

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. IPR2023-00571
U.S. Patent No. 10,951,271

DECLARATION OF APOSTOLOS K. KAKAES, PH.D.

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1.	Claim 1:.....	59
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 - c. [3b] “a second proportional sequence corresponds to a ratio(ratios) among the K2 channel quality values;”108
 - d. [3c] “a first receiving beamforming vector is used to receive signals transmitted through the K1 antenna port groups; a second receiving beamforming vector is used to receive signals transmitted through the K2 antenna port groups; the first receiving beamforming vector and the second receive beamforming vector are different;”109
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- 4. Claim 4: “The method according to claim 3, wherein any two antenna ports in the K1 antenna port groups are co-located or quasi-co-located (QCL), and any two antenna ports in the K2 antenna port groups are co-located or quasi-co-located (QCL); or any two antenna ports in the K1 antenna port groups are on a same carrier, and any two antenna ports in the K2 antenna port groups are on a same carrier; or the first signaling is further used to determine at least the last one of the K1, the K2 and the target threshold, a third channel quality is a best channel quality value among the K2 channel quality values, a fourth channel quality is a worse channel quality value among the K2 channel quality values, a ratio between the fourth channel quality and the third channel quality is greater than or equal to the target threshold, and the first information is further used to determine at least one of the first channel quality and the third channel quality.”113

5. Claim 5: “The method according to claim 3, further comprising: receiving a second wireless signal; wherein a target antenna port group is used to transmit the second wireless signal; the target antenna port group is associated with the K1 antenna port groups and the first proportional sequence, or the target antenna port group is associated with the K2 antenna port groups and the second proportional sequence.”116
6. Claim 6:.....119
 - a. [6Preamble] “A method for multi-antenna transmission in a base station, comprising:”119
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 - c. [6b] “transmitting, by the base station, a first wireless signal to the UE; and”.....119
 - d. [6c] “receiving, by the base station, first information from the UE;”120
 - e. [6d] [6d1] “wherein, K antenna port groups of the base station are used to transmit the first wireless signal;”120
 - f. [6d2] “the first signaling is used by the UE to determine the K antenna port groups transmitting the first wireless signal received by the UE; the K is a positive integer greater than 1;.....120
 - g. [6d3] “the K antenna port groups respectively correspond to K channel quality values; the K channel quality values are K non-negative real numbers; the K channel quality values are Reference Signal Received Powers (RSRPs) or Signal to Interference plus Noise Ratios (SINRs);”120
 - h. [6d4] “K1 antenna port groups of the K antenna port groups correspond to K1 channel quality

- values of the K channel quality values; the K1 is a positive integer less than or equal to the K;”120
- i. [6d5] “a first proportional sequence corresponds to a ratio(ratios) among the K1 channel quality values;”120
- j. [6d6] “the first information is used to determine the K1 antenna port groups and the first proportional sequence;”121
- k. [6d7] “the first signaling is used to determine a target threshold; the target threshold is a non-negative real number;”121
- l. [6d8] “a first channel quality is a best channel quality value among the K1 channel quality values; a second channel quality is a worse channel quality value among the K1 channel quality values;”121
- m. [6d9] “a ratio between the second channel quality and the first channel quality is greater than or equal to the target threshold.”121
7. Claim 7: “The method according to claim 6, wherein the K channel quality values are broadband channel quality values; or the first proportional sequence comprises K1 positive real numbers less than or equal to 1, and the first proportional sequence comprises at least one 1; or the first proportional sequence comprises quantized values corresponding to K1 positive real numbers; or the first proportional sequence comprises K1-1 positive real number(s), and the K1-1 positive real number(s) is(are) a ratio(ratios) between a channel quality value(s) other than the best channel quality value among the K1 channel quality values and the best channel quality value; or the first proportional sequence comprises quantized values corresponding to K1-1 positive real number(s).”122
8. Claim 8: [8Preamble] “The method according to claim 6, [8a] wherein K2 antenna port groups in the K antenna

port groups correspond to K2 channel quality values in the K channel quality values; the K2 is a positive integer less than or equal to the K; [8b] a second proportional sequence corresponds to a ratio(ratios) among the K2 channel quality values; [8c] a first receiving beamforming vector is used to receive signals transmitted through the K1 antenna port groups; a second receiving beamforming vector is used to receive signals transmitted through the K2 antenna port groups; the first receiving beamforming vector and the second receiving beamforming vector are different; [8d] “the first information is further used to determine the K2 antenna port groups and the second proportional sequence.”123

9. Claim 9: “The method according to claim 8, wherein any two antenna ports in the K1 antenna port groups are co-located or quasi-co-located (QCL), and any two antenna ports in the K2 antenna port groups are co-located or quasi-co-located (QCL); or any two antenna ports in the K1 antenna port groups are on a same carrier, and any two antenna ports in the K2 antenna port groups are on a same carrier; or the first signaling is further used to determine at least the last one of the K1, the K2 and the target threshold, a third channel quality is a best channel quality value among the K2 channel quality values, a fourth channel quality is a worse channel quality value among the K2 channel quality values, a ratio between the fourth channel quality and the third channel quality is greater than or equal to the target threshold, and the first information is further used to determine at least one of the first channel quality and the third channel quality.”124
10. Claim 10: “The method according to claim 8, further comprising: transmitting a second wireless signal; wherein a target antenna port group is used to transmit the second wireless signal; the target antenna port group is associated with the K1 antenna port groups and the first proportional sequence, or the target antenna port group is associated with the K2 antenna port groups and the second proportional sequence.”125

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c.	[11b] “a second receiver at the UE, receiving a first wireless signal originating from the base station; and”.....	126
d.	[11c] “a third transmitter at the UE, transmitting first information to the base station;”.....	131
e.	[11d] [11d1] “wherein, K antenna port groups of the base station are used to transmit the first wireless signal;”.....	131
f.	[11d2] “the first signaling is used by the UE to determine the K antenna port groups transmitting the first wireless signal received by the UE; the K is a positive integer greater than 1;”.....	131
g.	[11d3] “the K antenna port groups respectively correspond to K channel quality values; the K channel quality values are K non-negative real numbers; the K channel quality values are Reference Signal Received Powers (RSRPs) or Signal to Interference plus Noise Ratios (SINRs);”.....	131
h.	[11d4] “K1 antenna port groups of the K antenna port groups correspond to K1 channel quality values of the K channel quality values; the K1 is a positive integer less than or equal to the K;”.....	132
i.	[11d5] “a first proportional sequence corresponds to a ratio(ratios) among the K1 channel quality values;”.....	132

- j. [11d6] “the first information is used to determine the K1 antenna port groups and the first proportional sequence;”132
 - k. [11d7] “the first signaling is used to determine a target threshold; the target threshold is a non-negative real number;”132
 - l. [11d8] “a first channel quality is a best channel quality value among the K1 channel quality values; a second channel quality is a worse channel quality value among the K1 channel quality values;”132
 - m. [11d9] “a ratio between the second channel quality and the first channel quality is greater than or equal to the target threshold.”133
12. Claim 12: “The user equipment to claim 11, wherein the K channel quality values are broadband channel quality values; or the first proportional sequence comprises K1 positive real numbers less than or equal to 1, and the first proportional sequence comprises at least one 1; or the first proportional sequence comprises quantized values corresponding to K1 positive real numbers; or the first proportional sequence comprises K1-1 positive real number(s), and the K1-1 positive real number(s) is(are) a ratio(ratios) between a channel quality value(s) other than the best channel quality value among the K1 channel quality values and the best channel quality value; or the first proportional sequence comprises quantized values corresponding to K1-1 positive real number(s).”133
13. Claim 13: [13Preamble] “The user equipment to claim 11, [13a] wherein K2 antenna port groups in the K antenna port groups correspond to K2 channel quality values in the K channel quality values; the K2 is a positive integer less than or equal to the K; [13b] a second proportional sequence corresponds to a ratio(ratios) among the K2 channel quality values; [13c] a first receiving beamforming vector is used to receive

signals transmitted through the K1 antenna port groups; a second receiving beamforming vector is used to receive signals transmitted through the K2 antenna port groups; the first receiving beamforming vector and the second receiving beamforming vector are different; [13d] the first information is further used to determine the K2 antenna port groups and the second proportional sequence.”134

14. Claim 14: “The user equipment to claim 13, wherein any two antenna ports in the K1 antenna port groups are co-located or quasi-co-located (QCL), and any two antenna ports in the K2 antenna port groups are co-located or quasi-co-located (QCL); or any two antenna ports in the K1 antenna port groups are on a same carrier, and any two antenna ports in the K2 antenna port groups are on a same carrier; or the first signaling is further used to determine at least the last one of the K1, the K2 and the target threshold, a third channel quality is a best channel quality value among the K2 channel quality values, a fourth channel quality is a worse channel quality value among the K2 channel quality values, a ratio between the fourth channel quality and the third channel quality is greater than or equal to the target threshold, and the first information is further used to determine at least one of the first channel quality and the third channel quality.”135
15. Claim 15: “The user equipment to claim 13, wherein the second receiver further receives a second wireless signal; wherein a target antenna port group is used to transmit the second wireless signal; the target antenna port group is associated with the K1 antenna port groups and the first proportional sequence, or the target antenna port group is associated with the K2 antenna port groups and the second proportional sequence.”136
16. Claim 16:136
 - a. [16Preamble] “A base station for multi-antenna transmission comprising:”137

- b. [16a] “a first transmitter at the base station, transmitting a first signaling to a user equipment (UE);”137
- c. [16b] “a second transmitter at the base station, transmitting a first radio signal to the UE; and”137
- d. [16c] “a third receiver at the base station, receiving first information from the UE;”141
- e. [16d] [16d1] “wherein, K antenna port groups of the base station are used to transmit the first wireless signal;”141
- f. [16d2] “the first signaling is used by the UE to determine the K antenna port groups transmitting the first wireless signal received by the UE; the K is a positive integer greater than 1;”141
- g. [16d3] “the K antenna port groups respectively correspond to K channel quality values; the K channel quality values are K non-negative real numbers; the K channel quality values are Reference Signal Received Powers (RSRPs) or Signal to Interference plus Noise Ratios (SINRs);”142
- h. [16d4] “K1 antenna port groups of the K antenna port groups correspond to K1 channel quality values of the K channel quality values; the K1 is a positive integer less than or equal to the K;”142
- i. [16d5] “a first proportional sequence corresponds to a ratio(ratios) among the K1 channel quality values;”142
- j. [16d6] “the first information is used to determine the K1 antenna port groups and the first proportional sequence;”142
- k. [16d7] “the first signaling is used to determine a target threshold; the target threshold is a non-negative real number;”143

- l. [16d8] “a first channel quality is a best channel quality value among the K1 channel quality values; a second channel quality is a worse channel quality value among the K1 channel quality values;”143
 - m. [16d9] “a ratio between the second channel quality and the first channel quality is greater than or equal to the target threshold.”143
- 17. Claim 17: “The base station to claim 16, wherein the K channel quality values are broadband channel quality values; or the first proportional sequence comprises K1 positive real numbers less than or equal to 1, and the first proportional sequence comprises at least one 1; or the first proportional sequence comprises quantized values corresponding to K1 positive real numbers; or the first proportional sequence comprises K1-1 positive real number(s), and the K1-1 positive real number(s) is(are) a ratio(ratios) between a channel quality value(s) other than the best channel quality value among the K1 channel quality values and the best channel quality value; or the first proportional sequence comprises quantized values corresponding to K1-1 positive real number(s).”144
- 18. Claim 18: [18Preamble] “The base station to claim 16, [18a] wherein K2 antenna port groups in the K antenna port groups correspond to K2 channel quality values in the K channel quality values; the K2 is a positive integer less than or equal to the K; [18b] a second proportional sequence corresponds to a ratio(ratios) among the K2 channel quality values; [18c] a first receiving beamforming vector is used to receive signals transmitted through the K1 antenna port groups; a second receiving beamforming vector is used to receive signals transmitted through the K2 antenna port groups; the first receiving beamforming vector and the second receiving beamforming vector are different; [18d] the first information is further used to determine the K2 antenna port groups and the second proportional sequence.”145

19. Claim 19: “The base station to claim 18, wherein any two antenna ports in the K1 antenna port groups are co-located or quasi-co-located (QCL), and any two antenna ports in the K2 antenna port groups are co-located or quasi-co-located (QCL); or any two antenna ports in the K1 antenna port groups are on a same carrier, and any two antenna ports in the K2 antenna port groups are on a same carrier; or the first signaling is further used to determine at least the last one of the K1, the K2 and the target threshold, a third channel quality is a best channel quality value among the K2 channel quality values, a fourth channel quality is a worse channel quality value among the K2 channel quality values, a ratio between the fourth channel quality and the third channel quality is greater than or equal to the target threshold, and the first information is further used to determine at least one of the first channel quality and the third channel quality.”146
20. Claim 20: “The base station to claim 18, wherein the second transmitter further transmits a second wireless signal; wherein a target antenna port group is used to transmit the second wireless signal; the target antenna port group is associated with the K1 antenna port groups and the first proportional sequence, or the target antenna port group is associated with the K2 antenna port groups and the second proportional sequence.”147
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I. INTRODUCTION

1. I have been retained by Samsung Electronics Co., Ltd. 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. 10,951,271 (“the ’271 patent,” Ex. 1001). The application for the ’271 was filed June 27, 2019, as U.S. Patent Application No. 16/454,075 (“the ’075 application”). The ’271 patent claims priority as “a continuation of application No. PCT/CN2017/094209, filed on Jul. 25, 2017.” Ex. 1001, cover. The ’271 patent also claims priority to Chinese patent application CN 20161236923.2, filed December 28, 2016. Ex. 1001, cover.

5. I have been asked by Petitioner to provide my opinion whether the claims of the ’271 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 ’271 patent. In

performing my analysis, I have been asked to assume that the priority date is December 28, 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 '271 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 28, 2016), it is my opinion that claims 1-20 of the '271 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 included as Exhibit 1004.

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. 10,951,271 (“the ’271 patent”)

Exhibit	Description
Ex. 1002	File History of U.S. Patent No. 10,951,271
Ex. 1005	International Publication WO 2016/015307 A1 to Liu et al.
Ex. 1006	Certified English translation of International Publication WO 2016/015307 A1 to Liu et al. (“ <i>Liu</i> ”) ¹
Ex. 1007	Certification of English translation of International Publication WO 2016/015307 A1 to Liu et al.
Ex. 1008	International Publication WO 2016/126099 A1 to Park et al.
Ex. 1009	Certified English translation of International Publication WO 2016/126099 A1 to Park et al. (“ <i>Park</i> ”) ²
Ex. 1010	Certification of English translation of International Publication WO 2016/126099 A1 to <i>Park</i> et al.
Ex. 1011	U.S. Patent Application Publication No. 2013/0308608 A1 to Hu et al. (“ <i>Hu</i> ”)
Ex. 1012	U.S. Patent Application Publication No. 2011/0038330 A1 to Luo et al. (“ <i>Luo</i> ”)
Ex. 1013	U.S. Patent Application Publication No. 2011/0176519 A1 to Vitthaladevuni et al. (“ <i>Vitthaladevuni</i> ”)
Ex. 1014	Excerpts from Stefania Sesia et al., <i>LTE – The UMTS Long Term Evolution From Theory to Practice</i> (John Wiley & Sons Ltd. 2nd ed. 2011) (“ <i>Sesia LTE</i> ”)
Ex. 1015	3GPP TS 36.133 v13.2.0 (“Technical Specification Group Radio Access Network; Evolved Universal Terrestrial Radio Access (E-UTRA); Requirements for support of radio resource management (Release 13)”) (January 2016)

¹ Citations to *Liu* are made to the English translation.

² Citations to *Park* are made to the English translation.

Exhibit	Description
Ex. 1016	3GPP TS 36.211 v13.0.0 (“Technical Specification Group Radio Access Network; Evolved Universal Terrestrial Radio Access (E-UTRA); Physical channels and modulation (Release 13)”) (December 2015)
Ex. 1017	3GPP TS 36.212 v13.0.0 (“Technical Specification Group Radio Access Network; Evolved Universal Terrestrial Radio Access (E-UTRA); Multiplexing and channel coding (Release 13)”) (December 2015)
Ex. 1018	3GPP TS 36.213 v13.0.0 (“Technical Specification Group Radio Access Network; Evolved Universal Terrestrial Radio Access (E-UTRA); Physical layer procedures (Release 13)”) (December 2015)
Ex. 1019	3GPP TS 36.214 v13.0.0 (“Technical Specification Group Radio Access Network; Evolved Universal Terrestrial Radio Access (E-UTRA); Physical layer; Measurements (Release 13)”) (December 2015)
Ex. 1020	3GPP TS 36.331 v13.0.0 (“Technical Specification Group Radio Access Network; Evolved Universal Terrestrial Radio Access (E-UTRA); Radio Resource Control (RRC); Protocol specification (Release 13)”) (December 2015)
Ex. 1021	Farhana Afroz et al., <i>SINR, RSRP, RSSI and RSRQ Measurements in Long Term Evolution Networks</i> , International Journal of Wireless & Mobile Networks (IJWMN), Vol. 7, No. 4, pp. 113-123 (August 2015) (“Afroz”)
Ex. 1027	U.S. Patent Application Publication No. 2015/0036612 A1 to Kim et al. (“Kim”)
Ex. 1028	International Publication WO2015/131494 A2 to Chen et al.

Exhibit	Description
Ex. 1029	Certified English translation of International Publication WO2015/131494 A2 to Chen et al. (“ <i>Chen</i> ”) ³
Ex. 1030	Certification of English translation of International Publication WO2015/131494 A2 to Chen et al.

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 '271 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

³ Citations to *Chen* are made to the English translation.

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 '271 patent from the perspective of a person of ordinary skill in the art at the '271 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

37. 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 28, 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 '271 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.

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 of) transmissions using multi-antennas, which the '271 patent relates to. Ex. 1001, cover page.

51. Well before the earliest claimed priority date of the '271 patent (which I have been asked to assume is December 28, 2016), a large body of knowledge and associated techniques had been developed. This section 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.

52. To facilitate these explanations and to provide support for my opinions contained herein, I will use prior technical specifications developed by 3GPP, consistent with the named inventors' reference to 3GPP in the section titled "Related Art." Ex. 1001, 1:32-36. In my explanations, I will use 3GPP references from the 2015 time frame, although many of these concepts were developed in earlier years and can be found in earlier versions of the technical specifications.

53. In order to enable a user equipment ("UE") to communicate with a base station, several steps have to take place, ideally in a manner "invisible" to the end-user so as to "hide" the complexities involved. This makes the steps appear as simple as possible to the end-user or the user may even be unaware of the steps taking place. I will focus the discussion herein to the subset of such steps that are related to the '271 patent, which were well known in the time frame before the earliest priority date of the '271 patent.

54. One of these steps is the base station transmitting, and the UE receiving, control information, which informs the UE how the base station

operates. This is necessary for the UE to be in a position to communicate with the base station. This includes what is called “System information” which “is divided into the *MasterInformationBlock* (MIB) and a number of *SystemInformationBlocks* (SIBs). The MIB includes a limited number of most essential and most frequently transmitted parameters that are needed to acquire other information from the cell, and is transmitted on BCH” (Broadcast Channel). *See* 3GPP TS 36.331 v13.0.0, § 5.2.1.1 (emphasis in the original).

55. A Broadcast Channel (“BCH”) is one of the Transport Channels in the set of Transport Channels (“TrCh”) broadcast by the base station. Transport Channels are mapped to Physical Channels, which transmit the corresponding information after appropriate processing. As shown below, the BCH is mapped to the Physical Broadcast Channel (“PBCH”). *See* 3GPP TS 36.212 v13.0.0, § 4.2:

4.2 Downlink

Table 4.2-1 specifies the mapping of the downlink transport channels to their corresponding physical channels. Table 4.2-2 specifies the mapping of the downlink control channel information to its corresponding physical channel.

Table 4.2-1

TrCH	Physical Channel
DL-SCH	PDSCH
BCH	PBCH
PCH	PDSCH
MCH	PMCH

3GPP TS 36.212 v13.0.0, Table 4.2-1.

