

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

**DECLARATION OF DR. MARK MAHON IN SUPPORT OF PETITION
FOR INTER PARTES REVIEW OF U.S. PATENT NO. 11,876,548**

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1. 1[pre]: A wireless device configured for avoiding radiation of a user or structure, comprising the steps of: 63
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; 66
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; 70
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, ...75
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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 81
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. 82

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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;.....	93
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 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, ...121
 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 saidone or more computational devices, ...122
 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 127
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7. 7[f]: wherein said at least one steerable antenna operates on one or multiple bands, and 136
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 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 detector, 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; 138
 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; 139

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 t 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, ...	139
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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.

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

DECLARATION OF DR. MARK MAHON, Ph.D.

I, MARK MAHON, Ph.D. hereby declare as follows:

1. My name is Mark Mahon. I have been retained to testify as an expert in this Inter Partes Petition on behalf of Samsung Electronics Co., Ltd. (“SEC”) and Samsung Electronics America, Inc. (“SEA”) (collectively, “Samsung” or “Petitioner”). I am being compensated for my time spent on this matter at a rate of \$550 per hour. My compensation is in no way dependent on the outcome of this matter or on the opinions I provide in this declaration. All of the opinions expressed in this declaration are my own.

2. I have prepared this declaration in connection with Samsung’s related petition for inter partes review (“IPR”) of U.S. Patent No. 11,876,548 (the “’548 patent,” EX1001), which I am informed is being filed concurrently with this declaration. I have been asked to provide certain opinions relating to the patentability of the ’548 patent. Specifically, I have been asked to provide my opinion regarding whether claims 1-16 of the ’548 patent (“the Challenged Claims”) are invalid as obvious in view of the prior art. All emphasis and annotations throughout my declaration have been added unless otherwise noted.

I. SUMMARY OF OPINIONS

3. It is my opinion that the Challenged Claims are rendered obvious pursuant to Grounds 1-4 and the reasons discussed herein. As background, 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. *See, e.g.*, EX1001, Abstract; 10:35-42. The '548 patent purports to introduce beam steering that avoids radiating energy toward users or structures through sensor-based detection using, for example, cameras, gyroscopes, light detectors, range finders, and/or capacitive sensors. *See id.*, Abstract; 10:35-42; 11:10-17. In general, the beam steering 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 where the user or other structure are situated. *See, e.g., id.* at 5:21-46, Claim 1.

4. But, the claimed steerable antenna technologies of the '548 patent were already well-known in the art before the earliest effective filing date of the '548 patent (which I address further below in section V.B.1). As I detail further below, Schlub (EX1005) disclosed and rendered obvious the claimed steerable antenna features, 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 (EX1006) 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.

Yin (EX1008) provided exemplary implementation details for how POSITAs would use sensors and computing devices of the time to determine such zones and spans of directions, and how that information could be used to inform beam steering and null-forming operations of the wireless device. Seol (EX1007) disclosed the ability to utilize distinct transmission and reception beam patterns, together with the use of time division duplexing in the context of millimeter wave antenna applications. Finally, Oshiyama (EX1014) disclosed an antenna that is capable of simultaneous antenna operation in multiple frequency bands, among many other teachings that I will explain further below.

5. For the reasons discussed herein, all Challenged Claims of the '548 patent are unpatentable because they are anticipated by references cited herein (*e.g.*, Schlub), and/or they would have been obvious to a POSITA at the time of the alleged invention, especially in view of the references cited herein (*e.g.*, Schlub, Prasad, Seol, Yin, Oshiyama, etc.).

II. MATERIALS CONSIDERED

6. In forming my opinions provided in this declaration, I have reviewed the '548 patent, including the abstract, figures, specification, and claims. I have also reviewed and relied on the file history of the '548 patent, the prior art discussed in this declaration, the Exhibits cited in the Exhibit List above, and any other materials cited in this declaration. I have also relied on my relevant personal and professional

experience and expertise.

III. QUALIFICATIONS

7. I am over the age of 18 and am competent to write this declaration. I have personal knowledge, or have developed knowledge of these technologies based upon education, training, or experience, of the matters set forth herein. My qualifications are summarized here and explained in more detail in my curriculum vitae, which is attached as Appendix A to this report. Appendix A also includes a list of my publications and the cases in which I have testified at deposition, hearing, or trial within the past four years.

8. I am a Teaching Professor in the School of Electrical Engineering and Computer Science at Pennsylvania State University, University Park, PA (“Penn State” or “PSU”). I have worked on telecommunications and wireless networks, including Z-Wave, Bluetooth, Zigbee, Wi-Fi, NFC, AMPS, IS-95, CDMA2000, GSM, EDGE, UMTS/WCDMA, LTE, and 5G cellular systems since 1988.

9. I received my B.S. in Electronics Engineering from the University of Scranton in 1987. I received my M.S. in Electrical Engineering and Ph.D. in Acoustics from Penn State in 1991 and 2001, respectively.

10. In 1988, after I received my bachelor’s degree, I joined the Central Intelligence Agency (CIA) while pursuing my M.S. degree at Penn State part-time. My first job at the CIA involved designing and testing systems to automatically

capture and characterize telecommunication signals and emissions from various wireless and computer networking devices.

11. I returned to Penn State in early 1990 to pursue graduate research full-time and complete my M.S. degree. My graduate research work focused on wideband beamforming and adaptive signal processing. After completing my M.S. degree in EE in 1991, I accepted a full-time faculty research position at the Applied Research Lab at PSU, primarily working on classified programs, and began working on diverse radio frequency and acoustic sensor systems including wireless communications and small wireless networks for acoustic tracking, source localization, and feature extraction.

12. I began pursuing my Ph.D. part-time in 1993 while continuing my faculty research position. In 1997, as part of my faculty research position, I began working on classified programs focused on mathematical analytical modeling of cellular communication networks and the development of hardware and software systems to test against cellular networks. My role was to develop the algorithms and write the code running on a specially developed embedded system. For this work, I received a letter of recognition as the “genius behind the VELA software algorithms” from the Director of National Reconnaissance Office (NRO) Systems Engineering and Technology Office. As part of this same work, I was extensively involved in protocol and signaling analysis as well as researching model-specific performance

and unique functional characteristics associated with individual mobile devices. The work involved testing dozens of handsets from many manufacturers in controlled and real-world environments against network simulators and live operational networks for each research project.

13. In 2000, my research extended into utilizing non-orthogonal wavelets for improving detection and localization of cellular handsets from high altitude sensor systems. In 2001, I completed my Ph.D. and my research focused on the utilization of advanced communication signals for wideband characterization and remote sensing of propagation channels.

14. Beginning in 1997, my cellular communications research work focused on CDMA, GSM, EDGE, UMTS, LTE, and 5G cellular systems primarily under grants sponsored principally by the Department of Defense. This classified research work required 3GPP protocol analysis and development of real-time embedded hardware and software systems capable of interacting with cellular networks and cellular handsets. A large portion of my work was directed at architectures, protocols, software, and signaling.

15. I have been working on classified projects since 1988. Before 1998, because the work was not deemed highly classified, I was able to publish eight journal and conference papers prior to 2000. Between 1999 and 2015, however, I was allowed to publish only one article in an unclassified symposium and published

and presented about a dozen articles in classified settings. This is because during this period, the vast majority of my research was highly classified. As a result, nearly all of my research results were summarized in classified reports and not available to the general public. Further, because the U.S. government owns any intellectual property resulting from the sponsored research work, I did not pursue or file patent applications.

16. Beginning in 2003, I was co-principal investigator and technical lead on a 3 year multi-million-dollar research effort for developing the Global Information Grid (GIG). This project was sponsored by the Secretary of Defense's Office with a goal of developing a real-time, multi-intelligence (multi-Int) network for collecting, processing, storing, disseminating, and managing information on demand for decision makers including the warfighter, combatant command centers, policy makers, and support personnel and was the largest network-centric warfare project in development at the time. My research team (Ubiquitous Automated Information Manager) focused on building and deploying a scalable application to perform real-time, multi-int data fusion to support every user in the system. This software application was deployed in Combat Operation Centers, Joint Interagency Task Force locations, and on various platforms (mobile and small computing environments) used by various warfighters. The fused data sources included various content management systems, supply chain logistic reports, GPS-based reports, new

feeds, backend databases, sensor system reports, and various other broad data sources.

17. Beginning in 1994, I worked on various projects that involved the implementation and design of user interfaces to support the use of the research, design, analysis tools and signal processing systems for the end user. The user platforms included a broad array of footprints including, small handheld devices with screens or visual displays and those limited to audio-only inputs, medium sized laptops and small desktop systems, and also large, heavy devices, such as servers and clusters in operational environments (including combat operations centers and 3D immersive environments).

18. Specifically, for the GIG research effort, I led a team of software engineers to deploy our inferencing tool for a disparate range of end users, from dismounted combat soldiers with only a microphone as an interface to soldiers in mules with smart devices (tablets and laptops with multiple visual display interaction capabilities) to field command centers (medium sized clients with significant video displays and processing power with touch and stylus interfaces to the) to combat operation centers with high-powered processing and complex user-interface capabilities/modalities.

19. In 2015, I transferred to the School of Electrical Engineering and Computer Science at Penn State as a teaching faculty member. In that role, I have

continued teaching graduate and undergraduate courses, guiding Ph.D. and M.S. students in communication and mobile networking (including LTE and 5G cellular networks), and pursuing research in this and related areas. Since 2015, I have been an author on nine refereed papers as listed in my curriculum vitae (CV).

20. Because of my decades of research and my continuing work at Penn State, I have intimate knowledge of telecommunication networks, including the technology involved in the patents in this case. I have been highly recognized as an expert in such systems within the research community. I was recognized twice by the National Reconnaissance Office with commendation letters for work dealing with detecting cellular signals in low signal to noise ratio environments. The U.S. government awarded me over \$12M in grants between 2003 and 2015 for projects focused on mobile communication devices and networks, in which I served as a Principal Investigator (PI), Co- PI, and/or technical lead.

21. Additionally, during my research career, I interacted extensively with computer scientists and engineers responsible for the design, development, and testing of telephony and data networking systems and testbeds. As a research faculty member, I oversaw engineers and computer scientists that executed many joint projects with development organizations. These interactions exposed me to a wide range of computer scientists and engineers working on telecommunication network technologies. Since 2011, I have been teaching undergraduate and graduate classes

in communication and mobile networking and am familiar with the curricula being taught to electrical engineers and computer scientists. The interactions with a wide range of computer scientists and engineers working on telecommunication network technologies and the familiarity with the classes taught to electrical engineers and computer scientists have allowed me to have a good understanding of the level of skills possessed by a person of ordinary skill in the field of cellular technology.

22. I have extensive experience with mobile networks in general and LTE and 5G specifically. While most of my research efforts between 1998 and 2015 were highly classified, I can state that they included detailed investigation of network architectures, signaling, and functional behavior. A typical research effort would involve studying 3GPP, 3GPP2, IEEE, and other protocol standards to fully comprehend all aspects of L1, L2, and L3 requirements including timing, bit-level construction of the control and user plane messages, and timing characteristics for a given standard as well as functional behavior of network components and user equipment.

23. From 2006 through 2015, my research focused specifically on LTE. My research continues to this day, although I am no longer operating in a classified environment. During this time, I investigated the performance and functional differences of many varied network and handset devices to see how differing signaling and hardware configurations (including MIMO) and environmental factors

influenced the behavior of user equipment in a given network environment. This included how diversity techniques (transmit and receive), synchronization, timing, and signal to interference plus noise ratio (SINR) for a given device would affect specific functional aspects including elements of the receiver structure, decoding and demodulation performance, calculation of parameters used by the device for making decisions and deriving parameters reported to the network.

24. As part of my research work, I built several custom CDMA, GSM, UMTS, and LTE platforms that implemented specific network-side and user equipment-side functionality including custom signal generation and processing structures, particularly the signal processing chains on both the transmit and receive sides. This equipment was developed using network simulation hardware in a laboratory environment and was later tested with corresponding networks in both controlled and fully operational environments. Implementing the transmit and receive chains for custom built protocol-enabled equipment required me to gain an intimate understanding of the relevant 3GPP protocol specifications and the underlying structures. Since 2015, I have been primarily focused on guiding graduate students pursuing research including using code domain non-orthogonal multiple access (NOMA) combined with MIMO sparse coding multiple access to minimize latency and maximize user density in grant free Internet of Things (IoT) environments. Additionally, I am guiding my graduate students in pursuing research

in optimized distributed processing algorithms, implementation of block chain coding techniques to improve handover security, and edge computing resource allocation in 4G (LTE)/5G (NR) networks.

25. Much of the classified research work I performed also led to similar approaches for other wireless protocols including IEEE 802.11 and 802.15 (e.g., Zigbee, Bluetooth, and UWB), HART, and other short-range standards as well as HF radio and Wi-MAX.

26. My curriculum vitae, included as an appendix to this declaration, includes a list of publications on which I am a named author. It contains further details regarding my experience, education, publications, and other qualifications to render an expert opinion in connection with this proceeding.

27. In writing this Declaration, I have considered the following: my own knowledge and experience, including my work experience in the fields of wireless communication networks, research and development of wireless signaling, protocols, transmission, and detection techniques, design and construction of wireless test equipment, prototypes, engineering models, and related areas; my experience in teaching those subjects; and my experience in working with others involved in those fields, the materials cited and/or referenced throughout this Petition.

IV. LEGAL STANDARDS

28. Counsel for Samsung has informed me of the following legal standards.

I am not an attorney, and I am relying only on instructions from Samsung's attorneys for these legal standards.

A. Person of Ordinary Skill in the Art

29. I understand that issues of claim construction and invalidity are analyzed from the perspective of a person of ordinary skill in the art ("POSITA").

30. I understand that a POSITA is a hypothetical person who is used to analyzing the prior art without the benefit of hindsight. A POSITA is presumed to be one who thinks along the lines of conventional wisdom in the art.

31. I understand that the hypothetical POSITA is presumed to have knowledge of all references that are sufficiently related to one another and to the pertinent art, and to have knowledge of all arts reasonably pertinent to the particular problem that the claimed invention addresses.

32. I understand that factors considered in determining the level of ordinary skill in the art at the time of an invention include (1) the type of problems encountered in the art; (2) the prior art solutions to those problems; (3) the educational level of active workers in the field; (4) the rapidity with which innovations are made; and (5) the sophistication of the technology. I further understand that the inventors' specific levels of skill are not relevant to this inquiry.

B. Claim Construction

33. I have been informed by counsel that the Patent Trial and Appeal Board

(“PTAB”) applies the same claim construction standard used in district courts, where the claims are given their ordinary meaning as understood by one skilled in the art at the time of the invention, informed by the claim language itself, the specification, and the prosecution history. I also understand that “extrinsic evidence”—i.e., evidence other than the patent and prosecution history—can be relevant in determining how a POSITA would understand terms of art used in the claims. I have been informed, however, that extrinsic evidence may not be used to contradict the meaning of the claims as I described in the intrinsic evidence—i.e., evidence in the claim language itself, the specification, and the prosecution history.

C. Burden of Proof

34. I understand that for the PTAB to institute review of a challenged patent, it is the petitioner’s burden to show that there is a reasonable likelihood of success that the petitioner will prevail in showing at least one claim is invalid. I understand that it is ultimately the petitioner’s burden to show invalidity by a preponderance of the evidence in this proceeding.

D. Obviousness

35. I understand that even if a patent claim is not anticipated, it is still invalid if the differences between the claimed subject matter and the prior art are such that the subject matter, as a whole, would have been obvious at the time the invention was made to a person of ordinary skill in the pertinent art.

36. I understand that a person of ordinary skill in the art provides a reference point from which the prior art and claimed invention should be viewed. This reference point prevents one from using his or her own insight or hindsight in deciding whether a claim is obvious.

37. I also understand that an obviousness determination includes the consideration of various factors such as (1) the scope and content of the prior art, (2) the differences between the prior art and the asserted claims, (3) the level of ordinary skill in the pertinent art, and (4) the existence of secondary considerations or objective indicia of obviousness or non-obviousness.

38. I understand that an obviousness determination can be based on a single prior art reference or a combination of multiple prior art references or the knowledge of one of ordinary skill in the art. I understand that the prior art itself may provide a suggestion, motivation, or reason to combine or modify the teachings of the prior art, or that such a reason may come from other sources, such as the knowledge of a person having ordinary skill in the art, common sense, and market forces. I understand that the following rationales may support a finding of obviousness:

- combining prior art elements according to known methods to yield predictable results;
- simple substitution of one known element for another to obtain predictable results;

- use of known technique to improve similar devices (methods, or products) in the same way;
- applying a known technique to a known device (method or product) ready for improvement to yield predictable results;
- “obvious to try” - choosing from a finite number of identified, predictable solutions, with a reasonable expectation of success;
- known work in one field of endeavor may prompt variations of it for use in either the same field or a different one based on design incentives or other market forces if the variations are predictable to one of ordinary skill in the art;
- some teaching, suggestion, or motivation in the prior art that would have led one of ordinary skill to modify the prior art reference or to combine prior art reference teachings to arrive at the claimed invention.

39. I understand that an obviousness determination requires a reasonable expectation of success in achieving the claimed invention.

40. I understand that secondary considerations or objective indicia of obviousness or non-obviousness may include (1) a long felt but unmet need in the prior art that was satisfied by the invention of the patent; (2) commercial success or lack of commercial success of processes covered by the patent; (3) unexpected results achieved by the invention; (4) praise of the invention by others skilled in the art; (5) the taking of licenses under the patent by others; (6) deliberate copying of the invention; (7) teaching away; and (8) the simultaneous invention of the claimed subject matter. I also understand that there must be a relationship between any such

secondary considerations and the invention. I further understand that contemporaneous and independent invention by others is a secondary consideration supporting an obviousness determination.

41. I understand that any secondary considerations or objective indicia must bear a nexus to the claimed invention. Where the offered secondary consideration actually results from something other than what is both claimed and novel in the claim, there is no nexus to the merits of the claimed invention. I further understand that the patentee bears the burden of demonstrating that the relevant commercial success is attributable to the claimed invention, as opposed to other economic and commercial factors unrelated to the technical quality of the patented subject matter.

42. I understand that whether a prior art reference “teaches away” from the claimed invention is a fact to be considered in determining obviousness. I understand that it is improper to combine references where the references teach away from their combination. However, I understand that the nature of the teaching is highly relevant and must be weighed in substance – a known or obvious composition does not become patentable simply because it has been described as somewhat inferior to some other product for the same use. Furthermore, I understand that the prior art’s mere disclosure of more than one alternative does not constitute a teaching away from any of these alternatives because such disclosure does not criticize, discredit,

or otherwise discourage the solution claimed.

E. Written Description & Enablement

43. I understand that it is not enough for a patent to merely claim the benefit of an earlier-filed application, but that additional criteria must be met. In particular, the prior application itself must describe the claimed invention, and must do so in sufficient detail that one skilled in the art can clearly conclude that the inventor invented the claimed invention as of the filing date sought. First, I understand that a priority-date analysis is on a claim-by-claim basis. Second, I understand that, in order for a patent claim to be entitled to the filing date of an earlier patent application, a “Section 112 analysis” must be conducted. I am informed that a “Section 112” analysis encompasses looking to the earlier patent application, and ascertaining whether that earlier patent application meets both the written-description and enablement requirements as of the filing date of the earlier application. I understand that it is not enough that the claim would have been obvious from the earlier application, but that application itself must describe the claimed invention.

44. I understand that in order to satisfy the written description requirement the earlier application must reasonably convey to those skilled in the art that the inventors had possession of the subject matter of the patent as of the filing date of the earlier application. I have been informed that it is the disclosures of the earlier patent application that count, and that while the meaning of terms, phrases, or

diagrams in the earlier patent application must be interpreted from the vantage point of one skilled in the art, all of the claimed limitations must appear in the specification. Further, I understand that this analysis is not a question of whether one skilled in the art might be able to construct the claimed invention from the teachings of the disclosure. The question is not whether a claimed invention is an obvious variant of that which is disclosed in the specification; rather, I understand that an earlier application must itself describe each of the claim limitations. I also understand that in order to satisfy the enablement requirement, the earlier application must enable a person of ordinary skill in the art to practice the claimed invention without undue experimentation.

V. DETAILED OPINIONS

A. Technology Background and State of the Art

45. Since Tesla and Marconi first successfully demonstrated the transmission of wireless signals in the late nineteenth century using electromagnetic waves (electric and magnetic fields that propagate through space) at specific frequencies (typically between 3 kHz to 300 GHz), wireless communications have evolved tremendously. EX1030, 4. While other types of waves can be used to carry information, the utilization of electromagnetic energy (radio waves) for the purposes of transmitting signals is the predominant modality in modern wireless devices due to energy efficiency, propagation speed, transmission distance, and available

bandwidth. Wireless devices utilize an antenna to generate the electric and magnetic fields (signals) at a given frequency which travel (propagate) out in space to eventually arrive at a receiving antenna that is used to detect the signals and the information those waves are carrying. “In other words the antenna is the transitional structure between free-space and a guiding device...The guiding device or transmission line...is used to transport electromagnetic energy from the transmitting source to the antenna, or from the antenna to the receiver. In the former case we have a transmitting antenna and in the latter a receiving antenna.” EX1015, 4.

46. Antennas are necessary to facilitate energy-efficient communication. At the transmit device, antennas convert the electrical signals encoded with data/information into electromagnetic waves that are intended to be received by a desired/target device or devices (receivers). Likewise, at the receiving device, an antenna is necessary to detect efficiently the propagating electromagnetic signals and convert them to electric signals and process them to determine the encoded data. EX1016, 5-7; EX1017, 3. The antenna’s energy conversion efficiency (electric to electromagnetic) is related to various physical characteristics, and it will be more and less efficient at various frequencies (bands) across the spectrum. Therefore, it is important to match the antenna’s resonances (range of frequencies where it most efficiently couples the electric to electromagnetic energy) to the frequency bands used to transmit and the signals with the same necessary requirement at the receiver.

“Most antennas have one resonant frequency band. For transmission, when the antenna is excited in this frequency band by a feeder line, it supports standing electromagnetic waves. The standing waves are then coupled to electromagnetic waves radiated into space. For reception, the waves take the same forms but follow the path in reverse order.” EX1018, [0002]. If the transmitter and receiver are not using the same frequency band, then the signals will not be detected, and the data will not be communicated/sent between the devices. A mismatch between the devices is equivalent to tuning your radio to an FM frequency/channel at which no signal is being transmitted and receiving only noise rather than music.

