

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

Samsung Electronics America, Inc.
Samsung Electronics Co., Ltd.
Petitioners

v.

Massively Broadband LLC
Patent Owner

IPR2025-01563
Patent 11,876,548

PETITION FOR *INTER PARTES* REVIEW

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EXHIBIT LIST

Ex.	Description
1001	U.S. Patent No. 11,876,548 (“’548 Patent”)
1002	File History for U.S. Patent No. 11,876,548
1003	Declaration of Dr. Mark Mahon
1004	<i>Curriculum vitae</i> of Dr. Mark Mahon
1005	U.S. Patent Publication No. 2011/0250928A1 (“Schlub”)
1006	U.S. Patent Publication No. 2013/0237272A1 (“Prasad”)
1007	U.S. Patent No. 9,362,994 (“Seol”)
1008	WIPO Int’l Publication No. WO 2014/194455A1 (“Yin”)
1009	U.S. Patent Pub. No. 2011/0182174 (“Pi”)
1010	U.S. Patent Publication No. 2009/0295648 (“Dorsey”)
1011	U.S. Patent No. 8,593,358 (“the ’358 patent”)
1012	IEEE Standard 145-2013 - IEEE Standard for Definitions of Terms for Antennas
1013	Patent Owner’s Preliminary Infringement Contentions, Ex. 12
1014	U.S. Patent Publication No. 2006/0097918A1 (“Oshiyama”)
1015	Balanis, Constantine A., <i>Antenna Theory: Analysis and Design</i> , 2nd Ed., Wiley, 1997
1016	Lathi, B. P., <i>Modern Digital and Analog Communication Systems</i> , HRW, 1983
1017	Beard, Cory and Stallings, William, <i>Wireless Communication Networks and Systems</i> , Pearson, 2016
1018	U.S. Patent Publication No. 2004/0021605 A1

1019	Sanchez-Hernandez, David A., Editor, Multiband Integrated Antennas for 4G Terminals, Artech House, 2008
1020	U.S. Patent No. 5,794,145 (“Milam”)
1021	Marinez-Vazquez Marta, et al., “Integrated Planar Multiband Antennas for Personal Communication Handsets,” IEEE Transactions on Antennas and Propagation, Vol. 54, No. 2, February 2006
1022	B. D. Van Veen and K. M. Buckley, "Beamforming: a versatile approach to spatial filtering," in IEEE ASSP Magazine, vol. 5, no. 2, April 1988.
1023	M. A. Jensen and J. W. Wallace, "A review of antennas and propagation for MIMO wireless communications," in IEEE Transactions on Antennas and Propagation, vol. 52, no. 11, Nov. 2004.
1024	Yu, Zhong, et al., “Beamforming on Mobile Devices: A First Study,” Proceedings of the 17th International Conference on Mobile Computing and Networking, September 19-23, 2011, Las Vegas, NV.
1025	U.S. Patent No. 7,308,285 (“Nelson”)
1026	D. Mizell, "Using gravity to estimate accelerometer orientation," Seventh IEEE International Symposium on Wearable Computers, 2003. Proceedings., White Plains, NY, USA, 2003, pp. 252-253.
1027	K. Kunze, P. Lukowicz, K. Partridge and B. Begole, "Which Way Am I Facing: Inferring Horizontal Device Orientation from an Accelerometer Signal," 2009 International Symposium on Wearable Computers, Linz, Austria, 2009, pp. 149-150.
1028	Masters Thesis, Internal Control of a Beamforming Antenna Array for Use in Cellular Phones, Patrick Schmidt, 2010 (“Schmidt”)
1029	Johnson, D. H., & Dudgeon, D. E., Array Signal Processing: Concepts and Techniques, 1993.

Petition for *Inter Partes* Review
U.S. Patent No. 11,876,548

1030	Molisch, Andreas F., Wireless Communications 2nd Ed., Wiley, 2011
1031	U.S. Patent No. 11,063,625 (“’625 patent”)
1032	File History for U.S. Patent No. 11,063,625
1033	Patent Owner’s Preliminary Infringement Contentions, Ex. 11

LIST OF CHALLENGED CLAIMS

Claim	Limitation
1[pre]	A wireless device configured for avoiding radiation of a user or structure, comprising the steps of:
1[a]	one or more detectors selected from the group consisting of one or more cameras, microphones, audio sensors, ultrasound sensors or transducers, range finders, capacitive sensors, gyroscopes, light detectors, or motion detectors used for computational determination of spatial orientation in three dimensional space, for detecting an orientation of said wireless device relative to either or both said user and said structure;
1[b]	one or more processors for determining, based on information provided by said one or more detectors, zones or spans of directions in the three dimensional space corresponding with one or more directions of said user or structure relative to said at least one steerable antenna;
1[c][i]	one or more steerable antennas which operate on one or multiple bands and radiates or receives at one or more frequencies in the range of 10 GHz to 500 GHz,
1[c][ii]	wherein one or more beams of said one or more steerable antennas is adjustable to accentuate its radiation pattern in one or more directions which are not in said zones or spans of directions in the three dimensional space as determined by said one or more computational devices,
1[c][iii]	wherein said one or more steerable antennas are configured to steer or direct its radiation pattern in particular directions while attenuating the radiation pattern in other directions; and
1[d]	a controller for adjusting the radiation pattern of the one or more steerable antennas to accentuate one or more of said particular directions while attenuating the radiation pattern for said zones or spans of directions in the three dimensional space.

Claim	Limitation
2	The wireless device of claim 1 wherein said wireless device is selected from the group consisting of computers, telephones, portable computing or communication devices, games, wireless memory media, radio frequency identification tags, vehicles, clothing, personal data assistants, and navigation assistants.
3	The wireless device of claim 1 further comprising a tuner for tuning said at least one steerable antenna with one or more active elements which are selected or interconnected using electronic control.
4	The wireless device of claim 1 wherein said at least one steerable antenna is configured for transmitting, receiving, or transmitting and receiving simultaneously in a plurality of different bands.
5	The wireless device of claim 4 further comprising a processor for controlling tuning of one or more circuits for said at least one steerable antenna to operate in said plurality of different bands.
6	The wireless device of claim 1, wherein said at least one steerable antenna comprises a plurality of steerable antennas.
7[pre]	A method for avoiding or reducing radiation of a user or structure by a wireless device having at least one steerable antenna, comprising:
7[a]	sensing with one or more sensors selected from the group consisting of cameras, microphones, audio sensors, ultrasound sensors or transducers, range finders, capacitive sensors, gyroscopes, light detectors, or motion detectors used for

Claim	Limitation
	computational determination of spatial orientation in three dimensional space, an orientation of said wireless device relative to either or both said user and said structure;
7[b]	receiving signals from said one or more sensors pertaining to said orientation in the three dimensional space;
7[c]	using said signals, computing zones or spans of directions corresponding with one or more directions of said user or structure relative to said at least one steerable antenna in the three dimensional space; and
7[d]	adjusting one or more beams of said at least one steerable antenna to accentuate its radiation pattern in one or more directions which are not in said zones or spans of directions,
7[e]	wherein said at least one steerable antenna radiates or receives said one or more beams based on signals from said one or more processors determined on execution of said executable instructions,
7[f]	wherein said at least one steerable antenna operates on one or multiple bands, and
7[g]	wherein said at least one steerable antenna radiates or receives at one or more frequencies in the range of 10 GHz to 500 GHz.
8	The method of claim 7 wherein said wireless device is selected from the group consisting of computers, telephones, portable computing or communication devices, games, wireless memory media, radio frequency identification tags, vehicles, clothing, personal data assistants, and navigation assistants.
9	The method of claim 7 further comprising tuning said at least one steerable antenna with one or more active elements which are selected or interconnected using electronic control.

Claim	Limitation
10	The method of claim 7 wherein said at least one steerable antenna is configured for transmitting, receiving, or transmitting and receiving simultaneously in a plurality of different bands.
11	The method of claim 10 comprising controlling tuning of a tuner for said at least one steerable antenna to operate in said plurality of different bands.
12[pre]	A method for avoiding radiation of a user or structure by a wireless device with a steerable antenna system, comprising:
12[a]	detecting in a three dimensional space with one or more sensors selected from the group consisting of one or more cameras, microphones, audio sensors or transducers, ultrasound sensors, range finders, capacitive sensors, gyroscopes, light detectors, or motion detectors used for computational determination of spatial orientation in three dimensional space, an orientation of said wireless device relative to either or both said user and said structure;
12[b]	computing, with a computation module communicatively coupled to said one or more sensors, zones or spans of directions in the three dimensional space;
12[c]	adjusting at least one steerable antenna that operates on one or multiple bands, which radiates or receives at one or more frequencies in the range of 10 GHz to 500 GHz, and that is communicatively coupled to said computation module, so that the at least one steerable antenna radiates or receives one or more beams in one or more directions while attenuating its radiation pattern in said zones or spans of directions in the three dimensional space,

Claim	Limitation
12[d]	wherein said zones or spans of directions correspond with one or more directions or locations of said user or structure relative to said at least one steerable antenna in the three dimensional space,
12[e]	wherein said at least one steerable antenna is adjusted in the adjusting step to steer or direct its radiation pattern in particular directions while attenuating the radiation pattern in other directions in the three dimensional space.
13	The method of claim 12 wherein said wireless device is selected from the group consisting of computers, telephones, portable computing or communication devices, games, wireless memory media, radio frequency identification tags, vehicles, clothing, personal data assistants, and navigation assistants.
14	The method of claim 12 further comprising tuning said at least one steerable antenna with one or more active elements which are selected or interconnected using electronic control.
15	The method of claim 12 wherein said at least one steerable antenna is configured for transmitting, receiving, or transmitting and receiving simultaneously in a plurality of different bands.
16	The method of claim 15 comprising controlling tuning of a tuner for said at least one steerable antenna to operate in said plurality of different bands.

I. INTRODUCTION

The '548 Patent is directed to steerable antenna technologies for wireless devices that allegedly improve safety and performance by avoiding radiation toward a user or structure. The '548 Patent purports to introduce beamsteering and/or beamforming techniques that reduce electromagnetic radiation directed toward users or structures through sensor-based detection using, for example, cameras, gyroscopes, light detectors, range finders, and/or capacitive sensors. The beamsteering determinations are informed by detecting the device's orientation relative to the user (or structure), determining spatial zones or spans in the direction of the user (or structure), and adjusting beam patterns to direct energy away from these areas.

But, the claimed steerable antenna technologies of the '548 Patent were already known in the art before the earliest effective filing date. As detailed below, Schlub disclosed and rendered obvious the claimed steerable antenna features for avoiding radiation of the user, together with a wide range of sensors that could be used to detect the orientation of users and structures in the vicinity of the radiating elements of the antenna. Similarly, Prasad disclosed using sensors to detect the orientation of a wireless device, determining zones or spans where the user is located, and adjusting a steerable antenna to avoid radiation toward the user via beamforming.

For the reasons discussed herein, all Challenged Claims of the '548 Patent are unpatentable as anticipated under Section 102 and/or obvious under Section 103.

II. STANDING

Petitioners certify that they are not barred or estopped from requesting review of the Challenged Claims.

III. GROUNDS

Petitioners request cancellation of claims 1-16 on the following grounds:

Ground	Basis	Reference(s)	Claims
1	§102/ §103	Schlub	1-3, 6-9, 12-14
2	§103	Schlub in view of Oshiyama	4-5, 10-11, 15-16
3	§103	Prasad in view of Seol and Yin	1-3, 6-9, 12-14
4	§103	Prasad in view of Seol, Yin, and Oshiyama	4-5, 10-11, 15-16

IV. LEVEL OF ORDINARY SKILL IN THE ART

A person of ordinary skill in the art (“POSITA”) at the time of the effective priority date of the '548 Patent would have had at least a Bachelor’s degree in electrical engineering, computer engineering, physics, or a related field, and at least two years of experience working with design and integration of RF circuits and antennas for wireless communication devices. EX1003, ¶76. More education can substitute for practical experience and vice versa. *Id.* Petitioners’ expert, Dr. Mark Mahon, exceeds this skill level and thus has the qualifications and experience necessary to assess the '548 Patent from the perspective of a POSITA. *Id.*

V. TECHNOLOGY OVERVIEW

Modern wireless devices use radio waves to communicate with other devices. EX1003, ¶¶45-66. Antennas transmit and receive information on radio waves at predetermined frequencies. *Id.* Antennas are typically designed to operate at specific frequencies, and are often used to enable communications over cellular frequencies in mobile devices. As mobile devices became handheld and miniaturized, however, space constraints created a need for small, multiband antennas. *Id.* Well before the '548 Patent, numerous companies in the wireless communications space had developed multiband antennas that could operate at a plurality of different frequency bands. *Id.* These companies used a variety of different tuning techniques to enable tuning the antennas to a variety of different frequencies, and to match the antennas to the desired impedance. *Id.* Similarly, beamforming and beamsteering using an array of antenna elements were extensively researched and in use decades before the '548 patent. *Id.*

VI. THE '548 PATENT

A. Priority Date

The '548 Patent issued from U.S. Application No. 17/346,533 (the "'533 Application"), which is a continuation of U.S. Application No. 13/966,853 (the "'853 Application"), filed August 14, 2013, which issued as U.S. Pat. No. 11,063,625 (the '625 Patent). The '625 Patent is a continuation-in-part of U.S. Patent Application No. 13/713,804, which issued as U.S. Patent No. 8,593,358 (the "'358

Patent”) and claims priority to U.S. Patent No. 8,350,763 and U.S. Provisional Application No. 61/088,829.

The claims of the ’548 Patent are only entitled to claim the benefit of the filing date of the ’853 Application (August 14, 2013), and are not otherwise entitled to the priority dates of any of the earlier parent applications because they claim subject matter that was newly added in the ’853 Application and was not disclosed in any of the earlier parent applications. EX1003, ¶68. In particular, the disclosures in column 10 line 34 through column 14 line 52 of the ’625 specification comprise new matter that was first added in the ’853 Application and was not included in the specification of any earlier parent application. *See id.*, EX1031, 10:34-14:52; *see also* EX1001, 10:35-14:52. This new matter in the ’625 and ’548 specifications provides the only possible written description support under Section 112 for claims 1-16. EX1003, ¶68.

For example, every claim of the ’548 Patent recites sensors that detect the orientation of a wireless device relative to a user or structure and at least one steerable antenna configured to adjust its beam radiation pattern to steer or direct beams in certain directions where a user or structure are not located. EX1001, Claims 1, 7, 12. None of these elements are disclosed in any parent application prior to the ’853 Application. For example, the words “steer” and “steerable” do not even appear in the specification of the ’358 Patent, nor does the specification disclose

steerable antennas, detecting a user or structure relative to the orientation of a wireless device, or adjusting a beam radiation pattern to steer or direct a beam of radiation in certain directions. EX1030, *passim*. These limitations are disclosed only in the new matter first presented in the specification of the '625 Patent. *E.g.*, EX1031, 10:34-62 (steerable antennas), 10:63-11:26, 12:4-17 (use of sensors to detect user/structure relative to device), 11:27-12:3 (use of detection to steer/adjust beam pattern); EX1003, ¶69.

Accordingly, the priority date of all '548 Patent claims is the filing date of the '625 Patent, August 14, 2013.

B. Prosecution History

During prosecution, the Examiner rejected the claims on double-patenting, indefiniteness, and enablement grounds, and additionally rejected a subset of the claims on prior art grounds. EX1002, 62-78. In response, the Applicant cancelled the claims with prior art rejections and amended the remaining claims to address indefiniteness. *See id.* at 45-50 (June 19, 2023 amendments). The Applicant also filed a terminal disclaimer. *See id.* at 51. The claims were subsequently allowed. *See id.* at 3-4 (December 27, 2023 issue notification).

