003, and Li-Siam-Cui-2003-Wu) and is only the third reference in those combinations. *See K/S HIMPP v. Bragi GmbH*, IPR2023-01205, Paper 8 at 20 (PTAB March 19, 2024) (first prong not met when secondary reference is the only one arguably before the office: “We note that there is no evidence or argument that Hain or Sørensen were previously considered by the Office or cumulative of art that

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<sup>6</sup> Cui-2003 is relied on for teaching “idle power consumption” in claim 25. *See* Section XIII.B. Cui-2004 (Ex-1026) is not cumulative of Cui-2003 because it does not teach idle power consumption.

was in front of the Office.”); *Godbersen-Smith Constr. Co. d/b/a Gomaco Corp. v. Guntert & Zimmerman Const. Div., Inc.*, IPR2021-00050, Paper 24 at 19-21 (PTAB May 7, 2021) (where “neither [the combination references] nor similar prior art was before the examiner ... the prosecution history does not include any overlapping arguments directed to this prior art”). The primary reference, Li, and other references, Siam, Wu, and Tirola, are not of record.

Regardless, under the second prong, which need not be reached, it was a material error for the examiner not to have considered the disclosures of Cui-2005 to the extent they are similar to those of Cui-2003, as applied here. That is because Cui-2005, cited on an IDS with 18 other references (Ex-1004, 41-42, 79-80), clearly does teach “idle power consumption” (Ex-1025, 2), yet the Notice of Allowance recited the “idle power consumption” limitation as one of the reasons for allowance. Ex-1004, 184-190. Because the record is silent as to the examiner’s understanding of Cui-2005’s teachings, the examiner must have overlooked it (assuming the examiner understood the other limitations of Claim 25 as being taught by the prior art).<sup>7</sup> See *K/S HIMPP*, Paper 8 at 20-21. In view of the foregoing, the Board should

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<sup>7</sup> Although only a proposed rule, under the April 19, 2024 Notice of Proposed Rulemaking on discretionary denials, §325(d) is not applied to references not “meaningfully considered,” which is defined as situations “where the Office has evaluated the art or arguments and articulated its consideration of the art or arguments in the record of the application....” 89 Fed. Reg. 28693, 28700 (Apr. 19, 2024).

not exercise its discretion under §325(d) to deny institution.

### **XIII. DETAILED EXPLANATION OF THE UNPATENTABILITY GROUNDS**

#### **A. Ground 1: Claims 25, 27, and 28 Are Obvious Over Li combined with Siam**

##### **1. A POSITA would have been motivated to combine Li's and Siam's teachings and would have had a reasonable expectation of success**

A POSITA would have been motivated to combine Li and Siam (“Li-Siam”), and would have had a reasonable expectation of success in doing so. Both describe systems that select an optimal data communication mode in a wireless communication system, from among SISO, MISO, SIMO, and MIMO modes, in order to reduce the total energy consumption of the system. Ex-1005 ¶¶18-19; Ex-1006, 875; Ex-1002 ¶¶85-89. As discussed below, Li's system receives a network message and outputs a control signal in response. Ex-1005 ¶24. The control signal causes the mobile station to switch from a first communication mode (e.g., MIMO) to a second communication mode, (e.g., MISO) within a MIMO-capable system. Ex-1005 ¶¶24-25 (“An example of the first operating mode may include a SIMO operating mode and a MIMO operating mode. Examples of the second operating mode may include a SISO operating mode and a MISO operating mode.”). Li also expressly addresses idle power consumption of the receiver, noting that “a station in *idle mode* waiting for incoming signals may consume approximately 60% of its

battery energy.” Ex-1005 ¶18.<sup>8</sup> Li explains that the mode selection is intended to reduce power consumption, thereby extending the battery life of the mobile stations. Ex-1005 ¶19. For example, Li teaches switching the receive mode of mobile station STA 150, enabling two receive antennas and circuits, and also teaches enabling any number of transmitters, as well, such that mobile station STA 150 could be switched, for example, from a transmit SIMO to a transmit MIMO mode, as explained below. *See infra* Section XIII.A.2.e (applying Li-Siam to claim Element 25[d]). Regardless, such an optimization would have been obvious in view of Siam.

Siam complements Li by expressly teaching a protocol (called E-BASIC) for switching the *transmit* mode of a MIMO-capable system between using a single transmit antenna (e.g., SIMO) and using multiple transmit antennas (e.g., MIMO) to reduce total energy consumption. Ex-1006, 875. Like Li’s mode switching scheme, Siam’s E-BASIC protocol is also based on a multiple access (MAC) protocol. Ex-1006, 876. While both Li and Siam switch modes to reduce power consumption, Siam’s protocol expressly takes into consideration both radio frequency (RF)

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<sup>8</sup> Idle power consumption means that the circuits are powered but have nothing to transmit or receive. For example, the ’120 Patent explains that “idle time is a time during which the transceiver may be waiting to send data over the communications channel. The transceiver may, for example, be waiting for a scheduled start time for the transceiver to use the communications channel.” Ex-1001, 2:60-64. On the receiver side, idle power consumption means that the circuits are powered but have nothing to receive.

transmission power (i.e., what is radiated) and circuit power consumption (i.e., what is dissipated as heat). Ex-1006, 875-76. For example, Siam teaches that “[w]hile the MIMO mode requires less RF transmission energy than the other three modes, *it also incurs the highest circuit energy consumption.*” Ex-1006, 875. Thus, Siam recognizes explicitly that a tradeoff between transmit power and circuit power consumption is necessary to select the optimal mode. Ex-1006, 875-76.

A POSITA would have been motivated to improve Li’s mode-switching system by adding Siam’s teaching that expressly considers transmission and circuit power consumption to select an optimal transmit mode between SIMO and MIMO (or SISO and MISO) at the mobile station to minimize battery power consumption. Ex-1002 ¶¶90-91. Li already teaches using “its battery energy for communicating actual traffic.” Ex-1005 ¶18. In the combined Li-Siam system, Li’s PPDU message received by Li’s MAC 210 for switching receiver communication modes would also be based on Siam’s teaching that both transmission power and circuit power should be considered when selecting the optimal communication mode, because both references seek to optimize power consumption and preserve battery life. Ex-1002 ¶¶58, 91.

A POSITA would have had a reasonable expectation of success in combining the teachings of Li and Siam because they teach compatible systems—namely, electronic devices operating in accordance with IEEE 802.11 standard protocols or

other data communications standards for wireless communication systems. Ex-1005 ¶¶12, 18-25; Ex-1006, 875-78; Ex-1002 ¶92. Additionally, Li and Siam address the problem of inefficient power consumption in wireless communication devices in similar and predictable ways, namely, by selecting and/or switching to an optimal transmission mode between SISO, SIMO, MISO, and MIMO to reduce total power consumption and improve overall system performance. Ex-1005 ¶19; Ex-1006, Abstract; Ex-1002 ¶92. A POSITA would have understood that their teachings could be combined with little to no change in their respective functions. Ex-1002 ¶92.

## **2. Independent Claim 25**

### **a. Element 25[pre]: A mobile station for use in a communications system comprising:**

Li-Siam teaches or suggests Claim 25's preamble, to the extent it is limiting. Ex-1002 ¶93. Li teaches a wireless communication system 100, depicted in Figure 1, which includes multiple nodes that communicate information, such as media and control information. Ex-1005 ¶¶9-10, Fig. 1. Exemplary nodes include stations STA 120 and STA 150 (blue), which "may each be implemented as, for example, a wireless communication device, such as mobile or cellular telephone." Ex-1005 ¶14. STA 150, for example, is a claimed mobile station for use in a communication system.

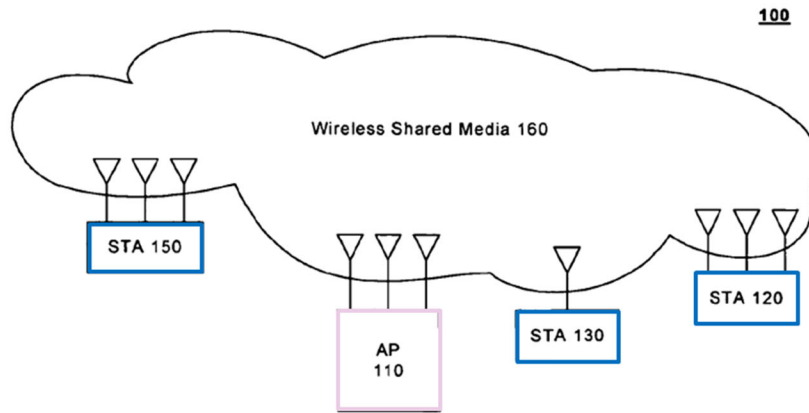


FIG. 1

**b. Element 25[a]: a first antenna and a second antenna;**

Li-Siam teaches or suggests Element 25[a]. Ex-1002 ¶¶94-95. Li's system 100 includes mobile station STA 150 (blue), which may be implemented as “[a] mobile or cellular telephone” and “may ... include a MIMO system having at least two transceivers and two antennas.” Ex-1005 ¶¶13-15, Fig. 1.

