

UNITED STATES PATENT AND TRADEMARK OFFICE

---

BEFORE THE PATENT TRIAL AND APPEAL BOARD

---

MERCEDES-BENZ USA, LLC,  
Petitioner

v.

NEO WIRELESS, LLC  
Patent Owner

---

Case (to be assigned)  
U.S. Patent No. 10,965,512

---

**PETITION FOR  
*INTER PARTES* REVIEW OF U.S. PATENT NO. 10,965,512  
UNDER 35 U.S.C. §§ 311-319 AND 37 C.F.R. §§42.100 *et seq.***

Filed on behalf of Petitioner:  
Celine Jimenez Crowson (Reg. No. 40,357)  
Joseph Raffetto (Reg. No. 66,218)  
Scott Hughes (Reg. No. 68,385)  
Helen Y. Trac (Reg. No. 62,250)  
HOGAN LOVELLS US LLP  
555 13th Street N.W.  
Washington, D.C. 20004  
Telephone: 202.637.5600  
Facsimile: 202.637.5710

## **TABLE OF CONTENTS**

	<b>Page</b>
I. INTRODUCTION .....	1
II. MANDATORY NOTICES (37 C.F.R. §42.8(A)(1)).....	2
III. GROUNDS FOR STANDING (37 c.F.R. §42.104(A)).....	5
IV. IDENTIFICATION OF CHALLENGE (37 C.F.R. §42.104(B)) .....	5
A. Citation of Prior Art .....	5
B. Statutory Grounds for the Challenge.....	6
V. TECHNOLOGY OVERVIEW.....	7
A. OFDMA Systems Were Well-Known .....	7
B. Communicating Various Pilots Signals Between Base Stations and Mobile Stations Was Well-Known .....	8
C. OFDM/OFDMA Cellular Systems Implemented Pilot Symbols for Channel Estimation and Data Recovery .....	8
D. Beamforming Was Well-Known.....	9
VI. THE '512 PATENT.....	9
A. Summary of the '512 Patent.....	9
B. Prosecution History Summary .....	11
C. Level of Ordinary Skill in the Art.....	11
D. Claim Construction.....	12
VII. OVERVIEW OF THE APPLIED REFERENCES .....	12
A. Kim .....	12
B. Ketchum .....	15
C. Tong.....	16
D. Smee .....	17
VIII. GROUNDS OF UNPATENTABILITY.....	17
A. Ground 1: The combination of Kim and Tong renders obvious claims 1-30.....	18
1. A POSA would have been motivated to combine Kim and Tong .....	18
2. Independent Claim 1.....	23

(a)	[1.P]: An orthogonal frequency division multiple access (OFDMA)-compatible base station that uses subcarriers in a frequency domain and time slots in a time domain, the OFDMA-compatible base station comprising:.....	23
(b)	[1.1] a plurality of antennas; and a transmitter operably coupled to the plurality of antennas; .....	24
(c)	[1.2] the transmitter configured to: insert first pilots of a first type onto a first plurality of subcarriers, wherein the first pilots are cell-specific pilots; and.....	25
(d)	[1.3] insert data and second pilots of a second type onto a second plurality of subcarriers;.....	28
(e)	[1.4] wherein at least some subcarriers of the first plurality of subcarriers or the second plurality of subcarriers are beam-formed; and .....	33
(f)	[1.5] the plurality of antennas configured to transmit the first plurality of subcarriers and the second plurality of subcarriers in at least one of the time slots;.....	34
(g)	[1.6] wherein the second type is different than the first type and wherein the first pilots do not interfere with the second pilots. ....	36
3.	Independent Claim 8 .....	37
(a)	[8.P] A method performed by an orthogonal frequency division multiple access (OFDMA)- compatible base station that uses subcarriers in a frequency domain and time slots in a time domain, the method comprising:.....	37
(b)	[8.1] inserting, by the OFDMA-compatible base station, first pilots of a first type onto a first plurality of subcarriers, wherein the first pilots are cell-specific pilots; .....	37
(c)	[8.2] inserting, by the OFDMA-compatible base station, data and second pilots of a second type onto a second plurality of subcarriers;.....	38
(d)	[8.3] wherein at least some subcarriers of the first plurality of subcarriers or the second plurality of subcarriers are beam-formed; and .....	38
(e)	[8.4] transmitting, by the OFDMA-compatible base	

	station, the first plurality of subcarriers and the second plurality of subcarriers in at least one of the time slots using a plurality of antennas;.....	38
(f)	[8.5] wherein the second type is different than the first type and wherein the first pilots do not interfere with the second pilots. ....	38
4.	Independent Claim 15 .....	39
(a)	[15.P] An orthogonal frequency division multiple access (OFDMA)-compatible mobile station that uses subcarriers in a frequency domain and time slots in a time domain, the OFDMA-compatible mobile station comprising: .....	39
(b)	[15.1] at least one antenna; and a receiver; and .....	39
(c)	[15.2] the at least one antenna and the receiver are configured to: receive first pilots of a first type on a first plurality of subcarriers, wherein the first pilots are cell-specific pilots; and .....	40
(d)	[15.3] receive second pilots of a second type and data on a second plurality of subcarriers, wherein the first plurality of subcarriers and the second plurality of subcarriers are received in at least one of the time slots; .....	41
(e)	[15.4] wherein at least some subcarriers of the first plurality of subcarriers or the second plurality of subcarriers are beam-formed; and .....	41
(f)	[15.5] the receiver is further configured to: recover the data using channel estimates from at least the second pilots; and.....	41
(g)	[15.6] recover cell-specific information using the cell-specific pilots; .....	44
(h)	[15.7] wherein the second type is different than the first type and wherein the first pilots do not interfere with the second pilots. ....	45
5.	Independent Claim 23 .....	45
(a)	[23.P] A method performed by an orthogonal frequency division multiple access (OFDMA)- compatible mobile	

	station that uses subcarriers in a frequency domain and time slots in a time domain, the method comprising:.....	45
(b)	[23.1] receiving first pilots of a first type on a first plurality of subcarriers, wherein the first pilots are cell-specific pilots; .....	45
(c)	[23.2] receiving second pilots of a second type and data on a second plurality of subcarriers, wherein the first plurality of subcarriers and the second plurality of subcarriers are received in at least one of the time slots; .....	45
(d)	[23.3] wherein at least some subcarriers of the first plurality of subcarriers or the second plurality of subcarriers are beam-formed; .....	46
(e)	[23.4] recovering the data using channel estimates from at least the second pilots; and .....	46
(f)	[23.5] recovering cell-specific information using the cell-specific pilots; .....	46
(g)	[23.6] wherein the second type is different than the .....	46
6.	Claims 2, 9, 16, and 24 .....	46
7.	Claims 3, 10, 17, and 25 .....	47
8.	Claims 4, 11, 18, and 26 .....	49
9.	Claims 5, 12, 21, and 29 .....	50
10.	Claims 6, 13, 20, and 28 .....	51
11.	Claims 7 and 14.....	51
12.	Claims 19 and 27.....	51
13.	Claims 22 and 30.....	52
<b>B.</b>	Ground 2: The combination of Ketchum and Li renders obvious claims 1, 3, 4, 6-8, 10, 11, 13-15, 17, 18, 20, 22, 23, 25, 26, 28, and 30 .....	53
2.	Independent Claim 1. ....	56
(a)	[1.P]: An orthogonal frequency division multiple access (OFDMA)-compatible base station that uses subcarriers in a frequency domain and time slots in a time domain, the OFDMA-compatible base station comprising:.....	56

<b>(b)</b>	[1.1] a plurality of antennas; and a transmitter operably coupled to the plurality of antennas; .....	58
<b>(c)</b>	[1.2] the transmitter configured to: insert first pilots of a first type onto a first plurality of subcarriers, wherein the first pilots are cell-specific pilots; and.....	59
<b>(d)</b>	[1.3] insert data and second pilots of a second type onto a second plurality of subcarriers;.....	62
<b>(e)</b>	[1.4] wherein at least some subcarriers of the first plurality of subcarriers or the second plurality of subcarriers are beam-formed; and .....	64
<b>(f)</b>	[1.5] the plurality of antennas configured to transmit the first plurality of subcarriers and the second plurality of subcarriers in at least one of the time slots;.....	65
<b>(g)</b>	[1.6] wherein the second type is different than the first type and wherein the first pilots do not interfere with the second pilots. ....	66
<b>3.</b>	Independent Claim 8 .....	67
<b>(a)</b>	[8.P] A method performed by an orthogonal frequency division multiple access (OFDMA)- compatible base station that uses subcarriers in a frequency domain and time slots in a time domain, the method comprising:.....	67
<b>(b)</b>	[8.1] inserting, by the OFDMA-compatible base station, first pilots of a first type onto a first plurality of subcarriers, wherein the first pilots are cell-specific pilots; .....	68
<b>(c)</b>	[8.2] inserting, by the OFDMA-compatible base station, data and second pilots of a second type onto a second plurality of subcarriers;.....	68
<b>(d)</b>	[8.3] wherein at least some subcarriers of the first plurality of subcarriers or the second plurality of subcarriers are beam-formed; and .....	68
<b>(e)</b>	[8.4] transmitting, by the OFDMA-compatible base station, the first plurality of subcarriers and the second plurality of subcarriers in at least one of the time slots using a plurality of antennas;.....	68
<b>(f)</b>	[8.5] wherein the second type is different than the first	

	type and wherein the first pilots do not interfere with the second pilots. ....	68
<b>4.</b>	<b>Independent Claim 15</b> .....	<b>69</b>
	(a) [15.P] An orthogonal frequency division multiple access (OFDMA)-compatible mobile station that uses subcarriers in a frequency domain and time slots in a time domain, the OFDMA-compatible mobile station comprising: .....	69
	(b) [15.1] at least one antenna; and a receiver; and .....	70
	(c) [15.2] the at least one antenna and the receiver are configured to: receive first pilots of a first type on a first plurality of subcarriers, wherein the first pilots are cell-specific pilots; and .....	70
	(d) [15.3] receive second pilots of a second type and data on a second plurality of subcarriers, wherein the first plurality of subcarriers and the second plurality of subcarriers are received in at least one of the time slots; .....	71
	(e) [15.4] wherein at least some subcarriers of the first plurality of subcarriers or the second plurality of subcarriers are beam-formed; and .....	71
	(f) [15.5] the receiver is further configured to: recover the data using channel estimates from at least the second pilots; and.....	72
	(g) [15.6] recover cell-specific information using the cell-specific pilots; .....	72
	(h) [15.7] wherein the second type is different than the first type and wherein the first pilots do not interfere with the second pilots. ....	73
<b>5.</b>	<b>Independent Claim 23</b> .....	<b>73</b>
	(a) [23.P] A method performed by an orthogonal frequency division multiple access (OFDMA)-compatible mobile station that uses subcarriers in a frequency domain and time slots in a time domain, the method comprising:.....	73
	(b) [23.1] receiving first pilots of a first type on a first plurality of subcarriers, wherein the first pilots are cell-	

	specific pilots; .....	73
(c)	[23.2] receiving second pilots of a second type and data on a second plurality of subcarriers, wherein the first plurality of subcarriers and the second plurality of subcarriers are received in at least one of the time slots; .....	73
(d)	[23.3] wherein at least some subcarriers of the first plurality of subcarriers or the second plurality of subcarriers are beam-formed; .....	74
(e)	[23.4] recovering the data using channel estimates from at least the second pilots; and .....	74
(f)	[23.5] recovering cell-specific information using the cell-specific pilots; .....	74
(g)	[23.6] wherein the second type is different than the first type and wherein the first pilots do not interfere with the second pilots. ....	74
6.	Claims 3, 10, 17, and 25 .....	74
7.	Claims 4, 11, 18, and 26 .....	76
8.	Claims 6, 13, 20, and 28 .....	77
9.	Claims 7 and 14.....	77
10.	Claims 22 and 30.....	78
C.	Ground 3: The Combination of Ketchum, Li, and Smee renders obvious claims 5, 12, 21, and 29 .....	78
IX.	DISCRETIONARY CONSIDERATIONS UNDER 314(A) AND 325(D) STRONGLY FAVOR INSTITUTION. ....	83
A.	The <i>Fintiv</i> factors strongly favor institution. ....	83
B.	The <i>Advanced Bionics</i> two-part framework strongly favors institution. ....	86
X.	CONCLUSION.....	87



## **PETITIONER’S EXHIBIT LIST**

<b>Exhibit No.</b>	<b>Description</b>
<b>1001</b>	U.S. Patent No. 10,965,512 to Li et al. (“’512 patent”)
<b>1002</b>	’512 Patent Prosecution History
<b>1003</b>	Declaration of Dr. Paul Min Submitted in IPR2022-01539
<b>1004</b>	International Patent Publication No. WO2004/049618 to Kim et al. (“Kim”)
<b>1005</b>	U.S. Patent No. 7,120,395 to Tong et al. (“Tong”)
<b>1006</b>	U.S. Patent Application Pub. No. 2004/0179627 to Ketchum et al. (“Ketchum”)
<b>1007</b>	U.S. Patent Application Pub. No. 2002/0163879 to Li et al. (“Li”)
<b>1008</b>	U.S. Patent No. 7,248,559 to Ma et al. (“Ma ’559”)
<b>1009</b>	Tufvesson, et al., <i>Pilot Assisted Channel Estimation For OFDM in Mobile Cellular Systems</i> , IEEE 47th Vehicular Technology Conference (1997)
<b>1010</b>	U.S. Patent No. 7,826,471 to Wilson et al. (“Wilson”)
<b>1011</b>	U.S. Patent No. 7,664,533 to Logothetis et al. (“Logothetis”)
<b>1012</b>	U.S. Patent No. 7,054,664 to Nagaraj (“Nagaraj”)
<b>1013</b>	International Patent Application No. WO 2004/056022 to Lee et al. (“Lee”)
<b>1014</b>	U.S. Patent No. 7,551,546 to Ma (“Ma ’546”)
<b>1015</b>	Anderson, <i>Fixed Broadband Wireless System Design</i> , Wiley (2003) (excerpts)
<b>1016</b>	U.S. Patent No. 7,852,746 to Jalali (“Jalali”).
<b>1017</b>	U.S. Patent Application Pub. No. 2004/0131007 to Smee et al. (“Smee”)
<b>1018</b>	U.S. Patent No. 7,650,152 to Li et al. (“Li ’152”).
<b>1019</b>	U.S. Patent Application Pub. No. 2004/0190598 to Seki et al. (“Seki”).
<b>1020</b>	Li, “ <i>A Novel Broadband Wireless OFDMA Scheme for Downlink in Cellular Communications</i> ,” Samsung Advanced Institute of Technology (IEEE) (2003) (“Li-Samsung”)

<b>Exhibit No.</b>	<b>Description</b>
<b>1021</b>	Hara et al., “ <i>Multicarrier Techniques for 4G Mobile Communications</i> ,” Artech House (2003) (excerpts) (“Hara”)
<b>1022</b>	U.S. Patent Application Pub. No. 2004/0228270 to Chen et al. (“Chen”)
<b>1023</b>	Van Nee et al., “OFDM for Wireless Multimedia Communications,” Artech House (2000) (“Van Nee”) (excerpts)
<b>1024</b>	Bahai et al., “ <i>Multi-Carrier Communications Theory and Applications of OFDM</i> ,” Springer Science (2004) (excerpts) (“Bahai”)
<b>1025</b>	U.S. Patent No. 7,039,001 to Krishnan et al. (Krishnan”)
<b>1026</b>	U.S. Patent No. 6,992,621 to Casas et al. (“Casas”)
<b>1027</b>	U.S. Patent No. 5,596,329 to Searle et al. (“Searle”)
<b>1028</b>	U.S. Patent Application Pub. No. 2005/0075125 to Bada et al. (“Bada”).
<b>1029</b>	<i>Curriculum Vitae</i> of Dr. Paul Min
<b>1030</b>	U.S. Provisional Patent Application No. 60/421,309 to Walton et al. (“’309 Provisional”)
<b>1031</b>	U.S. Patent No. 7,012,882 to Wang et al. (“Wang”)
<b>1032</b>	Transfer Order, <i>In re: Neo Wireless, LLC, Patent Litigation</i> , Case No. 2:22-md-3034 (E.D. Mich.), filed June 23, 2022 (ECF No. 1)
<b>1033</b>	Docket Sheet, <i>In re: Neo Wireless, LLC, Patent Litigation</i> , Case No. 2:22-md-3034 (E.D. Mich.)
<b>1034</b>	United States District Courts - National Judicial Caseload Profile, June 2022
<b>1035</b>	Conditional Transfer Order, <i>In re: Neo Wireless, LLC, Patent Litigation</i> , Case No. 2:22-md-3034 (E.D. Mich.), issued August 1, 2022 (ECF No. 88)
<b>1036</b>	Conditional Transfer Order, <i>Neo Wireless, LLC v. Mercedes-Benz USA, LLC</i> , Case No. 3:22-cv-780 (M.D. Fla.), issued August 1, 2022 (ECF No. 9)
<b>1037</b>	Conditional Transfer Order, <i>Neo Wireless, LLC v. Mercedes-Benz USA, LLC</i> , Case No. 2:22-cv-11769 (E.D. Mich.), issued August 1, 2022 (ECF No. 2)

<b>1038</b>	Declaration of Mr. Bruce McNair
<b>1039</b>	<i>Curriculum Vitae</i> of Mr. Bruce McNair

## I. INTRODUCTION

Mercedes-Benz USA, LLC. (“Mercedes” or “Petitioner”) petitions for *inter partes* review of claims 1-30 of U.S. Patent No. 10,965,512 (“the ’512 patent”).

The ’512 patent claims techniques for communicating two types of pilot signals within wireless systems. The ’512 patent admits it was known to use pilot signals to perform “many important system functions.” EX1001, 1:36-43. The ’512 patent’s only purported advancement was to use *two types* of pilot signals to perform such system functions. *E.g., id.*, 3:10-36. But this was well-known and disclosed in various patents and publications before the ’512 patent. This Petition demonstrates each challenged claim is not patentable based on a small subset of these patents and publications, and is supported by Mr. Bruce McNair,<sup>1</sup> who has over 55 years of experience working with cellular and other wireless systems. *See* EX1038, McNair Declaration.

The primary references presented herein include International Patent

---

<sup>1</sup> Petitioner retained Mr. Bruce McNair, who prepared a declaration adopting the opinions set forth in EX1003, the declaration of Dr. Paul Min submitted in IPR2022-01539, as his own. EX1038, ¶2. Petitioner cites Mr. McNair’s declaration (EX1038), and notes there are corresponding, identical opinions in Dr. Min’s declaration.

Publication No. WO2004/049618 (“Kim”), which discloses orthogonal frequency division multiple access (OFDMA) downlink signals that include a “[pilot] pattern in common for each cell,” and a different pilot pattern that is “different for each cell” (EX1004, Kim, 6:23-7:10, 24:20-25:5), and U.S. Patent Application Pub. No. 2004/0179627 (“Ketchum”), which discloses cellular downlink signals that include “various types of pilot[s].” EX1006, Ketchum, ¶¶11-13.

Kim and Ketchum used in various combinations teach claims 1-30 of the ’512 patent. Neither Kim nor Ketchum—nor any of the other prior-art references relied on herein—were previously before the Office. Had they been, the ’512 patent would not have been allowed. Accordingly, the Board should institute this proceeding and find claims 1-30 of the ’512 patent unpatentable.

## **II. MANDATORY NOTICES (37 C.F.R. §42.8(A)(1))**

**REAL PARTY-IN-INTEREST:** The real parties-in-interest are Petitioner Mercedes-Benz USA, LLC; Mercedes-Benz Intellectual Property GmbH & Co. KG; and Mercedes-Benz AG.

**RELATED MATTERS:** The ’512 patent is the subject of the following civil actions: *Neo Wireless, LLC v. Ford Motor Company*, Case No. 4-22-cv-00210 (W.D. Mo.), filed March 29, 2022; *Neo Wireless, LLC v. Nissan North America Inc. et al.*, Case No. 3-22-cv-00220 (M.D. Tenn.), filed March 29, 2022; *Neo Wireless, LLC v. American Honda Motor Co., Inc. et al.*, Case No. 2-22-cv-01824 (S.D. Ohio), filed

March 29, 2022; *Neo Wireless LLC v. Tesla, Inc.*, Case No. 2- 22-cv-00095 (E.D. Tex.), filed March 29, 2022; *Neo Wireless LLC v. General Motors Company et al.*, Case No. 2-22-cv-00094 (E.D. Tex.), filed March 29, 2022; *Neo Wireless LLC v. Toyota Motor North America, Inc. et al.*, Case No. 2- 22-cv-00093 (E.D. Tex.), filed March 29, 2022; *Neo Wireless, LLC v. Volkswagen Group of America, Inc. et al. (TV2)*, Case No. 1-22-cv-00076 (E.D. Tenn.), filed March 29, 2022; *Neo Wireless, LLC v. Volkswagen Group of America, Inc. et al.*, Case No. 2-22-cv-11404 (E.D. Mich.), filed June 28, 2022; *Neo Wireless LLC v. Toyota Motor North America, Inc. et al.*, Case No. 2-22-cv-11406 (E.D. Mich.), filed June 28, 2022; *Neo Wireless LLC v. General Motors Company et al.*, Case No. 2-22-cv-11407 (E.D. Mich.), filed June 28, 2022; *Neo Wireless LLC v. Tesla, Inc.*, Case No. 2-22-cv-11408 (E.D. Mich.), filed June 28, 2022; *Neo Wireless, LLC v. Nissan North America Inc. et al.*, Case No. 2-22-cv-11405 (E.D. Mich.), filed June 29, 2022; *Neo Wireless, LLC v. American Honda Motor Co., Inc. et al.*, Case No. 2-22-cv-11403 (E.D. Mich.), filed June 27, 2022; *Neo Wireless, LLC v. Ford Motor Company*, Case No. 2-22-cv-11402 (E.D. Mich.), filed June 27, 2022; *In re: Neo Wireless, LLC Patent Litigation*, Case No. 2-22-md-03034 (E.D. Mich.), filed June 23, 2022; *Neo Wireless, LLC v. Mercedes-Benz USA, LLC*, Case No. 3-22-cv-00780 (M.D. Fla.), filed July 15, 2022; *Neo Wireless, LLC v. Mercedes-Benz USA, LLC*, Case No. 2-22-cv-11769 (E.D. Mich.), filed August 1, 2022; *Neo Wireless, LLC v. FCA US LLC*, Case No. 3-22-

cv-01252 (N.D. Ohio), filed July 15, 2022; and *Neo Wireless, LLC v. FCA US LLC*, Case No. 2-22-cv- 11770 (E.D. Mich.), filed August 1, 2022.