The prosecution history of the parent '625 Patent include more detailed examination of the prior art. After the Examiner rejected the pending claims based on U.S. Patent Publication No. 2009/02945648 ("Dorsey") multiple times, the

Applicant appealed to the Board, arguing that Dorsey does not disclose determining zones or spans in “three dimensional space,” and Dorsey does not disclose adjusting the beam of a single antenna. EX1032 at 102-11. The Board found that Dorsey **does** disclose determining zones or spans in three dimensional space because Dorsey discloses “detect[ing] when an object such as a user’s ear is close to” a part of the wireless device. *Id.*, 41-42. However, the Board agreed that Dorsey does not disclose “adjusting the beam radiation pattern of the **one** steerable antenna” because Dorsey instead “**select[s] one of two or more** separately located, steerable antennas” to radiate from. *Id.*, 42-44.

C. Disclosure

The ’548 Patent is generally directed to using “steerable antenna” functionality to adjust wireless device radiation “beam patterns” so that they are directed away from the “zone or span of directions” where users of those devices are located (or structures in the vicinity that are desirable to avoid), including in the 10 GHz band and above. EX1001, Abstract, 11:52-12:3. The steering adjustment decisions are informed, in part, by the “orientation of the wireless device” relative to the user or other structure as determined based on information obtained about the surrounding “three dimensional space” via various types of sensors. EX1001, 12:4-17, 13:54-14:3.

VII. CLAIM CONSTRUCTION

Petitioners have applied the plain and ordinary meaning understood by a POSITA at the time of the alleged invention, in the context of the '548 Patent and its prosecution history. *Phillips v. AWH Corp.*, 415 F.3d 1303 (Fed. Cir. 2005); EX1003, ¶33. Petitioners do not believe that the Board need construe any claim limitation to institute review.

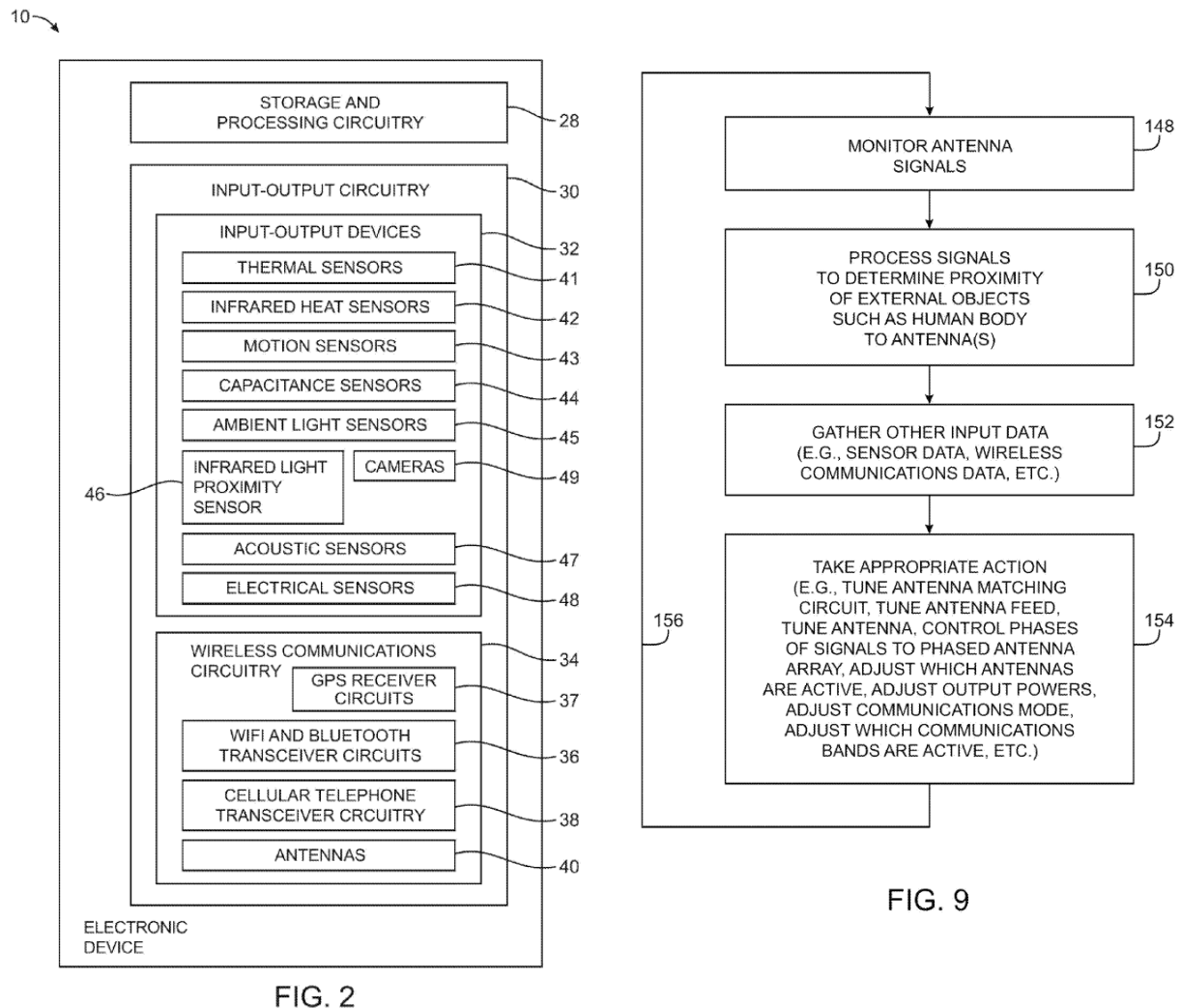
VIII. GROUND 1: SCHLUB ANTICIPATES AND RENDERS OBVIOUS CLAIMS 1-3, 6-9, AND 12-14

A. Schlub (EX1005)

U.S. Pat. Pub. 2011/0250928 (“Schlub”) was filed April 13, 2010 and published October 13, 2011. It is prior art under at least 35 U.S.C. §§102(a)(1).

Schlub relates to “wireless communications circuitry” in “handheld electronic devices” that “may be adjusted based on the proximity of the electronic device[] to external objects.” EX1005, [0001]-[0002]. Schlub uses “antenna impedance measurements” and other sensor data (*e.g.*, from “motion sensors, capacitance sensors, ambient light sensors, ... cameras,” and the like) to “determine whether a user’s body or other external object is within a given distance of an antenna” and “how a device is being oriented.” *Id.*, [0006]-[0007], [0022]. In response to detecting a user’s orientation relative to the wireless phone and its internal antenna, “processing circuitry” in the electronic device may make “adjustments” to “the direction in which the antenna array is operating” or to “matching circuits, antenna

feed locations, tuning circuits, and adjustable switches that control the size and shape of the active portions of antenna resonating elements within the antennas.” *Id.*, [0009]. Antennas may also be “selectively disabled and may have their powers adjusted individually.” *Id.* Schlub’s Figure 2 depicts the architecture of the proposed wireless device, and Figure 9 depicts the high-level process it is designed to achieve.



Id. Figs. 2, 9; see also Fig. 8.

B. Claim 1

1. 1[pre]: A wireless device configured for avoiding radiation of a user or structure, comprising the steps of:

To the extent the preamble is limiting, Schlub discloses it. Schlub discloses a “portable electronic device [that] has wireless communications circuitry” configured so that “signals that are emitted by the antenna array can be steered to avoid or minimize emissions into external objects (e.g., to comply with regulatory limits by avoiding radio-frequency emissions into human tissue).” EX1005, Abstract, [0032]. Just like the ’548 Patent, the Schlub uses “one or more antennas” in a portable electronic device. *Id.*, [0005], EX1001, 3:66-4:5 (“one or more antennas . . . in a portable wireless device”). Schlub’s wireless device implements a method that is summarized at a high level in Figure 9, reproduced and annotated below:

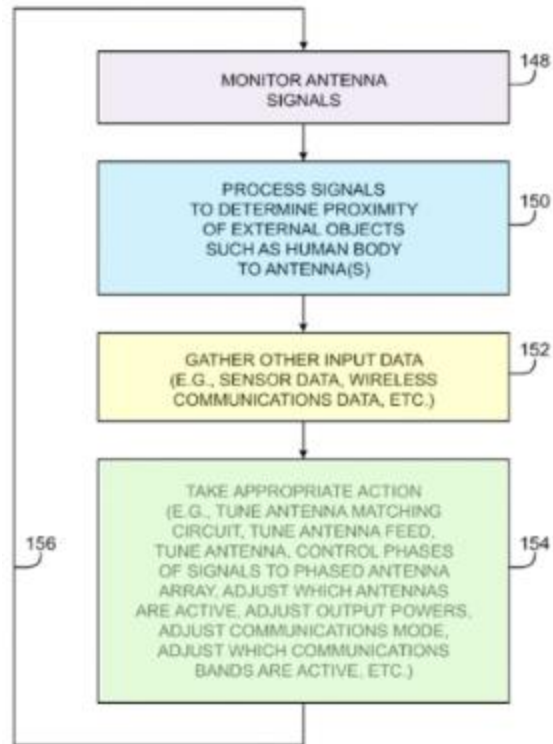


FIG. 9

Schlub's wireless device is configured "to determine whether a user's body or other external object is within a given distance of an antenna by making antenna impedance measurements" and to use other "sensors such as ... motion sensors, capacitance sensors, ambient light sensors, ... acoustic sensors, cameras" to "help accurately determine whether the external object is in the vicinity of the antenna." EX1005, [0006]. Once it is "determine[d] [that] a user's body or other external object is within a given distance of an antenna," the wireless device uses that information to adjust the radiation beams of a steerable antenna, such as "a phased antenna array," to modify "the direction in which the antenna array is operating" to avoid radiation toward the user. EX1005, [0006], [0009]. EX1003, ¶¶81-84.

As detailed further below, Schlub discloses that its solution can adjust the beam radiation direction when certain criteria are met, one of which is “how a device is being oriented” and one of which is “whether an external object appears to be in the vicinity of the device as measured by a light sensor, heat sensor, infrared light or heat sensor, acoustic sensor, or capacitive sensor, etc.” EX1005, [0022].

2. **1[a]: one or more detectors selected from the group consisting of one or more cameras, microphones, audio sensors, ultrasound sensors or transducers, range finders, capacitive sensors, gyroscopes, light detectors, or motion detectors used for computational determination of spatial orientation in three dimensional space, for detecting an orientation of said wireless device relative to either or both said user and said structure;**

“one or more detectors selected from the group consisting of one or more cameras, microphones, audio sensors, ultrasound sensors or transducers, range finders, capacitive sensors, gyroscopes, light detectors, or motion detectors”:

Schlub discloses several of the recited detectors that can be used alone or together to detect orientation of the wireless device in three dimensional space (discussed further below). For instance, Schlub discloses detecting orientation by (i) “making antenna impedance measurements,” and (ii) use of other “sensors such as ... motion sensors, capacitance sensors, ambient light sensors, ... acoustic sensors, cameras” EX1005, [0006]-[0007], Fig. 2 (reproduced below, showing exemplary detectors/sensors). EX1003, ¶86.

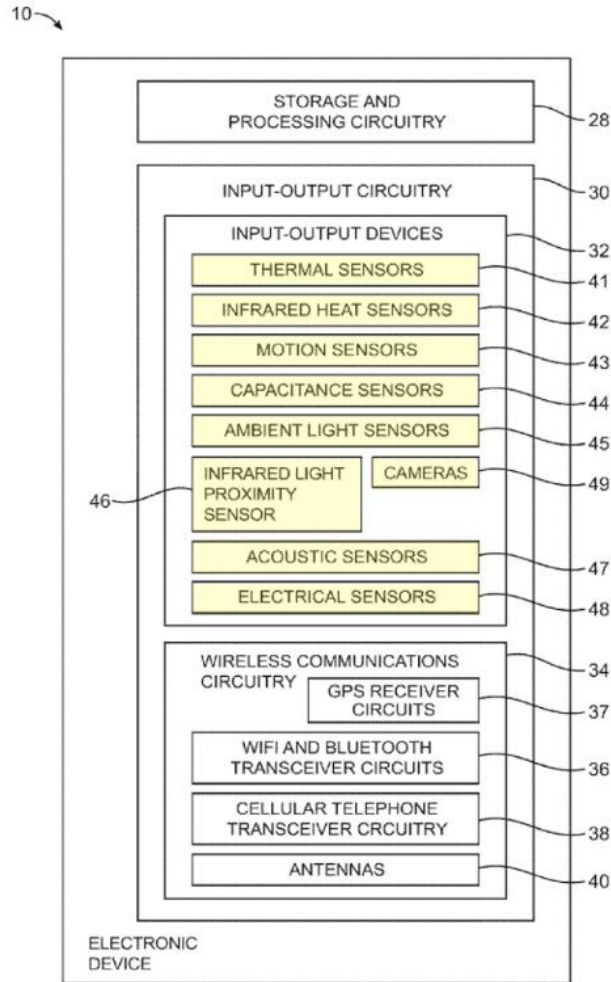


FIG. 2

“used for computational determination”: Schlub discloses “storage and processing circuitry 28” (shown in Fig. 2, above) that “process[es] the signals from the antenna-based proximity sensor (i.e., circuitry 61), the sensors of FIG. 2, and other circuitry in device 10” (i.e., performs a **computation** on the sensor data) in order to **“determine** whether antenna adjustments and other adjustments to the operation of the wireless circuitry of device 10 should be made.” EX1005, [0086]-[0087]; *see also id.*, [0036], [0047]-[0048]; EX1003, ¶87. This “processing” includes “determin[ing], for each antenna 40, whether an external object such as a

user's body is in the vicinity of the antenna.” *Id.*, [0086]-[0087]. For example, the processing circuitry may use “proximity sensor data” or data from “a light sensor, heat sensor, infrared light or heat sensor, acoustic sensor, or capacitive sensor, etc.” to compute “how close a user’s body may be located to a particular antenna,” “how a device is being oriented,” or “whether the an external object appears to be in the vicinity of the device.” *Id.*, [0022].

“*of spatial orientation in three dimensional space*”: Schlub discloses detection in three-dimensional space by detecting the plane of the wireless device where it is offset by some distance in another direction outside of the plane (*i.e.*, a third dimension) and in certain cases by some “non-zero angle relative to the plane of the earth’s surface.” EX1005, [0042]. Two planes at a nonzero angle to each other extend into a third dimension. EX1003, ¶88. Moreover, Schlub discloses that its “[c]ameras 49 may gather information that is used in determining whether or not a user’s body or other external objects are in the vicinity of device 10.” EX1005, [0047]-[0048]. The information gathered by the cameras may include “images containing a user’s face or other identifiable body part,” and “image data such as video data indicating motion towards the antennas of device 10 or other portion of device” or “images and other images in which a camera sensor (*i.e.*, a camera window and camera module lens) in device 10 has been obscured and therefore blocked by a human body part or other external object, etc.” *Id.* A POSITA would

have understood that cameras capture images and video that represent a 3D space, particularly since the cameras are described as capturing objects with two-dimensional surfaces (faces, body parts) and movement toward the camera (*i.e.*, change in distance along a third dimension). EX1003, ¶88. Schlub also expressly discloses using sensor data to compute “how a device is being oriented.” EX1005, [0022].

“for detecting an orientation of said wireless device relative to either or both said user and said structure”: Schlub discloses that its sensors are used “to determine whether *a user’s body or other external object* is within a given distance of an antenna” and to “**determine how device 10 is oriented** and whether device 10 is exhibiting movement characteristic of human use.” EX1005, [0006], [0022], [0042]. Schlub further explains that sensor data is used “to determine the **location of external objects relative to the device**,” including “a *user’s body*.” *Id.*, [0033], [0060]; *see also id.*, [0043] (describing the use of “proximity data” regarding “the proximity of external objects to device 10”); EX1003, ¶89.

