

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

LG ELECTRONICS INC.,

Petitioner,

v.

PANTECH CORPORATION,

Patent Owner.

Case IPR2023-01273

U.S. Patent No. 9,136,924

PETITION FOR *INTER PARTES* REVIEW

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EXHIBIT LIST

Exhibit	Description
Ex. 1001	U.S. Patent No. 9,136,924 (“924”)
Ex. 1002	File History of U.S. Patent No. 9,136,924 (“924FH”)
Ex. 1003	Declaration of Dr. Bertrand Hochwald in Support of Petition for <i>Inter Partes</i> Review of U.S. Patent No. 9,136,924 (“Hochwald”)
Ex. 1004	Declaration of Friedhelm Rodermund in Support of Petition for <i>Inter Partes</i> Review of U.S. Patent No. 9,136,924 (“Rodermund”)
Ex. 1005	U.S. Patent App. Pub. 2011/0274188 (“Sayana”)
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Ex. 1007	International Patent App. Pub. WO2010/050689 (“Lee-689”)
Ex. 1008	LTE; Evolved Universal Terrestrial Radio Access (E-UTRA); Physical layer procedures (3GPP TS 36.213 version 8.8.0 Release 8) (“TS36.213”)
Ex. 1009	LTE; Evolved Universal Terrestrial Radio Access (E-UTRA); Physical channels and modulation (3GPP TS 36.211 version 8.8.0 Release 8) (“TS36.211”)
Ex. 1010	U.S. Patent App. Pub. 2013/0064129 (“Koivisto”)
Ex. 1011	R1-102630, “Refinements of Feedback and Codebook Design,” submitted by Ericsson for 3GPP Meeting WG1 #61 (May 10-14, 2010) (“Ericsson”)
Ex. 1012	U.S. Patent App. Pub. 2011/0249713 (“Hammarwall”)
Ex. 1013	U.S. Patent App. Pub. 2011/0305263 (“Jongren”)
Ex. 1014	U.S. Patent App. Pub. 2011/0034192 (“Lim”)

Exhibit	Description
Ex. 1015	Third Amended Docket Control Order, <i>Pantech Corporation et al. v. LG Electronics Inc. et al.</i> , No. 5:22-cv-00113-RWS-JBB Dkt 98 (E.D. Tex.)
Ex. 1016	Docket Navigator “Time to Trial” report for Judge Robert W. Schroeder
Ex. 1017	Expert Report of Todor Cooklev, Ph.D. [Claim Construction] dated June 23, 2023
Ex. 1018	Joint Claim Construction and Prehearing Statement, <i>Pantech Corp. et al. v. LG Electronics Inc. et al.</i> , Case 5:22-cv-00113-RWS-JBB (E.D. Texas), Dkt. No. 118.
Ex. 1019	Redline Comparison between U.S. Patent App. Pub. 2011/0274188 and U.S. Provisional App. No. 61/331,818
Ex. 1020	International Patent App. Pub. WO2009/025619 (“Göransson-619”)
Ex. 1021	U.S. Patent No. 9,078,236 (“Chun”)
Ex. 1022	U.S. Patent No. 9,247,420 (“Jung”)
Ex. 1023	U.S. Patent No. 9,083,411 (“Li”)
Ex. 1024	U.S. Patent No. 7,369,511 (“Utsunomiya”)
Ex. 1025	U.S. Patent No. 8,649,456 (“Xia”)
Ex. 1026	Sesia, Stefania et al. LTE - The UMTS Long Term Evolution: From Theory to Practice. United Kingdom, Wiley, 2011.
Ex. 1027	Hui, Lin, and Wang Wen Bo. “Coordinated Beamforming technology in TD-LTE-Advanced system.” 2010 International Conference on Communications and Mobile Computing. Vol. 2. IEEE, 2010.
Ex. 1028	USCourts.gov “U.S. District Court – Judicial Caseload Profile” for Eastern District of Texas

Exhibit	Description
Ex. 1029	Declaration of Jonathan Bradford
Ex. 1030 to Ex. 1050	Reserved
Ex. 1051	Webpage, available at https://archive.org/legal/affidavit.php
Ex. 1052	Internet Archive Capture, available at https://web.archive.org/web/20110509054716/http://3gpp.org/Specification-Groups
Ex. 1053	Internet Archive Capture, available at https://web.archive.org/web/20090802220720/http://www.3gpp.org/
Ex. 1054	Internet Archive Capture, available at https://web.archive.org/web/20130812132958/http://3gpp.org/RAN1-Radio-layer-1
Ex. 1055	Internet Archive Capture, available at https://web.archive.org/web/20080917042036/http://www.3gpp.org/ftp/tsg_ran/WG1_RL1/
Ex. 1056	Internet Archive Capture, available at https://web.archive.org/web/20080803190713/http://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_55/
Ex. 1057	Webpage, available at https://www.3gpp.org/ftp/Specs
Ex. 1058	Internet Archive Capture, available at https://web.archive.org/web/20130110164645/http://www.3gpp.org/specifications
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Ex. 1060	Internet Archive Capture, available at https://web.archive.org/web/20081207063329/http://www.3gpp.org/ftp/Specs/html-info/36-series.htm
Ex. 1061	Internet Archive Capture, available at https://web.archive.org/web/20080612010911/http://www.3gpp.org/ftp/Specs/html-info/TSG-WG--r1.htm
Ex. 1062	Internet Archive Capture, available at https://web.archive.org/web/20081201145114/http://www.3gpp.org/ftp/specs/html-info/36213.htm
Ex. 1063	Internet Archive Capture, available at https://web.archive.org/web/20140326211003/http://3gpp.org/DynaReport/TSG-WG--R1.htm
Ex. 1064	Internet Archive Capture, available at https://web.archive.org/web/20140217112636/http://www.3gpp.org/DynaReport/36-series.htm
Ex. 1065	Internet Archive Capture, available at https://web.archive.org/web/20140326220443/http://3gpp.org/DynaReport/36213.htm
Ex. 1066	Internet Archive Capture, available at https://web.archive.org/web/20140326193752/http://3gpp.org/DynaReport/36211.htm
Ex. 1067	3GPP TS 36.211 V8.1.0 (2007-11), retrieved from https://web.archive.org/web/20140724150608/http://www.3gpp.org/ftp/Specs/archive/36_series/36.211/36211-810.zip (36211-810.doc in 36211-810.zip)
Ex. 1068	Internet Archive Capture, available at https://web.archive.org/web/20141014200927/http://www.3gpp.org/ftp/Specs/latest/Rel-8/

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Ex. 1069	Internet Archive Capture, available at https://web.archive.org/web/20080706152214/http://www.3gpp.org/ftp/Specs/latest/Rel-8/36_series/
Ex. 1070	Reserved
Ex. 1071	Internet Archive Capture, available at https://web.archive.org/web/20190529145715/https://list.etsi.org/scripts/wa.exe?SUBED1=3gpp_tsg_ran_wg1&A=1
Ex. 1072	Webpage, available at https://www.3gpp.org/ftp/Specs/archive/36_series/36.213
Ex. 1073	Webpage, available at https://www.etsi.org/deliver/etsi_ts/136200_136299/136213/08.08.00_60/
Ex. 1074	ETSI TS 136 213 V8.8.0 (2009-10), retrieved from https://www.etsi.org/deliver/etsi_ts/136200_136299/136213/08.08.00_60/ts_136213v080800p.pdf
Ex. 1075	Internet Archive Capture, available at http://web.archive.org/web/20081201081622/http://www.3gpp.org/ftp/specs/archive/36_series/36.213/
Ex. 1076	Internet Archive Capture, available at http://web.archive.org/web/20140601044332/http://www.3gpp.org:80/ftp/specs/archive/36_series/36.213
Ex. 1077	3GPP TS 36.213 V8.8.0 (2009-09), retrieved from https://www.3gpp.org/ftp/specs/archive/36_series/36.213/36213-880.zip (36213-880.doc in 36213-880.zip)
Ex. 1078	Internet Archive Capture, available at https://web.archive.org/web/20081113150830/http://www.3gpp.org/ftp/Specs/

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Ex. 1079	Internet Archive Capture, available at https://web.archive.org/web/20081013132648/http://www.3gpp.org/ftp/Specs/archive/
Ex. 1080	Internet Archive Capture, available at https://web.archive.org/web/20081012223857/http://www.3gpp.org/ftp/specs/archive/36_series/
Ex. 1081	Internet Archive Capture, available at https://web.archive.org/web/20140601044332/http://www.3gpp.org:80/ftp/specs/archive/36_series/36.213
Ex. 1082	Internet Archive Capture, available at https://web.archive.org/web/20081201231313/http://www.3gpp.org/ftp/Specs/latest
Ex. 1083	Internet Archive Capture, available at https://web.archive.org/web/20081208085335/http://www.3gpp.org:80/ftp/Specs/latest/Rel-8/
Ex. 1084	Internet Archive Capture, available at https://web.archive.org/web/20081209045248/http://www.3gpp.org/ftp/Specs/latest/Rel-8/36_series/
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Ex. 1086	Webpage, available at https://ieeexplore.ieee.org/document/5493598
Ex. 1087	Webpage, available at https://www.3gpp.org/ftp/Specs/archive/36_series/36.211
Ex. 1088	Webpage, available at https://www.etsi.org/deliver/etsi_ts/136200_136299/136211/08.08.00_60/

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Ex. 1089	ETSI TS 136 211 V8.8.0 (2009-10), retrieved from https://www.etsi.org/deliver/etsi_ts/136200_136299/136211/08.08.00_60/ts_136211v080800p.pdf
Ex. 1090	Webpage, available at https://web.archive.org/web/20170404095635/http://webapp.etsi.org/key/key.asp?full_list=y
Ex. 1091	Internet Archive Capture, available at https://web.archive.org/web/20140801181746/http://3gpp.org/ftp/specs/archive/36_series/36.211/
Ex. 1092	Internet Archive Capture, available at http://web.archive.org/web/20081201192809/http://www.3gpp.org/ftp/Specs/archive/36_series/36.211/
Ex. 1093	3GPP TS 36.211 V8.8.0 (2009-09), retrieved from https://www.3gpp.org/ftp/specs/archive/36_series/36.211/36211-880.zip (36211-880.doc in 36211-880.zip)
Ex. 1094	Internet Archive Capture, available at https://web.archive.org/web/20081201152358/http://www.3gpp.org/ftp/specs/html-info/36211.htm
Ex. 1095	Internet Archive Capture, available at https://web.archive.org/web/20140315022717/http://www.3gpp.org:80/DynaReport/36211.htm
Ex. 1096	Jae-Hyuk Lee, Jun-Ho Baek, Seung-Hoon Hwang and Byoung-Jo Choi, “On the selection of training sequence code pair for MIMO technology in 3GPP GERAN system,” 2010 The 12th International Conference on Advanced Communication Technology (ICACT), Phoenix Park, February 7-10, 2010, pp. 537-540
Ex. 1097	Webpage, available at https://ieeexplore.ieee.org/document/5440406

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Ex. 1098	Yanguang Liu, Wenjing Li, Heng Zhang and Weihao Lu, “Graph based automatic centralized PCI assignment in LTE,” The IEEE symposium on Computers and Communications, Riccione, June 22-25, 2010, pp. 919-921, doi: 10.1109/ISCC.2010.5546812
Ex. 1099	Webpage, available at https://ieeexplore.ieee.org/document/5546812
Ex. 1100	Webpage, available at http://3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_61/Docs/
Ex. 1101	3GPP R1-102630, retrieved from https://list.etsi.org/scripts/wa.exe?A3=ind1005A&L=3GPP_TSG_RAN_WG1&E=base64&P=85459760&B=--_007_E4CE3BC64C3AB6488038754A0E419DE11C0173F846ESES_SCMS0365e_&T=application%2Fzip-compressed;%20name=%22R1-102630.zip%22&N=R1-102630.zip&attachment=q&XSS=3 (R1-102630_refinements_of_fb_and_cb_design.doc in R1-102630.zip)
Ex. 1102	Webpage, available at https://list.etsi.org/scripts/wa.exe?A2=3GPP_TSG_RAN_WG1;a370e470.1005A&S=
Ex. 1103	Internet Archive Capture, available at https://web.archive.org/web/20100326093131/http://list.etsi.org/
Ex. 1104	Internet Archive Capture, available at https://web.archive.org/web/20120309181952/http://list.etsi.org:80/
Ex. 1105	Internet Archive Capture, available at https://web.archive.org/web/20140328154821/http://3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_61/Docs/
Ex. 1106	R1-102630, retrieved from https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_61/Docs/R1-102630.zip (R1-102630_refinements_of_fb_and_cb_design.doc in R1-102630.zip)

Exhibit	Description
Ex. 1107	Draft Report of 3GPP TSG RAN WG1 #61 v0.1.0 (Montreal, Canada, 10th – 14th May, 2010), retrieved from https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_61/Report/Draft_ReportWG1%2361_v010.zip (Draft_ReportWG1#61_v010.doc in Draft_ReportWG1%2361_v010.zip)
Ex. 1108	Webpage, available at https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_61/Report
Ex. 1109	Excel file “Tdoclist_RAN1#61(May_2010).xls,” retrieved from https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_61/Report/Draft_ReportWG1%2361_v010.zip
Ex. 1110	R1-103333, retrieved from https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_61/Docs/R1-103333.zip (R1-103333_refinements_of_fb_and_cb_design.doc in R1-103333.zip)
Ex. 1111	Redline comparing disclosures of R1-102630 and R1-103333.
Ex. 1112	Patent Application No. 13/698,419
Ex. 1113	Excel file “3gppRAN1_61.xls,” retrieved from https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_61/Report/Final_ReportWG1%2361_v300.zip

TABLE OF ABBREVIATIONS

'924	U.S. Patent No. 9,136,924 (Ex. 1001)
'924FH	File History of U.S. Patent No. 9,136,924 (Ex. 1002)
Claims	Claims 17-24 and 26-28 of U.S. Patent No. 9,136,924
Ericsson	R1-102630, "Refinements of Feedback and Codebook Design," submitted by Ericsson for 3GPP Meeting WG1 #61 (May 10-14, 2010) (Ex. 1011)
Hochwald	Declaration of Dr. Bertrand Hochwald in Support of Petition for <i>Inter Partes</i> Review of U.S. Patent No. 9,136,924 (Ex. 1003)
IPR	<i>Inter Partes</i> Review
Koivisto	U.S. Patent App. Pub. 2013/0064129 (Ex. 1010)
Lee-689	International Patent App. Pub. WO2010/050689 (Ex. 1007)
O.A.	Office Action
Petitioner	Petitioner LG Electronics Inc.
PO	Patent Owner Pantech Corporation
POSITA	Person of Ordinary Skill in the Art
PTAB	Patent Trial and Appeal Board
Resp.	Response to Office Action
Rodermund	Declaration of Friedhelm Rodermund in Support of Petition for <i>Inter Partes</i> Review of U.S. Patent No. 9,065,924
Sayana	U.S. Patent App. Pub. 2011/0274188 (Ex. 1005)
Sayana-Prov	U.S. Provisional App. No. 61/331,818 (Ex. 1006)
TS36.211	LTE; Evolved Universal Terrestrial Radio Access (E-UTRA); Physical channels and modulation (3GPP TS 36.211 version 8.8.0 Release 8) (Ex. 1009)
TS36.213	LTE; Evolved Universal Terrestrial Radio Access (E-UTRA); Physical layer procedures (3GPP TS 36.213 version 8.8.0 Release 8) (Ex. 1008)
USPTO/Office	United States Patent and Trademark Office

LIST OF CHALLENGED CLAIMS

[17.pre] A communication method of a receiving device in a wireless communication system, the method comprising:

[17.a] receiving codebook restricting information including at least one of a first bit sequence to restrict at least one precoding matrix from a first precoding matrix group and a second bit sequence to restrict at least one precoding matrix from a second precoding matrix group,

[17.b] each bit of the first bit sequence corresponding to one precoding matrix of the first precoding matrix group, respectively, the at least one precoding matrix of the first precoding matrix group being restricted from being used as a precoding matrix of a first precoder, each bit of the second bit sequence corresponding to one precoding matrix of the second precoding matrix group, respectively, and the at least one precoding matrix of the second precoding matrix group being restricted from being used as a precoding matrix of a second precoder; and

[17.c] transmitting, to a transmitting device, 1st channel status information indicating the precoding matrix of the first precoder and 2nd channel status information indicating the precoding matrix of the second precoder,

[17.d] the precoding matrix of the first precoder and the precoding matrix of the second precoder being selected, based on the codebook restricting information, from among precoding matrices that are not restricted,
[17.e] wherein a period of transmitting the information relating to the precoding matrix of the first precoder and a period of transmitting the information relating to the precoding matrix of the second precoder are different from each other.

[18.] The method of claim 17, wherein the first matrix group includes N precoding matrices, and the first bit sequence is an N-bit sequence, where N is an integer.

[19.] The method of claim 17, wherein the use of precoding matrices for the second precoder that make pairs with restricted precoding matrices of the first matrix group is restricted based on the first bit sequence, and the use of precoding matrices for the first precoder that make pairs with restricted precoding matrices of the second matrix group is restricted based on the second bit sequence.

[20.] The method of claim 17, wherein the transmitting device includes at least one antenna pair in which a first domain including at least one antenna polarized in one direction and a second domain including at least one antenna polarized in another direction intersect each other; and

the precoding matrix of the first precoder performs precoding on the first domain and the second domain, separately, and the precoding matrix of the second precoder performs phase mismatch correction to remove an effect from a phase mismatch between the first domain and the second domain.