Volkswagen Group of America, Inc. filed an IPR petition (IPR2022-01539) against the '512 patent on September 15, 2022. That petition is currently pending, and no institution decision has been made. Petitioner is concurrently filing a Motion to Join IPR2022-01539 herewith, and requests the Board consider that motion if IPR2022-01539 is instituted.<sup>2</sup>

**LEAD AND BACKUP COUNSEL:**

<b>Lead Counsel</b>	<b>Back-Up Counsel</b>
Celine J. Crowson (Reg. No. 40,357) celine.crowson@hogan.com  <u>Postal and Hand-Delivery Address</u> Hogan Lovells US LLP 555 13th Street	Joseph J. Raffetto (Reg. No. 66,218) joseph.raffetto@hoganlovells.com  <u>Postal and Hand-Delivery Address</u> Hogan Lovells US LLP 555 13th Street N.W. Washington, D.C. 20004 Telephone: 202.637.5600 Facsimile: 202.637.5910

---

<sup>2</sup> Should IPR2022-01539 be terminated prior to any institution decision, or otherwise not instituted for any reason, Petitioner submits its motion for joinder would be moot, and would request the Board consider this Petition on its own merits.

N.W. Washington,  
D.C. 20004  
Telephone: 202.637.5600  
Facsimile: 202.637.5910

Scott Hughes (Reg. No. 68,385)  
scott.hughes@hoganlovells.com

Postal and Hand-Delivery Address

Hogan Lovells US LLP  
555 13th Street N.W.  
Washington, D.C. 20004  
Telephone: 202.637.5600  
Facsimile: 202.637.5910

Helen Y. Trac (Reg. No. 62,250)  
helen.trac@hoganlovells.com

Postal and Hand-Delivery Address

Hogan Lovells US LLP  
Four Embarcadero,  
# 3500  
San Francisco, CA 94111  
Telephone: 415.374.2300  
Facsimile: 415.374.2399

**SERVICE INFORMATION:** Petitioner consents to electronic service by email at:

[celine.crowson@hoganlovells.com](mailto:celine.crowson@hoganlovells.com)

[joseph.raffetto@hoganlovells.com](mailto:joseph.raffetto@hoganlovells.com)

[scott.hughes@hoganlovells.com](mailto:scott.hughes@hoganlovells.com)

[helen.trac@hoganlovells.com](mailto:helen.trac@hoganlovells.com)

**III. GROUNDS FOR STANDING (37 C.F.R. §42.104(A))**

Petitioner certifies the '512 patent is available for *inter partes* review.

Petitioner is not barred or estopped from requesting this review.

**IV. IDENTIFICATION OF CHALLENGE (37 C.F.R. §42.104(B))**

**A. Citation of Prior Art**

The '512 patent's earliest possible priority date is January 29, 2004. EX1001,



(60). Without conceding this priority date is correct, all references relied upon herein are prior art as of January 29, 2004.

**Kim** (EX1004) was filed November 29, 2002 and published June 10, 2004. Kim designated the United States, and was published in English. EX1004, (26), (81). Therefore, Kim is prior art at least under 35 U.S.C. §102(e).

**U.S. Patent No. 7,120,395 (“Tong”)** (EX1005) was filed October 20, 2003 and issued October 10, 2006. Therefore, Tong is prior art at least under 35 U.S.C. §102(e).

**Ketchum** (EX1006) was filed June 30, 2003 and published September 16, 2004. Therefore, Ketchum is prior art at least under 35 U.S.C. §102(e).

**U.S. Patent Application Pub. No. 2002/0163879 (“Li”)** (EX1007) published November 7, 2002. Therefore, Li is prior art at least under 35 U.S.C. §102(b).

**U.S. Patent Application Pub. No. 2004/0131007 (“Smee”)** (EX1017) was filed February 7, 2003 and published July 8, 2004. Therefore, Smee is prior art at least under 35 U.S.C. §102(e).

## **B. Statutory Grounds for the Challenge**

<b>Ground</b>	<b>Basis</b>	<b>Claims</b>	<b>References</b>
1.	§103	1-30	Kim in view of Tong
2.	§103	1, 3, 4, 6-8, 10, 11, 13-15, 17, 18, 20, 22, 23, 25, 26, 28,	Ketchum in view of Li
3.	§103	5, 12, 21, and 29	Ketchum in view of Li and further in view of Smee

## **V. TECHNOLOGY OVERVIEW**

The '512 patent describes systems and techniques for communicating pilot signals of different types between base and mobile stations. EX1001, Abstract. The claims of the '512 patent recite these systems and techniques in terms of four general concepts: (i) the system is an orthogonal frequency division multiple access (OFDMA) system; (ii) base stations communicate various pilots signals to mobile stations; (iii) mobile stations use the pilot signals for channel estimation and to recover transmitted data; and (iv) base stations transmit signals using beamforming. But these concepts and combinations were well-known before the '512 patent. EX1038, ¶¶46-63.

### **A. OFDMA Systems Were Well-Known**

Mr. McNair explains OFDMA systems were well-known prior the '512 patent. *Id.*, ¶¶47-55. Indeed, orthogonal frequency-division multiplexing (OFDM) and its “logical extension,” OFDMA, have long been known in the art, including in cellular systems. EX1015, Anderson, 307; *see also* EX1038, ¶47.

“The basic principle of OFDM [] is to split a high-rate data stream into a number of lower rate streams that are transmitted simultaneously over a number of subcarriers.” EX1021, Hara, 43. The “frequency response of each sub-carrier is designed to be orthogonal to that of each other sub-carrier in order to allow data modulated to each sub-carrier to be independently recovered at a receiver.” EX1038,

¶¶48-53; EX1014, 10:15-19. OFDMA is a “variation” or “logical extension” of OFDM, in which “multiple-access is realized by providing each user with a fraction of the available number of subcarriers.” EX1023, Van Nee, 213; EX1015, Anderson, 307; EX1038, ¶¶54-55.

**B. Communicating Various Pilots Signals Between Base Stations and Mobile Stations Was Well-Known**

Mr. McNair explains the use of pilots signals was well-known prior to the ’512 patent. *Id.*, ¶¶56-60. Pilot signals are signals that have a “value known to the receiver,” and “enable the receiver to perform various functions,” such as “channel estimation, timing and frequency acquisition, data demodulation, and so on.” EX1008, Ma, 2:1-14; EX1007, Li, ¶28; EX1006, ¶8.

Mr. McNair also explains it was well-known that OFDM/OFDMA systems implement multiple types of pilots that could be used, for instance, for different functions. EX1038, ¶61. As described in detail below, Ketchum discloses an OFDM multiple-access system that implements “various types of pilot.” EX1006, Abstract. Further, Kim discloses an OFDMA cellular system that implements two types of pilot signals—a “[pilot] pattern in common for each cell,” and a separate pilot pattern that is “different for each cell.” EX1004, 6:23-7:10, 24:20-25:5.

**C. OFDM/OFDMA Cellular Systems Implemented Pilot Symbols for Channel Estimation and Data Recovery**

Mr. McNair explains the well-known role of pilot signals in performing

channel estimation for recovering data at the receiver. EX1038, ¶¶56-60; EX1025, Krishnan, 1:52-61. Specifically, receivers use pilot signals to determine “[a]n accurate estimate of the response” of the communication channel (e.g., air or space). EX1025, 1:52-61; EX1024, Bahai, 15, 117-118; EX1038, ¶¶56-57. “Since the pilot is made up of symbols that are known *a priori* by the receiver, the channel response can be estimated as the ratio of the received pilot symbol over the transmitted pilot symbol for each [subcarrier] used for pilot transmission.” EX1025, 1:55-61. The receiver then uses the channel estimate “to acquire the original [data]” provided by the base station. EX1024, 118; EX1038, ¶¶58-60.

#### **D. Beamforming Was Well-Known**

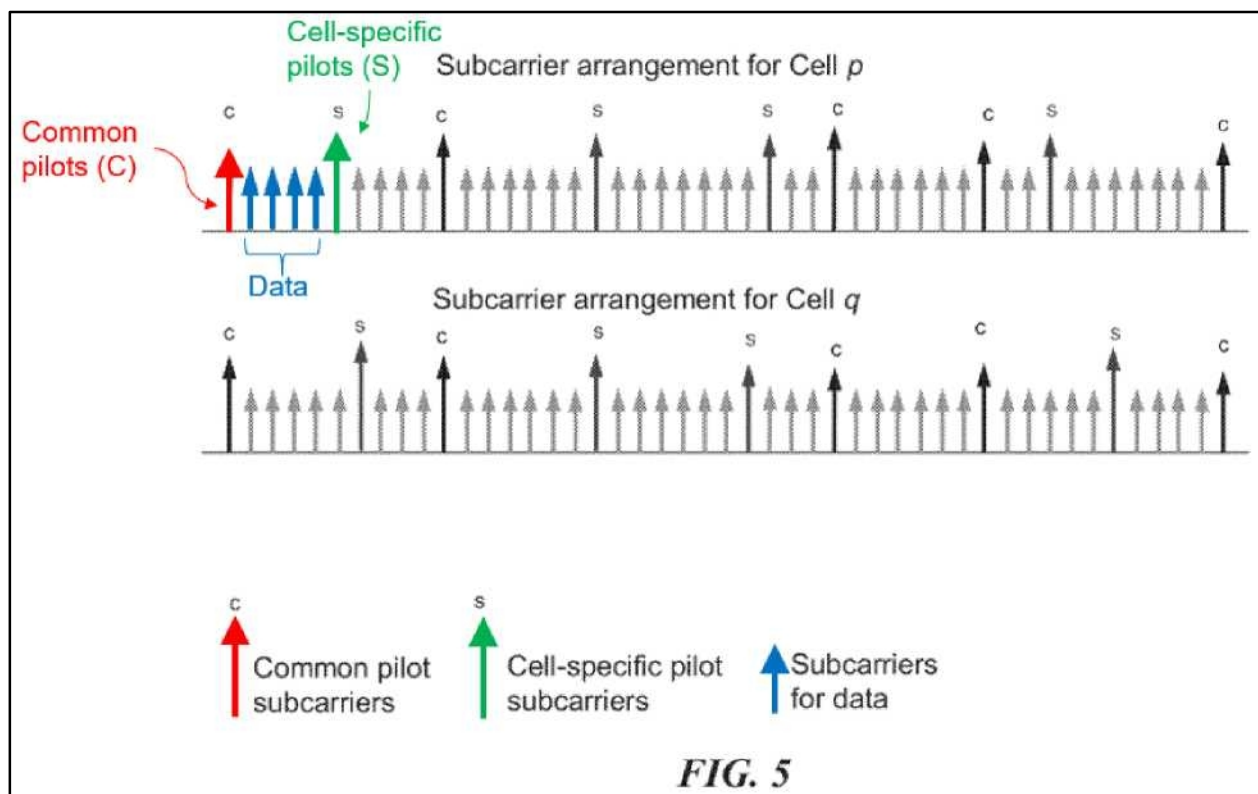
Mr. McNair explains beamforming was well-known prior to the ’512 patent. EX1038, ¶¶62-63. It was also well-known for cellular systems to communicate OFDM downlink signals (including pilot signals) using beamforming. *Id.* Beamforming is a communication technique in which electromagnetic waves transmitted by multiple antennas are “focused in a desired direction” to form a “beam.” EX1026, Casas, 1:20-24.

### **VI. THE ’512 PATENT**

#### **A. Summary of the ’512 Patent**

The ’512 patent is directed to a “multi-carrier cellular wireless network [that] employs base stations [] that transmit two different groups of pilot subcarriers”—“cell-specific pilot subcarriers, which are used by a receiver to extract information

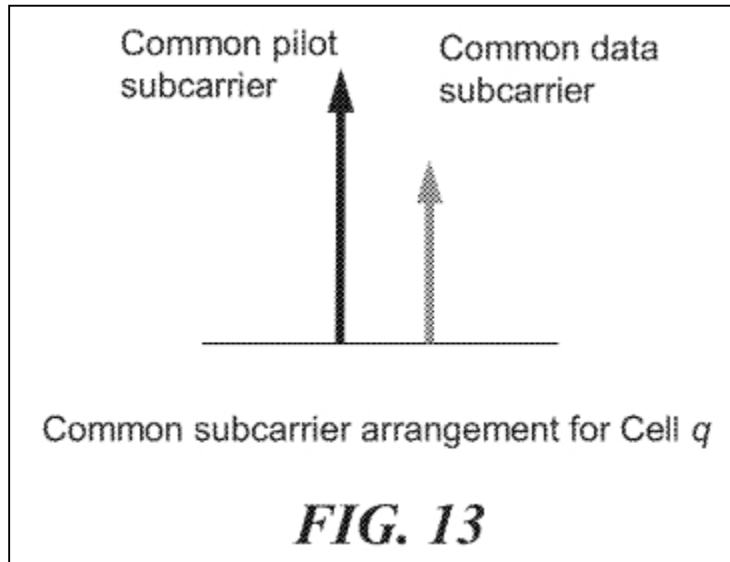
unique to each individual cell,” and “common pilots subcarriers, which are designed to possess a set of characteristics common to all the base stations [] of the system.” EX1001, Abstract; EX1038, ¶¶41-45. As shown in Figure 5, base stations within the system insert cell-specific pilots, common pilots, and data signals at appropriate subcarrier frequencies in a downlink signal. EX1001, 3:55-59, 5:34-48.



EX1001, FIG. 5 (annotated).

The “cell-specific pilot subcarriers can be used in channel estimation.” *Id.*, 3:17-23. The “common pilot subcarriers” can be used for “frequency offset estimation and timing estimation,” as well as to recover “data information common to all cells in the network.” *Id.*, 5:65-67, 8:65-9:5. To recover this data, mobile stations perform channel estimation using the common pilot subcarrier “to

compensate for the channel effect” between the base station and mobile station. *Id.*, 9:1-5.



EX1001, FIG. 13 (excerpt).

## **B. Prosecution History Summary**

The '512 patent received a first-action-allowance at the USPTO. EX1002, '512 Patent Prosecution History, 162-171. The Examiner stated that the “closest prior art of record” included U.S. Patent No. 7,650,152 (EX1018, Li '152) and U.S. Patent Pub. No. 2004/0190598 (EX1019, Seki). *Id.*, 167-168. But, as explained below, the claimed concepts existed well before the '512 patent. Had these references been before the Examiner, the '512 patent should not have been allowed.

## **C. Level of Ordinary Skill in the Art**

A person of ordinary skill in the art (“POSA”) would have a bachelor’s degree in electrical engineering, computer engineering, computer science, or an equivalent field, or an advanced degree in those fields, as well as least 3-5 years of academic or

industry experience in mobile wireless communications, or comparable industry experience. EX1038, ¶65.

#### **D. Claim Construction**

In *inter partes* review, claims are “construed using the same claim construction standard that would be used to construe the claim in a civil action under 35 U.S.C. 282(b).” 37 C.F.R. §42.100 (b). All claim terms must be given their ordinary and customary meaning as understood by a POSA at the time of the invention, in light of the specification and the prosecution history of the patent. *Id.* Solely for the purposes of this Petition, Petitioner submits all claim terms should receive their plain and ordinary meaning in the context of the ’512 patent specification.<sup>3</sup> EX1038, ¶66.

### **VII. OVERVIEW OF THE APPLIED REFERENCES**

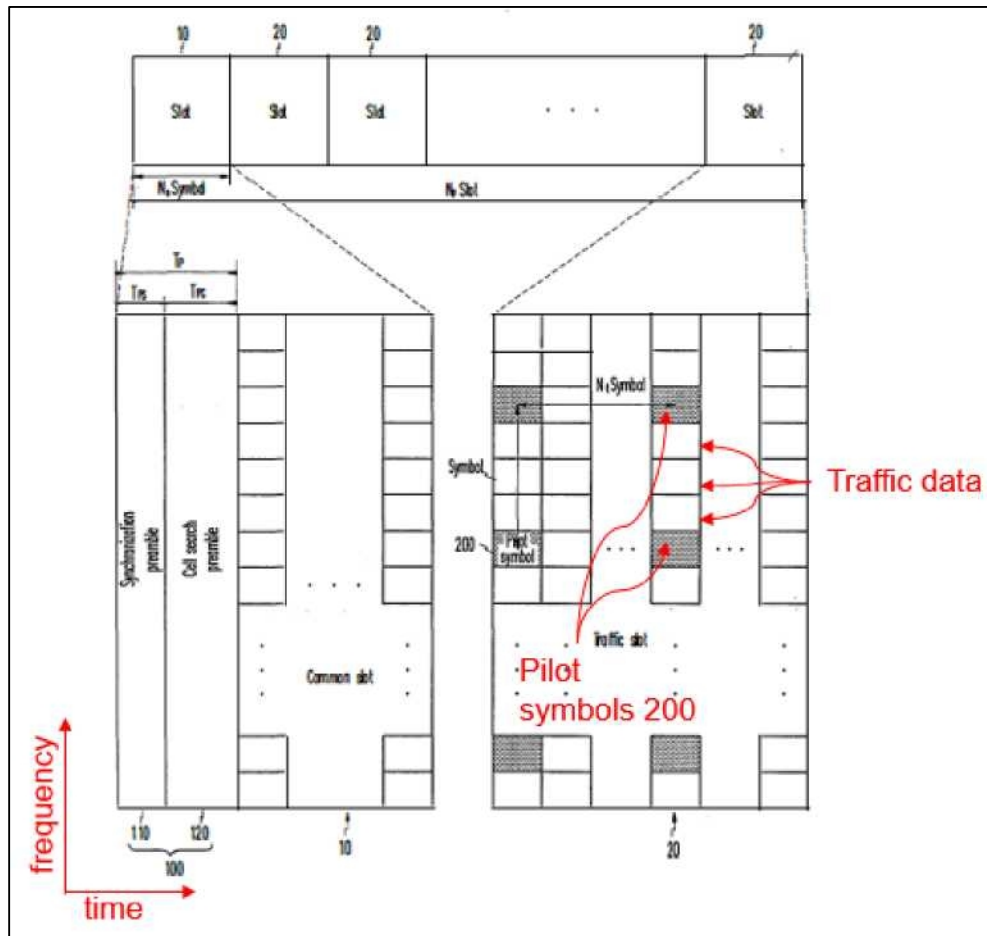
#### **A. Kim**

Kim describes an “OFDMA-based cellular system” including base stations that provide downlink signals to mobile terminals. EX1004, Abstract, 1:15-17; EX1038, ¶¶67-75. As shown in Figure 1, the downlink signal includes “traffic slots” 20 that include pilot symbols 200 inserted on a particular subcarrier (y-axis) for a particular timeslot (x-axis). EX1004, 1:14-21, 11:15-12:10. The traffic slots also

---

<sup>3</sup> Petitioner reserves the right to challenge the validity of the claims under 35 U.S.C. §112 in other proceedings and forums.

include “traffic data.” *Id.*, 46:2-16.

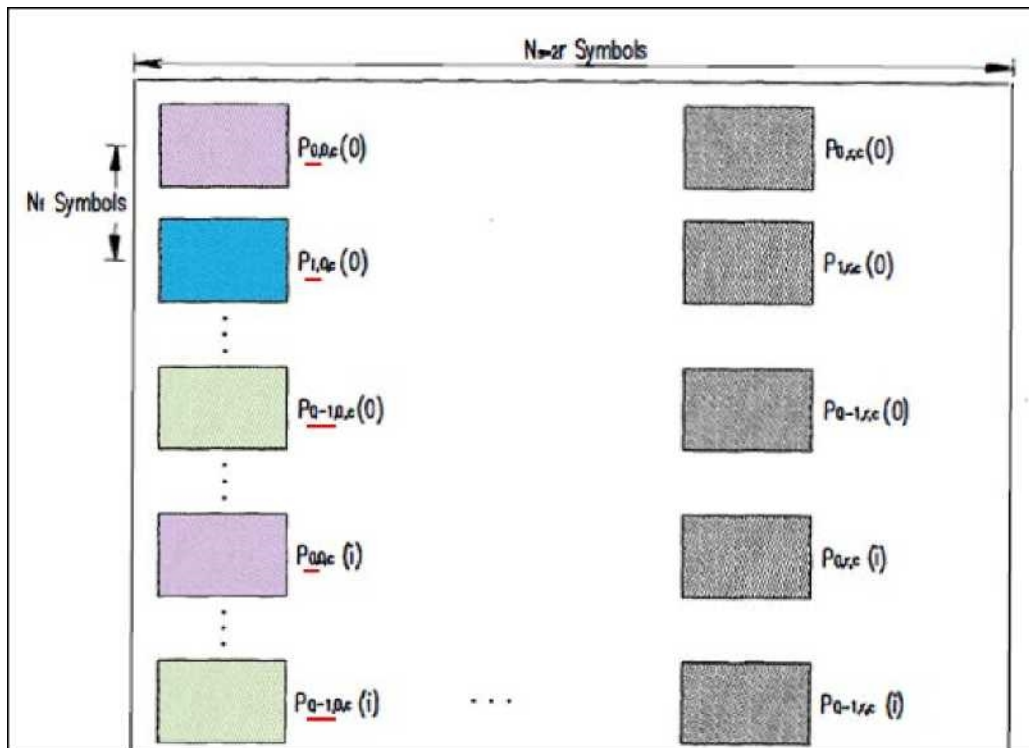


EX1004, FIG. 1 (annotated).

Kim’s pilots are implemented as a “combination of  $Q$  [pilot] patterns,” including at least one pilot pattern specific to the cell and at least one pilot pattern “used in common by all the cells.” *Id.*, 24:2-11, 24:20-25:5. Figure 10 shows three example pilot patterns, represented as  $P_{q,s,c}(i)$ , where  $q$  represents the respective pilot pattern. *Id.*, 24:20-25:5. The purple symbols represent pilot pattern 0, the blue symbols represent pilot pattern 1, and the green symbols represent pilot pattern  $Q-1$  (the pilot pattern number  $q$  for these patterns is underlined in red). In such OFDM



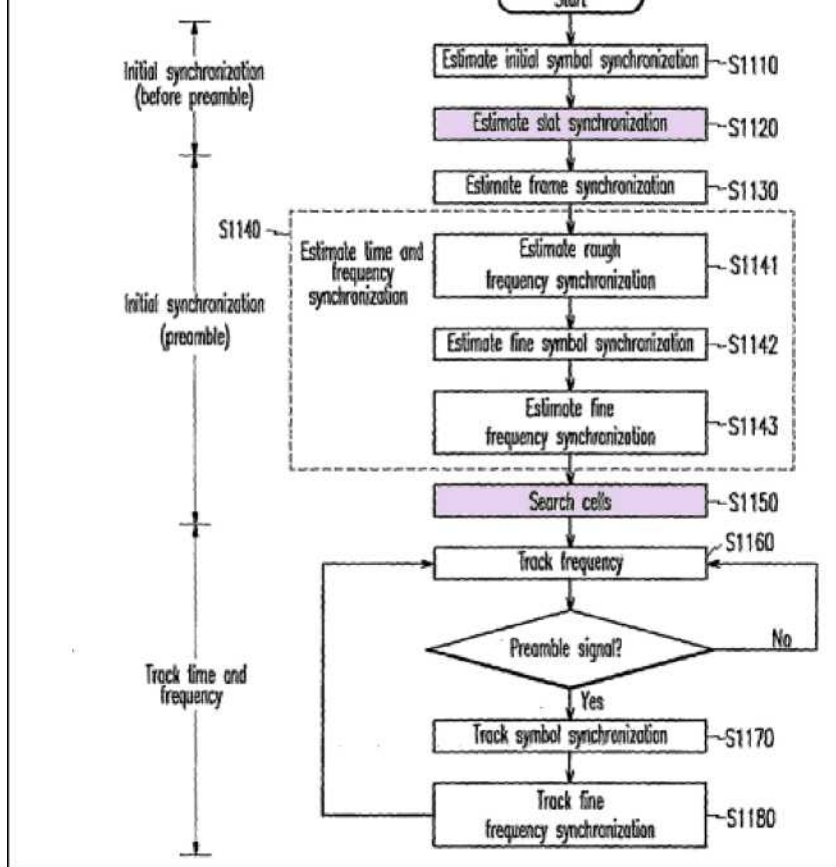
symbols, at least one of the pilot patterns (e.g., pattern 0, highlighted purple) represents one of the  $Q_1$  common pilot patterns and at least one of the pilot patterns (e.g., patterns 1 and  $Q-1$ , highlighted blue and green respectively) represents one of the  $Q_2$  cell-specific pilot patterns that are specific to the particular cell associated with the base station. EX1038, ¶73.



