

**Samsung Electronics Co., Ltd. and
Samsung Electronics America Co.
v.
Empire Technology Development LLC.**

Petitioner's Presentation For IPR2024-00896

U.S. Patent No. 8,798,120

September 17, 2025

Overview

- Alleged Invention
- Overview of the Prior Art
- Claim construction – Idle Power Consumption
- Grounds 1 and 2 – Li, Siam, and Cui 2003 (claims 25, 27, 28)
 - Idle Power Consumption (claim element 25(f))
 - Motivations
- Grounds 3 and 4 – Adding Wu (claim 26)
- Ground 5 – Adding Tirola (claim 29)

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- Grounds 3 and 4 – Adding Wu (claim 26)
- Ground 5 – Adding Tirola (claim 29)

'120 patent—selection of MIMO/SIMO based on power consumption

US008798120B2

(12) **United States Patent**
de Veciana et al.

(10) **Patent No.:** US 8,798,120 B2
(45) **Date of Patent:** Aug. 5, 2014

(54) **METHODS AND COMMUNICATION SYSTEMS HAVING ADAPTIVE MODE SELECTION**

(75) **Inventors:** Gustavo de Veciana, Austin, TX (US); Hongseok Kim, Chatham, NJ (US); Chan-Hyung Chae, Jersey City, NJ (US); Robert W. Heath, Jr., Austin, TX (US)

(73) **Assignee:** The Board of Regents of The University of Texas System, Austin, TX (US)

(*) **Notice:** Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 1002 days.

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US 2010/028449 A1 Nov. 11, 2010

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(51) **Int. Cl.**
H04B 1/38 (2006.01)

(52) **U.S. Cl.**
USPC 375/219; 375/295; 375/260

(58) **Field of Classification Search**
USPC 375/219, 295, 260
See application file for complete search history.

(56) **References Cited**
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8,140,023 B2 * 3/2012 Bougard 455/68
2002/0056606 A1 * 5/2002 Guebert et al. 714/759

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(Continued)

Primary Examiner — Michael Neff
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(57) **ABSTRACT**
Examples are generally described that include methods for selecting a transmit mode in a communications system. An example method may include calculating a first transmission rate for data in a multiple-input multiple-output mode of the communications system and calculating a second transmission rate for the data in a single-input multiple-output mode of the communications system. A mode may be selected from the group consisting of the multiple-input multiple-output mode and the single-input multiple-output mode based, at least in part, on an energy consumption of the first and second transmission rates. Data may be transmitted from a transceiver in the communications system using the selected mode.

29 Claims, 4 Drawing Sheets

Calculate a first transmission rate for a MIMO mode of a communications system 108

Calculate a second transmission rate for a SIMO mode of a communications system 110

Select a selected transmission mode from the group consisting of the MIMO and SIMO modes based, at least in part, on an energy consumption of the first and second transmission rates 112

Transmit data from a transceiver in the communications system using the selected MIMO or SIMO mode 114

(57)

ABSTRACT

Examples are generally described that include methods for selecting a transmit mode in a communications system. An example method may include calculating a first transmission rate for data in a multiple-input multiple-output mode of the communications system and calculating a second transmission rate for the data in a single-input multiple-output mode of the communications system. A mode may be selected from the group consisting of the multiple-input multiple-output mode and the single-input multiple-output mode based, at least in part, on an energy consumption of the first and second transmission rates. Data may be transmitted from a transceiver in the communications system using the selected mode.

