

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

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

v.

Massively Broadband LLC,
Patent Owner.

Case IPR2025-01565

U.S. Patent No. 8,350,763

**DECLARATION OF DR. MARK P. MAHON IN SUPPORT OF PETITION
FOR INTER PARTES REVIEW OF U.S. PATENT NO. 8,350,763**

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EXHIBIT LIST

Ex.	Description
1001	U.S. Pat. No. 8,350,763 (“’763 patent”)
1002	Prosecution History of U.S. Pat. No. 8,350,763
1003	Expert Declaration of Dr. Mark Mahon
1004	European Pat. App. No. 1,914,835 (“Wen”)
1005	U.S. Pat. No. 7,786,819 (“Ella”)
1006	U.S. Pat. Pub. No. 2004/0125027 (“Rubinshteyn”)
1007	Intentionally Left Blank
1008	U.S. Pat. No. 7,489,914 (“Govind”)
1009	Int. Pub. No. WO 2005/029720 (“Leenaerts”)
1010	U.S. Pat. No. 8,583,065 (“Ben-Bassat”)
1011	Infringement Contentions, <i>Massively Broadband LLC v. Samsung Electronics Co., Ltd., AND Samsung Electronics America, Inc.</i> , Case No. 2:25-cv-00608 (E.D. Tex.)
1012	IEEE dictionary, 7th ed. (2000)
1013	U.S. Pat. No. 5,962,751 (“Vlahos”)
1014	Molisch, Andreas F., <i>Wireless Communications</i> 2nd Ed., Wiley, 2011
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, <i>Multiband Integrated Antennas for 4G Terminals</i> , Artech House, 2008

Ex.	Description
1020	U.S. Patent No. 5,794,145
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	Bhuiyan, Ekram, et al., “Active Tuning and Miniaturization of Microstrip Antennas,” IEEE Antennas and Propagation Society International Symposium, Vol. 4, 2002

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. 8,350,763 (the “’763 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 ’763 patent. Specifically, I have been asked to provide my opinion regarding whether claims 1-17 of the ’763 patent (“the Challenged Claims”) are invalid as obvious in view of the prior art.

I. SUMMARY OF OPINIONS

3. It is my opinion that the Challenged Claims are anticipated or rendered obvious pursuant to Grounds I-VIII and the reasons discussed herein.

II. MATERIALS CONSIDERED

4. In forming my opinions provided in this declaration, I have reviewed the '763 patent, including the abstract, figures, specification, and claims. I have also reviewed and relied on the file history of the '763 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

5. My qualifications are summarized here and explained in more detail in my curriculum vitae, which is attached as Appendix A to this declaration. 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.

6. 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.

7. 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.

8. 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.

9. 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.

10. 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.

11. 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.

12. 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.

13. 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.

14. 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.

15. 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).

16. 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.

17. 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).

18. 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.

19. 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.

20. 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.

21. 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.

22. 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.

23. 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.

24. 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.

25. 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

26. 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

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

28. 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.

29. 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.

30. 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

31. 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 understand that claim terms can be construed in a manner deviating from their plain meaning only when: 1) there is a clear and unmistakable disclaimer by the applicant, or 2) when the inventor acts as his or her own lexicographer. 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. Additionally, I understand and have been instructed that, when a claim's recitation is purely functional and does not include any definite structure for performing the function claimed, the term is a

“means-plus-function” claim. It is my understanding that means-plus-function claims are construed using a two-step process: first, determination of the claimed function, and second, identification of the corresponding structure. If the term is understood by a POSITA as referring to a particular structure, however, this two-step process is not followed. I understand and have been instructed that, where the claim uses the word “means,” there is a presumption that it is a means-plus-function claim term. I also understand and have been instructed that an applicant for a patent must disclose adequate structure in the specification to perform the recited function, and that if adequate structure is not recited, the claim is indefinite. I am further instructed that when the corresponding structure is a general purpose computer or microprocessor, the specification must disclose the algorithm or process to be performed by the general purpose computer or microprocessor, or the claim is indefinite.

