

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent of: Xiaobo Zhang
U.S. Patent No.: 11,063,727 Attorney Docket No. 50095-0230IP1
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Title: METHOD AND DEVICE IN UE AND BASE STATION FOR
MULTI-ANTENNA SYSTEM

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PETITION FOR *INTER PARTES* REVIEW OF UNITED STATES PATENT

NO. 11,063,727 PURSUANT TO 35 U.S.C. §§ 311–319, 37 C.F.R. § 42

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LIST OF EXHIBITS

APPLE-1001	U.S. Patent No. 11,063,727
APPLE-1002	U.S. Patent No. 11,063,727 File History
APPLE-1003	Declaration and Curriculum Vitae of Dr. Akl
APPLE-1004	Complaint, <i>Apex Beam Technologies LLC v. Apple Inc.</i> , 6:24-cv-00223, W.D. Tex., filed April 29, 2024
APPLE-1005	U.S. Patent No. 10,720,972 B2 to Park, et al. (“Park”)
APPLE-1006	U.S. Patent Pub. No. 2016/0142189 A1 to Shin, et al. (“Shin”)
APPLE-1007	U.S. Patent No. 10,659,118 B2 to Rahman, et al. (“Rahman”)
APPLE-1008	U.S. Patent Pub. No. 2014/0177561 to Yu, et al. (“Yu”)
APPLE-1009	U.S. Prov. 62/378,578 to Rahman, et al. (“Rahman Provisional”)
APPLE-1010	First Amended Complaint, <i>Apex Beam Technologies LLC v. Apple Inc.</i> , 6:24-cv-00223, W.D. Tex., filed May 2, 2024
APPLE-1011	Proof of Service of Complaint, <i>Apex Beam Technologies LLC v. Apple Inc.</i> , 6:24-cv-00223, W.D. Tex.

LISTING OF CLAIMS

Claim 1	
[1.pre]	A method in a User Equipment (UE) for multi-antenna transmission, comprising:
[1.1]	receiving a first signaling, a second signaling, a first reference signal and a second reference signal; and
[1.2]	transmitting first channel information;
[1.3]	wherein the first reference signal comprises Q1 reference signal port(s), the Q1 reference signal port(s) is(are) transmitted by Q1 antenna port(s) respectively;
[1.4]	the second reference signal comprises Q2 reference signal port(s), the Q2 reference signal port(s) is(are) transmitted by Q2 antenna port(s) respectively;
[1.5]	the first signaling is used to determine L1 antenna port(s), the Q1 antenna port(s) is(are) a subset of the L1 antenna port(s);
[1.6]	the second signaling is used to determine the Q2 antenna port(s);
[1.7]	wherein the Q1 and the Q2 are positive integers respectively, the L1 is a positive integer greater than or equal to the Q1;
[1.8]	the first channel information corresponds to Q antenna ports; the Q antenna ports consist of the Q1 antenna port(s) and the Q2 antenna port(s), the Q is equal to a sum of the Q1 and the Q2;
[1.9]	the first reference signal is transmitted in a first time resources pool, and the second reference signal is transmitted in a second time resources pool, the first reference signal occurs multiple times in the first time resources pool, and time intervals between any two adjacent occurrences of the first reference signal in the first time resources pool are equal, the second reference signal occurs once in the second time resources pool.

Claim 2	
[2]	The method according to claim 1, comprising: transmitting first information; wherein the first information indicates Q3 antenna port(s) out of the L1 antenna port(s); the Q3 is a positive integer less than or equal to the L1.
Claim 3	
[3]	The method according to claim 1, comprising: receiving second information; wherein the second information indicates the Q1 antenna port(s) out of the L1 antenna port(s).
Claim 4	
[4]	The method according to claim 1, wherein beamforming vector(s) corresponding to the Q1 antenna port(s) is(are) used to determine beamforming vector(s) corresponding to transmission antenna port(s) for the second signaling.
Claim 5	
[5]	The method according to claim 1, comprising: the first signaling is a higher-layer signaling, and the second signaling is a physical layer signaling.
Claim 6	
[6.pre]	A method in a base station for multi-antenna transmission, comprising:
[6.1]	transmitting a first signaling, a second signaling, a first reference signal and a second reference signal; and
[6.2]	receiving first channel information;
[6.3]	wherein the first reference signal comprises Q1 reference signal port(s), the Q1 reference signal port(s) is(are) transmitted by Q1 antenna port(s) respectively;
[6.4]	the second reference signal comprises Q2 reference signal port(s), the Q2 reference signal port(s) is(are) transmitted by Q2 antenna port(s) respectively;

[6.5]	the first signaling is used to determine L1 antenna port(s), the Q1 antenna port(s) is(are) a subset of the L1 antenna port(s);
[6.6]	the second signaling is used to determine the Q2 antenna port(s);
[6.7]	wherein the Q1 and the Q2 are positive integers respectively, the L1 is a positive integer greater than or equal to the Q1;
[6.8]	the first channel information corresponds to Q antenna ports; the Q antenna ports consist of the Q1 antenna port(s) and the Q2 antenna port(s), the Q is equal to a sum of the Q1 and the Q2;
[6.9]	the first reference signal is transmitted in a first time resources pool, and the second reference signal is transmitted in a second time resources pool, the first reference signal occurs multiple times in the first time resources pool, and time intervals between any two adjacent occurrences of the first reference signal in the first time resources pool are equal, the second reference signal occurs once in the second time resources pool.
Claim 7	
[7]	The method according to claim 6, comprising: receiving first information; wherein the first information indicates Q3 antenna port(s) out of the L1 antenna port(s); the Q3 is a positive integer less than or equal to the L1.
Claim 8	
[8]	The method according to claim 6, comprising: transmitting second information; wherein the second information indicates the Q1 antenna port(s) out of the L1 antenna port(s).
Claim 9	
[9]	The method according to claim 6, wherein beamforming vector(s) corresponding to the Q1 antenna port(s) is(are) used to determine beamforming vector(s) corresponding to transmission antenna port(s) for the second signaling.

Claim 10	
[10]	The method according to claim 6, comprising: the first signaling is a higher-layer signaling, and the second signaling is a physical layer signaling.
Claim 11	
[11.pre]	A User Equipment (UE) for multi-antenna transmission, comprising:
[11.1]	a first receiver: receiving a first signaling, a second signaling, a first reference signal and a second reference signal; and
[11.2]	a first transmitter: transmitting first channel information;
[11.3]	wherein the first reference signal comprises Q1 reference signal port(s), the Q1 reference signal port(s) is(are) transmitted by Q1 antenna port(s) respectively;
[1.4]	the second reference signal comprises Q2 reference signal port(s), the Q2 reference signal port(s) is(are) transmitted by Q2 antenna port(s) respectively;
[11.5]	the first signaling is used to determine L1 antenna port(s), the Q1 antenna port(s) is(are) a subset of the L1 antenna port(s);
[11.6]	the second signaling is used to determine the Q2 antenna port(s);
[11.7]	wherein the Q1 and the Q2 are positive integers respectively, the L1 is a positive integer greater than or equal to the Q1;
[11.8]	the first channel information corresponds to Q antenna ports; the Q antenna ports consist of the Q1 antenna port(s) and the Q2 antenna port(s), the Q is equal to a sum of the Q1 and the Q2;

[11.9]	the first reference signal is transmitted in a first time resources pool, and the second reference signal is transmitted in a second time resources pool, the first reference signal occurs multiple times in the first time resources pool, and time intervals between any two adjacent occurrences of the first reference signal in the first time resources pool are equal, the second reference signal occurs once in the second time resources pool.
Claim 12	
[12]	The UE according to claim 11, wherein the first transmitter transmits first information; wherein the first information indicates Q3 antenna port(s) out of the L1 antenna port(s); the Q3 is a positive integer less than or equal to the L1.
Claim 13	
[13]	The UE according to claim 11, wherein the first receiver receives second information; wherein the second information indicates Q1 antenna port(s) out of the L1 antenna port(s).
Claim 14	
[14]	The UE according to claim 11, wherein beamforming vector(s) corresponding to the Q1 antenna port(s) is(are) used to determine beamforming vector(s) corresponding to transmission antenna port(s) for the second signaling.
Claim 15	
[15]	The UE according to claim 11, wherein the first signaling is a higher-layer signaling, and the second signaling is a physical layer signaling.
Claim 16	
[16.pre]	A base station for multi-antenna transmission, comprising:
[1.1]	a second transmitter: transmitting a first signaling, a second signaling, a first reference signal and a second reference signal;
[16.2]	a second receiver: receiving first channel information;

[16.3]	wherein the first reference signal comprises Q1 reference signal port(s), the Q1 reference signal port(s) is(are) transmitted by Q1 antenna port(s) respectively;
[16.4]	the second reference signal comprises Q2 reference signal port(s), the Q2 reference signal port(s) is(are) transmitted by Q2 antenna port(s) respectively;
[16.5]	the first signaling is used to determine L1 antenna port(s), the Q1 antenna port(s) is(are) a subset of the L1 antenna port(s);
[16.6]	the second signaling is used to determine the Q2 antenna port(s);
[16.7]	wherein the Q1 and the Q2 are positive integers respectively, the L1 is a positive integer greater than or equal to the Q1;
[16.8]	the first channel information corresponds to Q antenna ports; the Q antenna ports consist of the Q1 antenna port(s) and the Q2 antenna port(s), the Q is equal to a sum of the Q1 and the Q2;
[16.9]	the first reference signal is transmitted in a first time resources pool, and the second reference signal is transmitted in a second time resources pool, the first reference signal occurs multiple times in the first time resources pool, and time intervals between any two adjacent occurrences of the first reference signal in the first time resources pool are equal, the second reference signal occurs once in the second time resources pool.
Claim 17	
[17]	The base station according to claim 16, wherein the second receiver receives first information; wherein the first information indicates Q3 antenna port(s) out of the L1 antenna port(s); the Q3 is a positive integer less than or equal to the L1.
Claim 18	
[18]	The base station according to claim 16, wherein the second transmitter transmits second information; wherein the second information indicates Q1 antenna port(s) out of the L1 antenna port(s).

Claim 19	
[19]	The base station according to claim 16, wherein beamforming vector(s) corresponding to the Q1 antenna port(s) is(are) used to determine beamforming vector(s) corresponding to transmission antenna port(s) for the second signaling.
Claim 20	
[20]	The base station according to claim 16, wherein the first signaling is a higher-layer signaling, and the second signaling is a physical layer signaling.

I. INTRODUCTION

Apple Inc. (“Apple” or “Petitioner”) petitions for IPR of claims 1-20 (“Challenged Claims”) of U.S. Patent No. 11,063,727 (“the ’727 patent”). Evidence presented in this Petition demonstrates that the Challenged Claims are unpatentable.

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

A. Standing - 37 C.F.R. § 42.104(a)

Apple Inc. certifies that the ’727 patent is available for IPR. The present petition is being filed within one year of service of a complaint *Apex Beam Technologies LLC v. Apple Inc.*, 6-24-cv-00223 (WDTX), filed April 29, 2024. Petitioner is not barred or estopped from requesting this review challenging the Challenged Claims on the below-identified grounds.

B. Grounds and Relief Requested

Petitioner requests institution of IPR and cancellation of the Challenged Claims based on the following grounds:

Ground	’727 Patent Claims	Basis	Prior Art
Ground 1	1-2, 5-7, 10-12, 15-17, 20	§ 102/103	Park
Ground 2	3, 8, 13, 18	§ 103	Park, Rahman
Ground 3	4, 9, 14, 19	§ 103	Park, Yu
Ground 1A	1-2, 5-7, 10-12, 15-17, 20	§ 103	Park, Shin
Ground 2A	3, 8, 13, 18	§ 103	Park, Shin, Rahman

Ground	'727 Patent Claims	Basis	Prior Art
Ground 3A	4, 9, 14, 19	§ 103	Park, Shin, Yu

The grounds of this petition are further supported by the expert testimony of Dr. Robert Akl. APPLE-1003 (“Expert Declaration”).

The '727 patent is a continuation of an application filed July October 31, 2017, and claims priority to a Chinese patent application filed November 1, 2016. APPLE-1001, 1:7-11. As shown below, each prior art reference that forms the basis of the grounds of this Petition qualifies as prior art with respect to the '727 patent's earliest proclaimed priority date (November 1, 2016; “Critical Date”), which Petitioner does not concede.

Park qualifies as prior art under 35 U.S.C. § 102(a)(2). Specifically, Park is a patent granted based on a national phase application that was filed March 23, 2018, and which claims priority to International Patent App. PCT/KR2016/010763 filed September 26, 2016.

Shin qualifies as prior art under 35 U.S.C. § 102(a)(1) and 35 U.S.C. § 102(a)(2). Specifically, Shin is a March 19, 2016 publication of an application that was filed on November 6, 2015.

Rahman qualifies as prior art under 35 U.S.C. § 102(a)(2). Rahman is a patent granted based on an application filed on April 18, 2017, claiming priority to provisional applications filed on April 19, 2016, June 17, 2016, June 23, 2016,

August 22, 2016, and August 23, 2016. APPLE-1007, Cover. While there is no need to evaluate whether any claim of Rahman is actually entitled to its claimed priority to these provisional applications (*Penumbra, Inc. v. RapidPulse, Inc.*, IPR2021-01466, Paper 34 (March 10, 2023)), at least one of the provisional applications (i.e., U.S. Prov. 62/378,578 filed August 23, 2016,” Rahman Provisional”) readily supports Rahman’s claims. APPLE-1003, Section VII.D.1 (mapping exemplary support).

Yu qualifies as prior art under 35 U.S.C. § 102(a)(1) and 35 U.S.C. § 102(a)(2). Specifically, Yu is a June 26, 2014 publication of an application that was filed on December 23, 2013.

C. Claim Construction

To the extent necessary, 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. And yet, no claim terms need be construed to resolve issues of controversy in the present Petition. *Wellman, Inc. v. Eastman Chem. Co.*, 642 F.3d 1355, 1361 (Fed. Cir. 2011); APPLE-1003, Section IV.C.

D. Level of Ordinary Skill in the Art

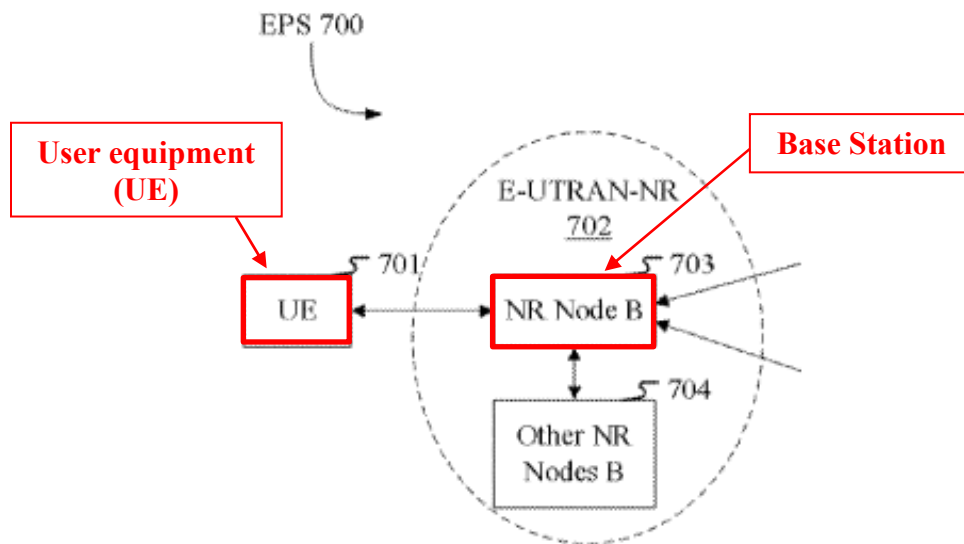
A person of ordinary skill in the art (“POSITA”) relating to the subject matter of the ’727 Patent as of the Critical Date would have a bachelor’s degree in electrical engineering, computer engineering, computer science, or a similar field,

along with two years of experience designing or developing wireless networks, including long-term evolution LTE/4G or 5G new radio (NR) cellular technology. APPLE-1003, Section V. Additional education might substitute for some of the experience, and additional substantial experience might substitute for some of the educational background. *Id.*

III. THE '727 PATENT

A. Brief Description

The '727 patent is directed to wireless communication systems with “multi-antenna transmission” in which user equipment (UE) performs “downlink channel estimation by measuring downlink reference signals transmitted by a base station.” APPLE-1001, 1:18-29. The '727 patent offers an example of network architecture in FIG. 7 (partially reproduced below, annotated), showing user equipment (UE) 701 communicating with a base station 703 (also referred to as an “NR Node B”). APPLE-1001, FIG. 7, 17:1-4.



APPLE-1001, FIG. 7 (partially reproduced, annotated)

The '727 patent describes two types of downlink reference signals transmitted from the base station to the UE, namely “**periodic** downlink reference signals” and “**aperiodic** downlink reference signals.” *Id.*, 1:31-40; APPLE-1003, ¶36. Based on measuring these reference signals, the UE “feeds back Channel State Information (CSI)” to the base station. *Id.*, 1:27-30. In particular, the '727 patent describes techniques for “jointly utilizing” both periodic and aperiodic reference signals to perform channel estimation. *Id.*, 1:55-58.