Schlub further explains that motion sensors can be used to determine the **orientation relative to the user**, by determining whether a surface of the wireless device is “in a plane parallel to the plane of the earth’s surface ... or at a non-zero angle relative to the plane of the earth’s surface.” EX1005, [0042]; EX1003, ¶90. For example, Schlub’s sensors can detect “if a user grips device 10 so that the user’s

hand or other body part is **flush** with an antenna feed portion of antenna 40,” which describes the relative orientation of the device to the user’s hand or other body part.

Id. [0064]; *see also id.*, [0087] (example using three sensor types to determine relative position of antennas to external objects); EX1003, ¶90.

3. 1[b]: one or more processors for determining, based on information provided by said one or more detectors, zones or spans of directions in the three dimensional space corresponding with one or more directions of said user or structure relative to said at least one steerable antenna;

“**one or more processors**”: Schlub discloses “storage and processing circuitry” (*i.e.*, **a processor**) in communication with “an antenna-based proximity sensor and ... other sensors and sources of data within the electronic device” (*i.e.*, the detectors) “to determine when external objects are within a given distance of the antennas in the device.” EX1005, [0009]; EX1003, ¶94. This circuitry may include “one or more **microprocessors**, microcontrollers, digital signal **processors**, application specific integrated circuits, etc.” configured to “control the operation of device 10.” EX1005, [0036]; *see also id.*, Fig. 2 (“storage and processing circuitry 28” (pink) coupled with sensors 41-48 (yellow)):

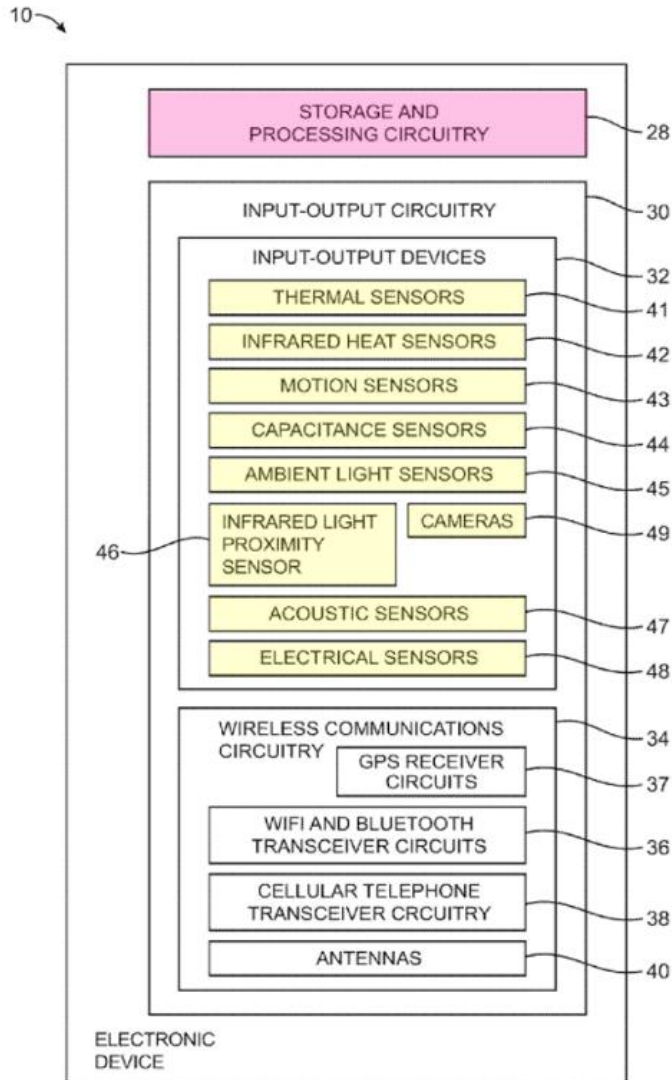


FIG. 2

“for determining, based on information provided by said one or more detectors, zones or spans of directions in the three dimensional space corresponding with one or more directions of said user or structure relative to said at least one steerable antenna”: Schlub’s “storage and processing circuitry 28” *“process[es] the signals from ... the sensors of FIG. 2”* in order to *“determine whether antenna adjustments and other adjustments to the operation of the wireless*

circuitry of device 10 should be made.” EX1005, [0086]; *see also id.*, [0036], [0048]; EX1003, ¶93. As part of this process, the storage and processing circuitry “determine[s], for each antenna 40, whether an external object such as a user’s body is in the vicinity of the antenna,” and then “determine[s] a suitable course of action” in response. EX1005, [0086]-[0087].

The “suitable course of action” may include adjusting “the direction of the signal beam associated with the antenna” so that “if an external object is detected in one location, the array can be adjusted so that antenna signals are oriented in a different direction.” *Id.*, [0088]. A POSITA would have understood that, as any real world “external object” (such as a user or other structure) exists in three-dimensions, the boundaries of the object (e.g., from the left side of the person to the right side of the person) will constitute a zone or a span of directions in three-dimensional space that the “array can be adjusted” to avoid. *Id.*; EX1003, ¶93. The zones or spans of directions corresponding to an external object are shaded in blue in Figure 8, reproduced and annotated below; the beam radiation pattern can be adjusted accordingly to radiate in the “different direction,” *e.g.*, the green area:

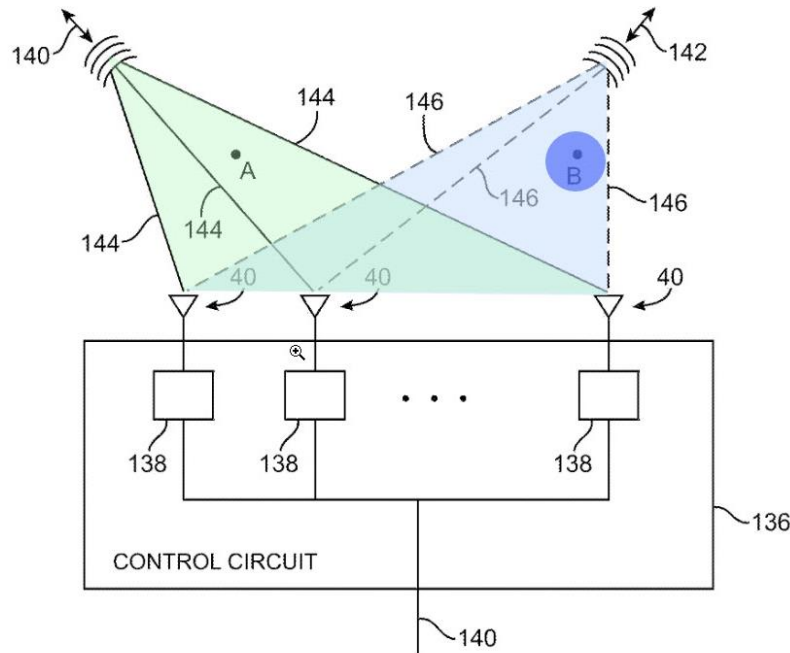


FIG. 8

Notably, Schlub includes far more disclosure of 1[b] than (i) the Dorsey reference that the Board determined discloses an equivalent limitation during prosecution of the parent '358 Application, and (ii) what PO relies on in its infringement contentions for equivalent limitations in the parent '625 Patent. EX1032, 41-42 (finding Dorsey discloses “determining zones or spans of directions in the three dimensional space corresponding with ... either or both said user and said structure” by “detect[ing] when an object such as a user’s ear is close to” a part of the wireless device); EX1033, 6-7 (PO contending “us[ing] one or more sensors to detect the location that the user of the Accused Instrumentalities is gripping the

device and deactivate[] the corresponding antenna to avoid the user” satisfies equivalent limitation 1[b] in the parent ’625 Patent); EX1003, ¶¶93-95.

4. **1[c][i]: one or more steerable antennas which operate on one or multiple bands and radiates or receives at one or more frequencies in the range of 10 GHz to 500 GHz,**

“one or more steerable antennas which operate on one or multiple bands”:

Schlub teaches that “[s]ingle-band and multiband antennas may be used,” such as “a multiband antenna ... to handle cellular telephone communications in multiple cellular telephone bands” or a “phased antenna array” (i.e., a **steerable antenna**) operating as a “multiband antenna.” EX1005, [0029]; EX1003, ¶98.

“radiates or receives at one or more frequencies in the range of 10 GHz to 500 GHz”: Schlub discloses that the “phased antenna array” can operate “at 60 GHz” and can support “other frequency bands of interest.” EX1005, [0034], [0080]; EX1003, ¶¶99-101.

5. **1[c][ii]: wherein one or more beams of said one or more steerable antennas is adjustable to accentuate its radiation pattern in one or more directions which are not in said zones or spans of directions in the three dimensional space as determined by said one or more computational devices,**

“wherein one or more beams of said one or more steerable antennas is adjustable”: Schlub teaches that its **steerable antenna** (see 1[c][i]) comprises “multiple antenna elements,” and that “control circuitry” may be “used to control the signals that are routed to and from the antenna elements (e.g., by controlling

signal phases).” EX1005, [0032]; EX1003, ¶¶102-03. In one example, Schlub discloses “a phased antenna array” that can be adjusted so that “the direction in which the antenna array is operating” will generate beam patterns that avoid radiation toward the user. EX1005, [0005]-[0006], [0009]; *see also* 1[b]. Schlub’s antenna is specifically designed so that “the direction of the signal beam associated with the antenna” is “steered in response to the proximity information.” EX1005, [0088].

“to accentuate its radiation pattern in one or more directions which are not in said zones or spans of directions in the three dimensional space”: Schlub expressly discloses that “[i]f ... an external object such as a user’s body is detected in the proximity of device 10, control circuitry 136 may be used to steer the direction in which the antenna array operates so as to bypass the external object.” *Id.*, [0081]. In particular, “if an external object is detected in one location, the array can be adjusted so that antenna signals are oriented in a different direction.” *Id.*, [0088]. A POSITA would have understood that orienting the antenna signals in a particular direction ***accentuates*** the radiation transmitted in that direction. EX1003, ¶104. The last step in Schlub’s Figure 9 (annotated below) reflects this process:

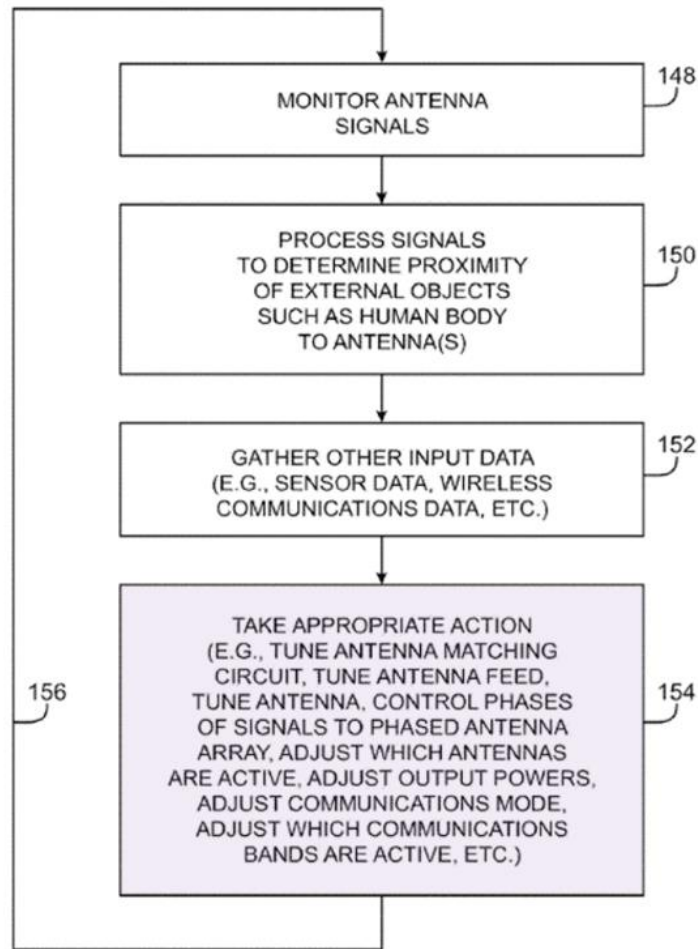


FIG. 9

Figure 8 (reproduced and annotated below) further illustrates this process in operation. For example, if the sensors “detect[] that an external object is located at point A [shaded in blue below], control circuitry 136 may be used to adjust the antenna array so that the antenna sends and receives signals along path 142 in the direction of point B [shaded in green below].” EX1005, [0081]. The antenna is steered by “produc[ing] a first set of phases on the transmitted signals” to “form a radio-frequency beam such as beam 142 that is oriented in the direction of point B,”

while attenuating the beam in the zones or spans of directions corresponding to the object. EX1005, [0080]. As a result, the beam radiation pattern in the direction that the antenna is steered to is **accentuated**, while the beam radiation pattern in the direction of the user or other detected structure is **attenuated**. EX1003, ¶105.

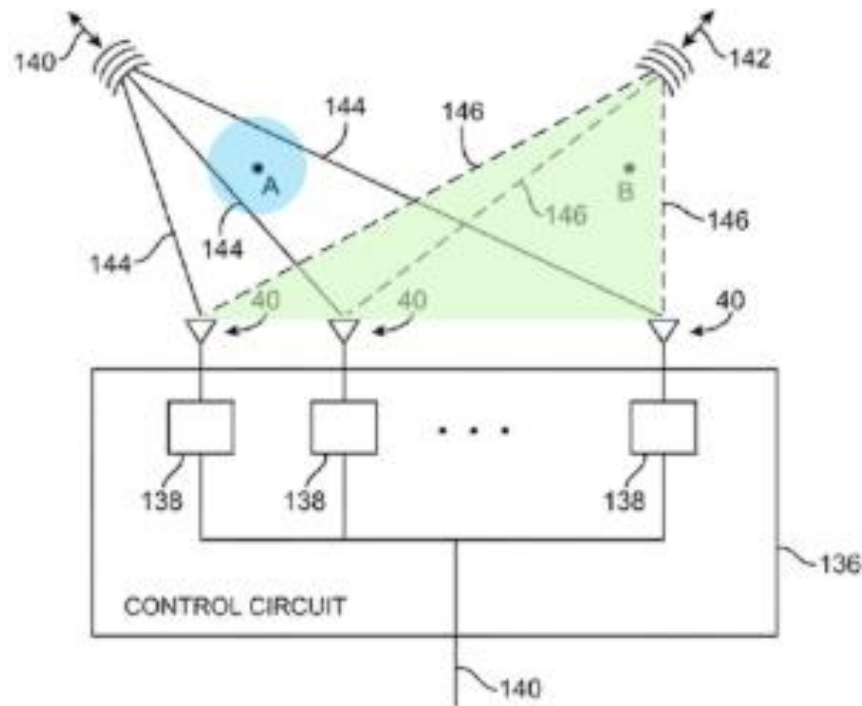


FIG. 8

To the extent PO argues that Schlub does not disclose **accentuating** the radiation pattern in one or more directions, it would have been obvious to a POSITA in view of the disclosures discussed above to use Schlub’s antenna array to accentuate a radiation pattern in one or more directions. EX1003, ¶105. For example, Schlub discloses that the embodiment in Figure 8 uses a “phased antenna

array” to “allow[] beam steering ... by controlling the relative phases of the signals for the antennas.” EX1005, [0078]-[0079]. A POSITA would have understood that in phased antenna arrays, the phases of individual antenna elements can be controlled to create constructive interference (accentuating the signal) in some directions, and to create destructive interference (attenuating the signal) in other directions. EX1003, ¶105. A POSITA would have been motivated to use constructive interference to maximize the signal strength in the directions not obstructed by a user or structure. *Id.*

“*as determined by said one or more computational devices*”: Schlub’s “storage and processing circuitry 28” (which include processors, *i.e.*, **computational devices**, see 1[a], 1[b]) “**determine whether antenna adjustments** and other adjustments to the operation of the wireless circuitry of device 10 should be made.” EX1005, [0086]; *see also* [0036], [0048]. EX1003, ¶¶106-07.