EX1004, FIG. 10 (excerpt, annotated).

Kim's base station provides the downlink signal on "each transmit antenna." EX1004, 54:8-10. A mobile terminal receives the downlink signal, and uses the common pattern pilots for "slot synchronization," and uses the cell-specific pattern pilots "to search the cells." *Id.*, 25:20-22, 26:3-7, 27:10-28:13.

FIG.11B



EX1004, FIG. 11B (annotated).

## B. Ketchum

Ketchum discloses a multiple-access wireless MIMO system that implements pilots of “different types” that “support various functions that may be needed for proper system operation, such as timing and frequency acquisition, channel estimation, calibration, and so on.” EX1006, Abstract, ¶11; EX1038, ¶¶76-79. “The various types of pilot” are shown in Table 1, below. EX1006, ¶12.

TABLE 1	
<u>Pilot Types</u>	
Pilot Type	Description
Beacon Pilot	A pilot transmitted from all transmit antennas and used for timing and frequency acquisition.
MIMO Pilot	A pilot transmitted from all transmit antennas with different orthogonal codes and used for channel estimation.
Steered Reference or Steered Pilot	A pilot transmitted on specific eigenmodes of a MIMO channel for a specific user terminal and used for channel estimation and possibly rate control.
Carrier Pilot	A pilot used for phase tracking of a carrier signal.

EX1006, Table 1.

Ketchum discloses base stations that provide the various pilots along with data to mobile terminals in OFDM symbols. *Id.*, ¶¶33, 35. As an example, Ketchum discloses that its beacon pilots can be provided on “a set of 12 BPSK modulation symbols for 12 specific subbands.” *Id.*, ¶39. Further, the steered reference pilot can be provided on a set of “52 QPSK modulation symbols.” *Id.*, ¶47.

User terminals use the beacon pilots to determine “system timing and frequency acquisition.” *Id.*, ¶¶41, 42. The terminals use the steered reference pilot “for channel estimation.” *Id.*, ¶12. The terminals then use the channel estimate “to recover the transmitted data.” *Id.*, ¶¶7-8.

### C. Tong

Tong also discloses a wireless communication system that “transmit[s]

multiple streams of data to a given user” element using beam-forming. EX1005, Tong, Abstract, 8:50-66, 11:60-12:4; EX1038, ¶¶80-82. The streams of data include pilot signals, which the receiver uses “for channel estimation,” and to “recover the originally transmitted data.” EX1005, 6:35-58.

#### **D. Li**

Li discloses a cellular system that implements “OFDMA.” EX1007, ¶19; EX1038, ¶83. Li’s system includes base stations that “broadcast pilot OFDM symbols” for various system functions, such as “time and frequency synchronization, channel estimation and signal-to-interference/noise (SINR) ratio measurement for cluster allocation.” EX1007, ¶28. “The pilot symbols may be different for different cells (or sectors).” *Id.*, ¶28.

#### **D. Smee**

Smee discloses “[p]ilot transmission schemes suitable for use in wireless multi-carrier (e.g., OFDM) communication systems.” EX1017, Abstract; EX1038, ¶¶84-85. The pilot transmission schemes utilize “frequency orthogonality” by causing different base stations to transmit pilots “on disjoint sets of subbands” (subcarriers). EX1017, ¶10; *see also* ¶¶39, 46.

### **VIII. GROUNDS OF UNPATENTABILITY**

Claims 1-30 are unpatentable for at least the reasons set forth below. EX1038, ¶¶86-261.

**A. Ground 1: The combination of Kim and Tong renders obvious claims 1-30.**

**1. A POSA would have been motivated to combine Kim and Tong**

**(a) A POSA would have been motivated to implement beamforming in Kim's base station, as taught by Tong.**

A POSA would have been motivated to implement beamforming, as taught by Tong, in Kim's system. EX1038, ¶¶87-93. Kim seeks to improve signal quality of its "downlink signal" that is transmitted using "at least one transmit antenna." EX1004, 29:16-18, 32:3-15, 34:12-17, 45:21-46:16; EX1038, ¶87. But Kim does not disclose how its multiple antennas could be used to improve signal quality—a well-known characteristic that had been a motivating force for cellular system designers for years before the '512 patent. EX1038, ¶87. A POSA would have thus sought references that taught efficient multi-antenna transmission techniques. *Id.* Tong is such a reference.

Like Kim, Tong teaches a cellular system that uses OFDM communication techniques to transmit pilot signals from a base station to mobile terminals using multiple antennas. EX1004, 29:16-18, 45:21-46:16; EX1005, 4:49-55, 5:64-8:7, 8:61-9:4. Tong explains that implementing beamforming to transmit signals from the base station to the mobile terminals is beneficial to "provide additional gain," to "increase the signal-to-noise ratio at a receiver," and to "improve[e] the system capacity," as well as to "optimize channel capacity, signal-to-noise ratios, or a

combination thereof.” *Id.*, 8:50-9:4, 11:23-28, 11:60-12:6. Tong’s beamforming techniques are implemented “in an efficient manner.” *Id.*, 1:62-67.

A POSA would have understood that such benefits could be achieved by implementing beamforming in Kim’s system. EX1038, ¶¶88-91. A POSA would have thus been motivated to implement such techniques in Kim’s system, such that Kim’s “plurality of transmit antennas” would be implemented to provide beamforming for at least some subcarriers of the first plurality of subcarriers or the second plurality of subcarriers of the downlink signal. *Id.*

A POSA would have been further motivated to combine Kim and Tong because both are in the field of cellular communications, and address the same problem—efficient communications between base stations and mobile terminals. EX1038, ¶92. A POSA would have had a reasonable expectation of success in implementing beamforming because it was a well-known technique commonly used in wireless communication systems for well over a decade prior to the priority date of the ’512 patent. *Id.*, ¶¶92-93. Kim’s base station already implements multiple antennas to transmit its downlink signal. *E.g.*, EX1004, 29:16-18, 30:1416. Implementation of beamforming in Kim’s base station would not require additional hardware other than implementing well-known mathematical algorithms related to beamforming leveraging the  $Q_1$  pilot pattern. EX1038, ¶92. Tong also discloses that its beam-forming techniques are “beneficial in OFDM environments,” such as

Kim's. EX1005, 14:24-25.

Further, as evident from the above discussion, a POSA could have combined the system of Kim with the teachings of Tong by known methods, and the results of the combination would have been predictable to a POSA. EX1038, ¶93. Indeed, a POSA would have readily understood how to adapt Kim's transmit antennas 2102 so that the base station implements beamforming, such as by implementing the antennas as arrays (e.g., leveraging Kim's transmit antennas) whose transmissions combine "in a constructive fashion." EX1005, 8:50-66. Thus, a POSA would have understood that implementing beam-forming in Kim's system would merely amount to the use of known technique to improve similar devices in the same way. EX1038, ¶¶92-93.

**(b) A POSA would have been motivated to use Kim's pilots for channel estimation, and to recover the transmitted data, as taught by Tong.**

A POSA would have also been motivated to combine Kim and Tong so that Kim's mobile terminals use the Q1 pilot pattern for channel estimation and to recover the data provided in Kim's downlink signal traffic slots. EX1004, 12:6-10; EX1005, 6:2-58; EX1038, ¶¶94-101.

Kim's "OFDMA-based cellular system" includes a terminal configured to receive and recover "traffic data" on a downlink signal from a base station. EX1004, 1:23-2:3. As Mr. McNair explains, in cellular systems, the "channel response"

causes the downlink signal to undergo variations in phase and amplitude caused during propagation of the signal along the channel between the base station and terminal. EX1038, ¶¶57, 95; *see also* EX1008, 2:1-4; EX1024, 117-118. Such cellular systems commonly determined estimates of the channel response (channel estimation) to “compensate for the channel degradation” of the channel and accurately recover the “traffic data” on the downlink signal. EX1038, ¶¶58-60, 95; EX1008, 2:4-7; EX1024, 117-118; EX1025, 1:52-61.

However, Kim does not explicitly disclose techniques for performing this channel estimation. Therefore, a POSA would have sought references that taught specific techniques for estimating channel responses of cellular systems such as Kim’s. EX1038, ¶96. Tong is such a reference. *Id.*, ¶¶96-97.

Tong’s user element 16 includes a “channel estimation function 86” that “use[s] [] pilot signals for channel estimation.” EX1005, 6:2-5, FIG. 5. Specifically, the channel estimation function “provide[s] sufficient channel response information to allow the STC decoder 88 to decode the symbols.” *Id.*, 6:33-42. The user element “recover[s] the originally transmitted data 104” based on the channel estimate. *Id.*, 6:35-39, 6:43-58.

A POSA would have understood that Tong’s techniques would be beneficial in Kim’s system to estimate the channel for accurate data recovery. EX1038, ¶98.

As Mr. McNair explains, cellular systems commonly implemented pilot



signals for channel estimation. *Id.* Thus, a POSA would have sought to enable Kim's terminal to use the received common pilot signals (Q1 pilot pattern) for estimating the channel to recover the traffic data provided on the downlink signal. *Id.*, ¶99. The Kim-Tong mobile terminals would implement a "receive path" including a "channel estimation function," for data recovery, such as taught by Tong. EX1005, 6:33-58, FIG. 5. This would enable Kim's terminal to estimate the channel response so that the terminal can accurately recover the traffic data. EX1038, ¶100.

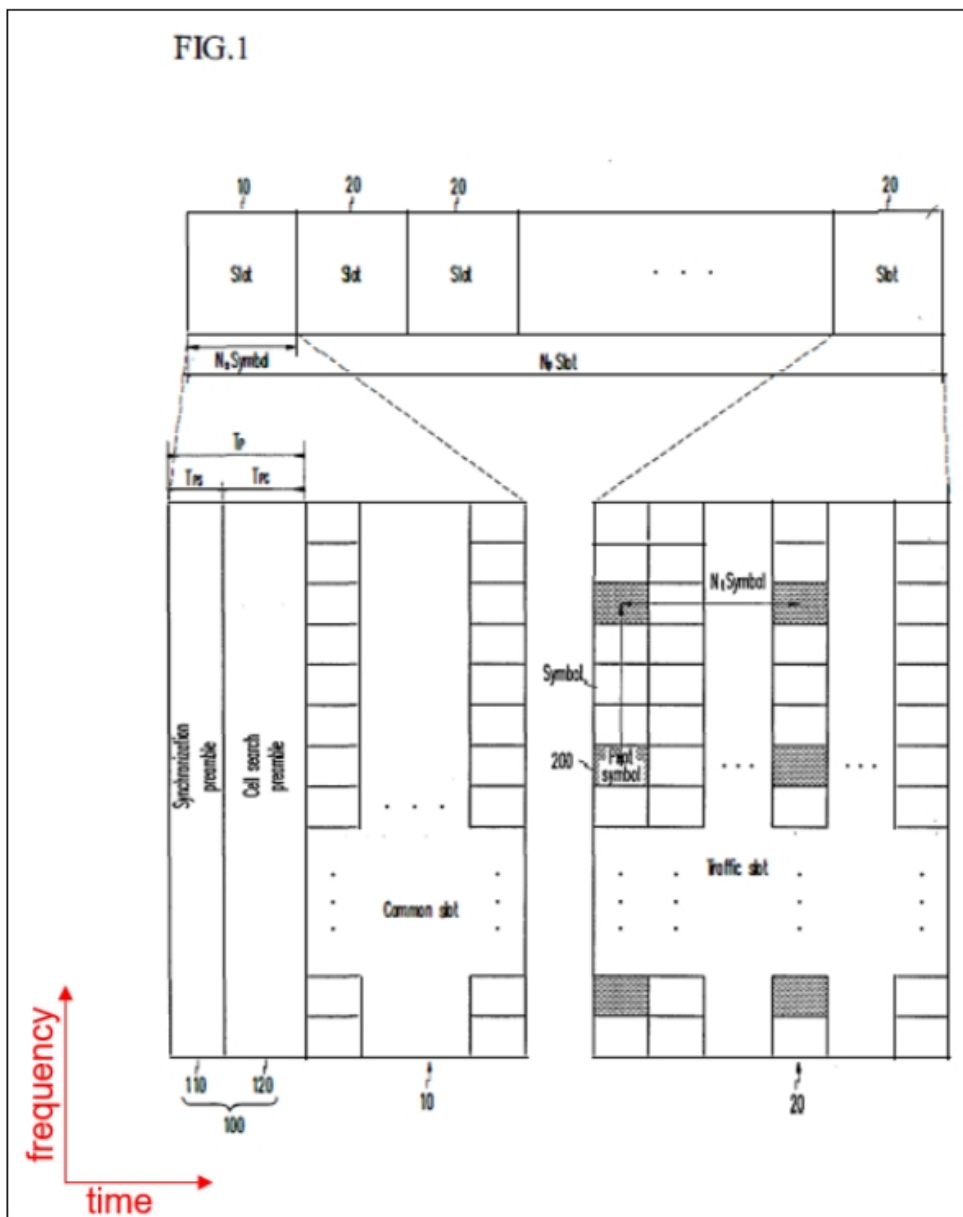
And a POSA would have had a reasonable expectation of success in implementing such well-known features by known methods, and the results of the combination would have been predictable to a POSA. *Id.*, ¶101. Indeed, a POSA would have understood that such techniques would be a natural and logical use of Kim's downlink pilot signals. *Id.* Thus, a POSA would have not encountered any unreasonable technical hurdles in implementing such modifications. *Id.* Accordingly, a POSA would have understood that such modifications would merely amount to the use of a known technique (pilot-aided channel estimation for data recovery) to improve similar devices (Kim's terminals) in the same way (accurate data recovery based on known channel degradation). *Id.*; *KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398 at 419-421.

## 2. Independent Claim 1.

- (a) **[1.P]: An orthogonal frequency division multiple access (OFDMA)-compatible base station that uses subcarriers in a frequency domain and time slots in a time domain, the OFDMA-compatible base station comprising:**

To the extent limiting, Kim discloses the preamble. EX1038, ¶¶103-105.

Kim discloses a “base station of an OFDMA-based mobile communication system.” EX1004, 45:21-46:1; *see also* 1:23-25. Kim’s base station *uses subcarriers in a frequency domain and time slots in a time domain* within the OFDMA-based mobile communication system. EX1038, ¶¶104-105. As shown in Figure 1, Kim’s base station transmits a “downlink signal” that “includes pilot symbol[s 200] given with respect to the time axis and the frequency axis.” EX1004, 11:18-21, 12:6-8; *see also* Abstract. “The pilot symbol 200 is inserted per group of  $N_f$  subcarriers with respect to the frequency axis and per group of  $N_t$  symbols with respect to the time axis.” *Id.*, 12:8-10; *see also* 24:2-25:5. A POSA would have understood that each cell in the traffic slot 20 shown in Figure 1 represents a time slot on the time axis and a subcarrier on the frequency axis. EX1038, ¶¶52-53, 105.

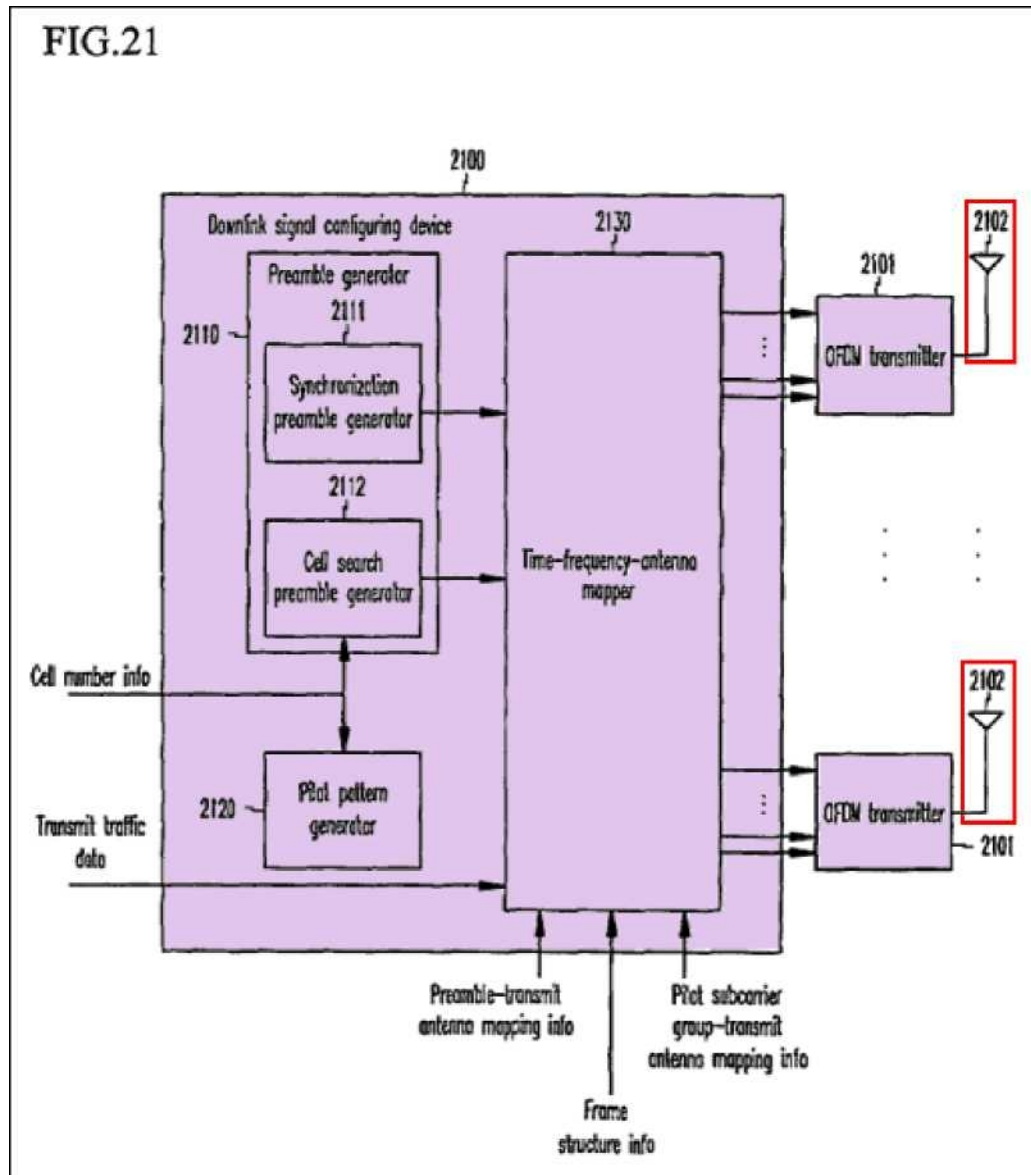


EX1004, FIG. 1 (annotated).

(b) [1.1] a plurality of antennas; and a transmitter operably coupled to the plurality of antennas;

Kim's base station includes "a plurality of transmit antennas" 2102. EX1004, 30:11-21. The transmit antennas are each coupled to an OFDM transmitter 2101, and to a downlink signal configuring device 2100. *Id.*, 46:2-16. A POSA would have

understood that the transmit antennas 2102 (shown in red below) are the claimed *plurality of antennas*, and the downlink signal configuring device 2100 and OFDM transmitters 2102 (purple below) are the claimed *transmitter*. EX1038, ¶106.



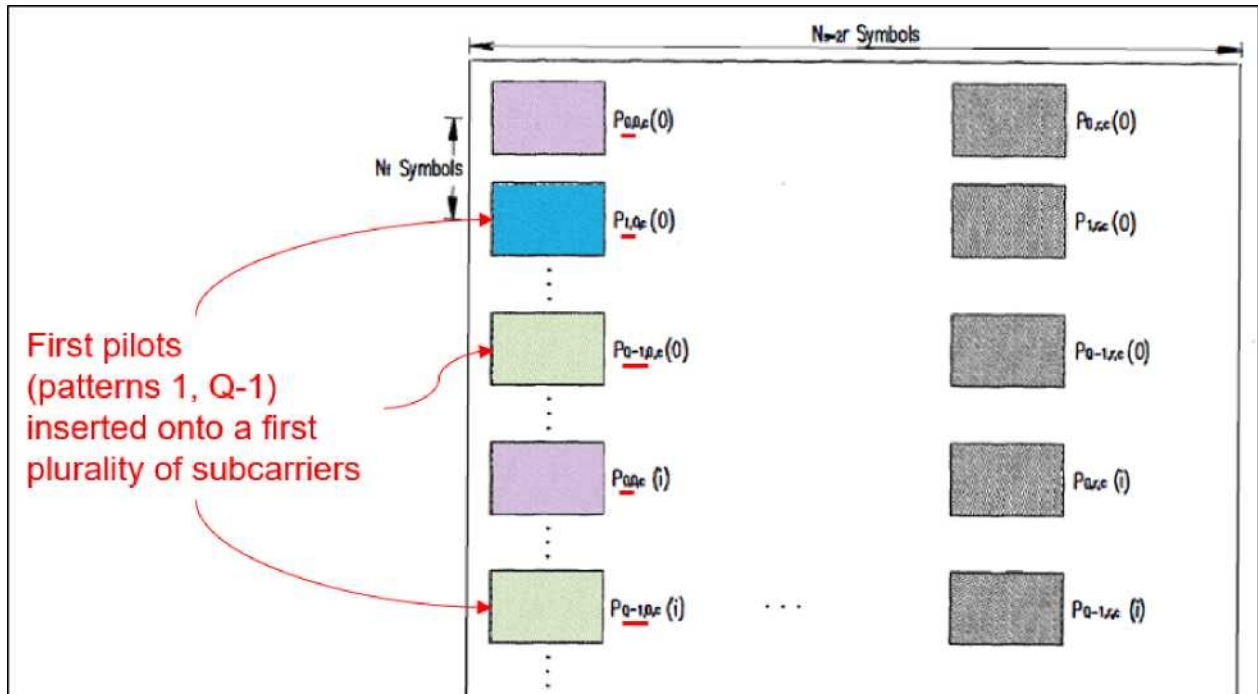
EX1004, FIG. 21 (annotated).