Fig. 1 (reproduced below) shows an example of the '727 patent transmission scheme, in which a base station transmits two different reference signals (a first reference signal and a second reference signal) to a UE, and the UE transmits channel information to the base station. APPLE-1001, 9:64-11:26; APPLE-1003, ¶37.

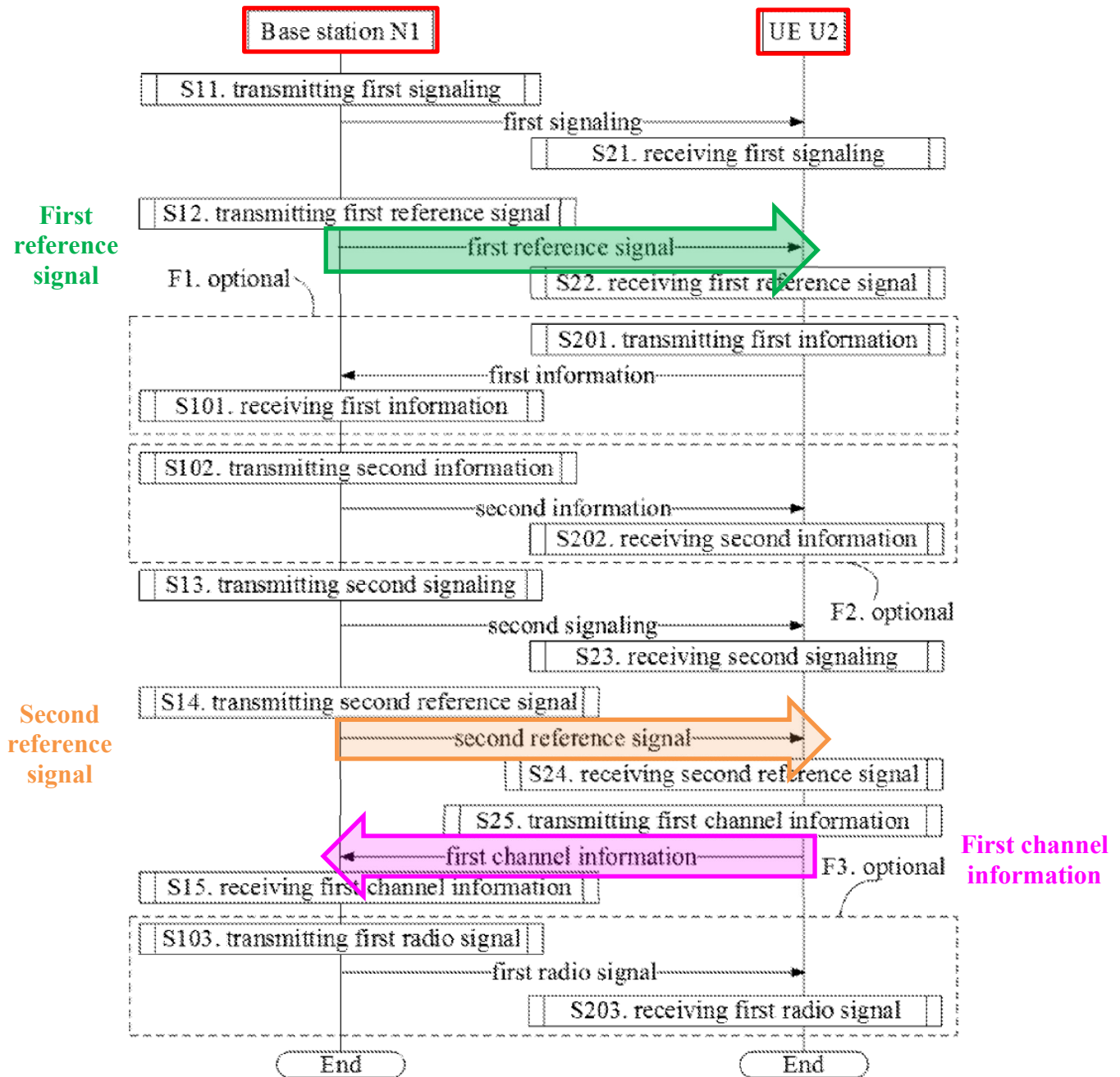


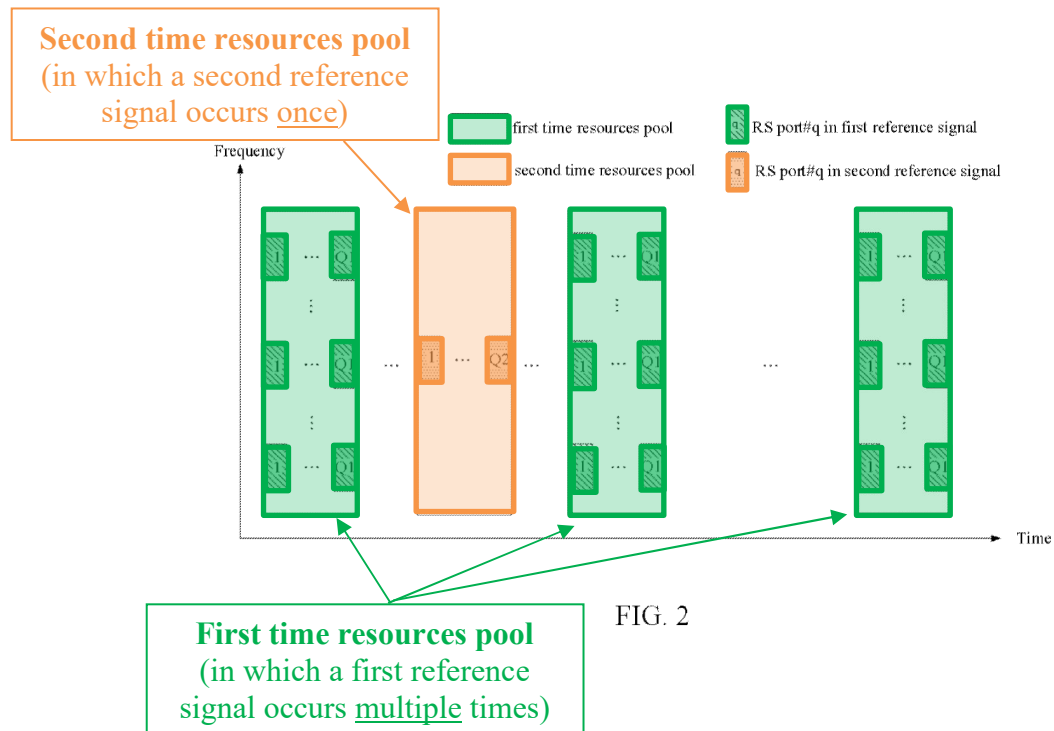
FIG. 1

APPLE-1001, FIG. 1 (annotated)

As shown in FIG. 11, the base station transmits a “first reference signal” and a “second reference signal” to the UE. APPLE-1001, 2:2-5, 10:3-16, 14:15-37,

FIG. 6. The '727 patent explains that “the first reference signal occurs **multiple** times in [a] first time resources pool, and time intervals between any two adjacent occurrences of the first reference signal in the first time resources pool are equal.” APPLE-1001, 2:63-67, 6:33-36, 15:8-11, 9:14-26 (referring to “periodic downlink reference signals”). In contrast, “the second reference signal occurs **once** in [a] second time resources pool.” APPLE-1001, 3:1-3, 6:37-38, 15:12-13, 9:14-26 (referring to “aperiodic downlink reference signals”); APPLE-1003, ¶36.

An example of the first and second references signals being transmitted in their respective resources pools is shown in FIG. 2, reproduced below. APPLE-1001, 11:27-12:12; APPLE-1003, ¶39.



APPLE-1001, FIG. (annotated)

The '727 patent describes using a number of “antenna ports” to transmit the two reference signals. APPLE-1003, ¶40. The '727 patent explains the concept of an “antenna port” as a virtual antenna “formed by multiple antennas through antenna virtualization superposition.” APPLE-1001, 3:35-38; APPLE-1003, ¶40. The specific mapping of “the multiple antennas to the antenna port” creates “a beamforming vector” (the '727 patent also refers to beamforming as “precoding”). *Id.*, 19:24-26, 20:28-30. In particular, the beamforming vector can be configured to be “pointing to the UE” which “improves transmission reliability and efficiency.” APPLE-1001, 3:35-38, 5:41-44; APPLE-1003, ¶40.

In particular, the first reference signal is “transmitted by **Q1** antenna port(s)” and the second reference signal is “transmitted by **Q2** antenna port(s).” APPLE-1001, 2:6-14, 6:4-10, 10:17-23, 14:26-28; APPLE-1003, ¶41. Having received the first and second reference signals through the Q1 and Q2 antenna ports, the UE performs a “measurement of the first reference signal and the second reference signal,” and based on these measurements, the UE transmits “Channel State Information (CSI)” to the base station (also referred to as “first channel information”). APPLE-1001, 2:2-5, 2:20-24; 10:3-16, 14:15-37, FIG. 6; APPLE-1003, ¶41. The Channel State Information (CSI) (first channel information) can include various types of information such as “a Rank Indicator (RI), a Precoder Type Indication (PTI), a Precoding Matrix Indicator (PMI), a Channel Quality

Indicator (CQI) .” *Id.*, 2:20-30, 3:45-46, 10:41-47, 10:65-66, 14:38-46, 15:53-54; APPLE-1003, ¶41.

Notably, the ’727 discloses “**jointly** utilizing” both the **periodic** and **aperiodic** reference signals to perform channel estimation. *Id.*, 1:55-58. In particular, “[t]he first channel information corresponds to Q antenna ports,” where “the Q antenna ports consist of the Q1 antenna port(s) and the Q2 antenna port(s)” such that “the Q is equal to a **sum** of the Q1 and the Q2.” APPLE-1001, 2:16-19, 6:13-16, 14:34-37; APPLE-1003, ¶42. The ’727 patent explains that “jointly utilizing” both “periodic reference signals and aperiodic reference signals” to perform channel estimation can reduce “overhead.” *Id.*, 55:58.

The ’727 patent also describes other types of signaling and information conveyed between the UE and base station, as shown in annotated FIG. 2 and 3, below. APPLE-1003, ¶43.

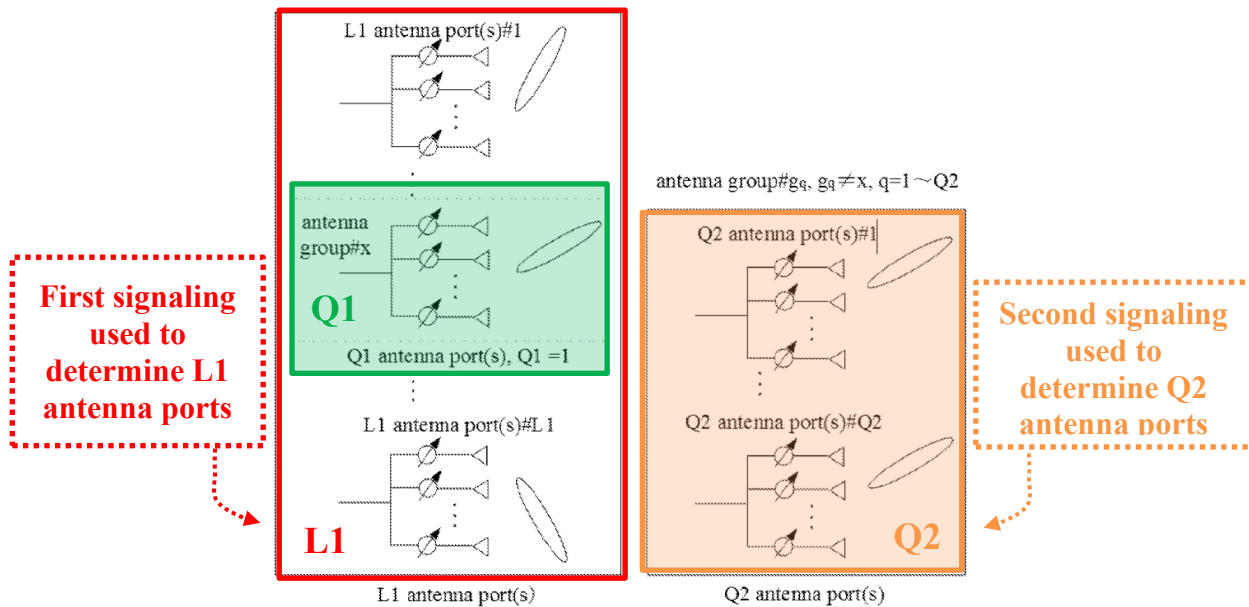


FIG. 3

$$Q = Q1 + Q2$$

APPLE-1001, FIGS. 2 and 3 (annotated)

As shown, the UE receives “first signaling” which is “used to determine L1 antenna port(s)” (of which the Q1 ports are a subset) and “second signaling” which is “used to determine the Q2 antenna port(s).” APPLE-1001, 2:10-16, 6:8-13, 14:28-34, FIGS. 1-3; APPLE-1003, ¶44.

B. Prosecution History

The Examiner initially rejected the claims of the '800 on priority grounds in view of combinations of U.S. Patent Pub. No. 2015/0043673 A1 to Lee, et al. (“Lee”), U.S. Patent Pub. No. 2018/0367274 A1 to Shi, et al. (“Shi”), and US 2013/0265962 A1 to Ouchi, et. al. (“Ouchi”). APPLE-1002, p.70-86. In response,

Applicant amended each of the independent claims. APPLE-1002, p.59-68. The Examiner subsequently entered a number of minor claim amendments via an Examiner's Amendment and allowed the claims. APPLE-1002, p.31-41.

There is no indication that the Examiner considered Park, Shin, Rahman, or Yu, which anticipate and/or render obvious the Challenged Claims, as discussed below. *See generally*, APPLE-1002; APPLE-1003, ¶49.

IV. THE CHALLENGED CLAIMS ARE UNPATENTABLE

Below, the Petition presents a first set of grounds based on primary reference Park (alone or in combination with Rahman and Yu) and a second set of grounds that additionally incorporates the disclosure of Shin.

In the first set of grounds 1, 2, and 3, the Petition relies on the disclosure of the primary reference Park, alone or in combination with Rahman or Yu, and explains why this disclosure, when interpreted in view of the general knowledge of a POSITA, discloses or renders obvious all limitations of the Challenged Claims. APPLE-1003, ¶112.

In the second set of grounds 1A, 2A, and 3A, the Petition relies on the same disclosure of Park as presented in Grounds 1, 2, and 3 but turns to Shin's disclosure to the extent its teachings would not have been within the general knowledge of a POSITA. APPLE-1003, XXX. Grounds 1 and 1A are discussed separately below, distinguished only by the additional use of Shin in Ground 1A

for limitation [1.6] of independent claim 1 (and similar limitations [6.6], [11.6], and [16.6]). However, because the disclosure and corresponding obviousness arguments are identical for the remaining Grounds 2/2A and Grounds 3/3A, the Petition discusses these grounds together for ease of presentation. APPLE-1003, ¶113.

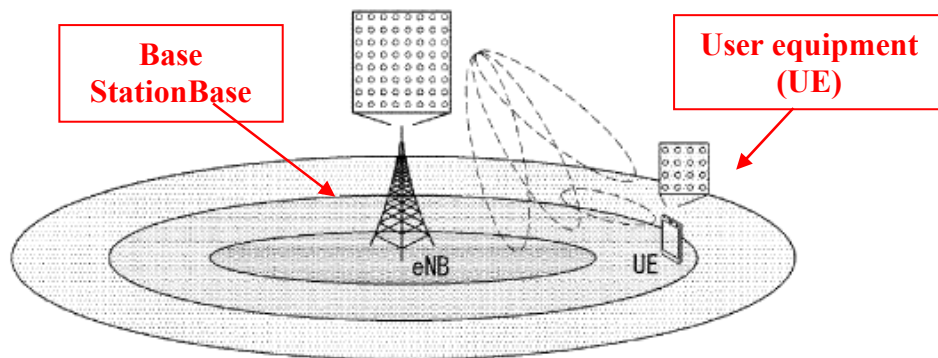
A. [GROUND 1] – CLAIMS 1-2, 5-7, 10-12, 15-17, 20 ARE ANTICIPATED BY AND/OR RENDERED OBVIOUS IN VIEW OF PARK

As explained below in Ground 1, Park discloses and/or renders obvious all limitations of the independent claims 1, 6, 11, and 16, as well as dependent claims 2, 5, 7, 10, 12, 15, 17, and 20.

1. Overview of Park

Park is analogous art to the '727 patent because, like the '727 patent, Park is directed to “transmitting and receiving channel state information in a wireless communication system” using downlink reference signals. APPLE-1005, Abstract, 42:57-58; APPLE-1001, 1:18-29, 16:22-32; APPLE-1003, ¶51. An example of the wireless communication system in Park is shown in FIG. 10 (reproduced below, annotated), showing a user equipment (UE) communicating with a base station (also referred to as a “Node B” or “eNB”). APPLE-1005, FIG. 10, 4:9-29, 24:17-21; APPLE-1003, ¶51.

【FIG. 10】



APPLE-1005, FIG. 10 (annotated)

Park, like the '727 patent, describes UE receiving a “channel state information [reference signal] RS” (“CSI-RS”) from the base station, and the UE performing measurements on the received CSI-RS to provide “feedback of channel state information” (“CSI”) to the base station. APPLE-1005, 15:32-50, 19:47-20:56, Abstract; APPLE-1003, ¶52.