C. Burden of Proof

32. 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. Invalidity

33. I understand that a patent claim is invalid if each and every element of the claim is disclosed by a single prior art reference. This is known as anticipation, and the claim is said to be “anticipated” by the prior art reference. I understand that disclosure of a limitation of a patent claim can be express or inherent. I also understand that sometimes the disclosure of a limitation can be implicit if it involves an inference that a POSITA would reasonably be expected to draw from the express disclosure or is a clear and unambiguous consequence of what is explicitly disclosed. I understand that a patent claim is also invalid if the claimed invention would have been obvious to a POSITA at the time the application was filed. This means that even if all of the requirements of the claim cannot be found in a single prior art reference that would anticipate the claim, the claim can still be invalid. 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.

34. 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.

35. 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.

36. 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.

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

38. 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.¹

¹ I am not aware of any secondary factors supporting non-obviousness of the Challenged Claims. To the extent the Patent Owner presents any such evidence, I reserve the right to respond.

39. 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.

40. 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.

V. Technology Background and State of the Art

41. 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. EX1014, 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.

42. 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, 1.

43. 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. *See, e.g.*, EX1016, 2-4; 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 the reverse order." EX 1018, [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.

44. 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. EX 1019, 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	

45. 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” *Id.*, 3.

46. 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 '763 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.

47. 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 multistranded 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.

48. 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.

49. As mentioned above; in order to optimize energy coupling to free space propagation, the antenna should optimally possess a resonance at the frequency associated with the radio waves being transmitted. This is true regardless of the antenna size, but there are specific challenges associated with small antennas for mobile devices. “Typically, in the design of small antennas, the first significant challenge is mitigation the high VSWR [Voltage Standing Wave Ratio] and mismatch loss by first tuning the antenna to resonance and then impedance matching the antenna to the desired characteristic impedance...Considering again the short monopole that has increasing capacitive reactance an decreasing radiation resistance, the first objective is to make it resonant (tuning) and the second objective is to then match it to the desired characteristic impedance....” EX1019, 8. It was thus also well known in the prior art to use active and passive techniques to modify antenna resonance frequencies and the bandwidth at those resonance frequencies. “The physical size of radio communication equipment and electronic devices on which

antennas are installed has been scaled down in recent years, especially in mobile communications. Therefore, there is demand for small size antennas with efficient electrical performance. In addition to the miniaturization, another desirable characteristic of modern antennas is wide-band operation, which has a single antenna to satisfy the frequency requirements of different applications.” “When varactor diodes are used as capacitive loads for the antenna, it allows reducing the size of the antenna with an added feature of tunability. By varying the biasing voltage of the varactors, resonant frequency can be varied over a wide range.” EX1022, 10.

VI. Summary of Patent

A. The '763 Patent

50. I understand that the '763 Patent issued on January 8, 2013, and claims priority to Provisional Application No. 61/088,829, filed on August 14, 2008.

B. Disclosure

51. The '763 patent describes “[w]ireless devices...which transmit or receive data or other signals at multiple frequency bands [that] utilize at least one antenna to transmit and receive in a plurality of different bands.” EX1001, Abstract. In one embodiment, the wireless devices “can simultaneously transmit or receive at a plurality of different bands.” EX1001, Abstract, 3:60-67. Multiple transceivers are “fed to a single antenna using multiple feedlines and active antenna tuners,

controlled by a controller,” where each tuner provides an impedance match for each transceiver. *Id.*, 4:40-45, 5:22-30, Fig. 3.