SIMO vs. MIMO

SIMO – Single Input, Multiple Output

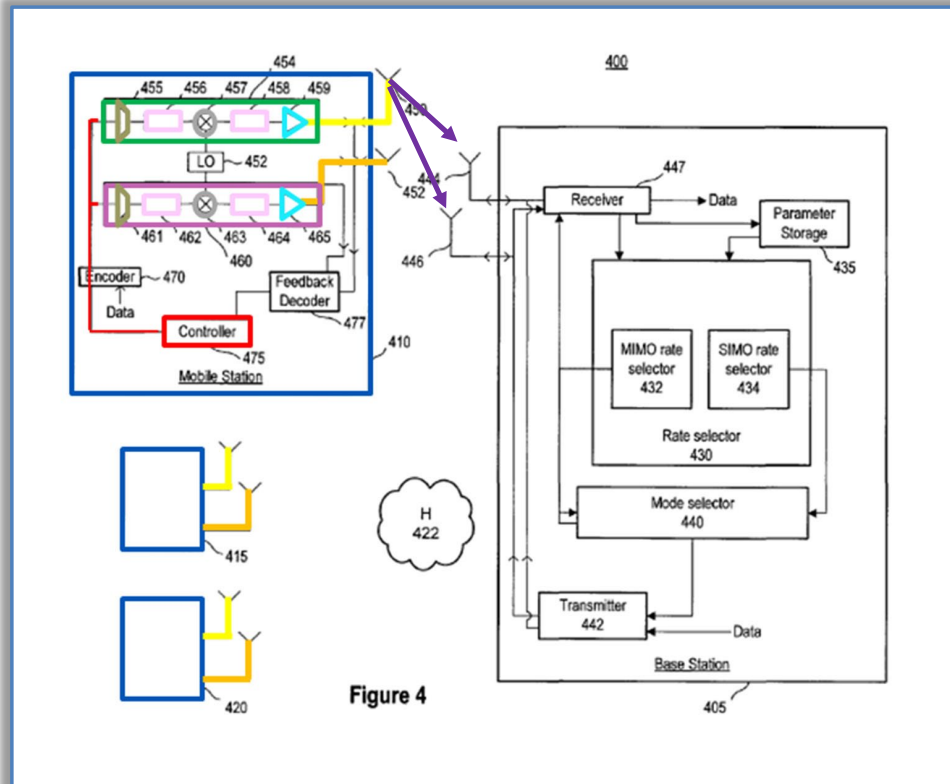


Figure 4

MIMO – Multiple Input, Multiple Output

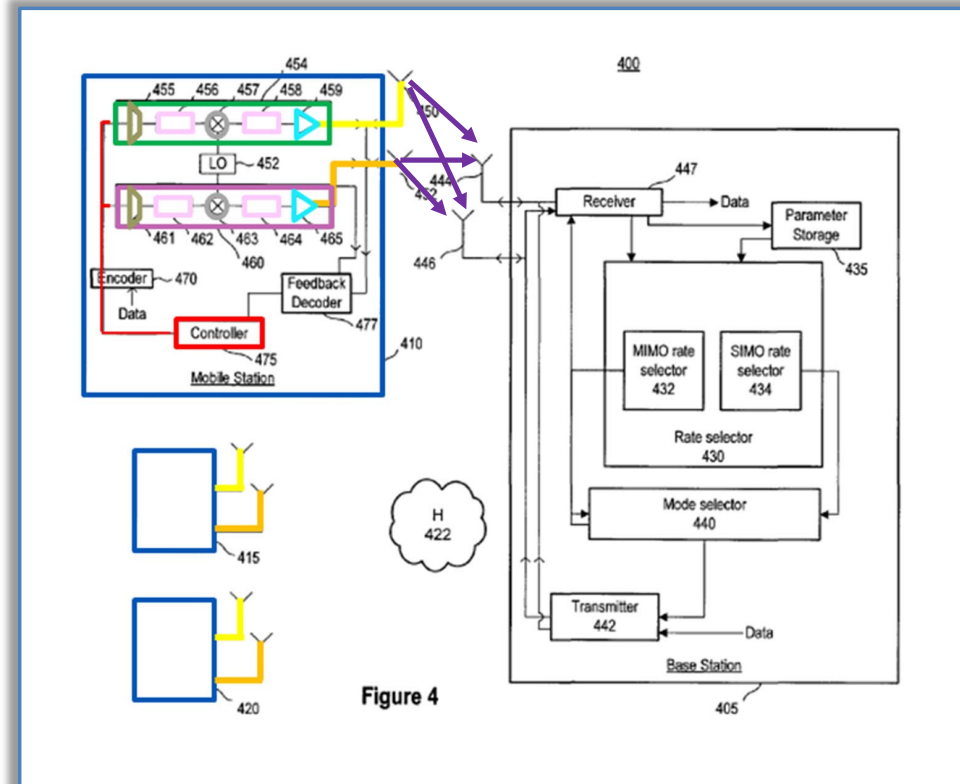


Figure 4

Ex-1001, Fig. 4; Petition (Paper 3) at 6

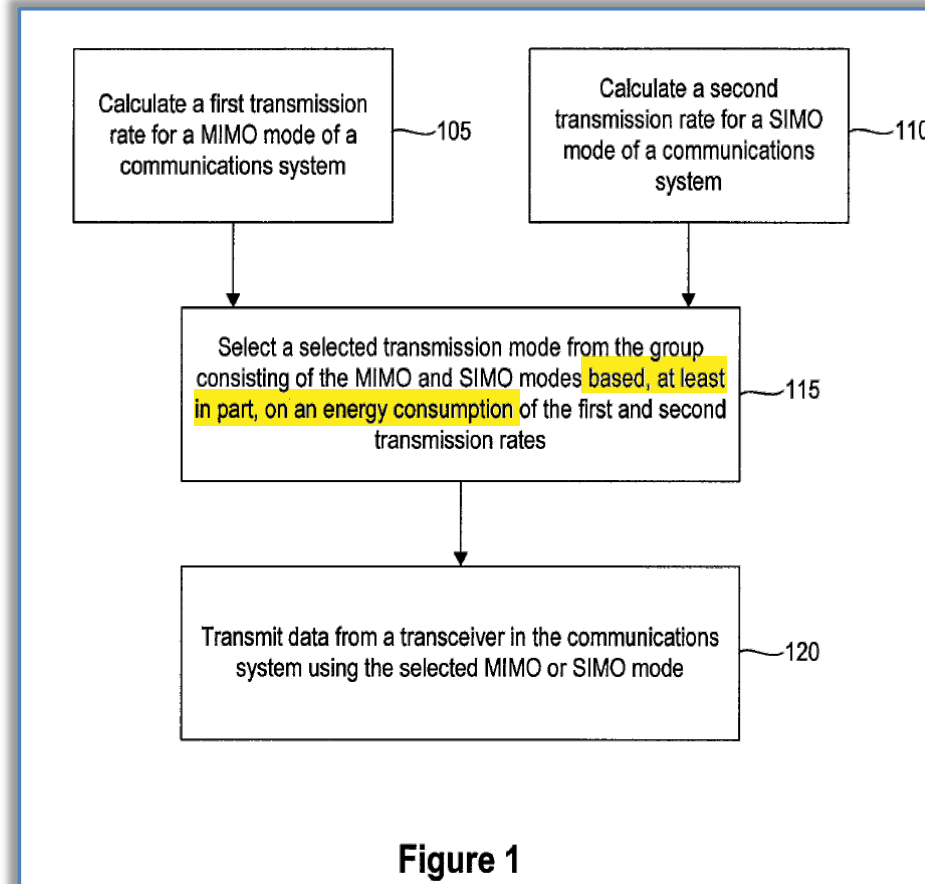
Demonstrative Exhibit Not Evidence

'120 patent—selection based on power consumption

an energy-optimized rate for data in the MIMO mode. The energy-optimized rate may be based, at least in part, on power consumption of circuitry coupled to a plurality of antennas at the transceiver which are configured to transmit in the MIMO mode. That is, the power consumed by the circuitry used to process signals for antennas used to transmit in the MIMO mode may be included in the calculation of the energy-optimized rate. The energy-optimized rate may also or instead be based, at least in part, on a power consumption of the transceiver during an idle time. The idle time is a time during

Mode selection based on power characteristics

'120 patent—selection based on power consumption



Mode selection based on power characteristics

Demonstrative Exhibit Not Evidence

Ex-1001, Fig. 1; Petition at 36-37

'120 patent—allegedly novel features

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

- a first antenna and a second antenna;
- 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
- a controller coupled to the first and second circuitry, wherein the controller is configured to receive a control signal and, 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, wherein the control signal is based, at least in part, on a power consumption of the first and second circuitry, wherein the control signal is based, at least in part, on an idle power consumption of the mobile station.

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

- [Same as Claim 25 except highlight] wherein the control signal is based, at least in part, on a number of users of the communications system.

DETAILED ACTION

Allowable Subject Matter

1. Claims 1-11, 13-25, 27, 29-31, 33 are allowed.
2. The following is an examiner's statement of reasons for allowance: subject matter: The prior art of record fails to anticipate or render obvious the limitations of the above cited claims.

Re claims 5, 20 and 27; the prior art of record fails to anticipate or render obvious the limitations regarding the consideration of power during idle periods in the mode selection processing.

[***]

Re claims 1 and 29; the prior art of record fails to anticipate or render obvious the limitations regarding the indication of the number of users in the channel environment factoring into the mode selection determination.

**Reasons for allowance:
“idle power consumption” and “number of users”**

Demonstrative Exhibit Not Evidence

Ex-1001, Cls. 25, 29; Ex-1004, 184-90; Petition at 7-8

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Grounds instituted for review

Institution decision:

F. Asserted Grounds

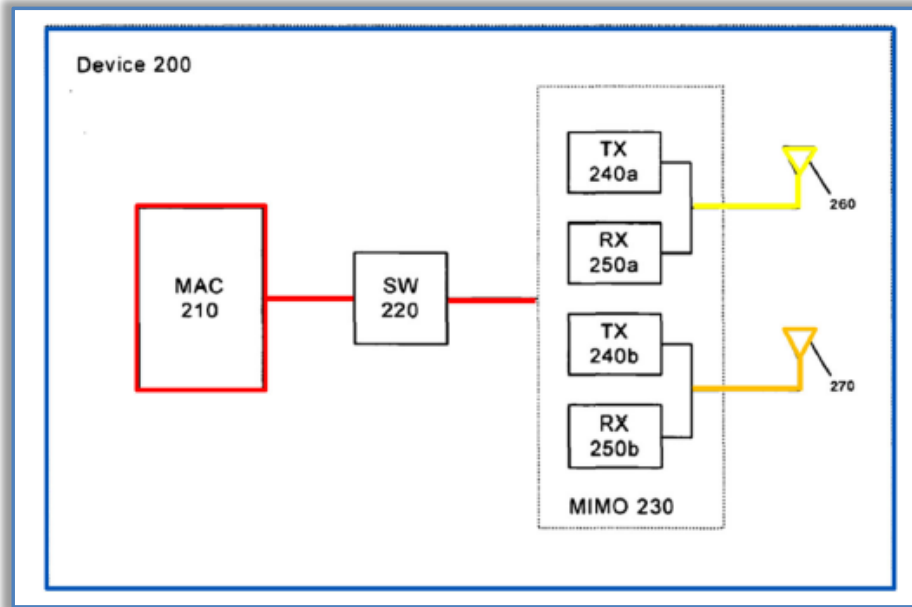
Petitioner asserts that claims 25–29 would have been unpatentable on the following grounds:

Claim(s) Challenged	35 U.S.C. § ²	Reference(s)/Basis
25, 27, 28	103(a)	Li, Siam
25, 27, 28	103(a)	Li, Siam, Cui-2003
26	103(a)	Li, Siam, Wu
26	103(a)	Li, Siam, Cui-2003, Wu
29	103(a)	Li, Siam, Tirola

US Pat. Pub. No. 2006/0067263 (Li)