The CSI-RS is transmitted by the base station using one or more “antenna ports.” APPLE-1005, 16:22-23, 42-44; 25:64-67 (“[f]or CSI measurement, a CSI-RS is transmitted through multiple antenna ports”). Park, like the '727 patent, explains that an antenna port is a virtual antenna where “a single antenna port may be mapped to multiple physical antenna elements” through “antenna port virtualization.” APPLE-1005, 25:1-3, 19-36, 44-50; APPLE-1003, ¶53. Park, like the '727 patent, further explains that the specific mapping of physical antenna elements to an antenna port can be configured to achieve “beamforming” (also

referred to as “precod[ing]”) so that “downlink transmission may be directed toward a specific UE.” APPLE-1005, 25:19-24, 44-52, 65-67; APPLE-1003, ¶53.

Park’s base station configures a “CSI process” which includes one or more (“ $K \geq 1$ ”) “CSI-RS resources.” APPLE-1005, 26:55-58, Abstract; APPLE-1003, ¶54. Each CSI-RS is transmitted on a CSI-RS resource. APPLE-1005, 30:61-63 (describing K CSI-RSs transmitted on K CSI-RS resources), 31:3-9 (describing one CSI-RS transmitted on one CSI-RS resource); APPLE-1003, ¶54. Each CSI-RS resource occupies a number of resource elements (REs), where each RE is a time-frequency resource occupying one OFDM symbol in time and one subcarrier in frequency. APPLE-1005, 7:27-34, FIG. 2, 16:17-20, 19:53-55, FIG. 8, 22:3-6; APPLE-1003, ¶54. The UE performs measurements on the K CSI-RS resources in the CSI process and reports channel state information to the base station. APPLE-1005, 27:59-61, Abstract; APPLE-1003, ¶54. The CSI process is configured by the base station “through high layer signaling (e.g., RRC signaling),” in particular by sending “configuration information” to the UE, which configures the number of CSI-RS resources (K) in the CSI process. APPLE-1005, 26:51-58, 28:11-14 (“K CSI-RS resources configured within the CSI process”), 28:25-33 (“a maximum value of K within the RRC configuration of a newly defined CSI process”), 30:61-62, 31:61-62, 39:52-60, 42:60-64, 43:1-19, FIG. 13 (step S1301), Abstract, 2:11-26; APPLE-1003, ¶54.

Each of the K CSI-RS resources in the CSI process is configured with a certain number of antenna ports, through which the CSI-RS (the reference signal) is transmitted. APPLE-1003, ¶55. In particular, the k -th CSI-RS resource (among the K CSI-RS resources in the CSI process) is configured with a number of antenna ports “ N_k ” (also referred to as the “CSI-RS port number”) where N_k can indicate 1, 2, 4, or 8 antenna ports. APPLE-1005, 26:51-58, 27:59-61, 29:41-43, 31:46-48, 32:23-26; APPLE-1003, ¶55. This “CSI-RS port number” (N_k) is configured by the base station “through high layer signaling” to the UE (e.g., as part of a “CSI-RS (resource) configuration” in the CSI process configuration) by a parameter “antennaPortsCount” indicating “the number of antenna ports used for CSI-RS transmission.” APPLE-1005, 22:6-15, 26:51-58, Abstract, 2:16-22, 21:63-64, FIG. 13; APPLE-1003, ¶55. Thus, for a CSI process configured with K CSI-RS resources and N_k antenna ports per CSI-RS resource, the total number of antenna ports configured for the CSI process is equal to $N_k * K$ (assuming N_k is the same for all k). APPLE-1005, 32:23-26; APPLE-1003, ¶55.

When the UE receives a CSI-RS (the reference signal) on the configured K CSI-RS resources of the CSI process, the UE performs measurements on the CSI-RS and sends channel state information (a “CSI report”) to the base station. APPLE-1005, 15:32-50, 19:47-20:56, 30:61-66, 31:3-9, 31:47-59, Abstract; APPLE-1003, ¶56. Like the ’727 patent, Park discloses the CSI report can include

a “channel quality indicator (CQI),” a “precoding matrix indicator (PMI),” and a “rank indicator (RI).” APPLE-1005, Abstract, FIG. 13, 27:61-64, 28:7-10; APPLE-1003, ¶56.

In some scenarios (discussed further below), the CSI report can further include a “beam selection indicator (BI) (or a CSI-RS resource indicator (CRI))” that indicates a particular beam or CSI-RS resource selected by the UE, among the K CSI-RS resources that are received in the CSI process. APPLE-1005, 28:11-24, 35:54-62, 36:57-61, 43:25-44, Abstract, 27:62-64; APPLE-1003, ¶57. Park explains that “beam selection may be the selection of a subset of antenna ports within a single CSI-RS resource,” i.e., the selection of “L” ports among “N_k” ports configured for a CSI-RS resource. APPLE-1005, 29:36-37, 31:42-44; APPLE-1003, ¶57.

Park refers to beamformed (or precoded) CSI-RS as “Class B” CSI-RS (distinguished from “Class A” which refers to “non-precoded CSI-RS”). APPLE-1005, 26:53-54, 59-60, 27:4-5; APPLE-1003, ¶58. Park further discloses two types of beamformed (Class B) CSI-RS, namely **periodic** beamformed CSI-RS and **aperiodic** beamformed CSI-RS. APPLE-1005, 30:57-64, 31:3-7; APPLE-1003, ¶58. In particular:

(i) Park refers to periodic beamformed CSI-RS as “Alternative 1” (“Alt 1”)

Class B CSI-RS, which has “K>1 CSI resources” and is “**periodically**

transmitted” by the base station to the UE (e.g., using a particular “transmission cycle”). APPLE-1005, 30:57-64, 31:61-63, 36:65-37:3; APPLE-1003, ¶58; and

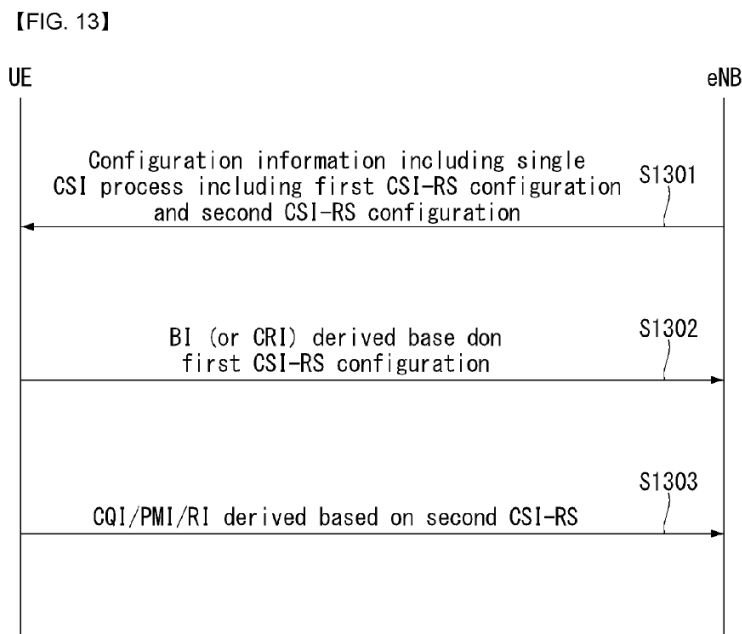
(ii) Park refers to aperiodic beamformed CSI-RS as “Alternative 4” (“Alt 4”) Class B CSI-RS, which has “K=1 CSI resources” and is “transmitted ... in a single measurement subframe” (e.g., “**aperiodic** CSI-RS transmission use cases”) by the base station to the UE. APPLE-1005, 36:53-61; 37:10-12, 37:58-38:4; APPLE-1003, ¶58.

As discussed above, each CSI-RS resource (for both periodic CSI-RS and aperiodic CSI-RS) is configured with N_k antenna ports. APPLE-1005, 26:51-58, 27:59-61, 29:41-43, 31:46-48, 32:23-26; APPLE-1003, ¶59.

Notably, Park describes a technique of transmitting “**hybrid** channel state information” that combines “two (or more) CSI-RS configurations within a single CSI process.” *Id.*, 1:51-54, 37:31-35. In particular, Park provides details of a hybrid CSI process that combines both **periodic** CSI-RS and **aperiodic** CSI-RS into a single CSI process. APPLE-1005, 37:51-61; APPLE-1003, ¶60.

In the example of FIG. 13, “a UE receives configuration information for a single CSI process comprising a first CSI-RS configuration and a second CSI-RS configuration from an eNB (S1301).” APPLE-1005, 42:60-63; APPLE-1003, ¶61. Based on the configuration information, “[t]he UE reports an indicator (i.e., BI or

CRI), derived based on the first CSI-RS configuration, to the eNB (S1302)” and “reports a CQI/PMI/RI, derived based on the second CSI-RS configuration, to the eNB (S1303).” APPLE-1005, 43:24-28; APPLE-1003, ¶61. Park discloses that the channel information for both CSI configurations can be “**together reported**” by a UE. APPLE-1005, 43:39-43 (reporting of CSI for the “first CSI-RS configuration” in “step **S1302**” and the reporting of CSI for the “second CSI-RS configuration” in “step **S1303**” “may be **performed together**”); APPLE-1003, ¶61. Specifically, Park’s “hybrid CSI” can include reporting CSI for two different CSI-RS configurations “**at once**” so they are “**merged**” and “reported” instead of being “separated.” APPLE-1005, 38:20-44; APPLE-1003, ¶61.



APPLE-1005, FIG. 13

Park discloses that the “single CSI process” (i.e., step S1301) can “correspond to a CSI process in which [a] hybrid CSI report type has been configured.” APPLE-1005, 42:64-67; APPLE-1003, ¶62. As Park explains, a “hybrid CSI report” refers to a scenario in which two CSI-RS configurations are merged into a “single CSI process” (e.g., the first CSI-RS configuration and the second CSI-RS configuration of step S1301). APPLE-1005, 42:64-67; APPLE-1003, ¶62. Specifically, according to the “hybrid CSI report,” the UE reports CSI (i.e., CQI/PMI/RI and BI/CRI) based on CSI measurements of the two CSI-RS configurations. APPLE-1005, 43:25-28; APPLE-1003, ¶62.

Park explains that “signaling overhead for reporting channel state information can be reduced by defining hybrid channel state information” as “compared to a case where two CSI processes are individually configured.” *Id.*, 2:54-58; 41:62-65; APPLE-1003, ¶63.

2. Analysis

(a) Claim 1

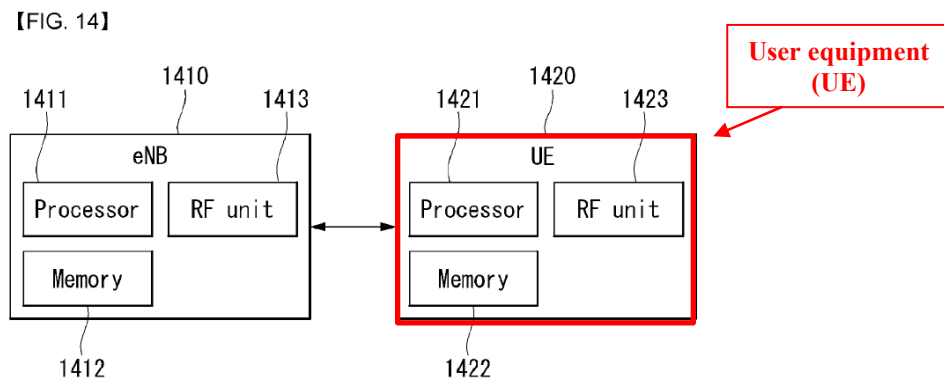
Park anticipates and/or renders obvious claim 1. APPLE-1003, ¶114.

[1.pre]

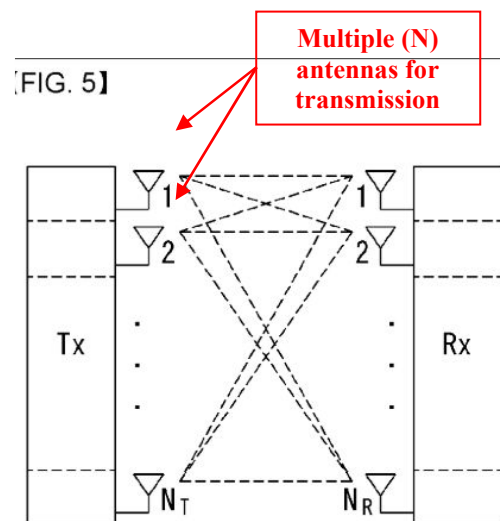
To the extent that the preamble is limiting, Park discloses or renders obvious [1.pre]. APPLE-1003, ¶116.

Park discloses “*user equipment*” (*UE*) configured to transmit data using

“multi-user-multi-input/output (MIMO)” technology, such as using “a multi-transmission (Tx) antenna” (*...for multi-antenna transmission*). APPLE-1005, 4:22-29, 44:10-13, 9:5-22, 9:40-60, FIG. 14 (depicting an example “UE”), FIG. 5 (depicting a “known MIMO communication system” for transmitting and receiving data using multiple transmission (Tx) antennas and multiple reception (Rx) antennas, respectively); APPLE-1003, ¶117.



APPLE-1005, FIG. 14 (annotated)



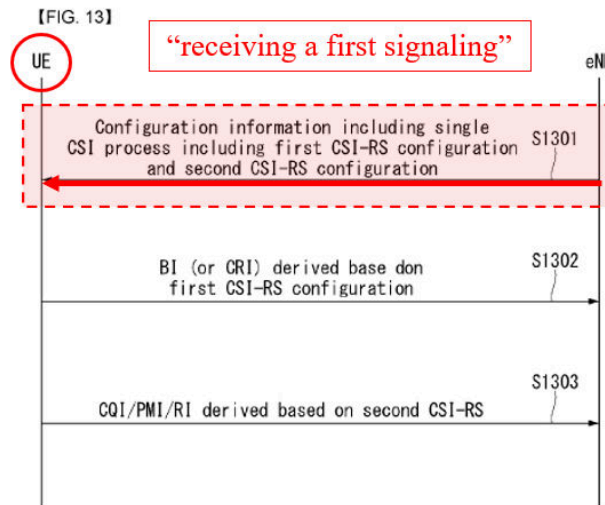
APPLE-1005, FIG. 5 (annotated)

Further, Park discloses or renders obvious *a method in a UE for multi-antenna transmission* including each of the operations recited in claim 1, as discussed in further detail below. APPLE-1003, ¶118.

[1.1]

As discussed in IV.A.1, Park discloses that the UE receives and measures two “reference signals” from the base station of eNB: an “Alt. 1 Class B CSI-RS” received on periodic resources (*receiving ... a first reference signal*) and an “Alt. 4 Class B CSI-RS” received aperiodically on a single resource (*... and a second reference signal*). APPLE-1003, ¶120.

Park also discloses that “a UE receives **configuration information** for a single CSI process” (*receiving a first signaling*) from a base station or eNB. APPLE-1005, 42:60-67, FIG. 13; APPLE-1003, ¶121. The “configuration information” includes “a first CSI-RS configuration and a second CSI-RS configuration” for providing a “**hybrid CSI report type.**” *Id.*



APPLE-1005, FIG. 13 (annotated)

Further, Park discloses that “in a situation in which hybrid CSI has been configured,” the UE receives a “DCI format” (*receiving a second signaling*) that triggers the UE to perform “aperiodic CSI” reporting. APPLE-1005, 38:20-36, 7:59-8:36 (explaining that “[c]ontrol information transmitted in a PDCCH is called Downlink Control Information (DCI)” and that “[a] plurality of PDCCHs may be transmitted within the control region, and UE may monitor a plurality of PDCCHs”); 8:37-39 (describing that “[a]n eNB determines the format of a PDCCH based on DCI to be transmitted to UE”); APPLE-1003, ¶122.

In general, a POSITA also would have recognized that as of the Critical Time, it was commonplace for a UE to receive DCI from a base station or eNB in this context. *See, e.g.*, APPLE-1006, [0114] (describing a beamformed (class B) aperiodic CSI reporting scenario where a base station can transmit a “DCI format”

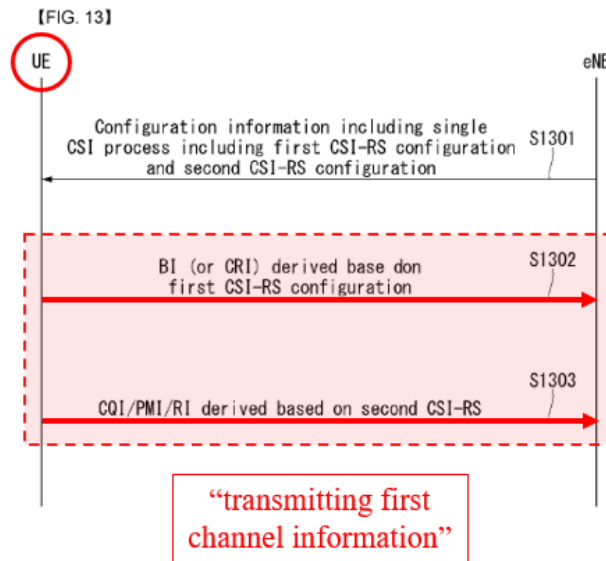
to a UE to trigger aperiodic CSI reporting), claim 8 (reciting that a “CSI request field of a DL (downlink) DCI (downlink control information) format” can “includ[e] information indicating the first CSI-RS antenna port group in a CSI request field of a DL (downlink) DCI (downlink control information) format”). APPLE-1003, ¶123.