C. The Challenged Claims

52. Below is a table described the Challenged Claims, including claims 1-17.

Claim 1	
1[pre]	A wireless device, comprising:
1[a]	one or more antennas; and
1[b]	a plurality of transmitters, receivers or transceivers that operate in one or more frequency bands,
1[c]	wherein at least one antenna of said one or more antennas is used by said plurality of transmitters, receivers or transceivers in a plurality of different bands,
1[d]	wherein said at least one antenna is one or more of a) an actively tuned antenna, and b) is tuned by one or more passive elements which are selected or interconnected using electronic control.
Claim 2	
2	The wireless device of claim 1 wherein said passive elements are comprised of either or both lumped or distributed elements.
Claim 3	
3	The wireless device of claim 1 wherein said at least one antenna is used for transmitting, receiving, or transmitting and receiving simultaneously in said plurality of different bands.
Claim 4	

4[a]	The wireless device of claim 1 further comprising one or more tuners associated with one or more transmitters, receivers or transceivers of said plurality of transmitters, receivers or transceivers; and
4[b]	a controller for controlling tuning of the tuner for said at least one antenna to operate in said plurality of different bands.
Claim 5	
5	The wireless device of claim 1 wherein said mobile device is selected from the group consisting of computers, telephones, portable computing or communication devices, games, wireless post it notes, wireless memory media, RFID tags, vehicles, clothing, personal data assistants and navigation assistants.
Claim 6	
6[pre]	A wireless device, comprising:
6[a]	one or more antennas;
6[b]	at least one multiband transmitter, receiver or transceiver;
6[c]	a tuner associated with said at least one multiband transmitter, receiver, or transceiver; and
6[d]	a controller for controlling tuning of the tuner to a plurality of different bands,
6[e]	wherein at least one antenna of said one or more antennas is used by said at least one multiband transmitter, receiver or transceiver in a plurality of different bands,
6[f]	wherein said at least one antenna is one or more of a) an actively tuned antenna, and b) is tuned by one or more passive elements which are selected or interconnected using electronic control.
Claim 7	

7	The wireless device of claim 6 said at least one antenna is used for transmitting, receiving, or transmitting and receiving simultaneously in said plurality of different bands.
Claim 8	
8	The wireless device of claim 6 wherein said mobile device is selected from the group consisting of computers, telephones, portable computing or communication devices, games, wireless post it notes, wireless memory media, RFID tags, vehicles, clothing, personal data assistants and navigation assistants.
Claim 9	
9	The wireless device of claim 6 wherein said passive elements are comprised of either or both lumped or distributed elements.
Claim 10	
10[pre]	A wireless device, comprising:
10[a]	at least one multiband antenna;
10[b]	at least one multiband transmitter, receiver or transceiver; and
10[c]	a tuner associated with said at least one multiband transmitter, receiver, or transceiver, said tuner matching said at least one multiband antenna to said at least one multiband transmitter, receiver or transceiver in a plurality of different bands simultaneously.
Claim 11	
11	The mobile device of claim 10 wherein said at least one antenna is used for transmitting, receiving, or transmitting and receiving simultaneously in said plurality of different bands.
Claim 12	
12	The wireless device of claim 10 wherein said mobile device is selected from the group consisting of computers, telephones, portable computing or communication devices, games, wireless post it notes,

	wireless memory media, RFID tags, vehicles, clothing, personal data assistants and navigation assistants.
Claim 13	
13[pre]	A wireless portable device, comprising:
13[a]	one or more antennas radiating or receiving electromagnetic energy at particular frequency bands, at least one of said one or more antennas radiating or receiving electromagnetic energy at a plurality of particular frequency bands;
13[b]	one or more components selected from the group consisting of receivers, transmitters and transceivers, said one or more components connected to said at least one of said one or more antennas, whereby
13[c]	at least one of said one or more components transmits or receives electromagnetic energy simultaneously at two or more of said plurality of particular frequency bands, or two or more components transmit or receive electromagnetic energy simultaneously at two or more of said plurality of particular frequency bands.
Claim 14	
14	The wireless portable device of claim 13 wherein said wireless portable device is selected from the group consisting of computers, telephones, personal data assistants, and navigation assistants.
Claim 15	
15	The wireless portable device of claim 13 further comprising one or more tuners which match electromagnetic energy at a particular frequency band to only one of said one or more components.
Claim 16	
16	The wireless portable device of claim 13 further comprising isolation means for isolating said one or more components from more than one particular frequency band of said plurality of frequency bands.
Claim 17	