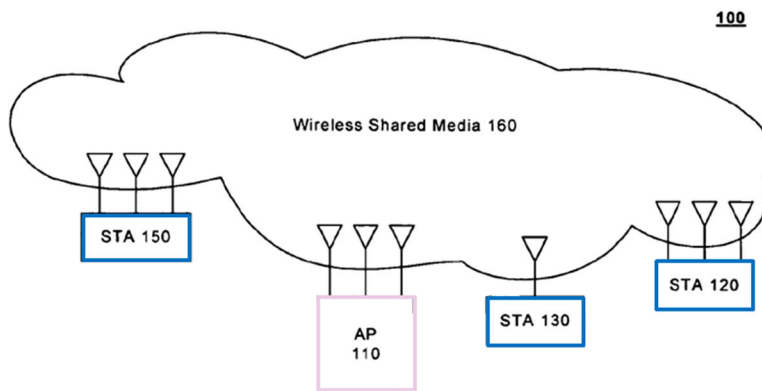
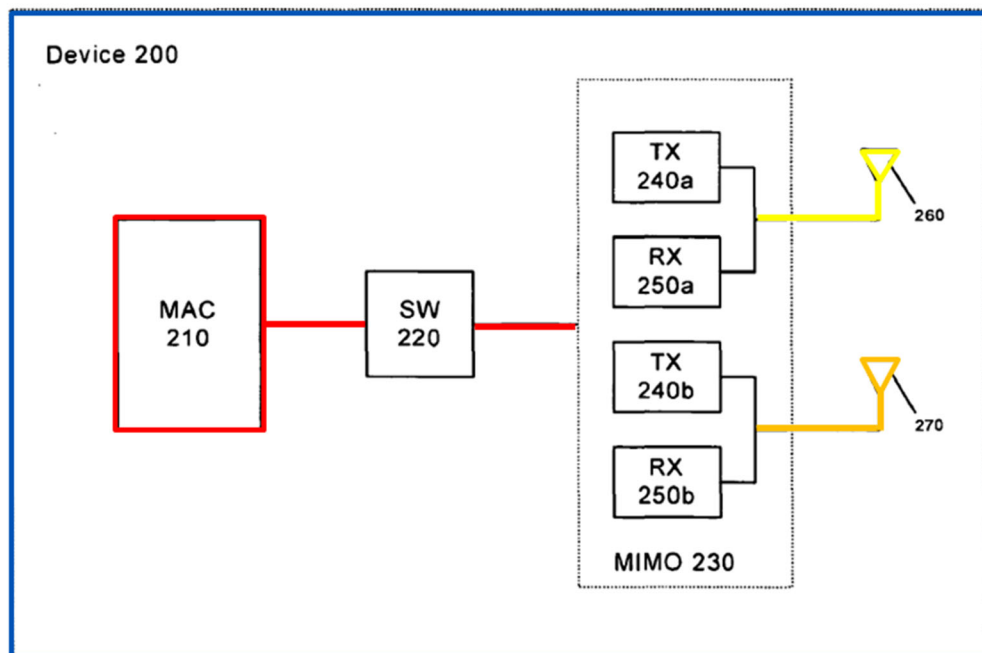


FIG. 1

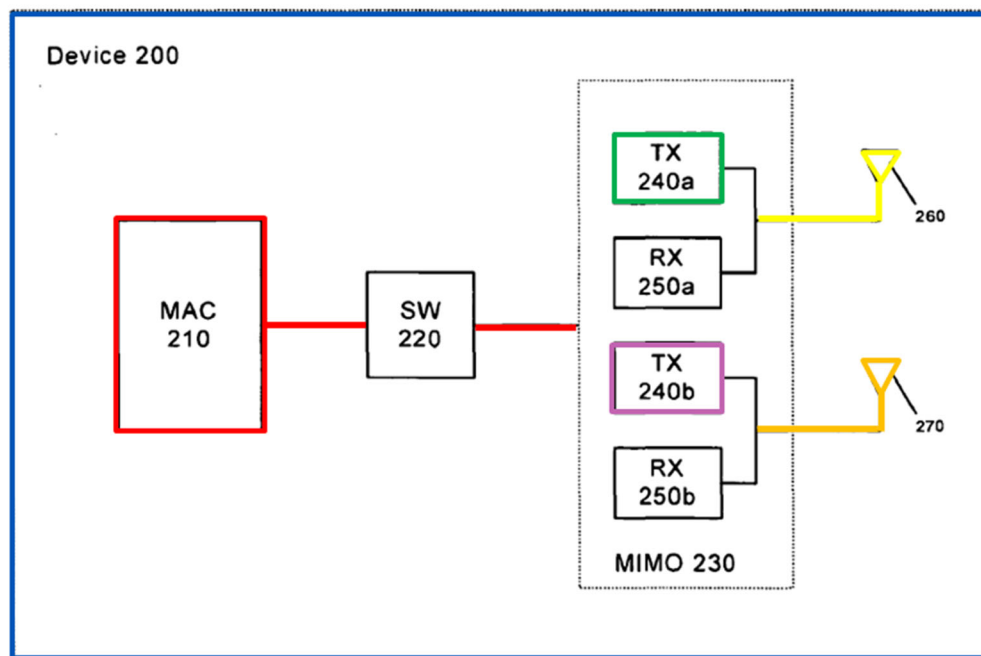
Node 200 (blue), depicted in Figure 2 (below), represents mobile station STA 150. Ex-1005 ¶20, Fig. 2. The mobile station STA 150 includes a first antenna 260 (yellow) and a second antenna 270 (orange). Ex-1005 ¶23, Fig. 2. First antenna 260 is coupled to transmitter 240a/receiver 250a in transceiver array 230, and second antenna 270 is coupled to transmitter 240b/receiver 250b, also in transceiver array 230. Ex-1005 ¶23, Fig. 2.



- c. **Element 25[b]: first circuitry coupled to the first antenna and configured to process signals for transmission by the first antenna; second circuitry coupled to the second antenna and configured to process signals for transmission by the second antenna; and**

Li-Siam teaches or suggests Element 25[b]. Ex-1002 ¶96. Li's first and second antennas are coupled to first and second circuitry that processes signals for

transmission by the respective antennas. In Figure 2, node 200 (blue), representing mobile station STA 150, includes transmitter circuitry 240a (green) that is “operatively coupled” to first antenna 260 (yellow) and transmitter circuitry 240b (purple) that is “operably coupled” to second antenna 270 (orange). Ex-1005 ¶¶21, 23; Fig. 2.



Li’s “transmitters 240a-b ... may communicate data frames with other wireless devices.” Ex-1005 ¶22. The “data frames may be modulated in accordance with a number of modulation schemes, to include Binary Phase Shift Keying (BPSK), Quadrature Phase-Shift Keying (QPSK),” and others. *Id.* A POSITA would have understood that in order to modulate data and communicate data frames, transmitters 240a and 240b would include circuitry “configured to process signals” for

transmission through the antennas to which they are “coupled.” Ex-1002 ¶97; *see also* Ex-1005 ¶¶20 (Node 200’s elements may be implemented using “one or more circuits, components, registers, processors, software subroutines, or any combination thereof.”), 52-56.

Moreover, a POSITA would have understood that the first and second circuitry process signals for transmission by the first and second antenna because Li teaches that “wireless communication devices with multiple antennas may include a [MIMO] modulation and/or coding system to control receiving and transmitting of RF signals through multiple antennas.” Ex-1005 ¶1; Ex-1002 ¶98.

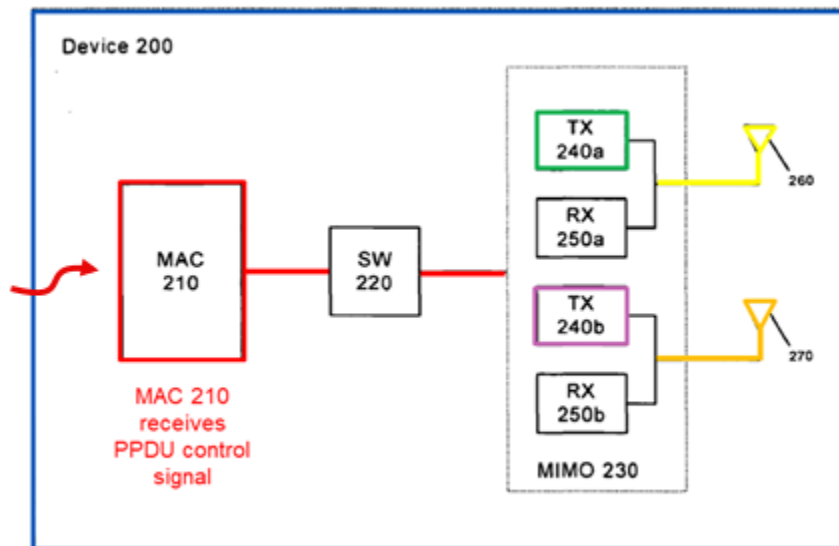
**d. Element 25[c]: a controller coupled to the first and second circuitry, wherein the controller is configured to receive a control signal and,**

Li-Siam teaches or suggests Element 25[c]. Ex-1002 ¶99. Li teaches a controller coupled to the first and second circuitry of mobile station STA 150, wherein the controller is configured to receive a control signal which may be sent by access point AP 110. Ex-1005 ¶¶27, 30. Media Access Control (MAC) processor 210 (red) of node 200 (blue) is “a controller”<sup>9</sup> configured to receive a PPDU message

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<sup>9</sup> Elsewhere Li refers to the MAC as the “media access controller” (*see* Ex-1005, claim 1), suggesting to a POSITA that the closely related terms controller and processor are being used interchangeably. Li also notes that its embodiments could be implemented in any suitable form including: processors, computers, and processing devices, etc. (Ex-1005 ¶58), which a POSITA would have understood to include controllers. Ex-1002 ¶¶55, 99.

(the claimed “control signal”) and “output a receiver control signal in response to the received PPDU.” Ex-1005 ¶24, Fig. 2. Although the example in paragraph 24 refers to the PPDU message as a “receiver control signal,” elsewhere Li teaches that “STA 150 may acknowledge the request [from AP 110] and may *enable an operation of desired number of receivers and transmitters* of the MIMO receivers-transmitters system.” Ex-1005 ¶19. Thus, while the specific example refers to receiving a receiver control signal, a POSITA would have understood that STA 150’s controller MAC 210 would also have been configured to receive (and acknowledge) control signals that would also enable the specified number of transmitters. Ex-1002 ¶99.