[1.2]

Park discloses that the UE transmits a “hybrid CSI report” (*transmitting first channel information*). APPLE-1005, 27:57-61, 42:64-67, 43:25-28, 43:49-43, FIG. 13; APPLE-1003, ¶125.

Park uses the term “hybrid CSI report” (*first channel information*) for a scenario in which a UE reports channel information for two CSI-RS configurations which are merged into a “single CSI process.” APPLE-1005, 42:64-67.; APPLE-1003, ¶126 According to the “hybrid CSI report,” the UE reports CSI (i.e., CQI/PMI/RI and BI/CRI) based on CSI measurements of the two CSI-RS configurations. APPLE-1005, 43:25-28; APPLE-1003, ¶126.

Further, Park discloses that the CSIs for both CSI configurations can be “together reported.” APPLE-1005, 43:39-43 (reporting of the CSI for the “first CSI-RS configuration” in “step S1302” and the reporting of the CSI for the “second CSI-RS configuration” in “step S1303” “may be performed together”), FIG. 13 (depicting the transmission of the two different CSIs); APPLE-1003, ¶127.



APPLE-1005, FIG. 13 (annotated)

Therefore, Park discloses or renders obvious [1.2]. APPLE-1003, ¶128.

[1.3]

As discussed in section IV.A.1, Park discloses that a CSI-RS is transmitted through “antenna ports.” APPLE-1005, 25:64-67 (“[f]or CSI measurement, a CSI-RS is transmitted through multiple antenna ports”); APPLE-1003, ¶130. In particular, Park discloses configuring a number of “CSI-RS ports” (e.g., “one CSI-RS port, two CSI-RS ports, four CSI-RS ports or eight CSI-RS ports”) that is “indicative of the number of antenna ports used for CSI-RS transmission.” APPLE-1005, 22:11-16; APPLE-1003, ¶130. The base station transmits a CSI-RS using “a maximum of eight antenna ports,” where the eight antenna ports have antenna port indices “p=15, ..., 22.” APPLE-1005, 16:21-23, 42-47; APPLE-1003, ¶130.

As discussed in section IV.A.1, Park uses the term “ N_k ” (also referred to as the “CSI-RS port number”) to denote the number of antenna ports configured for a particular CSI-RS resource. *Id.*, 26:55-60 (“CSI-RS port number for the k -th CSI-RS resource ... is N_k ”), 27:57-62 (“ K beamformed CSI-RS resources: each one having N_k port” for Class B configurations), 29:40-43 (“ $N_k \in \{1,2,4,8\}$ ” for class B); APPLE-1003, ¶131. Park provides examples of different antenna ports (among antenna port indicates $p=15, \dots, 22$) that can be configured as the N_k CSI-RS ports. APPLE-1005, 19:44-54, 20:28-39; APPLE-1003, ¶131. As one example, two antenna ports can be configured as CSI-RS ports, such as antenna ports with indices $\{15,16\}$, $\{17,18\}$, $\{19,20\}$ and $\{21,22\}$. APPLE-1005, 20:28-39; APPLE-1003, ¶131.

In the scenario of beamforming (Class B), Park further discloses that a subset of the N_k CSI-RS ports can be used to transmit the CSI-RS with a particular beam/direction. *Id.*, 29:35-39 (“a beam selection may be the selection of a subset of antenna ports within a single CSI-RS resource”), 31:41-44, 24:11-16 (“radio waves can be controlled both in the vertical direction (elevation) and the horizontal direction (azimuth) so that a transmission beam can be controlled in the 3D space ... called 3D beamforming”); APPLE-1003, ¶132. Specifically, for **periodic** beamformed (Class B “Alt 1”) CSI-RS (*the first reference signal*), Park describes that “ L ” ports among the N_k CSI-RS ports can be used to perform

beamforming for the periodic CSI-RS transmission (...comprises *Q1 reference signal ports*). APPLE-1005, 27:57-65 (“L port CQI/PMI/RI for a selected beam. A total number of configured ports is greater than L in all of CSI-RS resources within a CSI process”), 29:42-45 (“In the case of Alt. 1, a UE reports L port CSI, assuming one of $L=N_k$ and $L(<=N_k)$ ”), 31:24-27, 48-51; APPLE-1003, ¶132.

As such, Park discloses the **periodic** CSI-RS (*the first reference signal*) can be transmitted using L CSI-RS ports (*Q1 reference signal port(s)*), where L is less than or equal to N_k (the total number of antenna ports configured for a CSI-RS resource), and “[t]he number of antenna ports L for CSI may be 2, 4 or 8.” APPLE-1005, 29:43-45, 26:55-58, 35:43-50; APPLE-1003, ¶133. As explained above, the L CSI-RS ports are selected from among eight possible antenna ports that have antenna port indices “ $p=15, \dots, 22$ ” (*Q1 antenna port(s)*). APPLE-1005, 16:21-23, 42-47; APPLE-1003, ¶133. For example, as discussed above, two CSI-RS ports can use two antenna ports with indices {15,16}, {17,18}, {19,20} or {21,22}. APPLE-1005, 20:28-39; APPLE-1003, ¶133.

Therefore, Park’s beamformed **periodic** CSI-RS (*the first reference signal*) (Class B, Alt. 1 in Park) comprises L reference signal ports (*Q1 reference signal port(s)*), which are transmitted by the base station using L antenna ports (*Q1 antenna port(s)*), respectively. APPLE-1003, ¶134.

[1.4]

As discussed in section IV.A.1 and for [1.3], above, Park's CSI-RS is transmitted through "antenna ports." APPLE-1005, 25:64-67; APPLE-1003, ¶136. As discussed in [1.3], " N_k " CSI-RS ports are configured for the k -th CSI-RS resource. APPLE-1005, 26:55-60, 27:57-62, 29:40-43; APPLE-1003, ¶136. For CSI-RS with beamforming (Class B), Park discloses that a subset of the N_k CSI-RS ports can be used to transmit the CSI-RS with a particular beam/direction. *Id.*, 29:35-39; APPLE-1003, ¶136.

Specifically, for beamformed **aperiodic** (Class B "Alt 4") CSI-RS (*the second reference signal*), Park describes that " L " ports can be used to perform beamforming for the aperiodic CSI-RS transmission (*...comprises $Q2$ reference signal ports*). APPLE-1005, 28:7-10 (the UE reports " L port CQI/PMI/RI" where "[a] total number of configured ports within a CSI process is L "), 29:52-54 ("In the case of Alt. 4, a UE reports L port CSI, assuming $L=N_k$ "), 31:37-41, 57-59; APPLE-1003, ¶137.

As such, Park discloses the **aperiodic** CSI-RS (*the second reference signal*) can be transmitted using L CSI-RS ports (*$Q2$ reference signal port(s)*), where L is equal to N_k (the total number of antenna ports configured for a CSI-RS resource), and "[t]he number of antenna ports L for CSI may be 2, 4 or 8." APPLE-1005, 29:52-54, 26:55-58, 35:43-50; APPLE-1003, ¶138. Furthermore, as explained above, the L CSI-RS ports are selected from among eight possible antenna ports

that have antenna port indices “ $p=15, \dots, 22$ ” (***Q2 antenna port(s)***). APPLE-1005, 16:21-23, 42-47; APPLE-1003, ¶138.

Therefore, Park’s beamformed **aperiodic** CSI-RS (***the second reference signal***) (Class B, Alt. 4 in Park) comprises L reference signal ports (***Q2 reference signal port(s)***), which are transmitted by the base station using L antenna ports (***Q2 antenna port(s)***), respectively. APPLE-1003, ¶139.

[1.5]

the first signaling is used to determine L1 antenna port(s)...

As discussed in [1.3], Park discloses that the total number of antenna ports configured for each CSI-RS resource is “ N_k ” (***L1 antenna ports***). APPLE-1005, 29:43-45, 26:55-58; APPLE-1003, ¶141. In particular, as discussed in section IV.A.1, the k-th CSI-RS resource (among K CSI-RS resources in a CSI process) is configured with a number of antenna ports “ N_k ” (also referred to as the “CSI-RS port number” in Park) where N_k can indicate 1, 2, 4, or 8 antenna ports. APPLE-1005, 26:51-58, 27:59-61, 29:41-43, 31:46-48, 32:23-26; APPLE-1003, ¶141. This “CSI-RS port number” (N_k) is configured by the base station “through high layer signaling” to the UE (e.g., as part of a “CSI-RS (resource) configuration” in the CSI process configuration) by a parameter “antennaPortsCount” indicating “the number of antenna ports used for CSI-RS transmission.” APPLE-1005, 22:6-15, 26:51-58, Abstract, 2:16-22, 21:63-64, FIG. 13; APPLE-1003, ¶141.

As such, Park's UE receives "higher layer signaling" (*the first signaling*) to configure the " N_k " antenna ports for each CSI-RS resource (*...is used to determine L1 antenna ports*). APPLE-1005, 42:60-67, 19:33-39, 22:6-15, 28:38-43, 29:41-42; APPLE-1003, ¶142. Specifically, this higher-layer signaling includes "configuration information" for a single CSI process that includes both first CSI-RS configuration (periodic) and the second CSI-RS configuration (aperiodic). APPLE-1005, 42:60-67, FIG. 13, S1301; APPLE-1003, ¶142.

Furthermore, each CSI-RS configuration specifies a number of antenna ports. APPLE-1005, 19:33-39; APPLE-1003, ¶142. As discussed in section IV.A.1 and for [1.5] and [1.6], Park's "antennaPortsCount" is understood to be the same as Park's " N_k " (*LI*) because Park refers to both as a "CSI-RS port number." APPLE-1005, *compare* 22:11-15 (describing a CSI-RS resource configuration as including a parameter "CSI-RS port number (antennaPortsCount)" which is "indicative of the number of antenna ports used for CSI-RS transmission") *with* 26:55-58 ("a CSI-RS port number for the k-th CSI-RS resource ...is N_k "). Park further explains that " N_k " can be either 1, 2, 4, 8 (just as with Park's "antennaPortsCount"). APPLE-1005, 22:11-15, 29:41-42; APPLE-1003, ¶143.

... the Q1 antenna port(s) is(are) a subset of the L1 antenna port(s)

For beamformed **periodic** CSI-RS (Class B "Alt 1" in Park), Park discloses "selection of a subset of antenna ports within a single CSI-RS resource" to perform

beamforming. APPLE-1005, 29:35-39; APPLE-1003, ¶144. In particular, Park discloses selecting “L” antenna ports (*Q1 antenna ports*) which are a subset of the “N_k” antenna ports (... *are a subset of the L1 antenna ports*). APPLE-1005, 29:36-38, 31:42-44, 27-57:61, 29:18-23, 29:43-45; APPLE-1003, ¶144.

Thus, Park discloses beam selection which involves selecting L ports (*Q1 antenna ports*) from among a “total number of configured ports” for each CSI-RS resource, N_k (*are a subset of the L1 antenna ports*). APPLE-1003, ¶145.

[1.6]

To the extent the '727 patent explains this claim feature of using the “second signaling” to determine the “Q2 antenna ports,” the '727 patent describes “the second signaling **triggers** a transmission from the Q2 antenna port(s).” APPLE-1001, 2:38-39, 6:25-26, 8:2-3, 10:55-56, 14:52-53; APPLE-1003, ¶147. As such, a POSITA would have understood the '727 describes the second signaling “is used to determine” the Q2 antenna ports by the second signaling **triggering** a transmission from the Q2 antenna ports. APPLE-1003, ¶147.

Park discloses a signaling that **triggers** aperiodic CSI-RS transmission from L antenna ports (*Q2 antenna ports*). APPLE-1003, ¶148. As discussed in [1.1], Park discloses that “in a situation in which hybrid CSI has been configured,” the UE receives a “DCI format” (*second signaling*) that triggers the UE to perform “aperiodic CSI” reporting based on measuring an aperiodic CSI-RS. APPLE-

1005, 38:20-36 (“when an aperiodic CSI (A-CSI) report is **triggered** by an eNB according to the UL DCI format, a UE may perform the A-CSI report” by reporting “CSI for the second CSI-RS configuration”); 37:58-61 (the “second CSI-RS configuration ... may correspond to a Class B CSI-RS configuration having one CSI-RS resource ... an **aperiodic** CSI-RS transmission use case”); APPLE-1003, ¶148.

Park further discloses that “when an aperiodic CSI (A-CSI) report is **triggered** by an eNB according to the UL DCI format, a UE may perform the A-CSI report” for both a first CSI-RS configuration and a second CSI-RS configuration “at once.” *Id.*, 2:32-34 (“when an aperiodic CSI report is **triggered**, the indicator and the CQI/PMI/RI may be together reported to the eNB”); APPLE-1003, ¶149. In particular, “the second CSI-RS configuration ... may correspond to a Class B CSI-RS configuration having one CSI-RS resource” (Alt. 4, **aperiodic**). *Id.*, 37:57-61, 40:8-14, 44-48, 42:1-25, 43:1-19; APPLE-1003, ¶149.

At the base station, in such scenarios, the “**eNB may apply UE-specific beamforming coefficients** when transmitting a CSI-RS” and “the CSI-RS may be transmitted in a single measurement subframe triggered for the UE.” *Id.*, 37:12-17, 32:4-7; APPLE-1003, ¶150. Thus, when **aperiodic** CSI reporting is **triggered** by the base station sending a DCI format (“*the second signaling*”) to the UE, the eNB applies beamforming to a CSI-RS and transmits the beamformed CSI-RS to the UE

for measurement. ; APPLE-1003, ¶150. Furthermore, as discussed in [1.4], for the second CSI-RS configuration (Class B Alt 4, namely beamformed, aperiodic CSI-RS), Park describes that L ports (***Q2 antenna ports***) are used to perform beamforming for the aperiodic CSI-RS transmission. ; APPLE-1003, ¶150.

Therefore, a POSITA would have understood or found obvious that Park's "DCI format" (***second signaling***) is used by the base station (eNB) to trigger aperiodic CSI reporting, and that this requires the base station to determine the L CSI-RS ports (***determine the Q2 antenna port(s)***) for the base station to beamform the aperiodic CSI-RS transmission to the UE. APPLE-1003, ¶150.

At the UE, "**if an aperiodic CSI report is triggered**, the indicator (i.e., BI or CRI) derived based on the first CSI-RS configuration and the **CQI/PMI/RI derived based on the second CSI-RS configuration** may be together reported to the eNB." *Id.*, 43:37-42; APPLE-1003, ¶151. As discussed in [1.4], when the UE reports aperiodic CSI, the UE performs measurements on a beamformed CSI-RS that is transmitted on L ports (***Q2 antenna ports***), based on which the UE reports L-port CSI. APPLE-1005, 28:7-10 (the UE reports "L port CQI/PMI/RI" where "[a] total number of configured ports within a CSI process is L"), 29:52-54 ("In the case of Alt. 4, a UE reports L port CSI, assuming $L=N_k$ "), 31:37-41, 57-59; APPLE-1003, ¶151. As such, a POSITA would have understood or found obvious that Park's "DCI format" (***second signaling***) triggers the UE to aperiodic CSI

reporting, and this requires the UE to also determine the L ports (*determine the Q2 antenna port(s)*) for the UE to perform the L-port CSI report. APPLE-1003, ¶151.

Therefore, a POSITA would have understood or found obvious that Park's "DCI format" (*second signaling*) triggers aperiodic CSI reporting, and that this requires determining (at the base station and/or at the UE) the L CSI-RS ports (*determine the Q2 antenna port(s)*) for the base station (eNB) to transmit the beamformed aperiodic CSI-RS and for the UE to report the L-port CSI. *Id.*; APPLE-1003, ¶152. As noted above, this is consistent with how the '727 patent itself describes the second signaling being "used to determine" the Q2 antenna ports. APPLE-1001, 10:55-56; APPLE-1003, ¶152.

[1.7]

As discussed with reference to [1.3]-[1.6], Park discloses:

- (i) "N_k" (the number of antenna ports configured for each CSI-RS resource) (*L1*),
- (ii) "L" CSI-RS ports (the number of CSI-RS ports used for beamforming) which is **less than or equal** to N_k for Park's **periodic** ("Alt 1") CSI-RS (*Q1*), and
- (iii) "L" CSI-RS ports (the number of CSI-RS ports) which is **equal** to N_k for Park's **aperiodic** ("Alt 4") CSI-RS (*Q2*).

APPLE-1003, ¶154.