17[pre]	A wireless device component, comprising a tuner or a set of tuners or controller or other circuitry configurable to be coupled to at least one antenna and a plurality of transmitters, receivers, or transceivers that operate at one or more frequency bands, wherein said at least one antenna is used by said plurality of transmitters, receivers or transceivers in a plurality of different bands,
17[a]	wherein said at least one antenna is one or more of a) an actively tuned antenna, and b) is tuned by one or more passive elements which are selected or interconnected using electronic control.

VII. LEVEL OF ORDINARY SKILL IN THE ART

53. In my opinion, a person of ordinary skill in the art at the time of the '763 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 meet and exceed this definition of a POSITA, and I would have met and exceeded this definition as of the priority date of the '763 patent.

VIII. CLAIM CONSTRUCTION

54. For purposes of this declaration, except as noted below, I have applied the ordinary and customary meaning of the claim terms as they would have been understood to a POSITA as of the priority date of the '763 Patent, August 14, 2008.

I have considered that meaning in the context of the patent and its prosecution history.

55. I understand that Claim 16 uses “means-plus-function” language which requires identifying the claimed function and the corresponding structure in the specification. Claim 16 in relevant part, reads, “isolation means for isolating said one or more components from more than one particular frequency band of said plurality of frequency bands.” (Claim 16).

56. The '763 patent teaches that:

*The **key to proper operation is to** also, while providing good matching, **provide sufficient RF isolation** so that the transmitters in other hands do not overload the front end receiver of a band that is receiving. Fortunately, **RF filtering and overload protection** is improving in commercially available wireless transceivers in various popular bands, so that **overload protection may be offered within the wireless transceiver chip itself through the integrated circuitry.***

EX1001, 5:33-38; *see also id.*, 5:30-6:1, 7:9-14 (describing exemplary shielding and filtering techniques).

57. In my opinion, a POSITA would understand that the function defined by the claims, may be used to isolate RF components from particular frequency bands. In my opinion, in light of the specification disclosure, a POSITA would understand that the claimed function is “isolating said one or more components from more than one particular frequency band of said plurality of frequency bands” and

that the corresponding structure is “circuitry that provides overload protection, shielding, and/or filters out unwanted bands,” and equivalents thereof.

IX. Ground I: Wen Anticipates or Renders Obvious Claims 1-3 and 5

58. It is my opinion that Wen anticipates or renders obvious Claims 1-3 and 5.

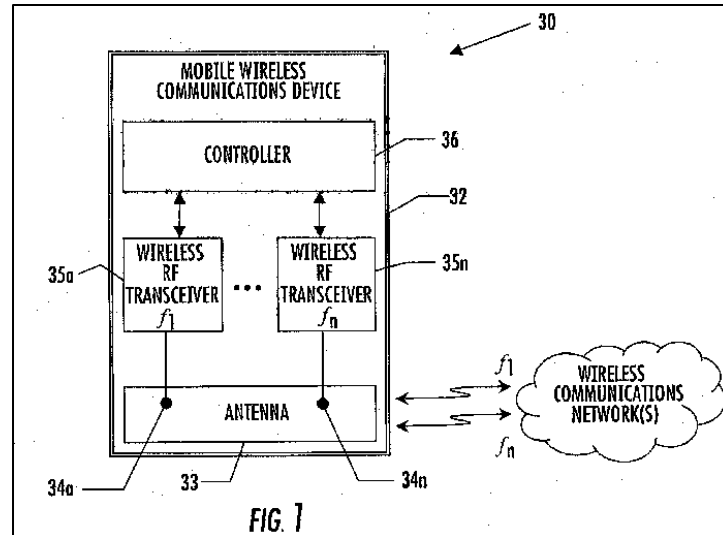
A. Wen (EX1004)

59. European Pat. No. 1,914,835 (“Wen”) was filed on August 14, 2007, and was first published on February 7, 2008. I understand that it qualifies as prior art.

