

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

SAMSUNG ELECTRONICS CO., LTD. AND
SAMSUNG ELECTRONICS AMERICA, INC.,

Petitioner,

v.

APEX BEAM TECHNOLOGIES LLC,

Patent Owner.

Case No. IPR2023-00603
U.S. Patent No. 10,944,527

~~PETITION FOR INTER PARTES REVIEW~~

DECLARATION OF APOSTOLOS K. KAKAES, PH.D.

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1.	~~[1pre]:~~ Claim 1	53
a.	~~[1Preamble]~~ “A method for multi-antenna transmission in a user equipment, comprising:”	~~1554~~
b.	~~[1a]:~~ “receiving a first radio signal from a base station; and”	~~1655~~
c.	~~[1b]:~~ “receiving a first signaling from the base station;”	~~1755~~
d.	~~[1c]:~~ “wherein the first radio signal is transmitted by K antenna port groups of the base station;”	~~1756~~
e.	~~[1d]:~~ “the antenna port group includes a positive integer number of antenna port(s);”	~~2059~~
f.	~~[1e]:~~ “a first antenna port group is one of the K antenna port groups;”	~~2060~~
g.	~~[1f]:~~ “the first signaling is used to determine a first time resource pool;”	~~2060~~
h.	~~[1g]:~~ “at least one of a first antenna virtualization vector and a second antenna virtualization vector is associated with the first antenna port group;”	~~2363~~
i.	~~First antenna virtualization vector~~	~~64~~
ii.	~~Second antenna virtualization vector~~	~~68~~
i.	~~[1h]:~~ “the first antenna virtualization vector is an antenna virtualization vector available to the base station in the first time resource pool;”	~~3476~~
a.	~~[1i]: “the second antenna virtualization vector is an antenna virtualization vector available to the user equipment in the first time resource pool; and”~~	~~35~~
b.	~~[1j]: “the K is a positive integer greater than 1.”~~	~~36~~
5.	~~Claim 4.....~~	~~36~~

j.	~~[4a]:[1i]~~ “the second antenna virtualization vector is an antenna virtualization vector available to the user equipment in the first time resource pool; and”	77
k.	~~[1j]~~ “the K is a positive integer greater than 1.”	78
2.	<u>Claim 4:</u> “The method of claim 1, further comprising: receiving first information, wherein the first information is used to determine the first antenna <u>port group; or transmitting second information, wherein the second information is used to determine K1 antenna port group(s); the K1 antenna port group(s) belong(s) to the K antenna port groups; the first antenna port group is one of the K1 antenna port group(s); the K1 is a positive</u> port group; or”	36
a.	~~[4b]: “transmitting second information”~~	38
6.	<u>Claim 5</u>	38
a.	~~[5a]: “The method of claim 1, wherein the first time resource pool is discontinuous in time~~ domain; or”	38
b.	~~[5b]: “the first signaling is a semi-static signaling.”~~	40
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	~~[6pre]:integer.”~~	79
3.	<u>Claim 5</u>	81
a.	<u>[5a]</u> “The method of claim 1, wherein the first time resource pool is discontinuous in time domain;”	81
b.	<u>[5b]</u> “the first signaling is a semi-static signaling.”	83
4.	<u>Claim 6</u>	84
a.	<u>[6Preamble]</u> “A method for multi-antenna ~~transmitting~~ <u>transmitting</u> in a base station, comprising:”	4184
b.	~~[6a]:~~ “transmitting a first radio signal to a target	

	receiver; and”	4185
a.	~~[6b]: “transmitting a first signaling to the target receiver;”~~	~~41~~
c.	<u>[6b] “transmitting a first signaling to the target receiver;”</u>	<u>85</u>
e.d.	<u>[6c]:</u> “wherein the first radio signal is transmitted by K antenna port groups of the base station;”	<u>4285</u>
d.e.	<u>[6d]:</u> “the antenna port group includes a positive integer number of antenna port(s);”	<u>4285</u>
e.f.	<u>[6e]:</u> “the first antenna port group is one of the K antenna port groups;”	<u>4285</u>
f.g.	<u>[6f]:</u> “the first signaling is used to determine a first time resource pool;”	<u>4286</u>
g.h.	<u>[6g]:</u> “at least one of a first antenna virtualization vector and a second antenna virtualization vector is associated with the first antenna port group;”	<u>4286</u>
h.i.	<u>[6h]:</u> “the first antenna virtualization vector is an antenna virtualization vector available to the base station in the first time resource pool;”	<u>4386</u>
i.j.	<u>[6i]:</u> “the second antenna virtualization vector is an antenna virtualization vector available to the target receiver of the first signaling in the first time resource pool; and”	<u>4386</u>
b.	~~[6j]: “the K is a positive integer greater than 1.”~~	~~43~~
8.	~~Claim 9~~	~~43~~
k.	<u>[9a]:[6j] “the K is a positive integer greater than 1.”</u>	<u>86</u>
3.5.	<u>Claim 9: “The method of claim 6, further comprising: transmitting first information, wherein the first information is used to determine the first antenna <u>port group; or receiving second information, wherein the</u></u>	

	<u>second information is used to determine K1 antenna port group(s); the K1 antenna port group(s) belong(s) to the K antenna port groups; the first antenna port group is one of the K1 antenna port group(s); the K1 is a positive</u>	
	<u>port group; or”</u>	<u>43</u>
	<u>a. — ~~[9b]: “receiving second information”~~</u>	<u>44</u>
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	<u>integer.”</u>	<u>87</u>
<u>6.</u>	<u>Claim 10</u>	<u>87</u>
	a. [10a ~~+~~]: “The method of claim 6, wherein the first time resource pool is discontinuous in time domain; or”	<u>4487</u>
	<u>a. — ~~[10b]: “the first signaling is a semi-static~~</u>	
	<u>signaling.”</u>	<u>44</u>
<u>10.</u>	<u>Independent Claim 11</u>	<u>44</u>
	<u>a. — ~~[11pre]: “A user equipment (UE) for multi-antenna transmission, comprising:”~~</u>	<u>44</u>
	<u>b. [10b]: “the first signaling is a semi-static</u>	
	<u>signaling.”</u>	<u>87</u>
<u>7.</u>	<u>Claim 11</u>	<u>88</u>
	<u>a. [11Preamble] “A user equipment (UE) for multi-antenna transmission, comprising:”</u>	<u>88</u>
	b. [11a ~~+~~]: “a first transceiver, receiving a first radio signal from a base station; and”	<u>4588</u>
	c. [11b ~~+~~]: “a second receiver, receiving a first signaling from the base station;”	<u>4689</u>
	d. [11c ~~+~~]: “wherein the first radio signal is transmitted by K antenna port groups of the base station;”	<u>4791</u>

e.	[11d]: “the antenna port group includes a positive integer number of antenna port(s);”	4891
b.	~~[11e]: “the first antenna port group is one of the K antenna port groups;”~~	~~48~~
f.	[11e] “the first antenna port group is one of the K antenna port groups;”	91
f.g.	[11f]: “the first signaling is used to determine a first time resource pool;”	4892
g.h.	[11g]: “at least one of a first antenna virtualization vector and a second antenna virtualization vector is associated with the first antenna port group;”	4892
h.i.	[11h]: “the first antenna virtualization vector is an antenna virtualization vector available to the base station in the first time resource pool;”	4892
i.j.	[11i]: “the second antenna virtualization vector is an antenna virtualization vector available to the user equipment in the first time resource pool; and”	4992
c.	~~[11j]: “the K is a positive integer greater than 1.”~~	~~49~~
11.	~~Claim 14~~	~~49~~
k.	[14a]:[11j] “the K is a positive integer greater than 1.”	92
4.8.	Claim 14: “The UE of claim 11, wherein: the second receiver further receives first information, wherein the first information is used to determine the first <u>antenna port group; or the first transceiver further transmits second information, wherein the second information is used to determine K1 antenna port group(s); the K1 antenna port group(s) belong(s) to the K antenna port groups; the first antenna port group; or</u> ”	49 is one of the K1

a.	~~[14b]: “the first transceiver ...”~~	~~50~~
12.	~~Claim 15~~	~~50~~
a.	~~[15a]: “The UE of claim 11, wherein the first time resource pool is discontinuous in time domain; or”~~	~~50~~
	~~[15b]: “antenna port group(s); the first signalingK1 is a semi-static positive integer.”~~	~~93~~
	~~signaling.”~~	~~50~~
13.	~~Independent Claim 16~~	~~50~~
a.	~~[16pre]: “A base station equipment for multi-antenna transmission, comprising:”~~	~~50~~
b.	~~[16a]: “a third transceiver, transmitting a first radio signal to a target receiver; and”~~	~~51~~
9.	Claim 15	93
a.	[15a] “The UE of claim 11, wherein the first time resource pool is discontinuous in time domain; or”	93
b.	[15b] “the first signaling is a semi-static signaling.”	94
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a.	[16Preamble] “A base station equipment for multi-antenna transmission, comprising:”	94
b.	[16a] “a third transceiver, transmitting a first radio signal to a target receiver; and”	95
a.c.	[16b ~~+~~]: “a second transmitter, transmitting a first signaling to the target receiver;”	5296
b.d.	[16c ~~+~~]: “wherein the first radio signal is transmitted by K antenna port groups of the base station;”	5398
e.e.	[16d ~~+~~]: “the antenna port group includes a positive integer number of antenna port(s);”	5498

~~e.~~	~~[16e]: “the first antenna port group is one of the K antenna port groups;”~~	~~54~~
f.	[16e] “the first antenna port group is one of the K antenna port groups;”	98
~~d.g.~~	~~[16f]:] “the first signaling is used to determine a first time resource pool;”~~	~~5498~~
~~e.h.~~	~~[16g]:] “at least one of a first antenna virtualization vector and a second antenna virtualization vector is associated with the first antenna port group;”~~	~~5498~~
~~f.i.~~	~~[16h]:] “the first antenna virtualization vector is an antenna virtualization vector available to the base station in the first time resource pool;”~~	~~5499~~
~~g.j.~~	~~[16i]:] “the second antenna virtualization vector is an antenna virtualization vector available to the target receiver of the first signaling in the first time resource pool; and”~~	~~5599~~
~~d.~~	~~[16j]: “the K is a positive integer greater than 1.”~~	~~55~~
~~14.~~	~~Claim 19.~~	~~55~~
	k. [19a]:[16j]: “the K is a positive integer greater than 1.”	99
5.11.	Claim 19: “The base station equipment of claim 16, wherein: the second transmitter further transmits first information, wherein the first information is <u>used to determine the first antenna port group; or the third transceiver further receives second information, wherein the second information is used to determine K1 antenna port group(s); the K1 antenna port group(s) belong(s) to the K antenna port groups; the first antenna port group is one of the K1 antenna port group(s); the K1 is a positive</u> <u>used to determine the first antenna port group; or”</u>	55
a.	[19b]: “the third transceiver”	56

15.	~~Claim 20~~	56
	~~integer.”~~	99
12.	Claim 20	100
a.	[20a ~~+~~]: “The base station equipment of claim 16, wherein the first time resource pool is discontinuous in time domain; or”	~~56~~ 100
a.	~~[20b]: “the first signaling is a semi-static signaling.”~~	56
b.	[20b] “the first signaling is a semi-static signaling.”	100
B.	Claims 2, 3, 7, 8, 12, 13, 17 and 18 Are <u>Rendered</u> Obvious ~~over~~ <u>Over</u> Kim, Zhang, and Park (Ground 3) or Kim, Zhang, Kang, and Park (Ground 4).....	~~56~~ 101
16.	Overview of <i>Park</i>	56
17.	~~Claim 2~~	57
a.	~~[2a]: “The method of claim 1, further comprising: receiving a second signaling; and”~~	57
b.	~~[2b]: “operating a second radio signal in a first time resource sub-pool;”~~	58
1.	Claim 2	101
a.	[2a] “The method of claim 1, further comprising: receiving a second signaling; and”	101
b.	[2b] “operating a second radio signal in a first time resource sub-pool;”	102
a.c.	[2c ~~+~~]: “wherein the operating is receiving from the base station, or the operating is transmitting to the base station;”	~~59~~ 103

~~b.d.~~ [2d]: “the second signaling is used to determine the first time resource sub-pool from the first time resource pool; and” 60105

~~e.e.~~ [2e]: “the second signaling is used to determine at least one of occupied frequency domain resources, an MCS, a HARQ process number, an RV, an NDI and (a) transmitting antenna port(s) of the second radio signal.” 64109

~~18. Claim 3~~.....66

2. ~~[3a]:~~Claim 3: “The method of claim 2, comprising: monitoring the second signaling in a second time resource pool, wherein the second signaling occupies one time resource block in the second time resource pool at most; and the second time resource pool includes a positive integer number of time resource block(s); or monitoring the second signaling in a second time resource pool and monitoring the first signaling in a third time resource pool, wherein the second signaling occupies one time resource block in the second time resource pool at most; the second time resource pool includes a positive integer number of time resource block(s); the first signaling is a dynamic signaling; the first signaling occupies one time resource block in the third time resource pool at most; the third time resource pool includes a positive integer number of time resource block(s); a minimum time interval between time resource blocks in the third time resource pool is greater than a minimum time interval between time resource blocks in the second time resource block(s); or” 66poo
1.” 113

~~a. [3b]: “monitoring ...”~~.....69

~~19. Claim 7~~.....70

~~a. [7a]: “The method of claim 6, further comprising: transmitting a second signaling; and”~~ 70

3.	Claim 7	118
a.	[7a] “The method of claim 6, further comprising: transmitting a second signaling; and”	118
~~a.b.~~	[7b ~~+~~]: “performing a second radio signal in a first time resource sub-pool;”	~~70~~ 118
~~b.c.~~	[7c ~~+~~]: “wherein the performing is transmitting to the target receiver, or the performing is receiving from the target receiver;”	~~70~~ 118
~~e.d.~~	[7d ~~+~~]: “the second signaling is used to determine the first time resource sub-pool from the first time resource pool;”	~~70~~ 119
~~d.e.~~	[7e]: “the second signaling is used to determine at least one of occupied frequency domain resources, an MCS, a HARQ process number, an RV, an NDI and (a) transmitting antenna port(s) of the second radio signal.”	~~71~~ 119
20.	Claim 8.....	71
3.4.	~~[8a]:~~ Claim 8: “The method of claim 7, comprising: transmitting the second signaling in a second time resource pool, wherein the second signaling occupies one time resource block in the second time resource pool at most; and the second time resource pool includes a positive integer number of <u>time resource block(s); or</u> <u>transmitting the second signaling in a second time</u> <u>resource pool and transmitting the first signaling in a</u> <u>third time resource pool, wherein the second signaling</u> <u>occupies one time resource block in the second time</u> <u>resource pool at most; the second time resource pool</u> <u>includes a positive integer number of time resource</u> <u>block(s); the first signaling is a dynamic signaling; the</u> <u>first signaling occupies one time resource block in the</u> <u>third time resource pool at most; the third time resource</u> <u>pool includes a positive integer number of time resource</u> <u>block(s); a minimum time interval between time resource</u> ”	

blocks in the third time resource pool is greater than a minimum time interval between time resource blocks in the second time resource block(s); or

.....71poo
1.” 119

a. ~~[8b]: “transmitting ...”~~ 71

21. ~~Claim 12~~..... 71

5. Claim 12 120

a. [12a]: “The UE of claim 11, comprising: a third receiver, receiving a second signaling; and” 71120

b. [12b]: “a second transceiver, operating a second radio signal in a first time resource sub-pool;” 73122

c. [12c]: “wherein the operating is receiving from the base station, or the operating is transmitting to the base station;” 74124

d. [12d]: “the second signaling is used to determine the first time resource sub-pool from the first time resource pool; and” 74124

e. [12e]: “the second signaling is used to determine at least one of occupied frequency domain resources, a MCS, a HARQ process number, a RV, a NDI and (a) transmitting antenna port(s) of the second radio signal.” 75124

22. ~~Claim 13~~..... 75

4.6. [13a]:Claim 13: “The UE of claim 12, the third receiver further monitors the second signaling in a second time resource pool, wherein the second signaling occupies one time resource block in the second time resource pool at most; the second time resource pool includes a positive integer number of time resource block(s); or the third receiver further monitors the second signaling in a second time resource pool, and the second receiver further monitors the first signaling in a third time

resource pool, wherein the second signaling occupies one time resource block in the second time resource pool at most; the second time resource pool includes a positive integer number of time resource block(s); the first signaling is a dynamic signaling; the first signaling occupies one time resource block in the third time resource pool at most; the third time resource pool includes a positive integer number of time resource block(s); a minimum time interval between time resource blocks in the third time resource pool is greater than a minimum time interval between time resource blocks in the second time resource pool; or

.....75poo
l.” 125

a. — ~~[13b]: “the third receiver”~~ 75

23. — ~~Claim 17~~.....75

7. Claim 17 125

a. [17a]: “The base station equipment of claim 16, further comprising: a third transmitter, transmitting a second signaling; and” 75126

b. [17b]: “a fourth transceiver, performing a second radio signal in a first time resource sub-pool;” 77127

c. [17c]: “wherein the performing is transmitting, or the performing is receiving;” 78129

d. [17d]: “the second signaling is used to determine the first time resource sub-pool from the first time resource pool;” 78129

e. [17e]: “the second signaling is used to determine at least one of occupied frequency domain resources, a MCS, a HARQ process number, a RV, a NDI and (a) transmitting antenna port(s) of the second radio signal.” 79129

24. — ~~Claim 18~~.....79

5.8. ~~[18a]~~Claim 18: “The base station equipment of claim 17, wherein: the third transmitter further transmits the second signaling in a second time resource pool, wherein the second signaling occupies one time resource block in the second time resource pool at most; and the second time resource pool includes a positive integer number of time resource block(s); or” ~~79~~ the third transmitter further transmits the second signaling in a second time resource pool, and the second transmitter further transmits the first signaling in a third time resource pool, wherein the second signaling occupies one time resource block in the second time resource pool at most; the second time resource pool includes a positive integer number of time resource block(s); the first signaling is a dynamic signaling; the first signaling occupies one time resource block in the third time resource pool at most; the third time resource pool includes a positive integer number of time resource block(s); a minimum time interval between time resource blocks in the third time resource pool is greater than a minimum time interval between time resource blocks in the second time resource pool.” 130

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I. INTRODUCTION

a. ~~—~~ *I have been retained by Samsung Electronics Co., Ltd.*
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PETITIONER'S EXHIBIT LIST

1. and Samsung Electronics America, Inc., (collectively "Petitioner") as an independent expert consultant in this proceeding before the United States Patent and Trademark Office.

2. I am over 21 years of age and, if I am called upon to do so, I would be competent to testify as to the matters set forth herein.

3. My compensation is in no way contingent on the nature of my findings, the presentation of my findings in testimony, or the outcome of any proceeding.

4. I understand that this proceeding involves U.S. Patent No. 10,944,527 ("the '527 patent," Ex. 1001). The application for the '527 was filed June 3, 2019, as U.S. Patent Application No. 16/429,077 ("the '077 application"). The '527 patent claims priority as "a continuation of application No. PCT/CN2017/112033, filed on Nov. 21, 2017." Ex. 1001, cover. The '527 patent also claims priority to Chinese patent application CN 20161108328.7, filed December 3, 2016. Ex. 1001, cover.

5. I have been asked by Petitioner to provide my opinion whether the claims of the '527 patent would have been obvious to a person of ordinary skill in the art at the time of the earliest claimed priority date of the '527 patent. In

performing my analysis, I have been asked to assume that the priority date is December 3, 2016. My opinions are set forth below.

6. Throughout this declaration, I refer to specific pages, figures, and/or line numbers of various exhibits. These citations are illustrative and are not intended to suggest that they are the only support for the propositions for which they are cited.

II. SUMMARY OF OPINIONS

7. This declaration considers claims 1-20 of the '527 patent. Below, I set forth the opinions I have formed, the conclusions I have reached, and the bases for these opinions and conclusions. I believe the statements contained in this declaration to be true and correct to the best of my knowledge.

8. Based on my experience, knowledge of the art at the time of the applicable priority date (I was told to assume a priority date of December 3, 2016), it is my opinion that claims 1-20 of the '527 patent would have been obvious based on the asserted grounds discussed below.

9. I am being compensated for my time at my normal hourly rate. My compensation is in no way contingent upon the nature of my findings, the presentation of my findings in testimony, or the outcome of this proceeding.

III. QUALIFICATIONS AND BACKGROUND

10. I believe that I am well qualified to serve as a technical expert in this matter based upon my qualifications, discussed in detail below. A copy of my curriculum vitae is attached as Appendix A.

11. I am competent to write this Declaration.

12. I have personal knowledge and expertise concerning the relevant technologies based upon my education, training, or experience. My relevant experience includes a deep understanding of the systems that we broadly refer to as “1G,” “2G,” “3G,” “4G,” “LTE,” and “5G” communications systems, as well as other wireless communication technologies, including those based on the IEEE 802.11 set of standards (often referred to as WiFi) as well as those related to IEEE 802.16 set of standards (often referred to as WiMAX).

13. I am an expert in the field of communication engineering and specifically, among others, the field of wireless communications. I have over 40 years of experience in electrical engineering and computer science and in fixed and mobile communications networks. I attended the University of Colorado from 1974 to 1980, during which I earned a Bachelor of Science (B.S.) and a Master of Science (M.S.) in applied mathematics with a minor in electrical engineering. I attended the Polytechnic Institute of New York between 1982 and 1988, during which I earned a Doctor of Philosophy (Ph.D.) in electrical engineering, with a

minor in applied mathematics. My Ph.D. thesis was titled “Topological Properties and Design of Multihop Packet Radio Networks.” While pursuing my Ph.D. degree, I held a joint appointment as Special Research Fellow and Adjunct Instructor at the Polytechnic Institute of New York between 1985 and 1986 teaching graduate-level courses in Electrical Engineering.

14. Between 1982 and 1987, I worked at AT&T Bell Laboratories in Holmdel, New Jersey. While at AT&T Bell Laboratories, I worked on modeling, analysis, design, and performance evaluation of voice and data networks. I developed algorithms for DNHR (Dynamic, Non-Hierarchical Routing) used in the telephone network. I also analyzed advanced data services and formulation of long-term plans for development of enhanced data services and network design tools to support such services.

15. I was an Assistant Professor of Electrical Engineering and Computer Science at The George Washington University (GWU) in Washington, D.C., between 1987 and 1994. During my association with GWU, I taught graduate courses in the area of communication engineering, including communication theory, coding theory, voice and data networking, and mobile communications. In the early 1990s I developed and taught the first course on Mobile Communications at GWU to Electrical Engineering graduate students. I also received several research awards/grants, including the prestigious NSF Research Initiation Award.

16. In 1988, I founded Cosmos Communications Consulting Corporation (“Cosmos”), which is a private communications engineering consulting firm specializing in mobile communications, and I have been the President of the company since its founding. Since 1994, I have worked full-time at Cosmos. At Cosmos, among various activities, I have consulted on high level technology-related issues and trends to corporate entities, governmental agencies, and international organizations, such as the United Nations.

17. I have provided technical consultancy to engineering firms, operators, and equipment vendors on issues related to existing or evolving technologies for mobile communications, and to the investment community on issues related to both fixed and wireless communications technologies. I developed and taught hundreds of courses to thousands of engineers around the world in the area of communication engineering, mostly in the area of mobile, wireless communications.

18. Over the course of my career, I have authored and co-authored some thirty (30) publications on various aspects of fixed and mobile communications, as noted in my curriculum vitae. I am a life member of the Institute of Electrical and Electronics Engineers (IEEE) and have been actively involved in the Communications Society and the Information Theory Society of the IEEE. Between 1991 and 1992, I served as the Secretary of IEEE Communications

Society National Capital Area Chapter. Between 1992 and 1993, I was the Vice-Chair of IEEE Communications Society National Capital Area Chapter. I was the Vice-Chair of the Communication Theory Technical Committee of the Communications Society of the IEEE for the 1993–1996 term, and Treasurer of the Communication Theory Technical Committee of the Communications Society of the IEEE for the 1996–1999 term.

19. I have served as a reviewer for the IEEE, book editors, other technical publications, and various National Science Foundation (NSF) Panels. I have organized technical sessions in technical conferences, including the IEEE International Conference on Communications (ICC) and IEEE Global Communications Conference (Globecom). I served as the Technical Program Chair for the Communication Theory Mini-Conference in 1992.

20. During the past 35+ years, I have been lucky enough to be part of the community of engineers that have contributed to the astounding growth of the mobile communications industry. It started from a niche industry that was thought of as being something for the “rich and the famous” to becoming one of the most widespread household concepts, providing useful tools to all segments of the global society.

21. My involvement in this industry included providing consulting services to company executives who needed to make deployment plans, taking into

consideration the strengths and weaknesses of the technology, economics, user value, etc. As such, I have developed a deep understanding of all aspects of a given technology, its features, added value, and the like. In addition, my consulting services included developing courses for the companies that were at the forefront of this developing technology. By definition, this previously non-existent technology was not taught in university courses, as it was too new. Having developed hundreds of courses over the years and taught thousands of engineers (and non-engineers alike), I have a solid understanding and knowledge of the technical developments and how their importance fits in the larger puzzle of a fast-developing technology.

22. My consulting included providing training to engineers in the field that were deploying the various networks. For example, I developed courses and provided training and consulting to the engineers deploying some of the earliest GSM networks in Germany and France, to be followed by many countries in Europe and around the world, including the United States when it was decided that GSM would be used in the U.S. Successful deployments of the initial GSM systems were followed by deployments of GPRS and EDGE, which was then followed by deployments of 3G UMTS systems worldwide. Of course, the 3G systems were followed by the currently most widespread deployments of 4G systems, also referred to as LTE, worldwide and most recently deployments of 5G

networks. Thus, as I explain above, my experience includes a deep understanding of the entirety of each system that we broadly refer to as “1G,” “2G,” “3G,” “4G,” “LTE,” and “5G.”

23. Similarly, I developed courses and provided training and consulting to engineers deploying and/or enhancing wireless local area networks using one or more of the IEEE 802.11 set of standards (often referred to as WiFi) as well as networks using the IEEE 802.16 set of standards (often referred to as WiMax).

24. As an expert consultant, I have served on both civil and criminal legal cases, including several patent infringement cases both at the ITC and in district courts, as well as in support of IPR petitions, such as the one in this case. I have also participated as a technical expert consultant in the analysis of large patent portfolios for the purposes of due diligence, sales, and merger and acquisition activities for some of the largest companies in the mobile communications space. These projects span a multidimensional spectrum of technologies in both fixed and mobile communications as they have evolved over the past more than 30 years.

IV. MATERIALS CONSIDERED

25. In forming my opinions, I have reviewed the following documents, and any other document cited in this declaration.

Exhibit	Description
Ex. 1001	U.S. Patent No. 10,944,527 to Zhang (“the ’527 patent”)
~~Ex. 1002~~	~~Declaration of Dr. Apostolos Kakaes, Ph.D. (“Kakaes”)~~
Ex. 1003	Prosecution History of the ’527 patent ~~(downloaded from Public PAIR)~~

<u>Exhibit</u>	<u>Description</u>
Ex. 1004	U.S. Patent Application Publication No. 2013/0182594 to Kim et al., published July 18, 2013 (“ <i>Kim</i> ”)
Ex. 1005	International Publication No. WO 2015/199414 to Zhang et al., published December 30, 2015 (“ <i>Zhang</i> ”)
Ex. 1006	U.S. Patent Application Publication No. 2015/0195025 to Kang et al., published July 9, 2015 (“ <i>Kang</i> ”)
Ex. 1007	U.S. Patent Application Publication No. 2019/0387501 to Park et al., published December 19, 2019 (“ <i>Park</i> ”)
Ex. 1008	U.S. Patent Application Publication No. 2010/0202560 to Luo et al., published August 12, 2010 (“ <i>Luo</i> ”)
Ex. 1009	International Publication No. WO 2017/084235 to Zhang et al., published May 26, 2017 (“ <i>Zhang-235</i> ”)
Ex. 1010	U.S. Patent Application Publication No. 2016/0112099 to Lee et al., published April 21, 2016 (“ <i>Lee</i> ”)
Ex. 1011	Ken Long and Wei-ling Wu, “An enhanced multi-antenna solution through beamforming to 3G long-term evolution,” 2009 International Conference on Networks Security, Wireless Communications and Trusted Computing, pp. 112-115 (“ <i>Long</i> ”)
Ex. 1012	U.S. Patent Application Publication No. 2016/0211902 to Park et al., published July 21, 2016 (“ <i>Park-902</i> ”)
Ex. 1013	T. Zhang and A. Manikas, “Joint Transmitter-Receiver Beamforming Over Space-Time Fading Channels,” IEEE International Conference on Communications, 2007, pp. 4913-4918 (“ <i>Zhang-ICC</i> ”)
Ex. 1014	Huy Hoang Pham, Tetsuki Taniguchi, and Yoshio Karasawa, “MIMO Beamforming for High-Bit-Rate Transmission over Frequency-Selective Fading Channels,” Eighth IEEE International Symposium on Spread Spectrum Techniques and Applications, 2004, pp. 275-279 (“ <i>Pham</i> ”)
<u>Exhibit</u>	<u>Description</u>
Ex. 1015	Yoshitaka Hara, Akinori Taira, and Takashi Sekiguchi, “Weight Control Scheme for MIMO System with Multiple Transmit and Receive Beamforming,” The 57th IEEE Semiannual Vehicular Technology Conference, 2003, pp. 823-827 (“ <i>Hara</i> ”)
Ex. 1016	3GPP TS 36.212 v12.2.0: 3rd Generation Partnership Project; Technical Specification Group Radio Access Network; (E-UTRA); Multiplexing and channel coding (Release 12), September 2014 (“TS 36.212 v12.2.0”)

<u>Exhibit</u>	<u>Description</u>
Ex. 1017	U.S. Patent Application Publication No. 2013/0308608 to Hu et al., published November 21, 2013 (“Hu”)
Ex. 1018	U.S. Patent Application Publication No. 2006/0164981 to Olsson et al., published July 27, 2006 (“Olsson”)
Ex. 1019	U.S. Patent Application Publication No. 2015/0326291 to Wong et al., published November 12, 2015 (“Wong”)
Ex. 1020	U.S. Patent Application Publication No. 2011/0038330 to Luo et al., published February 17, 2011 (“Luo-330”)
Ex. 1021	U.S. Patent Application Publication No. 2011/0176519 to Vitthaladevuni et al., published July 21, 2011 (“Vitthaladevuni”)
Ex. 1022	Plaintiff’s Disclosure of Asserted Claims and Infringement Contentions, Appendix D
Ex. 1023	3GPP TS 36.211 v8.9.0: 3rd Generation Partnership Project; Technical Specification Group Radio Access Network; (E-UTRA); Physical Channels and Modulation (Release 8), December 2009 (“TS 36.211 v8.9.0”)
Ex. ~~1024~~ <u>1028</u>	~~Apex Beam Technologies LLC v. Samsung Electronics Co. Ltd. et al., No. 2:22-cv-00188-JRG, Dkt. No. 1, Complaint for Patent Infringement (E.D. Tex. June 1, 2022)~~ U.S. Patent Application Publication No. <u>2013/028696</u> to Li et al., published October 31, 2013 (“Li”)
~~Apex Beam Technologies LLC v. Samsung Electronics Co. Ltd. et al., No. 2:22-cv-00031-JRG, Dkt. No. 34-1, Docket~~	

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ies LLC v.
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Electronie
s Co. Ltd.
et al., No.
2:22-cv-
00188-
JRG,
Plaintiff's
Infringem
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Contentio
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Pleading
(E.D. Tex.
Jan. 5,
2023)~~

Exhibit	Description
~~Ex. 1027~~	~~United States District Courts—National Judicial Caseload Profile, available at https://www.uscourts.gov/sites/default/files/fcms_na_distprofile0630.2022_0.pdf (retrieved Feb. 5, 2023)~~
~~Ex. 1028~~	~~U.S. Patent Application Publication No. 2013/028696 to Li et al., published October 31, 2013 (“Li”)~~
Ex. 1029	U.S. Patent Application Publication No. 2018/0309496 to Lee et al., published October 25, 2018 (“Lee-496”)

26. I have also relied on my education, experience, research, training, and knowledge in the relevant art, and my understanding of any applicable legal

principles described in this declaration.

27. All of the opinions contained in this declaration are based on the documents I reviewed and my knowledge and professional judgment. My opinions have also been guided by my understanding of how a person of ordinary skill in the art would have understood the claims of the '527 patent at the time of the earliest claimed priority date.

28. I reserve the right to supplement and amend any of my opinions in this declaration based on documents, testimony, and other information that becomes available to me after the date of this declaration.

V. LEGAL STANDARDS

29. I am not a lawyer. My understanding of the legal standards to apply in reaching the conclusions in this declaration is based on discussions with counsel for Petitioner, my experience applying similar standards in other patent-related matters, and my reading of the documents submitted in this proceeding. In preparing this declaration, I have tried to faithfully apply these legal standards to the challenged claims.

30. I have been informed that there are two ways in which prior art may render a patent claim unpatentable. First, I have been informed that the prior art can “anticipate” a claim. Second, I have been informed that the prior art can render a claim “obvious” to a person of ordinary skill in the art. I understand that a claim is patentable if it was not anticipated and would not have been obvious by the prior art at the effective filing date of the patent.

31. I have been informed that a dependent claim is a patent claim that refers back to another patent claim. I have been informed that a dependent claim includes all of the limitations of the claim to which it refers.

32. I have been asked to provide my opinions as to whether the cited prior art teaches or renders obvious claims 1-20 of the '527 patent from the perspective of a person of ordinary skill in the art at the '527 patent's earliest claimed priority date in 2016, as described in more detail below.

33. I have been informed that in *inter partes* review proceedings, such as this one, the party challenging the patent bears the burden of proving unpatentability by a preponderance of the evidence. I understand that a preponderance of the evidence means "more likely than not."

34. For purposes of this declaration, I have been asked to provide my opinions on issues regarding unpatentability. I have been informed of the following legal standards, which I have applied in forming my opinions.

A. Level of Ordinary Skill

35. I have been informed a person of ordinary skill in the art is determined by considering several factors, including the (i) type of problems encountered in the art; (ii) prior art solutions to those problems; (iii) rapidity with which innovations are made; (iv) sophistication of the technology; and (v) educational level of active workers in the field.

36. I have been instructed to assume a person of ordinary skill in the art is not a specific real individual, but rather a hypothetical individual having the qualities reflected by the factors discussed above.

B. Prior Art

Ex. 1030	3GPP Declaration of Friedhelm Rodermund
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I. PRELIMINARY STATEMENT

37. Petitioner Samsung Electronics Co., Ltd., and Samsung Electronics America, Inc. (collectively “Samsung”), requests *inter partes* review of U.S. Patent No. 10,944,527 (I have been advised and understand the information used to evaluate whether an invention was new and not obvious when made is generally referred to as “prior art.” I understand that prior art includes patents and printed publications that existed before the earliest claimed priority date or the earliest filing date of the patent (which I have been informed is also called the “effective filing date”). I have been informed and understand that a patent or published patent application is prior art if it was filed before the earliest filing date of the claimed invention and that a printed publication is prior art if it was publicly available before the earliest filing date.

C. Anticipation

38. I have been informed that under 35 U.S.C. § 102, a patent claim is unpatentable for anticipation if the claimed subject matter was patented or described in a printed publication before the effective filing date of the claimed invention. I have been informed that this is referred to as unpatentability by anticipation. I have been informed that a patent claim is anticipated under § 102 if a single prior art reference discloses all limitations of the claimed invention.

D. Obviousness

39. I have been informed that obviousness under 35 U.S.C. § 103, a patent claim is unpatentable if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have

been obvious to a person having ordinary skill in the art to which said subject matter pertains at the time the invention was made. I have been informed that this is referred to as unpatentability by obviousness.

40. I have been informed that a proper obviousness analysis includes the following:

- a. Determining the scope and content of the prior art;
- b. Ascertaining the differences between the prior art and the claims at issue;
- c. Resolving the level of ordinary skill in the pertinent art; and
- d. Considering evidence of secondary indicia of non-obviousness (if available).