- (c) [1.2] the transmitter configured to: insert first pilots of a first type onto a first plurality of subcarriers, wherein the first pilots are cell-specific pilots; and

Kim's downlink signal configuring device 2100 inserts pilot symbols into the

downlink signal “for each group of  $N_f$  subcarriers.” EX1004, 24:2-11. The pilots include a first pilot pattern in common for each cell and a second pilot pattern that is “different for each cell.” *Id.*, 6:23-7:11, 24:20-25:5, 48:22-49:4. Kim explains that its overall pilot pattern is configured to include “ $Q$  patterns.” *Id.*, 24:20-25:5. “ $Q_1$  patterns from among the  $Q$  patterns are used in common by all the cells, and residual  $Q_2 (= Q - Q_1)$  patterns are defined to be different for the respective cells.” *Id.* Each  $Q_2$  pattern is “a specific pattern for each cell.” *Id.*, 26:37. In such instance, the collective pilot pattern is given by  $P_{q,s,c}(i)$ , where  $q$  equals the particular pilot pattern number from 0 to  $Q-1$ ;  $s$  equals the symbol number;  $c$  equals the cell number; and  $i$  equals the  $i^{\text{th}}$  pilot subcarrier. *Id.*, 24:2-11, 24:20-25:5.

Figure 10, reproduced and annotated below, shows three example pilot patterns. EX1038, ¶¶107-108. The purple symbols represent pilot pattern 0, the blue symbol represents pilot pattern 1, and the green symbols represent pilot pattern  $Q-1$  (the pilot pattern number  $q$  is underlined in red). *Id.*; EX1004, 24:20-25:5, 26:3-7.



EX1004, FIG. 10 (excerpt, annotated).

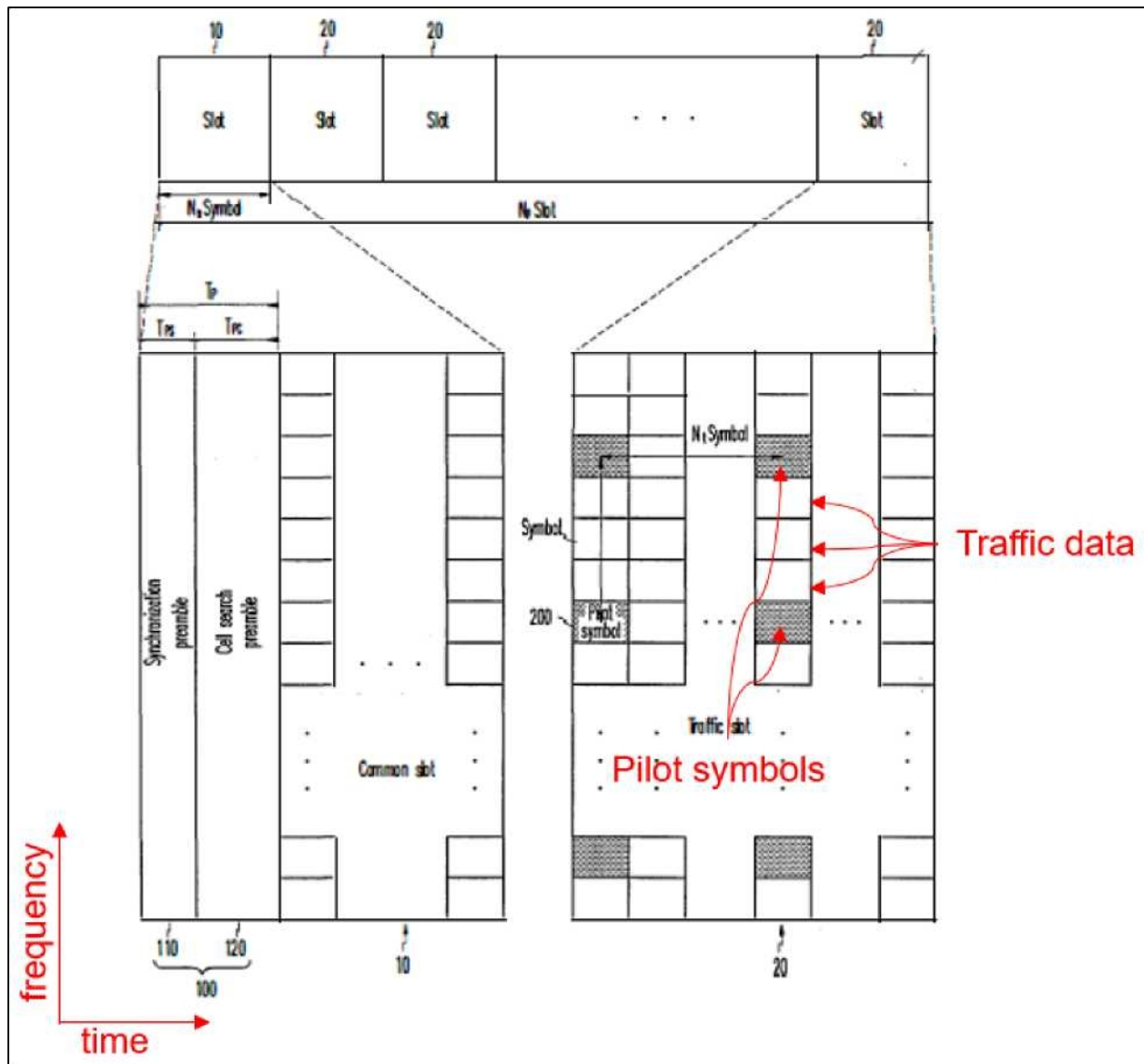
Figure 10 depicts a time-frequency grid with the y-axis representing frequency and the x-axis representing time. EX1004, 12:6-10, 24:2-8; EX1038, ¶109. Each row represents a different subcarrier. *Id.* The symbols of each pilot pattern are inserted onto different subcarriers. EX1004, 12:6-10. For instance, the purple symbols of pilot pattern 0 are inserted onto a first group of subcarriers, and the green symbols of pilot pattern Q-1 are inserted onto different subcarriers. EX1038, ¶109. As Mr. McNair explains, patterns 1 and Q-1 represent different pilot patterns that are each specific to the particular cell. *Id.*, ¶¶109-110. A POSA would have understood that one or more of the pilot patterns shown in Figure 10 (e.g., pilot pattern 0 (purple)) represents the  $Q_1$  common pilot pattern, and one or more other pilot patterns (e.g., pilot patterns 1 and Q-1 (blue and green)) represent the  $Q_2$  cell-

*specific* pilot patterns. *Id.* Thus, the  $Q_2$  (residual) *cell-specific* pilot patterns are inserted onto a first plurality of subcarriers. *Id.*

Thus, a POSA would have understood that Kim's transmitter is configured to insert first pilots of a first type onto a first plurality of subcarriers, wherein the first pilots are cell-specific pilots. *Id.*, ¶107-111.

**(d) [1.3] insert data and second pilots of a second type onto a second plurality of subcarriers;**

Kim's transmitter *inserts data* onto a *second plurality of subcarriers*. *Id.*, ¶¶112-113. As explained, Kim's downlink signal includes pilot symbols (grey cells in Figure 1) as well as "traffic data" (white cells in Figure 1). EX1004, 11:18-21, 46:11-16.



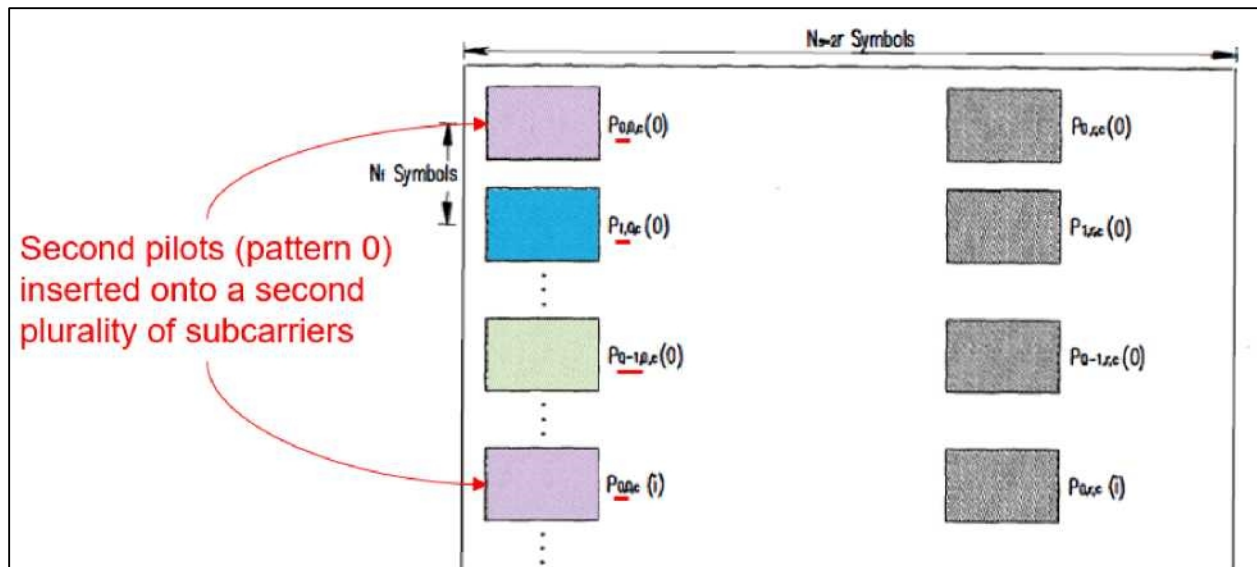
EX1004, FIG. 1 (annotated).

The transmitter “maps the [traffic] data according to the time, frequency, and antenna, and outputs mapped results to the OFDM transmitter 2101 per transmit antenna 2102.” *Id.*, 46:11-16. A POSA would have understood that the transmitter inserts the traffic data onto a plurality of subcarriers within the traffic slot that are not occupied by the pilot symbols (i.e., white cells in slot 20 in Figure 1). EX1038,



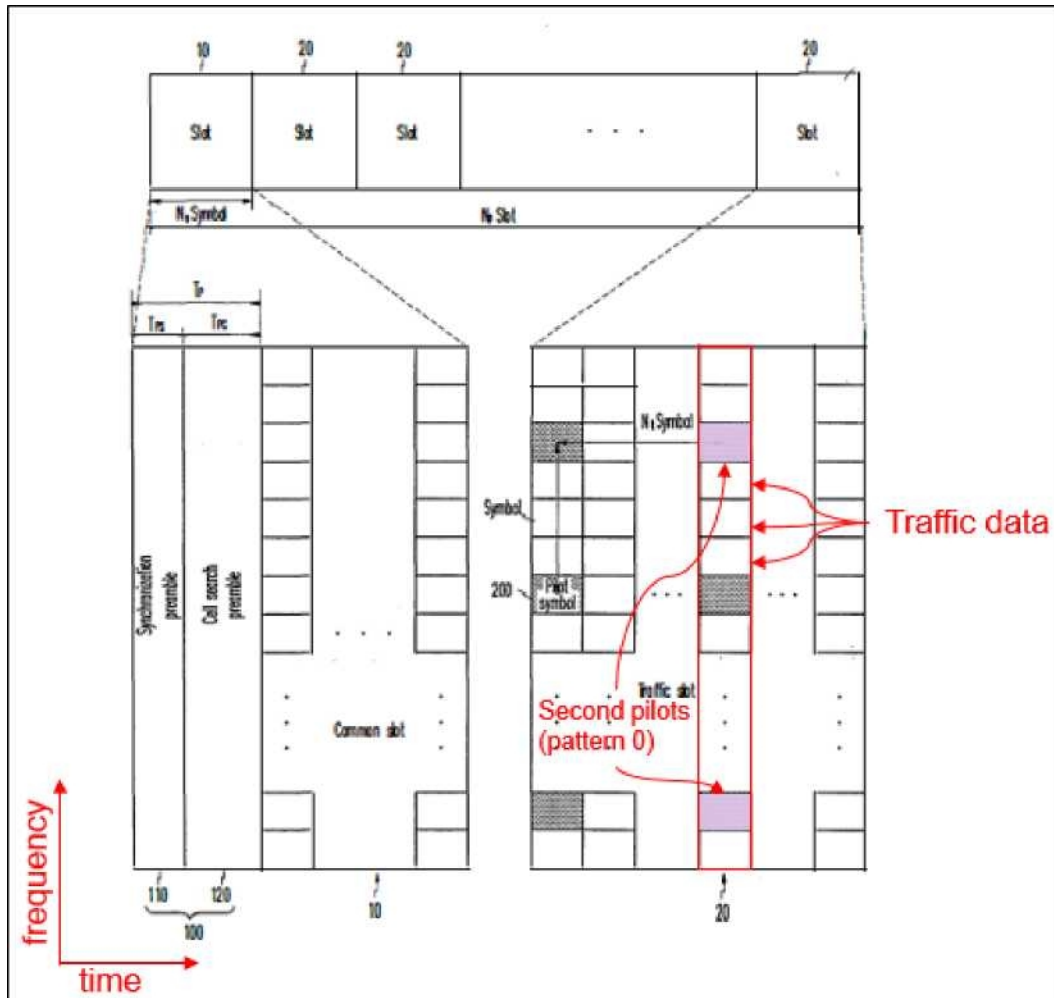
¶¶112-113.

Kim's transmitter also inserts *second pilots of a second type onto a second plurality of subcarriers*. *Id.*, ¶¶114-115. As explained for element [1.2], Kim's transmitter is configured to insert pilot signals onto subcarriers of the downlink signal. The pilot signals include Q patterns wherein Q<sub>1</sub> patterns "are used in common by all the cells," and Q<sub>2</sub> (= Q-Q<sub>1</sub>) patterns are defined to be different for the respective cells. *Id.* The Q<sub>1</sub> patterns that are "used in common by all the cells" are the claimed *second pilots of a second type*. *Id.*, ¶114. The different pilot patterns are inserted onto different subcarriers in the traffic slots of the downlink signal. *Id.*, ¶¶114-115. For instance, in continuing with the example from element [1.2], as shown in Figure 10, the pilot pattern 0 (purple) represents the Q<sub>1</sub> common pilot pattern, and pilot patterns 1 and Q-1 (blue and green) represent the Q<sub>2</sub> *cell-specific* pilot patterns. *Id.* Thus, the Q<sub>1</sub> common pilot patterns are inserted onto a *second plurality of subcarriers*. *Id.*, ¶114.



EX1004, FIG. 10 (excerpt, annotated).

The  $Q_1$  common pilot patterns,  $Q_2$  cell-specific pilot patterns, and traffic data are inserted onto subcarriers of an OFDM symbol that are transmitted in a same time slot. For instance the  $Q_1$  and  $Q_2$  pilots and traffic data are transmitted in an OFDM symbol in a traffic slot 20, as shown in Figure 1 below. EX1038, ¶115; *see also* EX1004, 12:2-10. Kim explains that the pilot patterns shown in Figure 10 are implemented in a downlink signal “having the same structure as that of FIG. 1.” EX1004, 25:6-9. Thus, the claimed *second plurality of subcarriers* comprises the subcarriers on which the  $Q_1$  common pilot patterns are inserted and also the subcarriers on which the traffic data is inserted—*e.g.*, the symbol highlighted below and including the white cells (traffic) and purple cells ( $Q_1$  common pilot patterns). EX1038, ¶115.



EX1004, FIG. 1 (annotated).

The  $Q_1$  pilot patterns used in common by all the cells are a different type of pilot from the  $Q_2$  pilot patterns that are specific to each cell because the  $Q_1$  common patterns are used to “estimate slot synchronization” and the  $Q_2$  specific patterns are used “to search the cells.” EX1004, 25:3-5, 25:18-26:7; EX1038, ¶¶116-118. Thus, the  $Q_1$  and  $Q_2$  pilot patterns are different types because they represent different types of information and are designed and used for different functions. *Id.*

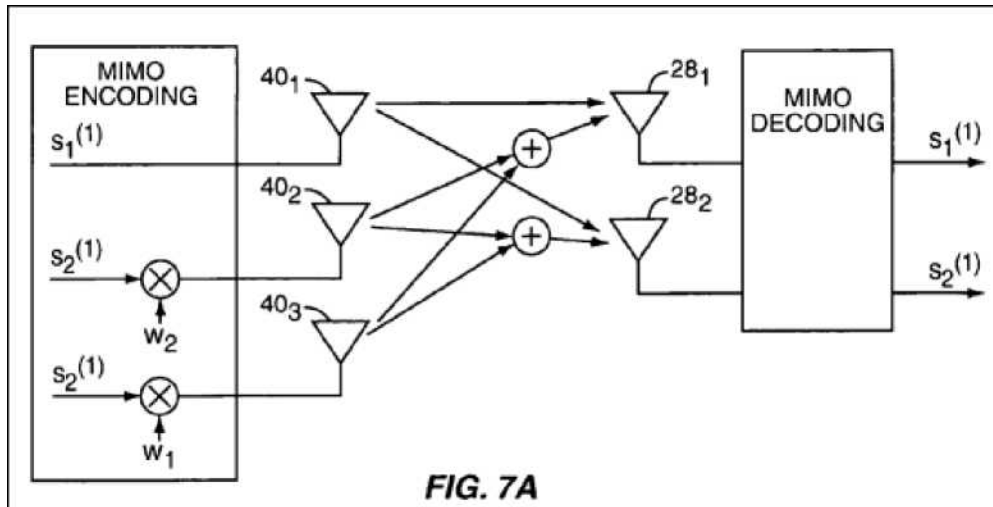
Therefore, a POSA would have understood that Kim’s transmitter is

configured to *insert data and second pilots of a second type onto a second plurality of subcarriers*. *Id.*, ¶¶112-118.

- (e) **[1.4] wherein at least some subcarriers of the first plurality of subcarriers or the second plurality of subcarriers are beam-formed; and**

The combination of Kim and Tong renders obvious this element. *Id.*, ¶¶119-121. As explained above, Kim's base-station inserts the  $Q_1$  and  $Q_2$  pilot patterns onto the first and second pluralities of subcarriers. However, Kim does not expressly disclose that at least some of these subcarriers are *beam-formed*. But Tong discloses this limitation.

Tong discloses a "wireless communication system" that allows a base station "to select N antennas from an associated group of M antennas for transmitting multiple streams of data to a given user." EX1005, Abstract. The base station 14's transmit antennas can transmit the data and pilot signals via beam-forming by "transmitting the same data simultaneously from multiple transmit antennas.. .to allow the energy of the multiple transmitted signals to combine in the channel in a constructive fashion to provide additional gain." *Id.*, 8:50-66. For instance, the system shown in Figure 7A implements beam-forming such that "data transmitted from transmit antennas 40 2 and 40 3 combine during transmission to effectively reinforce each other and provide a stronger signal at the receiver." *Id.*, 11:60-12:4.

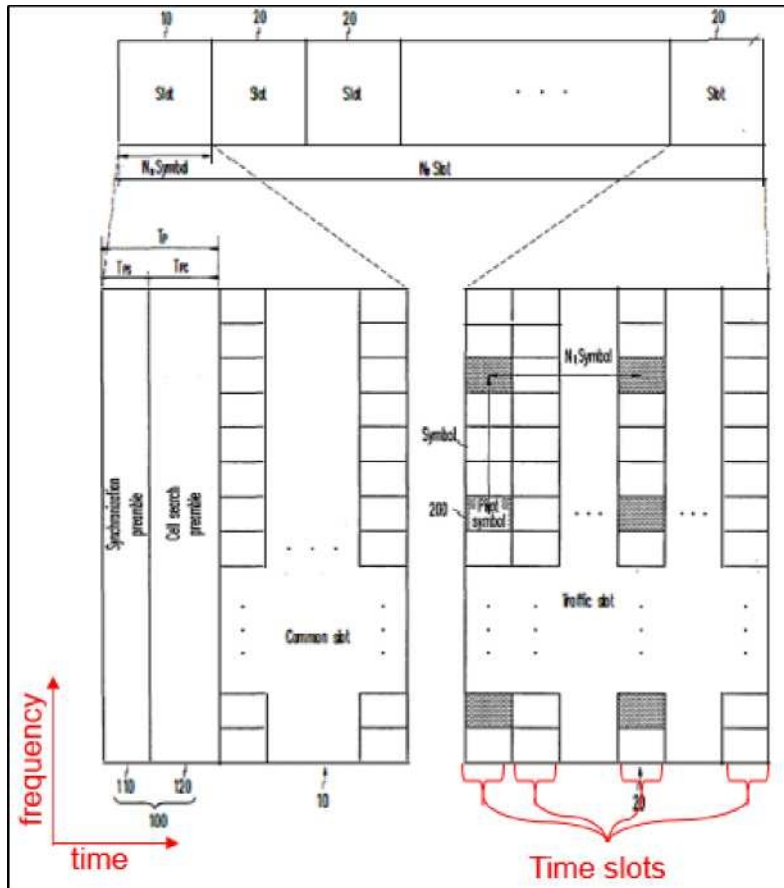


EX1005, FIG. 7A.

A POSA would have been motivated to implement beamforming, as taught by Tong, in Kim's OFDMA-based cellular system with a reasonable expectation of success for the reasons provided in §VIII.A.1. EX1038, ¶121.

- (f) [1.5] the plurality of antennas configured to transmit the first plurality of subcarriers and the second plurality of subcarriers in at least one of the time slots;**

As explained for element [1.P], Kim's base station uses *subcarriers in a frequency domain and time slots in a time domain*. Specifically, Kim's transmit antennas *transmit the first plurality of subcarriers and the second plurality of subcarriers in at least one of the time slots*. For instance, as shown in Figure 1, the traffic slot 20 maps traffic data (white cells) and pilot symbols (gray cells) to different time slots on the time axis. EX1004 12:4-12 (the traffic slot 20 includes symbols "given with respect to the time axis and the frequency axis").

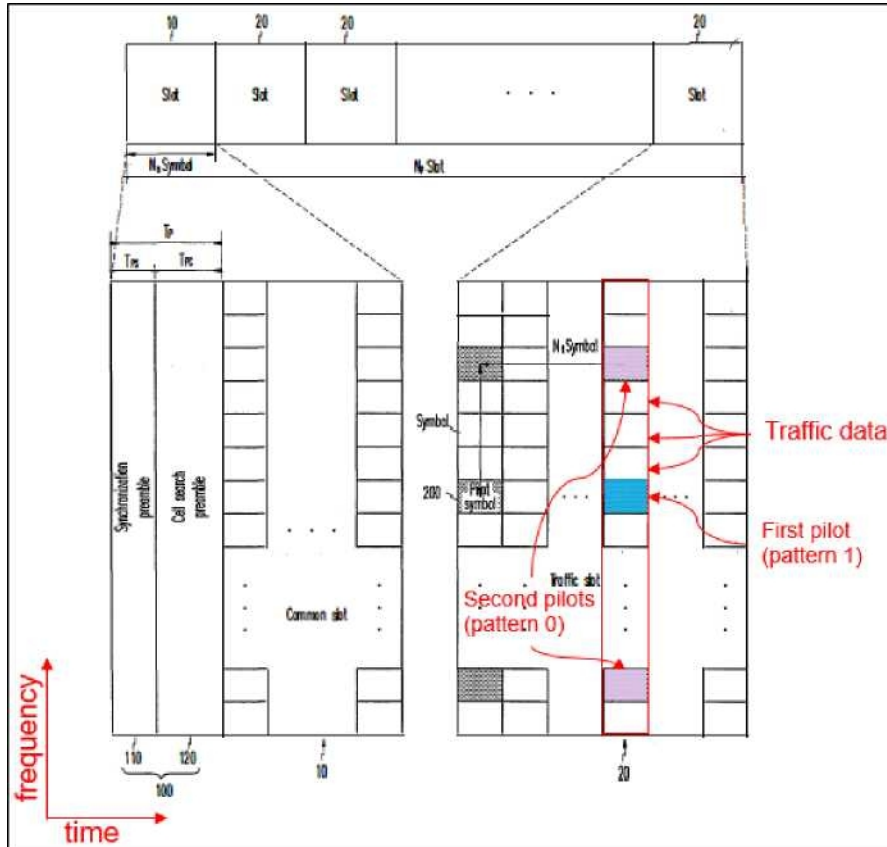


EX1004, FIG. 1 (annotated).

