

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent of: Xuefeng Yin
U.S. Patent No.: 8,891,347 Attorney Docket No. 50095-0250IP1
Issue Date: November 18, 2014
Appl. Serial No.: 13/522,422
Filing Date: July 16, 2012
Title: USER-FOCUSING TECHNIQUE FOR WIRELESS
COMMUNICATION SYSTEMS

Mail Stop Patent Board

Patent Trial and Appeal Board
U.S. Patent and Trademark Office
P.O. Box 1450
Alexandria, VA 22313-1450

**PETITION FOR *INTER PARTES* REVIEW OF UNITED STATES PATENT
NO. 8,891,347 PURSUANT TO 35 U.S.C. §§ 311–319, 37 C.F.R. § 42**

TABLE OF CONTENTS

I.	REQUIREMENTS FOR IPR UNDER 37 C.F.R. § 42.104.....	1
A.	Grounds for Standing Under 37 C.F.R. § 42.104(a).....	1
B.	Challenge Under 37 C.F.R. § 42.104(b) and Relief Requested	1
II.	SUMMARY OF THE '347 PATENT	2
A.	Brief Description.....	2
B.	Prosecution History.....	4
III.	LEVEL OF ORDINARY SKILL	5
IV.	CLAIM CONSTRUCTION	5
V.	DETAILED EXPLANATION OF GROUNDS.....	5
A.	GROUND 1–Hardacker – Claims 1, 6, 8, and 14-15, 19	5
1.	Hardacker (APPLE-1004)	5
2.	Application to Challenged Claims - 19	10
3.	Claims 1, 6, 8, 14-15	22
B.	GROUND 2–Hardacker–Medbo – Claims 2-4, 6, 9-12, 16, and 20-23.....	35
1.	Hardacker (APPLE-1004)	35
2.	Medbo (APPLE-1005)	35
3.	Combination of Hardacker-Medbo	37
4.	Application to Challenged Claims – 20-23	42
5.	Claims 2-4, 6, 9-12, 16	47
C.	GROUND 3–Wallace – Claims 1-2, 8, 12, 15-17, 19-20, 23.....	49
1.	Wallace (APPLE-1006).....	49
2.	Application to Challenged Claims – 19-20, 23	50
3.	Claims 1-2, 8, 12, 15-17	68
D.	GROUND 4–Wallace-Medbo – Claims 2-4, 16, and 20-22	78
1.	Wallace (APPLE-1006).....	78
2.	Medbo (APPLE-1005)	78
3.	Combination of Wallace and Medbo	78
4.	Application to Challenged Claims -20-22.....	82
5.	Claims 2-4, and 16.....	85
VI.	DISCRETIONARY DENIAL IS NOT WARRANTED.....	86
VII.	CONCLUSION.....	86
VIII.	MANDATORY NOTICES UNDER 37 C.F.R § 42.8(a)(1).....	87
A.	Real Party-In-Interest Under 37 C.F.R. § 42.8(b)(1).....	87
B.	Related Matters Under 37 C.F.R. § 42.8(b)(2)	87

C. Lead And Back-Up Counsel Under 37 C.F.R. § 42.8(b)(3).....	88
D. Service Information	88

LIST OF EXHIBITS

APPLE-1001	U.S. Patent No. 8,891,347 (“’347 Patent”)
APPLE-1002	Excerpts from the Prosecution History of the ’347 Patent
APPLE-1003	Declaration of Dr. Zhi Ding
APPLE-1004	U.S. Patent Pub. 2010/0159855A1 (“Hardacker”)
APPLE-1005	U.S. Patent Pub. 2014/0010274A1 (“Medbo”)
APPLE-1006	U.S. Patent No. 6,473,467 (“Wallace”)
APPLE-1007	Stefania Sesia, et al., <i>LTE: The UMTS Long Term Evolution from Theory to Practice Second Edition</i> , 2011 (“Sesia”).
APPLE-1008	Rudolf F. Graf, <i>Modern Dictionary of Electronics Seventh Edition</i> , 1999.
APPLE-1009	Patent Trial and Appeal Board (PTAB) Boardside Chat: Interim Processes Relating to institution in AIA Proceedings (Apr. 17, 2025)
APPLE-1010	Coke Morgan Stewart, Interim Processes for PTAB Workload Management (Mar. 26, 2025)

LISTING OF CLAIMS

Claim 1	
[1.1]	A method for wireless communication in a system including a transmitter, a receiver, and a plurality of propagation paths formed between the transmitter and the receiver which are capable of carrying a signal transmitted by the transmitter to the receiver, the method comprising:
[1.2]	transmitting a first signal from the transmitter to the receiver via a first propagation path of the plurality of propagation paths;
[1.3]	receiving the first signal at the receiver;
[1.4]	performing a channel estimation based on the first signal to obtain path parameter information of the first propagation path;
[1.5]	sending the channel estimation that includes the path parameter information from the receiver to the transmitter via the first propagation path;
[1.6]	predistorting a second signal at the transmitter in a time domain, a frequency domain, and a spatial domain, according to the channel estimation based on the first signal;
[1.7]	transmitting the predistorted second signal from the transmitter to the receiver via the first propagation path; and
[1.8]	receiving the predistorted second signal at the receiver.
Claim 2	
[2]	The method of claim 1, wherein the path parameter information of the first propagation path includes at least one of an estimation of a delay, an estimation of a Doppler frequency, an estimation of a direction of arrival, an estimation of a direction of departure, and an estimation of a complex amplitude of the first propagation path.

Claim 3	
[3]	The method of claim 2, wherein the path parameter information of the first propagation path further includes an estimation of a polarization status of the first propagation path.
Claim 4	
[4]	The method of claim 1, wherein the path parameter information is obtained by at least one estimation technique of the group consisting of a maximum-likelihood estimation algorithm, periodogram, correlatorgram, spectral-based methods, Bartlett beamformers, Capon beamformers, subspace-based techniques, MUSIC (Multiple Signal Classification), ESPRIT (Estimation of Signal Parameters via Rotational Invariance Techniques), approximation of the maximum-likelihood method based on iterative schemes, SAGE (Space-Alternating Generalized Expectation-maximization), RiMAX (Richter's Maximum Likelihood method), maximum-a-posteriori based methods, Evidence Framework, Bayesian techniques, tracking algorithms, Kalman filtering techniques, enhanced Kalman filtering techniques, particle filtering techniques, and least-square-error methods.
Claim 6	
[6]	The method of claim 1, further comprising equalizing the predistorted second signal at the receiver.
Claim 8	
[8.1]	A system for wireless communication comprising: a receiver; a transmitter; and a plurality of propagation paths formed between the transmitter and the receiver which are capable of carrying a signal transmitted by the transmitter to the receiver,
[8.2]	wherein the receiver is configured to receive a first signal that is transmitted along a first propagation path of the plurality of propagation paths from the transmitter,

[8.3]	perform a channel estimation based on the first signal to obtain path parameter information of the first propagation path, and
[8.4]	send the channel estimation that includes the path parameter information to the transmitter via the first propagation path, and
[8.5]	wherein the transmitter is configured to predistort a second signal in a time domain, a frequency domain, and a spatial domain according to the channel estimation that is based on the first signal and received from the receiver and
[8.6]	to transmit the predistorted second signal to the receiver via the first propagation path.
Claim 9	
[9]	The system of claim 8, wherein the path parameter information of the first propagation path includes at least one of an estimation of a delay, an estimation of a Doppler frequency, an estimation of a direction of arrival, an estimation of a direction of departure, and an estimation of a complex amplitude of the first propagation path.

Claim 10	
[10]	The system of claim 8, wherein the path parameter information of the first propagation path further includes an estimation of a polarization status of the first propagation path.
Claim 11	
[11]	The system of claim 8, wherein the path parameter information is obtained by at least one estimation technique of the group consisting of a maximum likelihood estimation algorithm, periodogram, correlatorgram, spectral-based methods, Bartlett beamformers, Capon beamformers, subspace-based techniques, MUSIC (Multiple Signal Classification), ESPRIT (Estimation of Signal Parameters via Rotational Invariance Techniques), approximation of the maximum-likelihood method based on iterative schemes, SAGE (Space-Alternating Generalized Expectation-maximization), RiMAX (Richter's Maximum Likelihood method), maximum-a-posteriori based methods, Evidence Framework, Bayesian techniques, tracking algorithms, Kalman filtering techniques, enhanced Kalman filtering techniques, particle filtering techniques, and least-square-error methods.
Claim 12	
[12]	The system of claim 8, wherein the transmitter and the receiver each comprise multiple antennas in a multiple-input and multiple-output (MIMO) wireless communication system or a single antenna in a single-input and single-output (SISO) wireless communication system.
Claim 14	
[14]	The system of claim 8, wherein the receiver is further configured to equalize the predistorted second signal.

Claim 15	
[15.1]	A base station for performing wireless communication with a receiver in a wireless device via a plurality of propagation paths, the base station comprising: a transmitter;
[15.2]	a computing device; and a computer-readable storage medium having computer-executable instructions stored thereon that are executable by the computing device to perform operations comprising:
[15.3]	transmitting a first signal from the transmitter to the receiver via a first propagation path of the plurality of propagation paths;
[15.4]	receiving a channel estimation based on the first signal, the channel estimation including path parameter information of the first propagation path;
[15.5]	predistorting a second signal in a time domain, a frequency domain, and a spatial domain according to the channel estimation based on the first signal; and
[15.6]	transmitting the predistorted second signal from the transmitter to the receiver via the first propagation path.
Claim 16	
[16]	The base station of claim 15, wherein the path parameter information of the first propagation path includes at least one of an estimation of a delay, an estimation of a Doppler frequency, an estimation of a direction of arrival, an estimation of a direction of departure, an estimation of a complex amplitude of the first propagation path, and an estimation of a polarization status of the first propagation path.

Claim 17	
[17]	The base station of claim 15, wherein the transmitter comprises multiple antennas in a multiple-input and multiple-output (MIMO) wireless communication system or a single antenna in a single-input and single-output (SISO) wireless communication system.
Claim 19	
[19.1]	A wireless device for performing wireless communication with a base station with a transmitter via a plurality of propagation paths, the wireless device comprising: a receiver;
[19.2]	a computing device; and a computer-readable storage medium having computer-executable instructions stored thereon that are executable by the computing device to perform operations comprising:
[19.3]	receiving a first signal at the receiver via a first propagation path of the plurality of propagation paths;
[19.4]	performing a channel estimation based on the first signal to obtain path parameter information of the first propagation path;
[19.5]	sending the channel estimation that includes the path parameter information to the transmitter; and
[19.6]	receiving a second signal via the first propagation path, the second signal predistorted in a time domain, a frequency domain, and a spatial domain according to the channel estimation based on the first signal.
Claim 20	
[20]	The wireless device of claim 19, wherein the path parameter information of the first propagation path includes at least one of an estimation of a delay, an estimation of a Doppler frequency, an estimation of a direction of arrival, an estimation of a direction of departure, and an estimation of a complex amplitude of the first propagation path.

Claim 21	
[21]	The wireless device of claim 20, wherein the path parameter information of the first propagation path further includes an estimation of a polarization status of the first propagation path.
Claim 22	
[22]	The wireless device of claim 19, wherein the path parameter information is obtained by at least one estimation technique of the group consisting of a maximum likelihood estimation algorithm, periodogram, correlatorgram, spectral-based methods, Bartlett beamformers, Capon beamformers, subspace-based techniques, MUSIC (Multiple Signal Classification), ESPRIT (Estimation of Signal Parameters via Rotational Invariance Techniques), approximation of the maximum-likelihood method based on iterative schemes, SAGE (Space-Alternating Generalized Expectation-maximization), RiMAX (Richter's Maximum Likelihood method), maximum-a-posteriori based methods, Evidence Framework, Bayesian techniques, tracking algorithms, Kalman filtering techniques, enhanced Kalman filtering techniques, particle filtering techniques, and least-square-error methods.
Claim 23	
[23]	The wireless device of claim 19, wherein the receiver comprises multiple antennas in a multiple-input and multiple-output (MIMO) wireless communication system or a single antenna in a single-input and single-output (SISO) wireless communication system.

Apple Inc. (“Apple” or “Petitioner”) petitions for IPR of claims 1-4, 6, 8-12, 14-17 and 19-23 (“Challenged Claims”) of U.S. Patent No. 8,891,347 (“’347 Patent”). Evidence presented in this petition demonstrates the Challenged Claims are unpatentable.

I. REQUIREMENTS FOR IPR UNDER 37 C.F.R. § 42.104

A. Grounds for Standing Under 37 C.F.R. § 42.104(a)

Petitioner certifies that the ’347 Patent is available for IPR and Petitioner is not barred/estopped from requesting this review.

B. Challenge Under 37 C.F.R. § 42.104(b) and Relief Requested

Petitioner requests IPR based on the following grounds, as further explained in this Petition and supported by a declaration from Dr. Ding (APPLE-1003):

Ground	’347 Patent Claims	§103 Basis
1	1, 6, 8, 14-15, 19	Hardacker
2	2-4, 6, 9-12, 16, 20-23	Hardacker-Medbo
3	1-2, 8, 12, 15-17, 19-20, 23	Wallace
4	2-4, 16, 20-22	Wallace-Medbo

Each applied reference pre-dates W.I.P.O. Internation Application No. PCT/CN11/77718, filed on July 28, 2011, which is the earliest filed application of the ’347 Patent:

Reference	Date
U.S. Patent Pub. 2010/0159855A1 (“Hardacker”)	Filing Date: December 19,

Reference	Date
	2008
U.S. Patent Pub. 2014/0010274A1 (“Medbo”)	PCT Filing Date: April 14, 2011
U.S. Patent No. 6,473,467 (“Wallace”)	Filing Date: March 30, 2000

None of the above references were applied in a substantive office action or cited during original prosecution.

II. SUMMARY OF THE ’347 PATENT

A. Brief Description

The ’347 Patent describes a pre-distortion technique for transmitting signals wirelessly from a transmitter (e.g., a base station or eNodeB) to a receiver (e.g., UE) in a wireless communication system. *See* APPLE-1001, 12:54-58, Abstract; APPLE-1003, ¶45.

The ’347 Patent describes a “user-focusing” technique designed to enhance wireless communication system performance by leveraging precise channel knowledge, primarily by shifting compensation from the receiver to the transmitter through pre-distortion. APPLE-1001, 3:20-54. The method begins with a wireless device receiving a first signal transmitted from a base station (transmitter) over one or more radio propagation paths. *Id.* This first signal is distorted by the propagation environment (e.g., propagation loss). *Id.* The received, distorted first signal allows the receiver to accurately perceive and characterize the propagation path’s

influence on the signal e.g., the effect of propagation loss on received/transmitted signals. *Id.*; APPLE-1003, ¶46.

Based on the reception of this first signal, the wireless device is configured to perform a channel estimation to obtain detailed channel estimation including “path parameter information.” APPLE-1001, 8:4-16. The ’347 Patent lists some common channel characteristics that are measurable via different methods: they include precise estimations of propagation delay, Doppler frequency, direction of arrival (DOA), direction of departure (DOD), and complex amplitude for the propagation path. APPLE-1001, 3:39-54, 8:4-16. The ’347 Patent also notes the potential for estimating polarization status for more advanced focusing. APPLE-1001, 10:14-19, 12: 22-31. The estimation can employ a wide array of sophisticated algorithms, including but not limited to Maximum Likelihood (ML) estimation (e.g., SAGE, RiIMAX), spectral-based methods (e.g., Bartlett, Capon, MUSIC), subspace-based techniques (e.g., ESPRIT), Bayesian approaches, and various tracking algorithms such as Kalman filtering. APPLE-1001, 8:17-57, Cl. 4; APPLE-1003, ¶47.

Once the channel parameters are estimated by the wireless receiving device during channel estimation, the receiving device then sends this channel estimation, including the “path parameter information,” back to the transmitter. APPLE-1001, 1: 45-2:32. This feedback channel information enables the transmitter to execute

its “user-focusing” function. *Id.* The transmitter then pre-distorts and transmits a subsequent (second) signal using this received channel information. *Id.* This predistortion is applied across the time, frequency, and spatial domains and compensates for the channel’s distortions during propagation, ensuring a constructive and coherent arrival at the receiver. APPLE-1001, 7:50-55; APPLE-1003, ¶48. The wireless device ultimately receives this pre-distorted second signal. APPLE-1001, 1: 45-2:32.

B. Prosecution History

The ’347 Patent issued on November 18, 2014 from U.S. Patent Application No. 13/522,422 filed July 16, 2012. APPLE-1002, 77-78. This application was a National Stage Entry of W.I.P.O International Application No. PCT/CN11/77718, filed July 28, 2011. APPLE-1002, 295; APPLE-1003, ¶49.

During prosecution claims were rejected under §102 as being anticipated by U.S. 2007/0177551 A1 (“Joham”) and §103 as being unpatentable over Joham in view of U.S. 2010/0177746 A10 (“Gorokhov”). APPLE-1002, 150-165; APPLE-1003, ¶50.

Applicant argued that Joham “only discloses compensating for the spatial components and not . . . the time domain, the frequency domain, and the spatial domain.” APPLE-1002, 139 (emphasis added). The notice of allowance agreed that Joham did not teach the combination of all three types of pre-distortion. APPLE-

1002, 109; APPLE-1003, ¶51.

III. LEVEL OF ORDINARY SKILL

A person of ordinary skill in the art at the time of the '347 Patent (a “POSITA”) would have had a bachelor’s degree in electrical engineering, computer engineering, computer science, or a related field, and two to three years of experience in the design or development of wireless telecommunication systems, or the equivalent. Additional graduate education could substitute for professional experience, or significant experience in the field could substitute for formal education. APPLE-1003, ¶¶20-22.

IV. CLAIM CONSTRUCTION

All claim terms should be construed according to the Phillips standard. *Phillips v. AWH Corp.*, 415 F.3d 1303 (Fed. Cir. 2005); 37 C.F.R. § 42.100. The Board has repeatedly explained that “claim terms need only be construed to the extent necessary to resolve [a] controversy.” *Wellman, Inc. v. Eastman Chem. Co.*, 642 F.3d 1355, 1361 (Fed. Cir. 2011). As the prior art discloses the claims under each of the constructions offered in the Petition, the Board need not construe the claims to resolve unpatentability. *Id.*

V. DETAILED EXPLANATION OF GROUNDS

A. GROUND 1–Hardacker – Claims 1, 6, 8, and 14-15, 19

1. Hardacker (APPLE-1004)

U.S. Patent Pub. 2010/0159855A1 (Hardacker) is titled “TECHNIQUES FOR PRE-DISTORTING TRANSMITTED SIGNALS FOR A TRANSMITTER DEVICE.” APPLE-1004, Title (emphasis added). The method addresses a fundamental challenge in communication systems: the inherent asymmetry and complexity between transmitters and receivers, particularly in broadcast scenarios where receivers are often constrained by cost and power, thus the receivers having limited capabilities for compensation of channel distortions. APPLE-1004, [0001]-[0002]. The core teaching of Hardacker revolves around shifting the burden of distortion compensation from the receiver to the transmitter through intelligent pre-distortion techniques. APPLE-1004, [0004]-[0005]; APPLE-1003, ¶52. Hardacker is analogous to the ’347 Patent because Hardacker is in the same field of endeavor and addresses problems reasonably pertinent to those discussed in the ’347 Patent.

Traditionally, a transmitter simply broadcasts a signal, and a receiver, equipped with an equalizer, attempts to recover the transmitted original signal from the channel-distorted reception. APPLE-1004, [0002]; APPLE-1003, ¶53.