56. In the interest of conciseness, I will not describe the specifics the information transmitted in the MIB. But, there is at least one piece of information

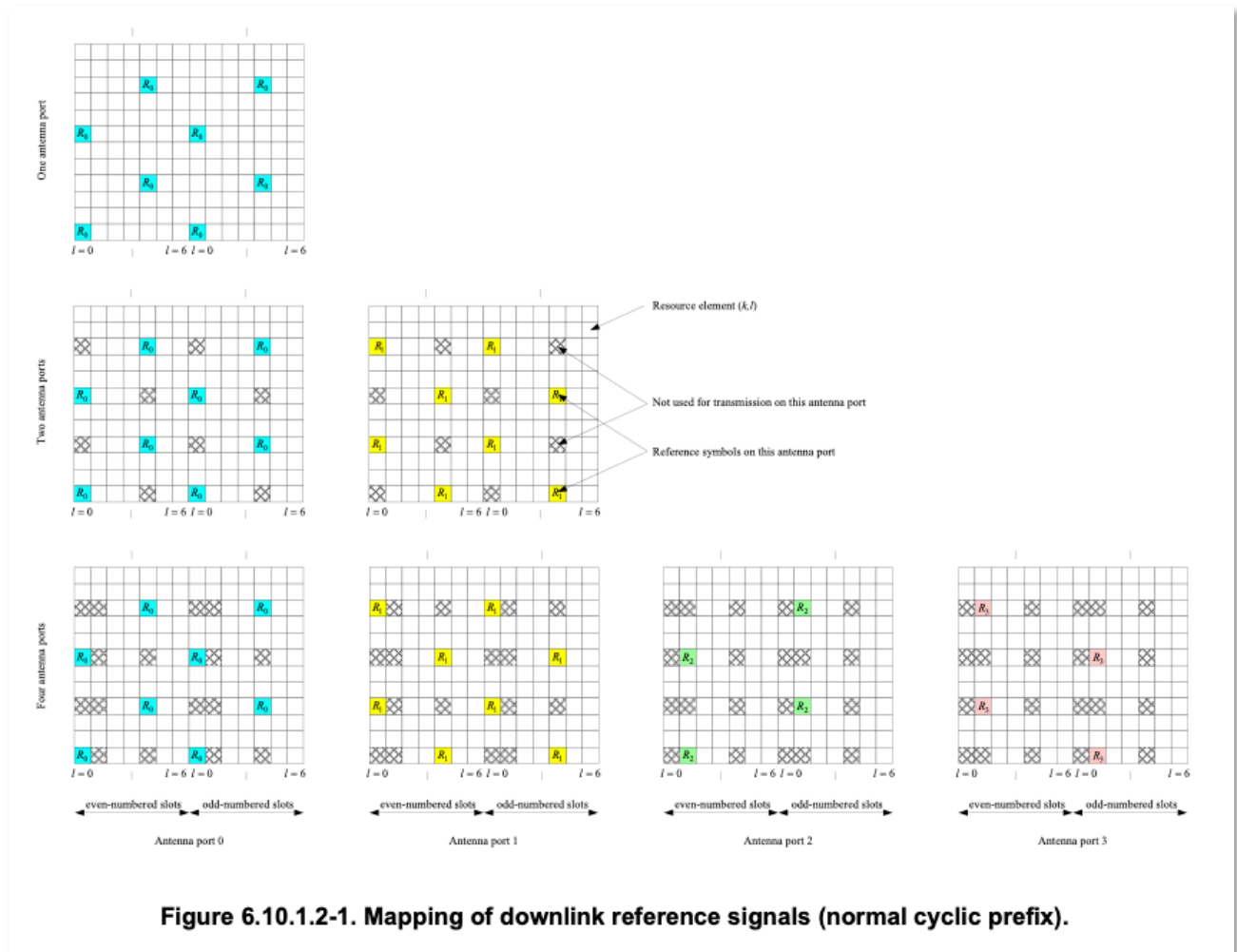
that is conveyed by the PBCH that is relevant to the '271 patent which I will discuss below.

57. As shown below, a base station may use 1, 2, or 4 antenna ports for its transmissions. A simple discussion of the relationship between an “antenna” and an “antenna port” may be useful: At the most basic level, an “antenna” (also referred to as an “antenna element” or a “physical antenna”) is a radiating device for transmitting or receiving wireless signals. It is often desirable to build an “antenna” that has certain desired properties by placing several “antenna elements” in a specific, well-designed configuration that achieves the desired overall behavior by the collective action of all the antenna elements involved. The result is that the so-configured “antenna elements” are no longer “an antenna” as it actually consists of several “antennas,” namely the individual antenna elements. However, the antenna elements, working together, appear to act as a single antenna, which is referred to as an “antenna port.” Thus, signals transmitted using an “antenna port” present the same characteristics from the perspective of the user equipment, even though the “antenna port” may actually consist of one physical antenna or more than one physical antenna acting together. The radiating pattern that results from the combination of these physical antennas is the radiation pattern of the corresponding “antenna port.” This is explained, for example, by *Sesia LTE* as shown below:

Each RS pattern is transmitted from an *antenna port* at the eNodeB. An antenna port may in practice be implemented either as a single physical transmit antenna, or as a combination of multiple physical antenna elements. In either case, the signal transmitted from each antenna port is not designed to be further deconstructed by the UE receiver: the transmitted RS corresponding to a given antenna port defines the antenna port from the point of view of the UE, and enables the UE to derive a channel estimate for all data transmitted on that antenna port – regardless of whether it represents a single radio channel from one physical antenna or a composite channel from a multiplicity of physical antenna elements together comprising the antenna port. The designations of the antenna ports available in LTE are summarized below:

Sesia LTE at 167.

58. Returning to the transmission of the PBCH, the base station may use 1, or 2, or 4 antenna ports for the transmission of the PBCH. *See* 3GPP TS 36.211 v13.0.0, § 6.6.3. Depending on how many antenna ports are to be used, the base station also transmits “reference signals” corresponding to each of the antenna ports on specific time and frequency occasions (Resource Elements), as shown below. *See* 3GPP TS 36.211 v13.0.0, § 6.10.1.2. The figure below illustrates the transmission of reference signals at a high level, which I discuss further below.



See 3GPP TS 36.211 v13.0.0, Figure 6.10.1.2-1.

59. Referring to the figure above, each “large square” represents what the LTE standard calls a “Resource Block” (“RB”). Each RB consists of a number of Resource Elements (“RE”), wherein each RE corresponds to a specific subcarrier (in the frequency domain) and a specific symbol (in the time domain), which is used for the transmission of one modulation symbol. In the example above, each Resource Block (“RB”) consists of 12 subcarriers and 14 symbols corresponding to $12 \times 14 = 168$ Resource Elements (“RE”). In the figure above, the first row

(consisting of a single RB) represents the case of transmitting on only one antenna port (port0), while the second and third row (consisting of 2 and 4 RBs, respectively) represent the case of transmitting on 2 and 4 antenna ports, respectively. Furthermore, each column of the Resource Blocks (RB) represents how the RB is used for transmission on a particular antenna port. The first, leftmost RB column (wherein some of the RE are colored blue) represents the transmission on antenna port0; similarly, the second RB column (wherein some RE are colored yellow) represents antenna port1; similarly, the third RB column (wherein some RE are colored green) represents antenna port2; and the fourth, rightmost RB column (wherein some RE are colored red) represents antenna port3. The RB rows, from top to bottom represent whether one antenna port is being used (topmost RB row, port0 (blue) only), two antenna ports are being used (middle RB row of ports0,1 (blue, yellow)), and all four antenna ports are being used (bottom RB row of ports0,1,2,3 (blue, yellow, green, red)). The respective colored RE in each grid are Resource Elements used for transmitting reference signals on a particular antenna port. The cross-hatched cells are not used for **any** transmission, because they correspond to resource elements of another antenna port, which is why there are more cross-hatched cells in the bottom row for port 0 in the bottom row, and no cross-hatched cells in the top row for port 0. The blank cells in each grid are available for transmission of other information, e.g., user data. Thus, for

example, if two antenna ports are used (antenna port 0 and antenna port 1) the “blue” resource elements are used for transmission of reference signals on antenna port 0 and the yellow ones for transmission of reference signals on antenna port 1. In contrast, *nothing* is transmitted by an antenna port on the resource elements on which another antenna port is transmitting reference signals (cross-hatched cells). I will return to this information below.

60. The UE needs to know how many antenna ports are being used (1, 2, or 4). The way the UE knows how many ports are being used by the base station is provided by 3GPP TS 36.212, v13.0.0, using a Cyclic Redundancy Code (“CRC”) mask. 3GPP TS 36.212 v13.0.0, § 5.3.1.1. The specifics of the CRC mask are not necessary to understand the ’271 patent’s disclosure. The UE uses the transmitted reference signals to determine the effect of the channel on the transmitted signal from each antenna port. In other words, the reference signals are known ahead of time, but the UE receives a distorted version of the original reference signal and knowing the reference signal allows the UE to calculate the difference between the received signal and the transmitted reference signal. To use a simple analogy, if the UE knows that on antenna port 0 the base station transmits the value “5” and the UE receives the value “7,” the UE knows that the difference between “5” and “7,” i.e., the distortion, was caused by the channel, because no other antenna port is transmitting using that RE. The UE can make similar evaluations of the channel

conditions for each of the antenna ports that is being used by the base station. In addition, the UE can determine the received power, referred to as the Reference Signal Received Power, or RSRP, for each of the antenna ports that is being used.

61. A UE will generally report different types of information to a base station. These are generally called Channel State Information, or CSI. *Sesia LTE* at 280-281. A transmitter, such as a base station “can configure the UE to report measurement information to support the control of UE mobility.” *Sesia LTE* at 75. These requirements can be transmitted by the base station using, for example, the “RRCConnectionReconfiguration message.” *Sesia LTE* at 75. One such configuration is a “Reporting configuration” that “cause[s] the UE to send a measurement report,” which may include information such as Reference Signal Received Power (RSRP)” for a given antenna port. *Sesia LTE* at 75. The Reference Signals are used to determine the downlink quality of the signal. “Each RS pattern is transmitted from an *antenna port* at the eNodeB.” *Sesia LTE* at 167. In particular, it was well known that “RSRP is measured by the UE over the cell-specific Reference Signals (RS) within the measurement bandwidth over a measurement period. RSRP is a type of signal strength measurement and is indicative of the cell coverage. It is defined as the linear average over the power contributions (in Watts) of the REs that carry cell-specific RSs within the

considered measurement frequency bandwidth RSRP is therefore considered to be the most important measurement quantity for E-UTRAN.” *Sesia LTE* at 513.

62. A POSITA would have known that “[a]n antenna port may in practice be implemented either as a single physical transmit antenna, or as a combination of multiple physical antenna elements.” *Sesia LTE* at 167. The antenna port, whether a single antenna or combination of antennas transmits a wireless signal, such as the Reference Signal, and “the transmitted RS corresponding to a given antenna port defines the antenna port from the point of view of the UE, and enables the UE to derive a channel estimate for all data transmitted on that antenna port – regardless of whether it represents a single radio channel from one physical antenna or a composite channel from a multiplicity of physical antenna elements together comprising the antenna port.” *Sesia LTE* at 167. Thus, the UE measures the RSRP of a particular antenna port, which represents the state of, or information about, the channel being measured, and transmits the RSRP back to the base station. *See Sesia LTE* at 167. When the UE reports back to the base station, it provides a measurement report for each antenna port measured. Various reporting criteria can cause the UE to send a measurement report, such a periodic or event-triggered criteria. *Sesia LTE* at 75. One of the details that the UE may report to the base station is Reference Signal Received Power (RSRP). *Sesia LTE* at 75.

63. As one example, 3GPP TS 36.133 v13.2.0, Section 9.1.4, specifies a mapping table of the RSRP range measured by the UE for a given transmission cell. For example, “[t]he reporting range of RSRP is defined from -140 dBm to -44 dBm with 1 dB resolution. The mapping of measured quantity is defined in Table 9.1.4-1. The range in the signaling may be larger than the guaranteed accuracy range.” 3GPP TS 36.133 v13.2.0, § 9.1.4. In particular, “[t]he measurement report mapping for RSRP measurements is as defined in Section 9.1.4.” 3GPP TS 36.133 v13.2.0, § 9.1.18.2.1. Table 9.1.4-1: RSRP measurement report mapping, for reporting RSRP values from the UE is shown below:

Table 9.1.4-1: RSRP measurement report mapping

Reported value	Measured quantity value	Unit
RSRP_00	$\text{RSRP} < -140$	dBm
RSRP_01	$-140 \leq \text{RSRP} < -139$	dBm
RSRP_02	$-139 \leq \text{RSRP} < -138$	dBm
...	...	...
RSRP_95	$-46 \leq \text{RSRP} < -45$	dBm
RSRP_96	$-45 \leq \text{RSRP} < -44$	dBm
RSRP_97	$-44 \leq \text{RSRP}$	dBm

3GPP TS 36.133 v13.2.0, § 9.1.4. Table 9.1.4-1. Similarly, the measurement report may also report the CSI-RSRP, as shown in 3GPP TS 36.133 v13.2.0, § 9.1.14.3.3. Table 9.1.143.3-1: CSI-RSRP measurement report mapping, shown below:

Table 9.1.14.3.3-1: CSI-RSRP measurement report mapping

Reported value	Measured quantity value	Unit
CSI_RSRP_00	$\text{CSI_RSRP} < -140$	dBm
CSI_RSRP_01	$-140 \leq \text{CSI_RSRP} < -139$	dBm
CSI_RSRP_02	$-139 \leq \text{CSI_RSRP} < -138$	dBm
...	...	...
CSI_RSRP_95	$-46 \leq \text{CSI_RSRP} < -45$	dBm
CSI_RSRP_96	$-45 \leq \text{CSI_RSRP} < -44$	dBm
CSI_RSRP_97	$-44 \leq \text{CSI_RSRP}$	dBm

3GPP TS 36.133 v13.2.0, § 9.1.14.3.3.

64. Other 3GPP standards also state that RSRP may be reported as *rsrpResult*, which is the measured RSRP of a particular antenna port, or cell, measured by the UE. See 3GPP TS 36.331 v13.0.0, at 365 (“*MeasResults* field descriptions”, “*rsrpResult*”). This is done, for example, using the *reportCRS-Meas* parameter, which “indicates that the UE shall report *rsrp*, *rsrp* together with *csi-rsrp* in the measurement report, if possible.” See 3GPP TS 36.331 v13.0.0, at 370 (“*ReportConfigEUTRA* field descriptions”).

65. The base station also uses precoding matrices, which are applied to the signals to be transmitted by the particular antenna ports, as discussed and illustrated below. See 3GPP TS 36.211 v13.0.0, § 6.3.

6.3 General structure for downlink physical channels

This section describes a general structure, applicable to more than one physical channel.

The baseband signal representing a downlink physical channel is defined in terms of the following steps:

- scrambling of coded bits in each of the codewords to be transmitted on a physical channel
- modulation of scrambled bits to generate complex-valued modulation symbols
- mapping of the complex-valued modulation symbols onto one or several transmission layers
- precoding of the complex-valued modulation symbols on each layer for transmission on the antenna ports
- mapping of complex-valued modulation symbols for each antenna port to resource elements
- generation of complex-valued time-domain OFDM signal for each antenna port

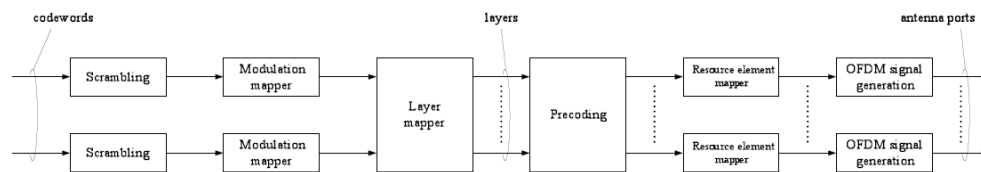


Figure 6.3-1: Overview of physical channel processing.

66. When the UE receives the Reference Signals, it determines which precoding matrix will result in the best correction of the distortion that the channel will cause during transmission. The precoding matrix that the UE determines is the best one to be used is identified by an index, referred to as the Precoding Matrix Indicator (PMI). *See, e.g., 3GPP TS 36.213 v13.0.0, § 7.2; Sesia LTE at 272-273, section 11.2.2.4).* The PMI is then sent back to the base station as part of the CSI. The base station, in turn, can apply the precoding matrix identified by the UE to preemptively compensate for the distortion caused by the channel to the transmissions to the UE. The base station can also use a different precoding matrix than the one suggested by the UE. In either case, the precoding matrix used by the base station is reported to the UE so that the UE can properly account for the

impact of the channel to the received Reference Signal. *See* 3GPP TS 36.212 v13.0.0, § 5.3.3.1.3A, “Format 1B”; *see also Sesia LTE* at 273-274 (“this enables the UE to derive the correct phase reference relative to the cell-specific RSs in order to demodulate the PDSCH data”), *Sesia LTE* at 266-267.

67. In some cases, the base station may supply predetermined set of precoding matrices to the UE, and the UE selects the best precoding matrix to indicate to the base station from that set. To simplify the measurements and reporting by the UE, the “eNodeB [base station] may also restrict the set of precoders which the UE may evaluate and report.” *Sesia LTE* at 273. “This is known as *codebook subset restriction*” and “enables the eNodeB to prevent the UE from reporting precoders which are not useful” *Sesia LTE* at 273.

68. Other examples of CSI reported by the UE to the base station include Channel Quality Indicator (CQI), a Precoding Matrix Indicator (PMI) as discussed above, and Rank Indicator (RI), as shown below:

7.2 UE procedure for reporting Channel State Information (CSI)

If the UE is configured with a PUCCH-SCell, the UE shall apply the procedures described in this clause for both primary PUCCH group and secondary PUCCH group unless stated otherwise

- When the procedures are applied for the primary PUCCH group, the terms ‘secondary cell’, ‘secondary cells’, ‘serving cell’, and ‘serving cells’ in this clause refer to secondary cell, secondary cells, serving cell or serving cells belonging to the primary PUCCH group respectively unless stated otherwise.
- When the procedures are applied for secondary PUCCH group, the terms ‘secondary cell’, ‘secondary cells’, ‘serving cell’ and ‘serving cells’ in this clause refer to secondary cell, secondary cells (not including the PUCCH-SCell), serving cell, serving cells belonging to the secondary PUCCH group respectively unless stated otherwise. The term ‘primary cell’ in this clause refers to the PUCCH-SCell of the secondary PUCCH group.

The time and frequency resources that can be used by the UE to report CSI which consists of Channel Quality Indicator (CQI), precoding matrix indicator (PMI), precoding type indicator (PTI), CSI-RS resource indicator (CRI), and/or rank indication (RI) are controlled by the eNB. For spatial multiplexing, as given in [3], the UE shall determine a RI corresponding to the number of useful transmission layers. For transmit diversity as given in [3], RI is equal to one.

3GPP TS 36.213 v13.0.0, § 7.2.

The CQI identifies the modulation scheme and the coding scheme for the base station to transmit subsequent information to the UE. *See* 3GPP TS 36.213 v13.0.0, Table 7.2.3-1. Ever since Release 10 of the LTE standards, the base station was capable of transmitting data to the UE using up to eight antenna ports indicated in the measurement report from the UE.

6.3.4.4 Precoding for spatial multiplexing using antenna ports with UE-specific reference signals

Precoding for spatial multiplexing using antenna ports with UE-specific reference signals is only used in combination with layer mapping for spatial multiplexing as described in clause 6.3.3.2. Spatial multiplexing using antenna ports with UE-specific reference signals supports up to eight antenna ports and the set of antenna ports used is $p = 7, 8, \dots, v + 6$.

3GPP TS 36.211 v13.0.0, § 6.3.4.4; *see also* Ex. 1027, Kim, [0071], [0164] (“CSI-RSs may be transmitted through 1, 2, 4 or 8 antenna ports” and “although CSI-RSs contained in ‘set_1’ may be selected from number of antenna ports (1, 2, 4, 8), the

number of antenna ports of CSI-RSs contained in the remaining set_n($n > 1$) may be set to a predetermined number, for example, 1 or 2.”).

Table 7.2.3-1: 4-bit CQI Table

CQI index	modulation	code rate x 1024	efficiency
0	out of range		
1	QPSK	78	0.1523
2	QPSK	120	0.2344
3	QPSK	193	0.3770
4	QPSK	308	0.6016
5	QPSK	449	0.8770
6	QPSK	602	1.1758
7	16QAM	378	1.4766
8	16QAM	490	1.9141
9	16QAM	616	2.4063
10	64QAM	466	2.7305
11	64QAM	567	3.3223
12	64QAM	666	3.9023
13	64QAM	772	4.5234
14	64QAM	873	5.1152
15	64QAM	948	5.5547

See 3GPP TS 36.213 v13.0.0, Table 7.2.3-1.

69. Thus, a POSITA in 2016 would have recognized that it was well known in the art to provide (a) for a base station to transmit signaling information, which is received by the UE, (b) the UE uses the signaling information to determine the number of antenna ports used by the base station and thus identifies the RS used by each antenna port, (c) for the base station to transmit reference signals (wireless signals) using the antenna ports, which are received by the UE,

(d) the UE uses the reference signals to determine, among other things, the RSRP and channel quality, (e) for the UE to transmit information to the base station, such as in a measurement report, which enables the base station to make decisions about what resources to use for the given transmission to the UE and how to transmit to the given UE on the given resources available.

VII. THE '271 PATENT

A. Alleged Invention of the '271 Patent

70. The '271 patent relates to “a scheme for multi-antenna transmission in a wireless communication system.” Ex. 1001, 1:18-19.

71. The patent describes “a method for multi-antenna transmission in a user equipment (UE), including: receiving a first signaling; receiving a first wireless signal; and transmitting first information.” Ex. 1001, 1:59-63. In the method, “K antenna port groups are used to transmit the first wireless signal” and “the first signaling is used to determine the K antenna port groups,” where “K is a positive integer greater than 1.” Ex. 1001, 1:64-67. “[T]he K antenna port groups respectively correspond to K channel quality values,” which “are K non-negative real numbers.” Ex. 1001, 1:67-2:2. The patent explains that, “[i]n one embodiment, the channel quality value is ... Reference Signal Received Power (RSRP).” Ex. 1001, 3:63-65. Similarly, “K1 antenna port groups of the K antenna port groups” correspond to “K1 channel quality values of the K channel quality values,”

where K1 “is less than or equal to the K.” Ex. 1001, 2:2-5. In the method, “a first proportional sequence corresponds to a ratio(ratios) among the K1 channel quality values,” and “the first information is used to determine ... the K1 antenna port groups[and] the first proportional sequence.” Ex. 1001, 2:5-9. The “K1 channel quality values” include “a first channel quality [that] is a best channel quality value” and “a second channel quality [that] is a worse channel quality value,” and the method includes “a ratio between the second channel quality and the first channel quality [being] greater than or equal to [a] target threshold” determined from the first signaling. Ex. 1001, 2:9-16. When discussing antenna port groups, the '271 patent explains that “[i]n one embodiment, the antenna port group is composed of one antenna port.” Ex. 1001, 2:45-46, 13:64-65. These disclosures parallel the claims of the '271 patent.