41. I have been informed that the relevant time for considering whether a claim would have been obvious to a person of ordinary skill in the art is the time of invention. For my obviousness analysis, counsel for Petitioner instructed me to assume that the date of invention for the Challenged Claims is December 3, 2016. My opinions would not change if I assumed a later date of invention.

42. I have been informed that a reference may be modified or combined with other references or with a person of ordinary skill in the art's own knowledge if the person would have found the modification or combination obvious. I have also been informed that a person of ordinary skill in the art is presumed to know all

the relevant prior art, and the obviousness analysis may take into account the inferences and creative steps that a person of ordinary skill in the art would employ.

43. I have been informed that whether a prior art reference renders a patent claim obvious is determined from the perspective of a person of ordinary skill in the art. I have also been informed that, while there is no requirement that the prior art contain an express suggestion to combine known elements to achieve the claimed invention, and while a suggestion to combine known elements to achieve the claimed invention may come from the prior art as a whole or individually and may consider the inferences and creative steps a person of ordinary skill in the art would employ, as filtered through the knowledge of one skilled in the art, obviousness grounds cannot be sustained by mere conclusory statements and must include some articulated reasoning with some rational underpinning to support the legal conclusion of obviousness.

44. In determining whether a prior art reference could have been combined with another prior art reference or other information known to a person having ordinary skill in the art, I have been informed that the following principles may be considered:

- a. A combination of familiar elements according to known methods is likely to be obvious if it yields predictable results;

- b. The substitution of one known element for another is likely to be obvious if it yields predictable results;
- c. The use of a known technique to improve similar items or methods in the same way is likely to be obvious if it yields predictable results;
- d. The application of a known technique to a prior art reference that is ready for improvement to yield predictable results;
- e. Any need or problem known in the field and addressed by the reference can provide a reason for combining the elements in the manner claimed;
- f. A person of ordinary skill often will be able to fit the teachings of multiple references together like a puzzle; and
- g. The proper analysis of obviousness requires a determination of whether a person of ordinary skill in the art would have a “reasonable expectation of success”—but not “absolute predictability” of success—in achieving the claimed invention by combining prior art references.

45. I have been informed that, when a work is available in one field, design alternatives and other market forces can prompt variations of it, either in the same field or in another. I have been informed that if a person of ordinary skill in the art could have implemented a predictable variation and would have seen the

benefit of doing so, that variation is likely to have been obvious. I have been informed that, in many fields, there may be little discussion of obvious combinations, and in these fields market demand—not scientific literature—may drive design trends. I have been informed that, when there was a design need or market pressure and there are a finite number of predictable solutions, a person of ordinary skill in the art would have had a good reason to pursue those known options.

46. I have been informed that the law permits the application of “common sense” in examining whether a claimed invention would have been obvious to a person skilled in the art. For example, I have been informed that combining familiar elements according to known methods and in a predictable way may suggest obviousness when such a combination would yield nothing more than predictable results. I understand, however, that a claim is not obvious merely because every claim element is disclosed in the prior art and that a party asserting obviousness must still provide a specific motivation to combine or modify the references as recited in the claims and explain why one skilled in the art would have reasonably expected to succeed in doing so.

47. I have been informed that there is no rigid rule that a reference or combination of references must contain a “teaching, suggestion, or motivation” to combine references. But I also understand that the “teaching, suggestion, or

motivation” test can be a useful guide in establishing a rationale for combining elements of the prior art. I have been informed that this test poses the question as to whether there is an express or implied teaching, suggestion, or motivation to combine prior art elements in a way that realizes the claimed invention, and that it seeks to counter impermissible hindsight analysis.

48. I am not aware of any evidence of secondary considerations that would support a determination of non-obviousness of the claimed subject matter in the ’527 patent.

49. I have been informed that, in an obviousness analysis, prior art must be analogous prior art to the patent being considered. I have been informed that a prior art reference is considered to be analogous, or in the same field of art, if the reference is either (1) in the same field of endeavor as the challenged patent, regardless of the problems the challenged patent and the prior art address, or (2) reasonably pertinent to the particular problem being solved by the challenged patent.

~~Ex. 1001), assigned to Patent Owner Apex Beam Technologies LLC, and cancellation of claims 1-20.~~

~~All challenged claims are directed to multi-antenna transmission in a wireless communication system. Specifically, the ’527 patent aims to solve a problem of “signaling overhead of wireless resource dynamic scheduling.”~~

~~Ex. 1001, 1:42-44. According to the patent, it solves this problem “by associating~~

~~[a] first time resource pool with [a] first antenna port group,” enabling a user equipment to “quickly determine” the location of the first time resource pool and antenna virtualization vectors used for receiving a radio signal transmitted on the first time resource pool. *Id.*, 2:3–14. The Examiner allowed the claims because she thought using antenna virtualization vectors at both a base station and a user equipment was not in the prior art. ~~Ex. 1003~~, 378–379. But this concept was already a well-known technique in the field of multi-antenna transmission.~~

~~For example, *Kim* (~~Ex. 1004~~), *Zhang* (~~Ex. 1005~~), and *Kang* (~~Ex. 1006~~) disclose the alleged inventive concept of associating the first time resource pool with the first antenna port group, as well as the use of antenna virtualization~~

vectors at both a base station and a user equipment. The Examiner did not have the benefit of any of these references during the application process.

As set forth below, *Kim* in combination with *Zhang, Kang, and/or Park* (~~Ex. 1007~~) renders claims 1-20 obvious. The Board should institute review and cancel all challenged claims.

I.VI. TECHNOLOGY BACKGROUND AND STATE OF THE PRIOR ART

50. The development of wireless communications has been rapid, fueled in no small part by the world-wide adoption and usage of services made possible by wireless communications. One of the sub-areas within the broad area of wireless communications is the development of techniques to enable (and

capitalize on the resulting benefits) transmissions using multi-antennas, which the '527 patent relates to. Ex. 1001, cover page.

51. Well before the earliest claimed priority date of the '527 patent (which I have been asked to assume is December 3, 2016), a large body of knowledge and associated techniques had been developed. In this section I will provide an overview of the state of the related art that would have been well known to a POSITA at the earliest claimed priority date. I will focus the discussion herein to the techniques of antenna virtualization and antenna port groups that are related to the '527 patent.

A. Antenna Virtualization in Multi-Antenna Systems

Antenna virtualization was widely used in multi-antenna systems long before the earliest claimed priority date of the '527 patent, December 3, 2016.⁺
As described by the '527 patent, antenna Ex. 1002 (“Kakaes”), ¶52. Antenna virtualization refers to the technique of mapping one or more physical antenna elements to a logical antenna port (i.e., virtual antenna) for transmission of signals. Kakaes, ¶52; Ex. 1001, 2:34-38 (“the antenna port is formed by superposing multiple physical antennas through antenna virtualization; the mapping coefficients from the multiple physical antennas to the antenna port(s) constitute an antenna virtualization vector for the antenna virtualization”). The Ex. 1001, 2:34-38. The

8.52. use of a virtual antenna allows implementation of various

transmission modes with the physical antennas. For example, as described in the
'527 patent, beamforming,

which maps multiple physical antennas to one virtual antenna to obtain a signal with enhanced quality, is an antenna virtualization technique. ~~Kakaes, ¶52; Ex. 1001, 4:43-53 (describing generating a “transmitting analog beam” and a “receiving analog beam” by adopting a first and second antenna virtualization vector, respectively). Ex. 1001, 4:43-53.~~

⁺ ~~Petitioner reserves the right to challenge the priority date here and/or in other proceedings.~~

9.53. To map the multiple physical antennas to antenna port(s) or vice versa, an antenna virtualization vector is applied. Ex. Kakaes, ¶53; Ex. 1001, 2:36-38; 1001, 2:36-38 (“the mapping coefficients from the multiple physical antennas to the antenna port(s) constitute an antenna virtualization vector for the antenna virtualization”). The antenna virtualization vector is also referred to as a precoding vector or a beamforming vector, as shown below. Kakaes, ¶53; Luo, Abstract, ¶[0042]; Zhang; For example, Luo explains that a UE can “create virtual antenna(s) by implementing precoding,” which can enable “utilizing power amplifiers (PAs) associated with the multiple physical transmit antennas efficiently while transmitting over the virtual antenna(s).” Luo, ¶[0042]; see also Luo, Abstract (“The precoding vector can be applied to a signal for transmission over the particular virtual antenna, and the disparate precoding vector can be applied to a disparate signal for transmission over the disparate virtual antenna.”). ¶¶[63], [100].

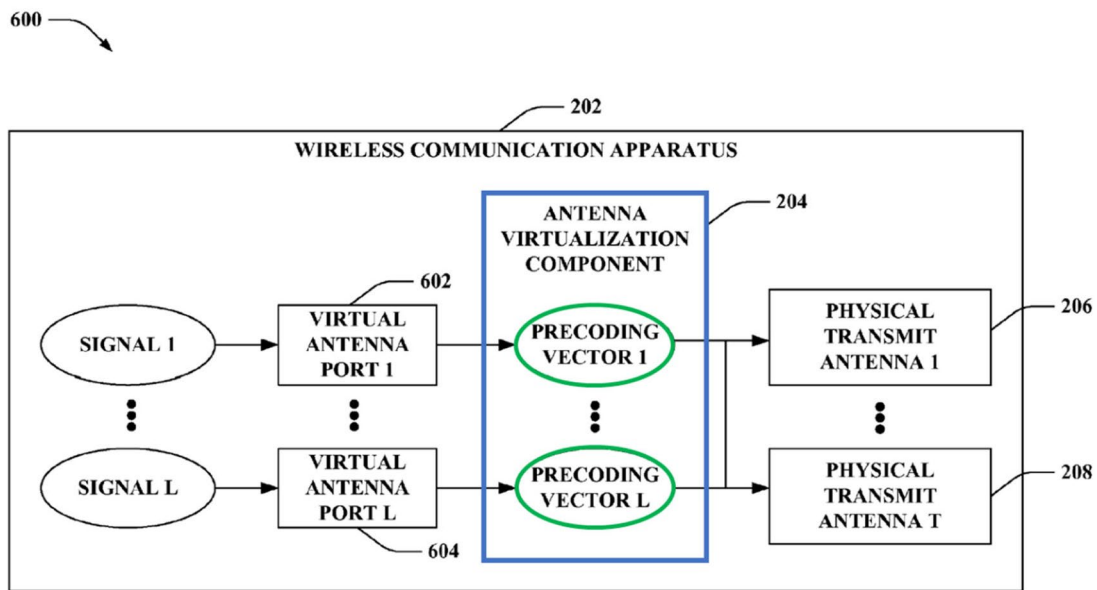


FIG. 6

Luo, Fig. 6.²

² ~~All figures in this Petition containing color are annotated relative to the original figures in the prior art or '527 patent, and all text in color is added.~~

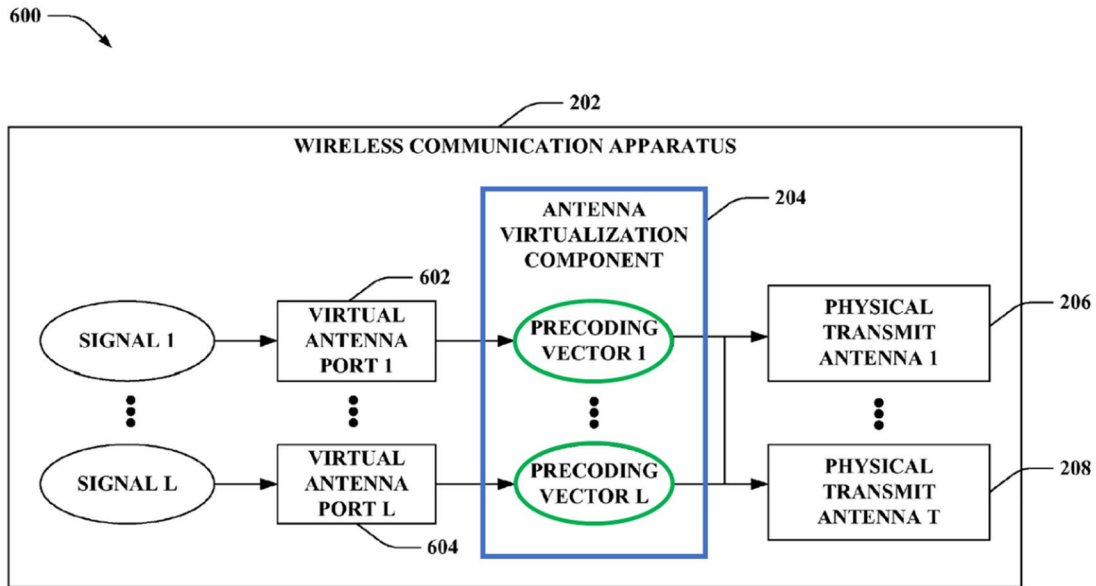


FIG. 6

Luo, Fig. 6 (annotated). Zhang also describes that antenna port virtualization may be implemented by “applying different vertical beamforming vectors to implement port virtualization for the different CRS [Cell-specific Reference Signal] antenna ports.” Zhang, ¶[63]. Zhang further explains that “port virtualization to transmit antennas refers to precoding the reference signal for the CRS port with a precoding vector.” Zhang, ¶[100].

54. It was also well known that antenna virtualization can be implemented at both a base station (also called an eNB) and a user equipment (UE) in a multi-antenna system. Kakaes, ¶54; For example, Zhang-235 teaches transmitting beamforming at the base station and receiving beamforming at the user equipment. Zhang-235, 4:1-21; Kang, ¶¶ teaches implementing reception antenna

virtualization such that a group of

physical antennas can operate “as if the antennas are a single antenna.” *Kang*, ¶[0125], [0142]. Furthermore, as *Kang* teaches, it was known that “the transmission antenna virtualization method and the reception antenna virtualization method are not limited to the same method” and that various different configurations were known. *Kang*, ¶[0142], Fig. 10. ~~For example,~~ In some communication systems, it would be advantageous that the base station implements transmitting beamforming to transmit signals, and the user equipment implements receiving beamforming to receive the signals transmitted from the base station. ~~Kakaes~~, ¶54; ~~Zhang-235~~, 4:1-21, 6:7-19; *Kang*, ¶[0125], [0142], Fig. ~~See Zhang-235~~, 4:1-21 (describing using “Tx [transmitting] beam and Rx [receiving] beam pairs” for data transmission), 6:7-19 (Table 1 illustrating the UE measuring various transmitting beams and receiving beams); *Kang*, ¶[0125] (forming a receiving beam using multiple reception antennas), ¶[0142] (discussing using both transmission and reception antenna virtualization), Fig. 10. The antenna virtualization scheme at the base station and user equipment can be independently configured. ~~Kakaes~~, ¶54; See *Kang*, ¶[0142].

¶[0142] (“a transmission antenna virtualization method and a reception antenna virtualization method may be independently configured.”).

B. Antenna Port Groups

55. The concept of dividing antenna ports into groups where each group is

associated with a particular set of resources was also well known. For example,
Kim teaches dividing transmission antennas into five antenna groups, each group

having eight transmission antennas. Kim, ¶[0057]; see also Kim, ¶[0083]
(dividing transmission antennas into five beam groups, “each antenna group
includes 8 transmission antennas”). I note that Kim teaches that “Although the
grouping is made based on actual transmission antennas in FIG.4, the grouping
may be made based on virtual transmission antennas other than the actual
transmission antennas” Kim, ¶[0057]. I furthermore note that the ’527 patent
teaches that an antenna port group can consist of a single antenna port. Ex. Kakaes,
¶55; Kim, ¶¶[0057], [0083].1001, 3:18-19 (“the antenna port group includes only
one antenna port”). When the number of antenna ports is high, there may not be
enough resources to transmit signals for all the antenna ports at the same time.
~~Kakaes, ¶55.~~ Dividing the antenna ports into groups allows coordination on
transmission opportunities among the antenna ports. ~~Kakaes, ¶55. For example,~~
~~as~~For example, Lee teaches transmitting signals for different antenna port groups
at different time/frequency resources. Lee, ¶¶[0118]- [0119]. As shown below,
where the horizontal axes represent time and the vertical axes represent frequency,
signals for antenna port group 1 are transmitted at certain time/frequency
resources, and signals for antenna port group 2 are transmitted at different
time/frequency resources. ~~Kakaes, ¶55; Lee, ¶¶[0118]-[0119].~~

FIG. 12

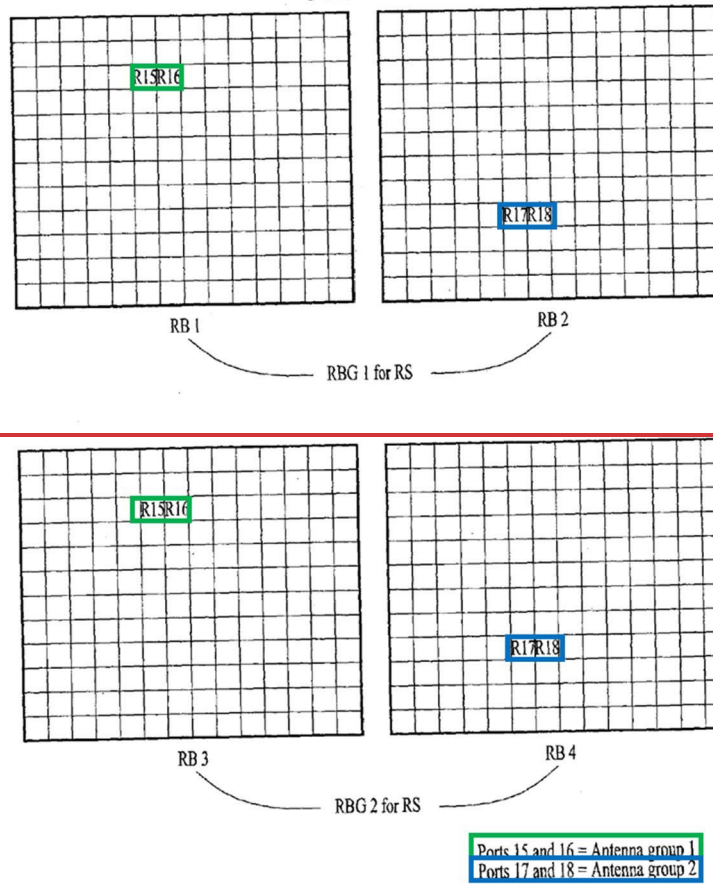
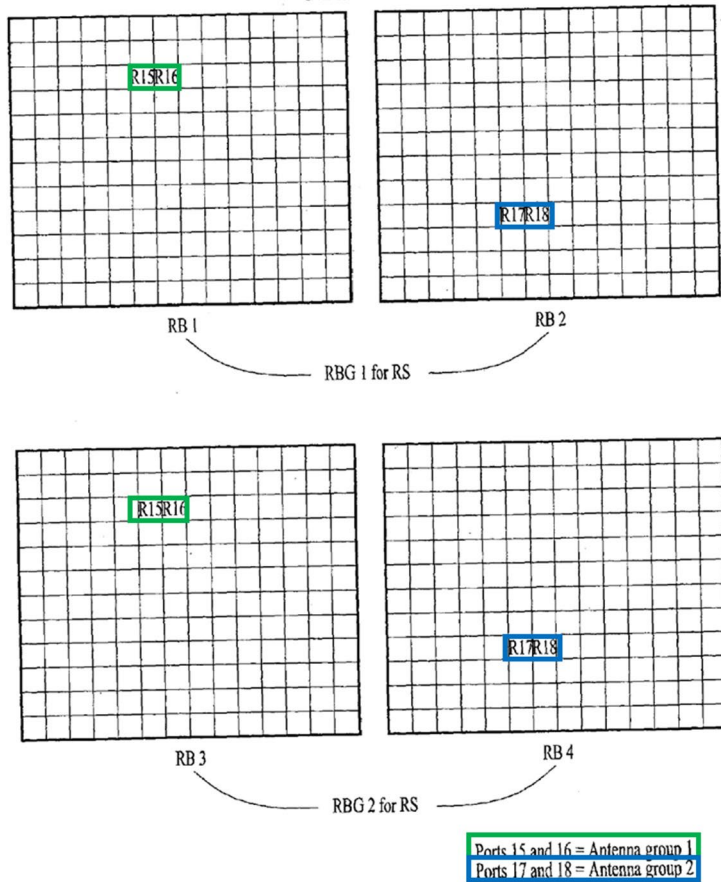


FIG. 12



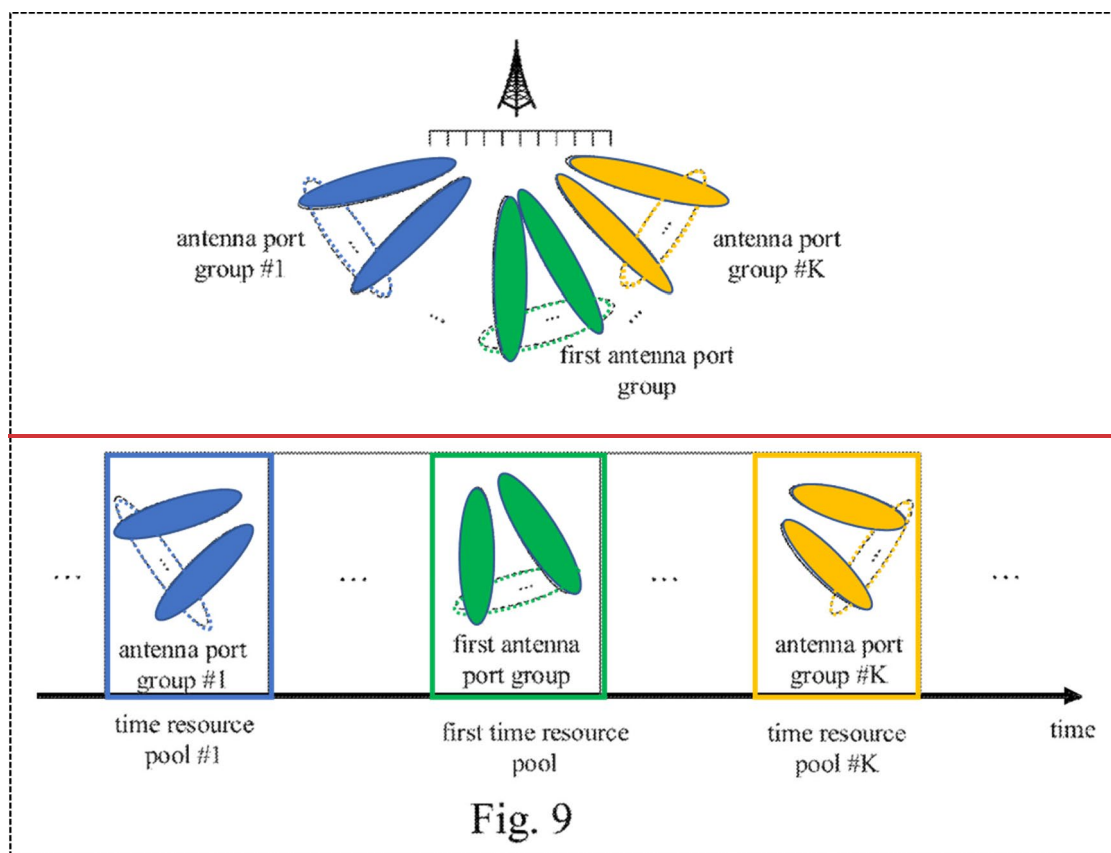
Lee, Fig. 12; (annotated); see also Lee, Fig. 26; As another example, Kim also teaches transmitting signals for different antenna port groups at different time and frequency resources. Kim, ¶¶[0060], [0083], Figs. 5, 7.

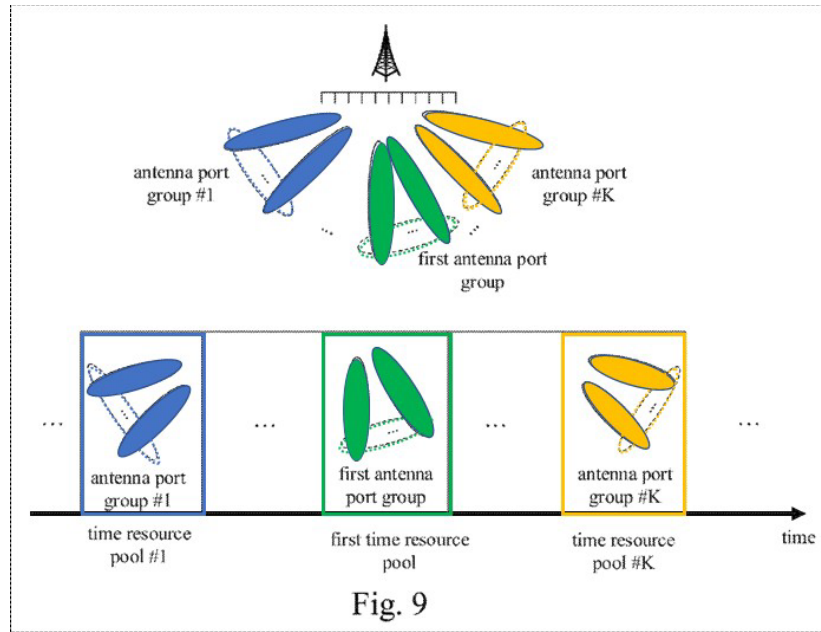
H.VII. THE '527 PATENT

A. Alleged Invention of the '527 patent

10-56. The '527 patent is directed to “a method and device for multi-antenna transmission in UE and base station.” Ex. 1001, Abstract. According to the '527 patent, “signaling overhead of wireless resource dynamic scheduling is an urgent problem to be solved in massive MIMO system[s].” Ex. ~~1001~~, 1:42-46.

~~44~~.57. The '527 patent aims to solve this problem by associating a time resource pool with an antenna port group, enabling a UE to quickly determine the location of the corresponding time resource pool and the antenna virtualization vectors used for receiving signals on the time resource pool. Ex. ~~44~~.1001, 2:3-14. Figure 9 below illustrates how a different time resource pool is assigned to each antenna port group for transmitting signals. Ex. ~~44~~.1001, 16:65-17:6.





Ex. 1001, Fig. 9. (annotated).

12:58. The '527 patent also describes using an antenna virtualization vector to map the physical antennas to the antenna port(s). Ex. ~~Id.~~ 1001, 2:34-38. For example, the '527 patent describes the base station using a first antenna virtualization vector to generate a transmitting beam, and the UE using a second antenna virtualization vector to generate a receiving beam. ~~Id.~~, 4:47-53, 18:46-51, 20:3-8. These concepts, however, were already taught by the prior art applied in this Petition. The

'527 patent

describes “the first antenna virtualization vector is used to transmit the first reference signal(s) group.” Ex. 1001, 4:47-53. The ’527 patent further describes a first antenna virtualization vector for the base station, and a second antenna virtualization vector for a target receiver. Ex. 1001, 18:46-51. The ’527 patent also explains “[t]he first antenna virtualization vector is used to form an analog transmitting beam for transmitting the first reference signal group, and the second antenna virtualization vector is used to form an analog receiving beam for receiving the first reference signal group(s).” Ex. 1001, 20:3-8. The above are examples of the alleged invention as discussed in the ’527 patent. As I explained below in Section XI, the prior art taught these concepts as claimed in the respective claims.

B. Prosecution History

59. The ~~application that issued as the~~ ’527 patent was filed ~~as a continuation of an International~~ June 3, 2019, as U.S. Patent Application ~~filed on November 21, 2017~~, No. 16/429,077 and ~~claimed~~ claims priority to a Chinese patent application

no. 201611098328.7, filed ~~on~~ December 3, 2016. Ex. 1001, cover.

~~After amendments to address rejections~~ During prosecution, the examiner rejected claims 1-20 under 35 U.S.C. § 112, ~~as indefinite and failing to comply with the written description requirement. Ex. Examiner~~ 1003, 306-317. (in addition to a double patenting rejection). In response, the applicant filed a terminal disclaimer and an amendment. Ex 1003, 352-364. The examiner then allowed the

claims because she thought the prior art did not disclose ~~that~~

“the first

antenna virtualization vector is an antenna virtualization vector available to the base station in the first time resource pool; [and] the second antenna virtualization vector is an antenna virtualization vector available to the user equipment in the first time resource pool.” Ex. 1003, 379.

~~Ex. 1003, 379. The Examiner did not have the benefit of the prior art applied in this Petition.³~~

C. Claim Construction

60. I have been instructed that the “intrinsic record” includes the patent itself, including the claims, description, and figures (Ex. 1001), and the patent’s prosecution history—i.e., the record of proceedings at the U.S. Patent and Trademark Office (“Patent Office”) concerning the patent (Ex. 1003). I understand that, like the claims and written description, the prosecution history provides evidence to a person of ordinary skill in the art of how the inventor intended his patent to be understood, and how the Patent Office understood the patent. I understand that the inventor is permitted to apply a special definition to the terms or to limit the scope of claim terms in his patent claims, which may differ from the term’s plain and ordinary meaning. That special definition or limitation on scope may be provided in the patent’s written description, the patent’s prosecution history, or both.

61. I understand that claim interpretation may also be informed by “extrinsic evidence” (that is, evidence outside of the patent record itself). I have

been informed that extrinsic evidence may include dictionaries, technical treatises,

and other materials evidencing the meaning of a claim term and the understanding held by a POSITA in the relevant time period.

62. I have been asked for purposes of this declaration to apply the plain and ordinary meaning of the claim terms as they would have been understood by a person of ordinary skill in the art at the earliest claimed priority date of the '527 patent.

63. I understand that no claim term's construction is in dispute at this time. Based on my review of these materials and my personal knowledge and experience, I have considered each term of the '527 patent as it would have been understood by a person of ordinary skill in the art at the earliest claimed priority date of December 3, 2016.

VIII. LEVEL OF ORDINARY SKILL IN THE ART

64. In rendering the opinions set forth in this declaration, I have been asked to consider the '527 patent's claims and the prior art through the eyes of a person of ordinary skill in the art (which I may also refer to as "one skilled in the art," "skilled artisan," "POSITA," or similar variation). I have considered factors such as the educational level and years of experience of those working in the pertinent art, the types of problems encountered in the art, the teachings of the prior art, patents and publications of other persons or companies, and the sophistication of the technology.

43-65. Taking the factors described in the Legal Standards – Level of Ordinary Skill section into consideration, it is my opinion that a person of ordinary skill in the art (“POSITA”) would have had at least a master’s degree in electrical engineering or a similar field and at least two years of experience working with multiple-input multiple-output (MIMO) technology in telecommunications systems. More work experience can compensate for less education, and vice versa.

~~The Board construes claims per *Phillips v. AWH Corp.*, 415 F.3d 1303 (Fed. Cir. 2005) (en banc). 37 C.F.R. § 42.100(b). Claims must be construed only to the extent necessary to resolve a controversy. *Nidec Motor Corp. v. Zhongshan Broad Ocean Motor Co.*, 868 F.3d 1013, 1017 (Fed. Cir. 2017). Here, no terms need construction to resolve the controversy in this forum.⁴~~

~~II. STATEMENT OF PRECISE RELIEF REQUESTED~~

~~B. Prior Art~~

IX. Ex. 1004, U.S Patent Publication No. 2013/0182594 to Kim et al., THE PRIOR ART

66. In forming my opinions, I found the following prior art relevant when considering whether the claims of the ’527 patent would have been obvious to a person of ordinary skill in the art.

<u>Ex. 1004</u>	<u>U.S Patent Publication No. 2013/0182594 to Kim et al. (“Kim”)</u>
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<u>Ex. 1005</u>	<u>International Publication No. WO 2015/199414 to Zhang et al.</u> <u>(“Zhang”)</u>
<u>Ex. 1006</u>	<u>U.S. Patent Publication No. 2015/0195025 to Kang et al. (“Kang”)</u>
<u>Ex. 1007</u>	<u>U.S. Patent Publication No. 2019/0387501 to Park et al. (“Park”)</u>

A. *Kim* (US2013/0182594)

14.67. *Kim* was published July 18, 2013, is prior art to the '527 patent under at least 35 U.S.C as U.S. Patent publication no. § 102(a)(1).

³ The Examiner cited another US2013/0182594, making *Kim* prior art.

68. *Kim*, like the '527 patent, teaches a massive MIMO system where a base station transmits a wireless signal, such as a reference signal, through multiple transmission antennas. *Kim*, ¶¶[0016], [0017], [0049]-[0050], [0055]. *Kim* teaches that a user equipment (UE) receives the reference signal and measures a channel state (e.g., the intensity of a channel, the intensity of interference between a base station and a UE) using the received reference signal. *Kim*, ¶¶[0007], [0051]-[0052].

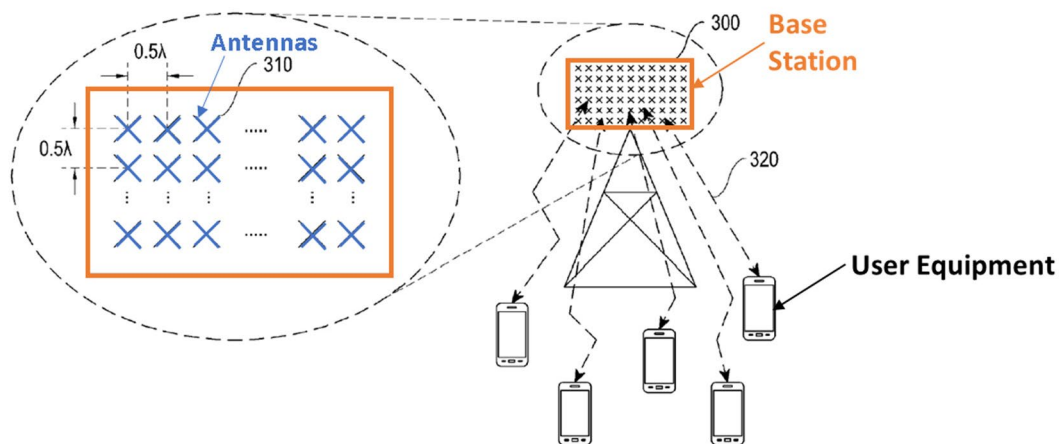


FIG.3

Kim, Fig. 3 (annotated).

69. Kim discloses that the base station (evolved Node B, eNB) transmits the reference signal, such as a Channel State Information-Reference Signal (CSI-

RS), over multiple beam groups. *Kim*, ¶¶[0080]-[0081] (US2017/0195100). A POSITA would have understood that the beam groups correspond to antenna port groups because, the same as an antenna port, each beam presents the same wireless channel characteristics to the UE, which *Kim* confirms: “the plurality of beams may be grouped into a plurality of beam groups for transmission, as the above case of grouping the multiple transmission antennas into multiple antenna groups for transmission”. *Kim*, ¶[0081].

15.70. For example, as shown below, *Kim* discloses grouping a plurality of beams into five beam groups, where each beam group contains eight differently precoded beams, which correspond to eight antenna ports. *Kim*, ¶¶[0082]-[0083]. *Kim* teaches that each beam group is transmitted at different ~~from the *Kim* reference (Ex. 1004, US2013/0182594) cited in this Petition.~~ time resources, e.g., at different subframes, “using one CSI-RS resource 700 for 8 ports in each transmission interval”. *Kim*, ¶¶[0082]-[0083].