TECHNIQUES TO MANAGE MULTIPLE RECEIVERS

Pub. No.: US 2006/0067263 A1
Pub. Date: Mar. 30, 2006



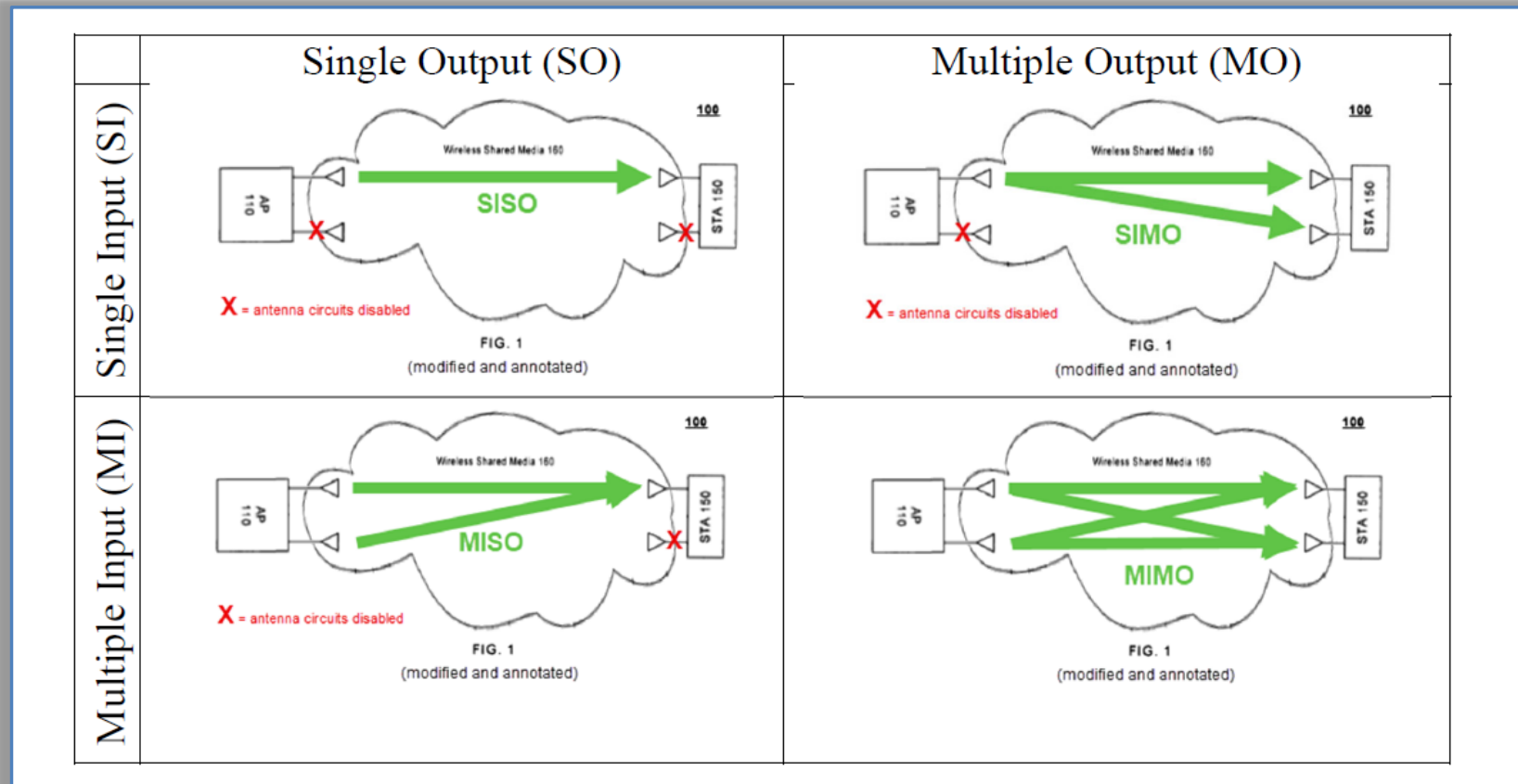
Demonstrative Exhibit Not Evidence

consumption. For example, a station in idle mode waiting for incoming signals may consume approximately 60% of its battery energy. This inefficient use of energy may be exacerbated by MIMO devices, since more than one antenna may be turned on for reception. The power consumed by low

[0019] Some embodiments may solve this and other problems. In one embodiment, for example, AP 110, STA 120 and/or STA 150 may be initially set to operate in a SISO or a MISO operating mode, and may be subsequently switched to a MIMO operating mode. For example, AP 110 operating in a MISO or a SISO operating mode may send a request over wireless shared media 160 to switch STA 120 and STA 150 to a SIMO or MIMO operating mode, if desired. STA 120 and STA 150 may acknowledge the request and may enable an operation of desired number of receivers and transmitters of the MIMO receivers-transmitters system. In this manner, power consumption for STA 120 and STA 150 may be reduced, thereby extending the battery life for STA 120 and STA 150.

Petition at 24-25; Ex-1005 ¶¶18-19, Fig. 2

SIMO and MIMO modes were well known



Siam et al., *Adaptive Multi-antenna Power Control...* (Siam)

Adaptive Multi-antenna Power Control in Wireless Networks

IWCMC'06, July 3–6, 2006, Vancouver, British Columbia, Canada.
Copyright 2006 ACM 1-59593-306-9/06/0007 ...\$5.00.

ability (p_t) and the specific transmission mode. As for the circuit power (P_c), it is given by [4]

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

where P_{DAC} , P_{mix} , P_{LNA} , P_{IFA} , P_{filt} , P_{filr} , P_{ADC} , and P_{syn} are the 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 at the transmitter and the receiver sides, the analog-to-digital converter (ADC), and the frequency synthesizer, respectively.

capable wireless LANs with two antennas per node. Our protocol, called E-BASIC, is based on a modification of the classic CSMA/CA access scheme, where we dynamically adjust the “transmission mode” and the transmission power on a per-packet basis so as to minimize the total energy consumption. By “transmission mode” we mean one of the four possible transmit/receive antenna configurations: 1×1 (SISO), 2×1 (MISO), 1×2 (SIMO), and 2×2 (MIMO). Our energy model accounts for both the transmission and the circuit powers. While the MIMO mode requires less RF

Optimizing between SIMO and MIMO based on power characteristics was well known

3.3 Power-Aware Routing based on E-BASIC

We now combine E-BASIC with power-aware Routing (PAR/E-BASIC) to further improve the power efficiency,

***]

be decomposed into two steps. Step 1, we choose the most energy efficient multi-antenna mode for each pair of connected nodes and delete the paths resulting from the other three modes such that the overall network is reduced to a single-link network, as shown in Figure. 1 where in this example we assume the optimal modes for $X \rightarrow Y$, $X \rightarrow Z$, and $Y \rightarrow Z$ are SISO, MIMO, and SIMO, respectively. Step 2, we run the modified Dijkstra's algorithm where the path weight is defined as the minimum E_{bt} that is achievable over that path among four different multi-antenna modes. Note that the complexity is only increased by $4M$ compared with a regular Dijkstra's algorithm, where M is the number of links in the network.

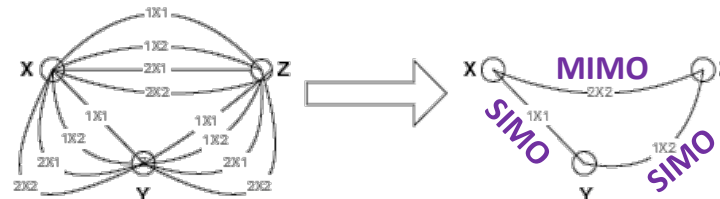


Figure 1: Power-aware routing: mode selection.

Cui et al., *Modulation Optimization...* (Cui-2003)

Modulation Optimization under Energy Constraints

Shuguang Cui, Andrea J. Goldsmith, and Ahmad Bahai
Department of Electrical Engineering
Stanford University, Stanford, CA, 94305

©2003 IEEE.

We assume that the transceiver circuitry works on a multi-mode 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. The multi-mode oper-

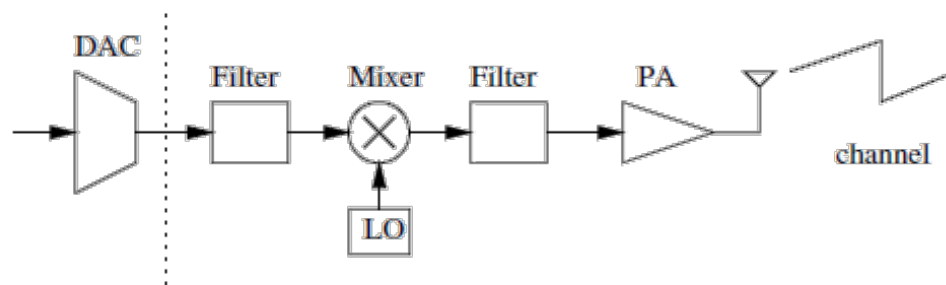


Fig. 1. Transmitter Circuit Blocks (Analog)

Optimizing total power using lower-power modes was well known

We assume a node has L bits to transmit with a deadline T . The transceiver spends time $T_{on} \leq T$ to communicate these bits, where T_{on} is a parameter to optimize, and then returns to the sleep mode where all the circuits in the signal path are shut down for energy saving. Although the transient duration from

fast enough to be neglected). Correspondingly, the total energy consumption E required to send L bits also consists of three components:

$$\begin{aligned} E &= P_{on}T_{on} + P_{sp}T_{sp} + P_{tr}T_{tr} \\ &= (P_t + P_{c0})T_{on} + P_{sp}T_{sp} + P_{tr}T_{tr}, \end{aligned} \quad (1)$$

where P_{on} , P_{sp} and P_{tr} are power consumption values for the active mode, the sleep mode, and the transient mode, respectively. The active mode power P_{on} comprises the transmission

US Pat. Pub. No. 2007/0171808 (Wu)

ADAPTIVE ORTHOGONAL SCHEDULING FOR VIRTUAL MIMO SYSTEM

Pub. No.: US 2007/0171808 A1
Pub. Date: Jul. 26, 2007

Wu's selection of SIMO or MIMO mode
depends on degree of channel correlation
(orthogonality of channel)

