IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent of:	Xiaobo Zhang	
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Appl. Serial No.:	17/138,945	
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Title:	METHOD AND DEVICE FOR MULTI-ANTENNA TRANSMISSION IN USER EQUIPMENT (UE) AND BASE STATION	

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PETITION FOR *INTER PARTES* REVIEW OF UNITED STATES PATENT NO. 11,626,904 PURSUANT TO 35 U.S.C. §§ 311–319, 37 C.F.R. § 42

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LISTING OF CLAIMS

Claim 1	
1.pre	A method for multi-antenna transmission in a user equipment (UE), comprising:
1.a	receiving a first signaling;
1.b	receiving a first wireless signal; and
1.c	transmitting first information;
1.d1	wherein, K antenna port groups are used to transmit the first wireless signal;
1.d2	the first signaling is used to determine the K antenna port groups transmitting the first wireless signal; the K is a positive integer greater than 1;
1.d3	the K antenna port groups respectively correspond to K channel quality values; the K channel quality values are K non-negative real numbers; the K channel quality values are Reference Signal Received Powers (RSRPs) or Signal to Interference plus Noise Ratios (SINRs);
1.d4	K1 antenna port groups of the K antenna port groups correspond to K1 channel quality values of the K channel quality values; the K1 is a positive integer less than or equal to the K;
1.d5	a first proportional sequence corresponds to a ratio(ratios) among the K1 channel quality values;
1.d6	the first information is used to determine the K1 antenna port groups and the first proportional sequence;
1.d7	the first signaling is used to determine a target threshold; the target threshold is a non-negative real number;
1.d8	a first channel quality is a best channel quality value among the K1 channel quality values; a second channel quality is a worse channel quality value among the K1 channel quality values;

1.d9	a ratio between the second channel quality and the first channel quality is greater than or equal to the target threshold;
1.d10	the first signaling is a RRC (Radio Resource Control) signaling; the first information is transmitted in a CSI (Channel State Information) report; the first information is carried by a PUSCH (Physical Uplink Shared Channel) or a PUCCH (Physical Uplink Control Channel).
Claim 2	
2.	The method according to claim 1, wherein the K channel quality values are broadband channel quality values; or the first proportional sequence comprises K1 positive real numbers less than or equal to 1, and the first proportional sequence comprises at least one 1; or the first proportional sequence comprises quantized values corresponding to K1 positive real numbers; or the first proportional sequence is composed of K1 positive real numbers, and the K1 positive real numbers are respectively ratios between the K1 channel quality values and the best channel quality value of the K1 channel quality values; or the first proportional sequence comprises K1-1 positive real number(s), and the K1-1 positive real number(s) is(are) a ratio(ratios) between a channel quality value(s) other than the best channel quality value among the K1 channel quality values and the best channel quality value; or the first proportional sequence comprises quantized values corresponding to K1-1 positive real number(s).
Claim 3	
3.	The method according to claim 1, wherein the first signaling is UE specific; or, the unit of the target threshold is dB; or, the first signaling implicitly indicates the target threshold; or, the K antenna port groups correspond to K reference signal groups, the time domain resources occupied by any two of the K reference signal groups are orthogonal, the analog beamforming vectors corresponding to any two of the K reference signal groups cannot be considered to be the same, the K reference signal groups occupy K time windows, and the K time windows are orthogonal in the time domain.

Claim 4	
4.	The method according to claim 1, wherein any two antenna ports in the K1 antenna port groups are co-located or quasi-co-located (QCL); or any two antenna ports in the K1 antenna port groups are on a same carrier; or the first signaling is further used to determine the K1, and the first information is further used to determine the first channel quality.
Claim 5	
5.	The method according to claim 1, wherein the K antenna port groups respectively correspond to K reference signal groups; the K reference signal groups are respectively transmitted through the K antenna port groups; the first wireless signal is composed of the K reference signal groups; the antenna port group is composed of one antenna port, or, the antenna port group is composed of a plurality of antenna ports; the antenna port corresponds to a reference signal; the reference signal is transmitted through the antenna port; the reference signal is a SS (Synchronization Signal) or a CSI-RS (Channel State Information Reference Signal) or a DMRS of a PBCH (Physical Broadcast Channel).
Claim 6	
6.pre	A method for multi-antenna transmission in a base station, comprising:
6.a	transmitting a first signaling;
6.a	transmitting a first wireless signal; and
6.c	receiving first information;
6.d1	wherein, K antenna port groups are used to transmit the first wireless signal;
6.d2	the first signaling is used to determine the K antenna port groups transmitting the first wireless signal; the K is a positive integer greater than 1;

6.d3	the K antenna port groups respectively correspond to K channel quality values; the K channel quality values are K non-negative real numbers; the K channel quality values are Reference Signal Received Powers (RSRPs) or Signal to Interference plus Noise Ratios (SINRs);
6.d4	K1 antenna port groups of the K antenna port groups correspond to K1 channel quality values of the K channel quality values; the K1 is a positive integer less than or equal to the K;
6.d5	a first proportional sequence corresponds to a ratio(ratios) among the K1 channel quality values;
6.d6	the first information is used to determine the K1 antenna port groups and the first proportional sequence;
6.d7	the first signaling is used to determine a target threshold; the target threshold is a non-negative real number;
6.d8	a first channel quality is a best channel quality value among the K1 channel quality values; a second channel quality is a worse channel quality value among the K1 channel quality values;
6.d9	a ratio between the second channel quality and the first channel quality is greater than or equal to the target threshold;
6.d10	the first signaling is a RRC (Radio Resource Control) signaling; the first information is transmitted in a CSI (Channel State Information) report; the first information is carried by a PUSCH (Physical Uplink Shared Channel) or a PUCCH (Physical Uplink Control Channel).

Claim 7	
7.	The method according to claim 6, wherein the K channel quality values are broadband channel quality values; or the first proportional sequence comprises K1 positive real numbers less than or equal to 1, and the first proportional sequence comprises at least one 1; or the first proportional sequence comprises quantized values corresponding to K1 positive real numbers; or the first proportional sequence is composed of K1 positive real numbers, and the K1 positive real numbers are respectively ratios between the K1 channel quality values and the best channel quality value of the K1 channel quality values; or the first proportional sequence comprises K1-1 positive real number(s), and the K1-1 positive real number(s) is(are) a ratio(ratios) between a channel quality value(s) other than the best channel quality value among the K1 channel quality values and the best channel quality value; or the first proportional sequence comprises quantized values corresponding to K1-1 positive real number(s).

Claim 8	
8.	The method according to claim 6, wherein the first signaling is UE specific; or, the unit of the target threshold is dB; or, the first signaling implicitly indicates the target threshold; or, the K antenna port groups correspond to K reference signal groups, the time domain resources occupied by any two of the K reference signal groups are orthogonal, the analog beamforming vectors corresponding to any two of the K reference signal groups cannot be considered to be the same, the K reference signal groups occupy K time windows, and the K time windows are orthogonal in the time domain.

Claim 9	
9.	The method according to claim 8, wherein any two antenna ports in the K1 antenna port groups are co-located or quasi-co-located (QCL); or any two antenna ports in the K1 antenna port groups are on a same carrier; or the first signaling is further used to determine the K1, and the first information is further used to determine the first channel quality.
Claim 10	
10.	The method according to claim 6, wherein the K antenna port groups respectively correspond to K reference signal groups; the K reference signal groups are respectively transmitted through the K antenna port groups; the first wireless signal is composed of the K reference signal groups; the antenna port group is composed of one antenna port, or, the antenna port group is composed of a plurality of antenna ports; the antenna port corresponds to a reference signal; the reference signal is transmitted through the antenna port; the reference signal is a SS (Synchronization Signal) or a CSI-RS (Channel State Information Reference Signal) or a DMRS of a PBCH (Physical Broadcast Channel).
Claim 11	
11.pre	A user equipment (UE) for multi-antenna transmission comprising:
11.a	a first receiver, receiving a first signaling;
11.b	a second receiver, receiving a first wireless signal; and
11.c	a third transmitter, transmitting first information;
11.d1	wherein, K antenna port groups are used to transmit the first wireless signal;
11.d2	the first signaling is used to determine the K antenna port groups transmitting the first wireless signal; the K is a positive integer greater than 1;

11.d3	the K antenna port groups respectively correspond to K channel quality values; the K channel quality values are K non-negative real numbers; the K channel quality values are Reference Signal Received Powers (RSRPs) or Signal to Interference plus Noise Ratios (SINRs);
11.d4	K1 antenna port groups of the K antenna port groups correspond to K1 channel quality values of the K channel quality values; the K1 is a positive integer less than or equal to the K;
11.d5	a first proportional sequence corresponds to a ratio(ratios) among the K1 channel quality values;
11.d6	the first information is used to determine the K1 antenna port groups and the first proportional sequence;
11.d7	the first signaling is used to determine a target threshold; the target threshold is a non-negative real number;
11.d8	a first channel quality is a best channel quality value among the K1 channel quality values; a second channel quality is a worse channel quality value among the K1 channel quality values;
11.d9	a ratio between the second channel quality and the first channel quality is greater than or equal to the target threshold;
11.d10	the first signaling is a RRC (Radio Resource Control) signaling; the first information is transmitted in a CSI (Channel State Information) report; the first information is carried by a PUSCH (Physical Uplink Shared Channel) or a PUCCH (Physical Uplink Control Channel).

Claim 12	
12.	The user equipment to claim 11, wherein the K channel quality values are broadband channel quality values; or the first proportional sequence comprises K1 positive real numbers less than or equal to 1, and the first proportional sequence comprises at least one 1; or the first proportional sequence comprises quantized values corresponding to K1 positive real numbers; or the first proportional sequence is composed of K1 positive real numbers, and the K1 positive real numbers are respectively ratios between the K1 channel quality values and the best channel quality value of the K1 channel quality values; or the first proportional sequence comprises K1-1 positive real number(s), and the K1-1 positive real number(s) is(are) a ratio(ratios) between a channel quality value(s) other than the best channel quality value among the K1 channel quality values and the best channel quality value; or the first proportional sequence comprises quantized values corresponding to K1-1 positive real number(s).
Claim 13	
13.	The user equipment to claim 11, wherein the first signaling is UE specific; or, the unit of the target threshold is dB; or, the first signaling implicitly indicates the target threshold; or, the K antenna port groups correspond to K reference signal groups, the time domain resources occupied by any two of the K reference signal groups are orthogonal, the analog beamforming vectors corresponding to any two of the K reference signal groups cannot be considered to be the same, the K reference signal groups occupy K time windows, and the K time windows are orthogonal in the time domain.

Claim 14	
14.	The user equipment to claim 13, wherein any two antenna ports in the K1 antenna port groups are co-located or quasi-co-located (QCL); or any two antenna ports in the K1 antenna port groups are on a same carrier; or the first signaling is further used to determine the K1, and the first information is further used to determine the first channel quality.
Claim 15	
15.	The user equipment to claim 11, wherein the K antenna port groups respectively correspond to K reference signal groups; the K reference signal groups are respectively transmitted through the K antenna port groups; the first wireless signal is composed of the K reference signal groups; the antenna port group is composed of one antenna port, or, the antenna port group is composed of a plurality of antenna ports; the antenna port corresponds to a reference signal; the reference signal is transmitted through the antenna port; the reference signal is a SS (Synchronization Signal) or a CSI-RS (Channel State Information Reference Signal) or a DMRS of a PBCH (Physical Broadcast Channel).
Claim 16	
16.pre	A base station for multi-antenna transmission comprising:
16.a	a first transmitter, transmitting a first signaling;
16.b	a second transmitter, transmitting a first radio signal; and
16.c	a third receiver, receiving first information;
16.d1	wherein, K antenna port groups are used to transmit the first wireless signal;
16.d2	the first signaling is used to determine the K antenna port groups transmitting the first wireless signal; the K is a positive integer greater than 1;

16.d3	the K antenna port groups respectively correspond to K channel quality values; the K channel quality values are K non-negative real numbers; the K channel quality values are Reference Signal Received Powers (RSRPs) or Signal to Interference plus Noise Ratios (SINRs);
16.d4	K1 antenna port groups of the K antenna port groups correspond to K1 channel quality values of the K channel quality values; the K1 is a positive integer less than or equal to the K;
16.d5	a first proportional sequence corresponds to a ratio(ratios) among the K1 channel quality values;
16.d6	the first information is used to determine the K1 antenna port groups and the first proportional sequence;
16.d7	the first signaling is used to determine a target threshold; the target threshold is a non-negative real number;
16.d8	a first channel quality is a best channel quality value among the K1 channel quality values; a second channel quality is a worse channel quality value among the K1 channel quality values;
16.d9	a ratio between the second channel quality and the first channel quality is greater than or equal to the target threshold;
16.d10	the first signaling is a RRC (Radio Resource Control) signaling; the first information is transmitted in a CSI (Channel State Information) report; the first information is carried by a PUSCH (Physical Uplink Shared Channel) or a PUCCH (Physical Uplink Control Channel).

Claim 17	
17.	The base station to claim 16, wherein the K channel quality values are broadband channel quality values; or the first proportional sequence comprises K1 positive real numbers less than or equal to 1, and the first proportional sequence comprises at least one 1; or the first proportional sequence comprises quantized values corresponding to K1 positive real numbers; or the first proportional sequence is composed of K1 positive real numbers, and the K1 positive real numbers are respectively ratios between the K1 channel quality values and the best channel quality value of the K1 channel quality values; or the first proportional sequence comprises K1-1 positive real number(s), and the K1-1 positive real number(s) is(are) a ratio(ratios) between a channel quality value(s) other than the best channel quality value among the K1 channel quality values and the best channel quality value; or the first proportional sequence comprises quantized values corresponding to K1-1 positive real number(s).
Claim 18	
18.	The base station to claim 16, wherein the first signaling is UE specific; or, the unit of the target threshold is dB; or, the first signaling implicitly indicates the target threshold; or, the K antenna port groups correspond to K reference signal groups, the time domain resources occupied by any two of the K reference signal groups are orthogonal, the analog beamforming vectors corresponding to any two of the K reference signal groups cannot be considered to be the same, the K reference signal groups occupy K time windows, and the K time windows are orthogonal in the time domain.

Claim 19	
19.	The base station to claim 18, wherein any two antenna ports in the K1 antenna port groups are co-located or quasi-co-located (QCL); or any two antenna ports in the K1 antenna port groups are on a same carrier; or the first signaling is further used to determine the K1, and the first information is further used to determine the first channel quality.
Claim 20	
20.	The base station to claim 16, wherein the K antenna port groups respectively correspond to K reference signal groups; the K reference signal groups are respectively transmitted through the K antenna port groups; the first wireless signal is composed of the K reference signal groups; the antenna port group is composed of one antenna port, or, the antenna port group is composed of a plurality of antenna ports; the antenna port corresponds to a reference signal; the reference signal is transmitted through the antenna port; the reference signal is a SS (Synchronization Signal) or a CSI-RS (Channel State Information Reference Signal) or a DMRS of a PBCH (Physical Broadcast Channel).