72. The '271 patent describes “the advantage of the foregoing method” “is that the base station may obtain a proportional relationship among reception qualities corresponding to multiple beams,” Ex. 1001, 2:17-22, but the claims do not recite sending any ratios to the base station. Instead, the claims recite transmitting only “first information,” which “is used to determine the K1 antenna port groups and the first proportional sequence.” *E.g.*, Ex. 1001, 27:20-21, 27:37-39. As explained below, the prior art taught this.

73. The '271 patent thus taught conventional antenna selection methods, such as measuring RSRP of reference signals and selecting the channels corresponding to one or more reference signals that meets a particular criteria or threshold, as explained above in Section VI.

B. Prosecution History

74. The '271 patent was filed June 27, 2019, as U.S. Patent Application No. 16/454,075 and claims priority to Chinese patent application no. 201611236923.2, filed December 28, 2016. Ex. 1002, 15, 73. During prosecution, the examiner rejected claims 1-20 under 35 U.S.C. §§ 112 and 103 as indefinite and rendered obvious. Ex. 1002, 402-414. In response, the applicant amended the independent claims to clarify which device performed various claimed steps and to add that “the K channel quality values is a Reference Signal Received Power (RSRP) or a Signal to Interference plus Noise Ratio (SINR).” Ex. 1002, 462-467. The applicant distinguished the cited prior art by arguing that it did not use RSRP or SINR for antenna selection and instead used “a threshold of **delay spread or Doppler**,” while “the target threshold in the present application and the claims is a threshold ratio between two channel qualities such as **RSRP and SINR**.” Ex. 1002, 471-472 (emphasis in original).

75. The examiner then allowed the claims and certain post-allowance amendments to correct “formal matters.” Ex. 1002, 480-483, 502-510.

C. Claim Construction

76. 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. 1002). 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.

77. 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.

78. 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 '271 patent.

79. 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 '271 patent as it would have been understood by a person of ordinary skill in the art at the earliest claimed priority date of December 28, 2016.

VIII. LEVEL OF ORDINARY SKILL IN THE ART

80. In rendering the opinions set forth in this declaration, I have been asked to consider the '271 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.

81. 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

telecommunications systems, including multiple-input multiple-output (MIMO) technology. Additional relevant work experience can compensate for less education, and *vice versa*.

IX. THE PRIOR ART

82. In forming my opinions, I found the following prior art relevant when considering whether the claims of the '271 patent would have been obvious to a person of ordinary skill in the art.

Ex. 1005	International Publication WO 2016/015307 A1 to Liu et al.
Ex. 1006	Certified English translation of International Publication WO 2016/015307 A1 to Liu et al. (" <i>Liu</i> ") ⁴
Ex. 1008	International Publication WO 2016/126099 A1 to Park et al.
Ex. 1009	Certified English translation of International Publication WO 2016/126099 A1 to Park et al. (" <i>Park</i> ") ⁵

⁴ Citations to *Liu* are to the English translation (Ex. 1006).

⁵ Citations to *Park* are to the English translation (Ex. 1009).

A. *Liu* (WO 2016/015307)

83. *Liu* published February 4, 2016, as WIPO PCT publication no. WO2016/015307, from PCT application no. PCT/CN2014/083479, filed July 31, 2014. I understand and have been asked to assume that *Liu* is prior art.

84. *Liu*, like the '271 patent, teaches a “signal transmission method and an associated device for performing more effective antenna selection.” *Liu*, 1. *Liu* teaches that, “[d]uring antenna configuration, a second network device transmits configuration information of M antenna ports to a first network device and transmits signals of the M antenna ports to the first network device, which receives the signals of the M antenna ports transmitted by the second network device based on the configuration information, where M is a positive integer” *Liu*, 15. “[T]he first network device may be user equipment (UE), and the second network device may be a base station” *Liu*, 15.

85. *Liu* teaches that the M antenna ports may be individual ports and that the user equipment measures and selects the optimal ports, which it reports back to the base station: “The first network device needs to select N antenna ports from among M antenna ports according to a certain criterion and to notify the second network device of first information of the selected N antenna ports, wherein the first information is channel state information (CSI) corresponding to the N antenna ports or index information corresponding to the N antenna ports.” *Liu*, 16.

86. *Liu* also teaches that the M ports may be divided into groups having more than one antenna port per group:

the first network device performing cell selection according to antenna correlation information of the M antenna ports after they have been measured specifically is: for example, $M = 10$, corresponding to 5 cells, each cell having 2 antennas, cell 1 corresponding to port0 and port1, cell 1 corresponding to port2 and port3, cell 1 corresponding to port4 and port5, cell 1 corresponding to port6 and port7, and cell 1 corresponding to port8 and port9;

UE measures the 5 groups of antenna ports corresponding to these 5 cells and discovers that the received signal power is strongest for ports0,1 corresponding to cell 1; for example, $RSRP_1 > RSRP_2 > RSRP_3 > RSRP_4 > RSRP_5$, with $RSRP_1$ representing the received signal power corresponding to cell 1, $RSRP_2$ representing the received signal power corresponding to cell 2, and $RSRP_n$ representing the received signal power corresponding to cell n.

Liu, 16-17. The base station then uses the reported information to transmit data over a wireless signal using the selected antenna port groups: “the CSI corresponding to these N antenna ports or the index information corresponding to these N antenna ports is provided as a notification to the second network device so as to cause the second network device to transmit data on these N antenna ports to the first network device.” *Liu*, 17.

87. *Liu* is analogous art to the '271 patent because *Liu*, like the '271 patent, is directed to the “field of telecommunications technology and in particular to a signal transmission method” that uses “multiple-input multiple-output (MIMO) wireless systems” and describes “a signal transmission method and an associated device for performing more effective antenna selection” from the multiple antennas. *Liu*, 1; Ex. 1001, 1:18-19 (“The present disclosure relates to a scheme for multi-antenna transmission in a wireless communication system.”).

B. *Park* (WO 2016/126099)

88. *Park* published August 11, 2016, as WIPO PCT publication no. WO2016/126099, from PCT application no. PCT/KR2016/001177, filed February 3, 2016, and claiming priority to U.S. provisional application nos. 62/131,221, filed March 10, 2015, and 62/112,621 filed February 5, 2015. I understand and have been asked to assume that *Park* is prior art.

89. *Park*, like the '271 patent, “relates to a wireless communication system” and discloses an antenna selection method by “feeding back CSI from a terminal based on a reference signal.” *Park*, [1]. *Park*, like *Liu* and the '271 patent, discloses the user equipment “measur[ing] the signal strength of the serving cell and the neighbor cell or the signal strength in comparison with total reception power, and the like, including measuring the reference signal receive power (RSRP)” *Park*, [292]. Once the RSRP is measured for each antenna port, such

as shown in FIG. 12, *Park*'s "UE aligns the RSRP(r, m), and reports the RSRP of L antenna ports chosen from among these that are strongly received" and "report[s] RSRPs of ports that are within a certain difference compared to the RSRP of the selected antenna ports, in other words, $\max(\text{RSRP}(r, m))$." *Park*, [372]. *Park* determines an RSRP ratio for each antenna port by comparing the RSRP of each antenna port to the maximum RSRP. *Park*, [372]-[373]. *Park* then compares each ratio to a threshold value to determine the "strongly received" signals: "an RSRP difference greater than a certain threshold value is expressed as an RSRP ratio or dB scale" using the equation $\text{RSRP}(r, m) - \max(\text{RSRP}(r, m)) > \text{Threshold}$. *Park*, [372]-[373]. Thus, *Park* teaches performing an RSRP-to-max(RSRP) ratio comparison and selecting those antennas that satisfy the ratio comparison threshold. *Park*, [371]-[378].

90. *Park* is analogous art to the '271 patent because *Park*, like the '271 patent, is directed to "a wireless communication system" that provides for "feeding back CSI [channel state information] from a terminal based on a reference signal" for selecting from multiple antennas in multiple antenna (MIMO and massive MIMO) systems. *Park*, [1], [92]-[97], [341]-[356]; Ex. 1001, 1:18-19 ("The present disclosure relates to a scheme for multi-antenna transmission in a wireless communication system.").

X. GROUNDS OF UNPATENTABILITY

91. 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 '271 patent would have been obvious to one of ordinary skill in the art.

92. In particular, it is my opinion that claims 1-20 of the '271 patent would have been obvious to a person of ordinary skill in the art based on the combination shown below:

Ground	Claims	Basis	Prior Art
1	1-20	§ 103	<i>Liu</i> in combination with <i>Park</i>

XI. THE CHALLENGED CLAIMS ARE UNPATENTABLE OVER THE PRIOR ART

93. In my opinion claims 1-20 would have been obvious to a person of ordinary skill in the art at the earliest priority date of the '271 patent.

A. Ground 1: Claims 1-20 Are Rendered Obvious by *Liu* and *Park***1. Claim 1:**

94. In my opinion, the combination of *Liu* and *Park* renders obvious claim 1.

95. *Liu* teaches or suggests each element of claim 1. To the extent Patent Owner argues that a “proportional sequence” is not disclosed or suggested by *Liu*,

Park discloses and renders obvious the proportional sequence suggested by *Liu* and a ratio of a worse channel quality value to the best channel quality value, as recited in the later elements of claim 1.

a. [1Preamble] “A method for multi-antenna transmission in a user equipment (UE), comprising:”

96. To the extent the preamble is limiting, *Liu* discloses a method for multi-antenna transmission in a user equipment (“UE”).

97. *Liu* discloses user equipment receiving a multi-antenna transmission (e.g., multiple-input multiple-output (“MIMO”) or massive MIMO transmission) between a base station (“BS”) and user equipment (“UE”) to “carry out more effective antenna selection.” *Liu*, Abstract, 1, 15, 25, FIG. 1, FIG. 5. *Liu*, FIG. 1, discloses “a flowchart of a signal transmission method” in which “a first network device receives signals of M antenna ports transmitted by a second network device,” where the “first network device” is a “user equipment (UE)” and the “second network device” is a “base station.” *Liu*, 15, FIG. 1. Once the user equipment identifies the preferred N antenna ports for transmission, the base station “transmit[s] data on these N antenna ports to the first network device [UE].” *Liu*, 17.

b. [1a] “receiving, by the UE, a first signaling originating from a base station;”

98. In my opinion, *Liu* discloses receiving, by the user equipment (UE), a first signaling originating from a base station.

99. For example, *Liu* discloses that the first network device (user equipment) receives, from the base station, configuration information and broadcasting and specific signal notifications, such as codebook information (e.g., pre-coding matrices), high-layer signaling and dynamic signaling for M antenna ports, and criteria and threshold requirements (collectively “first signaling”). *Liu*, 15, 17, 21, 22-23. Specifically, “[d]uring antenna configuration, a second network device [BS] transmits configuration information of M antenna ports to a first network device [UE] ..., which receives the signals of the M antenna ports transmitted by the second network device based on the configuration information” *Liu*, 15. The configuration information and broadcasting and signal notifications (“first signaling”) are used by the user equipment when measuring channel state information and channel quality indicators of the antenna ports to select antenna port groups. *Liu*, 15, 22-23. The configuration information described in *Liu* is the same type of signaling and control information that was well known prior art systems because *Liu*’s procedures occur “[d]uring RRM measurement,” which is the radio resource management process in which the configuration information and measurement reports are exchanged during beam selection,

described above in Section VI (Technology Background). *Liu*, 21, 30. Such understanding is also confirmed *Kim* (Ex. 1027), which explains that during antenna selection and radio resource management (RRM), such as described in *Liu*, the base station configures the CSI-RS wireless signals to be transmitted from antenna ports and the configurations describing and identifying the CSI-RS configurations are transmitted to the UE for measurement and reporting. *See* Ex. 1027, *Kim*, [0078]-[0080], [0106], [0110]-[0111], [0119], [0135]-[0136] (describing the base station configuring antenna ports for radio resource management measurements (RRM, like those described in *Liu*) and signaling to the UE which antenna ports should be measured to determine channel quality).

100. *Liu* discloses at least two examples of using the configuration information and broadcasting and signal notifications to select antenna port groups. First, *Liu*'s base station sends configuration information, along with broadcasting and signal information, for M antenna ports, each of which is measured by the user equipment, where the M antenna ports correspond to groups having one antenna port each. *Liu*, 16 ("The configuration information of the M antenna ports comprises an antenna port pattern, i.e., information such as positions of antenna port time-frequency resources and transmission cycles and powers of antenna port signals," and "the configuration information is the configuration information of the M antenna ports"). The '271 patent explains that an antenna port group may

comprise only one antenna port. Ex. 1001, 2:45-46, 13:64-65. Second, *Liu* alternatively divides the M antenna ports into X groups of multiple ports, such as two antenna ports per group. *Liu*, 16. For example, when M=10, the 10 antenna ports may be divided into “5 cells, each cell having 2 antennas,” with “cell 1 corresponding to port0 and port1, cell 1 [sic: 2⁶] corresponding to port2 and port3, cell 1 [sic: 3] corresponding to port4 and port5,” etc., where the “UE measures the 5 groups of antenna ports corresponding to these 5 cells” *Liu*, 16-17. For multiple cells, the first signaling includes “multiple pieces of configuration information, with each piece of configuration information corresponding to the configuration of one of the antenna port groups,” *Liu*, 16, and the broadcasting and signal notifications include various criteria and threshold information. *Liu*, 22-23.

⁶ Although *Liu* refers to “cell 1” for each port group, a POSITA would have recognized these as typographical errors that should refer to cells 1-5, based on *Liu*’s subsequent discussion of “cell 1,” “cell 2,” and “cell n” to refer to the same five antenna port groups. *Liu*, 17. Even if the port groups correspond to the same cell (e.g., “cell 1”), they would still correspond to five antenna port groups, so *Liu* thus discloses the antenna port groups under either understanding.

c. [1b] “receiving, by the UE, a first wireless signal originating from the base station; and”

101. *Liu* discloses receiving, by the user equipment (UE), a first wireless signal originating from the base station.

102. For example, *Liu* discloses that the user equipment receives from the base station a first wireless signal of the M antenna ports, either separately (e.g., one antenna port per group) or as X antenna port groups having multiple antenna ports per group. The “second network device [BS] ... transmits signals of the M antenna ports to the first network device [UE], which receives the signals of the M antenna ports transmitted by the second network device based on the configuration information ...” *Liu*, 15, FIG. 1 (S101). *Liu* describes “wireless systems,” *Liu*, 1, and therefore the M or X antenna port group “signals” transmitted by the base station and received by the user equipment are “wireless signals.” Moreover, a POSITA would have understood that an “antenna” transmits and receives radiated wireless signals, confirming *Liu*’s disclosure that a first wireless signal is sent between the base station and user equipment. *See Sesia LTE* at 167 (“Each RS pattern is transmitted from an *antenna port* at the eNodeB.”). In particular, “the transmitted RS corresponding to a given antenna port defines the antenna port from the point of view of the UE, and enables the UE to derive a channel estimate for all data transmitted on that antenna port—regardless of whether it represents a single radio channel from one physical antenna or a composite channel from a

multiplicity of physical antenna elements together comprising the antenna port,” *Sesia LTE* at 167, as I explain above in the Technology Background, *see supra* § VI.

103. A POSITA would have recognized that *Liu*’s wireless signals, which the UE uses to measure the RSRP, RSSI, and RSRQ, are the conventional Reference Signals that were well-known prior art systems described above in Section VI (Technology Background); *Liu*, 16, 17, 21, 22, 26. For example, a POSITA would have understood that, by definition, RSRP, RSSI, and RSRQ—e.g., *Reference Signal Received Power*, *Reference Signal Strength Indicator*, *Reference Signal Received Quality*—are measured with respect to the Reference Signals broadcast by the base station, such as *Liu*’s base station, as described above in Section VI (Technology Background). *Kim* similarly confirms this, explaining that a base station configures the REs as CSI-RS sending wireless signals to the UE for measurements, such as RSRP and RSRP-to-max(RSRP) power ratio measurements, that may be reported back to the base station in a measurement report. *Kim*, [0051]-[0053], [0063], [0070] (describing reference signals transmitted by base station antenna ports to perform channel measurements, such as RSRP).

d. [1c] “transmitting, by the UE, first information to the base station;”

104. *Liu* discloses transmitting, by the user equipment (UE), first information to the base station.

105. For example, *Liu* explains that the user equipment transmits first information about the received wireless signal back to the base station after measuring each port signal. *Liu*, 16, FIG. 1 (S102). The first information includes “channel state information (CSI),” such as the RSRP, or “index information” corresponding to antenna port or port groups selected by the user equipment. *Liu*, 16, 17, 24, 25, 27.

106. The first information may be obtained and sent back for a subset of individual antenna ports in the M antenna ports (e.g., *Liu*’s N antenna ports in groups of one port per group) or for different groups of antenna ports, such as the groups from the X port groups (e.g., Cell 1 comprising ports 0,1), or other antenna port groups identified by *Liu* (antenna port groups N1, N2, or N3). *Liu*, 16-20. The “CSI corresponding to these N antenna ports or the index information corresponding to these N antenna ports is provided as a notification to the second network device so as to cause the second network device to transmit data on these N antenna ports to the first network device.” *Liu*, 17, 27. The determination of which antenna port information to send back to the base station is based on criteria

or threshold information that can be “predefined or provided through base station broadcasting” to the user equipment. *Liu*, 17, 22-23.

107. Moreover, the user equipment may measure information, such as RSRP, for each group of antenna ports corresponding to a particular cell for the wireless signal and sends back first information related to each group of antenna ports. *Liu*, 16-17. When the M ports are divided into five (X) port groups, the “UE measures the 5 groups of antenna ports corresponding to these 5 cells and discovers that the received signal power is strongest for ports0,1 corresponding to cell 1; for example $RSRP_1 > RSRP_2 > RSRP_3 > RSRP_4 > RSRP_5$, with ... $RSRP_n$ representing the received signal power corresponding to cell n.” *Liu*, 17. The user equipment then “feed[s] back first information of N antenna ports of the M antenna ports according to the first criterion” related to signal strength, such as SNR, when the “UE compares each SNR(i) to select a best antenna configuration and feeds its corresponding first information back to the base station,” “including antenna indices and/or CSI [RSRP].” *Liu*, 21, 30.

108. A POSITA would have recognized that *Liu*’s UE feeding back CSI information, such as RSRP, describes the well-known measurement report process used in prior art systems, as described above in Section VI (Technology Background). For example, “UE obtains the CSI based on the signal measurement resource and interference measurement resource and reports it.” *Liu*, 23. *Park* and

Kim confirm the POSITA's understanding, explaining that, during RRM measurements (such as in *Liu*), the UE measures the RSRP, RSRQ, RSRP-to-max(RSRP) power ratio, and other parameters of the CSI-RS wireless signals sent from the base station, then reports the values back to the base station in a measurement report. *Park*, [367]-[378] ("The RSRP of the RRM-RS is measured and reported for each antenna port. A plurality of RRM-RSs may be configured in a UE" and "If the UE reports the RSRP of an RRM-RS, it also provides notification of the number of the antenna port and the number of the RRM-RS for which the RSRP is the result of RSRP measurement" and "The UE aligns the RSRP(r, m), and reports the RSRP of L antenna ports chosen from among these that are strongly received" and "the RSRP of a maximum of L antenna ports, which have an RSRP difference greater than a certain threshold value expressed as an RSRP ratio or dB scale, is reported ..."); *Kim*, [0106], [0135]-[0137], [0139], [0148]-[0149] (UE measures the RSRP and RSRP-to-max(RSRP) ratio of the wireless signals and reports RSRP back to the base station in a measurement report).

- e. **[1d] [1d1] "wherein, K antenna port groups of the base station are used to transmit the first wireless signal;"**

109. *Liu* discloses wherein, K antenna port groups of the base station are used to transmit the first wireless signal, in at least two alternative ways.

110. First, the base station transmits the first wireless signal using M individual antenna ports, where M antenna ports (in *Liu*) corresponds to K antenna port groups (of the '271 patent) having one port per group. The '271 patent confirms that “the antenna port group [may] include[] only one antenna port.” Ex. 1001, 13:64-65; *see also* Ex. 1001 at 2:45-46. Second, the base station transmits the wireless signal using X cells, where X groups (in *Liu*) correspond to K antenna port groups (of the '271 patent) having two ports in each of the X groups, where each antenna port group in the X groups represents a cell. *Liu*, 16-17, 21, 23, 24, 25, 26, 30.

111. *Liu* explains that the base station “transmits signals of the M antenna ports” to the user equipment, “which receives the signals of the M antenna ports,” which a POSITA would have understood teaches transmitting and receiving the wireless signal of M antenna ports identified by the configuration information. *Liu*, 15, *see also Liu*, 23 (having same disclosure), 24 (having same disclosure), 25 (having same disclosure), 32 (having same disclosure), FIG. 1 (step S101), FIG. 3 (step S201), FIG. 3 (step S301). The “second network device” transmitting the M wireless signals “may be a base station,” and the “first network device” receiving the M wireless signals “may be user equipment (UE).” and *Liu*, 15, *see also Liu*, 23. A POSITA would have understood that the base station “transmit[ing] signals

of the M antenna ports” describes transmitting the wireless signal using the M (K, in the ’271 patent) antenna port groups where each group corresponds to one port.