However, if the channel distortion exceeds the equalizer’s recovery capability, the transmitted signal cannot be accurately reconstructed at the receiver. *Id.* Hardacker proposes a solution where the transmitter has measured channel information about the distortion characteristics (e.g., propagation loss) of the communication medium, i.e., channel, and uses this prior knowledge to pre-distort the transmitted

signal. APPLE-1004, [0003]-[0006]. This ensures that by the time the signal traverses the communication/propagation path, the overall channel distortion to a signal, accounting for the predistortion and actual channel distortion, is manageable by a less complex receiver. APPLE-1004, [0005]; APPLE-1003, ¶53.

The mechanism for the transmitter to acquire this measured channel information is crucial. APPLE-1004, [0006]. In a bi-directional communication system, a return channel (or “back channel”) is leveraged. APPLE-1004, [0005]. For instance, as seen in figure 4, if Device 1 transmits to Device 2, Device 2 can measure the channel distortion experienced by the signal transmitted by Device 1 and then relay this distortion information back to Device 1. APPLE-1004, FIG. 4, [0022]-[0026]. Hardacker describes accounting for propagation loss using this system in two scenarios, symmetrical and asymmetrical. APPLE-1003, ¶54.

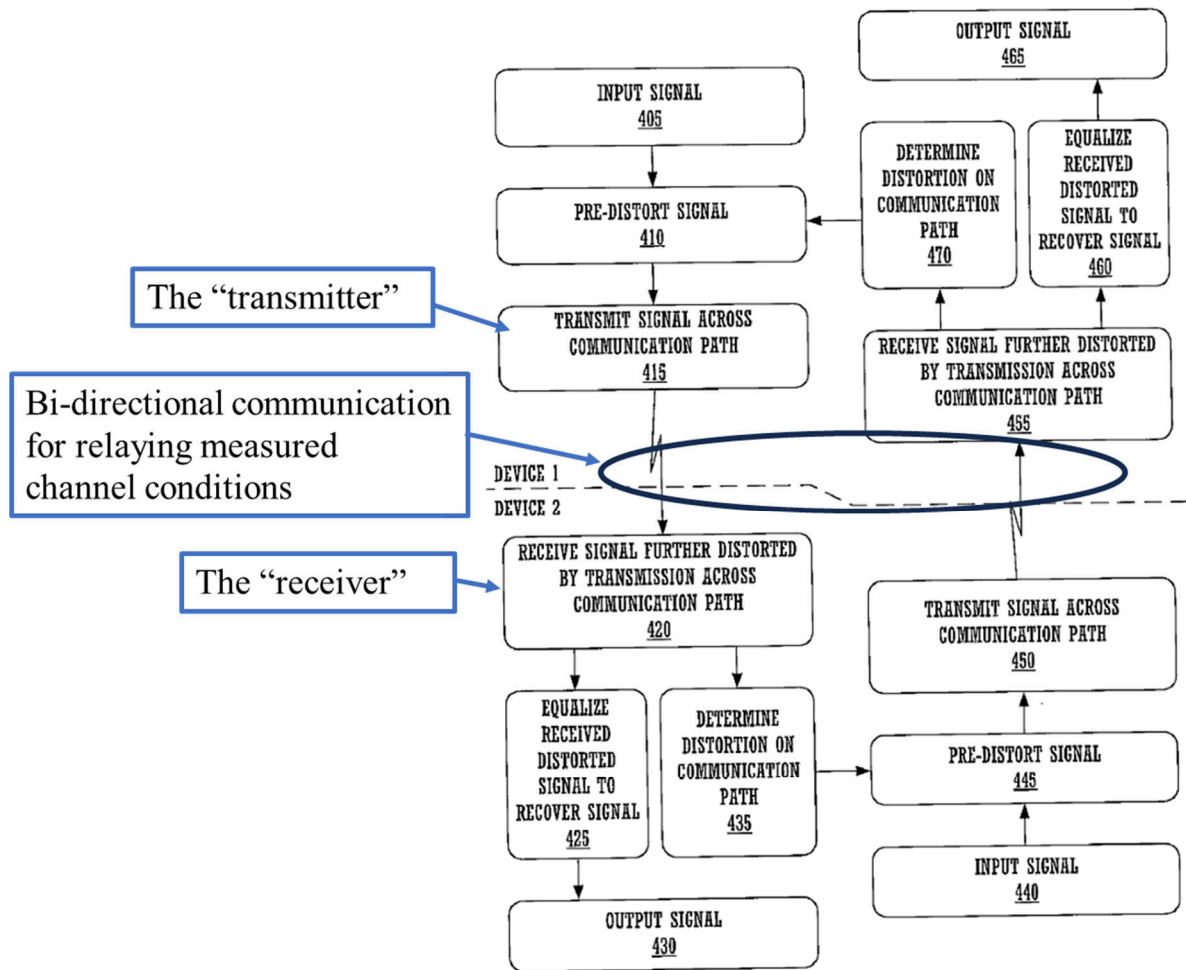


FIGURE 4

APPLE-1004, FIG. 4¹.

Specifically, for the symmetrical scenario Hardacker teaches in figure 4, a bi-directional communication scheme where both devices actively engage in pre-distortion to manage propagation path losses, predicated on the assumption that channel distortion—measured using the received signals—is substantially

¹ All figures are annotated in color unless otherwise noted.

consistent and steady in time between the communicating entities. APPLE-1004, [0023]-[0027]. In this example, Device 1 initiates transmission of a first input signal which is pre-distorted by its pre-distortion circuit using an estimate of the channel's distortion. *Id.* This pre-distortion factor is determined from prior channel measurements made by Device 1's distortion determination circuit upon receiving a previous signal from Device 2. *Id.* When this pre-distorted signal traverses the channel and is further distorted by the channel conditions, it arrives at Device 2's receiver. *Id.* Device 2 then calculates/determines the channel distortion based on this received signal. *Id.* Subsequently, when Device 2 prepares to transmit a second input signal back to Device 1, it uses this newly determined channel distortion to determine and apply a corresponding pre-distortion on its own outgoing signal. *Id.* This pre-distorted signal is then transmitted, passes through the channel, and is received by Device 1, which then determines its channel distortion estimate for future transmissions, based on the newly received signal. *Id.* This adaptive pre-compensation strategy means that each transmitting device continuously refines its understanding of the channel characteristics and applies the inverse distortion to its transmitted signals, thereby reducing the complexity requirements for the respective receivers and improving overall link performance. APPLE-1003, ¶55. The channel distortion parameters representing the path parameter information, which can include various types including multi-path, amplitude, or phase

distortion, are determined during setup, periodically, or when performance metrics, such as bit error rate (BER), degrade. *Id.*, [0003], [0006], [0019].

In the asymmetrical scenario, Hardacker discloses conditions in which the channel distortion may be different in the two transmission directions. APPLE-1004, [0027]. In these circumstances, the receiver of Device 2 transmits the data indicating the channel distortion in the direction from Device 1 to Device 2, determined at Device 2, back to Device 1 for use by the transmitter of Device 1 in preconditioning signals sent from Device 1 to Device 2. *Id.*; cl. 9 (“wherein the first device further comprises: a second receiver communicatively coupled to the communication path for receiving the data indicating the distortion on the communication path from the first device to the second device.”); APPLE-1003, ¶56.

2. Application to Challenged Claims - 19²

Claim 19

² The Petition leads with Claim 19 because it describes one side of the communication architecture, focusing on the wireless device’s role. This provides a conceptually simpler entry point than Claim 1, which details the full, end-to-end method involving both the transmitter and receiver simultaneously.

[19.1] A wireless device for performing wireless communication with a base station with a transmitter via a plurality of propagation paths, the wireless device comprising: a receiver;

Hardacker renders obvious [19.1]. A POSITA would have understood and found obvious that Hardacker's disclosure of wireless devices, that include transmitters, receivers, and distortion determination circuits for communication over a wireless communication network, would satisfy or encompass the understanding of a *wireless device* and a *base station—for performing wireless communication*. APPLE-1003, ¶69. For example, the definition of “base station” is “1. [a] fixed station used by a dispatcher to communicate with mobile units. 2. The central transmitter in a communications system that acts as the cell hub for communicating with handsets and/or mobile units.” APPLE-1008, 6³. Thus, at the very least, which device is the “base station” is not predetermined and the configuration of such a system would be a design choice based on a POSITA's knowledge of such wireless communication systems and commonsense. APPLE-1003, ¶69.

Moreover, Hardacker discloses *a base station with a transmitter via a plurality of propagation paths, the wireless device comprising: a receiver*.

APPLE-1004, FIG. 2, [0014]-[0016]; APPLE-1003, ¶70.

³ Refers to PDF pagination.

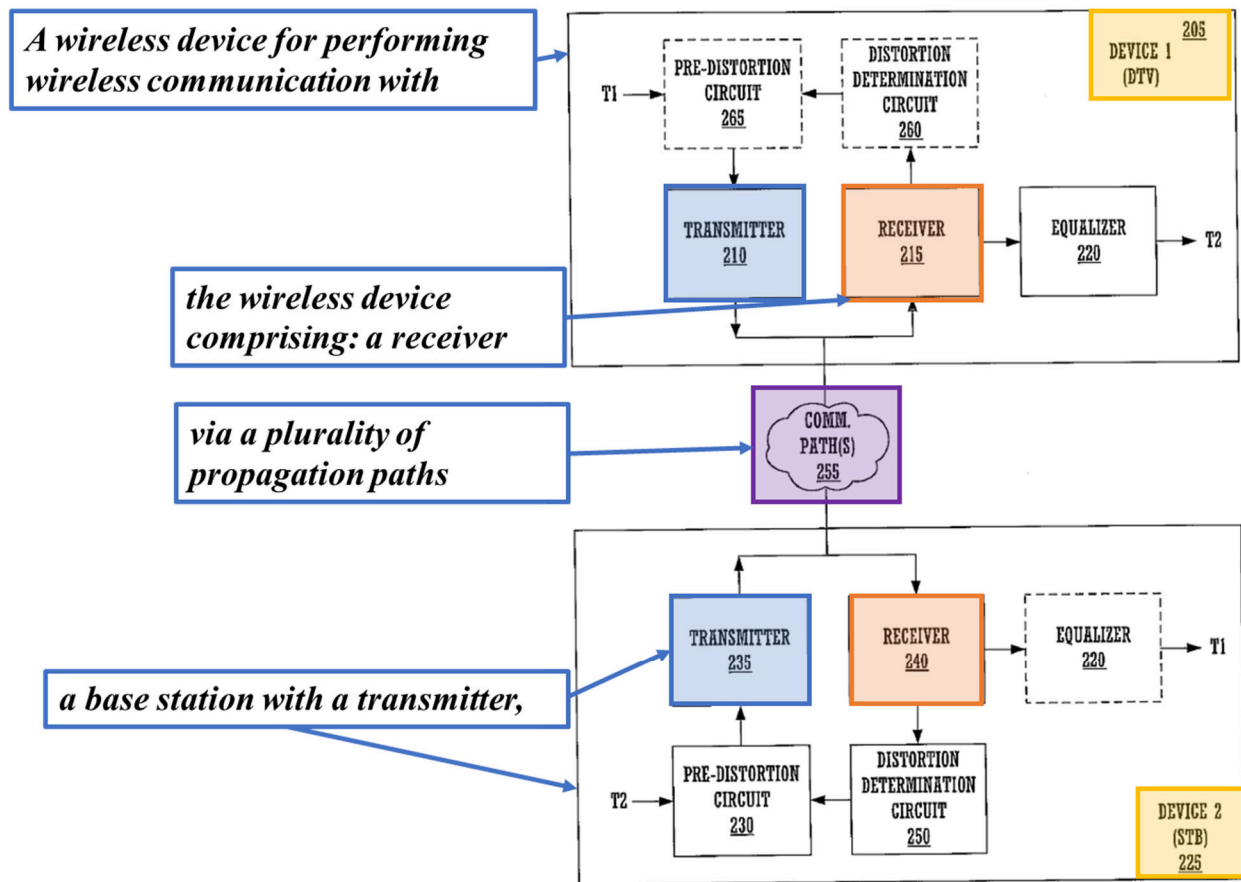


FIGURE 2

APPLE-1004, FIG. 2.

[19.2] a computing device; and a computer-readable storage medium having computer-executable instructions stored thereon that are executable by the computing device to perform operations comprising:

Hardacker renders obvious [19.2]. Specifically, a POSITA would have understood and found obvious that the signal processing, pre-distortion, channel determination, and iterative modulation schemes detailed in Hardacker would necessarily be implemented using programmable hardware or software. APPLE-1003, ¶71. For instance, Hardacker, filed more than a year after the release of the

iPhone, states that “pre-distortion functionality as described below is performed in the digital domain.” APPLE-1004, [0032], [0038] (“reduce the number of necessary bits in the analog to digital converter circuits which in turn reduces power consumption.”). Performing operations in the digital domain requires a computing device capable of executing algorithms and processing digital data and is indicated by Hardacker’s mention of using “bits.” APPLE-1004, [0038]; APPLE-1003, ¶71. While Hardacker refers to “circuits” like “pre-distortion circuit” and “distortion determination circuit”, it also discusses these circuits compensating for various “distortion types, e.g., multi-path, amplitude, frequency, phase.” The adaptive and iterative nature of these compensations strongly indicates that these circuits are not merely fixed analog or simple digital gates, but rather include programmable elements. APPLE-1003, ¶71.

Thus, in implementing such a system as Hardacker in mobile communication devices available at the time of the critical date, a POSITA would have understood and found obvious that Hardacker’s process could be implemented using *a computing device; and a computer-readable storage medium having computer-executable instructions stored thereon that are executable by the computing device to perform operations comprising the measurement and predistortion of signals according to Hardacker’s disclosure.* APPLE-1003, ¶72.

[19.3] receiving a first signal at the receiver via a first propagation path of the plurality of propagation paths;

Hardacker renders obvious [19.3]. For example, Hardacker teaches *a “first input signal [T(1)] is transmitted across the communication path 255 [via a first propagation path] by the transmitter 210 . . . and is received by the receiver 240.”*

APPLE-1004, [0017]. Thus, Hardacker renders obvious *receiving the first signal at the receiver*. APPLE-1003, ¶73. Moreover, a POSITA would have understood and found obvious that i) Hardacker’s description of transmissions in a system including multiple communication paths (“communication paths 255”) and ii) Hardacker’s description of “determining the nature of the distortion and/or interference on a communication path” teaches that *a first signal* is transmitted *from the transmitter to the receiver via a first propagation path of the plurality of propagation paths*. APPLE-, [0003], FIG. 1-2, [0014] (“The first and second devices 205 and 225 transmit and receive signals across one or more communication paths 255 of the communication network.”); APPLE-1003, ¶73.

[19.4] performing a channel estimation based on the first signal to obtain path parameter information of the first propagation path;

Hardacker renders obvious [19.4]. For example, Hardacker teaches *“the first input signal [T(1)] is a training or configuration signal specifically utilized to determine the nature of the distortion or interference on the communication path [(path parameter information of the first propagation path)].”* APPLE-1004,

[0016]; APPLE-1003, ¶74.

Specifically, Hardacker teaches a “distortion determination circuit 250 determines the distortion [D(1)] on the communication path.” APPLE-1004, [0024]. A POSITA would have understood and found obvious that Hardacker’s “distortion [] on the communication path” is at least one type of ***path parameter information*** because Hardacker discloses that “types of distortion includ[e] equalization, multi-path, amplitude, frequency, phase and other well[-]known types” of wireless communication path distortion. APPLE-1004, [0024], [0003]; APPLE-1003, ¶75. Below, Hardacker’s annotated figure 4 demonstrates an example process of receiving ***the first signal, performing a channel estimation based on the first signal***, and feeding that path parameter information back to the transmitter. APPLE-1004, FIG. 4, [0023]-[0027].

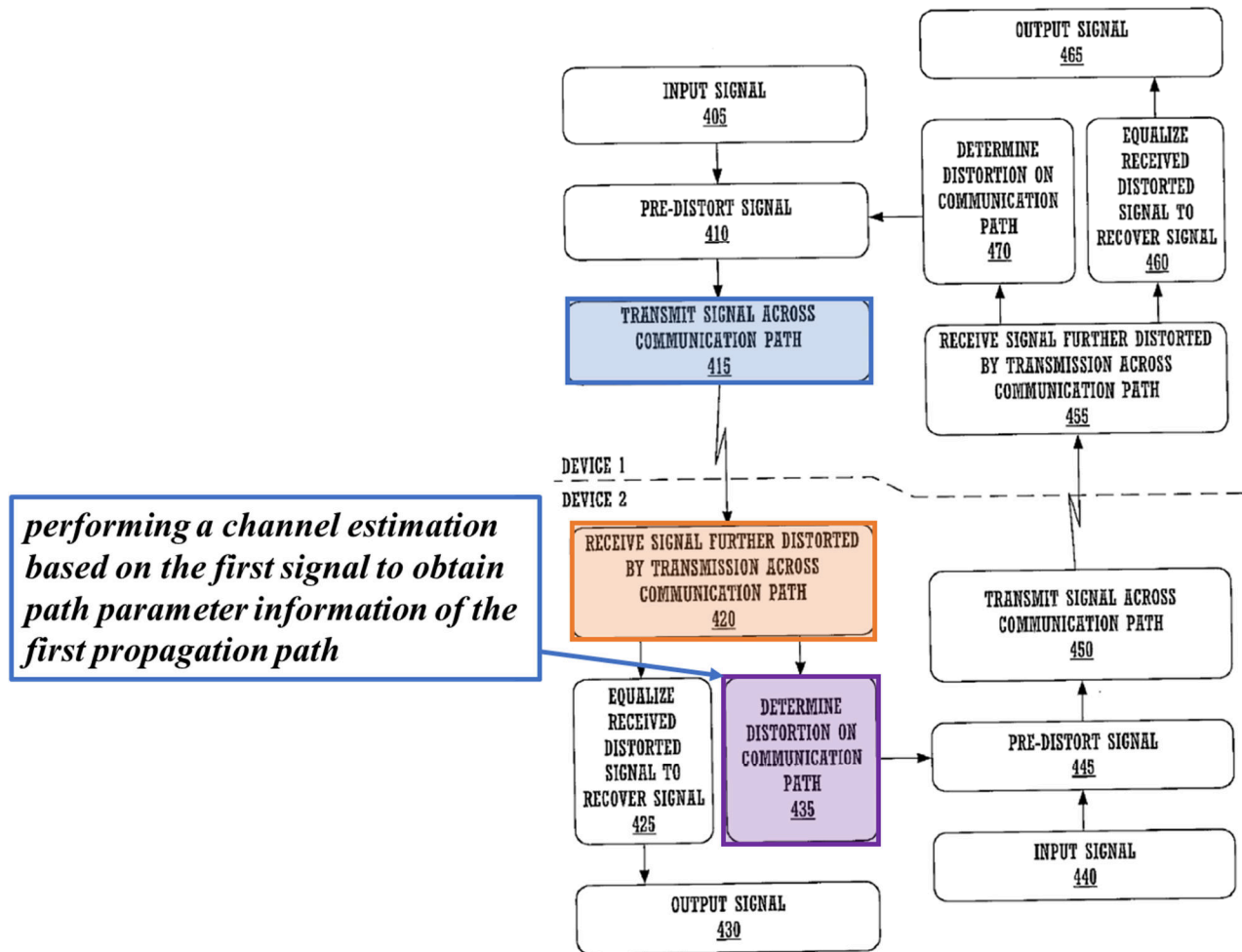


FIGURE 4

APPLE-1004, FIG. 4.

Hardacker’s “channel estimation” produces *path parameter information of the first propagation path* because Hardacker teaches that the path parameter information may not be the same in both directions between the two devices, and for this reason, the data about *the first propagation path* is sent back to the transmitter. APPLE-1004, [0027]. Specifically, Hardacker teaches “data [(*channel estimation*)] indicating the distortion [(*path parameter information of the first*

propagation path)] determined at process 435 is transmitted from the second device 225 back to the first device 205 and used by the pre-distortion circuit 260 of the first device 205 to pre-distort the signal [] transmitted from the first device 205 to the second device 225.” APPLE-1004, [0027]; APPLE-1003, ¶76.