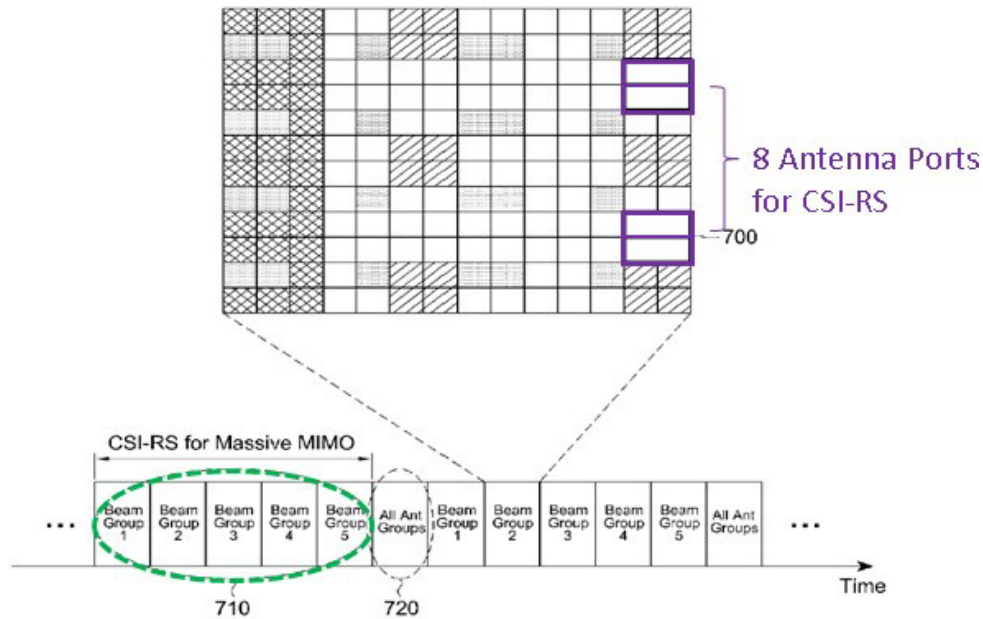


FIG.7

Kim, Fig. 7 (annotated).

71. Kim is analogous art to the '527 patent because Kim, like the '527 patent, relates to “a wireless mobile communication system” and “an effective transmission and reception method in a MIMO system having scores or more transmission antennas.” Kim, ¶¶[0003], [0017]; Ex. 1001, 1:19-20 (“The present disclosure relates to a multiple antenna transmission method in a wireless communication system.”); see also Kim, ¶¶[0016], [0049]-[0050], [0055].

Furthermore, both Kim and the '527 patent use the 3GPP RAN, including specific terms and naming conventions therein, in the various embodiments that they present. See, e.g., '527 patent 1:29-32, 2:29-33, 14:54-58, 20:46-56, 28:61-64,

Fig. 1, Fig. 13 as well as Kim, ¶¶[0005]-[0007], [0010]-[0013], [0018]-[0023] as well as throughout the respective specifications.

Zhang ~~Ex. 1003, 378-379. These two references have no overlapping inventors and are not related.~~

⁴ ~~Petitioner reserves the right to argue in an appropriate forum that certain limitations in the challenged claims are indefinite.~~

B. ~~Ex. 1005, International Publication No. (WO 2015/199414 to)~~

72. ~~Zhang et al.,~~ was published December 30, 2015, ~~is~~ as WIPO PCT publication no. WO2015/199414, making Zhang prior art ~~to~~.

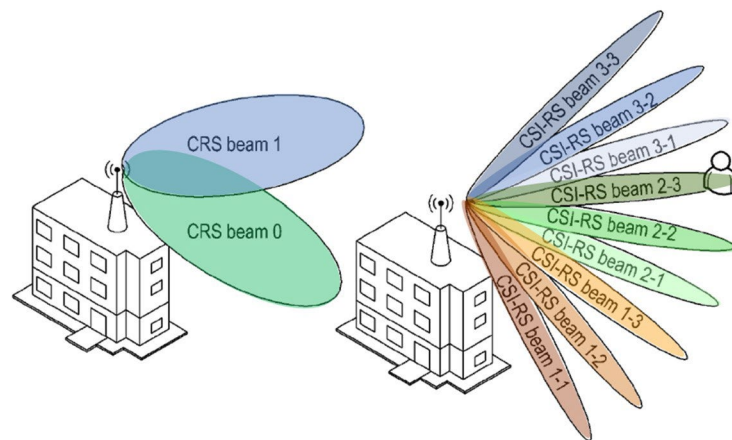
73. Zhang, like the '527 patent, discloses a multiple-antenna system where a base station transmits a reference signal, such as a CRS (Cell-specific Reference Signal) or CSI-RS (Channel State Information-Reference Signal), to a user equipment through multiple antennas. Zhang, ¶¶[1], [24], [101]-[102], [149]. Zhang discloses that the reference signal is transmitted on virtual antenna ports. Zhang, ¶¶[16], [63], [67], [100]-[101], [149]-[150]. ~~under at least 35 U.S.C. §~~

74. Zhang teaches that antenna port virtualization is implemented by applying a precoding vector, also referred to as a beamforming vector. Zhang, Abstract (“Port virtualization to a transmit antennas may be implemented for multiple cell-specific reference signal (CRS) antenna ports and applying different vertical beamforming vectors to implement port virtualization for the different CRS antenna ports”), ¶¶[41] (“embodiments of the present disclosure implement port virtualization to transmit antennas via using multiple CRS antenna ports and applying different vertical beamforming vectors to the different CRS antenna ports”), [63] (same), [100]-[101] (“The port virtualization to transmit antennas

refers to precoding the reference signal for the CRS port with a precoding vector.”), [136] (“four different precoding vectors are adopted to implement the port virtualization to transmit antennas of four CRS ports”).

75. For example, as shown in Figure 19 below, Zhang describes transmitting the CRS in two antenna ports and transmitting the CSI-RS in nine antenna ports by applying different precoding vectors. Zhang, ¶¶[149]-[153].

[Fig. 19]



Zhang, Fig. 19 (annotated).

16-76. Zhang is analogous art to the '527 patent because Zhang, like the '527 patent, is directed to “mobile communication systems” and “reference signal transmitting and receiving in active antenna systems.” Zhang, ¶[1]; Ex. 1001, 1:19-20 (“The present disclosure relates to a multiple antenna transmission method in a wireless communication system.”); see also Zhang, ¶¶[24], [101]-[102(a)(1)-], [149]. Just as the '527 patent and Kim use the 3GPP system as an example of a relevant mobile communication system, so does Zhang throughout the specification.

~~Ex. 1006, U.S. Patent Publication No. 2015/0195025 to Kang et al.,~~

C. Kang (US2015/0195025)

- ~~Kang was published July 9, 2015, is prior art to the '527 patent under at least~~

~~35 U.S.C.~~

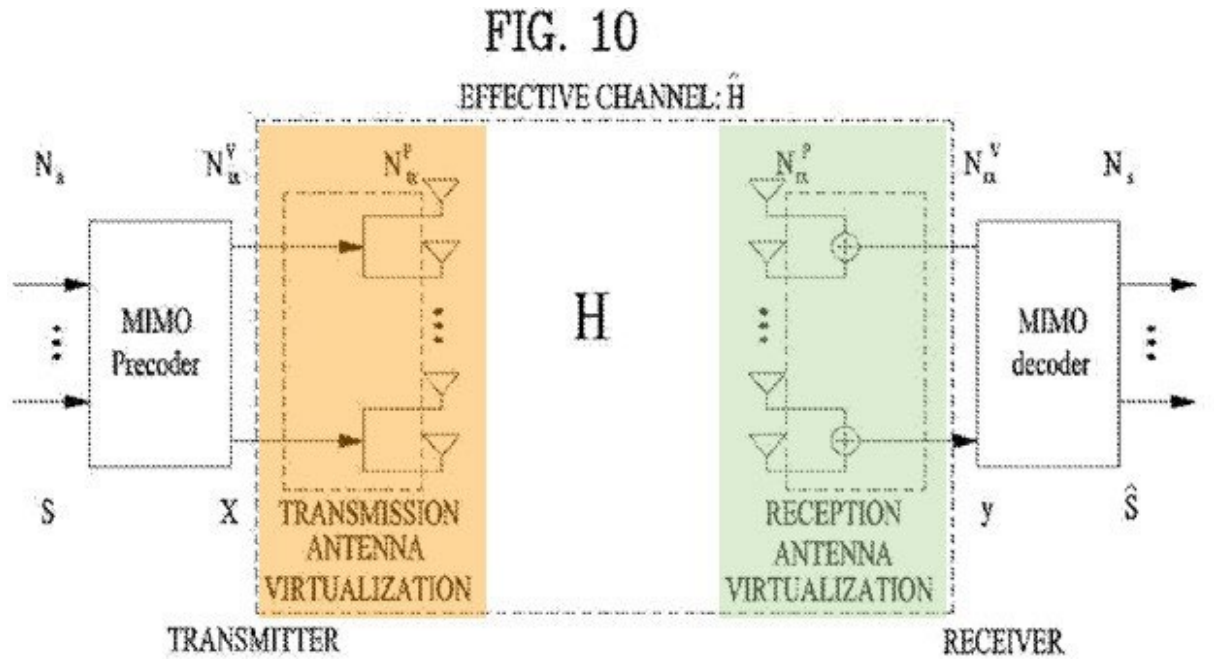
~~§ 102(a)(1).~~

77. Ex. 1007, as U.S. Patent publication no.

US2015/0195025, making Kang prior art.

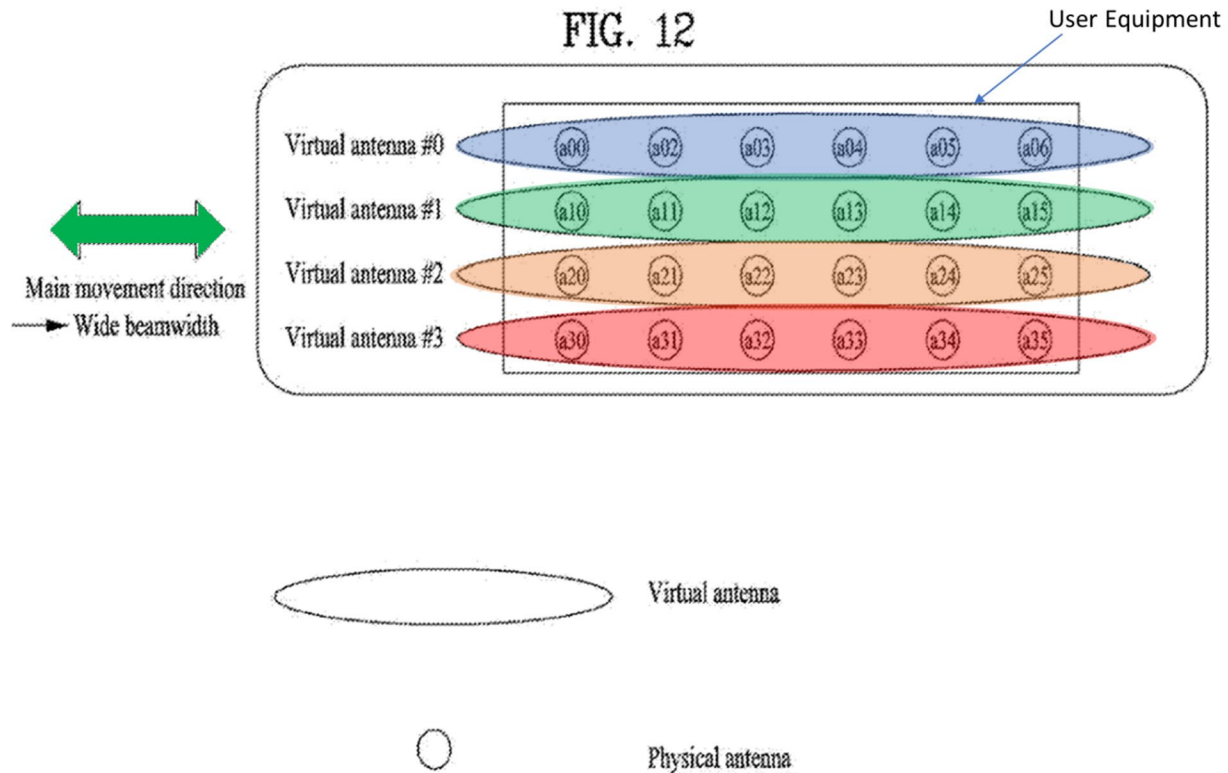
78. Kang, like the '527 patent, discloses a multiple-antenna system where a base station transmits a reference signal, such as a CRS or CSI-RS, to a user equipment through multiple antennas. Kang, ¶¶[0095]-[0098], [0104]. Kang discloses that the reference signal is transmitted on virtual antenna ports. Kang, ¶¶[0122]-[0126] (“If 16 transmission physical antennas are present, then every two antennas can be grouped to form 8 virtual antennas for CSI-RS transmission or every four antennas can be grouped to form 4 virtual antennas for CRS transmission”).

79. Kang further explains that antenna virtualization is “a technology for mapping a physical antenna to a virtual antenna (or antenna port).” Kang, ¶[0127]. Kang teaches that antenna virtualization is implemented at both the transmission side (e.g., a base station) and reception side (e.g., a user equipment) to make a channel between a virtual transmission antenna and a virtual reception antenna “more advantageous for communication.” Kang, ¶¶[0123]-[0128]. Figure 10 below shows implementing antenna virtualization at both the transmitter and the receiver.



Kang, Fig. 10.

80. As Publication No. 2019/0387501 to Park et al., shown in Figure 12 below, multiple physical antennas at a user equipment are mapped into virtual antennas such that a wide beam is obtained at the moving direction of the UE to increase antenna gain.



Kang, Fig. 12 (annotated). See also Kang, ¶¶[0140]-[0141], [0157]

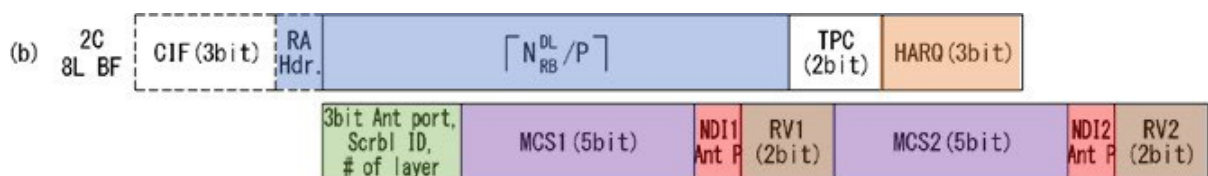
81. Kang is analogous art to the '527 patent because Kang, like the '527 patent, is directed to “a wireless communication system” with “multiple antennas” and “virtualizing an antenna.” Kang, ¶¶[0001], [0089], [0115]; Ex. 1001, 1:19-20 (“The present disclosure relates to a multiple antenna transmission method in a wireless communication system.”); see also Kang, ¶¶[0095]-[0098], [0104]. Just as the '527 patent, Kim and Zhang discussed above use the 3GPP system as an example of a relevant mobile communication system, so does Kang throughout the specification.

D. Park (US2019/0387501)

17.82. Park was filed October 4, 2016, is prior art to the '527 patent under 35 as U.S.C. § 102(a)(2). Patent application no.

15/765,356, making Park prior art.

83. Park discloses a method for “transmitting and receiving Downlink Control Information (DCI) in a wireless communication system.” Park, ¶[0002]. Park describes control information transmitted in a PDCCH as Downlink Control Information (DCI). Park, ¶[0072]. As shown below, Park describes a DCI format 2C which includes information indicating occupied frequency domain resources (blue), an MCS (purple), a HARQ process number (orange), an RV (brown), an NDI (red), and a transmitting antenna port (green).



Park, Fig. 14(b) (annotated).

A.—Park explains that the UE monitors the PDCCH and attempts to decode the DCI format to receive data transmitted to the UE over a physical downlink shared channel (PDSCH). Challenges

Ground	Challenged Claims	Basis	Prior Art
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84. Park, ¶¶[0154]-[0156] (“In order to receive the PDCCH transmitted to the UE, the UE should perform blind decoding on all CCEs present in the control region of the non-DRX subframe”), [0071] (“a maximum

of three OFDM symbols located in a front portion of a first slot of a

subframe correspond to a control region in which control channels are allocated, and the remaining OFDM symbols correspond to a data region in which a physical downlink shared channel (PDSCH) is allocated.”).

85. *Park* is analogous art to the ’527 patent because *Park*, like the ’527 patent, relates to a MIMO communication system. *Park*, ¶¶[0004], [0109], [0281]; Ex. 1001, 1:19-20 (“The present disclosure relates to a multiple antenna transmission method in a wireless communication system.”). Just as the ’527 patent, *Kim*, *Zhang*, and *Kang* discussed above use the 3GPP system as an example of a relevant mobile communication system, so does *Park* throughout the specification.

X. GROUNDS OF UNPATENTABILITY

86. Based on my review of the materials set forth above, including my application of the knowledge of a person of ordinary skill in the art, it is my opinion that claims 1-20 of the ’527 patent would have been obvious to one of ordinary skill in the art.

87. In particular, it is my opinion that claims 1-20 of the ’527 patent would have been obvious to a person of ordinary skill in the art based on the Grounds and corresponding combinations shown below:

<u>Ground</u>	<u>Claims</u>	<u>Basis</u>	<u>Prior Art</u>
---------------	---------------	--------------	------------------

1	1, 4-6, 9-11, 14-16, and 19-20	§ 103	<i>Kim and Zhang</i>
2	1, 4-6, 9-11, 14-16, and 19-20	§ 103	<i>Kim, Zhang, and Kang</i>
3	2-3, 7-8, 12-13, and 17-18	§ 103	<i>Kim, Zhang, and Park</i>
4	2-3, 7-8, 12-13, and 17-18	§ 103	<i>Kim, Zhang, Kang, and Park</i>

~~III.I. LEVEL OF ORDINARY SKILL IN THE ART~~

~~A person of ordinary skill in the art (POSITA) would have had at least a master's degree in electrical engineering or a similar field and at least two years of~~

~~experience working with multiple input multiple output (MIMO) technology in telecommunications systems. More work experience can compensate for less education, and vice versa. Kakaes, ¶¶65.~~

IV.XI. THE CHALLENGED CLAIMS ARE UNPATENTABLE OVER THE PRIOR ART

88. In my opinion claims 1-20 would have been obvious to one skilled in the art at the earliest priority date of the '527 patent.

A. Claims 1, 4-6, 9-11, 14-16, and 19-20 Are Rendered Obvious over-by Kim and Zhang (Ground 1) or Kim, Zhang, and Kang (Ground 2)

1. Overview of Claim 1:

1.—In my opinion, Kim

~~Like the '527 patent, Kim discloses a massive MIMO system where a base station transmits a wireless signal, such as a reference signal, through multiple transmission antennas, and is thus analogous art to the '527 patent. Compare Kim, ¶¶[0016]–[0017], [0049]–[0050], [0055], with Ex. 1001, 1:19–20, 1:24–44, 2:25–33; Kakaes, ¶71. A user equipment (UE) receives the reference signal and measures a channel state (e.g., the intensity of a channel) using the received reference signal. Kim, ¶¶[0007], [0051]–[0052].~~

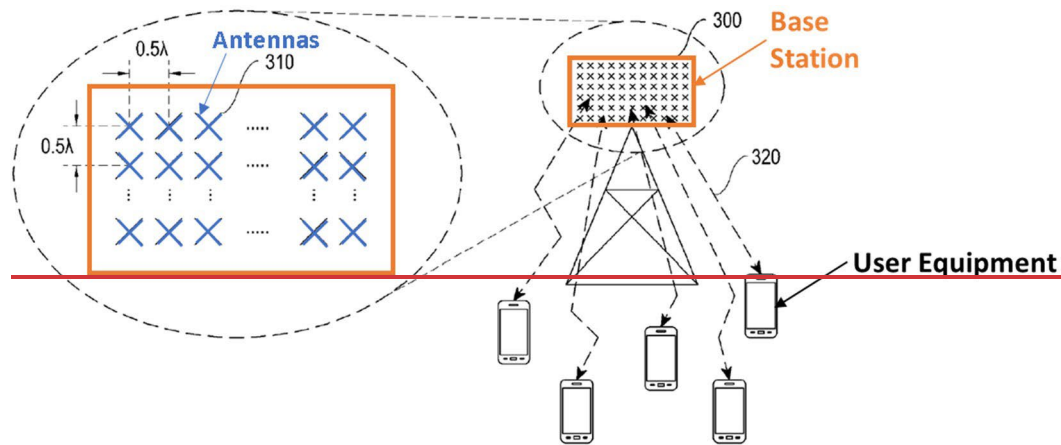


FIG.3

in view
~~Kim, Fig. 3.~~

~~Kim discloses that the base station (eNB) transmits the reference signal, such as a Channel State Information-Reference Signal (CSI-RS), over multiple beam groups. Kim, ¶¶[0080]-[0081]; Kakaes, ¶69. For example, as shown below, Kim discloses grouping a plurality of beams into five beam groups, where each beam group contains eight differently precoded beams corresponding to eight antenna ports. Kim, ¶¶[0082]-[0083]; Kakaes, ¶69. Each beam group is transmitted at different time resources, e.g., at different subframes. Kim, ¶¶[0082]-[0083].~~

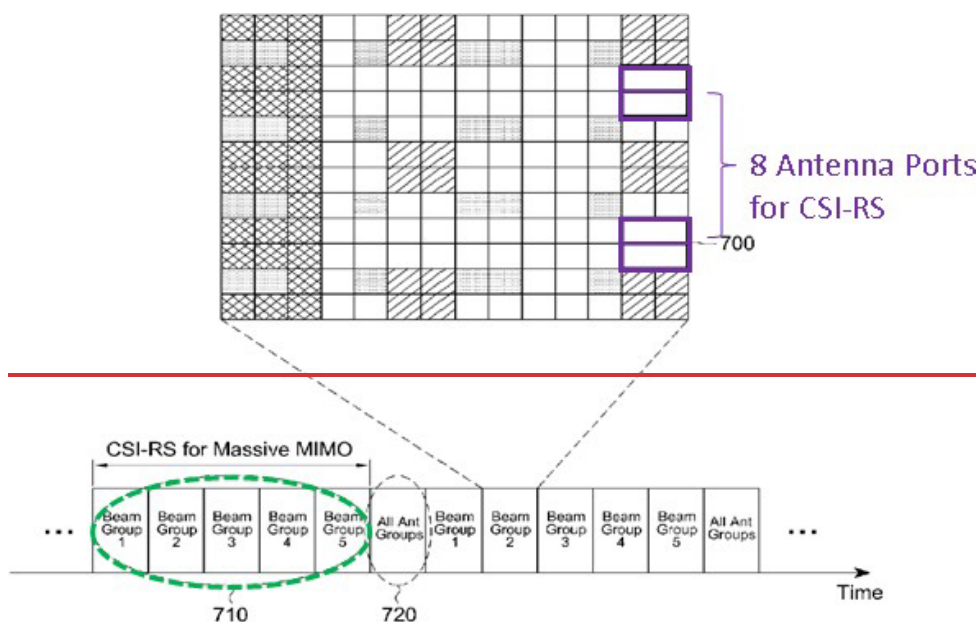


FIG.7

~~Kim, Fig. 7.~~

2. Overview of Zhang

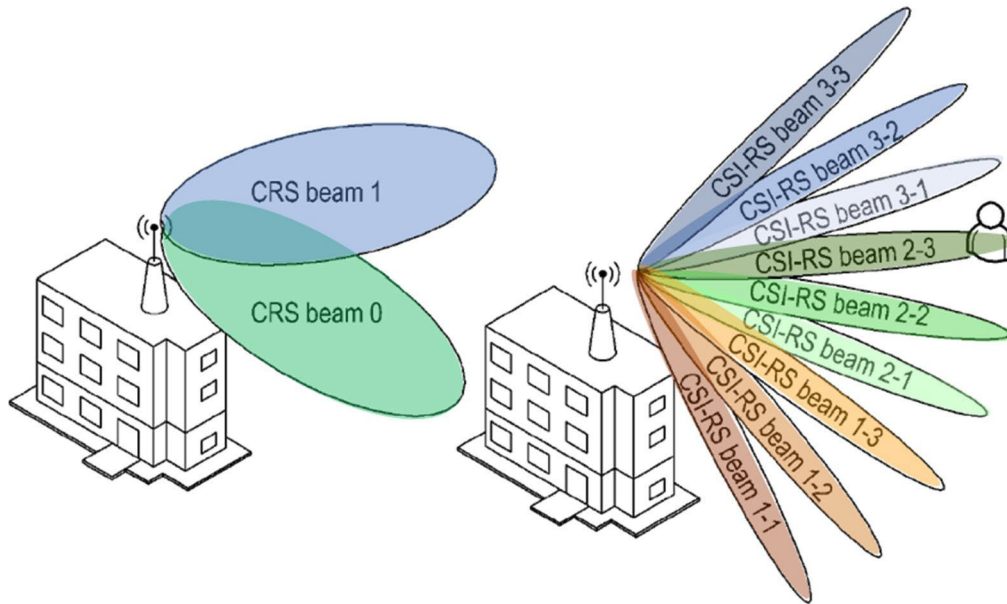
~~18.89. Like the '527 patent, or Kim in view of Zhang discloses a multiple antenna system where a base station transmits a reference signal, such as a CRS (Cell-specific Reference-Signal) or CSI-RS (Channel State Information Reference Signal), to a user equipment through multiple antennas, and is thus analogous art to the '527 patent. Compare Zhang, ¶¶[1], [24], [101] [102], [149], with Ex. 1001, 1:24-44, 2:25-33; and Kakaes, ¶76. Zhang discloses that the reference signal is transmitted on virtual antenna ports. Zhang, ¶¶[16], [63], [67], [100] [101], [149] [150]. Specifically, Kang renders obvious claim 1.~~

~~Kim teaches or suggests each element of claim [1Preamble]-[1f] and [1j]. To the extent Patent Owner argues that a “first antenna port-virtualization vector” in claim elements [1g] and [1h] is implementednot disclosed or suggested by applying a precoding vector, also referred to asKim, Zhang discloses and renders obvious a beamforming “first antenna virtualization vector. Zhang, Abstract,~~

~~¶¶[41], [63], [100] [101],~~

[136]. For example, *Zhang* describes transmitting the CRS in two antenna ports and transmitting the CSI-RS in nine.” If claim [1g] requires a “second antenna ports by applying different precoding vectors. *Zhang*, ¶¶[149] [153]; Kakaes, ¶75.

[Fig. 19]



virtualization vector,”

Zhang, Fig. 19.

3. Overview of *Kang*

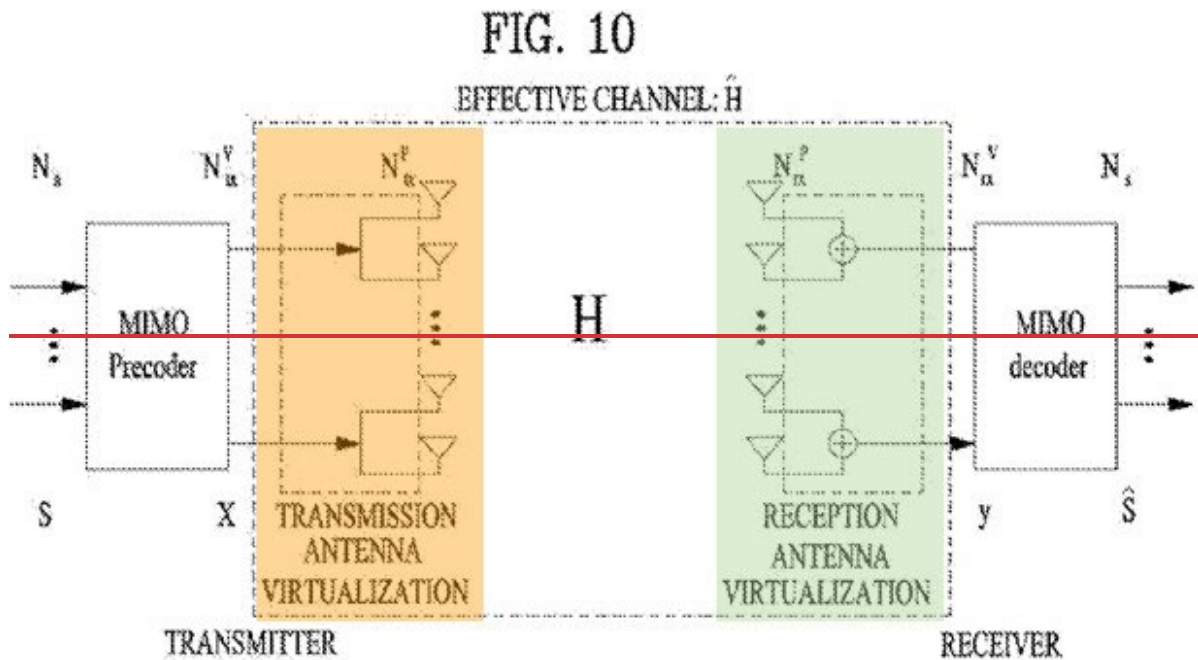
Like the ’527 patent, *Kang* discloses a multiple and renders obvious a “second antenna system where a base station transmits a reference signal, such as a CRS or CSI-RS, to a user equipment through multiple antennas, and is thus analogous art to the ’527 patent. Compare *Kang*, ¶¶[0095] [0098], [0104], with Ex. 1001, 1:24-44, 2:25-33; Kakaes, ¶81.

Kang discloses that the reference signal is transmitted on virtual antenna ports.

Kang, ¶¶[0122] [0126]. *Kang* further explains that antenna virtualization is “a

19.90. technology for mapping a physical antenna to a virtual antenna (or antenna port)” and is implemented at both the transmission side (e.g., a base station) and reception side (e.g., a user equipment) to make a channel between a virtual transmission antenna vector” in claim elements [1g] and a virtual reception antenna more advantageous for communication. [1h].

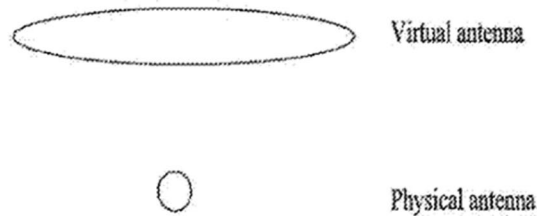
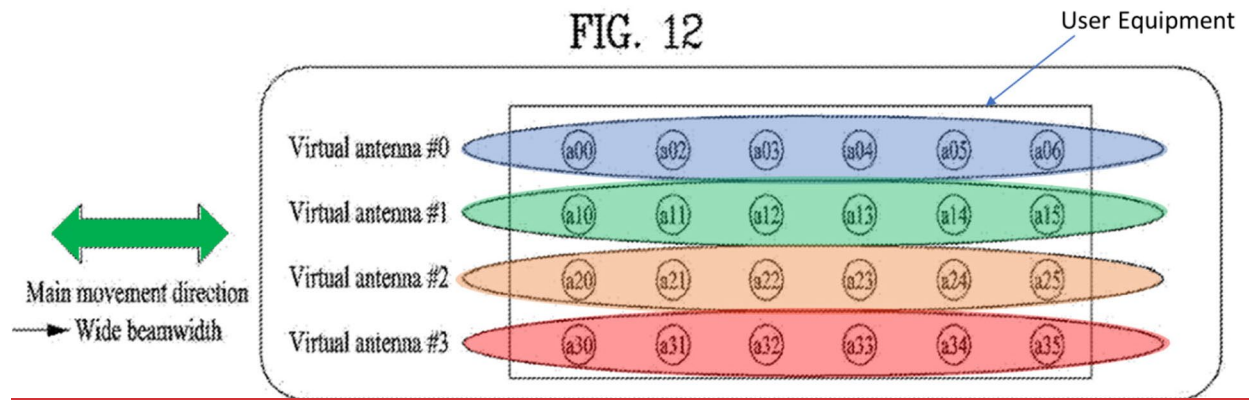
20.7. Kang, ¶¶[0123] [0128]. Figure 10 below shows implementing antenna virtualization at both the transmitter and the receiver.



[1Preamble]

~~Kang, Fig. 10.~~

~~Figure 12 below shows mapping multiple physical antennas at a user equipment into virtual antennas such that a wide beam is obtained at the moving direction of the UE to increase antenna gain. Kang, ¶¶[0140] [0141], [0157], Fig. 12.~~



~~Kang, Fig. 12.~~

4. Independent Claim 1

- a. ~~[pre]:~~ “A method for multi-antenna transmission in a user equipment, comprising:”

[22.91.](#) To the extent the preamble is limiting, *Kim* discloses a method for multi-antenna transmission in a user equipment.

[22.92.](#) ~~Kakaes, ¶¶91.~~ For example, *Kim* discloses a method that includes transmitting, by multiple antennas of a base station, a reference signal to a user equipment. *Kim*, Abstract, ¶¶[0050]-[0053]. As shown in Figure 3 below, *Kim* discloses a base station (300) equipped with multiple transmission antennas (310) for transmitting wireless signals to a user equipment (320).

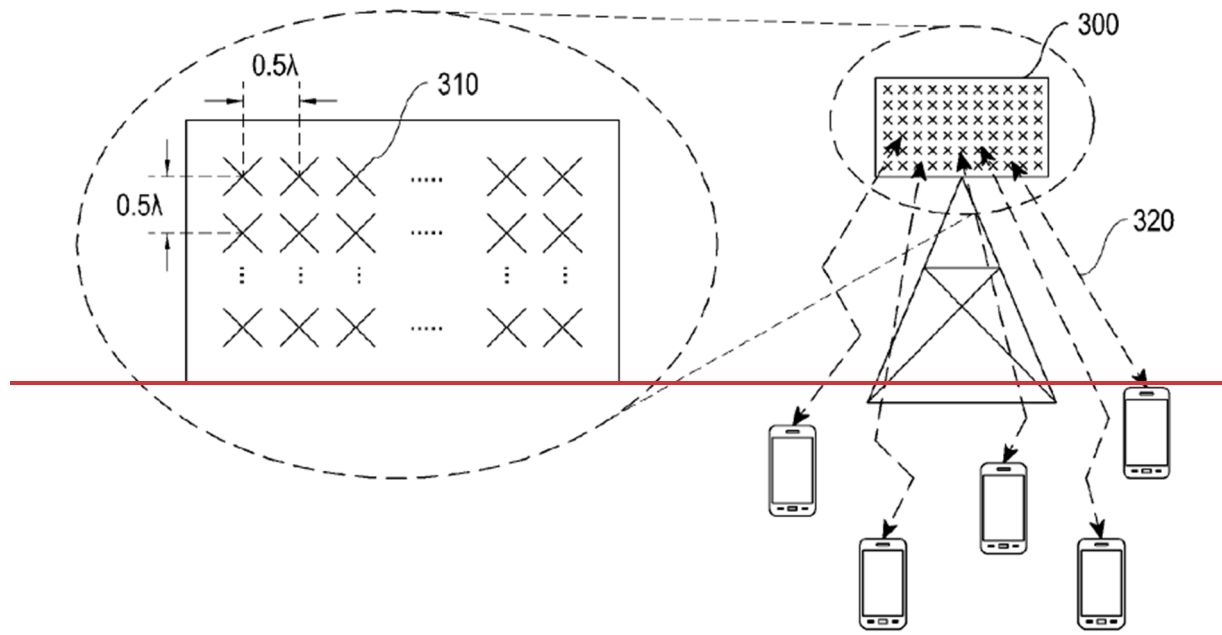


FIG.3

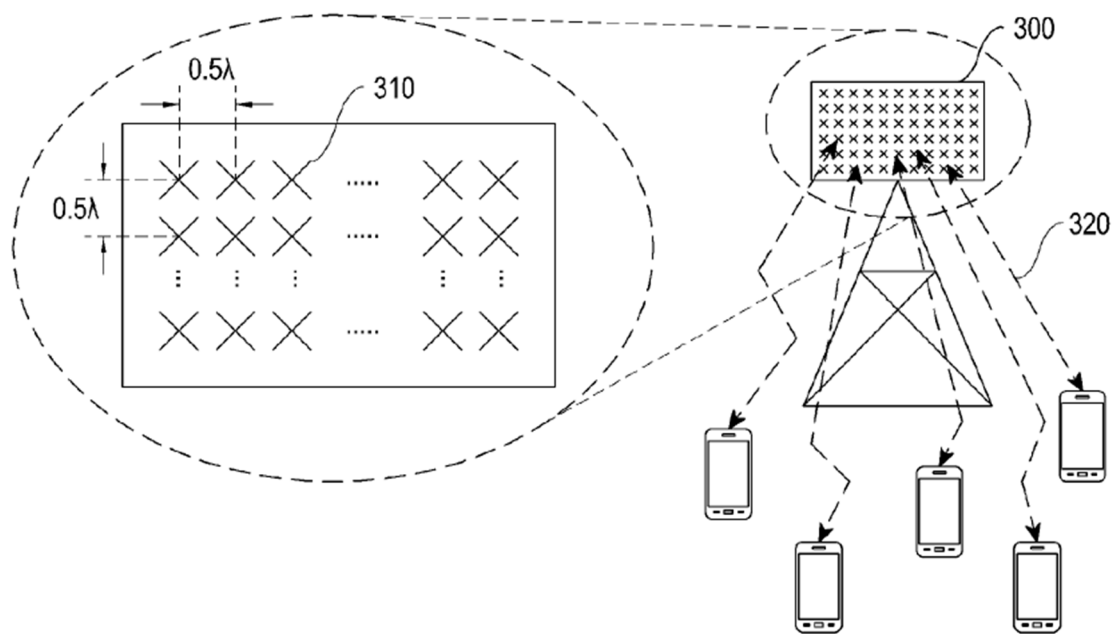


FIG.3

Kim, Fig. 3.

b. [1a]: “receiving a first radio signal from a base station; and”

23-93. In my opinion, *Kim* discloses receiving a first radio signal from a base station.