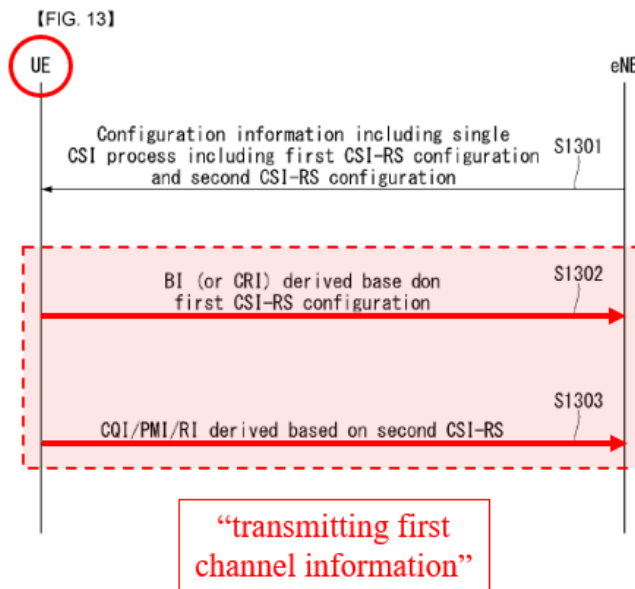
Park explains that “[t]he number of antenna ports L for both periodic and aperiodic Class B CSI-RS may be 2, 4 or 8” (*wherein the $Q1$ and the $Q2$ are positive integers respectively*). APPLE-1005, 35:43-50; APPLE-1003, ¶155. Furthermore, Park’s N_k ($L1$) is greater than or equal to Park’s L ($Q1$) for Park’s “Alt 1 (periodic) CSI-RS (*the $L1$ is a positive integer greater than or equal to the $Q1$*). APPLE-1005, 29-43:45 (disclosing “ L port CSI-RS” and explaining L ($Q1$) can be less than or equal to N_k ($L1$) for Alt. 1); APPLE-1003, ¶155.

[1.8]

As discussed with reference to [1.2], Park’s UE transmits a “hybrid CSI report” (*first channel information*) which corresponds to a sum of Park’s L ports for “Alt 1” CSI-RS configuration ($Q1$) and Park’s L ports for “Alt 4” CSI-RS configuration ($Q2$). APPLE-1003, ¶157. Specifically, Park’s “hybrid CSI” includes and reports CSI for two different CSI-RS configurations “at once” so they are “merged” and “reported” instead of being “separated.” APPLE-1005, 38:20-44; APPLE-1003, ¶158.

Further, Park’s UE reports different types of information (e.g., PMI/CQI/RI and BI/CRI) in the hybrid CSI report, based on the CSI measurements on the two CSI-RS configurations. APPLE-1005, 43:25-28; APPLE-1003, ¶159. As Park discloses, both of these CSI can be “together reported.” APPLE-1005, 53-49:53 (reporting of the CSI for the “first CSI-RS configuration” in “step S1302” and the

reporting of the CSI for the “second CSI-RS configuration” in “step S1303” “may be performed together”). *Id.*, FIG. 13 (depicting the transmission of the two different CSIs); APPLE-1003, ¶159.



APPLE-1005, FIG. 13 (annotated)

Although FIG. 13 shows the first CSI-RS configuration as only transmitting BI/CRI, Park later discloses that the UE reports BI/CRI and CQI/PMI/RI as part of the periodic CSI-RS process (Park’s “Alt 1” CSI-RS). APPLE-1005, 29:20-24; APPLE-1003, ¶160. Therefore, both of Park’s S1302 and S1303 can include CQI/PMI/RI (and in some scenarios BI/CRI as well), which are collectively ***first channel information***. APPLE-1003, ¶160.

As discussed in [1.3] and [1.4], “[i]n the case of Alt. 1, a UE reports L port CSI, assuming one of $L=N_k$ and $L (<=N_k)$ ” and “[i]n the case of Alt. 4, a UE

reports L port CSI, assuming $L=N_k$ ”). *Id.*, 29:42-45, 29:52-54, 31:37-41, 57-59; APPLE-1003, ¶161. As such, in Park’s hybrid CSI report, the UE reports both L-port CSI for the periodic CSI-RS in Alt. 1 (***Q1 antenna ports***) together with L-port CSI for aperiodic CSI-RS in Alt. 4 (***Q2 antenna ports***). APPLE-1003, ¶161.

Park also explains that the CSI report based on periodic CSI-RS and the CSI report based on aperiodic CSI-RS are “derived independently.” *Id.*, 38:49-53, 40:40-44 (“each CSI-RS configuration may be independently configured in the first CSI-RS configuration ... and the second CS I-RS configuration”), 43:7-10, 43:29-37 (“the UE may derive one or more of the CQI, PMI and RI based on the second CSI-RS configuration ... Furthermore, the CQI/PMI/RI may be calculated independently of the first CSI-RS configuration. That is, in calculating the CQI/PMI/RI, interdependence may not be present between the first CSI-RS configuration and the second CSI-RS configuration”), 2:27-31; APPLE-1003, ¶162. As such, a POSITA would have understood that Park’s hybrid CSI process configures the aperiodic CSI-RS and periodic CSI-RS independently and calculates CSI for the aperiodic CSI-RS and periodic CSI-RS independently. APPLE-1003, ¶162.

In combining these independent CSI-RS configurations into a single “hybrid” CSI-RS process, Park explains that the total number of CSI-RS resources is simply the sum of the number of CSI-RS resources in each CSI-RS resource

configuration. APPLE-1005, 37:51-61 (the “combined CSI process (i.e., hybrid CSI) may have $K+1$ CSI-RS resources,” where K is the number of CSI-RS resources for the periodic CSI-RS and there is one CSI-RS resource for the aperiodic CSI-RS); APPLE-1003, ¶163. Furthermore, in a scenario where multiple CSI-RS resources are aggregated together in a single CSI process, Park explains that the aggregate number of **ports** for the single CSI process is simply the sum of the number of ports for each CSI-RS resource. APPLE-1005, 32:23-26 (“a total number of CSI-RS ports within the CSI process #1 is $N_k * K$ ” where K is the number of CSI-RS resources in the CSI process and N_k is the number of antenna ports per CSI-RS resource) ; APPLE-1003, ¶163.

Based on these teachings of Park, a POSITA would have understood or found obvious that Park’s hybrid CSI report would correspond to a combined set of antenna ports for the periodic and aperiodic CSI-RS, and that Park’s hybrid CSI report is based on measurements obtained from the $L (\leq N_k)$ antenna ports for the **periodic** CSI-RS and the $L (= N_k)$ antenna ports for the **aperiodic** CSI-RS. APPLE-1003, APPLE-1003, ¶164.

Therefore, a POSITA would have understood or found obvious that Park’s “hybrid CSI report” (*first channel information*) corresponds to a set of antenna ports (**Q**) consisting of the sum or combination of both the $L (\leq N_k)$ ports of Park’s **periodic** CSI-RS configuration (**$Q1$ antenna ports**) and the $L (= N_k)$ ports

of Park's **aperiodic** CSI-RS configuration (***Q2 antenna ports***), in order to provide channel quality information with respect to both of the CSI-RSs configurations.

APPLE-1003, ¶165.

[1.9]

As discussed with reference to [1.1], Park discloses two types of Class B (beamformed) CSI-RS:

(i) **Periodic** ("Alt 1") CSI-RS (***first reference signal***), which is

"periodically transmitted" over a "**plurality** of subframes" by the base station (eNB) to the UE (APPLE-1005, 21:20-27, 30:57-64), and

(ii) **Aperiodic** ("Alt 4") CSI-RS (***second reference signal***), which is

"transmitted ... in a **single** measurement subframe" (i.e.,

aperiodically) by the base station (eNB) to the UE (APPLE-1005, 31:3-7).

See also APPLE-1005, 37:45-50, 37:51-61; APPLE-1003, ¶167.

In particular, for **periodic** CSI-RS (Park's Alt. 1), Park explains that when the eNB "periodically transmits K CSI-RSs" the "transmission cycle may be long, for example, 50 ms or 100 ms." *Id.*, 30:61-64, 31:61-64, 36:65-37:3, 21:20-27 (CSI-RS is "configured to be transmitted in each transmission period corresponding to a **plurality** of **subframes** ... a subframe period (hereinafter referred to as a "CSI transmission period")) (***time intervals between any two***

adjacent occurrences of the first reference signal in the first time resources pool are equal); APPLE-1003, ¶168. A POSITA would have understood or found obvious that over a given number of Park’s “CSI transmission periods” (*the first time resources pool*), the periodic CSI-RS occurs multiple times, e.g., over “a plurality of subframes” (*the first reference signal occurs multiple times in the first time resources pool*). APPLE-1005, 21:20-27; APPLE-1003, ¶168.

For **aperiodic** CSI-RS (Park’s Alt. 4), as noted above, the CSI-RS is transmitted in a “**single** measurement **subframe**” APPLE-1005, 31:3-7; APPLE-1003, ¶169. As such, a POSITA would have understood or found obvious that over the same number of CSI transmission periods (*the second time resources pool*) as the periodic CSI-RS, the aperiodic CSI-RS occurs **once** during that time, e.g., in a “**single** measurement subframe” (*the second reference signal occurs once in the second time resources pool*). APPLE-1005, 31:3-7; APPLE-1003, ¶169. Indeed, the ’727 patent itself allows for the second time resources pool to “belong to” the first time resources pool. APPLE-1001, 3:11-13 (“In one subembodiment, time units in the second time resources pool belong to the first time resources pool”), 15:21-22; APPLE-1003, ¶169.

Therefore, a POSITA would have understood or found obvious that Park’s **periodic** (“Alt 1”) CSI-RS (*the first reference signal*) occurs periodically multiple times in a first time resources pool (*...is transmitted in a first time resources pool*

and occurs multiple times in the first time resources pool, where time intervals between any two adjacent occurrences of the first reference signal in the first time resources pool are equal), and that Park's aperiodic ("Alt 4") CSI-RS (*the second reference signal*) occurs once in a second time resources pool (... *is transmitted in a second time resources pool and occurs once in the second time resources pool*). APPLE-1003, ¶170.

(b) **Claim 2**

As explained below, Park's UE reports a beam selection indicator (BI) (*transmitting first information*) which indicates a selected beam, and Park explains that beam selection is the selection of a subset of L antenna ports among the N_k antenna ports (*Q3 antenna port(s) out of the L1 antenna port(s)*). APPLE-1003, ¶173.

In particular, Park discloses the UE reporting "an indicator for beam selection" (e.g., CSI-RS resource indicator (CRI) or beam selection indicator (BI)) (*transmitting first information*) as part of the "Alt 1" (periodic) CSI-RS process. APPLE-1005, 29:20-23, 35:53-57; APPLE-1003, ¶174. This is consistent with the '727 patent's description of "CRI" as an example of the claimed "first information." APPLE-1001, 4:52; APPLE-1003, ¶174.

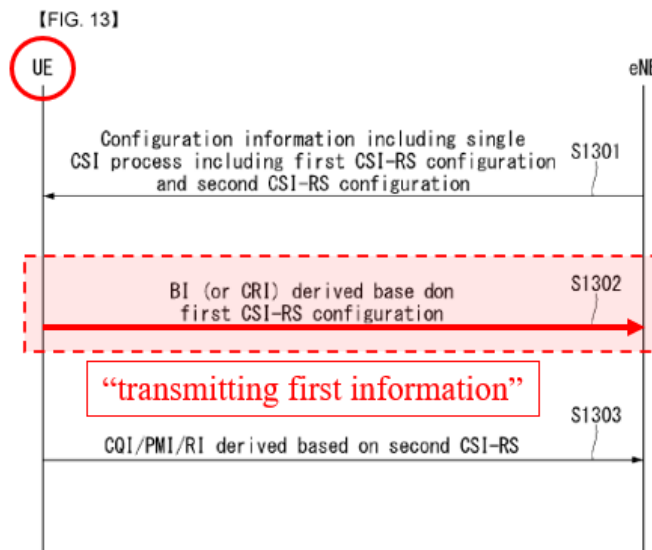
Park explains that beam selection refers to "the selection of a subset of antenna ports within a single CSI-RS resource" and that a UE's selection of a

vertical beam is reported by the UE through BI feedback (*first information*).

APPLE-1005, 34:15-16, 29:36-38, 31:42-44; APPLE-1003, ¶175. Specifically, the BI feedback includes an “indicator for beam selection” (*the first information*) which indicates L ports/beams out of N_k antenna. APPLE-1005, 31:17-27; APPLE-1003, ¶175. Therefore, a POSITA would have understood or found obvious that Park’s “BI feedback” indicates L ports out of the N_k ports configured for the CSI process (...*the first information indicates Q3 antenna port(s) out of the L1 antenna port(s)*). APPLE-1003, ¶175.

Additionally, Park discloses that a BI or CRI is determined based on a reference signal (periodic CSI-RS) as a part of the “Alt 1” CSI report. APPLE-1005, 35:53-57; APPLE-1003, ¶176. In particular, Park’s “CSI process #1” (Alt 1, K>1, periodic) can result in UE reporting BI / CRI, and this may be used to apply “beamforming” when transmitting CSI-RS for CSI process #2 (Alt 4, K=1, aperiodic). APPLE-1005, 36:65-37:17, 43:25-28 (disclosing reporting BI/CRI (*first information*) based on the first CSI-RS configuration (Alt 1, periodic)); APPLE-1003, ¶176.

Park’s FIG. 13 shows the UE transmitting BI/CRI (*first information*), which is part of the information provided to the eNB in a “hybrid CSI report” (*first channel information*) See [1.2]; APPLE-1003, ¶177.



APPLE-1005, FIG. 13 (annotated)

Park discloses an option where the hybrid CSI report **includes** BI/CRI (along **with** CSI) for both periodic and aperiodic CSI-RS configurations. APPLE-1005, 38:25-52 (describing “Option 1” where the “UE may report both a BI (or CRI) and CSI to the eNB at once” and specifically the “UE may report CSI for the first CSI-RS configuration ... and CSI for the second CSI-RS configuration ... the eNB at once” and this CSI is “merged” with “reporting a preferred BI (or CRI)”); APPLE-1003, ¶178. In this case, the BI/CRI would be transmitted (*transmitting first information*) as part of the hybrid CSI report, along with CSI (i.e., PMI/CQI/RI) for both periodic and aperiodic CSI-RS configurations. APPLE-1003, ¶178.

Alternatively, Park discloses another option where the BI/CRI can be reported **separately** from the CSI that is reported in the hybrid CSI report.

APPLE-1005, 38:54-65 (describing “Option 2” where the “the UE reports only CSI (e.g., RI, PMI, CQI)” and “in BI feedback, a preferred BI (or CRI) may be reported in another report form”); APPLE-1003, ¶179. In this case, the BI/CRI would be transmitted separately (*transmitting first information*), in another report form, separate from the hybrid CSI report that includes only CSI (i.e., PMI/CQI/RI) for both periodic and aperiodic CSI-RS configurations. APPLE-1003, ¶179.

In both scenarios, Park’s UE receives K CSI-RS resources, selects a particular beam (L antenna ports) among the configured N_k antenna ports in a CSI-RS resource, and transmits the BI/CRI (*transmitting first information*) either as part of the hybrid CSI report or as a separate transmission, where the BI/CRI indicates the selected L antenna ports out of the N_k antenna ports in the CSI-RS resource (*indicates Q3 antenna port(s) out of the L1 antenna port(s)*). APPLE-1005, 34:15-16, 36:65-37:17; APPLE-1003, ¶180. In this case, the L antenna ports reported in Park’s BI/CRI (*Q3 antenna port(s)*) are the same as the L antenna ports through which the periodic CSI-RS was transmitted (*Q1 antenna port(s)*).

APPLE-1003, ¶180. Indeed, this is consistent with the ’727 patent’s description that Q3 can be equal to Q1. APPLE-1001, 4:56 (“In one embodiment, the Q3 is equal to the Q1. In one subembodiment, the Q3 antenna port(s) is(are) equal to the Q1 antenna port(s)”); APPLE-1003, ¶180.

Further, Park discloses that the value of “L” (**Q3**) ports is a positive integer less than or equal to Park’s N_k (**L1**) ports. APPLE-1005, 29:43-45 (describing “L port CSI-RS” and explaining L can be less than or equal to N_k); APPLE-1003, ¶181.

(c) **Claim 5**

As discussed for claim 1, Park discloses that “a UE receives configuration information for a single CSI process” (*the first signaling*). See, e.g., [1.1]; APPLE-1003, ¶183. Park further discloses that configuration information can be provided to a UE via “high layer signaling” such as RRC signaling (*...is a higher-layer signaling*). APPLE-1005, 37:36-43, 37:66-38:4, 39: 49-40:3; APPLE-1003, ¶183.

As discussed for [1.1], Park ‘s UE also receives a “DCI format” (*the second signaling*) that triggers the UE to perform “aperiodic CSI” reporting. APPLE-1003, ¶184. A POSITA would have understood that it was well-known that a “DCI format” *is physical layer signaling*. APPLE-1005, 7:59-63 (describing that “DCI” refers to “[c]ontrol information transmitted in a PDCCH” or Physical Downlink Control Channel), 6:59-62; APPLE-1003, ¶184.