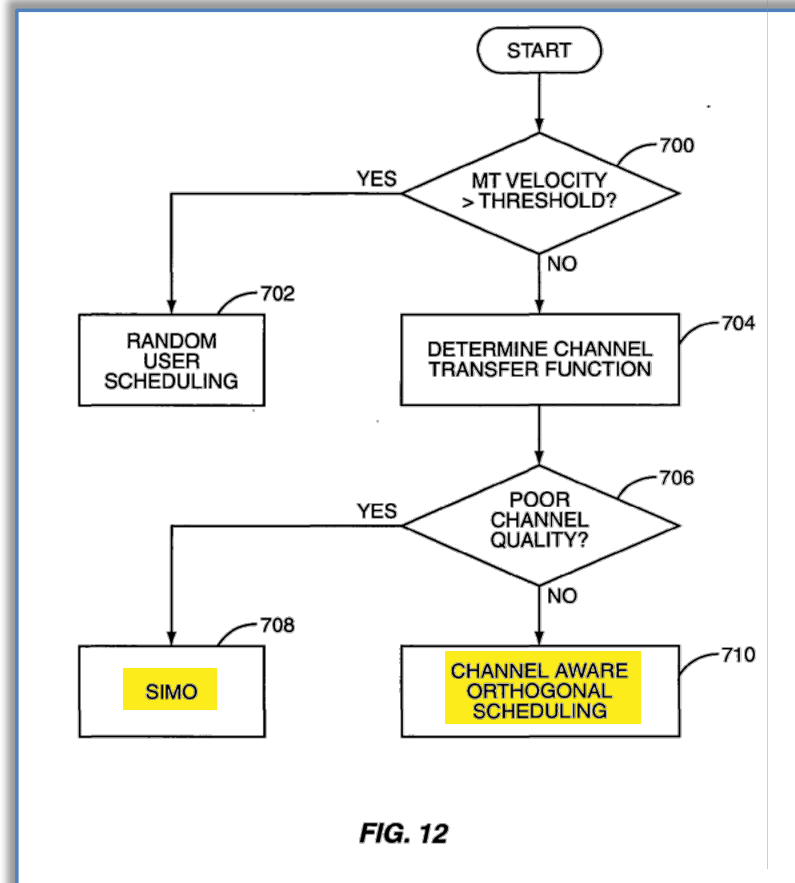


FIG. 12

Tirola et al., *Performance of a UMTS...* (Tirola)

Performance of a UMTS Uplink MIMO Scheme

Esa Tirola and Juha Ylitalo

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Tirola's selection of SIMO or MIMO mode
depends on number of users

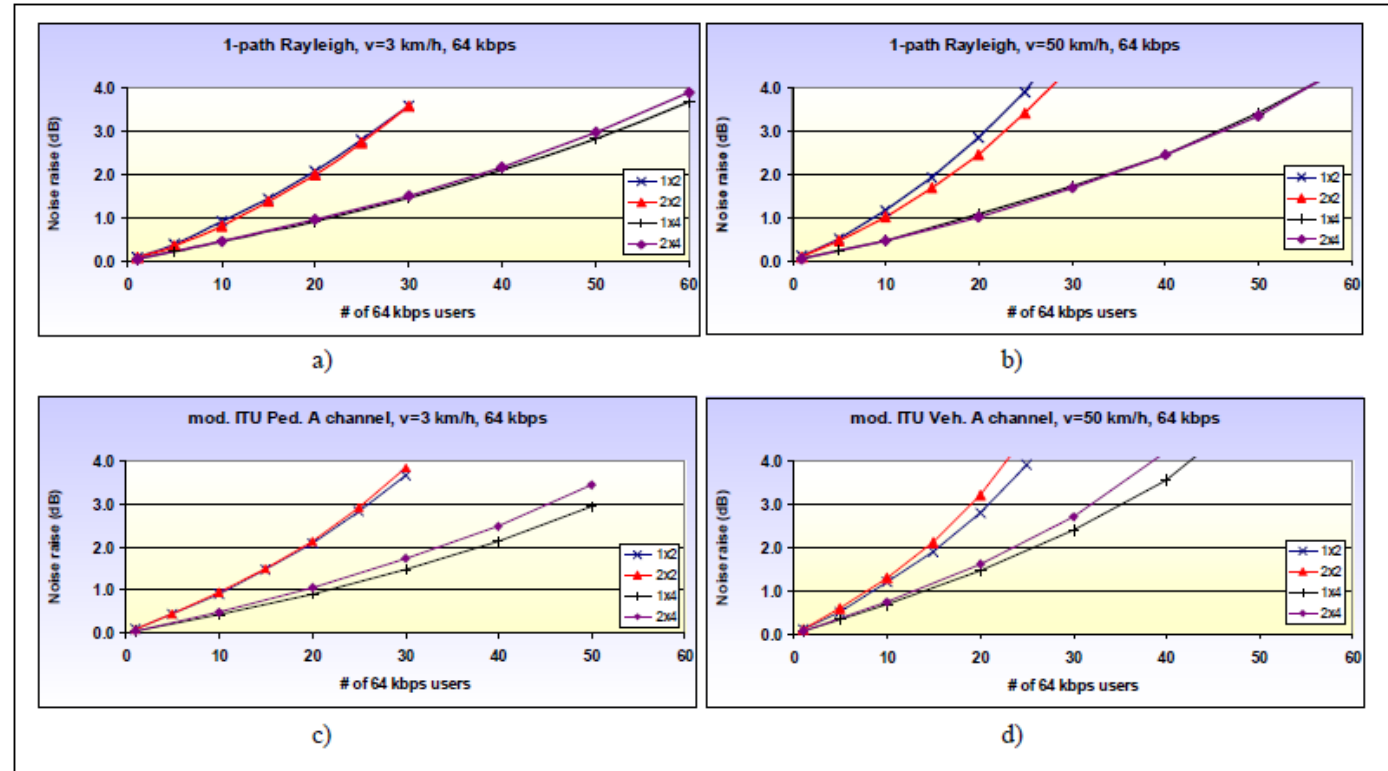


Figure 4. UL noise rise, SIMO and MIMO, 64 kb/s.

Petition at 18-19; Ex-1008, 659-62, Fig. 4

Demonstrative Exhibit Not Evidence

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- Claim construction – Idle Power Consumption
- Grounds 1 and 2 – Li, Siam, and Cui 2003 (claims 25, 27, 28)
 - Idle Power Consumption (claim element 25(f))
 - Motivations
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“Idle power consumption”

over a communications channel, wherein the control signal is based, at least in part, on a power consumption of the first and second circuitry, wherein the control signal is based, at least in part, on **an idle power consumption of the mobile station.**

Board’s Preliminary Construction

“Power consumption during which the transceiver may be ***waiting to send data, whether the transceiver is on or off***”

District Court’s Construction

“A power consumed by the mobile station when the ***mobile station is powered on and waiting to send.***”

“The Court agrees with [PO] that a fully powered-off mobile station does not have ‘idle power consumption’ within the meaning of the claims. **Nor must all the circuitry of the mobile station be turned on for it to be ‘idle.’**”

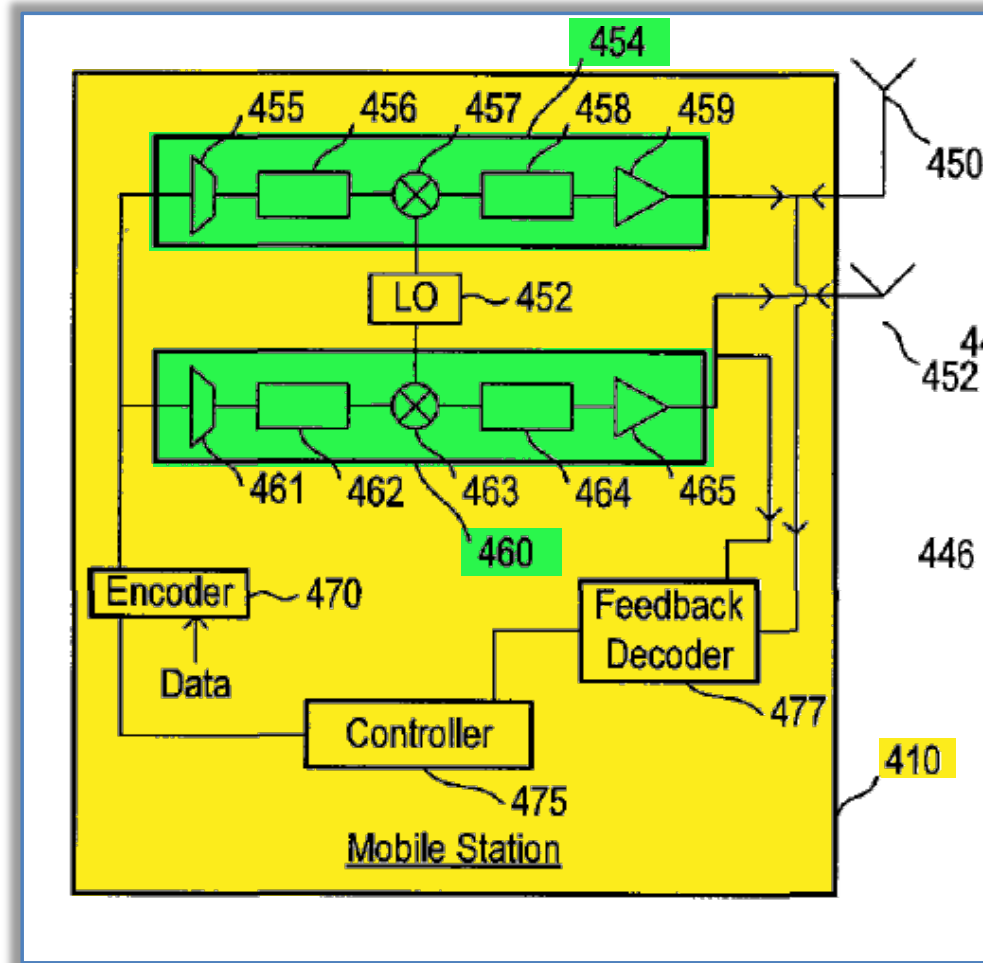
“Idle power consumption” – The parties’ dispute

over a communications channel, wherein the control signal is based, at least in part, on a power consumption of the first and second circuitry, wherein the control signal is based, at least in part, on **an idle power consumption of the mobile station.**