24-94. ~~Kakaes, ¶93.~~ For example, *Kim* discloses the user equipment receiving a CSI-RS (Channel State Information-Reference Signal) from a base station. *Kim*, ¶¶[0055]-[0058], [0091]. The CSI-RS is a radio signal transmitted by transmission antennas of the base station. because the base station transmits wireless signals, including the CSI-RS, at a frequency that would be understood to be “radio” frequency of the ’527 patent. *Kim*, ¶¶[0050], [0058]; ~~Kakaes, ¶94.~~ The ’527 patent does not delineate “radio” frequency but (a) the term would be understood by a POSITA to include the frequencies described for the “wireless” signals in *Kim* and (b) both the ’527 patent and *Kim* use the 3GPP LTE & LTE-A as exemplary embodiments of their respective systems; thus *Kim*’s “wireless” signals are certainly within the scope of the ’527 patent’s “radio” signals.

c. [1b]: “receiving a first signaling from the base station;”

25-95. In my opinion, *Kim* discloses receiving a first signaling from the base station. ~~Kakaes, ¶95.~~

26-96. For example, *Kim* discloses the user equipment receiving a signaling including control information from the base station, where the control information

indicates positions of time resources at which a CSI-RS for each antenna group is transmitted. *Kim*, ¶¶[0065], [0069]. The *Kim* explains that the control information includes “[i]nformation on the time and frequency resource positions at which CSI-RSs for massive MIMO are transmitted”. *Kim*, ¶[0069]. *Kim* further explains that the control information is “transferred to the UE, separately from the CSI-RSs.” *Kim*, ¶[0079]. *Kim* further describes that the control information is received via a first signaling, such as “a PDCCH (Physical Downlink Control Channel) or an E-PDCCH (Enhanced-PDCCH);” or “a higher layer signaling.” *Kim*, ¶[0107].

- d. **[1c:] “wherein the first radio signal is transmitted by K antenna port groups of the base station;”**

27.97. In my opinion, *Kim* discloses that the ~~CSI-RS~~ (first radio signal (i.e., CSI-RS signal)) is transmitted by K antenna port groups of the base station.-

~~Kakaes, ¶97.~~

28.98. For example, *Kim* discloses the base station dividing transmission antennas into a plurality of antenna groups and transmitting the CSI-RS over the antenna groups, as shown in Figure 5 below. *Kim*, ¶¶[0055]-[0058].

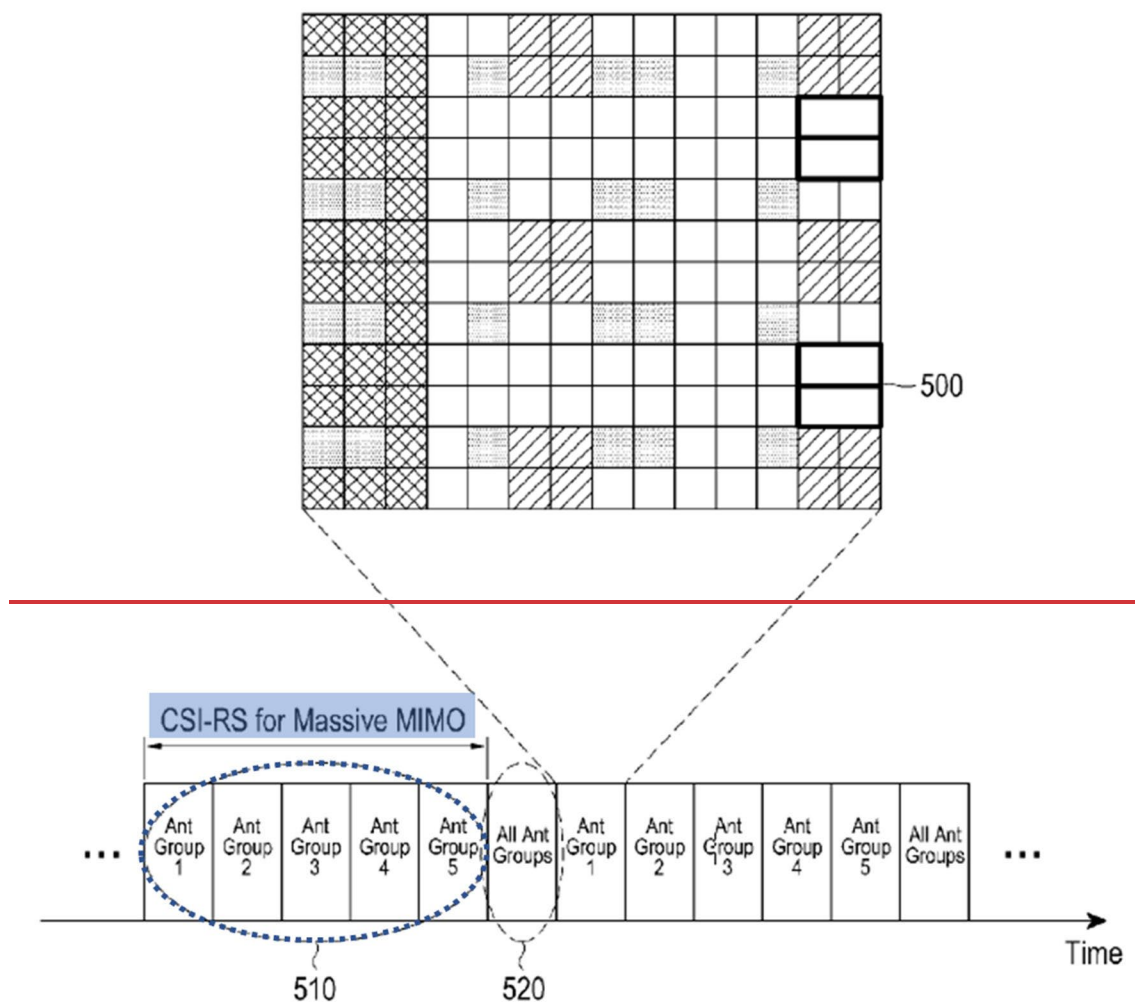


FIG.5

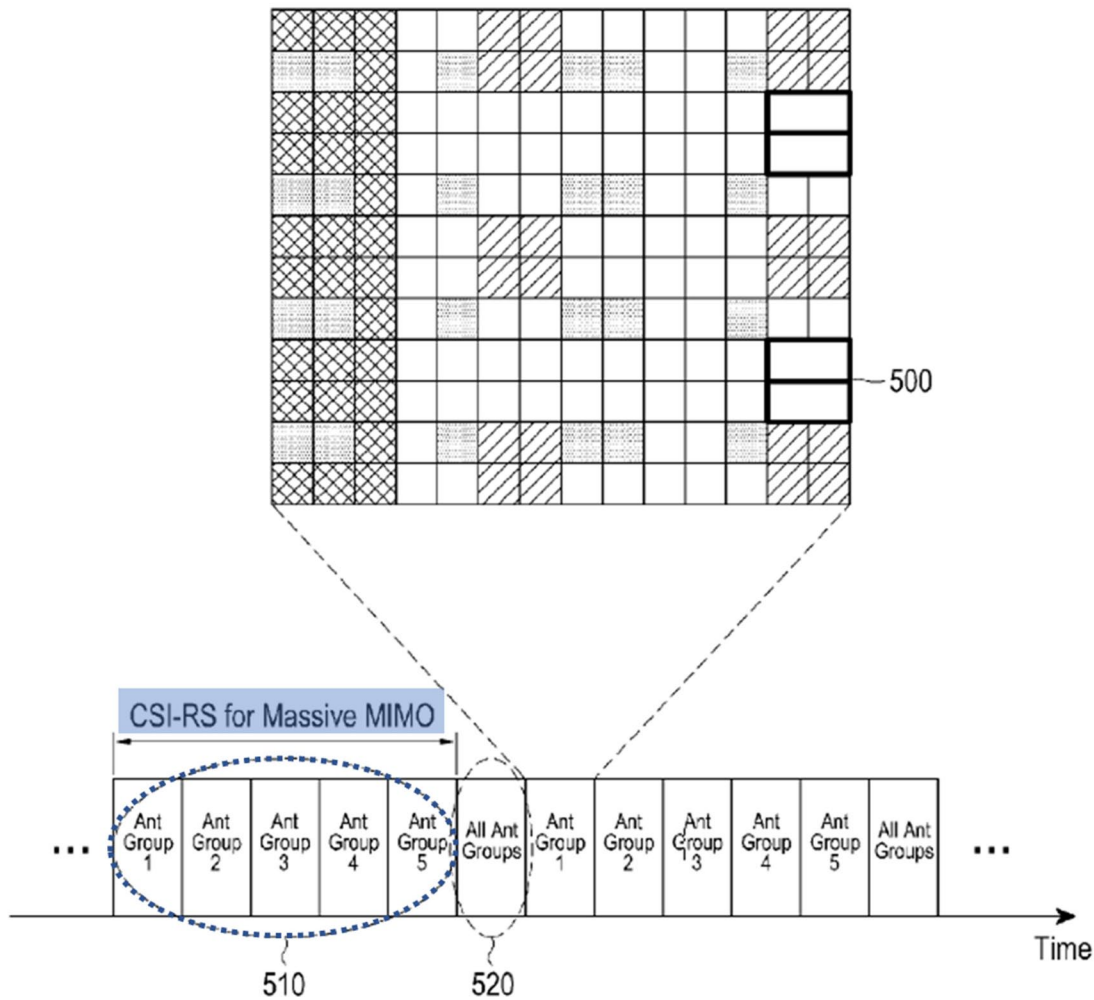


FIG.5

Kim, Fig. 5-5 (annotated). Kim notes that “the grouping may be made based on virtual transmission antennas [antenna ports],” and that the antenna grouping can be “commonly applied” to the virtual transmission antennas and actual transmission antennas. Kim, ¶[0057]. A POSITA would have understood that in Kim, each virtual transmission antenna constitutes an antenna port because signals

transmitted over each virtual transmission antenna experience the same channel characteristics, and the UE receives the signals from each virtual transmission antenna as if they are transmitted from a single antenna.

29.99. As another example, Kim discloses the base station dividing transmission beams (antenna ports) into a plurality of beam groups (antenna port groups) and transmitting the CSI-RS over the beam groups, as shown in Figure 7 below. Kim, ¶¶[0080]-[0081].

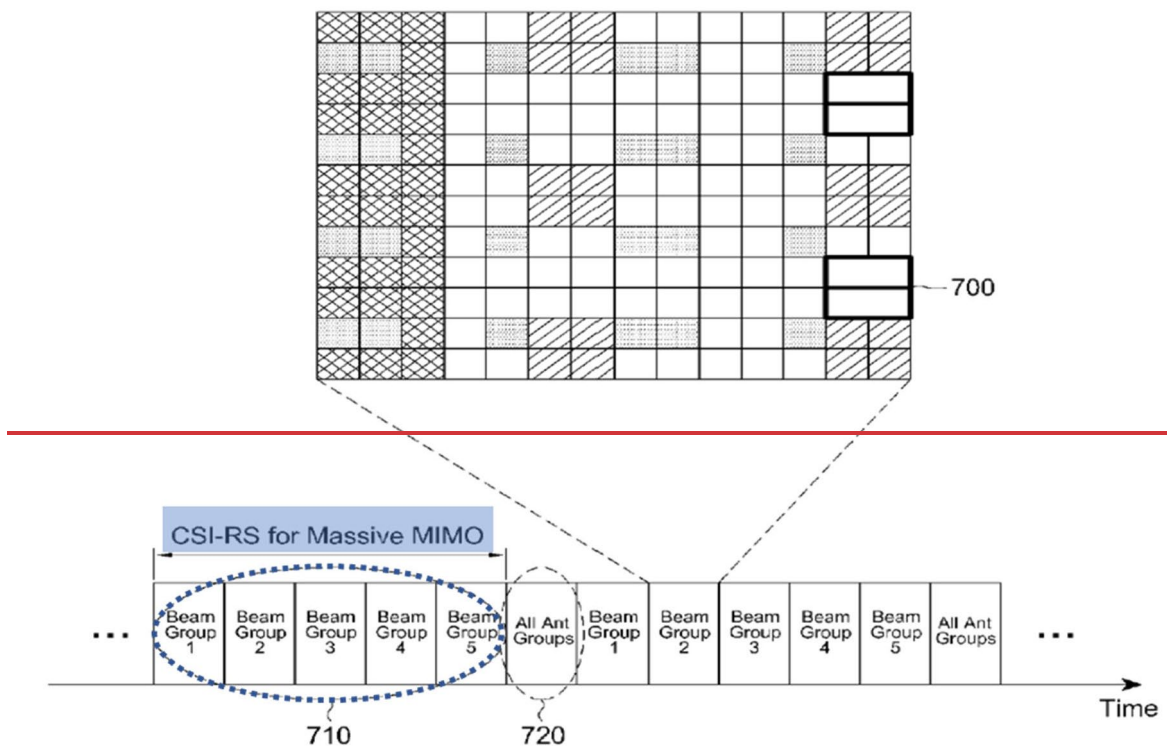


FIG.7

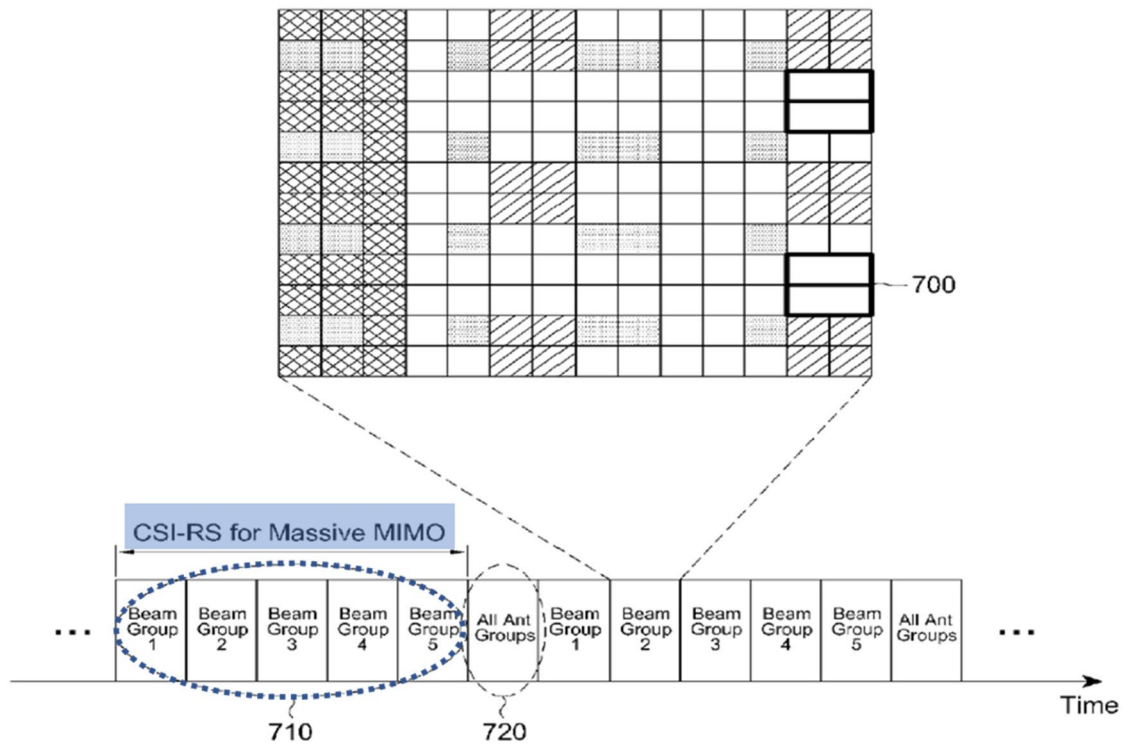


FIG. 7

Kim, Fig. ~~7-7~~ (annotated).

30-100. *Kim* explains that in Figure 7, each beam group includes eight antenna ports. *Kim*, ¶[0083]. *Kim* also explains that the beams are generated by applying different precoding schemes on the same multiple transmission antennas.

Kim,

¶[0080]. A POSITA would have understood that in *Kim*, each beam corresponds to an antenna port (i.e., virtual antenna),) because each beam experiences the same channel characteristics, and the UE receives each beam as if it is transmitted from a single antenna. For the same reason, a POSITA would have also understood that the plurality of beams in *Kim* corresponds to multiple antenna ports, and the plurality of beam groups in *Kim* corresponds to multiple antenna port groups. The '527 patent also confirms that "K antenna port groups respectively correspond to K different beam groups." Ex. 1001, 17:2-3.

~~antenna port groups. Kakaes, ¶100. The '527 patent also confirms that “K antenna port groups respectively correspond to K different beam groups.” Ex. 1001, 17:2-3.~~

- e. ~~[1d]:]~~ **“the antenna port group includes a positive integer number of antenna port(s);”**

~~31.101.~~ In my opinion, *Kim* discloses that the antenna port group includes a positive integer number of antenna port(s).

~~32.102.~~ ~~Kakaes, ¶101.~~ As I explained above, in claim [1c], *Kim* discloses that each antenna port group includes a ~~plurality~~ positive integer number of antenna port(s), e.g., eight antenna ports, ~~although only one antenna port~~ and undoubtedly “8” is ~~required by the claim.~~ a positive integer number. *Kim*, ¶¶[0055]-[0057], [0080]-[0083]; *supra*, §~~VI~~XI.A.41.d.

- f. ~~[1e]:~~ “a first antenna port group is one of the K antenna port groups;”

~~33.103.~~ In my opinion, *Kim* discloses that a first antenna port group is one of the K antenna port groups.

~~34.104.~~ ~~Kakaes, ¶103.~~ For example, any of antenna port groups 1-5 in Figures 4, 5, and 7 of *Kim* correspond to “a first antenna port group.” *Kim*, ¶¶[0055]-[0057], [0059]-[0060], [0080]-[0083], Figs. 4, 5, 7; ~~Kakaes, ¶104;~~ *supra*, §~~VI~~XI.A.41.d.

- g. ~~[1f]:~~ “the first signaling is used to determine a first time resource pool;”

~~35.105.~~ In my opinion, *Kim* discloses that the first signaling~~(, i.e.,~~ signaling including the control information)~~;~~₂ is used to determine a first time resource pool.

~~36.106.~~ ~~Kakaes, ¶105.~~ For example, *Kim* discloses that the control information includes “positions of time and frequency resources at which a CSI-RS for each antenna group is transmitted.” *Kim*, ¶[0069]. Annotated Figures 5 and 7 of *Kim* below show that CSI-RSs for each antenna port group are transmitted over separate time resources (subframes). *Kim*, ¶¶[0060], [0082]-[0083].

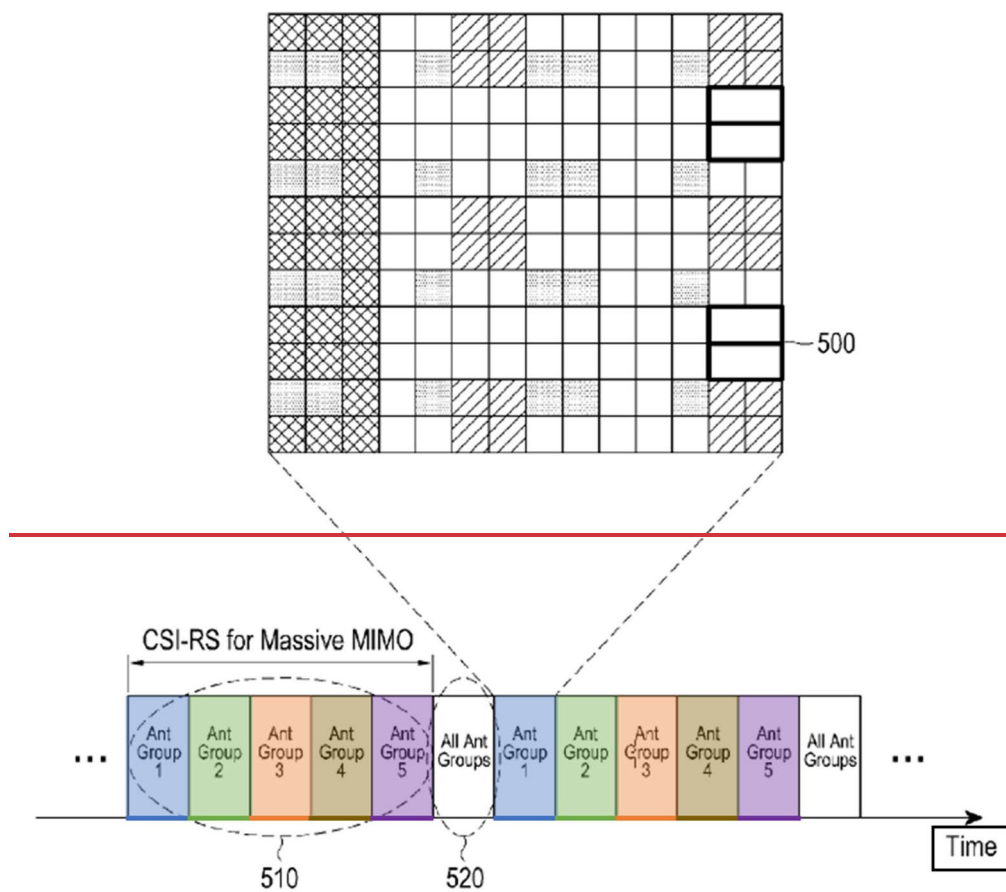


FIG.5

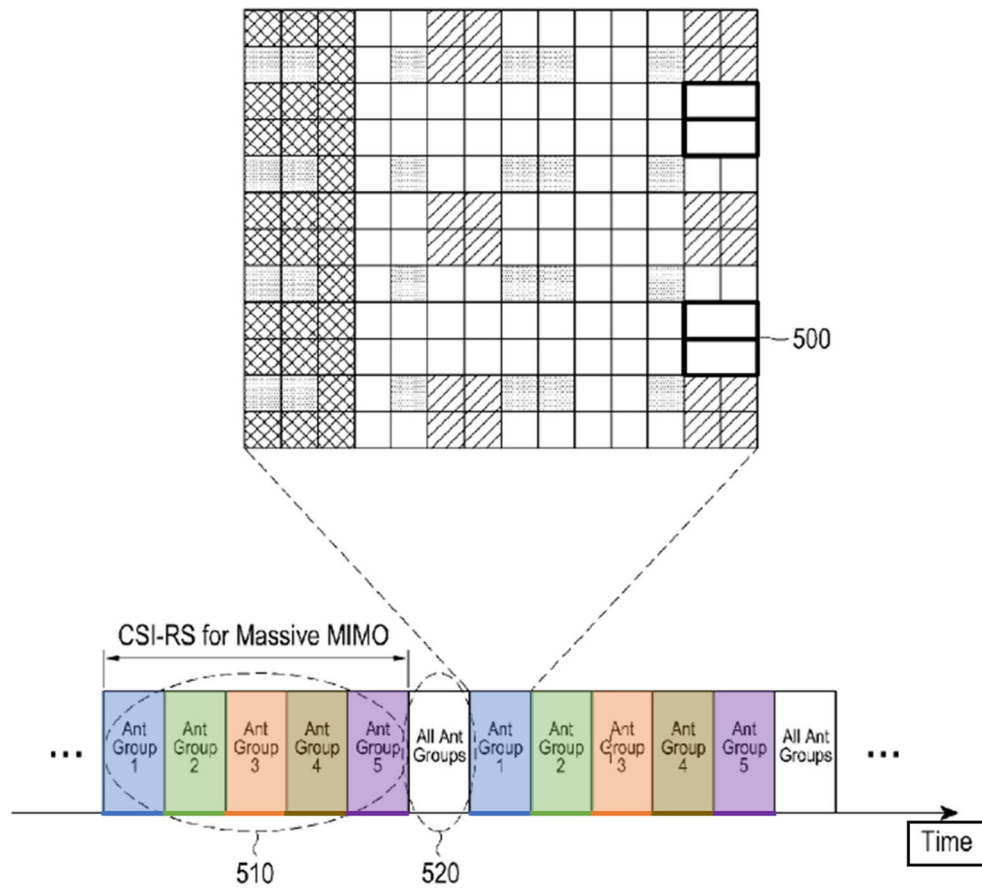


FIG.5

Kim, Fig. 5- (annotated).

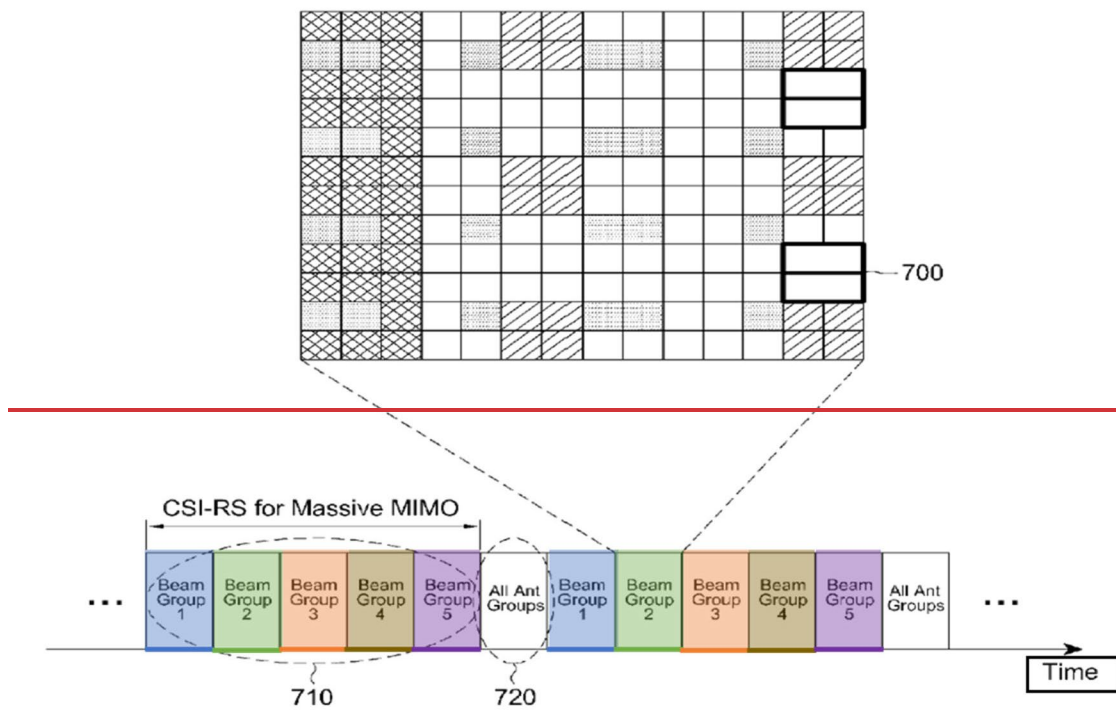


FIG. 7

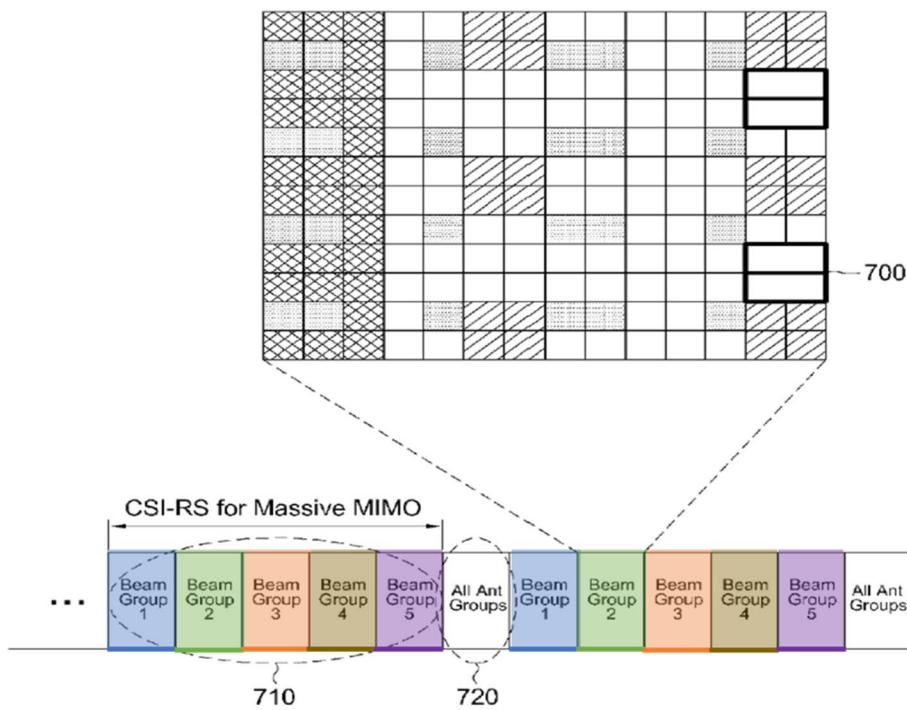


FIG. 7

Kim, Fig. 7: (annotated).

107. *Kim* explains that the control information is “imperative for proper reception of the CSI-RSs for massive MIMO.” *Kim*, ¶[0065]. *Kim* explains that the CSI-RS is used by the UE to measure the channel state between the base station and the UE, which is then used to determine a data rate for the UE to request from the base station. *Kim*, ¶¶[0006]-[0007], [0019], [0021], [0052], [0060], [0080]. *Kim* further states that the UE uses the received CSI-RS signal to “measure channels for a plurality of transmission antennas or a plurality of beams generated by a plurality of transmission antennas,” and based on the measurement, conveys channel state information to the base station. *Kim*, ¶¶[0130], [0120]. By using the channel state

information for the first antenna port group provided by the UE, the base station selects candidate UEs for wireless resource allocation and determines the antenna ports for transmitting another CSI-RS for the selected UEs. Kim, ¶¶[0120], [0105].

Based on all these teachings, a POSITA would have understood that the first signaling including the control information is used by the user equipment to determine a first time resource pool over which the CSI-RS for the first antenna port group is transmitted. ~~Kakaes,~~ such that the user equipment can properly receive the CSI-RS for the first antenna port group.

¶107.

- h. ~~[1g]:~~ “at least one of a first antenna virtualization vector and a second antenna virtualization vector is associated with the first antenna port group;”

~~37.108.~~ I understand that in Patent Owner’s infringement contentions, Patent Owner appears to interpret “at least one of a first antenna virtualization vector and a second antenna virtualization vector” to require *either* a first antenna virtualization *or* a second antenna virtualization vector, but not both. *See* Ex. 1022, 15-26 (mapping only “second antenna virtualization vector” to the standards the accused products allegedly implement); ~~Kakaes, ¶108.~~ According to this interpretation of claim [1g], *Kim* in view of *Zhang* renders this limitation obvious because *Kim* in view of *Zhang* renders obvious “a first antenna virtualization vector” associated with the first antenna port group. ~~Kakaes, ¶108. If the Board determines~~ I have also been informed that ~~[1g] requires both a first antenna virtualization vector and a second antenna virtualization vector, Kim in view of~~ the construction of *Zhang* and *Kang* renders this limitation obvious. ~~Kakaes, ¶108. See SuperGuide Corp. v. DirecTV Enters., Inc., 358 F.3d 870, 885-88 (Fed. Cir. 2004) (holding that the list in the phrase~~ the phrase “at least one of ... and” is ~~conjunctive)...~~ and” may require each item listed in the phrase. If the

Board determines that [1g] requires **both** a first antenna virtualization vector and a second antenna virtualization vector, *Kim* in view of *Zhang* and *Kang* renders this limitation obvious.

i. First antenna virtualization vector

109. In my opinion, the combination of *Kim* and *Zhang* renders obvious that a first antenna virtualization vector is associated with the first antenna port group.

Kim discloses that each antenna port group includes multiple antenna ports. *Kim*, ¶¶[0055]-[0057], [0080]-[0083]; *supra*, §~~V~~XI.A.41.d. In *Kim*, the base station applies a precoding scheme to multiple physical antennas to form an antenna port (beam or virtual antenna) for transmitting the CSI-RS. *Kim*, ¶¶[0080]-~~[0081]~~;

~~Kakaes, ¶110.~~]. As is known in the art, this means the base station uses an antenna virtualization vector to form the antenna port for transmitting the CSI-RS. ~~Kakaes, 38-110. ¶110.~~ And, in the context of the antenna port for transmitting the CSI-RS, a POSITA would understand that a first antenna virtualization vector is associated with the first antenna port group because the antenna port formed by the virtualization vector for transmitting the CSI-RS is part of the first antenna port group. As I noted earlier, the '527 patent teaches that an antenna port group can consist of a single antenna port. Ex. Kakaes, ¶1101001, 3:18-19.

39.111.....To

the extent Patent Owner argues that Kim does not explicitly disclose such a first antenna virtualization vector, Zhang renders it obvious. ~~Kakaes, ¶111.~~ Zhang discloses applying “beamforming vectors [antenna virtualization vectors] to implement port virtualization.” Zhang, ¶[63]; see also Zhang, ¶[150] (“CSI-RS resources adopt adjacent vertical beams to implement port virtualization.....”).

~~Zhang explains that “port virtualization to transmit antennas refers to precoding the reference signal for the CRS port with a precoding vector.” Zhang, ¶[100]. As an example, Zhang discloses “virtualization from signals of CRS port 0 to the antenna group 0 is.....”~~
~~$$W_0 = [w_0^{(0)} w_1^{(0)} \dots w_{M-1}^{(0)}]^T$$~~

implemented via Zhang explains that “port virtualization to transmit antennas refers to precoding the reference signal for the CRS port with a precoding vector.” Zhang, ¶[100]. As an example, Zhang discloses “virtualization from signals of CRS port 0 to the antenna

group 0 is implemented via the precoding vector $W_0 = [w_0^{(0)} w_1^{(0)} \dots w_{M-1}^{(0)}]^T$,” and “[t]he

virtualization from signals of CRS port 1 to the antenna group 1 is implemented

via the [precoding vector] ~~$W_1 = [w_0^{(1)} w_1^{(1)} \dots w_{M-1}^{(1)}]^T$~~ $W_1 = [w_0^{(1)} w_1^{(1)} \dots w_{M-1}^{(1)}]^T$.” Zhang,

¶[101]. Elements in the precoding $w_m^{(p)} = \frac{1}{\sqrt{M}} \exp(-j \frac{2\pi}{\lambda} m \cdot d_v \cdot \cos \theta_p)$.

~~$w_m^{(p)} = \frac{1}{\sqrt{M}} \exp(-j \frac{2\pi}{\lambda} m \cdot d_v \cdot \cos \theta_p)$~~ . Zhang, ¶[101]. Thus, Zhang discloses applying a

first antenna virtualization vector at a base station to implement an antenna port virtualization. ~~Kakaes, ¶111.~~

40.112. APOSITAIn my opinion, it would have been ~~motivated~~obvious to

use a first antenna virtualization vector disclosed in Zhang to form Kim's virtual antenna port in the first antenna port group because implementing antenna virtualization by an antenna virtualization vector ~~to form Kim's antenna port~~ was a known, conventional technique to a POSITA, as disclosed also confirmed by Zhang as discussed above.