112. Moreover, when the M antenna ports are divided into X cells, where X (in *Liu*) corresponds to K (in the ’271 patent) antenna port groups having groups of two antenna ports per cell, each cell has an antenna configuration the base station uses to transmit the wireless signal that is received by the user equipment. When “the M antenna ports are divided into X groups,” the “base station individually configures one codebook set for each antenna port group,” which a POSITA would have understood describes the base station transmitting the wireless signal for each of the X (K in the ’271 patent) antenna port groups because the codebook information for each group corresponds to the matrix that describes the beam pattern created for the transmission by the base station and received by the user equipment for that port group. *Liu*, 21. *Liu* confirms this, explaining that “the first group of antenna ports corresponds to antenna configuration 1, comprising antenna ports port0 and port1,” and “the base station configures codebook set C1 for antenna configuration 1.” *Liu*, 21. *Liu*’s user equipment “measures the 5 groups of antenna ports corresponding to these 5 cells” and records the received signal power (RSRP) for each cell’s wireless signal, which confirms a POSITA’s understanding that each group of antenna ports (e.g.,

cell) is used to transmit a corresponding wireless signal. *Liu*, 26. And these are the same wireless signal discussed in [1b].

- f. [1d2] “the first signaling is used by the UE to determine the K antenna port groups transmitting the first wireless signal received by the UE; the K is a positive integer greater than 1;”

113. *Liu* discloses that the first signaling is used by the user equipment (UE) to determine the K antenna port groups transmitting the first wireless signal received by the user equipment (UE); the K is a positive integer greater than 1.

114. *Liu* explains that “M is a positive integer” and “X is a positive integer,” each of which correspond to K antenna port groups being a positive integer, as explained in element [1d1]. *Supra* § XI.A.1.e; *see, e.g., Liu*, 15, 23, 31.

Liu discloses that the number of antenna port groups (K in the '271 patent and either M or X in *Liu*) is larger than one because it teaches that, in some embodiments, “the M antenna ports are divided into multiple groups, and the transmission to the first network device takes the form of multiple pieces of configuration information, with each piece of configuration information corresponding to the configuration of one of the antenna port groups.” *Liu*, 16. One example is further discussed in the context of Fig.2, showing M = 88 antenna ports numbered a11, a12, ..., a18, b11, b12, b13, ... k11, k12, ... k18. *Liu*, FIG. 2. *Liu* teaches that these 88 antenna ports can be used in groups that are traversed by the user equipment.

115. *Liu*'s user equipment uses the configuration information and broadcasting and signal notifications ("first signaling") to determine the M, or alternatively X, antenna port groups transmitting the first wireless signal received by the user equipment. *Liu*'s base station sends configuration information, as explained in element [1a], *supra* § XI.A.1.b (*see also Kim* [0078]-[0080], [0106], [0111], [0119], [0135]-[0136]), which "is the configuration information of the M antenna ports; alternatively, that the M antenna ports are divided into multiple [X] groups, ... with each piece of configuration information corresponding to the configuration of one of the antenna port groups." *Liu*, 16, 23, 25, 32. A POSITA would have understood that the user equipment uses this configuration information and broadcasting and signal notifications ("first signaling") to determine the M or X antenna port groups because the configuration information specifies the antenna port groups and includes "an antenna port pattern" and "codebook information [that] refers to information containing multiple precoding matrices" of the antenna port groups. *Liu*, 16, 21; *supra* § VI (Technical Background). The user equipment uses this information to determine and measure the antenna port groups, such as "calculat[ing] the SNR" or RSRP of each antenna port group "based on the configured codebook set." *Liu*, 16, 21. A POSITA would have understood the codebook in the configuration information and broadcasting and signal notifications ("first signaling") specifies the K antenna port groups and is used by

the user equipment to identify and measure the first wireless signal. *Liu* confirms this, because, for “the first group of antenna ports correspond[ing] to antenna configuration 1, comprising antenna ports port0 and port1; the base station configures codebook set C1 for antenna configuration 1, and the precoding matrices included in C1 are W11, W12, W1n, ..., W1N,” and, “[b]ased on the antenna ports corresponding to each antenna configuration, the user equipment provides one optimal rank, PMI(i), and SNR(i) in the corresponding codebook set Ci as feedback” *Liu*, 21. Once the user equipment has determined and measured each antenna port group, it selects the best antenna configuration and sends the identifying information back to the base station. *Liu*, 21.

- g. [1d3] “the K antenna port groups respectively correspond to K channel quality values; the K channel quality values are K non-negative real numbers; the K channel quality values are Reference Signal Received Powers (RSRPs) or a Signal to Interference plus Noise Ratios (SINRs);”**

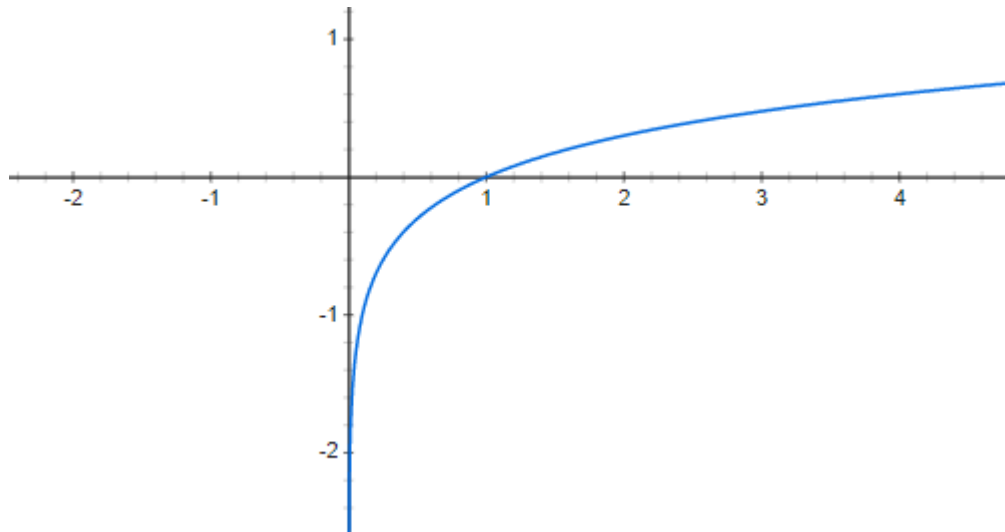
116. *Liu* discloses that the K antenna port groups respectively correspond to K channel quality values; the K channel quality values are K non-negative real numbers; the K channel quality values are Reference Signal Received Powers (RSRPs) or a Signal to Interference plus Noise Ratios (SINRs).

117. *Liu* explains that each of the M antenna ports or X antenna port groups (each corresponding to K antenna ports, as discussed in element [1d1], *supra* § XI.A.1.e), has channel state information (CSI) including a channel quality

value. The CSI measurements include RSRP, which a POSITA would have recognized is a non-negative real number, because RSRP is the received power of the wireless signal. *Liu*, 21. A POSITA would have known that power measurements in general, and received power or RSRP in particular, are measured in Watts (or milliWatts), which is always a non-negative real number. A POSITA would have also known and understood that an RSRP value can be represented using the decibel scale (abbreviated as “dB”), which can be a non-negative real number, such as disclosed by *Park*, when one uses a small enough value for the reference that the dB scale is using, as I explain below and as *Park* has done. See *Park*, [377]-[378], FIG. 12. When using the decibel scale, “dB” represents a measured power, P_{meas} , compared to a reference power, P_{ref} , using the formula Measured Power, P_{meas} , in dB = $10 \cdot \log(P_{meas}/P_{ref})$.⁷ When P_{meas} is less than P_{ref} , the ratio of P_{meas}/P_{ref} is less than 1 (and greater than 0, since both the numerator and the denominator represent power, and are thus are positive real numbers) and the dB value is less than 0. The log function is defined for positive real numbers and $\log(x)$ is positive if, and only if, $x > 1$. If $x < 1$, then $\log(x)$ is a negative number. If

⁷ I note that in the definition of the dB, the logarithm is base 10 and the symbol “log” without an indication of the base is conventionally understood to be base 10.

$x=1$, $\log(1)=0$. This is shown graphically below, and I note that, as x (on the horizontal axis) approaches 0, $\log(x)$ asymptotically approaches negative infinity.



118. Therefore, for RSRP or SINR, which are non-negative real numbers, the dB representation may involve non-negative or negative numbers. For example, if the RSRP is 5 mWatts, and the reference value is 1 mWatt, then $10 \cdot \log(5/1) = 6.99$ dB. If, however, the RSRP is 0.5 mWatts, using the same 1 mWatt reference value, then $10 \cdot \log(0.5/1) = -3.01$ dB. In either case, the dB value represents a non-negative real value for the RSRP, i.e., 5 mWatt or 0.5 mWatt, respectively. Similarly, if the reference power is agreed to be 0.1 mWatt, then the same 5 mWatt and 0.5 mWatt would be represented as 16.99 dB and 6.99 dB respectively. In short, the dB representation of a real-valued positive power may be a real-valued positive number, if the reference value is small enough and *Park* chose such a frame of reference in the example of Fig. 12.

119. *Liu* explains that “[d]uring RRM [radio resource management] measurement[s], the user equipment employs a random beamforming approach in the codebook set C_i corresponding to the pilot frequency of each antenna configuration to calculate and report the mean reference signal receiving power (RSRP)” *Liu*, 21. As one example, “the user equipment at the pilot frequency of antenna configuration 1 uses all the codebooks in C_1 to conduct random beamforming and obtain RSRP₁,” and performs similar RSRP measurements for each other antenna configuration. *Liu*, 16, 21-22. Similarly, the user equipment “UE measures the 5 groups of antenna ports corresponding to these 5 cells and discovers that the received signal power [RSRP] is strongest for ports_{0,1} corresponding to cell 1; for example, $RSRP_1 > RSRP_2 > RSRP_3 > RSRP_4 > RSRP_5$, with ... RSRP_n representing the received signal power corresponding to cell n.” *Liu*, 17, 26. *Liu* acknowledges that RSRP measurements were well-known in the prior art “when performing cell selection.” *Liu*, 26. Based on these disclosures, a POSITA would have understood that the user equipment uses the codebook set to measure the RSRP for each of the M or X antenna port groups (each corresponding to K antenna port groups, *supra* Section XI.A.1.e ([1d1])). *Liu*, 17, 26, 22.

120. A POSITA would have known that an RSRP value is a non-negative real number because the RSRP is the received signal power. Furthermore, I

understand that Patent Owner has alleged that dB values less than zero meet this limitation. If the claim is interpreted to cover that meaning, then *Park* discloses it as explained above by the disclosure of the RSRP using dB values.

h. [1d4] “K1 antenna port groups of the K antenna port groups correspond to K1 channel quality values of the K channel quality values; the K1 is a positive integer less than or equal to the K;”

121. *Liu* discloses that K1 antenna port groups of the K antenna port groups correspond to K1 channel quality values of the K channel quality values; the K1 is a positive integer less than or equal to the K.

122. As explained for element [1d3], *Liu*’s user equipment measures K channel quality values (RSRP) for each of the M or X antenna port groups (K antenna port groups). *Supra* § XI.A.1.g ([1d3]). Element [1d4] states that K1 is some or all of the K antenna port groups and K1 channel quality values is some or all of the K channel quality value discussed in elements [1d1]-[1d3].

123. *Liu* explains that the user equipment determines the channel quality values (RSRP) for a subset, N, of the M antenna ports transmitting the wireless signal, as described in element [1d3], by virtue of N being a subset of M antenna ports measured by the user equipment because “N is an integer less than or equal to M.” *Liu*, Abstract, 16, FIG. 1 (step S102). The user equipment selects N (K1 in the ’271 patent) antenna port groups and sends the channel quality value information (RSRP) back to the base station as first information.

124. *Liu*'s user equipment includes a "feedback unit" for "selecting N antenna ports from among M antenna ports, where N is the smallest number of antenna ports" fulfilling a particular criteria. *Liu*, 7, 11. A POSITA would have understood that, because N is less than or equal to M or corresponds to the "smallest number of antenna ports" meeting a specified criteria, N (e.g., K1) is a positive integer less than or equal to M or X (e.g., K), because N contains at least one antenna port or cell comprising an antenna port group being reported back, but is not larger than the complete set of ports or cells (e.g., M or X) measured by the user equipment. A POSITA would have understood that the N antenna port groups, or subset of X antenna port groups (e.g., Cell 1, ports0,1), are less than or equal to the M (e.g., K in the '271 patent) antenna port groups. Once the CSI information (e.g., RSRP) is determined for the N antenna ports, it "is provided as a notification to the second network device [base station]" so the base station can "transmit data on these N antenna ports to the first network device [user equipment]." *Liu*, 17.

i. **[1d5] "a first proportional sequence corresponds to a ratio(ratios) among the K1 channel quality values;"**

125. *Liu* discloses or suggests that a first proportional sequence corresponds to a ratio(ratios) among the K1 channel quality values. *Park* discloses and renders obvious a first proportional sequence that corresponds to a ratio(ratios) among the K1 channel quality values being based on RSRP. In my opinion, *Liu* in combination with *Park* renders obvious element [1d5].

126. For example, *Liu* discloses “the user equipment employs a random beamforming approach ... to calculate and report the mean reference signal receiving power (RSRP) or reference signal receiving quality (RSRQ)”. *Liu*, 21, 30, 16, 26 (discussing RSRP, RSSI, RSRQ), *supra* § XI.A.1.h ([1d4]). A POSITA would have recognized that RSRQ is “the ratio of RSRP to RSSI” for a particular Reference Signal. *Sesia LTE* at 514; *Park*, [295]. *Liu* also discloses a signal-to-noise ratio (SNR), which corresponds to a proportional sequence of the received signal power over the noise. *See, e.g., Liu*, 16, 23, 24, 25.

127. If the claim is interpreted to include or require that the ratio(ratios) in element [1d5] must include at least a ratio of different channel quality values, such as RSRP, described in element [1d9], or Patent Owner argues that *Liu* does not disclose such a ratio, *Park* renders such a ratio obvious because *Park* discloses “limit[ing] reporting to RSRPs of ports that are within a certain difference compared to the RSRP of the selected antenna ports, in other words, $\max(\text{RSRP}(r,m))$,” which describes comparing the RSRP of each measured antenna port group to the maximum RSRP of the received antenna port groups. *Park* also teaches that “the RSRP of a maximum of L antenna ports, which have an RSRP difference greater than a certain threshold value expressed as *an RSRP ratio* or dB scale.” *Park*, [370]-[373], [376]-[378] (emphasis added), FIG. 12. A POSITA would have understood that *Park*’s Equation 13 is using the “dB scale”

representation (based on the example in paragraphs [376]-[378] and FIG. 12), but that *Park* also discloses the “RSRP ratio,” which would have been understood as a division of the RSRP values in linear form, such as Watts or milliWatts, as compared to the “dB scale” difference. *Park*, [370]-[373], [376]-[378]. A POSITA would have understood this RSRP ratio to describe the power ratio $\text{RSRP}(r,m)/\max(\text{RSRP}(r,m))$. I explain the ratio between the linear power and logarithmic dB scale above in element [1d3]. *Supra* § XI.A.1.g.

128. *Park* teaches that the user equipment “aligns the $\text{RSRP}(r,m)$, and reports the RSRP of L antenna ports chosen from among these that are strongly received,” where $\text{RSRP}(r,m)$ is “the RSRP of the m^{th} antenna port of the r^{th} RRM-RS [radio resource management reference signal].”⁸ *Park*, [371], *see also Park*, [292], [324] (describing RRM), [359] (describing RRM-RS). To determine the “strongly received” antenna port signals, *Park* aligns each measured RSRP “and

⁸ *Park* further notes that “RRM-RS is made up of a plurality of antenna ports, and beamforming is configured differently for each antenna port so that the UE can measure the RSRP for each transmission beam,” which a POSITA would have understood describes similar configuration information and broadcasting and signal notifications (e.g., “first signaling”) to *Liu* for a beamformed antenna port group of one port (e.g., “first wireless signal”). *Park*, [359].

limits reporting to RSRPs of ports that are within a certain difference compared to the RSRP of the selected antenna ports, in other words, $\max(\text{RSRP}(r,m))$ ” and reports the antenna ports having “an RSRP difference greater than a certain threshold value expressed as an *RSRP ratio* or dB scale.” *Park*, [371]-[373] (emphasis added). As I discussed above, a POSITA reading *Park* would have recognized that an “RSRP ratio” describes the power ratio $\text{RSRP}(r,m)/\max(\text{RSRP}(r,m))$ because it is contrasted with the alternative “dB scale” option. *Park*, [371]-[373].

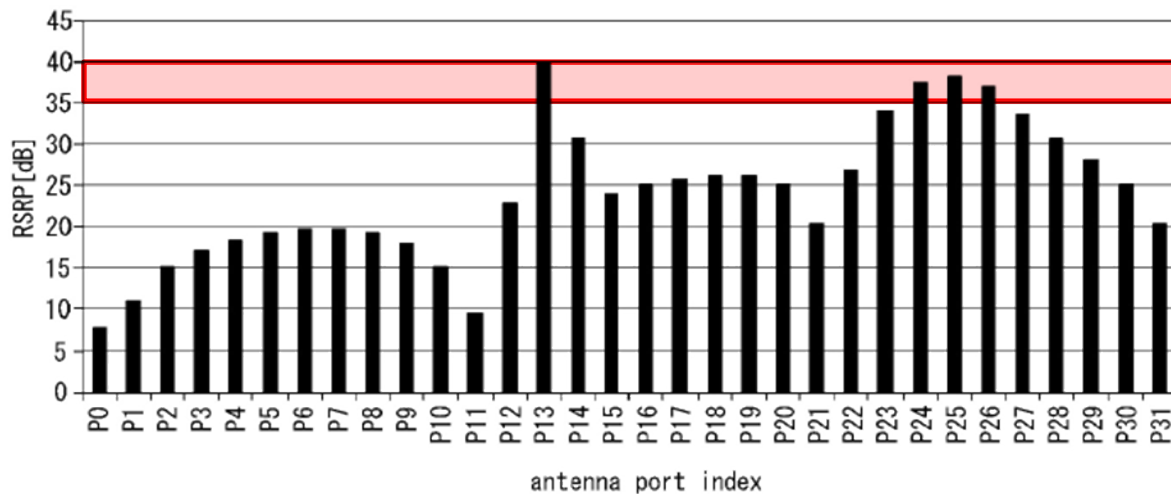
129. The description of FIG. 12 confirms that *Park* compares each measured RSRP to the $\max(\text{RSRP})$, which together form a proportional sequence of ratios, as described above. *Park*, [376]-[378], FIG. 12. *Park* performs the same RSRP ratio comparison for individual antenna ports and for “an antenna port group,” where the “base station may designate the [antenna port] group.” *Park*, [385]. Thus, *Park*, like *Liu*, teaches comparing the RSRP ratio(s) for antenna port groups with one antenna port per group (e.g., *Liu*’s M antenna ports) or multiple antenna ports per group (e.g., *Liu*’s X antenna port groups).

130. *Park* discloses that a group of antenna ports is selected when the antenna ports exceed a particular threshold. *Park*, [378], FIG. 12. For example, *Park* provides an example where, with reference to FIG. 12, “the UE has been configured to report the RSRP of an antenna port having an RSRP within 5 dB of

the antenna port with the greatest RSRP” *Park*, [378]. Although *Park* discloses an example involving the dB difference, a POSITA would have recognized from *Park*’s disclosure of the “RSRP ratio” calculation that the ratio could be determined by dividing the RSRP values ($\text{RSRP}(r,m)/\max(\text{RSRP}(r,m))$) using the measured received power in linear form (e.g., Watts or milliWatts), rather than taking the difference in dB. *Park*, [373], [378]. *Park* explains that, “because antenna port 13 has the greatest RSRP of 40 dB as shown in FIG. 12,” *Park*’s UE compares each of the other antenna ports’ RSRP values to antenna port 13 and “the UE reports antenna ports with an RSRP over 35 dB.” *Park*, [378]. As a result, *Park*’s UE reports “the RSRPs of antenna ports 24, 25 and 26 ... to [the] base station, along with antenna port 13” (the highest RSRP value). *Park*, [378], FIG. 12. A POSITA would have understood that the 40 dB value for port 13 in *Park*’s FIG. 12 is determined with respect to a particular reference value, and that same reference would be used to determine all the other RSRP values shown in FIG. 12. The goal, for example, in *Park* it to find a 5 dB difference between two RSRP values, which a POSITA would have understood could be determined by an RSRP ratio threshold of about 0.3162 (or $10^{-0.5}$), meaning the smaller RSRP value is not less than about 31.62% of the largest RSRP value. A POSITA would have recognized that calculating the RSRP ratios using the linear form (e.g., Watts or milliWatts) and dividing the measured RSRP value would have been simpler for

more conventional ratios, such as 50% or 75%. The annotated figure below shows the reported antenna ports based on *Park*'s threshold comparison in the red band of RSRP values satisfying *Park*'s example threshold compared to the maximum RSRP corresponding to port 13.

[FIG. 12]



Park, FIG. 12 (annotated).