47. The same context is true for various wireless communication protocols used by devices such as LTE (700 MHz–2.5 GHz), 5G NR (410 MHz–52 GHz), Wi-Fi (2.4, 5, and 6 GHz), NFC (13.56 MHz), UWB (3.1–10.6 GHz), Bluetooth/Bluetooth Low Energy (2.4 GHz ISM band), etc. The table below identifies some of the bands associated with these technologies. EX1019, 6.

Table 1.1 Wireless Communications Bands and Their Frequency Designations

<i>Band Designation</i>	<i>Alternate Description(s)</i>	<i>Transmit Frequency (Uplink) (MHz)</i>	<i>Receive Frequency (Downlink) (MHz)</i>
GSM 800 or GSM 850	AMPS DAMPS	824–849	869–894
P-GSM 900	Primary GSM 900	890–915	935–960
E-GSM 900	Extended GSM 900	880–915	925–960
GSM-R 900	Railways GSM 900	876–915	921–960
T-GSM 900	TETRA GSM 900	870.4–915	915.4–921
GPS		N/A	1,565.42–1,585.42
GSM 1800	DCS 1800	1,710–1785	1,805–1880
GSM 1900	PCS 1900	1,850–1910	1,930–1990
UMTS		1,885–2,025 1,710–1,755 (US)	2,110–2,200 2,110–2,155 (US)
802.11 b/g/n	Wi-Fi; ISM	2.4 – 2.4835 GHz ISM	
802.11 a/h/j	Wi-Fi; UNII	5.15–5.35 GHz (UNII) 5.47–5.725 GHz 5.725–5.825 GHz (ISM/UNII) 4.9–5 GHz (Japan) 5.03–5.091 GHz (Japan)	
802.15.4	Zigbee	898 MHz 915 MHz 2.4-GHz ISM	
802.15.1 1a	Bluetooth	2.4–2.4835-GHz ISM	
802.15.3	UWB	Typically > 500 MHz bands within the 3.1 – 10.6-GHz spectrum	
802.16	Wi-Max	Various bands within the 2–11-GHz spectrum. Mobile Networks: 2–6 GHz Fixed Network: < 11 GHz	

48. Given the operational frequency band associated with a specific protocol, early antennas were designed and developed to operate efficiently at that band, however they were not efficient at other bands. Thus, devices wishing to support communication using multiple wireless protocols, at the various frequency bands, required multiple antennas—one dedicated for each band/protocol. Multiple antennas require more space constraining the miniaturization and design of the wireless device. “In the past, one antenna operating at one frequency band was typically the design objective. Today, there are several frequency bands and

multiple antennas are required” EX1019, 3.

49. The need for a single antenna with the capability to support multiple frequency bands was well known in the art prior to the priority date of the '548 patent. “In some environments, it is necessary that the mobile device communicate with two or more cellular communication systems and another radio communication system, for example. Mobile devices in such situations typically include two or more radios with corresponding antennas in order to communicate wirelessly with the respective communication systems. Such multiple radios may operate in different frequency bands, employ different modulation techniques, or the like, which will allow the multiple radios within the mobile device to operate simultaneously.” EX1020, 1:63-2:6. The recognition of advantages associated with using a single antenna to cover multiple operational bands was the driving force to overcome the technical challenges associated with the same. “In today’s environment of almost constant connectivity, wireless devices are ubiquitous. As the RF electronics technology for these wireless devices continues to decrease in size, there is a corresponding demand for a similar decrease in size for the antenna element. Unfortunately, the performance requirements for the antenna are rarely relaxed with the demand for smaller size...In addition to dealing with the challenges of designing a small antenna, antenna engineers must also deal with the challenge of designing the small antenna to operate over multiple frequency bands.” EX1019, 5. From the mid-to-late 1990s

through early 2000s, devices continued to miniaturize and researchers continued to refine both design and manufacturing processes. “The constant evolution of the mobile phone market determines more stringent constraints for terminal antenna design, as the size of the terminals shrinks rapidly, while the functionalities of the handsets are ever increased. Multiband operation, which is nowadays almost a common standard, requires the use of enhanced radiating elements. Moreover, other aspects such as small size, weight, and integration have a great relevance for the final design, while material and assembling costs must be kept as low as possible[.]...The preferred antenna solution to deal with multistandard issues is the use of radiating patches with multiple resonances covering different bands, which are easily adapted to the shape of the handset, and can therefore be integrated within the back cover.” EX1021, 384.

50. Given the need for such antennas, numerous companies in the wireless communications field developed single antennas that operated at a plurality of different frequency bands. “Unlike conventional mobile terminals, however, each mobile terminal 66 includes a single antenna 68 which is shared by each of the radios included in the mobile terminal 66.... [S]ince only a single antenna 68 is needed to handle multi-band communication, additional benefits are gained due to the space and weight savings obtained over conventional mobile terminals employing two or more antennas.” EX1020, 5:38-49.

51. At the same time, the field of mobile communications was being expanded to use higher frequency bands to accommodate an ever-increasing demand and an ever-increasing number of devices competing for bandwidth. These efforts extended radio communications into the mmWave range for every day use. As researchers at the time stated: “As demands for traffic have accelerated due to increased demands for smartphones and tablet Personal Computers (PCs) and the resulting rapid growth of applications requiring a large amount of traffic, it is difficult to satisfy the soaring demands for wireless data simply by increasing spectral efficiency.” EX1007, 1:31-36. Seol noted that “[t]o avert the problem, recent interest has focused on a millimeter-wave wireless communication system.” EX1007, 1:37-46. However, Seol also recognized that “[w]hen wireless communication is provided in a millimeter-wave frequency band, propagation loss, such as path loss and reflection loss, is increased in view of the spectral nature of the millimeter-wave frequency band and the resulting shortened propagation distance reduces service coverage.” *Id.* Conveniently, for decades those in the field had developed and refined beamforming and beamsteering technologies, which was an obvious the solution for “mitigating the path loss of waves . . . [and] thus increasing the propagation distance of the waves” in the millimeter-wave frequency band. *Id.*

52. In fact, beamforming or spatial filtering has been an active topic of research and application since the late 19th century. An early version of a

beamformer was the Perrin array (designed by and named after Sergeant Jean Perrin) deployed during WWI. The early days of beamforming were dominated by acoustic (in air and underwater) applications primarily until the mid-20th century when radio antennas came on to the scene during WWII.

53. “Beamforming is the name given to a wide variety of array processing algorithms that, by some means, focus the array’s signal-capturing abilities in a given direction. Based on the analogy of a flashlight, the mainlobe of an array’s directivity pattern is called a beam[]. Just as one might point a telescope or a radar dish, a beamforming algorithm ‘points’ the array’s spatial filter toward desired directions but algorithmically rather than physically...the signal processing algorithms developed for these conventional beamforming algorithms date from the early days of array processing and are well understood.” EX1029, 4.

54. The use of antenna elements and antenna arrays for beamsteering and beamforming (as I will discuss below) was known for many decades before Priority Date of the ’548 patent and was applied to many areas of technology. Figure 2.1 below displays two beamforming receiver structures; the latter is a broadband configuration. Figure 3.1 shows the 3D sensing of a planar array and Table 1.1 presents some common areas of application of arrays at the time. “The term beamforming derives from the fact that early spatial filters were designed to form pencil beams [] in order to receive signals from other locations.” EX1022, 1-21.

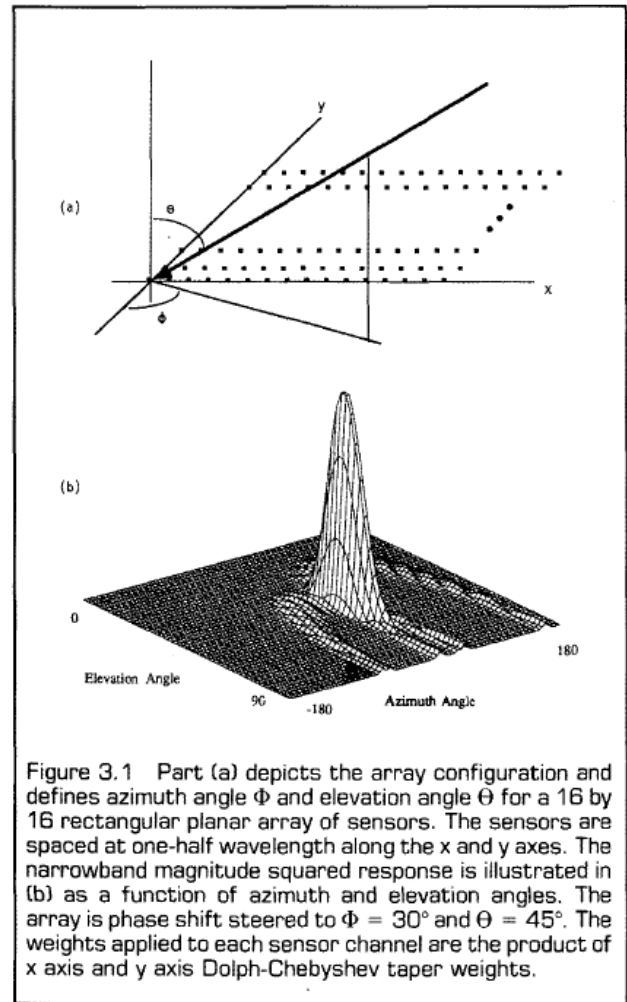
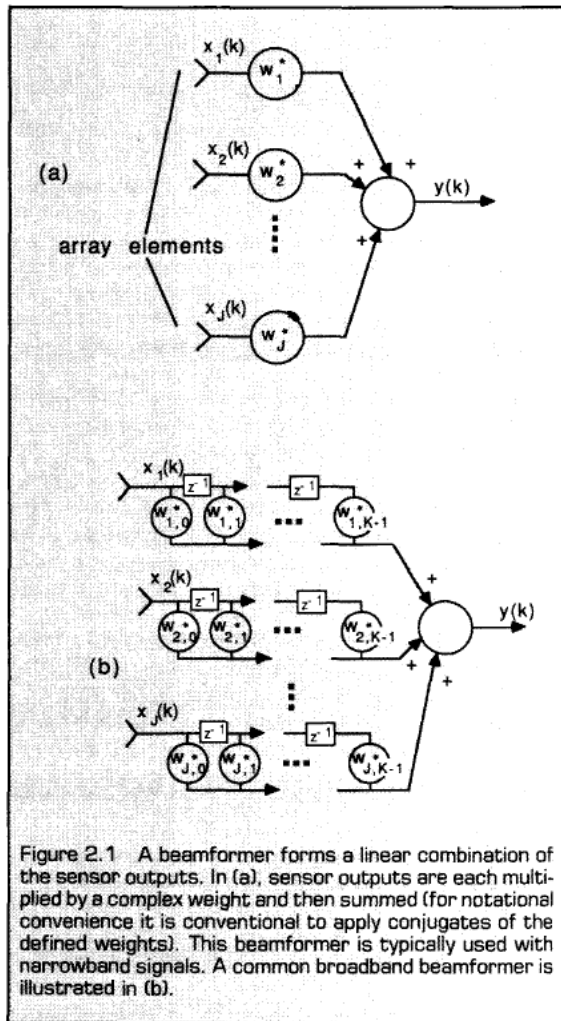


TABLE 1.1		
ARRAYS AND BEAMFORMERS PROVIDE AN EFFECTIVE AND VERSATILE MEANS OF SPATIAL FILTERING. THIS TABLE LISTS A NUMBER OF APPLICATIONS OF SPATIAL FILTERING, GIVES EXAMPLES OF ARRAYS AND BEAMFORMERS, AND PROVIDES A FEW KEY REFERENCES.		
Application	Description	References
RADAR	phased-array RADAR; air traffic control; synthetic aperture RADAR	Brookner [1985]; Haykin [1985]; Munson et al. [1983]
SONAR	source localization and classification	Knight et al. [1981]; Owsley [1985]
Communications	directional transmission and reception; sector broadcast in satellite communications	Mayhan [1976]; Compton [1978]; Adams et al. [1980]
Imaging	ultrasonic; optical; tomographic	Macovski [1983]; Pratt [1978]; Kak [1985]
Geophysical Exploration	earth crust mapping; oil exploration	Justice [1985]
Astrophysical Exploration	high resolution imaging of the universe	Readhead [1982]; Yen [1985]
Biomedical	fetal heart monitoring; tissue hyperthermia; hearing aids	Widrow et al. [1975]; Gee et al. [1984]; Peterson et al. [1987]

55. It was common knowledge to a POSITA during the development of beamsteering (i.e., adjusting the weights, $w_{J,K-1}$, in Figure 2.1 to adjust the receiver's spatial sensitivity in a specific spatial direction as depicted in Figure. 3.1 for a planar array) applications over the many decades the same architecture and algorithms could be applied at the transmitter or receiver, and implementation was limited only by constraints associated with available space, cost, and power. That is, there is nothing in the engineering or theory that prevents the same architecture to be associated with the transmitter or receiver. For example, a 2004 paper presented a review of the application of antennas in MIMO wireless communications "Multiple-Input-Multiple-Output (MIMO) wireless systems, characterized by multiple antenna

elements at the transmitter and receiver have demonstrated the potential for increased capacity in rich multipath environments []." EX1023, 2-16. The wireless communication systems referenced in this paper included mobile devices, "First, there is a notable study where several different array types were explored for both the base station and the mobile unit in an outdoor environment []." "The arrays on the mobile were constructed from monopoles to achieve spatial, angle, and/or polarization diversity." *Id.* 11.

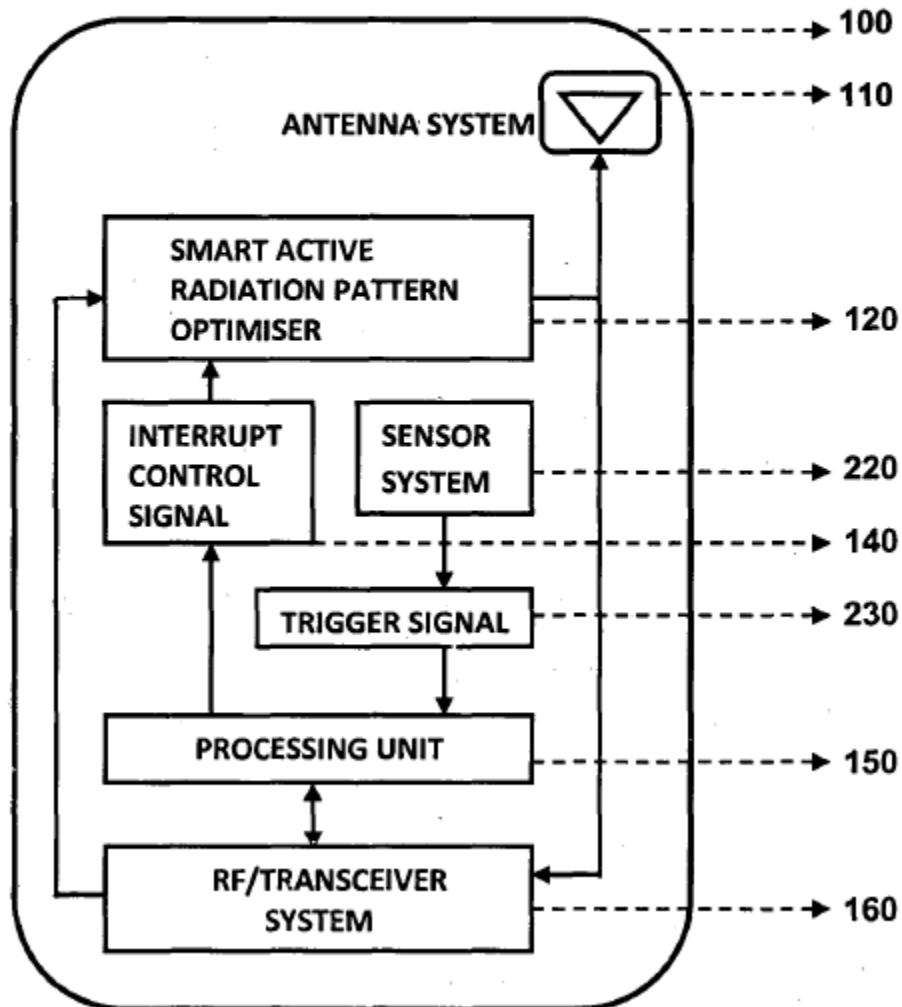
56. The fundamental concepts of using multiple antenna elements (acoustic or RF) to form an array which are used to spatially focus the transmit signal (transmit beam) or spatially filter the received signal (receive beam) have not changed significantly because it was the well-understood physics that permitted the original construction of the arrays. In the 1960's adaptive beamforming became an active area of research, development, and application and provided algorithms to automatically update weights for the elements of a given array to permit it to either optimize transmit/receive operations and/or track signals of interest.

57. As commercial wireless devices became more ubiquitous through the 1970's – 1990's along with the continued advancement of signal processing platforms, such as digital signal processors (DSPs), the well-known beamforming techniques could be transitioned beyond resource rich environments (such as base stations) to smaller, more resource constrained platforms.

58. Given the maturity of beamforming for several decades previous to the 2010's, engineers and standards bodies, such as IEEE, were integrating and proposing the implementation of beam steering in mobile wireless devices. For example, in a paper entitled "Beamforming on Mobile Devices: A First Study" (EX1024) the authors state, "We first demonstrate that beamforming is already feasible on mobile devices in terms of form factor, device mobility and power efficiency. Surprisingly, we show that by making an increasingly profitable tradeoff between transmit and circuit power, beamforming with state-of-the-art integrated CMOS implementations can be more power-efficient than its single antenna counterpart." EX1024, 1. Using antenna steering technologies to guide radiation beams in desired directions, based on the orientation of the wireless device, was also well known before the effective date of the '548 patent. Additionally, as I discuss further below, in 2011 Prasad discussed antenna steering variations, including a "smart dynamic radiation pattern optimising system is a design and technique to actively shape & optimise the radiation pattern of mobile device controlled by smart RF/Antenna system with signal processing algorithm that works by sensing the change in device proximity environment with nature or property, range, orientation, position, location, signal quality parameters and ambient intelligence to protect the user by controlling radiation exposure." See EX1006, Abstract. An illustrative diagram of the system discussed by Prasad is shown below, where antenna 119 is

steerable.

FIGURE 4
BLOCK DIAGRAM:
Wireless Mobile Device



Id., Fig. 4.

59. Numerous other references prior to the effective date of the '548 patent include steerable antennas. One such reference even dates back to the 1960s, where

phase shifts were used to shape signals generated by phase antenna arrays to create radiation patterns that targeted certain directions while avoiding others. *See* EX1025, Abstract. A phased array is a system comprising many small radiating elements whose signals are combined with electronically controlled phase shifts to form a steerable beam, without physically steering the array itself. By adjusting the relative phase of each element, all the elements work together to form one composite radiation pattern with increased power radiating in a desired direction while reducing it in other directions (e.g., through destructive interference).

60. To complement the use of beamforming and beamsteering, researchers had long recognized that steering algorithms should be informed by the external environment (i.e., an understanding of what objects or structures the beam should be steered around). Related work beginning in the late to early 2000's investigated various sensors associated with mobile devices explored the application of sensing the device's orientation and/or the orientation of the user with respect to the device and the local environment. A common sensor used for orientation sensing is an accelerometer which provides 3D acceleration information. One example of sensor-based sensing is from 2003 which explored how to determine device orientation when you do not know where on the body the mobile device may be carried. EX1026, 1-2.

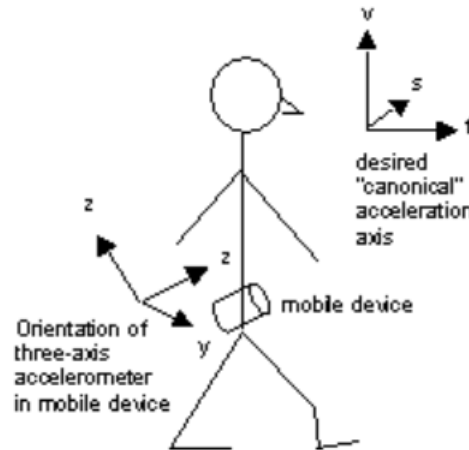


Fig. 1. Relevant coordinate systems

61. Similarly, another paper states, “We present a method to infer the orientation of a mobile device carried in a pocket from the acceleration signal acquired when the user is walking. Whereas previous work has shown how to determine the orientation in the vertical plane (angle towards earth gravity), we demonstrate how to compute the orientation within the horizontal plane.” EX1027, 2-3.

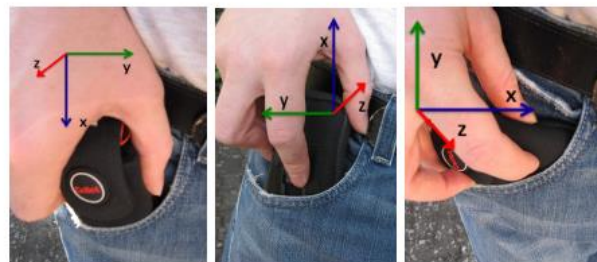


Figure 2. The Mtx motion sensor in the phone casing placed in the pocket depicted with the different axis orientations.

62. The integration of additional sensors and multiple antennas in mobile devices throughout the early 2000’s into the early 2010’s led to predictable research

efforts in combining sensor-based detection to continue to improve wireless communication link performance and mitigation of human effects, including in combination with beamsteering. For example, researchers at Rice University conducted a beamsteering experiment using an array of passive directional antennas, and to obtain device orientation information the researchers “collect[ed] accelerometer and compass readings along with network usage information” from smartphones in order to “estimate the orientation and rotation of the smartphones during wireless usage.” *Id.* By fixing a frame of reference (X, Y, Z) for the device (cell phone) relative to a geomagnetic frame of reference (x, y, z; where y is magnetic north), they were able to “derive the smartphone orientation” using simple and well-known coordinate rotations.