(a) Motivation to combine

~~41.113.~~ As I explained above, *Kim* and *Zhang* are both directed to transmitting and receiving a reference signal (e.g., CSI-RS) using multiple antennas in a wireless communication system, such as the LTE and LTE-A systems defined by 3GPP. *Supra*, §§~~VI~~IX.A.1, VI.A.2, IX.B. Like *Kim*, *Zhang* discloses the base station transmitting the reference signal on virtual antenna ports₂ or in different beams. *Zhang*, ¶¶[16], [63], [111]~~;~~ ~~Kakaes, ¶113.~~ A POSITA would have been motivated to virtualize *Kim*'s antenna ports or beams using *Zhang*'s antenna virtualization vector (precoding vector) for multiple reasons. ~~Kakaes, ¶113.~~

First, a POSITA would have been motivated to virtualize *Kim*'s antenna ports or beams using *Zhang*'s antenna virtualization vector (precoding vector) to enable the transmission of beams of reference signals in different directions.

~~42.114.~~ ~~Kakaes, ¶114.~~ *Kim* already discloses applying different precoding schemes to generate different beams in a beam group. *Kim*, ¶[0080]. And it would have been advantageous to be able to transmit the beams of reference signals in different directions because doing so would allow UEs to measure the channel state between the UE and base station in different directions, thereby informing the base station which direction of beam is suitable for transmitting data to the UE.

~~43.115.~~ Second, a POSITA would have been motivated to use *Zhang*'s precoding vector to effectively and flexibly implement the precoding scheme in *Kim*, allowing the beams to be steered towards a desired direction.

~~Kakaes, ¶115.~~ By using a

precoding vector, the base station can set elements of the vector to control the amplitudes and phases of the signals sent from the various transmit antennas individually such that the aggregated signals from the various transmit antennas correspond to a desired beam direction. ~~Id.~~ The precoding vector also allows the base station to reduce interference to other cells by selecting elements of the precoding vector such that the aggregated signals from the various transmit antennas are directed to UEs in its own cell. ~~Id.~~

44.116. And, third, a POSITA would also have been motivated to use Zhang's precoding vector to implement the precoding scheme in Kim, such that the reference signal beams are generated with different angles to provide coverage to UEs at different locations. Zhang, ¶¶[111], [121], [150]; Kakaes, ¶116. For example, as shown in Zhang's Zhang, Figure 19, nine CSI-RS beams directed to different directions provide coverage to UEs at different locations of the cell such that a UE can receive some of the CSI-RS beams regardless of where it is located within the cell. Zhang, ¶[150]; Kakaes, ¶116. ~~The various CSI-RS beams also ensure that a~~ Zhang, ¶[150]. ~~The various CSI-RS beams also ensure that a~~ UE continues to receive the CSI-RS signal when it moves around the cell. Kakaes,

~~¶116.~~

~~(a) — A POSITA would have reasonably expected to succeed in using Zhang's antenna virtualization vector to form Kim's antenna port~~

(b) Expectation of success

~~45.117.~~ Using an antenna virtualization vector (precoding vector) to implement a virtual antenna port was a well-known and conventional technique when the '527 patent was filed. ~~Kakaes, ¶117.~~ *Kim* describes a precoding scheme to generate

different beams (antenna ports) without explaining how a precoding scheme is specifically implemented with a precoding vector, because using precoding vectors to form virtual antenna ports was routine, conventional, and well understood in the art. ~~Id.~~ Both *Kim*'s and *Zhang*'s systems use the same underlying technology, e.g., wireless communication using multiple antennas and virtual antenna ports. ~~Id.~~

Zhang teaches that *Kim*'s precoding scheme could be implemented with a precoding vector according to its known, routine function to form a virtual antenna port. ~~Kakaes, ¶117; See, e.g., Zhang, ¶¶[100]-[101].]~~ (adopting a precoding vector to form a CRS port).

Using *Zhang*'s antenna virtualization vector in *Kim*'s precoding scheme to form a virtual antenna port would result in the ordinary and expected operation of antenna virtualization, which is used to transmit the reference signal. ~~Kakaes, ¶117; e.g., Zhang, ¶¶[101]-[102]. Thus, a POSITA would have reasonably expected to succeed in using~~ See, e.g., Zhang,

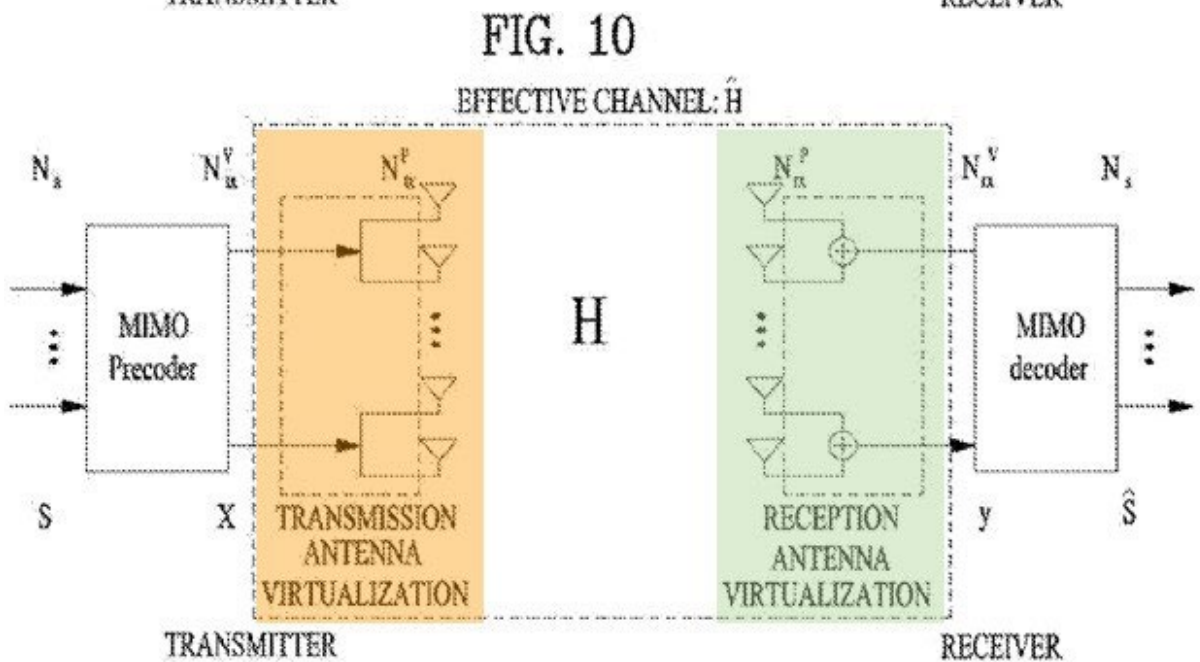
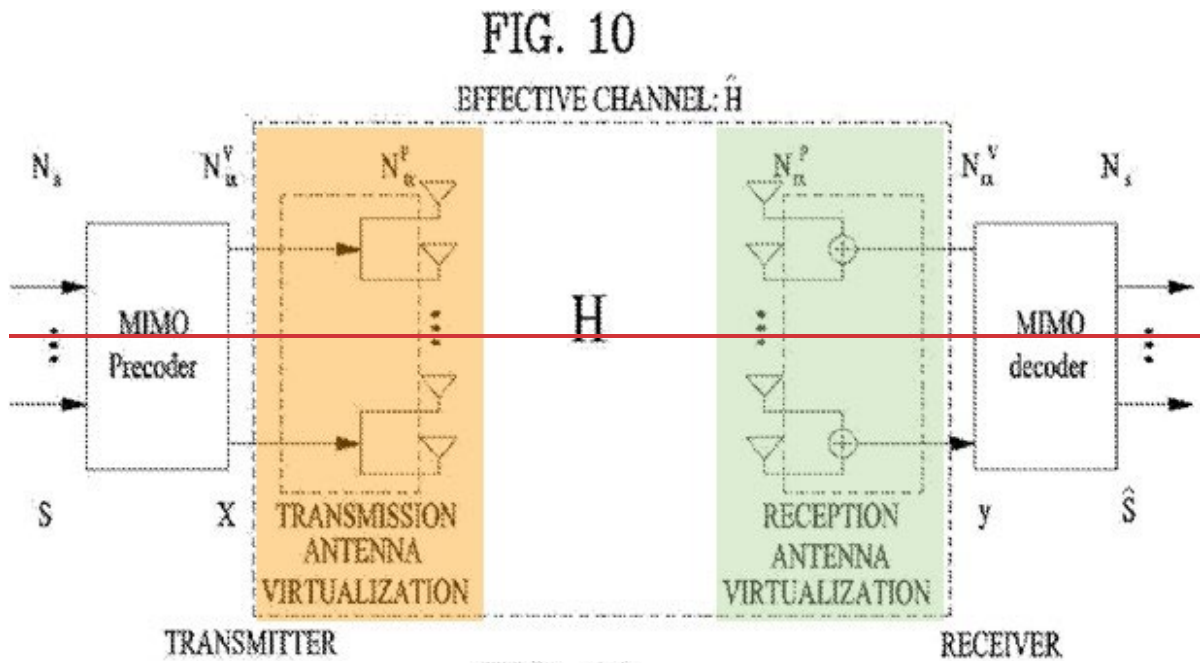
¶¶[101]-[102] (adopting a precoding vector to form a CRS port which is transmitted by the base station) . Thus, a POSITA would have reasonably expected to succeed in using *Zhang*'s antenna virtualization vector to form *Kim*'s antenna beams by associating an antenna virtualization vector (precoding vector) with a first antenna port group. ~~Kakaes, ¶117.~~

ii. Second antenna virtualization vector

118. In my opinion, the combination of *Kim* and *Kang* renders obvious that a second antenna virtualization vector is associated with the first antenna port group.

46.119. *Kim* discloses that a user equipment can be equipped with multiple reception antennas to receive multiple spatial channels. *Kim*, ¶[0051]; *Kakaes*, ¶119. *Kim*, ¶[0051] (describing that the UE can receive multiple spatial channels, which depends on the number of reception antennas at the UE). To the extent *Kim* does not explicitly disclose using an antenna virtualization vector at a user equipment, *Kang* renders obvious using a virtualization vector to implement antenna virtualization at the receiver side for receiving the CSI-RS signal transmitted over the first antenna port group. *Kakaes*, ¶119.

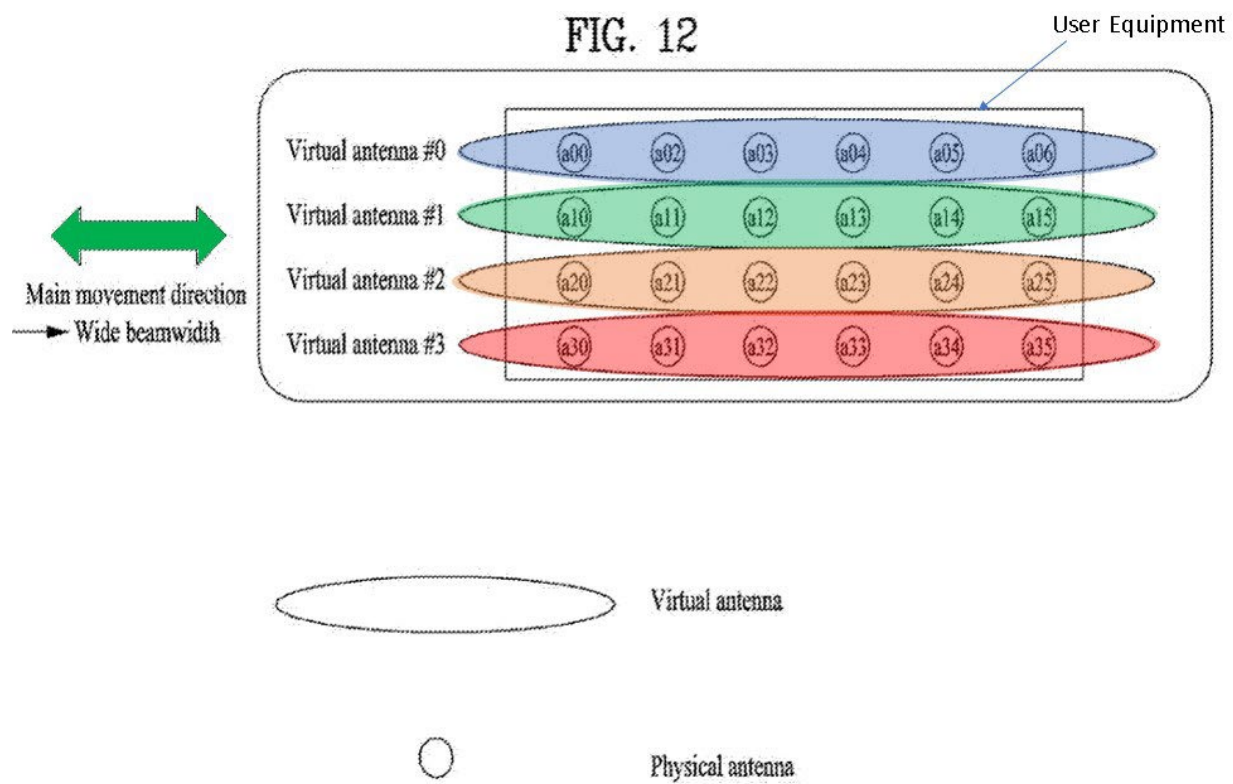
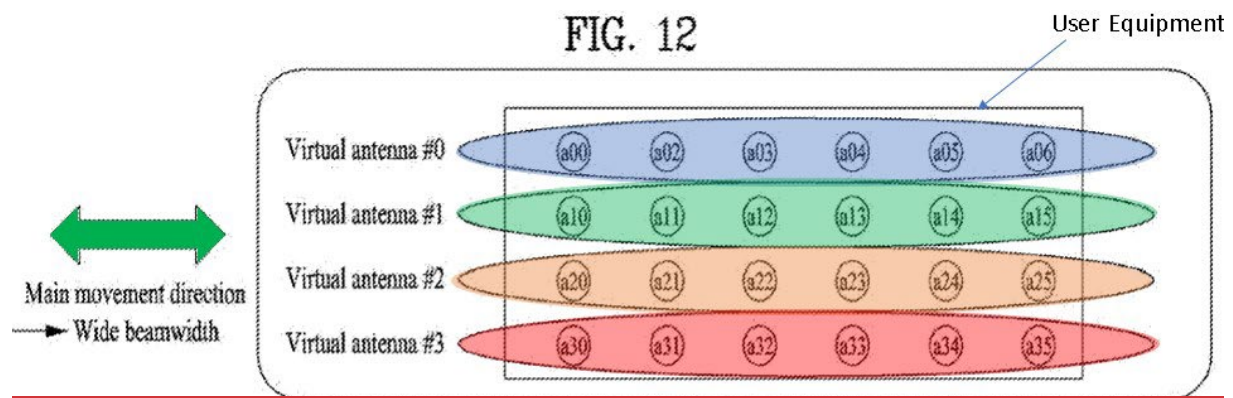
47.120. Figure 10 of *Kang* shows implementing antenna virtualization at both the transmitter and the receiver.



Kang, Fig. 10.

121. Kang discloses that a user equipment includes multiple antennas, and virtual antenna ports are formed to receive a reference signal, as shown below: [in](#)

annotated Figure 12. Kang, ¶¶[0088], [0125]-[0126], [0137]-[0142], [0157]-[0158], Figs. 10, 11(b), 12-13.



Kang, Fig. 12- (annotated).

48.122. *Kang* explains that the user equipment applies an antenna virtualization pattern to map the physical antennas to virtual antennas. *Kang*, ¶¶[0138], [0146], ¶[0138] (“antenna virtualization can be performed such that an antenna pattern having a wide beamwidth in the moving direction of the UE”), ¶[0146] (describing generating a virtual antenna pattern that is robust against channel aging). A POSITA would have understood that the antenna virtualization pattern in *Kang* corresponds to an antenna virtualization vector (beamforming vector) to form a receiving beam. ~~Kakaes, ¶122 (citing *Zhang, Long, Zhang-ICC, Pham, Hara, Li*).~~

receiving beam. This is shown by ample references describing using an antenna virtualization vector (beamforming vector) to form a receiving beam before the '527 patent was filed. For example, *Zhang* explains that beamforming vectors are used to implement antenna virtualization. *Zhang*, ¶ [63] (“Port virtualization to transmit antennas may be implemented for multiple Cell-specific Reference Signal (CRS) antenna ports and applying different vertical beamforming vectors to implement port virtualization for the different CRS antenna ports.”). Similarly, *Long* describes using a beamforming vector W_i to realize beamforming on multiple antennas. *Long*, 3. *Zhang-ICC* describes joint transmitter-receiver beamforming and constructing a receive beamforming vector w_r . *Zhang-ICC*, 2-3. The advantages of using joint transmitter-receiver beamforming over transmitter-only beamforming and/or receiver-only beamforming are clearly summarized in *Zhang-ICC* at Fig. 5 and Fig. 6 of *Zhang-ICC*. *Li* describes that receive beamforming is implemented by adding a phase shift to signals from each receive antenna and combining the phase-shifted signals, which in effect is applying an antenna virtualization vector to the signals received from the receive antennas. *Li*, ¶¶[0089], [0090]; Fig. 5C. *Pham* similarly describes constructing a receive beamforming vector W_r to receive signals transmitted in MIMO system. *Pham*, 2-3. *Hara* also describes constructing a beamforming vector v_n for receiving beamforming signals. *Hara*, 1-3.

49.123. *Kang* further explains that the antenna virtualization at the user equipment enables a wide beamwidth in the moving direction of the user equipment, such that channel state inconsistency is reduced when the user equipment moves at a high speed and antenna gain is increased. *Kang*, ¶¶[0141], [0157]. *Kang* also discloses that the signal received by the user equipment is transmitted over a virtual antenna port at the base station. *Kang*, ¶¶[0124], [0126].

50.124. It would have been obvious to a POSITA to apply *Kang*'s antenna virtualization vector at the user equipment to receive *Kim*'s CSI-RS signal that is transmitted over the first antenna port group at the base station.

~~Kakaes, ¶124.~~ *Kang*'s antenna virtualization vector would be associated with the first antenna port group because *Kang*'s antenna virtualization vector would be used to receive signals transmitted over the first antenna port group. ~~Kakaes, ¶124.~~

~~(a) — A POSITA would have been motivated to use an antenna virtualization vector at the user equipment to implement reception-antenna virtualization, as disclosed by *Kang*~~

(a) Motivation to combine

51.125. *Kim* and *Kang* are both directed to transmitting and receiving a reference signal (e.g., CSI-RS) using multiple antennas. *Supra*, §§~~VI~~ §§IX.A.1, ~~VI.A.3, IX.C.~~ Like *Kim*, *Kang* discloses the base station transmitting the reference signal on virtual antenna ports or beams. *Kang*, ¶¶[0090], [0126]; ~~Kakaes, ¶125.].~~ *Kim* teaches beamforming using multiple transmission antennas to improve signal

quality, and a POSITA would have understood that receiving beamforming—a reciprocal process to transmitting beamforming—similarly improves the received signal quality when multiple

receiving antennas are available. ~~Kakaes, ¶125~~; Kim, ¶¶[0006], [0013]; Pham, 1 (noting the architecture of “transmit and receive beamforming” had been studied extensively). A POSITA would have been motivated to implement reception antenna virtualization at Kim’s user equipment by using an antenna virtualization vector, so as to improve received signal quality at the user equipment in multiple ways. ~~Kakaes, ¶125~~.

126. First, it was well known that in a massive MIMO system as disclosed in Kim, the user equipment is equipped with multiple receiving antennas, and a reception beam can be formed by using an antenna virtualization vector to increase antenna gain and improve received signal quality. For example, Park-902 describes using multiple reception antennas at a user equipment and forming a reception beam to achieve a signal power increasing effect. Park-902, ¶¶ [0101]-[0102] (“when a reception beam is formed by utilizing a massive reception antenna, it may be able to expect a signal power increasing effect according to an antenna array gain”), Fig. 12. Similarly, Zhang-ICC explains that “joint transmitter-receiver beamforming [] offers a performance advantage of transmitter-only, or receiver-only beamforming and a computational burden balanced over both ends of the transmission link.” Zhang-ICC, 1. Figs. ~~Kakaes, ¶126~~ (citing Park-902, Zhang-ICC, Zhang-235, Li). 5 and 6 of Zhang-ICC shows that, by using joint transmitter-receiver beamforming (e.g., closed-form (8, 2) with eight transmit antennas and two receive antennas), the receiver performance is significantly

better than the transmitter-only beamforming (e.g.,

MSNR (8, 1) with eight transmit antennas and one receive antenna) in both the received bit error rate (BER) and signal-to-noise-and-interference ratio (SNIR) performance. Zhang-ICC, 5-6. Zhang-235 describing implementing “UE side Rx [receiving] beamforming to enable beam mobility.” Zhang-235, 4:6-21, Fig. 1. Li describes that beamforming is applied at both the base station and the UE and the base station chooses the best transmit and receive beam pairs from measurement report from the UE. Li, ¶¶[0117], [0131], [0133]; Figs. 11, 12. By using an antenna virtualization vector, received signals at each receiving antenna are appropriately combined to form a reception beam, achieving an antenna array gain at the UE. Kakaes, ¶126. The elements of the antenna virtualization vector can be selected based on the channel between each receiving antenna and the base station such that the reception beam is formed in the direction towards the UE, effectively increasing the received signal power at the UE. Id. Thus, a POSITA would have been motivated to take advantage of the multiple antennas at the UE by using an antenna virtualization vector to improve the received power of Kim’s reference signal, which allows the UE to receive data from the base station at a higher rate.- Id.

127. Second, as taught by Kang, implementing reception antenna virtualization by using an antenna virtualization vector would minimize performance deterioration due to channel aging resulting from the UE movement, which would be a problem for Kim’s ~~cell phone~~ user equipment.- in the form of cell

phones.

Kang, ¶¶[0141], [0151], [0157]; ~~*Kakaes*, ¶127.~~ For example, *Kang* explains that receiving antenna virtualization is performed to form an antenna pattern having a wide beamwidth in the moving direction of the UE, such that channel states remain the same when the UE moves at a high speed, which improves reception of data by the UE. ~~*Kang*, ¶¶[0138], [0146]; *Kakaes*, ¶127.~~*Kang*, ¶ [0138]. *Kang* further explains that the receiving antenna virtualization pattern is adapted based on the moving speed of the UE such that a proper balance between increasing transmission power efficiency and robust against channel aging is achieved when generating the virtual antenna pattern. *Kang*, ¶ [0146]. All of this would help improving reception of data by the UE.

~~(b) — A POSITA would have reasonably expected to succeed in using *Kang*'s antenna virtualization vector to implement reception antenna virtualization~~

(b) Expectation of success

52.128. Using an antenna virtualization vector to implement receiving beamforming at the user equipment was a well-known and conventional technique when the '527 patent was filed. ~~*Kakaes*, ¶128.~~ The '527 patent does not explain how to use an antenna virtualization vector to form a receiving beam, because using an antenna virtualization vector to form a receiving beam was routine, conventional, and well understood in the art. *See generally* Ex. 1001; ~~*Kakaes*, ¶128.~~ Both *Kim*'s and *Kang*'s systems use the same underlying technology, e.g., wireless communication

using multiple antennas and virtual antenna ports. ~~Kakaes, ¶128.~~ *Kim*'s massive MIMO system could include a user equipment with multiple receiving antennas to implement reception antenna virtualization with an antenna virtualization vector according to the known, routine

~~according to the known, routine~~ process of receiving beamforming, as taught by *Kang*. ~~Kakaes, ¶128; See~~ *Kang*, ¶¶[0138]-[0141]. Using *Kang*'s antenna virtualization vector to implement receiving beamforming in *Kim*'s MIMO system would result in the ordinary and expected operation of receiving beamforming, which is used to improve the quality of the received signal. ~~Kakaes, ¶128; See, e.g.,~~ *Kang*, ¶¶[0141], [0151], [0157]. Thus, a POSITA would have reasonably expected to succeed in using *Kang*'s receiving beamforming technique and receiving antenna virtualization vector at the UE to receive *Kim*'s reference signal, resulting in a second antenna virtualization vector associated with the first antenna port group.

~~Kakaes, ¶128.~~

- i. ~~[1h]:]~~ **“the first antenna virtualization vector is an antenna virtualization vector available to the base station in the first time resource pool;”**

129. In my opinion, the combination of *Kim* and *Zhang* renders obvious that the first antenna virtualization vector is an antenna virtualization vector available to the base station in the first time resource pool.

53-130. *Kim* discloses that the base station applies a precoding scheme in the first time resource pool (the time resource corresponding to the first antenna port group) for transmitting the CSI-RS corresponding to the first antenna port group. *Kim*, ¶¶[0080]-[0083]. ~~And because~~ As I discussed above for claim [1g], the combination of *Kim* and *Zhang* renders obvious that the precoding scheme applied

by the base station includes a precoding vector (first antenna virtualization vector);
~~the combination thus also renders obvious that the first antenna virtualization vector is an antenna-~~
~~virtualization vector available to the base station in the first time resource pool. Kakaes, ¶130; *supra*,~~
~~§VI.A.4.h.i.).~~ The combination

of Kim and Zhang thus also renders obvious that the first antenna virtualization vector is an antenna virtualization vector available to the base station in the first time resource pool. *Supra*, §XI.A.1.h.i.

- j. ~~[1i]:1~~ “the second antenna virtualization vector is an antenna virtualization vector available to the user equipment in the first time resource pool; and”

131. In my opinion, the combination of Kim and Kang renders obvious that the second antenna virtualization vector is an antenna virtualization vector available to the user equipment in the first time resource pool.

Kim discloses that the user equipment in a massive MIMO system could include multiple reception antennas. *Kim*, ¶[0051]. As I discussed above in claim [1g], *Kang* discloses that the user equipment uses a second antenna virtualization vector to form a reception beam for receiving the reference signal from the base station. *Kang*, ¶¶[0138], [0146]; *supra*,

54.132. ~~¶¶~~ §XI.A.41.h.ii. *Kang*’s second antenna virtualization vector used to form a reception beam would be available to the user equipment in the first time resource pool (the time resource corresponding to the first antenna port group) because that second antenna virtualization vector would be used to receive the reference signal transmitted by the first antenna virtualization vector in the first time resource pool. ~~Kakaes, ¶132.~~ Stated another way, in the combination, *Kim*’s CSI-RS signal is transmitted by the base station in the first time resource pool

using the first antenna virtualization vector, and is received by ~~the UE in the first time~~
~~resource pool using the second antenna virtualization vector. Kakaes, ¶132. And because the~~
~~combination of *Kim* and *Kang* renders obvious that the user equipment uses a beamforming vector~~
~~(second antenna virtualization vector) for receiving the CSI-RS transmitted from the base station, the~~
~~combination thus also renders obvious that the second antenna virtualization vector is an antenna~~
~~virtualization vector~~

~~available to the user equipment in the first time resource pool. Kakaes, ¶132;~~
~~*supra*, §VI.A.4.h.ii.~~

~~the UE in the first time resource pool using the second antenna virtualization~~
~~vector. And because the combination of *Kim* and *Kang* renders obvious that the~~
~~user equipment uses a beamforming vector (second antenna virtualization vector)~~
~~for receiving the CSI-RS transmitted from the base station, the combination thus~~
~~also renders obvious that the second antenna virtualization vector is an antenna~~
~~virtualization vector available to the user equipment in the first time resource pool.~~
~~*Supra*, §XI.A.1.h.ii. A POSITA would have understood that the transmit and~~
~~receive beams formed by the first and second antenna virtualization vector~~
~~respectively are related to the same transmission, thus are available to the base~~
~~station and user equipment respectively during the same “time resource pool”. See~~
~~also *Zhang-ICC*, 5-6 (showing applying joint transmitter-receiver beamforming for~~
~~one transmission, i.e., during the same time).~~

k. [1j]:] “the K is a positive integer greater than 1.”

~~55.133.~~ ~~In my opinion,~~ *Kim* discloses that the CSI-RS is transmitted by
a number of antenna port groups that is a positive integer greater than 1. ~~Kakaes,~~
~~¶133.~~ For example, *Kim* discloses transmitting the CSI-RS by five antenna port
groups. ~~It is indisputable that “5” is a positive integer greater than 1. Kim,~~
~~¶¶[0057], [0060], [0083]; *supra*, §~~vi~~XI.A.41.d.~~

5.—Claim 4

1.2. [4a]: “The method of claim 1, further comprising:
receiving first information, wherein the first information is
used to determine the first antenna port group; or”
**transmitting second information, wherein the second
information is used to determine K1 antenna port group(s);
the K1 antenna port group(s) belong(s) to the K antenna
port groups; the first antenna port group is one of the K1
antenna port group(s); the K1 is a positive integer.”**

For the reasons I discussed above, the combination of Kim and Zhang, or the
combination of Kim, Zhang, and Kang renders obvious claim 1. *Supra*,

134. §VI.A. In my opinion, the combination of Kim and Zhang or the
combination of Kim, Zhang, and Kang also renders obvious claim 4.

135. Claim 4 recites two alternative options separated by “or.” A POSITA
would have understood that satisfying any one of these two options satisfies the
requirements of claim 4, which I understand is consistent with legal standards.

56.136. Kim discloses that the user equipment receives first information,
which is used to determine the first antenna port group. ~~Kakaes, ¶136.~~ For example,
Kim discloses that the user equipment receives control information including
“[i]nformation on the number of antenna groups,” “[i]nformation on the number of
transmission antennas which configure each of the antenna groups,” and “positions
of time and frequency resources at which a CSI-RS for each antenna group is
transmitted.” Kim, ¶¶[0067]-[0069]; Kim, ¶[0057] (explaining that “the [antenna]
grouping may be made based on virtual transmission antennas [antenna ports]”).

Kim explains

~~Kim explains~~ that the control information is “imperative for proper reception of the CSI-RSs for massive MIMO.” *Kim*, ¶[0065].

A POSITA would have understood that *Kim*’s control information, e.g., the number of antenna groups and resources at which a CSI-RS for each antenna group is transmitted, is used to determine the first antenna port group over which the CSI-RS is transmitted such that the CSI-RS is properly received by the ~~UE.~~

~~Kakaes,~~

57.137. ¶137.user equipment. *Kim* explains that the CSI-RS is used by the UE to measure the channel state between the base station and the UE, which is then used to determine a data rate for the UE to request from the base station. *Kim*, ¶¶[0006]-[0007], [0019], [0021], [0052], [0060], [0080]; ~~Kakaes, ¶137.].~~ *Kim* further ~~says~~states that the UE uses the received CSI-RS signal to “measure channels for a plurality of transmission antennas or a plurality of beams generated by a plurality of transmission antennas,” information of which is notified to the base station as channel state information. *Kim*, ¶¶[0130], [0120]. By using the channel state information for the first antenna port group provided by the UE, the base station selects candidate UEs for wireless resource allocation and determines the number of antenna ports for transmitting another CSI-RS for the selected UEs. *Kim*, ¶¶[0120], [0105]. Therefore, *Kim* discloses that the first information, e.g., the number of antenna groups and resources at which a CSI-RS for each antenna

group, is used by the UE to determine the first antenna port group, and the channel state information of the first

~~Kim, ¶¶[0130], [0120]. By using the channel state information for the first antenna port group provided by the UE, the base station selects candidate UEs for wireless resource allocation and determines the number of antenna ports for transmitting another CSI-RS for the selected UEs. Kim, ¶¶[0120], [0105]; Kakaes, ¶137. Therefore, Kim discloses that the first information (e.g., the number of antenna groups and resources at which a CSI-RS for each antenna group) is used by the UE to determine the first antenna port group, and the channel state information of the~~

~~first~~ antenna port group is sent to the base station for subsequent reference signal and data transmissions. ~~Kakaes, ¶137.~~

~~a. — [4b]: “transmitting second information”~~

~~Claim 4 includes an “or” between [4a] and [4b], so only one of the two limitations must be taught to satisfy claim 4. *Brown v. 3M*, 265 F.3d 1349, 1351 (Fed. Cir. 2001); see also *Ex. 1022*, 28–30 (Patent Owner’s infringement contentions not addressing [4b]).~~

2.3. Claim 5:

a. ~~[5a]:] “The method of claim 1, wherein the first time resource pool is discontinuous in time domain; or”;~~

~~58.138.~~ For the reasons I discussed above, the combination of *Kim* and *Zhang*, or the combination of *Kim*, *Zhang*, and *Kang* renders obvious claim 1. *Supra*, In my opinion, the combination of *Kim* and *Zhang* or the combination of *Kim*, *Zhang*, and *Kang* also renders obvious claim 5.

~~59.139.~~ §VI.A.4. *Kim* discloses that the first time resource pool is discontinuous in time domain. ~~Kakaes, ¶139.~~ Annotated Figures 5 and 7 of *Kim* below show that the first time resource pool corresponding to the first antenna port group (e.g., antenna group 1, beam group 1) is discontinuous in time domain.

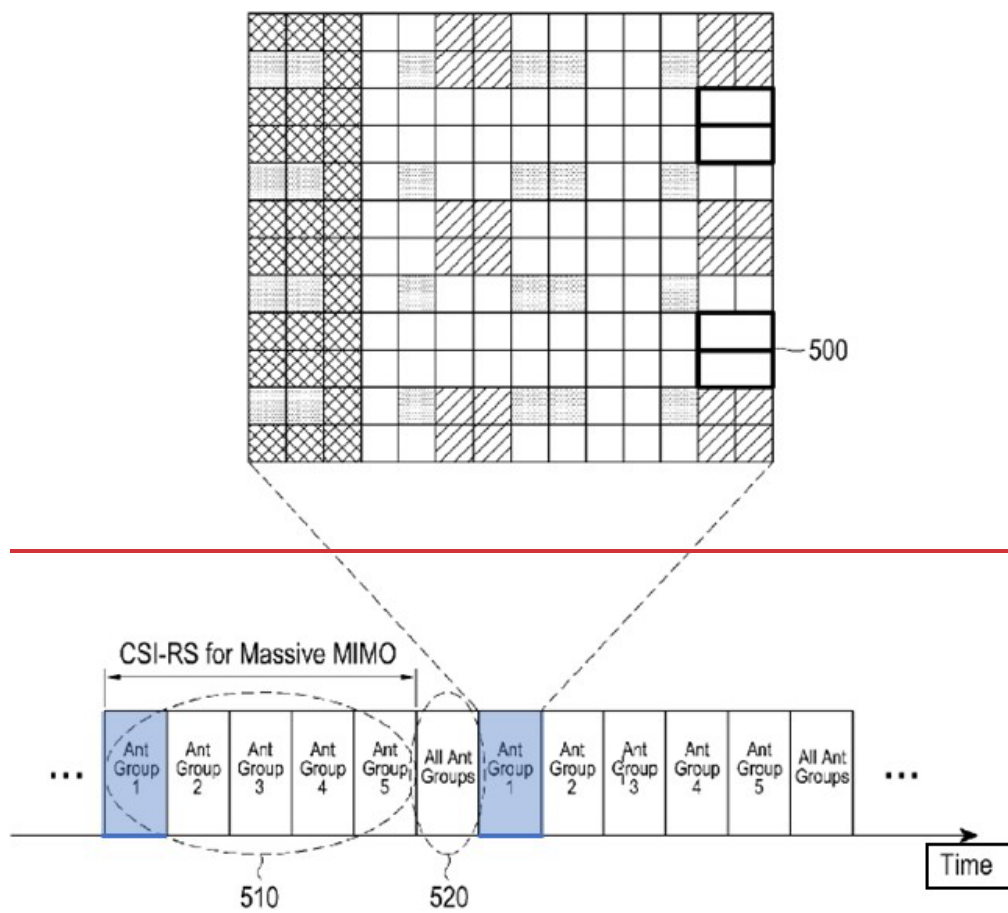


FIG.5

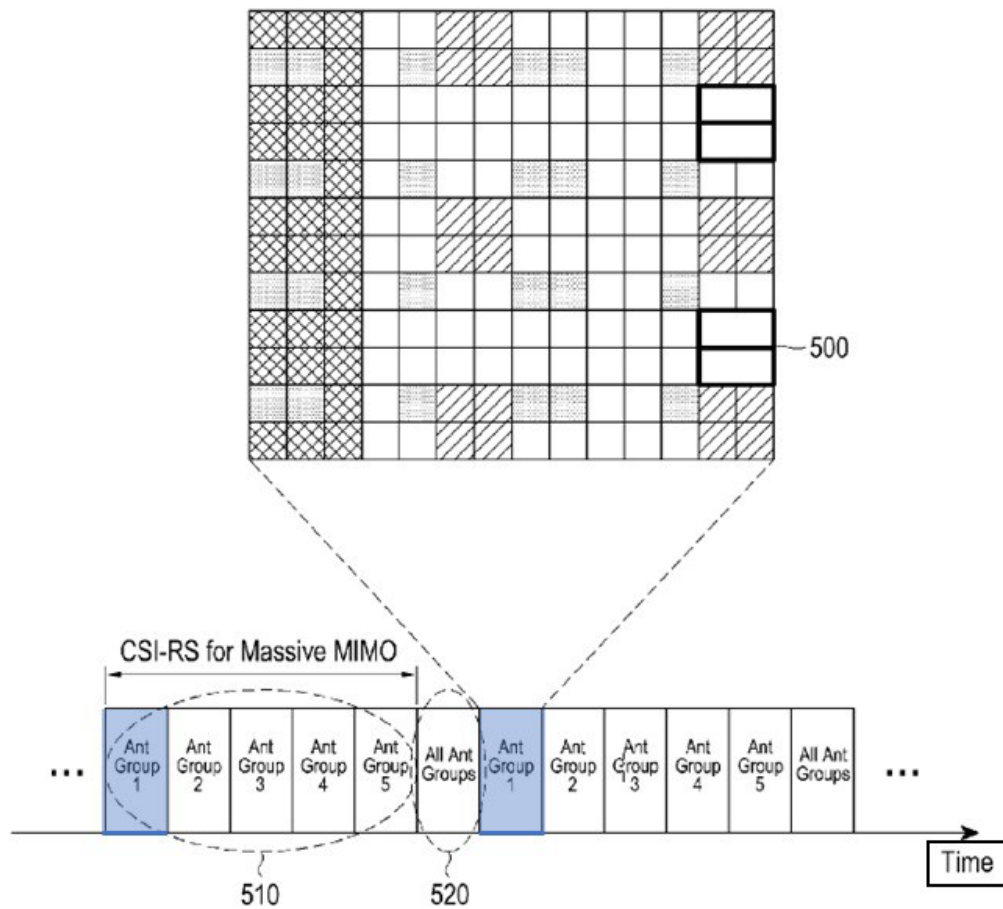


FIG.5

Kim, Fig. 5- (annotated).