[21.] The method of claim 20, wherein the precoding matrix of the first precoder corresponds to W_1 in the following Equation and the precoding matrix of the second precoder corresponds to W_2 in the following Equation:

$$W = \begin{pmatrix} R_0 & 0 \\ 0 & R_0 \end{pmatrix} \begin{pmatrix} I \\ \Lambda \end{pmatrix},$$

$\widetilde{W}_1 \qquad \qquad \widetilde{W}_2$

wherein R_0 denotes a value determined by a precoding gain when the first domain and the second domain have an identical spatial channel status, I denotes a unit matrix, and Λ denotes a phase mismatch correction value between the first domain and the second domain.

[22.] The method of claim 17, wherein the period of transmitting the information relating to the precoding matrix of the first precoder is longer than the period of transmitting the information relating to the precoding matrix of the second precoder.

[23.pre] A receiving device in a wireless communication system, the receiving device comprising:

[23.a] an antenna array to receive, as codebook restricting information, at least one of a first bit sequence to restrict at least one precoding matrix from a first precoding matrix group and a second bit sequence to restrict at least one precoding matrix from a second precoding matrix group,

[23.b] each bit of the first bit sequence corresponding to one precoding matrix of the first precoding matrix group, respectively, the at least one precoding matrix of the first precoding matrix group being restricted from being used as a precoding matrix of a first precoder, each bit of the second bit sequence corresponding to one precoding matrix of the second precoding matrix group, respectively, and the at least one precoding matrix of the second precoding matrix group being restricted from being used as a precoding matrix of a second precoder; and

[23.c] a channel information feedback device to transmit, to a transmitting device, information relating to the precoding matrix of the first precoder and information relating to the precoding matrix of the second precoder,

[23.d] the precoding matrix of the first precoder and the precoding matrix of the second precoder being selected, based on the codebook restricting information, from among precoding matrices that are not restricted,

[23.e] wherein a period of transmitting the information relating to the precoding matrix of the first precoder and a period of transmitting the information relating to the precoding matrix of the second precoder are different from each other.

[24.] The device of claim 23, wherein the first matrix group includes N precoding matrices, and the first bit sequence is an N-bit sequence, where N is an integer.

[26.] The device of claim 23, wherein the transmitting device includes at least one antenna pair in which a first domain including at least one antenna polarized in one direction and a second domain including at least one antenna polarized in another direction intersect each other; and the precoding matrix of the first precoder performs precoding on the first domain and the second domain, separately, and the precoding matrix of the second precoder performs phase mismatch correction to remove an effect from a phase mismatch between the first domain and the second domain.

[27.] The device of claim 26, wherein the precoding matrix of the first precoder corresponds to W1 in the following Equation, and the precoding matrix of the second precoder corresponds to W2 in the following Equation:

$$W = \begin{pmatrix} R_0 & 0 \\ 0 & R_0 \end{pmatrix} \begin{pmatrix} I \\ \Lambda \end{pmatrix},$$

$\widetilde{W}_1 \qquad \qquad \widetilde{W}_2$

wherein R_0 denotes a value determined by a precoding gain when the first domain and the second domain have an identical spatial channel status, I denotes a unit matrix, and Λ denotes a phase mismatch correction value between the first domain and the second domain.

[28.] The device of claim 23, wherein the period of transmitting the information relating to the precoding matrix of the first precoder is longer than the period of transmitting the information relating to the precoding matrix of the second precoder.

Pursuant to §§311-319 and §42.1,¹ Petitioner petitions for *inter partes* review (“IPR”) of claims 17-24, 26-28 (“Claims”) of U.S. Patent No. 9,136,924 (Ex. 1001, “’924”), assigned to Pantech Corporation (“PO”). There is a reasonable likelihood—and it is highly likely—that at least one Claim is unpatentable as explained herein. Petitioner requests review of the Claims, and judgment finding them unpatentable under §103.

I. INTRODUCTION

The ’924 Claims are directed to the use of “precoders” that reduce interference in Multiple-Input Multiple-Output (“MIMO”) cellphone systems that use multiple antennas at a base station (“BS”) and user equipment (“UE”). “Precoders” are selected from a “codebook,” and are used to map data bits to, and tune transmissions from a transmitting BS to avoid interfering with signals that are transmitted from other devices over the shared wireless medium. ’924, Abstract, 1:19-51, 3:13-41, 5:10-7:60, 8:7-18, 18:13-19:52, Figs. 1-4, 8-10; Hochwald, ¶43.

¹ Section cites reference 35 U.S.C. (pre-AIA) or 37 C.F.R. as context indicates. All emphasis/color annotations added unless noted. Figure annotations herein generally quote the Claims for reference. Citations herein are exemplary and not meant to be limiting.

In the '924, the UE measures a quality of the communication channel from the BS to UE, and provides two channel status information (“CSI”) feedbacks to the BS based on the measurement. '924, 6:45-54, 7:11-23, Figs. 2-4; Hochwald, ¶44. Each CSI includes a precoding matrix indicator (“PMI”) indicating a precoding matrix for the BS to use. *Id.*, 4:6-9. The UE selects a PMI from a “codebook” of precoding matrices known by the BS and UE. *Id.*, 3:57-4:9. The BS may indicate a codebook subset limited by “codebook subset restriction” information, *e.g.*, when the BS determines that certain precoding matrices cause interference and should not be used. '924, 3:57-4:33, 5:10-19, 5:40-52, Figs. 1-4; Hochwald, ¶¶44-45

During prosecution, the Claims were allowed after being amended to recite transmitting the first and second feedbacks to the BS at different periods. '924, 14:62-15:3; Ex. 1002 (“’924FH”), 544-559, 563-570; Hochwald, ¶46. But sending such feedbacks at different periods was known. For example, **Sayana** (Ex. 1005), including its incorporated provisional (Ex. 1006, “Sayana-Prov”), discloses a MIMO system in which a UE feeds back “a first representation of a first matrix” and “a second representation of a second matrix” selected from respective “first” and “second” codebooks “at different time instances and/or periodicities.” Sayana, Abstract, [0006], [0047], [0058], [0065], [0070]-[0082], [0085]-[0095], [0099]; Hochwald, ¶47.

Accordingly, Claims 17-24 and 26-28 are rendered obvious by **Sayana** in view of **Lee-689** (Ex. 1007), **TS36.213** (Ex. 1008), **TS36.211** (Ex. 1009) (which each teach using a “bitmap” to provide codebook restrictions of precoder matrices for feedback from a UE to BS) and/or **Koivisto** (Ex. 1010) (which incorporates by reference Ericsson (Ex. 1011), and teaches other dependent limitations). Hochwald, ¶48. Petitioner requests that the Board institute trial and find the Claims unpatentable.

II. MANDATORY NOTICES

A. Real Parties-in-Interest

Petitioner LG Electronics Inc. and LG Electronics U.S.A, Inc. are the real parties-in-interest. No other party had access to or control over the present Petition, and no other party funded or participated in preparation of the present Petition.

B. Related Matters

The '924 is the subject of the following co-pending civil action:

Pantech Corporation et al. v. LG Electronics Inc. et al., No. 5:22-cv-00113-RWS-JBB (E.D. Tex.) (“Texas Case”).

C. Counsel and Service Information:

James L. Davis, Jr. (Reg. No. 57,325) (Lead)
ROPES & GRAY LLP
1900 University Avenue, 6th Floor
East Palo Alto, CA 94303-2284
Phone: 650-617-4000

Fax: 617-235-9492
james.l.davis@ropesgray.com
LGE-Pantech-Ropes-IPR-Service@ropesgray.com@ropesgray.com

Daniel W. Richards (Reg. No. 69,652) (Back-Up)
ROPES & GRAY LLP
1900 University Avenue, 6th Floor
East Palo Alto, CA 94303-2284
Phone: 650-617-4000
Fax: 617-235-9492
daniel.richards@ropesgray.com

Shong Yin (Reg. No. 71,577) (Back-Up)
ROPES & GRAY LLP
1900 University Avenue, 6th Floor
East Palo Alto, CA 94303-2284
Phone: 650-617-4000
Fax: 617-235-9492
shong.yin@ropesgray.com

Customer No. 28120

Mailing address for all PTAB correspondence:
ROPES & GRAY LLP, IPRM—Floor 43
Prudential Tower, 800 Boylston Street,
Boston, MA 02199-3600

Petitioner consents to electronic service of documents to the email addresses of the counsel identified above.

III. PAYMENT OF FEES

The undersigned authorizes the Office to charge the fee required by §42.15(a) and any additional fees that might be due to Deposit Account No. 18-1945, under Order No. 104537-0034-653.

IV. REQUIREMENTS FOR *INTER PARTES* REVIEW

A. Grounds for Standing

Pursuant to §42.104(a), Petitioner certifies that the '924 is available for IPR. Petitioner and any real parties-in-interest are not barred or estopped from requesting IPR challenging the claims on the grounds herein.

B. Identification of Challenge

Pursuant to §§42.104(b)-(b)(1), Petitioner requests IPR of claims 17-24 and 26-28, and that the Board cancel the same as unpatentable.

1. Specific Art on Which the Challenge Is Based

Petitioner relies on the following prior art:

Name	Publication/ Title	Ex.	Filed	Published/ Issued	Prior art under at least
Sayana	US2011/0274188	1005	4/15/2011	11/10/2011	§102(e)
Lee-689	WO2010/050689	1007	10/14/2009	5/6/2010	§§102(a)/(e)
TS36.213	TS 36.213 v8.8.0	1008		9/2009-5/2010	§102(a)
TS36.211	TS 36.211 v8.8.0	1009		9/2009-6/2010	§102(a)
Koivisto	US2013/0064129	1010	6/2/2010	3/14/2013	§102(e)
Ericsson	R1-102630	1011		5/2010	§102(a)

Hochwald, ¶69. Each of **TS36.213**, **TS36.211** and Ericsson was publicly accessible to, and accessed by, POSITAs and interested persons well before the '924's alleged

priority date 7/5/2010. Ex. 1004 (“Rodermund”), ¶¶1-152; Exs. 1051-1113. **TS36.213** and **TS36.211** are technical specifications maintained by 3GPP that describe aspects of the Long Term Evolution (“LTE”) standard. Ericsson is a proposal submitted to 3GPP Working Group 1, which helped develop LTE. Ericsson, 1; Rodermund, ¶¶129-149; Hochwald, ¶69. As summarized below, in the prior art time frame, each reference was either published and publicly available on 3GPP’s ftp server and/or ETSI’s server, cited by publications, presented publicly, and/or distributed via email reflector without restriction or expectation of confidentiality, or via meeting. Rodermund, ¶¶82-149; *Apple v. Uniloc 2017 LLC*, IPR2019-00222, Pap. 28, *13-18; *LG Electronics, Inc. v. Core Wireless Licensing S.A.R.L.*, IPR2015-01986, Pap. 34, *26-31; *Samsung Electronics Co., Ltd. v. Ibex PT Holdings Co., Ltd.*, IPR2018-00011, Pap. 33, *4; Hochwald, ¶69.

Reference	3GPP Published	ETSI Published	3GPP Meeting Availability	Email Distribution	Citing Pubs.
TS36.213	9/19/2009 ²	10/5/2009 ³	N/A	N/A	5/2010 ⁴

² Ex. 1072.

³ Ex. 1073; See ETSI’s substantively identical TS 136.213. Ex. 1074; Rodermund, ¶¶85-89; Hochwald, ¶69.

⁴ Exs. 1085-1086.

Reference	3GPP Published	ETSI Published	3GPP Meeting Availability	Email Distribution	Citing Pubs.
TS36.211	9/19/2009 ⁵	10/5/2009 ⁶	N/A	N/A	2/2010 ⁷ 6/2010 ⁸
Ericsson	By 5/04/2010 ⁹	N/A	By 5/14/2010 ¹⁰	5/04/2010 ¹¹	N/A

2. Statutory Grounds on Which the Challenge Is Based

Ground (§103)	Claims	References
1		Sayana in view of Lee-689

⁵ Ex. 1087; Rodermund, ¶¶107-111.

⁶ Ex. 1088; *See* ETSI's substantively identical TS 136.211. Ex. 1089; Rodermund, ¶¶107-111; Hochwald, ¶69.

⁷ Ex. 1096-1097; Rodermund, ¶¶124-125.

⁸ Ex. 1098-1099; Rodermund, ¶¶126-127.

⁹ Ex. 1100; Rodermund, ¶¶131-138.

¹⁰ *See* substantively similar R1-103333 (presented at meeting). Exs. 1110-1111; Rodermund, ¶139. If Ericsson is found not to be publicly accessible, the same arguments herein apply to R1-103333. Hochwald, ¶69.

¹¹ Ex. 1102; Rodermund, ¶130.

Ground (§103)	Claims	References
2	17-19, 22-24, 28	Sayana in view of TS36.213
3		Sayana in view of TS36.213 and TS36.211
4-6	20-21, 26-27	Grounds 1-3 in view of Koivisto

Hochwald, ¶¶70-77.

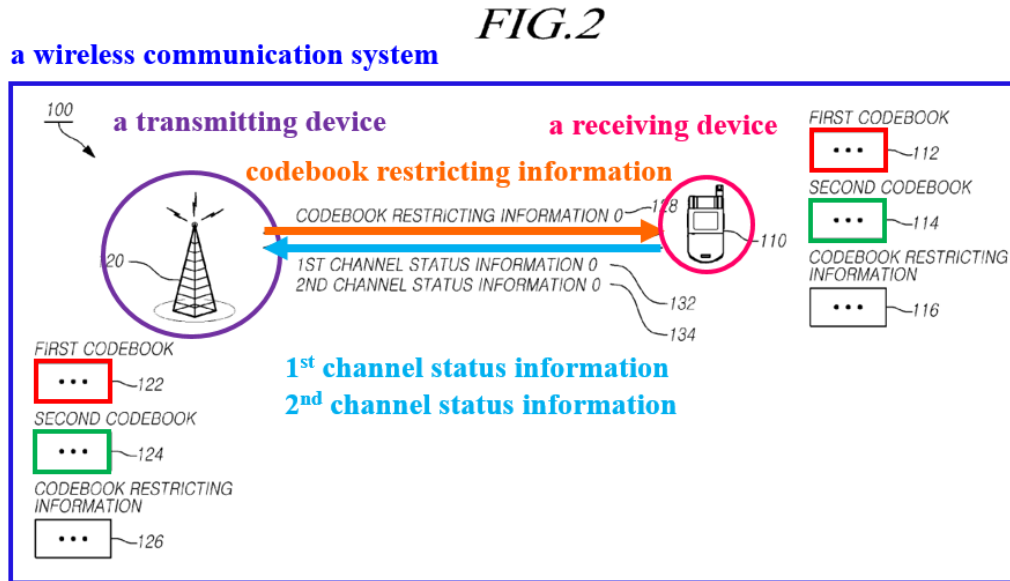
V. '924 PATENT AND PROSECUTION HISTORY

A. '924

As discussed in §I, the Claims relate to a MIMO system in which a BS uses two precoders with different codebooks to tune its transmissions to a UE to avoid interference with other signals in a shared wireless medium. The purported invention of the Claims is the transmission of first and second CSI feedbacks from the UE to BS at different periods. '924, 14:62-15:3; Hochwald, ¶¶49-50.

As illustrated below in Fig. 2, a **BS transmitting device** sends **codebook restricting information ("CRI")** for each of two codebooks associated with the two precoders to signal precoding matrices of the codebooks that are unavailable for selection by a **UE receiving device**. Hochwald, ¶51. Codebook restriction reduces inter-cell interference between different base stations that cover overlapping areas. *Id.*; '924, 5:10-19. The **UE** selects and feeds back indicators of two precoding matrices, which are not restricted by the **CRI**, to the **BS** for use in its two respective

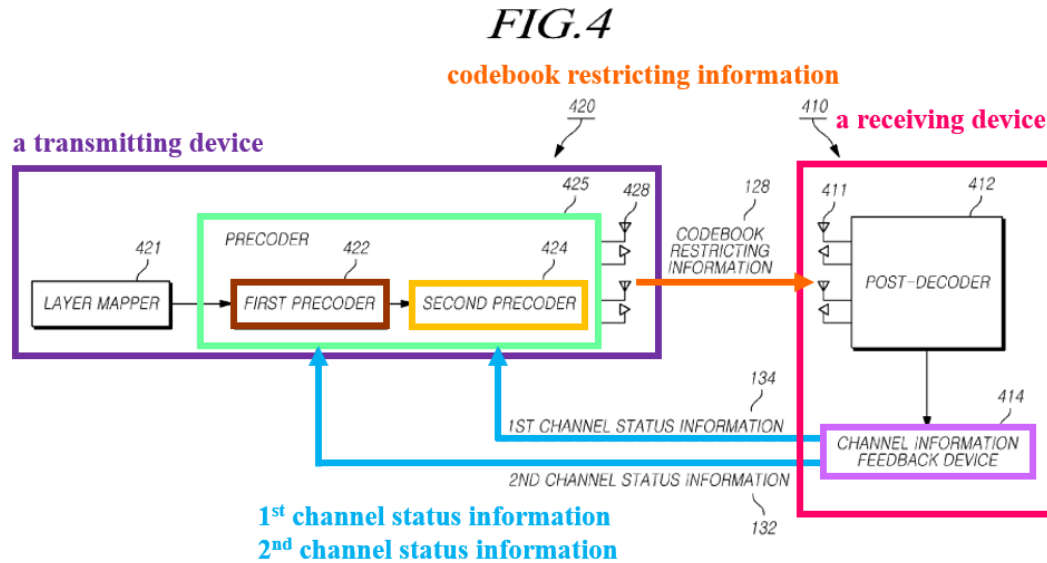
precoders. '924, Abstract, 1:19-22, 1:66-2:30, 3:7-51, 5:40-52, Figs. 1-2; Hochwald, ¶51.