63. Another example of this was shown by Schmidt. See EX1028, *passim*. Schmidt presented a solution that “accelerometer sensor inputs” and “return[ed] the progressive phase shifts required to direct the radio beam in an optimal direction.” EX1028, 63. Schmidt’s implementation “define[d] some quantities and references for the phone, user and INS,” and then oriented accelerometers with axes parallel to the axes of a frame defined with respect to the phone (shown as S in the figure below), such that “the x-axis of all accelerometers is parallel to i, the y-axis of all accelerometers is parallel to j, and the z-axis of all accelerometers is parallel to (k).” *Id.*

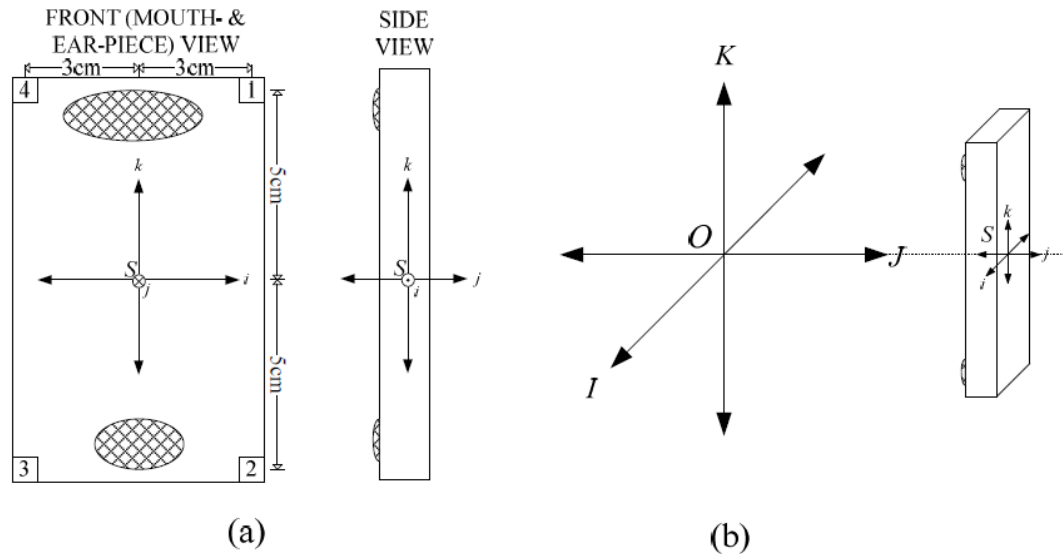
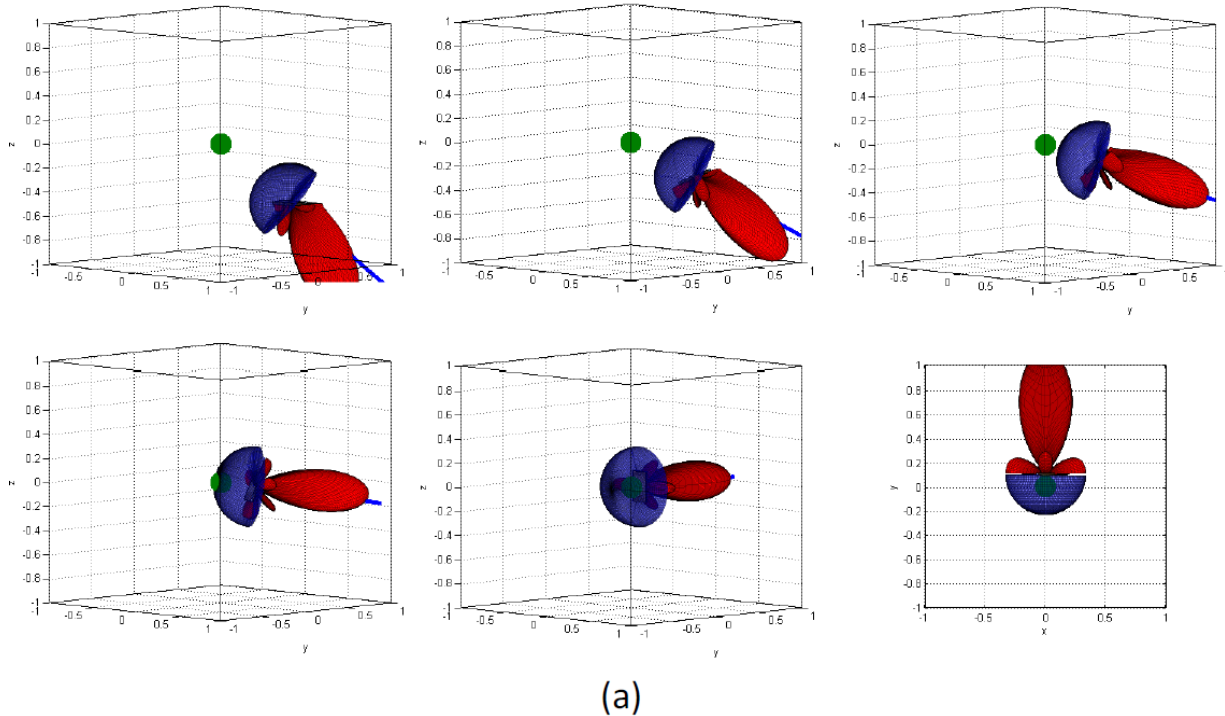


Figure 3.6.1 (a) Orientation of S within the phone. (b) Orientation of the phone and S with respect to the inertial frame O .

EX1028, Fig. 3.6.1.

64. Using the information gathered from the carefully oriented MEMS accelerometer, Schmidt demonstrated how the phone can then “track its own position and orientation with respect to the user so that it c[ould] determine the best direction to form the beam.” EX1028, 3. Based on the information from the “MEMS accelerometer[s]” and the known arrangement of the accelerometers relative to the phone, Schmidt’s implementation determined and defined a zone of directions that corresponded to a “region of bad radiation” in the three-dimensional space where parts of the user’s body are determined to be. A depiction of this is shown below in an example implementation where Schmidt showed different stages of a user picking a phone up off of a table and bringing it to their ear. EX1028, 67-68.



EX1028, 71-72 (Figure 7.4.1); *see also id.* 67-68 (Figure 7.2.1).

65. Combining sensor based spatial recognition from sensors internal to a mobile phone, Schmidt then employed a “process of varying the amplitude, phase, or geometry of an array in order to point the main beam in a certain direction.” EX1028, 57.

66. All of these teachings were well-known and well-established knowledge of a POSITA prior to the effective filing date of the ’548 patent.

B. THE ’548 PATENT

1. Priority Date

67. Based on my review, 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.

68. In my opinion, the claims of the ’548 Patent are only entitled to claim the benefit of the filing date of the ’853 Application filed on 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. 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. In my opinion, this new matter in the ’625 and ’548 specifications provides the only possible written description support under for claims 1-16.

69. 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. EX1011, *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).

70. Consequently, in my opinion the priority date of all '548 patent claims is the filing date of the '625 Application, August 14, 2013. Throughout my declaration I sometimes refer to the “effective filing date,” the “earliest effective filing date,” the “priority date” of the '548 patent, and the like. In other instances, I may reference an opinion I render based on the perspective of a POSITA or the state of the art “at the time of” the '548 patent, or other similar language. In all such cases my intent is to refer to August 14, 2013, for the reasons explained above.

2. Prosecution History

71. I have reviewed the prosecution history of the '548 patent. *See* EX002, *passim*. 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).

72. 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.

73. 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.

3. Disclosure

74. 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.

4. The Challenged Claims

75. Below is a table described the Challenged Claims, including claims 1-16.

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;

Claim	Limitation
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.
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.

Claim	Limitation
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 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

Claim	Limitation
	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.
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:

Claim	Limitation
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,
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.

Claim	Limitation
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.

VI. LEVEL OF ORDINARY SKILL IN THE ART

76. In my opinion, a person of ordinary skill in the art at the time of the '625 Patent ("POSITA") 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. More education can substitute for practical experience and vice versa. I exceed this skill level currently, and I exceeded this level of skill at least as of the effective filing date of the '625 Patent (August 14, 2013), and thus have the qualifications and experience necessary to assess the '625 patent from the perspective of a POSITA.

VII. CLAIM CONSTRUCTION

77. I 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. I do not believe that any claim limitation requires construction for purposes of my analysis below.

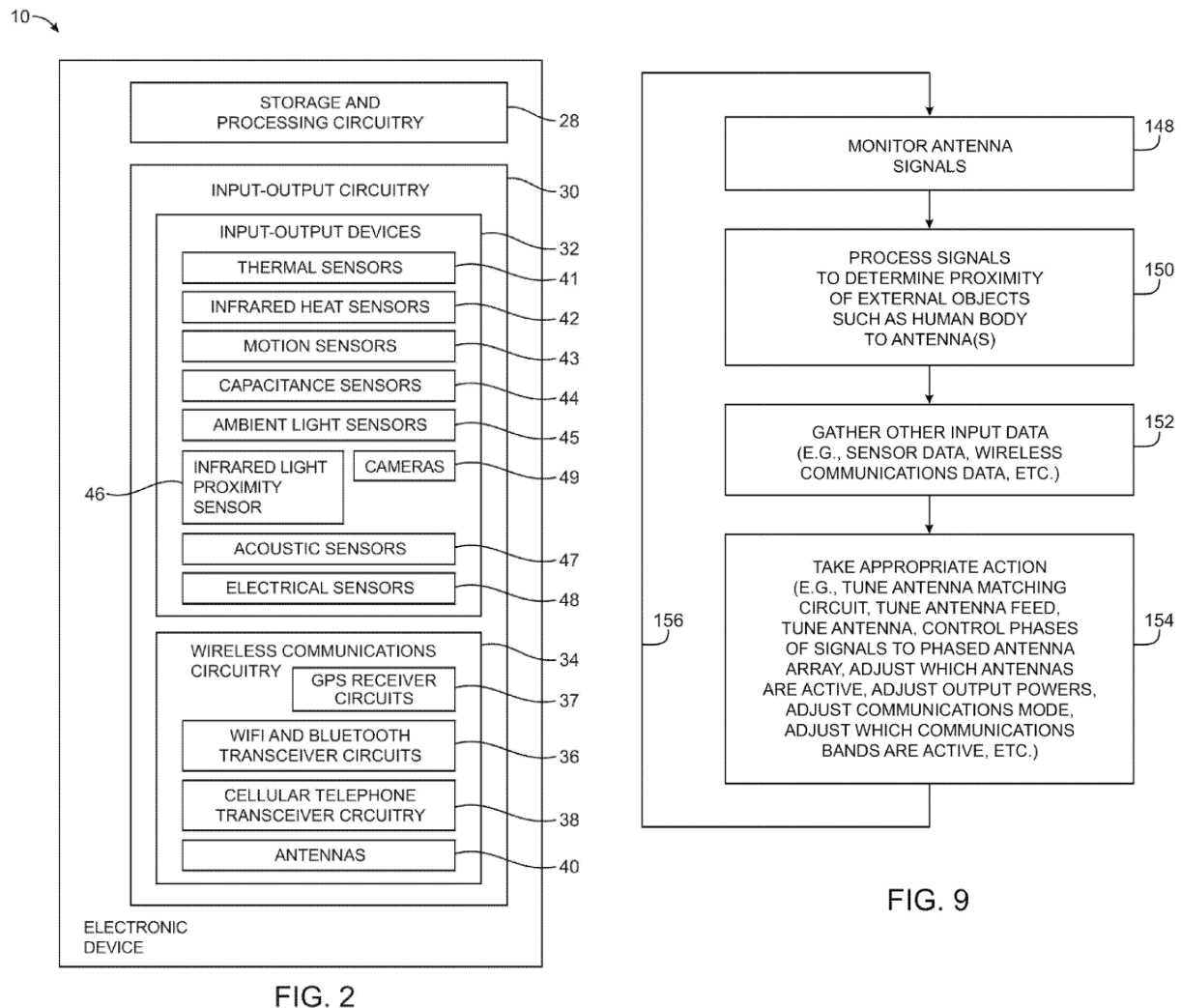
VIII. GROUND 1: SCHLUB ANTICIPATES AND RENDERS OBVIOUS CLAIMS 1-3, 6-9, AND 12-14

A. Schlub (EX1005)

78. The cover page of U.S. Pat. Pub. 2011/0250928 (“Schlub”) indicates it was filed April 13, 2010 and published October 13, 2011. I am informed that it is prior art to the '548 patent.

79. In general, 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.

80. Schlub's Figure 8 depicts a single antenna array 40 with multiple elements on the same control circuit (all elements identified by numeral 40), and depicts how individual radiating elements of the antenna 40 can be steered to form a beam along a path 140 to avoid a person at point B, or along path 142 to avoid a person at point A. *Id.*, [0080].

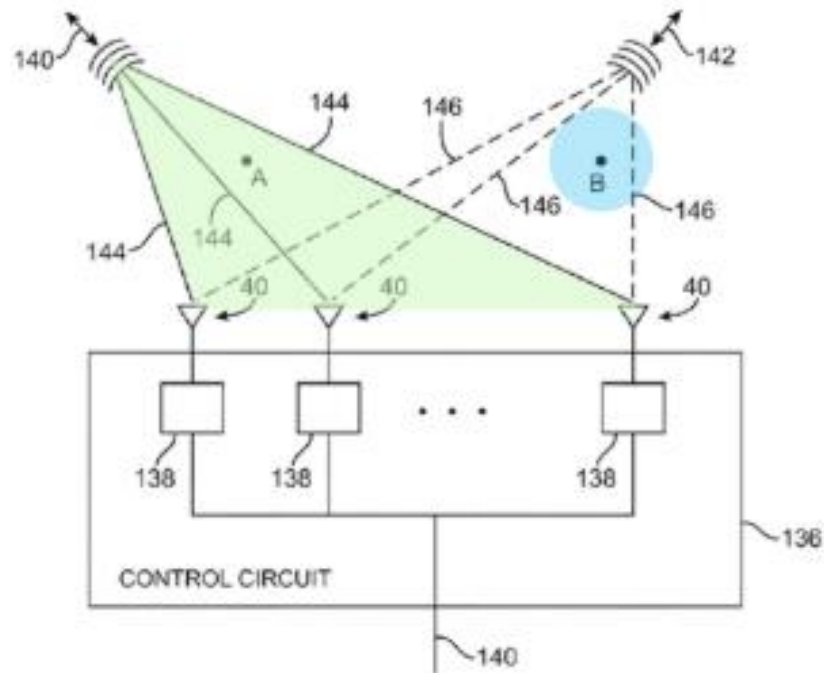


FIG. 8

Id., Fig. 8.

B. Claim 1

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

81. I understand that the preamble to a patent claim is generally not limiting. However, to the extent the preamble is limiting, in my opinion Schlub discloses it.

More specifically, 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]. In my opinion, the Schlub uses “one or more antennas” in a portable electronic device just like the ’548 Patent. *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:

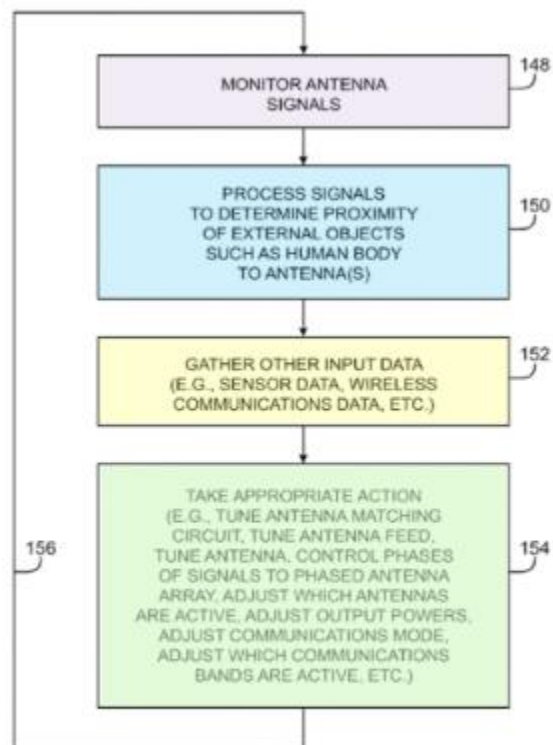


FIG. 9

82. As part of its solution, 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 also 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 processing components of the wireless device can use that information to adjust the radiation beams of a steerable antenna, including Schlub's "phased antenna array," to modify "the direction in which the antenna array is operating" to avoid radiation toward the user. EX1005, [0006], [0009].

83. As I detailed further below, Schlub discloses that its method can be configured to 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].

84. Accordingly, in my opinion Schlub discloses 1[pre] and a POSITA would have understood Schlub to disclose 1[pre].

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;**

85. In my opinion, Schlub discloses Limitation 1[a]. I have broken this limitation into sub-parts below, and discuss each in turn with reference to Schlub's disclosure.

86. In my opinion, Schlub discloses "***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***" requirement of Limitation 1[a]. In particular, Schlub discloses several of the recited detectors that can be used alone or together to detect the recited orientation of the wireless device in three dimensional space (discussed further below). For example, Schlub discloses (i) "making antenna impedance measurements," and (ii) use of other "sensors such as ... motion sensors, capacitance sensors, ambient light sensors...acoustic sensors, cameras...." Exemplary detectors/sensors that can be used in Schlub's solution are shown in the architectural diagram of Figure 2.

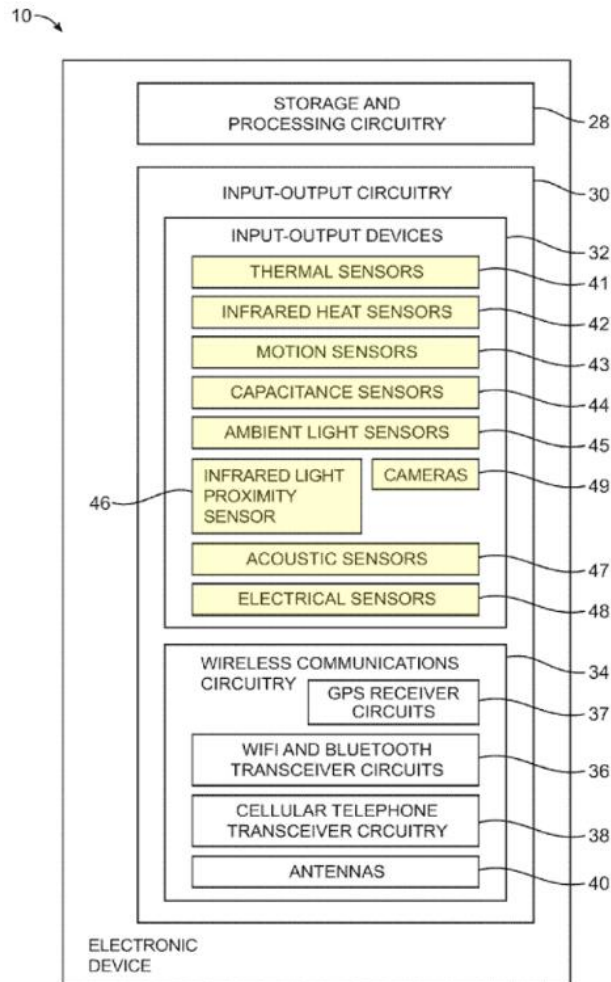


FIG. 2

Id., Fig. 2; *see also* [0049] (“Sensors such as sensors 41, 42, 43, 44, 45, 46, 47, 48, and 49 are merely illustrative. Other sensors may be used to gather data on the environment and operation of device 10 if desired. These sensors may serve as proximity sensors or may produce information that can be used in conjunction with proximity sensor data to enhance the accuracy of the proximity sensor data.”)

87. In my opinion, Schlub discloses “***used for computational determination***” requirement of Limitation 1[a]. In particular, 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]; *see also id.*, [0036], [0048]. 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].

88. In my opinion, Schlub discloses “**of spatial orientation in three dimensional space**” requirement of Limitation 1[a]. In particular, 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]. In my opinion, two planes at a nonzero angle to each other extend into a third dimension. 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, [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.* In my opinion, 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).

89. In my opinion, Schlub discloses “***for detecting an orientation of said wireless device relative to either or both said user and said structure***” requirement of Limitation 1[a]. In particular, 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], [0042]. Schlub further discloses 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”).

90. 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]. Specifically,

Schlub discloses that the 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].

91. Accordingly, in my opinion Schlub discloses Limitation 1[a] and a POSITA would have understood Schlub to disclose Limitation 1[a].

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;**

92. In my opinion, Schlub discloses Limitation 1[b]. I have broken this limitation into sub-parts below, and discuss each in turn with reference to Schlub’s disclosure.