131. I understand that Patent Owner has alleged that the “ratio(s)” and “proportional sequence” in elements [1d5]-[1d9] can be satisfied by subtracting dB values, *Park* teaches and renders obvious that interpretation.⁹ If this interpretation

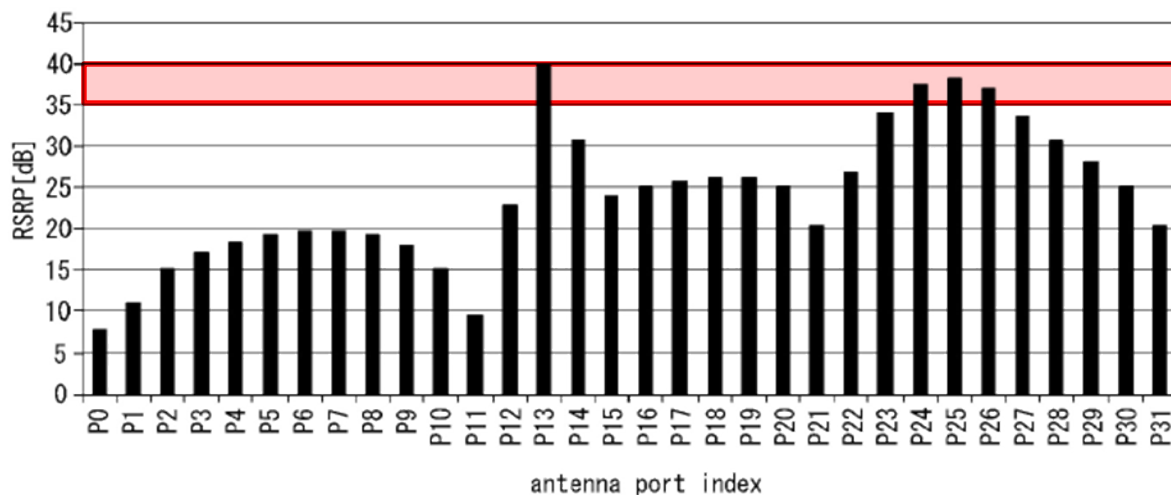
⁹ For purposes of my analysis here, I have been asked to consider Patent Owner’s interpretation, but I take no position on whether it is a proper interpretation of the claims. Rather, I have merely considered this alternative analysis, which, in my opinion is disclosed and rendered obvious by *Park*.

is found to be covered by the claims, *Park* discloses it, as an alternative to using the “RSRP ratio,” using Equation 13, shown below:

$$\text{RSRP}(r,m) - \max(\text{RSRP}(r,m)) > \text{Threshold}$$

Park, [372]-[373]. As explained above, *Park* uses this equation to determine whether the RSRP of a particular antenna port’s signal is within 5 dB of the strongest received antenna port signal (port 13) shown in FIG. 12. *Park*, [0376]-[0378], FIG. 12. “[B]ecause antenna port 13 has the greatest RSRP of 40 dB,” the UE compares each of the other antenna ports’ RSRP values to antenna port 13 and “the UE reports antenna ports with an RSRP over 35 dB.” *Park*, [378]. *Park*’s UE reports “the RSRPs of antenna ports 24, 25 and 26... to [the] base station, along with antenna port 13,” as shown by the red band in annotated FIG. 12 below. *Park*, [376]-[378], FIG. 12.

[FIG. 12]



Park FIG. 12 (annotated).

132. During prosecution of the '271 patent, the applicant argued that “the purpose of the target threshold in the present application and claims is a restriction of channel quality report, i.e., to restrict the difference between the largest and smallest channel qualities in a UE report.” Ex. 1002, 472. To the extent this limitation is interpreted to include or the Patent Owner argues that this requires the “proportional sequence” to include—and the UE to report—all of the RSRP values above a certain threshold, *Park* discloses this interpretation of the claims, as explained above.

133. A POSITA would have found it obvious to use *Park*’s “RSRP ratio” of the RSRP powers (proportional sequence)—or as argued by Patent Owner, the dB difference—in *Liu*’s system to determine the “received strongly” antenna port groups using *Park*’s relative comparison because it allows each UE to make the best use of the available transmitted wireless signal.

i. Motivation to combine

134. A POSITA would have been motivated to combine *Liu* and *Park*.

135. A POSITA would have been motivated to use *Park*’s proportional sequence to compare a ratio of *Liu*’s measured RSRP values for each of the K1 antenna port groups to identify the “strongly received” signals above a certain threshold, as explained by *Park*. *Park*, [371]-[373], [378], FIG. 12.

136. A POSITA would have been motivated to calculate *Park*'s RSRP-to-max(RSRP) ratio by dividing the raw RSRP values (in Watts)—or dB difference, as argued by Patent Owner—using *Liu*'s K1 measured RSRP channel quality values because doing so would allow the system to determine the relative strength of the received signals and select only those within a threshold range (e.g., 50% or higher—or 5 dB, about 31.62%—of the maximum power in Watts). *Park*, [371]-[373], [378], FIG. 12; *see also Kim*, [0135]-[0136], [0148]-[0149] (measuring RSRP-to-max(RSRP) power ratio in linear power measurement, such as mW). By considering *Park*'s ratio of RSRPs, rather than *Liu*'s ordinal rankings (e.g., 1st, 2nd, 3rd strongest signal), a POSITA would have recognized that the system would select only signals having a desired comparable strength to the strongest signal, which would have improved transmission and data transfer and thus improved the overall integrity and reliability of the system. For example, it would have improved data transfer over a particular transmission beam (e.g., antenna port group beam) because data throughput had been shown to be generally proportional to the RSRP and SNR in LTE systems, such as *Liu* and *Park*. *See Ex. 1021, Afroz, Measurements in Long Term Evolution Networks*, at 115, 118, 120, 122, FIG. 7 (explaining that throughput increases as SNR increases and RSRP is on the average proportional to SNR). Knowing the proportional strength of each received antenna port group's signal would have allowed for a determination of

which of the received signals (e.g., N or K1 antenna port group signals within the M or X antenna port groups) has sufficient strength to support transmit diversity over multiple beams. *See Liu*, 7 (“selecting N antenna ports from among M antenna ports ... that causes SNR to be less than or equal to or greater than or equal to a second threshold value after beamforming or transmit diversity”), 27, 34. *Park* confirms this, explaining that MIMO systems “collect[] a plurality of data pieces received through a plurality of antennas,” which describes transmitting the wireless signal using multiple base station antenna signals such that the received signal is divided across multiple transmissions, and received by multiple antennas, which improves the overall integrity and reliability of the system, such as in *Liu*. *Park*, [93]-[94], [405].

137. As one example, if the selection criteria were merely a cut-off value (e.g., all signals above a certain RSRP value), the system may select signals with very disparate powers if some of the received signals are much stronger than others, resulting in a wider disparity in signal strength and transmission rates, which could affect system performance. Similarly, because *Liu* and *Park*’s systems are MIMO systems, *see Park*, [93]-[94], *Liu*, 1, if the system were to select the three or four strongest signals to provide multiple transmission paths, the third or fourth signals may be much weaker than the first two, which could be disadvantageous to system performance because of the disparity in signal strength

makes the data transmitted on the weaker third and fourth signals less reliable. A POSITA would have recognized that this could be avoided by using *Park*'s ratios.

i. Expectation of success

138. A POSITA would have had a reasonable expectation of success in implementing *Park*'s proportional sequence selection criteria using an RSRP ratio in *Liu*'s system. *Park*'s proportional RSRP ratio determination performs a basic, well-known, and conventional calculation (division of power values or, as argued by Patent Owner as sufficient, subtraction of respective dB scale values) of the RSRP values measured by *Liu*'s system. *Park* compares the ratio to a threshold value and selects the antenna port groups satisfying the threshold. *See Park*, [372]-[373], [378]; *Kim*, [0135]-[0136], [0149] (measuring RSRP-to-max(RSRP) power ratio in linear power measurement, such as mW). *Liu* performs a similar threshold comparison to select a subset, e.g., N, of the M or X antenna port groups. *Liu*, 7 (“selecting N antenna ports from among M antenna ports ... that causes SNR to be less than or equal to or greater than or equal to a second threshold value after beamforming or transmit diversity”), 27, 34. Thus, using *Park*'s RSRP ratio comparison to determine a set of acceptable antenna port groups (e.g., beams for transmission) would have been a straightforward selection condition that applies only known, conventional calculations (determining each RSRP ratio and comparing it to a threshold) used according to their known functions to yield

predictable results (selecting antenna port group(s) based on the threshold comparison).

j. [1d6] “the first information is used to determine the K1 antenna port groups and the first proportional sequence;”

139. In my opinion, the combination of *Liu* and *Park* renders obvious the first information is used to determine the K1 antenna port groups and the first proportional sequence, as recited in [1d6].

140. As explained in element [1d5], the combination of *Liu* and *Park* renders obvious using the channel state information (CSI), such as RSRP, (“first information”) to determine the first proportional sequence and to select the N (e.g., K1 in the ’271 patent) antenna port groups of the M or X (K in the ’271 patent) antenna port groups. *Supra* § XI.A.1.i ([1d5]).

141. *Park* explains that “the UE reports antenna ports with an RSRP” ratio or difference from the max(RSRP) over a desired threshold to determine the selected port groups (e.g., *Liu*’s N or K1 antenna port groups). *Park*, [378]; *supra* § XI.A.1.i ([1d5]). *Liu*’s user equipment similarly sends antenna information identifying selected antenna port group(s) and the corresponding CSI (e.g., RSRP) values to the base station, specifically “the first information, including antenna indices and/or CSI.” *Liu*, 21, 30, 16. This includes antenna ports where the signal strength (e.g., signal-to-noise-ratio (SNR)) “is higher than” a threshold because the

“UE compares each SNR(i) to select a best antenna configuration and feeds its corresponding first information back to the base station.” *Liu*, 21, 30. “[T]he CSI [e.g., RSRP] corresponding to these N antenna ports or the index information corresponding to these N antenna ports is provided as a notification to the second network device [base station] so as to cause the second network device [base station] to transmit data on these N antenna ports to the first network device [UE].” *Liu*, 17.

142. A POSITA would have found it obvious to use *Liu*’s RSRP values to create the proportional sequence, as described above in element [1d5], *supra* § XI.A.1.i, which would, in turn, be used to determine *Liu*’s N (K1 in the ’271 patent) antenna port groups that “cause the second network device [base station] to transmit data on these N antenna ports to the first network device [UE].” *Liu*, 17. *Park*, like *Liu*, explains that “the UE has been configured to report the RSRP of an antenna port” group that meets the threshold criteria (K1 port groups, like *Liu*’s N port groups) to transmit data to the user equipment. *Park*, [378], [382]-[383]; *supra* § XI.A.1.i ([1d5]). To the extent this limitation is interpreted to include or the Patent Owner argues that the proportional sequence and the K1 antenna port groups are determined by those antenna ports that meet the threshold criteria, *see* Ex. 1002, 472, the combination of *Liu* and *Park* renders this obvious for at least the reasons explained in element [1d5]. *Supra* § XI.A.1.i; Ex. 1002, 472

(“Additionally, the purpose of the target threshold in the present application and claims is a restriction of channel quality report, i.e., to restrict the difference between the largest and smallest channel qualities in a UE report.”).

143. A POSITA would have found it obvious to combine *Liu* and *Park* to use *Park*’s proportional sequence, and would have reasonably expected to succeed in doing so, for the reasons set forth in element [1d5]. *Supra* § XI.A.1.i. The result would have been understood as using, or rendered obvious using, the first information to determine the K1 antenna port groups and the first proportional sequence for the reasons set forth in element [1d5]. *Supra* § XI.A.1.i. A POSITA would have reasonably expected to succeed in doing so because the use of *Park*’s proportional sequence was conventional and applied only well-known and conventional operations (e.g., RSRP ratio or dB difference) to achieve ordinary and expected results, as explained above in element [1d5]. *Supra* § XI.A.1.i; *Park*, [368]-[378].

- k. **[1d7] the first signaling is used to determine a target threshold; the target threshold is a non-negative real number;”**

144. *Liu* discloses or suggests, or alternatively the combination of *Liu* and *Park* renders obvious, that the first signaling is used to determine a target threshold; the target threshold is a non-negative real number.

145. *Liu* explains that the UE uses a “first criterion” or threshold, such as an SNR threshold, throughput threshold, or codebook information, to determine the selected antenna ports (K1 antenna port groups in the ’271 patent). *Liu*, 16-17. *Liu* explains that “the first criterion” or threshold for selecting antenna ports “may be predefined or provided through base station broadcasting,” which a POSITA would have understood to be part of the configuration information, broadcasting, and signal notifications (“first signaling”) described in element [1a]. *Liu*, 16-17. Indeed, *Liu* explains that “[t]he first network device [UE] needs to select N antenna ports from among M antenna ports according to a certain criterion and to notify the second network device of first information of the selected N antenna ports,” and that “the first network device feeds back first information of N antenna ports of the M antenna ports according to a first criterion, ... and the first criterion is at least one of antenna correlation information, SNR, channel capacity, throughput, SU (single-user)/MU (multi-user) transmission scheme, transmission mode, codebook information, and data packet size.” *Liu*, 16. For example, the base station “configures the first criterion, first threshold value, second threshold value, third threshold value, and fourth threshold value by broadcasting information, high-layer signaling, or dynamic signaling.” *Liu*, 22-23, 31. A POSITA would have understood that configuring these criteria and thresholds through configuration information and broadcasting and signal notifications (“first signaling”) describes

sending the threshold and criteria requirements to the user equipment in the first signaling of element [1a]. *Supra* § XI.A.1.b.

146. *Liu* describes the first signaling as including a power threshold, such as signal-to-noise ratio (“SNR”) threshold to “select[] N antenna ports from among M antenna ports,” and that the threshold may be sent as part of the first signaling, as explained above. *Liu*, 7, 8, 11, 14 (“antenna selection is carried out more effectively” using SNR threshold), 16, 18, 21. A POSITA would have found it obvious to send *Park*’s power ratio threshold through the same broadcast signaling as other threshold values to allow the base station to configure the user equipment according to the system requirements because *Liu* explains that “antenna selection is carried out more effectively” using thresholds, for example, as explained for [1d5]. *Liu*, 14; *see supra* § XI.A.1.i ([1d5]). A POSITA would have reasonably expected to succeed in transmitting the threshold for the RSRP ratio comparison with the *Liu*’s first signaling. Transmitting thresholds to the UE by the base station is taught by *Liu*, which discloses the base station sending, for example, an SNR threshold to be compared to the measured SNR, and other threshold values for comparison by the UE. *Liu*, 7, 8, 11, 14, 16, 18, 21. As such, determining the threshold value from the first signaling represented only the ordinary and expected use of transmitting information.

147. *Park*'s threshold ratio comparing measured-RSRP-to-max(RSRP) would have been known to be a non-negative real number because the ratio of two RSRP values in Watts, which are non-negative values, (or the dB representation of power) corresponds to a non-negative real number. For example, *Park*'s 5 dB difference threshold, corresponds to a non-negative real number power ratio of about 0.3162, as explained in element [1d5]. *See supra* § XI.A.1.i. Furthermore, when the ratio is calculated by performing a subtraction of the RSRP dB in log scale, the result is a negative number, which corresponds to a non-negative power ratio that is less than or equal to one, because of the logarithmic relationship described in element [1d5]. *See supra* § XI.A.1.i; *see Park*, [372]-[378], FIG. 12

148. Moreover, a POSITA would have understood that using a straight RSRP ratio of the power in Watts or dB values would be a non-negative real number. The ratio of two RSRP power values in Watts is also a positive value. Similarly, under Patent Owner's interpretation of the ratio, the ratio or magnitude difference of two respective dB values (when scaled to be positive values, as in *Park*'s example in FIG. 12 and paragraph [378]) is also positive, which *Park* describes "within 5 dB" of the highest RSRP value (a non-negative real number). *Park*, [0371]-[0378].

- I. **[1d8] “a first channel quality is a best channel quality value among the K1 channel quality values; a second channel quality is a worse channel quality value among the K1 channel quality values;”**

149. *Liu* discloses that a first channel quality is a best channel quality value among the K1 channel quality values and a second channel quality is a worse channel quality value among the K1 channel quality values.

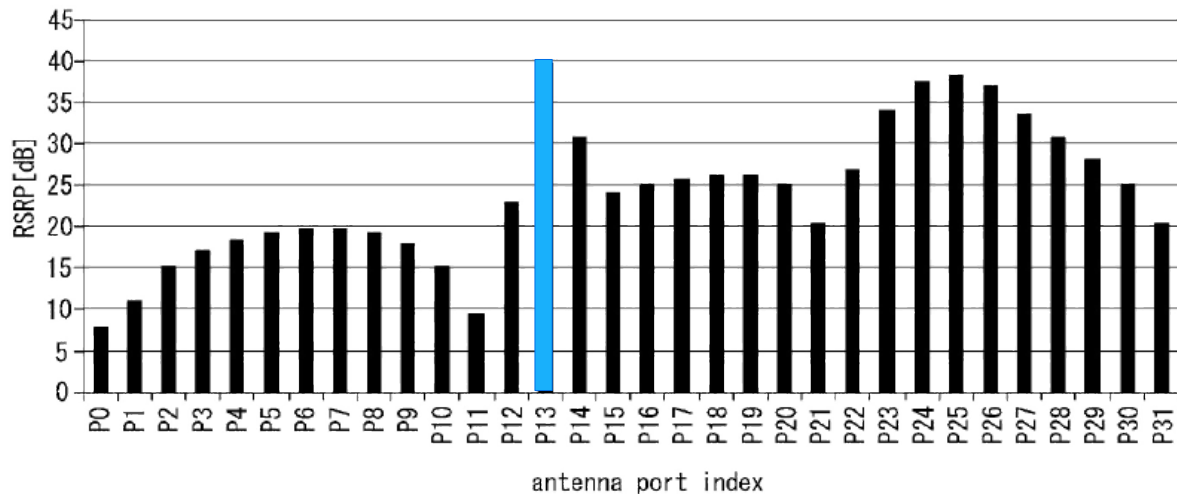
150. *Liu* discloses calculating the RSRP (“channel quality value”) for each of the N (K1 in the ’271 patent) antenna port groups within the M or X antenna port groups, where the RSRP values are compared and ranked from best (maximum value) to worse (less than the maximum value). *Liu*’s “UE measures the 5 groups of antenna ports corresponding to these 5 cells and discovers that the received signal power is strongest for ports0,1 corresponding to cell 1; for example, $RSRP_1 > RSRP_2 > RSRP_3 > RSRP_4 > RSRP_5$, with ... $RSRP_n$ representing the received signal power corresponding to cell n.” *Liu*, 17, 26. In this example, $RSRP_1$ is the “best channel quality value” or maximum RSRP and $RSRP_2$, $RSRP_3$, $RSRP_4$, and $RSRP_5$ are “worse channel quality value(s)” or lesser RSRPs.

151. *Park* confirms that the channel quality values include a maximum or “best” RSRP channel quality value, $\max(RSRP(r,m))$, and “worse” RSRP channel quality values that have a lesser RSRP. *Park*, [367]-[378], FIG. 12. *Park*’s FIG. 12, annotated below, shows antenna port 13 having the “best” channel quality value

(blue bar) with “the greatest RSRP of 40 dB” and the remaining antenna ports (black bars) have a “worse” channel quality value less than 40 dB. *Park*, [378],

FIG. 12.

[FIG. 12]



Park, FIG. 12 (annotated).

- m. [1d9] “a ratio between the second channel quality and the first channel quality is greater than or equal to the target threshold.”

152. In my opinion, the combination of *Liu* and *Park* renders obvious that a ratio between the second [worse] channel quality and the first [best] channel quality is greater than or equal to the target threshold.

153. *Liu* discloses that the criterion or threshold for selecting antenna port groups may rely on a power ratio calculation that is “greater than or equal to” a particular threshold, including power ratios, such as signal-to-noise (SNR) ratios.

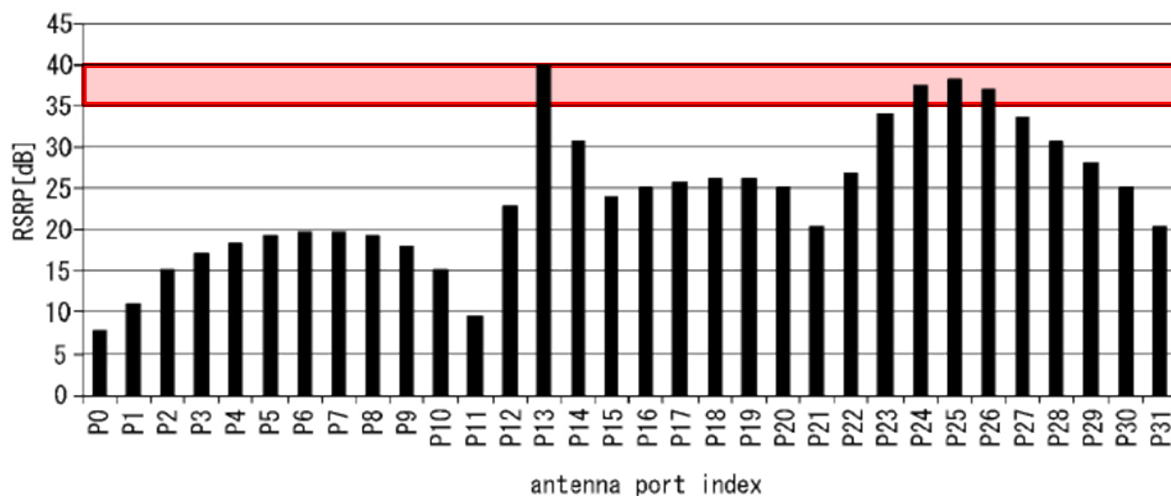
Liu, 2, 3, 7, 11, 17, 18, 19, 27, 28, 34, 35.