The **UE** and **BS** each stores a **first codebook** and **second codebook** that are known to both devices and include N and M precoding matrices, respectively. '924, 5:53-60, 6:55-63, Fig. 2; Hochwald, ¶52.

The **UE** receives from the **BS**, **CRI** that signals to the **UE** at least one precoding matrix from the **first codebook**, and at least one precoding matrix from the **second codebook** that are restricted from **UE** selection. '924, 5:61-6:7, 7:4-10, Figs. 2-3. **CRI** is an N bit sequence for the **first codebook**, and an M bit sequence for the **second codebook**, where each bit corresponds to one precoding matrix of the respective codebook. '924, 4:55-64, 7:4-10, 11:11-12:39; Hochwald, ¶53.

Annotated Fig. 4 below illustrates the **UE receiving device** and **BS transmitting device**. Hochwald, ¶54.

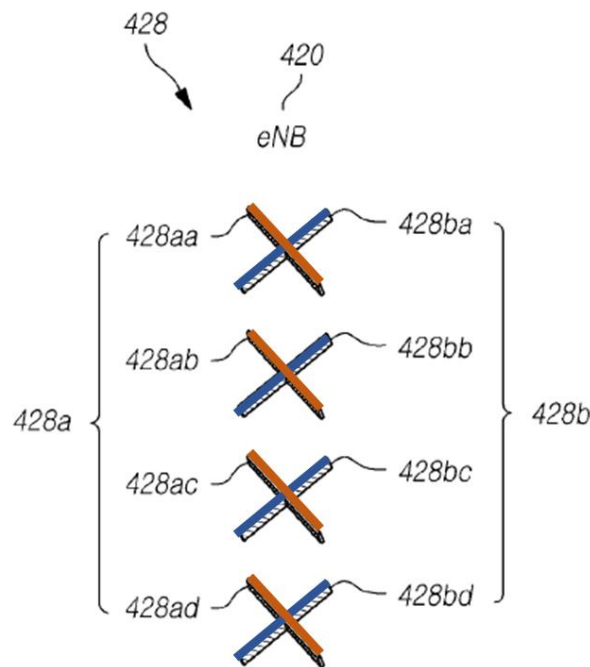


The **BS** includes a **multistage precoder** including **first** and **second** precoders. '924, 1:41-2:31, 5:20-60, 6:55-63, 8:19-28, Fig. 4. The **UE** includes a **channel information feedback device** that feeds back **1st** and **2nd** **channel status information** to the **BS** at different periods. '924, 7:50-8:18, 14:62-15:3, Fig. 4; Hochwald, ¶54.

The **1st** and **2nd** **CSI** indicate respective precoding matrices selected by the **UE** from the **first codebook** and the **second codebook** that are not restricted by the **CRI**, and that are signaled by the **UE** for the **first precoder** and **second precoder**. '924, 1:66-2:30, 4:65-5:9-43, 6:8-11, 7:11-41, Figs. 2-3; Hochwald, ¶55.

'924 claims 20-21, 26-27 further recite three concepts relating to cross-polarization of signals: (a) an “antenna pair” having first and second domains polarized in different, intersecting directions, (b) a first “precoding matrix” that separately “performs precoding” on the first and second domains, and (c) a second “precoding matrix” that “performs phase mismatch correction” between the first and second domains. Hochwald, ¶56.

The first concept, depicted in '924 Fig. 5 below, relates to a “dual polarized antenna array,” which includes perpendicular antennas arranged in a cross. '924, 7:42-8:48; Hochwald, ¶57.



A BS's cross-polarization antenna array includes a **first domain** (“428a”) of a first antenna set (“428aa-ad”) polarized in a first direction, and a **second domain**

(“428b”) of a second antenna set (“428ba-bd”) polarized in a second direction. *Id.*; *see also* Ex. 1026, Figs. 11.2, 11.5, 252-276; Ex. 1027; Hochwald, ¶57.

The ’924 depicts the second concept using first precoding matrix w_1 below, which precodes the antenna array domains as “two independent domains.” ’924, 9:33-10:24; Hochwald, ¶58. This matrix type, with all off-diagonal elements equaling zero, is a “block diagonal.” *Id.*

$$\frac{\begin{pmatrix} R_0 & 0 \\ 0 & R_0 \end{pmatrix}}{w_1}$$

The ’924 describes the third concept using second precoding matrix w_2 below, which performs “phase mismatch correction (co-phasing) between domains”; ‘ Λ ’ provides phase correction. ’924, 8:48-10:24; Hochwald, ¶59.

$$\frac{\begin{pmatrix} I \\ \Lambda \end{pmatrix}}{w_2}$$

B. Prosecution History

Following prior art rejections, the Applicant amended the Claims to recite [17.e]/[23.e] (reciting, e.g., the two periods that are “different” as discussed as

above)—and the Claims were allowed. ’924FH, 50-58, 419-435, 449-465, 468-487, 522-542, 544-559, 563-570, 595; Ex. 1012-1014; Hochwald, ¶60.

VI. §325(D) AND §314(A) DISCRETION DOES NOT APPLY

A. §325(d)

Under the two-part *Advanced Bionics* framework, the Board should not exercise discretion.

The grounds raised by this Petition are not the same or substantially the same as the art and arguments raised during ’924’s prosecution. Sayana, Lee-689, TS36.213, TS36.211, Koivisto, and Ericsson were not substantively considered during prosecution. Though the Examiner cited **Sayana** in a Notice of References Cited attached to an O.A., the Examiner did not substantively discuss or rely on **Sayana** in any rejection of the Claims, or consider its teachings in the combinations set forth in this Petition. *See* ’924FH, 435, 593; *Sony v. MZ Audio Scis., LLC*, IPR2022-01544, Pap. 12, *7 (§325(d) discretion improper where “Examiner did not consider the specific combination of references asserted”); *Google v. Personalized Media Commc’ns, LLC*, IPR2020-00721, Pap. 11, *12, *15-16 (§325(d) discretion improper where “there were no arguments about [reference cited in notice of references cited] during prosecution”). As explained below, the Claims are obvious under the identified Grounds, of which **Sayana** discloses the

“different periods” claim limitations that led to allowance and that were not rejected over any prior art. *See* §IX.

Even if the art or arguments were substantially the same, the Examiner erred in a manner material to the patentability of the Claims. Because the Examiner did not issue any rejections based on any of the cited art in this petition, it is “impossible ... to determine the consideration the Examiner gave” to any cited reference; “the absence of further evidence of the Examiner’s consideration of” the art supports finding that “the Office erred in a manner material to patentability.” *Ecobee Techs. v. Causam Enterprises, Inc.*, IPR2022-01339, Pap. 20, *20-21 (declining §325(d) discretion). The Examiner “did not expressly consider” the art cited herein, rendering it difficult, if not impossible, to explain “how the Examiner might have considered the arguments presented in the Petition.” *Bowtech, Inc. v. MCP IP, LLC*, IPR2019-00379, Pap. 14, *20 (declining §325(d) discretion). Moreover, the references were “not evaluated substantively” and therefore “weigh[] in favor” of error. *See Liquidia Techs., Inc. v. United Therapeutics Corp.*, IPR2021-00406, Pap. 18, *19. Even if any of the art substantively considered by the USPTO were substantially similar to these references (none is), the Examiner would have erred in allowing the Claims. Had the Examiner considered references that taught (as these references do) selecting indicators for two precoders, and feeding back the

indicators at different periods to a BS, the Examiner would have erred in failing to reject the Claims over art that teaches them.

Accordingly, the Board should not exercise its §325(d) discretion to deny institution.

B. §314(a)

The co-pending litigation also does not warrant exercising discretion under §314(a) based on the *Fintiv* factors.

1: Following institution, Petitioner intends to seek a stay of the Texas Case pending the outcome of this IPR.

2: Though the Texas Case's trial is currently set for 7/29/2024,¹² based on median trial time before the presiding judge of the Texas Case over the last 5 years, trial is expected 26 months¹³ from the 9/2/2022 filing date, in late 11/2024, (median time to trial in the district varies between 19 and 24 months over the last few years)¹⁴.

3: The case is in its early stages; the court has not ruled on the initial motion to dismiss and discovery has just begun.

¹² Ex. 1015.

¹³ Ex. 1016.

¹⁴ Ex. 1028.

4: This IPR challenges claims 18, 20-22 and 26-27, which are unasserted in the Texas Case. Moreover, after the final written decision, the same grounds and arguments could not be presented in the litigation.

5: The litigation and PTAB parties are the same.

6: The merits of this Petition are compelling as shown herein, particularly given the narrow reason for allowance and **Sayana's** disclosure of that limitation (*see* §§I, V.B, IX.A.1-IX.A.4).

VII. LEVEL OF ORDINARY SKILL

For purposes of this Petition only, Petitioner assumes the Claims are entitled to the '924's alleged priority date, 7/5/2010. Regardless, each of **Sayana**, **Lee-689**, **TS36.211**, **TS36.213** and **Koivisto** are prior art to the Claims. Hochwald, ¶61.

A person of ordinary skill in the art ("POSITA") as of the alleged '924 priority date would have had a bachelor's degree in electrical and computer engineering, computer science, or the equivalent thereof, and at least two years of experience with networking and wireless communication systems; more education can supplement practical experience, and vice-versa. This is consistent with PO's definition. Ex. 1017, ¶26. The prior art grounds render the Claims obvious under either definition as explained herein. Hochwald, ¶¶62-65.

VIII. CLAIM CONSTRUCTION

Claim terms subject to IPR are construed using *Phillips*. §42.100(b). While Petitioner has proposed constructions for certain claim terms (Ex. 1018), because the prior art asserted herein discloses embodiments within the Claims’ indisputable scope under any reasonable construction, including the preambles regardless of whether they are limiting, the Board need not construe the Claims’ outer bounds and for purposes of this Petition, the Claims should given their plain and ordinary meaning. *Nidec Motor Corp. v. Zhongshan Broad Ocean Motor*, 868 F.3d 1013, 1017 (Fed. Cir. 2017); Hochwald, ¶¶66-68.

IX. GROUNDS OF UNPATENTABILITY

This Petition is supported by the Declaration of Dr. Bertrand Hochwald, which describes the prior art’s scope and content at the time of the ’924. The prior art renders the Claims unpatentable based on six grounds. Hochwald, ¶¶1-42.

A. Ground 1: Sayana in View of Lee-689 (Claims 17-19, 22-24, 28)

1. Sayana

Sayana discloses “a wireless communication system” in which a BS uses “two” component precoders to precode transmissions and improve communications from the BS to “deliver more power to a targeted user [UE] while minimizing interference.” Sayana, Abstract, [0003], [0015]-[0016], [0049]. Hochwald, ¶78.

Sayana's “two” component precoders form a combined precoder at the BS. Sayana, Abstract, [0003], [0006], [0015]-[0016], [0048]-[0049], [0091]-[0095]; Hochwald, ¶79.¹⁵ **Sayana's** “first” and “second” precoders each use precoding matrices selected from a “first codebook” and a “second codebook” of “pre-defined vectors or matrices.” Sayana, Abstract, [0029], [0058], [0085]; Hochwald, ¶79.

Sayana discloses transmitting “codebook subset restriction” from a BS to “signal[]” “the UE to only use a subset of codebook entries for the feedback” of the “first” and “second” precoders. Sayana, [0006], [0085]-[0094]; Hochwald, ¶80. The UE receives and applies “codebook subset restriction” information to both “the first codebook” and “second codebook” when selecting respective first and second representations of first and second precoding matrices for the first and second precoders (e.g., “wideband” and “subband”) from the respective codebooks for feedback to the BS. Sayana, Abstract, [0029]-[0030], [0058]-[0059], [0080]-[0094]; Hochwald, ¶80.

Sayana discloses benefits of separately selecting precoding matrices for the “first” and “second” precoders when respective channel characteristics addressed by

¹⁵ These precoders are similar to the '924's “first” and “second” precoders. See '924, 5:20-60, 7:34-41, 17:42-60, Fig. 4; Hochwald, ¶79.

the precoders change at different time intervals. Sayana, Abstract, [0006], [0058], [0074]-[0082], [0093]-[0094], [0099]-[0100]; Hochwald, ¶81. The first and second representations are fed back “at different time instances and/or periodicities” to “reduce feedback overhead.” *Id.* For example, **Sayana** discloses that some characteristics are “fed back on a wideband basis and/or slowly in time” and others are “fed back on a subband basis and/or more frequently in time.” Sayana, [0006]. If the “wideband” feedback is transmitted less frequently than the “subband,” feedback overhead is reduced over a duration because fewer bits are used for “wideband.” Sayana, [0006]; Hochwald, ¶81.

While **Sayana’s** disclosures relied on herein are all interrelated and complimentary and describe aspects of two precoder feedback and codebook subset restriction, if they are considered separate embodiments, a POSITA would have been motivated to modify, apply, and combine their teachings in one system and expected success in doing so. *See, e.g.*, Sayana, [0025]-[0082] (precoder feedback), [0083]-[0101] (codebook subset restriction); *Bos. Sci. Scimed, Inc. v. Cordis Corp.*, 554 F.3d 982, 991 (Fed. Cir. 2009) (“Combining two embodiments disclosed adjacent to each other in a prior art patent does not require a leap of inventiveness.”); Hochwald, ¶82. These aspects were well-known, and as explained below, codebook subset restriction improves wireless communications by including precoding matrices that

improve communications between a BS and UE and precluding use of precoding matrices that cause interference to other transmitting devices. Sayana, Abstract, [0006], [0048]-[0049], [0083]-[0101]; Koivisto, [0035], [0044]-[0046], [0050]; Hochwald, ¶¶82-84, 90-101, 149-156, 185-191, 216-273. Additionally, the disclosures relating to codebook subset restriction are “exemplary methods” that are applicable to the first and second codebooks of the “two” component feedback frameworks and present example implementations to a POSITA. Sayana, [0085]-[0086]; Hochwald, ¶83.

2. Sayana’s Effective Priority Date

Sayana claims priority to Sayana-Prov, filed 5/5/2010, which predates the ’924’s alleged 7/5/2010 priority date. **Sayana** is entitled to its 5/5/2010 priority date because Sayana-Prov provides enabling written description support for: 1) **Sayana’s** claims (same claims are in both), and 2) **Sayana’s** disclosures that render the Claims obvious (shown in §IX.A.4) (specifications are substantively identical). *See Dynamic Drinkware, LLC v. Nat’l Graphics, Inc.*, 800 F.3d 1375, 1381 (Fed. Cir. 2015); *Ex parte Mann*, 2016 WL 7487271, at *3-6, n.5 (P.T.A.B.); *Whitserve, LLC v. Computer Packages, Inc.*, 694 F.3d 10, 23 (Fed. Cir. 2012) (presumed enabling). For example, **Sayana’s** claim 1 is identical to Sayana-Prov’s claim 1, is repeated in

Sayana-Prov at 36 and is further supported by Sayana-Prov. Abstract, ¶¶[0016], [0048], [0057], [0060], [0065]. Hochwald, ¶¶85-87.

Aside from **Sayana's** incorporation by reference of Sayana-Prov (Sayana, [0001]), the two are substantively identical. *See* Ex. 1019; Hochwald, ¶¶88-89. A table mapping Sayana-Prov and **Sayana** paragraphs is shown below. Hochwald, ¶¶88-89.

Sayana-Prov	Sayana
[0001]-[0023]	[0002]-[0024]
[0024]-[0025]	[0025]
[0026]-[0027]	[0026]
[0028]-[0029]	[0027]
[0030]-[0033]	[0028]-[0031]
[0034]-[0035]	[0032]
[0036]	[0033]
[0037]-[0038]	[0034]
[0039]	[0035]
[0040]-[0041]	[0036]

Sayana-Prov	Sayana
[0042]-[0046]	[0037]-[0041]
[0047]-[0048]	[0042]
[0049]-[0062]	[0043]-[0056]
[0063]-[0064]	[0057]
[0065]-[0066]	[0058]-[0059]
[0067]-[0068]	[0060]
[0069]-[0073]	[0061]-[0065]
[0074]-[0075]	[0066]
[0076]-[0077]	[0067]
[0078]-[0081]	[0068]-[0071]
[0082]-[0083]	[0072]
[0084]-[0090]	[0073]-[0079]
[0091]-[0092]	[0080]
[0093]-[0094]	[0081]
[0095]-[0096]	[0082]-[0083]
[0097]-[0099]	[0084]

Sayana-Prov	Sayana
[0100]-[0101]	[0085]-[0086]
[0102]-[0103]	[0087]
[0104]-[0118]	[0088]-[0102]

3. Motivation to Apply Lee-689’s Teachings to Sayana

Lee-689 teaches limiting selection of precoder matrices, for “closed-loop” feedback by a UE to BS, to a “base codebook subset” by using a “bitmap” to signal excluded codebook entries. Lee-689, Abstract, 2:3-7, 3:6-14, 6:3-16, 15:4-10, 16:17-18:15; Hochwald, ¶90. If an “ith element” of a “bitmap is 0, a base codebook subset does not include ith element of a base codebook,” and if an “ith element” of the “bitmap is 1, a base codebook subset includes ith element.” Lee-689, 18:5-15; Hochwald, ¶90. For example, **Lee-689** teaches a “base codebook” W that consists of 8 matrices ($W = [W_0 \ W_1 \ W_2 \ W_3 \ W_4 \ W_5 \ W_6 \ W_7]$). *Id.* The 1’s in the bitmap “0b10011110” correspond to the permitted first, fourth, fifth, sixth and seventh positions, and therefore indicate selecting a “base codebook subset” from this base codebook of $W = [W_0 \ W_3 \ W_4 \ W_5 \ W_6]$, while second, third, and eighth positions are restricted. *Id.* The number of elements in the bitmap (8) is the same as the number of matrices in the “base codebook” (8). *Id.*

Sayana and **Lee-689** are analogous prior art and in the same field as the '924—which includes MIMO wireless communications—and reasonably pertinent to alleged problems identified in the '924, including improving communication efficiency. '924, 1:34-36, 3:57-65, 4:10-19; Sayana, [0003]-[0005], [0085]; Lee-689, 1:10-14, 14:5-21; Hochwald, ¶91. **Lee-689**, like the '924, teaches that its bitmap solution reduces inter-cell interference in a system where a first BS transmits a set of precoding matrices to a neighboring second BS to be used or restricted to reduce interference from the second BS to UEs served by the first BS. '924, 5:10-19, 17:52-19:52, Figs. 8-10; Lee-689, 12:21-14:21, 15:11-16:16; Hochwald, ¶92.