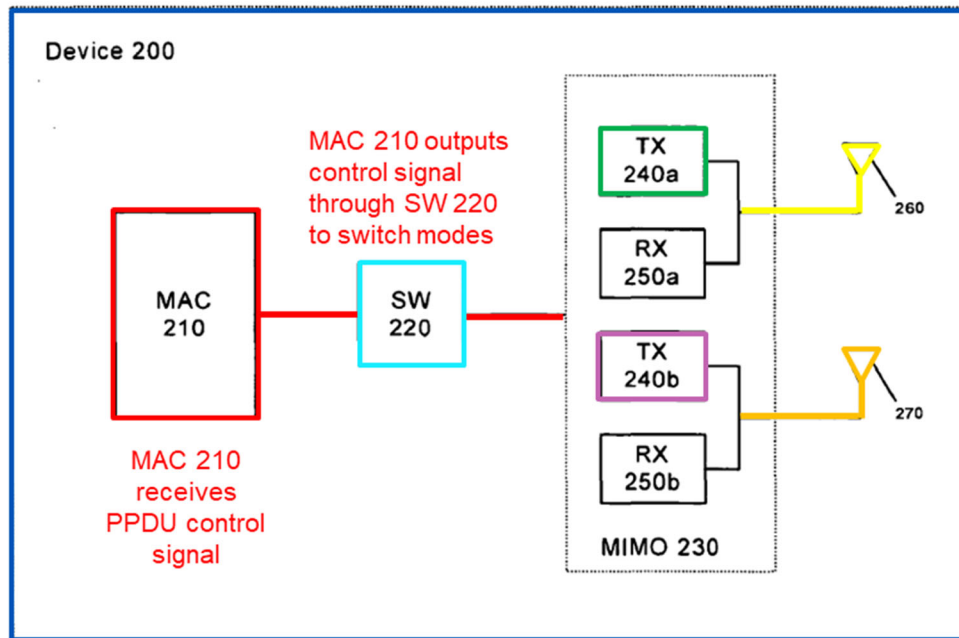


A POSITA would have understood that in order to output a signal to switch the communication mode, MAC processor 210 would need to be coupled to switch

120 and thence to the first and second circuitry, which are further coupled to the first and second antenna, because Li teaches that “wireless communication devices with multiple antennas may include a [MIMO] modulation and/or coding system to control receiving and transmitting of RF signals through multiple antennas.” Ex-1005 ¶1; Ex-1002 ¶100; *see also* Ex-1005 ¶20 (Node 200’s elements may be implemented using “one or more circuits, components, registers, processors, software subroutines, or any combination thereof.”).

- e. **Element 25[d]: in accordance with the control signal, to select between a multiple-input multiple-output (MIMO) mode wherein both the first and second antennas transmit data over a communications channel and a single-input multiple-output (SIMO) mode wherein only one of the first and second antennas transmit data over a communications channel,**

Li-Siam teaches or suggests Element 25[d]. Ex-1002 ¶101. As explained for Element 25[c], Li teaches that the control signal output by MAC processor 210 (red) in response to receiving the PPDU message, outputs a control signal to cause the system “to switch between a first operating mode” and “a second operating mode,” using switch 220 (teal). Ex-1005 ¶¶19, 24-25, Fig. 2.



Li describes an example where “the first operating mode may include a SIMO operating mode and a MIMO operating mode. Examples of the second operating mode may include a SISO operating mode and a MISO operating mode. The embodiments are not limited in this context.” Ex-1005 ¶24. In this non-limiting example, the switch from first mode to second mode is SIMO → SISO or is MIMO → MISO, which is controlling the number of receivers at the mobile STA 150 (i.e., the downlink). Ex-1002 ¶¶47-51, 102-104.

More broadly, Li also teaches that STA 150 can “operate in multiple operating modes” that enable one or multiple transmitter and receiver circuits, including:

In a SISO operating mode, a single transmitter and a single receiver may be used to communicate information signals over a wireless shared medium 160. In a MISO operating mode, two or more transmitters may transmit information signals over wireless shared media 160, and

information signals may be received from wireless shared media 160 by a single receiver of a MIMO system. In a ***SIMO operating mode, one transmitter*** and two or more receivers may be used to communicate information signals over wireless shared media. In a ***MIMO operating mode, two or more transmitters*** and two or more receivers may be used to communicate information signals over wireless shared media 160.

Ex-1005 ¶17.

Thus, because there are only four possible states for the controller (MAC 210) to “select” from, a POSITA would have recognized from the more general description of paragraphs 17 and 19, that the request (i.e., the control signal) from AP 110 may “enable an operation of desired number of receivers and transmitters” suggests that a first operating mode could also be MIMO, when mobile STA 150 is using both of the first and second antennas to transmit, and a second operating mode could be SIMO, when mobile STA 150 is using only one of the first and second antennas to transmit. When a POSITA has a finite set of predictable options, it would have been obvious to pursue any one of those options. *See, e.g., Uber Techs., Inc. v. X One, Inc.*, 957 F.3d. 1334, 1338-40 (Fed. Cir. 2020) (POSITA having a finite number of “predictable choices” is provided “with a simple design choice ... [b]ecause a person of ordinary skill ‘has good reasons to pursue the known options within his or her technical grasp.’” (citing *KSR Int’l Co. v. Teleflex Inc.*, 550 U.S. 417, 421 (2007))). For example, a POSITA would have recognized that in many circumstances, the propagation characteristics of the downlink path are similar to the

propagation characteristics of the uplink path, such that the use of MISO mode between AP 110 (two transmitters) and STA 150 (one receiver) as taught by Li (Ex-1005 ¶¶24) would have suggested to a POSITA to use (or consider using) SIMO mode on the uplink between STA 150 (one transmitter) and AP 110 (two receivers). Ex-1002 ¶¶47-51, 105-107. In other words, if the channel characteristics on the downlink are such that it is optimal to use two transmitters at AP 110 and one receiver at STA 150 (a MISO transmit mode), a POSITA would have considered that it might also be optimal to use that same single antenna at STA 150 to transmit to the two receive antennas at AP 110 (a SIMO transmit mode). Ex-1002 ¶¶107. Therefore, when Li's MAC receives the control signal to switch receiving STA 150 from MISO to MIMO (to enable a second receiver), a POSITA would have been motivated to apply a similar rationale to consider enabling the second transmit circuit, and use the second enabled antenna at the mobile station STA 150 to transmit data back to the AP 110. Ex-1002 ¶¶107-108. In any event, such a SIMO-MIMO mode switch would also have been obvious in view of Siam's teachings, as explained below for Element 25[e].

**f. Element 25[e]: wherein the control signal is based, at least in part, on a power consumption of the first and second circuitry,**

Li-Siam teaches or suggests Element 25[e]. Ex-1002 ¶¶109-110. As the '120 Patent explains, the selection of an optimal power mode needs to take into account

not only the transmitted power, but also “power consumption of circuitry coupled to a plurality of antennas at the transceiver” such that “power consumed by the circuitry used to process signals for antennas” is also “included in the calculation of the energy-optimized rate.” Ex-1001, 2:51-58.

Li-Siam teaches that the control signal for switching communication modes is based, at least in part, on a power consumption of the first and second circuitry used for transmission. For example, in the context of waiting to receive incoming signals, Li explains that when “more than one antenna may be turned on for reception,” “[t]he power consumed by low noise amplifiers and analog-to-digital converters may be multiplied by the number of antennas.” Ex-1005 ¶18. Although these are receiver circuit elements, Li’s mobile STA 150 also includes two transmitter circuits (240a-b) when placed in MIMO mode (Ex-1005 ¶17), and a POSITA would have understood that (as with more receiver circuits 250a-b) more enabled transmitter circuits corresponds to larger power consumption, while fewer enabled transmitter circuits corresponds to reduced power consumption “thereby extending the battery life for [mobile] STA120 and STA150.” Ex-1005 ¶19; Ex-1002 ¶¶53, 110-111. Li’s teachings are in the context of idling receiver circuits, however, Siam expressly teaches consideration of transmitter circuit power during transmission including during the switch from SIMO to MIMO mode.

Specifically, Siam teaches a protocol that explicitly selects between SIMO

and MIMO (and SISO and MISO) transmission modes in a MIMO-capable wireless network based on consideration of both transmission power and circuit power. Ex-1006, 875-76. Siam explains that “[w]hile the MIMO mode requires less RF transmission energy than the other three modes, it also incurs the highest circuit energy consumption.” Ex-1006, 875. Thus, “[d]epending on the transmitter-receiver distance,” any of the four modes, SISO, SIMO, MISO, or MIMO, mode could be “optimal” for reducing total energy consumption. Ex-1006, 875.

Siam teaches that the “total power consumption consists of transmission and circuit powers” and provides algorithms for determining under what conditions the system should select, for example, between a SIMO or MIMO mode. Ex-1006, 876. Specifically, Siam’s protocol uses a multi-antenna link layer model, where  $M_t$  and  $M_r$  are the number of transmitter and receiver antennas, respectively. Ex-1006, 876. Siam calculates transmission power ( $P_t$ )<sup>10</sup> and circuit power ( $P_c$ )<sup>11</sup> as follows:

$$P_t = (1 + \delta)P_{out}$$

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<sup>10</sup> For  $P_t$ , “ $\delta$  is a factor that depends on the drain efficiency of the power amplifier and the underlying modulation scheme” and “ $P_{out}$  is the total transmit power at the air interface.” Ex-1006, 876.

<sup>11</sup> For  $P_c$ , “ $P_{DAC}$ ,  $P_{mix}$ ,  $P_{LNA}$ ,  $P_{IFA}$ ,  $P_{filt}$ ,  $P_{fltr}$ ,  $P_{ADC}$ , and  $P_{syn}$  are the power consumption values for the digital-to-analog converter (DAC),” mixer (MIX), low noise amplifier (LNA), intermediate frequency amplifier (IFA), filters at the transmitter and the receiver sides (FILT), analog-to-digital converter (ADC), and frequency synthesizer (SYN), respectively. Ex-1006, 877.

$$P_c \approx M_t(P_{DAC} + P_{mix} + P_{filt}) + 2P_{syn} + \\ M_r(P_{LNA} + P_{mix} + P_{IFA} + P_{filt} + P_{ADC})$$