154. As explained for element [1d5], *Park* renders obvious determining a proportional sequence comprising a ratio(ratios) of the RSRP channel quality values for the received antenna port groups and selecting the antenna port groups that “have an RSRP difference greater than a certain threshold value expressed as an *RSRP ratio*,” or alternatively dB difference as argued by Patent Owner. *Supra* § XI.A.1.i; *Park*, [372]-[373], [378] (emphasis added). Thus, both *Liu* alone and the combination of *Liu* and *Park* teach determining particular power ratio measurements (e.g., SNR or RSRP ratio) for antenna port groups and comparing the power ratio to a threshold value. *Supra* § XI.A.1.i ([1d5]); *Park*, [385]. As I explain above, *Park*’s threshold represents an RSRP power ratio in Watts of about 0.3162 or 31.62% of the maximum RSRP (alternatively, 5 dB difference). Thus, *Park*’s system looks for those antenna ports having an RSRP-to-max(RSRP) ratio greater than 0.3162 in Watts or, greater than about 31.62% (alternatively -5 dB when represented in dB scale, which *Park* describes as “within 5 dB” difference, *Park*, [378]). As one example, based on *Park*’s FIG. 12, Port24 appears to have an RSRP of about 37 dB, which represents an RSRP power ratio in Watts of about 0.5012, meaning RSRP of Port24 is about half or just over 50% of RSRP of Port13 (or about -3dB when represented in dB scale). In contrast, Port20 appears to have an RSRP of about 25 dB, representing an RSRP power ratio in Watts of about 0.0316, meaning the RSRP of Port20 is about 3% of RSRP of Port13 (or

about -15 dB when represented in dB scale). *Park*, FIG. 12. Because *Park* described taking using a power “RSRP ratio” in Watts such as 0.3162—or, as Patent Owner has argued a 5 dB “dB scale” difference—*Park* teaches selecting Port24, but not Port20. *Park*, [372]; *supra* § XI.A.1.i ([1d5]); *also Kim*, [0135]-[0136], [0149] (measuring RSRP-to-max(RSRP) power ratio in linear power measurement, such as mW).

155. Annotated FIG. 12 of *Park* shows the selected values exceeding *Park*’s threshold in the red bar when determined by the RSRP ratio, or as argued by Patent Owner, the dB difference.

[FIG. 12]



Park, FIG. 12 (annotated).

156. *Park* and *Liu* both disclose that the power ratio is greater than a threshold value, *see above* and *supra* Section XI.A.1.i ([1d5]), which describes that

“a ratio between the second channel quality and the first channel quality is greater than or equal to the target threshold.”

157. A POSITA would have found it obvious to determine whether *Park*’s “RSRP ratio” is greater than or equal to a threshold value, as taught by *Liu. Supra* §§ XI.A.1.i ([1d5]), XI.A.1.k ([1d7]); *Park*, [371]-[373], [378] (the user equipment “report the RSRP of an antenna port having an RSRP within 5 dB of the antenna port with the greatest RSRP”), FIG. 12.

158. Although elements [1d8] and [1d9] recite only a “worse” channel quality value (e.g., any channel quality value that is not the “best” channel quality value), to the extent the Patent Owner argues that, based on the prosecution history, the threshold in element [1d9] requires the “worst” channel quality value to be above the target threshold, *Park* discloses and renders obvious the UE restricting and reporting the K1 channel quality values to only those values above the threshold value, as explained above in elements [1d5] and [1d6]. *See supra* §§ XI.A.1.i ([1d5]), XI.A.1.j ([1d6]); *Park*, [378], FIG. 12; *see* Ex. 1002, 472 (“Additionally, the purpose of the target threshold in the present application and claims is a restriction of channel quality report, i.e., to restrict the difference between the largest and smallest channel qualities in a UE report.”). In particular, *Park*’s Port27 represents the “worst” channel quality value of the selected and reported antenna port set, because it is the lowest RSRP value above *Park*’s

31.62% ratio (or 5 dB difference) threshold criteria, as shown in *Park*'s FIG. 12.

Park, [378], FIG. 12.

159. A POSITA would have been found it obvious to use *Park*'s RSRP ratio and determine whether it is "greater than or equal to" a threshold value (as described in *Liu*) to select strongly received antenna ports and provide for better data transfer by selecting those port groups that have strength in an acceptable range as compared to the strongest received signal.

i. Motivation to combine

160. As explained for elements [1d5]-[1d8], a POSITA would have found it obvious to implement *Park*'s RSRP-to-max(RSRP) ratio comparison between the worse (second) channel quality and the best (first) channel quality being greater than the target threshold. *Supra* §§ XI.A.1.i-XI.A.1.l.

161. A POSITA would have been motivated to implement *Park*'s RSRP-to-max(RSRP) ratio comparison between a worse (second) channel quality and the best (first) channel quality being greater than the target threshold. *Supra* §§ XI.A.1.i-XI.A.1.l ([1d5]-[1d8]). As explained above, both *Liu* and *Park* disclose threshold comparisons that require the power ratio to be "greater than," which satisfies being "greater than or equal to" the threshold value. Furthermore, using a "greater than" or "greater than or equal to" determination would have also been a matter of design choice to a POSITA and would have represented two known

options for selecting values greater than a particular threshold that were considered interchangeable options to a POSITA.

ii. Expectation of success

162. As explained for elements [1d5]-[1d8], a POSITA would have had a reasonable expectation of success in implementing *Park*'s RSRP-to-max(RSRP) ratio comparison between the worse (second) channel quality and the best (first) channel quality is greater than the target threshold. *Supra* §§ XI.A.1.i-XI.A.1.1 ([1d5]-[1d8]).

163. A POSITA also would have had a reasonable expectation of success in implementing a “greater than or equal to” comparison for *Park*'s threshold value because “greater than” and “greater than or equal to” were considered interchangeable to a POSITA. Moreover, the difference in implementing these comparisons in a particular system would have been a trivial matter of a single character in many cases (e.g., “>=” for “greater than or equal to,” and “>” for “greater than”) in the implementation software that would not have affected the operation of the other processes because both comparators were well known for operating within the same comparison formulas for nearly all available processing systems described in *Liu* and *Park*. As such, using *Liu*'s “greater than or equal to” comparison in *Park*'s RSRP-to-max(RSRP) ratio equation would have been a straightforward selection condition that applies only known, conventional

calculations (“greater than” versus “greater than or equal to”) used according to their known functions to yield predictable results (selecting a particular antenna port group based on the threshold).

- 2. Claim 2: “The method according to claim 1, wherein the K channel quality values are broadband channel quality values; or the first proportional sequence comprises K1 positive real numbers less than or equal to 1, and the first proportional sequence comprises at least one 1; or the first proportional sequence comprises quantized values corresponding to K1 positive real numbers; or the first proportional sequence comprises K1-1 positive real number(s), and the K1-1 positive real number(s) is(are) a ratio(ratios) between a channel quality value(s) other than the best channel quality value among the K1 channel quality values and the best channel quality value; or the first proportional sequence comprises quantized values corresponding to K1-1 positive real number(s).”**

164. For the reasons discussed above, the combination of *Liu* and *Park* renders obvious claim 1.

165. Claim 2 recites five alternative options separated by “or.” A POSITA would have understood that satisfying any one of these options satisfies the requirements of claim 2, which I understand is consistent with legal standards.

166. The combination of *Liu* and *Park* renders obvious the first proportional sequence comprising K1 ratios of positive real numbers less than or equal to 1, and the first proportional sequence comprising at least one 1.

167. As explained for elements [1d5]-[1d7] and [1d9], *Park* renders obvious determining, in *Liu*’s system, a proportional sequence of K1 RSRP-to-

max(RSRP) ratios results in values that are positive real numbers less than or equal to 1 and a value of 1 when the max(RSRP) is compared to itself. *Supra* §§ XI.A.1.i-XI.A.1.k ([1d5]-[1d7]), XI.A.1.m ([1d9]). For example, when the RSRP ratio of *Park*'s antenna 13 is calculated, RSRP is the same and the power ratio, $P_{\text{antenna13}}/P_{\text{antenna13}} = 1$ (and the difference is 0 dB because $\log(1) = 0 = 40\text{dB} - 40\text{dB}$). Similarly, for lesser RSRP (e.g., antennas 24, 25, 26) values, the power ratios, P_x/P_{max} , are positive real numbers less than 1 (dB difference is less than 0 because $P_x < P_{\text{max}}$). The same holds true when calculating *Liu*'s RSRP values.

168. Moreover, if the ratio RSRP(r,m)-to-max(RSRP(r,m)) is a direct division based on *Park*'s disclosure of an "RSRP ratio," *Park*, [378]; *supra* § XI.A.1.i ([1d5]), then the ratio will be 1 for $\text{max(RSRP(r,m))}/\text{max(RSRP(r,m))}$, and between 0 and 1, i.e., a non-negative real number less than 1, for all other $\text{RSRP(r,m)}/\text{max(RSRP(r,m))}$ since the numerator is smaller than the denominator and they are both positive real numbers.

3. Claim 3:

a. [3Preamble] "The method according to claim 1,"

169. For the reasons discussed above, the combination of *Liu* and *Park* renders obvious claim 1.

- b. [3a] “wherein K2 antenna port groups in the K antenna port groups correspond to K2 channel quality values in the K channel quality values; the K2 is a positive integer less than or equal to the K;”

170. *Liu* discloses wherein K2 antenna port groups in the K antenna port groups correspond to K2 channel quality values in the K channel quality values; the K2 is a positive integer less than or equal to the K.

171. *Liu* teaches that, within M or X antenna port groups (K antenna port groups), the user equipment may select two different sub-groups, such as N1 and N2 groups, for different purposes. *Liu* explains that the user equipment may select N1 antenna port groups from the M or X port groups (e.g., Cell 1), representing K1, and also N2 antenna port groups from the M or X port groups (e.g., Cell 2), representing K2. Because each of N1/Cell 1 (K1 in the '271 patent) and N2/Cell 2 (K2 in the '271 patent) includes one or more of the M antenna port groups, the N2/Cell 2 (K2 in the '271 patent) antenna port groups is a positive integer less than or equal to M (K in the '271 patent).

172. For example, “a first group of antenna ports,” N1, that is “optimal for transmit diversity transmission” may be selected and the “first information of the N1 antenna ports” (e.g., RSRP and antenna indices) is reported to the base station for selection, while “a second group of antenna ports,” N2, that is “optimal for beamforming transmission” may be selected and the “first information of the N2 antenna ports” (e.g., RSRP and antenna indices) is provided to the base station.

Liu, 12, 20; *see also Liu*, 19 (describing selecting N1 and N2 for optimal single-user and multi-user transmission, respectively), 29. *Liu* explains why multiple, different groups of antenna ports may be selected: “cross-polarized antennas may be selected for SU [single-user] because such antennas have low correlation, which aids spatial multiplexing; in the case of MU [multi-user] matching, each user optimally should select co-polarized antennas because they facilitate each user’s beamforming,” which a POSITA would have recognized as selecting two beamformed groups, based on the RSRP values discussed above to ensure sufficient power of the transmission, and possibly other factors, such as SU or MU requirements, as described in *Liu*. *Liu*, 29, 20.

173. A POSITA would have found it obvious to select different sets of antenna port groups based on the purpose of the group—e.g., single-user transmission or multi-user transmission—as disclosed in *Liu* or based on the frequency band(s) of the port groups to optimize the transmission of each transmission. A POSITA would have been motivated to select the K2 antenna port groups because it would allow the user equipment to apply additional criteria to further optimize the selection, such as for antenna correlation, single- or multi-user transmission, or a particular frequency band, by applying additional criteria to “giv[e] comprehensive consideration to signal power and [other criteria]” to select

the optimal transmission signals that may not be solely accounted for by RSRP ratios alone. *Liu*, 17, 26-27.

174. It also would have been obvious to a POSITA to select two sets of antenna port groups, K1 and K2, for example, because the carriers or frequency bands of each of the antenna port groups are different and, thus, each carrier or frequency band requires a different selection of antenna port groups to optimize the transmission from the base station to the user equipment. Similarly, a POSITA would have found it obvious to select the K2 antenna port groups during a second measurement report, such as a predetermined interval or occurrence of a triggering condition. *Liu*, for example, explains that the user equipment may measure SNR and a POSITA would have recognized that user equipment routinely measures the channel states and provides updated or additional measurement reports, such as at time intervals, at the base station's request, or upon a triggering condition. *Kim*, [0148] ("If the reporting is not triggered during a predetermined time (T2), the report triggering may be performed. In this case, N, M, T1, and T2 may be signaled to the UE through RRC signaling."). *Sesia LTE*, for example, also explains that measurement reporting may be carried out based on reporting configurations that may be "periodic or event triggered" to "cause the UE to send a measurement report." *Sesia LTE*, 75.

175. A POSITA would have found it obvious, as explained by *Liu*, to select different sets of antenna port groups based on the purpose of the group—e.g., transmit diversity, beamforming, or spatial multiplexing. *Liu*, 18, 20, 27, 29, 34, 35. A POSITA would have been motivated to select the K2 antenna port groups based on the purpose, such as transmit diversity, beamforming, or spatial multiplexing, or using a second measurement report, in addition to the K1 antenna port groups, because doing so would have allowed the user equipment to apply additional criteria to further optimize the selection of the antenna port groups to optimize each received signal. *Liu*, 18, 20, 27 29, 34, 35.

176. A POSITA would have had a reasonable expectation of success in selecting the K2 antenna port signals having channel quality values because such subset comprises a subset of the K channel quality (RSRP) values determined for every received signal, as explained in elements [1d3] and [1d4]. The K2 subset would have been a straightforward determination of those already-measured channel quality values that meet criteria already described in *Liu*, and therefore applies only known, conventional calculations used according to their known functions to yield predictable results.

c. [3b] “a second proportional sequence corresponds to a ratio(ratios) among the K2 channel quality values;”

177. *Liu* discloses, or the combination of *Liu* and *Park* renders obvious, that a second proportional sequence corresponds to a ratio(ratios) among the K2 channel quality values.

178. Because the K2 antenna port groups described in element [3a] are part of the original set of M or X antenna port groups, the user equipment prepares a second proportional sequence that corresponds to the RSRP-to-max(RSRP) ratio among the K2 RSRP values (channel quality values) because K2 is a subset of the K values already calculated when measuring the RSRP ratios, as explained in claim 1. *Supra* § XI.A.1.i ([1d5]), XI.A.1.l ([1d8]), XI.A.1.m ([1d9]). A POSITA also would have found it obvious to determine the proportional sequence of the K2 antenna port groups, which would be determined during the process described in element [1d5] because each ratio among the K2 antenna port groups would be determined when the user equipment performs the RSRQ¹⁰ or RSRP-to-max(RSRP) ratio comparison. *Liu*, [370]-[373]. As I explain above for element [1d5], a POSITA would have been motivated to determine antenna ports, such as

¹⁰ Unlike claim 1, claim 3 does not include any description regarding a specific ratio. The RSRQ ratio can satisfy claim 3 as a “second proportional sequence” even if Patent Owner argues it is not sufficient for claim 1.

the K2 antenna port groups using RSRQ or an RSRP-to-max(RSRP) ratio comparison and would reasonably have expected to succeed in doing so. *see supra* § XI.A.1.i ([1d5]).

- d. [3c] “a first receiving beamforming vector is used to receive signals transmitted through the K1 antenna port groups; a second receiving beamforming vector is used to receive signals transmitted through the K2 antenna port groups; the first receiving beamforming vector and the second receive beamforming vector are different;”

179. *Liu* discloses, or the combination of *Liu* and *Park* renders obvious, a first receiving beamforming vector is used to receive signals transmitted through the K1 antenna port groups, a second receiving beamforming vector is used to receive signals transmitted through the K2 antenna port groups, and that the first receiving beamforming vector and the second receive beamforming vector are different.

180. As explained for element [1d6] and below in element [3d], *Liu* teaches that the selected K1 and K2 antenna port groups “cause the second network device to transmit data on these N antenna ports to the first network device.” *Liu*, 17. A POSITA would have understood that each beam requires a beamforming vector for the respective antenna group.

181. *Liu* explains that, as was well known in the art, “[b]y merging transmit beamforming (BF)/precoding with reception, multiple-input multiple-output

(MIMO) wireless systems can attain diversity and array gain.” *Liu*, 1. *Liu* explains that a “typical system using BF [beamforming] or precoding generally may be expressed as:

$$\mathbf{y} = \mathbf{H}\mathbf{V}\mathbf{s} + \mathbf{n}$$

where $\mathbf{y}$ is the receive signal vector, $\mathbf{H}$ is the channel matrix, $\mathbf{V}$ is the precoding matrix, [and] $\mathbf{s}$ is the transmitted symbol vector”. *Liu*, 1. A POSITA would have recognized that the “precoding matrix” consists of a number of rows and a number of columns. When beamforming is used, as in *Liu*, each column of the precoding matrix is a beamforming vector and the forming of the beam is achieved through multiplying the precoding matrix by the transmitted symbol vector. *Liu* teaches that the user equipment knows the “precoding matrix, $\mathbf{V}$,” because the user equipment can “traverse[] all of the precoding matrices” when selecting antenna ports. *See Liu*, 18, 21-22, 27-28, 30-31. A POSITA would have recognized that the user equipment would then use each vector of a precoding matrix (the receiving beamforming vector) to receive the signals transmitted through the antenna port groups in order to calculate the channel distortion experienced by the reference signals. *See supra* § VI(Technology Background). That calculation, in turn, would allow the user equipment to tell the base station how to perform beamforming, i.e., what precoding to use, in an upcoming transmission. *Supra* § VI (Technology Background).

182. *Park* confirms that “beamforming is configured differently for each antenna port so that the UE can measure the RSRP for each transmission beam.” *Park*, [359]; *see also Vitthaladevuni*, [0005] (“The net effect of the array is to direct a (transmit or receive) beam in a predetermined direction.”). In other words, *Park* confirms *Liu*’s description that each port group (e.g., K1 and K2) would have its own different receiving beamforming vectors (and corresponding matrices) to account for the differences in the antenna port beams.

e. [3d] “the first information is further used to determine the K2 antenna port groups and the second proportional sequence.”

183. In my opinion, the combination of *Liu* and *Park* renders obvious the first information is further used to determine the K2 antenna port groups and the second proportional sequence.

184. As explained for elements [1d6] and [3b], the first information is used to determine the K2 antenna port groups and the second proportional sequence.

185. *Park* explains that “the UE reports antenna ports with an RSRP” over the desired threshold to select “strongly received” antenna port groups. *Park*, [378]; *supra* §§ XI.A.1.i-XI.A.1.j ([1d5]-[1d6]), XI.A.3.c ([3b]). *Liu* provides “the CSI [e.g., RSRP] corresponding to these N antenna ports or the index information corresponding to these N antenna ports ... as a notification to the second network device so as to cause the second network device to transmit data on these N

antenna ports to the first network device.” *Liu*, 17, 16, 21, 30. *Park* similarly explains that “the UE has been configured to report the RSRP of an antenna port” group that meets the threshold criteria for selection. *Park*, 371]-[373], [378], [382]-[383] (measuring RSRP for antenna port groups). A POSITA would have understood, based on these disclosures, the RSRP values (“first information”) are used to create the proportional sequence, as described above, and determine the antenna port groups above the desired threshold to select the N, N2, or Cell 2 antenna ports (K2 antenna port groups in the ’271 patent) and the corresponding beam or cell transmission associated with the port groups to transmit subsequent data.

4. **Claim 4: “The method according to claim 3, wherein any two antenna ports in the K1 antenna port groups are co-located or quasi-co-located (QCL), and any two antenna ports in the K2 antenna port groups are co-located or quasi-co-located (QCL); or any two antenna ports in the K1 antenna port groups are on a same carrier, and any two antenna ports in the K2 antenna port groups are on a same carrier; or the first signaling is further used to determine at least the last one of the K1, the K2 and the target threshold, a third channel quality is a best channel quality value among the K2 channel quality values, a fourth channel quality is a worse channel quality value among the K2 channel quality values, a ratio between the fourth channel quality and the third channel quality is greater than or equal to the target threshold, and the first information is further used to determine at least one of the first channel quality and the third channel quality.”**

186. For the reasons discussed above, the combination of *Liu* and *Park* renders obvious claim 3.

187. Claim 4 recites three alternative options, separated by “or.” As I indicated above in the context of claim 2, a POSITA would have understood that satisfying any one of these options satisfies the requirements of claim 4. As I also mentioned in the context of claim 2, it is my understanding that this is consistent with legal standards.

188. *Liu* discloses wherein any two antenna ports in the K1 antenna port groups are co-located or quasi-co-located (QCL), and any two antenna ports in the K2 antenna port groups are co-located or quasi-co-located (QCL).

189. *Liu* teaches that each of the M ports is located at a “second network device,” which may be “a base station” or “a macro base station.” *Liu*, 15, 16. “[T]he base station configures M antenna ports for UE,” *Liu*, 18, which a POSITA would have understood means that the M antenna ports are co-located or quasi-co-located at the base station configuring them. This is confirmed because the “UE traverses all the antennas and selects the antennas in such a manner that [the] UE’s own performance becomes optimal” and reports the selected antennas back to the base station, which would have been understood as a single base station, meaning that the antennas are co-located or quasi-co-located at the base station. *Liu*, 19-20.

190. This co-location or quasi-co-location is true when the M antenna ports are single antenna port groups or divided into X groups of multiple ports because *Liu* describes each antenna port as being part of the second network device. *Park* confirms the POSITA’s understanding of *Liu*, explaining that quasi-co-located includes when antenna ports “may be assumed to be transmitted at the same location (co-location) (for example, a terminal may assume antenna ports are transmitting from the same transmission point),” such as the single base station described in *Liu*. *Park*, [311].