6. **1[c][iii]: wherein said one or more steerable antennas are configured to steer or direct its radiation pattern in particular directions while attenuating the radiation pattern in other directions; and**

Schlub teaches that its “phased antenna array” (*i.e.*, **steerable antenna**) is configured with “multiple antenna elements,” and that “control circuitry” may be “used to control the signals that are routed to and from the antenna elements (e.g., by controlling signal phases).” EX1005, [0032]. Schlub further teaches that “[t]he control circuitry can alter the direction in which the antenna operates.” *Id.* “If, for

example, it is desired ***to point the antenna in a first direction***, the control circuitry can use a first group of antenna element phase settings.” *Id.* “If it is desired to point the antenna in a second direction that is different than the first direction, the control circuitry can use a distinct second group of phase settings.” *Id.* Schlub discloses that “if an external object is detected in one location, the array can be adjusted so that antenna signals are ***oriented in a different direction***.” *Id.*, [0088]. A POSITA would have understood that by steering or directing the antenna in specific directions, Schlub’s system also ***attenuates the radiation pattern*** in other directions. EX1003, ¶108. PO adopts the same interpretation in its infringement contentions in the related district court case. EX1013, 14 (contending that 1[c][iii] is met by “perform[ing] beam steering to avoid obstructions”).

7. **1[d]: a controller for adjusting the radiation pattern of the one or more steerable antennas to accentuate one or more of said particular directions while attenuating the radiation pattern for said zones or spans of directions in the three dimensional space.**

Schlub discloses “control circuitry” (*i.e.*, a ***controller***) that is “used to control the signals that are routed to and from the antenna elements (e.g., by controlling signal phases),” and thereby ***adjust the radiation pattern of the steerable antenna***. EX1005, [0032]; *see also* EX1003, ¶¶110-11; 1[c][iii]. Specifically, “the direction of the signal beam associated with the antenna” is “steered in response to the proximity information,” and “if an external object is detected in one location, the

array can be **adjusted** so that antenna signals are oriented in a different direction.”

EX1005, [0088].

- C. **Claim 2: The wireless device of claim 1 wherein said wireless device is selected from the group consisting of computers, telephones, portable computing or communication devices, games, wireless memory media, radio frequency identification tags, vehicles, clothing, personal data assistants, and navigation assistants.**

Schlub discloses that its solution is implemented in an “electronic device such as a portable electronic device [with] wireless communications circuitry” (*i.e.*, a **portable computing or communication device**). EX1005, Abstract; *see also id.*, [0020]; EX1003, ¶¶112-13. Other “suitable electronic devices” include “desktop” and “laptop **computers**,” “**game** consoles,” “cellular **telephones**,” and “global positioning system (GPS) devices” (*i.e.*, **navigation assistants**). EX1005, [0024]-[0025].

- D. **Claim 3: The wireless device of claim 1 further comprising a tuner for tuning said at least one steerable antenna with one or more active elements which are selected or interconnected using electronic control.**

“**a tuner for tuning said at least one steerable antenna with one or more active elements**”: Schlub discloses “matching circuits,” “tuning circuits,” and “adjustable switches that control the size and shape of the active portions of antenna resonating elements within the antennas” (*i.e.*, **tuners** that **tune** the antenna with **active elements**). EX1005, [0009]; EX1003, ¶¶114-15. For example, Schlub explains that “antenna 40 can be adjusted by adjusting a matching network,”

“adjusting antenna tuning” using “tunable circuit components,” and “adjusting the size and shape of the antenna itself” by “using switches or other controllable circuit components to selectively change the size and shape of the antenna resonating elements.” *Id.*, [0074]-[0075]; *see also id.* [0066] (“Actions that may be taken when close proximity of an external object to one or more antennas is detected may include tuning antennas in device 10, tuning matching circuitry in device 10, tuning antenna feeds in device 10, etc.”).

“which are selected or interconnected using electronic control”: Schlub discloses that “switches” and other “**controllable** circuit components” can be used to “change the size and shape of the antenna resonating elements,” and specifically, the “**active portions** of those elements.” EX1005, [0009], [0075]; *see also id.*, [0072] (describing using “storage and processing circuitry” to control “the size and shape of the resonating element in [the] antenna” via “tunable elements” that are “selectively connected and disconnected” from the antenna), [0074] (describing using “storage and processing circuitry” to control “[s]witches” to “interconnect[]” “antenna component[s]”). Similarly, a “switch” or “tunable component” (*e.g.*, **active elements** such as a “tunable resistor, tunable inductor, or other suitable circuitry ... that can be adjusted to tune [the] antenna”) can be “interconnected with the components of [the] antenna” to tune the antenna. *Id.*, [0073]; EX1003, ¶¶116-17.

E. Claim 6: The wireless device of claim 1, wherein said at least one steerable antenna comprises a plurality of steerable antennas.

Schlub discloses that “[d]evice 10 may include a phased antenna array” and that “include[s] **multiple antenna elements.**” EX1005, [0032]. Each antenna element is **steerable** using “[c]ontrol circuitry ... to control the signals that are routed to and from the antenna elements (e.g., by controlling signal phases).” *Id.* “The control circuitry can alter the direction in which the antenna operates.” *Id.*; EX1003, ¶¶118-19.

F. Claim 7

1. 7[pre]: **A method for avoiding or reducing radiation of a user or structure by a wireless device having at least one streerable [sic] antenna, comprising:**

See 1[pre] (avoiding radiation in the direction of a user or structure), 1[c][i] (steerable antenna).

2. 7[a]: **sensing with one or more sensors selected from the group consisting of cameras, microphones, audio sensors, ultrasound sensors or transducers, range finders, capacitive sensors, gyroscopes, light detectors, or motion detectors used for computational determination of spatial orientation in three dimensional space, an orientation of said wireless device relative to either or both said user and said structure;**

See 1[a].

3. 7[b]: **receiving signals from said one or more sensors pertaining to said orientation in the three dimensional space;**

Schlub’s “storage and processing circuitry 28” “**process[es] the signals from ... the sensors** of FIG. 2” in order to “determine whether antenna adjustments and

other adjustments to the operation of the wireless circuitry of device 10 should be made.” EX1005, [0086]; *see also id.*, [0036], [0048]; 1[b]. The signals must be **received** in order to be processed. EX1003, ¶122. The sensors provide signals indicating ***the orientation of the device in three dimensional space***. *See* 1[a].

4. 7[c]: using said signals, computing zones or spans of directions corresponding with one or more directions of said user or structure relative to said at least one steerable antenna in the three dimensional space; and

See 1[b].

5. 7[d]: adjusting one or more beams of said at least one steerable antenna to accentuate its radiation pattern in one or more directions which are not in said zones or spans of directions,

See 1[c][ii]-[iii], 1[d].

6. 7[e]: wherein said at least one steerable antenna radiates or receives said one or more beams based on signals from said one or more processors determined on execution of said executable instructions,

“said at least one steerable antenna radiates or receives said one or more beams based on signals from said one or more processors”: Schlub discloses that the “storage and processing circuitry” “adjust[s] a phased antenna array (e.g., to steer an antenna away from the user’s body.” EX1005, [0023]. The “storage and processing circuitry” includes “control circuitry” to “adjust ... transmitted radio-frequency antenna signals” to “form a radio-frequency beam ... that is oriented in” a particular “direction.” *Id.*, [0077], [0080]; *see also* 1[c][iii]; EX1003, ¶126.

“determined on execution of said executable instructions”: Schlub’s “storage and processing circuitry 28 may include storage such as hard disk drive storage, nonvolatile memory (e.g., flash memory or other electrically-programmable-read-only memory configured to form a solid state drive)” (*i.e.*, ***non-transitory computer readable media***). EX1005, [0036]. The “storage and processing circuitry 28” may be used to “run software on device 10” (*i.e.*, ***execute instructions***) to perform the various operations disclosed. *Id.*, [0037], [0091]; EX1003, ¶127.

7. **7[f]: wherein said at least one steerable antenna operates on one or multiple bands, and**

See 1[c][i].

8. **7[g]: wherein said at least one steerable antenna radiates or receives at one or more frequencies in the range of 10 GHz to 500 GHz.**

See 1[c][i].

- G. **Claim 8: The method of claim 7 wherein said wireless device is selected from the group consisting of computers, telephones, portable computing or communication devices, games, wireless memory media, radio frequency identification tags, vehicles, clothing, personal data assistants, and navigation assistants.**

See Claim 2.

- H. **Claim 9: The method of claim 7 further comprising tuning said at least one steerable antenna with one or more active elements which are selected or interconnected using electronic control.**

See Claim 3.

I. Claim 12

1. **12[pre]: A method for avoiding radiation of a user or structure by a wireless device with a steerable antenna system, comprising:**

See 1[pre] (avoiding radiation in the direction of a user or structure), 1[c][i] (steerable antenna).

2. **12[a]: detecting in a three dimensional space with one or more sensors selected from the group consisting of one or more cameras, microphones, audio sensors or transducers, ultrasound sensors, range finders, capacitive sensors, gyroscopes, light detectors, or motion detectors used for computational determination of spatial orientation in three dimensional space, an orientation of said wireless device relative to either or both said user and said structure;**

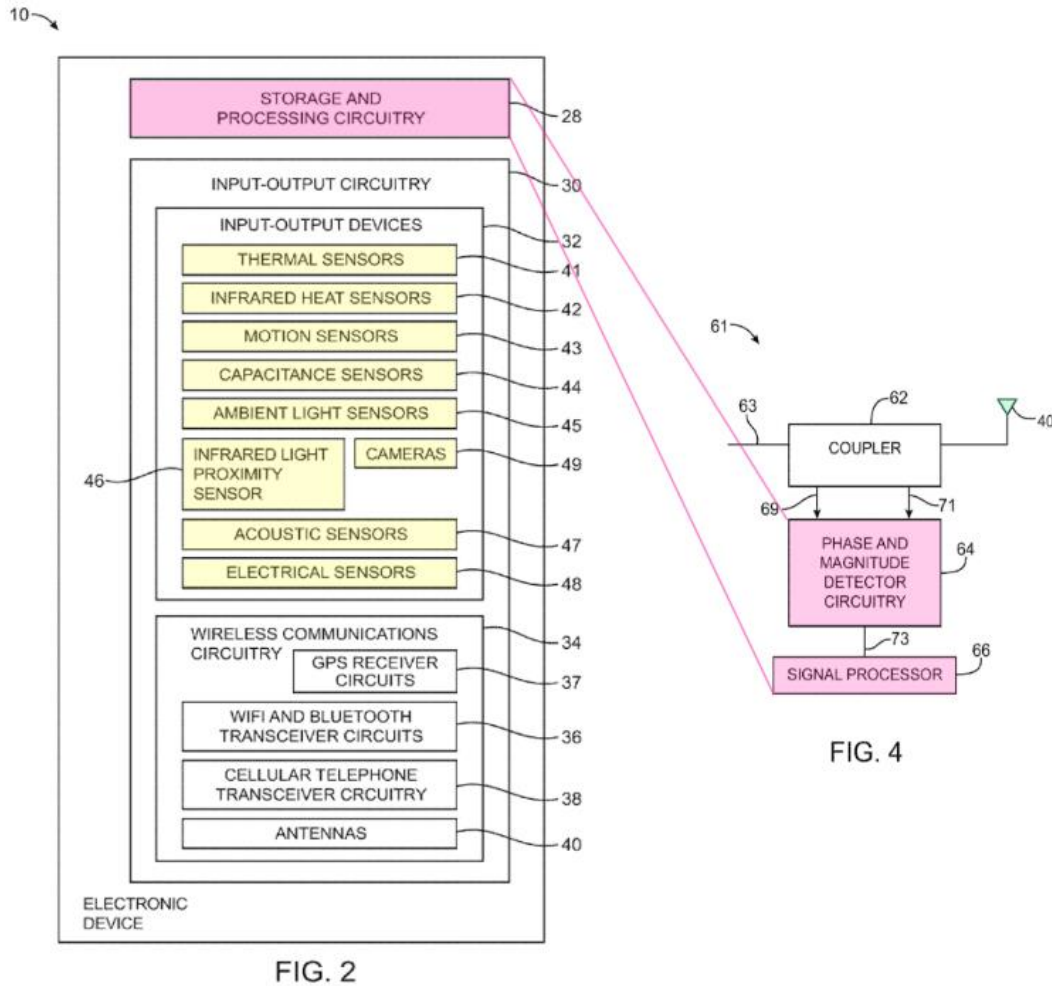
See 1[a].

3. **12[b]: computing, with a computation module communicatively coupled to said one or more sensors, zones or spans of directions in the three dimensional space;**

See 1[b] (describing computation of zones or spans of directions in three-dimensional space using “storage and processing circuitry” which comprises a ***computation module*** (*e.g.*, processor, microprocessor, ASIC) coupled to sensors).

4. **12[c]: adjusting at least one steerable antenna that operates on one or multiple bands, which radiates or receives at one or more frequencies in the range of 10 GHz to 500 GHz, and that is communicatively coupled to said computation module, so that the at least one steerable antenna radiates or receives one or more beams in one or more directions while attenuating its radiation pattern in said zones or spans of directions in the three dimensional space,**

See 1[c][i] (steerable antenna on one or multiple bands, operating at frequencies in the 10-500 GHz range). Schlub's steerable antenna is coupled with "phase and magnitude detector circuitry 64" and "signal processor 66," both of which can be "implemented using ... *suitable control circuitry (e.g., storage and processing circuitry 28* of FIG. 1)" (*i.e.*, the *computation module*). EX1005, [0059], Figs. 2, 4 (annotated below); EX1003, ¶¶136-38.



See 1[c][ii]-[iii] (describing adjusting the steerable antenna to direct beams in certain directions and attenuate radiation in the zones or spans of directions corresponding to an external object).

5. **12[d]: wherein said zones or spans of directions correspond with one or more directions or locations of said user or structure relative to said at least one steerable antenna in the three dimensional space,**

See 1[b].

6. **12[e]: wherein said at least one steerable antenna is adjusted in the adjusting step to steer or direct its radiation pattern in particular directions while attenuating the radiation pattern in other directions in the three dimensional space.**

See 1[c][iii].

- J. **Claim 13: The method of claim 12 wherein said wireless device is selected from the group consisting of computers, telephones, portable computing or communication devices, games, wireless memory media, radio frequency identification tags, vehicles, clothing, personal data assistants, and navigation assistants.**

See Claim 2.

- K. **Claim 14: The method of claim 12 further comprising tuning said at least one steerable antenna with one or more active elements which are selected or interconnected using electronic control.**

See Claim 3.

IX. GROUND 2: SCHLUB IN VIEW OF OSHIYAMA RENDERS OBVIOUS CLAIMS 4-5, 10-11, AND 15-16

Schlub discloses a wireless device operating with a steerable antenna that uses sensors (*e.g.*, a camera) to determine the orientation of the wireless device relative to external objects (*e.g.*, a user) in three-dimensional space and adjusts the radiation patterns of the steerable antenna based on detected external objects. Oshiyama discloses antennas that are capable of transmitting/receiving in multiple bands simultaneously. It would have been obvious to a POSITA to apply Oshiyama's teachings regarding simultaneous multi-band operation to Schlub's wireless device and steerable antenna as set forth below.