Samsung’s Position	Patent Owner’s Position
<p>The Board’s preliminary construction and the District Court’s construction are <i>correct and consistent</i>.</p> <p>This term refers to a power consumption of the “mobile station” as a whole, rather than focusing on whether constituent circuitry or transceiver components are on or off.</p>	<p>The Board’s preliminary construction <i>is wrong</i>, and the District Court’s construction needs to be understood <i>differently than what it says</i>.</p> <p>The term includes a <i>negative limitation</i> related to “transceivers”: “‘idle power consumption’ does not include times when the transceiver is off because idling means waiting to send and does not cover a powered-off transceiver.”</p>

“Idle power consumption” plainly refers to the “mobile station” as a whole

over a communications channel, wherein the control signal is based, at least in part, on a power consumption of the first and second circuitry, wherein the control signal is based, at least in part, on an idle power consumption of the mobile station.



Reply at 2-5; Ex-1001, Cl. 25, Fig. 4

The specification explains that the mobile station may consume “idle power” when the transceivers are turned off

Claim:

over a communications channel, wherein the control signal is based, at least in part, on a power consumption of the first and second circuitry, wherein the control signal is based, at least in part, on an idle power consumption of the mobile station.

Specification:

be stored in the parameter storage 435. Recall the idle time may include times during which the mobile station 410 is waiting to send data over the communications channel, such as waiting for a scheduled time to begin transmission. Alter-

a particular average throughput in some examples. However, if the transmission rate is too slow, a greater number of transceivers may become idle, waiting to send transmissions over the communications channel. Even if the idling transceivers turn off their transmission chains, some idle power may be consumed due to leakage current or other effects. The idle

PO's expert agrees that the "transmission chains" correspond to the first or second circuitry, not the mobile station itself

Claim:

over a communications channel, wherein the control signal is based, at least in part, on a power consumption of the first and second circuitry, wherein the control signal is based, at least in part, on an idle power consumption of the mobile station.

Patent Owner's expert:

Q: But the transmission chain is shown in block 454. Is that fair?

A: 454 is a first circuitry or an example of a first circuitry related to transmission. That is fair.

The Board and the Court are both consistent and correct

Samsung's Position

"Idle power consumption" refers to power consumed by the mobile station when waiting to send data, regardless of whether transceivers or other constituent circuits are on or off

Board's Preliminary Construction

"Power consumption during which the transceiver may be ***waiting to send data, whether the transceiver is on or off***"

District Court's Construction

"A power consumed by the mobile station when the ***mobile station is powered on and waiting to send.***"

"The Court agrees with [PO] that a fully powered-off mobile station does not have 'idle power consumption' within the meaning of the claims. **Nor must all the circuitry of the mobile station be turned on for it to be 'idle.'**"

PO seeks to re-write the claims and include a negative limitation

Patent Owner's Position

The Board's preliminary construction *is wrong*, and the District Court's construction needs to be understood *differently than what it says*.

The term includes a *negative limitation* related to "transceivers": "idle power consumption" **does not include times when the transceiver is off** because idling means waiting to send and does not cover a powered-off transceiver."

over a communications channel, wherein the control signal is based, at least in part, on a power consumption of the first and second circuitry, wherein the control signal is based, at least in part, on **an idle power consumption of the mobile station.**

Transceiver, not including when the Transceiver is off.

PO seeks to re-write the Court's claim construction order

Patent Owner's Position

The Board's preliminary construction *is wrong*, and the District Court's construction needs to be understood *differently than what it says*.

The term includes a *negative limitation* related to "transceivers": "idle power consumption" **does not include times when the transceiver is off** because idling means waiting to send and does not cover a powered-off transceiver."

The Court agrees with Empire that a fully powered-off ~~mobile station~~ ^{Transceiver} does not have "idle power consumption" within the meaning of the claims. Nor must all the circuitry of the mobile station be turned on for it to be "idle." Rather, the specification shows the "idle" time is simply the time in which the ~~device~~ ^{Transceiver} is on and waiting to transmit. '120 Patent at 3:3–5 ("[I]f the transmission

PO's "transmission chain" argument contradicts the specification

Patent Owner's expert:

1 Q Okay. And in your view, the circuitry that's
2 included in the transmission chain has to be on in order
3 for the transceiver to be consuming idle power?

4 MR. BROWAND: Objection to form.

5 THE WITNESS: I'm saying the hardware is on.
6 What's off is the sending. That's how a POSITA would
7 read that phrase. Again, those terms do not appear in
8 the claims so I'm not doing claim construction, and I
9 don't think they affect the claim language. I

'120 patent:

the communications channel. Even if the idling transceivers
turn off their transmission chains, some idle power may be
consumed due to leakage current or other effects. The idle

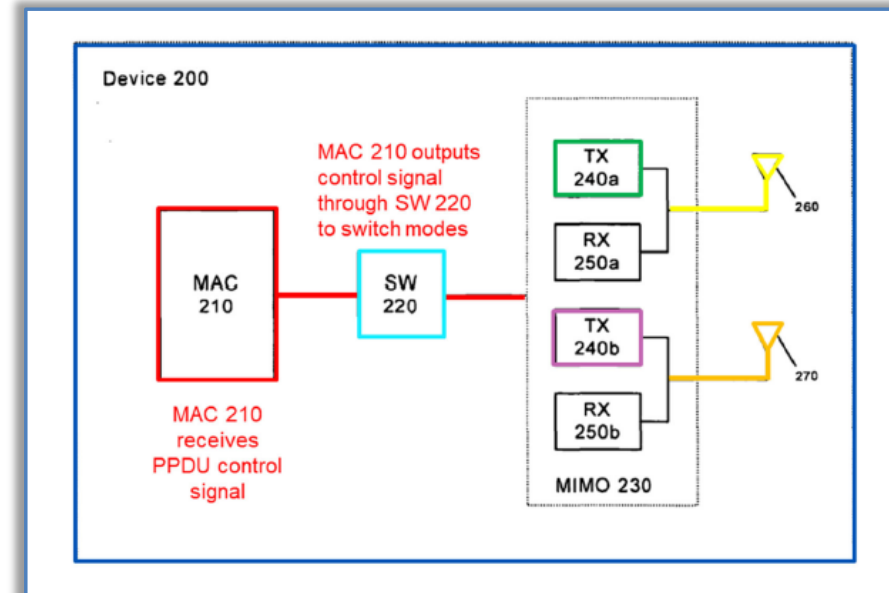
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Li-Siam teaches claim 25

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.

Li, Figure 2:



Li-Siam teaches claim 25

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.

Siam:

sumption. By “transmission mode” we mean one of the four possible transmit/receive antenna configurations: 1×1 (SISO), 2×1 (MISO), 1×2 (SIMO), and 2×2 (MIMO). Our energy model accounts for both the transmission and the circuit powers. While the MIMO mode requires less RF transmission energy than the other three modes, it also incurs the highest circuit energy consumption. Depending on the transmitter-receiver distance, any of the four modes can be the “optimal” one in terms of minimizing the total energy consumption. We study the performance of E-BASIC in ad

Li teaches that “idle mode” may be “an inefficient usage of energy” especially in devices using MIMO transmissions

Li:

consumption. For example, a station in idle mode waiting for incoming signals may consume approximately 60% of its battery energy. This inefficient use of energy may be exacerbated by MIMO devices, since more than one antenna may be turned on for reception. The power consumed by low

Li specifically teaches power inefficiencies from idling devices in MIMO mode

Siam explains how to calculate “total power consumption”

Siam:

3.1 Power Consumption Model

We adopt the multi-antenna link layer model of [4], where $M_t = M_r = 1$ for the SISO case, $M_t = 1$ and $M_r = 2$ for the SIMO case, $M_t = 2$ and $M_r = 1$ for the MISO case, and $M_t = M_r = 2$ for the MIMO case. The total power consumption consists of transmission and circuit powers. The transmis-

ability (p_b) and the specific transmission mode. As for the circuit power (P_c), it is given by [4]