Thus, Hardacker renders obvious *performing a channel estimation based on the first signal to obtain path parameter information of the first propagation path*. APPLE-1003, ¶77.

[19.5] sending the channel estimation that includes the path parameter information to the transmitter; and

Hardacker renders obvious [19.5]. For example, Hardacker teaches “data [(*the channel estimation*)] indicating the distortion [(*that includes the path parameter information*)] determined at process 435 is transmitted [(*sent*)] from the second device 225 [(*receiver*)] back *to the* first device 205 [(*transmitter*)] and used by the pre-distortion circuit 260 of the first device 205 to pre-distort the signal [] transmitted from the first device 205 to the second device 225.” APPLE-1004, [0027]; APPLE-1003, ¶78.

Thus, Hardacker renders obvious *sending the channel estimation that includes the path parameter information to the transmitter*. APPLE-1003, ¶79.

[19.6] receiving a second signal via the first propagation path, the second signal predistorted in a time domain, a frequency domain, and a spatial domain according to the channel estimation based on the first signal.

Hardacker renders obvious [19.6]. For example, Hardacker teaches “the receiver [(*at the receiver*)] 240 of the second device 225 receives the pre-distorted [(*second*)] *signal* $[T(1)]*[D(1)-1]$ further distorted by $[D(1)]$ after transmission across the communication path [(*via the first propagation path*)].” APPLE-1004, [0024]. A POSITA would have understood and found obvious from Hardacker’s disclosure that at least in some circumstances, the *second signal* is *receiv[ed] via the first propagation path* because Hardacker teaches using the channel estimation, that characterizes the distortion of the first propagation path, to pre-distort the second signal from the transmitter to the receiver. APPLE-1004, [0027]; APPLE-1003, ¶80. For example, Hardacker describes symmetrical circumstances “when the distortion on the communication path 255 is substantially the same” and consequently shows using the first propagation path parameter information to improve subsequent transmissions. APPLE-1004, FIG. 4, [0027]. In asymmetrical circumstances, the “data indicating the distortion [(*the channel estimation based on the first signal*)] determined at process 435 is transmitted from the second device 225 [(“the receiver”)] back to the first device 205 [(“the transmitter”)] and used by the pre-distortion circuit 260 of the first device 205 to pre-distort the [(*second*)] *signal* $(T(1))$ transmitted from the first device 205 to the second device 225 at process 410. ” Because the subsequent transmission uses measurements of the first propagation path *based on the first signal*, a POSITA would have

understood and found obvious that the “transmitter” is assumed to operate in at least the next transmission across *the first propagation path*. APPLE-1004, [0027]; APPLE-1003, ¶80. Thus, Hardacker renders obvious *receiving a second signal via the first propagation path*. APPLE-1003, ¶80.

Hardacker renders obvious *predistort[ing] a second signal ... according to the channel estimation based on the first signal*. For example, Hardacker teaches “data [(*channel estimation*)] indicating the distortion determined at process 435 [(at the “receiver”)] is transmitted from the second device 225 back to the first device 205 and used by the pre-distortion circuit 260 of the first device 205 [(the “transmitter”)] to pre-distort the signal [(*predistorting a second signal*)] (T(1)) transmitted from the first device 205 to the second device 225 at process 410 [(at the transmitter)].” APPLE-1004, [0027]; APPLE-1003, ¶81. Hardacker’s figure 4 below demonstrates *predistorting a second signal* at process 410. APPLE-1004, [0027].

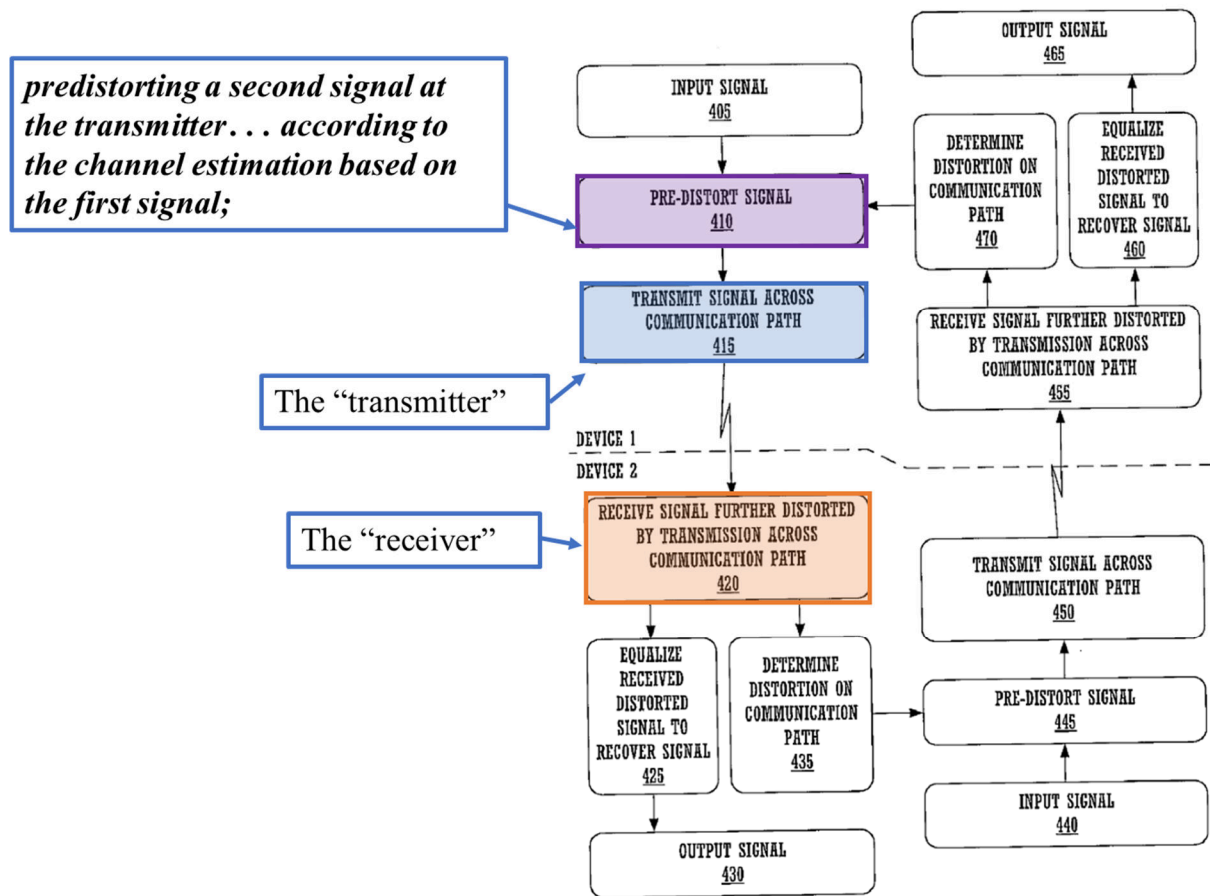


FIGURE 4

APPLE-1004, FIG. 4.

A POSITA would have understood and found obvious the pre-distortion performed at Hardacker’s step 410 includes at least a pre-distortion in *a time domain, a frequency domain, and a spatial domain*. APPLE-1003, ¶82. First, the distortion measured by Hardacker and transmitted back to the transmitter “may be determined for each signal received by the receiver 215 or periodically when the distortion changes over time.” APPLE-1004, [0026]. A POSITA would also have understood that, similarly, the distortion in the opposite direction measured by

Hardacker may also be determined for each signal received by the receiver 240 or periodically when the distortion changes over time. APPLE-1003, ¶82.

Additionally, Hardacker teaches accounting for well-known propagation path affects “e.g., multi-path, amplitude, frequency, phase and other well[-]known types and is therefore not limited to equalization.” APPLE-1004, [0033], [0003].

Subsequently, “[t]he pre-distortion [(of the *second signal*)] may be accomplished using various types of distortion including equalization, multi-path, amplitude, frequency, phase and other well[-]known types.” *Id.* A POSITA would have understood and found obvious, that Hardacker’s disclosure of “types of distortion” includes the “various types of distortion” of wireless signals, commonly known by a POSITA by the critical date, and included pre-distortion in *a time domain, a frequency domain, and a spatial domain*. APPLE-1003, ¶82.

For example, a POSITA would have known that in wireless communication systems, particularly systems in which multi-path propagation occurs, that a given propagation path would be affected in the *time domain* (e.g., in delayed receipt), the *frequency domain* (e.g., frequency-selective fading), and in the *spatial domain* (e.g., phase rotation based on angle of arrival (AoA)). APPLE-1007, 407-411⁴ (“differing propagation delays between different UEs”), 438-439 (“The transmitted

⁴ Refers to the PDF pagination.

signal traverses three paths with different delays.”), 439 (“In the frequency domain this corresponds to frequency-selective fading”), 439 (“Finally, the multipath characteristics define the frequency, time, and space correlations.”), 432-433 (Discussing phase rotation in a multi-antenna array based on angle of arrival at a mobile device); APPLE-103, ¶83. Measuring such propagation path characteristics—through channel estimation—would have been understood to contribute to a “channel model [] to reflect all the instantaneous space-time-frequency characteristics which affect the configuration of diversity, beamforming, and spatial multiplexing techniques” applied to overcome such effects. APPLE-1007, 438; APPLE-1003, ¶83.

Thus, a POSITA would have understood and found obvious that *predistorting a second signal. . . according to the channel estimation based on the first signal* would include predistortion in at least *a frequency domain, and a spatial domain*. APPLE-1003, ¶84.

3. Claims 1, 6, 8, 14-15

Claim 1

[1.1] A method for wireless communication in a system including a transmitter, a receiver, and a plurality of propagation paths formed between the transmitter and the receiver which are capable of carrying a signal transmitted by the transmitter to the receiver, the method comprising:

Hardacker renders obvious [1.1]. Hardacker teaches a *wireless*

communication “method of sending and receiving signals [that] includes determining the nature of the distortion and/or interference on a communication path.” APPLE-1004, [0003]. Demonstrated in the annotated figure 2 below, Hardacker’s signals are sent and received using a *wireless communication system including a transmitter, a receiver, and a plurality of propagation paths formed between the transmitter and the receiver*. APPLE-1004, FIG. 1-2, [0002], [0014]-[0015]; APPLE-1003, ¶85.

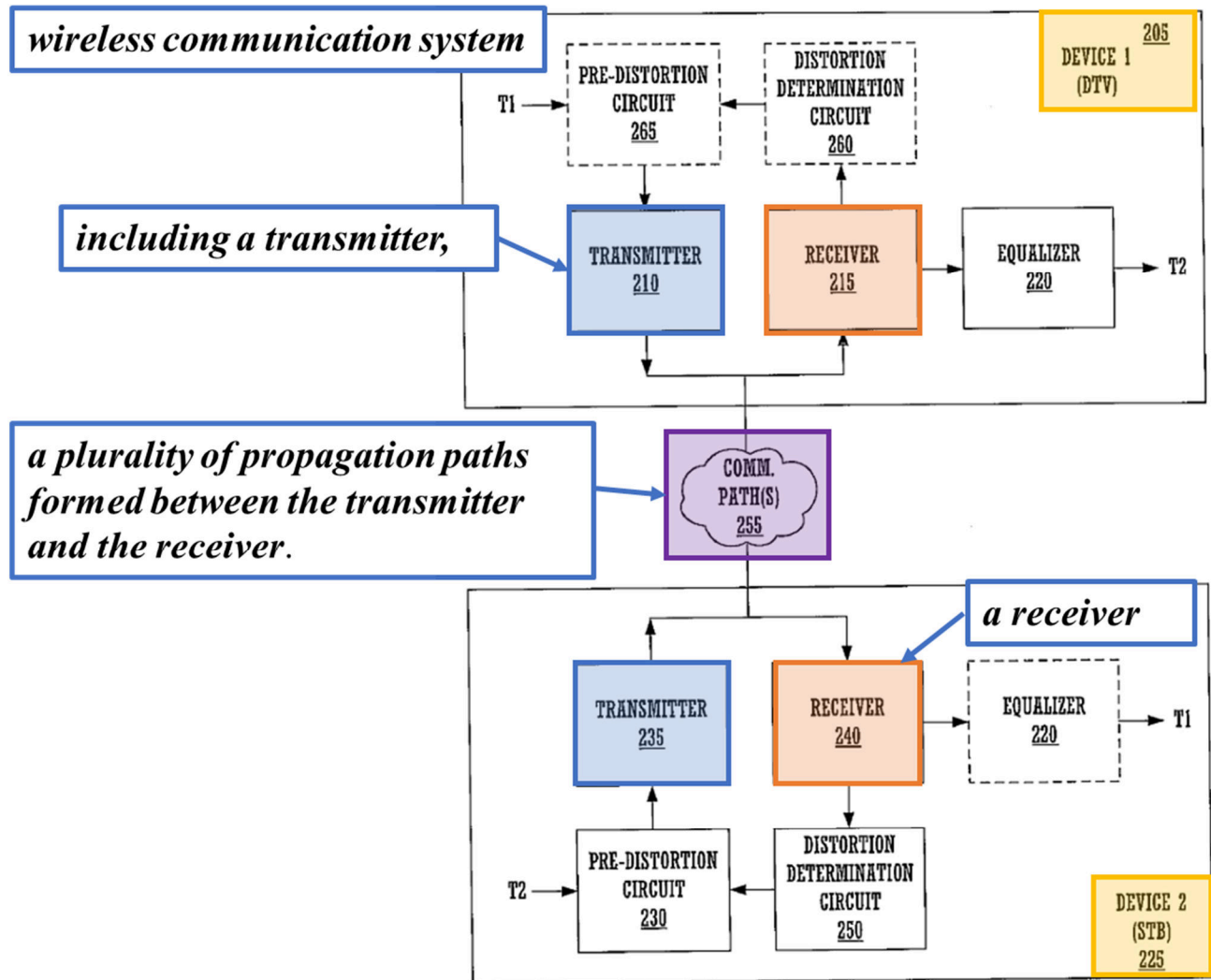


FIGURE 2

APPLE-1004, FIG. 2.

Hardacker describes the “[t]he first and second devices 205 and 225 transmit and receive *signals* across one or more communication paths [(a plurality of propagation paths formed between the transmitter and the receiver)] 255 of the communication network.” APPLE-1004, [0014]. Thus, Hardacker renders obvious

that the *propagation paths. . . are capable of carrying a signal transmitted by the transmitter to the receiver*. APPLE-1003, ¶86.

[1.2] transmitting a first signal from the transmitter to the receiver via a first propagation path of the plurality of propagation paths;

Hardacker renders obvious [1.2]. For example, Hardacker teaches a “*first* input *signal* [T(1)] is transmitted across the communication path [(*a first propagation path*)] 255 by the transmitter 210 . . . and is received by the receiver 240.” APPLE-1004, [0017]. Thus, a POSITA would have understood and found obvious that i) Hardacker’s description of transmission in a system including multiple communication paths (“COMM. PATH(S)”) and ii) Hardacker’s description of “determining the nature of the distortion and/or interference on a communication path” teaches that *a first signal* is transmitted *from the transmitter to the receiver via a first propagation path of the plurality of propagation paths*. APPLE-1004, [0003], FIG. 1-2, [0014] (“The first and second devices 205 and 225 transmit and receive signals across one or more communication paths 255 of the communication network.”); APPLE-1003, ¶87.

[1.3] receiving the first signal at the receiver;

See [19.3]; APPLE-1003, ¶88.

[1.4] performing a channel estimation based on the first signal to obtain path parameter information of the first propagation path;

See [19.4]; APPLE-1003, ¶89.

[1.5] sending the channel estimation that includes the path parameter information from the receiver to the transmitter via the first propagation path;

See [19.5]. A POSITA would have understood and found obvious from Hardacker's disclosure that "data [(*the channel estimation*)] indicating the distortion" is sent, at least in some circumstances, *via the first propagation path* because Hardacker teaches using the same *channel estimation* information (of *the first propagation path*) to pre-distort the signal from the receiver back to the transmitter. APPLE-1004, [0027]; APPLE-1003, ¶90. As a POSITA would have understood and found obvious, Hardacker describes circumstances "when the distortion on the communication path 255 is substantially the same" at least for a period of time. APPLE-1004, FIG. 1, FIG. 4, [0027]. In these circumstances, the "data [(*the channel estimation*)] indicating the distortion determined at process 470 is transmitted from the first device 205 back to the second device and used by the pre-distortion circuit 230 of the second device 225 to pre-distort the signal (T(2)) at process 445" because the transmission back to the "transmitter" is assumed to operate across *the first propagation path*. APPLE-1004, [0027]; APPLE-1003, ¶90. Thus, when Hardacker describes distorting the return transmission with the same channel estimation, the assumption is that the return transmission travels across *the first propagation path* and renders obvious *sending the channel estimation . . . via the first propagation path*. APPLE-1003, ¶90.

[1.6] predistorting a second signal at the transmitter in a time domain, a frequency domain, and a spatial domain, according to the channel estimation based on the first signal;

See [19.6]; APPLE-1003, ¶91.

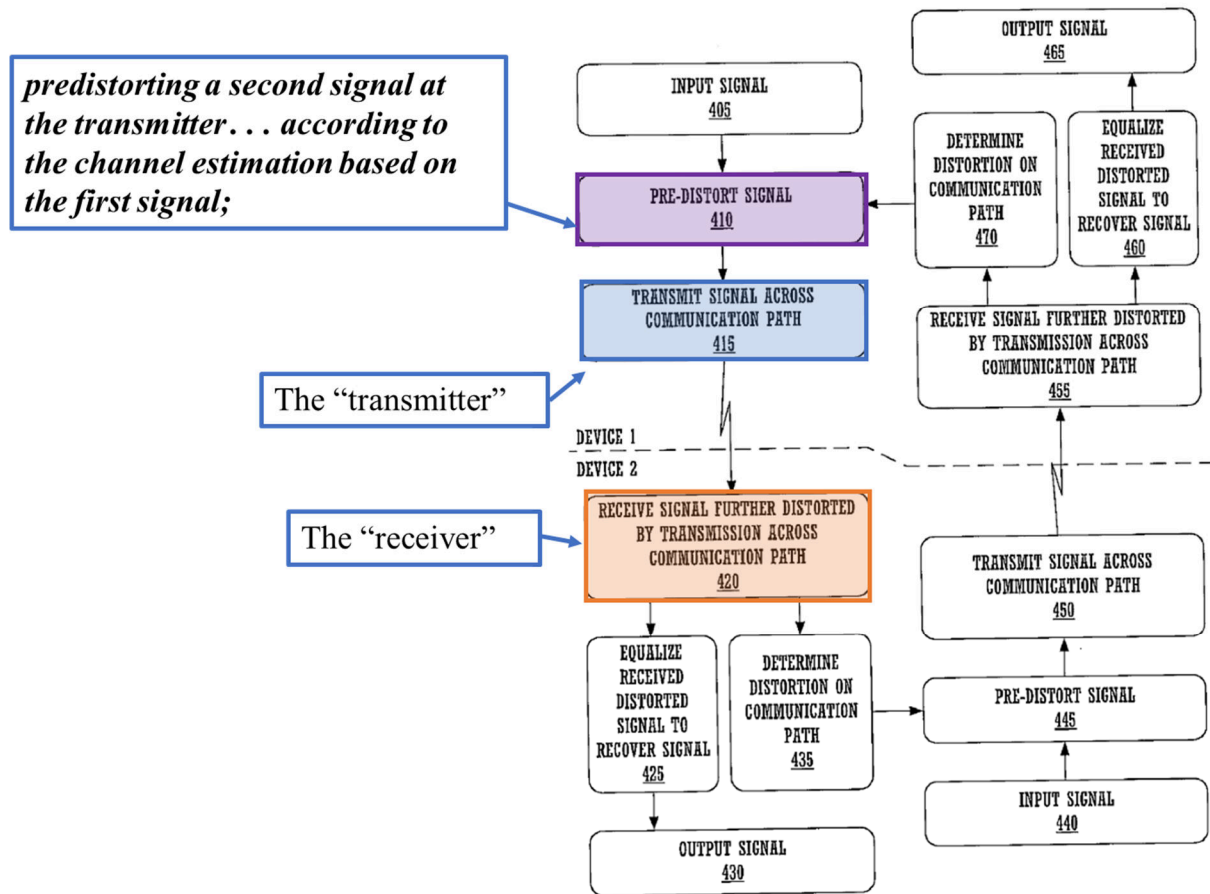


FIGURE 4

APPLE-1004, FIG. 4.