A. Oshiyama (EX1014)

U.S. Patent Publication No. 2006/0097918 (“Oshiyama”) was filed November 10, 2003 and published May 11, 2006. It is prior art under at least 35 U.S.C. §102(a)(1).

Oshiyama teaches a single-element, multiband antenna for mobile devices that reduces size/weight while covering disparate cellular and other services (e.g., AMPS/PCS in the U.S., GSM bands in Europe, GPS, Bluetooth, IMT-2000). EX1014, [0001]-[0005]. The core architecture feeds one end of the antenna element and ties the other end and one or more intermediate points to ground through (i) switches, (ii) series LC resonators, (iii) parallel LC resonators, or (iv) frequency-selective filters; the electrical lengths from the feed to those connection points (plus their connection lines) are set to resonate at different desired bands, so the structure supports multiple bands within a single physical element. *Id.*, [0011]-[0015]. Using switches lets the device select among bands or define the desired number of bands, while filter-based embodiments pass the target resonance and block others. *Id.*, [0012], [0014]. Oshiyama’s antenna is “capable of simultaneous antenna operation in multiple frequency bands,” citing concurrent GPS and cellular bands as an example. *Id.*, [0016].

B. Motivation to Combine

A POSITA would have been motivated to apply Oshiyama's teachings regarding simultaneous multi-band operation to Schlub's steerable antenna system, and would have reasonably expected the combination to succeed. EX1003, ¶147.

Oshiyama provides an express motivation to support simultaneous communications in multiple frequency bands. EX1003, ¶148. For example, Oshiyama identifies "situation[s] where simultaneous antenna operation in multiple frequency bands is required, for instance," when "both GPS and mobile phone systems are used." EX1014, [0016]. Oshiyama teaches that its multi-band antenna is "favorable for mobile communications" in such situations. *Id.* Further, Oshiyama teaches that a single multi-band antenna capable of simultaneous operation is preferable to multiple antennas, each operating in a different frequency band, because the single antenna solution is "ideal for the purpose of reducing antenna size and weight," which is in turn necessary to "reduce the size and weight of a mobile communication device." *Id.*, [0002], [0009]. A POSITA would have understood that in order to operate the antenna in multiple frequency bands simultaneously, appropriate tuning circuitry is needed and is also disclosed by Oshiyama. EX1003, ¶148.

In addition, Schlub, Oshiyama, and the '548 Patent are all analogous art because they are directed to the same technological subject matter, namely antennas

in wireless communication systems. EX1001, 1:20-22 (invention relates to “wireless portable devices” and “improvements in transmitting and receiving electromagnetic signals at multiple frequency bands”); EX1005, Abstract (disclosing a “portable electronic device” with “wireless communications circuitry” that “steer[s] a phased antenna array”); EX1014, [0001] (invention relates to “an antenna for multiple bands”), [0016] (invention is “favorable for mobile communications”); EX1003, ¶149.

Finally, a POSITA would have reasonably expected the combination to succeed. *Id.*, ¶150. Schlub already discloses an antenna capable of multi-band operation, and with multiple resonating elements and associated tuning circuits, and a POSITA would have understood that these elements can be configured to simultaneously operate in different frequency bands, particularly in view of Oshiyama. *Id.* Indeed, antennas with simultaneous multiband operation were well known by the priority date of the ’548 Patent, and providing such operation in Schlub’s steerable antenna would have required only routine engineering with predictable results. *Id.*

C. Claim 4: The wireless device of claim 1 wherein said at least one steerable antenna is configured for transmitting, receiving, or transmitting and receiving simultaneously in a plurality of different bands.

Schlub discloses a steerable antenna that can transmit and receive in a plurality of different bands. See Ground I, 1[c][i]. It would have been obvious to a POSITA

to implement Schlub’s antenna to operate ***simultaneously*** in a plurality of different bands in view of Oshiyama. EX1003, ¶151.

Oshiyama discloses an “antenna for multiple bands” that is configured for “simultaneous antenna operation in multiple frequency bands” (*i.e.*, ***transmitting, receiving, or transmitting and receiving simultaneously in a plurality of different bands***). EX1014, [0016], Abstract; *see also id.*, [0011], [0014] (describing the antenna “resonating” at different frequency bands); EX1003, ¶¶152-53. Oshiyama provides multiple exemplary circuit configurations that all may be used to support “simultaneous antenna operation in multiple bands.” EX1014, [0052]; *see also id.*, [0051] (disclosing antenna configuration “enabled to operate in the first to third frequency bands ... at the same time”), [0055] (same).

A POSITA would have been motivated to apply Oshiyama’s teachings regarding simultaneous multiband operation to Schlub’s steerable antenna system, and would have reasonably expected the combination to succeed, for the reasons set forth in Section IX.B.

D. Claim 5: The wireless device of claim 4 further comprising a processor for controlling tuning of one or more circuits for said at least one steerable antenna to operate in said plurality of different bands.

“a processor for controlling tuning of one or more circuits for said at least one steerable antenna”: Schlub discloses matching circuits, tuning circuits, and

adjustable switches, controlled by the “storage and processing circuitry,” that are used to tune the steerable antenna. See Claim 3; EX1003, ¶155.

“*to operate in said plurality of different bands*”: Schlub teaches that the “storage and processing circuitry” can “adjust[] which communications bands are active.” EX1005, [0023]. In particular, by controlling switches and tunable components (*e.g.*, as illustrated in the tuning circuit shown in Figure 6, reproduced below), Schlub’s system can “adjust[] the frequency response of the antenna.” *Id.*, [0072].

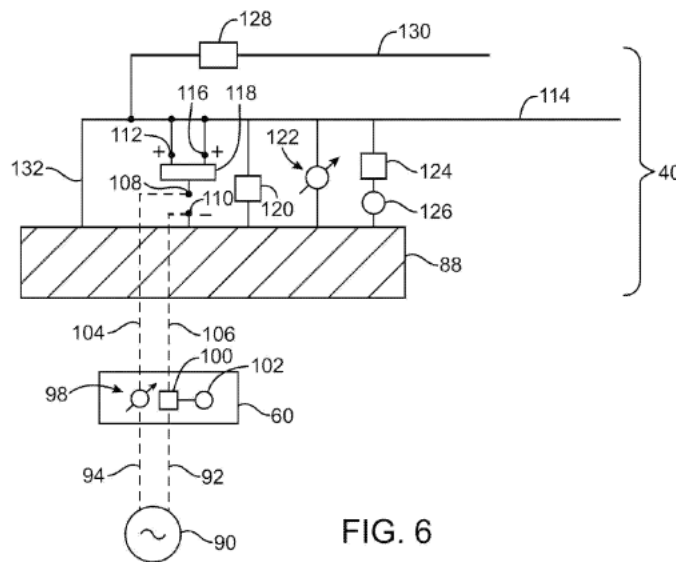
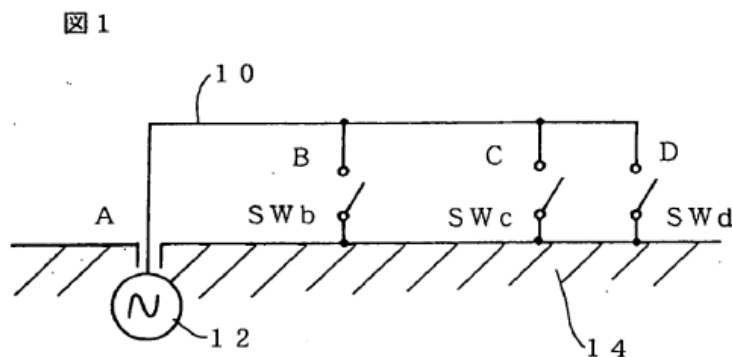


FIG. 6

It would have been obvious to a POSITA to use Schlub’s “storage and processing circuitry” to control tuning circuits to operate in a plurality of different bands *simultaneously*, as taught by Oshiyama. EX1003, ¶¶156-57.

Oshiyama discloses circuitry for tuning an antenna to a plurality of different frequency bands. EX1003, ¶¶158-60. For example, in one embodiment, depicted

in Figure 1, Oshiyama's system uses a set of switches (SWb, SWc, and SWd) to tune an antenna to one of three different supported frequency bands by selectively activating the switches to control the length of the antenna element. EX1014, [0047]-[0049]. In this respect, the tuning circuit in Figure 1 of Oshiyama is comparable to the tuning circuit in Figure 6 of Schlub, in which switches are similarly controlled to "adjust[] the size and shape of the antenna resonating element" in order to "adjust[] the frequency response of the antenna." EX1005, [0072]; EX1003, ¶158.



In other embodiments, Oshiyama discloses alternative tuning circuits that can tune the antenna to a plurality of different bands *simultaneously*. For example, the embodiment shown in Figure 2 replaces the switches with "first to third series resonant circuits, each set to a different frequency band. EX1014, [0050]. In this way, "the antenna of the second embodiment is enabled to operate in the first to third frequency bands f1, f2, and f3 *at the same time*." *Id.*, [0051]. A POSITA would have been motivated to make a similar modification to Schlub's tuning circuits to

support simultaneous multiband operation, and would have reasonably expected to succeed in doing so, as explained in Section IX.B.

- E. Claim 10: The method of claim 7 wherein said at least one steerable antenna is configured for transmitting, receiving, or transmitting and receiving simultaneously in a plurality of different bands.**

See Claim 4.

- F. Claim 11: The method of claim 10 comprising controlling tuning of a tuner for said at least one steerable antenna to operate in said plurality of different bands.**

See Claim 5.

- G. Claim 15: The method of claim 12 wherein said at least one steerable antenna is configured for transmitting, receiving, or transmitting and receiving simultaneously in a plurality of different bands.**

See Claim 4.

- H. Claim 16: The method of claim 15 comprising controlling tuning of a tuner for said at least one steerable antenna to operate in said plurality of different bands.**

See Claim 5.

X. GROUND 3: PRASAD IN VIEW OF SEOL AND YIN RENDERS OBVIOUS CLAIMS 1-3, 6-9, AND 12-14

Prasad discloses a wireless device that uses sensors (*e.g.*, cameras, gyroscopes, accelerometers, etc.) to detect a wireless device's orientation relative to a user in three-dimensional space, determines zones where the user is located relative to the wireless device, and adjusts a steerable antenna so that its radiation pattern points away from the zones or spans of directions where the user is located, and

instead radiates in other directions. Seol discloses using steerable antennas at frequencies within the claimed 10 GHz to 500 GHz range. It would have been obvious to a POSITA to apply Seol's teachings to Prasad's wireless device and steerable antenna as set forth below.

To the extent PO contends that Prasad and Seol do not disclose or render obvious determining and using "zones" or "spans of directions" (*e.g.*, 1[b] and 1[c][ii]), these limitations would have been obvious in view of Yin¹ as explained below.

A. Prasad (EX1006)

U.S. Patent Pub. No. 2013/0237272 ("Prasad") was filed September 16, 2011 and published September 12, 2013. It is prior art under at least 35 U.S.C. §102(a)(2).

Prasad discloses a "smart directional radiation protection system" for "portable wireless mobile devices" designed to "reduc[e] the intensity of radiation" on a "user[-]facing direction." EX1006, Abstract. Prasad's system "focus[es] on multi mode dynamic radiation pattern for actively varying, controlling and reducing the intensity of radiation on direction facing the user." *Id.*, [0007]. Prasad accomplishes this using a "tunable ... antenna system" with a "directional transmit power controller" that "actively controls the radiation on [the] required direction

¹ WIPO Pat. Pub. 2014/194455 ("Yin") was filed on June 3, 2013 and published December 11, 2014. It is prior art under at least 35 U.S.C. §102(a)(2).

facing the user.” *Id.*, [0020]. The system uses sensors (*e.g.*, “location sensor like proximity or contact sensor” or “orientation sensors like gyro sensor[or] accelerometer”) to “align the direction of controlling and reducing of radiation facing the user.” *Id.*, [0008], [0010]. When sensors detect that the device is near the user’s head or body, a microprocessor analyzes the sensed information and a controller then adjusts the antenna system to redirect radiation away from the user-facing direction using “beamforming” or “beam steering.” *Id.*, [0016], [0020]-[0025]. The antenna system uses “one or a combination of” tunable antennas. *Id.*, Claim 24(d).

B. Seol (EX1007)

U.S. Pat. No. 9,362,994 (“Seol”) was filed May 10, 2013 and issued June 7, 2016. It is prior art under at least 35 U.S.C. §102(a)(2).

Seol describes a “wireless mobile communication system” that uses improved “beamforming” for “signal transmission and reception between a Mobile Station (MS) and a Base Station (BS). EX1007, 1:18-21, 2:31-35. Seol’s system operates in the “millimeter-wave frequency band” (*i.e.*, in the 30-300 GHz range). *Id.*, 1:37-38, 2:27-30.

C. Motivation to Combine

A POSITA would have been motivated to operate Prasad’s wireless communication device and steerable antenna in millimeter-wave (mmWave)

frequency bands disclosed in Seol, and would have reasonably expected the combination to succeed. EX1003, ¶171.

First, Seol provides an express motivation to operate wireless communication devices in the mmWave frequency band. *Id.*, ¶172. Seol discloses that “demands for [wireless] traffic have accelerated due to increased demands for smartphones and tablet Personal Computers.” EX1007, 1:31-36. Seol teaches that “recent interest has focused on a millimeter-wave wireless communication system” to solve this problem. *Id.* Other references corroborate the advantages of mmWave communications. For example, U.S. Pat. Pub. 2011/0182174 (“Pi”), published in 2011, discloses that “the larger amount of spectrum available in the mmWave bands” allows for a “data rate ... much higher than that provided in cellular bands.” EX1009, [0051]. Thus, mmWave frequency bands “achieve data communications with very high throughput and low latency, thus greatly improving user experience and enabling new mobile communication applications.” *Id.*

Second, Seol’s teachings would motivate a POSITA to implement mmWave communications in a steerable antenna system, such as Prasad’s. EX1003, ¶173. Seol teaches that for wireless communication in mmWave frequencies, “propagation loss ... is increased ... and resulting shortened propagation distance reduces service coverage.” EX1007, 1:38-43. Thus, implementing effective mmWave communication systems requires “mitigating the path loss of waves using

beamforming and thus increasing the propagation distance of the waves.” *Id.*, 1:43-47. Accordingly, mmWave communication systems uniquely benefit from the beamforming capabilities of steerable antenna systems such as Prasad’s. EX1006, [0024] (Prasad disclosing that its steerable antenna is capable of “beamforming and beam steering”); EX1003, ¶173. Pi similarly discloses that beamforming can be used to overcome these known disadvantages of mmWave systems to “achieve good quality of communication,” providing additional motivation. EX1009, [0042].

Third, Prasad discloses that the “[o]bjective of the invention is to protect the user from mobile cell phone radiation and its adverse health effects simultaneously maintaining the quality of communication.” EX1006, [0006]. Prasad’s smart directional radiation protection system, which incorporates a steerable antenna and utilizes techniques such as beamforming and beam steering, achieves this goal. EX1006, Abstract. Thus, a POSITA would have understood that using Prasad’s steerable antenna in mmWave frequencies offers the added benefit of protecting users from potentially harmful radiation in that frequency band. EX1003, ¶174.

In addition, Prasad, Seol, and the ’548 Patent are all analogous art because they are directed to the same technological subject matter, namely antennas in wireless communication systems that can steer or direct beams of radiation in specific directions. EX1001, 4:36-38 (“a steerable antenna within a wireless device to avoid radiating towards a person or object.”); EX1006, [0007] (“antenna arrays ...

to achieve dynamic radiation pattern, beamforming, beam steering etc.”); EX1007, 1:18-19 (invention relates to a “beamforming-based wireless mobile communication system”); EX1003, ¶175.