60. Wen discloses “a mobile wireless communications device” which includes a plurality of wireless radio frequency (RF) transceivers” which are “coupled to respective ones of the signal feed points of the antenna.” EX1004, [0012]. “Each wireless RF transceiver preferably has a respective different operating frequency associated therewith.” *Id.* [0016]. The transceivers use the “common antenna at the same time.” EX1004, [0027].

61. Regarding the common antenna, Wen teaches that it “may comprise a patch antenna” having “a plurality of slots” where “first and second slots...define a plurality of leg portions” that are “selected to tune the desired operating frequencies” through their geometries. *Id.*, [0018]-[0020].

62. A “controller [is] configured to selectively operate at least some of said plurality of wireless radio frequency transceivers” “to advantageously use the common antenna at a same time” and “tune” the antenna. *Id.*, [0012], [0020], Claim 1. Figure 1, below, illustrates the controller (36) which is coupled to at least two wireless RF transceivers operating at different frequency (35a-35n), and is used to tune the operating bandwidths of the common antenna (whether simultaneous or otherwise).



Id., Fig. 1.

63. In short, Wen discloses a tunable multiband antenna comprising a controller and multiple transceivers.

B. Claim 1

1. 1[pre]: “A wireless device, comprising”

64. It is my opinion that, to the extent the preamble is limiting, Wen discloses the preamble. In particular, Wen teaches “a mobile wireless communications device.” EX1004, [0027], [0030], [0041], [0043].

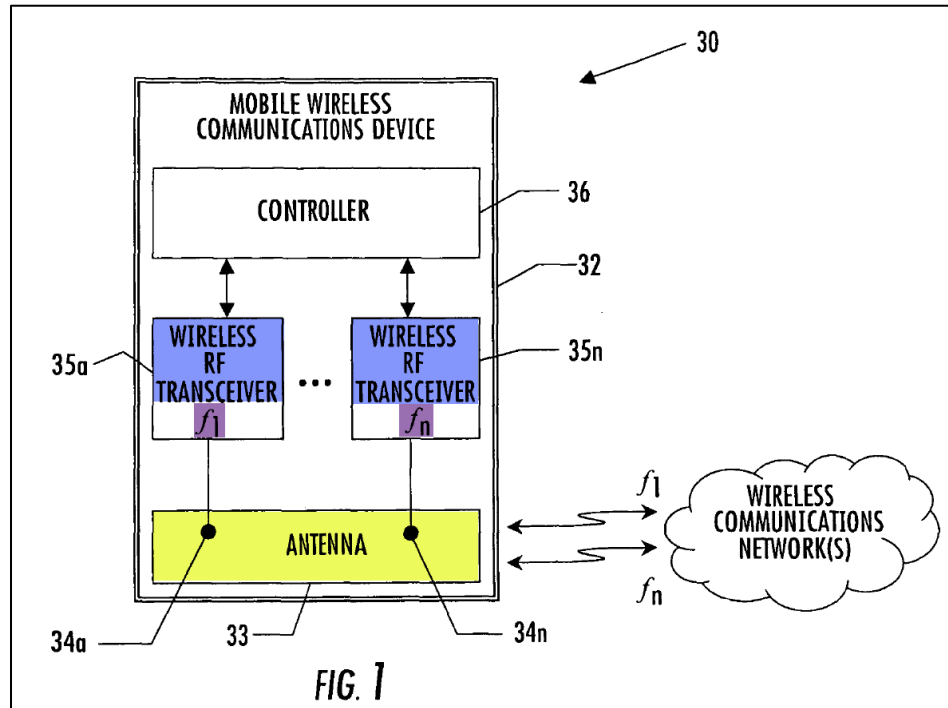
2. 1[a]: “one or more antennas”

65. It is my opinion that Wen discloses this limitation. In particular, Wen describes “a mobile wireless communications device ... which may include a housing and *a common antenna*.” EX1004, [0027]. “The antenna 33 is ‘common’” because “it is shared by a plurality of wireless radio frequency (RF) transceivers 35a-35n.” *Id.*, [0031]; *see also id.*, Fig. 1.