191. Because the K1 and K2 antenna port groups are subsets of the K antenna port groups, *see* elements [1d4], [3a], and the K antenna port groups are

co-located or quasi-co-located at *Liu*'s base station, then the K1 and K2 antenna port groups are also co-located or quasi-co-located at *Liu*'s base station.

192. Moreover, a POSITA would have found it obvious that any two antenna ports in the K1 antenna port groups are on a same carrier, and any two antenna ports in the K2 antenna port groups are on a same carrier. This is because it was routine for antenna ports to be measured in a measurement report for selecting ports to transmit a data signal that would be on the same carrier. *Park*, for example, discloses each of the reference signals (K wireless signals, which includes K1 and K2) being on the same subcarrier k' , which a POSITA would have understood that being on the same subcarrier corresponds to the same carrier. *Park*, [231]-[236]. Indeed, *Park* confirms that the a “management resource may be identically configured in all RRM-RSs [first wireless signals] having the same carrier frequency, namely, all the RRM-RSs configured in the same component carrier” for RSSI measurements, which would have simplified the configuration of the system when allowing the user equipment to perform measurement reports and antenna port selection. *Park*, [417]. A POSITA would have been motivated to have at least two ports of the K1 antenna port group on the same carrier and at least two ports of the K2 antenna port group on the same carrier, for example, to “obviate[] the need for a separate carrier frequency to offer mobile broadcast services” or mitigate the need for a frequency-specific offset value during the measurement.

Sesia LTE, 505, 506 (explaining that the user equipment identifies cells on the same carrier as the serving cell); *Kim*, [0170]. Placing at least two ports of the K1 antenna port groups on the same carrier and at least two ports of the K2 antenna port groups on the same carrier represents was well-known to POSITAs and represents nothing more than the use of known processes operating (transmitting on the same carrier from more than one antenna port) according to their ordinary and expected functions to yield predictable results (transmitting on a particular carrier at each of the antenna ports in the K1 and K2 antenna port groups).

5. **Claim 5: “The method according to claim 3, further comprising: receiving a second wireless signal; wherein a target antenna port group is used to transmit the second wireless signal; the target antenna port group is associated with the K1 antenna port groups and the first proportional sequence, or the target antenna port group is associated with the K2 antenna port groups and the second proportional sequence.”**

193. For the reasons discussed above, the combination of *Liu* and *Park* renders obvious claim 3.

194. In my opinion, the combination of *Liu* and *Park* renders obvious receiving a second wireless signal; wherein a target antenna port group is used to transmit the second wireless signal; the target antenna port group is associated with the K1 antenna port groups and the first proportional sequence, or the target antenna port group is associated with the K2 antenna port groups and the second proportional sequence. As with claims 2 and 4, claim 5 recites alternative

options—“the target antenna port group is associated with the K1 antenna port groups and the first proportional sequence, or the target antenna port group is associated with the K2 antenna port groups and the second proportional sequence”—and it is my understanding that satisfying either of these options is sufficient to meet the limitations of claim 5.

195. The claim language does not require that the “target antenna group” be different from either the K1 or K2 antenna port groups, or that the “second wireless signal be associated with both the K1 and K2 port groups or proportional sequences—only that it be “associated with” one of those groups and proportional sequences.

196. *Liu* explains that “the CSI corresponding to these N antenna ports [e.g., RSRP] or the index information corresponding to these N antenna ports is provided as a notification to the second network device so as to *cause the second network device* [base station] *to transmit data on these N antenna ports to the first network device* [user equipment].” *Liu*, 17 (emphasis added), 27. A POSITA would have understood this data transmission to be a second wireless signal that is transmitted using the selected antenna port group(s) and received by the user equipment. This second wireless signal (data transmission) is different from the first wireless signal at least because (a) it is transmitted at a later point in time than the first wireless signal and (b) it carries a signal directed to the user equipment,

rather than being the broadcast wireless signal used to measure and select the transmitting port group(s). *Liu*, 17, 27; *see also Kim*, [0071], [0164].

197. As explained above, *Liu*'s system sends a data transmission ("second wireless signal") received by the user equipment using the selected N, N1, or Cell 1 port groups (K1 antenna port groups). *Supra* §§ XI.A.1.i ([1d5]), XI.A.1.l ([1d8]), XI.A.1.m ([1d9]). The selected port group comprises a "target antenna port group" because it is the selected and desired antenna port group for transmission of data to the user equipment, given the selection criteria. The selected N, N1, or Cell 1 port groups are associated with the claimed K1 antenna port groups because the selected N, N1, or Cell 1 port groups are identified by their corresponding index and RSRP value, and associated with the first proportional sequence because they are selected based on the threshold comparison of the first proportional sequence, as explained in elements [1d5], [1d8], and [1d9]. *Supra* §§ XI.A.1.i, ([1d5]), XI.A.1.l ([1d8]), XI.A.1.m ([1d9]); *Liu*, 17 ("the CSI ... or the index information corresponding to these N antenna ports is provided as a notification to the second network device so as to cause the second network device to transmit data on these N antenna ports to the first network device"), 27 (same), 24, 25-26, 19-20 ("UE traverses all the antennas and selects the antennas in such a manner that UE's own performance becomes optimal; for example, it selects a11, b13, g15, and h18, and thus the antenna index information for a11, b13, g15, and h18 is

reported to the base station”), 33, 31 (UE feeds back RSRP information to base station); *Park*, [371]-[373], [378]; *see also* Ex. 1027, *Kim*, [0071], [0164], [0135]-[0136], [0149].

6. Claim 6:

198. 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], [6b], and [6c]. The remaining elements of claim 6, [6d1]-[6d9], are substantively the same as elements [1d1]-[1d9]. 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 *Liu* and *Park*. *Supra* § XI.A.1 (claim 1).

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

199. To the extent the preamble is limiting, *Liu* discloses [6Preamble] as discussed in [1Preamble]. *Supra* § XI.A.1.a.

b. [6a] “transmitting, by the base station, a first signaling to a user equipment (UE);”

200. *Liu* discloses [6a] as discussed in [1a]. *Supra* § XI.A.1.b.

c. [6b] “transmitting, by the base station, a first wireless signal to the UE; and”

201. *Liu* discloses [6b] as discussed in [1b]. *Supra* § XI.A.1.c.

- d. **[6c] “receiving, by the base station, first information from the UE;”**

202. *Liu* discloses [6c] as discussed in [1c]. *Supra* § XI.A.1.d.

- e. **[6d] [6d1] “wherein, K antenna port groups of the base station are used to transmit the first wireless signal;”**

203. *Liu* discloses [6d1] as discussed in [1d1]. *Supra* § XI.A.1.e.

- f. **[6d2] “the first signaling is used by the UE to determine the K antenna port groups transmitting the first wireless signal received by the UE; the K is a positive integer greater than 1;**

204. *Liu* discloses [6d2] as discussed in [1d2]. *Supra* § XI.A.1.f.

- g. **[6d3] “the K antenna port groups respectively correspond to K channel quality values; the K channel quality values are K non-negative real numbers; the K channel quality values are Reference Signal Received Powers (RSRPs) or Signal to Interference plus Noise Ratios (SINRs);”**

205. *Liu* discloses [6d3] as discussed in [1d3]. *Supra* § XI.A.1.g.

- h. **[6d4] “K1 antenna port groups of the K antenna port groups correspond to K1 channel quality values of the K channel quality values; the K1 is a positive integer less than or equal to the K;”**

206. *Liu* discloses [6d4] as discussed in [1d4]. *Supra* § XI.A.1.h.

- i. **[6d5] “a first proportional sequence corresponds to a ratio(ratios) among the K1 channel quality values;”**

207. *Liu* discloses or suggests, or the combination of *Liu* and *Park* renders obvious, [6d5] as discussed in [1d5]. *Supra* § XI.A.1.i.

- j. **[6d6] “the first information is used to determine the K1 antenna port groups and the first proportional sequence;”**

208. *Liu* discloses or suggests, or the combination of *Liu* and *Park* renders obvious, [6d6] as discussed in [1d6]. *Supra* § XI.A.1.j.

- k. **[6d7] “the first signaling is used to determine a target threshold; the target threshold is a non-negative real number;”**

209. *Liu* discloses or suggests, or the combination of *Liu* and *Park* renders obvious, [6d7] as discussed in [1d7]. *Supra* § XI.A.1.k.

- l. **[6d8] “a first channel quality is a best channel quality value among the K1 channel quality values; a second channel quality is a worse channel quality value among the K1 channel quality values;”**

210. *Liu* discloses [6d8] as discussed in [1d8]. *Supra* § XI.A.1.l.

- m. **[6d9] “a ratio between the second channel quality and the first channel quality is greater than or equal to the target threshold.”**

211. *Liu* discloses or suggests, or the combination of *Liu* and *Park* renders obvious, [6d9] as discussed in [1d9]. *Supra* § XI.A.1.m.

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

212. The combination of *Liu* and *Park* renders obvious claim 6, as discussed above.

213. The additional limitations of claim 7 are substantively identical to claim 2, and are therefore disclosed by *Liu*, or rendered obvious by the combination of *Liu* and *Park*, for the reasons discussed in claims 1-2 and 6. *Supra* §§ XI.A.1, XI.A.2, XI.A.6.

8. **Claim 8: [8Preamble] “The method according to claim 6, [8a] wherein K2 antenna port groups in the K antenna port groups correspond to K2 channel quality values in the K channel quality values; the K2 is a positive integer less than or equal to the K; [8b] a second proportional sequence corresponds to a ratio(ratios) among the K2 channel quality values; [8c] a first receiving beamforming vector is used to receive signals transmitted through the K1 antenna port groups; a second receiving beamforming vector is used to receive signals transmitted through the K2 antenna port groups; the first receiving beamforming vector and the second receiving beamforming vector are different; [8d] “the first information is further used to determine the K2 antenna port groups and the second proportional sequence.”**

214. The combination of *Liu* and *Park* renders obvious claim 6, as discussed above.

215. The additional limitations of claim 8 are substantively identical to claim 3, and are therefore disclosed by *Liu*, or rendered obvious by the combination of *Liu* and *Park*, for the reasons discussed in claims 1, 3, and 6. *Supra* §§ XI.A.1, XI.A.3, XI.A.6.

9. **Claim 9: “The method according to claim 8, wherein any two antenna ports in the K1 antenna port groups are co-located or quasi-co-located (QCL), and any two antenna ports in the K2 antenna port groups are co-located or quasi-co-located (QCL); or any two antenna ports in the K1 antenna port groups are on a same carrier, and any two antenna ports in the K2 antenna port groups are on a same carrier; or the first signaling is further used to determine at least the last one of the K1, the K2 and the target threshold, a third channel quality is a best channel quality value among the K2 channel quality values, a fourth channel quality is a worse channel quality value among the K2 channel quality values, a ratio between the fourth channel quality and the third channel quality is greater than or equal to the target threshold, and the first information is further used to determine at least one of the first channel quality and the third channel quality.”**

216. The combination of *Liu* and *Park* renders obvious claim 8, as discussed above.

217. The additional limitations of claim 9 are substantively identical to claim 4, and are therefore disclosed by *Liu*, or rendered obvious by the combination of *Liu* and *Park*, for the reasons discussed in claims 1, 4, and 6. *Supra* §§ XI.A.1, XI.A.4, XI.A.6.

10. Claim 10: “The method according to claim 8, further comprising: transmitting a second wireless signal; wherein a target antenna port group is used to transmit the second wireless signal; the target antenna port group is associated with the K1 antenna port groups and the first proportional sequence, or the target antenna port group is associated with the K2 antenna port groups and the second proportional sequence.”

218. The combination of *Liu* and *Park* renders obvious claim 8, as discussed above.

219. The additional limitations of claim 10 are substantively identical to claim 5, and are therefore disclosed by *Liu*, or rendered obvious by the combination of *Liu* and *Park*, for the reasons discussed in claims 1, 5, and 6. *Supra* §§ XI.A.1, XI.A.5, XI.A.6.

11. Claim 11:

220. 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]-[11c] recite a “first receiver,” a “second receiver,” and a “third transmitter” performing steps comparable to steps [1a]-[1c]. The above discussion for claim 1 describes why each element of claim 11 is taught or rendered obvious by the combination of *Liu* and *Park*, although the specific “receiver[s]” and “transmitter” are further discussed below. *Supra* § XI.A.1 (claim 1).

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

221. To the extent the preamble is limiting, *Liu* discloses [11Preamble] as discussed in [1Preamble]. *Supra* § XI.A.1.a.

b. [11a] “a first receiver at the UE, receiving a first signaling originating from a base station;”

222. *Liu* discloses [11a] for the reasons discussed in [1a]. *Supra* § XI.A.1.b. *Liu* explains that a user equipment has “a receiving unit 11, which is for receiving signals of M antenna ports transmitted by a second network device” (FIG. 5) or “receiver 41” (FIG. 8) for “receiving signals of M antenna ports transmitted by a second network device,” which a POSITA would have understood describes a receiver for receiving first signaling and wireless signals from the transmitting base station. *Liu*, 25, 34, FIGS. 5, 8.

c. [11b] “a second receiver at the UE, receiving a first wireless signal originating from the base station; and”

223. *Liu* discloses [11b] for the reasons discussed in [1b]. *Supra* § XI.A.1.c. *Liu* discloses a receiver or receiving unit for MIMO systems, as explained in element [3c] and Section IX.A, *Liu*, 1, which a POSITA would have understood includes more than one receiver because it requires “multiple output,” meaning that two receivers at the user equipment each receive the first signaling and the first wireless signal. To the extent the Patent Owner argues that *Liu* does

not disclose or suggest a second receiver, the combination of *Liu* and *Park* renders obvious the “second receiver” recited in [11b].

224. *Park* explains that “transmission/reception data efficiency may be improved by adopting a plurality of transmitting antennas and a plurality of receiving antennas.” *Park*, [207]. A POSITA would have found it obvious to include a plurality of receivers to receive the first signaling and the first wireless signal because the broadcast transmission from the base station being received at multiple receivers, *see Park*, [93]-[94], FIG. 5 (showing one receiver at each antenna), would have allowed the user equipment to process the received signal at each of the receiving antennas more effectively than would be possible with a single receiver. The use of MIMO systems in which a base station transmits signaling and wireless signals from multiple antenna ports and a UE receiving each of the transmitted signaling and wireless signals at multiple antennas was routine and conventional for years before the ’271 patent was filed. *See also Luo*, FIG. 2. [0037] (showing antennas 224a and 224t, each having a transmitter, sending signals received by antennas 252a and 252r, each having a receiver 254a through 254r); *Vitthaladevuni*, FIG. 10, [0116], [0120]-[0121] (showing antennas 1056a and 1056t, each having a transmitter, sending signals received by antennas 1061a and 1061r, each having a receiver); *Hu*, FIG. 12, [0142]-[0143] (showing antennas 1524A and 1524T, each having a transmitter, sending signals received by antennas

1522A and 1522R, each having a receiver). A POSITA would have known that having two receivers, each performing some of the required functionality and complimenting each other by receiving the signaling and wireless signals from the base station was conventional in MIMO systems, such as *Liu, Park*, and the '271 patent.

225. For example, as explained above, *Luo* described what was well known to a POSITA, that a first and second receivers (“RCVR”) in elements 254a and 254r (yellow), each corresponding to a particular antenna 252, shown in annotated FIG. 2 below.

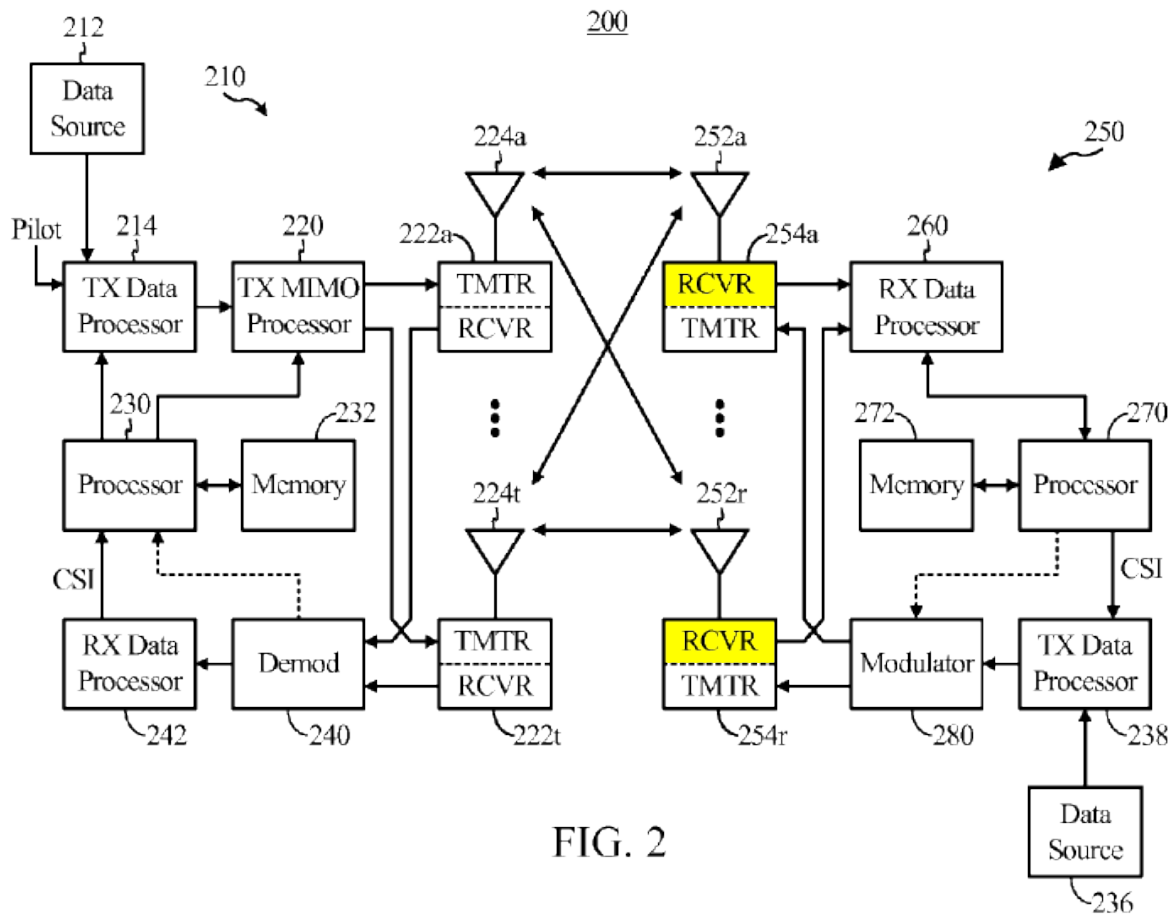


FIG. 2

Luo, FIG. 2 (annotated). *Luo* explains that “the transmitted modulated signals are received by N_R antennas 252a through 252r and the received signal from each antenna 252 is provided to a respective receiver (RCVR) 254a through 254r.” *Luo*, [0037]. *Luo* explains that “[e]ach receiver 254 conditions (e.g., filters, amplifies, and downconverts) a respective received signal, digitizes the conditioned signal to provide samples, and further processes the samples to provide a corresponding ‘received’ symbol stream” at the UE. *Luo*, [0037]. *Vitthaladevuni* and *Hu* confirm

this well-known knowledge of a POSITA. *Vitthaladevuni*, FIG. 10, [0116], [0120]-[0121]; *Hu*, FIG. 12, [0142]-[0143].

226. A POSITA would have been motivated to include two receivers to receive the first signaling and the first wireless signal because it would have assisted in enabling the MIMO operation disclosed in *Liu* and *Park* and would have facilitated greater throughput and increased the channel reliability because data transfer is generally proportional to the number of receiving and transmitting antennas, and having a receiver for each receiving antenna would have enhanced processing at the UE because processing could be divided amongst multiple receivers thereby improving operation of the system. Thus, multi-receiver and multi-transmitter configuration was a well-known design choice compared to using one receiver that alone performs all the required functionality and provides additional advantages over systems having only a single transmitter or receiver, as discussed above in Section VI (Technology Background). A POSITA would have reasonably expected to succeed in providing two receivers, each receiving the first signaling and the first wireless signal, in *Liu*'s user equipment because multiple receivers receiving this information was conventional and routine in the MIMO antennas described in *Liu* and *Park*. 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] “a third transmitter at the UE, transmitting first information to the base station;”**

227. *Liu* discloses [11c] for the reasons discussed in [1c]. *Supra*

§ XI.A.1.d. For example, *Liu* discloses that the user equipment includes a “transmitter 42 for feeding back first information of N antenna ports” to the base station and a “feedback unit 12” to transmit and “feed[] back first information of the N antenna ports” to the second network device (base station). *Liu*, 25, 34, FIGS. 5, 8.

- e. **[11d] [11d1] “wherein, K antenna port groups of the base station are used to transmit the first wireless signal;”**

228. *Liu* discloses [11d1] as discussed in [1d1]. *Supra* § XI.A.1.e.

- f. **[11d2] “the first signaling is used by the UE to determine the K antenna port groups transmitting the first wireless signal received by the UE; the K is a positive integer greater than 1;”**

229. *Liu* discloses [11d2] as discussed in [1d2]. *Supra* § XI.A.1.f.

- g. **[11d3] “the K antenna port groups respectively correspond to K channel quality values; the K channel quality values are K non-negative real numbers; the K channel quality values are Reference Signal Received Powers (RSRPs) or Signal to Interference plus Noise Ratios (SINRs);”**

230. *Liu* discloses [11d3] as discussed in [1d3]. *Supra* § XI.A.1.g.