I. INTRODUCTION

Apple Inc. ("Apple" or "Petitioner") petitions for IPR of claims 1-20 ("Challenged Claims") of U.S. Patent No. 11,626,904 ("the '904 patent").

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

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

Apple Inc. certifies that the '904 Patent is available for IPR. The present petition is being filed within one year of service of a complaint against Apple. Apple is not barred or estopped from requesting this review. EX1026-28.

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

Petitioner requests IPR of the Challenged Claims on the below grounds. Dr. Robert Akl provides supporting explanations in an expert declaration (EX1003) cited throughout this Petition. EX1003, ¶¶1-191.

Ground	Claims	§103 Basis
1	**1-20**	Kim and Chen

Each reference predates December 28, 2016, the '904 Patent's earliest claimed effective date, and thus qualifies as prior art, as shown by the table below.

Reference	Prior Art Date	Status
Kim (EX1004)	Published on Feb. 5, 2015	AIA §102(a)(1) & (2)
Chen (EX1005/06)	Published on September 11, 2015	AIA §102(a)(1) & (2)

III. SUMMARY OF THE '904 PATENT

A. Brief Description

The '904 patent describes a technique for "improving transmission quality" in which a base station obtains "a proportional relationship among reception qualities corresponding to multiple beams" and generates "a more accurate serving beam for the UE according to the proportional relationship." EX1001, 2:19-24; EX1003, §V (describing additional background knowledge by citing, among others, EX1015, EX1019, EX1020, EX1021, EX1022, and EX1023). To achieve these features, the '904 patent describes a method that includes "receiving a first signaling; receiving a first wireless signal; and transmitting first information." *Id.*, Abstract. In particular, the '904 patent purports to teach, "K antenna port groups are used to transmit the first wireless signal," and "the first signaling is used to determine the K antenna port groups." *Id.*, 1:67-2:1. "[T]he K antenna port groups respectively correspond to K channel quality values," which are "Reference Signal Received Power[s] (RSRP[s])." *Id.*, 2:2-2:3, 3:66-67. "K1 antenna port groups" correspond to "K1 channel quality values of the K channel quality values," where K1 is "less than or equal to the K." *Id.*, 2:4-7. Moreover, "a first proportional sequence corresponds to a ratio(ratios) among the K1 channel quality values," and "the first information is used to determine []the K1 antenna port groups[and] the first proportional sequence[]." *Id.*, 2:7-11. The "K1 channel quality values" include "a first channel quality [that] is a best channel quality value" and "a second channel quality [that] is a worse channel quality value," and "a ratio between the second channel quality and the first channel quality is greater than or equal to [a] target threshold" determined from the first signaling. *Id.*, 2:11-18. The '904 patent further explains that an "antenna port group" may be "composed of one antenna port." *Id.*, 2:47-48, 14:5-6. Notably, the independent claims recite transmitting or receiving "first information," which "is *used to determine*…the first proportional sequence," but without requiring the proportional sequence to be sent as part of the recited first information. *Id.*, 27:20-21, 27:37-39 (emphasis added); EX1003, ¶¶54-55.

B. Prosecution History

Only double patenting rejections were issued, which were addressed by terminal disclaimers with respect to claims 1-20 of the parent, namely, US 10,951,271 (the '271 patent). EX1002, 492-500 (Notice of Allowance).

During prosecution that led to the parent '271 patent, the Applicant argued that prior art (e.g., US9,520,973 ("Kim-973")) teaches parameters that "**do not depend on the results of channel measurement nor do they include channel quality information such as RSRP or SINR**" whereas "the first proportional sequence of the claims is calculated based on the results of channel measurements indicated by channel quality values of RSRP or SINR." EX1007, 464 (Applicant-Response) (emphasis original). Applicant further argued that Kim-973 teaches "a threshold of **delay spread or Doppler**," rather than "a threshold of a ratio between two channel qualities such as **RSRP and SINR**." *Id.*, 464-65 (emphasis original). The Examiner subsequently allowed the claims, stating: "prior art of record…appears to fail or fairly show or suggest…novel and unobvious limitations of [1.d], as recited in group claims 1-5 and 11-15; and [6.d], as recited in group claims 6-10 and 16-20." *Id.*, 479-485 (Notice of Allowance).

But as already recognized by the Office and demonstrated by this Petition, all of the recited features of the '904 claims are "not patentably distinct from the ['271] claim(s)," and were known in the art. EX1002, 440; EX1003, ¶¶56-58. If the Examiner had considered more pertinent prior art, such as Kim, Chen, Liu, or Park, the '904 claims would not have issued in their current form. *Id.*

IV. LEVEL OF ORDINARY SKILL

A person of ordinary skill in the art at the time of the '904 patent ("POSITA") would have had 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. EX1003, ¶¶29-32; ¶¶10, 16. Additional years of experience could substitute for an advanced-level degree (and vice versa). *Id*.

V. CLAIM CONSTRUCTION

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

Phillips v. AWH Corp., 415 F.3d 1303 (Fed. Cir. 2005); 37 C.F.R. §42.100. Especially in view of the similarity between the '904 patent specification's few examples and the prior art (e.g., Kim), the challenged claims are rendered obvious under any reasonable construction that is consistent with the specification, as explained *infra* §VI.A.4.[1.d1] (e.g., Kim demonstrates multiple antenna port groups are used for CSI-RS transmission (***transmitting the first wireless signal*** under Element [1.d1]), just like the '904 patent description), and [1.d5] (e.g., Kim provides "not only indexes of a maximum of M CSI-RSs…but also the RSRP estimation result of the corresponding CSI-RS," both of which satisfy the recited "***proportional sequence that corresponds to a ratio (ratios)***"). EX1003, ¶¶25, 88, 108.

Accordingly, and because "claim terms need only be construed to the extent necessary to resolve the controversy," no formal constructions are necessary in this proceeding, *Wellman, Inc. v. Eastman Chem. Co.*, 642 F.3d 1355, 1361 (Fed. Cir. 2011)[1].

That said, because Patent Owner proposed constructions of language similar to Elements [1.d1] and [1.d5] in an earlier proceeding involving a family member of

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[1] Petitioner is not conceding that each claim satisfies all statutory requirements, nor waiving any arguments concerning claim scope or grounds that can only be raised in district court.

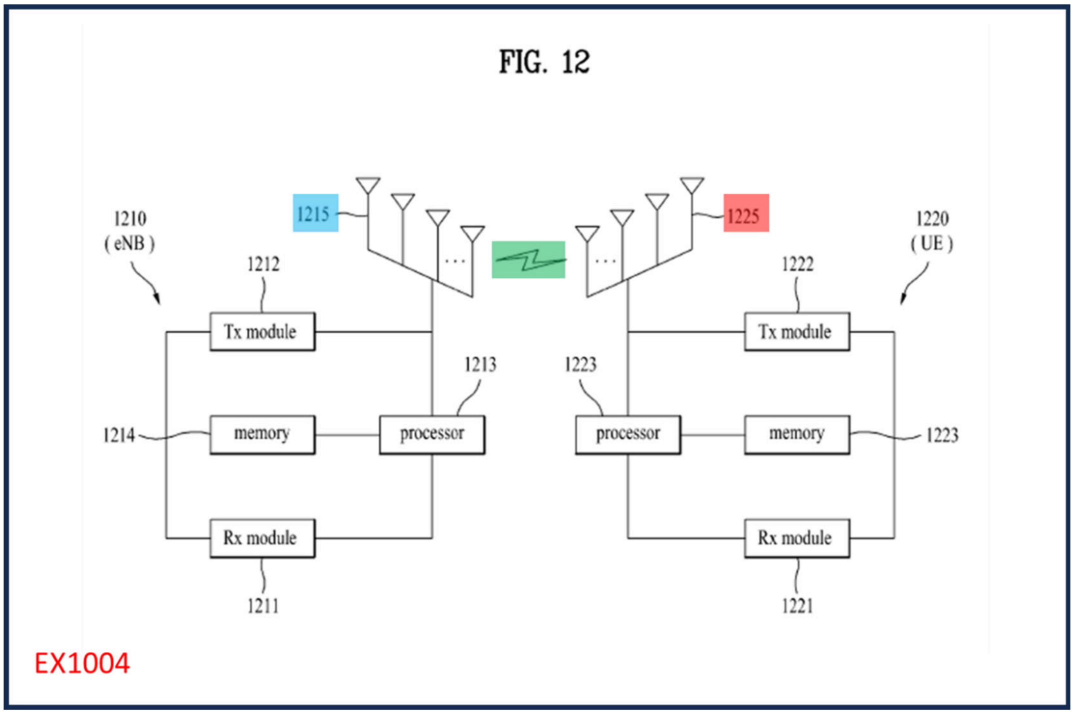
the '904 patent, (i.e., IPR2023-00747, Paper 14, 11-13), despite the absence of a need to construe, to resolve issues of invalidity relative to the comprehensive prior art advanced by this petition, and despite the readily apparent plain and ordinary meaning attributable to non-ambiguous claim terms recited by the Challenged Claims, Petitioner provides further analysis of interpretations applicable to key terms within its element-by-element analysis below, including discussion of alternative constructions that it proposes if construction is deemed necessary.

VI. THE CHALLENGED CLAIMS ARE UNPATENTABLE

A. GROUND 1 – Claims 1-20 Rendered Obvious by Kim and Chen

1. Kim (EX1004)

Like the '904 patent, Kim "relates to a wireless communication system" and "a method and apparatus for performing measurement report[s]" in MIMO systems. EX1004, [0001], [0053], [0102]. In FIG. 12 (below), Kim depicts a "UE device 1220" that "include[s] an Rx module 1221, a Tx module 1222,…and a plurality of antennas 1225," and a "BS [base station] device 1210" that "include[s] a reception (Rx) module 1211, a transmission (Tx) module 1212,…and a plurality of antennas 1215." *Id.*, [0174], [0177]. The "plurality of antennas" of the base station and UE indicate the devices "supporting MIMO transmission and reception." *Id.*



EX1003, ¶¶59-60 (EX1004, FIG 12 (annotated)).

Kim's base station transmits, to the UE, signaling that includes "CSI-RS [Channel State Information-Reference Signal] config information element[s]," such as "antennaPortsCount-r10" that "indicates the number of antennas" used for transmitting CSI-RS signals to the UE. EX1004, [0079-80], Table 3. In one example, Kim's base station "inform[s] the UE of specific information through RRC [Radio Resource Control] signaling," including "CSI-RS configuration" information that identifies an "antenna port pair" transmitting a particular CSI-RS signal. *Id.*, [0142]. These reference signals "may be transmitted through 1, 2, 4 or 8 antenna ports" of the base station, and each CSI-RS "may be mapped to REs [Resource Elements of a Resource Block ("RB")] on a per-antenna port basis." *Id.*, [0071],

[0074], [0076]. When receiving the CSI-RSs from the base station, "the UE performs RSRP measurement reporting" of the received signals and transmits a measurement report back to the base station. *Id.*, [0111]. Kim's "UE may report… indexes of a maximum of M CSI-RSs" having a "ratio (RSRP_n/max(RSRP_i))… which is higher than a predetermined threshold value" and "the RSRP estimation result of the corresponding CSI-RS." *Id.*, [0135-136] ("measurement report value for the n-th CSI-RS" can be "the ratio of the n-th CSI-RS average Rx power level to the best CSI-RS average Rx power level"), [0148-149].

2. Chen (EX1006)

Like the '904 patent, Chen relates to "a wireless communication system where "a transmit end and a receive end use a spatial multiplexing to obtain a higher data transmission rate by using a plurality of antennas." EX1006, 1-3 ("massive MIMO technology"). Chen particularly describes "a channel information feedback method" in which a UE receives and detects "pilot signals from the N pilot ports" of a base station, selects "K pilot ports from the N pilot ports according to received signal quality, and feeds back channel information of channels formed by the K pilot ports" to the base station. *Id.*, 3.

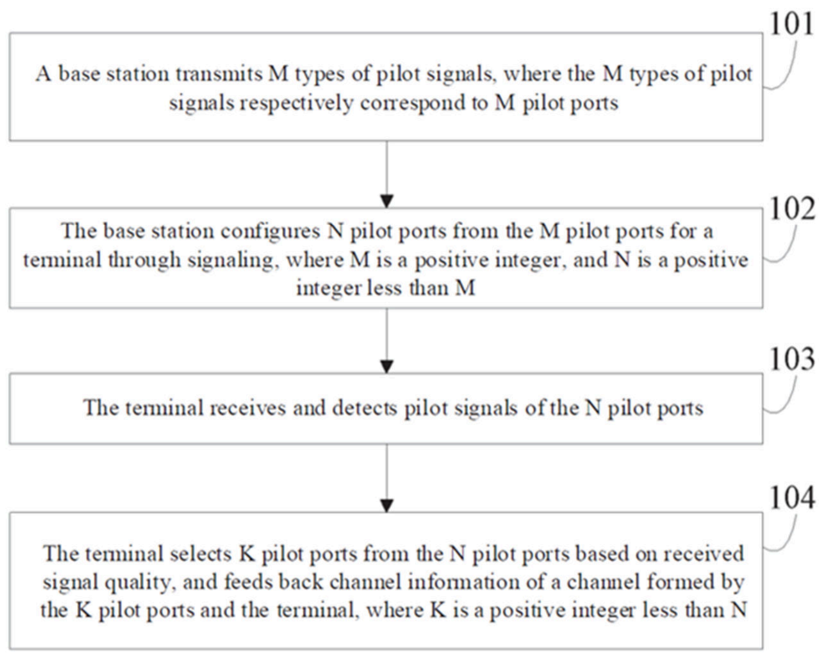


FIG. 1

EX1003, ¶¶61-62 (EX1006, FIG. 1).

According to Chen, a base station configures "the N pilot ports from the M pilot ports for the terminal based on terminal information reported by the terminal." EX1006, 10, FIG. 1 (above). The terminal (UE) receives and detects "pilot signals from the N pilot ports" and detects the N pilot signals of the N pilot ports based on the port information, to obtain received power corresponding to the N types of pilot signals.. *Id.*, 11, FIG. 1. "[T]he terminal selects K pilot ports from the N pilot ports based on the received power corresponding to the N types of pilot signals, and "sends channel information of the K pilot ports to the base station," where the K pilot ports are selected "based on a power threshold configured by the base station." *Id.*, 12, FIG. 1. Chen expressly discloses that the pilot ports and threshold are configured by the base station to the UE. *Id.*, Abstract, 9, 16, 19, 21. Chen's "power threshold," whether "a relative threshold or an absolute threshold," is "configured by the base station," (*id.*, 12, 20, 22), which would be through a form of signaling from the base station to the UE. EX1003, ¶62. One example of Chen's "relative threshold" is based on a "power ratio," i.e., determining whether "the ratio of the received power of the pilot signal of the selected pilot port to the maximum received power is greater than or equal to the preset threshold value." EX1006, 12-13; EX1003, ¶62.