3. 1[b]: “a plurality of transmitters, receivers or transceivers that operate in one or more frequency bands”

66. It is my opinion that Wen discloses this limitation. In particular, Wen teaches that the mobile device may “include *a plurality of wireless radio frequency (RF) transceivers*” where each has “*a respective different operating frequency* associated therewith.” EX1004, [0027], [0029] (“Also by way of example, the different operating frequencies may be within a range of about 900 MHz to 6 GHz. Further, the different operating frequencies have different user functions associated therewith”), [0031]. The transceivers (light purple below, 35_a - 35_n) operate in more

than one frequency band (dark purple below, $f_1 - f_n$), enabling the multiband antenna (yellow, below).



EX1004, Fig. 1.

4. 1[c]: “wherein at least one antenna of said one or more antennas is used by said plurality of transmitters, receivers or transceivers in a plurality of different bands”

67. As I described above for Ground I, Claim 1[b], Wen discloses a **plurality of transceivers** that operate in **a plurality of different bands**. See EX1004, [0029] (example with “different operating frequencies ... within a range of about 900 MHz to 6 GHz”).

68. Furthermore, Wen discloses **at least one antenna** (e.g., antenna 33) that **is used by the plurality of transceivers in a plurality of different bands** (e.g.,

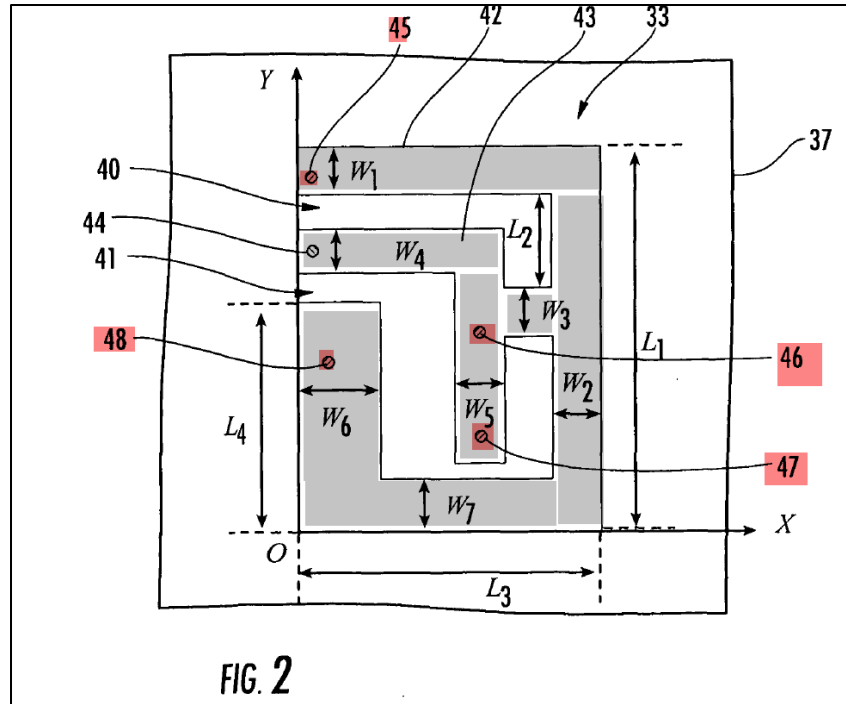
transceivers 35a-35n operating in bands f_1 to f_n). EX1004, [0031], Fig. 1. As shown in Figure 1 above, a single antenna is connected to and used by the plurality of transceivers. Wen expressly discloses that “[t]he antenna 33 ... is **shared** by a **plurality of wireless radio frequency (RF) transceivers 35a-35n** (e.g., cellular and/or wireless LAN transceivers)” and that “[e]ach wireless RF transceiver preferably has a respective **different operating frequency associated therewith.**” EX1004, [0031]; *see also id.*, [0039] (example where the antenna “provide[s] operation at 900 MHz, 1800 MHz, and 5 GHz via a selective connection of appropriate wireless RF transceivers 35”); [0036] (“[A] single multi-feed antenna [] may be used instead of a plurality of different antennas ... to provide multi-frequency band operation.”). Accordingly, in my opinion, the shared antenna is used in **a plurality of different bands, i.e.,** at least one band for each of the plurality of transceivers.