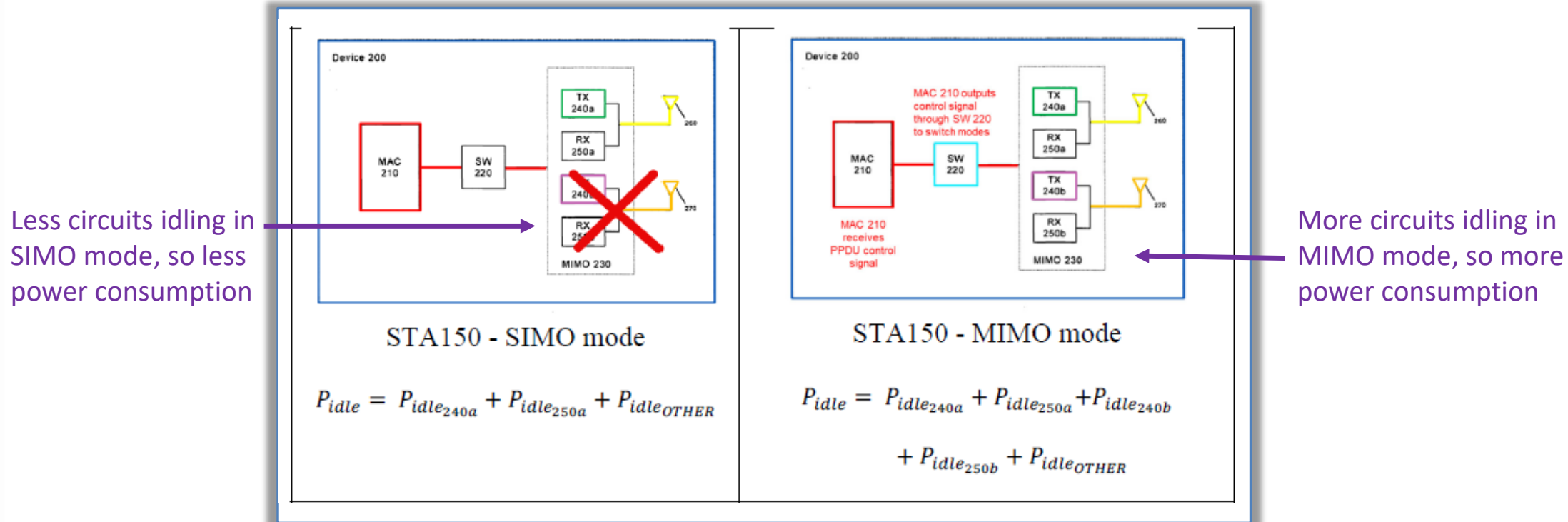
$$P_c \approx M_t(P_{DAC} + P_{mix} + P_{filt}) + 2P_{syn} + M_r(P_{LNA} + P_{mix} + P_{IFA} + P_{filr} + P_{ADC}) \quad (2)$$

where P_{DAC} , P_{mix} , P_{LNA} , P_{IFA} , P_{filt} , P_{filr} , P_{ADC} , and P_{syn} are the 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 at the transmitter and the receiver sides, the analog-to-digital converter (ADC), and the frequency synthesizer, respectively.

**Total power consumption depends on
power consumption of the transmission components**

A POSITA would have accounted for Li's idle mode when calculating total power consumption of Li's devices

Li, Figure 2, annotated by Petitioner's expert:



Demonstrative Exhibit Not Evidence

Petition at 40-43; Ex-1002 ¶¶119-24; Ex-1005 ¶¶18-19, 24, Fig. 2

Li teaches to switch between SIMO and MIMO to reduce power consumption and “save battery life”

Li:

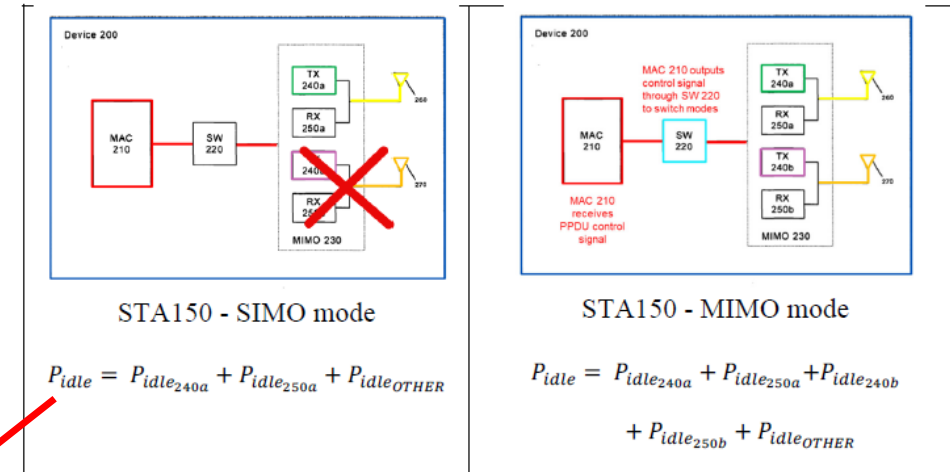
to a MIMO operating mode. For example, AP 110 operating in a MISO or a SISO operating mode may send a request over wireless shared media 160 to switch STA 120 and STA 150 to a SIMO or MIMO operating mode, if desired. STA 120 and STA 150 may acknowledge the request and may enable an operation of desired number of receivers and transmitters of the MIMO receivers-transmitters system. In this manner, power consumption for STA 120 and STA 150 may be reduced, thereby extending the battery life for STA 120 and STA 150.

Li specifically teaches switching between SIMO and MIMO
for power efficiency considerations

Li-Siam teaches claim 25 (f)

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.

Li, Figure 2; Petitioner's expert:



Demonstrative Exhibit Not Evidence

Petition at 40-43; Ex-1002 ¶¶119-24; Ex-1005 ¶¶18-19, 24, Fig. 2; Ex-1001, Cl. 25

PO disputes that Li-Siam teaches claim element 25(f)

- Patent Owner disputes only whether Li-Siam discloses the “idle power consumption” limitation

2013, 68:14-69:3. Rather, Li only mentions idle mode to identify the problem of power consumption but offers no teaching or suggestion about the possible use of idle mode. Ex-1005, [0018]; *see also* Ex-2013 at 69:11-19 (confirming that “this

Patent Owner ignores Li’s teachings

Demonstrative Exhibit Not Evidence

Patent Owner Response (Paper 19) at 35

PO disputes that Li-Siam teaches claim element 25(f)

- Patent Owner disputes only whether Li-Siam discloses the “idle power consumption” limitation
- But Patent Owner itself admits:

With respect to Li, Petitioners rely on a passing mention that “a station in idle mode waiting for incoming signals may consume approximately 60% of its battery energy.” Pet. at 41 (quoting Ex-1005 ¶ 18). Li also recognizes that switching from a

POR, 34

i.e., Li intends to address the problem of power consumption while in idle mode

Ex-2022, ¶ 83. To the contrary, Li expressly states that its disclosed embodiments solve the power consumption problem. Ex-1005, [0019]. For example, Li states that by switching “STA 120 and STA 150 to a SIMO or MIMO operating mode” the “power consumption for STA 120 and STA 150 may be reduced.” *Id.* Siam simply

POR, 33

i.e., Li solves the idle power consumption problem using a control signal that switches to a SIMO or MIMO operating mode to reduce idle power consumption

Patent Owner ignores Li’s teachings

Demonstrative Exhibit Not Evidence

Patent Owner Response at 33-34

PO disputes only claim element 25(f)

Patent Owner Sur-reply:

FALSE

Approximately
60% wasted
battery power

Ex-2022, ¶87. It is unrebutted that Li does not disclose how “idle mode” could be used for power consumption, how “idle mode” could be relevant to mode selection, or how “idle mode” might be considered with respect to a control signal received by the mobile station. *Id.*; Ex-2013, 69:11-19 (stating that one mention is “the extent of

Power wasted
“exacerbated
by MIMO”

Switching between
MIMO and SIMO to
extend battery life

Li-Siam-Cui-2003 further teaches claim element 25(f)

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.

We assume a node has L bits to transmit with a deadline T . The transceiver spends time $T_{on} \leq T$ to communicate these bits, where T_{on} is a parameter to optimize, and then returns to the sleep mode where all the circuits in the signal path are shut down for energy saving. Although the transient duration from

fast enough to be neglected). Correspondingly, the total energy consumption E required to send L bits also consists of three components:

$$\begin{aligned} E &= P_{on}T_{on} + P_{sp}T_{sp} + P_{tr}T_{tr} \\ &= (P_t + P_{c0})T_{on} + P_{sp}T_{sp} + P_{tr}T_{tr}, \end{aligned} \quad (1)$$

where P_{on} , P_{sp} and P_{tr} are power consumption values for the active mode, the sleep mode, and the transient mode, respectively. The active mode power P_{on} comprises the transmission signal power P_t and the circuit power consumption P_{c0} in the whole signal path. Specifically, P_{c0} consists of the power am-

Cui-2003 specifically teaches to include lower power modes in its calculations

Demonstrative Exhibit Not Evidence

Petition at 49-52; Ex-1007, 2806; Ex-1001, Cl. 25

PO disputes that Li-Siam-Cui-2003 teaches claim element 25(f) on claim construction grounds

Patent Owner Sur-reply:

ii. Petitioners fail to demonstrate that Li-Siam-Cui-2003 discloses the “idle power consumption” limitation of claim 25.