Sayana does not specify how to implement the communication of its “codebook subset restriction.” *E.g.*, Sayana, [0085]-[0092]; Hochwald, ¶93. **Lee-689** teaches how to perform such codebook subset restriction using a “bitmap” in which 0s/1s indicate precoding matrices to be restricted from or included in a subset for selection. Lee-689, 17:2-20, 18:5-15; Hochwald, ¶93.

For several reasons, a POSITA would have been motivated to modify **Sayana's** “codebook subset restriction” with **Lee-689's** bitmap teachings to improve the signaling of restricted precoding matrices to UEs. Hochwald, ¶94.

First, both **Sayana** and **Lee-689** look at the importance of precoding for improving wireless transmission power to intended UEs while reducing interference

to unintended UEs. Sayana [0003]; Lee-689, 6:19-7:3, 20:14-21:3; Hochwald, ¶95. Both **Sayana** and **Lee-689** view “precoding” transmissions as ways to respond to cell-specific and UE-specific requirements for multiple-antenna transmission, including interference—**Lee-689** also uses codebook restriction to mitigate interference from precoding. Sayana [0003]-[0004], [0091]-[0092]; Lee-689 13:23-14:4; Hochwald, ¶95.

Second, Sayana does not specify how to implement communication of its “codebook subset restriction.” Sayana, [0085]-[0092]; Hochwald, ¶96. **Sayana** discloses using bits (*e.g.*, “feedback bits to capture the wideband” and “subband” “information”) to represent indices to codebooks (*e.g.*, “2,” “4 or 6 bit codebook,” each codebook being “a set of predetermined precoding matrices”), but not how to restrict the codebooks.¹⁶ Sayana, [0039], [0070]. **Lee-689** teaches using bitmaps

¹⁶ **Sayana’s** “2,” “4 or 6 bit” codebooks refer to the number of “feedback bits” used to generate an index into a codebook, as compared to a bitmap of restriction information taught by **Lee-639** and **TS36.213**, in which the length of the bitmap is also the size of the codebook. Sayana, [0060], [0070]; Lee-639, 17:7-18:15; TS36.213, 34; Hochwald, ¶96 n.7. For example, a 2-bit codebook has (2^2) 4 precoding matrices; 4-bit codebook has (2^4) 16 precoding matrices; and 6-bit

for “base codebook subset” indication. Lee-689, 17:2-20, 18:5-15; Hochwald, ¶96. A POSITA would have been motivated to modify **Sayana’s** teachings of codebook subset restriction using **Lee-689’s** method because doing so would combine prior art elements according to known methods to yield predictable results. Sayana, [0085]-[0092]; Lee-689, 18:5-15; Hochwald, ¶96. Using bitmaps to implement codebook restriction was well known in the art. Lee-689, 18:5-15; WO2009/025619 (“Göransson-619”, Ex. 1020); TS36.213, 34; Hochwald, ¶96.

Third, using **Lee-689’s** bitmap teachings reduces inter-cell interference. Lee-689, 12:21-14:21, 15:11-16:16; Hochwald, ¶97. **Lee-689** teaches transmitting information about a set of precoding matrices from a first BS to neighboring second BS to indicate a subset that excludes precoding matrices that cause interference to UEs connected to the first BS, and therefore reduces interference to those UEs. *Id.* The second BS forms its “base codebook subset” based on the received bitmap so that its transmissions will not use precoding matrices that cause interference to UEs connected to the first BS. *Id.*

codebook has (2^6) 64 precoding matrices. **Sayana** describes that a “representation” of a chosen matrix is “the index” “within a codebook.” Sayana, [0060].

Fourth, using **Lee-689**'s bitmap teachings provides flexible specification of codebook subset restrictions because, “[f]or a specific precoder codebook,” a “bitmap can specify all possible precoder codebook subsets.” TS36.213, 34; Hochwald, ¶98. As taught by **TS36.213**, a POSITA would have been motivated to implement **Sayana**'s codebook subset restriction using **Lee-689**'s bitmap because doing so provides precise control to selectively disable precoding matrices of a respective codebook that cause sub-optimal communications, or interference to neighboring cells, and to separately select from the respective codebooks to address different channel properties by using appropriate precoding matrices (e.g., wideband and subband) of the codebooks. Sayana, [0006], [0085]-[0087]; Lee-689, 14:5-21, 15:4-17:1, 18:5-15; Göransson-619, [0023]; Hochwald, ¶98, 185-191. Moreover, using a separate bitmap for each codebook, rather than a combined bitmap across both codebooks, requires fewer bits, and therefore reduces overall overhead in the communication of codebook restriction information. For example, a 64 bit combined bitmap of possible pairs between a first codebook of 16 precoding matrices and second codebook of 4 precoding matrices requires more bits than separately sending 16 bit and 4 bit bitmaps. A POSITA would have further been motivated to reduce the length of transmitted bitmaps and expected success in doing

so. Hammarwall, [0010], [0018]. Because the other option is a combined bitmap, both options are predictable and obvious. Hochwald, ¶¶98.

Fifth, using **Lee-689's** bitmap teachings to implement a separate bitmap for each of **Sayana's** codebook subset restriction information would have been a design choice or predictable variation. *See Uber Techs., Inc. v. X One, Inc.*, 957 F.3d 1334, 1338 (Fed. Cir. 2020). As discussed above, there are two options of using **Lee-689's** bitmap with **Sayana's** codebook subset restriction: a combined bitmap, or two bitmaps. Given these limited design choices, and the varying benefits each (e.g., more granular selection with a combined bitmap, and fewer bits with two bitmaps), a POSITA would have been motivated to and found it obvious to use two bitmaps, and expected success in doing so. Hochwald, ¶99.

In light of the above teachings, a POSITA would have had a reasonable expectation of success in modifying **Sayana** with **Lee-689's** teachings of a bitmap having the same number of bits as the number of precoder matrices. Hochwald, ¶100. **Lee-689**, like **Sayana**, is directed to restriction of subsets of precoder matrices that are selectable by a UE for feedback to a BS. Lee-689, 17:7-18:15; Sayana, [0085]-[0092]; Hochwald, ¶100. It was well understood to use bitmaps having a same number of bits as precoding matrices to provide codebook subset restriction. *E.g.*, Lee-689, 17:7-18:15; TS36.213, 34; Göransson-619, [0023], [0030].

Modifying **Sayana** with **Lee-689**'s teachings would have been a straightforward application of those teachings that advantageously improves flexibility of a system that uses precoder matrices selected based on feedback from a UE. Hochwald, ¶100.

Thus, a POSITA would have been motivated to apply **Lee-689**'s teachings of a bitmap having a same number of bits as precoding matrices to implement **Sayana**'s "codebook subset restriction" information for **Sayana**'s "first" precoder, such that any precoding matrix in **Sayana**'s "first codebook" is advantageously selected or restricted. **Sayana**, [0039], [0070], [0085]-[0092]; **Lee-689**, 15:4-17:1, 18:5-15; Hochwald, ¶101. A POSITA also would have been motivated to apply these same teachings to **Sayana**'s "codebook subset restriction" information for **Sayana**'s "second" precoder for the same reasons. *Id.*

4. Claim Chart

In addition to §§IX.A.1-IX.A.3, the following identifies example disclosures followed by bulleted excerpts that each disclose and/or render obvious the Claims. Hochwald, ¶102.

'924 Claims	Sayana in view of Lee-689
[17.pre] A communication method of a receiving device in a wireless communication system, the	Sayana discloses a communication method (<i>e.g.</i> , "feedback scheme...to send a precoder matrix information to a [BS]") of a receiving device (<i>e.g.</i> , "wireless communication device," "UE" that "receives transmissions from a plurality of antennas") in a wireless communication system (<i>e.g.</i> , "wireless communication system[']").

'924 Claims	Sayana in view of Lee-689
method comprising:	<u>E.g., Sayana:</u> Sayana discloses a “feedback scheme” for use in “wireless communication systems” in which a UE receives “downlink communication signals” from a BS/“eNB.” Hochwald, ¶¶103-106. • Figure 1 The diagram, labeled FIG. 1, illustrates a wireless communication system 100. It features a base station (BS) 110 with two antennas, 112 and 114. A mobile station (MS) 102 is shown within a hexagonal cell boundary. A lightning bolt symbol indicates a signal path from the BS to the MS. The MS 102 is also labeled as 'a receiving device' in red text. The entire system is enclosed in a blue hexagonal boundary labeled 'a wireless communication system' in blue text. The reference numeral 100 is located at the top right of the diagram. FIG. 1 • Figure 2

'924 Claims	Sayana in view of Lee-689
	a wireless communication system FIG. 2 • [0002] (“The present disclosure relates ... to a feedback framework in wireless communication systems.”) • [0003] (“In wireless communication systems, channel state information at a transmitter, for example, at a [BS], is important for beam-forming transmissions (also referred to as precoding)”) • [0015] (“In FIG. 1, a wireless communication system 100 comprises one or more fixed base infrastructure units 110 and 120 forming a network ... remote units The base infrastructure unit may also be referred to as the transmitter, access point (AP), access terminal (AT), base, [BS], base unit (BU), Node-B (NB), enhanced Node-B (eNB), Home Node-B (HNB), Home eNB (HeNB) or by other terminology used in the art.”) • [0016] (“The one or more base units serve a number of remote units, for example, remote unit 102 and 104 in FIG. 1.... The remote units may be fixed units or wireless communication devices. The remote unit may also be referred to as a receiver, subscriber station (SS), mobile, mobile station (MS), mobile terminal, user, terminals, [UE], user terminal (UT)”)

'924 Claims	Sayana in view of Lee-689
	<i>or by other terminology used in the art. ... In FIG. 1, the base unit 110 transmits downlink communication signals to serve remote unit 102 The remote unit 102 communicates directly with base unit 110 via uplink communication signals.”)</i> • [0018] (“In ... FIG. 2, ... a base unit transmits from a plurality of antennas. Also in FIG. 2, a remote unit receives transmissions from a plurality of antennas, which may or may not be co-located. ... Such a base unit is also referred to as a serving cell....”) • [0019] (“[T]he wireless communication system is compliant with ... (3GPP) Universal Mobile Telecommunications System (UMTS) Long Term Evolution protocol, ... Evolved Universal Terrestrial Radio Access (EUTRA), or some future generation thereof. ... [T]he wireless communication system may implement some other open or proprietary communication protocol where channel feedback is useful or desired.”) • [0058] (“[T]he feedback scheme for a wireless communication device to send a precoder matrix information to a base station”) • See also [0025].
[17.a] receiving codebook restricting information including at least	Sayana discloses receiving codebook restricting information (e.g., receiving “codebook subset restriction”) to restrict at least one precoding matrix from a first precoding matrix group (e.g., “codebook subset restriction ...signals the UE to only use a subset of codebook entries” from a “first codebook,” “wideband codebook,” “W₁,” where “a predefined codebook [] consists of a set of pre-defined vectors or matrices”) and to restrict at least one precoding matrix from a second precoding matrix group (e.g., “codebook subset restriction ...signals the UE to only

'924 Claims	Sayana in view of Lee-689
one of¹⁷ a first bit sequence to restrict at least one precoding matrix from a first precoding matrix group and a second bit sequence to restrict at least one precoding matrix from a second precoding matrix group	use a subset of codebook entries” from a “second codebook,” “subband codebook,” “W₂”). <u>E.g., Sayana:</u> See [17.pre]. Sayana discloses that the BS/eNB sends “codebook subset restriction[s]” that are “applied to either the first codebook, or the second codebook, or both” to “signal[] the UE to only use a subset of codebook entries.” Sayana, [0085]; Hochwald, ¶¶107-108, 110, 115. The UE selects and feeds back a “preferred Precoding Matrix Index (PMI)” from each codebook based on the subset restrictions. Sayana, [0029], [0039], [0058], [0079], [0082], [0085], [0087], [0094], Figs. 1-2; Hochwald, ¶110. Sayana discloses, for example, that “wideband” “long-term” feedback associated with a “first” codebook and precoder, and “subband” “short-term” feedback is associated with a “second” codebook and precoder. Sayana, [0006], [0050]. Hochwald, ¶111. • [0006] (“<i>One of the components</i> representing the correlated channel characteristics <i>can be fed back on a wideband basis and/or slowly in time</i>, while the <i>other component is fed back on a subband basis and/or more frequently in time.</i>”)

¹⁷ While [17.a] requires that “codebook restricting information” include only “at least one of” a “first bit sequence” and a “second bit sequence,” Ground 1 nevertheless shows both sequences.

'924 Claims	Sayana in view of Lee-689
	• [0029] (“<i>[A] predefined codebook that consists of a set of pre-defined vectors or matrices. ... [T]he precoding matrix may be signaled by the base unit efficiently with a precoding matrix index (PMI) or with an index to a precoding matrix within a predefined codebook.</i>”) • [0039] (“<i>To support precoding operation from the [BS], a user terminal will be reporting back to the [BS] a preferred Precoding Matrix Index (PMI) which is an index to a set of predetermined precoding matrices. The recommended precoding matrix is obtained at the user terminal ... and is selected from one of the quantized codebook entries, wherein the codebook is known to the transmitter and the receiver. ... [T]he standard requires the UE to feedback the PMI that supports a MCS (modulation and coding scheme) with the highest rate</i>”) • [0050] (“<i>... long-term/correlated component corresponds to a wide frequency band</i> such as the whole system bandwidth and the <i>short-term component corresponds to a subband/narrowband</i>”) • [0058] (“<i>In the feedback scheme for a wireless communication device to send a precoder matrix information to a [BS], the wireless communication device sends a first representation of a first matrix chosen from a first codebook The wireless communication device sends a second representation of a second matrix chosen from a second codebook, wherein the first representation and the second representation together convey a precoder matrix....</i>”)

'924 Claims	Sayana in view of Lee-689
	• [0079] (“[A] product matrix based method of precoder matrix representation can be used to describe the two-component feedback.”) • [0082] (“The final precoder is obtained as $W = \text{reshape}(W_1 W_2)$ where a “‘reshaping’ operation is to re-arrange the columns of the product matrix to form the precoder matrix. ... $\text{reshape}(X = [X_1 X_2 X_3 X_4]) = \begin{bmatrix} X_1 & X_3 \\ X_2 & X_4 \end{bmatrix},,$”) • [0084] (“[T]he subband codebook may be expanded allowing the incorporation of a rotation codebook, in which case the wideband and subband codebook could be represented mathematically ...”) • [0085] (“... eNB... enabl[es] codebook subset restrictions at wideband and subband level. A codebook subset restriction is essentially where eNB signals the UE to only use a subset of codebook entries for the feedback. Subset restriction can be applied to either the first codebook, or the second codebook, or both.”) • [0086] (“Codebook subset restriction can be used for both wideband and subband components ...”) • [0087] (“[A] subset restriction can be imposed at wideband level to only transmit information regarding v1, by defining wideband codebook ... This would also implicitly result in following restriction for the subband codebook ...”) • [0094] (“[I]n FIG. 6. The first component could correspond to a wideband matrix W_1^{WB} A second matrix W_2^b corresponds to a to a band ‘b’. The precoder for a band ‘b’, represented as W^b is obtained

'924 Claims	Sayana in view of Lee-689
	as a function of W_1^{WB} and W_2^b. A preferred example of the function as described above is reshape ($W1 \times W2$).”) • See also Abstract, [0004], [0015]-[0016], [0018]-[0019], [0025]-[0028], [0037], [0043], [0050], [0064]-[0072], [0080]-[0081], [0088]-[0092]. Lee-689 teaches codebook restricting information including at least one bit sequence to restrict at least one precoding matrix (e.g., a “bitmap” of “codebook subset indication”). <u>E.g., Lee-689:</u> Sayana does not specify how “codebook subset restriction” information is signaled from a BS/eNB to a UE. Hochwald, ¶112. Lee-689 teaches using a “bitmap” as a “codebook subset indication” to “represent[] which precoding matrixes [sic] are included in a base codebook.” Lee-689, 18:5-15; Hochwald, ¶¶109, 113, 116. As further discussed in §IX.A.3, a POSITA would have been motivated to modify Sayana’s “codebook subset restriction” information with Lee-689’s teachings of bitmaps, yielding a system in which a separate bitmap is used for each of Sayana’s codebooks (e.g., wideband and subband) to identify precoding matrices to restrict from each respective codebook. Sayana, [0085]; Lee-689, 18:5-15; Hochwald, ¶114. • 18:5-15(“A base codebook subset indication represents which precoding matrixes are included in a base codebook subset among a rank 1 base codebook or not. A base codebook subset indication can be expressed by bitmap. For example, if ith