5. **1[d]: “wherein said at least one antenna is one or more of a) an actively tuned antenna, and b) is tuned by one or more passive elements which are selected or interconnected using electronic control”**

69. It is my opinion that Wen discloses or renders obvious this limitation. Wen at least teaches part (b) of the limitation because it describes an antenna that is tuned by one or more passive elements which are selected or interconnected using electronic control.

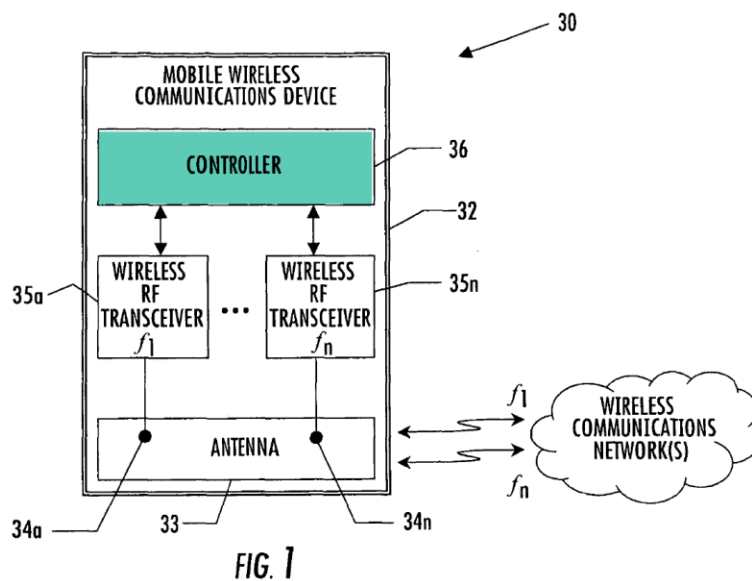
70. In particular, Wen discloses *passive elements* in the form of “leg portions” that make up the antenna and “may advantageously *be selected to tune* the desired operating frequencies of the antenna 33.” EX1004, [0035]. Wen discloses that each leg portion “may be substantially related to a given operating frequency band” or “may influence multiple operating frequency bands.” *Id.* Figure 2, reproduced and annotated below, illustrates an embodiment with “a plurality of leg portions defined by widths W_1 - W_7 and lengths L_2 and L_4 .” *Id.*, [0035], Fig. 2.

71. In my opinion, a POSITA would have understood that the “leg portions” of Wen’s antenna are passive elements because they have fixed electrical characteristics—specifically, because they are implemented as “conductive trace[s] on the dielectric substrate,” and do not include any additional circuitry that changes their electrical characteristics during operation. See EX1004, [0032] (“[T]he common antenna 33 may include at least one conductive trace on the dielectric substrate.”).



Id., Fig. 2.

72. Wen also discloses that the “leg portions” (*passive elements*) are used to **tune the antenna** by **selecting them using electronic control**, namely by the operation of a controller (36), illustrated in Figure 1 (annotated below).