3. Predictable Combination

A POSITA would have found it obvious to have the base station configure the relative threshold used by the UE, in accordance with Chen's suggestions, when implementing a MIMO system in accordance with Kim, to achieve known benefits. EX1003, ¶63. As further explained below, multiple reasons would have prompted a POSITA to combine Kim and Chen. *Id.*

A POSITA would have been motivated to combine Kim and Chen to implement the base station to configure the relative power threshold used by the UE, as taught by Chen, using a RRC signaling originated from the base station side, as taught in Kim, facilitating seamless operational control. EX1003, ¶64. Kim already teaches that "different threshold values may be signaled to the UE" by the base station. EX1004, [0163]. While Kim does not expressly enumerate the power threshold as one of the "different threshold values," Chen, also directed to measurement report of antenna ports, expressly teaches "a power threshold configured by the base station," where the power threshold can be "a relative threshold" (e.g., a "power ratio" such as RSRP ratio just like the one Kim uses). EX1006, 4, 5, 7-9, 12-13. In the combined system, the threshold values "signaled to the UE," as taught in Kim, include the power threshold, in accordance with Chen's suggestions. *Id.*, Abstract, 10, 16, 19, 21; EX1004, [0135-136]; EX1003, ¶64.

Based on Kim's description, a POSITA would have found it obvious for Kim's UE to know and utilize a predetermined threshold value when identifying "M CSI-RSs (the RSRP ratio (RSRP_n/max(RSRP_i)) of which is higher than a predetermined threshold value) from among N CSI-RSs." EX1004, [0148]. And, a POSITA would have found obvious that the base station beneficially provides such a threshold. EX1003, ¶65 (noting static configuration does not facilitate dynamic adjustment and hence not beneficial for mobile communication). Kim already teaches that "N, M, [and other parameters] may be signaled to the UE through RRC signaling" provided by the base station. *Id.*, [0148]. Adding the threshold value to the RRC signaling would have been operationally convenient because it requires no extra signaling mechanism, while providing the essential parameter for UE's continued operation, namely, the threshold value based on which better quality antenna ports can be identified. EX1003, ¶65 (further citing corroborating reference EX1014 ("Ng") (US20160218778A1) at [0152] ("The threshold can be configured by higher layer signaling (e.g., by radio resource control (RRC) signaling) by the network")). Indeed, such a technique was well known in the art. EX1003, ¶66 (additionally citing EX1012 ("Liu"), 16-17, 22-23). Moreover, a POSITA would have been prompted to implement Kim's system such that the first signaling (i.e., RRC signaling) is used to determine a target threshold. Doing so would have predictably facilitated enhanced control by the base station of the distribution of wireless signals selected by UEs. EX1003, ¶66. Overall system performance and consistency would have been improved by facilitating system balancing and scheduling through predictably signaling the UEs to select, e.g., the antenna port groups that provide corresponding signals with adequate quality (i.e., satisfying the target threshold). *Id.*

More, a Kim-Chen combination would have been motivated because it would have involved the application of known techniques (the base station configuring the relative power threshold used by the UE) to a known system (Kim's MIMO system) ready for improvement to yield predictable results (benefits articulated above). *KSR International Co. v. Teleflex Inc.* 550 U.S. 398, 416-417 (2007) ("[W]hen a patent 'simply arranges old elements with each performing the same function it had been known to perform' and yields no more than one would expect from such an arrangement, the combination is obvious."). EX1003, ¶67. A POSITA would have had a reasonable expectation of success at combining Kim's MIMO system with features from Chen because doing so merely involves "the predictable use of prior art elements according to their established functions" to "yield predictable results" such as using RRC signaling to additionally provide power threshold value to the UE) while the fundamental operations of Kim's MIMO system remain intact. EX1003, ¶67. To be clear, Kim and Chen describe analogous subject matter in the same field of endeavor of the '904 patent and pertinent to common challenges faced by the '904 patent, for the reasons noted above. *Id.*

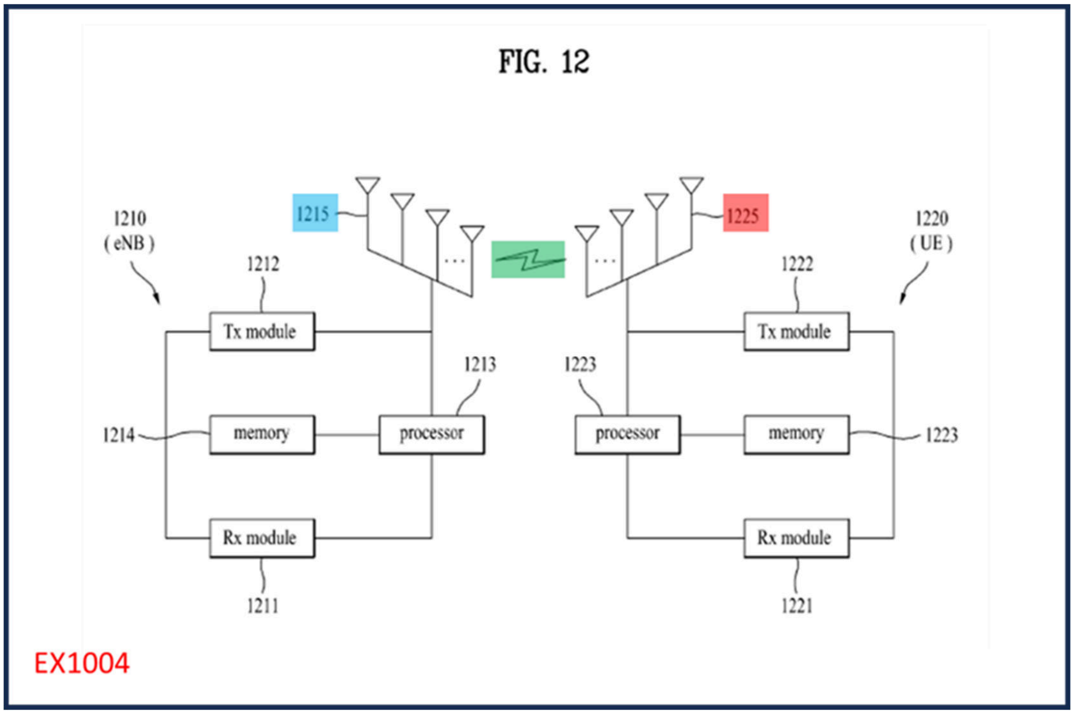
4. Application to Challenged Claims

(a) Claim 1

[1.pre]:

To the extent the preamble is limiting, the Kim-Chen combination renders it obvious. For example, Kim describes "***a method*** for a terminal carrying out a measurement report in a wireless communication system." EX1004, Abstract, [0001]. As illustrated in FIG. 12 (below), Kim's base station and UE each engage in multi-antenna transmission where multiple antennas at a base station ("BS" or "eNB") transmit to a terminal ("UE") and multiple antennas at the UE transmit to the base station. *Id.*, [0174], [0177], [0036]. Kim's UE and base station are "device[s] for supporting MIMO transmission and reception" where "UE device

1220" includes an "Rx module 1221," "Tx module 1222," and "a plurality of antennas 1225," and the "BS device 1210" includes a "reception (Rx) module 1211," "transmission (Tx) module 1212," and "a plurality of antennas 1215." *Id.*, [0174], [0177].



EX1003, ¶68 (citing EX1004, FIG. 12 (annotated))

Kim explains that "[i]f data is transmitted and received using multiple antennas, a channel state between each transmission antenna and each reception antenna should be known in order to accurately receive a signal." EX1004, [0053]. To probe each channel state, Kim discloses using "a reference signal per transmission antenna and, more particularly, per antenna port." *Id.*, [0069-81] ("Channel State Information-Reference Signal (CSI-RS)"), FIG. 6. Kim's method of transmission provides "a measurement report based on various reference signals (RSs)." *Id.*, [0003]; EX1003, ¶69.

[1.a]:

The Kim-Chen combination renders obvious [1.a]. Among other things, the combination performs [1.a] by having its UE receiving ***first signaling***, e.g., "RRC [Radio Resource Control] signaling" that includes "CSI-RS [Channel State Information-Reference Signal] configuration," originating from the base station. EX1004, [0142], [0146], [0148]. Kim explains that "CSI-RS config information element" signaled to the UE includes "antennaPortsCount-r10," which "indicates the number of antennas needed for CSI-RS transmission (for example, one, two, four, or eight antennas may be selected)," and "resourceConfig-r10," which "indicate[s] a CSI-RS transmission position" such as the "RE [Resource Element] of a single RB [Resource Block]" to be used by the CSI-RS transmission. *Id.*, [0079-81], Table 3 ("CSI-RS-configur-r10"). The "CSI-RS configuration" information in the RRC signaling can also indicate an "antenna port pair" allocated on the base station for the CSI-RS transmission. *Id.*, [0142]; EX1003, ¶70.

In the Kim-Chen combination, the RRC signaling, once received, can be used by the UE to identify a set of antenna port groups for measuring channel quality values. *Id.*, [0146]. For example, the UE measures the RSRP (Reference Signal

Received Power) based on the CSI-RS transmission from the base station and selects and reports the "M CSI-RS values each having the best quality," "where M…may be previously designated by the BS through RRC signaling." *Id.*; EX1003, ¶71.

The RRC signaling used in the Kim-Chen combination thus corresponds to the claimed "***first signaling***" in that it provides CSI-RS configuration information for the UE to determine a set (e.g., N) of antenna port groups on the base station where the CSI-RS transmission qualities of a subset (e.g., M of the N antenna port groups) are measured and the measurement report is fed back to the base station. EX1004, [0148] (UE providing "M CSI-RSs indicating the best RSRP result from among N CSI-RS" where "N, M…may be signaled to the UE through RRC signaling"), [0149] ("maximum of M CSI-RSs (the RSRP ratio (RSRP_n/max(RSRP_i)) of which is higher than a predetermined threshold value) from among N CSI-RSs"); *see also* [0038], [0078]-[0081], [0106], [0110]-[0111], [0119], [0135]-[0136]. Kim's disclosure parallels those of the '904 patent. EX1003, ¶¶72-73 (citing, *e.g.*, EX1001, 3:48-50 ("first signaling is a Radio Resource Control (RRC) signaling"), 3:18-19, 4:15-16).

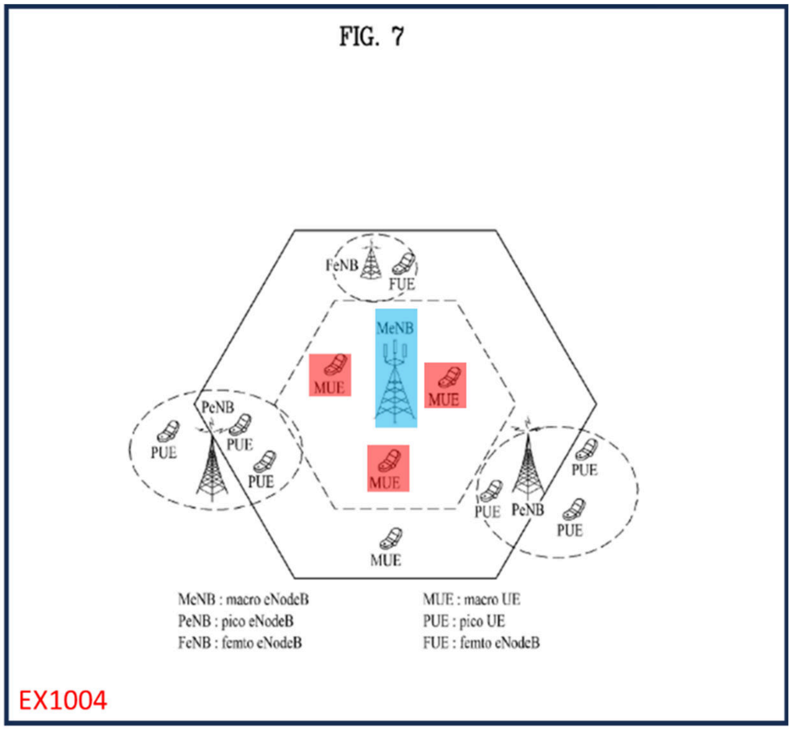
[1.b]:

In the Kim-Chen combination, the UE receives ***a first wireless signal*** (e.g., a set of CSI-RSs (Channel State Information-Reference Signals)), originating from the base station (e.g., the corresponding antenna ports), just like the descriptions from the ’904 patent. EX1004, [0052], [0057-64]; EX1001, 14:16-17 (“the first wireless signal is composed of K beam-formed CSI-RSs”), 3:18-19 (“the first wireless signal is an CSI-RS burst”); EX1003, ¶¶74-75 (explaining a burst can be a set of CSI-RSs).

In Kim, the CSI-RSs constitute a wireless signal originating from the base station because “CSI-RSs may be transmitted through 1, 2, 4 or 8 antenna ports” at the base station to the UE. *Id.*, [0071] (“Antenna port 15 may be used for one antenna port, antenna ports 15 and 16 for two antenna ports, antenna ports 15 to 18 for four antenna ports, and antenna ports 15 to 22 for eight antenna port.”). Each CSI-RS “may be mapped to REs on a per-antenna port basis” at the base station for transmission. *Id.* [0074], [0076], FIG. 6 (example of mapping antenna ports to REs of one RB). Kim explains that “CSI-RS is an RS used for channel measurement in an LTE-A system supporting up to eight antenna ports on downlink,” but “it is not necessary to transmit CSI-RSs in every subframe.” *Id.*, [0070]. “The UE receives the reference signal [such as the CSI-RSs] to perform channel measurement and data [demodulation].” *Id.*, [0064] (“for acquiring channel information”).

Kim teaches using one base station to transmit the set of CSI-RSs. EX1003, ¶76. In one example, Kim’s “[b]ase station (BS)” includes “a fixed station, a Node B, an eNode B (eNB), an access point (AP) and the like,” and a “‘cell’ may be understood as a base station (BS or eNB)” or “Remote Radio Head (RRH)…, etc.”

EX1004, [0036]. "[C]ells" may be "configured in the form of a distributed antenna or RRH of a single BS," indicating a single base station transmits multiple CSI-RSs to the UE. *Id.*, [0103] (emphasis added). As depicted in the example of FIG. 7 (below), only a single base station (MeNB) services three macro UEs within the cell.



EX1003, ¶76 (citing EX1004, FIG. 7 (annotated)).

Further, even if Kim's express description alone did not reveal a single base station with multiple antenna ports (which it does), the Kim-Chen combination renders this obvious, as further discussed *infra* [1.d1]. EX1003, ¶76.

Accordingly, in a Kim-Chen combination, it would have been obvious for the CSI-RSs from corresponding antenna ports of the base station to provide a ***first wireless signal***, as claimed. EX1004, [0069-81] ("Channel State Information-

Reference Signal (CSI-RS)"); EX1001, 3:18-19 ("the first wireless signal is an CSI-RS burst"); EX1003, ¶78-79.