As can be appreciated, circuit power, or  $P_c$ , increases with each additional transmitter and receiver,  $M_t$  and  $M_r$ . Siam's goal is to design a protocol that minimizes the total energy consumption per bit ( $E_{bt}$ ) for a pair of communicating nodes, calculated as:

$$E_{bt} = \frac{P_t + P_c}{R_b}$$

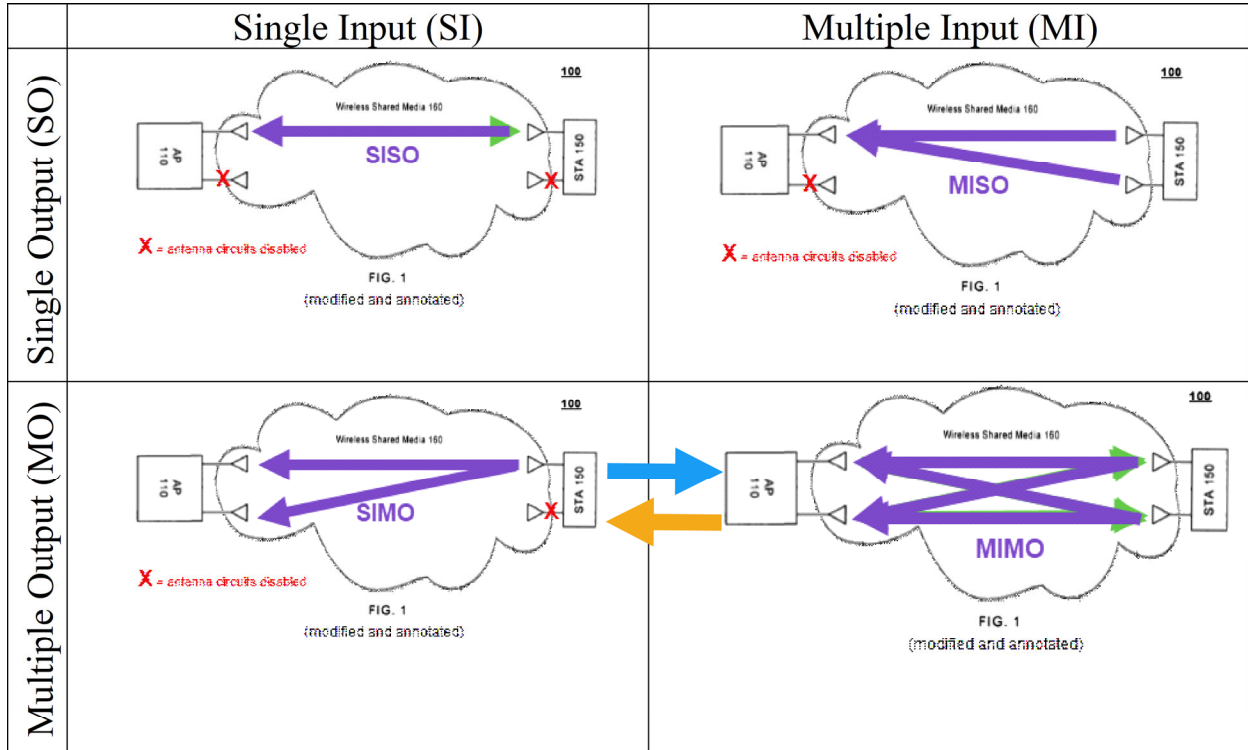
Ex-1006, 877 (“the bit rate  $R_b \approx B$  bits/sec for BPSK modulation”). As the foregoing equation shows, the energy per bit depends both on transmission power,  $P_t$ , and on the power consumption,  $P_c$ , of the circuitry coupled to the antenna. Ex-1002 ¶¶112-116. Applying these equations, Siam explains that:

***MIMO may not lead to the minimum total power consumption due to the large value of circuit power***, which has a varying significance relative to the transmission power in different scenarios. Specifically, at short distances, SISO is more power efficient than MIMO since the circuit power dominates the transmission power [4]. At long distances, MIMO is more power efficient than SISO. ***For intermediate distances, SIMO or MISO may be more power efficient.***

Ex-1006, 377.

Thus, as shown below (blue and orange arrows), the combined Li-Siam system would have included a control signal for selecting between a MIMO and SIMO mode, as taught by Li, that depends, at least in part, on the power consumption of the circuitry coupled to the antennas that has a relationship to the distance (short,

intermediate, long) between the access point and the mobile station, as taught by Siam. Ex-1002 ¶117.



As discussed above in Section XIII.A.1, a POSITA would have been motivated to implement Siam's teachings that circuit power consumption should be considered, at least in part, when selecting between a SISO and MIMO transmission mode with Li's system, and would have had a reasonable expectation of success in doing. Ex-1002 ¶118.

- g. Element 25[f]: wherein the control signal is based, at least in part, on an idle power consumption of the mobile station.**

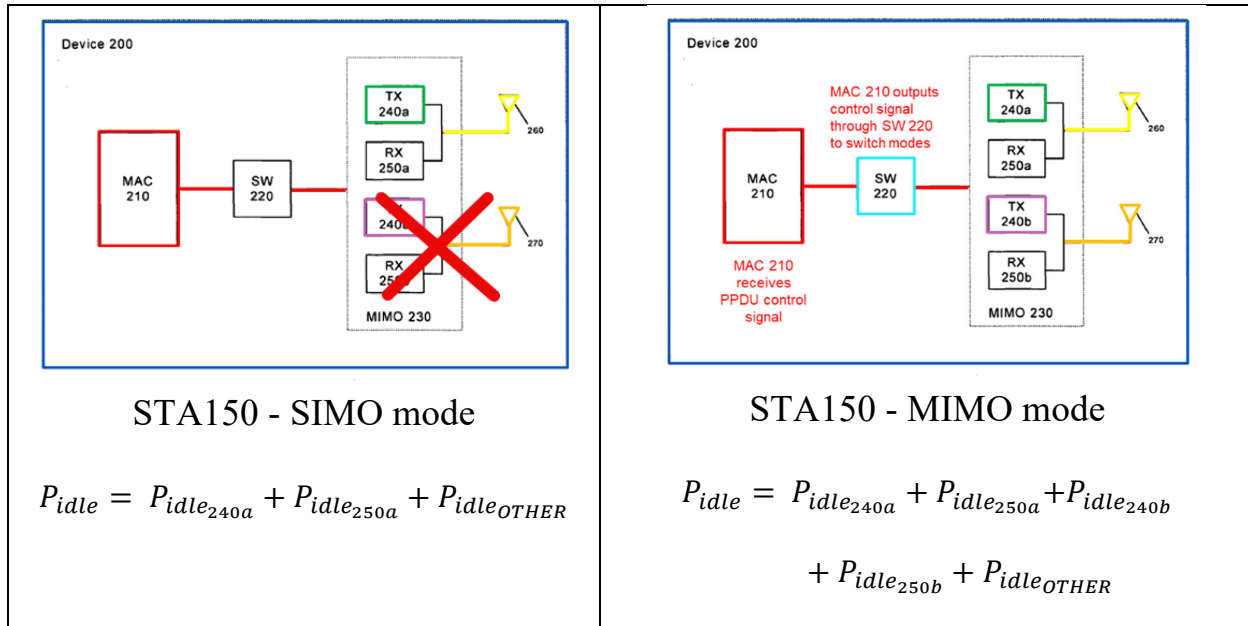
Li-Siam teaches or suggests Element 25[f]. Ex-1002 ¶119. As discussed for

Element 25[e], Li teaches that the control signal is based, at least in part, on an idle power consumption of the entire mobile station. Ex-1005 ¶18.<sup>12</sup> Li teaches that “a station *in idle mode* waiting for incoming signals may consume approximately 60% of its battery energy” and that such idle power consumption is particularly a problem in MIMO configurations where multiple antennas and their associated circuitry are enabled. Ex-1005 ¶18. A POSITA would have recognized that the overall idle power consumption for the mobile station is the sum of all the transmit and receiver idle power consumption for each activated antenna in MIMO mode plus all of the control circuitry (e.g., MAC 210 and other control circuits). Ex-1002 ¶¶56, 120-122. That is, in MIMO mode the idle power consumption is the sum of idle power consumption of idle transmitter circuits 240a and 240b (waiting to transmit) and idle power consumption of idle receiver circuits 250a and 250b (waiting to receive) plus all of the control circuits of the mobile station STA 150. Ex-1002 ¶122. In SIMO mode, where TX 240b is off and assuming RX 250b is also off, they no longer contribute to station idle power consumption. The difference in MIMO and SIMO station idle

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<sup>12</sup> As explained in Section XIII.A.1, idle power consumption means that the circuits are powered but have nothing to transmit or receive. For example, the '120 Patent explains that “idle time is a time during which the transceiver may be waiting to send data over the communications channel. The transceiver may, for example, be waiting for a scheduled start time for the transceiver to use the communications channel.” Ex-1001, 2:60-64. On the receiver side, idle power consumption means that the circuits are powered but have nothing to receive. Ex-1002 ¶¶86, 120.

power is indicated by Dr. Valenti's corresponding equations:



Ex-1002 ¶122.

Thus, as discussed for Element 25[e], Li teaches that AP 110 may send a control signal to STA 150 to switch between SISO and MIMO to enable the “desired number of receivers and transmitters” of the MIMO system. Ex-1005 ¶19. This allows power consumption to be reduced for STA 150, thereby extending its battery life. Ex-1005 ¶19. And, as also discussed, Siam teaches an algorithm that expressly takes circuit power into account when selecting between a SISO and MIMO mode. Ex-1006, 877. Thus, a POSITA would have understood and been motivated to configure Li's control signal for switching communication modes to also be based at least in part on overall circuit power consumption, and more precisely, on circuit power consumed while the mobile station is idle and not

receiving or transmitting.<sup>13</sup> Ex-1002 ¶¶123-124.

**3. Dependent Claim 27: The mobile station of claim 25, wherein the control signal is based, at least in part, on energy optimized rates for the MIMO mode and the SIMO mode.**

Li-Siam teaches or suggests Claim 27. Ex-1002 ¶125.

As explained in Section XIII.A.2.f, Siam assumes a fixed rate system and states that its goal is to design a protocol that minimizes the total energy consumption per bit ( $E_{bt}$ ) for a pair of communicating nodes, calculated as:

$$E_{bt} = \frac{P_t + P_c}{R_b}$$

Ex-1006, 877 (“the bit rate  $R_b \approx B$  bits/sec for BPSK modulation”). A POSITA would have understood that it would have been obvious that a system that assumes a fixed bit rate and selects the modulation scheme that minimizes the energy per bit is just the complement of a system that assumes a fixed power and selects the modulation scheme that maximizes the data rate for each mode. Ex-1002 ¶126. Thus, a POSITA would have understood that Siam’s algorithm for selecting between a MIMO mode and a SIMO mode would work the same way in either case. Ex-1002 ¶126. In other words, Siam’s algorithm would select the mode between SIMO and MIMO that would exhibit the highest bit rate for a given power. Thus, making Li’s

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<sup>13</sup> Ground 2: Li-Siam-Cui-2003 sets forth specific equations that disclose Elements 25[e] and [f].

control signal dependent on energy optimized rates for MIMO and SIMO, as calculated by Siam, would have been equivalent to making the control signal dependent on minimizing the energy per bit. So Li-Siam also renders Claim 27 obvious. Ex-1002 ¶¶126-127.