- h. **[11d4] “K1 antenna port groups of the K antenna port groups correspond to K1 channel quality values of the K channel quality values; the K1 is a positive integer less than or equal to the K;”**

231. *Liu* discloses [11d4] as discussed in [1d4]. *Supra* § XI.A.1.h.

- i. **[11d5] “a first proportional sequence corresponds to a ratio(ratios) among the K1 channel quality values;”**

232. *Liu* discloses or suggests, or the combination of *Liu* and *Park* renders obvious, [11d5] as discussed in [1d5]. *Supra* § XI.A.1.i.

- j. **[11d6] “the first information is used to determine the K1 antenna port groups and the first proportional sequence;”**

233. *Liu* discloses or suggests, or the combination of *Liu* and *Park* renders obvious, [11d6] as discussed in [1d6]. *Supra* § XI.A.1.j.

- k. **[11d7] “the first signaling is used to determine a target threshold; the target threshold is a non-negative real number;”**

234. *Liu* discloses or suggests, or alternatively the combination of *Liu* and *Park* renders obvious, [11d7] as discussed in [1d7]. *Supra* § XI.A.1.k.

- l. **[11d8] “a first channel quality is a best channel quality value among the K1 channel quality values; a second channel quality is a worse channel quality value among the K1 channel quality values;”**

235. *Liu* discloses [11d8] as discussed in [1d8]. *Supra* § XI.A.1.l.

- m. [11d9] **“a ratio between the second channel quality and the first channel quality is greater than or equal to the target threshold.”**

236. *Liu* discloses or suggests, or the combination of *Liu* and *Park* renders obvious, [11d9] as discussed in [1d9]. *Supra* § XI.A.1.m.

12. **Claim 12: “The user equipment to claim 11, wherein the K channel quality values are broadband channel quality values; or the first proportional sequence comprises K1 positive real numbers less than or equal to 1, and the first proportional sequence comprises at least one 1; or the first proportional sequence comprises quantized values corresponding to K1 positive real numbers; or the first proportional sequence comprises K1-1 positive real number(s), and the K1-1 positive real number(s) is(are) a ratio(ratios) between a channel quality value(s) other than the best channel quality value among the K1 channel quality values and the best channel quality value; or the first proportional sequence comprises quantized values corresponding to K1-1 positive real number(s).”**

237. The combination of *Liu* and *Park* renders obvious claim 11, as discussed above.

238. The additional limitations of claim 12 are substantively identical to claim 2, and are therefore disclosed by *Liu*, or rendered obvious by the combination of *Liu* and *Park*, for the reasons discussed in claims 1, 2, and 11. *Supra* §§ XI.A.1, XI.A.2, XI.A.11.

- 13. Claim 13: [13Preamble] “The user equipment to claim 11, [13a] wherein K2 antenna port groups in the K antenna port groups correspond to K2 channel quality values in the K channel quality values; the K2 is a positive integer less than or equal to the K; [13b] a second proportional sequence corresponds to a ratio(ratios) among the K2 channel quality values; [13c] a first receiving beamforming vector is used to receive signals transmitted through the K1 antenna port groups; a second receiving beamforming vector is used to receive signals transmitted through the K2 antenna port groups; the first receiving beamforming vector and the second receiving beamforming vector are different; [13d] the first information is further used to determine the K2 antenna port groups and the second proportional sequence.”**

239. The combination of *Liu* and *Park* renders obvious claim 11, as discussed above.

240. The additional limitations of claim 13 are substantively identical to claim 3, and are therefore disclosed by *Liu*, or rendered obvious by the combination of *Liu* and *Park*, for the reasons discussed in claims 1, 3, and 11. *Supra* §§ XI.A.1, XI.A.3, XI.A.11.

- 14. Claim 14: “The user equipment to claim 13, wherein any two antenna ports in the K1 antenna port groups are co-located or quasi-co-located (QCL), and any two antenna ports in the K2 antenna port groups are co-located or quasi-co-located (QCL); or any two antenna ports in the K1 antenna port groups are on a same carrier, and any two antenna ports in the K2 antenna port groups are on a same carrier; or the first signaling is further used to determine at least the last one of the K1, the K2 and the target threshold, a third channel quality is a best channel quality value among the K2 channel quality values, a fourth channel quality is a worse channel quality value among the K2 channel quality values, a ratio between the fourth channel quality and the third channel quality is greater than or equal to the target threshold, and the first information is further used to determine at least one of the first channel quality and the third channel quality.”**

241. The combination of *Liu* and *Park* renders obvious claim 13, as discussed above.

242. The additional limitations of claim 14 are substantively identical to claim 4, and are therefore disclosed by *Liu*, or rendered obvious by the combination of *Liu* and *Park*, for the reasons discussed in claims 1, 4, and 11. *Supra* §§ XI.A.1, XI.A.4, XI.A.11.

- 15. Claim 15:** “The user equipment to claim 13, wherein the second receiver further receives a second wireless signal; wherein a target antenna port group is used to transmit the second wireless signal; the target antenna port group is associated with the K1 antenna port groups and the first proportional sequence, or the target antenna port group is associated with the K2 antenna port groups and the second proportional sequence.”

243. The combination of *Liu* and *Park* renders obvious claim 13, as discussed above.

244. The additional limitations of claim 15 are substantively identical to claim 5, and are therefore disclosed by *Liu*, or rendered obvious by the combination of *Liu* and *Park* for the reasons discussed in claims 1, 5, and 11, because, as I explain above for claim 11, in MIMO systems, the two receivers at the UE receive the wireless signals, such as the data transmission (“second wireless signal,” *supra* § XI.A.5 (claim 5)) from the base station. *Supra* §§ XI.A.1, XI.A.5, XI.A.11.

16. Claim 16:

245. Claim 16 is substantively similar to claim 6, except that the base station itself performing functions, rather than a method. Elements [16a]-[16c] also recite a “first transmitter,” “second transmitter,” and “third receiver” performing steps comparable to steps [6a]-[6c]. The above discussions for claims 1 and 6 describe why each element of claim 16 is taught or rendered obvious by the

combination of *Liu* and *Park*, although the specific “transmitter[s]” and “receiver” are further discussed below. *Supra* §§ XI.A.1 (claim 1), XI.A.6 (claim 6).

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

246. To the extent the preamble is limiting, *Liu* discloses [16Preamble] as discussed in [6Preamble] and [1Preamble]. *Supra* §§ XI.A.1.a, XI.A.6.a.

b. [16a] “a first transmitter at the base station, transmitting a first signaling to a user equipment (UE);”

247. *Liu* discloses [16a] for the reasons discussed in [1a] and [6a]. *Supra* §§ XI.A.1.b, XI.A.6.b. *Liu* explains that a base station has “a transmitting unit 21” (FIG. 6), “transmitting unit 31” (FIG. 7), “transmitter 51” (FIG. 9), or “transmitter 61” (FIG. 10) for “transmitting signals of M antenna ports to a first network device,” which a POSITA would have understood describes a transmitter for transmitting first signaling and wireless signals to the user equipment. *Liu*, 32, 33, 37, FIGS. 6, 7, 9, 10.

c. [16b] “a second transmitter at the base station, transmitting a first radio signal to the UE; and”

248. *Liu* discloses [16b] for the reasons discussed in [1b] and [6b]. *Supra* §§ XI.A.1.c, XI.A.6.c. *Liu* discloses a base station having multiple transmitters or transmitting units in the form of transmitting antenna port groups transmitting wireless radio signals to the user equipment for MIMO systems, as explained for element [3c] and Section IX.A, *Liu*, 1. To the extent the Patent Owner argues that

Liu does not disclose or suggest a second transmitter, the combination of *Liu* and *Park* renders obvious the “second transmitter” recited in [16b].

249. *Park* explains that “transmission/reception data efficiency may be improved by adopting a plurality of transmitting antennas and a plurality of receiving antennas.” *Park*, [207]. A POSITA would have found it obvious to include two transmitters to transmit the first signaling and the first wireless signal respectively because the broadcast transmission from the base station being transmitted at multiple transmitters, *see Park*, [93]-[94], FIG. 5, would have allowed the base station to transmit signaling and wireless signals from multiple antenna ports, as explained for [11b], which was routine and conventional years before the '271 patent was filed. *See also Luo*, FIG. 2, [0036] (showing antennas 224a and 224t, each having a transmitter, sending signals received by antennas 252a and 252r, each having a receiver); *Vitthaladevuni*, FIG. 10, [0116], [0118]-[0119] (showing antennas 1056a and 1056t, each having a transmitter, sending signals received by antennas 1061a and 1061r, each having a receiver); *Hu*, FIG. 12, [0140]-[0141] (showing antennas 1524A and 1524T, each having a transmitter, sending signals received by antennas 1522A and 1522R, each having a receiver).

250. For example, as explained above, *Luo* discloses what was well known to a POSITA, that a first and second receivers (“TMTR”) in elements 222a and

222r (blue), each corresponding to a particular antenna 224, shown in annotated FIG. 2 below.

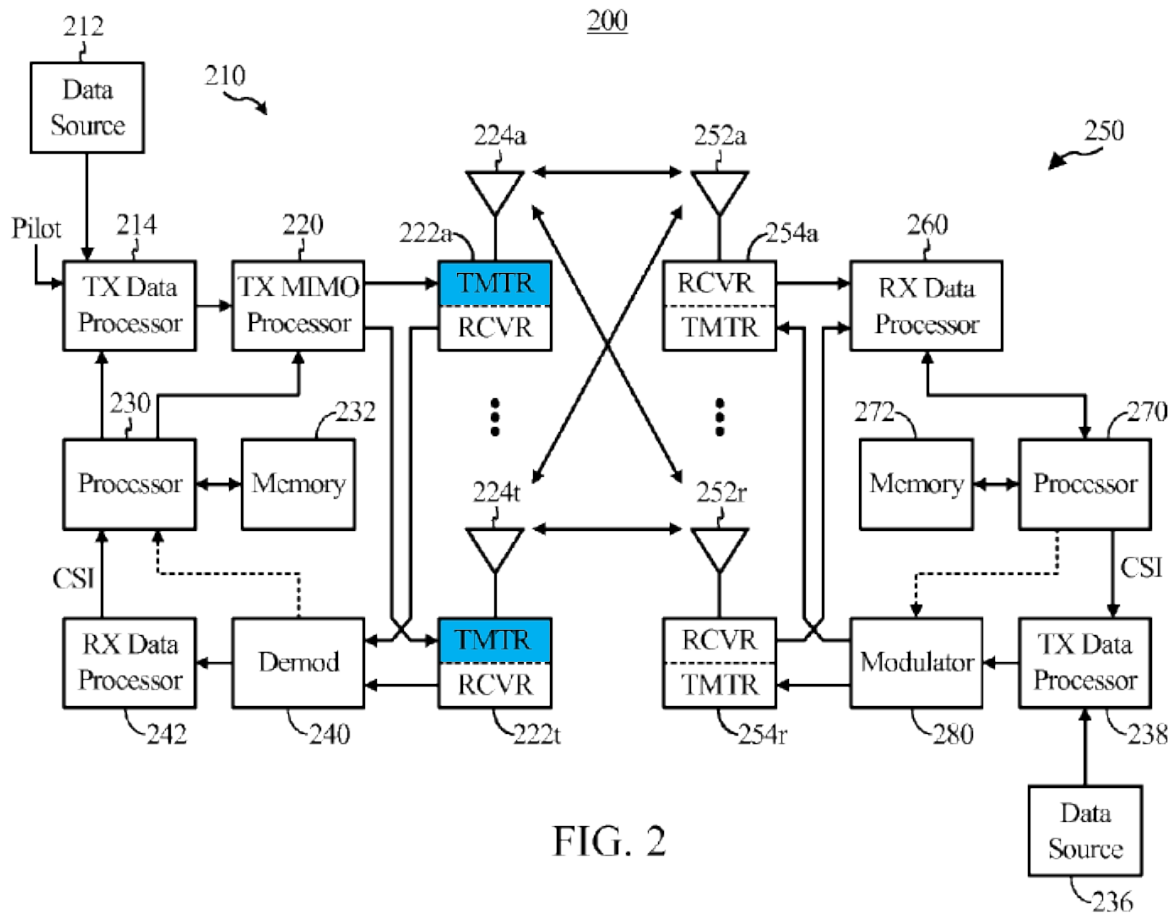


FIG. 2

Luo, FIG. 2 (annotated). Luo explains that a “TX [transmission] MIMO processor 220 then provides N modulation symbol streams to N transmitters (TMTR) 222a through 222t.” Luo, [0035]. Luo explains that “[e]ach transmitter 222 receives and processes a respective symbol stream to provide one or more analog signals” and “ N_T modulated signals from transmitters 222a through 222t are then transmitted from N antennas 224a through 224t, respectively.” Luo, [0036]. Vitthaladevuni

and Hu confirm this well-known knowledge of a POSITA. Vitthaladevuni, FIG. 10, [0116], [0118]-[0119]; Hu, FIG. 12, [0140]-[0141].

251. A POSITA would have been motivated to include two transmitters to transmit the first signaling and the first wireless signal because it would have assisted in enabling the MIMO operation disclosed in *Liu* and *Park* and would have facilitated greater throughput and increased the channel reliability because data transfer to the UE, which is generally proportional to the number of receiving and transmitting antennas. Having a transmitter for each transmitting antenna would have enhanced processing at the base station because the transmission processing could be divided amongst multiple transmitters thereby improving operation of the system. In particular, MIMO technologies were well established by the earliest priority date of the '271 patent, as explained above, and the use of multiple receivers, as claimed, would have required only the implementation of that well-established technology operating in its expected operation.

252. A POSITA would have reasonably expected to succeed in providing two transmitters, each transmitting the first signaling and the first wireless signal, in *Liu*'s base station because multiple transmitters transmitting this information was conventional and routine in the MIMO antennas described in *Liu* and *Park*. As such, the combination represents nothing more than known components operating

according to their ordinary and expected functions to yield predictable results (transmitting signals).

d. [16c] “a third receiver at the base station, receiving first information from the UE;”

253. *Liu* discloses [16c] for the reasons discussed in [1c] and [6c]. *Supra* §§ XI.A.1.d, XI.A.6.d. For example, *Liu* discloses that the base station includes a “a receiving unit 22” (FIG. 6), “receiving unit 32” (FIG. 7), “receivers 52” (FIG. 9), or “receiving unit 62” (FIG. 10) for “receiving first information of N antenna ports of the M antenna ports fed back by the first network device according to a first criterion,” which a POSITA would have understood describes a receiver for receiving the transmitted first information, such as antenna indices and RSRP values from the user equipment. *Liu*, 32, 33, 37, FIGS. 6, 7, 9, 10.

e. [16d] [16d1] “wherein, K antenna port groups of the base station are used to transmit the first wireless signal;”

254. *Liu* discloses [11d1] as discussed in [1d1] and [6d1]. *Supra* §§ XI.A.1.e, XI.A.6.e.

f. [16d2] “the first signaling is used by the UE to determine the K antenna port groups transmitting the first wireless signal received by the UE; the K is a positive integer greater than 1;”

255. *Liu* discloses [16d2] as discussed in [1d2] and [6d2]. *Supra* §§ XI.A.1.f, XI.A.6.f.

- g. **[16d3] “the K antenna port groups respectively correspond to K channel quality values; the K channel quality values are K non-negative real numbers; the K channel quality values are Reference Signal Received Powers (RSRPs) or Signal to Interference plus Noise Ratios (SINRs);”**

256. *Liu* discloses [16d3] as discussed in [1d3] and [6d3]. *Supra*

§§ XI.A.1.g, XI.A.6.g.

- h. **[16d4] “K1 antenna port groups of the K antenna port groups correspond to K1 channel quality values of the K channel quality values; the K1 is a positive integer less than or equal to the K;”**

257. *Liu* discloses [16d4] as discussed in [1d4] and [6d4]. *Supra*

§§ XI.A.1.h, XI.A.6.h.

- i. **[16d5] “a first proportional sequence corresponds to a ratio(ratios) among the K1 channel quality values;”**

258. *Liu* discloses or suggests, or the combination of *Liu* and *Park* renders obvious, [16d5] as discussed in [1d5] and [6d5]. *Supra* §§ XI.A.1.i, XI.A.6.i.

- j. **[16d6] “the first information is used to determine the K1 antenna port groups and the first proportional sequence;”**

259. *Liu* discloses or suggests, or the combination of *Liu* and *Park* renders obvious, [16d6] as discussed in [1d6] and [6d6]. *Supra* §§ XI.A.1.j, XI.A.6.j.

- k. [16d7] “the first signaling is used to determine a target threshold; the target threshold is a non-negative real number;”**

260. *Liu* discloses or suggests, or the combination of *Liu* and *Park* renders obvious, [16d7] as discussed in [1d7] and [6d7]. *Supra* §§ XI.A.1.k, XI.A.6.k.

- l. [16d8] “a first channel quality is a best channel quality value among the K1 channel quality values; a second channel quality is a worse channel quality value among the K1 channel quality values;”**

261. *Liu* discloses [16d8] as discussed in [1d8] and [6d8]. *Supra* §§ XI.A.1.l, XI.A.6.l.

- m. [16d9] “a ratio between the second channel quality and the first channel quality is greater than or equal to the target threshold.”**

262. *Liu* discloses or suggests, or the combination of *Liu* and *Park* renders obvious, [16d9] as discussed in [1d9] and [6d9]. *Supra* §§ XI.A.1.m, XI.A.6.m.

- 17. Claim 17: “The base station to claim 16, wherein the K channel quality values are broadband channel quality values; or the first proportional sequence comprises K1 positive real numbers less than or equal to 1, and the first proportional sequence comprises at least one 1; or the first proportional sequence comprises quantized values corresponding to K1 positive real numbers; or the first proportional sequence comprises K1-1 positive real number(s), and the K1-1 positive real number(s) is(are) a ratio(ratios) between a channel quality value(s) other than the best channel quality value among the K1 channel quality values and the best channel quality value; or the first proportional sequence comprises quantized values corresponding to K1-1 positive real number(s).”**

263. The combination of *Liu* and *Park* renders obvious claim 16, as discussed above.

264. The additional limitations of claim 17 are substantively identical to claims 2 and 7, and are therefore disclosed by *Liu*, or rendered obvious by the combination of *Liu* and *Park*, for the reasons discussed in claims 1, 2, 6, 7, and 16.

Supra §§ XI.A.1, XI.A.2, XI.A.6, XI.A.7, XI.A.16.

- 18. Claim 18: [18Preamble] “The base station to claim 16, [18a] wherein K2 antenna port groups in the K antenna port groups correspond to K2 channel quality values in the K channel quality values; the K2 is a positive integer less than or equal to the K; [18b] a second proportional sequence corresponds to a ratio(ratios) among the K2 channel quality values; [18c] a first receiving beamforming vector is used to receive signals transmitted through the K1 antenna port groups; a second receiving beamforming vector is used to receive signals transmitted through the K2 antenna port groups; the first receiving beamforming vector and the second receiving beamforming vector are different; [18d] the first information is further used to determine the K2 antenna port groups and the second proportional sequence.”**

265. The combination of *Liu* and *Park* renders obvious claim 16, as discussed above.

266. The additional limitations of claim 18 are substantively identical to claims 3 and 8, and are therefore disclosed by *Liu*, or rendered obvious by the combination of *Liu* and *Park*, for the reasons discussed in claims 1, 3, 6, 8, and 16. *Supra* §§ XI.A.1, XI.A.3, XI.A.6, XI.A.8, XI.A.16.

- 19. Claim 19: “The base station to claim 18, wherein any two antenna ports in the K1 antenna port groups are co-located or quasi-co-located (QCL), and any two antenna ports in the K2 antenna port groups are co-located or quasi-co-located (QCL); or any two antenna ports in the K1 antenna port groups are on a same carrier, and any two antenna ports in the K2 antenna port groups are on a same carrier; or the first signaling is further used to determine at least the last one of the K1, the K2 and the target threshold, a third channel quality is a best channel quality value among the K2 channel quality values, a fourth channel quality is a worse channel quality value among the K2 channel quality values, a ratio between the fourth channel quality and the third channel quality is greater than or equal to the target threshold, and the first information is further used to determine at least one of the first channel quality and the third channel quality.”**

267. The combination of *Liu* and *Park* renders obvious claim 18, as discussed above.

268. The additional limitations of claim 19 are substantively identical to claims 4 and 9, and are therefore disclosed by *Liu*, or rendered obvious by the combination of *Liu* and *Park*, for the reasons discussed in claims 1, 4, 6, 9, and 16. *Supra* §§ XI.A.1, XI.A.4, XI.A.6, XI.A.9, XI.A.16.

20. Claim 20: “The base station to claim 18, wherein the second transmitter further transmits a second wireless signal; wherein a target antenna port group is used to transmit the second wireless signal; the target antenna port group is associated with the K1 antenna port groups and the first proportional sequence, or the target antenna port group is associated with the K2 antenna port groups and the second proportional sequence.”

269. The combination of *Liu* and *Park* renders obvious claim 18, as discussed above.

270. The additional limitations of claim 15 are substantively identical to claims 5 and 10, and are therefore disclosed by *Liu*, or rendered obvious by the combination of *Liu* and *Park*, for the reasons discussed in claims 1, 5, 6, 10, and 16, because, as I explain above for claim 16, in MIMO systems, the two transmitters at the base station transmit the wireless signals, such as the data transmission (“second wireless signal,” *supra* § XI.A.5 (claim 5)), to the UE. *Supra* §§ XI.A.1, XI.A.5, XI.A.6, XI.A.10, XI.A.16.

XII. CONCLUSION

271. 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 '271 patent obvious.

272. 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.

273. 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: March 28, 2023

Respectfully submitted,

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