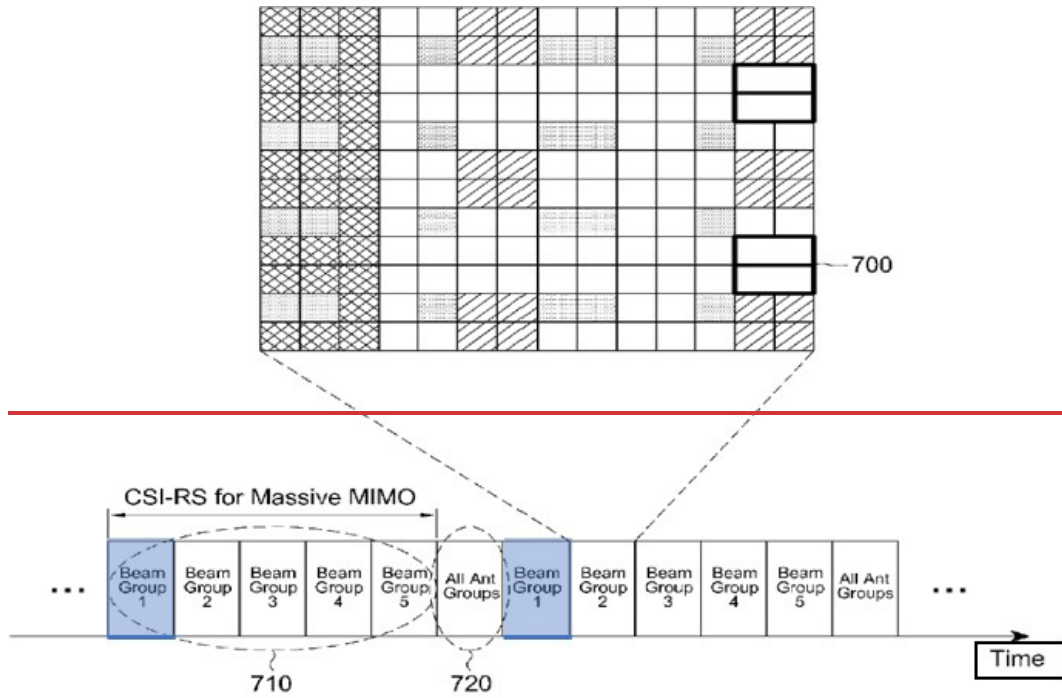


FIG.7

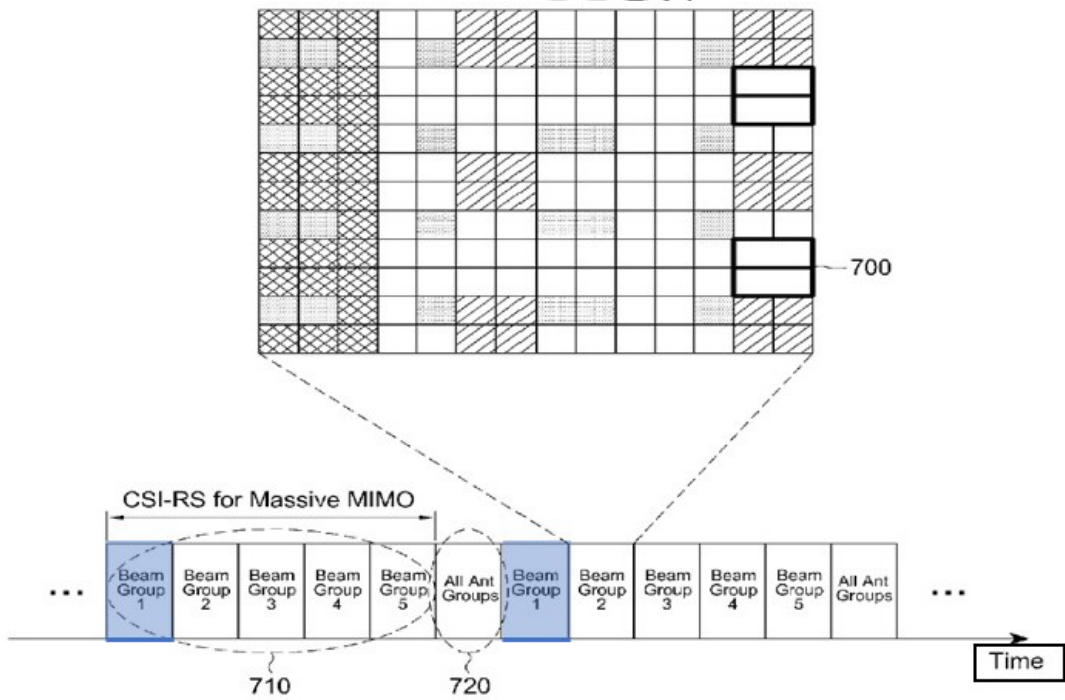


FIG.7

Kim, Fig. 7: (annotated).

b. [5b] “the first signaling is a semi-static signaling.”

60-140. Claim 5 includes an “or” between [5a] and [5b]. A POSITA would have understood that satisfying any one of these two limitations must be taught to satisfy the requirements of claim 5. See Brown, 265 F.3d at 1351, which I understand is consistent with legal standards.

61-141. Nonetheless, *Kim* discloses that the first signaling (signaling including control information) is a semi-static signaling. ~~Nonetheless, *Kim* discloses that the first signaling (signaling including control information) is a semi-static signaling.~~ Kakaes, ¶141. For example, *Kim* discloses that “some of the information may be set using a higher layer signaling while only indispensable [sic] information is transmitted using a PDCCH or an E-PDCCH” as well as that one way of “reducing the quantity of control information” is to “semi-

statically set the transmission resources.” *Kim*, ¶¶[0107]-[0108]. The ’527 patent confirms that the semi-static signaling includes a higher layer signaling, such as RRC signaling. Ex. 1001, 14:54-56. A POSITA would have also understood that higher layer signaling is used for configuring parameters semi-statically as “semi-static” configuration of parameters was known in 3GPP 3G and 4G telecommunication standards.

3.4. Independent Claim 6:

142. ~~[6pre]~~: Claim 6 is substantively identical to claim 1, except that it recites the base station transmitting and receiving, rather than the user equipment receiving and transmitting, information, [6Preamble], [6a], and [6b]. The remaining elements of claim 6, [6c]-[6j], are substantively the same as elements [1c]-[1j]. The above discussion for claim 1 describes both the transmission and reception of the base station and user equipment and, therefore, also explains why each element of claim 6 is taught or rendered obvious by the combination of Kim and Zhang or the combination of Kim, Zhang, and Kang. Supra § XI.A.1 (claim 1).

a. **[6Preamble] “A method for multi-antenna transmitting in a base station, comprising:”**

62.143. To the extent the preamble is limiting, *Kim* discloses ~~a method for multi-antenna transmitting in a base station. Kakaes, ¶143.~~ [6Preamble] as discussed in [1Preamble]. Supra § XI.A.1.a. As discussed for ~~[1pre]~~ [1Preamble], *Kim* discloses a method that includes transmitting, by multiple antennas of a base

station, a reference signal to a user equipment. *Kim*, Abstract, ¶¶[0050]-[0053], Fig. 3.

b. [6a]: “transmitting a first radio signal to a target receiver; and”

Kim discloses ~~transmitting a first radio signal to a target receiver. Kakaes,~~

~~63.144. ¶144.[6a] as discussed in [1a].~~ For example, *Kim* discloses the base station transmitting a CSI-RS to a ~~UE~~user equipment (target receiver). *Kim*, ¶¶[0055]-[0058], [0091], [0132]; ~~supra, §VI § XI.A.41.b.~~

c. [6b]: “transmitting a first signaling to the target receiver;”

Kim discloses ~~transmitting a first signaling to the target receiver. Kakaes,~~

~~64.145. ¶145.[6b] as discussed in [1b].~~ For example, *Kim* discloses the base station transmitting a first signaling including control information to the ~~UE~~user equipment (target receiver), the control information indicating positions of time resources at which a CSI-RS for each antenna group is transmitted. ~~*Kim*, ¶¶[0065], [0069], [0079]; supra, §VI.A.4.c. Kim,~~
~~¶¶[0065], [0069], [0079]; supra § XI.A.1.c.~~

d. [6c]: “wherein the first radio signal is transmitted by K antenna port groups of the base station;”

~~65.146. As discussed above for [1e], Kim discloses this limitation. [6c] as discussed in [1c]. Supra, §VI § XI.A.41.d; Kakaes, ¶146.~~

e. [6d]: “the antenna port group includes a positive integer number of antenna port(s);”

~~66.147.~~ ~~As discussed above for [1d],~~ *Kim* discloses ~~this limitation.~~ [6d] as discussed in [1d]. *Supra*, §VI § XI.A.41.e; *Kakaes*, ¶147.

- f. ~~[6e]:~~ “the first antenna port group is one of the K antenna port groups;”

~~67.148.~~ ~~As discussed above for [1e],~~ *Kim* discloses ~~this limitation.~~ [6e] as discussed in [1e]. *Supra*, §VI § XI.A.41.f; *Kakaes*, ¶148.

- g. [6f]: “the first signaling is used to determine a first time resource pool;”

~~68.149.~~ ~~As discussed above for [1f], Kim discloses this limitation. [6f] as discussed in [1f]. Supra, § VI § XI.A.41.g; Kakaes, ¶149.~~

- h. [6g]: “at least one of a first antenna virtualization vector and a second antenna virtualization vector is associated with the first antenna port group;”

~~150. As discussed above for [1g], Kim in combination with Zhang or Kim in combination with Zhang or Kim in combination with Zhang~~

and Kang renders ~~this limitation~~ obvious. ~~[6g] as discussed in [1g]. Supra, § XI.A.1.h. § VI.A.4.h; Kakaes, ¶150.~~

- i. ~~[6h]:]~~ “the first antenna virtualization vector is an antenna virtualization vector available to the base station in the first time resource pool;”

~~69-151.~~ As discussed above for [1h], Kim in combination with Zhang renders this limitation obvious. ~~[6h] as discussed in [1h]. Supra, §VI § XI.A.41.i; Kakaes, ¶151.~~

- j. ~~[6i]:]~~ “the second antenna virtualization vector is an antenna virtualization vector available to the target receiver of the first signaling in the first time resource pool; and”

~~70-152.~~ As discussed above for [1i], Kim in combination with Kang renders obvious ~~that the second antenna virtualization vector is an antenna virtualization vector available to the user equipment (target receiver of the first signaling) in the first time resource pool. Supra, §VI.A.4[6i] as discussed in [1i]. Supra § XI.A.1.j; Kakaes, ¶152.~~

- k. ~~[6j]:]~~ “the K is a positive integer greater than 1.”

~~71-153.~~ As discussed above for [1j], Kim discloses ~~this limitation.~~ [6j] as discussed in [1j]. Supra, §VI § XI.A.41.k; Kakaes, ¶153.

~~6.~~—Claim 9

~~4.5.~~ ~~[9a]~~∴ “The method of claim 6, further comprising:
transmitting first information, wherein the first information
is used to determine the first antenna port group; or”²²
receiving second information, wherein the second
information is used to determine K1 antenna port group(s);
the K1 antenna port group(s) belong(s) to the K antenna
port groups; the first antenna port group is one of the K1
antenna port group(s); the K1 is a positive integer.”

~~72.154.~~ The combination of Kim and Zhang, or the combination
of Kim, Zhang, and Kang renders obvious claim 6.~~Supra, as
discussed above.~~

~~§VI.A.7. Kim discloses that the base station transmits first information which is~~

~~used to determine the first antenna port group. Kim, ¶¶[0067]–[0069], [0057], [0065]; Kakaes, ¶154; supra, §VI.A.5.a.~~

~~a. — [9b]: “receiving second information”~~

~~Claim 9 includes an “or” between [9a] and [9b], so only one of the two limitations must be taught to satisfy claim 9. See Brown, 265 F.3d at 1351.~~

155. The additional limitations of claim 9 are substantively identical to claim 4, and are therefore disclosed by Kim for the reasons discussed in claim 4. Supra § XI.A.2.

5.6. Claim 10:

- a. ~~[10a]:] “The method of claim 6, wherein the first time resource pool is discontinuous in time domain; or”~~

73.156. The combination of Kim and Zhang, or the combination of Kim, Zhang, and Kang renders obvious claim 6. Supra, as discussed above.

~~§VI.A.7. As discussed above for [5a], Kim discloses this additional limitation. Supra, §VI.A.6.a; Kakaes, ¶157.~~

157. The additional limitations of claim [10a] are substantively identical to claim [5a], and are therefore disclosed by Kim, for the reasons discussed in claim [5a]. Supra § XI.A.3.a.

- b. [10b]: “the first signaling is a semi-static signaling.”

~~Claim 10 includes an “or” between [10a] and [10b], so only one of the two~~The
additional limitations ~~must be taught to satisfy of~~ claim 10. ~~See Brown, 265 F.3d at~~
~~1351.~~

~~Nonetheless, as discussed above for [10b] are substantively identical to claim~~
~~[5b], and are therefore disclosed by Kim discloses this limitation.~~

~~74.158.~~ for the reasons discussed in claim [5b]. ~~Supra, §VI § XI.A.63.b;~~
~~Kakaes, ¶158.~~

6.7. Independent Claim 11:

159. ~~[11pre]~~ Claim 11 is substantively similar to claim 1, except that it claims the user equipment itself performing functions, rather than being a method claim. Elements [11a]-[11b] recite a “first transceiver,” and a “second receiver” performing steps comparable to steps [1a]-[1b]. The above discussion for claim 1 describes why each element of claim 11 is taught or rendered obvious by the combination of Kim and Zhang or the combination of Kim, Zhang, and Kang, although the specific “transceiver” and “receiver” are further discussed below. Supra § XI.A.1 (claim 1).

- a. **[11Preamble] “A user equipment (UE) for multi-antenna transmission, comprising:”**

75-160. To the extent the preamble is limiting, Kim discloses ~~a user-~~ equipment for multi-antenna transmission. Kakaes, ¶60. [11Preamble] as discussed in [1Preamble]. For example, Kim discloses that a base station transmits a reference signal to a user equipment through multiple transmission antennas. Kim, Abstract, ¶¶[0050]-[0053], Fig. 3; ~~supra, §VI~~ § XI.A.41.a.

- b. **[11a]: “a first transceiver, receiving a first radio signal from a base station; and”**

161. As Kim discloses [11a] for the reasons discussed above for in [1a], Kim’s user equipment receives a first radio signal (e.g., CSI-RS) from a base station.] Supra, §VI
§ XI.A.41.b; Kakaes, ¶161. Kim discloses that the user equipment includes

receivers 1510 and 1530 for receiving the CSI-RS signals. *Kim*, ¶¶[0021], [0132], Fig. 15, claim 29. But it would have been obvious to implement at least one of these receivers as part of a transceiver because *Kim*'s user equipment also transmits signals, such as

channel state information, to the base station. *Kim*, ¶¶[0019], [0021]. A transceiver, i.e., a combination of a transmitter and a receiver in a single module, was routinely implemented in user equipment (e.g., mobile phones and tablets) for wireless communication and provides benefits such as space saving and cost saving in the mobile devices. ~~Kakaes, ¶161; see, e.g., Hu, The use of a transceiver in a UE to transmit and receive signals was routine and conventional years before the '527 patent was filed. See, e.g., Hu,~~

¶[0142] (describing having transceivers (XCVR) in the access terminal 1550); *Olsson*, ¶¶[0046]-[0047] (describing a transceiver circuitry in a user equipment); *Vitthaladevuni*, ¶[0160] (the transmitter and receiver “may be collectively referred to as a transceiver”). Because *Kim*’s user equipment also performs the functionality of transmitting to the base station, it would have been obvious to a POSITA to implement at least one of *Kim*’s receivers as part of a transceiver in the user equipment to receive the first radio signal from the base station, to save space and cost. ~~Kakaes, ¶161.~~ And a POSITA would have had a reasonable expectation of success in doing so because implementing a transceiver in a UE to receive and transmit information was a conventional and routine technique, as described in *Hu* and *Olsson*. ~~Kakaes, ¶161.~~

- c. [11b]: “a second receiver, receiving a first signaling from the base station;”

162. As *Kim* discloses [11b] for the reasons discussed above for in [1b], *Kim*’s user equipment receives a first signaling (signaling including control information) from the base

~~station.]. Supra, §VI~~

~~§ XI.A.41.c; Kakaes, ¶162.~~ It would have been obvious to implement a second receiver in *Kim*'s user equipment for receiving a first signaling from the base station. ~~Kakaes, ¶162.~~

~~76-163.~~ Kim discloses that the user equipment includes multiple receivers for receiving signals from the base station. *Kim*, ¶¶[0021], [0132]. *Kim* also discloses that the user equipment includes a controller 1520 for receiving control information from the base station and for controlling multiple receivers. *Kim*, ¶¶[0021], [0132], Fig. 15. *Kim* further discloses a massive MIMO system where the user equipment is equipped with multiple reception antennas. *Kim*, ¶¶[0049]-[0051]; ~~Kakaes, ¶163.~~ It would have been obvious to implement in *Kim*'s user equipment multiple antennas and multiple receivers connected to the antennas, each antenna being connected to a receiver to convert the radio signal received from the antenna to a baseband signal for further MIMO processing. ~~Kakaes, ¶163.~~ A POSITA would have found implementing in a user equipment multiple antennas and multiple receivers connected to the antennas routine and conventional years before the '527 patent was filed, and would have had a reasonable expectation of success in doing so. ~~Kakaes, ¶163; see~~ See also Luo-330, ¶[0037] (providing multiple antennas and receivers where a respective receiver is connected to each antenna), Fig. 2; (showing receivers 254a and 254r, each connected to antennas 252a and 252r for receiving respective signals); Vitthaladevuni, ¶[0120] (same providing multiple antennas and receivers where a respective receiver is connected to each antenna), Fig. 10; (showing receivers 1062a and 1062r, each connected to antennas 1061a and 1061r for receiving respective signals); Hu,

¶¶[0059], [0142]-[0143], (providing multiple antennas and

transceivers where a respective transceiver is connected to each antenna), Figs. 3, 12 (showing transceivers 1554A and 1554R, each connected to antennas 1522A and 1522R for receiving respective signals).~~Figs. 3, 12.~~ Such arrangement was a conventional and commonly adopted architecture in a MIMO system, allowing for efficient processing of radio signals received from multiple antennas and individual control of the antennas. ~~Kakaes,~~

~~¶163.~~ Therefore, it would have been obvious to implement in *Kim*'s user equipment a second receiver connected to a second antenna, where the second receiver is configured to receive signals, including a first signaling, ~~transmitted from the base station.~~ ~~Kakaes, ¶163.~~ (signaling including control information), transmitted from the base station. As such, the combination represents nothing more than known components operating according to their ordinary and expected functions to yield predictable results (receiving transmitted signals).

d. [11c]: “wherein the first radio signal is transmitted by K antenna port groups of the base station;”

164. ~~As discussed above for [1c],~~ *Kim* discloses ~~this limitation.~~ [11c] for the reasons discussed in [1c]. *Supra*, §VI

§ XI.A.41.d; ~~Kakaes, ¶164.~~

e. [11d]: “the antenna port group includes a positive integer number of antenna port(s);”

77.165. ~~As discussed above for [1d],~~ *Kim* discloses ~~this limitation.~~ [11d] as discussed in [1d]. *Supra*, §VI § XI.A.41.e; ~~Kakaes, ¶165.~~

f. [11e:] “the first antenna port group is one of the K antenna port groups;”

78.166. ~~As discussed above for [1e], Kim discloses this limitation. [11e] as discussed in [1e]. Supra, §VI § XI.A.41.f; Kakaes, ¶166.~~

- g. [11f]: “the first signaling is used to determine a first time resource pool;”

~~79.167. As discussed above for [1f], Kim discloses this limitation. [11f] as discussed in [1f]. Supra, §VI § XI.A.41.g; Kakaes, ¶167.~~

- h. [11g]: “at least one of a first antenna virtualization vector and a second antenna virtualization vector is associated with the first antenna port group;”

~~80.168. As discussed above for [1g], Kim in combination with Zhang or Kim in combination with Zhang~~

and Kang renders ~~this limitation~~ obvious. ~~[11g] as discussed in [1g]. Supra, § XI.A.1.h. §VI.A.4.h; Kakaes, ¶168.~~

- i. [11h]: “the first antenna virtualization vector is an antenna virtualization vector available to the base station in the first time resource pool;”

~~81.169. As discussed above for [1h], Kim in The combination with of Kim and Zhang renders this limitation obvious. [11h] as discussed in [1h]. Supra, §VI § XI.A.41.i; Kakaes, ¶169.~~

- j. [11i]: “the second antenna virtualization vector is an antenna virtualization vector available to the user equipment in the first time resource pool; and”

~~82.170. As discussed above for [1i], Kim in The combination with of Kim and Kang renders this limitation obvious. [11i] as discussed in [1i]. Supra, §VI § XI.A.41.j; Kakaes, ¶170.~~

- k. [11j]: “the K is a positive integer greater than 1.”

~~83-171.~~ ~~As discussed above for [1j],~~ *Kim* discloses this limitation. ~~[11j] as discussed~~
~~in [1j]. Supra, §VI § XI.A.41.k; Kakaes, ¶171.~~

~~7.~~—Claim 14

~~7.8.~~ ~~[14a]:~~ “The UE of claim 11, wherein: the second receiver further receives first information, wherein the first information is used to determine the first antenna port group; or” the first transceiver further transmits second information, wherein the second information is used to determine K1 antenna port group(s); the K1 antenna port group(s) belong(s) to the K antenna port groups; the first antenna port group is one of the K1 antenna port group(s); the K1 is a positive integer.”

~~84.172.~~ The combination of Kim and Zhang, or the combination of Kim, Zhang, and Kang renders obvious claim 11. ~~Supra, as discussed above.~~

~~85.173.~~ §VI.A.10. As discussed above for [4a], Kim discloses this The additional limitation. Supra, §VI.A.5.a; Kakaes, ¶173. As explained limitations of claim 14 are substantively identical to claim 4, and are therefore disclosed by Kim, for the reasons discussed in claim 4. Supra § XI.A.2. As I explained above for [11b], it would have been obvious to implement a second receiver in Kim’s user equipment for receiving “a first signaling from the base station.” ~~Supra, §VI.A.10.7.c.~~ Supra, §XI.A.7.c. As a result, the second receiver would further receive the “first information” because the “first information” is transmitted from the base station, and the second receiver is connected to an antenna to receive signals transmitted from the base station.

~~Kakaes, ¶173.~~

a. ~~—[14b]: “the first transceiver”~~

Claim 14 includes an “or” between [14a] and [14b], so only one of the two limitations must be taught to satisfy claim 14. *See Brown*, 265 F.3d at 1351; see also ~~Ex. 1022, 28–30, 36–37~~ (Patent Owner’s infringement contentions not addressing [14b]).

8.9. Claim 15:

a. [15a~~+~~]: “The UE of claim 11, wherein the first time resource pool is discontinuous in time domain; or”

174. The combination of Kim and Zhang, or the combination of Kim, Zhang, and Kang ~~render~~renders obvious claim 11, as discussed above.

175. The additional limitations of claim [15a] are substantively identical to claim [5a], and are therefore disclosed by Kim, for the reasons discussed in claim [5a]. Supra, § XI.A.3.a.

§VI.A.10. As discussed above for [5a], Kim discloses this additional limitation. Supra, §VI.A.6.a; Kakaes, ¶175.

b. [15b]: “the first signaling is a semi-static signaling.”

Claim 15 includes an “or” between [15a] and [15b], so only one of the two additional limitations must be taught to satisfy of claim 15. See Brown, 265 F.3d at 1351.

Nonetheless, as [15b] are substantively identical to claim [5b], and are therefore disclosed by Kim for the reasons discussed above for [5b], Kim discloses this limitation.

86.176. in claim [5b]. Supra, §VI § XI.A.63.b; Kakaes, ¶176.

9.10. Independent Claim 16:

177. [16pre]: Claim 16 is substantively similar to claim 6, except that the base station itself performing functions, rather than a method. Elements [16a]-[16b] also recite a “third transceiver” and “second transmitter” performing steps comparable to steps [6a]-[6b]. The above discussions for claims 1 and 6 describe why each element of claim 16 is taught or rendered obvious by the combination of Kim and Zhang or the combination of Kim, Zhang, and Kang, although the specific

“transceiver” and “transmitter” are further discussed below. *Supra* §§ XI.A.1 (claim 1), XI.A.4 (claim 6).

- a. **[16Preamble] “A base station equipment for multi-antenna transmission, comprising:”**

To the extent the preamble is limiting, *Kim* discloses ~~a base station~~ equipment for multi-antenna transmission. ~~Kakaes, ¶178. For example, *Kim*~~

87.178. _____ discloses that a base station transmits [16Preamble] as discussed in [6Preamble] and [1Preamble]. *Supra* §§ XI.A.1. ~~a reference signal to, XI.A.4. a user~~ equipment through multiple transmission antennas. *Kim*, Abstract, ¶¶ [0050] [0053], Fig. 3; *supra*, §VI.A.4.a.

b. [16a]: “a third transceiver, transmitting a first radio signal to a target receiver; and”

~~179. As discussed above~~ *Kim* discloses [16a] for the reasons discussed in [1a], *Kim*’s base station equipment transmits a first radio signal (e.g., CSI-RS) to a user equipment (target receiver). *Supra*, §VI.A.4.] and [6a]. *Supra*

§§ XI.A.1.b; ~~Kakaes, ¶179.~~ XI.A.4.b. It would have been obvious to implement in *Kim*’s base station equipment a third transceiver for transmitting a first radio signal to a target receiver. ~~Kakaes, ¶179.~~ *Kim* discloses that the base station includes transmitters 1400 and 1420 for transmitting the CSI-RS signals. *Kim*, ¶¶[0020], [0130], Fig. 14. It would have been obvious to implement at least one of these transmitters as part of a transceiver because *Kim*’s base station also receives signals, such as channel state information, from the user equipment. *Kim*, ¶¶[0018], [0020]. A transceiver, i.e., a combination of transmitter and receiver in a single module, was routinely implemented in base stations for wireless communication and provides benefits such as space saving and cost saving. ~~Kakaes, ¶179; see~~ *See, e.g., Hu*, ¶[0140] (describing having transceivers (XCVR) in the access point 1510); *Wong*, ¶¶[0077]-[0080], Fig. 3 (describing having transceivers (TX/RX) in the base station); *Vitthaladevuni*, ¶[0154] (the transmitter and receiver “may be collectively referred to as a transceiver”). Because *Kim*’s base station also performs the functionality of receiving from the user equipment, it would have been obvious to implement at least one of *Kim*’s transmitters as part of a transceiver in the base station, to save space and cost. ~~Kakaes, ¶179.~~ And a POSITA would have had a

reasonable expectation of success in doing so because implementing a

transceiver in a base station to receive and transmit information was conventional and routine, as described in *Hu and Wong*. ~~Kakaes, ¶179.~~

c. [16b]: “a second transmitter, transmitting a first signaling to the target receiver;”

~~180. As Kim discloses [16b] for the reasons discussed above for in [1b], Kim’s base station equipment transmits a first signaling to a user equipment (target receiver).] and [6b]. Supra, §VI~~

~~§§ XI.A.1.c, XI.A.4.c; Kakaes, ¶180.~~

~~Kim discloses that the base station includes multiple transmitters for transmitting signals to the user equipment. Kim, ¶¶[0020], [0130]. Kim also discloses that the base station includes a controller 1410 for transmitting control information to the user equipment and for controlling the transmitters. Kim, ¶¶[0020], [0130], Fig. 14. Kim further discloses a massive MIMO system where the base station is equipped with multiple transmission antennas. Kim, ¶¶[0049]-[0051]. It would have been obvious to implement in Kim’s base station multiple transmitters connected to the antennas, each antenna being connected to a transmitter to convert a baseband signal to a radio signal for transmission by the antenna. Kakaes, ¶180. A POSITA would have found implementing in a base station multiple antennas and multiple transmitters connected to the antennas routine and conventional years before the ’527 patent was filed, and would have had a reasonable expectation of success in doing so. Kakaes, ¶180; see also Luo-330, ¶¶[0035]-[0036] (providing multiple antennas and transmitters where a~~

respective transmitter is connected ~~to~~ each antenna), Fig. 2; ~~Vitthaladevuni,~~
~~(showing transmitters 222a and 222t, each connected to antennas 224a and 224t~~
~~for transmitting respective signals);~~
~~¶¶[0118] [0119] (same), Fig. 10; Hu, ¶¶[0140] [0141], Fig. 12; Wong, ¶¶[0077]-~~
~~[0080], Fig. 3.~~

Vitthaladevuni, ¶¶[0118]-[0119] (providing multiple antennas and transmitters where a respective transmitter is connected each antenna), Fig. 10 (showing transmitters 1055a and 1055t, each connected to antennas 1056a and 1056t for transmitting respective signals); Hu, ¶¶[0140]-[0141] (providing multiple antennas and transceivers where a respective transceiver is connected each antenna), Fig. 12 (showing transceivers 1522A and 1522T, each connected to antennas 1524A and 1524T for transmitting respective signals); Wong, ¶¶[0077]-[0080] (providing multiple antennas and transceivers where a transceiver is connected respective group of antennas), Fig. 3 (showing transceivers 302A through 302N, each connected to a respective group of antennas for transmitting signals). Such arrangement was a conventional and commonly adopted architecture in a MIMO system, allowing for simplified processing of radio signals for transmission on multiple antennas and individual power control of the antennas. ~~Kakaes, ¶180.~~ As such, the combination represents nothing more than known components operating according to their ordinary and expected functions to yield predictable results (transmitting signals). Therefore, it would have been obvious to implement in *Kim*'s base station a second transmitter connected to a second antenna, where the second transmitter is configured to transmit signals, including the first signaling, to the user equipment via the second antenna. ~~Kakaes, ¶180.~~

- d. ~~[16c]:~~ “wherein the first radio signal is transmitted by K antenna port groups of the base station;”

~~181.~~ ~~As discussed above for [1e], Kim discloses this limitation.~~ ~~[16c] for the reasons discussed in [1c] and [6c].~~ ~~Supra, §VI~~

~~§§ XI.A.1.d, XI.A.4.d; Kakaes, ¶181.~~

- e. ~~[16d]:~~ “the antenna port group includes a positive integer number of antenna port(s);”

~~88-182.~~ ~~As discussed above for [1d], Kim discloses this limitation.~~ ~~[16d] as discussed in [1d] and [6d].~~ ~~Supra, §VI §§ XI.A.1.e, XI.A.4.e; Kakaes, ¶182.~~

- f. ~~[16e]:~~ “the first antenna port group is one of the K antenna port groups;”

~~89-183.~~ ~~As discussed above for [1e], Kim discloses this limitation.~~ ~~[16e] as discussed in [1e] and [6e].~~ ~~Supra, §VI §§ XI.A.1.f, XI.A.4.f; Kakaes, ¶183.~~

- g. ~~[16f]:~~ “the first signaling is used to determine a first time resource pool;”

~~90-184.~~ ~~As discussed above for [1f], Kim discloses this limitation.~~ ~~[16f] as discussed in [1f] and [6f].~~ ~~Supra, §VI §§ XI.A.1.g, XI.A.4.g; Kakaes, ¶184.~~

- h. ~~[16g]:~~ “at least one of a first antenna virtualization vector and a second antenna virtualization vector is associated with the first antenna port group;”

~~As discussed above for [1g], Kim in combination with Zhang or Kim in combination with Zhang and Kang renders this limitation obvious.~~ ~~[16g] as discussed in [1g] and [6g].~~ ~~Supra,~~

91.185. ~~§VI §§ XI.A.1.h, XI.A.4.h, Kakaes, ¶185.~~

- i. [16h]: “the first antenna virtualization vector is an antenna virtualization vector available to the base station in the first time resource pool;”

92.186. ~~As discussed above for [1h],~~ Kim in combination with Zhang renders ~~this limitation~~ obvious. [16h] as discussed in [1h] and [6h]. *Supra*, §VI §§ XI.A.1.i, XI.A.4.i; Kakaes, ¶186.

- j. [16i]: “the second antenna virtualization vector is an antenna virtualization vector available to the target receiver of the first signaling in the first time resource pool; and”

93.187. ~~As discussed above for [1i],~~ Kim in combination with Kang renders obvious ~~that the second antenna virtualization vector is an antenna virtualization vector available to the user equipment (target receiver of the first signaling) in the first time resource pool.~~ [16i] as discussed in [1i] and [6i]. *Supra*, §VI §§ **Error! Reference source not found.**, XI.A.4.j; Kakaes, ¶187.

- k. [16j]: “the K is a positive integer greater than 1.”

94.188. ~~As discussed above for [1j],~~ Kim discloses ~~this limitation.~~ [16j] as discussed in [1j] and [6j]. *Supra*, §VI §§ XI.A.1.k, XI.A.4.k; Kakaes, ¶188.

8. — Claim 19

10.11. [19a]: “The base station equipment of claim 16, wherein: the second transmitter further transmits first information, wherein the first information is used to determine the first antenna port group; or² the third transceiver further receives second information, wherein the second information is used to determine K1 antenna port group(s); the K1 antenna port group(s) belong(s) to the K antenna

port groups; the first antenna port group is one of the K1 antenna port group(s); the K1 is a positive integer.”

95-189. The combination of Kim and Zhang, or the combination of Kim, Zhang, and Kang renders obvious claim 16. Supra, as discussed above.