Finally, a POSITA would have reasonably expected the combination to succeed. *Id.*, ¶176. As Seol acknowledges, mmWave communications were well known and in use prior to the ’548 Patent. EX1007, 1:31-38; *see also* EX1009, [0009]. In addition, as both Prasad and Seol acknowledge, antenna steering techniques (including beamforming and beam steering) were also well known and in use prior to the ’548 Patent. EX1006, [0007]; EX1007, 1:43-1:59; *see also* EX1009, [0033], [0042]; EX1003, ¶176. A POSITA would thus have been capable of configuring Prasad’s antennas to operate at mmWave frequencies, including within the 10 GHz to 500 GHz range. EX1003, ¶176. Indeed, Prasad’s implementation is not limited to or dependent on certain operating frequencies, and a POSITA would have understood that Prasad’s steerable antenna may be configured to operate at frequencies including in the 10-500 GHz band. *Id.* All these changes to Prasad would have required only routine engineering with predictable results. *Id.*

D. Claim 1

1. 1[pre]

To the extent the preamble is limiting, Prasad discloses it.

Prasad discloses a “directional ***radiation protection system*** for ***wireless mobile device*** to reduce SAR [Specific Absorption Rate].” EX1006, Title; *see also id.*, [0015]-[0016] (disclosing methods to “reduc[e] SAR”), [0017] (system is “mainly concerned about varying and ***reducing the intensity of radiation 180 facing the user***”). “SAR” refers to how much radiation a user absorbs when exposed to electromagnetic fields emitted by the wireless device. EX1003, ¶¶177-80.

Prasad reduces radiation directed to a user through “dynamic radiation pattern[s], beamforming, beam steering etc.” EX1006, [0024]. These techniques are implemented using an antenna that “varies and controls the directional transmission & intensity of radiation” (*i.e.*, a steerable antenna). *Id.*, [0027].

2. 1[a]

“one or more detectors selected from the group consisting of one or more cameras, microphones, audio sensors, ultrasound sensors or transducers, range finders, capacitive sensors, gyroscopes, light detectors, or motion detectors”:

Prasad discloses each of the recited sensor types, including “2D & 3D cameras,” “MIC ... to sense the change in sound,” “ultrasonic sensors,” “distance or range sensor,” “capacitive sens[ors],” “[g]yro sensor,” “light sensors,” and “accelerometer.” EX1006, cl. 22; *see also id.*, [0008-10], [0020-22]; EX1003, ¶182.

“used for computational determination”: Prasad discloses a “processing unit” that “**compute[s]** the information from the sensors” and “controls the sensor system” in order to “optimize the radiation pattern based on sensor system parameters.” EX1006, Claim 23; EX1003, ¶183. The sensor data is used “by the processing unit for user recognition, face recognition, iris recognition and environment sensing with dimension and range.” *Id.*, cl. 23. The information received from the sensors is then used to “decide on further action” and “**determine** ... [a] control signal for varying the directional transmission of radiation with corresponding least SAR.” *Id.*, [0027].

“of spatial orientation in three dimensional space”: Prasad’s sensor system includes three-**dimensional sensors**, such as “2D & **3D cameras**” for “for scanning and detecting the environment in all possible directions [*i.e.*, in **all three dimensions**].” EX1006, cl. 22(c) (using “**360 degree** or **omnidirectional sensors**”). For example, Prasad uses “optical or visual & infrared cameras or sensors for sensing the user presence with direction, range, dimension” (*i.e.*, **in three dimensions**). *Id.*, cl. 30. Prasad also discloses using sensors with “multi dimension and axis sensing capability,” which would be capable of detecting in **three dimensions**. *Id.*, cl. 22. A POSITA would have understood that these disclosures all describe techniques for detecting users or structures in three dimensional space. EX1003, ¶184.

“for detecting an orientation of said wireless device relative to either or both said user and said structure”: Prasad discloses a “sensor system 130 to determine ... device ***orientation*** and proximity of wireless device ***to user***.” EX1006, [Abstract]; *see also* [0010] (using sensors to “sense the change in ***orientation of the device***”), cl. 22(d) (using sensors to “sense the change in ***orientation*** and direction ***of the mobile device***”); *see also* EX1003, ¶185.

3. 1[b]

“one or more processors”: Prasad discloses a “processing unit” that “compute[s] the information from the sensors” and “controls the sensor system.” EX1006, Cl. 23; EX1003, ¶188. For example, the processing unit may be a “***microprocessor***” that “***interact[s] with [the] sensor system***.” EX1006, [0019].

“determining, based on information provided by said one or more detectors, zones or spans of directions in the three dimensional space corresponding with one or more directions of said user or structure relative to said at least one steerable antenna”: Prasad discloses that the processing unit/microprocessor “***compute[s]*** the information from the sensors.” EX1006, Cl. 23; EX1003, ¶189. It then “determine[s] the nature of the control signal for varying the directional transmission of radiation with corresponding least SAR.” EX1006, [0027]. For example, in Figure 2, Prasad illustrates the radiation emitted by the antenna of the wireless device in different directions (represented by concentric circles). EX1006,

[0018], Fig. 2. As shown in Figure 2, Prasad's system detects the "direction facing head" (i.e., the **zones/spans corresponding with the direction of the user relative to the antenna**). *Id.*, [0018].

Prasad **determines** the zones and spans corresponding with the direction of the user based on the sensor detections described above. See 1[a]; EX1006, [0027]. The zones/spans corresponding to the user are illustrated with the "dotted lines" (annotated in yellow below), which represent "controlled and reduced radiation 180" in the direction of the user. *Id.*; EX1003, ¶¶190-92.

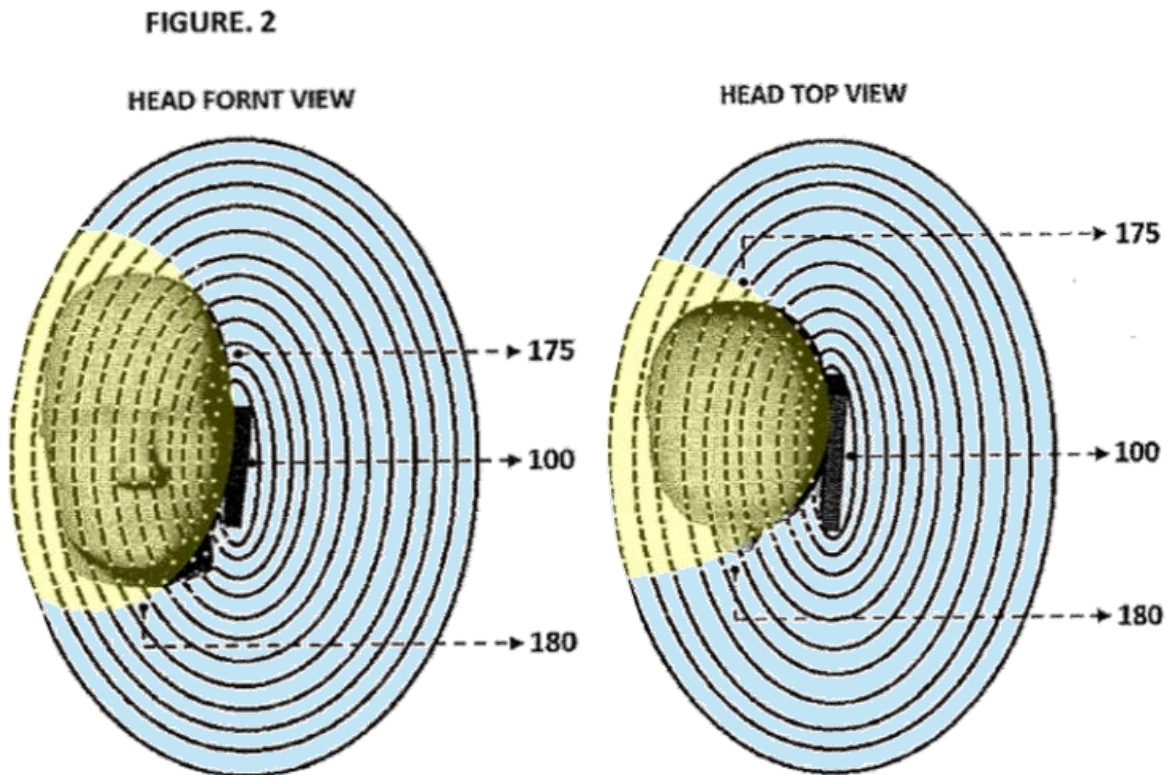
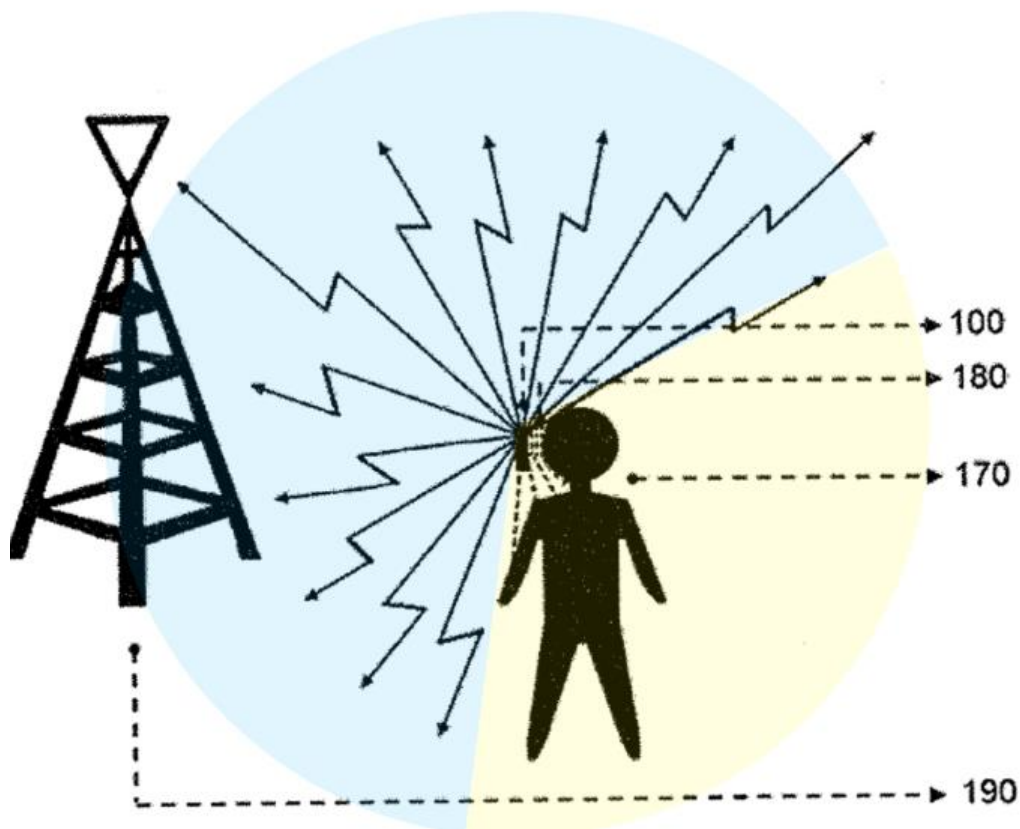


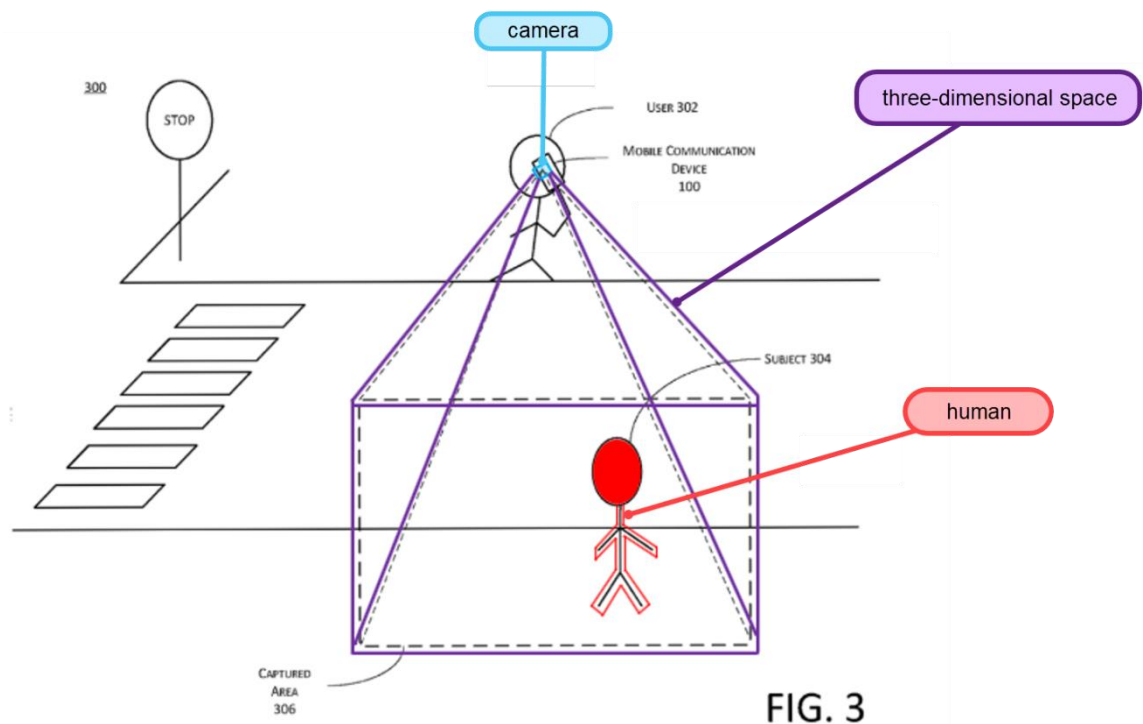
Figure 2 shows the emitted radiation from both a top view (*e.g.*, an x-y plane) and a front view (*e.g.*, an x-z plane), confirming detection in all three dimensions (*i.e.*, **three dimensional space**). EX1006, [0018], Fig. 2.

Figure 1 provides an alternative illustration that also shows the zones or spans corresponding with the direction of the user in three dimensional space. *Id.*, [0017], Fig. 1. Here, again, the **zones/spans corresponding to the direction of the user** are illustrated with dotted lines (annotated in yellow below), which represent the “controlling of radiation intensity 180” in that direction. *Id.*, [0017].