A POSA would have understood that each cell in the traffic slot 20 shown in Figure 1 represents a time slot on the time axis and a subcarrier on the frequency axis. EX1038, ¶¶122-124. The downlink signal configuring device 2100 “receives... pilot subcarrier group-transmit antenna mapping information. and transmit traffic data,” and maps the data and pilots “according to the time, frequency, and antenna, and outputs mapped results to the OFDM transmitter 2101 per transmit antenna 2102.” EX1004, 46:11-16.

As also explained for element [1.3], the first and second plurality of subcarriers are implemented within a single OFDM symbol, and transmitted in a

single time slot. This is shown in the below annotations of Figure 1. EX1038, ¶¶125-126. Kim also explains that “the pilot pattern shown in Figure 10 is used in common for all the antennas” and transmitted on all the antennas. EX1004, 31:10- 16; 58:12-14.



EX1004, FIG. 1 (annotated).

- (g) [1.6] wherein the second type is different than the first type and wherein the first pilots do not interfere with the second pilots.

The  $Q_1$  pilot patterns (*second type*) are different than the  $Q_2$  pilot patterns (*first type*) because the  $Q_1$  pilot patterns are common to all the cells, and the  $Q_2$  pilot patterns are specific to each cell. EX1038, ¶¶127-128. Further, as explained for

element [1.3], the Q<sub>1</sub> common patterns are used to “estimate slot synchronization” and the Q<sub>2</sub> cell-specific patterns are used “to search the cells.” EX1004, 25:3-5, 25:18-26:7. Thus, the Q<sub>1</sub> and Q<sub>2</sub> pilot patterns are different types because they represent different types of information and are designed and used for different functions. EX1038, ¶127.

A POSA would have understood that the Q<sub>1</sub> common patterns do not interfere with the Q<sub>2</sub> cell-specific patterns because the respective patterns are inserted on different, orthogonal subcarriers in the OFDM symbol. *Id.*, ¶128. As Mr. McNair explains, different subcarriers in an OFDM symbol do not interfere with each other because they are spaced orthogonally, thereby creating signal nulls in the adjacent subcarrier frequencies and preventing inter-carrier interference. *Id.*

### **3. Independent Claim 8**

- (a) [8.P] A method performed by an orthogonal frequency division multiple access (OFDMA)- compatible base station that uses subcarriers in a frequency domain and time slots in a time domain, the method comprising:**

To the extent limiting, Kim teaches the preamble for the reasons provided for element [1.P]. Indeed, as explained for claim 1 and below for claim 8, Kim’s base station performs the claimed method. *Id.*, ¶130.

- (b) [8.1] inserting, by the OFDMA-compatible base station, first pilots of a first type onto a first plurality of subcarriers, wherein the first pilots are cell-specific pilots;**



Kim teaches element [8.1] for the reasons provided for element [1.2]. *Id.*,

¶131.

- (c) **[8.2] inserting, by the OFDMA-compatible base station, data and second pilots of a second type onto a second plurality of subcarriers;**

Kim teaches element [8.2] for the reasons provided for element [1.3]. *Id.*,

¶132.

- (d) **[8.3] wherein at least some subcarriers of the first plurality of subcarriers or the second plurality of subcarriers are beam-formed; and**

Kim-Tong teaches element [8.3] for the reasons provided for element [1.4].

*Id.*, ¶133.

- (e) **[8.4] transmitting, by the OFDMA-compatible base station, the first plurality of subcarriers and the second plurality of subcarriers in at least one of the time slots using a plurality of antennas;**

Kim teaches element [8.4] for the reasons provided for element [1.5]. *Id.*,

¶134.

- (f) **[8.5] wherein the second type is different than the first type and wherein the first pilots do not interfere with the second pilots.**

Kim teaches element [8.5] for the reasons provided for element [1.6]. *Id.*,

¶135.

#### 4. Independent Claim 15

- (a) **[15.P] An orthogonal frequency division multiple access (OFDMA)-compatible mobile station that uses subcarriers in a frequency domain and time slots in a time domain, the OFDMA-compatible mobile station comprising:**

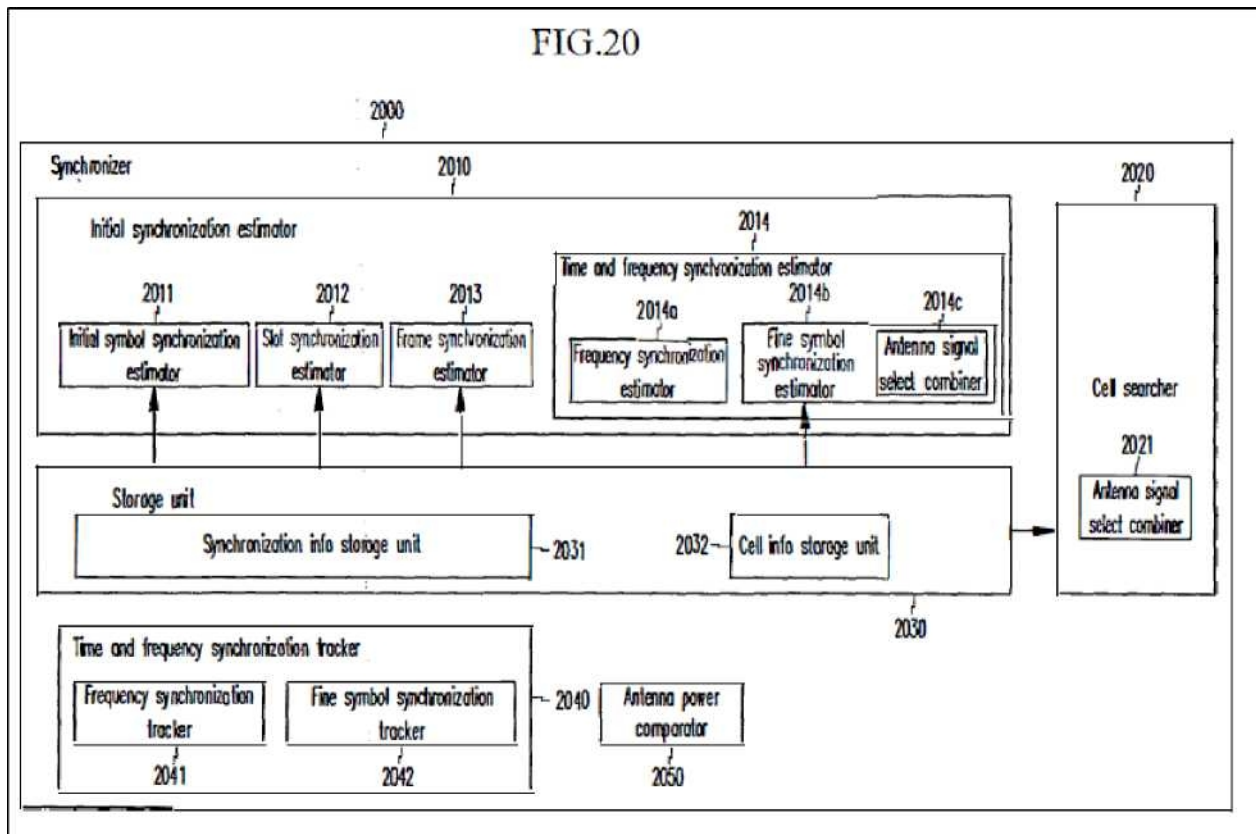
To the extent limiting, Kim discloses the preamble. *Id.*, ¶¶137-138. Kim discloses “an OFDMA-based mobile communication system” that includes a “terminal” (i.e., *mobile station*) configured “to read signals of [the] base station.” EX1004, 1:23-25, 45:21-46:1; *see also* Abstract, FIG. 20.

Kim’s terminal uses subcarriers in a frequency domain and time slots in a time domain for the reasons provided above for element [1.P]. Indeed, Kim’s terminal receives the OFDM symbols provided on the downlink by the base station. *Id.*, 38:23-39:4; *see also* 1:23-2:3 (the terminal “read[s] signals of a base station and synchronize[s] its time and frequency with the terminal for initial synchronization, and search[es] cells in a cellular system”); EX1038, ¶138.

- (b) **[15.1] at least one antenna; and a receiver; and**

Kim’s terminal includes “at least one receive antenna.” EX1004, 38:23-39:4; *see also* 1:23-25, 45:9-16. Kim’s terminal also includes a *receiver* comprising a synchronizer 2000 and that receives an “OFDM transmit signal.” *Id.*, 43:9-45:20; *see also* 14:14-16, 27:19-23. For instance, the synchronizer is configured to perform slot synchronization using “a pattern of a pilot in common for each cell,” and to perform cell searching using a pilot pattern “specific to each cell.” *Id.*, 43:16-44:10;

EX1038, ¶139.



EX1004, FIG. 20.

- (c) [15.2] the at least one antenna and the receiver are configured to: receive first pilots of a first type on a first plurality of subcarriers, wherein the first pilots are cell-specific pilots; and

Kim's at least one receive antenna and synchronizer receive the OFDM downlink signal. EX1004, 11:15-17, 14:14-16, 38:23-39:4. The downlink signal includes *first pilots of a first type on a first plurality of subcarriers, wherein the first pilots are cell-specific pilots* for the reasons provided above for element [1.2]. A POSA would have understood that Kim's terminal thus receives such *cell-specific pilots* on the *first plurality of subcarriers* via the antennas and receiver. See *id.*,

38:23-39:4; EX1038, ¶140.

- (d) **[15.3] receive second pilots of a second type and data on a second plurality of subcarriers, wherein the first plurality of subcarriers and the second plurality of subcarriers are received in at least one of the time slots;**

Kim's at least one receive antenna and receiver receive the OFDM downlink signal. *E.g.*, EX1004, 11:15-17, 14:14-16, 38:23-39:4. The downlink signal includes *second pilots of a second type and data on a second plurality of subcarriers* for the reasons provided above for element [1.3]. A POSA would have understood that Kim's terminal thus receives such *second pilots of a second type and data* on the *second plurality of subcarriers* via the antennas and receiver. *See id.*, 38:23-39:4. *The first plurality of subcarriers and the second plurality of subcarriers are received in at least one of the time slots* for the reasons provided above for elements [1.3] and [1.5]. EX1038, ¶141.

- (e) **[15.4] wherein at least some subcarriers of the first plurality of subcarriers or the second plurality of subcarriers are beam-formed; and**

Kim-Tong teaches this element for the reasons provided for element [1.4]. *Id.*, ¶142.

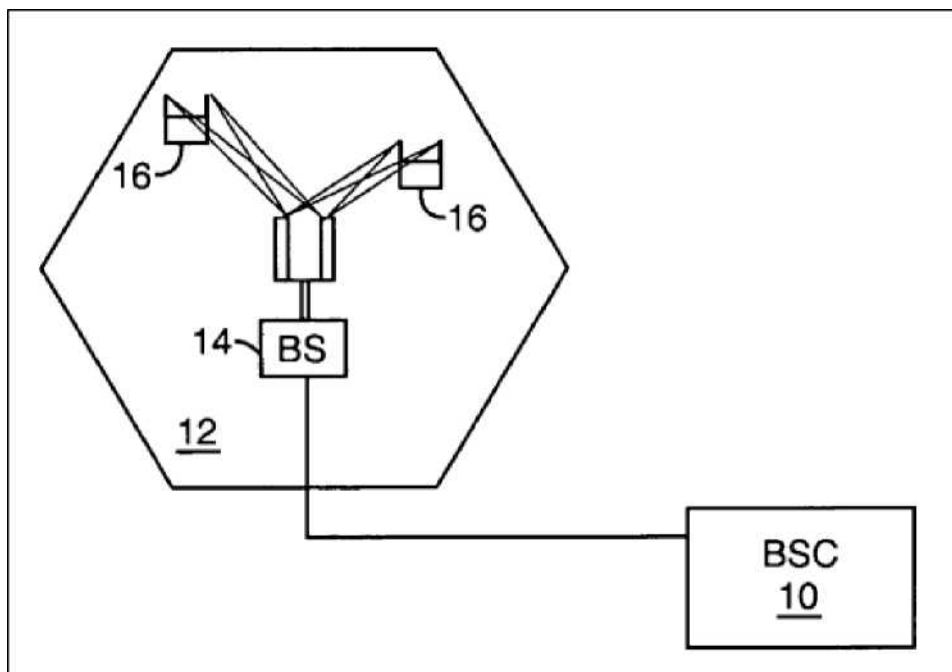
- (f) **[15.5] the receiver is further configured to: recover the data using channel estimates from at least the second pilots; and**

As explained for element [1.3], Kim's Q1 patterns that are "used in common by all the cells" are the claimed *second pilots of a second type*. Kim's terminal is

configured to perform “slot synchronization” using the  $Q_1$  pilots. EX1004, 24:20-25:5. A POSA would have understood that the “slot synchronization” provides an estimate of the channel between the base station and mobile terminal. EX1038, ¶143. As Mr. McNair explains, once the slots are synchronized using the  $Q_1$  pilots, the receiver is able to determine the positions of the data symbols within the slots. *Id.* These positions become the precise timing for the data symbols, which lead to recovery of the data. *Id.*

To the extent Kim does not expressly disclose that the receiver is further configured to: recover the data using channel estimates from at least the second pilots, Tong discloses this limitation. EX1038, ¶¶144-147.

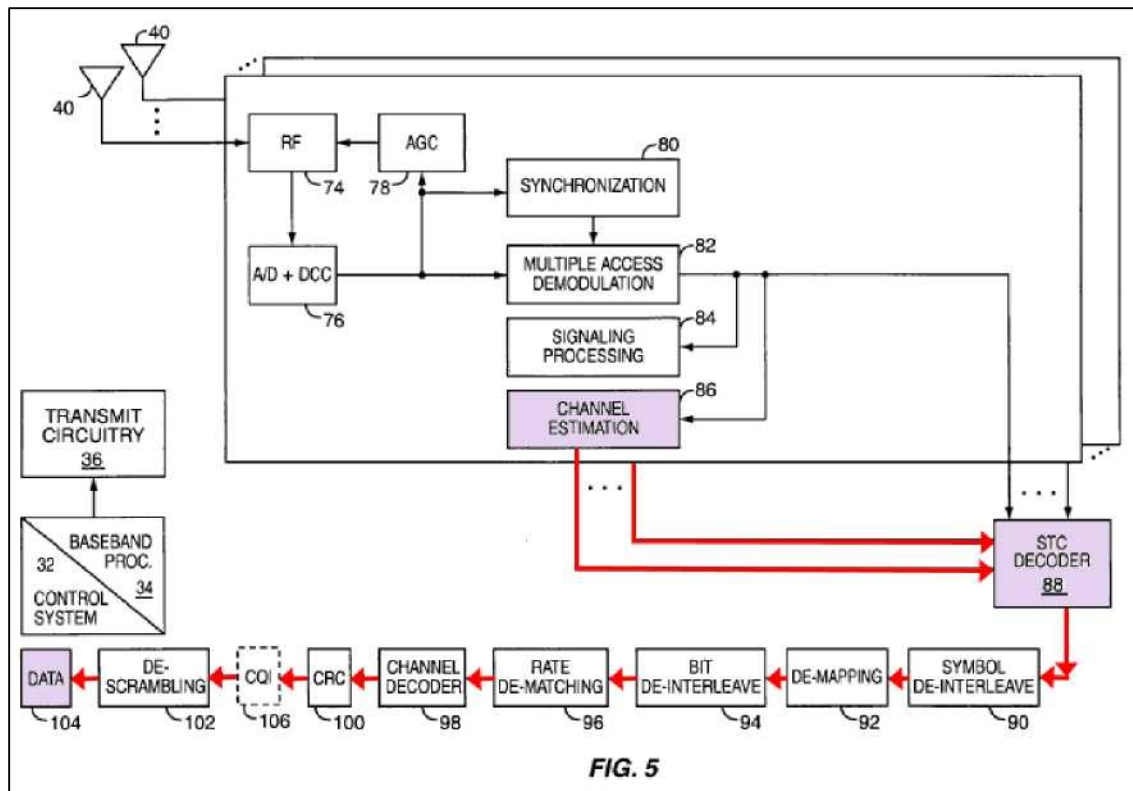
Tong discloses a cellular system that includes a base station 14 that transmits “downlink” signals to user elements 16 that are located within the cell 12 corresponding to the base station 14. EX1005, 3:19-31, 4:44-55, FIG. 1.



EX1005, FIG. 1 (excerpt).

In the downlink signal, the base station 14 transmits to the user element 16 “data” and “pilot signals... known by the intended user element 16.” *Id.*, 5:67-6:1, *see also* 3:60-4:6. “The user element...use[s] the pilot signals for channel estimation.” *Id.*, 6:2-5. The user element uses the channel estimate “to recover the originally transmitted data” in the downlink signal. *Id.*, 6:53-58.

To implement channel estimation for data recovery, the user element 16 includes a “channel estimation function 86” that “provides channel responses corresponding to channel conditions” of the received downlink signal “to allow the STC decoder 88 to decode the symbols.” *Id.*, 6:33-35, 6:39-42, FIG. 5. The decoded symbols are provided on a “receive path” that ends with “de-scrambling logic 102” to “recover the originally transmitted data 104.” *Id.*, 6:35-39, 6:43-58.



EX1005, FIG. 5 (annotated).

A POSA would have been motivated to combine Kim and Tong so that Kim's mobile terminals use channel estimates from the  $Q_1$  pilot patterns to recover the data provided in Kim's downlink signal traffic slot for the reasons provided in §VIII.A.1(b). EX1038, ¶¶145-148.

**(g) [15.6] recover cell-specific information using the cell-specific pilots;**

As explained for element [1.2], Kim's  $Q_2$  pilot patterns are the claimed *cell-specific pilots*. These pilots implement a "specific pattern for each cell," and "are used to search the cells." EX1004, 26:3-7. Specifically, Kim's terminal uses the  $Q_2$  pilots to "obtain [] cell information" (*cell-specific information*), and thereby identify the cell/base station that provided the downlink signal. *Id.*, 2:18-3:9. Specifically, to

search the cells, the terminal determines a “cell number” associated with the cell that transmitted the downlink signal. *Id.*, 41:2-5, *see also* 46:7-10, FIG. 18; EX1038, ¶149.

- (h) **[15.7] wherein the second type is different than the first type and wherein the first pilots do not interfere with the second pilots.**

Kim teaches this element for the reasons provided above for element [1.6]. EX1038, ¶150.

## **5. Independent Claim 23**

- (a) **[23.P] A method performed by an orthogonal frequency division multiple access (OFDMA)-compatible mobile station that uses subcarriers in a frequency domain and time slots in a time domain, the method comprising:**

To the extent limiting, Kim teaches the preamble for the reasons provided for element [15.P]. *Id.*, ¶152.

- (b) **[23.1] receiving first pilots of a first type on a first plurality of subcarriers, wherein the first pilots are cell-specific pilots;**

Kim teaches this element for the reasons provided for element [15.2]. *Id.*, ¶153.

- (c) **[23.2] receiving second pilots of a second type and data on a second plurality of subcarriers, wherein the first plurality of subcarriers and the second plurality of subcarriers are received in at least one of the time slots;**

Kim teaches this element for the reasons provided above for element [15.3].



*Id.*, ¶154.

- (d) **[23.3] wherein at least some subcarriers of the first plurality of subcarriers or the second plurality of subcarriers are beam-formed;**

Kim-Tong teaches this element for the reasons provided for element [15.4].

*Id.*, ¶155.

- (e) **[23.4] recovering the data using channel estimates from at least the second pilots; and**

Kim-Tong teaches this element for the reasons provided for element [15.5].

*Id.*, ¶156.

- (f) **[23.5] recovering cell-specific information using the cell-specific pilots;**

Kim teaches this element for the reasons provided above for element [15.6].

*Id.*, ¶157.

- (g) **[23.6] wherein the second type is different than the first type and wherein the first pilots do not interfere with the second pilots.**

Kim teaches this element for the reasons provided above for element [15.7].

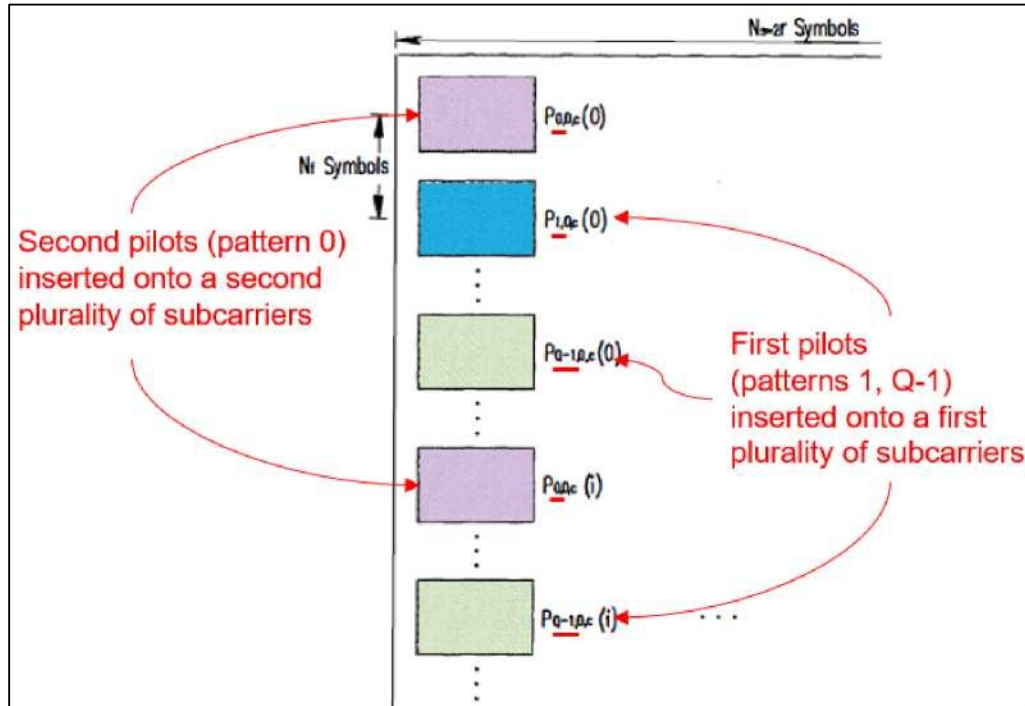
*Id.*, ¶158.