[1.c]:

In the Kim-Chen combination, Kim's UE transmits to the base station ***first information*** (e.g., a "measurement report" containing such information as antenna port indices, RSRP values, RSRP-to-max(RSRP) ratios based on measuring the CSI-RSs transmission). EX1004, [0149] ("UE may report not only indexes of a maximum of M CSI-RSs (the RSRP ratio (RSRP_n/max(RSRP_i)) of which is higher than a predetermined threshold value) from among N CSI-RSs…but also the RSRP estimation result of the corresponding CSI-RS"); EX1003, ¶80.

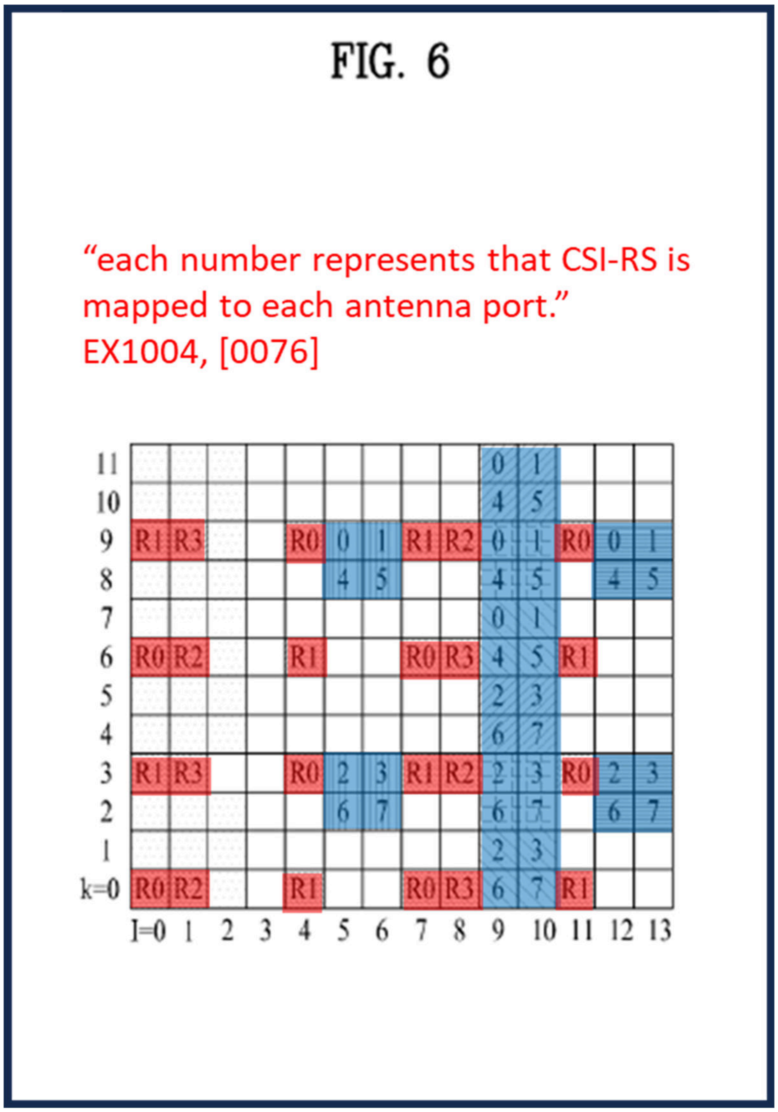
The measurement report "covers Radio Resource Management (RRM) measurement of measuring the signal strengths…of a serving cell…including Reference Signal Received Power (RSRP)." EX1004, [0106] ("a UE may perform…measurement of received signal strength"), [0113] ("CSI-RS based RSRP/RSRQ measurement reporting"), [0136] ("if CSI-RS having the best average Rx power level is selected from among a plurality of CSI-RSs, the measurement report value for the n-th CSI-RS may be defined as the ratio of the n-th CSI-RS average Rx power level to the best CSI-RS average Rx power level"), [0148-149] ; EX1003, ¶81.

In the Kim-Chen combination, the "measurement report" is just like the '904 patent specification, which recites this conventional technique. EX1003, ¶¶82-83 (citing EX1001, 4:3-10 ("the first information…indicates the K1 antenna port groups" and "indicates the first proportional sequence") and citing as corroboration EX1010 ("Park"), [368-378] (UE reports RSRP of antenna ports)).

[1.d]/ [1.d1]:

In the Kim-Chen combination, it would have been obvious to use ***K antenna port groups*** of the base station ***to transmit the first wireless signal*** (e.g., composed of a set of CSI-RSs). EX1004, [0057-0063], [0076], [0053]; *supra* Element [1.b]; EX1003, ¶84. The antenna port groups are identified by corresponding Resource Elements ("REs") of the transmitting base station. EX1004, [0079-81]; EX1003, ¶84.

In more detail, Kim states that the CSI-RSs "may be transmitted" to the UE "through 1, 2, 4 or 8 antenna ports" of the base station. *Id.*, [0071]. In FIG. 6 (below), Kim illustrates an example in which the base station identifies ***K*** CSI-RS antenna port groups using configuration information. EX1004, [0076]. In this example, "CSI-RSs are mapped to REs on a per-antenna port basis according to a specific CSI-RS configuration," where "each number represents that CSI-RS is mapped to each antenna port." *Id.*; *see also* [0048] ("One resource block [depicted in the example of FIG. 2] includes 12×7 resource elements," namely, "12 subcarriers in frequency domain." *i.e.*, the y-axis, and as shown in FIG. 6 below, "7 OFDM symbols" in time domain, *i.e.*, the x-axis).



EX1003, ¶85 (citing EX1004, FIG .6 (annotated)).

As illustrated in FIG. 6 (above), "RE denoted by 0 or 1 may be mapped to CSI-RS corresponding to antenna port 0 or 1," and so on for each of the antenna ports 0 through 7 (e.g., 8 antenna port groups in hatch patterns). EX1004, [0076] ("each number represents that CSI-RS is mapped to each antenna port"). Kim also states that "R0 to R3 [in shaded patterns] denote that CRS are mapped to [four] respective antenna ports" according to "the number of transmit antennas of the base station." *Id.*; *see also id.*, [0065] ("The CRS…is transmitted per subframe"), [0070] ("not necessary to transmit CSI-RSs in every subframe"); EX1003, ¶86 (explaining that CRS and CSI-RS are both reference signals for measurement purposes). Moreover, in cases where a pair (group) of two CSI-RS antenna ports are "mapped to the same RE," the CSI-RS corresponding to each antenna port in the pair "may be identified by different orthogonal codes." *Id.*, [0076], [0132] ("CSI-RS of the CDM (Code Division Multiplexing)-processed antenna pair"). Thus, in Kim, for example, a CSI-RS involves using an "antenna port group" having (1) one antenna port per group or (2) an antenna port pair having two antenna ports per group. *Id.*; EX1003, ¶86.

Significantly, Kim's example performs transmission of a first wireless signal (e.g., composed of a set of CSI-RSs) emanating from corresponding antenna ports. Here again, this is like the '904 patent's example in which each "antenna port group includes only one antenna port," (EX1001, 14:5-6), each "antenna port corresponds to a reference signal," (*id.*, 2:58-59), and each "reference signal is a Channel State Information Reference Signal (CSI-RS)," (*id.*, 3:5-6). EX1003, ¶87. Moreover, the '904 patent describes examples in which "the first wireless signal is composed of K beam-formed CSI-RSs" using "K different analog beamforming vectors," where the K beamformed CSI-RSs respectively "correspond[] to [the] K antenna port groups." EX1001, 14:16-17, 3:29-31,3-4; *see also id.*, 3:5-6, 3:25-28, 14:3-8. Here again, Kim's disclosure parallels the '904 patent's examples.

The '904 patent also explains "the first wireless signal is an *CSI-RS burst*" and "is composed of the *K reference signal groups*" that "are *respectively* transmitted through the K antenna port groups," where each "reference signal group" may include "only one reference signal." *Id.*, 3:18-19, 3:25-28, 14:7-8 (emphases added); *see also id.*, claim 5. In fact, it was conventional to perform a CSI-RS transmission as a set of CSI-RS signals. EX1003, ¶87 (citing as corroboration EX1012 ("Liu") at 1, 15, FIG. 1 with further description of beamforming that applies precoding matrix on each antenna port and generates the set of CSI-RSs).

Figure 6 of Kim illustrates multiple antenna port groups are used for CSI-RS transmission (***transmitting the first wireless signal***). EX1003, ¶88. Kim's FIG. 12 shows <u>one base station</u> ("BS device 1210" with "a plurality of antennas 1215") engaging in multi-antenna communication with a UE ("UE device 1220"). EX1004, [0173-179]. Kim follows up by stating: "The specific configurations of the BS device and the UE device [of FIG. 12] may be implemented such that the various embodiments of the present invention [including FIG. 6] are performed independently…." *Id.*, [0180], *see also* [0103] ("[C]ells" may be "configured in the form of a distributed antenna or RRH of a single BS"). Therefore, Kim teaches [1.d1]. EX1003, ¶88.

To be clear, the plain and ordinary meaning of [1.d1] was readily understandable to a POSITA, and thus construction is not believed necessary. *Supra*, §V (Claim Construction). Alternatively, if construed, Kim-Chen likewise renders obvious [1.d1] for the reasons described herein, as construction of [1.d1] must take account of the context of the claim language and the specification. For example, as set forth in the '904 specification, a first wireless signal includes one or more sub-components, of which CSI-RSs are provided as an express example in which "the first wireless signal is composed of K beam-formed CSI-RSs" using "K different analog beamforming vectors," where the K beamformed CSI-RSs respectively "correspond[] to [the] K antenna port groups." EX1001, 14:16-17, 3:29-31,3-4; *see also id.*, 3:5-6, 3:25-28, 14:3-8 ("antenna port group includes only one antenna port"). Thus, the Kim-Chen combination likewise renders obvious [1.d1] construed consistent with the specification, for the same reasons described above, based on Kim's description of multiple antenna port groups that are used to transmit CSI-RSs. EX1003, ¶88.

Kim's MIMO system can include "a multi-cell environment" where "[a] UE can receive data from multi-cell base stations collaboratively using the CoMP system." EX1004, [0092], [0100]; *see generally* [0090-100] (explaining "Coordinated Multi-Point").

Even if Kim did not expressly delineate K antenna port groups of a single base station (which is not recited by claim 1) being used to transmit the first wireless signal (which it does), would have found it obvious to configure Kim's MIMO system to use a single base station equipped with a multitude of antenna port groups, as specifically taught in Chen, to improve transmission range and communication quality of Kim's MIMO system. EX1003, ¶¶89-90. Kim already describes a MIMO system having a serving cell with only one base station to service UE devices. EX1004, [0036] ("The term 'cell' may be understood as **a** base station (BS or eNB), a sector, a Remote Radio Head (RRH), a relay, etc. and may be a comprehensive term capable of identifying a component carrier (CC) at a specific transmission/reception (Tx/Rx) point"); EX1003, ¶90. As explained *supra* §V.A.2, Chen discloses that "a large-scale antenna array is configured on a base station side, for example, 100 antennas or more antennas are configured." EX1006, 2. Chen describes the same transmission and reporting process as Kim, where "a base station transmits M types of pilot signals" using "M pilot ports," where "N pilot ports" of the M ports are configured for and identified to the UE by the base station so that the UE "receives and detects pilot signals from the N pilot ports" and selects a subset of pilot ports to report to the base station. Chen, Abstract, 3-5, 11, 13, 18-19. Chen teaches forming N pilot ports by virtualization of a same group of antennas, EX1006, 3, 5, 7, 9, 16, which a POSITA would have understood as a group of antennas at a single base station. EX1003, ¶90.

Inspired by Chen's express teachings, a POSITA would have been motivated to utilize multiple antenna port groups, in a serving cell with only one base station, as already envisioned by Kim (e.g., [0036], FIG. 7 (below)), to optimize transmission to various UEs within range of the base station. *First*, multiple antenna ports would have added up to provide more transmitted power, thereby facilitating improved signal reception at each UE so that the base station can provide improved transmission to the UEs within its broadcast range, as revealed in Kim and Chen, and confirmed by Liu, Park, and the 3GPP standards as conventional activities. EX1004, [0103]; EX1006, 6-7, 9, 11, 15, 22; EX1012, 4, 20, 22; EX1010, [0206], [0208], [0205-222]; EX1013, 155, 167, 169, 654; EX1015. For example, it was well known that data transfer rate can be increased when the number of transmitting antennas is higher or using transmit diversity. EX1006, 1; EX1008 ("Afroz"), 115, 118, 120, 122, FIG. 7; EX1003, ¶¶91-92.

Second, multiple antenna ports would have facilitated each UE to measure the received signal strengths of the full set of antenna ports and select a subset of antenna ports that result in better reception quality at the UE, which would have accommodated dynamic selection of antenna ports to improve, e.g., data throughput, which has been shown to be generally proportional to the signal strength, RSRP, and SNR. EX1006, 4, 6, 7, 9, 11, 15, 22; EX1008 ("Afroz"), 115, 118, 120, 122, FIG. 7; EX1003, ¶93.

Moreover, a POSITA would have a reasonable expectation of success at combining Kim's MIMO system with these features from Chen because doing so merely involves "the predictable use of prior art elements according to their established functions" (e.g., single base station with a multitude of antenna ports) to "yield predictable results" (e.g., transmitting pilot signals from respective antenna port groups at a base station) without more while the fundamental operations of Kim's MIMO system remain intact. *KSR*, 550 U.S. 398, 416-417; *supra*, §VI.A.3; EX1003, ¶¶94-95.

[1.d2]:

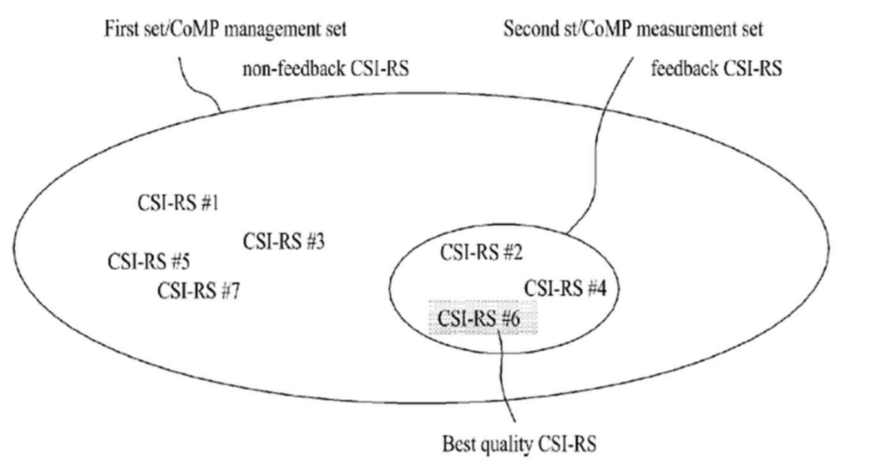
In the Kim-Chen combination, Kim's UE uses RRC (***the first signaling***) ***to determine the K antenna port groups*** that will be ***transmitting*** the set of CSI-RSs (***first wireless signal)***, which K antenna port groups are identified in the Resource Block by the corresponding Resource Elements ("REs"). *Supra* Elements [1.a] and

[1.d2]. In Kim-Chen, 2, 4, or 8 antenna ports are used for CSI-RS transmission, thus rendering obvious K as a positive integer greater than 1. *Id.;* EX1003, ¶96.