**4. Dependent Claim 28: The mobile station of claim 25, wherein the control signal is transmitted to the mobile station by a base station.**

Li-Siam teaches or suggests Claim 28. Ex-1002 ¶128.

Li teaches that access point AP 110 communicates signals encoded with control information using wireless shared media 160. Ex-1005 ¶12. In one embodiment, AP 110 acting as a base station “may send a request over wireless shared media 160 to switch” mobile stations “STA 120 and STA 150 to a SIMO or MIMO operating mode, if desired.” Ex-1005 ¶19. STA 120 and STA 150 then “acknowledge the request and may enable an operation of the desired number of receivers and transmitters of the MIMO receivers-transmitters system.” *Id.*; *see also id.* ¶25 (“When implemented as part of an AP such as AP 110, node 200 may initiate a request to switch a station ... into a SIMO or MIMO operating mode.”). A POSITA would have understood that in this embodiment the control signal to select a SIMO or MIMO mode is the PPDU message transmitted to the mobile station (STA 120 and STA 150) by a base station (AP 110). Ex-1005 ¶¶24, 27, 30; Ex-1002 ¶¶47-51, 129.

**B. Ground 2: Claims 25, 27, and 28 Are Obvious Over Li-Siam in View of Cui-2003**

**1. A POSITA would have been motivated to combine Li-Siam and Cui-2003's teachings and would have had a reasonable expectation of success**

A POSITA would have been motivated to combine Li-Siam and Cui-2003 (“Li-Siam-Cui-2003”) and would have had a reasonable expectation of success in doing so. All three describe systems that select an optimal data communication mode in a wireless communication system, from among SISO, MISO, SIMO, and MIMO modes, in order to reduce the total energy consumption of the system. Ex-1005 ¶¶18-19; Ex-1006, 875; Ex-1007, 2805; Ex-1002 ¶¶130-132. As discussed for Ground 1, above, Li-Siam teaches mode selection using MAC 210 that receives a PPDU message (i.e., a network message) and outputs a control signal in response. Ex-1005 ¶24. The control signal causes the system to switch from a transmit SIMO to a transmit MIMO mode, as explained above. *See* Section XIII.A.2.e (applying Li-Siam to claim Element 25[d]).

As further explained above, Siam complements Li by expressly teaching a protocol (called E-BASIC) that expressly takes into consideration both RF transmission power and circuit power consumption during transmission. Ex-1006, 875 (“While the MIMO mode requires less RF transmission energy than the other three modes, it also incurs the highest circuit energy consumption.”), 876.

Cui-2003 further improves the method for selecting the best transmission

mode for “minimizing the total energy consumption.” Ex-1007, 2805. Cui-2003 specifically considers the power consumption of the circuitry coupled to the antennas in active mode, sleep mode, and during transitions back to active mode. Ex-1007, 2806. This “multi-mode operation” allows significant energy to be saved when the sleep mode is used. Ex-1007, 2806; Ex-1002 ¶133.

A POSITA would have been motivated to improve Li-Siam’s mode-switching system by adding Cui-2003’s express teaching that power consumption during sleep (i.e., idle) mode should be expressly considered in determining the most efficient modulation strategy. Ex-1002 ¶¶56, 134. Cui-2003 explains that “when there is a signal to transmit all circuits work in active mode, [and] when there is no signal to transmit they work in sleep mode ....” Ex-1007, 2806. Thus, a POSITA would have recognized that Cui-2003’s “sleep” mode is the claimed “idle” mode (i.e., circuits powered on but not transmitting). Ex-1002 ¶134. In the combined Li-Siam-Cui-2003 system, Li’s PPDU message (a control signal) received by Li’s MAC 210 for switching communication modes would be based on both Siam’s teaching that both transmission power and circuit power should be considered and Cui-2003’s teaching that power expended in a sleep (i.e., idle) mode should also be considered when selecting the optimal communication mode. Ex-1002 ¶134. Additionally, it would ensure a more efficient system because the mobile station would be able to use “[more] of its battery energy for communicating actual traffic.” Ex-1005 ¶18; Ex-

1002 ¶134.<sup>14</sup>

A POSITA would have had a reasonable expectation of success in combining the teachings of Li-Siam and Cui-2003 because they teach compatible systems—namely, electronic devices operating in accordance with IEEE 802.11 standard protocols or other data communications standards for wireless communication systems. Ex-1005 ¶¶12, 18-25; Ex-1006, 875-78; Ex-1007, 2805-806; Ex-1002 ¶136. Additionally, Li-Siam and Cui-2003 address the problem of inefficient power consumption in wireless communication networks in similar and predictable ways, namely, by selecting and/or switching to an optimal transmission mode to reduce total power consumption and improve overall system performance. Ex-1005 ¶19; Ex-1006, Abstract; Ex-1007, 2805 (“[I]n order to find the optimal transmission scheme, the overall energy consumption including both transmission and circuit energy consumption needs to be considered.”); Ex-1002 ¶136. A POSITA would

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<sup>14</sup> A POSITA would have additionally been motivated to combine Cui-2003 with Li-Siam because one of the authors of Siam (Shuguang Cui) is the first listed author of Cui-2003, demonstrating that they may relate to continued work in a common field of effort and continued related developments in that field. Ex-1002 ¶135. Moreover, Siam expressly cites to a similar publication authored by Cui and published in 2005 (Cui-2005 (Ex-1025)) for its discussion of trading off transmission and circuit power consumption. Ex-1006, 875-76, 880 (“[A] distance-dependent tradeoff emerges between transmission and circuit powers.” (citing Cui-2005)). A POSITA would thus have been motivated to look to Cui-2003’s teachings for additional implementation details with the Li-Siam combination and would have been brought directly to Cui-2003 given Siam’s citation to Dr. Cui’s other publications in this field of research and the overlapping author on Siam and Cui-2003. Ex-1002 ¶135.

have understood that their teachings could be combined with little to no change in their respective functions. Ex-1002 ¶136.

**2. Independent Claim 25**

**a. Element 25[pre]: A mobile station for use in a communications system comprising:**

Li-Siam-Cui-2003 teaches or suggests Claim 25's preamble, to the extent it is limiting, for the same reasons described in Section XIII.A.2.a. Ex-1002 ¶137.

**b. Element 25[a]: a first antenna and a second antenna;**

Li-Siam-Cui-2003 teaches or suggests Element 25[a] for the same reasons described in Section XIII.A.2.b. Ex-1002 ¶138.

**c. Element 25[b]: first circuitry coupled to the first antenna and configured to process signals for transmission by the first antenna; second circuitry coupled to the second antenna and configured to process signals for transmission by the second antenna; and**

Li-Siam-Cui-2003 teaches or suggests Element 25[b] for the same reasons described in Section XIII.A.2.c. Ex-1002 ¶139.

**d. Element 25[c]: a controller coupled to the first and second circuitry, wherein the controller is configured to receive a control signal and,**

Li-Siam-Cui-2003 teaches or suggests Element 25[c] for the same reasons described in Section XIII.A.2.d. Ex-1002 ¶140.

- e. **Element 25[d]: in accordance with the control signal, to select between a multiple-input multiple-output (MIMO) mode wherein both the first and second antennas transmit data over a communications channel and a single-input multiple-output (SIMO) mode wherein only one of the first and second antennas transmit data over a communications channel,**

Li-Siam-Cui-2003 teaches or suggests Element 25[d] for the same reasons described in Section XIII.A.2.e. Ex-1002 ¶141.

- f. **Element 25[e]: wherein the control signal is based, at least in part, on a power consumption of the first and second circuitry,**

Li-Siam-Cui-2003 teaches or suggests Element 25[e] for the same reasons described in Section XIII.A.2.f. Ex-1002 ¶142.

- g. **Element 25[f]: wherein the control signal is based, at least in part, on an idle power consumption of the mobile station.**

Li-Siam-Cui-2003 teaches or suggests Element 25[f]. Ex-1002 ¶¶86, 143-144.

As explained in Section XIII.A.1, idle power consumption means that the circuits are powered but have nothing to transmit or receive. For example, the '120 Patent explains that “idle time is a time during which the transceiver may be waiting to send data over the communications channel. The transceiver may, for example, be waiting for a scheduled start time for the transceiver to use the communications channel.” Ex-1001, 2:60-64. On the receiver side, idle power consumption means that the circuits are powered but have nothing to receive.

Cui-2003 teaches methods for selecting “the best modulation strategy to minimize the total energy consumption” in a wireless transceiver network while meeting data throughput and delay requirements. Ex-1007, 2805. For example, Cui-2003 teaches that “in order to find the optimal transmission scheme, the overall energy consumption including both transmission and circuit energy consumption needs to be considered.” Ex-1007, 2805.

Cui-2003’s Figures 1 and 2 depict “signal paths on the transmitter and receiver sides.” Ex-1007, 2806, Figs. 1-2 (having identical circuitry (green) components coupled to an antenna (yellow) as in the ’120 Patent’s Figure 4: digital-to-analog converter (brown), filters (pink), mixer (grey), power amplifier (teal)). Cui-2003 considers the power consumption of the circuitry coupled to the antennas in active mode, sleep mode, and during transitions back to active mode. Ex-1007, 2806. Specifically, Cui-2003 “assume[s] that the transceiver circuitry works on a multimode basis: when there is a signal to transmit all circuits work in active mode, ***when there is no signal to transmit they work in sleep mode***, and when switching from sleep mode to active mode there is a transient mode.” Ex-1007, 2806. This “multi-mode operation” allows significant energy to be saved when the sleep mode is used. Ex-1007, 2806; Ex-1002 ¶¶145-146.