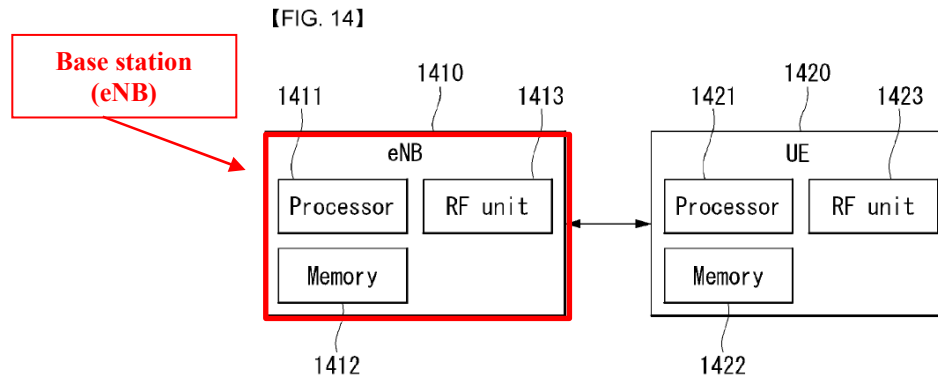
(d) **Claim 6**

Claim 6 mirrors claim 1, except that it recites a method performed from the perspective of a base station rather than from a perspective of a UE.

[6.pre]

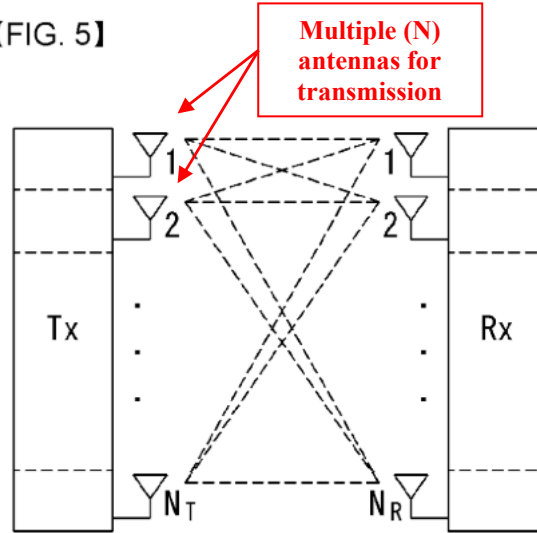
To the extent that the preamble is limiting, Park discloses or renders obvious [6.pre]. APPLE-1003, ¶186.

Park discloses a “**base station**” configured to transmit data using “multi-user-multi-input/output (MIMO)” technology, such as using “a multi-transmission (Tx) antenna” (*...for multi-antenna transmission*). APPLE-1005, 4:22-29, 43:63-44:9, 9:5-22, 9:40-60, FIG. 14, FIG. 5; APPLE-1003, ¶187.



APPLE-1005, FIG. 14 (annotated)

【FIG. 5】



APPLE-1005, FIG. 5 (annotated)

Further, as discussed below, Park discloses or renders obvious *a method in a base station for multi-antenna transmission* including each of the operations recited in claim 6. APPLE-1003, ¶188.

[6.1]

As discussed for [1.1], Park discloses that a base station or eNB transmits, to a UE, each “configuration information for a single CSI process” (*transmitting a first signaling*), “a DCI format” (*a second signaling*), an “Alt. 1 Class B CSI-RS” (*a first reference signal*), and an “Alt. 4 Class B CSI-RS” (*... and a second reference signal*). APPLE-1003, ¶190.

[6.2]

As discussed for [1.2], Park discloses that a base station or eNB receives, from a UE, a “hybrid CSI report” (*receiving first channel information*). APPLE-

1003, ¶192.

[6.3]-[6.9]

Park discloses or renders obvious each of [6.1]-[6.9]. *See* [1.3]-[1.9] (reciting the same subject matter as in [6.3]-[6.9], but in the context of a method performed by UE rather than by a base station). APPLE-1003, ¶193.

(e) Claims 7 and 10

Park anticipates or renders obvious each of claims 7 and 10. *See* Section IV.A.2.b regarding Claim 2 (detailing Park’s disclosure with respect to the transmission of “first information” by a UE, and a receipt of such “first information” by a base station) and Section IV.A.2.c regarding Claim 5 (detailing Park’s disclosure regarding “first signaling” and “second signaling”). APPLE-1003, ¶194.

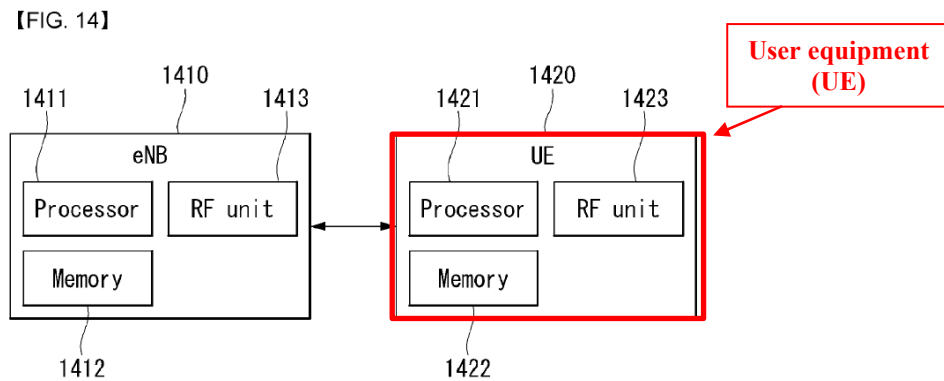
(f) Claim 11

Park discloses and/or renders obvious claim 11. APPLE-1003, ¶195. *See* Claim 1. Claim 11 mirrors claim 1, except that claim 11 recites the claimed subject matter in the context of a UE device rather than a method performed by a UE. APPLE-1003, ¶195.

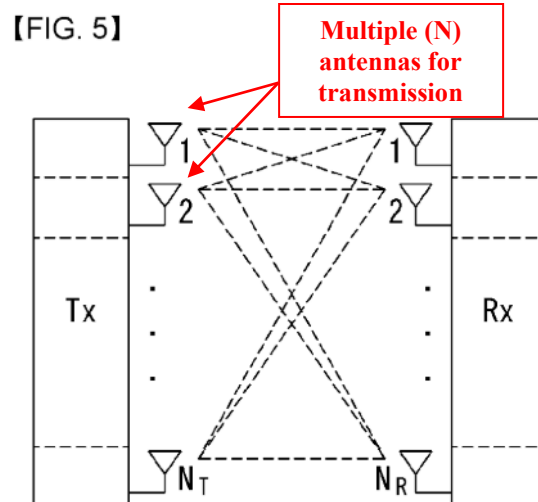
[11.pre]

To the extent that the preamble is limiting, Park discloses or renders obvious [11.pre]. APPLE-1003, ¶196.

Park discloses a “*user equipment*” (*UE*) configured to transmit data using “multi-user-multi-input/output (MIMO)” technology, such as using “a multi-transmission (Tx) antenna” (*...for multi-antenna transmission*). APPLE-1005, 4:22-29, 44:10-13, 9:5-22, 9:40-60, FIG. 14, FIG. 5; APPLE-1003, ¶197.



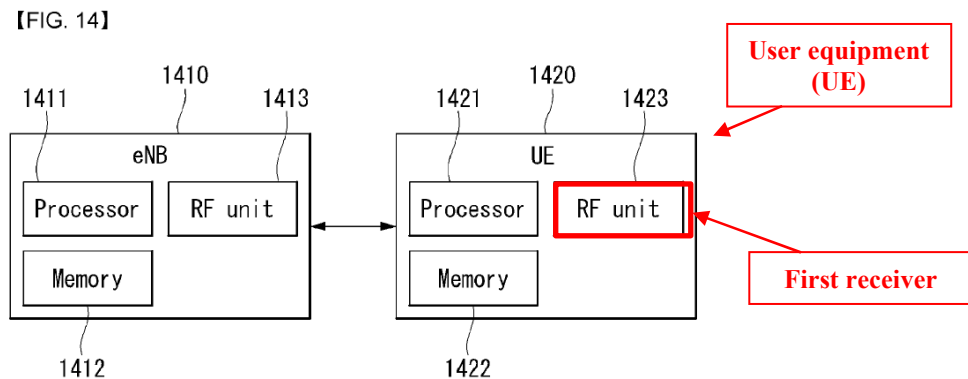
APPLE-1005, FIG. 14 (annotated)



APPLE-1005, FIG. 5 (annotated)

[11.1]

Park discloses a UE including an “processor 1421 [that] implements the functions, processes and/or methods” proposed in Park and an “RF unit 1423 [that] is connected to the processor 1421, and transmits and/or receives radio signals” (*a first receiver*). APPLE-1005, 44:10-18; APPLE-1003, ¶200.



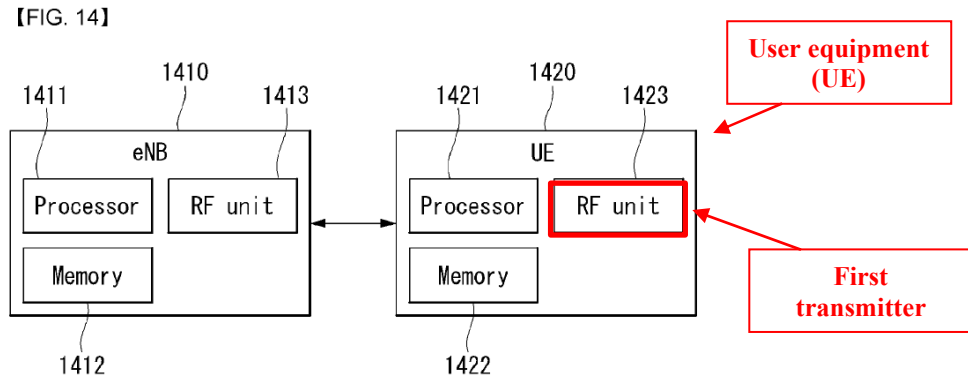
APPLE-1005, FIG. 14 (annotated)

Further, as discussed for [1.1], Park discloses that the UE (e.g., using the processor and the RF unit) receives, from a base station or eNB, each of “configuration information for a single CSI process” (*receiving a first signaling*), “DCI format” (*a second signaling*), an “Alt. 1 Class B CSI-RS” (*a first reference signal*), and an “Alt. 4 Class B CSI-RS” (*... and a second reference signal*). See [1.1]; APPLE-1003, ¶201.

[11.2]

Park discloses a UE including an “processor 1421 [that] implements the functions, processes and/or methods” proposed in Park and an “RF unit 1423 [that]

is connected to the processor 1421, and transmits and/or receives radio signals” (*a first transmitter*). APPLE-1005, 44:10-18; APPLE-1003, ¶203.



APPLE-1005, FIG. 14 (annotated)

As discussed with reference to [1.2], Park discloses that the UE transmits, to a base station or eNB, a “hybrid CSI report” (*transmitting first channel information*). See [1.2], APPLE-1003, ¶204.

[11.3]-[11.9]

Park discloses or renders obvious each of [11.3]-[11.9]. See [1.3]-[1.9] (detailing Park’s disclosure with respect to the same subject matter as in [11.3]-[11.9], but in the context of a UE device rather than a method performed by the UE). APPLE-1003, ¶205.

(g) Claims 12 and 15

Park anticipates or renders obvious each of claims 12 and 15. See Claims 2 and 5. APPLE-1003, ¶206.

See Section IV.A.2.b regarding Claim 2 detailing Park’s disclosure with

respect to the transmission of “first information” by a UE. APPLE-1003, ¶207. In view of Park’s disclosure regarding an “RF unit 1423 [that] is connected to the processor 1421, and transmits and/or receives radio signals” (*a first transmitter*), a POSITA would have found it obvious to use such a “RF unit” to transmit Park’s “first information” to a base station or eNB. *See* [11.2]; APPLE-1003, ¶207.

See also Section IV.A.2.c regarding Claim 5 (detailing Park’s disclosure regarding “first signaling” and “second signaling”). APPLE-1003, ¶208.

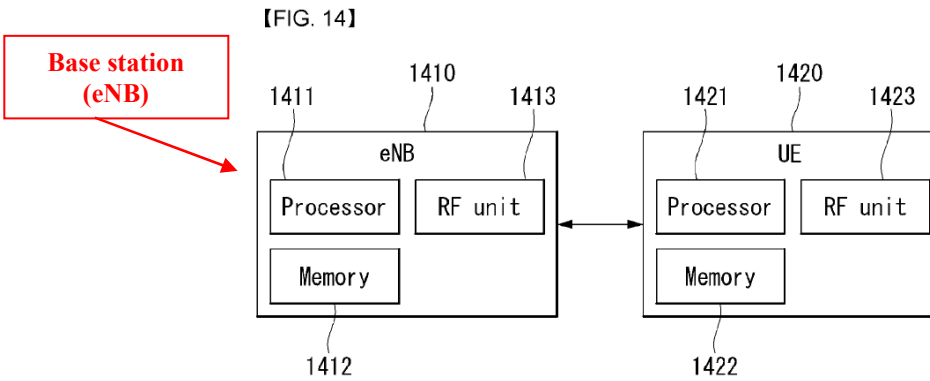
(h) **Claim 16**

Park anticipates and/or renders obvious claim 16. APPLE-1003, ¶209. . Claim 16 mirrors claims 1 and 6, except that claim 16 recites the claimed subject matter in the context of a base station device rather than a method performed by a UE or a method performed by a base station.

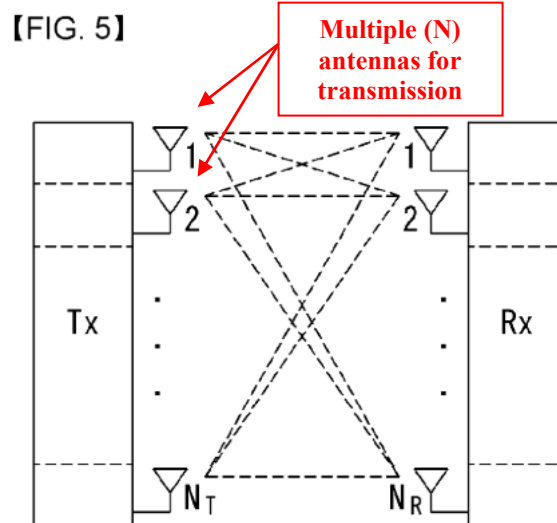
[16.pre]

To the extent that the preamble is limiting, Park discloses or renders obvious [16.pre]. APPLE-1003, ¶210.

Park discloses a “*base station*” configured to transmit data using “multi-user-multi-input/output (MIMO)” technology, such as using “a multi-transmission (Tx) antenna” (*...for multi-antenna transmission*). APPLE-1005, 4:22-29, 43:63-44:9, 9:5-22, 9:40-60, FIG. 14, FIG. 5; APPLE-1003, ¶211.



APPLE-1005, FIG. 14 (annotated)

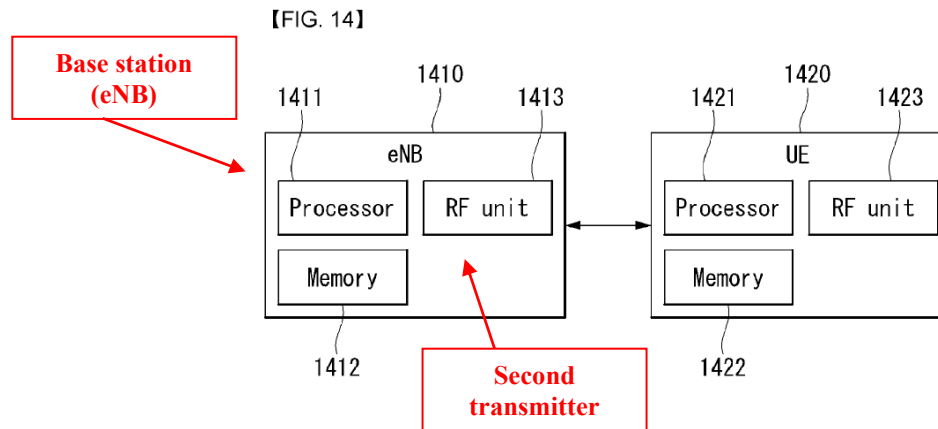


APPLE-1005, FIG. 5 (annotated)

[16.1]

Park discloses a “base station” (also referred to as an “eNB”) including a “processor 1411 [that] implements the functions, processes and/or methods” described in Park and “RF unit 1413 [that] is connected to the processor 1411, and

transmits and/or receives radio signals” (*a second transmitter*). APPLE-1005, 44:1-9; APPLE-1003, ¶213.

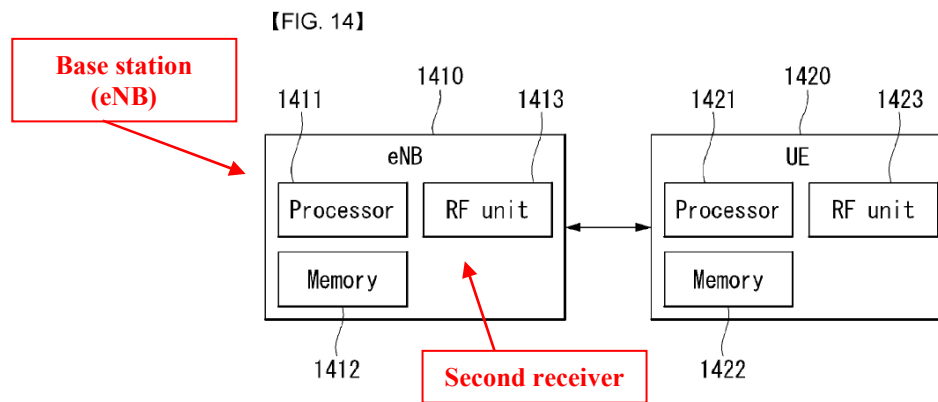


APPLE-1005, FIG. 14 (annotated)

Further, as discussed for [1.1], Park discloses that a base station (eNB) transmits, to a UE, each “configuration information for a single CSI process” (*transmitting a first signaling*), “a DCI format” (*a second signaling*), an “Alt. 1 Class B CSI-RS” (*a first reference signal*), and an “Alt. 4 Class B CSI-RS” (*... and a second reference signal*). See [1.1]; APPLE-1003, ¶214.