[1.7] transmitting the predistorted second signal from the transmitter to the receiver via the first propagation path; and

Hardacker renders obvious [1.7]. For example, Hardacker teaches the transmission of signals from the transmitter to the receiver, where the signal is pre-distorted based on previous transmissions. APPLE-1004, [0023], [0027].

Specifically, Hardacker's transmitter can "pre-distort the signal (T(1)) transmitted [(*transmitting the predistorted second signal*)] *from the* first device [(*transmitter*)] 205 *to the* second device [(*receiver*)] 225 at process 410" seen in the annotated figure 4 below. APPLE-1004, [0027]. Indeed, Hardacker describes the continued measuring of channel conditions and adjusting predistortion values which accounts for changes in channel conditions over time, thus affecting future pre-distortions applied at 410 to subsequent transmissions. APPLE-1004, [0026] ("the communication path 255 may be determined for each signal received by the receiver 215 or periodically when the distortion changes over time."); APPLE-1003, ¶92.

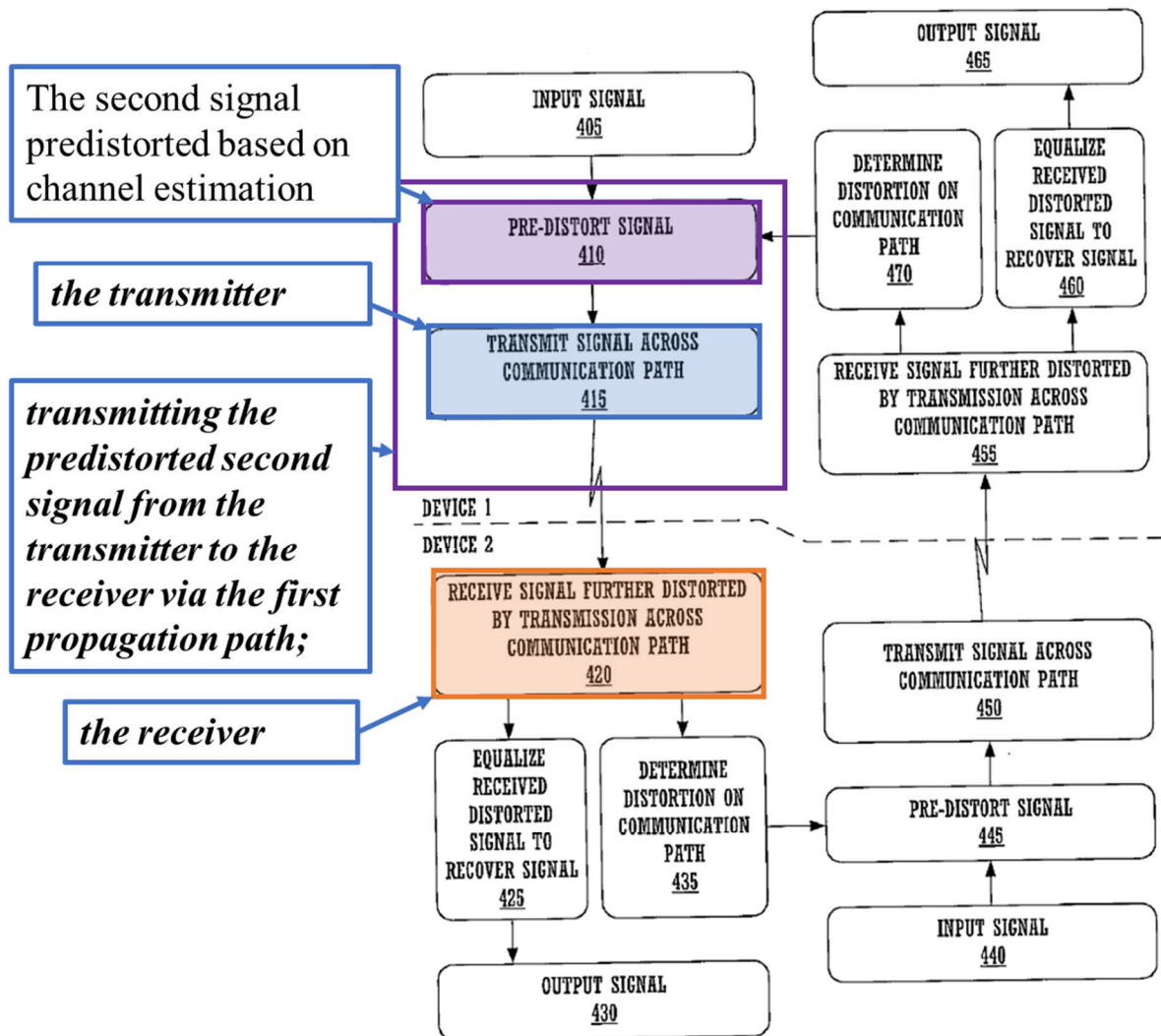


FIGURE 4

APPLE-1004, FIG. 4.

As discussed in [1.5], Hardacker explains that transmissions between the transmitter and receiver can occur over the same path (*the first propagation path*). APPLE-1004, [0026]-[0027]. Specifically, Hardacker teaches that, in some instances, the distortion of the communication path (*the first propagation path*) “does not regularly fluctuate.” APPLE-1004, [0026]; APPLE-1003, ¶93.

Hardacker teaches that “the pre-distorted signal [] is transmitted by the transmitter 210 across the communication path 255”. APPLE-1004, [0023]. A POSITA would have understood and found obvious that the transmission of pre-distorted signal across Hardacker’s communication path 255 that does not regularly fluctuate functionally equates to *transmitting . . . via the first propagation path*, because *the first propagation path* is the part of the signal channel from the transmitter and receiver. APPLE-1003, ¶93. In other words, Hardacker transmits a second signal using information learned from measurements of the first signal, therefore the second signal is pre-distorted with the assumption that the second signal will travel *via the first propagation path*, which is assumed to not have appreciably changed since the measurement. APPLE-1003, ¶93. Thus, Hardacker’s disclosure renders obvious that when pre-distorting the second signal based on the first channel estimation, that the subsequent transmissions are transmitted *via the first propagation path* to take advantage of the pre-distortion. APPLE-1003, ¶93.

[1.8] receiving the predistorted second signal at the receiver.

See [19.6]; APPLE-1003, ¶94.

Claim 6

[6]

Hardacker renders obvious [6]. For example, Hardacker discloses a receiver

that includes an equalizer. APPLE-1004, [0002], [0006]. Indeed, Hardacker discloses that “equalizer 245 of the second device 225 equalizes the received pre-distorted [(*second*)] *signal*” *at the receiver*. APPLE-1004, [0020], [0024].

Hardacker’s annotated figure 4 demonstrates the device *equalizing the predistorted second signal at the receiver*. APPLE-1004, FIG. 4; APPLE-1003, ¶95.

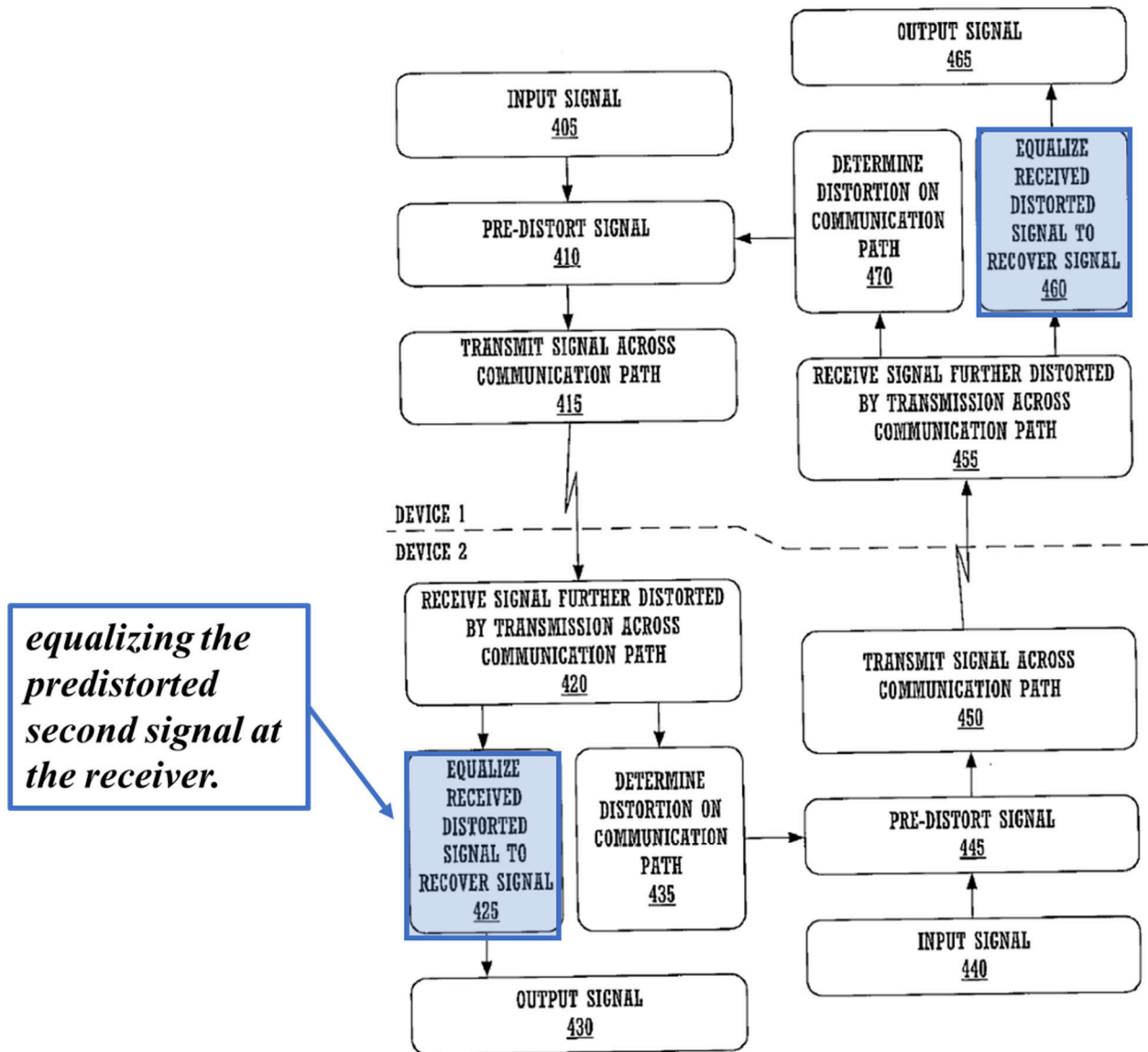


FIGURE 4

APPLE-1004, FIG. 4.

Claim 8

[8.1] A system for wireless communication comprising: a receiver; a transmitter; and a plurality of propagation paths formed between the transmitter and the receiver which are capable of carrying a signal transmitted by the transmitter to the receiver,

See [1.1]-[1.2]; APPLE-1004, [0001]; APPLE-1003, ¶96.

[8.2] wherein the receiver is configured to receive a first signal that is transmitted along a first propagation path of the plurality of propagation paths from the transmitter,

See [1.2]-[1.3]; APPLE-1003, ¶97.

[8.3] perform a channel estimation based on the first signal to obtain path parameter information of the first propagation path, and

See [1.4]; APPLE-1003, ¶98.

[8.4] send the channel estimation that includes the path parameter information to the transmitter via the first propagation path, and

See [1.5]; APPLE-1003, ¶99.

[8.5] wherein the transmitter is configured to predistort a second signal in a time domain, a frequency domain, and a spatial domain according to the channel estimation that is based on the first signal and received from the receiver and

See [1.6]; APPLE-1003, ¶100.

[8.6] to transmit the predistorted second signal to the receiver via the first propagation path.

See [1.7]; APPLE-1003, ¶101.

Claim 14

[14]

See [6]; APPLE-1003, ¶102.

Claim 15

[15.1] A base station for performing wireless communication with a receiver in a wireless device via a plurality of propagation paths, the base station comprising: a transmitter;

See [19.1]. Dr. Ding explains a POSITA would have understood and found obvious that Hardacker's disclosure of devices that include transmitters, receivers, distortion determination circuits for communication over a wireless communication network would satisfy or encompass the understanding of a *wireless device* and a *base station*. APPLE-1003, ¶103.

[15.2] a computing device; and a computer-readable storage medium having computer-executable instructions stored thereon that are executable by the computing device to perform operations comprising:

See [19.2]; APPLE-1003, ¶104.

[15.3] transmitting a first signal from the transmitter to the receiver via a first propagation path of the plurality of propagation paths;

See [1.2]; APPLE-1003, ¶105.

[15.4] receiving a channel estimation based on the first signal, the channel estimation including path parameter information of the first propagation path;

A POSITA would have understood and found obvious from the teachings that render obvious [1.5], that the “base station” of claim 15 would *receiv[e] a channel estimation based on the first signal, the channel estimation including path parameter information of the first propagation path* because claim [1.5] provides for “sending *the channel estimation that includes the path parameter information* from the receiver to the transmitter via the first propagation path.” See [1.5] (“sending the channel estimation that includes the path parameter information from the receiver to the transmitter via the first propagation path”); APPLE-1003,

¶106.

[15.5]predistorting a second signal in a time domain, a frequency domain, and a spatial domain according to the channel estimation based on the first signal; and

See [1.6]; APPLE-1003, ¶107.

[15.6]transmitting the predistorted second signal from the transmitter to the receiver via the first propagation path.

See [1.7]; APPLE-1003, ¶108.

B. GROUND 2–Hardacker–Medbo – Claims 2-4, 6, 9-12, 16, and 20-23

1. Hardacker

See V.A.1.

2. Medbo

Medbo is analogous to the '347 Patent because it is in the same field of endeavor as the '347 Patent and contains teachings reasonably pertinent to the field by addressing an advanced approach for channel estimation based on channel modeling, a technique crucial for modern and future wireless radio communication technologies that demand high bandwidth efficiency and flexibility. APPLE-1005, [0002]-[0003]. This method involves characterizing radio channels from channel measurements, particularly for channel modeling in radio link and system simulations. *Id.* Medbo emphasizes that a key application of this high resolution channel estimation is for improved channel prediction, which in turn facilitates

enhanced link adaptation, including the control of coding and/or transmit power.

APPLE-1005, [0002]-[0003], [0043]. Essentially, by precisely understanding the channel's behavior, the transmission parameters can be optimally adjusted to match the channel conditions. *Id.*; APPLE-1003, ¶57.

For example, Medbo's channel estimation can rely on Maximum Likelihood (ML) parameter estimation in conjunction with discrete wave channel models.

APPLE-1005, [0004], [0044]-[0046]. Medbo also mentions use of other commonly known methods of channel estimation including Space Alternating Generalized Expectation (SAGE) and Richter's Maximum (RIMAX) Likelihood method.

APPLE-1005, [0004]. This approach involves determining a windowed likelihood function based on measured and modeled channel responses. APPLE-1005, [0010]-[0012]. The objective is to maximize this likelihood function to estimate wave parameters such as wave propagation delays, wave propagation directions, and complex amplitudes of the discrete waves that constitute the channel. APPLE-1005, [0076], [0081]. These precise parameters, unlike simplified channel state information, allow for more accurate channel prediction. APPLE-1005, [0040]. For instance, the channel estimator can provide an updated channel prediction that the transmitter control unit uses for link adaptation, specifically by controlling the coding/modulation and/or transmit power in response to the predicted channel conditions. APPLE-1005, [0043]; APPLE-1003, ¶58.

3. Combination of Hardacker-Medbo

The integration of Hardacker's pre-distortion techniques with Medbo's advanced channel estimation methodologies represents a compelling proposition for optimizing wireless communication systems, particularly for the purposes of improving effective signal qualities at reception through active signal adjustments/pre-distortion (taught by Hardacker and Medbo). APPLE-1004, [0004]-[0006]; APPLE-1005, [0003]-[0004]. From a fundamental engineering perspective, this combination is a direct application of the core principles of an adaptive control loop, where precise system state feedback enables a feed-forward control action. APPLE-1003, ¶60. The synergy aims to mitigate channel impairments at the source, prior to transmission, thereby enhancing received signal quality, spectral efficiency, and system reliability. APPLE-1004, [0004]-[0006]; APPLE-1005, [0003]-[0004]; APPLE-1003, ¶60.

First, the motivation to combine Hardacker's pre-distortion with Medbo's channel estimation lies in the critical dependency of effective pre-distortion on accurate and detailed determination/estimation of the channel distortion. APPLE-1004, [0026] ("the distortion [D(l)] on the communication path 255 may be determined for each signal received by the receiver 215 or periodically when the distortion changes over time."); APPLE-1005, [0003] ("Another use of highly resolved channel estimation is improved channel prediction, which in turn can be

used for enhanced link adaptation including controlling coding and/or transmit power.”); APPLE-1003, ¶61. Hardacker’s method relies on having measured “information regarding the transmission medium and path” and knowing “the nature of the distortion or interference” to effectively pre-distort the signal. APPLE-1004, [0005]. Medbo’s channel estimator is “configured to operate based on a discrete wave channel model and measured channel responses” to “determine so-called wave parameters” such as “wave propagation delay(s) and predetermined wave propagation direction(s),” and a “complex polarimetric amplitude matrix”.

APPLE-1005, [0012], [0057], [0048] (“Each one of the discrete waves is associated with wave parameters to be determined including at least one of wave propagation direction(s) and wave propagation delay.”), [0084] (“configured to extract, for each of the discrete waves, a complex polarimetric amplitude matrix that is included in the wave parameters.”). This is likely to be a more comprehensive characterization than aggregated channel quality indicators (CQI) or precoding matrix indicators (PMI) typically fed back in cellular systems.

APPLE-1003, ¶61 (citing APPLE-1007, 175-187). A POSITA would have understood and found obvious that such high-resolution channel information is vital for precise pre-distortion of a signal transmission, allowing the transmitter to effectively pre-cancel channel distortions. APPLE-1004, [0028] (“the pre-distortion substantially compensates for the distortion introduced by the

communication path”). The ability to identify individual wave parameters of a channel, as provided by at least Medbo’s ML estimation, allows for a targeted pre-compensation that would be difficult with less detailed CSI. APPLE-1003, ¶61. A POSITA would have understood and found obvious the “design need” (precise channel knowledge for Hardacker) could have been met by “predictable solutions” from another field (Medbo’s detailed channel estimation). *KSR International Co. v. Teleflex Inc.*, 550 U.S. 398, 421 (2007).