## **6. Claims 2, 9, 16, and 24**

Claims 2, 9, 16, and 24 recite, “*wherein all subcarriers of the first plurality of subcarriers are different than all subcarriers of the second plurality of subcarriers.*”

Kim discloses these claims. As shown in Figure 10, and as explained for elements [1.2]-[1.3] above, Kim’s downlink signal implements the Q<sub>2</sub> pilot patterns

that are specific to each cell (*first pilots*) on different subcarriers than the  $Q_1$  patterns “used in common by all the cells” (*second pilots*). Thus, all subcarriers of the *first plurality of subcarriers* are different than all subcarriers of the *second plurality of subcarriers*. *Id.*, ¶160.



EX1004, FIG. 10 (excerpt, annotated).

## 7. Claims 3, 10, 17, and 25

Claims 3, 10, 17, and 25 recite, “wherein the second plurality of subcarriers includes an  $n$ th subcarrier and an  $n+18$  subcarrier spaced apart from the  $n$ th subcarrier by 17 subcarriers and the first plurality of subcarriers includes an  $m$ th subcarrier and an  $m+20$  subcarrier spaced apart from the  $m$ th subcarrier by 19 subcarriers.”

As explained for elements [1.2]-[1.3], Kim’s base-station inserts the  $Q_2$  cell-

specific pilot patterns onto the first plurality of subcarriers, and inserts traffic data and the  $Q_1$  common pilot patterns onto a second plurality of subcarriers. Although Kim does not expressly disclose that *the second plurality of subcarriers includes an  $n$ th subcarrier and an  $n+18$  subcarrier spaced apart from the  $n$ th subcarrier by 17 subcarriers and the first plurality of subcarriers includes an  $m$ th subcarrier and an  $m+20$  subcarrier spaced apart from the  $m$ th subcarrier by 19 subcarriers*, a POSA would have found it obvious to implement the subcarriers in this claimed manner as an obvious design choice. *Id.*, ¶¶162-165.

Kim's base station inserts the pilot patterns into the downlink signal at certain pilot symbol intervals. *Nf. EX1004*, 12:6-10, 24:2-25:5, 30:22-31:16, FIGs. 9, 10, 13. Kim discloses flexibility in the placement of its pilot symbols on various subcarriers. *See id.*, FIGs. 1, 9, 10. For instance, the base station generates different pilot patterns based on characteristics of the respective cells, such as "cell number information." *EX1004*, 46:2-7.

As Mr. McNair explains, a POSA would have been motivated to optimize the particular pilot patterns on the downlink signal because "pilot symbols... should be as few in number as possible in order to maximize the transmission rate of data symbols." *EX1038*, ¶164; *EX1008*, 2:15-17; *see also EX1009*, Tufvesson, Abstract, 1639. A POSA would have sought to configure the Kim-Tong pilot patterns to reduce "overhead" while still "enabl[ing] reliable channel estimates." *EX1009*,

1639; EX1038, ¶¶164-165.

And in doing so, a POSA would have found it obvious to position the pilot patterns such that *the second plurality of subcarriers includes an  $n$ th subcarrier and an  $n+18$  subcarrier spaced apart from the  $n$ th subcarrier by 17 subcarriers and the first plurality of subcarriers includes an  $m$ th subcarrier and an  $m+20$  subcarrier spaced apart from the  $m$ th subcarrier by 19 subcarriers*. EX1038, ¶¶164-165. Mr. McNair explains that this implementation would merely be a matter of routine experimentation that would not find unreasonable technical barriers. *Id.*; *see also E.I. DuPont de Nemours & Co. v. Synvina C.V.*, 904 F.3d 996, 1006 (Fed. Cir. 2018) (“where the general conditions of a claim are disclosed in the prior art, it is not inventive to discover the optimum or workable ranges by routine experimentation”). Indeed, the ’512 patent does not place any criticality on the claimed pilot arrangement, merely depicting such arrangement, without explanation, in the example shown in Figure 5. The mere arrangement of pilot subcarriers, without more, is not inventive. EX1038, ¶165.

## **8. Claims 4, 11, 18, and 26**

Claims 4, 11, 18, and 26 recite “*wherein each cell-specific pilot of the cell-specific pilots is unique to a respective cell.*”

As explained for element [1.2], each  $Q_2$  pilot pattern (*cell-specific pilot*) is “a specific pattern for each cell.” EX1004, 26:3-7. Thus, each cell-specific pilot of the

cell-specific pilots is unique to a respective cell. EX1038, ¶167.

### 9. Claims 5, 12, 21, and 29

Claims 5, 12, 21, and 29 recite “*wherein the first plurality of subcarriers are not aligned in frequency with subcarriers of at least another cell onto which respective cell-specific pilots are inserted.*”

Kim discloses that “the positions of the pilot symbols of antennas for the respective adjacent cells” can be differentiated. EX1004, 32:3-7. For instance, Kim discloses that “subcarrier group numbers (group 0 to group 3) represent positions of the subcarriers for transmitting predefined pilot symbols so as to transmit pilot symbols of an antenna.” *Id.*, 32:12-15. As shown in Table 1 below, the pilot symbols for adjacent cells (e.g., Cell C and Cell D) are transmitted on different subcarrier groups (for each antenna). Thus, these subcarriers are not aligned in frequency with subcarriers of at least another cell onto which respective cell-specific pilots are inserted. EX1038, ¶169.

	Antenna 0	Antenna 1	Antenna 2	Antenna 3
Cell A	Group 0	Group 1	Group 2	Group 3
Cell B	Group 0	Group 2	Group 3	Group 1
Cell C	Group 3	Group 0	Group 2	Group 1
Cell D	Group 1	Group 2	Group 0	Group 3
Cell E	Group 3	Group 1	Group 0	Group 2
Cell F	Group 2	Group 3	Group 0	Group 1

EX1004, Table 1.

#### **10. Claims 6, 13, 20, and 28**

Claims 6, 13, 20, and 28 recite “*wherein the second plurality of subcarriers are beam-formed.*”

The combination of Kim and Tong renders obvious these claims for the reasons provided for element [1.4]. A POSA would have been motivated to beam-form the second plurality of subcarriers for the same reasons as provided for element [1.4]. EX1038, ¶171. A POSA would have understood that the advantages described for element [1.4] would apply to the beam-forming the second plurality of subcarriers. *Id.*

#### **11. Claims 7 and 14**

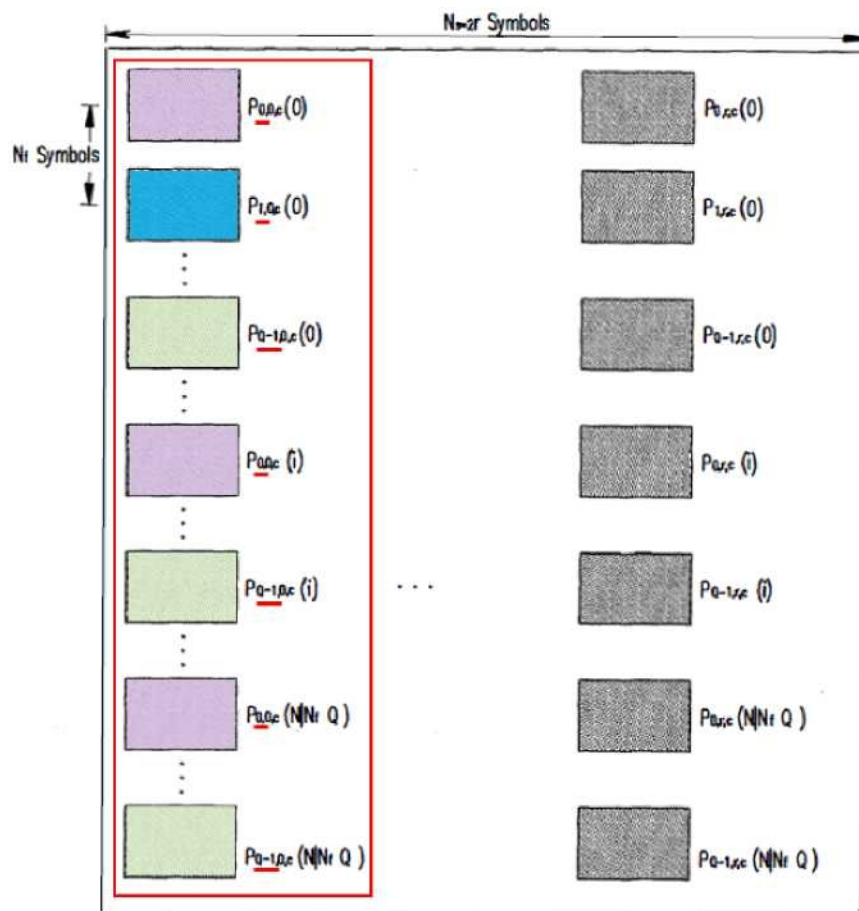
Claims 7 and 14 recite “*wherein the cell-specific pilots are used to convey cell-specific information.*”

As explained for element [15.6], Kim’s Q2 pilot patterns (i.e., *cell-specific pilots*) are used by the terminal to “obtain [] cell information,” (*cell-specific information*) and thereby identify the cell/base station that provided the downlink signal. EX1004, 2:18-3:9. The cell information includes a “cell number” associated with the cell that transmitted the downlink signal. *Id.*, 41:2-5, *see also* 46:7-10, FIG. 18; EX1038, ¶173.

#### **12. Claims 19 and 27**

Claims 19 and 27 recite “*wherein the first plurality of subcarriers are transmitted at a same time as the second plurality of subcarriers.*”

As explained for elements [1.2]-[1.3], the first and second plurality of subcarriers are transmitted within the same OFDM symbol. These subcarriers within the OFDM symbols are transmitted at the same time within the same slot on the time axis. EX1004, 12:6-10, 24:2-8, 24:20-25:5, FIGs. 9-10; EX1038, ¶175.



EX1004, FIG. 10 (annotated, excerpt).

### 13. Claims 22 and 30

Claims 22 and 30 recite “*extract[ing] cell-specific information from the cell-specific pilots.*”

As explained for element [15.6] and claims 7 and 14, Kim’s  $Q_2$  pilot patterns (i.e., *cell-specific pilots*) are used to convey a “cell number” (*cell-specific*

information) associated with the cell that transmitted the downlink signal. EX1004, 41:2-5, *see also* 46:7-10, FIG. 18. Upon receiving these pilot patterns, Kim's terminal extracts the cell number from the signal for cell-searching. *Id.*, 35:6-8, 41:2-5; EX1038, ¶177.

**B. Ground 2: The combination of Ketchum and Li renders obvious claims 1, 3, 4, 6-8, 10, 11, 13-15, 17, 18, 20, 22, 23, 25, 26, 28, and 30**

**1. A POSA would have been motivated to combine Ketchum and Li**

A POSA would have been motivated to modify Ketchum's system to handle cellular communications, and to include OFDMA-compatible base stations (access points) and mobile stations, as taught by Li. EX1038, ¶¶179-186.

Ketchum's system is a "multiple-access" MIMO-OFDM system "that supports a number of users." EX1006, ¶26. But Ketchum does not expressly disclose how its system implements the multiple-access communications. A POSA would have thus sought references for implementing multiple-access communication techniques that leverage OFDM. EX1038, ¶¶179-181. Li is such a reference.

Li discloses a cellular communication system that communicates using OFDMA techniques. EX1007, ¶¶19, 28. Like Ketchum's system, Li's OFDMA-compatible system implements carriers "containing multiple OFDM frequency subcarriers." *Id.*, ¶19. A POSA would have sought to implement the "multiple-access" aspects of Ketchum's system using OFDMA techniques, as taught by Li.



EX1038, ¶181. As Mr. McNair explains, “OFDMA is a logical extension of OFDM” that utilizes OFDM in communicating with multiple users (i.e., multiple-access). *Id.* Specifically, OFDMA divides a communication channel into orthogonal subchannels or subcarriers using OFDM techniques. EX1015, 307; EX1016, Jalali, 1:16-34. OFDMA then extends OFDM to implement multiple-access by assigning subsets of the orthogonal sub-carriers to individual subscriber devices. EX1015, 307. And because OFDMA was one of a finite number of identified, predictable solutions for implementing multiple-access in an OFDM system (e.g., multicarrier CDMA, OFDM with TDMA, OFDMA, etc.), a POSA would have found it obvious to implement OFDMA in Ketchum’s system, as explicitly taught by Li. EX1038, ¶¶180-181; EX1015, 305.

A POSA would have further been motivated to implement Ketchum’s system as a cellular system, as taught by Li, such that Ketchum’s base stations are implemented to communicate within respective coverage areas, or cells. EX1038, ¶182. Ketchum does not limit its “wireless communication system” to a particular type of system. *See* EX1006, ¶6, 26. For instance, Ketchum refers to its access points 110 as “base stations,” which is a term commonly associated with cellular systems. EX1006, ¶26; *see also e.g.*, EX1009, 1641. Ketchum’s base station also communicates within a particular “coverage area,” such as a cell. EX1006, ¶32. Further, as explained by Mr. McNair, OFDMA cellular systems were well-known in

the art. EX1038, ¶182.

Thus, in the combined system, each of Ketchum's base stations would communicate using OFDMA within respective cells, as taught by the combination of Ketchum and Li. *See* EX1006, ¶32; EX1007, ¶¶19, 28. Each of Ketchum-Li's base stations would periodically broadcast pilots (e.g., beacon pilots, steered reference pilots, etc.) to every subscriber within its cell, as taught by the combination of Ketchum and Li. EX 1003, ¶183; EX1007, ¶28; EX1006, ¶217.

A POSA would have been further motivated to combine Ketchum and Li because both are in the same general field of wireless communications, and address the same problem—implementing multiple access OFDM communication between base stations and mobile terminals. EX1038, ¶184. Accordingly, a POSA would have had a reasonable expectation of success in implementing Ketchum's system as a cellular, OFDMA compatible system, as taught by Li. *Id.*, ¶¶184-185. As Mr. McNair explains, because Ketchum and Li both utilize the same general framework (e.g., OFDM), teaching from one can be implemented in the other with relative ease. *Id.*

Thus, because OFDMA and cellular communication techniques were well-known and compatible with Ketchum's system, a POSA would not have experienced any unreasonable technical hurdles in implementing these modifications. *Id.*, ¶¶185-186. In this manner, a POSA would have understood that modifying Ketchum's

system for cellular OFDMA communications would merely amount to combining prior art elements (Ketchum's multiple-access MIMO system and Li's OFDMA-based cellular system) according to known methods (implementing Ketchum's system using OFDMA communication techniques) to yield predictable results (e.g., an OFDMA-compatible cellular communication system). *Id.*

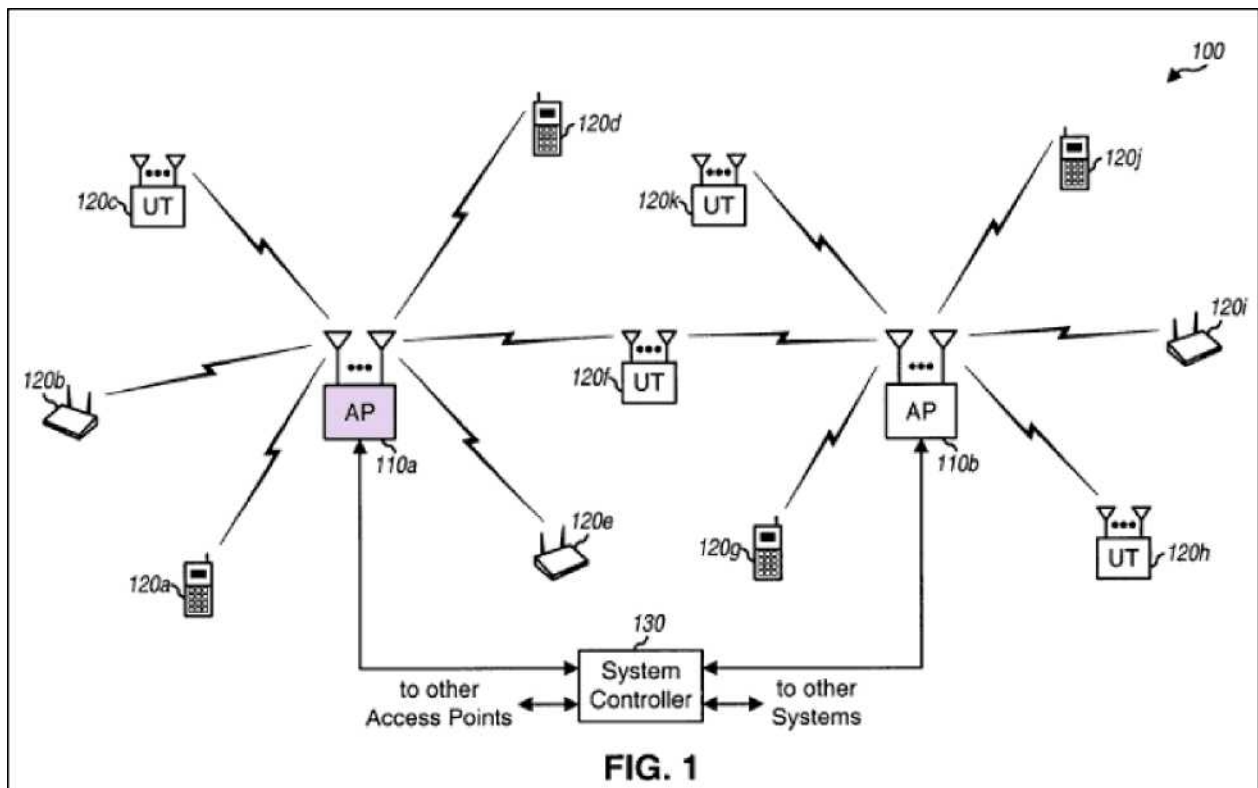
## 2. Independent Claim 1.

- (a) **[1.P]: An orthogonal frequency division multiple access (OFDMA)-compatible base station that uses subcarriers in a frequency domain and time slots in a time domain, the OFDMA-compatible base station comprising:**

To the extent limiting, Ketchum, or the combination of Ketchum and Li, teaches the preamble. *Id.*, ¶¶188-193. Ketchum discloses a “multiple-access MIMO system 100 that supports multiple users.” EX1006, ¶26. The multiple access system 100 includes access points 110 that are also referred to as “base station[s].” *Id.* The access points 110 communicate using “orthogonal frequency division multiplexing (OFDM).” *Id.*, ¶¶33, 223-224. In this manner, the access points 110 transmit OFDM symbols having data on “a number of (N F) orthogonal subbands,” each of which is “associated with a respective subcarrier upon which data may be modulated.” *Id.*, ¶¶34, 36. The OFDM symbols are sent in particular time slots in the time domain (e.g., during an “OFDM symbol period”). *Id.*, ¶36.

A POSA would have found it obvious to implement Ketchum's system to

communicate using OFDMA because there were a finite number of known techniques for implementing a *multiple-access* OFDM system, such as Ketchum's. EX1038, ¶¶189-190; EX1006, ¶¶26, 34; EX1015, 305 (disclosing "multicarrier CDMA, [OFDMA], OFDM with TDMA, OFDM with CSMA/CA, OFDM with SDMA as multiple-access techniques). As Mr. McNair explains, a POSA would have also had a reasonable expectation of success in implementing Ketchum as an OFDMA system because OFDMA is a "logical extension" of OFDM. EX1038, ¶190; EX1015, 305, 307; *see also* §VIII.B.1. In the modified system, Ketchum's base station and terminals would be OFDMA-compatible.



EX1006, FIG. 1 (annotated).

Moreover, to the extent it is argued that Ketchum's "multiple access" system

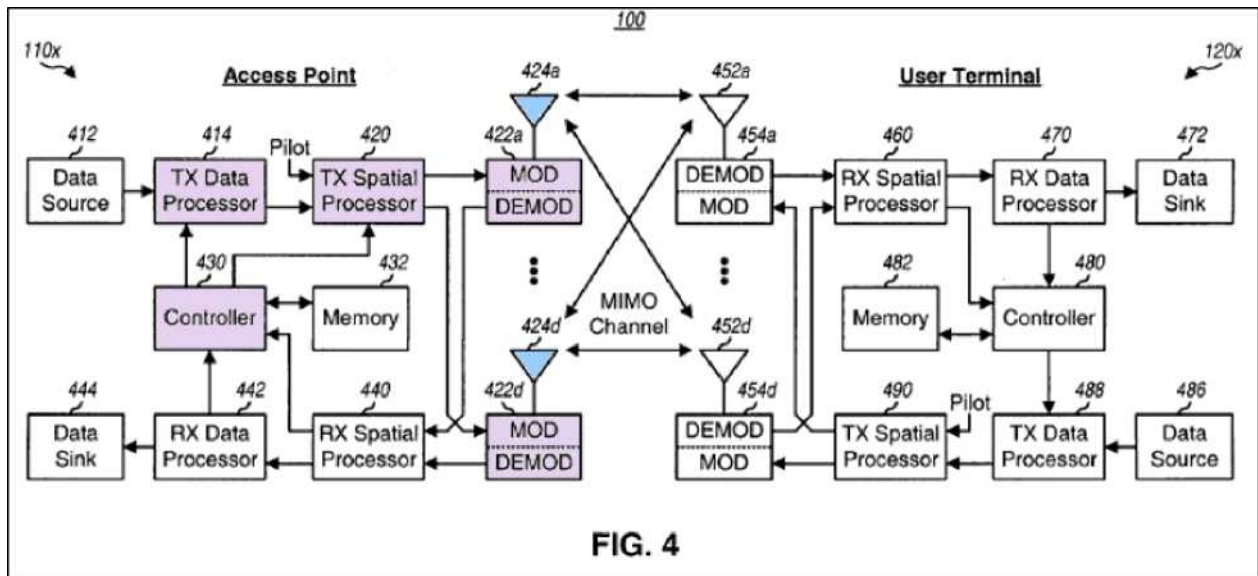
that uses OFDM does not disclose or render obvious an OFDMA-compatible base station, Li discloses this feature. EX1038, ¶¶191-193.

Li discloses a cellular communication system that communicates using OFDMA. EX1007, ¶¶19, 28. The system includes base stations that “periodically broadcast[] pilot OFDM symbols to every subscriber within its cell (or sector).” *Id.*, ¶28. Thus, Li’s base stations and subscribers (mobile stations) are OFDMA-compatible. EX1038, ¶¶192-193.

A POSA would have been motivated to modify Ketchum’s system to handle cellular communications, and to include OFDMA-compatible base stations (access points) and mobile stations, as taught by Li, for the reasons provided in §VIII.B.1. *Id.*

**(b) [1.1] a plurality of antennas; and a transmitter operably coupled to the plurality of antennas;**

Each of Ketchum’s access points (*base stations*) include “antennas 424a through 424d.” EX1006, ¶¶223, 225. The access points also include a *transmitter* that includes a “controller 430,” a “transmit (TX) data processor 414,” a “TX spatial processor 420,” and “modulators 422 a through 422 d.” *Id.*, ¶¶224-225. As shown in Figure 4, the transmitter is operably coupled to the antennas 424. *Id.*, ¶225.



EX1006, FIG. 4 (annotated).