In more detail, Kim explains that the base station "may inform the UE of specific information through RRC signaling," including "CSI-RS configuration" information. EX1004, [0142]. For example, the UE receives, from the base station, first signaling, such as "CSI-RS config information element[s]," which includes "antennaPortsCount-r10" that "indicates the number of antennas needed for CSI-RS transmission (for example, one, two, four, or eight antennas may be selected)," and "resourceConfig-r10" that "indicates which RE [Resource Element] located on time-frequency frequencies" is used for the CSI-RS transmission. *Id.*, [0079-81], Table 3. The base station uses this signaling information to "designate[] a plurality of configurations of CSI-RSs" to be measured and "inform[] the UE" of the CSI-RSs to be measured. *Id.*, [0119], [0111], [0137] ("BS [base station] independently designates the number of antenna ports to be used for RSRP measurement according to each CSI-RS configuration"), [0142] (base station "inform[s] the UE of specific information through RRC signaling" to indicate CSI-RS configuration and antenna ports), [0143], [0146-148] (CSI-RS "previously designated by the BS through RRC signaling" and "N, M, T1, and T2 may be signaled to the UE through RRC signaling"); EX1003, ¶97.

The antenna port groups specified for CSI-RS measurements may include a "management set" of transmitted signals where the subset or "measurement set" meeting a particular criterion (such as RSRP ratio threshold, *infra* Element [1.d5]) is reported back to the base station. EX1004, [0130]. Kim's FIG. 9 (below) illustrates an example where the management set of CSI-RS #1-#7 is identified by the base station for reporting RSRP values in the configuration information to the base station, and the measurement set of CSI-RS #2, CSI-RS #4, and CSI-RS #6 is measured and the measurement values are reported back to the base station. *Id.*, [0111] ("BS sets configurations of [CSI-RSs] each of which will perform RSPR [sic: RSRP]…measurement…, and informs the UE of the resultant configurations," and UE "perform[s] RSRP…measurement of CSI-RSs transmitted from cells contained in the CoMP management set" and reports those where "the measurement result satisfies a specific condition"), [0119] ("BS designates a plurality of configurations of CSI-RSs to be RSRP/RSRQ-measured as a CoMP management set"), [0136], [0148]-[0149].

FIG. 9



EX1003, ¶¶98-99 (citing EX1004, FIG. 9)

[1.d3]:

The Kim-Chen combination renders obvious [1.d3]. Indeed, Kim discloses that each of the antenna ports transmitting the CSI-RSs has a corresponding ***channel quality value*** (e.g., ***RSRP***). EX1004, [0111], [0132], [0135], [0148-149]. In Kim, the RSRP is measured in milliwatts (mW), which are ***non-negative real numbers***. *Id.*, [0135].

After receiving the configuration information used to determine the K antenna port groups (*supra* [1.d2]), "[t]he UE may perform RSRP…measurement of CSI-

RSs transmitted from cells contained in the CoMP management set." EX1004, [0111]. "If the measurement result satisfies a specific condition, the UE may perform reporting." *Id.*, [0136], [0148-149].

"[T]he UE may report…indexes of a maximum of M CSI-RSs (the RSRP ratio (RSRP_n/max(RSRP_i)) of which is higher than a predetermined threshold value) from among N CSI-RSs contained in the CoMP management set," as well as "the RSRP estimation result of the corresponding CSI-RS." EX1004, [0149]. To determine the "M CSI-RSs" (reported measurement set) from among the "N CSI-RSs" (management set), the UE determines the RSRP (channel quality value) of each of the N CSI-RSs in the management set. *Id.*, [0111], [0148-0149]. Here, each of Kim's N antenna port groups in the management set (K antenna port groups) has a corresponding channel quality RSRP value that is non-negative real numbers (e.g., measured in mW). *Id.*, [0135]; EX1003, ¶¶100-103.

[1.d4]:

As explained *supra* [1.d3], in the Kim-Chen combination, Kim renders obvious measuring ***K antenna port groups*** (e.g., management set of N antenna ports) that have real, non-negative RSRP channel quality values. Kim also discloses ***K1 antenna port groups of the K antenna port groups*** (i.e., the measurement set of M antenna port groups included within the N antenna port groups) by reporting "a maximum of M CSI-RSs (the RSRP ratio (RSRP_n/max(RSRP_i)) of which is higher than a predetermined threshold value) from among [the] N CSI-RSs contained in the CoMP management set" to the base station. EX1004, [0149]. The M reported RSRP values (measurement set) of Kim correspond to the ***K1 antenna port groups*** each with a measured RSRP ratio that is "higher than a predetermined threshold value. *Id.*, [0111], [0136]. Because "a maximum of M" CSI-RS port groups are reported, and M is "a maximum" number selected "from among N" antenna ports, M is a positive integer less than or equal to N. *Id.*, [0149]. Thus, a Kim-Chen combination renders obvious ***K1 antenna port groups of the K antenna port groups having K1 channel quality values*** (e.g., M RSRP of measured N CSI-RSs), where the ***K1*** (e.g., M) is ***a positive integer less than or equal to the K*** (e.g., N). EX1003, ¶104.

[1.d5]:

As explained *supra* [1.d4], Kim renders obviousreporting the K1 antenna ports that satisfy "the RSRP ratio" (when measured from the CSI-RS on a corresponding antenna port group and compared to the maximum received RSRP) being "higher than a predetermined threshold value." EX1004, [0149], [0136]. To qualify for reporting, an assessment is made of "the RSRP ratio (RSRP_n/max(RSRP_i)) based on "Equation 4" which provides: "RSRP_ *n*/max(RSRP_*i*)>Threshold." *Id.*, [0149], [0136]. Kim reported "not only indexes of a maximum of M CSI-RSs…but also the RSRP estimation result of the corresponding CSI-RS." *Id.* [0149]. As explained below, both the indexes and the RSRP estimation results (for the set of CSI-RSs) qualify for the claimed "proportional sequence [that] corresponds to a ratio (ratios)," consistent with the specification of the '904 patent.

Kim's report includes a sequence of indexes of the antenna port groups, which provide the claimed ***first proportional sequence that corresponds to a ratio(ratios) among the K1 channel quality values***—Kim teaches reporting the indexes of those antenna port groups (e.g., a maximum of M) that correspond to CSI-RSs with RSRP measurement values "higher than a predetermined threshold value." EX1004, [0149]. Indeed, this is consistent with the description of the '904 patent (EX1001, 14:52-54 ("the first proportional sequence is composed of K1 non-negative real numbers not greater than one")). EX1003, ¶¶105-106 (noting the indexes are non-negative real numbers).

Kim's report additionally includes "RSRP estimation result of the corresponding CSI-RS" for those qualifying antenna port groups. EX1004, [0149]. The sequence of these RSRP estimation results is based on the RSRP ratios (e.g., "RSRP_*n*/max(RSRP_*i*)," as provided by Equation 4) such that the sequence would be proportional. *Id*, [0149]. Kim expressly states that "measurement report value for the n-th CSI-RS may be defined as the ratio of the n-th CSI-RS average Rx power level to the best CSI-RS average Rx power level." *Id.*, [0136]. For this reason, the sequence of these RSRP estimation results, which are non-negative real numbers and indexed by the antenna port group numbers, also qualify for the claimed ***first proportional sequence that corresponds to ratios among the K1 channel quality values***. EX1003, ¶107 (noting ubiquitous to report a sequence of measurement values according to a logical order such as based on antenna port indexes by citing EX1010 ("Park") at FIG. 12.

Significantly, the plain language of Element [1.d5] recites that the proportional sequence "***corresponds to***" ratios. EX1001, 27:40-42. Moreover, dependent claims 2, 7, 12, and 17 recite the "first proportional sequence comprises *quantized values* **corresponding to** [K1/K1-1] positive real numbers," rather than the proportions or ratios. *Id.*, 27:60-28:8, 29:12-27, 30:32-47, 31:50-32:16.

The Kim-Chen combination renders obvious [1.d5] based on its plain and ordinary meaning, which was readily understandable to a POSITA, and thus construction is not necessary. *Supra*, §V (Claim Construction). Alternatively, even if construction were considered necessary, the Kim-Chen combination likewise renders obvious [1.d5] for the same reasons described above. Here again, construction of [1.d5] must take account of the context of the claim language and the specification, including dependent claims that further inform the meaning, which confirm that the sequence can have a number other than exactly K1 values, and describe examples that the "first proportional sequence comprises quantized values corresponding to [K1/K1-1] positive real numbers." *See* EX1001, 27:35-28:8, 29:12-27, 30:32-47, 31:50-32:16. Thus, the Kim-Chen combination likewise renders obvious [1.d5] construed consistent with the specification, for the same reasons described above. EX1003, ¶¶108-109.

[1.d6]:

Kim-Chen renders obvious [1.d6]. As explained *supra* [1.c] & [1.d5], in the Kim-Chen combination, ***the first information*** (antenna port indices, RSRP values, and RSRP-to-max(RSRP) ratios), once received by the base station, is used by the base station to determine the ***K1 antenna port groups*** (e.g., the M reported antenna port groups satisfying the threshold of Equation 4) and the ***first proportional sequence*** (e.g., the proportional sequence of RSRP-to-max(RSRP) values) in that both are contained in the first information. EX1004, [0149] ("the UE may report not only indexes of a maximum of M CSI-RSs…from among N CSI-RSs contained in the CoMP management set, but also the RSRP estimation result of the corresponding CSI-RS"), [0148], [0150]; EX1003, ¶¶110-111.

[1.d7]:

Kim-Chen renders obvious [1.d7]. Kim explains that the UE reports "a maximum of M CSI-RSs (the RSRP ratio (RSRP_n/max(RSRP_i)) of which is higher than a predetermined threshold value) from among N CSI-RSs contained in the CoMP management set" that satisfy "RSRP_n/max(RSRP_i)>Threshold." EX1004, [0149], [0136], [0150-151]. Kim's threshold is a non-negative real number because it corresponds to a ratio between two RSRPs and each RSRP is a "linear value" in milliwatts (mW), which is a positive non-negative real number. *Id.*, [0135-136]. Kim teaches that "different threshold values may be signaled to the UE" by the base station. *Id.*, [0163]. To the extent that Kim is argued to be without specific teaching on how the RSRP ratio threshold (e.g., Equation 4) is determined by the UE, Chen provides the details. EX1003, ¶112.

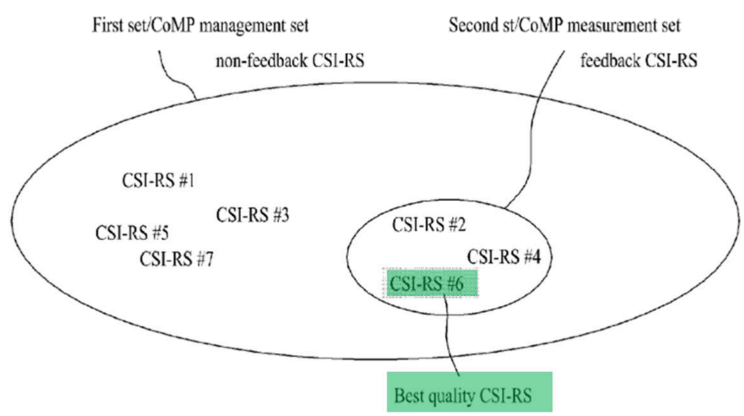
As explained *supra* §V.A.2, Chen teaches that UE selects antenna ports according to "a power threshold configured by the base station" where the power threshold can be "a relative threshold" (e.g., RSRP ratio). EX1006, 7, 9, 11, 13, 16-19 (reporting antenna port "when the ratio of the received power [RSRP] to the maximum received power [max(RSRP)] is greater than or equal to a preset threshold"), 23, 26, 28. Chen's base station configures the pilot signals "through signaling." *Id.*, Abstract, 10, 13, 19, 23, 26.

As explained *supra* §V.A.3, it would have been obvious use the first signaling (e.g., RRC signaling as taught by Kim) to determine a target threshold (e.g., to have the base station configure the relative power threshold used by the UE, as taught by Chen and suggested by Kim's transmitting other threshold values for antenna port selection) to provide seamless operational control. EX1004 [0163]; EX1006, Abstract, 13-14, 16-17, 19-20, 22; EX1003, ¶¶113-115.

[1.d8]:

Kim-Chen renders obvious [1.d8]. As explained *supra* §V.A.1 and [1.b]/[1.d3-1.d5], Kim discloses ***a first channel quality is a best channel quality*** (e.g., "max(RSRP_i)" or "best CSI-RS average Rx power level") ***among the K1 channel quality values*** (e.g., the selected M antenna ports). EX1004, [0136], [0149]. In FIG. 9, *Kim* shows an example for identifying the "[b]est quality CSI-RS" (CSI-RS #6) from "CSI-RSs (#2, #4, #6) contained in the CoMP measurement set." *Id.*, [0119].

FIG. 9



EX1003, ¶116 (citing EX1004, FIG. 9))

Kim discloses ***a second channel quality is a worse channel quality among the selected K1 antenna ports***, such as when RSRP_n is less than max(RSRP_i) while the ratio of RSRP_n/max(RSRP_i) is greater than the threshold value (for example, CSI-RS #2 or #4 in FIG. 9 (above)). EX1004, [0148-149], [0136]. In this example, Kim selects "CSI-RSs (#2, #4, #6)", which correspond to the selected K1 antenna ports, "from among CSI-RSs (#1~#7)." *Id.*, [0119], [0149] ("a maximum of M CSI-RSs"), [0146] ("The UE may periodically report the quality of M CSI-RS values"), [0148]; EX1003, ¶117-118.

[1.d9]:

Kim-Chen renders obvious [1.d9]. As explained *supra* §V.A.1 and [1.d5]-[1.d8], Kim discloses that ***a ratio between the second*** ("worse") ***channel quality*** (RSRP_n) ***and first*** ("best") ***channel quality*** (max(RSRP_i)) ***is greater than a threshold*** (Equation 4's target threshold). EX1004, [0136] ("the measurement report value for the n-th CSI-RS may be defined as the ratio of the n-th CSI-RS average Rx power level to the best CSI-RS average Rx power level"), [0148-149]. Kim's RSRP_n (e.g., CSI-RS #2 or #4) thus corresponds to a second ("worse") channel quality, where the ratio RSRP_n/max(RSRP_i) is greater than the threshold of Equation 4 and thus is one of the M antenna ports being reported in the measurement set. *Id.*, [0136], [0148-149]; EX1003, ¶¶119-120.

[1.d10]:

Kim-Chen renders obvious [1.d10]. As explained *supra* [1.a] and §§V.A.1-2, Kim's ***first signaling is a RRC (Radio Resource Control) signaling***. EX1004, [0146] ("the quality of M CSI-RS values…can be reported" and "M may be predetermined or may be previously designated by the BS through RRC signaling"), [0142] ("the BS or eNB may inform the UE of specific information through RRC signaling"); EX1003, ¶121.