[16.2]

Park discloses a “base station” (“eNB”) including a “processor 1411 [that] implements the functions, processes and/or methods” proposed in Park and “RF unit 1413 [that] is connected to the processor 1411, and transmits and/or receives radio signals” (*a second receiver*). APPLE-1005, 44:1-9; APPLE-1003, ¶216.



APPLE-1005, FIG. 14 (annotated)

Further, as discussed with reference to [1.2], Park discloses that a base station (eNB) receives, from a UE, a “hybrid CSI report” (*receiving first channel information*). See [1.2], APPLE-1003, ¶217.

[16.3]-[16.9]

Park anticipates or renders obvious each of [16.3]-[16.9]. APPLE-1003, ¶218. See [1.3]-[1.9] (detailing Park’s disclosure with respect to the same subject matter as in [16.3]-[16.9], but in the context of a UE rather than a method performed by base station). See also [6.3]-[6.9].

(i) Claims 17 and 20

Park anticipates or renders obvious claims 17 and 20. See Claims 2, 5, 7, and 10. APPLE-1003, ¶219.

See Section IV.A.2.b regarding Claim 2 detailing Park’s disclosure with respect to the transmission of “first information” by a UE, and a receipt of such “first information” by a base station). In view of Park’s disclosure regarding an

“RF unit 1423 [that] is connected to the processor 1421, and transmits and/or receives radio signals” (a second receiver), a POSITA would have found it obvious to use such a “RF unit” to receive Park’s “first information” from a UE. *See* [16.2]; APPLE-1003, ¶219.

See also Section IV.A.2.c regarding Claim 5 (detailing Park’s disclosure regarding “first signaling” and “second signaling”). APPLE-1003, ¶220.

**B. [GROUND 1A] – CLAIMS 1-2, 5-7, 10-12, 15-17, AND 20
ARE RENDERED OBVIOUS IN VIEW OF PARK AND
SHIN**

As explained below in Ground 1A, Park and Shin render obvious all limitations of the independent claims 1, 6, 11, and 16, as well as dependent claims 2, 5, 7, 10, 12, 15, 17, and 20. APPLE-1003, ¶222. Here in Ground 1A, the same disclosure of Park is relied upon as in Ground 1, but Shin’s disclosure is additionally cited for limitation [1.6] of independent claim 1 (and the analogous limitation in independent claims 6, 11, and 16) to the extent Shin’s teachings would not have been within the general knowledge of a POSITA. *Id.* In particular, Shin merely provides disclosure of the well-known feature that a DCI format (*second signaling*) that triggers aperiodic CSI reporting (as disclosed in Park) includes a “CSI request field” which indicates the number of ports (*Q2 antenna ports*) that are to use for aperiodic reporting. *Id.*

1. Overview of Shin

Shin is analogous art to the '727 patent because, like the '727 patent, Shin is directed to transmission of reference signals and CSI reporting in a multi-antenna wireless communication system. APPLE-1006, Abstract; APPLE-1001, 1:18-29; APPLE-1003, ¶64.

Shin is directed to “[a] method in which a base station transmits a CSI (channel state information)-RS (reference signal) in a MIMO (multiple input multiple output) antenna system.” APPLE-1006, Abstract. In particular, Shin describes a scenario where a UE (also referred to as a “terminal”) transmits “a PUSCH-based **aperiodic** CSI report to the base station.” *Id.*, [0114]; APPLE-1003, ¶65. In this scenario of aperiodic CSI reporting, Shin’s UE “receives a CSI request from the base station through a **CSI request field** in the UL **DCI format**” and the UE “accordingly performs measurement and report.” *Id.*

Shin teaches that the CSI request field in the DCI is used by the base station for “requesting a[n] aperiodic CSI report from the terminal.” APPLE-1006, [0020]; APPLE-1003, ¶66. In particular, the “base station may request the terminal to report CSI on **some of antenna ports** by using the CSI request field.” *Id.* As an example, as recited in Shin’s claim 8, “when a CSI report on a **first CSI-RS antenna port group** among the plurality of CSI-RS antenna port groups is to be requested to the terminal,” a “CSI request field of a DL (downlink) DCI (downlink control information) format” can “includ[e] **information indicating the**

first CSI-RS antenna port group in a CSI request field of a DL (downlink) DCI (downlink control information) format.” APPLE-1006, Claim 8; APPLE-1003, ¶66.

Shin explains that specific antenna ports can be used by the base station to apply beamforming. APPLE-1006, [0057] (“where a beam is formed using some antenna ports”); [0053]; APPLE-1003, ¶67. In particular, Shin refers to scenarios of beamforming CSI-RS transmissions as a “second CSI-RS mode” or “CSI reporting class B.” APPLE-1006, [0140] (“[t]ransmitting of a CSI-RS AP signal such that a beam width is smaller than cell coverage and different combinations of CSI-RS AP and CSI-RS resource have different beam directions is defined as a second CSI-RS mode”); [0141] (referring to the second CSI-RS mode as “CSI reporting class B”). In this beamformed (class B) CSI reporting mode, “when the terminal measures CSI, the terminal selects all or some of beams applied to CSI-RS APs, measures CSI (for example, an arbitrary combination of CQI, PMI, and RI) for the selected beams, and reports the measured CSI.” APPLE-1006, [0141]; APPLE-1003, ¶67.

2. Combination of Park and Shin

In view of Shin, a POSITA would have found it obvious that in Park’s beamformed **aperiodic** CSI-RS (Class B, Alt. 4) scenario, Park’s “DCI format” (which triggers aperiodic CSI reporting) would include an explicit “CSI request

field” that indicates the specific antenna ports used by the base station for transmitting the beamformed aperiodic CSI-RS and used by the UE to report the aperiodic CSI, as taught by Shin. APPLE-1003, ¶68.

Combining Park and Shin would have involved (1) combining prior art elements according to known methods to yield predictable results; and (2) use of a known technique to improve similar devices (methods, or products) in the same way. *See KSR Int’l Co. v. Teleflex Inc.*, 550 U.S. 398, 415-421, 82 USPQ2d 1385, 1395-97 (2007); MPEP 2143. APPLE-1003, ¶69.

Like Park, Shin describes a beamformed (class B) aperiodic CSI reporting scenario where a base station can transmit a “DCI format” to a UE to trigger aperiodic CSI reporting. APPLE-1006, [0114]; APPLE-1003, ¶70. In such scenarios, Shin discloses that the DCI format includes a “CSI request field” that indicates the specific antenna ports for the beamformed CSI-RS. *Id.* Further, Shin explicitly discloses that “[t]he base station may request the terminal to report CSI on **some of antenna ports** by using the CSI request field.” *Id.* Similarly, Shin’s claim 8 recites that “when a CSI report on a **first CSI-RS antenna port group** among the plurality of CSI-RS antenna port groups is to be requested to the terminal,” a “CSI request field of a DL (downlink) DCI (downlink control information) format” can “includ[e] **information indicating the first CSI-RS antenna port group** in a CSI request field of a DL (downlink) DCI (downlink

control information) format.” APPLE-1006, Claim 8; APPLE-1003, ¶70.

In the resulting Park-Shin combination, Park’s “DCI format” (which is transmitted from the base station to UE to trigger aperiodic CSI reporting) would include information (such as Shin’s “CSI request field”) indicating a particular antenna port group (i.e., Park’s “L” antenna ports) for aperiodic CSI-RS transmission and for which the UE would generate a CSI report. APPLE-1003, ¶71. A POSITA would have recognized that this modification would allow the network to directly configure the CSI report behavior of a UE, such that the base station or eNB can obtain channel state information regarding specific channels used by the UE and base station to exchange data (e.g., as taught by Shin). APPLE-1003, ¶71..

3. Analysis

(a) Claim 1

[1.1]-[1.5], [1.7]-[1.9]

As discussed in Section IV.A.2 (Ground 1), Park discloses or renders obvious each of [1.1]-[1.5] and [1.7]-[1.9], and therefore the Park-Shin combination discloses or renders obvious these features. *See* section IV.A.2 (Ground 1), Claim 1, [1.1]-[1.5] and [1.7]-[1.9]; APPLE-1003, ¶223.

[1.6]

Park-Shin renders obvious [1.6]. APPLE-1003, ¶224.

As discussed in Section A.2 for [1.1], Park discloses that “in a situation in which hybrid CSI has been configured,” the UE receives a “DCI format” (*the second signaling*) that triggers the UE to perform “aperiodic CSI” reporting. APPLE-1005, 38:20-36; APPLE-1003, ¶225. Further, as discussed in Section A.2. for [1.4], Park discloses that the Class B “Alt 4” (beamformed aperiodic) CSI-RS (*the second reference signal*) is transmitted using corresponding antenna ports (*Q2 antenna port(s)*). APPLE-1005, 28:7-10, 29:52-53, 35:43-53, 16:42-47, 19:44-52, 20:28-39; APPLE-1003, ¶225.

To the extent that Park does not explicitly describe using the “DCI format” to determine the antenna ports for transmitting the Class B “Alt 4” (beamformed aperiodic) CSI-RS, a POSITA nevertheless would find it obvious that Park’s DCI format (*second signaling*) would have included information (such as a “CSI request field” as taught by Shin) that indicates the Park’s L antenna ports (*Q2 antenna ports*) that are used for transmitting the beamformed aperiodic CSI-RS. APPLE-1003, ¶226.

As discussed in section IV.B.2, in the Park-Shin combination, the base station transmits a “CSI request” to a UE “through a CSI request field in the UL DCI format.” APPLE-1006, [0114]; APPLE-1003, ¶227. In particular, as explained, the CSI request field in the DCI format requests the UE to report CSI on “some of antenna ports.” *Id.*

Similarly, Shin’s claim 8 recites that “when a CSI report on a **first CSI-RS antenna port group** among the plurality of CSI-RS antenna port groups is to be requested to the terminal,” a “CSI request field of a DL (downlink) DCI (downlink control information) format” can “includ[e] **information indicating the first CSI-RS antenna port group** in a CSI request field of a DL (downlink) DCI (downlink control information) format.” APPLE-1005, Claim 8; APPLE-1003, ¶228.

Accordingly, in the Park-Shin combination, Park’s “DCI format” (*the second signaling*) and in particular the “CSI request field” in the DCI format (as taught by Shin) is used by the UE to determine Park’s “L” antenna ports for transmitting the “Alt 4” (aperiodic) CSI-RS (*...is used to determine the Q2 antenna port(s)*). APPLE-1003, ¶229.

(b) **Claims 5, 11, and 16**

See section IV.A.2 (Ground 1), Claims 5, 11, and 16.

C. [GROUND 2/2A] – CLAIMS 3, 8, 13, 18 ARE RENDERED OBVIOUS IN VIEW OF PARK AND RAHMAN AND CLAIMS 3, 8, 13, 18 ARE RENDERED OBVIOUS IN VIEW OF PARK, SHIN, AND RAHMAN

As discussed below, the combination of Park and Rahman (Ground 2) and the combination of Park, Shin, and Rahman (Ground 2A) each render obvious claims 3, 8, 13, and 18. APPLE-1003, ¶231. In particular, Rahman supplements Park by merely providing disclosure of the well-known feature that a UE can

receive RRC signaling that indicates a specific number of antenna ports to use for CSI reporting based on periodic CSI-RS. *Id.*

1. Overview of Rahman

Rahman is analogous art to the '727 patent because, like the '727 patent, Rahman is directed to transmission of reference signals and CSI reporting in a multi-antenna wireless communication system. APPLE-1007, Abstract, 1:60-2:67; APPLE-1001, 1:18-29; APPLE-1003, ¶72.

Rahman is directed to “[a] method for a channel state information (CSI) feedback. APPLE-1007, Abstract. In an example implementation of this method, a device (e.g., a UE) “receiv[es] CSI feedback configuration information for the CSI feedback,” “deriv[es] [a] spatial channel information indicator” based on the CSI configuration information, and “transmit[s] over an uplink channel, the CSI feedback including the spatial channel information indicator” (e.g., to a base station). APPLE-1007, Abstract, 1:60-2:67; APPLE-1003, ¶73.

Rahman describes that the base station (eNB) transmits, to a UE, one or more CSI reference signals (CSI-RSs) in order to facilitate obtaining CSI feedback. *See, e.g.*, APPLE-1007, 19:37-20:42, 21:18-37, 47:3-49:9; APPLE-1003, ¶74.

Rahman discloses that the CSI-RS transmission can be beamformed, explaining that an eNB or base station can transmit a “beamformed CSI-RS (BF CSI-RS),” noting that “[i]n this case, beamforming operation, either cell-specific (with $K > 1$

CSI-RS resources) or UE-specific (with $K=1$ CSI-RS resource), is applied on a non-zero-power (NZP) CSI-RS resource (consisting of multiple ports).” APPLE-1007, 19:48-58; APPLE-1003, ¶74. In particular, Rahman discloses that a beam formed CSI-RS can be associated with “ $K \geq 1$ resources” and “ L BF [beam forming] ports which are beam-formed using L basis vectors $\{b_l\}$ ” APPLE-1007, 33:10-22; APPLE-1003, ¶74. Specifically, Rahman describes that in embodiments in which the UE is “configured with $K > 1$ BF CSI-RS resource and L ports,” “the eNB can determine L basis vectors $\{b_l\}$ using UL SRS measurement.” APPLE-1007, 33:10-22; APPLE-1003, ¶74. Further, Rahman’s “ L BF ports” are selected from a set of “ $L_1 L_2$ beams.” APPLE-1007, 43:28-33; APPLE-1003, ¶74.

Notably, Rahman explicitly describes that “ L BF ports” can be “configured via higher layer RRC signaling.” APPLE-1007, 42:28-33, 42:45-50; APPLE-1003, ¶75. In particular, Rahman explains that “an L value is configured via RRC signaling and the UE reports a Config value corresponding to the reported L .” *Id.*, 43:45-50; APPLE-1003, ¶75.

Rahman, like Park, discloses a “hybrid” CSI-RS scenario in which “1st eMIMO-Type Class B, $K=1$ and 2nd eMIMO-Type Class B, $K=1$ can be configured” in a single CSI process. APPLE-1007, 38:18-28, 48:44-64, Table 13; APPLE-1003, ¶76. Rahman also describes that each CSI-RS can be transmitted with a periodicity in time. *Id.*, 20:35-40 (“a first BF CSI-RS transmitted with

periodicity T1 (ms) and a second NP CSI-RS transmitted with periodicity T2 (ms)"); 48:45-49; APPLE-1003, ¶76.

2. Combination of Park and Rahman (and the combination of Park-Shin and Rahman in Ground 2A)

As discussed above in Grounds 1 and 1A, Park (and the combination of Park and Shin in Ground 1A) describes a hybrid CSI process in which each CSI-RS resource is configured with a total of “N_k” antenna ports, among which “L” antenna ports are used for CSI-RS beamforming in the Class B (beamformed CSI-RS) scenario, as taught by Park. APPLE-1003, ¶83.

In view of Rahman, a POSITA would have found it obvious that Park’s UE would receive RRC signaling from a base station (eNB), where the RRC signaling indicates the specific “L” antenna ports out of a set “N_k” antenna ports for beamforming. APPLE-1003, ¶84. Combining Park and Rahman would have involved (1) combining prior art elements according to known methods to yield predictable results; and (2) use of a known technique to improve similar devices (methods, or products) in the same way. *See KSR Int’l Co. v. Teleflex Inc.*, 550 U.S. 398, 415-421, 82 USPQ2d 1385, 1395-97 (2007); MPEP 2143. *Id.*

Like Park, Rahman discloses a “hybrid CSI” scenario in which beamformed periodic CSI-RS can be associated with “K≥1 resources” and “L BF [beam forming] ports which are beam-formed using L basis vectors {b_l}.” APPLE-1007,

33:10-22, 20:35-40, 48:45-49; APPLE-1003, ¶85. Specifically, Rahman describes that in embodiments in which the UE is “configured with $K > 1$ BF CSI-RS resource and L ports,” “the eNB can determine L basis vectors $\{b_l\}$ using UL SRS measurement.” APPLE-1007, 33:10-22; APPLE-1003, ¶85. Further, Rahman’s “ L BF ports” are selected from a set of “ $L_1 L_2$ beams.” APPLE-1007, 43:28-33; APPLE-1003, ¶85.

Notably, Rahman explicitly describes that “ L BF ports” can be “configured via higher layer RRC signaling.” APPLE-1007, 42:28-33, 42:45-50; APPLE-1003, ¶86. In particular, Rahman explains that “an L value is configured via RRC signaling and the UE reports a Config value corresponding to the reported L .” *Id.*, 43:45-50; APPLE-1003, ¶86.