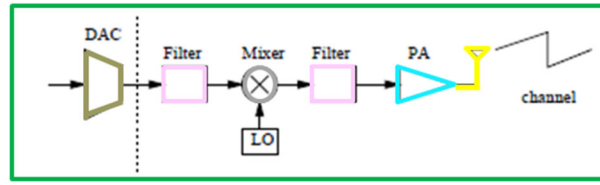


Fig. 1. Transmitter Circuit Blocks (Analog)

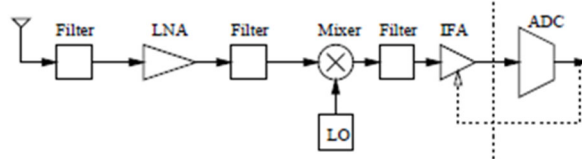


Fig. 2. Receiver Circuit Blocks (Analog)

Cui-2003 further teaches that “the total energy consumption  $E$  required to send  $L$  bits” has three components:

$$\begin{aligned} E &= P_{on}T_{on} + P_{sp}T_{sp} + P_{tr}T_{tr} \\ &= (P_t + P_{c0})T_{on} + P_{sp}T_{sp} + P_{tr}T_{tr}, \end{aligned}$$

“where  $P_{on}$ ,  $P_{sp}$ , and  $P_{tr}$  are power consumption values for the active mode, the sleep mode, and the transient mode, respectively.” Ex-1007, 2806. Because Cui-2003 explains that “when there is a signal to transmit all circuits work in active mode, [and] when there is no signal to transmit they work in sleep mode” (Ex-1007, 2806), a POSITA would have understood that “sleep mode” means a mode in which the mobile station is idle and not actively transmitting or receiving data but that mobile stations in sleep mode may nevertheless continue to consume power since they are not completely shut down. Ex-1002 ¶¶56, 147. Thus, a POSITA would have

understood Cui-2003's  $P_{sp}$ <sup>15</sup> to be the power consumed by the mobile station when in an idle state. *Id.* A POSITA would thus have understood that Cui-2003 bases modulation selection, in part, on the idle power consumption of a wireless node. Ex-1002 ¶147. Because each idle circuit's power consumption contributes to the mobile station's idle power consumption, Li's control signal for switching communication modes in the combined Li-Siam-Cui-2003 system would be based, at least in part, on an idle power consumption of the mobile station.

A POSITA would have been motivated to implement Cui-2003's teaching that power consumption during sleep (i.e., idle) mode should be expressly considered in determining the most efficient modulation strategy with the combined Li-Siam system, and would have had a reasonable expectation of success in doing so for the same reasons discussed in Section XIII.B.1. Ex-1002 ¶148.

**3. Dependent Claim 27: The mobile station of claim 25, wherein the control signal is based, at least in part, on energy optimized rates for the MIMO mode and the SIMO mode.**

Li-Siam-Cui-2003 teaches or suggests Claim 27 for the same reasons discussed in Section XIII.A.3. Ex-1002 ¶149.

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<sup>15</sup> Cui-2003 sets  $P_{sp}=0$  for some of its analysis, noting that for CMOS technology, leakage current of transistors will be small compared to power expended in active mode. Ex-1007, 2807. But Cui-2003 notes that such analysis "can be easily modified to incorporate  $P_{sp}\neq 0$ ." *Id.*, 2806.

4. **Dependent Claim 28: The mobile station of claim 25, wherein the control signal is transmitted to the mobile station by a base station.**

Li-Siam-Cui-2003 teaches or suggests Claim 28 for the same reasons discussed in Section XIII.A.4.Ex-1002 ¶150.

**C. Ground 3: Claim 26 Is Obvious Over Li-Siam in View of Wu**

1. **Dependent Claim 26: The mobile station of claim 25, wherein the control signal is based, at least in part, on a correlation in the communications channel.**

Li-Siam renders Claim 25 obvious as set forth in Ground 1 (Section XIII.A.2). Li-Siam in view of Wu (“Li-Siam-Wu”) teaches or suggests Claim 26. Ex-1002 ¶155.

Wu teaches a communication system including base station 14 and multiple mobile terminals 16 in which the base station “periodically performs an analysis and groups the mobile terminals 16 into two groups: a virtual MIMO group” and a SIMO group (“also [] referred to as a 1x2 diversity group”) based on the degree of channel correlation. Ex-1009 ¶71. A POSITA would have been motivated to combine Li-Siam and Wu’s teachings and would have had a reasonable expectation of success in doing so, because each describes systems that select an optimal data communication mode in a wireless communication system. Ex-1005 ¶¶18-19; Ex-1006, 875; Ex-1009 ¶¶73-76; Ex-1002 ¶¶151, 156. As discussed for Ground 1, Li-Siam teaches a controller in a wireless communication system that switches

communication modes based on a control signal that depends at least in part on circuit power consumption. Ex-1002 ¶151. Wu similarly selects between a virtual MIMO mode and a SIMO mode but bases its selection on channel quality. Ex-1009 ¶71, Figs. 11A-12.

In particular, Wu's base station selects one mobile device and then looks for another having the most orthogonal channel (i.e., correlation is low) and organizes them into a virtual MIMO group (a CAOS group) to communicate with the base station in a MIMO mode. Ex-1009 ¶74. It then proceeds to the next device and finds its most orthogonal pair device and sets up another MIMO link between those devices and the base station. Ex-1009 ¶¶7, 76; *see also id.* ¶¶55-57, 63, 65, 67 (describing the CAOS process with Fig. 11A); Ex-1002 ¶157.

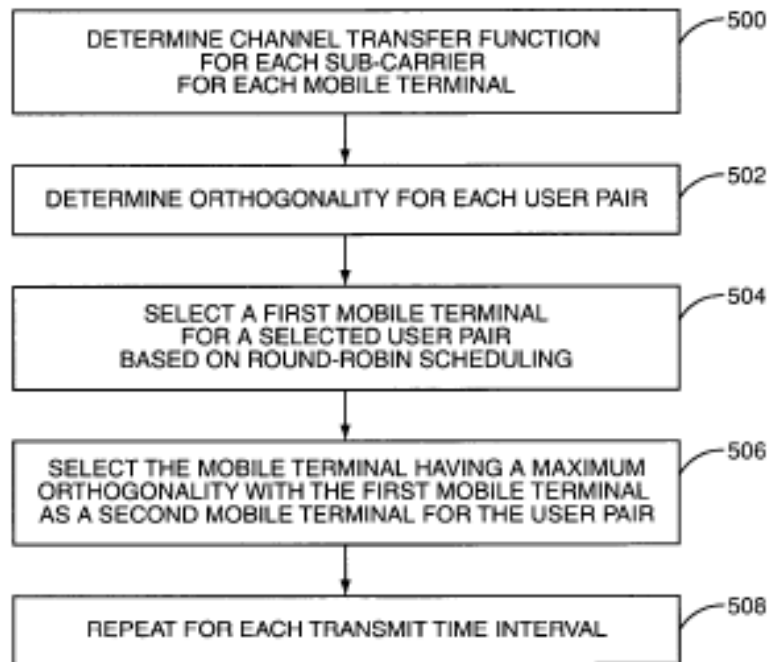


**FIG. 11A**

Wu further teaches that if a certain device has poor channel quality because of high channel correlation, the system instead just sets up a SIMO link for that device to communicate to the base station individually. Ex-1009 ¶75. Wu explains the well-known relationship that channels that are highly orthogonal to one another have very low correlation. Ex-1009 ¶56. A channel exhibiting high correlation, on the other hand, is a poor quality channel that leads to selection of a SIMO communication mode. Ex-1009 ¶75; Ex-1002 ¶158. The flowchart of Wu's Figure 12 shows this concept:

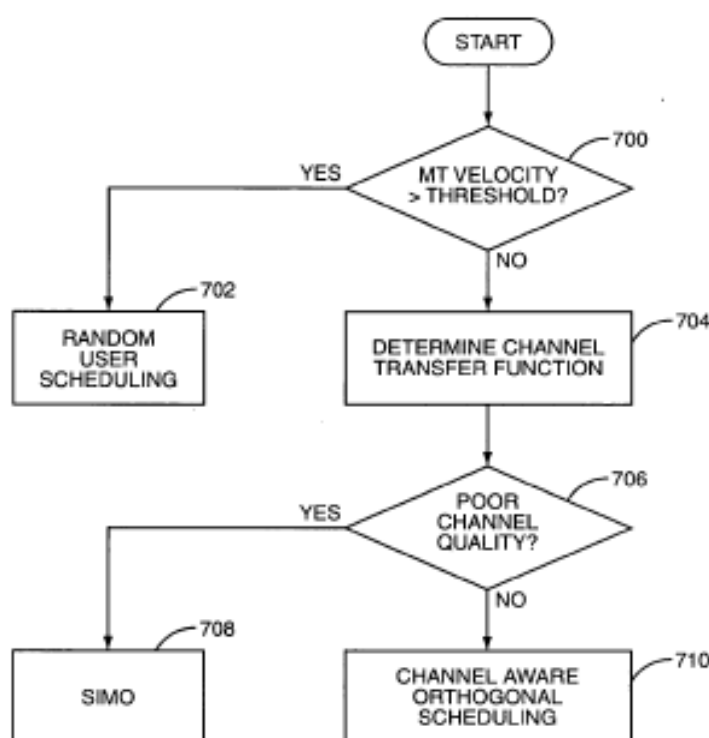


**FIG. 12**

Therefore, Wu teaches that if two devices exhibit low correlation with each other, they have high orthogonality and they are placed in the CAOS group, where they communicate as a virtual MIMO system with the base station. Ex-1009 ¶¶75-76. If the channel associated with a device exhibits a high correlation, its channel quality is deemed low, and it communicates by itself with the base station in a SIMO mode. Ex-1009 ¶¶75-76; Ex-1002 ¶159.