In the Kim-Chen combination, ***the first information is transmitted in a CSI report*** because Kim's "UE may perform RSRP measurements on the CRS and CSI-

RS signals transmitted by the base station and report the RSRP values and RSRP-to-max(RSRP) ratios back to the base station." EX1004, [0113], [0136], [0148-149].

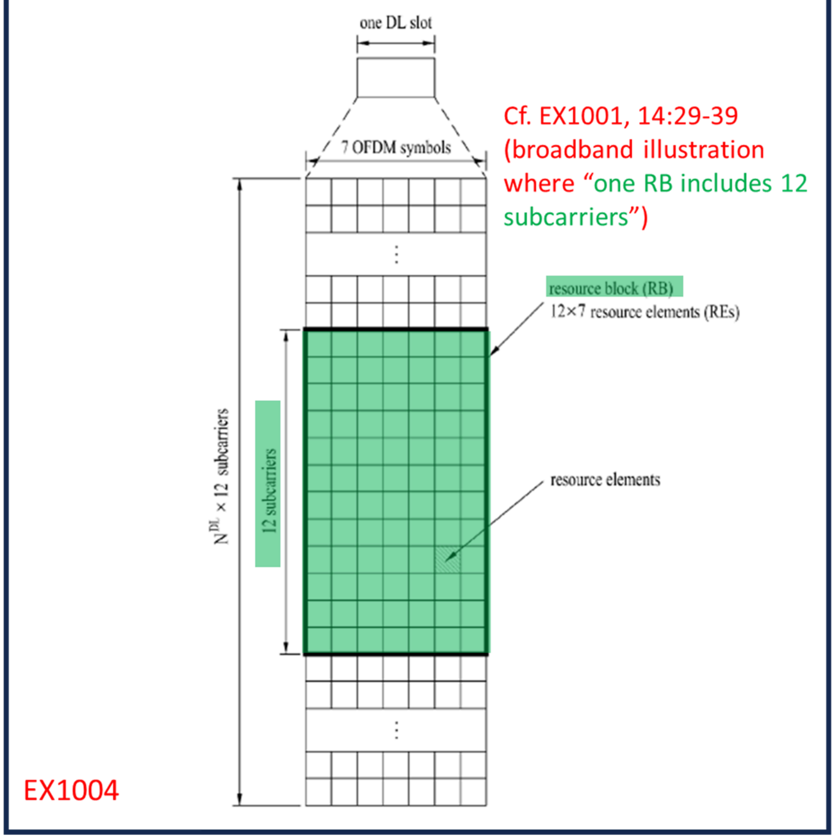
In the Kim-Chen combination, ***the first information is carried by a PUSCH (Physical Uplink Shared Channel) or a PUCCH (Physical Uplink Control Channel)***. Kim provides using an uplink reference signal to convey "channel estimation" from the UE to the base station, e.g., "via a PUSCH and a PUCCH." EX1004, [0055], [0050] (discussing "a physical UL shared channel (PUSCH)…for one user equipment is assigned to a resource block pair (RB pair) in a subframe"). It would have been obvious for the Kim-Chen combination to use one of the PUSCH and PUCCH, as already disclosed in Kim, to carry the CSI-RS measurement report, as provided by *supra* [1.c]/[1.d6], so that the base station is apprised of the results of the measurements by the UE. EX1003, ¶¶122-123. A POSITA would have been motivated to inform the base station of the measurement results when the PUSCH and PUCCH channels present ready-to-use uplink channels for feedbacking the first information to the base station. Doing so would have a reasonable expectation of success because using one of the PUSCH and PUCCH channels to carry the CSI-RS measurement report merely involves "the predictable use of prior art elements according to their established functions" to "yield predictable results" while retaining the fundamental operations of Kim's MIMO system. *KSR,* 550 U.S. 398, 416-417; EX1003, ¶¶123-124.

Claim 2.

Claim 2 recites five alternative options in disjunctive. Satisfying any one of these options satisfies the requirements of claim 2. *Brown v. 3M*, 265 F.3d 1349, 1351 (Fed. Cir. 2001).

In the Kim-Chen combination, Kim teaches ***the K channel quality values are broadband channel quality values***. Kim teaches using "a reference signal" for estimating "channel state between each transmission antenna and each reception antenna." EX1004, [0052] ("detecting channel information using a distortion degree when the signal is received via the channel"), [0053] ("a reference signal is present per transmission antenna and, more particularly, per antenna port"). Kim emphasizes "the reference signal is transmitted over a wide band." *Id.*, [0064]. In FIG. 2 (below), Kim shows an example of "a resource grid" in which "one downlink (DL) slot includes 7 OFDM symbols and one resource block (RB) includes 12 subcarriers in frequency domain." *Id.*, [0048]. Kim's description parallels the descriptions of the '904 patent. *See e.g.*, EX1001, 14:29-39 ("the broadband is composed of a plurality of sub-bands, and the sub-bands are composed of one or more Resource Blocks (RBs)" and "one RB includes 12 subcarriers").

FIG. 2



EX1003, ¶¶125-126 (citing EX1004, FIG. 2 (annotated)).

In the Kim-Chen combination, ***the first proportional sequence comprises K1 positive real numbers less than or equal to 1***, and ***the first proportional sequence comprises at least one 1***. As explained *supra,* Elements [1.d5]-[1.d9], Kim discloses a proportional sequence comprising, e.g., a maximum of M RSRP-to-max(RSRP) ratios (i.e., "RSRP_n/max(RSRP_i)"), which are positive real numbers less than or equal to 1. EX1004, [0149]. When RSRP_n is less than max(RSRP_i), but still satisfies Equation 4 (i.e., "RSRP_*n*/max(RSRP_*i*)>Threshold"), the ratio will be a positive real number less than 1. *Id.*, [0135-136], [0148-149]. Similarly, when the ratio is computed for the maximum of RSRP values (e.g., CSI-RS #6 in FIG. 9), the ratio value will be 1. *Id.*, [0135-136], [0148-149]; EX1003, ¶127.

For similar reasons, ***the first proportional sequence*** in the Kim-Chen combination ***is composed of K1 positive real numbers*** (e.g., a maximum of M RSRP-to-max(RSRP) ratios (i.e., "RSRP_n/max(RSRP_i)"), which are positive real numbers), ***and the K1 positive real numbers are respectively ratios between the K1 channel quality values and the best channel quality value of the K1 channel quality values*** (e.g., the ratios of "RSRP_n/max(RSRP_i)"). *Supra* Elements [1.d5]-[1.d9]; EX1004, [0135-136], [0148-149]; EX1003, ¶128.

In the Kim-Chen combination, ***the first proportional sequence comprises quantized values corresponding to K1 positive real numbers*** at least for the same reason above and additionally because the ratio values in the proportional sequence are quantized values when reported back to the base station. EX1003, ¶129. Reporting the ratios (e.g. "RSRP_n/max(RSRP_i)") from the UE to the base station would have entailed encoding each ratio in a quantized digital format so that the UE can "perform data modulation." EX1004, [0149], [0064]; EX1003, ¶129.

To the extent that Kim is argued to not expressly teach quantizing the ratios (i.e., RSRP-to-max(RSRP) ratios or "RSRP_n/max(RSRP_i)") when modulating the information for reporting back to the base station (which it does), Chen specifically teaches quantizing reported "amplitude/power ratio." EX1006, 18 ("a magnitude level of an amplitude or power is first indicated, and then a coefficient at the magnitude level is indicated," and "[t]he coefficient may be uniformly quantized."), 1 (background discussion of "quantized feedback" of "codebook-based channel information"); EX1003, ¶130.

A POSITA would have been motivated to apply quantization, as expressly taught in Chen, to the ratios of Kim so that the measurement report can be encoded efficiently and transmitted with reduced overhead from the UE to the base station. EX1003, ¶131.

A POSITA would have had a reasonable expectation of success in implementing quantized values for reporting because transmitting quantized values was well known to limit the amount of reported data based on the number of bits allocated to the quantization. *Id.*; EX1006, 15-16, 4, 15; *see* EX1013 ("Sesia LTE"), 390-391 (quantization of codebook configurations), 663 (reporting "quantized" values "to reduce the overhead to a reasonable level"). In fact, the quantization was already implemented in the 3GPP standards. EX1015 ("3GPP TS 36.133 v13.2.0"), §9.1.4, Table 9.1.4-1 (RSRP quantized into 1dBm intervals). Having the first proportional sequence comprise quantized values corresponding to K1 positive real numbers would therefore have been a straightforward operation that applies only known, conventional operations (quantized reporting of the ratio) used according to their known functions to yield predictable results (transmitting a quantized value). *KSR*, 550 U.S. at 416; EX1003, ¶¶132-133.

Claim 3.

The Kim-Chen combination further renders obvious at least two of the alternative options recited by claim 3. *Brown v. 3M*, 265 F.3d 1349, 1351 (Fed. Cir. 2001).

First, in the Kim-Chen combination, ***the first signaling is UE specific***. In Kim, "the BS or eNB may inform the UE of specific information through RRC signaling." EX1004, [0142], [0143], [0146] (parameter "M may be…previously designated by the BS through RRC signaling"), [0147-148] (parameters "N, M, T1, and T2 may be signaled to the UE through RRC signaling"), [0079-81], Table 3. Here, Kim specifically uses a singular form when referring to the UE being configured "through RRC signaling" (e.g., *id.*, [0142], [0148]) while multiple UEs are depicted within the range of a single base station. *Id.*, FIG. 7 (depicting three macro UEs served by one MeNB). EX1003, ¶134.

Moreover, Kim's RRC signaling configures "M CSI-RSs indicating the best RSRP result from among N CSI-RS contained in the CoMP management set," as well as "a predetermined time (T1)" (i.e., "after the above result is reported once to avoid the occurrence of frequent reporting") and "a predetermined time (T2)" (to trigger reporting "[i]f the reporting is not triggered [during T2]"). EX1003, ¶135.

In the Kim-Chen combination, at least some of these parameters, namely, N, M, T1 and T2, are specific to a UE because each UE can have "UE-specific power control," leading to UE-specific configurations for channel state estimation (e.g., "[d]eciding CoMP measurement set of a specific UE"). *Id.*, [0092], [0111]. Indeed, Kim acknowledges that "the BS or eNB may inform the UE of specific information through RRC signaling" so that information specifying "antenna port pair is transmitted through a CSI-RS configuration in which only the corresponding antenna port is established through the above RRC signaling." *Id.*, [0142]. To the extent that these parameters (e.g., the measurement set of antenna ports) being configured via RRC signaling are specific to a UE, the RRC signaling (i.e., the claimed first signaling) is UE specific. EX1003, ¶136; *see also, id.*, [0059] ("a UE-specific reference signal for a specific UE").

Second, the Kim-Chen combination also renders obvious that ***the first signaling implicitly indicates the target threshold***. As explained *supra* Element [1.d7] and §V.A.3, the Kim-Chen combination renders obvious that the first signaling is used to determine a target threshold. EX1004 [0163]; EX1006, Abstract, 11, 18, 21, 23.

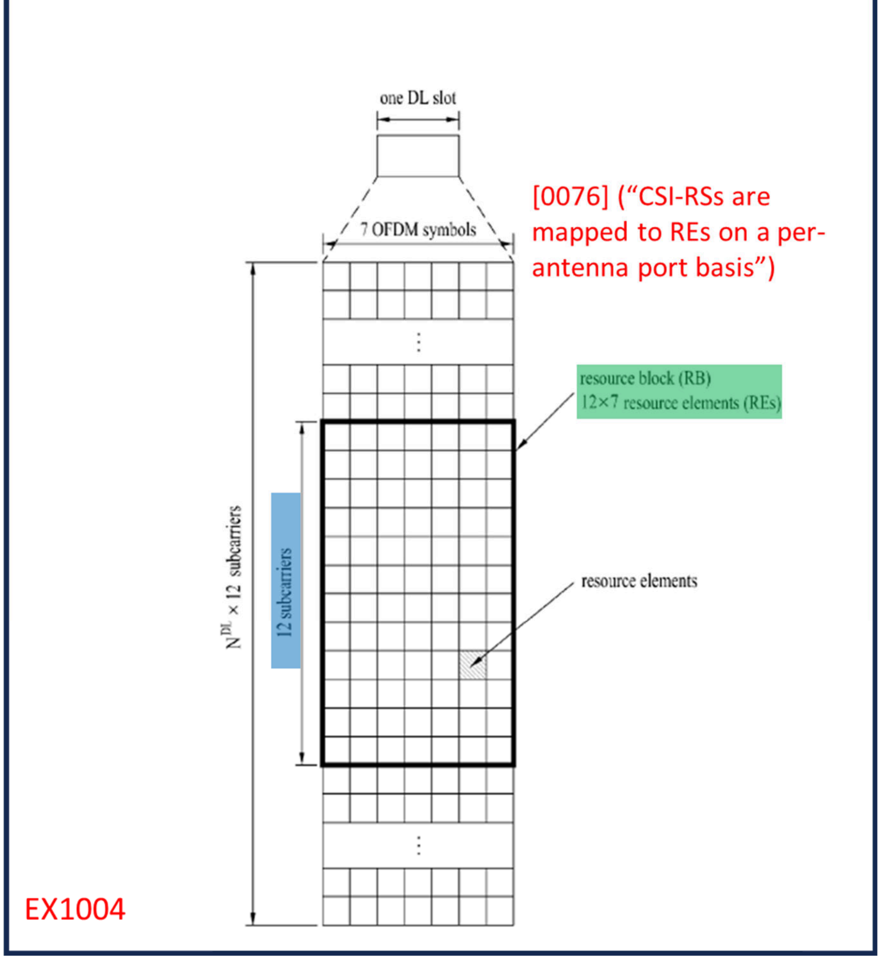
When the first signaling (e.g., RRC signaling as taught by Kim) is used by the receiving UE to determine a target threshold provided by the base station (as taught by Chen), the first signaling ***implicitly indicates the target threshold***. EX1003, ¶¶137-139 (noting the UE needs to decode the target threshold information from the received RRC signaling). The specification of the '904 reveals nothing specific about implicitly indicating and hence acknowledges that this would have been within a POSITA's knowledge and skill. *Uber Techs., Inc. v. X One, Inc.*, 957 F.3d 1334, 1339 (Fed. Cir. 2020) (lack of description of how to implement a feature shows that a POSITA would have been "more than capable" of implementing it); *In re Epstein*, 32 F.3d 1559, 1568 (Fed. Cir. 1994) ("[O]ne skilled in the art would have known how to implement the features of the [prior art] references" where patent itself did not describe how to implement those features.); *In re Publicover*, 813 F. App'x 527, 532 (Fed. Cir. 2020) (POSITA would know how to modify a prior art system to include the claimed feature because the patent was "just as sparse" on how to implement that feature).

Claim 4.