93. In my opinion, Schlub discloses “*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*” requirement of Limitation 1[b]. In particular, Schlub discloses that by “[b]y analyzing data from . . . sensors” and on that basis “determin[ing] whether external objects are in the vicinity of each antenna,” its solution “can determine a suitable course of action.” Schlub, [0087]. For example, Schlub discloses that a “suitable course of action” may be

adjusting “the direction of the signal beam associated with the antenna” so that it is “steered in response to the proximity information” – *e.g.*, “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]. In my opinion, 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 that the “array can be adjusted” to avoid. *Id.* Specifically, in my opinion, the “location” of the external object corresponds to claimed zones or spans of directions in the three dimensional space that are associated the user or a structure. *Id.* It is also my opinion that the “different direction” referenced in Schlub, in which the antenna signals are directed, would be understood by a POSITA to be any direction that does not fall within the span of directions where the user is located, for example. *Id.* The zones or spans of directions that the user or other external object are in is shaded in blue in Figure 8, reproduced and annotated below, while the beam radiation pattern can be adjusted accordingly to radiate in the “different direction” that for example, could correspond to the green area:

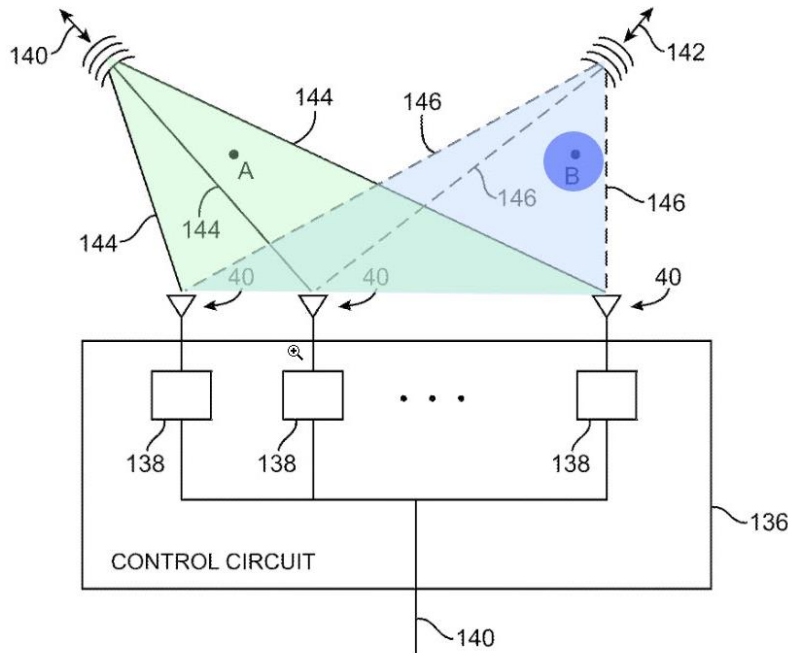


FIG. 8

94. In my opinion, Schlub discloses “*one or more processors for determining*” requirement of Limitation 1[b]. In particular, Schlub confirms the aforementioned *determination* is achieved using one or more processors within the wireless device. Specifically, Schlub explains that it is the “storage and processing circuitry 28” (shown in Fig. 2) of the wireless device that is used to “process the signals from the antenna-based proximity sensor (i.e., circuitry 61), the sensors of FIG. 2, and other circuitry in device 10” in order to “determine whether antenna adjustments and other adjustments to the operation of the wireless circuitry of device 10 should be made.” *Id.* [0086]; *see also* [0036], [0048]. Schlub confirms that this “determination” involves the determination of the claimed “zones or spans

of directions in three dimensional space” as I explained and depicted above. Further, Schlub notes that it is during this “processing” that the device “may, for example, determine, for each antenna 40, whether an external object such as a user's body is in the vicinity of the antenna.” *Id.* In my opinion, a POSITA would understand these teachings to disclose that the processors of the wireless device determine, based on information provided by the sensors/detectors, zones or spans of directions in the three dimensional space corresponding with the direction of the user relative to the wireless device and its internal antennas. *See, e.g.,* [0048] (“image data such as video data indicating motion ***towards the antennas of device 10 or other portion of device***”).

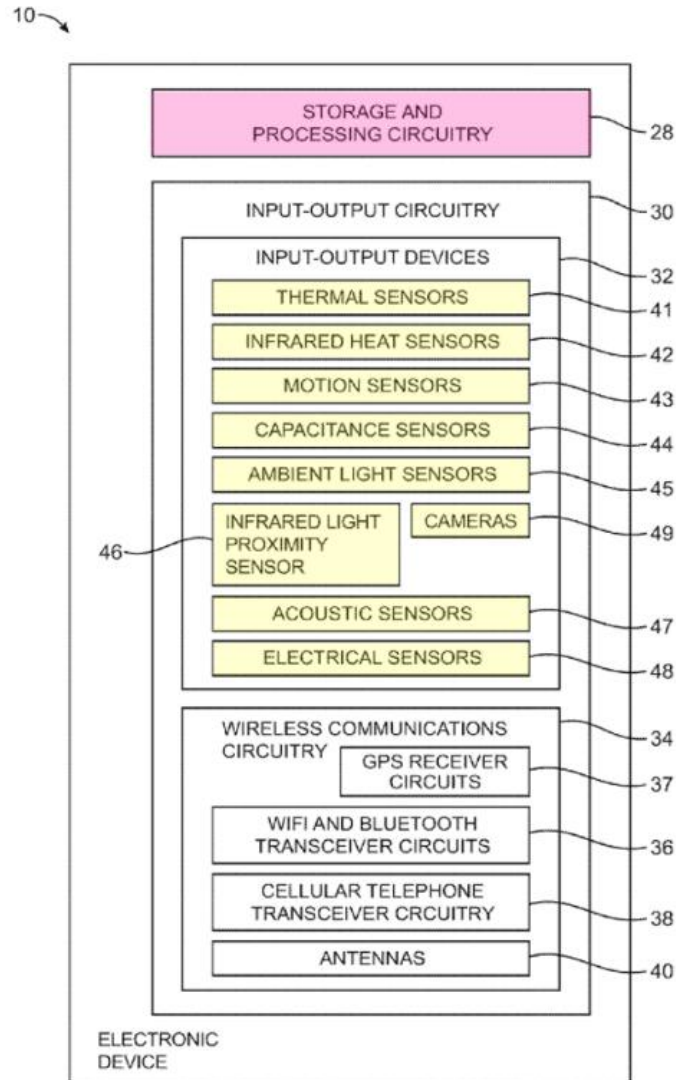


FIG. 2

95. In my opinion, Schlub includes far more disclosure of Limitation 1[b] than what the Board determined satisfied a limitation substantially similar to 1[b] in the Dorsey reference during prosecution of the related '625 Patent. *See, e.g.*, EX1032, 22-23 (the Board confirming that Dorsey's disclosure of "detect[ing] when an object such as a user's ear is close to" a part of the wireless device discloses the limitation requiring "determining zones or spans of directions in the three dimensional space

corresponding with one or more directions of either or both said user and said structure relative to said at least one steerable antenna”). I agree with the Board’s determination in connection with Dorsey’s more limited disclosure, and hold the further opinion that Schlub discloses as much and more than Dorsey in connection with Limitation 1[b].

96. Accordingly, in my opinion Schlub discloses Limitation 1[b] and a POSITA would have understood Schlub to disclose Limitation 1[b].

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,

97. In my opinion, Schlub discloses Limitation 1[c][i]. I have broken this limitation into sub-parts below, and discuss each in turn with reference to Schlub’s disclosure.

98. In my opinion, Schlub discloses “***one or more steerable antennas which operate on one or multiple bands***” requirement of Limitation 1[c][i]. In particular, 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].

99. In my opinion, Schlub also discloses “***radiates or receives at one or more frequencies in the range of 10 GHz to 500 GHz***” requirement of Limitation

1[c][i]. In particular, Schlub discloses that the “phased antenna array” can operate “at 60 GHz” and can support “other frequency bands of interest.” EX1005, [0034], [0080].

100. Tying both requirements together, Schlub discloses that the “array of antennas in FIG. 8 may be used to handle a communications band such as a communications band at 60 GHz (as an example)” and that “other frequency bands of interest *may also* be supported” by that very same array of antennas. EX1005, [0080].

101. Accordingly, in my opinion Schlub discloses Limitation 1[c][i] and a POSITA would have understood Schlub to disclose Limitation 1[c][i].

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,**

102. In my opinion, Schlub discloses Limitation 1[c][ii]. I have broken this limitation into sub-parts below, and discuss each in turn with reference to Schlub’s disclosure.

103. In my opinion, Schlub discloses “*wherein one or more beams of said one or more steerable antennas is adjustable*” requirement of Limitation 1[c][ii]. In particular, as I explained for 1[pre] above, Schlub discloses a *steerable antenna* that 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]. For example, Schlub discloses “a phased antenna array” that can be adjusted so that “the direction in which the antenna array is operating” will generate signal patterns that avoid radiation toward the user. EX1005, [0005]-[0006], [0009]; *see also* 1[b]. Schlub discloses an antenna that 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].

104. In my opinion, Schlub discloses “***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***” requirement of Limitation 1[c][ii]. In particular, 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 my opinion, this accentuates radiation in the directions that are not in the directions of the zones or spans of directions in the three dimensional space discussed in connection with 1[b]. 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]. In my opinion, a POSITA would have understood that orienting the beams in some directions over others accentuates the beams in the desired directions and attenuates them on the undesired directions. Accordingly, it

is my opinion that Schlub discloses that its steerable antenna can be adjusted “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.” This feature of Schlubs solution corresponds to the last step in the process shown in Schlub’s Fig. 9, shown below (shaded in purple):

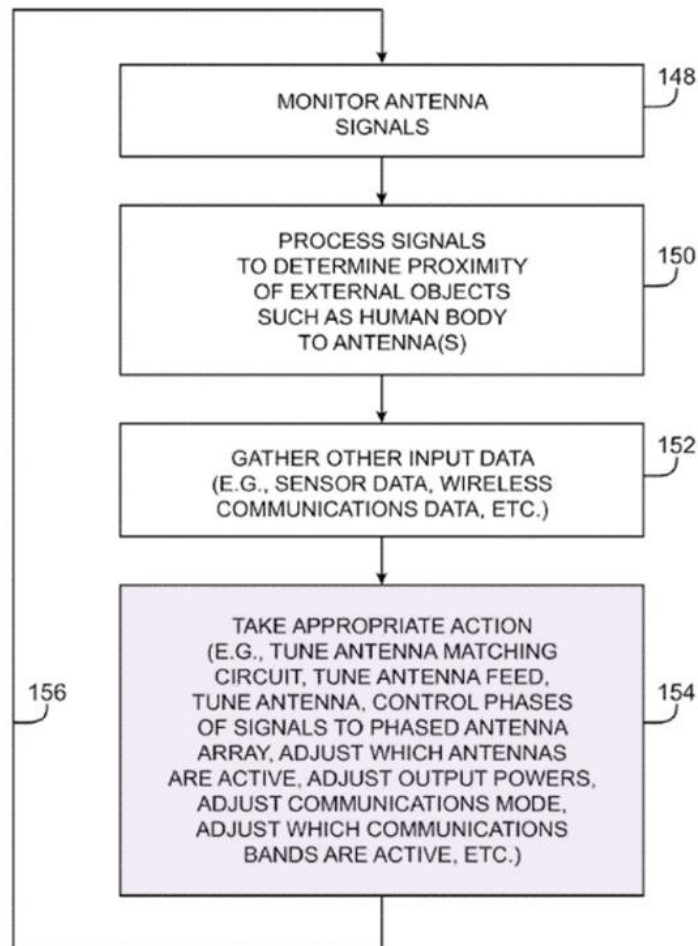


FIG. 9

105. 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, in my opinion, 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***. At a minimum, it would have been obvious to a POSITA to use a phased antenna array as disclosed by Schlub to accentuate radiation in directions where a user or other structure is not detected. A POSITA would have understood that phased antenna arrays control the phases and magnitudes of signals from individual antenna elements to selectively cause constructive interference in certain directions and destructive interference in other directions. It would have been obvious to a POSITA to use constructive interference in order to increase (accentuate) the radiation in directions not obstructed by a user or structure in order to increase the signal strength in those directions.

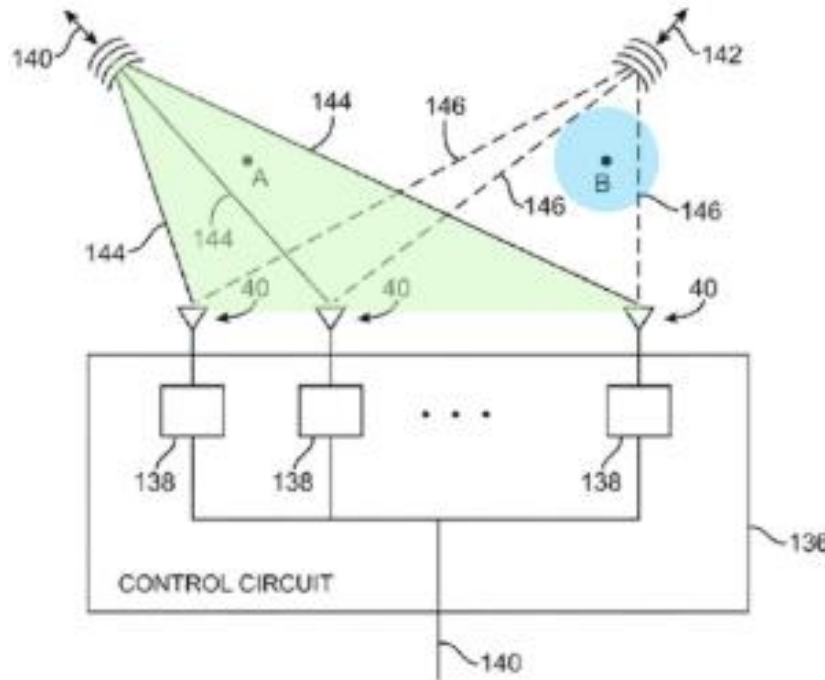


FIG. 8

106. In my opinion, Schlub discloses “*as determined by said one or more computational devices*” requirement of Limitation 1[c][ii]. In particular, Schlub discloses that the *adjusting* step I discussed above is achieved using one or more processors, which alone or together with the wireless device are “computational devices.” Specifically, Schlub explains that it is the “storage and processing circuitry 28” (shown in Fig. 2, above, which include processors, *i.e.*, *computational devices*) of the wireless device performs processing operations “*determine whether antenna adjustments and other adjustments to the operation of the wireless circuitry of device 10 should be made.*” *Id.* [0086]; *see also* [0036], [0048]. Schlub discloses that this “determination” is based on “process[ing] the signals from the

antenna-based proximity sensor (i.e., circuitry 61), the sensors of FIG. 2, and other circuitry in device 10,” which aids in the determination of the claimed “***zones or spans of directions in three dimensional space***” as explained and depicted above. In my opinion, a POSITA would understand these teachings from Schlub to disclose 1[c][ii].

107. Accordingly, in my opinion Schlub discloses Limitation 1[c][ii] and a POSITA would have understood Schlub to disclose Limitation 1[c][ii].

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

108. In my opinion, Schlub discloses 1[c][iii]. As I noted above, Schlub teaches that its “phased antenna array” is a steerable antenna 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]. Furthermore, Schlub 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]. In my opinion, 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.

109. Accordingly, in my opinion Schlub discloses Limitation 1[c][iii] and a POSITA would have understood Schlub to disclose Limitation 1[c][iii].

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.**

110. In my opinion, Schlub discloses Limitation 1[d]. In particular, Schlub discloses “control circuitry”—a controller that comprises a controller that performs the “adjusting” as recited in 1[d]. As I noted above, Schlub teaches that its “phased antenna array” 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),” and thereby ***adjust the radiation pattern of the steerable antenna***. EX1005, [0032], *see also id.*, [0080]. 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]. Furthermore, as I explained above in connection with Limitation 1[c][iii] and noted in connection with Schlub’s examples provided in Figure 8, Schlub’s ability to steer radiation patterns in desired directions while attenuating them in others discloses 1[c][iii], and the fact that such adjustments are achieved under control of the above mentioned “control circuitry” confirms that Schlub discloses ***“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.”***

111. Accordingly, in my opinion Schlub discloses Limitation 1[d] and a POSITA would have understood Schlub to disclose and render obvious Limitation 1[d]. As such, in my opinion Schlub discloses and renders obvious the entirety of claim 1, and a POSITA would have understood Schlub to disclose and render obvious the entirety of claim 1.

- 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.**

112. In my opinion, Schlub discloses the additional limitations recited in

Claim 2. For example, Schlub discloses that its solution is implemented in “[a]n electronic device such as a portable electronic device has wireless communications circuitry.” EX1005, Abstract; see also [0020]. In my opinion, a “portable electronic device” that “has wireless communications circuitry” is a “***portable computing or communication device***” as recited Claim 2. Schlub further discloses that “[p]ortable electronic devices” can include “laptop computers or small portable computers such as ultraportable computers, netbook computers, and tablet computers,” which in my opinion constitute “***computers***” and “***personal data assistants***” as recited in claim 2. Schlub, [0025].

113. Accordingly, in my opinion Schlub also discloses the additional limitation of Claim 2 and a POSITA would have understood Schlub to disclose the additional limitation of Claim 2. As such, in my opinion Schlub discloses and renders obvious the entirety of Claim 2, and a POSITA would have understood Schlub to disclose and render obvious the entirety of Claim 2.

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.

114. In my opinion, Schlub discloses the additional limitations recited in Claim 3. I have broken this claim into sub-parts below, and discuss each in turn with reference to Schlub’s disclosure.

115. In my opinion, Schlub discloses “***a tuner for tuning said at least one***

steerable antenna with one or more active elements” requirement of Claim 3. In particular, Schlub specifically discloses that its portable wireless device contains “tuning circuits” (corresponding to “***a tuner for tuning said at least one steerable antenna***”) that can be used to “control the size and shape of the active portions of antenna resonating elements within the antennas” (corresponding to “***with one or more active elements***”). EX1005, [0009]. Specifically, Schlub provides examples of such tuning circuitry, and explains how the tuning can be used to adjust the operation of the antenna. As an example, Schlub explains that “antenna 40 can be adjusted . . . by adjusting antenna tuning” and that this can be done “by using . . . tunable circuit components.” *Id.*, [0074]-[0075]; *see also id.* [0066] (“[a]ctions 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.).

116. In my opinion, Schlub discloses “***which are selected or interconnected using electronic control***” requirement of Claim 3. In particular, Schlub discloses that the “tunable circuit components” can tune active elements of an antenna that are interconnected using electronic control. I note that Schlub’s “tunable circuit components” is further detailed in connection with its exemplary “[t]unable component 122,” which Schlub explains “may be a tunable capacitor, tunable resistor, tunable inductor, or other suitable circuitry having a tunable impedance that

can be adjusted to tune antenna 40.” EX1005, [0073]. As an example, Schlub discloses that this tuning component can control individual interconnected active elements of the antenna. Schlub explains that “[t]unable component 122,” can be “connected in series with antenna resonating element branches such as branches 114 and 130, may be connected in series with short circuit antenna branch 132, may be connected in parallel with these antenna structures, or may otherwise be interconnected with the components of antenna 40.” *Id.*, [0073]. Furthermore, Schlub also confirms that “resonating element structures may likewise be selectively connected and disconnected from the antenna resonating element in antenna 40 if desired,” which in my opinion confirms that Schlub discloses “tuning [the] steerable antenna with one or more active elements which are selected or interconnected using electronic control” as required by Claim 3.

117. Accordingly, in my opinion Schlub also discloses the additional limitation of Claim 3 and a POSITA would have understood Schlub to disclose the additional limitation of Claim 3. As such, in my opinion Schlub discloses and renders obvious the entirety of Claim 3, and a POSITA would have understood Schlub to disclose and render obvious the entirety of Claim 3.

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

118. In my opinion, Schlub discloses the additional limitation of Claim 6. In particular, Schlub discloses that “[d]evice 10 may include a phased antenna array”

and that “[t]he array may include multiple antenna elements (i.e., multiple antennas).” EX1005, [0032]. Specifically, Schlub confirms that a plurality of these antennas is steerable through the control of signal phases, and discloses that “[c]ontrol circuitry may be used to control the signals that are routed to and from the antenna elements (e.g., by controlling signal phases)” and that “[t]he control circuitry can alter the direction in which the antenna operates.” *Id.* In my opinion, Schlub also provides examples of how subsets of antennas may be controlled via phase settings. *See, e.g.*, EX1005, [0032].

119. Accordingly, in my opinion Schlub also discloses the additional limitation of Claim 6 and a POSITA would have understood Schlub to disclose the additional limitation of Claim 6. As such, in my opinion Schlub discloses and renders obvious the entirety of Claim 6, and a POSITA would have understood Schlub to disclose and render obvious the entirety of Claim 6.

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 steerable [sic] antenna, comprising:

120. For at least the same reasons I explain and reference above in connection with 1[pre] and Limitation 1[c][i] of Ground 1, which I incorporate herein by reference, it is my opinion that Schlub discloses avoiding radiation in the direction of a user or structure with a steerable antenna and therefore discloses and

renders obvious 7[pre].

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;**

121. For at least the same reasons I explain and reference above in connection with 1[a] of Ground 1, which I incorporate herein by reference, it is my opinion that Schlub discloses and renders obvious 7[a].

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

122. For at least the same reasons I explain and reference above in connection with 1[b] of Ground 1, which I incorporate herein by reference, it is my opinion that Schlub discloses and renders obvious 7[b]. Specifically, Schlub discloses that its “storage and processing circuitry” is configured to “process the signals from the antenna-based proximity sensor” in order to “determine whether antenna adjustments and other adjustments to the operation of the wireless circuitry of device 10 should be made.” *Id.* [0086]; *see also* [0036], [0048]. As I explained above in connection with Limitation 1[b], this “determination” involves the determination of the claimed “zones or spans of directions in three dimensional space” as explained and depicted above. Furthermore, Schlub notes that it is during this “processing” that the device “may, for example, determine, for each antenna 40,

whether an external object such as a user's body is in the vicinity of the antenna.” *Id.* In my opinion, a POSITA would understand Schlub’s teachings to disclose that the “storage and processing circuitry” receives and “process the signals” from the sensors, and that those signals are what pertain to the orientation in three dimensional space.

123. Accordingly, in my opinion Schlub discloses Limitation 7[b] and a POSITA would have understood Schlub to disclose Limitation 7[b].

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**

124. For at least the same reasons I explain and reference above in connection with 1[b] of Ground 1, which I incorporate herein by reference, it is my opinion that Schlub discloses and renders obvious 7[c].

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,**

125. For at least the same reasons I explain and reference above in connection with Limitations 1[c][ii]-[iii] and 1[d] of Ground 1, which I incorporate herein by reference, it is my opinion that Schlub discloses and renders obvious 7[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,**

126. In my opinion, Schlub discloses “***said at least one steerable antenna radiates or receives said one or more beams based on signals from said one or more processors***” requirement of Limitation 7[e]. In particular, 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]. Specifically, Schlub discloses 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].

127. In my opinion, Schlub discloses “***determined on execution of said executable instructions***” requirement of Limitation 7[e]. In particular, 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]. Specifically, Schlub discloses 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].

128. Accordingly, in my opinion Schlub discloses Limitation 7[e] and a POSITA would have understood Schlub to disclose Limitation 7[e].

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

129. For at least the same reasons I explain and reference above in connection with 1[c][i] of Ground 1, which I incorporate herein by reference, it is my opinion that Schlub discloses and renders obvious 7[c].

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.

130. For at least the same reasons I explain and reference above in connection with 1[c][i] of Ground 1, which I incorporate herein by reference, it is my opinion that Schlub discloses and renders obvious 7[c].

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.

131. For at least the same reasons I explain and reference above in connection with Claim 2 of Ground 1, which I incorporate herein by reference, it is my opinion that Schlub discloses and renders obvious the additional limitations of Claim 8. As such, in my opinion Schlub discloses and renders obvious the entirety of Claim 8, and a POSITA would have understood Schlub to disclose and render obvious the entirety of Claim 8.

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.