Second, the Hardacker-Medbo combination offers a significant advantage in dynamic link adaptation and real-time channel improvement, addressing the time-varying nature of wireless channels. APPLE-1004, [0026] (“the distortion changes over time”). A POSITA would have understood and found obvious that channel conditions, affected by fading, mobility, and interference, can vary with time and are often fluctuating. *Id.*; APPLE-1003, ¶62 (citing APPLE-1007, 179 (“propagation conditions change and therefore need appropriate reestimation regularly”)). Medbo emphasizes that this high resolution channel estimation enables improved channel prediction. APPLE-1005, [0006]-[0015]. Specifically, Medbo’s predictions are “configured to operate based on a discrete wave channel model and measured channel responses.” APPLE-1005, [0012]. By feeding Medbo’s precise channel estimations to Hardacker’s pre-distortion module, the system can proactively adjust transmission parameters to match the predicted

channel conditions. APPLE-1005, [0004]. Indeed, Hardacker's "pre-distortion circuit pre-distorts the signals to be transmitted by the transceiver of the given device as a function of the distortion on the communication path" such as the measurements described by Medbo. *Id.*; APPLE-1004, [0004]. This is particularly critical in systems like 3GPP LTE-Advanced cellular networks that employ advanced multi-antenna techniques and experience multi-path propagation affects. APPLE-1004, [0006] ("distortion types, e.g., multi-path, amplitude, frequency, phase and other well[-]known types."), [0034] ("Channel distortion can have phase, amplitude and multipath distortion characteristics which may all be non-linear"). The combination of Medbo's high-resolution channel estimation and Hardacker's feedback and predistortion based on those channel estimates would have used common techniques and known methods (Medbo's processes) to yield predictable results (Hardacker's feedback and pre-distortion based in part on Medbo's measurements). APPLE-1003, ¶62; *KSR*, 550 U.S., 416.

Third, this combination provides a powerful framework for enhanced interference management and spatial exploitation, particularly relevant in dense cellular deployments. In scenarios with multiple transmit and receive antennas (MIMO) or heterogeneous networks, inter-user or inter-cell interference is a significant limiting factor. Hardacker's pre-distortion, when informed by Medbo's detailed channel knowledge, can enable sophisticated channel adaptation

techniques. For instance, the system could utilize knowledge of the channel conditions to improve communication between devices in a high-density deployment landscape. APPLE-1003, ¶63. The motivation here aligns with the principle articulated in *KSR* that when there is a design need or market pressure (exhibit in part by Haradacker’s motivations) and a finite number of predictable solutions, combining known options within one’s technical grasp (Medbo’s channel condition measurements and highly resolved channel estimation with Hardacker’s feedback and predistortion techniques) is obvious if it leads to anticipated success. 550 U.S., 421. Here, the explicit need for robust interference management in complex radio environments provides a clear motivation for combining these complementary techniques. APPLE-1003, ¶63.

Fourth, integrating Medbo’s efficiency gains with Hardacker’s objectives reduces overall system complexity and improves link performance. APPLE-1003, ¶64. Hardacker states that its techniques “reduce the complexity of the receiver by placing some of the burden on the transmitter.” APPLE-1004, [0030]. It aims to allow “complex modulation” at the source while using “circuits having only limited complexity” at the sink. APPLE-1004, [0006]. Medbo’s use of a “windowed likelihood function” significantly improves the computational efficiency and accuracy of channel estimation by enabling the decoupling and “clipping of data.” APPLE-1005, [0049], [0061]. The possible “hundredfold”

complexity reduction in channel estimation makes it practical to implement the detailed signal and system analyses required to generate the precise channel condition data that Hardacker needs, even within the real-time constraints of a transmitter. APPLE-1005, [0061]; APPLE-1004, [0027]. This synergy means that the burden shift to the transmitter becomes computationally feasible, leading to the “improved performance, such as fewer bit errors and/or greater link distances” Hardacker promises, while simultaneously reducing the complexity of the end-user devices. APPLE-1004, [0005]; APPLE-1003, ¶64. This is a practical “design need” that makes the combination of these technologies particularly compelling. *KSR*, 550 U.S., 421; APPLE-1003, ¶64.

4. Application to Challenged Claims – 20-23

Claim 20

[20] The wireless device of claim 19, wherein the path parameter information of the first propagation path includes at least one of an estimation of a delay, an estimation of a Doppler frequency, an estimation of a direction of arrival, an estimation of a direction of departure, and an estimation of a complex amplitude of the first propagation path.

Hardacker-Medbo renders obvious [20]. For example, Hardacker describes measuring or characterizing well-known propagation distortion (*path parameter information*) such as “equalization, multi-path, amplitude, frequency, phase and other well[-]known types.” APPLE-1004, [0003]. Medbo further describes the types of well-known distortions teaching “[t]he measured channel responses can

for example be represented in frequency, time/delay, code and/or space.” APPLE-1005, [0041], [0057] (“desirable to determine ... wave propagation delay of each of these waves”). Thus, a POSITA would have understood and found obvious when *the path parameter information of the first propagation path includes at least one of an estimation of a delay . . . of the first propagation path*. APPLE-1003, ¶109; See [2].

Claim 21

[21] The wireless device of claim 20, wherein the path parameter information of the first propagation path further includes an estimation of a polarization status of the first propagation path.

Hardacker-Medbo renders obvious [21]. For example, Medbo teaches “it is desirable to determine the number of discrete waves and at least one of the wave propagation direction(s) and wave propagation delay of each of these waves.” APPLE-1005, [0057]. The inclusion of a “complex polarimetric amplitude matrix” directly provides the estimation of polarization status. APPLE-1003, ¶110. “Preferably, the complex amplitudes, described by a complex polarimetric amplitude matrix, for each of the discrete waves should also be determined.” APPLE-1005, [0057]. Medbo further explains that “to achieve positive definite $C^H \bullet C$, the antennas used must account for the full polarization matrix.” APPLE-1005, [0120]. Medbo then teaches the use of these determined “complex polarimetric amplitude matrix” for later transmission of signals. APPLE-1005, [0120]. From

this, a POSITA would have understood and found obvious that the determination and accounting for antenna “polarizations” characteristics, includes *an estimation of a polarization status of the first propagation path*. APPLE-1003, ¶110.

Indeed, Sesia corroborates that a POSITA would have understood and found obvious that multi-path propagation parameters, for example “MIMO propagation channel parameters,” can include “the arrival and departure angles in addition to the traditional power and delay,” and “the polarization information.” APPLE-1007, 444-445; APPLE-1003, ¶111.

Thus, a POSITA would have understood from Hardacker and Medbo’s disclosure of determining channel characteristics and Medbo’s specific accounting for polarization affects using polarimetric matrices at transmission, that *the path parameter information of the first propagation path further includes an estimation of a polarization status of the first propagation path*. APPLE-1003, ¶112.

Claim 22

[22] The wireless device of claim 19, wherein the path parameter information is obtained by at least one estimation technique of the group consisting of a maximum likelihood estimation algorithm, periodogram, correlatorgram, spectral-based methods, Bartlett beamformers, Capon beamformers, subspace-based techniques, MUSIC (Multiple Signal Classification), ESPRIT (Estimation of Signal Parameters via Rotational Invariance Techniques), approximation of the maximum-likelihood method based on iterative schemes, SAGE (Space-Alternating Generalized Expectation-maximization), RiMAX (Richter's Maximum Likelihood

method), maximum-a-posteriori based methods, Evidence Framework, Bayesian techniques, tracking algorithms, Kalman filtering techniques, enhanced Kalman filtering techniques, particle filtering techniques, and least-square-error methods.

Hardacker-Medbo renders obvious [22]. For example, Medbo teaches channel estimation using a maximum-likelihood (ML) estimation algorithm and other well-known methods for channel estimation. APPLE-1005, [0004]. Specifically, Medbo discloses “[i]t is well known that *Maximum Likelihood [(estimation algorithm)]* in principle is one of the most accurate methods available.” APPLE-1005, [0004]. Additionally, “[d]ifferent methods have previously been proposed for complexity reduction like *Space Alternating Generalized Expectation (SAGE)* maximization, and a maximum likelihood framework called *RIMAX*.” APPLE-1005, [0004], [0046]; APPLE-1003, ¶113.

Thus, a POSITA would have understood and found obvious that *the path parameter information is obtained by at least one estimation technique of the group consisting of a maximum-likelihood estimation algorithm, . . . SAGE (Space-Alternating Generalized Expectation-maximization), and RiMAX (Richter's Maximum Likelihood method)*. APPLE-1003, ¶114.

Claim 23

[23] The wireless device of claim 19, wherein the receiver comprises multiple antennas in a multiple-input and multiple-output (MIMO) wireless communication system or a single antenna in a single-input and single-output (SISO) wireless communication system.

Hardacker-Medbo renders obvious [23]. For example, Medbo describes measuring the “channel” between transmitters and receivers in “Single-Input Single-Output (SISO), . . . and Multiple-Input Multiple-Output (MIMO) antenna cases.” APPLE-1005, [0038], FIG. 1. Thus, a POSITA would have understood and found obvious *the receiver comprises multiple antennas in a multiple-input and multiple-output (MIMO) wireless communication system or a single antenna in a single-input and single-output (SISO) wireless communication system*. APPLE-1003, ¶115. Indeed, Medbo’s example in figure 1 is a MIMO system. APPLE-1005, FIG. 1.

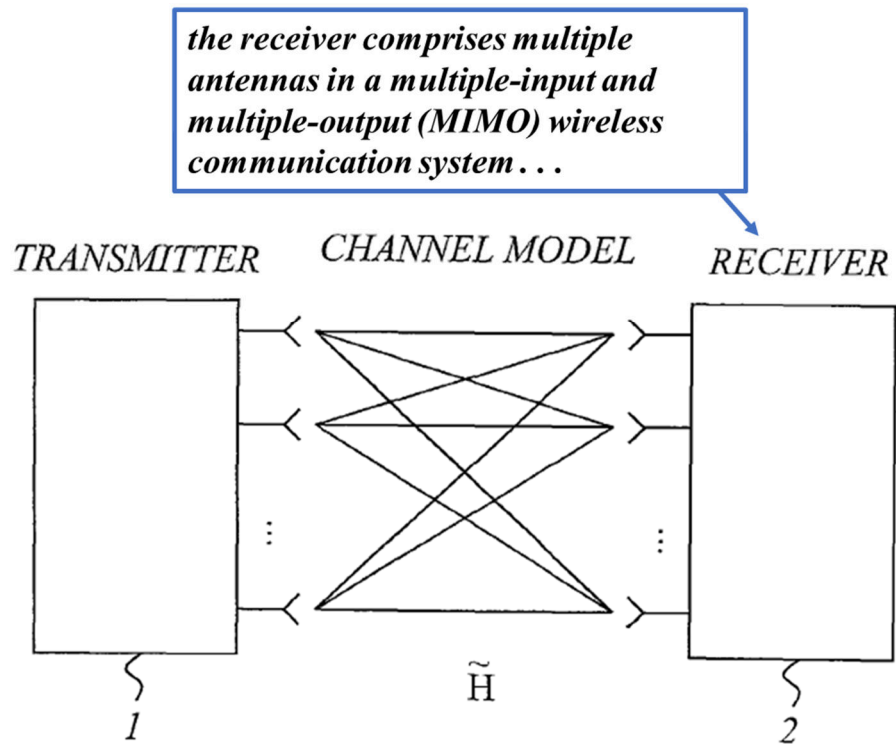


Fig. 1

APPLE-1005, FIG. 1.

5. Claims 2-4, 6, 9-12, 16

Claim 2

[2]

See [20]; APPLE-1003, ¶116.

Claim 3

[3]

See [21]; APPLE-1003, ¶117.

Claim 4

[4]

See [22]; APPLE-1003, ¶118.

Claim 6

[6]

In addition to the reasons stated in §V.A.3.[6], Hardacker-Medbo renders obvious [6]. For example, Medbo discloses a receiver that includes an equalizer.

APPLE-1005, [0002], [0006]; APPLE-1003, ¶119.

Claim 9

[9]

See [20]; APPLE-1003, ¶120.

Claim 10

[10]

See [21]; APPLE-1003, ¶121.

Claim 11

[11]

See [22]; APPLE-1003, ¶122.

Claim 12

[12]

See [23]; APPLE-1003, ¶123.

Claim 16

[16]

See [20] (“ . . . an estimation of a complex amplitude of the first propagation path.”); *See* [21] (“information of the first propagation path further includes an estimation of a polarization status of the first propagation path”); APPLE-1003, ¶124.

C. GROUND 3–Wallace – Claims 1-2, 8, 12, 15-17, 19-20, 23

1. Wallace

Wallace is analogous to the ’347 Patent because Wallace operates in the same field of endeavor as the ’347 Patent and addresses a reasonably pertinent challenge of enhancing efficiency and performance in modern wireless communication systems, particularly those employing Multiple Input/Multiple Output (MIMO) architectures, by effectively managing dynamic channel conditions. APPLE-1006, 1:57-2:22. A core problem in such environments is the deleterious channel effect of fading and multipath propagation loss, where transmitted signals arrive at a receiver via multiple paths with differing delays, leading to destructive signal effects. APPLE-1006, 1:57-2:22. To counteract such effect, Wallace centers on the measurement and timely reporting of transmission path characteristics reported from receiver back to the transmitter. APPLE-1006, 2:25-49 (an “information signal carries the set of transmission characteristics for at least one of the plurality of sub-channels”). This feedback reporting enables the transmitter to precondition transmissions by optimizing signal parameters before

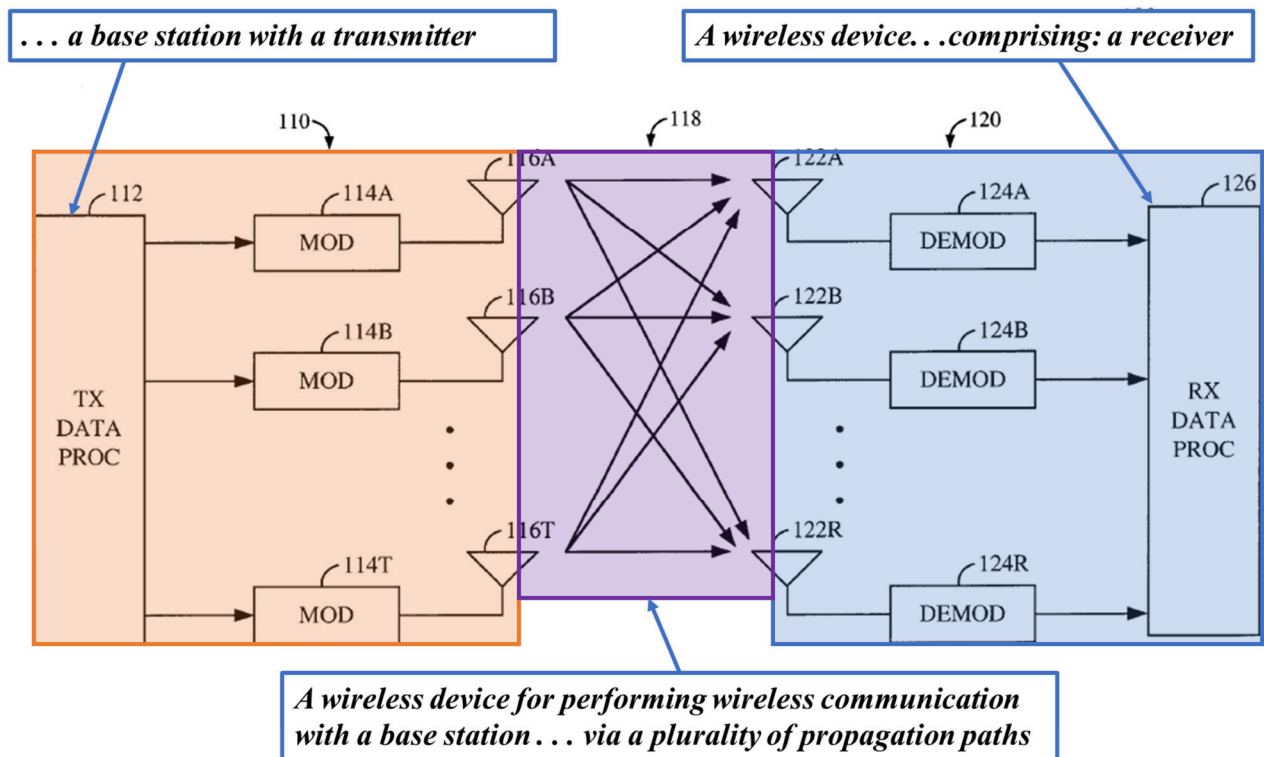
they are sent, thereby improving spectral efficiency, reducing bit-error rates, and enhancing system flexibility in accommodating diverse user requirements. APPLE-1006, 2:25-49, 3:34-54. The utility of the channel characteristic reports is critically dependent on its rapid determination and transmission, as channel characteristics, influenced by factors like receiver movement, can change quickly. APPLE-1006, 2:9-22; APPLE-1003, ¶59.

2. Application to Challenged Claims – 19-20, 23

Claim 19

[19.1] A wireless device for performing wireless communication with a base station with a transmitter via a plurality of propagation paths, the wireless device comprising: a receiver;

Wallace renders obvious [19.1]. For example, Wallace teaches an “apparatus for the measuring and reporting of channel state information” between *a base station with a transmitter* and *a wireless device* with *a receiver*. APPLE-1006, 2:25-48, 3:55-4:28; APPLE-1003, ¶125. Specifically, Wallace describes a “communications system 100 [that] includes a first system 110 [(*a base station with a transmitter*)] in communication with a second system 120 [(*a wireless device* with *a receiver*)].” APPLE-1006, 3:55-4:28, FIG. 1.



APPLE-1006, FIG. 1A.

In Wallace's figure 1A above, "system 110" (*base station*) is shown as an MIMO system *with a transmitter*. APPLE-1006, FIG. 1A, 3: 34-4:28. System 120 (the *wireless device*) includes *a receiver*. APPLE-1006, FIG. 1A, 3: 34-4:28. Because Wallace's system shown in figure 1A is a known wireless communication system type, e.g., MIMO, a POSITA would have understood and found obvious that system 120 with multiple antennas is a *wireless device* for the purposes of wireless communication *via a plurality of propagation paths*. APPLE-1006, 1:57-2:8, 6:14-31 ("an RF modulated signal from a transmitter unit may reach the receiver unit via a number of transmission paths."); APPLE-1003, ¶126. Wallace's

wireless device (system 120) which includes *a receiver*. . . *perform[s] wireless communication with a base station* (system 110) *with a transmitter via a plurality of propagation paths* because Wallace describes communication between the base station and wireless device “over communications links 118 to system 120.”

APPLE-1006, FIG. 1A, 3:34-4:28.

In further detail, Wallace’s system describes transmitting “signals over a propagation channel between *a transmitter* unit and *a plurality of receiver* units . . . and the propagation channel comprises a plurality of sub-channels between the transmitter unit and the plurality of receiver units,” APPLE-1006, 2:25-48;

APPLE-1003, ¶127. Wallace describes measuring/determining the characteristics of the “plurality of sub-channels” to determining a level of fading along the propagation paths because “[w]hen signals arrive from multiple propagation paths [(*a plurality of propagation paths*)], components of the signals can combine destructively, which is referred to as ‘fading.’” APPLE-1006, 1:57-2:8.

Specifically, Wallace describes the propagation path characteristics or “characteristics of the propagation channel can be determined through a set of K sub-channels carrying the pilot symbols.” APPLE-1006, 2:50-63. A POSITA would have understood and found obvious that Wallace’s “multiple propagation paths” functionally equate to *a plurality of propagation paths* formed between the transmitter and the receiver which are capable of carrying a signal transmitted by

the transmitter to the receiver. APPLE-1003, ¶127. Further, the propagation channel can be characterized by a set of K sub-channels and is capable of carrying at least Wallace's "pilot signals" which is at least one example of a first signal. APPLE-1006, 1:57-2:8 ("Multipath occurs when a transmitted signal arrives at a receiver unit through multiple propagation paths with differing delays.")