A POSITA would have been motivated to implement Wu's teachings, which specifically consider correlation in the communications channel when selecting and/or switching between SIMO and MIMO modes, with the Li-Siam system

because MIMO modes that might otherwise be energy efficient may not perform well in the presence of high channel correlation. Ex-1002 ¶152. For example, a MIMO mode may be desirable for its high data throughput despite that it may consume more circuit power. *See* Ex-1005 ¶18; Ex-1006, 875. But if the channel over which the MIMO communication is to take place exhibits high correlation, MIMO will not perform well, and it would be better to save power and select a SIMO mode as Wu suggests. Ex-1009 ¶¶75-76 (selecting a SIMO communication mode when channel quality is low because of high correlation). Thus, consideration of channel correlation would improve the accuracy of the communication mode optimization algorithm. Ex-1002 ¶152. A POSITA would, thus, have understood that optimizing overall performance of the system would require consideration of both circuit power consumption as well as a correlation in the communications channel. Ex-1002 ¶¶52, 152.

A POSITA would have understood the benefits of implementing Wu's teachings in the Li-Siam system because it would increase the mobile station's and/or system's performance in terms of, for example, call quality, data transmission speed, data transmission performance, and battery lifetime because of its ability to accurately optimize transmission modes. Ex-1009 ¶¶71, 73-76; Ex-1002 ¶153.

A POSITA would have had a reasonable expectation of success in combining the teachings of Wu with Li-Siam because they teach compatible systems—namely,

electronic devices communicating in wireless communication systems using multiple antennas coupled to circuitry. Ex-1005 ¶¶18-25; Ex-1006, 875; Ex-1009 ¶¶25-30; Ex-1002 ¶154. Although Wu teaches grouping mobile devices into a virtual MIMO group, its teachings would also apply to mobile terminals having two antennas that could be operated in a MIMO configuration. Ex-1002 ¶154. Additionally, Li-Siam and Wu purport to solve the problem of inefficient power consumption in wireless communication networks in similar and predictable ways, namely, by selecting and/or switching to an optimal transmission mode to improve overall system performance. Ex-1002 ¶154. Accordingly, a POSITA would have understood that their teachings could be combined with little to no change in their respective functions. Ex-1002 ¶154. Implementing Wu's teachings to consider a correlation in the communications channel in selecting and/or switching between a SIMO mode or MIMO mode in the Li-Siam system would have been straightforward, well within the capabilities of a POSITA, and would have been a matter of ordinary engineering and not the product of innovation. Ex-1002 ¶154. A POSITA thus would have understood that Li-Siam-Wu teaches or suggests selecting between a SIMO and MIMO mode based on a correlation of the communications channel. Ex-1002 ¶¶154, 160.

**D. Ground 4: Claim 26 Is Obvious Over Li-Siam-Cui-2003 in View of Wu**

- 1. Dependent Claim 26: The mobile station of claim 25, wherein the control signal is based, at least in part, on a correlation in the communications channel.**

Li-Siam-Cui-2003 renders Claim 25 obvious as set forth in Ground 2 (Section XIII.B.2). Li-Siam-Cui-2003 in view of Wu (“Li-Siam-Cui-2003-Wu”) teaches or suggests Claim 26 for the same reasons described in Ground 3 (Section XIII.C.1). Ex-1002 ¶162.

A POSITA would have been motivated to combine Li-Siam-Cui-2003 and Wu and would have had a reasonable expectation of success in doing so for the same reasons described in Sections XIII.B.1 and XIII.C.1. Ex-1002 ¶161.

**E. Ground 5: Claim 29 Is Obvious Over Li-Siam in View of Tirola**

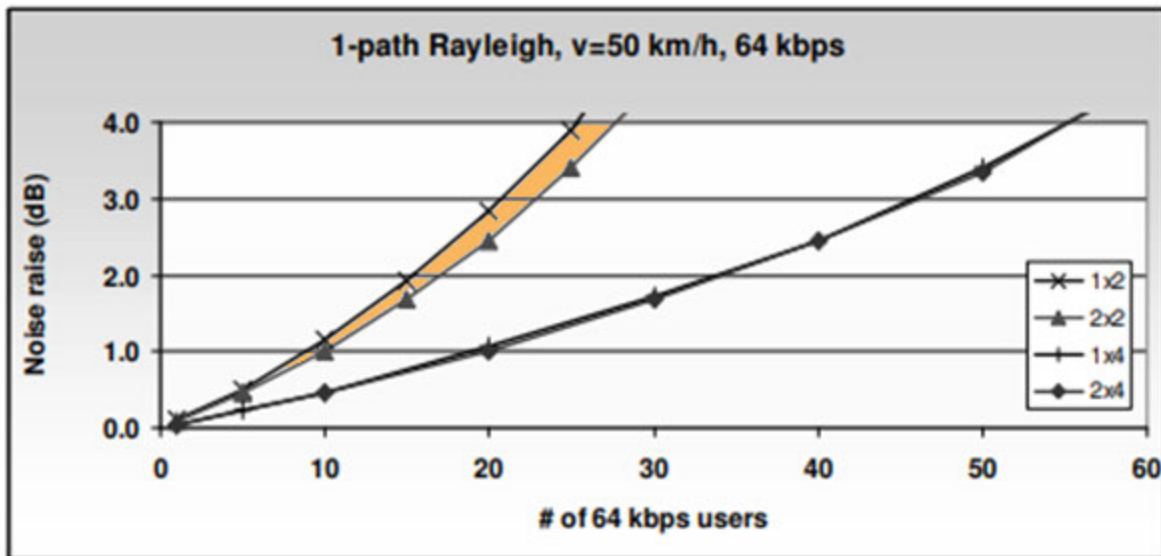
- 1. A POSITA would have been motivated to combine Li-Siam and Tirola’s teachings and would have had a reasonable expectation of success**

A POSITA would have been motivated to combine Li-Siam and Tirola’s teachings (“Li-Siam-Tirola”) and would have had a reasonable expectation of success in doing so, because all three describe systems that select an optimal data communication mode in a wireless communication system. Ex-1005 ¶¶18-19; Ex-1006, 875; Ex-1008, 657; Ex-1002 ¶163. As discussed for Ground 1, Li-Siam teaches or suggests a controller in a wireless communication system that switches between a MIMO and SIMO transmission mode based on a control signal that

depends at least in part on circuit power consumption. Ex-1002 ¶¶163-164. Tirola similarly considers the relative performance of different antenna configurations that mobile stations may use on the uplink to transmit to a base station, such as 1x2 (SIMO), 1x4 (SIMO), 2x2 (MIMO), and 2x4 (MIMO). Ex-1008, 657, Fig. 1. In addition, Tirola considers the effect of multiple users on the noise level, which can degrade channel performance. For example, Tirola calculates and simulates the effects of the number of users ( $J$ ) on uplink performance in a code-division-multiple-access (CDMA) system. Ex-1008, 657-58. While Li discloses one embodiment that may use orthogonal frequency division multiplexing (OFDM) and that is, therefore, relatively immune to increased noise due to multiple users, Li's "embodiments are not limited in this context." Ex-1005 ¶53. Li notes that "[t]ypes of WLAN transmitters and/or receivers intended to be within the scope of the embodiments may include, although are not limited to, transmitters and/or receivers for transmitting and/or receiving spread spectrum signals such as, for example, Frequency Hopping Spread Spectrum (FHSS), [and] Direct Sequence Spread Spectrum (DSSS) ..." *Id.* A POSITA would have understood that the performance of a system using DSSS (upon which CDMA is also based), would be impacted by multiple users and would benefit from Tirola's teachings for mitigating degradation caused by multiple users.

Specifically, Tirola calculates the increase in noise from the UL (uplink) load

factor based on the number of users for various antenna configurations. Ex-1008, 658. Tirola's simulation of noise rise demonstrates that under certain conditions, noise rise is larger for a 1x2 (SIMO) mode than for a 2x2 (MIMO) mode and the advantage of a MIMO mode increases with increasing number of users. Ex-1008, 659-61, Fig. 4(b). This is shown below by the increasing amount by which the top curve (1x2 SIMO) exceeds the curve immediately below (2x2 MIMO).



A POSITA would have been motivated to implement Tirola's teachings, which specifically consider the number of users of the communications system when selecting and/or switching between SIMO and MIMO modes, with Li's system for at least its DSSS embodiments. Ex-1002 ¶165. For example, Li notes that MIMO mode can be inefficient and consume a large amount of circuit power (Ex-1005 ¶18), suggesting that a SIMO mode may be more favorable. But Tirola teaches that if there are many users, selecting SIMO mode might increase noise levels sufficiently

that RF power (and circuit power) would have to be increased to meet the same data throughput metric. Ex-1008, 659-61, Fig. 4(b); Ex-1002 ¶165. Therefore, a consideration of the number of users would improve the accuracy of the communication mode optimization algorithm. Ex-1002 ¶165. A POSITA would thus have understood that optimizing overall performance of the system would require consideration of both circuit power consumption as well as the number of users. Ex-1002 ¶¶54, 57-58, 165. Because both Li and Tirola teach compatible systems that use direct sequence spread spectrum (DSSS) signaling, which code division multiple access (CDMA) systems are based on, a POSITA would have been motivated to combine their teachings to improve the Li-Siam system in the presence of multiple users. Ex-1002 ¶165.

A POSITA would have understood the benefits of implementing these Tirola teachings in the Li-Siam system because it would increase the mobile station's and/or system's performance in terms of, for example, call quality, data transmission speed, data transmission performance, and battery lifetime because of its ability to accurately optimize transmission modes. Ex-1008, 658; Ex-1002 ¶166.

A POSITA would have had a reasonable expectation of success in combining the teachings of Tirola with Li-Siam because they teach compatible systems—namely, electronic devices communicating in wireless communication systems using multiple antennas coupled to circuitry. Ex-1005 ¶¶18-25; Ex-1006, 879-90;

Ex-1008, 657-58; Ex-1002 ¶167. Additionally, Li-Siam and Tirola purport to solve the problem of inefficient power consumption in wireless communication networks in similar and predictable ways, namely, by selecting and/or switching to an optimal transmission mode to improve overall system performance. Ex-1002 ¶167. Accordingly, a POSITA would have understood that their teachings could be combined with little to no change in their respective functions. Ex-1002 ¶167. Implementing Tirola's teachings to consider the number of users of the system in selecting and/or switching between a SIMO mode or MIMO mode in the Li-Siam system would have been straightforward, well within the capabilities of a POSITA, and would have been a matter of ordinary engineering and not the product of innovation. Ex-1002 ¶167.