In view of Rahman, a POSITA would have found it obvious that Park’s UE would receive RRC signaling (as taught by Rahman) which indicates the specific “ L ” antenna ports (out of a set of “ N_k ” antenna ports that are configured for a CSI-RS resource) that correspond to the beamformed CSI-RS based on which the UE reports CSI. APPLE-1003, ¶87. A POSITA would have recognized that this would allow Park’s base station to directly configure the CSI report behavior of a UE, such that the base station or eNB can obtain channel state information regarding specific beamformed channels used by the UE and base station to exchange data (e.g., as taught by Rahman). APPLE-1003, ¶87.

3. Analysis

Claim 3

The Park-Rahman combination (for Ground 2) and the Park-Shin-Rahman combination (for Ground 2A) each renders obvious claim 3. APPLE-1003, ¶232.

As discussed in section IV.A.2 (Ground 1) for [1.3] and [1.5], Park discloses:

- (i) “N_k” (the number of antenna ports for each CSI-RS resource) (*L1 antenna port(s)*), and
- (ii) L (number of antenna ports) used for CSI-RS beamforming among N_k antenna ports, for Park’s “Alt 1” (periodic CSI-RS with K>1) CSI-RS (*Q1 antenna port(s)*).

APPLE-1003, ¶233.

To the extent that Park does not explicitly describe receiving second information indicating L ports for Park’s “Alt 1” (periodic CSI-RS with K>1) CSI-RS (*Q1 antenna port(s)*) among the N_k ports (*L1 antenna port(s)*), a POSITA nevertheless would have found it obvious that Park’s system would do so in view of Rahman. APPLE-1003, ¶234.

As discussed in section IV.C.2, like Park, Rahman discloses that a beam formed CSI-RS can be associated with “K≥1 resources” and “L BF [beam forming] ports which are beam-formed using L basis vectors {b_l}” (*Q1 antenna port(s)*).

APPLE-1007, 33:10-22; APPLE-1003, ¶235. Specifically, Rahman describes that in embodiments in which the UE is “configured with $K > 1$ BF CSI-RS resource and L ports,” “the eNB can determine L basis vectors $\{b_l\}$ using UL SRS measurement.” APPLE-1007, 33:10-22; APPLE-1003, ¶235. Further, Rahman’s “ L BF ports” are selected from a set of “ $L_1 L_2$ beams” (*L1 antenna port(s)*). APPLE-1007, 43:28-33; APPLE-1003, ¶235.

Rahman also explicitly describes that “ L BF ports” (*Q1 antenna port(s)*) can be “configured via higher layer RRC signaling.” APPLE-1007, 42:28-33, 42:45-50; APPLE-1003, ¶236.

In view of Rahman, a POSITA would have found it obvious that Park’s UE receives RRC signaling from a base station or eNB (*receiving second information*), where the RRC signaling indicates the specific antenna ports out of a set antenna ports for a CSI-RS process. APPLE-1003, ¶237. A POSITA would have made this modification, as a POSITA would have recognized that it would allow the network (via the base station or eNB) to directly configure the CSI report behavior of a UE, such that the base station or eNB can obtain channel state information regarding specific channels used by the UE and base station to exchange data. APPLE-1003, ¶237.

Accordingly, in view of Rahman, a POSITA would have found it obvious that Park’s UE receives, from the base station, RRC signaling (*receiving second*

information) indicating L antenna ports for Park's "Alt 1" (periodic CSI-RS with $K > 1$) CSI-RS (*$Q1$ antenna port(s)*) out of the N_k antenna ports (*$L1$ antenna port(s)*) to facilitate explicit configuration of the CSI report behavior of UE by the network. APPLE-1003, ¶238.

(a) **Claims 8, 13, and 18**

See Claim 3.

D. [GROUND 3/3A] – CLAIMS 4, 9, 14, AND 19 ARE RENDERED OBVIOUS IN VIEW OF PARK AND YU and CLAIMS 4, 9, 14, AND 19 ARE RENDERED OBVIOUS IN VIEW OF PARK, SHIN, AND YU

As discussed below, the combination of Park and Yu (Ground 3) and the combination of Park, Shin, and Yu (Ground 3A) each render obvious claims 4, 9, 14, and 19. APPLE-1003, ¶240. In particular, Yu supplements Park by merely providing disclosure of the well-known feature that a base station can perform beamforming by applying specific beamforming vectors that are reported by a UE. *Id.*

1. Overview of Yu

Yu is analogous art to the '727 patent because, like the '727 patent, Yu is directed to beamforming and measuring/reporting channel qualities of beams in a multi-antenna wireless communication system. APPLE-1008, Abstract, [0043]-[0044]; APPLE-1001, 1:18-29, 19:24-26, 20:28-30; APPLE-1003, ¶88.

Yu is directed to "A method and apparatus for transmitting and receiving a

control channel by beamforming in a wireless communication system.” APPLE-1008, Abstract. In an example implementations of this method, a “Mobile Station” (MS) (i.e., UE) measures channel qualities and reports best beams to the base station. APPLE-1008, [0043] (“If the MS 120 is configured to support Rx beamforming, the MS 120 measures the channel qualities of a plurality of Tx beams 112 received from the BS 100 with respect to each Rx beam 122 and reports total or some high-ranked measurements of all Tx-Rx beam pairs to the BS 100”); APPLE-1003, ¶90. Further, “[t]he MS 120 feeds back information about one or more best Tx beams determined for the BS 100 to the BS 100, periodically or aperiodically.” APPLE-1008, [0044]; APPLE-1003, ¶90.

As Yu explains, transmission beamforming ensures “directivity” and the above technique provides a benefit in the PDCCH being “directed to the MS successfully.” APPLE-1008, [0037], [0050]; APPLE-1003, ¶91.

2. Combination of Park and Yu (and the combination of Park-Shin and Yu in Ground 3A)

As discussed above in Grounds 1 and 1A, Park (and the combination of Park and Shin in Ground 1A) describes a hybrid CSI process in which each CSI-RS resource is configured with a total of “N_k” antenna ports, among which “L” antenna ports are used for CSI-RS beamforming in the Class B (beamformed CSI-RS) scenario, as taught by Park. APPLE-1003, ¶92. Furthermore, as discussed in

Grounds 1 and 1A., Park (and the combination of Park and Shin in Ground 1A) describes the UE reporting “L-port CSI” indicating a selected/preferred beam. *Id.* Park further discloses that the base station uses the UE’s reported BI (which indicates the UE’s selected L antenna ports for beamforming) is to apply “beamforming” for subsequent aperiodic CSI-RS transmissions and to perform a “beam change” (e.g., in order to potentially improve the quality of the channel). APPLE-1005, 37:8-9; 42:50-53; APPLE-1003, ¶92.

In view of Yu, a POSITA would have found it obvious that Park’s base station would also apply Park’s “beam change” (based the UE’s reported L-port BI/CRI) to a transmission of DCI that triggers an aperiodic CSI report, as taught by Yu. APPLE-1003, ¶93. In particular, a POSITA would have found it obvious, based on Yu’s teachings, that a base station can perform beamforming on a DCI transmission by using a beam selected from a UE’s feedback, to ensure appropriate “directivity” to the UE and such that the physical layer signals (e.g., DCI) are “directed to the [UE] successfully.” APPLE-1008, [0037], [0050]; APPLE-1003, ¶93.

Combining Park and Yu (and Park-Shin and Yu in Ground 3A) would have involved (1) combining prior art elements according to known methods to yield predictable results; and (2) use of a known technique to improve similar devices (methods, or products) in the same way. *See KSR Int’l Co. v. Teleflex Inc.*, 550

U.S. 398, 415-421, 82 USPQ2d 1385, 1395-97 (2007); MPEP 2143. APPLE-1003, ¶93.

As discussed in Section IV.A, Park discloses that the “CSI process #1” (“Alt 1,” $K > 1$, periodic) can result in UE reporting BI / CRI, and this may be used to apply "beamforming" when transmitting CSI-RS for “CSI process #2” (“Alt 4,” $K = 1$, aperiodic). APPLE-1005, 37:4-9; APPLE-1003, ¶94. Further, Park explains that the eNB (base station) uses the UE’s report of BI to apply a “beam change.” APPLE-1005, 42:48-53; APPLE-1003, ¶94.

As Park explains, beamforming can be used to transmit signals (e.g., from an eNB to a UE) using multiple physical antennas, such that signals are directed to a specific UE. APPLE-1005, 25:19-30 (“In beamforming, multiple physical antenna elements are used, so downlink transmission may be directed toward a specific UE”); APPLE-1003, ¶95. In view of Park, a POSITA would have understood or found it obvious to transmit signals (e.g., from an eNB to a UE) using vectors representing the characteristics of beamformed signals. APPLE-1003, ¶95.

Indeed, evidence of such knowledge is provided by Yu, which describes details of such a feature. APPLE-1003, ¶96. First, Yu teaches that a “Mobile Station” (MS) (i.e., UE) measures channel qualities and reports best beams to the base station. APPLE-1008, [0043] (“If the MS 120 is configured to support Rx beamforming, the MS 120 measures the channel qualities of a plurality of Tx

beams 112 received from the BS 100 with respect to each Rx beam 122 and reports total or some high-ranked measurements of all Tx-Rx beam pairs to the BS 100”); APPLE-1003, ¶97.

Further, Yu discloses that “[t]he MS 120 feeds back information about one or more best Tx beams determined for the BS 100 to the BS 100, periodically or aperiodically.” APPLE-1008, [0044]; APPLE-1003, ¶98. Yu also discloses a base station transmitting PDCCH by using a Tx beam selected from the beams indicated by the MS feedback. APPLE-1008, [0045] (“The BS 100 transmits a PDCCH to the MS 120 by a Tx beam selected from best P Tx beams indicated by a feedback received from the MS 120”); APPLE-1003, ¶98.

As Yu explains, transmission beamforming ensures “directivity” and the above technique results in the PDCCH being “directed to the MS successfully.” APPLE-1008, [0037], [0050]; APPLE-1003, ¶99. This is the same benefit as disclosed in the ’727 patent with respect to beamforming. APPLE-1001, 5:42-43 (“the above method ensures that the second signaling is transmitted via a beamforming vector point to the UE, which improves transmission reliability and efficiency of the second signaling”); APPLE-1003, ¶99.

Therefore, a POSITA would have found it obvious that the base station of Park (and the base station of Park-Shin in Ground 3A) would use the UE’s reported beam (in the UE’s CRI/BI report) to apply a “beam change” to the base

station's transmission of the DCI which triggers aperiodic CSI reporting, to ensure "directivity" and such that the physical layer signals (e.g., DCI) are "directed to the MS successfully" as taught by Yu. APPLE-1003, ¶100.

3. Analysis

(a) Claim 4

The Park-Yu combination (for Ground 3) and the Park-Shin-Yu combination (for Ground 3A) each renders obvious claim 4. APPLE-1003, ¶241.

As discussed in section IV.A.2 (Ground 1) for [1.3], Park discloses L antenna ports (***Q1 antenna port(s)***) used for beamforming CSI-RS among N_k antenna ports, for Park's "Alt 1" (periodic CSI-RS with K>1) CSI-RS. *See, e.g.*, APPLE-1005, 27:57-65, 29:43-45, 35:43-53, 16:42-47, 19:44-52, 20:28-39; APPLE-1003, ¶242. As discussed for [1.1], Park also discloses that "in a situation in which hybrid CSI has been configured," the UE receives a "DCI format" (***second signaling***) that triggers the UE to perform "aperiodic CSI" reporting. APPLE-1005, 38:20-36; APPLE-1003, ¶242.

Further, Park discloses that the "CSI process #1" ("Alt 1," K>1, periodic) can result in UE reporting BI / CRI, and this may be used to apply "***beamforming***" when transmitting CSI-RS for "CSI process #2" ("Alt 4," K=1, aperiodic). APPLE-1005, 37:4-9; 32:1-2 ("The reported BI may be used to transmit a CSI-RS associated with a CSI process #2"); APPLE-1003, ¶243.

Park also explains that the eNB (base station) uses the UE's report of BI to apply a "beam change." APPLE-1005, 42:48-53; APPLE-1003, ¶244. As such, a POSITA would have understood or found obvious that the L antenna ports (***Q1 antenna port(s)***) reported by the UE's BI/CRI in Park are used by the eNB to apply a "beam change" and specifically transmit subsequent aperiodic CSI-RS. APPLE-1005, 42:48-53; APPLE-1003, ¶244.

As Park explains, beamforming can be used to transmit signals (e.g., from an eNB to a UE) using multiple physical antennas, such that signals are directed to a specific UE. APPLE-1005, 25:19-30 ("In beamforming, multiple physical antenna elements are used, so downlink transmission may be directed toward a specific UE"); APPLE-1003, ¶245. Further, Park describes that, according to MIMO (Multiple Input Multiple Output) operations, signals can be transmitted according to a virtualization technique, whereby a vector is used to map ports for transmitting downlink signals (e.g., "DMRS," downlink "data," and CSI-RS) to a TXRU (transmission and reception unit). APPLE-1005, 25:58-26:3; APPLE-1003, ¶245. Park additionally discloses that, according to MIMO operations, "[s]everal channels may be grouped and expressed in a vector and matrix form." APPLE-1005, 11:54-56; APPLE-1003, ¶245.

In view of Park, a POSITA would have understood or found it obvious to transmit signals (e.g., from an eNB to a UE) using vectors representing the

characteristics of beamformed signals (*beamforming vector(s)*). APPLE-1003, ¶246.

Further, a POSITA would have understood or found it obvious to use the same beamforming characteristics (*beamforming vector(s)*) for transmitting downlink signals from an eNB to a particular UE, such that the downlink signals are directed specifically to that UE (e.g., to improve the reliability of reception by the UE). APPLE-1003, ¶247. In doing so, the base station of Park (and the base station of Park-Shin in Ground 3A) would use the same *beamforming vector(s)* corresponding to the antenna ports for transmitting both (i) the first CSI-RS (*Q1 antenna port(s)*) and (ii) other downlink signals, such as a DCI that triggers the aperiodic CSI-RS (*second signaling*). APPLE-1003, ¶247.

However, to the extent that Park does not explicitly disclose that the “beam change” is also applied to the eNB’s transmission of the DCI which triggers the aperiodic CSI-RS, a POSITA nevertheless would have found it obvious to implement such a feature in view of Yu. APPLE-1003, ¶248.

As discussed in Section IV.D.2, Yu teaches that a “Mobile Station” (MS) (i.e., UE) measures channel qualities and reports best beams to the base station. APPLE-1008, [0043]; APPLE-1003, ¶249. Yu also discloses that “[t]he MS 120 feeds back information about one or more best Tx beams determined for the BS 100 to the BS 100, periodically or aperiodically.” APPLE-1008, [0044]; APPLE-

1003, ¶250. Yu further discloses a base station transmitting PDCCH by using a Tx beam selected from the beams indicated by the MS feedback. APPLE-1008, [0045]; APPLE-1003, ¶250. Yu explains that transmission beamforming ensures “directivity” and the above technique results in the PDCCH being “directed to the MS successfully.” APPLE-1008, [0037], [0050]; APPLE-1003, ¶251. As noted in Section IV.D.2, this is the same benefit as disclosed in the ’727 patent with respect to beamforming. APPLE-1001, 5:42-43; APPLE-1003, ¶251.

Therefore, in view of Yu, a POSITA would have found it obvious to modify Park’s system, such that a “beam change” is also applied to the eNB’s transmission of the DCI which triggers the aperiodic CSI-RS, to ensure “directivity” and such that the physical layer signals (e.g., DCI) are “directed to the MS successfully.” APPLE-1003, ¶252. According to this modification, beamforming vectors corresponding to Park’s L (number of CSI-RS ports) used for beamforming “Alt 1” (periodic CSI-RS with $K > 1$) CSI-RS (***Q1***) would be used to determine beamforming vectors corresponding to transmission antenna ports for Park’s “DCI format” (***second signaling***). APPLE-1003, ¶252.

(b) **Claims 9, 14, and 19**

See Claim 4.

V. PTAB DISCRETION SHOULD NOT PRECLUDE INSTITUTION

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.

VI. CONCLUSION AND FEES

The Challenged Claims are unpatentable. Petitioner authorizes charge of fees to Deposit Account 06-1050.

VII. 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 the real party-in-interest.

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

Petitioner is not aware of any disclaimers, reexamination certificates or petitions for inter partes review for the '727 patent. The '727 patent is the subject of civil actions: *Apex Beam Technologies LLC v. Apple Inc.*, 6-24-cv-00223 (WDTX), filed April 29, 2024; *Apex Beam Technologies LLC v. Samsung Electronics Co., Ltd. et al.*, 2-24-cv-00203 (EDTX), filed March 20, 2024 (dismissed September 18, 2024).

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

Petitioner provides the following designation of counsel.

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D. Service Information

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

Petitioner consents to electronic service by email at IPR50095-0230IP1@fr.com.

Respectfully submitted,

Dated: April 29, 2025

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CERTIFICATION UNDER 37 CFR § 42.24

Under the provisions of 37 CFR § 42.24(d), the undersigned hereby certifies that the word count for the foregoing Petition for *Inter Partes* Review totals 13,974 words, which is less than the 14,000 allowed under 37 CFR § 42.24.

Dated: April 29, 2025

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CERTIFICATE OF SERVICE

Pursuant to 37 CFR §§ 42.6(e)(4)(i) *et seq.* and 42.105(b), the undersigned certifies that on April 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:

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