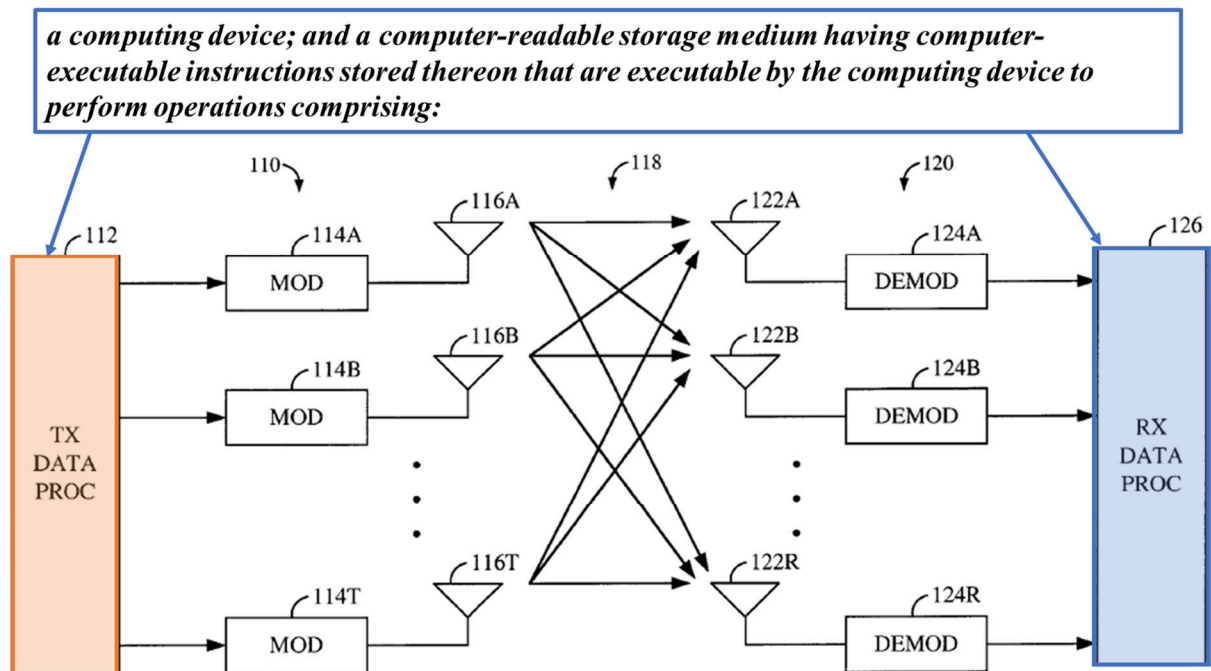
In more detail, a POSITA would have understood and found obvious that disclosure of devices that include transmitters, receivers, distortion determination circuits for communication over a wireless communication network would satisfy or encompass the understanding of a *wireless device* and a *base station* communicating wirelessly via multiple propagation paths. For example, the definition of "base station" is "[a] fixed station used by a dispatcher to communicate with mobile units. 2. The central transmitter in a communications system that acts as the cell hub for communicating with handsets and/or mobile units." APPLE-1008, 6. Thus, at the very least, which device is the "base station" is not determined and the configuration of such a system would be a design choice requiring a POSITA's base-line knowledge of such wireless communication systems and commonsense. *See* [1.1] ("a plurality of propagation paths formed between the transmitter and the receiver"); APPLE-1003, ¶128.

Additionally, Wallace describes that "an RF modulated signal from *a transmitter* unit may reach the *receiver* unit via a number of transmission paths [(*a*

*plurality of propagation paths)]” APPLE-1006, 6: 14-31; 3:55-67. Thus, a POSITA would have understood and found obvious that Wallace describes a *wireless device for performing wireless communication with a base station with a transmitter via a plurality of propagation paths, the wireless device comprising: a receiver*. APPLE-1003, ¶129.*

[19.2] a computing device; and a computer-readable storage medium having computer-executable instructions stored thereon that are executable by the computing device to perform operations comprising:

Wallace renders obvious [19.2]. For example, Wallace describes a processor used for processing the channel characteristics. APPLE-1003, ¶130. Notably, each of the base station (system 112) and the wireless device (system 120) have processors. APPLE-1006, FIG. 1A, 3:34-4:28.



APPLE-1006, FIG. 1A.

Wallace goes on to describe that the processors “can be implemented in various manners such as . . . a microcontroller, a microprocessor, or other electronic circuits designed to perform the functions described herein.” APPLE-1006, 28:58-29:4. And they can be “operated to execute instruction codes that achieve the functions described herein [so that] the processing units described herein can be implemented using hardware, software, or a combination thereof.” APPLE-1006, 28:58-29:4. A POSITA would have understood and found obvious that the implementations called for in Wallace involve *a computing device; and a computer-readable storage medium having computer-executable instructions stored thereon that are executable by the computing device to perform operations comprising*. APPLE-1003, ¶131.

[19.3] receiving a first signal at the receiver via a first propagation path of the plurality of propagation paths;

Wallace renders obvious [19.3]. For example, for the purposes of measuring the channel characteristics, Wallace describes “*receiving*, by a first receive antenna of a first receiver unit [*(at the receiver)*], *the first* pilot symbol [*(signal)*].” APPLE-1006, 2:25-49; cl 1; APPLE-1003, ¶132. Wallace describes receiving signals “via different transmission paths” where each signal is received *via a first propagation path of the plurality of propagation paths*. APPLE-1006, 6:39-51,

FIG. 1A, 1:57-2:8 (“Multipath occurs when a transmitted signal arrives at a receiver unit through multiple propagation paths with differing delays.”).

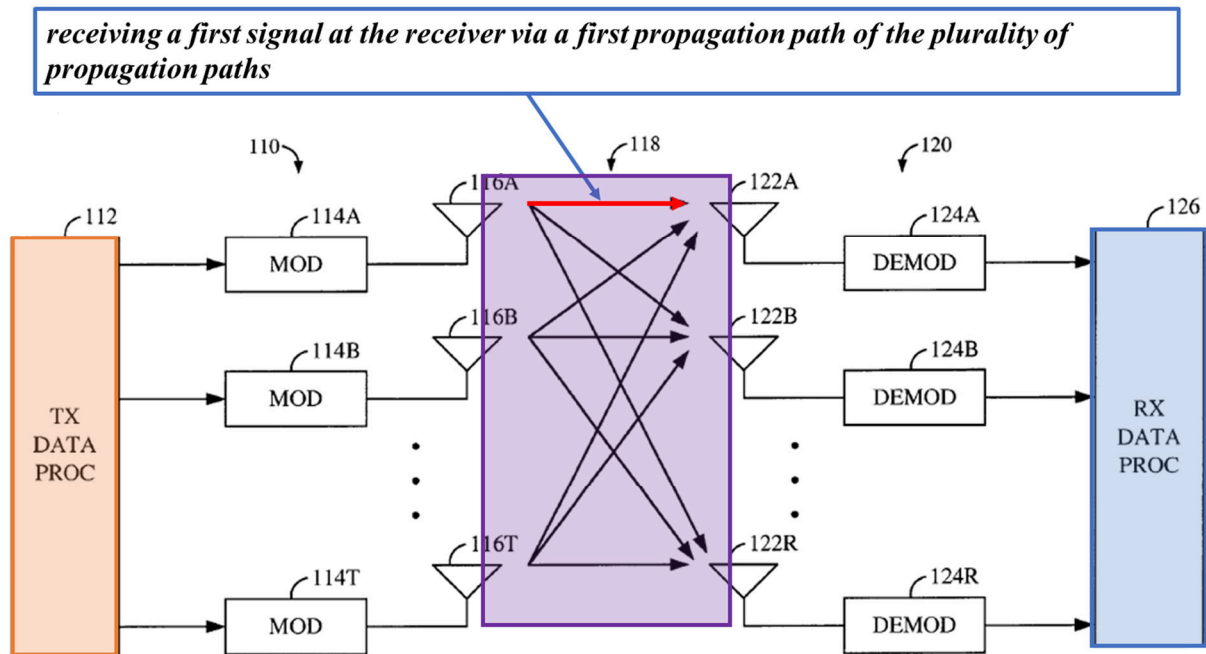


FIG. 1A

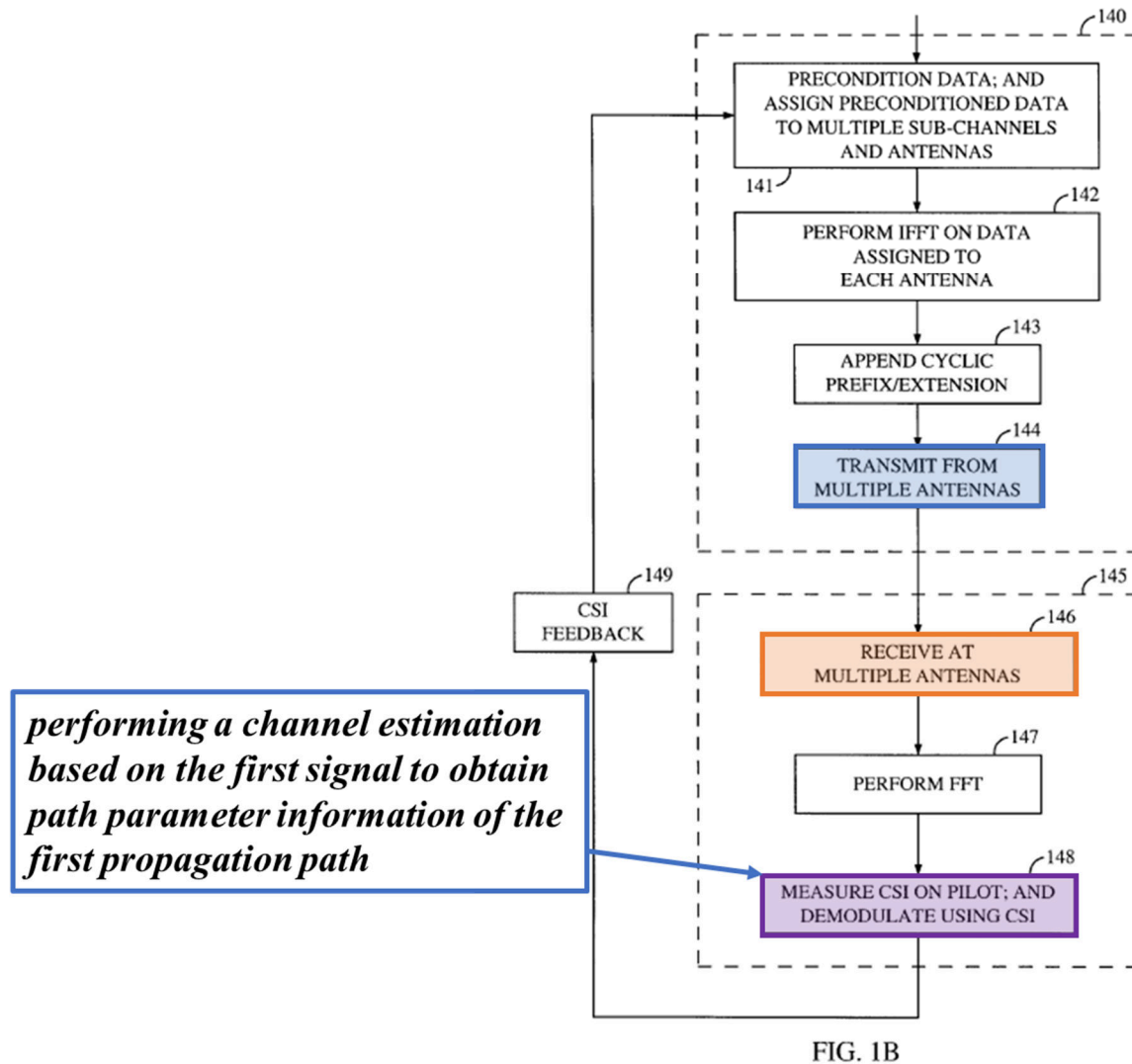
APPLE-1006, FIG. 1A.

Thus, a POSITA would have understood and found obvious *receiving a first signal at the receiver via a first propagation path of the plurality of propagation paths*. APPLE-1003, ¶133.

[19.4]performing a channel estimation based on the first signal to obtain path parameter information of the first propagation path;

Wallace renders obvious [19.4]. For example, Wallace teaches “determining a set of transmission characteristics for at least one of the plurality of sub-

channels.” APPLE-1006, 2:25-49, Abstract (“receiver units determine the [channel state information] for the disjoint sub-channels that carried pilot symbols.”), FIG. 1B; APPLE-1003, ¶134.



APPLE-1006, FIG. 1B.

As seen in figure 1B above, Wallace describes *performing a channel estimation* based on the received signal to determine Channel State Information

(CSI). APPLE-1006, 14:56-15:2; APPLE-1003, ¶135. Wallace describes “[f]ull CSI includes sufficient characterization of the propagation path (i.e., amplitude and phase) between all pairs of transmit and receive antennas for each sub-band [and] also includes the information of the relative levels of interference and noise in each sub-channel.” APPLE-1006, 8:53-9:3. Wallace’s “CSI may be embodied in a set of matrices of complex gain values that are descriptive of the conditions of the transmission paths from the transmit antennas to the receive antennas.”

APPLE-1006, 8:53-9:3; 13:3-21. Because the measurement of the received signal would indicated the characteristics of the path traveled by the signal (*the first propagation path*), a POSITA would have understood and found obvious that Wallace’s performance of *channel estimation* is *based on the first signal* in order *to obtain path parameter information of the first propagation path*. APPLE-1003, ¶135.

Wallace provides an additional method of *performing channel estimation* when it is undesirable to compress CSI for transmission. APPLE-1006, 18:33-45. When employing this option, the channel state (e.g., how received signals are affected by “multipath components”), is represented in a matrix “a time-domain representation of the channel response” or *channel estimation based on the first signal*. APPLE-1006, 18:33-45. This representation captures the effect of multipath propagation, where signals reach the receiver via multiple paths, each

with a different delay and amplitude. APPLE-1003, ¶136. Wallace’s “resulting channel impulse responses [(*channel estimation*)] are then translated into a set of amplitudes and delays [(*to obtain path parameter information of the first propagation path*)] that are reported to the transmitter” in order to precondition (i.e., pre-distort) the transmissions between the transmitter and receiver. APPLE-1006, 18:33-45; *See* [1.4]; APPLE-1003, ¶136. The channel estimation may also “be embodied in a set of matrices of complex gain values that are descriptive of the conditions of the transmission paths from the transmit antennas to the receive antennas.” APPLE-1006, 13:3-21.

[19.5] sending the channel estimation that includes the path parameter information to the transmitter; and

Wallace renders obvious [19.5]. For example, Wallace teaches the “deriv[ation of] characteristics of the propagation channel and to report such characteristics to the transmission site.” APPLE-1006, 18:5-32. Specifically, Wallace teaches “reporting [(*sending*)] an information signal [(*the channel estimation*)] from each of the plurality of receiver units [(from the receiver)] *to the transmitter* unit, wherein the information signal carries the set of transmission characteristics for at least one of the plurality of sub-channels [(*the channel estimation that includes the path parameter information*)]”. APPLE-1006, 2:25-49. Shown in Wallace’s figure 1B below, the measured channel estimation is sent

to the transmitter for later “preconditioning” or pre-distortion of future signals.

APPLE-1006, 14:56-15:7, FIG. 1B; APPLE-1003, ¶137.

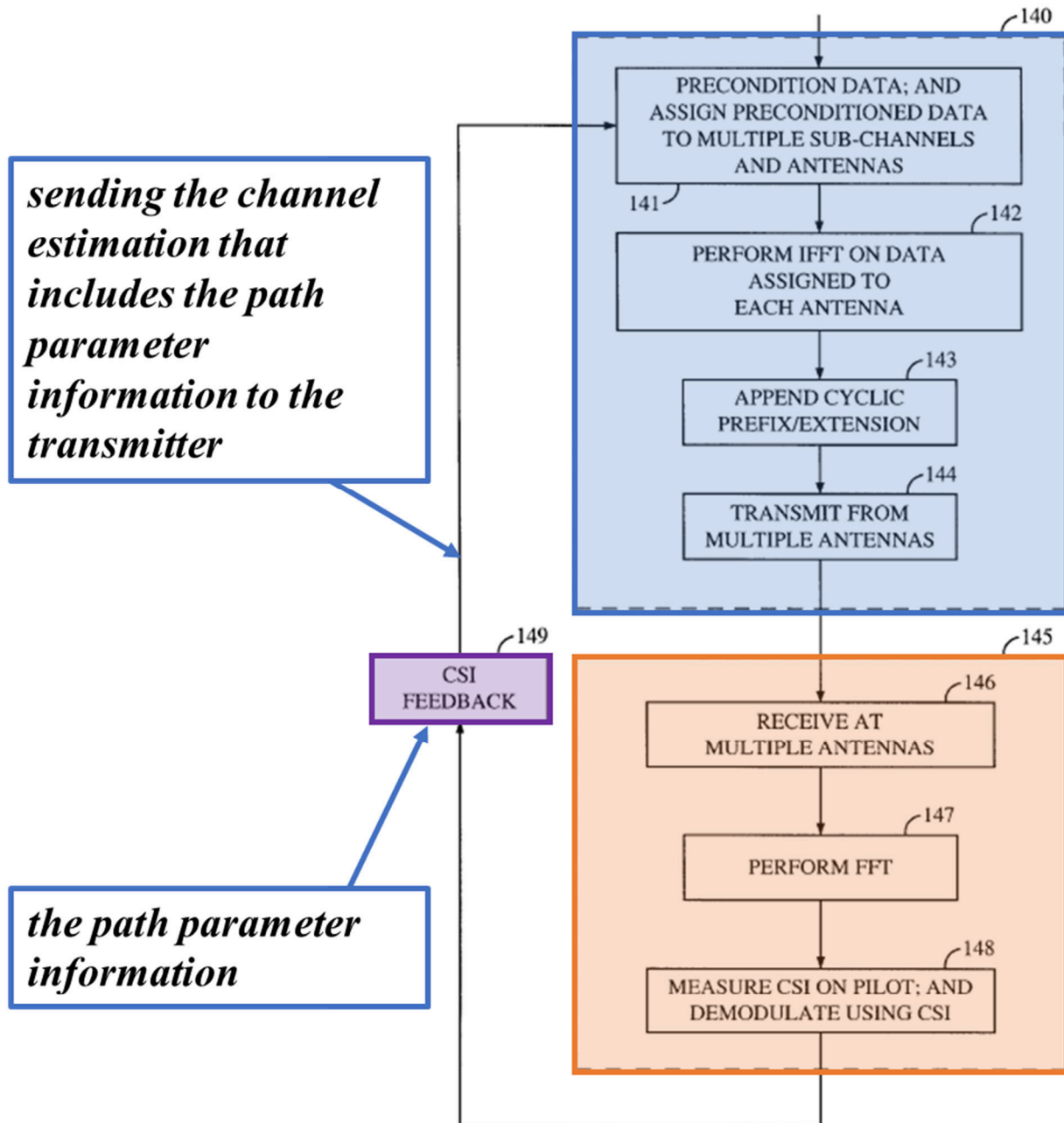


FIG. 1B

APPLE-1006, FIG. 1B.

Thus, a POSITA would have understood and found obvious from Wallace's teachings that after performing channel estimation, the device would *send[] the channel estimation that includes the path parameter information to the transmitter*. APPLE-1003, ¶138.

[19.6] receiving a second signal via the first propagation path, the second signal predistorted in a time domain, a frequency domain, and a spatial domain according to the channel estimation based on the first signal.

Wallace renders obvious [19.6]. First, Wallace renders obvious *receiving a second signal via the first propagation path*. For example, “[a]s long as the channel does not change appreciably from the time it is measured by the receiver unit and subsequently sent back to the transmitter and used to precondition the transmission, the intended receiver unit can demodulate the [pre-distorted] transmission [(receiving a second signal via the first propagation path)].”