## **2. Independent Claim 29**

### **a. Element 29[pre]<sup>16</sup>: A mobile station for use in a communications system comprising:**

Li-Siam-Tirola teaches or suggests Claim 29's preamble, to the extent it is limiting, for the same reasons described in Section XIII.A.2.a. Ex-1002 ¶168.

### **b. Element 29[a]: a first antenna and a second antenna;**

Li-Siam-Tirola teaches or suggests Element 29[a] for the same reasons

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<sup>16</sup> Claims 25 and 29 of the '120 Patent are identical except for limitations 25[f] and 29[f]. See Ex-1020 (claim mapping table). The analysis in Ground 1 thus applies equally to limitations 29[pre]-29[e]. Limitation 29[f] is discussed below.

described in Section XIII.A.2.b. Ex-1002 ¶169.

- c. **Element 29[b]: first circuitry coupled to the first antenna and configured to process signals for transmission by the first antenna; second circuitry coupled to the second antenna and configured to process signals for transmission by the second antenna; and**

Li-Siam-Tirola teaches or suggests Element 29[b] for the same reasons described in Section XIII.A.2.c. Ex-1002 ¶170.

- d. **Element 29[c]: a controller coupled to the first and second circuitry, wherein the controller is configured to receive a control signal and,**

Li-Siam-Tirola teaches or suggests Element 29[c] for the same reasons described in Section XIII.A.2.d. Ex-1002 ¶171.

- e. **Element 29[d]: in accordance with the control signal, to select between a multiple-input multiple-output (MIMO) mode wherein both the first and second antennas transmit data over a communications channel and a single-input multiple-output (SIMO) mode wherein only one of the first and second antennas transmit data over a communications channel,**

Li-Siam-Tirola teaches or suggests Element 29[d] for the same reasons described in Section XIII.A.2.e. Ex-1002 ¶172.

- f. **Element 29[e]: wherein the control signal is based, at least in part, on a power consumption of the first and second circuitry,**

Li-Siam-Tirola teaches or suggests Element 29[e] for the same reasons described in Section XIII.A.2.f. Ex-1002 ¶173.

- g. Element 29[f]: wherein the control signal is based, at least in part, on a number of users of the communications system.**

Li-Siam-Tirola teaches or suggests Element 29[f]. Ex-1002 ¶¶174-175.

Tirola studies uplink (UL) performance in a mobile telecommunications system assuming different SIMO and MIMO transmission approaches from mobile stations having a maximum of two transmit antennas to base stations having up to four antennas. Ex-1008, 657. Figure 1 depicts a “block diagram of the considered SIMO [] and MIMO transmission schemes.” Ex-1008, 657, Fig. 1.

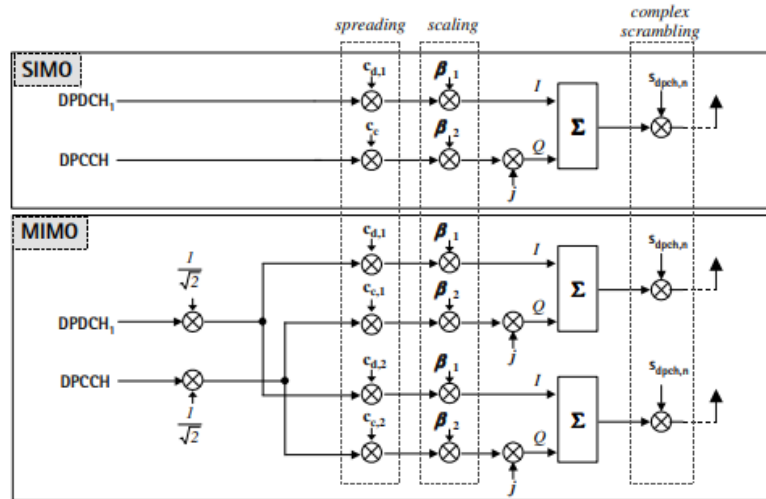


Figure 1. Block diagram of the considered transmission schemes.

Tirola calculates and simulates the effects of the number of users on uplink performance. Specifically, Tirola teaches that “[w]hen studying the UL performance of different transmission schemes, the UL load factor, denoted as  $\eta$  plays an important role” and is calculated as follows:

$$\eta = (1+i) \cdot \sum_{j=1}^J \frac{1}{1 + \frac{1}{(E_c/N_0)_j}},$$

“where  $i$  is the ratio of other cell to own cell interference, ***J is the number of users*** and  $E_c/N_0$  is the chip energy per total noise power density.” Ex-1008, 658; Ex-1002 ¶¶176-177.

Tiirola also calculates the increase in noise from the UL load factor based on the number of users for various antenna configurations as follows:

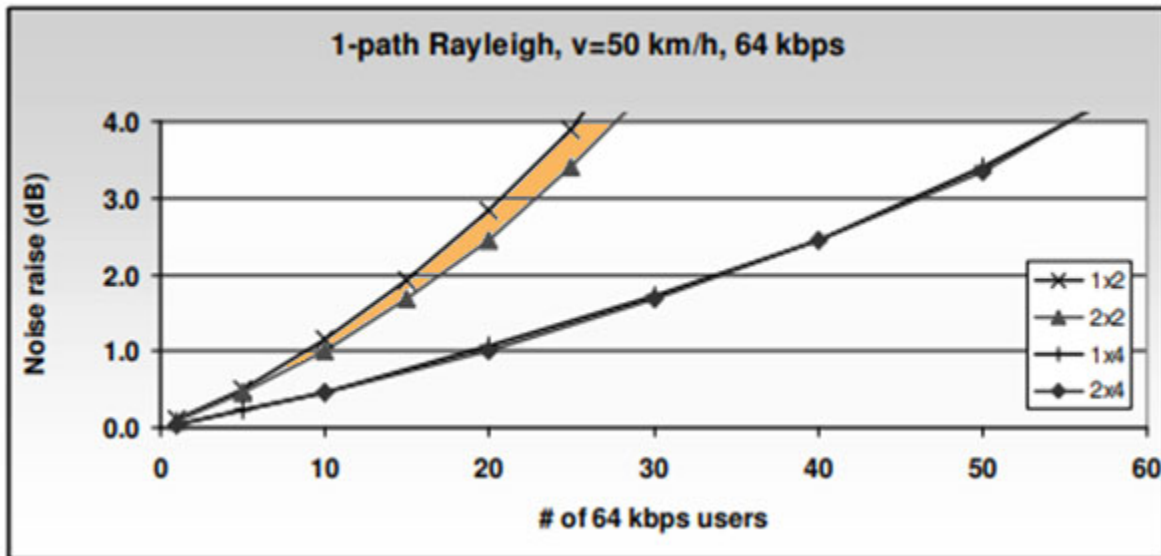
$$\text{Noise\_rise} = 10 * \log_{10} \left( \frac{1}{1-\eta} \right).$$

$$\text{Noise\_rise}(j) = \text{Rx} \frac{E_b}{N_0}(j) - \text{Rx} \frac{E_b}{N_0}(1) + \text{Noise\_rise}(1),$$

“where  $\text{Rx } E_b/N_0(j)$  (dB) is the simulated average  $\text{Rx } E_b/N_0$  value (dB) obtained from the multi-user simulation having  $j$  simultaneous users and  $\text{Noise\_rise}(1)$  (dB) corresponds the noise rise caused by a single user.” Ex-1008, 658.

Tiirola’s simulation of noise rise, depicted in Figure 4(b), demonstrates that noise rise is larger for a 1x2 (SIMO) mode than for a 2x2 (MIMO) mode and the advantage of a MIMO mode increases with increasing number of users. Ex-1008, 659-61, Fig. 4(b). In other words, the noise penalty (below, orange region) of selecting a 1x2 (SIMO) mode over a 2x2 (MIMO) mode increases with the number of users. However, the advantage of a MIMO mode diminishes when the base station

uses four antennas instead of two antennas. Ex-1008, 659-60; Ex-1002 ¶178.



A POSITA would have understood based on Tirola's teachings that channel noise considerations might favor, for example, a MIMO mode over a SIMO mode based on the noise increase in the presence of a large number of users. Ex-1002 ¶179. Li, on the other hand, teaches that MIMO mode consumes more circuit power than SIMO mode. Ex-1005 ¶18. A POSITA, therefore, would have understood that there could be a crossover point in Figure 4(b) such that consideration of both the power consumption and the number of users of the system might lead the system to choose a SIMO mode over a MIMO mode. Ex-1002 ¶¶54, 57-58, 179-180. This understanding is consistent with the teachings of the '120 Patent. *See, e.g.*, Ex-1001, 3:28-4:38 (stating that "[a]ny of a variety of power models may be used to calculate the amount of power consumed by user *i* during transmission in the MIMO mode" and considering noise power in those calculations), 4:62-5:7 ("A crossover point for

when SIMO consumes less power than MIMO, or vice versa, may be considered a function of any of a variety of variables including, but not limited to, the power consumed by circuitry processing signals for the receive antennas, a number of receive antennas, and channel correlations.”). Thus, in the combined Li-Siam-Tirola system, Li’s control signal is based, at least in part, on a number of users of the communications system. Ex-1002 ¶¶181-186.

#### **XIV. DENIAL UNDER *FINTIV* IS NOT APPROPRIATE**

Should Patent Owner argue against institution under *Fintiv*, Petitioner may serve a prior art stipulation and/or respectfully request leave for a Preliminary Reply to respond.

#### **XV. CONCLUSION**

Petitioner requests institution of IPR for Claims 25-29 of the ’120 Patent based on each of the grounds in this Petition.

Respectfully Submitted,

/s/ William M. Fink

**CERTIFICATE OF WORD COUNT**

Pursuant to 37 C.F.R. §42.24(d), Petitioner certifies that this petition includes 12,371 words, as measured by Microsoft Word, exclusive of the table of contents, mandatory notices under §42.8, certificates of service, word count, and exhibits.

**CERTIFICATE OF SERVICE (37 C.F.R. § 42.6(e)(1))**

The undersigned hereby certifies that the above document was served on June 12, 2024, by filing this document through the Patent Trial and Appeal Board P-TACTS System, as well as delivering a copy via express mail upon the following attorneys of record for the Patent Owner and Petitioner:

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