190. §VI.A.13. As discussed above for [4a], Kim discloses this The additional limitation. limitations of claim 19 are substantively identical to claims 4 and 9, and are therefore disclosed by Kim, for the reasons discussed in

claims 4 and 9. Supra, §VI §§ XI.A.2, XI.A.5.a; Kakaes, ¶190. As explained for claim element [16b], it would have been obvious to implement a second transmitter in *Kim*'s base station equipment for transmitting "a first signaling to the target receiver." *Supra, §VI*
§XI.A.1310.c. For the same reasons, it would have been obvious to implement the second transmitter for transmitting the "first information." Kakaes, ¶190.

a. ~~—[19b]: “the third transceiver”~~

~~Claim 19 includes an “or” between [19a] and [19b], so only one of the two limitations must be taught to satisfy claim 19. See Brown, 265 F.3d at 1351.~~

11.12. Claim 20:

a. ~~[20a]:~~ “The base station equipment of claim 16, wherein the first time resource pool is discontinuous in time domain; or”

~~The combination of Kim and Zhang, or the combination of Kim, Zhang, and Kang render renders obvious claim 16. Supra,~~

~~96.191. §VI.A.13. As, as discussed above for [5a], Kim discloses this additional limitation. Supra, §VI.A.6.a; Kakaes, ¶192.~~

~~192. The additional limitations of claim [20a] are substantively identical to claims [5a] and [10a], and are therefore disclosed by Kim, for the reasons discussed in claims [5a] and [10a]. Supra §§ XI.A.3.a, XI.A.6.a.~~

b. ~~[20b]:~~ “the first signaling is a semi-static signaling.”

~~Claim 20 includes an “or” between [20a] and [20b], so only one of the two The additional limitations must be taught to satisfy of claim 20. See Brown, 265 F.3d at 1351.~~

~~Nonetheless [20b] are substantively identical to claims [5b] and [10b], and are therefore disclosed by Kim for the reasons discussed above for [5b], Kim discloses this limitation in claims [5b] and [10b]. Supra,~~

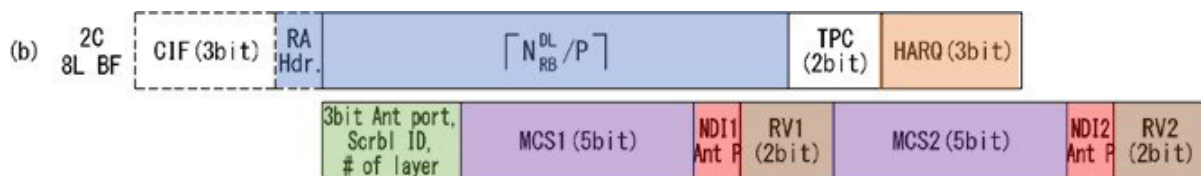
~~97.193. §VI §§ XI.A.3.b, XI.A.6.b; Kakaes, ¶193.~~

B. Claims 2, 3, 7, 8, 12, 13, 17 and 18 Are **Rendered** Obvious ~~over~~**Over** Kim, Zhang, and Park (Ground 3) or Kim, Zhang, Kang, and Park (Ground 4)

9. Overview of *Park*

~~*Park* discloses a method for “transmitting and receiving Downlink [C]ontrol Information (DCI) in a wireless communication system.” *Park*, ¶[0002]. Like the ‘527 patent, *Park* relates to a MIMO communication system, and is thus analogous art to the ‘527 patent. *Park*, ¶¶[0004], [0109], [0281]; Kakaes, ¶83. *Park* describes~~

~~control information transmitted in a PDCCH as Downlink Control Information (DCI). Park, ¶[0072]. In particular, Park describes a DCI format 2C, which includes information indicating occupied frequency domain resources (blue), an MCS (purple), a HARQ process number (orange), an RV (brown), an NDI (red), and a transmitting antenna port (green), as shown below.~~



~~Park, Fig. 14(b). Park explains that the UE monitors the PDCCH and attempts to decode the DCI format to receive data transmitted to the UE over a physical downlink shared channel (PDSCH). Park, ¶¶[0154]–[0156], [0071].~~

1. **Claim 2:**

194. In my opinion, the combination of Kim, Zhang, and Park or the combination of Kim, Zhang, Kang, and Park renders obvious claim 2.

a. [2a:] “The method of claim 1, further comprising: receiving a second signaling; and”

For the reasons discussed above, the combination of Kim and Zhang, or the combination of Kim, Zhang, and Kang renders obvious claim 1. Supra,

195. §VI.A.4. In my opinion, Kim discloses receiving a second signaling (PDCCH).

98-196. Kim discloses receiving a second signaling (the PDCCH used

for data reception). ~~Kakaes, ¶196.~~ *Kim* discloses that the user equipment receives “control information for data reception from the eNB.” *Kim*, ¶¶[0021], [0120] (same), describing the base station transmitting “control information needed for reception of a traffic channel to the selected UEs”, [0091] (same). *Kim* further discloses “a Physical Downlink Control Channel (PDCCH) used for transmission of a control signal.” *Kim*, ¶[0010]. ~~*Kim*’s second signaling is different~~ *Kim*, ¶[0010]. As shown in annotated Figure 1 below, *Kim* discloses a control region in a subframe for receiving control channel transmission and a data region in a subframe for receiving data transmission (e.g., PDSCH).

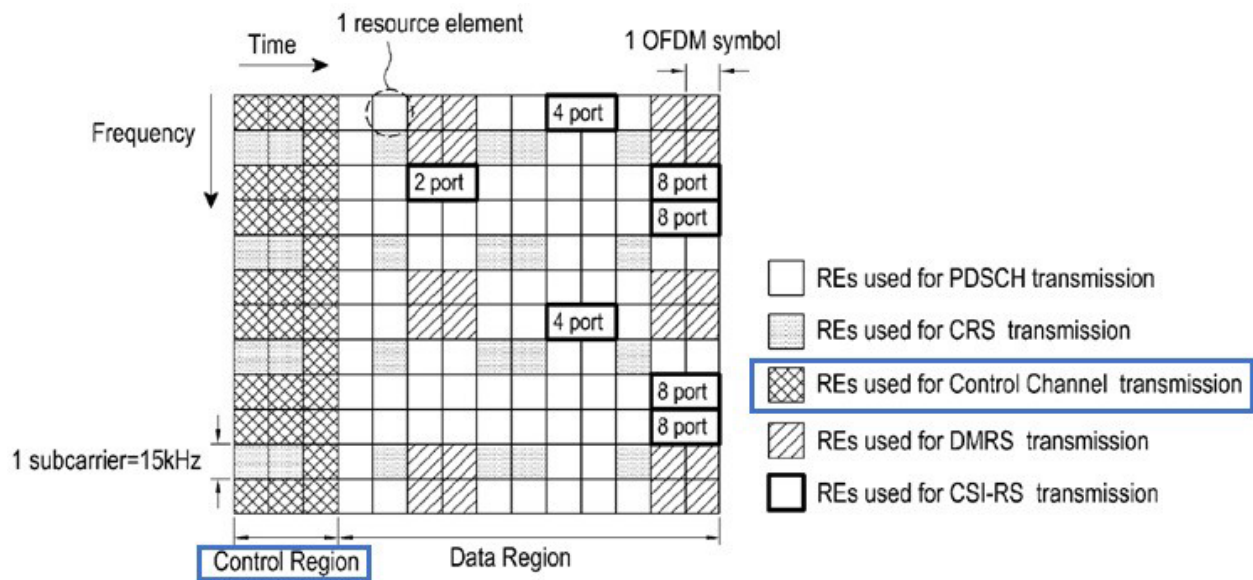


FIG. 1
(RELATED ART)

Kim, Fig. 1 (annotated).

99.197. Kim's "second signaling" is different from the "first signaling" in claim 1, which because the "second signaling" is used for receiving data (e.g., PDSCH) while the "first signaling" is used for receiving a reference signal (e.g., CSI-RS). Kakaes, ¶197; supra, §VI Supra, §XI.A.41.c.

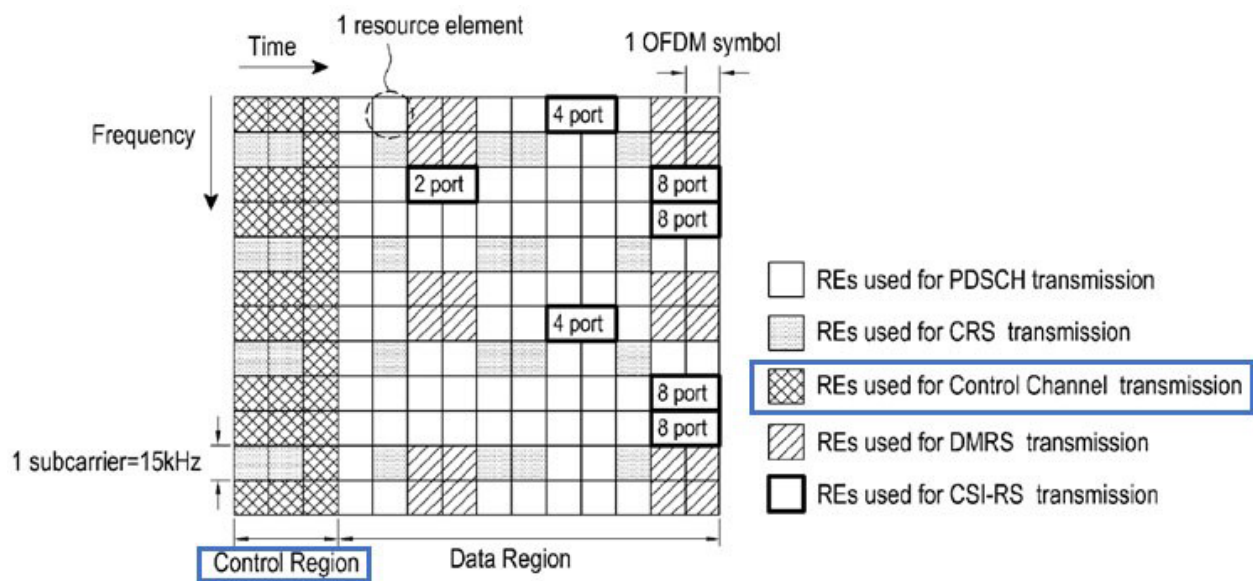


FIG.1
(RELATED ART)

~~Kim, Fig. 1.~~

- b. [2b-1] “operating a second radio signal in a first time resource sub-pool;”

198. In my opinion, Kim discloses operating a second radio signal in a first time resource sub-pool.

100-199. Kim discloses operating a second radio signal (e.g., a PDSCH) in a first time resource sub-pool (data region in a subframe). ~~Kakaes,~~
~~¶199.~~ For example, Kim

discloses that a first time resource pool (subframe) includes a data region with a Physical Downlink Shared Channel (PDSCH) used for transmission of traffic data.

Kim, ¶[0010]. Annotated Figure 1 below shows that the data region occupies 11 OFDM time symbols while a subframe contains 14 OFDM time symbols. Kim,-
 ¶[0010], Fig. 1.

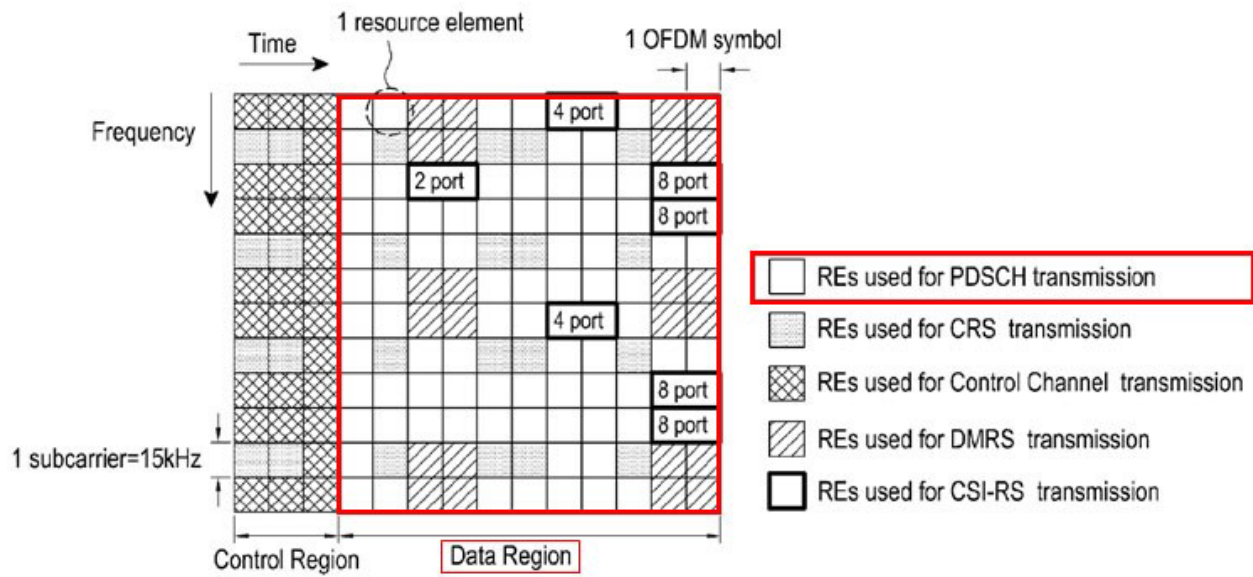


FIG.1
 (RELATED ART)

¶[0010], Fig. 1.

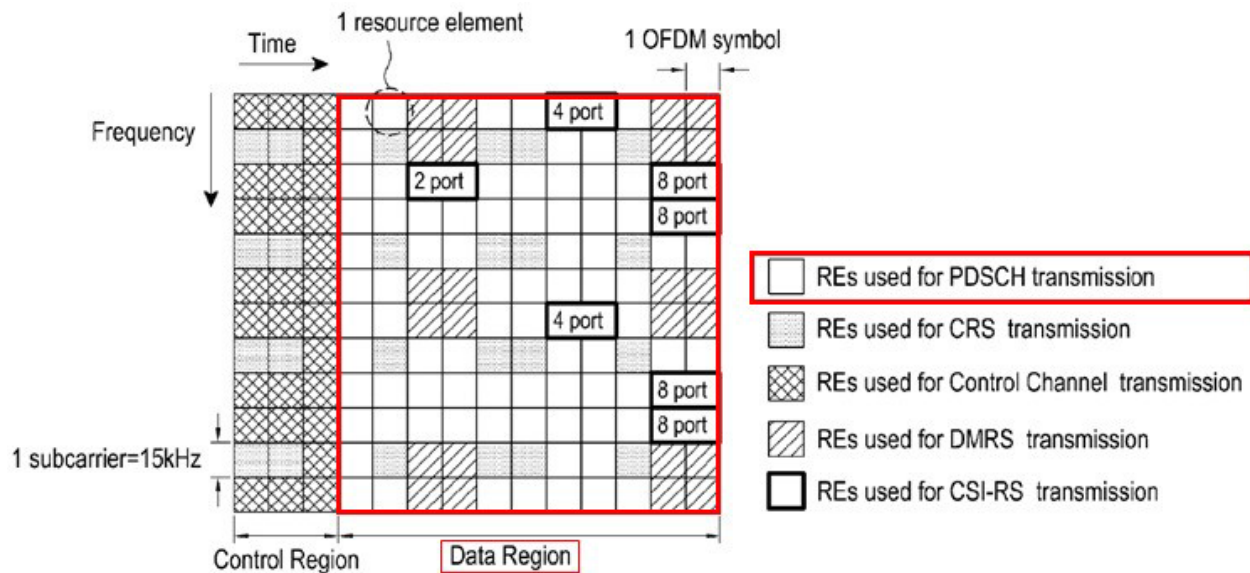


FIG. 1
(RELATED ART)

Kim, Fig. 4.1 (annotated).

- c. [2c] “wherein the operating is receiving from the base station, or the operating is transmitting to the base station;”

401.200. In my opinion, Kim discloses the operating is receiving from the base station. Kakaes, ¶201, or the operating is transmitting to the base station.

102.201. *Kim* discloses the operating is receiving from the base station.

For example, *Kim* discloses that the user equipment receives traffic data from the base station in the data region. *Kim*, ¶¶[0010] (using PDSCH to receive downlink traffic data from the base station), [0091] (the eNB allocates “downlink wireless resources” to the UE), [0106] (“a PDSCH transmitted for a data signal”); Abstract (“allocating “wireless resources” to UEs).

~~103-202. resources” to the UE), [0106] (“a PDSCH transmitted for a data signal”). A~~

POSITA would have understood that based on the control information in PDCCH, *Kim*’s UE determines the allocated downlink wireless resources in PDSCH and receives data from the base station in the allocated downlink wireless resources. As explained in *Kim*, the resources of time, frequency and transmission power are limited in a mobile communication system (*Kim*, Kakaes, ¶202. ¶[0008]), and the base station allocates wireless resources to only a subset of UEs in the cell (*Kim*, ¶[0018]). Thus, a POSITA would have understood that a UE first receives control information indicating that wireless resources are allocated to it, then receives data in the corresponding wireless resources. See *Kim*, ¶[0018] (base station “transmitting control information for data reception to the selected final UEs”); see also *Kim*, ¶[0120] (base station “selects UEs to which actual downlink wireless resources are to be allocated, and transmits control information needed for reception of a traffic channel to the selected UEs.”). Therefore, *Kim* discloses the

operating is receiving data from the base station based on the control information for data reception.

- d. ~~[2d]~~ “the second signaling is used to determine the first time resource sub-pool from the first time resource pool; and”

203. In my opinion, Kim in combination with Park renders obvious the second signaling is used to determine the first time resource sub-pool from the first time resource pool.

104.204. Kim teaches or suggests that the second signaling (PDCCH for data reception) is used to determine the first time resource sub-pool (data region) from the first time resource pool (the subframe in which CSI-RS for the first antenna port group is transmitted). ~~Kakaes, ¶204.~~ For example, Kim discloses that control information is needed for data reception by the UE, which can be transmitted in a PDCCH. Kim,

¶¶[0021], [0120], [0010]. It would have been obvious to a POSITA that the second signaling (PDCCH for data reception) is used to determine the first time resource sub-pool (data region) such that traffic data transmitted to the UE can be properly received. ~~Kakaes, ¶204.~~

105.205. To the extent Kim does not explicitly disclose the second signaling is used to determine the first time resource sub-pool from the first time resource pool, Park renders this limitation obvious. Park discloses that when a UE detects a PDCCH intended for the UE, the UE decodes a corresponding PDSCH in

the same

subframe. *Park*, ¶[0180]. *Park* also discloses that the UE blindly decodes a PDCCH according to fields in the DCI formats and decodes the PDSCH according to the detected PDCCH. *Park*, ¶¶[0155], [0180]-[0181]. *Park* discloses that when the UE detects a PDCCH intended for the UE, the UE determines the presence of data in the data region of the subframe and decodes a corresponding PDSCH (data) in a subframe. *Park*, ¶[0180]. For example, *Park* discloses that PDCCH control signaling, such as DCI format 2C, is used to determine occupied frequency domain resources, an MCS, a HARQ process number, an RV, an NDI, and (a) transmitting antenna port(s) of the second radio signal. *Park*, Fig. 14(b). Based on all these teachings, a POSITA would have understood that *Park*'s PDCCH control signaling is used to determine a time resource of the second radio signal. ~~Kakaes, ¶205; See also Lee-496, ¶[0148].~~

~~¶[0148] (describing using a control channel to indicate a time-frequency resource associated with a transmit beam for the data channel).~~

~~106.206.~~ It would have been obvious to use the PDCCH, including the DCI format 2C, in *Park* to determine the first time resource sub-pool (data region) from the first time resource pool to enable efficient data reception by the UE.-

~~Kakaes, ¶206.~~

~~(a) — A POSITA would have been motivated to use *Park*'s PDCCH, such as DCI format 2C, in *Kim*'s second signaling to determine the first time resource sub-pool~~

(a) Motivation to combine

107.207. A POSITA would have been motivated to use *Park*'s PDCCH, including DCI format 2C, in *Kim*'s second signaling to determine the first time resource sub-pool (data region) from the first time resource pool (the subframe in

which CSI-RS for the first antenna port group is transmitted). ~~Kakaes, ¶207.~~ A POSITA would have understood that the PDCCH indicating occupied frequency domain resources of the second radio signal is required for the user equipment to properly and efficiently decode the second radio signal (data) transmitted on the PDSCH because the second radio signal can be transmitted in various configurations and it would be impractical for the user equipment to blindly decode every possible configuration for the PDSCH. ~~Kakaes, ¶207.~~ A POSITA would also have been motivated to use *Park*'s PDCCH, including DCI format 2C, for *Kim*'s second signaling to comply with the LTE and LTE-Advanced (LTE-A) standards such that the user equipment can be used in the LTE and LTE-A systems. ~~Kakaes, ¶207.~~

Both *Kim* and *Park* relate to the LTE and LTE-A standards, which were the dominant telecommunication systems implemented in the United States. ~~Kakaes, ¶207; Kim, ¶¶[0005], [0009], [0052]; Park, ¶¶[0052], [0071].~~ *Park* explains that the DCI formats are used in LTE-A standards. ~~*Park, Park, ¶¶[0142]-[0143].*~~ ~~A POSITA thus would have been motivated to use *Park*'s PDCCH, such as DCI format 2C, to determine the first time resource sub-pool (data region) from the first time resource pool such that *Kim*'s user equipment can operate properly in the LTE and LTE-A systems. Kakaes, ¶207.~~

~~¶¶[0142]-[0143].~~ A POSITA thus would have ~~reasonably expected~~ been motivated to ~~succeed in using~~ *Park*'s PDCCH, such as DCI format 2C, ~~in *Kim*'s second~~

~~signaling~~ to determine the first time resource sub-pool (data region) from the first time resource pool such that *Kim*'s user equipment can operate properly in the LTE and LTE-A systems.

(b) Expectation of success

108.208. A POSITA would have expected to succeed in using *Park*'s PDCCH, such as DCI format 2C, in *Kim*'s second signaling to determine the first time

resource sub-pool. PDCCH control signaling, such as DCI format 2C, was a well-known format for transmitting control signaling in a MIMO system and was specified in the LTE-A standards years before the '527 patent. ~~Kakaes, ¶208;~~ see TS 36.212 v12.2.0 (Ex. 1016), 79-81. Both *Kim*'s and *Park*'s systems support the same underlying standards, e.g., 3GPP LTE and LTE-A standards.

~~Kakaes, ¶208.~~ *Park* teaches that *Kim*'s control information could use the PDCCH and DCI format 2C according to its known, routine function to convey control information for the user equipment to determine the first time resource sub-pool (data region) for receiving data. ~~Kakaes, ¶208;~~ See, e.g., *Park*, ¶¶[0212], [0295], [0336]. *Kim*'s control information for data reception (PDSCH) could use the PDCCH and DCI format 2C, as described in *Park*, according to its known and conventional function of conveying control information for data reception. ~~Kakaes, ¶208.~~ The fact that the same DCI format was already specified in

LTE-A standards confirms that using such control signaling to convey control information for determining the first time resource sub-pool (data region) was routine, conventional, and well-understood in the art.

~~Kakaes, ¶208.~~ Using *Park*'s PDCCH, such as DCI format 2C, to determine the first time resource sub-pool (data region) would result in the ordinary and expected operation of receiving control information in the PDCCH and determining the first time resource sub-pool (data region) from the first time resource pool (the subframe in which CSI-RS for the first antenna port group is transmitted). ~~Kakaes,~~

¶208.

- e. [2e:] “the second signaling is used to determine at least one of occupied frequency domain resources, an MCS, a HARQ process number, an RV, an NDI and (a) transmitting antenna port(s) of the second radio signal.”

209. In my opinion, Kim in combination with Park renders obvious the second signaling is used to determine at least one of occupied frequency domain resources, an MCS, a HARQ process number, an RV, an NDI and (a) transmitting antenna port(s) of the second radio signal.

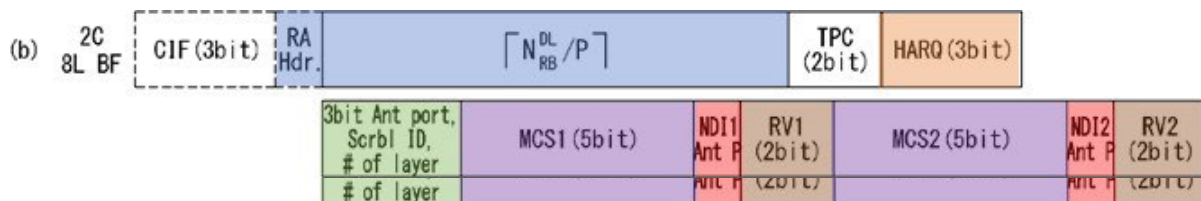
109.210. Kim discloses that the second signaling (PDCCH for data reception) is needed for data reception by the UE. Kim, ¶¶[0021], [0120], [0010]. Park renders obvious that the second signaling is used to determine ~~one of the items in the claimed list (to the extent the Board determines that is all “at least one of ... and” requires, consistent with Patent Owner’s infringement contentions (see supra claim [1g])) and also all of the items in~~ on the ~~claimed list, namely~~ of occupied frequency domain resources, an MCS, a HARQ process number, an RV, an NDI, and (a) transmitting antenna port(s) of the second radio signal (traffic data) ~~(if that is what).~~ To the extent the Board determines that only one of the items in the “at least one of ...and” term is required, Park discloses and ~~requires).~~ Kakaes, ¶210. renders obvious claim [2e] because Park discloses each of the items listed in claim [2e].

110.211. Park discloses that PDCCH control signaling, such as DCI format 2C, is used to determine at least one of occupied frequency domain

resources, an MCS, a HARQ process number, an RV, an NDI, and (a) transmitting antenna port(s) of the second radio signal. *Park* discloses that when the UE detects a PDCCH intended for the UE, the UE decodes a corresponding PDSCH (data) in a subframe. *Park*,

¶[0180]. *Park's Figure*

Park, ¶[0106]. *Park*, Fig. 14(b)), shows that the PDCCH in DCI format 2C indicates occupied frequency domain resources (**blue**), an MCS (**purple**), a HARQ process number (**orange**), an RV (**brown**), an NDI (**red**), and a transmitting antenna port (**green**).



Park, Fig. 14(b); *see* (annotated). *See also* *Park*, ¶[0073], [0209], [0336].

212. The DCI format 2C shown in Figure 14(b) of *Park* conforms to the DCI format 2C in LTE standards that was specified years before the '527 patent was filed. *See* TS 36.212 v12.2.0 (Ex. 1016), 79-80. Consistent with the LTE standards, the field “RA Hdr.” in Figure 14(b) of *Park* is a resource allocation header indicating the type of resource allocation. For example, in LTE, resource allocation type 0 divides resource blocks into multiple groups and allocates resources to a UE based on the resource block groups. By contrast, in LTE, resource allocation type 1 allows resource allocation on the level of an individual resource block. The field “ N_{RB}^{DL}/P ” in Figure 14(b) of *Park* indicates the frequency resource allocation to the UE, i.e., the frequency block(s) allocated to the UE for data reception (e.g., PDSCH). *See also* TS 36.212 v12.2.0 (Ex. 1016),

79-80.

213. Consistent with the LTE standards, the field “HARQ” in Figure 14(b) of *Park* indicates the HARQ process number of the corresponding data (e.g. PDSCH), which is used to track the multiple HARQ processes between the base station and UE. See also TS 36.212 v12.2.0 (Ex. 1016), 79-80.

214. Consistent with the LTE standards, the fields “MCS1” and “MCS2” in Figure 14(b) of *Park* indicate a modulation and coding scheme (MSC) for transport block 1 and transport block 2, respectively. See also TS 36.212 v12.2.0 (Ex. 1016), 79-80.

215. Consistent with the LTE standards, the fields “RV1” and “RV2” in Figure 14(b) of *Park* indicate a redundancy version (RV) for transport block 1 and transport block 2, respectively. The redundancy version notifies the UE the amount of redundancy added into the codeword for transmission of PDSCH. See also TS 36.212 v12.2.0 (Ex. 1016), 79-80.

216. Consistent with the LTE standards, the fields “NDI1” and “NDI2” in Figure 14(b) of *Park* indicate a new data indicator (NDI) for transport block 1 and transport block 2, respectively. See also TS 36.212 v12.2.0 (Ex. 1016), 79-80. The NDI bit informs the UE whether the data in the PDSCH is new or re-transmission.

217. Consistent with the LTE standards, the fields “Ant. Port Scrbl ID. # of layer” in Figure 14(b) of *Park* indicate antenna port(s), scrambling identity and

number of layers used for the PDSCH transmission. See also TS 36.212 v12.2.0 (Ex. 1016), 79-81.

411.218. Park also explains that the UE blindly decodes a PDCCH according to fields in the DCI formats and decodes the PDSCH according to the detected PDCCH. *Park*, ¶¶[0155], [0180]-[0181].

412.219. A POSITA would have understood that the information indicating occupied frequency domain resources, an MCS, a HARQ process number, an RV, an NDI, and (a) transmitting antenna port(s) of the second radio signal is required for the user equipment to properly and efficiently decode the second radio signal (data) transmitted on the PDSCH. ~~Kakaes, ¶219.~~ For the same reasons explained above in element [2d], it would have been obvious to implement *Kim*'s second signaling (PDCCH for data reception) and use it to determine information indicating occupied frequency domain resources, an MCS, a HARQ process number, an RV, an NDI, and a transmitting antenna port, as taught by *Park*, such that the second radio signal (e.g., PDSCH) can be properly decoded, and a POSITA would have had a reasonable expectation of success in doing so.

~~Kakaes, ¶219;~~ supra, Supra, §XI.B.1.d.

~~10.~~ Claim 3

2. ~~{3a}:~~ “The method of claim 2, comprising: monitoring the second signaling in a second time resource pool, wherein the second signaling occupies one time resource block in the second time resource pool at most; and the second time resource pool includes a positive integer number of time resource block(s); or” monitoring the second signaling in a second time resource pool and monitoring the first signaling in a third time resource pool, wherein the second signaling occupies one time resource block in the second time resource pool at most; the second time resource pool includes a positive integer number of time resource block(s); the first signaling is a dynamic signaling; the first signaling occupies one time resource block in the third time resource pool at most; the third time resource pool includes a positive integer number of time resource block(s); a minimum time interval between time resource blocks in the third time resource pool is greater than a minimum time interval between time resource blocks in the second time resource pool.”

220. For the reasons discussed above, the combination of *Kim*, *Zhang*, and *Park*, or the combination of *Kim*, *Zhang*, *Kang*, and *Park* ~~render~~renders obvious claim 2. ~~*Supra*, §VI.B.2.~~In my opinion, the combination of *Kim*, *Zhang*, and *Park* or the combination of *Kim*, *Zhang*, *Kang*, and *Park* renders obvious claim 3.

221. Claim 3 recites two alternative options separated by “or.” A POSITA would have understood that satisfying any one of these two options satisfies the requirements of claim 3, which I understand is consistent with legal standards.

~~113-222.~~ 222. *Park* discloses monitoring the second signaling (PDCCH for data reception) in a second time resource pool (a first slot in a subframe),

wherein the second signaling occupies one time resource block (one to three OFDM symbols)

in the second time resource pool at most; and the second time resource pool

includes a positive integer number of time resource block(s). ~~Kakaes,~~

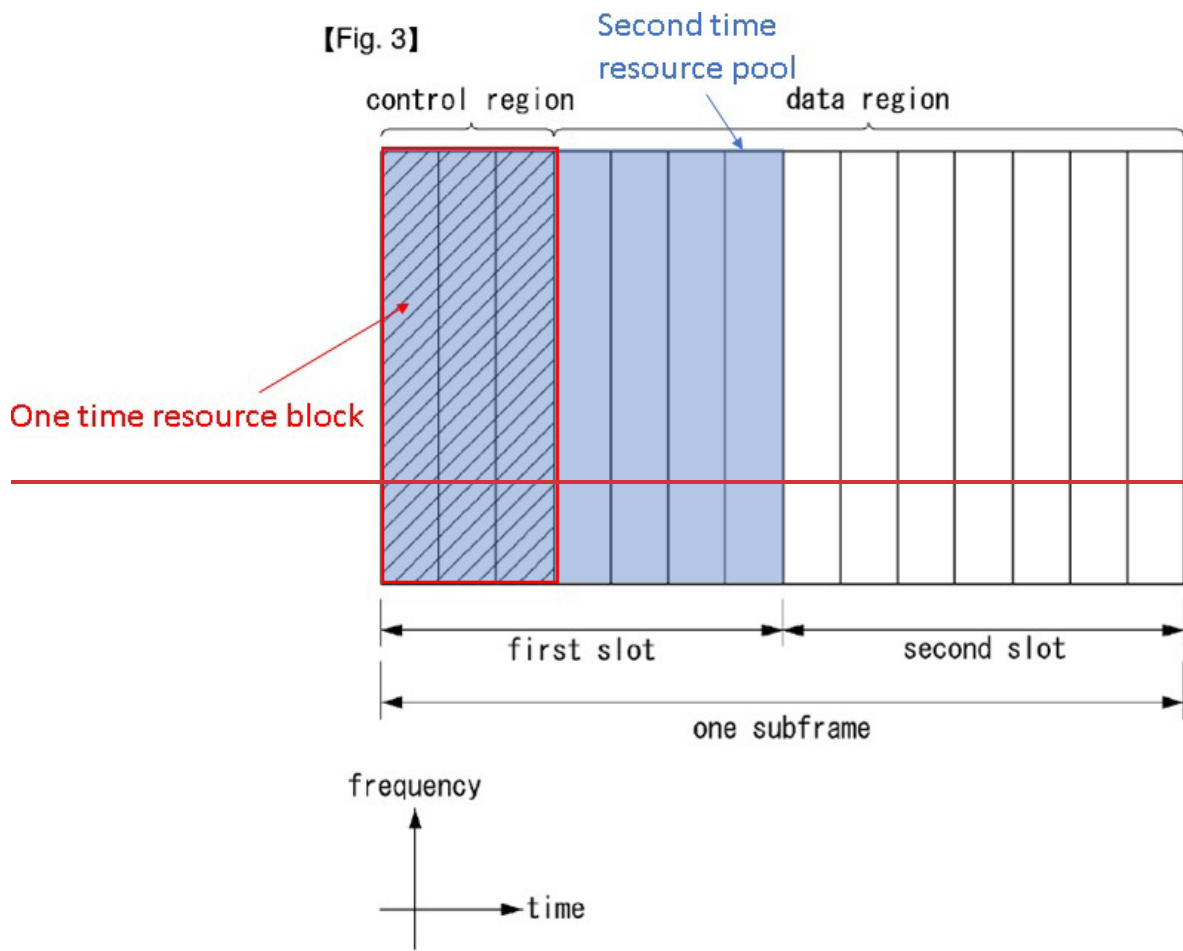
~~¶222.~~

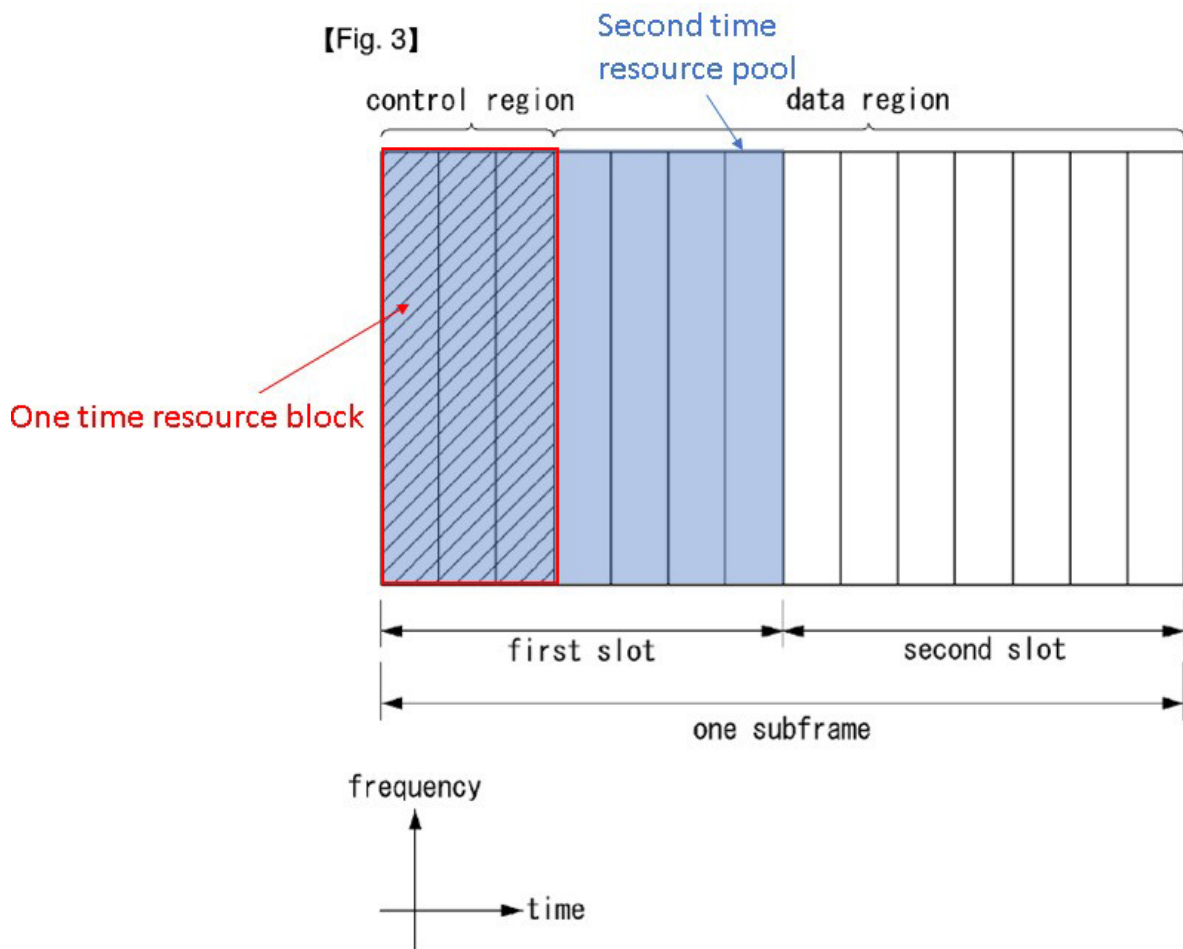
For example, *Park* discloses monitoring a PDCCH control signaling, such as DCI format 2C, in a first slot of a subframe, where each subframe consists of two slots in a time domain.