132. For at least the same reasons I explain and reference above in connection with Claim 3 of Ground 1, which I incorporate herein by reference, it is my opinion that Schlub discloses and renders obvious the additional limitations of Claim 9. As such, in my opinion Schlub discloses and renders obvious the entirety of Claim 9, and a POSITA would have understood Schlub to disclose and render obvious the entirety of Claim 9.

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:

133. For at least the same reasons I explain and reference above in connection with 1[pre] of Ground 1, which I incorporate herein by reference, it is my opinion that Schlub discloses and renders obvious 12[pre].

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;

134. For at least the same reasons I explain and reference above in connection with 1[a] of Ground 1, which I incorporate herein by reference, it is my

opinion that Schlub discloses and renders obvious 12[a].

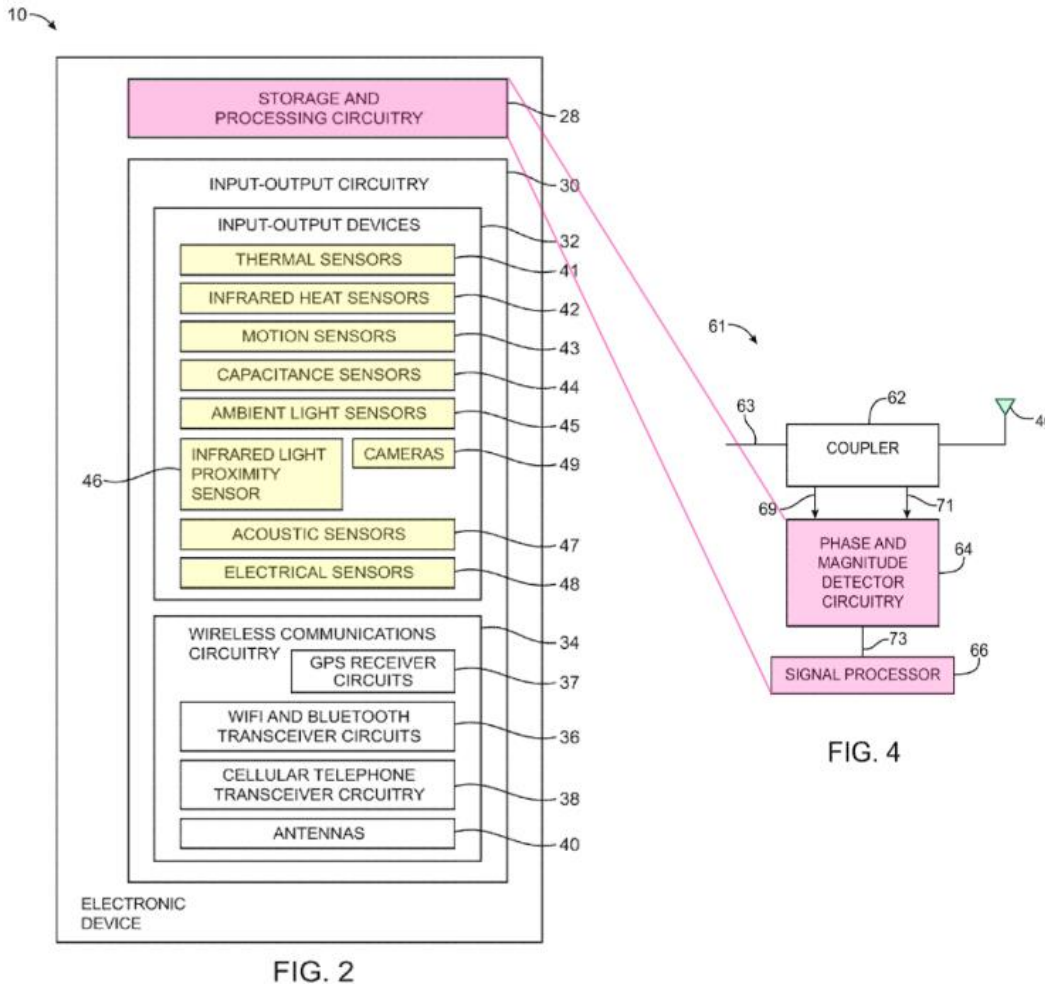
3. **12[b]: computing, with a computation module communicatively coupled to said one or more sensors, zones or spans of directions in the three dimensional space;**

135. For at least the same reasons I explain and reference above in connection with 1[b] of Ground 1, which I incorporate herein by reference, it is my opinion that Schlub discloses and renders obvious 12[b].

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,**

136. For at least the same reasons I explain and reference above in connection with Limitations 1[c][i]-[iii] of Ground 1, which I incorporate herein by reference, it is my opinion that Schlub discloses and renders obvious 12[c].

137. As I explained above in connection with Limitation 1[c][i], Schlub discloses a steerable antenna on one or multiple bands, operating at frequencies in the 10-500 GHz range. In particular, 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).



138. As I explained above in connection with Limitation1[c][ii]-[iii], Schlub discloses 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,**

139. For at least the same reasons I explain and reference above in connection with 1[b] of Ground 1, which I incorporate herein by reference, it is my

opinion that Schlub discloses and renders obvious 12[d].

- 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.**

140. For at least the same reasons I explain and reference above in connection with Limitation 1[c][iii] of Ground 1, which I incorporate herein by reference, it is my opinion that Schlub discloses and renders obvious 12[e].

- 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.**

141. For at least the same reasons I explain and reference above in connection with Claim 2 of Ground 1, which I incorporate herein by reference, it is my opinion that Schlub discloses and renders obvious the additional limitations of Claim 13. As such, in my opinion Schlub discloses and renders obvious the entirety of Claim 13, and a POSITA would have understood Schlub to disclose and render obvious the entirety of Claim 13.

- 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.**

142. For at least the same reasons I explain and reference above in connection with Claim 3 of Ground 1, which I incorporate herein by reference, it is my opinion that Schlub discloses and renders obvious the additional limitations of

Claim 14. As such, in my opinion Schlub discloses and renders obvious the entirety of Claim 14, and a POSITA would have understood Schlub to disclose and render obvious the entirety of Claim 14.

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

143. In connection with the combination of art noted in this Ground 2, 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. In my opinion, 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)

144. The cover page of Patent U.S. Publication No. 20060097918 ("Oshiyama") indicates it was filed November 10, 2003 and published May 11, 2006. I am informed that it is prior art to the '548 patent.

145. In general, 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].

146. Critically, Oshiyama discloses that its antenna is “capable of simultaneous antenna operation in multiple frequency bands,” citing concurrent GPS and cellular bands as an example. *Id.*, [0016]. Numerous embodiments and handset-ready layouts are provided—*e.g.*, a switch-based first embodiment with specific length settings, plus variations using a matching circuit, inductively coupled parallel conductors, and meandered traces—and an exterior view expressly configured for a mobile phone application. *Id.*, [0047]-[0048], [0021]-[0023], [0028]-[0029], [0040]-[0041].

B. Motivation to Combine

147. In my opinion, 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.

148. In my opinion, Oshiyama provides an express motivation to support simultaneous communications in multiple frequency bands. 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]. In my opinion, 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.

149. In my opinion, 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”).

150. Finally, in my opinion, a POSITA would have reasonably expected the combination to succeed. In particular, Schlub already discloses an antenna capable of multi-band operation, and with multiple resonating elements and associated tuning circuits, and in my opinion, a POSITA would have understood that these elements can be configured to simultaneously operate in different frequency bands, particularly in view of Oshiyama. Indeed, in my opinion that 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.

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.

151. In my opinion, Schlub discloses a steerable antenna that can transmit and receive in a plurality of different bands. See Ground I, 1[c][i]. In my opinion, 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.

152. In my opinion, 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). Specifically, 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].

153. In my opinion, 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 I set forth in Section IX.B. As such, in my opinion Schlub in view of Oshiyama discloses and renders obvious the entirety of Claim 4, and a POSITA would have understood Schlub in view of Oshiyama to disclose and render obvious the entirety of Claim 4.

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.

154. In my opinion, Schlub in view of Oshiyama renders obvious Claim 5. I have broken this claim into sub-parts below, and discuss each in turn with reference to Schlub’s disclosure.

155. In my opinion, Schlub discloses “***a processor for controlling tuning of one or more circuits for said at least one steerable antenna***” requirement of Claim 5. In particular, as I explained above in connection with Limitation 1[b] and Claim 3 in Ground 1, Schlub discloses that its “tuning circuitry” operates under the control of its “processor.” In particular, Schlub discloses that its “[p]rocessing circuitry may be based on one or more microprocessors . . .” and that this circuitry “may be used to control the operation of device 10.” EX1005, [0036]. One of the operations of device 10 is “tuning” via “tuning circuitry” as explained in connection with Claim 3. Accordingly, in my opinion, Schlub discloses at least one “***a processor for controlling tuning of one or more circuits for said at least one steerable antenna,***” which in some implementations may be the same processor I identified above in connection with Limitation in 1[b] in Ground 1.

156. In my opinion, Schlub discloses “***to operate in said plurality of different bands***” requirement of Claim 5. In particular, Schlub teaches that the “storage and processing circuitry” can “adjust[] which communications bands are active.” EX1005, [0023]. For example, by controlling switches and tunable components 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].

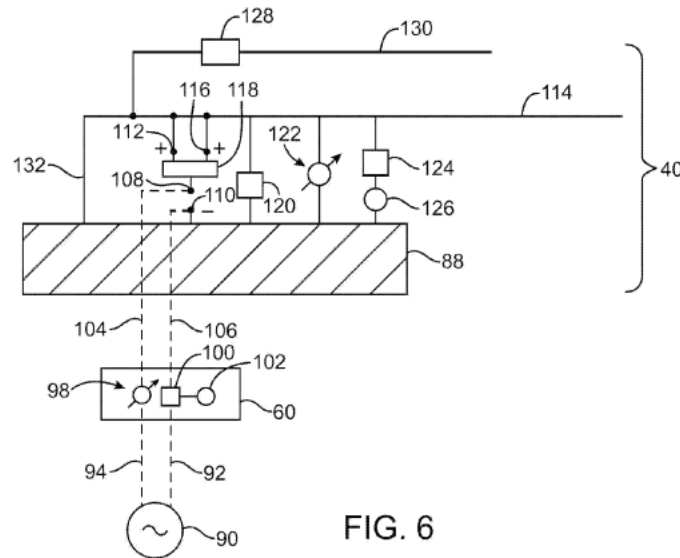
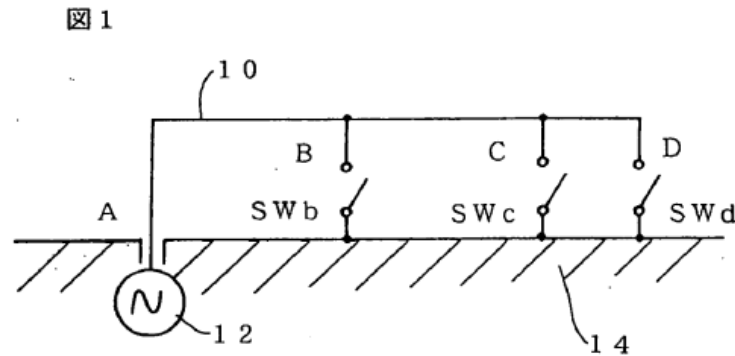


FIG. 6

157. In my opinion, 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.

158. In my opinion, Oshiyama discloses circuitry for tuning an antenna to a plurality of different frequency bands. For example, in one embodiment as depicted in Figure 1 below, Oshiyama discloses a system that 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, it is my opinion that 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].



159. As another example, in other embodiments, Oshiyama discloses alternative tuning circuits that can tune the antenna to a plurality of different bands **simultaneously**. In particular, 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]. Therefore, “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]. In my opinion, 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.

160. Accordingly, in my opinion Schlub in view of Oshiyama discloses and renders obvious the additional limitation of Claim 5 and a POSITA would have understood that Schlub in view of Oshiyama renders obvious the additional limitation of claim 5. Further, in my opinion Schlub in view of Oshiyama discloses and renders obvious the entirety of Claim 5, and a POSITA would have understood

Schlub in view of Oshiyama to disclose and render obvious the entirety of Claim 5.

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.

161. For at least the same reasons I explain and reference above in connection with Claim 4 of Ground 2, which I incorporate herein by reference, it is my opinion that Schlub in view of Oshiyama discloses and renders obvious the additional limitations of Claim 10. As such, in my opinion Schlub in view of Oshiyama discloses and renders obvious the entirety of Claim 10, and a POSITA would have understood Schlub in view of Oshiyama to disclose and render obvious the entirety of Claim 10.

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.

162. For at least the same reasons I explain and reference above in connection with Claim 5 of Ground 2, which I incorporate herein by reference, it is my opinion that Schlub in view of Oshiyama discloses and renders obvious the additional limitations of Claim 11. As such, in my opinion Schlub in view of Oshiyama discloses and renders obvious the entirety of Claim 11, and a POSITA would have understood Schlub in view of Oshiyama to disclose and render obvious the entirety of Claim 11.

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.

163. For at least the same reasons I explain and reference above in connection with Claim 4 of Ground 2, which I incorporate herein by reference, it is my opinion that Schlub in view of Oshiyama discloses and renders obvious the additional limitations of Claim 15. As such, in my opinion Schlub in view of Oshiyama discloses and renders obvious the entirety of Claim 15, and a POSITA would have understood Schlub in view of Oshiyama to disclose and render obvious the entirety of Claim 15.

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.

164. For at least the same reasons I explain and reference above in connection with Claim 5 of Ground 2, which I incorporate herein by reference, it is my opinion that Schlub in view of Oshiyama discloses and renders obvious the additional limitations of Claim 16. As such, in my opinion Schlub in view of Oshiyama discloses and renders obvious the entirety of Claim 16, and a POSITA would have understood Schlub in view of Oshiyama to disclose and render obvious the entirety of Claim 16.

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

165. As I explain in further detail below, 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. In my opinion, 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.

166. 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]), in my opinion, these limitations would have been obvious in view of Yin¹ as I explain below and it would have been obvious to a POSITA to apply those teaching to Prasad's wireless device as explained further below.

A. Prasad (EX1006)

167. The cover page of U.S. Patent Pub. No. 2013/0237272 ("Prasad") indicates it was filed September 16, 2011 and published September 12, 2013. I am informed that it is prior art to the '548 patent.

168. In general, Prasad discloses a "smart directional radiation protection system" for "portable wireless mobile devices" designed to "reduc[e] the intensity

¹ WIPO Publication No. 2014/194455 ("Yin") was filed on June 3, 2013 and published December 11, 2014. I am informed that Yin is prior art to the '548 patent.

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 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)

169. The cover page of U.S. Pat. No. 9,362,994 (“Seol”) indicates it was filed May 10, 2013 and issued June 7, 2016. I am informed that it is prior art to the ’548 patent.

170. In general, 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

171. In my opinion, 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.

172. First, Seol provides an express motivation to operate wireless communication devices in the mmWave frequency band. 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. In my opinion, 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.*

173. Second, in my opinion, Seol’s teachings would motivate a POSITA to

implement mmWave communications in a steerable antenna system, such as Prasad's. In particular, 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, in my opinion, 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"). 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].

174. 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, in my opinion, 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.

175. In addition, it is my opinion that 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”).

176. Finally, in my opinion, a POSITA would have reasonably expected the combination to succeed. 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]. In my opinion, 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. Indeed, Prasad's implementation is not limited to or dependent on certain operating frequencies, and, in my opinion, a POSITA

would have understood that Prasad's steerable antenna may be configured to operate at frequencies including in the 10-500 GHz band. In my opinion, all these changes to Prasad would have required only routine engineering with predictable results.

D. Claim 1

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

177. I understand that the preamble to a patent claim is generally not limiting. However, to the extent the preamble is limiting, in my opinion Prasad discloses it.

178. More specifically, 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***”). Here, “SAR” used by Prasad refers to how much radiation a user absorbs when exposed to electromagnetic fields emitted by the wireless device.

179. Specifically, 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].

180. Accordingly, in my opinion Prasad discloses 1[pre] and a POSITA

would have understood Prasad to disclose 1[pre].

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;**

181. In my opinion, Prasad discloses Limitation 1[a]. I have broken this limitation into sub-parts below, and discuss each in turn with reference to Prasad's disclosure.

182. In my opinion, Prasad discloses "***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***" requirement of Limitation 1[a]. In particular, 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].

183. In my opinion, Prasad discloses "***used for computational determination***" requirement of Limitation 1[a]. In particular, Prasad discloses a "processing unit" that "***compute[s]*** the information from the sensors" and "controls the sensor system." EX1006, Claim 23. 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].

184. In my opinion, Prasad discloses “**of spatial orientation in three dimensional space**” requirement of Limitation 1[a]. In particular, 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. In my opinion, a POSITA would have understood that these disclosures all describe techniques for detecting users or structures in three dimensional space.

185. In my opinion, Prasad discloses “**for detecting an orientation of said wireless device relative to either or both said user and said structure**” requirement of Limitation 1[a]. In particular, 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***”).

186. Accordingly, in my opinion Prasad discloses Limitation 1[a] and a POSITA would have understood Prasad to disclose Limitation 1[a].

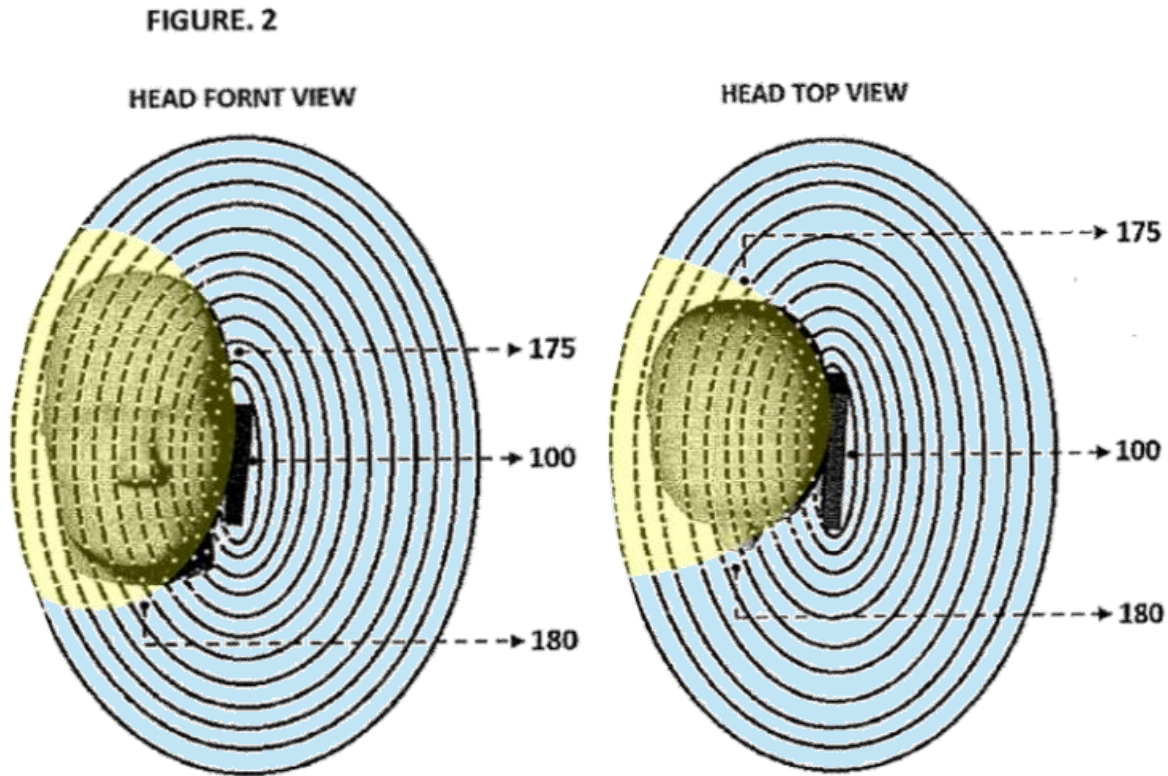
3. **1[b]: one or more processors for determining, based on information provided by said one or more detectors, zones or spans of directions in the three dimensional space corresponding with one or more directions of said user or structure relative to said at least one steerable antenna;**

187. In my opinion, Prasad discloses 1[b]. Additionally, to the extent PO contends that Prasad does not disclose 1[b], in my opinion, Prasad in combination with Yin discloses and renders it obvious. I have broken this limitation into sub-parts below, and discuss each in turn with reference to Prasad’s disclosure.

188. In my opinion, Prasad discloses “***one or more processors***” requirement of Limitation 1[b]. In particular, Prasad discloses a “processing unit” that “compute[s] the information from the sensors” and “controls the sensor system.” EX1006, Claim 23. For example, the processing unit may be a “***microprocessor***” that “***interact[s] with [the] sensor system.***” *Id.*, [0019]. In my opinion, a POSITA would understand Prasad’s disclosure that the “processing unit” is involved in “comput[ing] the information form the sensors” to disclose that the “processing unit” is “one or more processors for determining...” as required by 1[b].

189. In my opinion, Prasad discloses “**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**” requirement of Limitation 1[b]. In particular, Prasad discloses that the processing unit/microprocessor “**compute[s]** the information from the sensors.” EX1006, Cl. 23. Prasad further discloses “determin[ing] 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 reproduced below, 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].