FIGURE. 1

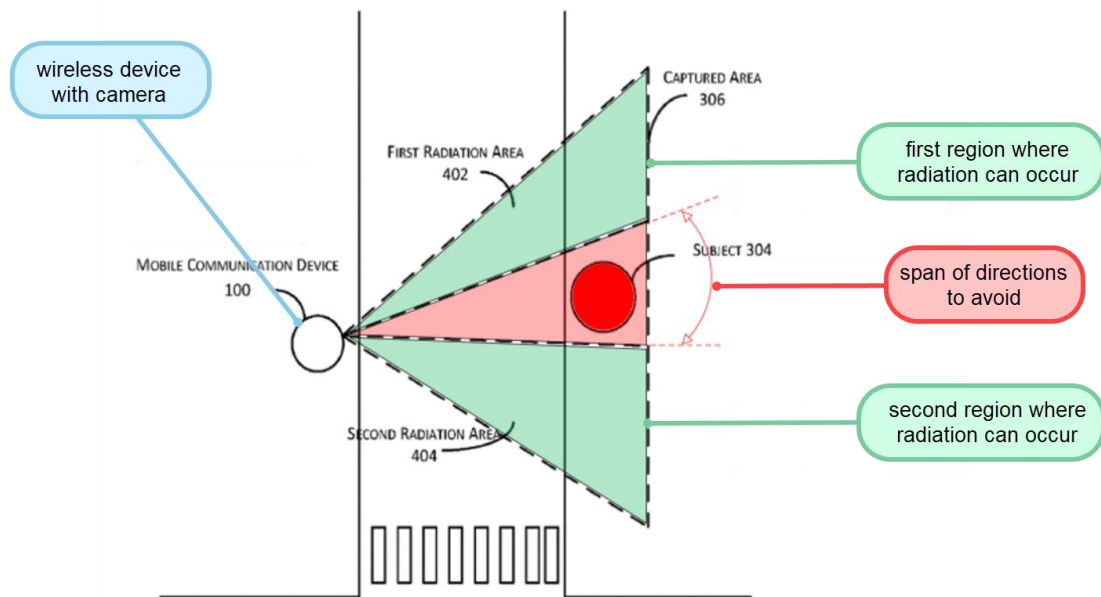


To the extent PO contends Prasad alone does not disclose “zones” or “spans of directions,” Yin renders it obvious. Yin describes a mobile communication system that addresses health and performance concerns related to electromagnetic radiation exposure. EX1008, 1:9-14. To accomplish this goal, Yin “capture[s] a digital photograph” of the three-dimensional area around the wireless device and “identif[ies] a presence of one or more people in the area.” EX1008, 1:19-26, 7:6-12, 8:5-23; EX1003, ¶¶193-95. Figure 3 (reproduced and annotated below) illustrates this process:



Yin determines “regions in the area”/ “regions in the surroundings” (*i.e.*, **zones or spans of directions**) where people are located. *Id.*, 1:19-26, 7:12-13. The determined zones dictate where radiation should be directed and where it should be

avoided. *Id.*, 7:12-13, 8:24-9:6. This process is illustrated in Figure 4 (reproduced and annotated below), where radiation is directed to a “first radiation region 402” and a “second radiation region 404” where radiation is to be directed, while avoiding the zone between those two regions is where a person was detected. Specifically, “[o]nce the one or more subject(s) 304 are detected, processor 206 may determine regions to which the EM radiation may be preferably directed, i.e., away from subject(s) 304.” *Id.* 10:3-8.



A POSITA would have been motivated to apply Yin’s teachings regarding the determination and usage of zones or spans of directions to Prasad’s wireless device and would have reasonably expected the combination to succeed. EX1003, ¶195.

As discussed above, Prasad already discloses detecting the presence and location of a user in order to steer away potentially harmful radiation. To the extent

not already disclosed by Prasad, a POSITA would have been motivated to apply Yin's method of determining zones or spans because doing so simplifies and improves control of the antenna, *e.g.*, by identifying objects and steering based on discrete zones, rather than more complex contours and boundaries defining the outlines of particular objects. EX1003, ¶196. Prasad and Yin both disclose similar camera solutions coupled to processing circuitry, and a POSITA would have understood that both systems can thus be configured to determine zones based on object detections using routine software and programming, and thus reasonably expected the combination to succeed. *Id.* Indeed, Yin expressly recognizes that “it is common within the art to describe devices and/or processes in the fashion set forth herein, and thereafter use engineering practices to integrate such described devices and/or processes into data processing systems.” EX1008, 13:7-11.

In addition, like Prasad, Seol, and the '548 Patent, Yin is analogous art because it is directed to the same technological subject matter, namely antennas in wireless communication systems that can steer or direct beams of radiation in specific directions. EX1008, 1:19-26 (invention is a “mobile communication device” with a “multi-element antenna array” that “avoid[s] EM radiation being directed toward...one or more regions”). EX1003, ¶¶197-98.

In addition, Prasad and Yin both provide more disclosure of 1[b] than Dorsey (cited during prosecution of the parent '358 Application) or the elements PO accuses

of infringement in the related district court action. EX1032, 22-23; EX1033, 6-7; Ground 1, 1[b].

4. 1[c][i]

Prasad in view of Seol renders 1[c][i] obvious. Prasad discloses that its “system can be designed to adopt ***different multi band antennas***” such as a “dual band” antenna system that ***operates on multiple bands***. EX1006, [0024].

It would have been obvious to a POSITA to operate Prasad’s steerable antenna system to radiate at frequencies in the range of 10 GHz to 500 GHz in view of Seol. EX1003, ¶200.

Seol discloses transmitting and receiving signals by “beamforming in a millimeter-wave communication system.” EX1007, 2:27-30; *see also id.*, 5:29-37. A POSITA would have known that mmWave systems operate at frequencies between 30 and 300 GHz, *i.e.*, ***in the range of 10 to 500 GHz***. EX1003, ¶¶199-202; *see also* EX1007, 5:38-42 (example using 60 GHz); EX1015, [0006] (explaining that mmWave systems operate at “a radio frequency of 30 GigaHertz (GHz)-300 GHz”). Seol also discloses that beamforming is implemented using an “antenna array” that “focus[es] signal waves in a specific direction” (*i.e.*, a ***steerable antenna***). EX1007, 5:12-28.

A POSITA would have been motivated to apply Seol’s teachings regarding mmWave band steerable antennas to Prasad’s steerable antenna system, and would

have reasonably expected the combination to succeed, for the reasons set forth in Section X.C.

5. 1[c][ii]

“*wherein one or more beams of said one or more steerable antennas is adjustable*”: Prasad’s *steerable antenna* (see 1[pre]; EX1006, [0027]) comprises an “[a]ntenna system” with “*one or more* radiating element[s]” used “to achieve *dynamic radiation pattern*.” EX1006, cl. 24(f). As such, Prasad discloses “*at least one* steerable antenna” that itself has its beam radiation pattern adjusted to achieve a dynamic radiation pattern. A POSITA would have understood that the dynamic radiation pattern of Prasad refers to a pattern of a single antenna² that can be adjusted at different points in time. EX1003, ¶204. In that respect, Prasad discloses the key limitation the Board found the Dorsey prior art did not disclose during prosecution of the parent ’358 Application—use of beamforming by a single antenna. See EX1032, 42-44.

Other disclosures in Prasad confirm this understanding. For example, Prasad discloses sending a “control signal” based on the sensor detection to the “antenna

² The ’548 patent specification teaches that a steerable antenna may itself include multiple sub-elements or antennas. See, e.g., 14:32-43 (“[T]he disclosed invention with *single antenna* which *may have one or more elements or antennas*...may be used in conjunction with other antennas in various switching, phasing, or active or passive combining techniques to form a larger or distributed antenna structure that also works over multiple frequencies.”); 13:35-37 (“*Multiple embedded antenna elements* 75 are usable to provide *a steerable antenna beam*.”).

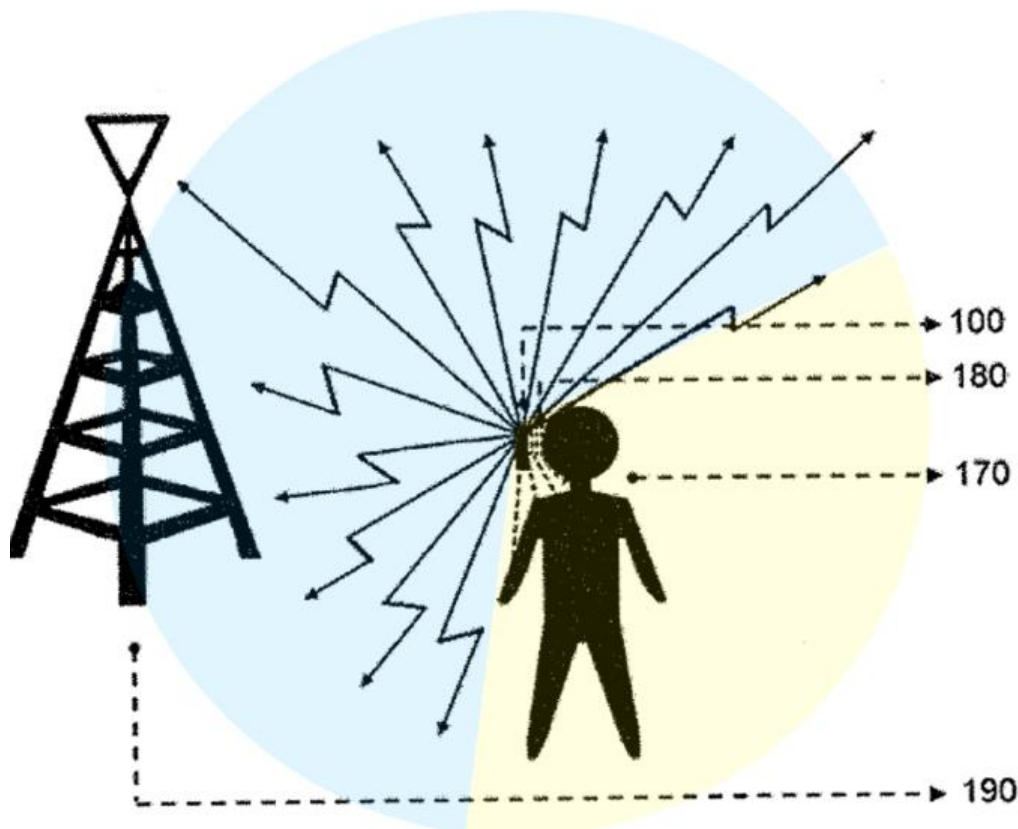
system” that “varies and controls [*i.e.*, ***adjusts***] the directional transmission & intensity of radiation on the user facing direction.” EX1006, [0027]; *see also id.*, [0026] (distinguishing Prasad’s “active dynamic radiation pattern solution” from the “fixed radiation pattern approach”). Prasad further discloses that the antenna system is “tunable” such that the “structure” of the antenna material “can be ***adjusted*** in real time, making it possible to reconfigure the structure during operation.” *Id.*, [0024]; *see also id.*, [0026] (system can “change and adapt to various radiation patterns which in turn alters the intensity of radiation in required direction and time”). By tuning the structure of the antenna during operation, the system is able to “actively control[] the radiation intensity in required direction and time.” *Id.*; *see also id.*, [0020] (describing the use of a “control signal” to “actively control[] the radiation on required direction facing the user utilising tunable ... antenna system 110”).

In addition, Prasad consistently discloses that the radiation pattern is determined by a singular “antenna system 110” or “tunable metamaterial or tunable EBG antenna system,” as opposed to multiple selectable antenna structures. *Id.*, [0019]-[0022], [0024], [0027], Fig. 3; EX1003, ¶¶204-06.

“to accentuate its radiation pattern in one or more directions which are not in said zones or spans of directions in the three dimensional space”: Prasad expressly discloses adjusting the radiation pattern of its antenna system to accentuate radiation in the directions where the user was ***not*** detected. EX1003, ¶207. For

example, Figure 1, reproduced and annotated below, illustrates how the antenna is adjusted to ***accentuate its radiation pattern*** in the directions highlighted in blue, which are ***not the zones or spans of directions in the three dimensional space*** where the user is located (*i.e.*, the yellow-highlighted zone):

FIGURE. 1



EX1006, Fig. 1; *see also id.*, Fig. 2 (illustrating the same).

Prasad explains that “[t]he radiation protection system is mainly concerned about varying and ***reducing the intensity of radiation 180 facing the user 170 while maintaining the radiation on other directions.***” EX1006, [0017]; *see also id.*, [0007] (disclosing “multi mode dynamic radiation patterns for actively varying,

controlling and ***reducing the intensity of radiation on direction facing the user and accordingly maintaining the radiation on other directions***”). Thus, Prasad’s system “control[s] [the] radiation intensity from wireless device to reduce SAR,” as illustrated by the “dotted lines [180] in the diagram on user facing direction.” *Id.*, [0017]. The antenna continues to radiate in the “other directions,” represented by the solid arrows in Figure 1. *Id.*, [0026] (“The present invention provides a fine tuning and controllable radiation on the user facing direction while maintaining the radiation on other direction.”). As a result, radiation in the other directions is ***accentuated*** relative to radiation in the direction of the user (which is ***reduced*** or ***attenuated***). EX1003, ¶208.

“as determined by said one or more computational devices”: Prasad discloses that the processing unit (*i.e.*, a ***computational device***) uses the “sensor system parameters” (*i.e.*, ***said signals***) for “user recognition ... and environment sensing with dimension and range,” and to “determine the nature of the control signal for varying the directional transmission of radiation with corresponding least SAR.” EX1006, [0027], cl. 23; EX1003, ¶209.

To the extent PO argues that Prasad does not disclose determining zones or spans of direction to avoid (*i.e.*, zones or spans of directions corresponding to a user or other structure), Yin renders this obvious. (*see* Section X.D.3, *supra*).

6. 1[c][iii]

As discussed in 1[c][ii], Prasad's *steerable antenna is configured to direct energy in particular directions* (i.e., directions where a user is not detected) *while attenuating the radiation pattern in other directions* (i.e., directions where a user is detected). EX1003, ¶211. Specifically, Prasad discloses that its system controls the antenna to “reduc[e] the intensity of radiation 180 facing the user 170 while maintaining the radiation on other directions.” EX1006, [0017]; *see also id.*, [0007], [0018], [0026], Fig. 1, Fig. 2.

7. 1[d]

Prasad, alone or in combination with Yin, discloses and renders obvious 1[d].

First, Prasad discloses that the processing unit “comput[es] the control signal” used to *adjust the “antenna radiation pattern.”* EX1006, cl. 21; *see also id.*, [0022] (“microprocessor 150 manipulate[s] the ... control signal” to “control[] the radiation pattern”); *see also* 1[c][ii]. The “processing unit” thus comprises a “controller” as claimed. EX1003, ¶¶214-16.

Second, as discussed in 1[c][ii], Prasad discloses adjusting the beam radiation pattern to accentuate radiation in one or more directions that do not correspond to zones or spans where the user is located. EX1006, [0007] (disclosing “dynamic radiation pattern for actively varying, controlling and reducing the intensity of radiation on direction facing the user and accordingly maintaining the radiation on

other directions.”). The adjusting step also includes the step of adjusting the radiation pattern to attenuate the radiation in the zones or spans of directions where the user is located. *Id.*, [0026] (“Instead of fixed radiation pattern approach the present invention provides an ***active dynamic radiation pattern solution that can change and adapt to various radiation pattern*** which in turn ***alters the intensity of radiation in required direction and time according to scenarios to protect user from radiation.***”).

As Prasad explains, “[t]he lattice structure of the tuneable metamaterial and EBG is ***adjusted in real time***, making it possible to ***reconfigure the structure during operation.***” *Id.* An advantage of this is that “[i]nstead of fixed radiation pattern approach the present invention provides an ***active dynamic radiation pattern solution that can change and adapt to various radiation pattern*** which in turn ***alters the intensity of radiation in required direction and time according to scenarios to protect user from radiation.***” *Id.*, [0026]. This steerable antenna is configured to steer radiation energy away from the user and into the areas where the user is not located, thereby attenuating radiation in the direction of the user, as illustrated in Figure 1.

To the extent a POSITA looked to Yin to determine the zones to accentuate and attenuate, it would have been obvious for a POSITA to use Prasad’s ability to adjust beam radiation patterns of its steerable antenna to accentuate and attenuate

radiation in different directions based on zones or spans of directions in the three dimensional space as disclosed in Yin. See EX1003, ¶217; 1[b].

E. Claim 2

Prasad discloses that its solution is “for portable wireless mobile devices like mobile cell phone 100” (*i.e.*, **telephone**). EX1006, Abstract; EX1003, ¶¶218-19. Other applicable devices include “walky talkie” (*i.e.*, **portable communication devices**), “laptops” (*i.e.*, **computers**), and “gaming devices” (*i.e.*, **games**). EX1006, Cl. 38.