Park, ¶¶[0056], [0073], [0153]. *Park* further discloses that the PDCCH control signaling occupies a maximum of three OFDM symbols (one time resource block) in a front portion of a first slot of a subframe, corresponding to a control region.

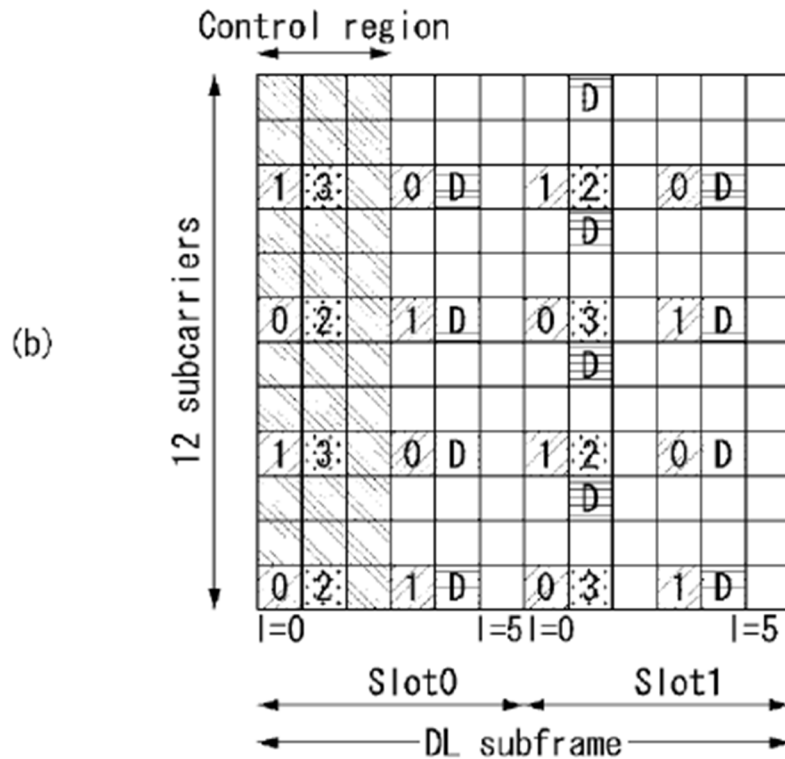
Park, ¶[0071]. *Park* further discloses that the second time resource pool (a first slot in a subframe) includes seven OFDM symbols ~~(and thus two time resource blocks).~~ *Park*, ¶[0067], Fig. 2; ~~see *Genentech, Inc. v. Chiron Corp.*, 112 F.3d 495, 501 (Fed. Cir. 1997) (“[c]omprising” means that the named elements are essential, but other elements may be added within the scope of the claim).~~ 2.

114.223. *Park* also discloses that a slot (second time resource pool) consists of six OFDM symbols in the case of an extended cyclic prefix ~~and thus two time resource blocks).~~ *Park*, ¶[0106], Fig. 5(b). Thus, *Park* discloses that the second time resource pool includes ~~two~~ 2 (a positive integer) time resource blocks, each time resource block being three OFDM symbols as shown below. ~~Kakaes, ¶223.~~





Park, Fig. 3- (annotated).



Park, Fig. 5(b).

115.224. Alternatively, *Park* discloses that the PDCCH control signaling occupies a maximum of three OFDM symbols corresponding to a control region, and a POSITA would have understood that in LTE systems, the control region can occupy only one symbol. ~~Kakaes, ¶224; see~~ See 3GPP TS 36.211 v8.9.0 (Ex. 1023), 57, Table 6.7-1 (showing that the number of OFDM symbols for PDCCH can be configured as one symbol); ~~Ex. 1030.~~ Thus, *Park*'s control region can be configured to consist of only one OFDM symbol (time resource block) at most, and the second time resource pool includes 7 time resource blocks, each time resource block being one OFDM symbol.

~~and the second time resource pool includes seven time resource blocks, each time resource block being one OFDM symbol. Kakaes, ¶224.~~

~~116.225.~~ For the same reasons explained above in limitation [2e], it would have been obvious to use *Park*'s PDCCH control signaling format for *Kim*'s second signaling. *Supra*, §~~VI~~XI.B.21.e; ~~Kakaes, ¶225.~~ In addition, a POSITA would have been motivated to use *Park*'s PDCCH control signaling format for *Kim*'s second signaling such that the UE monitors the second signaling only during the control region (e.g., first OFDM symbol) in the second time resource pool, thereby simplifying the blind decoding by the UE for PDCCH control signal and saving the UE power for the processing. ~~Kakaes, ¶225.~~ A POSITA would have understood that using at most one OFDM symbol (i.e., the first OFDM symbol in the subframe) for the second signaling (PDCCH) would leave more resources for data transmission to UEs, increasing the data throughput for UEs. A POSITA would have also understood that using at most one OFDM symbol for the second signaling (PDCCH) would reduce the amount of blind decoding the UE needs to perform to detect a PDCCH, thereby saving the UE's battery power. A POSITA would have reasonably expected to succeed in using *Park*'s PDCCH control signaling format for *Kim*'s second signaling because the control channel structure as shown in ~~*Park*'s Figure~~*Park*, Fig. 3 was adopted in the LTE and LTE-A standards and widely implemented in LTE and LTE-A systems before the '527 patent. *Park*,

¶[0052]; *Kim*, ¶[0009]-[0010], Fig. 1; *Kang*, ¶[0059], Fig. 3.

~~Fig. 1; Kang, ¶[0059], Fig. 3; Kakaes, ¶225.~~

~~a. — [3b]: “monitoring”~~

~~Claim 3 includes an “or” between [3a] and [3b], so only one of the two limitations must be taught to satisfy claim 3. *Brown*, 265 F.3d at 1351.~~

3. Claim 7

226. In my opinion, the combination of Kim, Zhang, and Park or the combination of Kim, Zhang, Kang, and Park renders obvious claim 7.

- a. ~~[7a]:~~ “The method of claim 6, further comprising: transmitting a second signaling; and”

For the reasons discussed above, the combination of Kim and Zhang, or the combination of Kim, Zhang, and Kang render renders obvious claim 6. Supra,

~~117.227.~~ §VI.A.7. Kim discloses [7a] as discussed in [2a]. Kim discloses the base station transmitting a second signaling. Kim, ¶¶[[0021], [0120], [0091]; Kakaes, ¶227; supra, §VI XI.B.21.a.

- b. ~~[7b]:~~ “performing a second radio signal in a first time resource sub-pool;”

~~118.228.~~ Kim discloses [7b] as discussed in [2b]. Kim discloses the base station performing a second radio signal (e.g., PDSCH) in a first time resource sub-pool (data region in a subframe); Kim, ¶[0010], Fig. 1; Kakaes, ¶228; supra, §VI.B.2.b197.

- c. ~~[7c]:~~ “wherein the performing is transmitting to the target receiver, or the performing is receiving from the target receiver;”

229. Kim discloses [7c] as discussed in [2c]. Kim discloses the performing is transmitting to the target receiver (user equipment). Kim, ¶¶[[0010], [0091]; Kakaes, ¶229; supra, §VI XI.B.21.c.

- d. [7d]: “the second signaling is used to determine the first time resource sub-pool from the first time resource pool;”

~~119.230.~~ ~~As discussed above for [2d], Kim in view of combination with~~

~~Park renders this limitation obvious.~~ claim [7d] as discussed in [2d]. Supra,

~~§ VI XI.B.21.d; Kakaes, ¶230.~~

- e. [7e]: “the second signaling is used to determine at least one of occupied frequency domain resources, an MCS, a HARQ process number, an RV, an NDI and (a) transmitting antenna port(s) of the second radio signal.”

~~120.231.~~ ~~As Park renders obvious [7e] as discussed above for [2e], Park renders this limitation obvious.] Supra,~~

~~§ VI XI.B.21.e; Kakaes, ¶231.~~

~~11.~~—Claim 8

4. ~~[8a]:~~ “The method of claim 7, comprising: transmitting the second signaling in a second time resource pool, wherein the second signaling occupies one time resource block in the second time resource pool at most; and the second time resource pool includes a positive integer number of time resource block(s); or” transmitting the second signaling in a second time resource pool and transmitting the first signaling in a third time resource pool, wherein the second signaling occupies one time resource block in the second time resource pool at most; the second time resource pool includes a positive integer number of time resource block(s); the first signaling is a dynamic signaling; the first signaling occupies one time resource block in the third time resource pool at most; the third time resource pool includes a positive integer number of time resource block(s); a minimum time interval between time resource blocks in the third time resource pool is greater than a minimum time

interval between time resource blocks in the second time resource pool.”

121-232. For the reasons discussed above, the combination of *Kim, Zhang,*
and

Park, or the combination of *Kim, Zhang, Kang, and Park* ~~render~~ and renders obvious claim 7.

~~Supra, §VI.B.4. As discussed above for [3a], Park renders this limitation obvious.~~
~~Supra, §VI.B.3.a; Kakaes, ¶232 the additional limitations of claim 8, for the~~
~~reasons discussed in claim 3. Supra § XI.B.2.~~

~~a. — [8b]: “transmitting”~~

~~Claim 8 includes an “or” between [8a] and [8b], so only one of the two~~
~~limitations must be taught to satisfy claim 8. Brown, 265 F.3d at 1351.~~

5. Claim 12

~~233. In my opinion, the combination of Kim, Zhang, and Park or the~~
~~combination of Kim, Zhang, Kang, and Park renders obvious claim 12.~~

~~a. [12a]: “The UE of claim 11, comprising: a third~~
~~receiver, receiving a second signaling; and”~~

~~For the reasons discussed above, the combination of Kim and Zhang, or the~~
~~combination of Kim, Zhang, and Kang renderrenders obvious claim 11. Supra,~~
~~§VI.A.10. As discussed above Kim discloses [12a] for the reasons discussed in [2a],~~
~~Kim’s user equipment receives a second~~

~~122.234.~~ signaling.]. *Supra*, §VI § XI.B.21.a; ~~Kakaes, ¶234.~~ *Kim* discloses that the user equipment includes multiple receivers for receiving signals from the base station. *Kim*, ¶¶[0021], [0132]. *Kim* further discloses a massive MIMO system where the user equipment is equipped with multiple reception antennas. *Kim*, ¶¶[0049]-[0051]; ~~Kakaes, ¶234.~~ It would have been obvious to implement in *Kim*'s user equipment multiple antennas (e.g., ~~four~~4 antennas) and multiple receivers (e.g., ~~four~~4 receivers) connected to the antennas, each antenna being connected to a receiver to convert the radio signal received from the antenna to a baseband signal for further MIMO processing. ~~Kakaes, ¶234; see~~See also Luo-330, ¶[0037], (providing multiple antennas and receivers where a respective receiver is connected to each antenna), Fig. 2; (showing receivers 254a and 254r, each connected to antennas 252a and 252r for receiving respective signals); Vitthaladevuni, ¶[0120] (providing multiple antennas ~~¶[0120], Fig. 10; Hu, ¶¶[0059], [0142]-[0143], Figs. 3, 12. A POSITA would have~~

and receivers where a respective receiver is connected to each antenna), Fig. 10 (showing receivers 1062a and 1062r, each connected to antennas 1061a and 1061r for receiving respective signals); Hu, ¶¶[0059], [0142]-[0143] (providing multiple antennas and transceivers where a respective transceiver is connected to each antenna), Figs. 3, 12 (showing transceivers 1554A and 1554R, each connected to antennas 1522A and 1522R for receiving respective signals). A POSITA would have understood that the increased number of antennas in the UE enhances the signal quality and data rate received at the UE. ~~Kakaes, ¶234.~~ Such arrangement was a conventional and commonly adopted architecture in a MIMO system, allowing for efficient processing of radio signals received from multiple antennas and individual control of the antennas; Implementing in Kim's user equipment a third receiver connected to a third antenna to receive signals would have been straightforward and asimple for a POSITA, as described by Luo-330, Vitthaladevuni, and Hu. A POSITA would have had a reasonable expectation of success in implementing in Kim's user equipment a third receiver.~~Kakaes, ¶234.~~ to receive signals. Therefore, it would have been obvious to implement in Kim's user equipment a third receiver connected to a third antenna, where the third receiver is configured to receive signals, including a second signaling (PDCCH for data reception), transmitted from the base station.~~Kakaes, ¶234.~~

b. [12b]: “a second transceiver, operating a second radio signal in a first time resource sub-pool;”

123-235. ~~As~~ *Kim* discloses [12b] as discussed ~~above for~~ in [2b₁]. *Kim*’s user equipment operates a second radio signal (e.g., PDSCH) in a first time resource sub-pool (data region in a subframe). *Supra*, § ~~VI.B.2.b; Kakaes, ¶235-197~~. It would have been obvious to implement in *Kim*’s user equipment a second transceiver for operating the second radio signal. ~~Kakaes, ¶235~~. *Kim* discloses that the UE receives data from a base station, as well as transmitting information to a base station in an uplink transmission. *Kim*, ¶¶[0006], [0010], [0097]. It would have been obvious to implement in *Kim*’s user equipment a second transceiver for receiving data from and transmitting data to the base station. ~~Kakaes, ¶235~~. A transceiver, i.e., a combination of transmitter and receiver in a single module, was routinely implemented in user equipments (e.g., mobile phones and tablets) for wireless communication and provides benefits such as space saving and cost saving in the mobile devices. ~~Kakaes, ¶235; see, e.g., Hu, ¶[0142] (describing having transceivers (XCVR) in the access terminal 1550); Olsson, ¶¶[0046]-[0047] (describing a transceiver circuitry in a user equipment); Vitthaladevuni, ¶[0160] (the transmitter and receiver “may be collectively referred to as a transceiver”).~~

124-236. ~~¶[0142]; Olsson, ¶¶[0046]-[0047]; Vitthaladevuni, ¶[0160]~~. Further, it would have been obvious to implement in *Kim*’s user equipment multiple antennas (e.g., ~~four~~4 antennas) and multiple transceivers (e.g., ~~four~~4 transceivers)

connected to the antennas, each antenna being connected to a transceiver to convert the radio signal received from the antenna to a baseband signal for further ~~MIMO processing.~~

signal for further MIMO processing. ~~Kakaes, ¶236; see also Luo-330, ¶[0037], Fig. 2;~~
~~Vitthaladevuni, ¶[0120], Fig. 10;~~

Hu, ¶¶ [0142]-[0143], Fig. 12. See also Luo-330, ¶[0037] (providing multiple antennas and receivers where a respective receiver is connected to each antenna), Fig. 2 (showing receivers 254a and 254r, each connected to antennas 252a and 252r for receiving respective signals); Vitthaladevuni, ¶[0120] (providing multiple antennas and receivers where a respective receiver is connected to each antenna), Fig. 10 (showing receivers 1062a and 1062r, each connected to antennas 1061a and 1061r for receiving respective signals); Hu, ¶¶ [0142]-[0143] (providing multiple antennas and transceivers where a respective transceiver is connected to each antenna), Fig. 12 (showing transceivers 1554A and 1554R, each connected to antennas 1522A and 1522R for receiving respective signals). A POSITA would have understood that the increased number of antennas in the UE enhances the signal quality and data rate received at the UE. ~~Kakaes, ¶236.~~ Such arrangement was a conventional and commonly adopted architecture in a MIMO system, allowing for efficient processing of radio signals received from multiple antennas and individual control of the antennas~~;~~. Implementing in Kim's user equipment a second transceiver to transmit and receive signals would have been straightforward and simple for a POSITA, as described by Luo-330, Vitthaladevuni, and Hu. A POSITA would have had a reasonable expectation of success in implementing in Kim's user equipment a second transceiver. ~~Kakaes, to transmit and receive signals.~~

~~¶236.~~ Therefore, it would have been obvious to implement in *Kim*'s user equipment a

second transceiver operating a second radio signal received in a first time resource sub-pool. ~~Kakaes, ¶236.~~

- c. [12c]: “wherein the operating is receiving from the base station, or the operating is transmitting to the base station;”

237. ~~As discussed above for [2e],~~ Kim discloses this limitation as discussed above for [2c]. *Supra*, ~~§VI~~

§XI.B.21.c; ~~Kakaes, ¶237.~~

- d. [12d]: “the second signaling is used to determine the first time resource sub-pool from the first time resource pool; and”

125-238. ~~As discussed above for [2d],~~ Kim in ~~view of~~ combination with

Park renders this limitation obvious as discussed above for [2d]. *Supra*,

~~§VI~~XI.B.21.d; ~~Kakaes, ¶238.~~

- e. [12e]: “the second signaling is used to determine at least one of occupied frequency domain resources, a MCS, a HARQ process number, a RV, a NDI and (a) transmitting antenna port(s) of the second radio signal.”

239. ~~As discussed above for [2e],~~ *Park* renders this limitation obvious as discussed above for [2e].

Supra, §XI.B.1.e.

§VI.B.2.e; Kakaes, ¶239.

12.—Claim 13

6. ~~[13a]::~~ “The UE of claim 12, the third receiver further monitors the second signaling in a second time resource pool, wherein the second signaling occupies one time resource block in the second time resource pool at most; the second time resource pool includes a positive integer number of time resource block(s); or²² the third receiver further monitors the second signaling in a second time resource pool, and the second receiver further monitors the first signaling in a third time resource pool, wherein the second signaling occupies one time resource block in the second time resource pool at most; the second time resource pool includes a positive integer number of time resource block(s); the first signaling is a dynamic signaling; the first signaling occupies one time resource block in the third time resource pool at most; the third time resource pool includes a positive integer number of time resource block(s); a minimum time interval between time resource blocks in the third time resource pool is greater than a minimum time interval between time resource blocks in the second time resource pool.”

For the reasons discussed above, the combination of Kim, Zhang, and Park, or the combination of Kim, Zhang, Kang, and Park ~~render~~renders obvious claim 12. Supra, §VI.B.6. As ~~discussed above for [3a],~~ Park renders ~~this limitation~~ obvious. Supra, §VI.B.3.a; Kakaes, ¶240.

a.—[13b]: “the third receiver”

126.240. Claim 13 includes an “or” between [13a] and [13b], so only one of the ~~two~~additional limitations must be taught to satisfy claim 13. Brown, 265 F.3d at 1351, for the reasons discussed in claim 3. Supra § XI.B.2.

7. Claim 17

241. In my opinion, the combination of *Kim, Zhang, and Park* or the combination of *Kim, Zhang, Kang, and Park* renders obvious claim 17.

- a. **[17a]: “The base station equipment of claim 16, further comprising: a third transmitter, transmitting a second signaling; and”**

For the reasons discussed above, the combination of Kim and Zhang, or the combination of Kim, Zhang, and Kang renders obvious claim 16. Supra,

242. §VI.A.13. As Kim discloses [17a] as discussed above for in claim [2a], Kim’s] and [7a]. Kim discloses the base station equipment transmits transmitting a second signaling. Supra, §VI Kim, ¶¶[0021], [0120], [0091]; supra, § XI.B.21.a; Kakaes, ¶242.

127.243. Kim discloses that the base station equipment includes multiple transmitters for transmitting signals to the user equipment. Kim, ¶¶[0020], [0130]. Kim further discloses a massive MIMO system where the base station is equipped with multiple transmission antennas. Kim, ¶¶[0049]-[0051]. It would have been obvious to implement in Kim’s base station multiple transmitters (e.g., four transmitters) connected to the antennas (e.g., four antennas), each antenna being connected to a transmitter to convert a baseband signal to a radio signal for transmission from the antenna. Kakaes, ¶243; see See also Luo-330, ¶¶[0035]-[0036], Fig. 2; Vitthaladevuni, ¶¶[0118]-[0119], Fig. 10; Hu, ¶¶[0140]-[0141], Fig. 12; Wong, ¶¶[0140]-[0141], Fig. 12; Wong, ¶¶[0077]-[0080], Fig. 3. A POSITA would have understood that the increased number of antennas in the base station enhances the signal quality and data rate received at the UEs in the cell. Kakaes, ¶243. Such

arrangement was a conventional and commonly adopted architecture in a MIMO system, allowing for simplified processing of radio signals for transmission on multiple antennas and individual ~~power control of the antennas, and a POSITA~~ would have had a reasonable expectation of success in implementing in *Kim's* base station a third transmitter. ~~Kakaes, ¶243. Therefore, it would have been obvious to implement in *Kim's* base station a third transmitter connected to a third antenna, where the third transmitter is configured to transmit signals, including a second signaling, to the user equipment via the third antenna. Kakaes, ¶243.~~

power control of the antennas. Implementing in *Kim*'s base station a third transmitter connected to a third antenna to transmit signals would have been straightforward and simple for a POSITA, as described by *Luo-330*, *Vitthaladevuni*, *Wong*, and *Hu*. A POSITA would have had a reasonable expectation of success in implementing in *Kim*'s base station a third transmitter to transmit signals. Therefore, it would have been obvious to implement in *Kim*'s base station a third transmitter connected to a third antenna, where the third transmitter is configured to transmit signals, including a second signaling, to the user equipment via the third antenna.

b. [17b]: “a fourth transceiver, performing a second radio signal in a first time resource sub-pool;”

128-244. As discussed above for claim [2b] and [7b], *Kim*'s base station equipment performs a second radio signal in a first time resource sub-pool. *Supra*, §VI.B.2.b; *Kakaes*, ¶244§197. It would have been obvious to implement in *Kim*'s base station a fourth transceiver for performing a second radio signal in a first time resource sub-pool.

129-245. ~~*Kakaes*, ¶245.~~ *Kim* discloses that the base station transmits data to a user equipment, as well as receiving information from a user equipment in an uplink transmission. *Kim*, ¶¶[0020], [0130]. It would have been obvious to implement in *Kim*'s base station a fourth transceiver for transmitting data to and receiving data from the user equipment. ~~*Kakaes*, ¶245.~~ A transceiver, i.e., a

combination of transmitter and receiver in a single module, was routinely implemented in base station equipments for wireless

communication and provides benefits such as space saving and cost saving. ~~Kakaes, ¶245; Hu,~~

¶[0140]; Wong, ¶¶[0077]-[0080], Fig. 3; Vitthaladevuni, ¶[0154]. Further, it would have been obvious to implement in Kim's base station multiple transceivers (e.g., ~~four~~⁴ transceivers) connected to the multiple antennas (e.g., ~~four~~⁴ antennas), each antenna being connected to a transceiver to convert the baseband signal to a radio signal for transmission from the antenna. ~~Kakaes, ¶245; Luo-330, ¶¶[0035]-[0036], Fig. 2; Vitthaladevuni,~~

¶¶[0118]-[0119], Fig. 10; Hu, ¶¶[0140]-[0141], Fig. 12; Wong, ¶¶[0077]-[0080], Fig. 3. A POSITA would have understood that the increased number of antennas in the base station enhances the signal quality and data rate received at the UEs in the cell. ~~Kakaes, ¶245.~~ Such arrangement was a conventional and commonly adopted architecture in a MIMO system, allowing for simplified processing of radio signals for transmission on multiple antennas and individual power control of the antennas, ~~and a POSITA would have had a reasonable expectation of success in implementing in Kim's base station a fourth transceiver. Kakaes, ¶245. Therefore, it would have been obvious to implement in Kim's base station a fourth transceiver connected to a fourth antenna, where the fourth transceiver is configured to perform a second radio signal in a first-time resource sub-pool. Kakaes, ¶245.~~
Implementing in Kim's base station a fourth transceiver connected to a fourth antenna to transmit and receive signals would have been straightforward and

simple for a POSITA, as described by Luo-330, Vitthaladevuni, Wong, and Hu. A POSITA would have had a reasonable expectation of success in implementing in Kim's base station a fourth transceiver to transmit and receive signals. Therefore, it would have been obvious to implement in Kim's base station a fourth transceiver connected to a fourth antenna, where the fourth transceiver is configured to perform a second radio signal in a first time resource sub-pool.

- c. [17c]: “wherein the performing is transmitting, or the performing is receiving;”

246. *Kim* discloses the performing is transmitting to the target receiver

(user equipment), as discussed in claim [2c] and [7c]. *Kim*, ¶¶[0010], [0091];

~~Kakaes, ¶246; *supra*, §VI~~

~~§§XI.B.21.c., XI.B.3.c.~~

- d. [17d]: “the second signaling is used to determine the first time resource sub-pool from the first time resource pool;”

130.247. ~~As discussed above for [2d],~~ *Kim* in ~~view of~~ combination with

Park renders ~~this limitation obvious;~~ claim [17d] as discussed in [2d]. *Supra*,

~~§VI XI.B.21.d.; Kakaes, ¶247.~~

- e. [17e]: “the second signaling is used to determine at least one of occupied frequency domain resources, a MCS, a HARQ process number, a RV, a NDI and (a) transmitting antenna port(s) of the second radio signal.”

131.248. ~~As~~ *Park* renders obvious [7e] as discussed above for [2e], ~~*Park* renders this limitation obvious.~~ *Supra*,

~~§VI XI.B.21.e.; Kakaes, ¶248.~~

13.—Claim 18

8. ~~[18a]:~~ “The base station equipment of claim 17, wherein: the third transmitter further transmits the second signaling in a second time resource pool, wherein the second signaling occupies one time resource block in the second time resource pool at most; and the second time resource pool includes a positive integer number of time resource block(s); or” the third transmitter further transmits the second signaling in a second time resource pool, and the second transmitter further transmits the first signaling in a third time resource pool, wherein the second signaling occupies one time resource block in the second time resource pool at most; the second time resource pool includes a positive integer number of time resource block(s); the first signaling is a dynamic signaling; the first signaling occupies one time resource block in the third time resource pool at most; the third time resource pool includes a positive integer number of time resource block(s); a minimum time interval between time resource blocks in the third time resource pool is greater than a minimum time interval between time resource blocks in the second time resource pool.”

For the reasons discussed above, the combination of Kim, Zhang, and Park, or

the combination of Kim, Zhang, Kang, and Park ~~render renders~~ obvious claim 17.

~~Supra, §VI.B.8. As discussed above for [3a], Park renders this limitation~~

~~obvious. Supra, §VI.B.3.a; Kakaes, ¶249.~~

a.—[18b]: “the third transmitter”

~~Claim 18 includes an “or” between [18a] and [18b], so only one of the two the additional limitations must be taught to satisfy of claim 18. Brown, 265 F.3d at 1351.~~

III.—DISCRETIONARY DENIAL IS NOT WARRANTED

A.—Denial of Institution Is Not Warranted Under *Fintiv*

~~*Fintiv* and the Office’s interim guidelines dated June 21, 2022 (“Interim~~

Procedures”) require institution. Factor 6 requires institution because Petitioner

~~presents a compelling unpatentability challenge; Factors 3 and 4 favor institution; and Factors 1, 2, and 5 are, at worst, neutral.~~

~~132.249. Factor 3 favors institution because Petitioner acted diligently and almost no parallel investment has occurred. Patent Owner served infringement contentions only last month. Ex. 1026. Fact discovery opened only this month, and will not close until February 2024, with expert discovery closing March 2024. Ex. 1025, 3. The parties will not begin, for the reasons discussed in claim construction until August 2023 and the hearing will not take place until December 2023. Ex. 1025, 4, 53. Supra § XI.B.2.~~

~~Factor 4 favors institution because this Petition challenges claims 6-10 and 16-20, which are not involved in the litigation. Moreover, Petitioner has not served invalidity contentions, so no overlap currently exists. Petitioner reserves the right to submit a stipulation after serving invalidity contentions.~~

~~Regarding Factors 1, 2, and 5, Patent Owner filed its Complaint against Petitioner on June 1, 2022. Ex. 1024. No stay has been requested, trial is currently scheduled for June 24, 2024, and the median time to trial in the Eastern District of Texas is 24.5 months, so trial is projected to occur, at the earliest, in June or July 2024. Ex. 1025, 1; Ex. 1027, 35. An FWD is anticipated in August 2024, about one month after trial ends. In these circumstances, Factors 1, 2, and 5 are at worst neutral. *Protect Animals with Satellites v. OnPoint Sys., LLC*, IPR2021-01483, Paper 11 at 12-13, 17 (Mar. 4, 2022). Indeed, the Board has instituted with far~~

~~more time between trial and FWD. See *NetNut Ltd. v. Bright Data Ltd.*, IPR2021-01492, Paper 12 at 9-16 (Mar. 21, 2022) (instituting IPR without stipulation and copending trial date six months before FWD); *Protect Animals*, IPR2021-01483, Paper 11 at 18 (instituting IPR without stipulation and copending trial date one month before FWD); Interim Procedures, 8.~~

~~Denial of institution is not warranted under *Fintiv*.~~

~~**B. — Denial of Institution Is Not Warranted Under § 325(d)**~~

~~No other proceedings involving the '527 patent are currently pending or have been brought before the Patent Office. Additionally, none of the asserted prior art references were before the Examiner during prosecution. Thus, denial of institution is not warranted under § 325(d).~~

~~**IV. — MANDATORY NOTICES**~~

~~**A. — Real Party in Interest**~~

~~The real parties in interest are Samsung Electronics Co., Ltd., and Samsung Electronics America, Inc.~~

~~**B. — Related Matters**~~

~~Apex asserted the '527 patent in the following litigations: *Apex Beam Technologies LLC v. Samsung Electronics Co., Ltd. et al.*, Case No. 2:22-cv-00188-JRG (E.D. Tex.); *Apex Beam Technologies LLC v. ZTE Corporation*, Case No. 2:22-cv-00031-JRG-RSP (E.D. Tex.); *Apex Beam Technologies LLC v.*~~

~~OnePlus Technology (Shenzhen) Co., Ltd., Case No. 2:22-cv-00032-JRG (E.D. Tex.); and Apex Beam Technologies LLC v. TCT Mobile International Limited et al., Case No. 2:21-cv-00438-JRG (E.D. Tex.).~~

~~The '527 patent is related to U.S. Patent No. 11,546,110 and pending U.S. Patent Application No. 18/089,999.~~

~~C. — Lead and Backup Counsel, and Service Information~~

~~Lead Counsel~~	~~Backup Counsel~~
~~Joshua L. Goldberg, Reg. No. 59,369 joshua.goldberg@finnegan.com Finnegan, Henderson, Farabow, Garrett & Dunner, LLP 901 New York Avenue, NW Washington, DC 20001 Phone: 202-408-4000 Fax: 202-408-4400~~	~~Yi Yu, Reg. No. 69,397 yi.yu@finnegan.com Finnegan, Henderson, Farabow, Garrett & Dunner, LLP 1875 Explorer Street, Suite 800 Reston, VA 20190-6023 Phone: 571-203-2700 Fax: 202-408-4400~~ ~~Kevin D. Rodkey, Reg. No. 65,506 Kevin.rodkey@finnegan.com Finnegan, Henderson, Farabow, Garrett & Dunner, LLP 271 17th Street NW Suite 1400 Atlanta, GA 30363 Phone: 404-653-6400 Fax: 404-653-6444~~

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~~Please address all correspondence to counsel at the address above. Petitioner consents to electronic service by email at the above email addresses.~~

~~V. — GROUNDS FOR STANDING~~

~~Petitioner certifies that the '527 patent is available for IPR and that Petitioner is not barred or estopped from requesting IPR challenging the patent claims on the grounds identified herein.~~

V.XII. CONCLUSION

~~Petitioner requests institution and cancellation of each challenged claim.~~

~~Dated: February 28, 2023~~ ~~By: /Joshua L. Goldberg/~~
~~Joshua L. Goldberg, Lead Counsel~~
~~Reg. No. 59,369~~

~~CERTIFICATION OF WORD COUNT~~

~~Pursuant to 37 C.F.R. § 42.24, Petitioner certifies that the word count of
Petitioner's Petition for *Inter Partes* Review (exclusive of any table of contents,
table of authorities, mandatory notices under § 42.8, certificates of service and
word count, and list of exhibits or claim listing) as measured by Microsoft Word is
13,998.~~

~~Dated: February 28, 2023~~ By: /Joshua L. Goldberg/
Joshua L. Goldberg, Lead Counsel
Reg. No. 59,369

CERTIFICATE OF SERVICE

Pursuant to 37 C.F.R. §§ 42.6(e) and 42.105(a), the undersigned certifies that on February 28, 2023, a copy of the foregoing Petition for *Inter Partes* Review, the associated powers of attorney, and Exhibits 1001-1030 were served by FedEx Priority Overnight on the correspondence address of record indicated in the Patent Office's Patent Center website for U.S. Patent No. 10,944,527:

Jialin Zhong
Zhong Law, LLC
51 JFK Parkway
1st Floor West
Short Hills, NJ 07078

A courtesy copy of the foregoing was also served by FedEx Priority Overnight on the address listed on the same law firm's website (<https://zhong-law.com/>):

Jialin Zhong
Zhong Law, LLC
100 Connell Drive
Suite 2300
Berkeley Heights, NJ 07922

250. For the reasons set forth in Section XI, it is my opinion that one skilled in the art would have found claims 1-20 of the '527 patent obvious.

251. In signing this declaration, I understand that the declaration will be filed as evidence in a contested case before the Patent Trial and Appeal Board of

the United States Patent and Trademark Office. I acknowledge that I may be subject to cross-examination in this case and that cross-examination will take place within the United States. If cross-examination is required of me, I will appear for cross-examination within the United States during the time allotted for cross-examination.

252. I declare that all statements made herein of my knowledge are true, and that all statements made on information and belief are believed to be true, and that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code.

Date: February 28, 2023
submitted,

GARRETT & DUNNER, LLP

By: ~~/William Esper/~~ Respectfully

~~William Esper~~
~~Case Manager and PTAB Coordinator~~
~~FINNEGAN, HENDERSON, FARABOW,~~

/Apostolos K. Kakaes/
Apostolos K. Kakaes, Ph.D.