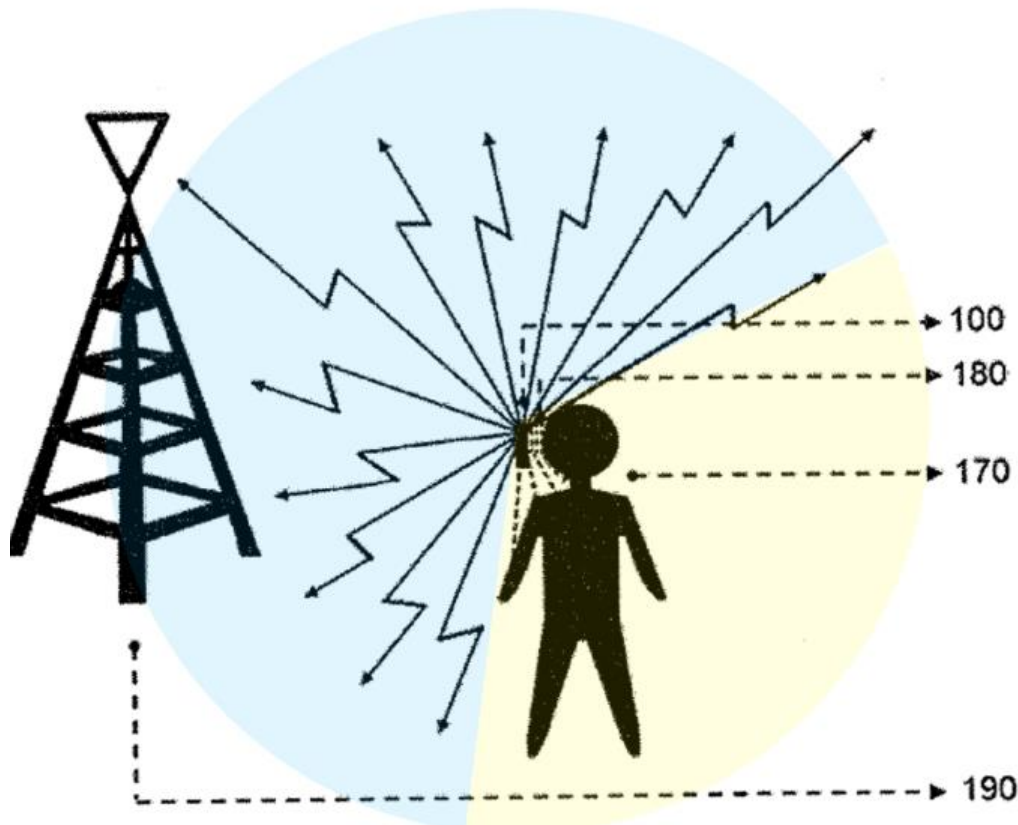
190. Specifically, Prasad **determines** the zones and spans corresponding with the direction of the user based on the sensor detections described above. *See* 1[a]; EX1006, [0027]. For example, the zones/spans corresponding to the user are illustrated with the “dotted lines” (annotated in yellow below),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



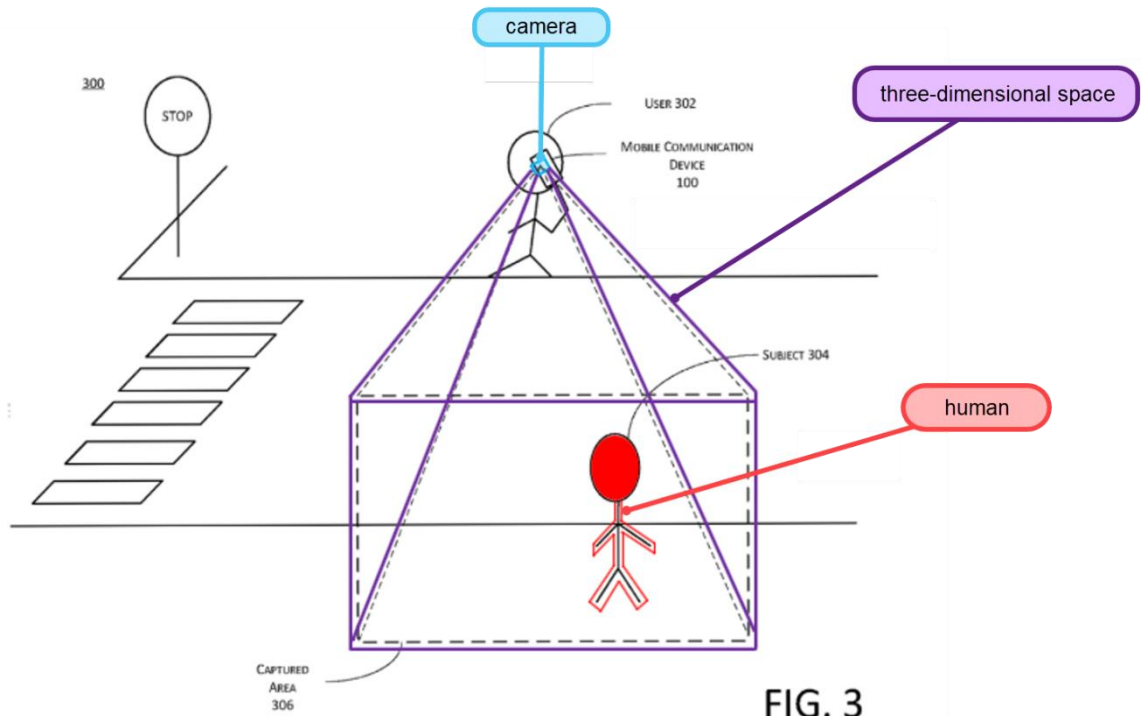
191. Figure 2 shows the emitted radiation from both a top view (*e.g.*, an x-y plane) and a front view (*e.g.*, an x-z plane), confirming detection in all three dimensions (*i.e.*, **three dimensional space**). EX1006, [0018], Fig. 2.

192. Prasad provides an alternative illustration in Figure 1 that also shows the zones or spans corresponding with the direction of the user in three dimensional space. EX1006, [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].

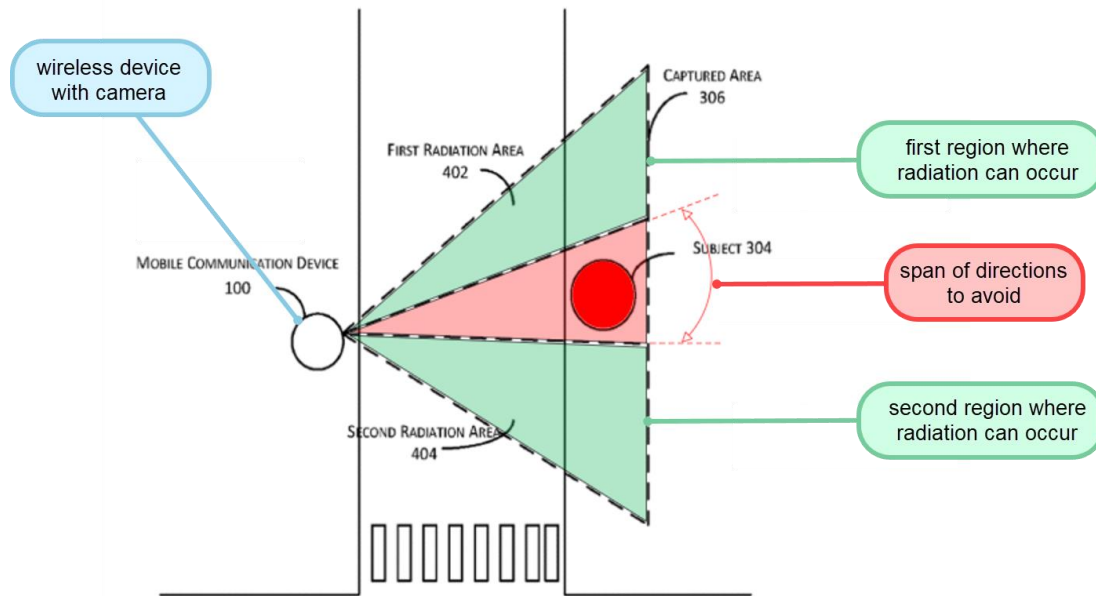
FIGURE. 1



193. To the extent PO contends Prasad alone does not disclose “zones” or “spans of directions,” in my opinion, Yin renders it obvious. In particular, 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. Figure 3 (reproduced and annotated below) illustrates this process:



194. Specifically, 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.



195. In my opinion, 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.

196. As I 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, in my opinion, 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. Prasad and Yin both disclose similar camera solutions coupled to processing circuitry, and in my opinion, 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. 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.

197. In addition, it is my opinion that, 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”).

198. For at least the same reasons I explained and referenced above in connection to Limitation 1[b] in Ground 1, in my opinion, Prasad and Yin includes far more disclosure of Limitation 1[b] than what the Board determined satisfied a limitation substantially similar to 1[b] in the Dorsey reference during prosecution of the related ’625 Patent. *See* EX1032, 22-23. I agree with the Board’s determination in connection with Dorsey’s more limited disclosure, and hold the further opinion that Prasad and Yin discloses as much and more than Dorsey in connection with Limitation 1[b]. Accordingly, in my opinion Prasad discloses Limitation 1[b] and a

POSITA would have understood Prasad to disclose Limitation 1[b]. Additionally, in my opinion, Prasad in combination with Yin discloses and renders Limitation 1[b] obvious, and a POSITA would have understood Prasad in combination with Yin to disclose Limitation 1[b].

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,

199. In my opinion, Prasad in view of Seol renders 1[c][i] obvious. In particular, 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].

200. In my opinion, 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.

201. For example, Seol discloses transmitting and receiving signals by “beamforming in a millimeter-wave communication system.” EX1007, 2:27-30; *see also id.*, 5:29-37. In my opinion, 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***. *See* 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.

202. In my opinion, 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 I set forth in Section X.B. Accordingly, in my opinion, Prasad in combination with Seol renders Limitation 1[c][i] obvious.

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,**

203. In my opinion, Prasad discloses 1[c][ii]. I have broken this limitation into sub-parts below, and discuss each in turn with reference to Prasad’s disclosure.

204. In my opinion, Prasad discloses “***wherein one or more beams of said one or more steerable antennas is adjustable***” requirement of Limitation 1[c][ii]. In particular, as I explained in connection with 1[pre] in Ground 3, Prasad discloses a ***steerable antenna*** comprises an “[a]ntenna system” with “***one or more*** radiating element[s]” used “to achieve ***dynamic radiation pattern***.” EX1006, cl. 24(f), [0027]. As such, Prasad discloses “***at least one*** steerable antenna” that itself has its beam radiation pattern adjusted to achieve a dynamic radiation pattern. In my opinion, 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. In that respect, in my opinion, 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.

205. Additional disclosures in Prasad further confirm this understanding. For example, Prasad discloses sending a “control signal” based on the sensor detection to the “antenna 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”). Therefore, by tuning the structure of the antenna during operation, the system is able to “actively control[] the radiation intensity in

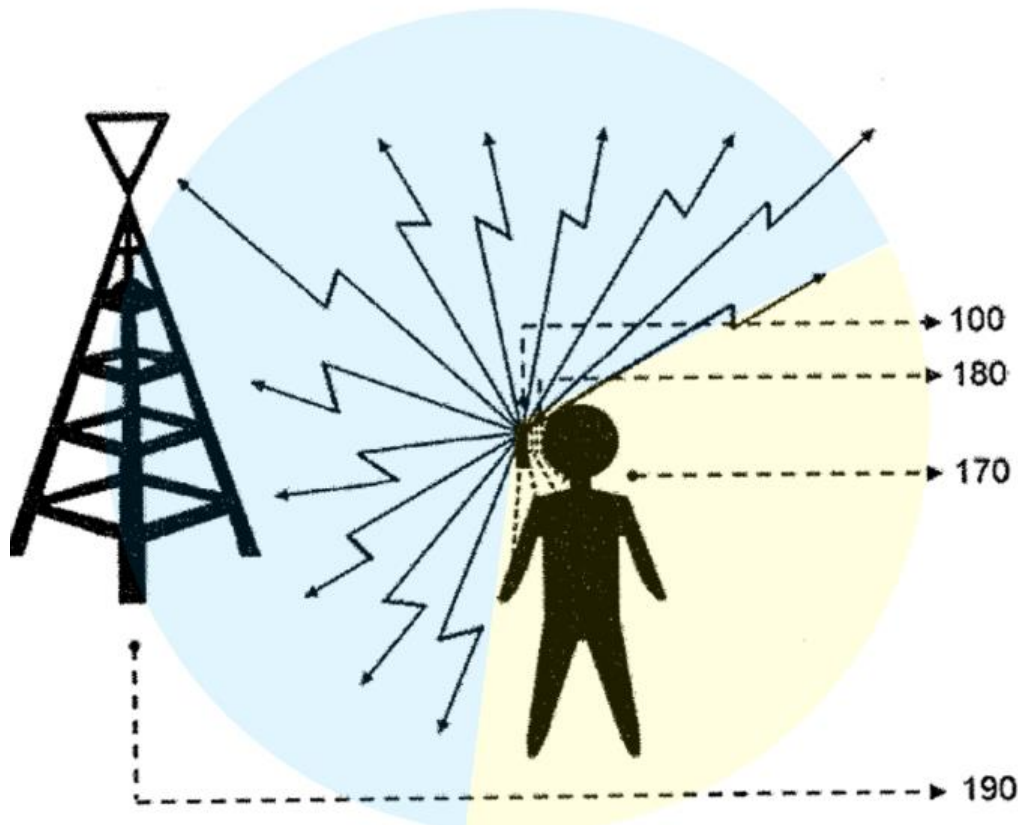
² The '548 patent specification teaches that a steerable antenna may itself include multiple sub-elements or antennas. *See, e.g.*, 14:32-43 (“[T]he disclosed invention with **single antenna** which **may have one or more elements or antennas**...may be used in conjunction with other antennas in various 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**.”).

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”).

206. In addition, I note that 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.

207. In my opinion, Prasad discloses “***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***” requirement of Limitation 1[c][ii]. In particular, I note that Prasad expressly discloses adjusting the radiation pattern of its antenna system accentuate to radiation in the directions where the user was ***not*** detected. 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).

208. 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 discloses a system that “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, in my opinion, radiation in the other directions is ***accentuated*** relative to radiation in the direction of the user (which is ***reduced*** or ***attenuated***).

209. In my opinion, Prasad discloses “***as determined by said one or more computational devices***” requirement of Limitation 1[c][ii]. In particular, 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.

210. 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), for at least the same reasons I explained and referenced above in connection with Limitation 1[b] in Ground 3, Yin renders this obvious. Accordingly, in my opinion Prasad, alone or in combination with Yin, discloses and renders obvious Limitation 1[c][ii] and that Prasad, alone or in combination with Yin, in combination with Yin also discloses and renders Limitation 1[c][ii] obvious.

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**

211. In my opinion, Prasad discloses 1[c][iii]. As I discussed above in connection with Limitation 1[c][ii] in Ground 3, 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). 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.

212. Accordingly, in my opinion Prasad discloses Limitation 1[c][iii] and a POSITA would have understood Prasad to disclose Limitation 1[c][iii].

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.**

213. In my opinion, Prasad, alone or in combination with Yin, discloses and renders obvious 1[d]. I have broken this limitation into sub-parts below, and discuss each in turn with reference to Prasad's disclosure.

214. First, in my opinion, 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.

215. Second, as I discussed above in connection with Limitation 1[c][ii] in Ground 3, 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.”). In particular, 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.***”).

216. Prasad discloses that “[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.* Prasad discloses that 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.

217. To the extent a POSITA looked to Yin to determine the zones to avoid and zones to direct radiation toward, for at least the same reasons I explained and referenced above in connection with Limitation 1[b] in Ground 3, 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. Accordingly, in my opinion Prasad, alone or in combination with Yin, discloses and renders obvious Limitation 1[d] and that Prasad, alone or in combination with Yin, in combination with Yin also discloses and renders Limitation 1[d] obvious.

E. 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.

218. In my opinion, Prasad discloses the additional limitations recited in Claim 2. In particular, Prasad discloses that its solution is “for portable wireless

mobile devices like mobile cell phone 100.” EX1006, Abstract. A “mobile cell phone” is a “**portable . . . communication device**” as recited claim 2. Prasad further discloses that its solution works with devices comprising “cordless phones” (i.e., telephones), “walky talkie” (i.e., “**portable . . . communication devices**”), “laptops” (i.e., “**portable . . . computing devices**”), “satellite phones” (i.e., “**portable . . . communication devices**”), “gaming devices” (i.e., “**games**”), and “IP phones with form factor of the device selected form group consisting of bar, slate, flip, slider, swivel, flexible, watch, transparent, tablet and mixed type” (i.e., “**portable . . . communication devices**”) as recited in claim 2. EX1006, Cl. 38.

219. Accordingly, in my opinion Prasad discloses the additional limitation of Claim 2 and a POSITA would have understood Prasad to disclose the additional limitation of Claim 2. As such, in my opinion Prasad in view of Seol, and/or Prasad in view of Seol and Yin, discloses and renders obvious the entirety of Claim 2, and a POSITA would have understood Prasad in view of Seol, and/or Prasad in view of Seol and Yin, to disclose and render obvious the entirety of Claim 2.

F. 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.

220. In my opinion, Prasad discloses the additional limitations recited in Claim 3. In particular, Prasad discloses a “smart directional transmit power or radiation controller 120” (“**tuner**,” as recited) coupled with a “tunable metamaterial

or tunable EBG antenna system 110.” EX1006, Abstract, Fig. 3. Prasad discloses 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” (“**for tuning said at least one steerable antenna**,” as recited). See EX1006, [0025]. As to the “**one or more active elements**” requirement of Claim 3, Prasad also discloses that the “metamaterials and EBG are most commonly composed of **small elements**, typically built onto circuit boards or assembled using nanofabrication techniques,” and that the antenna system “works by **activating different pattern of tuneable EBG and metamaterial elements** that **act according to configuration by actively controlling** the radiation intensity in required direction and time” (“**one or more active elements which are selected or interconnected using electronic control**,” as recited). *Id.*, [0024]. Prasad further confirms that the active elements are interconnected using electronic control with its disclosure that the antenna is “composed of small elements” that are (1) physically interconnected by being “built onto [a] circuit board[]” in a “lattice structure”, and (2) electrically interconnected through the electrical conductivity of the physical connections, and (3) 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.*

221. Accordingly, in my opinion Prasad discloses the additional limitation

of Claim 3 and a POSITA would have understood Prasad to disclose the additional limitation of Claim 3. As such, in my opinion Prasad in view of Seol, and/or Prasad in view of Seol and Yin, discloses and renders obvious the entirety of Claim 3, and a POSITA would have understood Prasad in view of Seol, and/or Prasad in view of Seol and Yin, to disclose and render obvious the entirety of Claim 3.

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

222. In my opinion, 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.” In my opinion, 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. *See* EX1007, 5:14-16 (explaining that an “antenna array” comprises a set of “individual antennas ... called antenna elements”).

223. Accordingly, in my opinion Prasad discloses the additional limitation of Claim 6 and a POSITA would have understood Prasad to disclose the additional limitation of Claim 6. As such, in my opinion Prasad in view of Seol, and/or Prasad in view of Seol and Yin, discloses and renders obvious the entirety of Claim 6, and a POSITA would have understood Prasad in view of Seol, and/or Prasad in view of Seol and Yin, to disclose and render obvious the entirety of Claim 6.

H. 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:**

224. For at least the same reasons I explain and reference above in connection with 1[pre] of Ground 3, which I incorporate herein by reference, it is my opinion that Prasad discloses and renders obvious 7[pre].

- 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;**

225. For at least the same reasons I explain and reference above in connection with 1[a] of Ground 3, which I incorporate herein by reference, it is my opinion that Prasad discloses and renders obvious 7[a].

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

226. For at least the same reasons I explain and reference above in connection with 1[b] of Ground 3, which I incorporate herein by reference, it is my opinion that Prasad discloses and renders obvious 7[b]. Specifically, Prasad discloses that its “processing unit” is configured to “control[] the sensor system” and that it “computes the information from the sensors.” EX1006, Claim 23. For example, the processing unit may be a “*microprocessor*” that “*interact[s] with [the] sensor*

system.” *Id.*, [0019]. In my opinion, a POSITA would understand Prasad’s teachings to disclose that the “processing unit” receives signals from the sensors, and the information from the sensors must be ***received*** in order to be processed. As I explained above in connection with Limitation 1[a] in Ground 3, the sensors provide information indicating ***the orientation of the device in three dimensional space.*** Accordingly, in my opinion Prasad discloses and renders obvious 7[b] and a POSITA would have understood Prasad to disclose and render obvious 7[b].

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

227. For at least the same reasons I explain and reference above in connection with 1[b] of Ground 3, which I incorporate herein by reference, it is my opinion that Prasad or Prasad in combination with Yin discloses and renders obvious 7[c]. In particular, Prasad discloses that it’s “processing unit” is configured to “control[] the sensor system” and that it “computes the information from the sensors.” EX1006, [0019], Claim 23. Because Prasad discloses that some of the “information” computed from the sensors involves the aforementioned orientation detection (1[a]) and zone/spans determination (1[b]), it is my opinion that a POSITA would understand Prasad’s teachings to disclose that the “processing unit” receives signals from the sensors, and that those signals are used to ***“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” as required by 7[c]. Accordingly, in my opinion Prasad or Prasad in combination with Yin discloses and renders obvious 7[c] and a POSITA would have understood Prasad or Prasad in combination with Yin to disclose and render obvious 7[c].

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,**

228. For at least the same reasons I explain and reference above in connection with Limitations 1[c][ii]-[iii] and 1[d] of Ground 3, which I incorporate herein by reference, it is my opinion that Prasad or Prasad in combination with Yin discloses and renders obvious 7[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,**

229. In my opinion, Prasad discloses Limitation 7[e]. I have broken this limitation into sub-parts below, and discuss each in turn with reference to Prasad’s disclosure.

230. In my opinion, Prasad discloses “*said at least one steerable antenna radiates or receives said one or more beams based on signals from said one or more processors*” requirement of Limitation 7[e]. In particular, as I explained above in connection with Limitation 1[c][iii] in Ground 3, Prasad’s processing unit uses a

“**control signal**,” determined “based on signal[s] from ... [the] sensors” to control the **antenna radiation pattern**. EX1006, [0021].

231. In my opinion, Prasad discloses “**determined on execution of said executable instructions**” requirement of Limitation 7[e]. In particular, as I discussed above in connection with Limitation 1[b] in Ground 3, Prasad discloses a “processing unit” such as a “microprocessor.” In my opinion, 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. 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.

232. Accordingly, in my opinion Prasad discloses Limitation 7[e] and a POSITA would have understood Prasad to disclose Limitation 7[e].

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

233. For at least the same reasons I explain and reference above in connection with 1[c][i] of Ground 3, which I incorporate herein by reference, it is my opinion that Prasad discloses and renders obvious 7[f].

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.

234. For at least the same reasons I explain and reference above in

connection with 1[c][i] of Ground 3, which I incorporate herein by reference, it is my opinion that Prasad in view of Seol discloses and renders obvious 7[g].