Cui-2003’s sleep mode is completely different from the claimed “idle power consumption” because in sleep mode the circuit are shut down. Cui-2003 describes

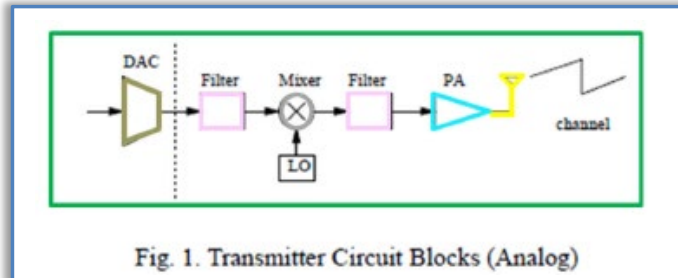
Thus, consistent with the proper interpretation of “idle power consumption”

discussed *supra*, a POSITA would not understand a sleep mode “where all the circuits in the signal path are shut down” to suggest the claimed “idle power.” Ex-2022, ¶104.

Patent Owner has no argument against Cui-2003 if their construction is not adopted

Cui-2003's sleep mode is equivalent to '120 patent's idle mode

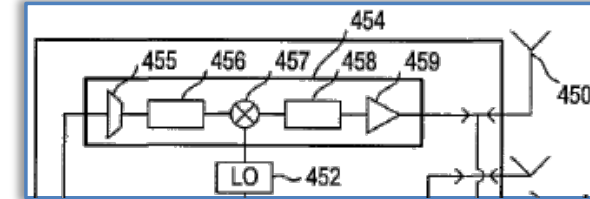
Cui-2003: components in signal path



We assume a node has L bits to transmit with a deadline T . The transceiver spends time $T_{on} \leq T$ to communicate these bits, where T_{on} is a parameter to optimize, and then returns to the sleep mode where all the circuits in the signal path are shut down for energy saving. Although the transient duration from

In the sleep mode, the power consumption is dominated by the leaking current I_l of the switching transistors if the circuitry is properly designed. Since CMOS technology is exclusively

'120 patent: transmission chain



if the transmission rate is too slow, a greater number of transceivers may become idle, waiting to send transmissions over the communications channel. Even if the idling transceivers turn off their transmission chains, some idle power may be consumed due to leakage current or other effects. The idle

Cui-2003 teaches the claims even under PO's construction: sleep mode power may be non-zero

Patent Owner Response:

Cui-2003's sleep mode is completely different from the claimed "idle power consumption" because there is almost no power consumption in sleep mode, whereas the '120 Patent is focused on the power consumed while idling since it may be significant. Ex-2022, ¶ 104. For example, the '120 Patent recognizes that the "idle

FALSE

Cui-2003:

In the sleep mode, the power consumption is dominated by the leaking current I_l of the switching transistors if the circuitry is properly designed. Since CMOS technology is exclusively used in our analysis, the leaking current $I_l \approx 0$ [11] compared with the active mode. Thus, we set $P_{sp} = 0$. Our analysis can be easily modified to incorporate $P_{sp} \neq 0$.

$$E = P_{on}T_{on} + P_{sp}T_{sp} + P_{tr}T_{tr}$$

Li-Siam teaches claim 27

- Patent Owner presents no independent arguments that claim 27 is not obvious

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.

Siam minimizes the energy per bit, E_{bt} , where P_t = transmit power, P_c = circuit power, and R_b = bit rate:

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

Selecting a transmission scheme that minimizes the energy per bit for a fixed bit rate is just the complement of a system that maximizes the bit rate for a fixed energy per bit.

Li-Siam teaches claim 28

- Patent Owner presents no independent arguments that claim 28 is not obvious

28. The mobile station of claim 25, wherein the control signal is transmitted to the mobile station by a base station.

cols. System 100 may include an access point (AP) 110, a station (STA) 120, a STA 130, and a STA 150, all arranged to communicate information signals using wireless shared media 160. Information signals may include any type of

to a MIMO operating mode. For example, AP 110 operating in a MISO or a SISO operating mode may send a request over wireless shared media 160 to switch STA 120 and STA 150 to a SIMO or MIMO operating mode, if desired. STA

Motivation to combine Li and Siam

Li:

consumption. For example, a station in idle mode waiting for incoming signals may consume approximately 60% of its battery energy. This inefficient use of energy may be exacerbated by MIMO devices, since more than one antenna may be turned on for reception. The power consumed by low

to a MIMO operating mode. For example, AP 110 operating in a MISO or a SISO operating mode may send a request over wireless shared media 160 to switch STA 120 and STA 150 to a SIMO or MIMO operating mode, if desired. STA 120 and STA 150 may acknowledge the request and may enable an operation of desired number of receivers and transmitters of the MIMO receivers-transmitters system. In this manner, power consumption for STA 120 and STA 150 may be reduced, thereby extending the battery life for STA 120 and STA 150.

Siam:

the circuit powers. While the MIMO mode requires less RF transmission energy than the other three modes, it also incurs the highest circuit energy consumption. Depending on the transmitter-receiver distance, any of the four modes can be the “optimal” one in terms of minimizing the total energy consumption. We study the performance of E-BASIC in ad

E-BASIC protocol uses adaptive multi-antenna schemes along with power control to send packets. Specifically, it uses the maximum power level for RTS/CTS handshake with the fixed MIMO scheme, but the minimum allowable power level for DATA/ACK packets with an optimally chosen multi-antenna scheme (among SISO, SIMO, MISO, or MIMO) according to the total power consumption that each scheme results. This protocol saves more power than both

Both Li and Siam recognize problems related to power consumption
Li + Siam optimizes power consumption

PO's challenge to motivation to combine is wrong

Patent Owner Sur-reply:

presents a protocol for optimizing power while transmitting..." *Id.* But neither Li nor Siam considers power consumption when not transmitting, nor is there any suggestion to consider idle power consumption in a control signal for purposes of mode selection. Thus, whether a "POSITA would have been motivated to combine

FALSE

Petitioner's expert:

11 Q And Li doesn't say anything about
12 using the power consumption in an idle mode in
13 any way, right?
14 A Well, there is just a suggestion. So
15 in paragraph 18 it is talking about idle mode,
16 and in paragraph 19 it says that the embodiments
17 solve this problem, "this problem" being the
18 consumption in idle mode. But that would be the

Motivation to combine Li-Siam and Cui-2003

Li:

consumption. For example, a station in idle mode waiting for incoming signals may consume approximately 60% of its battery energy. This inefficient use of energy may be exacerbated by MIMO devices, since more than one antenna may be turned on for reception. The power consumed by low

Cui-2003:

We assume that the transceiver circuitry works on a multi-mode 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. The multi-mode operation provides a significant saving of energy when the sleep mode is deployed. We also assume that the power consump-

fast enough to be neglected). Correspondingly, the total energy consumption E required to send L bits also consists of three components:

$$\begin{aligned} E &= P_{on}T_{on} + P_{sp}T_{sp} + P_{tr}T_{tr} \\ &= (P_t + P_{c0})T_{on} + P_{sp}T_{sp} + P_{tr}T_{tr}, \end{aligned} \quad (1)$$

where P_{on} , P_{sp} and P_{tr} are power consumption values for the active mode, the sleep mode, and the transient mode, respectively. The active mode power P_{on} comprises the transmission

PO's challenge to motivation to combine is wrong

Patent Owner Sur-reply:

Indeed, a plain reading of the misquoted sentence shows that Cui-2003 repeatedly uses the word “work” to mean operate, not that circuitry is actively doing anything as Petitioners’ misleadingly suggest: “We assume 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....” Ex-1007, 2806. Petitioners’ misreading of Cui-2003 only shows that Cui-2003’s sleep mode is completely different from, and does not disclose or suggest, idling. Ex-2022, ¶111.