The Kim-Chen combination further renders obvious at least two of the alternative options recited by claim 4. *Brown v. 3M*, 265 F.3d 1349, 1351 (Fed. Cir. 2001).

First, in the Kim-Chen combination, ***any two antenna ports in the K1 antenna port groups are on a same carrier*** because Kim teaches same carrier operation, namely, "single carrier frequency division multiple access" or "SC-FDMA," for its MIMO network. EX1004, [0039], [0002]. In examples of its same carrier operation, Kim further describes using "SC-FDMA symbol" in the time domain and "contiguous subcarriers" in the frequency domain for transmitting from the base station to the UE. *Id.*, [0043]. Specifically, "one downlink (DL) slot includes 7 OFDM symbols [in time domain (i.e., the x-axis)] and one resource block (RB) includes 12 subcarriers in frequency domain," i.e., the y-axis. *Id.*, [0048], FIG. 2 (below), 6 (example for mapping CSI-RS to each antenna port).

FIG. 2



EX1003, ¶140 (EX1004, FIG. 2)

As explained by Dr. Akl, it was general knowledge that a single carrier contains multiple subcarriers within the single carrier's bandwidth. EX1003, ¶141 (citing EX1013 ("Sesia LTE")). Kim thus teaches same carrier operation using a "single carrier" with multiple "contiguous subcarriers" where "CSI-RSs [for prompting measurement report] are mapped to REs [of the RB] on a per-antenna port basis." EX1004, [0039], [0043], [0076]. As illustrated in FIG. 2 (above), the antenna ports, as mapped to one of the "12×7 resource elements," are on the same carrier, the bandwidth of which includes "12 subcarriers." *Id.*, [0048]; EX1003, ¶141.

Second, the Kim-Chen combination renders obvious ***the first signaling is further used to determine the K1, and the first information is further used to determine the first channel quality***, as articulated below.

In the Kim-Chen combination, ***the first signaling is used by the UE to determine the K antenna port groups***, *supra* Elements [1.d2]/[1.d5], e.g., the N antenna ports (corresponding to "N CSI-RS contained in the CoMP management set") for which channel status information are sought, as taught in Kim. EX1004, [0148] ("N, M, T1, and T2 may be signaled to the UE through RRC signaling"), [0142] (base station "inform[s] the UE of specific information through RRC signaling" to indicate CSI-RS configuration and antenna ports, e.g., "a CSI-RS configuration in which only the corresponding antenna port is established through the above RRC signaling").

As explained *supra* Element [1.d7], in the Kim-Chen combination, ***the first signaling*** (e.g., RRC signaling as taught by Kim) ***is used to determine a target threshold*** (e.g., to have the base station configure the relative power threshold used in the UE, as taught by Chen). EX1004 [0163]; EX1006, Abstract, 11, 18, 21, 23.

Therefore, in the Kim-Chen combination, the first signaling is ***further used to determine the K1***, i.e., the number of antenna ports with corresponding RSRP measurement values over the threshold value. EX1004, [0149] ("a maximum of M CSI-RSs (the RSRP ratio (RSRP_n/max(RSRP_i)) of which is higher than a predetermined threshold value) from among N CSI-RSs." EX1004, [0149] ("M CSI_RSs configured to satisfy… RSRP_*n*/max(RSRP_*i*)>Threshold"), [0111] ("BS sets configurations of [CSI-RSs]…, and informs the UE of the resultant configurations," and UE "perform[s] RSRP…measurement of CSI-RSs transmitted from cells contained in the CoMP management set" and reports those where "the measurement result satisfies a specific condition"); EX1006, 4, 5, 7, 9, 14-15, 19, 22, 24; EX1003, ¶¶142-145.

Moreover, Kim-Chen renders obvious that ***the first information is further used to determine the first channel quality*** because the measurement report (i.e., ***the first information***) indicates whether the corresponding RSRP of an antenna port is over a threshold, which indication is ***used to determine the first channel quality***. EX1004, [0149] (citing Equation 4); EX1003, ¶¶146-147.

Claim 5.

The Kim-Chen combination further renders obvious all clauses of claim 5, treated as recited in the conjunctive solely for this proceeding.

First, in the Kim-Chen combination, Kim teaches that ***the K antenna port groups respectively correspond to K reference signal groups***. As explained *supra*

[1.d3], Kim discloses that ***the K antenna port groups respectively correspond to K channel quality values*** (e.g., Reference Signal Received Powers (RSRPs)). Kim also discloses that the RSRP value of each antenna port is measured from a corresponding CSI-RS transmitted from the base station to the UE. EX1004, [0140] ("if the BS configures only one antenna port for CSI-RS configuration, RSRP of the corresponding antenna port is measured and reported"), [0132] ("CSI-RS RSRP is defined as Rx power of a reference signal (RS) of a CSI-RS transmission RE"). As explained *supra* [1.d1], "CSI-RSs are mapped to REs [of a resource block] on a per-antenna port basis" so that "[one] CSI-RS is mapped to each antenna port." *Id.*, [0076] (explaining details of FIG. 6 where each "antenna port group" can have one port per group), [0065], [0141]. Kim's teachings thus parallel the disclosure of the '904 patent. EX1001, 14:5-12 (explaining that "the antenna port group includes only one antenna port," "the reference signal group includes only one reference signal," and "the reference signal is a CSI-RS"). Hence, Kim from the combination teaches ***the K antenna port groups*** (*supra* [1.d3]) ***respectively correspond to K reference signal groups*** (e.g., "the CSI-RSs mapped to REs on a per-antenna port basis" when each antenna port group includes one antenna port and each reference signal group includes one reference signal, namely, a CSI-RS). *Id.*, [0076]; EX1003, ¶¶148-149.

Second, in the Kim-Chen combination, Kim also teaches that ***the K reference signal groups are respectively transmitted through the K antenna port group.*** As explained above and *supra* [1.d1], Kim teaches that "the CSI-RSs [are] mapped to REs on a per-antenna port basis" where a "CSI-RS is mapped to each antenna port." EX1004, [0076], [0071] ("CSI-RSs may be transmitted through 1, 2, 4 or 8 antenna ports"); EX1003, ¶150.

Third, in the combination, Kim also teaches that ***the first wireless signal is composed of the K reference signal groups***. As explained *supra* [1.d1], Kim teaches CSI-RS transmission using multiple signals (e.g., "CSI-RSs may be transmitted through 1, 2, 4 or 8 antenna ports" using a per-antenna port assignment in which "[one] CSI-RS is mapped to each antenna port," EX1004, [0076], [0071]), which comports with the description of '904 Patent. EX1001, 3:27-29 ("K different analog beamforming vectors for analog beamforming of the K antenna port groups" to provide the first wireless signal), 2:58-60 (each "antenna port corresponds to a reference signal" and "[t]he reference signal is transmitted through the antenna port"), 3:5-6 (each "reference signal is a Channel State Information Reference Signal (CSI-RS)"); EX1003, ¶151.

Fourth, in the combination, Kim also teaches that ***the antenna port group is composed of one antenna port….*** As explained above and *supra* [1.d1], Kim teaches an example where an "antenna port group" has one antenna port. EX1004, [0076], [0141]; EX1003, ¶152.

Fifth, in the combination, Kim further teaches ***the antenna port corresponds to a reference signal.*** As explained above and *supra* [1.d1] and [1.d3], Kim teaches that "CSI-RSs are mapped to REs [of a resource block] on a per-antenna port basis" so that "[one] CSI-RS is mapped to each antenna port." EX1004, [0076], [0065], [0141]; EX1003, ¶153.

Sixth, in the combination, Kim additionally teaches ***the reference signal is transmitted through the antenna port; the reference signal is…a CSI-RS (Channel State Information Reference Signal)***. As explained above and *supra* [1.d1], Kim teaches that "the CSI-RSs [are] mapped to REs on a per-antenna port basis" where a "CSI-RS is mapped to each antenna port." EX1004, [0076]; see generally [0069-75] ("Channel State Information-Reference Signal (CSI-RS)" as "an RS used for channel measurement"); EX1003, ¶¶154-155.

Claim 6

Claim 6 recites the base station transmitting and receiving, rather than the UE receiving and transmitting (claim 1), information. *Compare* [6.pre] *with* [1.pre]. As shown below, each element of claim 6 is met by the Kim-Chen combination at least for the same reasons as articulated *supra* §V.A.4(a) (claim 1). EX1003, ¶156.

[6.pre]:

To the extent the preamble is limiting, the Kim-Chen combination provides [6.pre] at least for the same reasons as articulated *supra* §V.A.4 (Element [1.pre]). EX1003, ¶157.

[6.a], [6.b], [6.c]:

The Kim-Chen combination renders obvious Element [6.a]-[6.c] at least for the same reasons as articulated *supra* §V.A.4 (Elements [1a]-[1c]). EX1003, ¶158.

[6.d]/ [6.d1]-[6.d10]

The Kim-Chen combination renders obvious Element [6.d1]-[6.d10], which are substantively identical to elements [1.d10]-[1.d10], respectively. *Supra* §§V.A.1 (Elements [1.d1]-[1.d10]); EX1003, ¶¶159-160.

Claims 7-10

Claims 7-8, 10 depend from claim 6, which, as discussed above, is met by the Kim-Chen combination. Claims 7-8, 10 are substantively identical to claims 2-3, 5, respectively, and likewise met by the Kim-Chen combination, at least for the same reasons as articulated *supra* §§V.A.1.b-c, e (claims 2-3, 5). Claim 9 depends from claim 8. Claim 9 is substantively identical to claim 4, and is met by the Kim-Chen combination, at least for the same reasons as articulated *supra* §§V.A.1.d (claim 4); EX1003, ¶¶161-162.

Claim 11

Claim 11 is substantively similar to claim 1, with Elements [11a]-[11c] reciting a "first receiver," "second receiver," and "third transmitter" performing functions substantially identical to the method recited by Elements [1.a]-[1.c]. EX1003, ¶163. The elements of claim 11 are met by the Kim-Chen combination for reasons articulated *supra* § V.A.4(a) (claim 1) and further discussed below (with respect to additionally recited "receiver[s]" and "transmitter"). *Id.*

[11.pre]:

To the extent the preamble is limiting, the Kim-Chen combination provides [11.pre] at least for the same reasons as articulated *supra* §V.A.4 (Element [1.pre]). EX1003, ¶164.

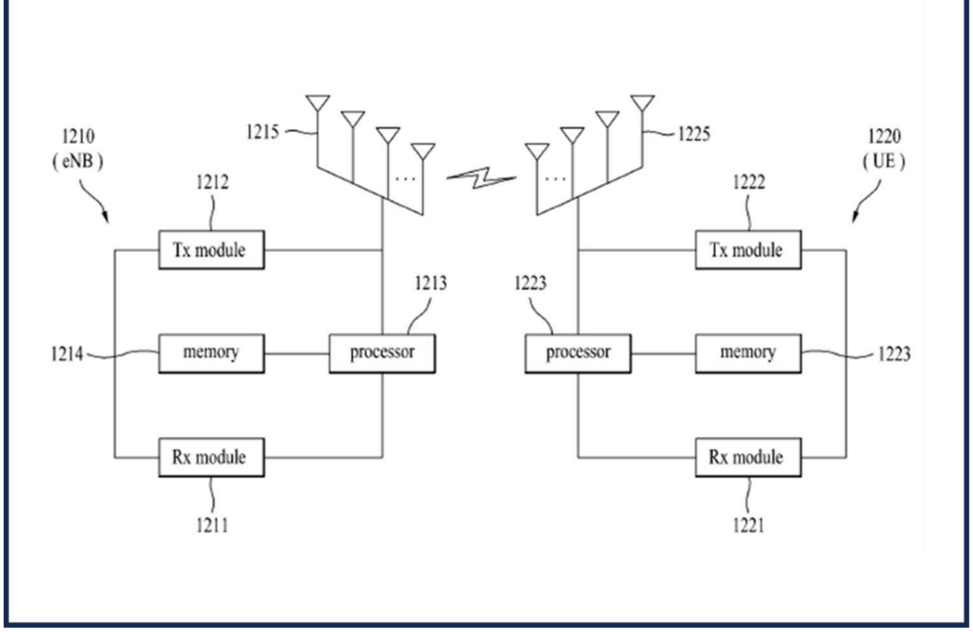
[11.a]-[11.b]:

Kim discloses the functions of receiving a first signaling and a first wireless signal, as respectively recited by Elements [11.a]-[11.b] and [1.a]-[1.b]. *Supra* §V.A.4 (Elements [1.a]-[1.b]); EX1003, ¶165. Further, the Kim-Chen combination at least renders obvious the claimed "***first receiver***," and "***second receiver***," as explained below.

Kim discloses a MIMO receiver or receiving unit (*supra* claim 1), which includes multiple receivers because MIMO operation requires "multiple output."

EX1003, ¶166. Thus, Kim's UE has multiple receivers to receive the first signaling (e.g., RRC signaling) and the first wireless signal (e.g., CSI-RSs) transmitted from the BS. *Id.* As illustrated in FIG. 12 (below), Kim's UE receives the first signaling and the first wireless signal at "a plurality of antennas 1225" (*supra* Elements ([1.a]-[1.b])), and processes these signals at "Rx module 1221," which may "receive downlink signals, data and information from the BS." EX1004, [0177].

FIG. 12



EX1003, ¶166 (citing EX1004, FIG. 12).

As Dr. Akl explains, it was ubiquitous to use multiple antennas for transmission and reception in a MIMO system, like the one in the Kim-Chen combination. EX1003, ¶167 (citing EX1010 ("Park") at [0207] ("transmission/reception data efficiency may be improved by adopting a plurality of transmitting antennas and a plurality of receiving antennas"). Under the MIMO operation, each of Kim's antennas 1225 would have a corresponding receiver to receive the incoming CSI-RS signals and RRC signaling and pass these signals to Rx module 1221, as was ubiquitously known in the art, as corroborated by e.g., EX1017 ("Luo") at FIG. 2, [0037], EX1018 ("Vitthaladevuni") at FIG. 10, [0116], [0118]-[0119], and EX1016 ("Hu") at FIG. 12, [0140-141]. EX1003, ¶167. Specifically, Luo explains that "transmitted modulated signals are received by NR antennas 252a through 252r and the received signal from each antenna 252 is provided to a respective receiver (RCVR) 254a through 254r" at the UE, as depicted in FIG. 2 (below), corroborating this conventional technique. EX1017 ("Luo"), [0037].