235. As such, in my opinion Prasad in view of Seol, and/or Prasad in view of Seol and Yin, discloses and renders obvious the entirety of claim 7, and a POSITA would have understood Prasad in view of Seol, and/or Prasad in view of Seol and Yin, to disclose and render obvious the entirety of claim 7.

- I. 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.**

236. For at least the same reasons I explain and reference above in connection with Claim 2 of Ground 3, which I incorporate herein by reference, it is my opinion that Prasad discloses and renders obvious the additional limitations of Claim 8. As such, in my opinion Prasad in view of Seol, and/or Prasad in view of Seol and Yin, discloses and renders obvious the entirety of Claim 8, and a POSITA would have understood Prasad in view of Seol, and/or Prasad in view of Seol and Yin, to disclose and render obvious the entirety of Claim 8.

- J. 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.**

237. For at least the same reasons I explain and reference above in connection with Claim 3 of Ground 3, which I incorporate herein by reference, it is

my opinion that Prasad discloses and renders obvious the additional limitations of Claim 9. As such, in my opinion Prasad in view of Seol, and/or Prasad in view of Seol and Yin, discloses and renders obvious the entirety of Claim 9, and a POSITA would have understood Prasad in view of Seol, and/or Prasad in view of Seol and Yin, to disclose and render obvious the entirety of Claim 9.

K. 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:**

238. For at least the same reasons I explain and reference above in connection with 1[pre] of Ground 3, which I incorporate herein by reference, it is my opinion that Prasad discloses and renders obvious 12[pre].

- 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;**

239. For at least the same reasons I explain and reference above in connection with 1[a] of Ground 3, which I incorporate herein by reference, it is my opinion that Prasad discloses and renders obvious 12[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;**

240. For at least the same reasons I explain and reference above in connection with Limitation 1[b] of Ground 3, which I incorporate herein by reference, it is my opinion that Prasad or Prasad in combination with Yin discloses and renders obvious 12[b].

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,**

241. For at least the same reasons I explain and reference above in connection with Limitations 1[c][i]-[iii] of Ground 3, which I incorporate herein by reference, it is my opinion that Prasad in view of Seol and/or Prasad in view of Seol and Yin discloses and renders obvious 12[c].

242. As I explained above in connection with Limitation 1[c][i] in Ground 3, Prasad in view of Seol discloses and renders obvious steerable antenna on one or multiple bands, operating at frequencies in the 10-500 GHz range. In particular, Prasad's steerable antenna is in communication with—*i.e.*, ***communicatively coupled with***—Prasad's ***processor***. 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).

243. As I explained above in connection with Limitations 1[c][ii]-[iii] in Ground 3, Prasad or Prasad in view of Yin discloses and renders obvious adjusting a 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,**

244. For at least the same reasons I explain and reference above in connection with Limitation 1[b] of Ground 3, which I incorporate herein by reference, it is my opinion that Prasad discloses and renders obvious 12[d].

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.**

245. For at least the same reasons I explain and reference above in connection with Limitations 1[c][ii]-[iii] and 1[d] of Ground 3, which I incorporate herein by reference, it is my opinion that Prasad discloses and renders obvious 12[e].

246. As such, in my opinion Prasad in view of Seol, and/or Prasad in view

of Seol and Yin, discloses and renders obvious the entirety of claim 12, and a POSITA would have understood Prasad in view of Seol, and/or Prasad in view of Seol and Yin, to disclose and render obvious the entirety of claim 12.

- L. 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.**

247. For at least the same reasons I explain and reference above in connection with Claim 2 of Ground 3, which I incorporate herein by reference, it is my opinion that Prasad discloses and renders obvious the additional limitations of Claim 13. As such, in my opinion Prasad in view of Seol, and/or Prasad in view of Seol and Yin, discloses and renders obvious the entirety of Claim 13, and a POSITA would have understood Prasad in view of Seol, and/or Prasad in view of Seol and Yin, to disclose and render obvious the entirety of Claim 13.

- M. 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.**

248. For at least the same reasons I explain and reference above in connection with Claim 3 of Ground 3, which I incorporate herein by reference, it is my opinion that Prasad discloses and renders obvious the additional limitations of Claim 14. As such, in my opinion Prasad in view of Seol, and/or Prasad in view of Seol and Yin, discloses and renders obvious the entirety of Claim 14, and a POSITA

would have understood Prasad in view of Seol, and/or Prasad in view of Seol and Yin, to disclose and render obvious the entirety of Claim 14.

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

249. As I explain in further detail below, 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. In my opinion, 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

250. In my opinion, a POSITA would have been motivated to combine Prasad, Seol, and Yin as outlined in Ground 3 as I described above in Section X.C.

251. In my opinion, 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.

252. I note that, Oshiyama provides an express motivation to support simultaneous communications in multiple frequency bands. 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]. Specifically, Oshiyama discloses that its multi-band antenna is “favorable for mobile communications” in such situations. 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]. In my opinion, 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.

253. In addition, in my opinion, 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”).

254. Finally, in my opinion, a POSITA would have reasonably expected the combination to succeed. 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. Indeed, antennas with simultaneous multiband operation were well known by the priority date of the '548 Patent, and in my opinion, providing such operation in Prasad's steerable antenna would have required only routine engineering with predictable results.

B. 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.

255. In my opinion, Prasad in view of Seol and/or Yin and Oshiyama discloses the additional limitations in Claim 4. For at least the same reasons I explained and referenced above in connection with Limitation 1[c][i] in Ground 3, Prasad discloses a steerable antenna that can transmit and receive in a plurality of different bands. In my opinion, 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. In particular, 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). Specifically, 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].

256. In my opinion, 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. As such, in my opinion Prasad in view of Seol and/or Yin and in further view of Oshiyama discloses and renders obvious the entirety of Claim 4, and a POSITA would have understood Prasad in view of Seol and/or Yin and in further view of Oshiyama to disclose and render obvious the entirety of Claim 4.

C. 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.

257. In my opinion, Prasad in view of Oshiyama renders obvious the additional limitations recited in Claim 5. I have broken this claim into sub-parts below, and discuss each in turn with reference to Schlub’s disclosure.

258. In my opinion, Prasad discloses “*a processor for controlling tuning of*

one or more circuits for said at least one steerable antenna” requirement of Claim

5. In particular, 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). Specifically, 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].

259. In my opinion, Prasad in view of Oshiyama renders obvious “***to operate in said plurality of different bands***” requirement of Claim 5. In my opinion, 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. In particular, 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]. In my opinion,

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 I explained above in Section XI.A.

260. Accordingly, in my opinion Prasad in view of Oshiyama discloses the additional limitation of claim 5 and a POSITA would have understood Prasad in view of Oshiyama to disclose the additional limitation of claim 5. As such, in my opinion Prasad in view of Seol and/or Yin, and in further view of Oshiyama discloses and renders obvious the entirety of Claim 5, and a POSITA would have understood Prasad in view of Seol and/or Yin, and in further view of Oshiyama to disclose and render obvious the entirety of Claim 5.

D. 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.

261. For at least the same reasons I explain and reference above in connection with Claim 4 of Ground 4, which I incorporate herein by reference, it is my opinion that Prasad in view of Seol and/or Yin, and in further view of Oshiyama discloses and renders obvious the additional limitations of Claim 10. As such, in my opinion Prasad in view of Seol and/or Yin, and in further view of Oshiyama discloses and renders obvious the entirety of Claim 10, and a POSITA would have understood Prasad in view of Seol and/or Yin, and in further view of Oshiyama to disclose and render obvious the entirety of Claim 10.

E. 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.

262. For at least the same reasons I explain and reference above in connection with Claim 5 of Ground 4, which I incorporate herein by reference, it is my opinion that Prasad in view of Oshiyama renders obvious the additional limitations of Claim 11. As such, in my opinion Prasad in view of Seol and/or Yin, and in further view of Oshiyama discloses and renders obvious the entirety of Claim 11, and a POSITA would have understood Prasad in view of Seol and/or Yin, and in further view of Oshiyama to disclose and render obvious the entirety of Claim 11.

F. 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.

263. For at least the same reasons I explain and reference above in connection with Claim 4 of Ground 4, which I incorporate herein by reference, it is my opinion that Prasad in view of Seol and/or Yin, and in further view of Oshiyama discloses and renders obvious the additional limitations of Claim 15. As such, in my opinion Prasad in view of Seol and/or Yin, and in further view of Oshiyama discloses and renders obvious the entirety of Claim 15, and a POSITA would have understood Prasad in view of Seol and/or Yin, and in further view of Oshiyama to disclose and render obvious the entirety of Claim 15.

G. 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.

264. For at least the same reasons I explain and reference above in connection with Claim 5 of Ground 4, which I incorporate herein by reference, it is my opinion that Prasad in view of Oshiyama renders obvious the additional limitations of Claim 16. As such, in my opinion Prasad in view of Seol and/or Yin, and in further view of Oshiyama discloses and renders obvious the entirety of Claim 16, and a POSITA would have understood Prasad in view of Seol and/or Yin, and in further view of Oshiyama to disclose and render obvious the entirety of Claim 16.

I, Mark Mahon, declare under penalty of perjury under the laws of the United States that the foregoing is true and correct.

Dated: October 8, 2025



Mark Mahon, Ph.D.

Appendix A

Mark P. Mahon, Ph.D.
Teaching Professor
Pennsylvania State University
School of Electrical Engineering and Computer Science
W209A Westgate Bldg.
University Park, PA

Highlights

Teaching faculty experienced in research and systems development in cellular and mobile wireless networks, wireless local area networks, wireless network security, mobility management, mobile data systems including networks, protocols, and applications, wideband signal processing, modulation theory, algorithms, mathematical/analytical modeling, communication, detection and estimation, and control systems. Pursues funding for and conducts advanced research in computer and mobile networks, theoretical and experimental analysis of communication systems, cellular, wireless, and mobile systems, wideband signal processing, sensors, tracking, localization, and data fusion. Experienced in hardware/software development, data acquisition, integration, and testing, field test planning, preparation, and execution. Extensive programming experience including UI, analysis tools, real-time object-oriented programming, and embedded systems code development in C, C++, python, java, Verilog, RTL, VHDL, HDL, and assembly.

Education

PhD. Acoustics, The Pennsylvania State University, University Park, PA 16802, 2001
M.S. Electrical Engineering, The Pennsylvania State University, University Park, PA, 16802, 1991
B. S. Electronics Engineering, The University of Scranton, Scranton, PA, 18510, 1987

Employment

July 2021 – Present: *Teaching Professor, School of Electrical Engineering and Computer Science, The Pennsylvania State University, University Park, PA 16801*

June 2018 – June 2021: *Associate Teaching Professor*

Aug. 2015 – June 2018: *Assistant Teaching Professor*

Teach graduate and undergraduate courses in computer science and electrical engineering such as communication networks, mobile networks, neural networks, programming, mathematics, and wireless security. Advise and direct graduate students' MS and PhD research in the areas of wireless and computer networks, data pipelining, network resource allocation and optimization techniques, ultrawide band systems, multiple antenna applications, and wireless security. Guide Schreyer Honors College students' honors theses. HackPSU, BlockChain@PSU, and ML@PSU faculty adviser, member of graduate advising committees, member of Computer Science Undergraduate Curriculum Committee, member of School of EECS Management Committee, advise undergraduate electrical engineering, computer science, computer engineering, and data science students.

2003 – Aug. 2015: *Associate Research Professor, Applied Research Laboratory, Communications, Information, and Navigation Office, The Applied Research Laboratory, The Pennsylvania State University, State College, PA* Principal Investigator, Co-Principal Investigator, Technical lead conducting research on multi-Int data fusion and UI design to support intelligence analysts in Combat Operation Centers, cellular and mobile networks, computer network security, mobile communication systems, and wideband signals and image processing with total funding over \$12M.

2002 – 2003: *Sr. Systems Engineer, Klein & Stump, Inc., 2120 Washington Blvd. #400, Arlington, VA 22204* Researcher and technical consultant working on wireless communications projects for US Special Operations Command (SOCOM) and Naval Information Warfare Activity (NIWA). Awarded \$150k SBIR for SOCOM advanced signal simulator.

1991 – 2002: *Assistant Research Professor, Applied Research Laboratory, Communication Sciences and Technology Division, The Applied Research Laboratory, The Pennsylvania State University, State College, PA 16804* Principal Investigator and researcher conducting research on cellular and mobile networks, wideband signals, tracking and localization, adaptive signal processing, acoustic propagation, sensor systems, remote sensing, and active noise control. Awarded \$750k for development of novel wavelet based wideband signal detection for high altitude sensors.

1988 – 1989: *Program Engineer, Central Intelligence Agency, Langley, VA 22101*

Assisted in the development of algorithms and signal processing systems for novel applications in the areas of RF communications and signal modulation techniques.

Detailed Research Experience:

Current ongoing research:

Resource allocation and scheduling improvements in NG networks and edge computing; Multiple Input Multiple Output antenna techniques for increased capacity in NG systems; Fast handover techniques using blockchains to reduce mobility interruption times in 5G networks; AI/NN techniques applied to network scheduling and optimization, and mobile robotics for localization and mapping; Automated object detection and 3D mapping using sonar array data. Security vulnerabilities in UWB ranging.

2015 – Present

Lead graduate and undergraduate student research in wireless communication networks, distributed video processing in cellular systems, UWB ranging, communication systems and security, software defined network security, application of game theory to cyber resiliency, wireless, machine learning, big data analytics, and artificial intelligence for mobile and computer network security and automated detection in acoustic and sonar systems.

2014 – 2015

Leading internal research and development effort on deep packet inspection for zero day and predictive detection for data networks. Technical performer developing novel deformable wavelet-based contour matching technique for automated object detection in satellite images. Acoustic tracking and identification of drones for area defense system.

2014

Developed real-time scanner for 802.15.4 (LR-WPAN) protocol deployed on software defined radio platform.

2013-2014

Technical lead on developing novel mathematical model for analyzing torpedo acoustic threat surrogate systems for US Navy. Experimental lead on disposable, adaptive, high bandwidth fiber-optic undersea communication system for US Navy.

2013

Implemented a novel matched filter receiver for a unique OFDM signal of interest to facilitate signal detection in a high co-channel interference environment of a wide field of view high altitude receiver and wideband signal set design in highly complex propagation environments for Department of Defense (DoD).

2012-2013

Technical lead for design and implementation of a real-time transmitter/receiver on a software defined radio platform for maritime communication systems (Automatic Information System/Maritime Security).

2012

Communications/signal processing technical consultant on Maritime Domain Operations and Unmanned Surface Ship Interdiction study effort for US Navy.

2011-2012

Principal Investigator, technical and experimental lead on fiber optic undersea communication system for Advanced Submarine System Development effort for US Navy.

2011

Technical lead on mathematical analysis, algorithm development, and implementation of pattern of life signal to noise ratio analysis in high co-channel interference environment for DoD.

Trusted agent for Army Research Lab to review and critically analyze work associated with wideband signaling and passive emissions collection from cell phones. Reviewed contractor data analysis and technical briefings for scientific accuracy and rigor. Advised the sponsor on contractor testing methodologies, procedures, and analysis techniques. Technical lead implementing unique wideband acoustic communication system and specialized signal processing hardware for an acoustic system being utilized in a complex maritime environment for the DoD.

2009 – 2010

Tiger team lead for large unmanned undersea vehicle (UUV) assigned to identify platform induced electromagnetic interference with electronic payload system in the HF and acoustic regimes for the US Navy.

Developed and implemented a novel algorithm to calculate the effective force charge based on muzzle sensor data utilizing MEMS transducers and PIC controller on a portable howitzer for the US Army.

Conducted study and authored Intelligence, Surveillance, and Reconnaissance (ISR) for Unmanned/Minimally Manned Undersea Vehicle (UMUV) report presented to Defense Advanced Research Projects Agency (DARPA).

2006 – 2009

Principal Investigator for a multi-year research and FPGA-based engineering prototype development effort in the area of 3G/4G (UMTS/LTE) cellular and wireless (IEEE 802.16 and 802.11) communication systems; Effort consisted of three phases: theoretical and analytical study, proof-of-concept development, and testing, and prototype development for DoD.

2005-2006

Technical lead on Information Fusion engine integration into a sandbox enclave at Joint Interagency Task Force South (JIATF-S) to support multi-int data fusion.

2003 – 2006

Principal Investigator for multi-year Office of Secretary of Defense sponsored research program in the area of multi-intelligence data fusion (fusion engine and UI interface) as part of the overall initiative of Force Transformation; worked extensively with NSA, DIA, DISA, OSD, all military services, and some coalition components. Led team of software engineers to develop scalable user-facing

application and backend data fusion engines.

2002 – 2003

Pursued funding for research interests in the areas of wireless/wideband communications, wideband systems, source detection/localization, intelligent system of systems design, and data fusion; Awarded Phase I, Small Business Innovative Research contract for Portable Signal Training System by SOCOM (02-013); Technical consultant for Naval Information Warfare Center on Common for High Performance Computing Software Support Initiative's (CHSSI) Electronic Battlefield Environment (EBE) portfolio (Electromagnetic Environmental Effects Toolkit), SBIR, MERIT/TENCAP, TST programs

1998 – 2002

Researcher and principal investigator performed research in large time-bandwidth product (wavelets) source detection and localization – theoretical, analytical, and field testing; CDMA IS-95A/3G cellular communications; Developed mathematical analytical models and included code development of the CDMA air interface physical layer implementing major aspects of the CDMA protocol for test and analysis purposes; Built real-time hardware platform for deploying developed CDMA physical layer code.

1996 – 1998

Principal Investigator in charge of signal processing algorithm and code development, image acquisition and compression, telephony, and user interface design for an experimental remote, autonomous, acoustic rockslide detection for Conrail. Work included algorithm and code development utilizing embedded digital signal processing (DSP) board and development of unique algorithms for real-time monitoring of transducers to create an event detection system.

1991 – 1997

Performed fundamental research in the areas of signal processing algorithm development, acoustic atmospheric propagation, detection, source localization, beamforming, system identification, and active control; Main responsibilities include real-time code development (C, Visual C++, assembly) for signal processing systems, adaptive beamforming, and embedded processing for eight major projects during this time. Multiple DSP platform development; Active Noise Control, feature extraction, data logging and fusion, passive acoustic tracking, beamforming, and analysis for these projects

1988-1989

Assisted in the development of algorithms and signal processing systems for novel applications in the areas of RF communications and signal modulation techniques.

Case History:

July 2025, McKool Smith

Ericsson v. Transsion

Consulted for plaintiff Ericsson on 4G/5G signaling technology. Submitted two declarations on international patents asserted in Vietnam.

May 2025 – Present, Anand and Anand

AX Wireless v. Xiamoi and Vivo, New Delhi, India

Consulting for plaintiff on WiFi technology. Reply report filed 9/5/25.

February 2025 – June 2025, Fish & Richardson

Samsung v. Wilus, IPR proceedings

Consulting for petitioner Samsung on WiFi technology. Filed declarations on 4/30/25.

December 2024 – May 2025, Stearne, Kessler, Goldstein

ISG v. Dell, HP, and Lenovo, In re matter of Certain Wireless Communication Devices and Components Thereof, ITC No. 337-3785.

Consulted for petitioner ISG on WiFi-6 technology. No reports filed.

October 2024 – Present, Latham & Watkins, LLP

Advanced Coding Technologies LLC v. Google LLC, Case No. 2:24-cv-00353 (EDTX)

Consulting for defendant Google on coding techniques in 5G cellular systems.

Submitted claim construction declaration 6/24/25. Deposed 7/15/25.

October 2024 – July 2025, Carmichael, IP

Aylo Freesites LTD v. Wellcomemat LLC IPR2024-00710

Consulting for respondent Wellcomemat. Technology related to remote editing of video content. Filed declaration 2/12/25. Deposed 3/13/25.

September 2024 – August 2025, Norton Rose Fulbright

Apple v. Smith Interface Technologies IPR2024-01085, -01090, -01087

Consulting for respondent SIT on technology related to user interface design on mobile devices.

Declarations filed 4/14/25, 4/16/25, and 4/30/25. Deposed 6/19/25. Claim construction declaration filed 7/14/25. Deposed 7/21/25 and 7/30/25.

September 2024 – Present, GreenbergTraurig

GenghisComm Holdings, LLC v. Samsung Electronics America, Inc. Case No. 2:24-cv00242 (EDTX)

Consulting for defendant Samsung on technology related to 5G/4G cellular signaling.

July 2024 – September 2025, Alston & Bird

Pegasus Wireless Innovation LLC v. Cellco Partnership d/b/a Verizon Wireless et al., Case No. 2:23-cv-00640-JRG (Lead Case), EDTX. Consulting for defendants. Invalidity, non-infringement, and first supplemental non-infringement reports filed 4/23/25, 5/20/25 and 6/18/25. No deposition.

May 2024 – April 2025, McKool Smith

AT&T Services, Inc, Cellco Partnership D/B/A Verizon Wireless, Ericsson, Inc., and Nokia Corporation v. ASUS Technology Licensing, Inc. and Innovative Sonic, Case No. 2:23-cv-00486, IPR2024-0099, -009917

Consulting for petitioners. Technology related to signaling in 4G and 5G networks. Filed declarations on 6/4/24 and 10/16/24. Filed Ex Parte reexam declaration 4/1/25.

May 2024 – July 2024, Merchant & Gould

Apex Beam Technologies LLC v. TCT Mobile International Ltd. Case No. 2:21-cv-438 (EDTX)

Consulting for defendant TCT. Technology related to signaling in 5G cellular networks. Wrote submitted claim construction declaration filed on 7/17/24. Deposed 7/31/24 on claim construction declaration.

May 2024 – Present, McKool Smith

Aspen Networks v. AT&T, Case No. 2:23-cv-00476

Consulting for defendant AT&T. Technology related to VoWiFi signaling.

May 2024 – June 2024, Merchant & Gould

L2 Mobile Technologies LLC v. TCL Electronics Holdings Ltd., Case No. 1:22-cv-1306

Consulted for defendant TCL. No work product exchanged. Case settled.

March 2024 – Present, Quinn Emanuel, LLP

Collision Communications, Inc. v. Samsung Electronics Co., Ltd. v. Samsung Electronics America, Inc., Case No. 2:23-cv-00587 (EDTX)

Consulting for defendant. Filed invalidity and non-infringement reports 4/25/25 and 5/16/25. Deposed 5/27-28/25.