FALSE

Petitioner Reply:

Ex-1007, 2806; Petition, 46; Ex-1002 ¶¶56, 134; Ex-2013, 90:15-22. And Cui-2003’s “total energy consumption E required to send L bits” that it seeks to optimize includes P_{sp} , the power consumed during sleep mode:

$$E = P_{on}T_{on} + P_{sp}T_{sp} + P_{tr}T_{tr}$$

to transmission mode selection. POR, 41. But Cui-2003’s “sleep” mode is no different from the ’120 Patent’s disclosure that “if the idling transceivers turn off their transmission chains, some idle power may be consumed due to leakage current or other effects.” Ex-1001, 3:5-7. In Cui-2003’s sleep mode, the circuitry is *working* and ready to send:

PO's challenge to motivation to combine is wrong

Patent Owner Sur-reply:

Reply, 15. But this is insufficient because a POSITA would not have considered the power expended in sleep mode to be relevant to transmission mode selection since Cui-2003 sets the power consumed in sleep mode to zero. Ex-2022, ¶98. The possibility of non-zero power consumption in sleep mode is simply speculation since a POSITA reading Cui-2003 would understand that sleep mode has no impact at all on selecting an efficient transmission mode. *Id.*; see *Los Angeles Biomedical Res.*

FALSE

Petitioner Reply:

technology, P_{sp} may be approximated as zero. Ex-1007, 2806. However, “our analysis can be easily modified to incorporate $P_{sp} \neq 0$.” *Id.*; Ex-2013, 93:18-94:10 (Petitioner’s expert: “Cui does allow for it to be non-zero. ... You could use it set to zero or not.”). Thus, Cui-2003’s analytical framework could accommodate higher sleep-mode power consumption, even the 60% disclosed in Li. Ex-1005 ¶18; Petition, 51-52; Ex-1002 ¶147. Thus, a POSITA would not have rejected Cui-2003’s

Overview

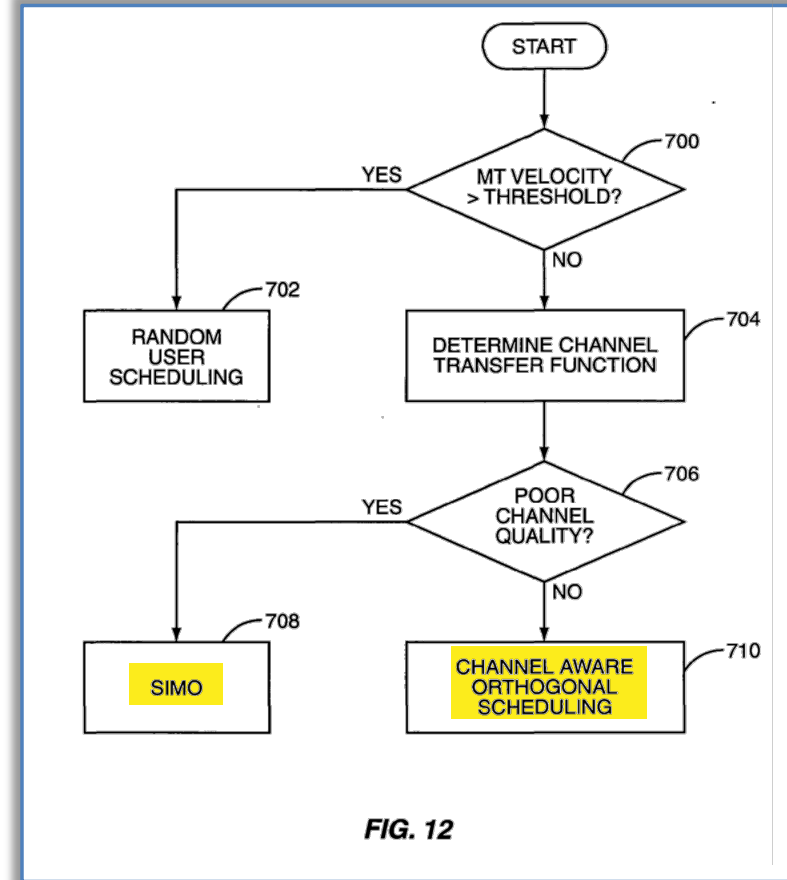
- Alleged Invention
- Overview of the Prior Art
- Claim construction – Idle Power Consumption
- Grounds 1 and 2 – Li, Siam, and Cui 2003 (claims 25, 27, 28)
 - Idle Power Consumption (claim element 25(f))
 - Motivations
- Grounds 3 and 4 – Adding Wu (claim 26)
- Ground 5 – Adding Tirola (claim 29)

Li-Siam-Wu or Li-Siam-Cui-2003-Wu Teach Claim 26

- Patent Owner presents no independent arguments that claim 26 is not obvious

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

Wu's selection of SIMO or MIMO mode depends on degree of channel correlation (orthogonality of channel)

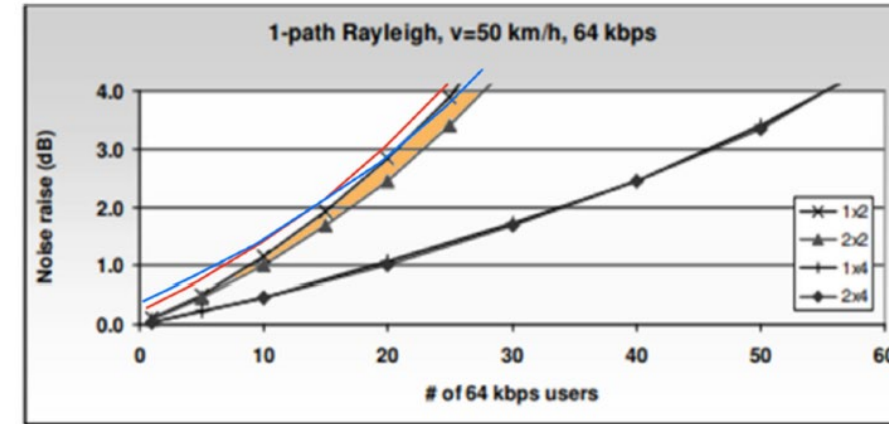


Overview

- Alleged Invention
- Overview of the Prior Art
- Claim construction – Idle Power Consumption
- Grounds 1 and 2 – Li, Siam, and Cui 2003 (claims 25, 27, 28)
 - Idle Power Consumption (claim element 25(f))
 - Motivations
- Grounds 3 and 4 – Adding Wu (claim 26)
- Ground 5 – Adding Tirola (claim 29)

Li-Siam-Tirola Teaches Claim 29

29. 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 a number of users of the communication system.



Noise rise, considered with energy for SIMO and MIMO transmissions, can alter the crossover point (red / blue) for selecting an optimal transmission mode.

Motivation to combine Li-Siam and Tirola

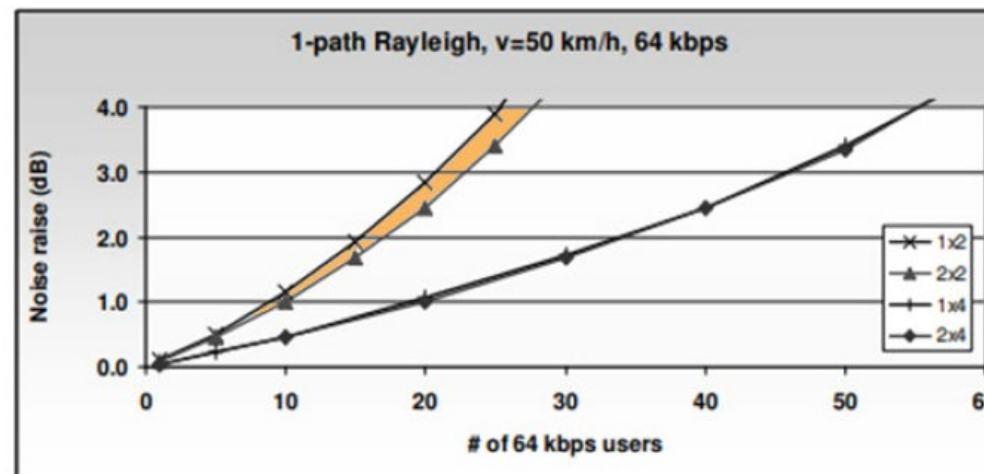
Li:

to a MIMO operating mode. For example, AP 110 operating in a MISO or a SISO operating mode may send a request over wireless shared media 160 to switch STA 120 and STA 150 to a SIMO or MIMO operating mode, if desired. STA

Siam:

sumption. By “transmission mode” we mean one of the four possible transmit/receive antenna configurations: 1×1 (SISO), 2×1 (MISO), 1×2 (SIMO), and 2×2 (MIMO). Our energy model accounts for both the transmission and the circuit powers. While the MIMO mode requires less RF transmission energy than the other three modes, it also incurs the highest circuit energy consumption. Depending on

Tirola:



Noise rise is different, as a function of number of users, depending on SIMO or MIMO configuration

approach with 1 Tx and 4 Rx antennas. Results show also that MIMO transmission will provide some benefit (up to 2 dB) for UL coverage and UE battery consumption. However, doubling

**Samsung Electronics Co., LTD and
Samsung Electronics America Co.
v.
Empire Technology Development LLC.**

Petitioner's Presentation For IPR2024-00896

U.S. Patent No. 8,798,120

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