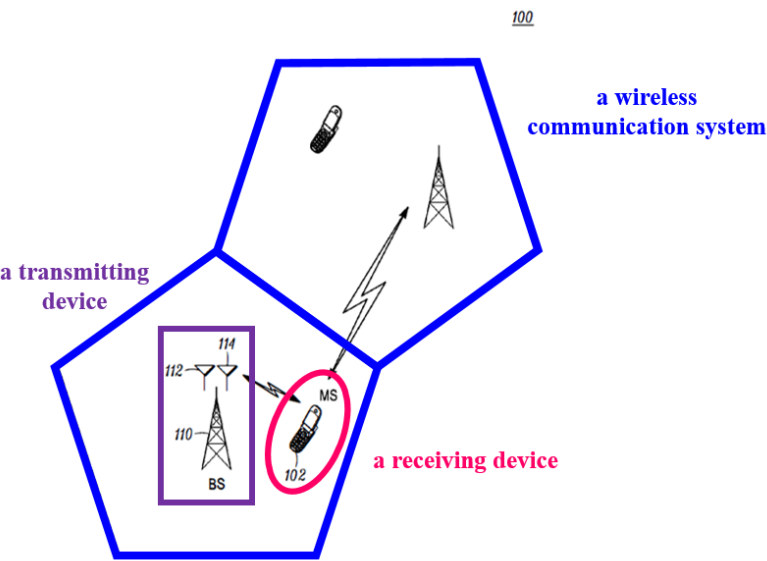
'924 Claims	Sayana in view of Lee-689
	<i>element of a base codebook subset indication expressed by bitmap is 0, a base codebook subset does not include ith element of a base codebook. And, if ith element of a base codebook subset indication expressed by bitmap is 1, a base codebook subset includes ith element of a base codebook.</i> That is, a base codebook subset indication for a base codebook subset of equation 7 is ‘0b10011110’.”) • See also 12:5-16; 17:7-20:23
[17.b] each bit of the first bit sequence corresponding to one precoding matrix of the first precoding matrix group, respectively, the at least one precoding matrix of the first precoding matrix group being restricted from being used as a precoding matrix of a first	Sayana discloses the at least one precoding matrix of the first precoding matrix group (see [17.a]) being restricted from being used as a precoding matrix of a first precoder (see [17.a]; e.g., “codebook subset restrictions at wideband ... level,” “first” precoder, “W1”), and the at least one precoding matrix of the second precoding matrix group (see [17.a]) being restricted from being used as a precoding matrix of a second precoder (see [17.a]; e.g., “codebook subset restrictions at ... subband level,” “second” precoder, “W2”). <u>E.g., Sayana:</u> See [17.pre]-[17.a]. Sayana discloses “two” component precoders including “first” and “second” precoders that are used to form one composite precoder at the BS.¹⁸ Hochwald, ¶¶117-118. For

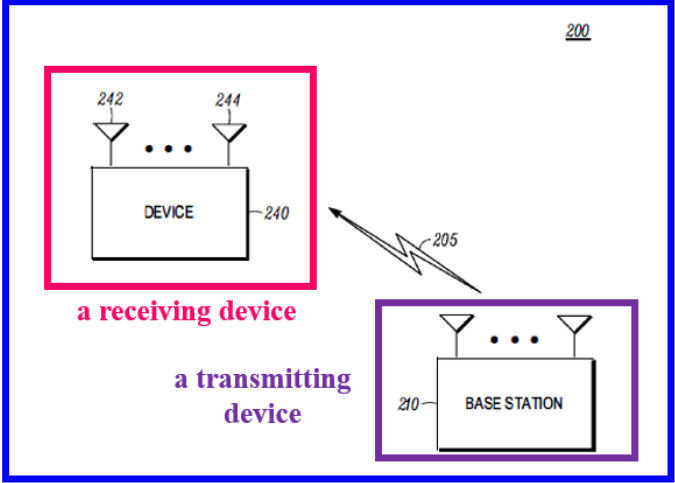
¹⁸ As discussed in §IX.A.1, **Sayana’s** disclosure of two precoders is the same as the ‘924’s disclosure that “a multistage precoder includ[es] at least two precoders” and “precoder 425 may include the first precoder 422 and the second precoder 424 to

'924 Claims	Sayana in view of Lee-689
precoder, each bit of the second bit sequence corresponding to one precoding matrix of the second precoding matrix group, respectively, and the at least one precoding matrix of the second precoding matrix group being restricted from being used as a precoding matrix of a second precoder;	example, a “two” component precoder includes a “wideband” precoder “W1” or “W₁^{WB}” and a “subband” precoder “W2” or “W₂^B”. See §IX.A.1. Sayana, [0048]-[0050], [0082], [0093]-[0094]; Hochwald, ¶¶120. Sayana further discloses using a “[c]odebook subset restriction” with a “first codebook” and “second codebook” to restrict selection of respective precoding matrices for “first” and “second” precoders of “two” component precoders. Sayana, [0049], [0085]-[0086]; Hochwald, ¶¶121-122, 125. • [0048] (“[T]wo structures are shown which allow <i>expressing the overall precoder as a Kronecker product of two precoders.</i>”) • [0049] (“[T]he <i>Kronecker representation leads to an elegant separation to two component precoders</i> and is <i>one way to achieve two-component feedback</i>”) • [0050], [0082], [0085]-[0086], [0094] (see [17.a]) • [0093] (“<i>The two component feedback scheme described above is applicable to multiple feedback modes as further described below.</i>”) • See also [0003], [0006], [0015]-[0016], [0029], [0039], [0054], [0092], [0095] Lee-689 discloses each bit of the bit sequence corresponding to one precoding matrix of the precoding

perform precoding of data symbols.” Compare ’924, 5:20-60, 7:34-41, 8:19-28, 17:42-60, Fig. 4 with Sayana, Abstract, [0003], [0006], [0015]-[0016], [0048]-[0050], [0058]-[0059], [0091], [0095]; Hochwald, ¶79.

'924 Claims	Sayana in view of Lee-689
	matrix group, respectively (see [17.a], <i>e.g.</i>, “if ith element of a base codebook subset indication expressed by bitmap is 0, a base codebook subset does not include ith element of a base codebook”). <u>E.g., Lee-689:</u> <i>See</i> [17.a]. Sayana does not specify how a “codebook subset restriction” is signaled from a BS/eNB to a UE for each of the first (<i>e.g.</i>, wideband) and second (<i>e.g.</i>, subband) components. Hochwald, ¶¶122, 126. Lee-689 provides additional teachings of using a “bitmap” as a “codebook subset restriction indication,” in which a “bitmap” for a given codebook provides a separate “element” indicating whether the associated precoding matrix is “included in a base codebook.” Lee-689, 18:5-15; Hochwald, ¶¶119, 123. As further discussed in §IX.A.3, a POSITA would have been motivated to modify Sayana’s “codebook subset restriction” information with Lee-689’s teachings of bitmaps, yielding a system in which a separate bitmap is used for each codebook (wideband and subband) to identify a respective codebook subset restriction, rendering obvious this element. <i>See</i> [17.a]; Lee-689, 18:5-15; Hochwald, ¶124. • 18:5-15([17.a])
[17.c] transmitting, to a transmitting device, 1 st channel status information indicating the precoding matrix	Sayana discloses transmitting, to a transmitting device (see [17.pre]; <i>e.g.</i>, transmitting to the [BS]/“eNB” “via uplink communication signals”), 1st channel status information indicating the precoding matrix of the first precoder (<i>e.g.</i>, “a first representation of a first matrix chosen from a first codebook” “along with an associated CQI feedback”; see [17.pre]-[17.b]) and 2nd channel status information indicating the precoding matrix of the

'924 Claims	Sayana in view of Lee-689
of the first precoder and 2nd channel status information indicating the precoding matrix of the second precoder,	second precoder (e.g., “a second representation of a second matrix chosen from a second codebook” “along with an associated CQI feedback”; see [17.pre]-[17.b]). <u>E.g., Sayana:</u> See [17.pre]-[17.b]. Sayana also discloses that the “wireless communication device” transmits a “first representation of a first matrix chosen from a first codebook” and a “second representation of a second matrix chosen from a second codebook” to a [BS] “via uplink communication signals.” Sayana, Figures 1-2, [0015]-[0016], [0018], [0058]-[0059]; Hochwald, ¶¶127-130. The “[first/second] representation” corresponds to the “index of the chosen matrix within a [first/second] codebook” of the first/second precoder (see [17.pre]-[17.b]), respectively. Sayana, [0058], [0060]. Sayana teaches that the “feedback” includes “an associated CQI feedback.” Sayana, [0095]; Hochwald, ¶¶127-130. Figure 1 

'924 Claims	Sayana in view of Lee-689
	- Figure 2  a wireless communication system FIG. 2 - Abstract (“<i>sending a first representation of a first matrix chosen from a first codebook, ... sending a second representation of a second matrix chosen from a second codebook, and the base station obtaining a precoder from the first representation and the second representation.</i>”) [0015]-[0016], [0018] (see [17.pre]) [0058] (see [17.a]) [0059] (“<i>The two-component feedback conveys the information of a precoder matrix recommended by the user to the [BS].</i>”) [0060] (“<i>A user feeds back a representation of a first chosen matrix ... wherein the representation can be just the index of the chosen matrix within a codebook. Then, the user feeds back a representation of a second matrix ...also as index within a codebook format. The precoder information conveyed by these</i>

'924 Claims	Sayana in view of Lee-689
	two representations corresponds to a final precoder matrix....”) • [0095] (“<i>[F]eedback could be defined along with an associated CQI feedback.</i>”) • <i>See also Abstract, [0003], [0017], [0085]-[0086].</i>
[17.d] the precoding matrix of the first precoder and the precoding matrix of the second precoder being selected, based on the codebook restricting information, from among precoding matrices that are not restricted,	Sayana discloses the precoding matrix of the first precoder and the precoding matrix of the second precoder (see [17.b]) being selected (e.g., “first representation of a first matrix chosen from a first codebook”; “second representation of a second matrix chosen from a second codebook”), based on the codebook restricting information, from among precoding matrices that are not restricted (see [17.a]; e.g., “subset restriction ... signals the UE to only use a subset of codebook entries” and “can be applied to either the first codebook, or the second codebook, or both”). <u>E.g., Sayana:</u> <i>See [17.pre]-[17.c].</i> Sayana discloses a “first” precoder associated with “wideband” information and a “second” precoder associated with “subband” information. <i>See [17.a]-[17.b]; Hochwald, ¶¶131-134.</i> Sayana also discloses that a BS “signals the UE to only use a subset of codebook entries for the feedback.” <i>Sayana, [0085]; Hochwald, ¶133.</i> Sayana discloses that a UE applies “codebook subset restrictions” received from the BS to “the first codebook” and “second codebook,” to select one precoding matrix from each of the restricted “first codebook” and restricted “second codebook.” <i>Id.</i> For example, a respective “index to a set of predetermined precoding

'924 Claims	Sayana in view of Lee-689
	matrices” (<i>e.g.</i>, “information of a precoder matrix recommended by the user to the [BS]”) is used to select respective “wideband” and “subband” components of a precoder matrix. Sayana, [0039], [0059], [0094]; Hochwald, ¶133. • [0039], [0050], [0058], [0085]-[0086], [0094] (<i>see</i> [17.a]) • [0048]-[0049] (<i>see</i> [17.b]) • [0059] (<i>see</i> [17.c]) • <i>See also</i> [0030], [0087], [0091], [0095].
[17.e] wherein a period of transmitting the information relating to the precoding matrix of the first precoder and a period of transmitting the information relating to the precoding matrix of the second precoder are different from each other.	Sayana discloses a period of transmitting the information relating to the precoding matrix of the first precoder (<i>see</i>, [17.a]-[17.d]) and a period of transmitting the information relating to the precoding matrix of the second precoder (<i>see, e.g.</i>, [17.a]-[17.d]) are different from each other (<i>e.g.</i>, “the first matrix may be further feedback [sic] at different time instances and/or periodicities compared to the second matrix”). <u>E.g., Sayana:</u> <i>See</i> [17.pre]-[17.d]. Sayana also teaches that the indicators of the first and second precoding matrices of the first and second precoders, respectively (<i>see</i> [17.c]) are fed back from a UE to a BS “at different time instances and/or periodicities.” Hochwald, ¶¶135-138. • [0006], [0050], [0058] (<i>see</i> [17.a]) • [0099] (“<i>[T]he first matrix may be further feedback [sic] at different time instances and/or periodicities</i>

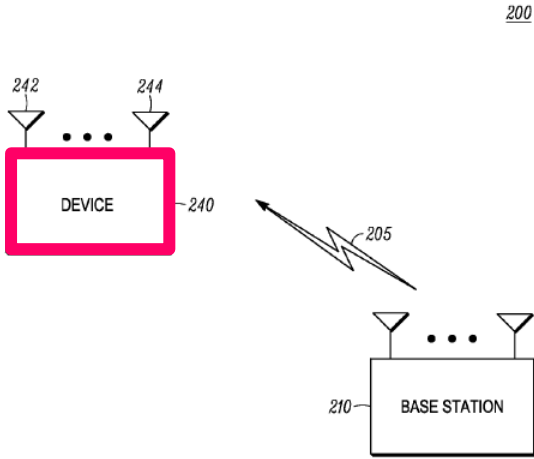
'924 Claims	Sayana in view of Lee-689
	<i>compared to the second matrix</i>. This can ... be useful to alleviate the feedback load on the uplink in a single reporting instance like a subframe.”) • <i>See also</i> [0065], [0085]-[0086].
[18] The method of claim 17, wherein the first matrix group includes N precoding matrices, and the first bit sequence is an N-bit sequence, where N is an integer.	<i>See</i> [17]. Sayana discloses that the first matrix group includes precoding matrices. <i>See</i> [17.pre]-[17.a]. Hochwald, ¶¶139-140. Lee-689 teaches a matrix group includes N precoding matrices, and the first bit sequence (e.g., “bitmap”) is an N-bit sequence, where N is an integer (e.g., “0b10011110” has 8 bits). <u>E.g., Lee-689:</u> <i>See</i> [17.a]. Lee-689 also teaches that an integer number of precoding matrices in a “base codebook” (e.g., 8 entries in $W = [W_0 \ W_1 \ W_2 \ W_3 \ W_4 \ W_5 \ W_6 \ W_7]$) corresponds to the length of the bit sequence (e.g., “base codebook subset indication for a base codebook subset ... is ‘0b10011110’”). Lee-689, 18:5-15, 17:7-20; Hochwald, ¶¶141-142, 144. This not only renders obvious but affirmatively discloses using an N-bit sequence that corresponds to a codebook with N precoding matrices from which to choose because it uses 8 bits to select between 8 matrices—advantageously allowing the selection of any combination of the matrices within the codebook. Hochwald, ¶142. As further discussed in §IX.A.3, a POSITA would have been motivated to modify Sayana’s “codebook subset restriction” information for a “first” precoder with

'924 Claims	Sayana in view of Lee-689
	Lee-689's teachings of a bitmap having a same number of bits as precoding matrices, rendering obvious this element. <i>See</i> [17.a]. Hochwald, ¶143. • 17:7-20 (“[B]ase codebook is as equation 6” “$W = [W_0 \ W_1 \ W_2 \ W_3 \ W_4 \ W_5 \ W_6 \ W_7]$” and a “codebook subset as equation 7” “$W = [W_0 \ W_3 \ W_4 \ W_5 \ W_6]$.”) • 18:5-15 (<i>see</i> [17.a])
[19] The method of claim 17, wherein the use of precoding matrices for the second precoder that make pairs with restricted precoding matrices of the first matrix group is restricted based on the first bit sequence, and the use of precoding matrices for the first precoder that make pairs with restricted precoding matrices of the second matrix group is restricted based on the second bit sequence.	<i>See</i> [17]. Sayana discloses that the use of precoding matrices for the second precoder (<i>see</i> [17.a]-[17.b]; <i>e.g.</i>, precoding matrices of a “second codebook”, “W_2^B”) that make pairs with restricted precoding matrices of the first matrix group (<i>see</i> [17.a]-[17.b]; <i>e.g.</i>, “codebook subset restriction information” applied to a “first codebook”, “W_1^{WB}”) is restricted, and the use of precoding matrices for the first precoder (<i>see</i> [17.a]-[17.b]; <i>e.g.</i>, precoding matrices of a “first codebook”, “W_1^{WB}”) that make pairs with restricted precoding matrices of the second matrix group (<i>see</i> [17.a]-[17.b]; <i>e.g.</i>, “codebook subset restriction information” applied to a “second codebook”, “W_2^B”) is restricted (<i>e.g.</i>, “[t]he precoder” is a “function” of two components, “W_1” and “W_2”). <u>E.g., Sayana:</u> <i>See</i> [17.pre]-[17.e]. Hochwald, ¶¶145, 148-156. As discussed in §IX.A.1, Sayana discloses that a combined precoder is formed of a “first” precoder and a “second” precoder. Hochwald, ¶¶146, 156. For example, a “final precoder” is formed by a product of a “first” precoder (<i>e.g.</i>, “W_1,” “wideband matrix W_1^{WB}”) associated with a “first