March 2024 – February 2025, Duane Morris

Ericsson and Nokia v. Active Wireless IPR2024-00886, -00951, -00985, -00986

Active Wireless v. T-Mobile, Ericsson, and Nokia Case No. 2:23-cv-00261 (EDTX)

Consulted for petitioners Ericsson and Nokia. Technology related to signaling in 4G and 5G cellular networks. Wrote four declarations for IPR. Consulted for defendants T-Mobile and intervenors. Submitted invalidity report for defendant and intervenors; deposed 12/4/24.

March 2024 – May 2024, Quinn Emanuel, LLP

Samsung Electronics Co., Ltd. v. Datang Mobile Communications Equipment Co., Ltd.

Consulted for petitioner Samsung. Technology related to random access in 4G/5G cellular networks. Wrote declaration in support of claim construction. Case stayed.

March 2024, Rimon Law

L2 Mobile Technologies LLC v. OnePlus Technology (Shenzhen) Co., Ltd., No. 2:23-cv-00087

No work product oral or written exchanged. Case settled.

January 2024 – Present, McKool Smith

Headwater Research, LLC v. AT&T Corp. et al, Case No. 2:23-cv-00398

Consulting for defendant. Technology related to control of battery and data usage in 4G/5G user devices. Filed a rebuttal report 3/13/25. Deposed 3/19/25.

December 2023 – March 2024, Duane Morris

Ericsson, Inc. and Nokia of America v. XR Communications, LLC, IPR2024-00613 (IPR); Case No. 2:23-CV-00202-JRG-RSP (EDTX). Consulted for petitioners and defendants. Technology related to MIMO in cellular networks. Filed declarations on 3/6/24. Deposed 1/7/25.

October 2023 – April 2024, Erise IP; Finnegan, DLA Piper, Husch Blackwell

BNR v. ASUSTek/Media Tek/Laird/NXP Inc. Inv. No. 337-TA-1367 (USITC). Consulting for defendant ASUS on ASUS (Qualcomm-based products) non-infringement and JDG (ASUS/Media Tek/ Laird/ NXP) on Tech DI non-infringement on WiFi wireless devices and semiconductor chips with wireless capabilities related to wireless transmission technologies. Wrote rebuttal report. BNR settled with ASUS and Media Tek; BNR withdrew complaint for NXP.

September 2023 – April 2024, McKool Smith

Daingean Technologies Ltd. v. AT&T, et al, Case No. IPR2024-00309. Consulting for petitioner AT&T. Technology related to 5G wireless transmissions. Wrote declarations. Case settled.

August 2023 – December 2023, Greenberg Traurig

Atlas Global Technologies, LLC v. Acer Incorporated, No. 2:22-cv-00259 WDTX. Consulting for defendant Acer. Technology related to wireless transmissions in WiFi networks. No reports. Settled.

August 2023 – February 2025, McKool Smith

Ericsson v. Lenovo/Motorola, In the Matter of Certain Mobile Phones, Components Thereof, and Products Containing Same, Inv. No. 337-TA-1375 (USITC); IPR204-00702 (IPR)

Consulting for Complainant Ericsson on technology related to 5G cellular signaling technology. Infringement and invalidity rebuttal. Testified at the ITC. Filed Decl 12/6/24. Deposed IPR 2/12/25.

August 2023 – Present, Caldwell, Cassidy and Curry

Neo Wireless, LLC v. Ford, et al., Case No. 2:22-MD-03034. Consulting for plaintiff on technology related to 4G cellular radio access. Wrote infringement and invalidity rebuttal reports.

June 2023 – November 2023, Duane Morris

Ericsson, Inc., and Cellco Partnership D/B/A Verizon Wireless v. Woodbury Wireless LLC., IPR 2023-01364. Consulted for petitioner Verizon. IPR. Technology related to MIMO and minimization of interference. Declaration filed 10/10/23. Case settled.

January 2023 – April 2023, McKool Smith

Ericsson v. Koninklijke KPN N.V., Case No. IPR2023-00582. Consulting for Petitioner Ericsson. IPR. Technology related to neighbor cell lists in wireless systems. Declaration filed 2/17/23.

November 2022 – April 2023, Finnegan, Henderson, Farabow, Garrett & Dunner, LLP

Qualcomm, Inc. vs. FedEx, Inc., IPR 2022-00585. Consulting for patent owner FedEx. Wrote IPR declaration. Deposed 4/19/23. Technology related to sensor information collected by tracking devices.

October 2022 – November 2023, BC Law Group, P.C.

Lionra Technologies Limited v. Apple, Inc. Case No. 6:22-cv-00351-ADA, WDTX
Consulting for patent owner Lionra. Case dismissed 11/18/23.

September 2022 – June 2023, Quinn Emanuel, LLP

Google LLC v. Sonos, Inc., Inv. No. 337-TA-1330 (USITC)

Consulting for patent owner Google. Wrote infringement and validity rebuttal reports. Technology related to voice assistants and smart devices. Deposed 4/14/23. Testified at trial 6/20/23 and 6/23/23.

September 2022 – August 2023, BC Law Group, P.C.

Apple, Inc. vs. Speir Technologies Limited, IPR2022-01512 and -00151

Consulted for patent owner Speir on UWB localization technology. Wrote IPR declarations. Deposed 10/25/23. Case dismissed 11/18/23.

August 2022 – July 2024, Venable, LLP

VoIP-Pal.com, Inc. v. Verizon Communications Inc. Case No. 6:21-cv-00672, WDTX

Consulting for defendant Verizon. Wrote non-infringement report. Deposed 5/17/23. Technology relates to VoIP in cellular networks. Summary judgement of non-infringement.

July 2022 – November 2023, Quinn Emanuel Urquhart & Sullivan, LLP

Evolved Wireless LLC v. Samsung Electronics Co., Ltd., and Samsung Electronics America, Inc., Case No. 2:21-cv-00033, EDTX. Technology related to handovers in 4G networks.

Consulting for defendant Samsung. Wrote non-infringement and validity rebuttal report. Deposed 7/5/23; Testified at trial 11/14/23.

March 2022 – Dec. 2022, Knobbe, Martens, Olson & Bear, LLP

Jawbone Innovations, LLC v. Amazon.com, Inc., et al.

Consulting for petitioner Amazon (IPR). Technology related to tracking using acoustic arrays. Case stayed. No reports.

May 2022 – Dec. 2022, McKool Smith; Alston Bird

Ericsson Inc. and Telefonaktiebolaget LM Ericsson vs. Apple Inc., Case No. 2:21-cv-376, EDTX

Consulted for plaintiff and counter-defendant Ericsson.

Report on Essentiality and Rebuttal report (FRAND). Deposed 10/4/2022. Testified 12/7/2022. Case settled during trial.

Broad spectrum of technology related to cellular networks (core network and mobile device)

March 2022 – Dec. 2022, McKool Smith

Ericsson Inc. and Telefonaktiebolaget LM Ericsson vs. Apple Inc., Inv. No. 337-TA-1299, ITC
Consulted for Ericsson. Opening and Rebuttal report. Deposed 10/7/2022. Case settled.
Technology related to security in cellular systems.

January 2022 – March 2023, Duane Morris

Telecom Network Solutions v. AT&T Inc., et al, Case No. 2:21-cv-415 and Verizon Communications Inc., et al, Case No 2:21-cv-416, EDTX
Consulted for defendants AT&T and Verizon on Invalidity. Case settled; no reports filed.
Technology related to QoS in cellular networks.

September 2021 – December 2021, Duane Morris, LLP

KAIFI LLC v. Verizon Wireless, Case No. 2:20-cv-280-JRG, EDTX
Consulted for defendant Verizon. Wrote Non-Infringing Alternatives and Non-Infringement reports.
Deposed 12/15/21. Case settled. Technology related to cellular and WiFi enablement cellular systems.

September 2021 – December 2021, Quinn Emanuel, LLP

L2 Mobile Technologies, LLC v. Google, Case No. 6:21-cv-358, WDTX
Consulted for defendant Google. Wrote reply Claim Construction brief. Case settled.
Technology related to control signaling in cellular systems.

August 2021 – May 2022, McKool Smith

Godo Kaisha IP Bridge 1 v. Ericsson, Case No. 2:21-cv-00213-JRG, EDTX
Consulted for defendant Ericsson. IPR and Claim Construction declarations.
Technology related to signaling in OFDM systems.

July 2021 – August 2021, Quinn Emanuel, LLP

Finesse Wireless, LLC v. Nokia, et al., Case No. 2:21-CV-00063-JRG, EDTX
Consulted for defendant Nokia on claim construction. Wrote declaration and deposed on 8/17/21.
Technology related to coding techniques in wireless systems.

Case Testimony History:

October 2024 – July 2025, Carmichael, IP

Aylo Freesites LTD v. Wellcomemat LLC IPR2024-00710 (IPR)
Consulting for respondent Wellcomemat. Technology related to remote editing of video content. Filed declaration 2/12/25. Deposed 3/13/25.

October 2024 – Present, Latham & Watkins, LLP

Advanced Coding Technologies LLC v. Google LLC, Case No. 2:24-cv-00353 (EDTX)
Consulting for defendant Google on coding techniques in 5G cellular systems.
Submitted claim construction declaration 6/24/25. Deposed 7/15/25.

September 2024 – Present, Norton Rose Fulbright

Apple v. Smith Interface Technologies IPR2024-01085, IPR2024-01090, IPR2024-01087
Consulting for respondent SIT on technology related to user interface design on mobile devices.
Declarations filed 4/14/25, 4/16/25, and 4/30/25. Deposed 6/19/25. . Claim construction declaration filed 7/14/25. Deposed 7/21/25 and 7/30/25.

July 2024 – Present, Alston & Bird

Pegasus Wireless Innovation LLC v. Cellco Partnership d/b/a Verizon Wireless et al., Case No. 2:23-cv-00640-JRG (Lead Case), EDTX. Consulting for defendants. Invalidity, non-infringement, and first supplemental non-infringement reports filed 4/23/25, 5/20/25 and 6/18/25

May 2024 – July 2024, Merchant & Gould

Apex Beam Technologies LLC v. TCT Mobile International Ltd. Case No. 2:21-cv-438-JRG (EDTX); Case Filed 04/22/24. Consulting for defendant TCT. Technology related to signaling in 5G cellular networks. Submitted claim construction declaration 7/17/24. Deposed 7/31/24 on claim construction declaration.

March 2024 – Present, Quinn Emanuel, LLP

Collision Communications, Inc. v. Samsung Electronics Co., Ltd. v. Samsung Electronics America, Inc., Case No. 2:23-cv-00587 (EDTX)

Consulting for defendant. Filed invalidity and non-infringement reports 4/25/25 and 5/16/25. Deposed 5/27-28/25.

March 2024 – February 2024, Duane Morris

Ericsson and Nokia v. Active Wireless IPR2024-00886, -00951, -00985, -00986

Consulted for petitioners Ericsson and Nokia. Technology related to signaling in 4G and 5G cellular networks. Wrote four declarations for IPR. Deposed 12/4/24.

January 2024 – Present, McKool Smith

Headwater Research, LLC v. AT&T Corp. et al, Case No. 2:23-cv-00398

Consulting for defendant. Technology related to control of battery and data usage in 4G/5G user devices. Filed a rebuttal report 3/13/25. Deposed 3/19/25.

December 2023 – March 2024, Duane Morris

Ericsson, Inc. and Nokia of America v. XR Communications, LLC, IPR2024-00613 (IPR); Case No. 2:23-CV-00202-JRG-RSP (EDTX). Consulted for petitioners and defendants. Technology related to MIMO in cellular networks. Filed declarations on 3/6/24. Deposed 1/7/25.

October 2023 – April 2024, Erise IP; Finnegan, DLA Piper, Husch Blackwell

BNR v. ASUSTek/Media Tek/Laird/NXP Inc. Inv. No. 337-TA-1367 (USITC). Consulting for defendant ASUS on ASUS (Qualcomm-based products) non-infringement and JDG (ASUS/Media Tek/ Laird/ NXP) on Tech DI non-infringement. Wrote declarations on WiFi wireless devices and semiconductor chips with wireless capabilities related to wireless transmission technologies. Wrote rebuttal report. Deposed 2/8/24. BNR settled with ASUS and Media Tek; BNR withdrew complaint before hearing.

September 2023 – June 2023, Quinn Emanuel, LLP

Google LLC v. Sonos, Inc., Inv. No. 337-TA-1330 (USITC)

Consulting for patent owner Google. Wrote infringement and validity rebuttal reports. Technology related to voice assistants and smart devices. Deposed 4/14/23. Testified 6/20-23/23.

August 2023 – July 2024, McKool Smith

Ericsson v. Lenovo/Motorola, In the Matter of Certain Mobile Phones, Components Thereof, and Products Containing Same, Inv. No. 337-TA-1375 (USITC); IPR204-00702 (IPR)

Consulting for complainant Ericsson on technology related to 5G cellular signaling technology. Wrote infringement and invalidity rebuttal. Deposed 5/23/24. Testified 7/16/24. Wrote IPR declaration filed on 12/6/24. Deposed for IPR 2/12/25.

August 2023 – Present, Caldwell, Cassidy and Curry

Neo Wireless, LLC v. Ford, et al., Case No. 2:22-MD-03034. Consulting for plaintiff on technology related to 4G cellular radio access. Wrote infringement and invalidity rebuttal reports. Deposed 5/16/24 and 5/17/24.

November 2022 – April 2023, Finnegan, Henderson, Farabow, Garrett & Dunner, LLP

Qualcomm, Inc. vs. FedEx, Inc., IPR 2022-00585

Consulting for patent owner FedEx. Wrote IPR declaration. Deposed 4/19/23.

Technology related to sensor information collected by tracking devices.

September 2022 – November 2023, BC Law Group, P.C.

Apple, Inc., vs. Speir Technologies Limited, IPR2022-01512 and -00151

Consulted for patent owner Speir on UWB localization technology. Wrote IPR declarations. Deposed 10/25/23. Case dismissed 11/18/23.

August 2022 – July 2024, Venable, LLP

VoIP-Pal.com, Inc. v. Verizon Communications Inc. Case No. 6:21-cv-00672, WDTX

Consulting for defendant Verizon. Wrote non-infringement report. Deposed 5/17/23.

Technology relates to VoIP in cellular networks. Summary judgement of non-infringement.

July 2022 – November 2023, Quinn Emanuel Urquhart & Sullivan, LLP

Evolved Wireless LLC v. Samsung Electronics Co., Ltd., and Samsung Electronics America, Inc., Case No. 2-21-cv-00033, EDTX. Technology related to handovers in 4G networks.

Consulting for defendant Samsung. Wrote non-infringement and validity rebuttal report. Deposed 7/5/23; Testified at trial 11/14/23. Jury found for defendant on all counts.

March 2022 – December 2022, McKool Smith

Ericsson Inc. and Telefonaktiebolaget LM Ericsson vs. Apple Inc., Inv. No. 337-TA-1299, ITC

Consulting for Ericsson. Opening and Rebuttal report. Deposed 10/7/2022. Testified 12/7/2022. Case settled during trial.

May 2022 – December 2022, McKool Smith; Alston Bird

Ericsson Inc. and Telefonaktiebolaget LM Ericsson vs. Apple Inc., Case No. 2:21-cv-376, EDTX

Consulting for plaintiff and counter-defendant Ericsson.

Report on Essentiality and Rebuttal report. Deposed 10/4/2022. Case settled.

September 2021 – December 2021, Duane Morris, LLP

KAIFI LLC v. Verizon Wireless, Case No. 2:20-cv-280-JRG, EDTX

Consulted for defendant Verizon. Wrote Non-Infringing Alternatives and Non-Infringement reports. Deposed 12/15/21. Case settled.

July 2021 – August 2021, Quinn Emanuel, LLP

Finesse Wireless, LLC v. Nokia, et al., Case No. 2:21-CV-00063-JRG, EDTX

Consulted for defendant Nokia on claim construction. Technology related to noise in the front-end of receiver. Deposed on 8/17/21.

Teaching:

Courses:

- CSE 516 (Mobile Networks): Redesigned the course to integrate latest developments in mobile network architecture design. The course now includes signaling, control, and protocol issues unique to 4G/5G architectures addressing eMBB, mMTC, and URLLC use cases critical to IoT and future wireless network development and future NG networks.
- CSE 514 (Communication Networks)
- CSE 590 (Colloquium)
- CMPEN 462 (Wireless Communication Systems and Security): Created and designed this course to address a gap in the wireless communications area focusing on security. This course is included in the cybersecurity computational foundations minor.
- EE 466 (Introduction to Software-Defined Radio: Overview of the principles of software-defined radio systems with laboratory components.
- EE 456 (Introduction to Neural Networks): This course is intended to address the need for EE and CMPEN students to be exposed to the principles associated with artificial intelligence.

- CMPEN/EE 362 (Communication Networks)
- CMPSC 263 (Blockchains and Modern Web Development): This course is ‘module’ driven and designed to provide students with a broad range of academic backgrounds an opportunity to learn about blockchains and cryptography. Under supervision, students in the Distributed Ledger Society teach the modules including theory and practice in the areas of programming, math, and cryptography.
- ACS 505 (Experimental Techniques in Acoustics)
- MATH 141 (Calculus with Analytical Geometry II)
- CMPSC 101 (Programming in C++)

Publications:

Rublein, Mehmeti, Mahon, and LaPorta, “Bilateral Reinforcement Learning for Distributed Resource Allocation in Edge Computing”, *IEEE Transactions on Network and Service Management*. Submitted June 2025.

Rublein, Mehmeti, Mahon, and LaPorta, “Improved Methods of Task Assignment and Resource Allocation with Preemption in Edge Computing Systems”, *IEEE Transactions on Parallel and Distributed Systems*, June 30, 2025.

Rublein, Mehmeti, Mahon, and LaPorta, “Impact of Client Choice on Distributed Resource Allocation in Edge Computing”, *The 33rd International Conference on Computer Communications and Networks (ICCCN 2024)*, IEEE and IEEE Communication Society, July 29 – 31, 2024, Big Island, Hawaii, USA.

Sorensen, Mahon, Mehmeti, and LaPorta, QoE-Analysis of 5G Network Resource Allocation Schemes for Competitive Multi-User Video Streaming Applications, *IEEE Conference on Vehicular Technology*, Florence, Italy, June 2023.

Sorensen, Mehmeti, Mahon, LaPorta, and Cao, “EQMS: An Improved Energy-Aware and QOE-aware Video Streaming Policy across Multiple Competitive Mobile Devices”, *Wireless Networks: The Journal of Mobile Communication, Computation and Information*, Dec. 2022.

Sorensen, Mehmeti, Mahon, Qui, Chan, Qui, and LaPorta, “Optimal Resource Allocation for Crowdsourced Image Processing”, *IEEE Transactions on Mobile Computing*, June 2022.

Sorensen, Mehmeti, Mahon, La Porta, Cao, “Mutli-User Competitive Energy-Aware and QoE-Aware Video Streaming on Mobile Devices”, *ACM Proceedings of the QoS and Security for Wireless and Mobile Networks (Q2SWinet) Symposium collocated with Modeling, Analysis, and Simulation of Wireless and Mobile Systems (MSWIM 2020)*, Alicante, Spain, Nov. 2020.

Sorensen, Mehmeti, Mahon, Qui, Chan, and LaPorta, “Optimal Resource Allocation for Crowdsourced Image Processing”, *IEEE International Conference on Sensing and Networking (IEEE SECON 2020)*, Como, Italy, June 2020.

Swanson, Mahon, Norris, and Mast, “Atmospheric Multipath Resolution Using Spread Spectrum Acoustic Signals”, *Proceedings of Meetings on Acoustics*, September 2017.

Aquaviva, Mahon, Einfalt, and LaPorta, “Optimal Cyber-Defense Strategies for Advanced Persistent Threats: A Game Theoretic Approach,” *2017 International Symposium on Reliable and Distributed Systems*, Hong Kong, China, September 27 – 29, 2017.

Young, Mahon, and Wyckoff, "Automated Information Management," Chap. 12, *Mathematical Techniques in Multisensor Data Fusion*, Hall, David L., Artech House Inc., Mar 2004

Mahon, Sonstebly, and Wenchel, "Application of Non-Orthogonal Waveletes for Geolocation," *Radiolocation and Direction Finding Symposium*, Southwest Research Institute, San Antonio, Texas, 2-4 Nov. 1999.

Myers, Lovette, Kilgus, Giannini, Swanson, Reichard, Mahon, Mast, "A Java-based Information System for Wayside Sensing and Control," *Proc. of the 1998 ASME/IEEE Joint Railroad Conference*, 1998, pp. 135-147.

Swanson, Mast, Mahon, "Atmospheric Multipath Resolution Using Spread Spectrum Acoustic Signals," *Proceedings of the 133rd Meeting of the ASA*, June 15-20, 1997.

Mahon, Swanson, "Acoustic Holography as an Active Control Measurement Tool," *Proceedings of Active 95, The 1995 International Symposium on Active Control of Sound and Vibration*, Newport Beach, CA, July 1995, pp. 673-684.

Mahon, Sibul, Valenzuela, "A Sliding Window Update for the Basis Matrix of the QR Decomposition," *IEEE Transactions on Signal Processing*, May 1993, pp. 1951-1953.

Mahon, Sibul, Valenzuela, "An Alternative Updating Scheme for the QR Algorithm as Applied to Adaptive Beamforming," *Proc. 25th Annual Conf. on Info. Sciences and Systems*, Johns Hopkins University, Baltimore, MD, March 1991, pp. 193-199.

Awards/Honors:

Senior Member IEEE

2001 Formal citation letter from National Reconnaissance Office (NRO) for experimental work with mobile wireless systems

2001 Formal citation letter for excellence in software development from the NRO for work associated with mobile wireless systems.

2000 Formal citation letter from NRO for development of wavelet course presented at NRO Technology Symposium

1997 Invited session chair of "Signal Processing in Acoustics: General Signal Processing," Noise-Con '97, 133rd meeting of the ASA.

1996 Simowitz Citation Acoustics Department PSU for outstanding publication by a graduate student

1995 Invited co-chair of "Transducers for Active Control of Sound and Vibration," Active 95, Active Noise Control Conference

1993 Simowitz Award Acoustics Department PSU for outstanding publication by a graduate student

1987 Dr. A. J. Cawley Award for Excellence in Electronics Engineering by Physics/EE Department University of Scranton