Therefore, Ketchum discloses *a plurality of antennas and a transmitter operably coupled to the plurality of antennas*. EX1038, ¶¶194-195.

- (c) [1.2] the transmitter configured to: insert first pilots of a first type onto a first plurality of subcarriers, wherein the first pilots are cell-specific pilots; and

Ketchum's access points 110 are configured to send "various types of pilot[s]" in the downlink signal. EX1006, ¶12. The pilots "include[] a beacon pilot, a MIMO pilot, a steered reference or steered pilot, and a carrier pilot." *Id.* A POSA would have understood that the beacon pilots are the claimed *first pilots of a first type*. EX1038, ¶¶196-197.

TABLE 1	
<u>Pilot Types</u>	
Pilot Type	Description
Beacon Pilot	A pilot transmitted from all transmit antennas and used for timing and frequency acquisition.
MIMO Pilot	A pilot transmitted from all transmit antennas with different orthogonal codes and used for channel estimation.
Steered Reference or Steered Pilot	A pilot transmitted on specific eigenmodes of a MIMO channel for a specific user terminal and used for channel estimation and possibly rate control.
Carrier Pilot	A pilot used for phase tracking of a carrier signal.

EX1006, Table 1.

The beacon pilot includes a “set of pilot symbols” that are inserted onto “12 specific subbands” corresponding to a “B OFDM symbol.” EX1006, ¶39. Specifically, the access point “multiplexes the scaled pilot symbols for all subbands used for beacon pilot transmission.” EX1006, ¶231, FIG. 5. As explained above, “each subband is associated with a respective subcarrier upon which data may be modulated.” *Id.*, ¶34. A POSA would have understood that these 12 subcarriers are the claimed *first plurality of subcarriers*. EX1038, ¶197.

The beacon pilots are *cell-specific pilots*. *Id.*, 1ff198-199. The user terminal 120 uses the beacon pilot to “acquire the [] frequency and timing” of the access point that transmitted the beacon pilot. EX1006, ¶217, *see also* ¶¶12, 31, 41, 119; EX1030,

'309 Provisional, ¶1302.<sup>4</sup> For instance, Ketchum's user terminal uses the beacon pilots to determine and lock its frequency to "to the clock at the access point." EX1006, ¶42. A POSA would have thus understood that Ketchum's access points 110 are associated with a "coverage area" or cell of the access points. EX1038, ¶¶198-199; EX1006, ¶13. Because the beacon pilots are used to determine frequency and timing of the respective access points for the respective cells, the beacon pilots are *cell-specific pilots*. EX1038, ¶199. The frequency and timing of the access points are information specific to the particular access points corresponding to the respective cells. *Id.*

To the extent Ketchum does not expressly disclose or render obvious that the beacon pilots are *cell-specific*, the combination of Ketchum and Li does. *Id.*, ¶¶200-202.

Li discloses that its base stations "periodically broadcast[] pilot OFDM symbols to every subscriber within its cell (or sector)." EX1007, ¶28. The pilots are "different for different cells (or sectors)" (i.e., *cell-specific*). *Id.* The pilots "serve multiple purposes: time and frequency synchronization, channel estimation and signal-to-interference/noise (SINR) ratio measurement for cluster allocation." *Id.*

---

<sup>4</sup> Ketchum incorporates the '309 Provisional by reference "in [its] entirety for all purposes." EX1006, ¶1.



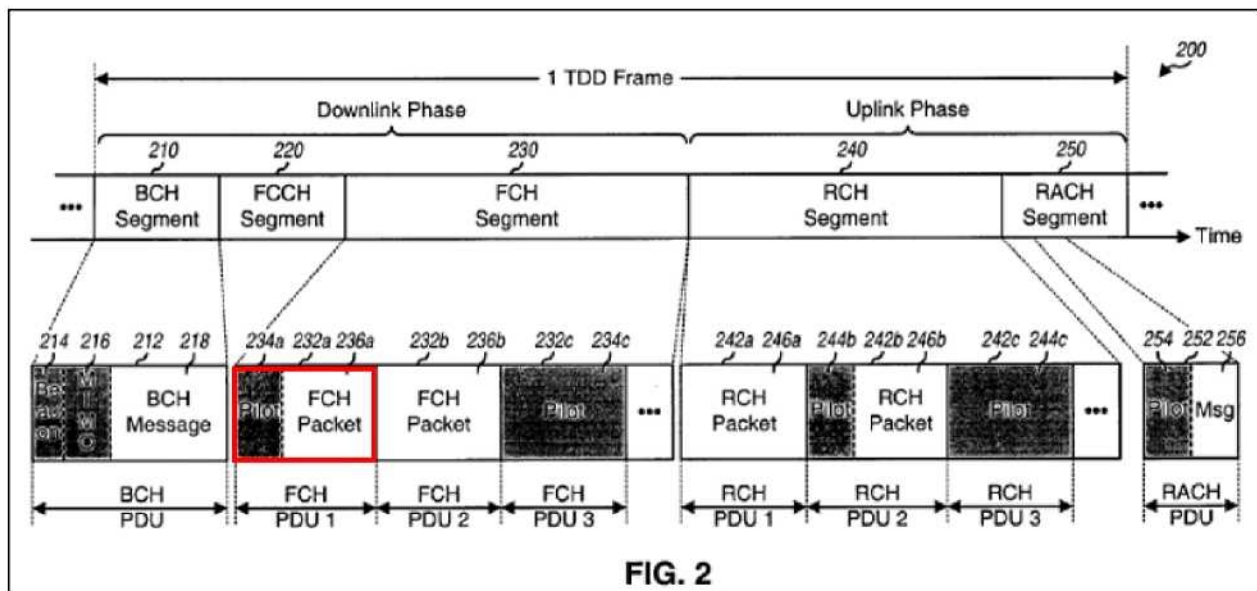
A POSA would have been motivated to implement Ketchum's communication system as a cellular system using OFDMA communication techniques, as explained above in §VIII.B.1. EX1038, ¶202. In the modified system, Ketchum's base stations would communicate cell-specific beacon pilots within respective cells to "acquire the [] frequency and timing" of the access point that transmitted the beacon pilot. *Id.*; EX1006, ¶217; *see also* ¶¶12, 31, 41, 119; EX1007, ¶28. And as explained, in the modified system, each access point represents a particular coverage area/cell. EX1038, ¶202.

**(d) [1.3] insert data and second pilots of a second type onto a second plurality of subcarriers;**

Ketchum's access point 110 also transmits steered reference pilots in the downlink signal to the user terminal. EX1006, ¶¶12-13, 30-31. The steered reference pilots are the claimed *second pilots of a second type*. EX1038, ¶203. The steered reference pilot "comprises one or more sets of pilot symbols" that are "transmitted on one set of subbands... in a given symbol period." EX1006, ¶72; *see also* ¶34 ("each subband is associated with a respective subcarrier upon which data may be modulated"). For instance, the set of pilot symbols of the steered reference pilot can be the "P OFDM symbol." *Id.*, ¶73. The steered reference pilot is thus inserted *onto a second plurality of subcarriers* associated with the set of subbands. *Id.*, ¶¶103, 238-240.

The access point 110 also inserts *data* onto the *second plurality of subcarriers*.

EX1038, ¶204. Ketchum explains that “48 subbands... may be used for data transmission.” EX1006, ¶35. As shown in Figure 2, Ketchum’s downlink signal includes a “FCH [protocol data unit] PDU 232 a” that includes “a portion 236 a for a data packet.” *Id.*, ¶101. A POSA would have understood that the FCH PDU 232 a includes data inserted on at least some of the 48 subbands that “may be used for data transmission.” *Id.*, ¶¶35, 101.



EX1006, FIG. 2 (annotated).

As also shown in Figure 2, the FCH PDU 232 a also includes “a portion 234 a for a pilot.” *Id.*, ¶101. The pilot is a steered reference pilot that, as explained, includes pilot symbols structured according to the P OFDM symbol (*second pilots*). *Id.*, ¶¶73, 103. Thus, the *second plurality of subcarriers* includes the subcarriers used for the FCH PDU 232 a to transmit the steered reference pilot as well as the subcarriers used to transmit the data. EX1038, ¶205.

A POSA would have understood that these subcarriers are a *second plurality of subcarriers* relative to *the first plurality of subcarriers* used to transmit the beacon pilot. *Id.*, ¶¶206-207. This is because beacon pilots are transmitted in a B OFDM symbol (*first plurality of subcarriers*) in “BCH protocol data unit (PDU) 212” symbol periods (as shown in Figure 2). EX1006, ¶¶101, 103. And conversely, steered reference pilots and data are transmitted in OFDM symbols (P OFDM symbols and data OFDM symbols, *second plurality of subcarriers*) in “FCH PDU[] 232” symbol periods. *Id.*, ¶¶101, 103.

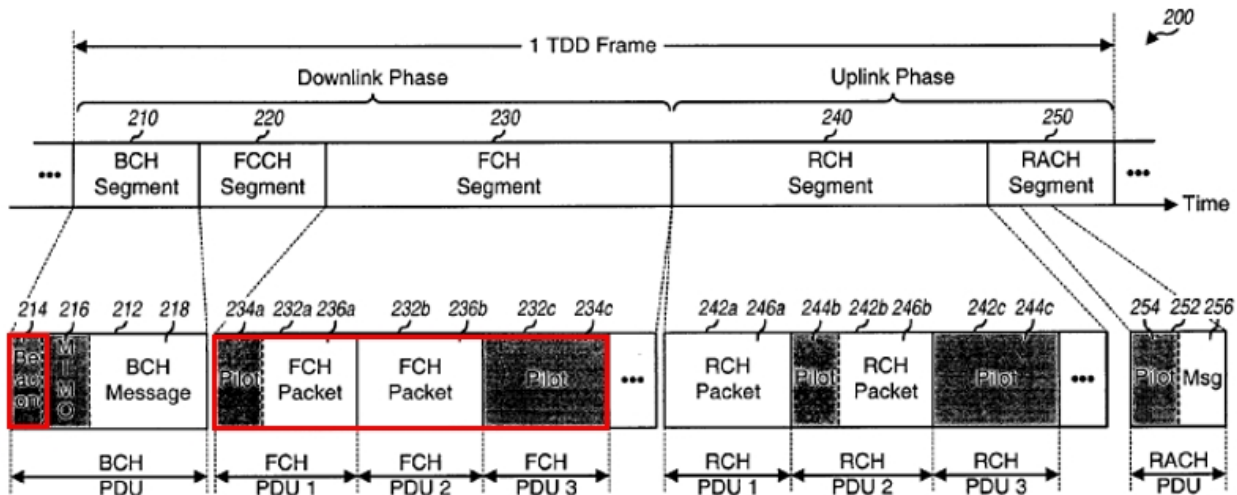


FIG. 2

EX1006, FIG. 2 (annotated).

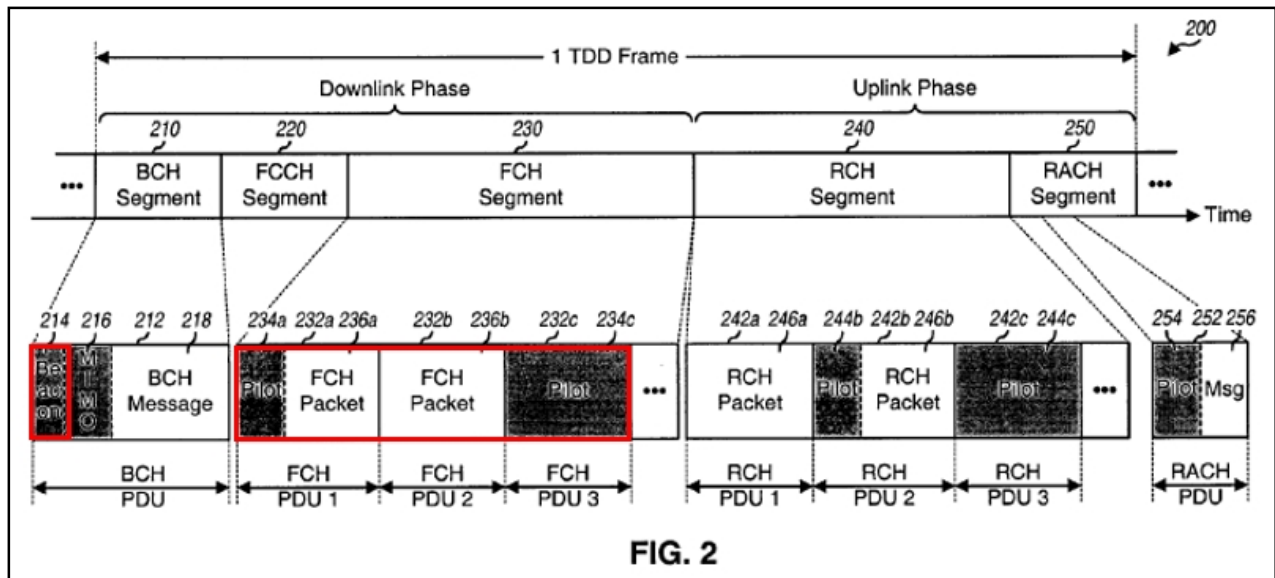
- (e) [1.4] wherein at least some subcarriers of the first plurality of subcarriers or the second plurality of subcarriers are beam-formed; and

Ketchum discloses that its steered reference pilots are transmitted “using beam-forming.” *Id.*, ¶74; *see also* ¶¶72, 147, 150, claim 61. As explained above for

element [1.3], the steered reference pilots are the claimed *second pilots of a second type* that are inserted *onto a second plurality of subcarriers*. Thus, at least some of the second plurality of subcarriers are beam-formed. EX1038, ¶208.

**(f) [1.5] the plurality of antennas configured to transmit the first plurality of subcarriers and the second plurality of subcarriers in at least one of the time slots;**

Ketchum discloses that its access point's antennas transmit the first and second plurality of subcarriers as part of the downlink signal that "spans a particular time duration." EX1006, ¶100. The downlink signal includes multiple OFDM symbols, each carrying data and/or pilots on multiple subcarriers, and sent during respective OFDM symbol periods (i.e., *time slots*) within the "time duration." *Id.*, *see also* ¶¶36, 38, 72, 120. For instance, beacon pilots are transmitted on the *first plurality of subcarriers* during "NB symbol periods designated for beacon pilot transmission," and steered reference pilots and data are transmitted on the second plurality of subcarriers during certain "given symbol period[s]." *Id.*, ¶¶38, 154. The beacon pilots, steered reference pilots, and data (i.e., first and second pluralities of subcarriers) are transmitted from each of the base station's transmit antennas. *Id.*, ¶¶38, 154, 223. As shown in Figure 2, beacon pilots are transmitted in symbol periods corresponding to transmission of a "BCH protocol data unit (PDU) 212." *Id.*, ¶¶101, 103. Steered reference pilots and data are transmitted in symbol periods corresponding to transmission of "one or more FCH PDUs 232." *Id.*; EX1038, ¶209.



EX1006, FIG. 2 (annotated).

- (g) [1.6] wherein the second type is different than the first type and wherein the first pilots do not interfere with the second pilots.

As explained for elements [1.2]-[1.3], Ketchum's beacon pilots are the *first pilots of a first type* and the steered reference pilots are the *second pilots of a second type*. The beacon pilots and steered reference pilots “may be considered as being of different types that are designed and used for different functions.” EX1006, ¶11; EX1038, ¶210.

TABLE 1	
<u>Pilot Types</u>	
Pilot Type	Description
Beacon Pilot	A pilot transmitted from all transmit antennas and used for timing and frequency acquisition.
MIMO Pilot	A pilot transmitted from all transmit antennas with different orthogonal codes and used for channel estimation.
Steered Reference or Steered Pilot	A pilot transmitted on specific eigenmodes of a MIMO channel for a specific user terminal and used for channel estimation and possibly rate control.
Carrier Pilot	A pilot used for phase tracking of a carrier signal.

EX1006, Table 1.

The beacon pilots do not interfere with the steered reference pilots because the beacon pilots are transmitted during different time periods than the steered reference pilots (as explained for elements [1.3] and [1.5]). EX1006, ¶¶38, 154; EX1038, ¶211.

### 3. Independent Claim 8

- (a) **[8.P] A method performed by an orthogonal frequency division multiple access (OFDMA)- compatible base station that uses subcarriers in a frequency domain and time slots in a time domain, the method comprising:**

To the extent limiting, Ketchum, alone or in combination with Li, teaches the preamble for the reasons provided for element [1.P]. EX1038, ¶213. Indeed, as

explained for claim 1 and below for claim 8, Ketchum or Ketchum-Li's base station performs the claimed method.

- (b) **[8.1] inserting, by the OFDMA-compatible base station, first pilots of a first type onto a first plurality of subcarriers, wherein the first pilots are cell-specific pilots;**

Ketchum or Ketchum-Li teaches element [8.1] for the reasons provided for element [1.2]. *Id.*, ¶214.

- (c) **[8.2] inserting, by the OFDMA-compatible base station, data and second pilots of a second type onto a second plurality of subcarriers;**

Ketchum teaches element [8.2] for the reasons provided for element [1.3]. *Id.*, ¶215.

- (d) **[8.3] wherein at least some subcarriers of the first plurality of subcarriers or the second plurality of subcarriers are beam-formed; and**

Ketchum teaches element [8.3] for the reasons provided for element [1.4]. *Id.*, ¶216.

- (e) **[8.4] transmitting, by the OFDMA-compatible base station, the first plurality of subcarriers and the second plurality of subcarriers in at least one of the time slots using a plurality of antennas;**

Ketchum teaches element [8.4] for the reasons provided for element [1.5]. *Id.*, ¶217.

- (f) **[8.5] wherein the second type is different than the first type and wherein the first pilots do not interfere with the second pilots.**

Ketchum teaches element [8.5] for the reasons provided for element [1.6]. *Id.*,

¶218.

#### 4. Independent Claim 15

- (a) [15.P] An orthogonal frequency division multiple access (OFDMA)-compatible mobile station that uses subcarriers in a frequency domain and time slots in a time domain, the OFDMA-compatible mobile station comprising:

To the extent limiting, Ketchum or the combination of Ketchum and Li teaches the preamble. EX1038, ¶¶220-221. Ketchum discloses a “multiple-access MIMO system 100 that supports multiple users.” EX1006, ¶26. Ketchum’s system 100 includes user terminals 120, also referred to as “mobile station[s],” dispersed throughout the system. *Id.*, ¶¶26-27. The mobile stations communicate using “orthogonal frequency division multiplexing (OFDM).” *Id.*, ¶¶17, 33.

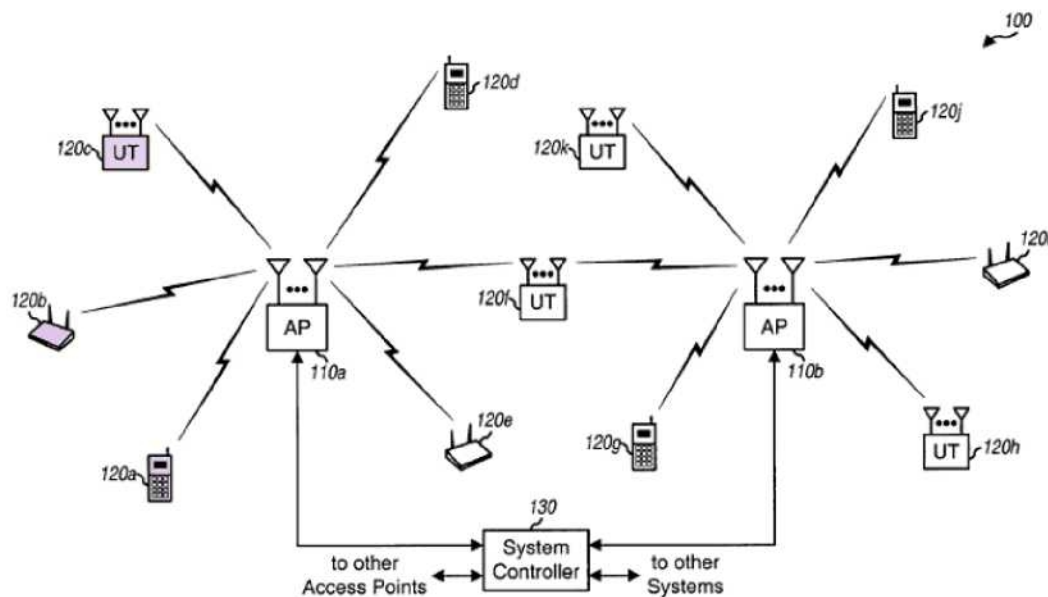


FIG. 1

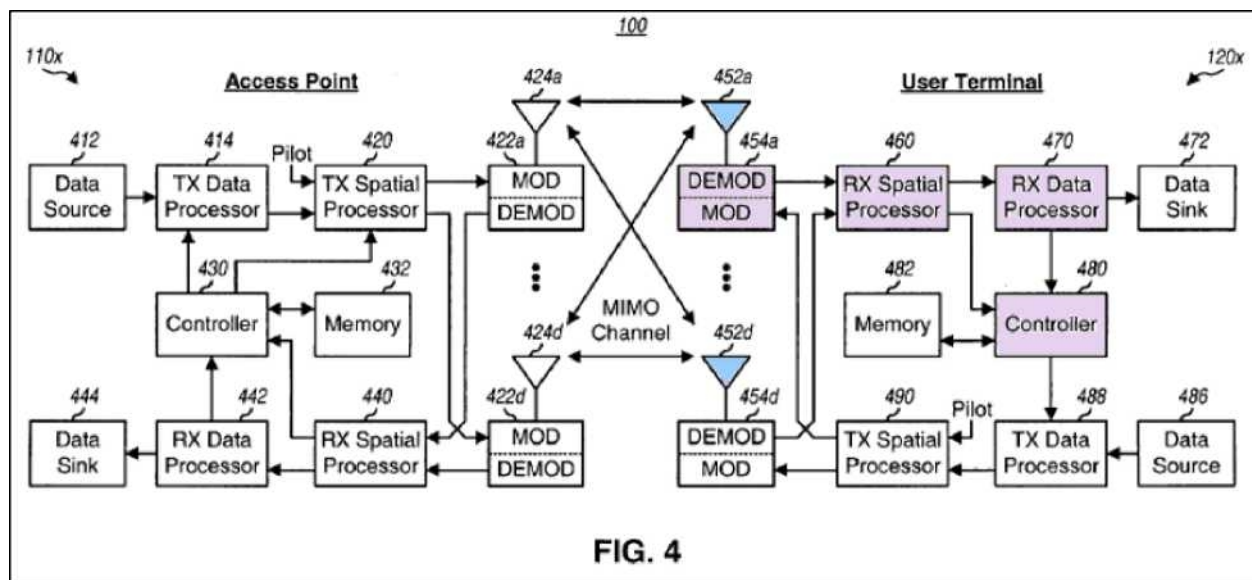
EX1006, FIG. 1 (annotated).



A POSA would have been motivated to implement Ketchum's system to communicate using OFDMA for the reasons provided for element [1.P]. *See also* §VIII.B.1. In such a system, Ketchum's mobile stations 120 would be OFDMA-compatible. EX1038, ¶221.