APPLE-1006, 9:4-15; APPLE-1003, ¶139. A POSITA would have understood and found obvious from the above disclosure, that the *second signal*, which is pre-distorted based on earlier measurements, is received *via the same first propagation path*. In addition, a POSITA would have understood and found obvious that Wallace demonstrates that that the transmitter preconditions (*predistorts*) the transmission of a second signal for the very purpose *receiving the predistorted*

second signal at the receiver via the first propagation path that does not change appreciably from the time it is measured by the receiver unit. *Id.*

Second, Wallace renders obvious *the second signal predistorted in a time domain, a frequency domain, and a spatial domain according to the channel estimation based on the first signal*. For example, Wallace teaches using the previously measured “information as to the characteristics of the propagation channel [(*channel estimation*)] . . . in order to precondition [(*predistort[]*)] the signal before transmission.” APPLE-1006, 1:57-2:8. Shown in Wallace’s figure 1B below, step 149, the system performs the process of *predistorting a second signal at the transmitter . . . according to the channel estimation based on the first signal*. APPLE-1006, 14:56-15:2, cl. 19 (“preconditioning a transmission symbol according to the determined CSI.”); APPLE-1003, ¶140. Wallace’s preconditioning (*predistorting*) based on the previously measured channel conditions (*channel estimation*) would have been understood and obvious to a POSITA as applied to a *second signal* (e.g., a signal sent after Wallace’s pilot signals), that was *predistort[ed] . . . at the transmitter . . . according to the channel estimation based on the first signal*. APPLE-1003, ¶140.

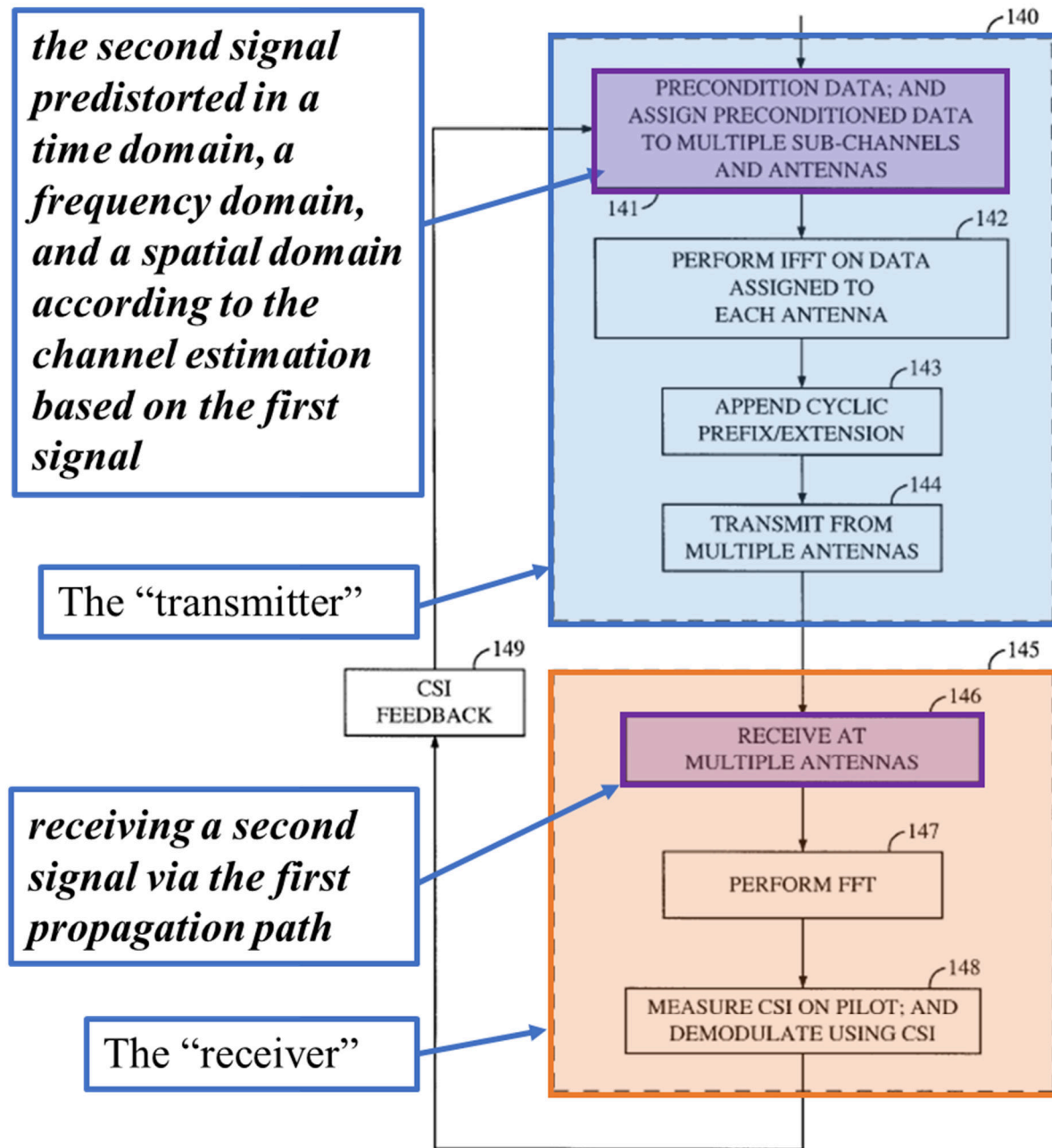


FIG. 1B

APPLE-1006, FIG. 1B.

Wallace teaches that the measured *channel estimation*, used to pre-distort

the second signal, includes information about *a time domain, a frequency domain, and a spatial domain*. APPLE-1006, 3:55-66; APPLE-1003, ¶141. Indeed, as Wallace explains and a POSITA would have found obvious, a “combination of antenna [(*spatial domain*)], frequency [(*frequency domain*)], and temporal [(*time domain*)] diversity allows the communications system of the invention to provide robust performance.” APPLE-1006, 7:33-43; *Id.* 3:34-54; APPLE-1003, ¶141. Specifically, Wallace teaches the preconditioning of a signal, prior to transmission, to provide *a time domain, a frequency domain, and a spatial domain* diversity. APPLE-1006, 3:55-66. Wallace discloses that “*frequency* and *temporal diversity* may be used in conjunction with the different transmit antennas.” APPLE-1006, 6:44-51. A POSITA would have understood that different transmit/receive antennas and transmission paths provide spatial domain diversity. APPLE-1003, ¶141. Wallace teaches that, at the transmitter, data—which can include the channel estimation data received from the previous transmission—is used prior to transmission “to provide antenna [(*spatial*)], frequency, or temporal **diversity**, or a combination thereof.” APPLE-1006, 3:55-66; 5:46-6:5 (“The communications system of the invention provides the above-described features and advantages . . . by employing antenna, frequency, or temporal **diversity**, or a combination thereof. Antenna, frequency, or temporal diversity can be independently achieved and dynamically selected.”), 7:33-44; APPLE-1008, 7 (“**diversity**- 1. A form of

transmission and/or reception using several modes, usually in space or in time, to compensate for fading or outages . . . using different frequencies or different polarization.”); APPLE-1003, ¶141.

In addition, a POSITA would have understood and found obvious that Wallace’s disclosure at 5:45- 6:67, including Wallace’s description regarding adjusting transmissions based on channel estimation, teaches the preconditioning of a signal in *a time domain, a frequency domain, and a spatial domain*. APPLE-1006, 5:45- 6:67; APPLE-1003, ¶142. Specifically, Wallace discloses compensating for transmission characteristics in the *spatial domain* includes the “use of more than one transmit antenna in a manner to improve the reliability of the communications link.” APPLE-1006, 5:45- 6:67. Wallace’s compensation in the *frequency domain* “can be provided by use of a multi-carrier modulation Scheme Such as Orthogonal frequency division multiplexing (OFDM).” *Id.* Wallace’s compensation in the *time domain* “is achieved by transmitting the data over different times.” *Id.* Indeed, Wallace’s “information indicative of the conditions (i.e., the ‘state’) of the communications links,” can include “a time-domain representation of the channel response.” APPLE-1006, 8:53-9:3, 18:33-44. Finally, Wallace discloses combining and compensating for all of these domains to “improve the reliability of the communications link.” *Id.* Thus, a POSITA would have understood and found obvious [19.6]. APPLE-1003, ¶¶142-143.

Claim 20

[20]

Wallace renders obvious [20]. First, Wallace's teaching of "information [(*the path parameter information*)] indicative of the conditions (i.e., the 'state') of the communications links [(*of the first propagation path*)],” can include “channel impulse responses are then translated into a set of amplitudes and *delays* that are reported to the transmitter.” APPLE-1006, 8:53-9:3; 18:33-44. A POSITA would have understood and found obvious that such disclosure renders obvious *the path parameter information of the first propagation path includes at least one of an estimation of a delay*. APPLE-1003, ¶¶144-145.

Second, Wallace teaches measuring “sufficient characterization of the propagation path (i.e., *amplitude* and phase)” between pairs of transmit and receive antennas (*of the first propagation path*). APPLE-1006, 8:53-9:3. A POSITA would have understood and found obvious that Wallace's *the path parameter information of the first propagation path includes at least one of . . . an estimation of a complex amplitude of the first propagation path* because Wallace's “characterization of the propagation path” can include information on the “*amplitude* and phase” of a channel gain value. *Id.*; APPLE-1003, ¶146. In fact, Wallace states that the channel information is often “embodied in a set of matrices of complex gain values that are descriptive of the conditions of the

transmission paths from the transmit antennas to the receive antennas.” APPLE-1006, 8:53-9:3.

Third, Wallace’s “information indicative of the conditions (i.e., the ‘state’) of the communications links [(*of the first propagation path*)],” can include “a time-domain representation of the channel response [(*the path parameter information*)].” APPLE-1006, 8:53-9:3, 18:33-44; *See* [19.5]. The “time-domain representation” is an alternative CSI. APPLE-1006, 18:33-44. Rather than reporting complex gain matrices across all sub-bands, the receiver can perform an Inverse Fast Fourier Transform (IFFT) on a determined channel response to obtain the channel impulse responses in the time domain. APPLE-1006, 18:33-44. These impulse responses are then simplified and reported as a set of “amplitudes and delays that are reported to the transmitter.” APPLE-1006, 18:33-44. This method is particularly efficient when the time-domain representation of the channel is “simple, as in cases where there are only two or three multipath components,” effectively summarizing the channel’s time-dispersive properties (e.g., amplitudes and delays). APPLE-1006, 18:33-44. Thus, a POSITA would have recognized and found obvious that Wallace’s alternative time-domain representations include *path parameter information of the first propagation path includes at least one of an estimation of a delay . . . and an estimation of a complex amplitude of the first propagation path*. APPLE-1003, ¶147.

Notably, all of Wallace's approaches (full CSI, partial CSI, and an alternative CSI) align with a narrower interpretation of the '347 Patent teachings. Specifically, the '347 Patent states that its approach differs from conventional precoding techniques, which often use "simplified representations of channel, e.g. in terms of code-book," APPLE-1001, 11:60-12-7, 14:17-24 ("the systems and methods described herein make use of the parameters of propagation instead of the simplified channel status information"); APPLE-1003, ¶148.

Claim 23

[23]

Wallace renders obvious [23]. Wallace's describes examples where *the transmitter and the receiver each comprise multiple antennas in a multiple-input and multiple-output (MIMO) wireless communication system*. APPLE-1006, 1:57-2:8 ("In order to improve the efficiency and decrease the complexity of the MIMO system, information as to the characteristics of the propagation channel can be transmitted back to the transmitter unit in order to precondition the signal before transmission.") In fact, Wallace's figure 1 is "a diagram of a multiple-input multiple-output (MIMO) communications system" that is "capable of implementing some embodiments of the invention." APPLE-1006, 3:4-5, 34-54; FIG. 1; See [12]; APPLE-1003, ¶149.

3. Claims 1-2, 8, 12, 15-17

Claim 1

[1.1] A method for wireless communication in a system including a transmitter, a receiver, and a plurality of propagation paths formed between the transmitter and the receiver which are capable of carrying a signal transmitted by the transmitter to the receiver, the method comprising:

Wallace renders obvious [1.1]. For example, Wallace teaches a “***method*** and apparatus for the measuring and reporting of channel state information” in ***wireless communication*** systems. APPLE-1006, 2:25-48. Wallace’s system includes transmitting “***signals*** over a propagation channel between ***a transmitter*** unit and ***a*** plurality of ***receiver*** units . . . and the propagation channel comprises a plurality of sub-channels between the transmitter unit and the plurality of receiver units,” APPLE-1006, 2:25-48. Wallace describes measuring the characteristics representing a “plurality of sub-channels” making up the propagation channel to determine a level of fading along the propagation paths because “[w]hen signals arrive from multiple propagation paths [(***a plurality of propagation paths***)], components of the signals can combine destructively, which is referred to as ‘fading.’” APPLE-1006, 1:57-2:8; APPLE-1003, ¶150. Specifically, Wallace describes the propagation path characteristics or “characteristics of the propagation channel ... determined through a set of K sub-channels carrying the pilot symbols.” APPLE-1006, 2:50-63. Additionally, Wallace describes that “an RF modulated ***signal*** from ***a transmitter*** unit may reach the ***receiver*** unit via a number of

transmission paths [(*a plurality of propagation paths*)].” APPLE-1006, 6: 14-31; 3:55-67. A POSITA would have understood and found obvious that Wallace’s “multiple propagation paths” functionally equate to *a plurality of propagation paths formed between the transmitter and the receiver which are capable of carrying a signal transmitted by the transmitter to the receiver*. APPLE-1003, ¶150. Further, the propagation channel can be characterized by a set of K sub-channels and is capable of carrying at least Wallace’s “pilot signals.” APPLE-1006, 1:57-2:8 (“Multipath occurs when a transmitted signal arrives at a receiver unit through multiple propagation paths with differing delays.”)

Thus, a POSITA would have understood and found obvious that Wallace’s *system includ[es] a transmitter, a receiver, and a plurality of propagation paths formed between the transmitter and the receiver which are capable of carrying a signal transmitted by the transmitter to the receiver*. APPLE-1003, ¶151.

[1.2] transmitting a first signal from the transmitter to the receiver via a first propagation path of the plurality of propagation paths;

Wallace renders obvious [1.2]. For example, Wallace describes “*transmitting* the plurality of pilot signals [(*a first signal*)] over a propagation channel [(*via a first propagation path*)] between a transmitter unit and a plurality of receiver units [(*from the transmitter to the receiver*)] . . . the propagation channel comprises a plurality of sub-channels [(*of the plurality of propagation*]

paths)] between the transmitter unit and the plurality of receiver units.” APPLE-1006, 2:25-49. Specifically, Wallace teaches the “pilot wave form[] is transmitted over a separate one [(a first propagation path)] of the plurality of sub-channel subsets [(of the plurality of propagation paths)].” APPLE-1006, cl. 19; cl. 1 (“transmitting, by the first transmit antenna, a first pilot symbol over the sub-channels of the first subset of sub-channels”). Wallace explains and a POSITA would have understood and found obvious that Wallace’s transmission of a pilot symbol (the *first signal*) over the various paths would have sent the same pilot signal (the *first signal*) over various different propagation paths, at least one of them arriving at a receiver via *a first propagation path*. APPLE-1006, cl. 2 (“transmitting the first pilot symbol over each of the sub-channels of a first subset of the plurality of OFDM sub-channel subsets.”), 2:50-63 (“pilot symbols are transmitted on a plurality of disjoint OFDM sub-channel sets.”), cl. 19 (“transmitting a plurality of Orthogonal Frequency Division Multiplexed (OFDM) pilot waveforms from the at least one transmitter unit to at least one receiver unit, wherein each of the plurality of OFDM pilot wave forms is transmitted over a separate one of the plurality of sub-channel subsets.”); APPLE-1003, ¶152.

Indeed, one of Wallace’s goals is to “precondition the signal before transmission” based on “information as to the characteristics of the propagation channel.” APPLE-1006, 1:57-2:8. These characteristics are determined from

measured “deleterious effects of multipath. . . [that] occurs when a transmitted signal arrives at a receiver unit through multiple propagation paths with differing delays. APPLE-1006, 1:57-2:8; APPLE-1003, ¶153.

[1.3] receiving the first signal at the receiver;

See [19.3]; APPLE-1003, ¶154.

[1.4] performing a channel estimation based on the first signal to obtain path parameter information of the first propagation path;

See [19.4]; APPLE-1003, ¶155.

[1.5] sending the channel estimation that includes the path parameter information from the receiver to the transmitter via the first propagation path;

See [19.5]. Given the well-known nature of “multipath delay spread or differential path delay introduced by the propagation environment between the transmitting antenna and the receiver antenna,” a POSITA would have understood and found obvious that such a transmission “between the transmitting antenna and the receiver antenna” could occur *via the first propagation path*. APPLE-1006, 25:44-48; APPLE-1003, ¶¶156, 127, 136. For example, Wallace explains, and a POSITA would have understood and found obvious that channel conditions between a transmitter and receiver stay nearly the same, at least for a short period of time. APPLE-1006, 9:4-15; APPLE-1003, ¶150-151. In fact, Wallace’s system relies on the assumption that the communication path between the transmitter and receiver “does not change appreciably from the time it is measured by the receiver

unit and subsequently sent back to the transmitter and used to precondition the transmission.” APPLE-1006, 9:4-15; Abstract (“Channel state information (CSI) can be used by a communications system to precondition transmissions between transmitter units and receiver units.”); 2:9-22 (“channel characteristics, such as fading and interference statistics, be determined and transmitted quickly to the transmitter unit before the channel characteristics change significantly.”). Thus, Wallace renders obvious that the return transmission is experiences nearly equivalent propagation losses and functionally equates to *sending the channel estimation . . . via the first propagation path*. APPLE-1003, ¶156.

[1.6] predistorting a second signal at the transmitter in a time domain, a frequency domain, and a spatial domain, according to the channel estimation based on the first signal;

See [19.6]; APPLE-1003, ¶157.

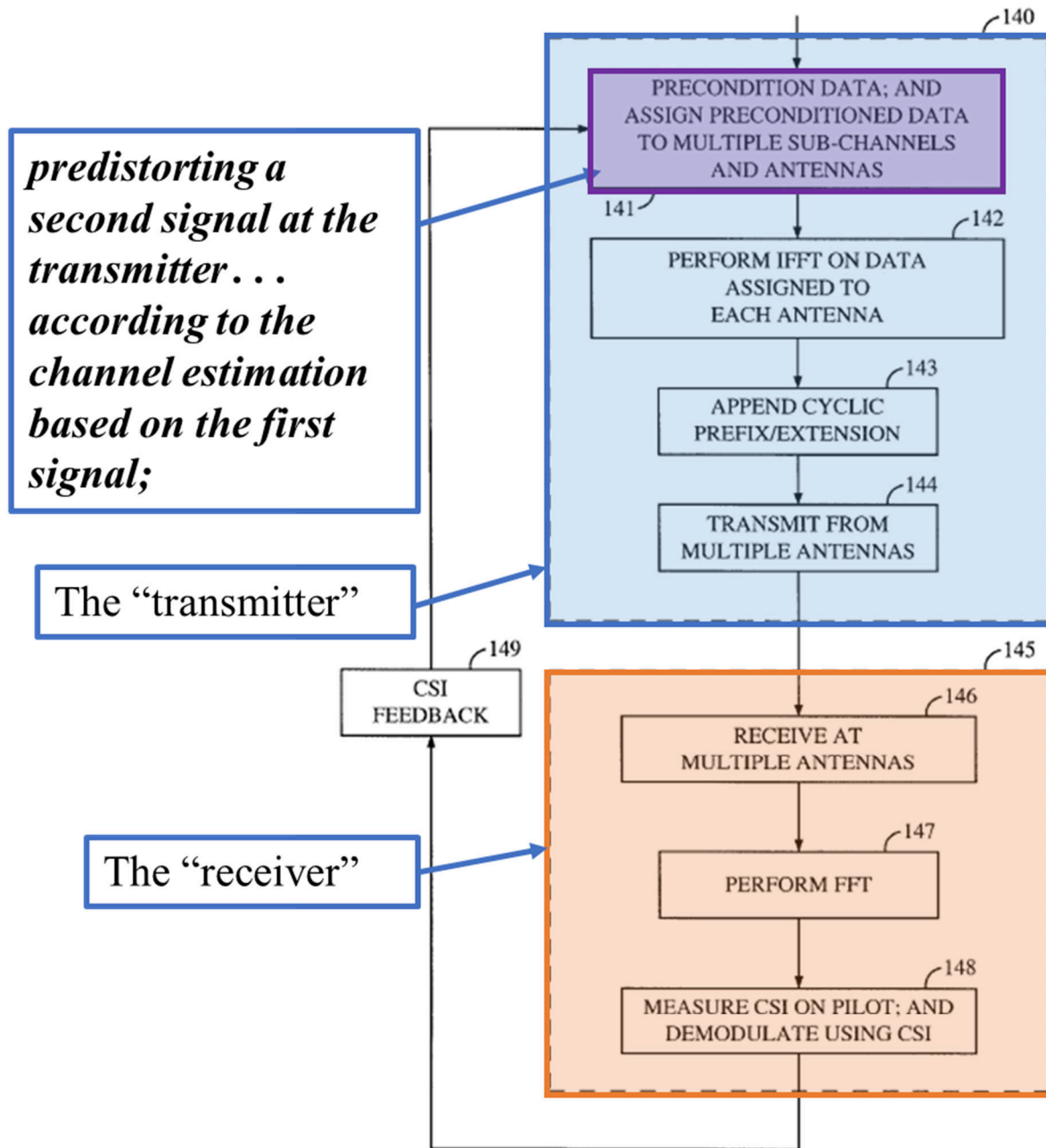


FIG. 1B

APPLE-1006, FIG. 1B.