'924 Claims	Sayana in view of Lee-689
	codebook” that makes a pair with a “second” precoder (e.g., “W_2,” “second [subband] matrix W_2^b”) associated with a second codebook. Sayana, Abstract, [0006], [0079], [0082], [0094]; Hochwald, ¶¶156, 159. Sayana also discloses using “codebook subset restriction” information to restrict a subset of the “first codebook” and the “second codebook” from which the UE selects for feedback. Sayana, [0085]-[0086]; Hochwald, ¶157. Sayana further discloses a “4” “bit” “first codebook” of $16 (2^4)$ precoding matrices that “represent[s] the wideband entries”; and a “2 bit” “second codebook” of $4 (2^2)$ subband precoding matrices “for subband vectors.” Sayana, [0070]; Hochwald, ¶157. Each precoding matrix of Sayana’s “wideband” “first codebook” is paired with a precoding matrix of Sayana’s “subband” “second codebook” to form a composite precoder at the BS. Sayana, [0079], [0082], [0094]; Hochwald, ¶157. Just as the ’924 discloses that a restriction of a first precoding matrix of a first codebook restricts pairs of a second precoding matrix of a second codebook from being used with that first precoding matrix, Sayana also discloses that restriction of a first precoding matrix precludes “second precoding matrices” from being used with the “first precoding matrix” and vice-versa. Hochwald, ¶157. • [0006], [0079], [0082], [0085]-[0086] (see [17.a]) • [0070] (“[U]se a 2 bit codebook for subband vectors and a 4 or 6 bit codebook to represent the wideband entries.”) • [0094] (“The first component could correspond to a wideband matrix W_1^{WB} A second matrix W_2^b corresponds to a to a band ‘b’. The precoder for a band ‘b’, represented as W^b is obtained as a function of W_1^{WB} and W_2^b. A preferred example of the function as described above is reshape ($W_1 \times W_2$). A UE is required to feedback the wideband

'924 Claims	Sayana in view of Lee-689
	<i>precoder/matrix for the whole band and the subband precoder/matrix for each subband.”)</i> • <i>See also</i> [0007], [0029], [0039], [0080]-[0081], [0091]. Lee-689 teaches the matrix group is restricted based on the bit sequence (see [17.a]; e.g., “bitmap” as “codebook subset indication”). <u>E.g., Lee-689:</u> See [17.a]. Hochwald, ¶147. When applied to Sayana, Lee-689’s teachings separately provide a first bitmap (first bit sequence) as codebook restriction information for Sayana’s “wideband” “first codebook” and a second bitmap (second bit sequence) as codebook restriction information for Sayana’s “subband” “second codebook.” See [17.a]; Hochwald, ¶¶158, 160. A restriction of wideband precoding matrices of the “first codebook” as indicated by the first bit sequence also restricts the subband precoding matrices of the subband “second codebook” that makes pairs with the wideband precoding matrices as discussed above—and vice-versa. See §IX.A.3; Hochwald, ¶158. • 18:5-15(see [17.a]) • <i>See also</i> 12:5-16; 17:7-20:23
[22] The method of claim 17, wherein the period of transmitting the information	<i>See</i> [17]. Sayana discloses that the period of transmitting the information relating to the precoding matrix of the first precoder (e.g., “fed back on a wideband basis and/or slowly in time”) is longer than the period of transmitting the

'924 Claims	Sayana in view of Lee-689
relating to the precoding matrix of the first precoder is longer than the period of transmitting the information relating to the precoding matrix of the second precoder.	information relating to the precoding matrix of the second precoder (e.g., “fed back on a subband basis and/or more frequently in time”). <u>E.g., Sayana:</u> See [17.pre], [17.c]-[17.e]. Sayana discloses transmitting a “first representation of a first matrix chosen from a first codebook” that is “fed back on a wideband basis and/or slowly in time” than a “second representation of a second matrix chosen from a second codebook” that is “fed back on a subband basis and/or more frequently in time.” Hochwald, ¶¶161-164; Sayana, Abstract, [0006], [0058], [0085]-[0086], [0094]. • Abstract (see [17.c]) • [0006], [0058], [0085]-[0086], [0094] (see [17.a]) • [0099] (see [17.e]) • See also [0015]-[0018], [0065], [0100].
[23.pre] A receiving device in a wireless communication system, the receiving device comprising:	Sayana discloses a receiving device in a wireless communication system. See [17.pre]. Hochwald, ¶¶165-166.
[23.a] an antenna array to receive, as codebook restricting information, at	Sayana in view of Lee-689 discloses the receiving device (see [23.pre]) comprises an antenna array (“remote unit” having an array of “antennas”) to receive, as codebook restricting information, at least one of a first bit sequence to restrict at least one precoding matrix from a first precoding matrix group and a second bit sequence to

'924 Claims	Sayana in view of Lee-689
least one¹⁹ of a first bit sequence to restrict at least one precoding matrix from a first precoding matrix group and a second bit sequence to restrict at least one precoding matrix from a second precoding matrix group,	restrict at least one precoding matrix from a second precoding matrix group (see [17.a]). <u>E.g., Sayana:</u> See [23.pre], [17.a]. Hochwald, ¶169. Sayana discloses, in Fig. 2 annotated below, a “remote unit” such as a UE that has an array of “antennas” for “one or more transmitters and one or more receivers.” Sayana, [0016], [0018]; Hochwald, ¶¶167-171. • [0016] (“<i>The remote units also comprise one or more transmitters and one or more receivers.</i>”) • Fig. 2  FIG. 2

¹⁹ While [23.a] requires that “codebook restricting information” include only “at least one of” a “first bit sequence” and a “second bit sequence,” Ground 1 nevertheless discloses both sequences.

'924 Claims	Sayana in view of Lee-689
	• [0018] (“<i>[I]n FIG. 2, a remote unit receives transmissions from a plurality of antennas, which may or may not be co-located. As a conventional mode of operation, also sometimes referred to as a single-point transmission scheme, a remote unit 240 receives transmissions from a plurality of antennas of a single base unit 210.</i>”) • [0028] (“<i>y₁ ... y_{NR} may be the received data at the UE receive antenna #1 to #N_R, respectively.</i>”) • <i>See also [0003]-[0004], [0031]-[0032], [0085].</i>
[23.b] ²⁰	See [17.b]. Hochwald, ¶172.
[23.c] a channel Information feedback device to <i>transmit, to a transmitting device, information relating to the precoding matrix of the first precoder and information relating to the precoding matrix</i>	Sayana discloses that the receiving device (see [23.pre]) comprises a channel Information feedback device (e.g., UE processor running software providing a CSI and a channel quality indicator (“CQI”) as “feedback” to a BS) to transmit, to a transmitting device (e.g., “BS”), information relating to the precoding matrix of the first precoder and information relating to the precoding matrix of the second precoder (e.g., UE reporting CSI including “a preferred Precoding Matrix Index (PMI)” “along with an associated CQI feedback”). <u>E.g., Sayana:</u> See [23.pre], [17.c]. Hochwald, ¶175. A POSITA would have understood, or at least found it obvious that Sayana’s UE includes a processor that runs software to operate as a channel information feedback

²⁰ [23.b], [23.d]-[23.e], [24], and [28] are the same or substantially the same as the corresponding limitations in [17]-[18] and [22], and are met for the same reasons.

'924 Claims	Sayana in view of Lee-689
<i>of the second precoder</i> , ²¹	device. Sayana, [0016]; Ex. 1021, 16:43-55, Fig. 11; Ex. 1022, 15:51-60, 16:1-8; Hochwald, ¶¶175-179.

²¹ Petitioner maintains that such terms should be given their plain meaning and are not means-plus-function limitations. The terms include components (e.g., “channel information feedback device”) sufficient to connote structure. Ex. 1023, 3:4-12; Ex. 1024, Abstract, 7:4-63; Ex. 1025, Abstract, Figs. 3a-3d, 3:56-58, 8:62-10:19; Hochwald, ¶176. PO has not asserted that these limitations invoke §112(6) and cannot take a different position here for patentability. Ex. 1018; 35 U.S.C. §301(a)(2). Nonetheless, even if this were means-plus-function, any purported function (bolded in [23.c]) is disclosed for the reasons stated herein and any corresponding structure (e.g., UE processor performing the algorithm at '924, 8:12-18 (“receiv[ing] a reference signal [RS],” “estimat[ing] a channel using the [RS]”), 14:1-7, 17-23 (feeding back, a first precoding matrix determined by “excluding precoding matrices that are restricted ... based on first information included in [CRI]” and based on the channel estimate and second precoding matrix determined by “excluding matrices that are restricted from being used ... based on second information included in [CRI]” and based on the channel estimate, to a base station), Fig. 4) or its equivalent is also disclosed for the reasons herein. **Sayana** discloses hardware (e.g., UE processor running software) performing the [23.c] function by

'924 Claims	Sayana in view of Lee-689
	Sayana also discloses that a receiver receives reference signals (<i>e.g.</i>, CRS, CSI-RS) and the “receiver estimates CSI [channel state information]” based on such reference signals “between each receiver antenna and each transmitter antenna.” Sayana, [0032]; Hochwald, ¶¶173-175. Sayana

receiving RS such as “CRS or CSI-RS”, “estimat[ing] the CSI” based on the RS ([0032]), determining “CQI feedback” and selecting a first representation of a first precoder (*e.g.*, “ W_1^{WB} ”) and a second representation of a second precoder (*e.g.*, “ W_2^b ”) as components of a precoder for feedback to the BS. Sayana, [0032], [0039], [0058], [0095]; Hochwald, ¶¶175-178. Alternatively, **Sayana** discloses a UE’s processor running software performs the aforementioned function in substantially the same way (measuring reference signals and determining first and second precoding matrices that are not restricted and feedback information associated with the matrices) to achieve the same result (sending indicators of the first and second precoding matrix indicators to the BS), because both **Sayana** and the ’924 determine a first indicator of a first precoding matrix from a first codebook and a second indicator of a second precoding matrix from a second codebook, and feed back the first and second indicators to a base station for use with the base station’s precoders. Sayana, [0032], [0039], [0058], [0095]; ’924, 8:12-18, 14:1-7, 17-23; Hochwald, ¶179.

'924 Claims	Sayana in view of Lee-689
	further discloses that a “UE” processor running software provides a CSI including “PMI”, and CQI as “feedback” to a BS. Sayana, [0032], [0039], [0095]; Hochwald, ¶¶175-180. Sayana discloses transmitting 1st channel status information and 2nd channel status information to a BS. See [17.c] • [0015]-[0016] ([17.pre]) • [0020] (“These pilots ... allow users <i>to estimate the channel state information (CSI).</i>”) • [0032] (“<i>From either CRS or CSI-RS, the remote unit receiver can estimate the CSI.</i>”) • [0039] ([17.a]) • [0095] (“<i>[T]he feedback could be defined along with an associated CQI feedback. The CQI feedback could correspond to a modulation and coding scheme (MCS) recommendation The CQI could ...consist of multiple CQI. ... In this case, the UE must select the components W_1^{WB} and W_2^b such that the subband precoders can support the CQI reported</i> corresponding to the subband on the hypothesis UE is allocated that subband, while satisfying an error rate target. ... <i>[A] single CQI may be reported for the whole band</i>, in which case the reported CQI must meet the error rate target....”) • See also [0094].
[23.d]-[23.e], [24], [28]	See [17.d]-[17.e], [18], [22], [23]. Hochwald, ¶¶181-184.

B. Ground 2: Sayana in View of TS36.213 (Claims 17-19, 22-24, 28)

1. TS36.213; Motivation to Apply TS36.213's Teachings to Sayana

As an alternative to **Lee-689**, **TS36.213** teaches restricting PMI of a UE to precoding matrices specified by a “bitmap parameter *codebookSubsetRestriction*.” TS36.213, 34; Hochwald, ¶185.

TS36.213 a Technical Specification titled “LTE; Evolved Universal Terrestrial Radio Access (E-UTRA); Physical layer procedures.” Hochwald, ¶186.

For the same reasons as **Sayana** and **Lee-689**, **TS36.213** is analogous prior art in the same field as the '924. See §IX.A.3. For example, **TS36.213** describes multi-antenna operations and MIMO. TS36.213, 15, 35, 48; Hochwald, ¶187. **TS36.213** teaches that its bitmap “specif[ies] all possible precoder codebook subsets” “[f]or a specific precoder codebook,” and thereby provides flexibility and precision to select a subset of precoding matrices for restriction of respective codebooks. TS36.213, 34; Hochwald, ¶187.

Sayana does not specify how to implement communication of its “codebook subset restriction.” *E.g.*, Sayana, [0085]-[0092]; Hochwald, ¶188. **TS36.213** teaches how to perform such restriction: a “UE is restricted to report PMI ... within a precoder codebook subset specified by a bitmap parameter *codebookSubsetRestriction*.” TS36.213, 34; Hochwald, ¶188. A “bitmap ...

$a_{A-1}, \dots, a_3, a_2, a_1, a_0$ ” in which “a bit value of zero indicates that the PMI ... reporting is not allowed to correspond to precoder(s) associated with the bit.” TS36.213, 34; Hochwald, ¶188. The number of bits in the bitmap is the same as the number of precoders. For example, Table 7.2-1c teaches an “[a]ssociation of bits in *codebookSubSetRestriction* bitmap to precoders in the 2 antenna port codebook” where bitmap has 6 bits (*e.g.*, $a_0, a_1, a_2, a_3, a_4, a_5$) (highlighted in yellow), the same as the number of precoding matrices. TS36.213, Table 7.2-1c; Hochwald, ¶188.

Table 7.2-1c: Association of bits in *codebookSubSetRestriction* bitmap to precoders in the 2 antenna port codebook of Table 6.3.4.2.3-1 in [3].

Codebook index i_c	Number of layers ν	
	1	2
0	a_0	-
1	a_1	a_4
2	a_2	a_5
3	a_3	-

As another example, Table 7.2-1b teaches that a number of bits in the bitmap (*e.g.*, A_c) is associated with a same number of precoders. TS36.213, Table 7.2-1b; Hochwald, ¶188.

Table 7.2-1b: Number of bits in codebook subset restriction bitmap for applicable transmission modes.

		Number of bits A_c	
		2 antenna ports	4 antenna ports
	Transmission mode 3	2	4
	Transmission mode 4	6	64
	Transmission mode 5	4	16
	Transmission mode 6	4	16

A POSITA would have been motivated to modify **Sayana’s** “codebook subset restriction” with **TS36.213’s** bitmap teachings to improve the signaling of restricted precoding matrices to UEs, for the same reasons discussed in §IX.A.3, including (1) **Sayana** and **TS36.213** look at the importance of precoding for improving wireless transmission power to intended UEs while reducing interference to unintended UEs, (2) **Sayana’s** lack of specificity on communication of its “codebook subset restriction” and **TS36.213’s** teachings to implement such restriction, (3) **TS36.213’s** bitmap teachings reduce inter-cell interference, and (4) **TS36.213’s** bitmap teachings provide flexibility to specify codebook subset restriction within a particular codebook. Hochwald, ¶189.

In light of the above teachings and reasons discussed in §IX.A.3, a POSITA would have had a reasonable expectation of success modifying **Sayana** with **TS36.213**'s teachings of a bitmap having the same number of bits as precoder matrices. Hochwald, ¶190.

Thus, a POSITA would have been motivated to apply **TS36.213**'s teaching of a bitmap having the same number of bits as precoding matrices in implementing **Sayana**'s "codebook subset restriction" for **Sayana**'s "first" precoder. such that any of the precoding matrices in **Sayana**'s "first codebook" can advantageously be selected or restricted. Sayana, [0039], [0070], [0085]-[0092]; TS36.213, 34; Hochwald, ¶191. A POSITA also would have been motivated to apply these same teachings to **Sayana**'s "codebook subset restriction" information for **Sayana**'s "second" precoder for the same reasons. *Id.*; Hochwald, ¶191.

2. Claim Chart

TS36.213's teachings of bitmap codebook restricting information provide an alternative to **Lee-689**'s teachings of a bitmap. In addition to §IX.B.1, the following identifies example disclosures followed by bulleted excerpts that each disclose and/or render obvious the limitations relied for **Lee-689** in §IX.A.4, and thus, when combined with **Sayana**'s teachings (see §IX.B.1), render obvious claims 17-19, 22-24 and 28. Hochwald, ¶192.

'924 Claims	Sayana in view of TS36.213
[17.a] receiving codebook restricting information including at least one of ²² a first bit sequence to restrict at least one precoding matrix from a first precoding matrix group and a second bit sequence to restrict at least one precoding matrix from a second precoding matrix group	TS36.213 teaches codebook restricting information including at least one bit sequence to restrict at least one precoding matrix (e.g., a “bitmap parameter <i>codebookSubsetRestriction</i>” or “bit sequence” of which a “bit value of zero indicates that the PMI ... is not allowed to correspond to precoder(s) associated with the bit”). <u>E.g., TS36.213:</u> TS36.213 teaches a “bitmap parameter <i>codebookSubsetRestriction</i>” “forms the bit sequence” “where a bit value of zero indicates that the PMI ... is not allowed to correspond to precoder(s) associated with the bit.” TS36.213, 34; Hochwald, ¶¶193-196. As discussed in §IX.B.1, a POSITA would have been motivated to modify Sayana’s “codebook subset restriction” information with TS36.213’s bitmaps to provide flexibility in the signaling of precoding matrices to UEs. TS36.213, 34; Hochwald, ¶¶187-189. When applied to Sayana, TS36.213’s bitmap parameter separately provides a first bitmap (first bit sequence) and a second bitmap (second bit sequence) as codebook restriction information for Sayana’s first and second codebooks respectively because the two codebooks in Sayana are different and require distinct restriction information. Sayana, [0006]; TS36.213, 34; Hochwald, ¶195. • 33-34 (“§7.2 ...<i>The time and frequency resources that can be used by the UE to report ... PMI</i>”) • 34 (“<i>A UE is restricted to report PMI ... within a precoder codebook subset specified by a bitmap</i>”)

²² While [17.a] requires that “codebook restricting information” include only “at least one of” a “first bit sequence” and a “second bit sequence,” Ground 2 nevertheless discloses both sequences.