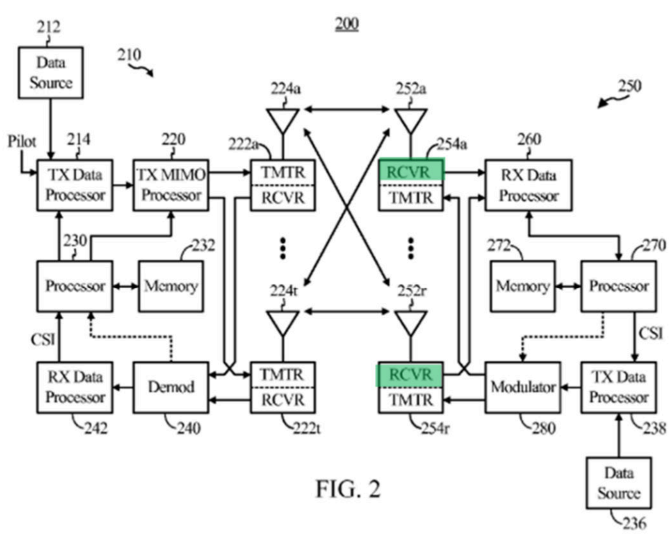


FIG. 2

EX1003, ¶168 (noting EX1017 ("Luo") at FIG. 2 (annotated above) generally matches FIG. 4 of the '904 patent, both showing one receiver per antenna). A POSITA would have found it apparent that Kim's disclosure provides respective receivers for each of Kim's antennas 1225, or at a minimum found this obvious in view of the general knowledge of a POSITA, as explained below. *Koninklijke Philips N.V. v. Google Inc.*, 948 F.3d 1330, 1337 (Fed. Cir. 2020) (internal citations omitted) ('[a]s *KSR* established, the knowledge of such an artisan is part of the store of public knowledge…must be consulted when considering whether a claimed invention would have been obvious.'"); EX1003, ¶169.

A POSITA would have been motivated to include multiple receivers (e.g., using one receiver for each of Kim's antennas) on the MIMO system of the Kim-Chen combination for increased throughout and improved reliability. ***First***, a multiple-receiver configuration would have more advantageously utilized each antenna during operation. In comparison, one receiver shared among multiple antennas would have limited access to each antenna at the expense of overall throughput to the detriment of MIMO operations. EX1003, ¶170 (noting throughput would generally scale up with the number of antennas using the multi-receiver configuration). ***Second***, a multiple-receiver configuration would have improved operational reliability when multiple receivers can complement each other during operation. EX1003, ¶170 (noting using multiple receivers can provide a level of redundancy to alleviate single-point failure).

A POSITA would have reasonably expected success at using the multi-receiver combination because doing so merely involves incorporating well-established components operating according to their known functions to yield predictable results, namely, improved reception of incoming signals. EX1003, ¶171.

In the Kim-Chen combination where each of Kim's antenna**s** 1225 has a respective receiver, one of the receivers would qualify as the claimed first receiver, and another one of the receivers would qualify as the claimed second receiver, just like the descriptions from the '904 patent. EX1003, ¶172. For example, FIG. 4 of the '904 patent merely shows each antenna coupled to a receiver (or transceiver), which, as demonstrated above, was general knowledge because the configuration was ubiquitous by the time of the purported invention. EX1003, ¶172 (noting Applicant never relied on FIG. 4 during prosecution and the Notice of Allowance never mentioned FIG. 4 as reason for allowance).

[11.c]:

Kim discloses the function transmitting first information, as recited by Elements [11.c] and [1.c]. *Supra* §V.A.4 (Element [1.c]); EX1003, ¶173. Kim's UE includes a "Tx module 1222 [that] may transmit uplink signals, data and information to the BS (eNB)" using antennas 1225. EX1004, [0177], FIG. 12. Kim thus describes a transmitter (e.g., Tx module 1222 along with antennas 1225 and other conventional components) transmitting the first information, such as the measurement report, to the base station, as discussed *supra* §V.A.4 (Element [1c]). EX1003, ¶173.

[11d] [11d1]-[11d10];

The Kim-Chen combination meets elements [11.d1]-[11.d10], which are substantively identical to elements [1.d10]-[1.d10], respetively. *Supra* §§ V.A.4 (Elements [1.d1]-[1.d10]); EX1003, ¶¶174-175.

Claims 12-15

Claims 12, 13, and 15 depend from claim 11, which, as discussed above, is met by the Kim-Chen combination. Claims 12, 13, and 15 are substantively identical to claims 2, 3, and 5, respectively, and likewise are met by the Kim-Chen combination at least for the same reasons as articulated *supra* §§V.A.1.a (claims 2, 3, and 5). EX1003, ¶176.

Claim 14 depends from claim 13, which, as discussed above, is met by the Kim-Chen combination. Claims 14 is substantively identical to claim 4, and likewise is met by the Kim-Chen combination, for the same reasons as articulated *supra* §§ V.A.1.d (claim 4). EX1003, ¶¶176-177.

Claim 16

Claim 16 is substantively identical to claim 6, with Elements [16a]-[16c] reciting a "first transmitter," "second transmitter," and "third receiver" performing functions substantially identical to the method recited by Elements [6.a]-[6.c]. EX1003, ¶178. The elements of claim 16 are met by the Kim-Chen combination for reasons articulated *supra* § V.A.4 (claims 1 and 6) and further discussed below (with respect to additionally recited "transmitter[s]" and "receiver"). *Id.*

[16.pre]:

To the extent the preamble is limiting, the Kim-Chen combination provides [16.pre] at least for the same reasons as articulated *supra* §V.A.4(Element [1.pre]/[6.pre]). EX1003, ¶179.

[16.a]:

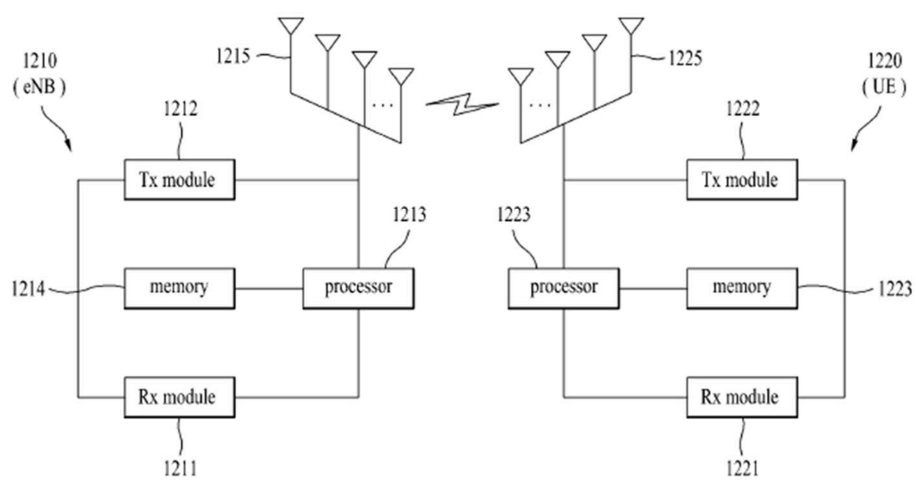
[16.b]:

Kim discloses the functions of ***transmitting a first signaling*** and ***a first radio***/wireless ***signal***, as respectively recited by Elements [16.a]-[16.b] and [6.a]-[6.b]. *Supra* §§V.A.4 (Elements [1.a]-[1.b]&[6.a]-[6.b]); EX1003, ¶180. Further, the Kim-Chen combination at least renders obvious the claimed "***first transmitter***," "***second transmitter***," as explained below.

Kim discloses a MIMO transmitter at the base station which includes multiple transmitters because MIMO operation requires "multiple input." EX1003, ¶181.

Thus, Kim's base station has multiple transmitters to transmit the first signaling (e.g., RRC signaling) and the first radio signal (e.g., CSI-RS signals) to the UE. *Id.* As illustrated in FIG. 12 (below), Kim's base station transmits the first signaling and the first radio signal at "a plurality of antennas 1215" using "transmission (Tx) module 1212." EX1004, [0174] ("may transmit a variety of signals, data and information on a downlink for the UE").

FIG. 12



EX1003, ¶181 (citing EX1004, FIG. 12).

As Dr. Akl explains, it was ubiquitous to use multiple antennas for transmission and reception in a MIMO system, like the one in the Kim-Chen combination. EX1003, ¶182 (citing EX1010 ("Park") at [0207] ("transmission/reception data efficiency may be improved by adopting a plurality of transmitting antennas and a plurality of receiving antennas"). Under the MIMO operation, each of Kim's antennas 1215 would have a corresponding transmitter to transmit the out bounding CSI-RS signals and RRC signaling, as was ubiquitously known in the art and corroborated by, e.g., EX1017 ("Luo") at FIG. 2, [0036], EX1018 ("Vitthaladevuni") at FIG. 10, [0116], [0118]-[0119], and EX1016 ("Hu") at FIG. 12, [0140-141]. EX1003, ¶182. Specifically, Luo explains that "[e]ach transmitter [("TMTR")] 222 receives and processes a respective symbol stream," and "NT modulated signals from transmitters 222a through 222t are then transmitted from NT antennas 224a through 224t, respectively" at the base station, as depicted in FIG. 2 (below). EX1017 ("Luo"), [0036].

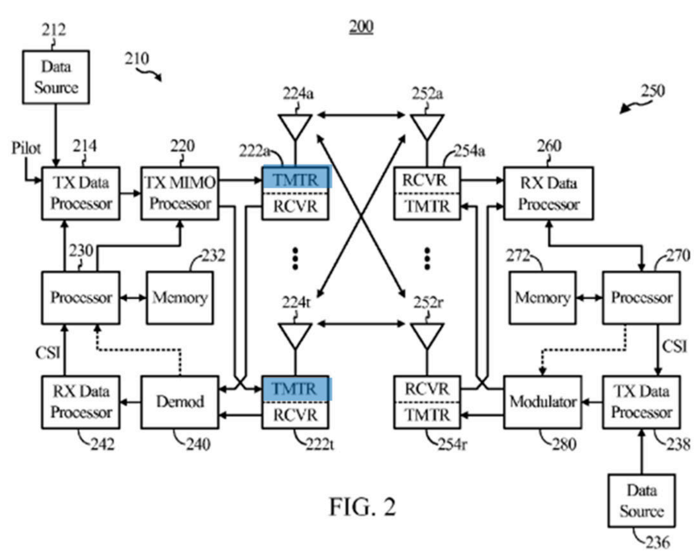


FIG. 2

EX1003, ¶183 (noting Luo's FIG. 2 (annotated above) generally matches FIG. 4 of the '904 patent, both showing one transmitter per antenna).

A POSITA would have found it apparent that Kim's disclosure provides respective transmitters for each of Kim's antenna**s** 1215, or at a minimum found this obvious in view of the general knowledge of a POSITA, as explained below. *Koninklijke Philips N.V.*, 948 F.3d 1330, 1337 (Fed. Cir. 2020) (internal citations omitted) ("[a]s *KSR* established, the knowledge of such an artisan is part of the store of public knowledge…must be consulted when considering whether a claimed invention would have been obvious"); EX1003, ¶184.

A POSITA would have been motivated to include multiple transmitters (e.g., using one transmitter for each of Kim's antennas) on the MIMO system of the Kim-Chen combination for increased throughout and improved reliability. ***First***, a multiple-transmitter configuration would have more advantageously utilized the accessibility of each antenna during operation. In comparison, one transmitter shared among multiple antennas would have limited access to each antenna at the expense of overall throughput to the detriment of MIMO operations. EX1003, ¶185 (noting throughput would generally scale up with the number of antennas using the multi-receiver configuration). ***Second***, a multiple-transmitter configuration would have improved operational reliability when multiple transmitters can complement each other during operation. EX1003, ¶185 (noting using multiple transmitters can provide a level of redundancy to alleviate single-point failure).

A POSITA would have reasonably expected success at using the multi-transmitter combination because doing so merely involves incorporating well-established components operating according to their known functions to yield predictable results, namely, improved transmission of out bounding signals. EX1003, ¶186.

In the Kim-Chen combination where each of Kim's antenna**s** 1215 has a respective transmitter, one of the transmitters would qualify as the claimed first receiver, and another one of the transmitters would qualify as the claimed second receiver, just like the descriptions of the '904 patent. EX1003, ¶187. For example, FIG. 4 of the '904 patent merely shows each antenna coupled to a transmitter (or transceiver), which, as demonstrated above, was general knowledge because the configuration was ubiquitous by the time of the purported invention. EX1003, ¶187 (noting Applicant never relied on FIG. 4 during prosecution and the Notice of Allowance of neither the '904 patent nor the '271 patent ever mentioned FIG. 4 as reason for allowance).

[16.c]:

Kim discloses the function of receiving first information, as recited by Elements [16.c] and [6.c]. *Supra* §V.A.4 (Element [6.c]); EX1003, ¶188. Kim's base station includes "reception (Rx) module 1211" that receives "signals, data and information" from the UE using antenna 1215. EX1004, [0174], FIG. 12. Kim thus describes a receiver (e.g., Rx module 1221 along with antennas 1215 and other conventional components) receiving first information, such as the measurement report, from the UE, as discussed *supra* §V.A.4 (Element [6.c]). EX1003, ¶188.

[16.d]/ [16.d1]-[16.d10]

The Kim-Chen combination meets elements [16.d1]-[16.d10], which are substantively identical to elements [6.d10]-[6.d10], respectively. *Supra* §§ V.A.4 (Elements [6.d1]-[6.d10]); EX1003, ¶¶189-190.

Claims 17-20

Claims 17-19 depend from claim 16, which, as discussed above, is met by the Kim-Chen combination. Claims 17-19 are substantively identical to claims 2-4 and 7-9, respectively, and likewise are met by the Kim-Chen combination at least for the same reasons as articulated *supra* §§V.A.4 (claims 2-4, 7-9). EX1003, ¶191.

Claim 20 depends from claim 18, which, as discussed above, is met by the Kim-Chen combination. Claims 20 is substantively identical to claims 5, 10, and

15, and likewise is met by the Kim-Chen combination at least for the same reasons as articulated *supra* §§V.A.4 (claims 5, 10, 15). EX1003, ¶191.

VII. DISCRETIONARY CONSIDERATIONS

Petitioner believes that discretionary denial is unwarranted, and yet, Petitioner intends to utilize the bifurcated briefing process contemplated by the March 26, 2025, Stewart Memorandum to rebut contentions if offered by Patent Owner to the contrary. *See, e.g. Learn about the new interim processes relating to institution in AIA proceedings* (available at *https://www.uspto.gov/about-us/events/learn-about-new-interim-processes-relating-institution-aia-proceedings*, April 24, 2025); https://uspto.cosocloud.com/p9xpz6s4jn75/ (Video).

VIII. PAYMENT OF FEES – 37 C.F.R. § 42.103

Petitioner authorizes the Patent and Trademark Office to charge any fees to Deposit Account No. 06-1050.

IX. CONCLUSION

Petitioner respectfully requests institution of an IPR of the '904 patent for the ground presented herein.

X. 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 ’904 Patent. The ’904 patent is the subject of a number of civil actions including: *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. The ’904 patent is the subject of IPR2025-00923, filed concurrently herewith. The ’271 patent, a family member of the ’904 patent, is the subject of IPR2025-00898 and IPR2025-00922, filed concurrently herewith. The ’271 patent was also the subject of IPR2023-00571 and IPR2023-00747, which were instituted and terminated before FWDs.

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 IPR50095-0234IP1@fr.com.

Respectfully submitted,

Dated: May 2, 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 12,692 words, which is less than the 14,000 allowed under 37 CFR § 42.24.

Dated: May 2, 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 May 2, 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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