[1.7] transmitting the predistorted second signal from the transmitter to the receiver via the first propagation path; and

Wallace renders obvious [1.7]. For example, Wallace teaches “information as to the characteristics of the propagation channel can be transmitted back to the transmitter unit in order to precondition the signal before transmission.” APPLE-1006, 1:57-2:8. Thus, the transmitter utilizes the information about the channel estimation (sent to the transmitter in [1.5]) in *transmitting the predistorted second signal from the transmitter to the receiver via the first propagation path*. APPLE-1006, 1:57-2:22, FIG. 1B; APPLE-1003, ¶158.

Wallace’s system describes providing channel estimation information in order for the transmitter to pre-distort and transmit a *second signal . . . via the first propagation path* because “information regarding channel characteristics, such as fading and interference statistics, [should] be determined and transmitted quickly to the transmitter unit before the channel characteristics change significantly.” APPLE-1006, 2:9-22. Wallace aims to take advantage of the measured conditions of *the first propagation path* in subsequent transmission and indeed is preconditioning the second signal optimized for *the first propagation path*. APPLE-1006, 2:25-63; APPLE-1003, ¶159. Thus, Wallace renders obvious [1.7].

[1.8] receiving the predistorted second signal at the receiver.

See [19.6]; APPLE-1003, ¶160.

Claim 2

[2]

See [20]; APPLE-1003, ¶161.

Claim 8

[8.1] A system for wireless communication comprising: a receiver; a transmitter; and a plurality of propagation paths formed between the transmitter and the receiver which are capable of carrying a signal transmitted by the transmitter to the receiver,

See [1.1], [19.1]; APPLE-1006, cl. 19; APPLE-1003, ¶162.

[8.2] wherein the receiver is configured to receive a first signal that is transmitted along a first propagation path of the plurality of propagation paths from the transmitter,

See [1.2]-[1.3]; APPLE-1003, ¶163.

[8.3] perform a channel estimation based on the first signal to obtain path parameter information of the first propagation path, and

See [1.4]; APPLE-1003, ¶164.

[8.4] send the channel estimation that includes the path parameter information to the transmitter via the first propagation path, and

See [1.5]; APPLE-1003, ¶165.

[8.5] wherein the transmitter is configured to predistort a second signal in a time domain, a frequency domain, and a spatial domain according to the channel estimation that is based on the first signal and received from the receiver and

See [1.6]; APPLE-1003, ¶166.

[8.6] to transmit the predistorted second signal to the receiver via the first propagation path.

See [1.7]; APPLE-1003, ¶167.

Claim 12

[12]

See [23]; APPLE-1003, ¶168.

Claim 15

[15.1] A base station for performing wireless communication with a receiver in a wireless device via a plurality of propagation paths, the base station comprising: a transmitter;

See [19.1]; APPLE-1003, ¶169.

[15.2] a computing device; and a computer-readable storage medium having computer-executable instructions stored thereon that are executable by the computing device to perform operations comprising:

See [19.2]; APPLE-1003, ¶170.

[15.3] transmitting a first signal from the transmitter to the receiver via a first propagation path of the plurality of propagation paths;

See [1.2]; APPLE-1003, ¶171.

[15.4] receiving a channel estimation based on the first signal, the channel estimation including path parameter information of the first propagation path;

A POSITA would have understood and found obvious from the teachings that render obvious [19.5] and [1.5], that the “base station” of claim 15 would ***receiv[e] a channel estimation based on the first signal, the channel estimation including path parameter information of the first propagation path*** because claim [1.5] provides for “sending ***the channel estimation*** that ***includes the path parameter information*** from the receiver to the transmitter via the first propagation path.” APPLE-1003, ¶172.

[15.5]predistorting a second signal in a time domain, a frequency domain, and a spatial domain according to the channel estimation based on the first signal; and

See [1.6]; APPLE-1003, ¶173.

[15.6]transmitting the predistorted second signal from the transmitter to the receiver via the first propagation path.

See [1.7]; APPLE-1003, ¶174.

Claim 16

[16]

See [20]; APPLE-1003, ¶175.

Claim 17

[17]

See [23]; APPLE-1003, ¶176.

D. GROUND 4—Wallace-Medbo – Claims 2-4, 16, and 20-22

1. Wallace

See V.C.1.

2. Medbo

See V.B.2.

3. Combination of Wallace and Medbo

A POSITA would have understood and found obvious to combine the teachings of Wallace and Medbo. This motivation stems from the well-known and articulated needs within such sophisticated systems to precisely characterize the dynamic radio channel while maintaining computational feasibility and

maximizing system efficiency. APPLE-1003, ¶65. Specifically, “[w]hen there is a design need or market pressure to solve a problem and there are a finite number of identified, predictable solutions, a person of ordinary skill has good reason to pursue the known options within his or her technical grasp.” *KSR*, 550 U.S. 398, 421. Similarly, if a technique has been shown to improve one device and a skilled artisan would recognize its applicability to similar devices, that application is likely obvious. *Id.*, 417.

First, a POSITA would have understood and found Wallace-Medbo obvious to address the critical need for highly accurate and efficient channel state information for preconditioning. APPLE-1003, ¶66. Wallace emphasizes the “present need... for efficient techniques that will provide rapid determination of the channel characteristics” to enable preconditioning and achieve a “higher efficiency, higher performance wireless communications system.” APPLE-1006, 1:57-2:22. This rapid and accurate channel condition analysis is vital because “the channel response can change with time due to the movement of the receiver unit or changes in the environment.” *Id.* Medbo, addresses “serious accuracy and efficiency problems” in prior art channel estimation, positing “substantial improvements regarding computational efficiency and/or parameter estimate accuracy” through, for one example, a modified Maximum Likelihood (ML) approach. APPLE-1005, [0047]. Medbo’s focus is on accurately characterizing radio channels by extracting

precise “wave parameters” such as propagation delays and directions. APPLE-1005, [0010]. A POSITA would have recognized that Medbo’s ability to provide a more refined and accurate characterization of the fundamental wave parameters of the radio channel would directly translate into more precise channel condition information for Wallace’s preconditioning process. APPLE-1003, ¶66. This improvement of a core input to enhance a system’s primary function represents a clear, predictable application of a known technique to an existing problem, aligning with *KSR*’s principle regarding improving similar devices.

Second, a POSITA would have understood and found obvious the Wallace-Medbo combination to enhance data compression and improve the efficiency of channel measurement information feedback on Wallace’s reverse link. APPLE-1006, FIG. 1B; APPLE-1003, ¶67. Wallace explicitly identifies “compression of the amount of information necessary to reconstruct the characteristics of the propagation channel” as a means to “minimize[]” the reverse link reporting “through compression techniques and resource allocation techniques.” APPLE-1006, 2:50-63, Abstract. Wallace further notes that “the full CSI is a large amount of information and also highly redundant,” making compression critical. APPLE-1006, 18:5-32. Medbo’s methodology includes a feature for channel information data reduction “Reduction of Data Size by Clipping.” APPLE-1005, [0155]-[0157]. This technique removes “data which correspond to uncorrelated waves” in

delay and/or angle domains, thereby reducing the data set size and “increasing the efficiency of parameter estimation” because “computational complexity is proportional to the size of the data set.” *Id.* A POSITA would have discerned that Medbo’s clipping mechanism and measured channel responses (similar to those in Wallace’s system) would serve as an effective analysis and compression step prior to reporting channel conditions to the transceiver. APPLE-1003, ¶67. This direct synergistic benefit, addressing an explicitly stated need for data reduction in Wallace’s system with a proven method from Medbo, constitutes a clear motivation for combination, as it represents a predictable use of known elements according to their established functions.

Third, a POSITA would have understood and found obvious the Wallace-Medbo combination to facilitate more granular channel knowledge and enhance overall system adaptability. APPLE-1003, ¶68. Wallace’s system relies on channel information to “optimiz[e] a set of transmission parameters” and for “pre-condition[ing] the data prior to transmission.” APPLE-1006, Claim 1, 2:25-63, 8:53-9:3. This preconditioning, in turn, enables channels to compensate for propagation loss and provides for “enhanced flexibility” and maximizing spectral efficiency. APPLE-1006, 3:34-67. One of Medbo’s contributions is a “discrete wave channel model” which yields high-resolution “wave parameters” including “propagation delay(s) and direction(s).” APPLE-1005, [0010]. This detailed

parameter extraction is specifically stated to be “suitable for channel prediction and/or simulation purposes” and for “improved channel prediction, which in turn can be used for enhanced link adaptation including controlling coding and/or transmit power.” APPLE-1005, [0040], [0003]. A POSITA, with an understanding of radio propagation physics, would have recognized Medbo's output—a detailed, physics-based characterization of individual multipath components—provides a richer and more accurate representation of the channel than typical channel impulse response estimates. APPLE-1003, ¶68. This type of fundamental channel knowledge would allow Wallace's preconditioning algorithms to be significantly more effective and robust, adapting with greater precision to complex multipath environments and dynamic channel conditions. This represents fitting the “teachings of multiple patents together like pieces of a puzzle” to achieve a superior outcome. *KSR*, 550 U.S., 420.

4. Application to Challenged Claims -20-22

Claim 20

[20] The wireless device of claim 19, wherein the path parameter information of the first propagation path includes at least one of an estimation of a delay, an estimation of a Doppler frequency, an estimation of a direction of arrival, an estimation of a direction of departure, and an estimation of a complex amplitude of the first propagation path.

Wallace-Medbo renders obvious [20] for the reasons stated in Grounds 2 and

3. In addition, Medbo further describes the types of well-known distortion

characteristics teaching “[t]he measured channel responses can for example be represented in frequency, time/delay, code and/or space.” APPLE-1005, [0041], [0057] (“desirable to determine ... wave propagation delay of each of these waves”). Thus, a POSITA would have understood and found obvious when *the path parameter information of the first propagation path includes at least one of an estimation of a delay . . . of the first propagation path*. APPLE-1003, ¶177.

Claim 21

[21] The wireless device of claim 20, wherein the path parameter information of the first propagation path further includes an estimation of a polarization status of the first propagation path.

Wallace-Medbo render obvious [21] for the same reasons as Ground 2. For example, Medbo teaches when determining channel characteristics that “[p]referably, the complex amplitudes, described by a complex polarimetric amplitude matrix, for each of the discrete waves should also be determined.” APPLE-1005, [0057]. The inclusion of a “complex polarimetric amplitude matrix” directly implies the estimation of polarization status. APPLE-1003, ¶178. Medbo further explains that “to achieve positive definite $C^H \bullet C$, the antennas used must account for the full polarization matrix.” APPLE-1005, [0120]. Medbo then teaches the use of these determined “complex polarimetric amplitude matrix” for later transmission of signals. APPLE-1005, [0120]. From this, a POSITA would have understood and found obvious that the determination and accounting for

antenna “polarizations” characteristics, includes *an estimation of a polarization status of the first propagation path*. APPLE-1003, ¶178.

Indeed, Sesia corroborates that a POSITA would have understood and found obvious that multi-path propagation parameters, for example “MIMO propagation channel parameters,” can include “the arrival and departure angles in addition to the traditional power and delay,” and “the polarization information.” APPLE-1007, 444-445, 665 (“sub-band reporting can be useful for the spatial component that captures co-phasing across polarizations (referred to as W_2).”); APPLE-1003, ¶179. A POSITA would have understood and found obvious that polarization information was an important measurement in MIMO systems and measuring such properties would be part of the channel conditions, thus rendering obvious [21]. APPLE-1003, ¶179.

Claim 22

[22] The wireless device of claim 19, wherein the path parameter information is obtained by at least one estimation technique of the group consisting of a maximum likelihood estimation algorithm, periodogram, correlatorgram, spectral-based methods, Bartlett beamformers, Capon beamformers, subspace-based techniques, MUSIC (Multiple Signal Classification), ESPRIT (Estimation of Signal Parameters via Rotational Invariance Techniques), approximation of the maximum-likelihood method based on iterative schemes, SAGE (Space-Alternating Generalized Expectation-maximization), RiMAX (Richter's Maximum Likelihood method), maximum-a-posteriori based methods, Evidence Framework, Bayesian techniques, tracking algorithms, Kalman filtering techniques, enhanced Kalman filtering techniques, particle filtering techniques, and least-square-error methods.

Wallace-Medbo renders obvious [22]. For example, Medbo teaches channel estimation using a maximum-likelihood (ML) estimation algorithm and other well-known methods for channel estimation. APPLE-1005, [0004]. Specifically, Medbo discloses “[i]t is well known that *Maximum Likelihood [(estimation algorithm)]* in principle is one of the most accurate methods available” *Id*; APPLE-1003, ¶180. Additionally, “[d]ifferent methods have previously been proposed for complexity reduction like *Space Alternating Generalized Expectation (SAGE)* maximization, and a maximum likelihood framework called *RIMAX*.” APPLE-1005, [0004], [0046].

Thus, a POSITA would have understood and found obvious that *the path parameter information is obtained by at least one estimation technique of the group consisting of a maximum-likelihood estimation algorithm, . . . SAGE (Space-Alternating Generalized Expectation-maximization), RiMAX (Richter's Maximum Likelihood method)*. APPLE-1003, ¶181.

5. Claims 2-4, and 16

Claim 2

[2]

See [20]; APPLE-1003, ¶182.

Claim 3

[3]

See [21]; APPLE-1003, ¶183.

Claim 4

[4]

See [23]; APPLE-1003, ¶184.

Claim 16

[16]

See [20], [3]; APPLE-1003, ¶185.

VI. DISCRETIONARY DENIAL IS NOT WARRANTED

Petitioner believes that discretionary denial is unwarranted, and yet, Petitioner intends to utilize the bifurcated briefing process contemplated by the March 26, 2025, Stewart Memorandum to rebut contentions if offered by Patent Owner to the contrary. *See* APPLE-1009; APPLE-1010; Video at <https://uspto.cosocloud.com/p9xpz6s4jn75/>.

VII. CONCLUSION

Petitioner respectfully requests institution of IPR for the Challenged Claims. Petitioner authorizes the Patent and Trademark Office to charge any fees to Deposit Account No. 06-1050.

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

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

Apple Inc. is the petitioner and real party in interest.

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

Petitioner is not aware of any disclaimers, or reexamination certificates for the '347 Patent. The '347 Patent is the subject of the following petitions for *inter partes* review: *Samsung Electronics America, Inc. f/k/a Samsung Telecommunications America LLC et al v. Cobblestone Wireless, LLC*, IPR2024-00319 (PTAB), filed December 18, 2023; *T-Mobile USA, Inc. et al v. Cobblestone Wireless, LLC*, IPR2024-00136 (PTAB), filed December 4, 2023. The '347 Patent is also the subject of the following civil actions: *Cobblestone Wireless, LLC v. Motorola Mobility LLC*, 1-24-cv-08726 (NDIL), filed September 20, 2024; *Cobblestone Wireless, LLC v. Apple Inc.*, 7-24-cv-00232 (WDTX), filed September 20, 2024; *Cobblestone Wireless, LLC v. Samsung Electronics Co., Ltd. et al.*, 2-23-cv-00285 (EDTX), filed June 16, 2023; *Cobblestone Wireless, LLC v. T-Mobile USA, Inc. et al.*, 2-22-cv-00477 (EDTX), filed December 16, 2022; *Cobblestone Wireless, LLC v. Verizon Communications Inc. et al.*, 2-22-cv-00478 (EDTX), filed December 16, 2022; *Cobblestone Wireless, LLC v. AT&T Inc. et al.*, 2-22-cv-00474 (EDTX), filed December 15, 2022.

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

Petitioner provides the following designation of counsel.

Lead Counsel	Backup Counsel
W. Karl Renner, Reg. No. 41,265 Fish & Richardson P.C. 60 South Sixth Street, Suite 3200 Minneapolis, MN 55402 Tel: 202-783-5070 Fax: 877-769-7945 Email: IPR50095-0250IP1@fr.com	Hyun Jin In, Reg. No. 70,014 Jonathan C. Driesslein, Reg. No. 82,202 Fish & Richardson P.C. 60 South Sixth Street, Suite 3200 Minneapolis, MN 55402 Tel: 202-783-5070 Fax: 877-769-7945 Email: IPR50095-0250IP1@fr.com

D. Service Information

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

Petitioner consents to electronic service by email at IPR50095-0250IP1@fr.com.

Respectfully submitted,

Dated: August 29, 2025

/W. Karl Renner/
W. Karl Renner, Reg. No. 41,265
Hyun Jin In, Reg. No. 70,014
Jonathan C. Driesslein, Reg. No. 82,202
Fish & Richardson P.C.
60 South Sixth Street, Suite 3200
Minneapolis, MN 55402
T: 202-783-5070
F: 877-769-7945

(Control No. IPR2025-01496)

Attorneys for Petitioner

CERTIFICATION UNDER 37 CFR § 42.24

Under the provisions of 37 CFR § 42.24(d), the undersigned hereby certifies that the word count for the foregoing Petition for *Inter Partes* Review totals 13,983 words, which is less than the 14,000 allowed under 37 CFR § 42.24.

Dated: August 29, 2025

/W. Karl Renner/

W. Karl Renner, Reg. No. 41,265

Hyun Jin In, Reg. No. 70,014

Jonathan C. Driesslein, Reg. No. 82,202

Fish & Richardson P.C.

60 South Sixth Street, Suite 3200

Minneapolis, MN 55402

T: 202-783-5070

F: 877-769-7945

(Control No. IPR2025-01496)

Attorneys for Petitioner

CERTIFICATE OF SERVICE

Pursuant to 37 CFR §§ 42.6(e)(4)(i) *et seq.* and 42.105(b), the undersigned certifies that on August 29, 2025, a complete and entire copy of this Petition for *Inter Partes* Review, Power of Attorney and all supporting exhibits were provided via Federal Express, to the Patent Owner by serving the correspondence address of record as follows:

Maschoff Brennan/Allied Inventors
111 East Broadway, Suite 725
Salt Lake City, UT 84111
UNITED STATES
(801) 297-1850

/Crena Pacheco/
Crena Pacheco
Fish & Richardson P.C.
60 South Sixth Street, Suite 3200
Minneapolis, MN 55402
pacheco@fr.com