'924 Claims	Sayana in view of TS36.213																																						
	<i>parameter codebookSubsetRestriction For a specific precoder codebook and associated transmission mode, the bitmap can specify all possible precoder codebook subsets....</i> The bitmap forms the bit sequence $a_{A_c-1}, \dots, a_3, a_2, a_1, a_0$ where a_0 is the LSB and a_{A_c-1} is the MSB and where a bit value of zero indicates that the PMI ... reporting is not allowed to correspond to precoder(s) associated with the bit.”) - Table 7.2-1b: Number of bits in codebook subset restriction bitmap for applicable transmission modes. <table><tr><th colspan="2"></th><th colspan="2">Number of bits A_c</th></tr><tr><th colspan="2"></th><th>2 antenna ports</th><th>4 antenna ports</th></tr><tr><td rowspan="4"></td><td>Transmission mode 3</td><td>2</td><td>4</td></tr><tr><td>Transmission mode 4</td><td>6</td><td>64</td></tr><tr><td>Transmission mode 5</td><td>4</td><td>16</td></tr><tr><td>Transmission mode 6</td><td>4</td><td>16</td></tr></table> - Table 7.2-1c: Association of bits in <i>codebookSubSetRestriction</i> bitmap to precoders in the 2 antenna port codebook of Table 6.3.4.2.3-1 in [3]. <table><tr><th rowspan="2">Codebook index i_c</th><th colspan="2">Number of layers v</th></tr><tr><th>1</th><th>2</th></tr><tr><td>0</td><td>a_0</td><td>-</td></tr><tr><td>1</td><td>a_1</td><td>a_4</td></tr><tr><td>2</td><td>a_2</td><td>a_5</td></tr><tr><td>3</td><td>a_3</td><td>-</td></tr></table>			Number of bits A_c				2 antenna ports	4 antenna ports		Transmission mode 3	2	4	Transmission mode 4	6	64	Transmission mode 5	4	16	Transmission mode 6	4	16	Codebook index i_c	Number of layers v		1	2	0	a_0	-	1	a_1	a_4	2	a_2	a_5	3	a_3	-
		Number of bits A_c																																					
		2 antenna ports	4 antenna ports																																				
	Transmission mode 3	2	4																																				
	Transmission mode 4	6	64																																				
	Transmission mode 5	4	16																																				
	Transmission mode 6	4	16																																				
Codebook index i_c	Number of layers v																																						
	1	2																																					
0	a_0	-																																					
1	a_1	a_4																																					
2	a_2	a_5																																					
3	a_3	-																																					

'924 Claims	Sayana in view of TS36.213
[17.b] each bit of the first bit sequence corresponding to one precoding matrix of the first precoding matrix group, respectively, the at least one precoding matrix of the first precoding matrix group being restricted from being used as a precoding matrix of a first precoder, each bit of the second bit sequence corresponding to one precoding matrix of the second precoding matrix group, respectively, and the at least one precoding matrix of the second precoding matrix group being restricted from being used as a precoding matrix	TS36.213 discloses each bit of the bit sequence corresponding to one precoding matrix of the precoding matrix group, respectively (<i>see</i> [17.a]). <u>E.g., TS36.213:</u> <i>See</i> [17.a]. TS36.213 teaches using a “bitmap parameter <i>codebookSubsetRestriction</i>.” TS36.213 teaches that “a bit value of zero indicates that the PMI ... is not allowed to correspond to precoder(s) associated with the bit.” Hochwald, ¶¶197-199. As further discussed in [17.a], a POSITA would have been motivated to modify Sayana’s “codebook subset restriction” information with TS36.213’s “<i>codebookSubsetRestriction</i>” bitmaps to advantageously provide flexible signaling of precoding matrices to UEs because TS36.213’s bitmaps “can specify all possible precoder codebook subsets,” for a specific precoder. <i>See</i> [17.a]; §IX.B.1; TS36.213, 34; Hochwald, ¶199.

'924 Claims	Sayana in view of TS36.213
of a second precoder; [18] The method of claim 17, wherein the first matrix group includes N precoding matrices, and the first bit sequence is an N-bit sequence, where N is an integer.	TS36.213 teaches a matrix group includes N precoding matrices (e.g., “bitmap forms the bit sequence $a_{A_k-1}, \dots, a_3, a_2, a_1, a_0$ where a_0 is the LSB and a_{A_k-1} is the MSB”), and the first bit sequence (e.g., “bitmap”) is an N-bit sequence, where N is an integer (e.g., a_{A_k-1}, integer values in Table 7.2-1b and Table 7.2-1c). <u>E.g., TS36.213:</u> See [17.a]. Hochwald, ¶202. TS36.213 also teaches that an integer number of precoding matrices (e.g., 2, 4, 6, 16, 64 entries) corresponds to the length of the bit sequence (e.g., 2, 4, 6, 16, 64 bits). TS36.213, 33-35; Hochwald, ¶¶200-203. As further discussed in §IX.B.1, a POSITA would have been motivated to modify Sayana’s “codebook subset restriction” information for a “first” precoder using TS36.213’s bitmap teachings having a same number of bits as precoding matrices. See [17.a]. Hochwald, ¶202. • 33-34 ([17.a]) • Tables 7.2-1b-7.2-1c ([17.a])
[19] The method of claim 17, wherein the use of precoding matrices for the second precoder that make pairs with restricted precoding	TS36.213 teaches the matrix group is restricted based on the bit sequence (see [17.a]; e.g., “bitmap”). <u>E.g., TS36.213:</u> See [17.a]. Hochwald, ¶206. When applied to Sayana, TS36.213’s teachings separately provide a first bitmap (first bit sequence) as codebook

'924 Claims	Sayana in view of TS36.213
matrices of the first matrix group is restricted based on the first bit sequence, and the use of precoding matrices for the first precoder that make pairs with restricted precoding matrices of the second matrix group is restricted based on the second bit sequence.	restriction information for Sayana's “wideband” “first codebook” and a second bitmap (second bit sequence) as codebook restriction information for Sayana's “subband” “second codebook.” Hochwald, ¶¶204-206.

C. Ground 3: Sayana in View of TS36.213 and TS36.211 (Claims 17-19, 22-24, 28)

In addition to **Sayana's** and **TS36.213's** teachings, **TS36.211** teaches further details of [17.b]/[23.b] (“each bit of the [first/second] bit sequence corresponding to one precoding matrix of the [first/second] precoding matrix group”) and [18]/[24] (“the first matrix group includes N precoding matrices, and the first bit sequence is an N-bit sequence, ...”). Hochwald; ¶207. **TS36.211** teaches that each claimed bit of a bit sequence is associated with a precoding matrix of a “Codebook.” TS36.211, 53-55; Hochwald; ¶207.

TS36.213 teaches that bitmaps of its codebooks (*e.g.*, associated with transmissions modes 5-6 of Table 7.2-1b) are associated with precoding matrices of **TS36.211**'s codebooks in Tables 6.3.4.2.3-1 and 6.3.4.2.3-2. **TS36.213**, 34-35; **TS36.211**, 53-55; Hochwald, ¶¶208-211. **TS36.213** expressly cross-references **TS36.211**'s Tables 6.3.4.2.3-1 and 6.3.4.2.3-2. **TS36.213**, 34-35 (citing to reference “[3]” which is “3GPP TS 36.211”). *Id.* As shown below, **TS36.213**'s Table 7.2-1b also indicates that a 16-bit bitmap is used for “4 antenna ports” that correspond to 16 precoder matrices in **TS36.211**'s Table 6.3.4.2.3-2 (**light-orange**); a similar mapping exists for “2 antenna ports” for codebooks (*e.g.*, associated with the same transmission modes 5-6) that correspond to 4 precoder matrices in **TS36.211**'s Table 6.3.4.2.3-1, and for transmission mode 4 of **TS36.213**'s Table 7.2-1c and **TS36.211**'s Table 6.3.4.2.3-1. *Id.*

Table 7.2-1b: Number of bits in codebook subset restriction bitmap for applicable transmission modes.

		Number of bits A_c	
		2 antenna ports	4 antenna ports
	Transmission mode 3	2	4
	Transmission mode 4	6	64
	Transmission mode 5	4	16
	Transmission mode 6	4	16

Sayana, **TS36.213**, and **TS36.211** are analogous prior art and in the same field as the '924, for the reasons discussed in §IX.B.1. **TS36.211** describes using multiple “antenna ports,” which supports **TS36.213**’s MIMO. **TS36.211**, 53-54 (§6.3.4.2.3). Moreover, as discussed in §IX.B.1, **TS36.213** expressly references **TS36.211** in MIMO implementations, and the referenced **TS36.211** provisions are considered **TS36.213** provisions. **TS36.213**, p.6 (“provisions which, through reference in this text, constitute provisions of the present document”), 34-35 (citing “[3] [TS 36.211]”); Hochwald, ¶12.

A POSITA would have been motivated to modify **Sayana** and **TS36.213**’s precoding functionality using **TS36.211**’s teachings of bitmap associated precoding

matrices at least because **TS36.213** expressly references **TS36.211**'s teachings of bitmap associated precoding matrices, as discussed above. **TS36.213**, 6 (citing **TS36.211**), 34-35; **TS36.211**, 53-54; Hochwald, ¶213.

In light of the above teachings, a POSITA would have had a reasonable expectation of success in modifying **Sayana** and **TS36.213**'s teachings by using **TS36.211**'s teachings of codebooks of precoding matrices associated with bitmaps. Hochwald, ¶214. **TS36.213** expressly cites **TS36.211** to show codebooks that are restricted by bitmaps to form subsets of precoder matrices that are selectable by a UE for feedback to a BS. **TS36.213**, 6, 34-36; **TS36.211**, 53-54; **Sayana**, [0085]-[0092]; Hochwald, ¶214.

Thus, a POSITA would have been motivated to apply **TS36.211**'s teachings of codebooks and bitmaps to **TS36.213**'s teachings of a bitmap having the same number of bits as precoding matrices in implementing **Sayana**'s "codebook subset restriction" information, such that any precoding matrix in **Sayana**'s "first codebook" or "second codebook" advantageously can be selected or restricted. **TS36.213**, 34; **TS36.211**, 53-54; Lee-689, 15:4-17:1, 18:5-15; Hochwald, ¶215.

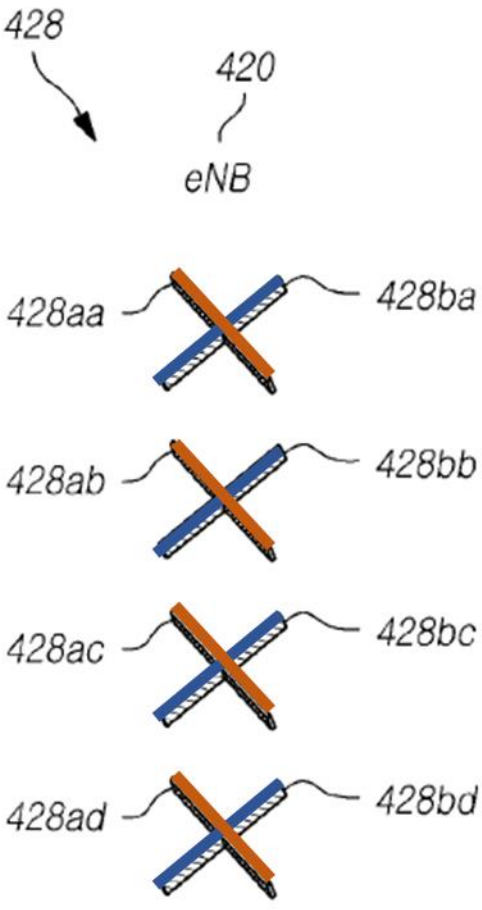
D. Grounds 4-6: Grounds 1-3 in Further View of Koivisto (Claims 20-21, 26-27)

In addition to the teachings discussed in §§IX.A-IX.C (Grounds 1-3), **Sayana** and **Koivisto** further render obvious the cross-polarization features recited in claims

20-21, 26-27 (*see* §V.A). *See also* Ex. 1026, Figs. 11.2, 11.5, 252-276 (e.g., 11.2.2.2-11.2.2.3); Ex. 1027; Hochwald, ¶¶216-244.

1. Sayana; Koivisto's Cross-Polarization Teachings

Sayana discloses an antenna pair having first and second domains at a BS. Hochwald, ¶245. As shown in the comparison of excerpted '924's Fig. 5 and **Sayana's** Fig. 4, each of '924's and **Sayana's** cross-polarized configuration includes a first set of antennas (solid lines) polarized in a first direction, and a second set of antennas (dotted lines) polarized in a second direction intersecting the first. '924, 8:29-47, Fig. 5; Sayana, [0040], Fig. 4; Hochwald, ¶245.

'924 Cross-Pol (Fig. 5)	Sayana's Cross-Pol (Fig. 4)
 428 420 eNB 428aa 428ba 428ab 428bb 428ac 428bc 428ad 428bd	 440 4 ANTENNA XPOL, CLOSELY SPACED

Koivisto further discloses a “double codebook” feedback structure for first and second precoder matrices (W_1 , W_2) used for separately precoding antenna domains, and co-phasing. Koivisto, Abstract, [0035], [0045], [0057], [0059], [0069], [0079], Fig. 9; Hochwald, ¶246. **Koivisto** teaches a “block diagonal” first precoder matrix W_1 that addresses “wideband” effects and a “co-phasing” second precoder matrix W_2 that addresses “subband” effects. Koivisto, [0045]; Hochwald, ¶247.

Koivisto also fully incorporates by reference Ericsson’s teachings, including its “block diagonal” and “co-phasing” precoder matrix teachings. Koivisto, [0044]-[0046]; Ericsson, §3.3; Hochwald, ¶248.²³ **Koivisto** teaches a first precoder matrix ($W^{(1)}$) and second precoder matrix ($W^{(2)}$) in its equation (2). Ericsson, §§3.1, 3.3.1; Hochwald, ¶249.

Koivisto discloses the *second concept* because its “block diagonal” first precoder matrix “separately precodes each group of co-polarized and closely spaced antennas.” Ericsson, §3.1; Hochwald, ¶¶217-241, 250-251.

'924 First Precoding Matrix	Koivisto/Ericsson First Precoding Matrix
$\frac{\begin{pmatrix} R_0 & 0 \\ 0 & R_0 \end{pmatrix}}{w_1}$	$\begin{bmatrix} \tilde{W}^{(1)} & 0 \\ 0 & \tilde{W}^{(1)} \end{bmatrix}$

Koivisto discloses the “co-phasing” *third concept* because its second precoder matrix $W^{(2)}$ “adjusts the relative phase shift” between first and second antenna domains. Ericsson, §3.3.1; Hochwald, ¶¶220-244, 252-254.

²³ Even if further evidence of incorporation were required, it also would have been obvious to apply Ericsson’s teachings to **Koivisto** for the same reasons.

'924 Second Precoding Matrix	Koivisto Second Precoding Matrix
$\underbrace{\begin{pmatrix} I \\ \Lambda \end{pmatrix}}_{w_2}$	$\begin{bmatrix} 1 \\ \alpha \end{bmatrix}$

2. Motivation to Apply Koivisto's Teachings to Sayana and Lee-689

Like Sayana, Lee-689, TS36.213, and TS36.211, Koivisto is analogous prior art and in the same field as the '924 for the reasons discussed in §IX.B.1. Hochwald, ¶255. For example, Koivisto also supports MIMO using a double codebook structure. Koivisto, [0035]-[0036], [0042]-[0043]; Hochwald, ¶255. Sayana and Koivisto teach using a first precoder matrix to address wideband effects, and a second precoder matrix to address subband effects to improve communication efficiency. Sayana, [0006], [0085]-[0086]; Koivisto, [0035]-[0036], [0042]-[0046]; Ericsson, §1; Hochwald, ¶¶255-256.

A POSITA would have been motivated to modify Sayana in view of Lee-689 (and TS36.213 and TS36.211) with Koivisto's teachings of a block diagonal matrix for Sayana's first precoding matrix, and a co-phasing matrix for Sayana's second precoding matrix to form precoders that improve communications between a UE and BS, and are "well-matched" for channel conditions of Sayana's "closely spaced"

cross-pole antennas. Ericsson, §3.3.1; Sayana, Fig. 4; Hochwald, ¶257. Doing so would have combined prior art elements (e.g., codebooks for precoder matrices addressing wideband/long-term, and subband/short-term effects), according to known methods to yield predictable results of addressing wideband and narrowband interference, and would have been a simple substitution of one known element (one precoding matrix) for another (precoding matrix) to obtain predictable results. Hochwald, ¶257.

Sayana teaches that its codebook subset restriction applies to various codebooks depending on operating conditions. Sayana, [0059]-[0063]; Hochwald, ¶258. **Sayana** teaches a “product matrix based method of precoder matrix representation” to describe “two-component feedback” of “wideband and subband codebook[s].” Sayana, [0079]-[0090]; Hochwald, ¶258. **Sayana** teaches that such codebooks contain matrix forms corresponding to the block diagonal first precoding matrix and co-phasing second precoding matrix disclosed in '924, and **Koivisto**. Sayana, [0063], [0084]; Koivisto, [0044]-[0046]; Ericsson, §§1-3, 3.1, 3.3.1. **Sayana's** Fig. 4 also teaches using “closely spaced” cross-pol antennas. Hochwald, ¶¶258-270.

Koivisto (incorporating Ericsson) teaches first and second precoding matrix groups (below) that are compatible and complementary with **Sayana's** teachings.