**(b) [15.1] at least one antenna; and a receiver; and**

Ketchum's mobile station 120 includes "antennas 452 a through 452 d." EX1006, ¶226. The mobile station also includes a receiver that includes demodulators 454, a receive (RX) spatial processor 460, an RX data processor 470, and a controller 480. *Id*; EX1038, ¶222.



EX1006, FIG. 4 (annotated).

**(c) [15.2] the at least one antenna and the receiver are configured to: receive first pilots of a first type on a first plurality of subcarriers, wherein the first pilots are cell-specific pilots; and**

Ketchum's antennas and receiver receive the OFDM downlink signal from the

access point 110. EX1006, ¶226. Ketchum's downlink signal, either alone or in combination with Li, includes *first pilots of a first type on a first plurality of subcarriers, wherein the first pilots are cell-specific pilots* for the reasons provided above for element [1.2]. A POSA would have understood that Ketchum's mobile station thus receives such *cell-specific pilots* on the *first plurality of subcarriers* via the antennas and receiver. EX1038, ¶223; EX1006, ¶226.

- (d) **[15.3] receive second pilots of a second type and data on a second plurality of subcarriers, wherein the first plurality of subcarriers and the second plurality of subcarriers are received in at least one of the time slots;**

Ketchum's at least one receive antenna and receiver receive the OFDM downlink signal. EX1006, ¶226. The downlink signal includes *second pilots of a second type and data on a second plurality of subcarriers* for the reasons provided above for element [1.3]. A POSA would have understood that Ketchum's mobile station thus receives such *second pilots of a second type and data* on the *second plurality of subcarriers* via the antennas and receiver. EX1038, ¶224; EX1006, ¶226. *The first plurality of subcarriers and the second plurality of subcarriers are received in at least one of the time slots* for the reasons provided above for elements [1.3] and [1.5].

- (e) **[15.4] wherein at least some subcarriers of the first plurality of subcarriers or the second plurality of subcarriers are beam-formed; and**

Ketchum discloses this element for the reasons provided above for element

[1.4]. EX1038, ¶225.

- (f) **[15.5] the receiver is further configured to: recover the data using channel estimates from at least the second pilots; and**

As explained for element [1.3], Ketchum's steered reference pilots are the claimed *second pilots*. The steered reference pilot is "used for channel estimation." EX1006, Abstract, ¶¶12, 24, 30, 153, 190-191, 201-202. Ketchum's receiver then "recover[s] the transmitted data" based on the channel estimation. *Id.*, ¶¶7-8, 226 (the receiver "performs spatial processing on the received symbols from all demodulators 454 a through 454 d to provide recovered symbols, which are estimates of the modulation symbols transmitted by the access point"); EX1038, ¶226.

- (g) **[15.6] recover cell-specific information using the cell-specific pilots;**

As explained for element [1.2], Ketchum's beacon pilots are the claimed *cell-specific pilots*. The mobile station 120 uses the beacon pilot to "acquire the [] frequency and timing" of the access point that transmitted the beacon pilot. EX1006, ¶217; *see also* ¶¶12, 31, 41, 119; EX1030, ¶1302. And as explained for element [1.2], the access point 110 (alone or as modified by Li) is associated with a particular coverage area/cell. In this manner, the mobile station *recovers cell-specific information* in the form of such frequency and timing of the access point (cell). EX1038, ¶227. For instance, the mobile station determines the "clock at the access

point” using the beacon pilots, and locks its frequency to the clock. EX1006, ¶42.

- (h) **[15.7] wherein the second type is different than the first type and wherein the first pilots do not interfere with the second pilots.**

Ketchum teaches this element for the reasons provided for element [1.6].  
EX1038, ¶228.

## **5. Independent Claim 23**

- (a) **[23.P] A method performed by an orthogonal frequency division multiple access (OFDMA)-compatible mobile station that uses subcarriers in a frequency domain and time slots in a time domain, the method comprising:**

To the extent limiting, Ketchum or Ketchum-Li teaches the preamble for the reasons provided for element [15.P]. *Id.*, ¶230.

- (b) **[23.1] receiving first pilots of a first type on a first plurality of subcarriers, wherein the first pilots are cell-specific pilots;**

Ketchum or Ketchum-Li teaches element [23.1] for the reasons provided for element [15.2]. *Id.*, ¶231.

- (c) **[23.2] receiving second pilots of a second type and data on a second plurality of subcarriers, wherein the first plurality of subcarriers and the second plurality of subcarriers are received in at least one of the time slots;**

Ketchum teaches element [23.2] for the reasons provided for [15.3]. *Id.*, ¶232.

- (d) **[23.3] wherein at least some subcarriers of the first plurality of subcarriers or the second plurality of subcarriers are beam-formed;**

Ketchum teaches element [23.3] for the reasons provided for element [15.4].

*Id.*, ¶233.

- (e) **[23.4] recovering the data using channel estimates from at least the second pilots; and**

Ketchum teaches element [23.4] for the reasons provided for element [15.5].

*Id.*, ¶234.

- (f) **[23.5] recovering cell-specific information using the cell-specific pilots;**

Ketchum teaches element [23.5] for the reasons provided for element [15.6].

*Id.*, ¶235.

- (g) **[23.6] wherein the second type is different than the first type and wherein the first pilots do not interfere with the second pilots.**

Ketchum teaches element [23.6] for the reasons provided for element [15.7].

*Id.*, ¶236.

## **6. Claims 3, 10, 17, and 25**

Claims 3, 10, 17, and 25 recite “*wherein the second plurality of subcarriers includes an  $n$ th subcarrier and an  $n+18$  subcarrier spaced apart from the  $n$ th subcarrier by 17 subcarriers and the first plurality of subcarriers includes an  $m$ th subcarrier and an  $m+20$  subcarrier spaced apart from the  $m$ th subcarrier by 19 subcarriers.*”

As explained for elements [1.2]-[1.3], Ketchum's beacon pilots (*first pilots*) are provided on a *first plurality of subcarriers* corresponding to a "B OFDM symbol," and Ketchum's steered reference pilots (*second pilots*) are provided on a *second plurality of subcarriers* corresponding to a "P OFDM symbol" (which is the same symbol as used for the MIMO pilots). EX1006, ¶¶39, 47, 73. The subbands/subcarriers of the B and P OFDM symbols are shown in Ketchum's Table 2, reproduced below. As shown, the P OFDM symbol (*second plurality of subcarriers*) includes an *n*th subcarrier and an *n*+18 subcarrier spaced apart from the *n*th subcarrier by 17 subcarriers (e.g., subbands/subcarriers -26 and -8). EX1038, ¶238. Also, the B OFDM symbol (*first plurality of subcarriers*) includes an *m*th subcarrier and an *m*+20 subcarrier spaced apart from the *m*th subcarrier by 19 subcarriers (e.g., subbands/subcarriers -24 and -4). *Id.*



particular coverage area/cell within which the access points broadcast. Thus, the beacon pilots are *unique to a respective cell*. EX1038, ¶¶240-241.

#### **8. Claims 6, 13, 20, and 28**

Claims 6, 13, 20, and 28 recite “*wherein the second plurality of subcarriers are beam-formed.*”

Ketchum discloses that its steered reference pilots (*second pilots of a second type* that are inserted *onto a second plurality of subcarriers*) are transmitted “using beam-forming.” EX1006, ¶74; *see also* ¶¶72, 147, 150, claim 61. Thus, the second plurality of subcarriers are beam-formed. EX1038, ¶243.

#### **9. Claims 7 and 14**

Claims 7 and 14 recite “*wherein the cell-specific pilots are used to convey cell-specific information.*”

As explained for element [1.2], Ketchum’s beacon pilots (*cell-specific pilots*) are used to “acquire the [ ] frequency and timing” of the access point that transmitted the beacon pilot. EX1006, ¶217; *see also* ¶¶12, 31, 41, 119; EX1030, ¶1302. For instance, Ketchum’s user terminal uses the beacon pilots to determine and lock its frequency to “to the clock at the access point.” EX1006, ¶42. As also explained, the access points (alone or as modified by Li) are associated with a particular coverage area/cell within which the access points broadcast. EX1007, ¶28; EX1006, ¶42. Thus, the beacon pilots *convey cell-specific information* in the form of the frequency



and timing information for the cell/access point. EX1038, ¶¶245-246.

#### **10. Claims 22 and 30**

Claims 22 and 30 recite “*extract[ing] cell-specific information from the cell-specific pilots.*”

As explained for element [1.2], Ketchum’s beacon pilots (*cell-specific pilots*) are used to “acquire the [] frequency and timing” of the access point that transmitted the beacon pilot. EX1006, ¶217; *see also* ¶12, 31, 41, 119; EX1030, ¶1302. For instance, Ketchum’s mobile station uses the beacon pilots to determine and lock its frequency to “to the clock at the access point.” EX1006, ¶42. As also explained, the access points (alone or as modified by Li) are associated with a particular coverage area/cell within which the access points broadcast. EX1007, ¶28; EX1006, ¶217. Thus, the mobile station extracts *cell-specific information* from the beacon pilots in the form of the frequency and timing information for the cell/access point. EX1038, ¶¶248-249.

#### **C. Ground 3: The Combination of Ketchum, Li, and Smee renders obvious claims 5, 12, 21, and 29**

Claims 5, 12, 21, and 29 recite “*wherein the first plurality of subcarriers are not aligned in frequency with subcarriers of at least another cell onto which respective cell-specific pilots are inserted.*”

As explained above for element [1.2], Ketchum’s beacon pilots (alone or as modified by Li) are *cell-specific pilots* that are transmitted on a first plurality of

subcarriers. EX1007, ¶28; EX1006, ¶¶39, 217; *see also* EX1030, ¶1302. The combination of Ketchum and Li does not explicitly teach that the *first plurality of subcarriers are not aligned in frequency with subcarriers of at least another cell onto which respective cell-specific pilots are inserted*. But, Smee discloses this limitation. EX1038, ¶¶253-261.

Smee discloses “[p]ilot transmission schemes suitable for use in wireless multi-carrier (e.g., OFDM) communication systems.” EX1017, Abstract. The pilot transmission schemes utilize “frequency orthogonality” by causing different base stations to transmit pilots “on disjoint sets of subbands” (subcarriers). *Id.*, ¶10; *see also* ¶39. “Each cell or sector only transmits pilot on the subbands in the set assigned to that cell/sector.” *Id.*, ¶46.

For instance, Smee’s Table 2 shows an example subband set allocation for frequency orthogonality. *Id.*, ¶47. Each “set” includes different subbands or subcarriers assigned to a particular cell or cell sector for pilot transmission. *Id.*, ¶46; EX1038, ¶¶253-255.

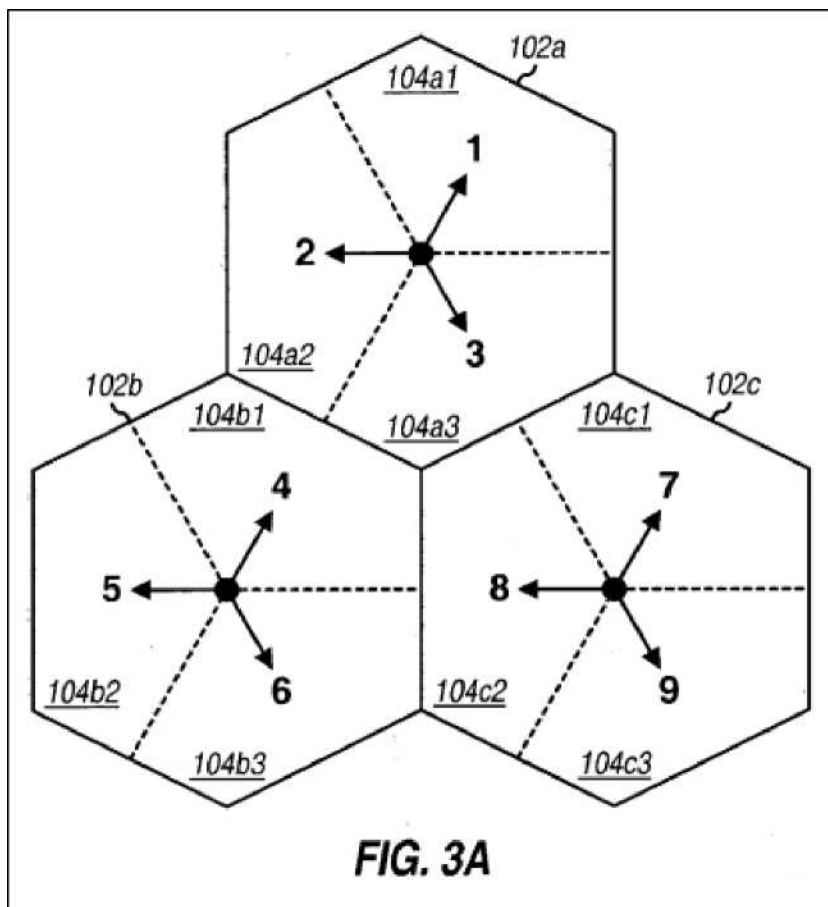
TABLE 2	
Set	Subbands
1	10, 20, 30, . . . 500
2	11, 21, 31, . . . 501
3	12, 22, 32, . . . 502
4	13, 23, 33, . . . 503
5	14, 24, 34, . . . 504
6	15, 25, 35, . . . 505
7	16, 26, 36, . . . 506
8	17, 27, 37, . . . 507
9	18, 28, 38, . . . 508

EX1017, Table 2.

As shown in Figure 3A, “[e]ach of the 9 sectors in the cluster is assigned one of 9 subband sets” (sets 1-9 as indicated in Table 2 and Figure 3A). EX1017, ¶56.

“Each sector would then transmit its pilot on only the subbands in its assigned set.”

*Id.*



EX1017, FIG. 3A.

Thus, Smee teaches that each cell and cell sector transmits *a first plurality of subcarriers [that] are not aligned in frequency with subcarriers of at least another cell onto which respective cell-specific pilots are inserted*. EX1038, ¶¶253-256.

A POSA would have been motivated to implement the Ketchum-Li system so that a base station transmits beacon pilots (*i.e., cell-specific pilots*) on a *first plurality of subcarriers are not aligned in frequency with subcarriers of at least another cell onto which respective cell-specific pilots are inserted*, as taught by Smee. *Id.*, ¶¶257-261.

As explained for element [1.2], Ketchum's base stations transmit beacon pilots (*cell-specific pilots*) on certain subcarriers. Ketchum explains that downlink communication channels can experience "external interference." EX1006, ¶6. But although Ketchum discloses techniques for combating "inter-symbol interference" between different OFDM symbols transmitted by the base station (i.e., within the same cell) (EX1006, ¶36), Ketchum does not explicitly disclose techniques for combating inter-cell interference between base stations (cells). EX1038, ¶258. Thus, a POSA would have sought references for combating such inter-cell interference. *Id.* Smee is such a reference.

Smee's "frequency orthogonality" techniques are "used to avoid interference resulting from simultaneous transmission of pilots by multiple base stations." EX1017, ¶43. Thus, by causing adjacent cells to transmit pilots on "disjoint sets of subbands" (EX1017, ¶10), such inter-cell interference is avoided. EX1017, ¶43.

A POSA would have understood that Smee's frequency orthogonality techniques would provide similar benefits in Ketchum-Li's system. EX1038, ¶¶259-260. A POSA would have thus been motivated to implement the Ketchum- Li system so that a first base station (cell) transmits beacon pilots (*cell-specific pilots*) on a first set of subcarriers, and an adjacent base station (cell) transmits beacon pilots on a second set of subcarriers, as taught by Smee. *Id.*

And a POSA would have had a reasonable expectation of success in

implementing such techniques. *Id.*, ¶261. Ketchum discloses flexibility in determining which subbands are used for providing the beacon pilots. *E.g.*, EX1006, ¶¶40-41 (describing an “exemplary embodiment” of an OFDM symbol in which beacon pilots are transmitted), ¶221. A POSA would have thus readily understood how to implement Ketchum’s base stations so that adjacent base stations transmit beacon pilots on disjoint subbands or subcarriers. EX1038, ¶261. In this manner, a POSA would have understood that such implementation would merely amount to the use of a known technique (Smee’s frequency orthogonality technique) to improve similar devices (Ketchum-Li and Smee’s base stations) in the same way (avoiding interference from adjacent base stations/cells). *Id.*

## **IX. DISCRETIONARY CONSIDERATIONS UNDER 314(A) AND 325(D) STRONGLY FAVOR INSTITUTION.**

### **A. The *Fintiv* factors strongly favor institution.**

The *Fintiv* factors strongly favor institution. *Apple Inc. v. Fintiv, Inc.*, IPR2020-00019, Paper 11 (P.T.A.B. Mar. 20, 2020) (precedential); *see also* June 21, 2022 Memorandum: Interim Procedure for Discretionary Denials in AIA Post Grant Proceedings with Parallel District Court Litigation (“June 2022 Memo”).

On July 15, 2022, Patent Owner filed a complaint alleging infringement of the ’512 patent against Petitioner. On August 1, 2022, the case was centralized for pre-trial proceedings in a multidistrict litigation (MDL) in the Eastern District of Michigan (EDMI). *See* EX1032, EX1035, EX1036, EX1037. On September 12,

2022, Petitioner filed a partial motion to dismiss. EX1033. The court held a scheduling conference September 16, 2022, but has not issued a scheduling order or set a trial date. *Id.* Patent Owner served infringement contentions on September 28, 2022, but the parties have not exchanged claim construction positions or invalidity contentions. The median time to trial for civil actions in EDMI is 46.8 months. EX1034, 40.

The stage and location of the parallel litigation (factors 2, 3), Petitioner’s below stipulation (factor 4), and the strong merits (factor 6), demonstrate denial under *Fintiv* is inappropriate. *See* June 2022 Memo, 3-5, 7-9.

**Factor 1** is neutral or favors institution. No motion to stay has been filed and the court has not indicated whether it would grant such motion. Factor 1 thus carries little weight. *Sand Revolution II, LLC v. Continental Intermodal Group - Trucking LLC*, IPR2019-01393, Paper 24 at 7 (P.T.A.B. June 16, 2020) (informative).

**Factor 2** favors institution because the EDMI litigation is in early stages, no trial date has been set, and the median time to trial for civil actions in EDMI is 46.8 months. EX1034, 40; *see* June 2022 Memo, 3 (under factor 2 “the PTAB will consider the median time from filing to disposition of the civil trial for the district in which the parallel litigation resides”). Thus, trial would likely occur (if at all) in early 2026—years after the Board’s projected deadline for a final decision here. *See Mylan Pharma. Inc. v. Bayer Pharma. Aktiengesellschaft*, IPR2022-00517, Paper 15 at 8-9

(P.T.A.B. Aug. 9, 2022).

**Factor 3** favors institution because, at institution, neither the parties nor the court will have invested significant resources in the parallel litigation. Currently, the court has not issued a scheduling order, or any substantive rulings. Petitioner reserves the right to update the Board should circumstances change before the institution deadline. Petitioner's diligence filing the Petition less than six months after being sued confirms that factor 3 strongly favors institution.

**Factor 4** favors institution. Petitioner stipulates that, if the Board institutes this Petition, Petitioner will not raise at trial in the parallel litigation any invalidity challenges based on the prior art asserted here. This significantly mitigates the concerns for duplication and inconsistent conclusions embodied in factor 4.

**Factor 6** favors institution because the merits of the Petition are strong. *See supra*; June 2022 Memo, 3-5. Other considerations favoring institution under factor 6 include: (1) the Board is best suited to address the technical issues raised here; (2) a decision on the merits at institution may aid the parties in resolving their disputes through alternative dispute resolution; and (3) a patentability ruling will benefit the public by providing a complete record and rationale absent from a black box jury verdict form, such as by deterring future litigation. Patent Owner has filed suit against nine defendants and is likely to file against others given the remaining patent term of the '512 patent and Patent Owner's allegations the '512 patent is essential to



certain telecommunication standards.

Considered holistically, the *Fintiv* factors strongly favor IPR.

**B. The *Advanced Bionics* two-part framework strongly favors institution.**

Applying the two-part framework from *Advanced Bionics, LLC v. MED-EL Elektromedizinische Gerate GmbH* demonstrates that denial under §325(d) is not appropriate. IPR2019-01469, Paper 6 at 8-9 (P.T.A.B. Feb. 13, 2020) (precedential). Under part one, the same or substantially the same art or arguments were *not* previously presented to the Office, ending the inquiry in favor of institution. The “new, noncumulative prior art asserted in the Petition” strongly favors IPR. *Oticon Medical AB v. Cochlear Ltd.*, IPR2019-00975, Paper 15 at 20 (P.T.A.B. Oct. 16, 2019) (§§II.B and II.C precedential). Should Patent Owner attempt to analogize any previously considered art or arguments to those presented here, Petitioner reserves the right to respond. Moreover, discretionary denial in view of pending IPR2022-01539 is inappropriate. This petition seeks to conditionally join IPR2022-01539, and Petitioner will take an inactive role unless and until Volkswagen ceases to participate in IPR2022-01539.

The Board should institute review because the merits are strong and the circumstances here trigger none of the discretionary denial policy considerations. Should Patent Owner raise any discretionary denial theory not addressed above, Petitioner reserves the right to respond before institution.

## **X. CONCLUSION**

For the reasons above, *inter partes* review and cancellation of claims 1-30 of the '512 patent are requested.

Date: October 19, 2022

Respectfully submitted,

/s/ Celine J. Crowson

Celine J. Jimenez Crowson (Reg. No. 40,357)

Joseph Raffetto (Reg. No. 66,218)

Scott Hughes (Reg. No. 68,385)

Helen Y. Trac (Reg. No. 62,250)

HOGAN LOVELLS US LLP

555 13th Street N.W.

Washington, D.C. 20004

Telephone: 202.637.5600

Facsimile: 202.637.5710

*Counsel for Petitioner*

*Mercedes-Benz USA, LLC*

## **CERTIFICATE OF COMPLIANCE**

The undersigned hereby certifies that the foregoing **Petition for *Inter Partes* Review** contains 13,998 words, excluding those portions identified in 37 C.F.R. § 42.24(a), as measured by the word-processing system used to prepare this paper.

/s/ Celine J. Crowson

Celine J. Crowson, Lead Counsel  
**(Reg. No. 40,357)**

## **CERTIFICATION OF SERVICE**

The undersigned certifies that, in accordance with 37 C.F.R. § 42.6(e) and 37 C.F.R. § 42.105, the foregoing **Petition for *Inter Partes* Review**, and **Exhibits 1001 through 1039** were served on October 19, 2022, by Overnight Courier at the following address of record and addresses known to Petitioner as likely to effect service and the address of record for the '512 patent:

Volpe Koenig  
30 South 17<sup>th</sup> Street, 18<sup>th</sup> Floor  
Philadelphia, PA 19103

Caldwell Cassady & Curry  
2121 N. Pearl St.  
Suite 1200  
Dallas, Texas 75201

/Stephanie McDonough/  
Stephanie McDonough  
IP Specialist

Hogan Lovells US LLP  
609 Main Street, Suite 4200  
Houston, TX 77002  
Telephone: (713) 632.1400  
Facsimile: (713) 632.1401