F. Claim 3

Prasad discloses a “smart directional transmit power or radiation controller 120” (*i.e.*, **tuner**) coupled with a “tunable metamaterial or tunable EBG antenna system 110.” EX1006, Abstract, Fig. 3; EX1003, ¶¶220-21. Prasad explains that “[t]he change in **radiation pattern is balanced and tuned** in achieving between least SAR and best signal quality by also accounting received signal parameters so that the quality of communication is not compromised” (*i.e.* **for tuning said at least one steerable antenna**). EX1006, [0025].

Prasad’s antenna system “works by **activating** different pattern of **tuneable EBG and metamaterial elements**” (*i.e.*, **active elements**) to “actively control[] the radiation intensity in required direction and time” (*i.e.*, using **electronic control**). *Id.*, [0024]. The active elements are interconnected using electronic control because

they are electronically controlled by the circuitry of the wireless device, and in particular are “actively controll[ed]” such that the elements are “reconfigur[able] ... during operation.” *Id.*

G. Claim 6

Prasad discloses that “the antenna design” of the steerable antenna may use “antenna arrays or diversity with RF system to achieve dynamic radiation pattern, beamforming, beam steering.” EX1006, [0024]; *see also id.*, cl. 24 (reciting an “[a]ntenna system” that uses “MIMO and antenna arrays.” A POSITA would have understood that an “antenna array” is made up of an organized arrangement of **a plurality of steerable antenna** elements, each of which operates an individual antenna. EX1003, ¶¶222-23; *see also* EX1007, 5:14-16 (explaining that an “antenna array” comprises a set of “individual antennas ... called antenna elements”).

H. Claim 7

1. 7[pre]

See 1[pre] (avoiding radiation in the direction of a user or structure), 1[c][i] (steerable antenna).

2. 7[a]

See 1[a].

3. 7[b]

Prasad’s s “processing unit” is configured to “control[] the sensor system” and “computes the information from the sensors.” EX1006, Claim 23; *see also* 1[b]. The

information from the sensors must be ***received*** in order to be processed. EX1003, ¶226. The sensors provide information indicating ***the orientation of the device in three dimensional space***. See 1[a].

4. 7[c]

See 1[b].

5. 7[d]

See 1[c][ii]-[iii], 1[d].

6. 7[e]

“said at least one steerable antenna radiates or receives said one or more beams based on signals from said one or more processors”: Prasad’s processing unit uses a ***“control signal,”*** determined ***“based on signal[s] from ... [the] sensors”*** to control the ***antenna radiation pattern***. EX1006, [0021]; *see also* 1[c][iii]; EX1003, ¶230.

“determined on execution of said executable instructions”: As discussed above, Prasad discloses a “processing unit” such as a “microprocessor.” See 1[b]. A POSITA would have understood that a microprocessor executes instructions (*i.e.*, ***executable instructions***) stored in memory (*i.e.*, a ***non-transitory computer readable medium***) to perform specific functions. EX1003, ¶231. Indeed, Prasad expressly discloses that the processing units “utilise[s]” information, such as “[c]orrelation tables or lookup tables” that “are saved in memory of mobile device.” EX1006, cl. 23.

7. 7[f]

See 1[c][i].

8. 7[g]

See 1[c][i].

I. Claim 8

See Claim 2.

J. Claim 9

See Claim 3.

K. Claim 12

1. 12[pre]

See 1[pre] (avoiding radiation in the direction of a user or structure), 1[c][i] (steerable antenna).

2. 12[a]

See 1[a].

3. 12[b]

See 1[b] (describing computation of zones or spans of directions in three-dimensional space using a “processing unit” which comprises a **computation module** (*e.g.*, microprocessor) coupled to sensors).

4. 12[c]

See 1[c][i] (steerable antenna on one or multiple bands, operating at frequencies in the 10-500 GHz range). Prasad’s steerable antenna is in

communication with (*i.e.*, ***communicatively coupled with***) Prasad’s ***processor***.

EX1003, ¶242. Among other things, Prasad’s “processing unit” may “actively shape & optimise the antenna radiation pattern,” “compute[] and control[] the antenna system of the communicating devices,” and “reconfigure the antenna system in real time. EX1006, Cl. 23; *see also id.*, [0022] (embodiment using microprocessor to “manipulate” a “control signal” to “control[] the radiation pattern” of the antenna).

See also 1[c][ii]-[iii] (describing adjusting the steerable antenna to direct beams in certain directions and attenuate radiation in the zones or spans of directions corresponding to an external object).

5. 12[d]

See 1[b].

6. 12[e]

See 1[c][iii].

L. Claim 13

See Claim 2.

M. Claim 14

See Claim 3.

XI. GROUND 4: PRASAD IN VIEW OF SEOL, YIN, AND OSHIYAMA RENDERS OBVIOUS CLAIMS 4-5, 10-11, AND 15-16

Prasad, Seol, and Yin render obvious a wireless device that uses sensors (*e.g.*, cameras, gyroscopes, accelerometers, etc.) to detect a wireless device’s orientation

relative to a user in three-dimensional space, determines zones where the user is located relative to the wireless device, and adjusts a steerable antenna so that its radiation pattern points away from the zones or spans of directions where the user is located, and instead radiates in other directions. Oshiyama discloses antennas that are capable of transmitting/receiving in multiple bands simultaneously. It would have been obvious to a POSITA to apply Oshiyama's teachings regarding simultaneous multi-band operation to the Prasad/Seol/Yin wireless device and steerable antenna as set forth below.

A. Motivation to Combine

A POSITA would have been motivated to combine Prasad, Seol, and Yin as outlined in Ground 3.

A POSITA would have further been motivated to apply Oshiyama's teachings regarding simultaneous multi-band operation to the combined Prasad/Seol/Yin steerable antenna system, and would have reasonably expected the combination to succeed. EX1003, ¶251.

Oshiyama provides an express motivation to support simultaneous communications in multiple frequency bands. *Id.*, ¶252. For example, Oshiyama identifies "situation[s] where simultaneous antenna operation in multiple frequency bands is required, for instance," when "both GPS and mobile phone systems are used." EX1014, [0016]. Oshiyama teaches that its multi-band antenna is "favorable

for mobile communications” in such situations. *Id.* Further, Oshiyama teaches that a single multi-band antenna capable of simultaneous operation is preferable to multiple antennas, each operating in a different frequency band, because the single antenna solution is “ideal for the purpose of reducing antenna size and weight,” which is in turn necessary to “reduce the size and weight of a mobile communication device.” *Id.*, [0002], [0009]. A POSITA would have understood that in order to operate the antenna in multiple frequency bands simultaneously, appropriate tuning circuitry is needed and is also disclosed by Oshiyama. EX1003, ¶252.

In addition, Prasad, Seol, Yin, Oshiyama, and the ’548 Patent are all analogous art because they are directed to the same technological subject matter, namely antennas in wireless communication systems. EX1001, 1:20-22, 4:36-38; EX1006, [0007]; EX1007, 1:18-19; EX1014, [0001] (invention relates to “an antenna for multiple bands”), [0016] (invention is “favorable for mobile communications”); EX1003, ¶253.

Finally, a POSITA would have reasonably expected the combination to succeed. EX1003, ¶254. Prasad already discloses an antenna capable of multi-band operation, and a POSITA would have understood that the antenna can be configured to simultaneously operate in different frequency bands, particularly in view of Oshiyama. *Id.* Indeed, antennas with simultaneous multiband operation were well known by the priority date of the ’548 Patent, and providing such operation in

Prasad's steerable antenna would have required only routine engineering with predictable results. *Id.*

B. Claim 4

Prasad discloses a steerable antenna that can transmit and receive in a plurality of different bands. *See* Ground 3, 1[c][i]. It would have been obvious to a POSITA to implement Prasad's antenna to operate ***simultaneously*** in a plurality of different bands in view of Oshiyama. EX1003, ¶255.

Oshiyama discloses an “antenna for multiple bands” that is configured for “simultaneous antenna operation in multiple frequency bands” (*i.e.*, ***transmitting, receiving, or transmitting and receiving simultaneously in a plurality of different bands***). EX1014, [0016], Abstract; *see also id.*, [0011], [0014] (describing the antenna “resonating” at different frequency bands). Oshiyama provides multiple exemplary circuit configurations that all may be used to support “simultaneous antenna operation in multiple bands.” *Id.*, [0052]; *see also id.*, [0051] (disclosing antenna configuration “enabled to operate in the first to third frequency bands ... at the same time”), [0055] (same).

A POSITA would have been motivated to apply Oshiyama's teachings regarding simultaneous multiband operation to Prasad's steerable antenna system (as modified by Seol and/or Yin), and would have reasonably expected the combination to succeed, for the reasons set forth in Section XI.A.

C. Claim 5

“a processor for controlling tuning of one or more circuits for said at least one steerable antenna”: Prasad discloses that its “processing unit” may “actively shape & optimise the antenna radiation pattern,” “compute[] and control[] the antenna system of the communicating devices,” and “reconfigure the antenna system in real time.” EX1006, Cl. 23; *see also id.*, [0022] (embodiment using microprocessor to “manipulate” a “control signal” to “control[] the radiation pattern” of the antenna). In particular, Prasad’s processing unit “works by **activating** different pattern of **tuneable EBG and metamaterial elements**” to “actively control[] the radiation intensity in required direction and time. *Id.*, [0024]; EX1003, ¶258.

“to operate in said plurality of different bands”: It would have been obvious to a POSITA to use Prasad’s “processing unit” to control tuning circuits to operate in a plurality of different bands **simultaneously**, as taught by Oshiyama. EX1003, ¶259.

Oshiyama discloses circuitry for tuning an antenna to a plurality of different frequency bands. In several embodiments, Oshiyama discloses tuning circuits that can tune the antenna to a plurality of different bands **simultaneously**. For example, the embodiment shown in Figure 2 uses “first to third series resonant circuits, each set to a different frequency band. EX1014, [0050]. In this way, “the antenna of the

second embodiment is enabled to operate in the first to third frequency bands f1, f2, and f3 ***at the same time.***” *Id.*, [0051]. A POSITA would have been motivated to include similar tuning circuits in Prasad’s system to support simultaneous multiband operation, and would have reasonably expected to succeed in doing so, as explained in Section XI.A.

D. Claim 10

See Claim 4.

E. Claim 11

See Claim 5.

F. Claim 15

See Claim 4.

G. Claim 16

See Claim 5.

XII. MANDATORY DISCLOSURES

Pursuant to 37 C.F.R. § 42.8(a)(1), the following mandatory notices are provided as part of this Petition.

A. Real Party in Interest

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

B. Related Matters

Patent Owner filed a patent infringement lawsuit against Petitioners asserting the '625 patent in related district court litigation captioned *Massively Broadband LLC v. Samsung Electronics Co., Ltd. et al*, 2:25-cv-00608-JRG (E.D. Tex.). Petitioners are submitting additional petitions for *inter partes* review of patents within the same family as the '548 Patent, namely U.S. Patent Nos. 11,063,625 and 8,350,763—the proceedings for which are associated with IPR Case Nos. IPR2025-01564, IPR2025-01565, whereas a petition for U.S. Patent No. 8,593,358 patent is forthcoming.

C. Lead and Back-Up Counsel (37 C.F.R. § 42.8(b)(3)) and Service Information (37 C.F.R. § 42.8(b)(3)-(4))

Petitioners provide the following counsel and service information. Pursuant to 37 C.F.R. § 42.10(b), a Power of Attorney accompanies this Petition. Petitioners agree to accept electronic service at the email addresses listed below and at:

qe-samsung-mbl-ipr@quinnemanuel.com

LEAD COUNSEL	BACK-UP COUNSEL
James M. Glass Reg. No. 46,729 jimglass@quinnemanuel.com QUINN EMANUEL URQUHART & SULLIVAN, LLP 295 5th Avenue, 9th Floor New York, New York 10016 Tel: (212) 849-7000	John McKee Reg. No. 65,926 johnmckee@quinnemanuel.com Matthew Robson <i>pro hac vice</i> forthcoming matthewrobson@quinnemanuel.com Ron Hagiz <i>pro hac vice</i> forthcoming ronhagiz@quinnemanuel.com

Fax: (212) 849-7100

QUINN EMANUEL URQUHART
& SULLIVAN, LLP
295 5th Avenue, 9th Floor
New York, New York 10016
Tel: (212) 849-7000
Fax: (212) 849-7100

Quincy Lu

Reg. No. 76,954
quincylu@quinnemanuel.com
QUINN EMANUEL URQUHART
& SULLIVAN, LLP
1109 First Avenue, Suite 210
Seattle, WA 98101
Tel: (206) 905-7000
Fax: (206) 905-7100

Benjamin Kleinman

Reg. No. 66,856
benjaminkleinman@quinnemanuel.com
QUINN EMANUEL URQUHART
& SULLIVAN, LLP
50 California Street, 22nd Floor
San Francisco, CA 94111
Tel: (415) 875-6600
Fax: (415) 875-6700

D. Payment of Fees (37 C.F.R. § 42.15(a))

The undersigned authorizes the Office to charge the fee required for this Petition for *Inter Partes* Review to Deposit Account No. 50-5708. Any additional fees that might be due are also authorized.

XIII. CONCLUSION

Petitioner requests institution of an IPR and cancellation of the Challenged Claims.

Date: October 9, 2025

Respectfully submitted,

By: /s/ James M. Glass
James M. Glass

Counsel for Petitioner

**CERTIFICATE OF COMPLIANCE WITH
TYPE-VOLUME LIMITATION, TYPEFACE REQUIREMENTS,
AND TYPE STYLE REQUIREMENTS**

1. This Petition complies with the type-volume limitation of 14,000 words, comprising 13,025 words, as counted using the Microsoft Word software that was used to prepare this paper, excluding the parts exempted by 37 C.F.R. § 42.24(a).

2. This Petition complies with the general format requirements of 37 C.F.R. § 42.6(a) and has been prepared using Microsoft® Word 2016 in 14-point Times New Roman.

Date: October 9, 2025

By: /s/ James M. Glass
James M. Glass
QUINN EMANUEL URQUHART
& SULLIVAN, LLP
51 Madison Avenue, 22nd Floor
New York, NY 10010
Tel: (212) 849-7000
Fax: (212) 849-7100

Counsel for Petitioner

CERTIFICATE OF SERVICE

Pursuant to 37 C.F.R. §§ 42.6(e), 42.105(a), the undersigned hereby certifies service on the PO of a copy of this Petition and its respective exhibits at the official correspondence address for the attorneys of record for the '548 Patent as shown in USPTO PAIR via FedEx:

30743 - WC&F IP
11491 SUNSET HILLS ROAD, SUITE 340
RESTON, VA 20190
UNITED STATES

Courtesy copies were also sent via FedEx and electronic mail to Patent Owner's counsel of record in the related district court proceeding:

Patrick J. McElhinny
K&L Gates LLP
210 Sixth Avenue
Pittsburgh, Pennsylvania 15222
Email: patrick.mcelhinny@klgates.com

Mark Knedeisen
Email: mark.knadeisen@klgates.com

Christopher Verdini
Email: christopher.verdini@klgates.com

Anna Shabalov
Email: anna.shabalov@klgates.com

Rachel Ellenberger
Email: rachel.ellenberger@klgates.com

Andrea L. Fair
MILLER FAIR HENRY PLLC
1507 Bill Owens Parkway

Longview, Texas 75604
E-mail: andrea@millerfairhenry.com

Date: October 9, 2025

By: /s/ James M. Glass
James M. Glass
QUINN EMANUEL URQUHART
& SULLIVAN, LLP
51 Madison Avenue, 22nd Floor
New York, NY 10010
Tel: (212) 849-7000
Fax: (212) 849-7100

Counsel for Petitioner