Sayana, [0072]-[0082]; Ericsson, §3.3.1; Hochwald, ¶271. **Koivisto** teaches that channel properties of “Closely Spaced Cross-Pole” antennas are “well-matched” to a “block diagonal” matrix form of a first precoder matrix ($W^{(1)}$), and a complex valued matrix form of a second precoder matrix ($W^{(2)}$) that adjusts a “relative phase shift” by co-phasing. Sayana, [0040], [0072]-[0082], Fig. 4; Koivisto, [0044]; Ericsson, §3.3.1; Hochwald, ¶271.

$$\mathbf{W} = \underbrace{\begin{bmatrix} \tilde{\mathbf{w}} & \mathbf{0} \\ \mathbf{0} & \tilde{\mathbf{w}} \end{bmatrix}}_{\mathbf{W}^{(1)}} \underbrace{\begin{bmatrix} 1 \\ \alpha \end{bmatrix}}_{\mathbf{W}^{(2)}}, \quad \alpha \in \{1, -1, j, -j\}$$

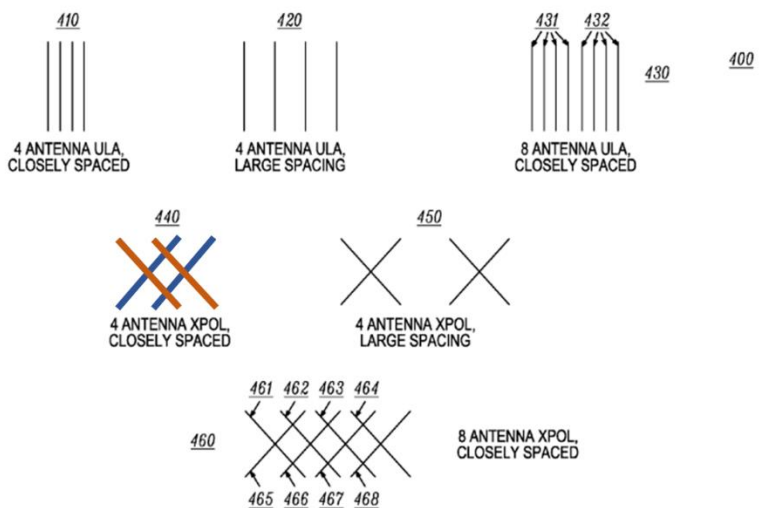
Thus, a POSITA would have been motivated to apply **Koivisto’s** teachings of precoding matrix formats for **Sayana’s** first precoder matrix and second precoder matrix because doing so would have been implementing known alternatives to achieve predictable results. Hochwald, ¶272.

In light of the above teachings, a POSITA would have had a reasonable expectation of success in modifying **Sayana’s** closely spaced cross-polarization antennas in view of **Lee-689** with **Koivisto’s** teachings of a “block diagonal” first precoder matrix and a “co-phasing” second precoder matrix. Hochwald, ¶273.

3. Claim Chart

In addition to §§IX.A-IX.C, the following identifies example disclosures followed by bulleted excerpts that each disclose and/or render obvious claims 20-21, 26-27. Hochwald, ¶274.

'924 Claims	Grounds 1-3 in further view of Koivisto
[20] The method of claim 17, wherein the transmitting device includes at least one antenna pair in which a first domain including at least one antenna polarized in one direction and a second domain including at least one antenna polarized in another direction intersect each other; and the precoding matrix of the first precoder performs precoding on the first domain and the second domain, separately, and the precoding	See [17]. Sayana discloses the transmitting device (see [17.c]) includes at least one antenna pair (e.g., “two antennas”, “antenna subsets”) in which a first domain (e.g., first “cross pole”) including at least one antenna polarized in one direction and a second domain (e.g., second “cross pole”) including at least one antenna polarized in another direction intersect each other (e.g., “cross-polarized configuration with two sets of cross-poles each with two antennas at +/-45 polarizations”). <u>E.g., Sayana:</u> Sayana discloses a “cross-polarized configuration” of “two antennas at +/-45 polarizations.” Sayana, [0040]; Hochwald, ¶¶275-276, 278, 283. Sayana teaches, as a claimed first antenna pair, a 2 antenna cross pole (e.g., boxed in Fig. 4’s 440 below). Hochwald, ¶278. Sayana teaches as a first domain, a first antenna of the cross pole (e.g., solid line), and as a second domain, a second antenna of the cross pole (e.g., dotted line) that intersect each other. Sayana, Figure 4, [0040], [0043]; Hochwald, ¶278. • Figure 4

'924 Claims	Grounds 1-3 in further view of Koivisto
matrix of the second precoder performs phase mismatch correction to remove an effect from a phase mismatch between the first domain and the second domain.	 FIG. 4 [0040] (“FIG. 4 illustrates ... antenna configurations at <i>a base unit</i>. ... <i>A cross-polarized configuration with two sets of cross-poles each with two antennas at $\pm 45^\circ$ polarizations</i> ... in 440.”) [0043] (“<i>The polarization Kronecker component R_{Pol} captures the correlation submatrix between subsets with similar cross-polarized configuration, namely antenna subsets (461,465), (462,466), (463,467) and (464,468) in FIG. 4. The above representation in the covariance matrix also translates to similar structure for the precoder.</i>”) Koivisto discloses that the precoding matrix of the first precoder (e.g., “precoder matrix W_1”) performs precoding on the first domain and the second domain, separately (e.g., “precoder matrix W_1 is block diagonal” and “separately precodes each group of co-polarized and closely spaced antennas”), and the precoding matrix of the second precoder (e.g., precoder matrix W_2) performs phase mismatch correction to remove an effect from a phase mismatch between the first domain and the second

'924 Claims	Grounds 1-3 in further view of Koivisto
	domain (<i>e.g.</i>, “cross-polarized combining (co-phasing and orthogonalization)” and “adjust[ing] the relative phase shift between polarizations”). <u>E.g., Koivisto:</u> Koivisto discloses that “precoder matrix W_1 is block diagonal” and “handled in the wideband,” and that “precoder matrix W_2” “handle[s] the cross-polarized combining (co-phasing and orthogonalization) after the W_1 matrix structure has been applied to the communication channel.” Koivisto, [0040], [0044]-[0045]; Hochwald, ¶¶277, 279-281, 284. Koivisto, including Ericsson’s incorporated teachings, teaches that the first precoder matrix “$W^{(1)}$ separately precodes each group of co-polarized and closely spaced antennas,” and that the second precoder matrix “$W^{(2)}$” “adjusts the relative phase shift between polarizations.” Koivisto, [0044]; Ericsson, §3.3.1; Hochwald, ¶¶279-281. As explained in §§IX.D.1-IX.D.2, a POSITA would have been motivated to modify Sayana and Lee-689 with Koivisto’s teachings of first and second precoder matrices because doing so would have combined prior art elements (<i>e.g.</i>, codebooks for first and second precoders) according to known methods to yield predictable results, and would have been a simple substitution of one known element for another to obtain predictable results, because each of the codebooks in Sayana and Koivisto were known to be implementations for precoding, and further in light of Koivisto’s teaching that its precoder matrices are well-suited to channel conditions of closely spaced cross-polarization antennas, as used in Sayana. Hochwald, ¶282. • [0040] (“The final precoder matrix W is the output of a $W_2 * W_1$ matrix multiplication.”)

'924 Claims	Grounds 1-3 in further view of Koivisto
	• [0044] (“... <i>R1-102630 ... is incorporated herein by reference.</i>”) • [0045] (“<i>[T]he precoder matrix W_1 is mainly handled in the wideband sense, compressing the communication channel in the spatial dimension Further combining (co-phasing) of the two remaining dimensions (or beams) (for cross-polarized antennas) or orthogonalization between the streams is handled through the matrix W_2, which is applied ... at a subband level. The precoder matrix W_1 is block diagonal.... The purpose of the precoder matrix W_2 is to handle the cross-polarized combining (co-phasing and orthogonalization) after the W_1 matrix structure has been applied to the communication channel....</i>”) • See also [0043] • Ericsson, §3.1 (“<i>This structure is well-suited for efficiently supporting common antenna setups such as closely spaced cross-poles or closely spaced ULA. ...[C]onsider the common case of an array of closely spaced cross-poles. The antennas can then be divided into two groups based on polarization and the corresponding channels are denoted H_1 and H_2, respectively.</i> Assuming for example that the inner precoder $W^{(1)}$ has a block diagonal structure, $W^{(1)} = \begin{bmatrix} \tilde{W}^{(1)} & 0 \\ 0 & \tilde{W}^{(1)} \end{bmatrix} \quad (1)$ The product of the MIMO channel and the overall precoder can then be written as $HW = \begin{bmatrix} H_1 & H_2 \end{bmatrix} W^{(1)} W^{(2)} = \begin{bmatrix} H_1 & H_2 \end{bmatrix} \begin{bmatrix} \tilde{W}^{(1)} & 0 \\ 0 & \tilde{W}^{(1)} \end{bmatrix} W^{(2)} = \begin{bmatrix} H_1 \tilde{W}^{(1)} & H_2 \tilde{W}^{(1)} \end{bmatrix} W^{(2)} = H_{\text{eff}} W^{(2)}$

'924 Claims	Grounds 1-3 in further view of Koivisto
	As seen, $\tilde{\mathbf{W}}^{(1)}$ <i>separately precodes each group of co-polarized and closely spaced antennas</i> forming a smaller and improved effective channel $\mathbf{H}_{\text{eff}}$.”) Ericsson, §3.3.1 (“The <i>closely spaced cross-pole is a common antenna array setup, ... the antennas can then be divided into two separate groups depending on the polarization direction of the antenna.</i> ... Such an antenna setup thus creates quite pronounced channel properties, <i>which are well-matched to a block diagonal design</i> along the lines of $\mathbf{W} = \begin{bmatrix} \tilde{\mathbf{W}}^{(1)} & \mathbf{0} \\ \mathbf{0} & \tilde{\mathbf{W}}^{(1)} \end{bmatrix} \mathbf{W}^{(2)}$ very well. <i>The precoder on the diagonal, $\tilde{\mathbf{W}}^{(1)}$, is targeting a co-polarized antenna group. ... The outer precoder, $\mathbf{W}^{(2)}$, adjusts the relative phase shift between polarizations</i> For rank 1, the precoder could for example be formed as $\mathbf{W} = \begin{bmatrix} \tilde{\mathbf{w}} & \mathbf{0} \\ \mathbf{0} & \tilde{\mathbf{w}} \end{bmatrix} \begin{bmatrix} 1 \\ \alpha \end{bmatrix}, \quad \alpha \in \{1, -1, j, -j\}$... The rank 2 case would follow similarly as $\mathbf{W} = \begin{bmatrix} \tilde{\mathbf{w}} & \mathbf{0} \\ \mathbf{0} & \tilde{\mathbf{w}} \end{bmatrix} \begin{bmatrix} 1 & 1 \\ \alpha & -\alpha \end{bmatrix}, \quad \alpha \in \{1, j\}, \quad \tilde{\mathbf{w}} \in G_q^{(1,2)}”)$
[21] The method of claim 20, wherein the precoding matrix of the first precoder corresponds to W1 in the following	See [20]. Koivisto discloses the precoding matrix of the first precoder corresponds to W1 (e.g., $\begin{bmatrix} \tilde{\mathbf{W}}^{(1)} & \mathbf{0} \\ \mathbf{0} & \tilde{\mathbf{W}}^{(1)} \end{bmatrix}$) in the following Equation and the precoding matrix of the

'924 Claims	Grounds 1-3 in further view of Koivisto
Equation and the precoding matrix of the second precoder corresponds to W2 in the following Equation: $W = \begin{pmatrix} R_0 & 0 \\ 0 & R_0 \end{pmatrix} \begin{pmatrix} I \\ \Lambda \end{pmatrix},$ wherein R0 denotes a value determined by a precoding gain when the first domain and the second domain have an identical spatial channel status, I denotes a unit matrix, and Λ denotes a phase mismatch correction value between the first domain and the second domain.	second precoder corresponds to W2 (e.g., $\begin{bmatrix} 1 \\ \alpha \end{bmatrix}$, $\begin{bmatrix} 1 & 1 \\ \alpha & -\alpha \end{bmatrix}$) in the following Equation $W = \begin{pmatrix} R_0 & 0 \\ 0 & R_0 \end{pmatrix} \begin{pmatrix} I \\ \Lambda \end{pmatrix},$ wherein R0 denotes a value determined by a precoding gain when the first domain and the second domain have an identical spatial channel status (e.g., “closely spaced cross-poles”), I denotes a unit matrix, and Λ denotes a phase mismatch correction value between the first domain and the second domain (e.g., see [20]). <u>E.g., Koivisto:</u> Koivisto, including Ericsson’s incorporated teachings, discloses that the “precoder matrix W₁ is block diagonal” in the form of $\begin{bmatrix} \tilde{W}^{(1)} & 0 \\ 0 & \tilde{W}^{(1)} \end{bmatrix}$. Koivisto, [0044] (incorporating Ericsson, §3.3.1); Hochwald, ¶¶285-288. Koivisto incorporating Ericsson by reference, teaches that in “closely spaced cross-pols,” the value on the block diagonal is a same precoding gain W⁽¹⁾. Koivisto, [0043]-[0044]; Ericsson, §§3.1, 3.3.1; Hochwald, ¶287. Koivisto also teaches that “precoder matrix W₂” “adjusts the relative phase shift between polarizations” and is in the form $\begin{bmatrix} 1 \\ \alpha \end{bmatrix}$ or $\begin{bmatrix} 1 & 1 \\ \alpha & -\alpha \end{bmatrix}$. Koivisto, [0044]-[0045]; Ericsson, §3.3, 3.3.1; Hochwald, ¶287. The value “1” is a base form of the unit matrix “I” (multiplying a parameter by 1 or the unit matrix returns the same parameter), and the value “α” represents an adjusted relative phase shift. Koivisto, [0044]-[0045]; Ericsson, §3.3, 3.3.1; Hochwald, ¶287. As explained in §IX.D.2, a POSITA would have been motivated to modify Sayana and Lee-689 with Koivisto’s teachings of first and second precoder

'924 Claims	Grounds 1-3 in further view of Koivisto
	matrices because doing so would have combined prior art elements (<i>e.g.</i>, codebooks for the first and second precoders) according to known methods to yield predictable results, and would have been a simple substitution of one known element for another to obtain predictable results, because each of the codebooks in Sayana and Koivisto (and Ericsson incorporated by reference) were known to be implementations for precoding. Sayana, [0040], Fig. 4; Koivisto, [0044]-[0046]; Ericsson, §3.1; Hochwald, ¶287. • [0044]-[0045] (<i>see</i> [20]). • Ericsson, §§3.1, 3.3.1 (<i>see</i> [20]) • See also [0046].
[26]-[27]	<i>See</i> [23], [20]-[21], [26]. [26]-[27] recite the same limitations as [20]-[21]. Hochwald, ¶¶289-290.

X. SECONDARY CONSIDERATIONS

There is no evidence in the '924's prosecution history or elsewhere supporting any secondary considerations arguments, or evidence of nexus to any Claim. *See generally* '924FH. Indeed, as demonstrated by the prior art herein, any purported solutions to problems or unexpected results in the '924 were already well-known. Hochwald, ¶291. To the extent PO asserts the existence of any secondary considerations in its responses, Petitioner reserves the right to address any such evidence.

XI. CONCLUSION

Substantial, new, and noncumulative technical teachings have been presented for '924 Claims 17-24 and 26-28, which are obvious for the reasons set forth above. Hochwald, ¶¶292-296. There is a reasonable likelihood that Petitioner will prevail as to the Claims. *Inter partes* review of claims 17-24 and 26-28 is accordingly requested.

Respectfully submitted,

Dated: Aug. 11, 2023

By: /James L. Davis, Jr./
Name: James. L. Davis, Jr.
Counsel for Petitioner

CERTIFICATE OF COMPLIANCE

Pursuant to §42.24(d), the undersigned certifies that the foregoing Petition for *Inter Partes* Review of U.S. Patent No. 9,136,924 contains, as measured by the word-processing system used to prepare this paper, 13,921 words. This word count does not include the items excluded by §42.24 as not counting towards the word limit.

Respectfully submitted,

Dated: Aug. 11, 2023

By: / Shong Yin/
Name: Shong Yin
Counsel for Petitioner

CERTIFICATE OF SERVICE

I hereby certify that on August 11, 2023, I caused a true and correct copy of the foregoing Petition for *Inter Partes* Review of U.S. Patent No. 9,136,924 and supporting exhibits to be served via express mail on the Patent Owner at the following correspondence address of record as listed on Patent Center:

66390 - LEX IP MEISTER, PLLC
5160 PARKSTONE DRIVE, SUITE 140
CHANTILLY, VA
UNITED STATES

A courtesy copy was also sent via electronic mail to the Patent Owner's litigation counsel at the following addresses:

Kelly Tidwell
TX Bar No. 20020580
Geoffrey Culbertson
TX Bar No. 24045732
PATTON, TIDWELL & CULBERTSON, LLP
2800 Texas Boulevard
Texarkana, TX 75503
(903) 792-5859
(903) 792-8233 Fax
kbt@texarkanalaw.com
gpc@texarkanalaw.com

James A. Fussell, III
Jamie B. Beaber
Saqib J. Siddiqui
Tiffany A. Miller
Baldine Paul*
Clark S. Bakewell

Seth W. Bruneel*
MAYER BROWN LLP
1999 K Street, N.W.
Washington D.C. 20006
(202) 263-3000
jbeaber@mayerbrown.com
jfussell@mayerbrown.com
ssiddqui@mayerbrown.com
tmiller@mayerbrown.com
bpaul@mayerbrown.com
cbakewell@mayerbrown.com
sbruneel@mayerbrown.com

Graham M. Buccigross
MAYER BROWN LLP
Two Palo Alto Square, Suite 300
3000 El Camino Real
Palo Alto, CA 94306
(650) 331-2000
gbuccigross@mayerbrown.com

Gregory J. Apgar
MAYER BROWN LLP
1221 Avenue of the Americas
New York, NY 10020
(212) 506-2500
gapgar@mayerbrown.com

Luiz Miranda
MAYER BROWN LLP
71 S. Wacker Drive
Chicago, IL 60606
(312) 782-0600
lmiranda@mayerbrown.com

Dated: August 11, 2023

By: /Jonathan Bradford/
Name: Jonathan Bradford
ROPES & GRAY LLP