EX1004, Fig. 1. Wen's controller "selectively operat[es] at least some of the wireless RF transceivers to ... use the common antenna at a same time." *Id.*, [0027]. The antenna is then "tuned to provide operation at" specific frequency bands "via a selective connection of appropriate wireless RF transceivers" to different "feed point[s]" on different leg portions of the antenna (annotated in red in Figure 2, above). EX1004, [0039]-[0040]; *see also id.*, [0034] (describing the structure of the feed points). For example, Wen discloses an embodiment where "the antenna 33 is tuned to provide operation at 900 MHz, 1800 MHz, and 5 GHz via a selective connection of appropriate wireless RF transceivers 35 to the first feed point 45." *Id.*, [0039]. Other frequencies may be obtained by selective connection of appropriate transceivers to the other three feed points. *Id.*, [0040] (examples using the second, third, and fourth feed points to tune the antenna to operating frequencies of 2.45 GHz; 2.1 GHz, 5.2 GHz, and 5.8 GHz; and 1.54 GHz, respectively).

73. Therefore it is my opinion that, a POSITA would have understood that Wen uses controller 36 (*i.e.*, **electronic control**) to tune the antenna by **selecting** different leg portions (**passive elements**). Specifically, by selectively operating individual transceivers, the controller causes the selected transceiver to provide a signal to one of the feed points on a particular leg portion of the antenna, thereby selecting the corresponding leg portion and tuning the antenna to the operating frequency or frequencies associated with that leg portion. Thus, the selective

connection of a transceiver to a feed point on a leg portion is performed via electronic control by the controller. *Id.*; see also EX1004, Abstract, [0027], [0031-32], [0039-40].

74. To the extent PO argues that Wen does not disclose using electronic control to select passive elements for tuning, it is my opinion that Wen also discloses, or at least renders obvious, an ***actively tuned antenna*** because Wen's selective operation of transceivers operates to actively tune the antenna. Specifically, as I discussed above, Wen discloses a controller that ***actively*** selects different leg portions ("passive elements") by operating transceivers connected to different spaced-apart signal feed points "***to tune the desired operating frequencies*** of the antenna 33." EX1004, [0035]. The controller actively selects to "operate[]" at least some (i.e., two or more) of the wireless RF transceivers 35a-35n to advantageously use the common antenna 33 at a same time." *Id.*, [0031]. In my opinion, a POSITA would have understood, or it would have been obvious, that the selective operation of particular transceivers is accomplished using active circuit elements, such as switches. In addition, a POSITA would also have reasonably expected to be successful using active circuit elements, such as switches, to selectively operate Wen's transceivers. Switches and other active circuit elements are standard circuit components that are routinely used in circuits, and have been for decades. A

POSITA would have been more than capable of using these basic components in Wen's system to select individual transceivers.

C. Claim 2: "The wireless device of claim 1 wherein said passive elements are comprised of either or both lumped or distributed elements"

75. It is my opinion that Wen discloses this claim. In particular, Wen discloses passive elements (*i.e.*, leg portions of an antenna) that comprise ***distributed elements***. In my opinion, the claim terms "lumped" and "distributed" are terms of art that a POSITA would understand describe how the electrical properties of the elements may be modeled. Lumped element modeling assumes that electrical properties concentrate at a single discrete point in a circuit, while distributed element modeling recognizes that elements may have electrical properties spread throughout the physical dimensions of a component. This is consistent with definitions in technical dictionaries. See EX1012, 3 ("distributed: Spread out over an electrically significant length or area."), 4 ("lumped: effectively concentrated at a single point").

76. Therefore, Wen's "leg portions" (***passive elements***) have electrical characteristics (*e.g.*, operating frequency) that are dependent on their lengths and widths. EX1004, [0034]-[0035] (explaining how the widths and lengths of the leg portions are "selected to tune the desired operating frequencies of the antenna"). Because these dimensions must be accounted for when electrically modelling the

elements, in my opinion, a POSITA would view Wen's leg portions as ***distributed elements***.

D. Claim 3: "The wireless device of claim 1 wherein said at least one antenna is used for transmitting, receiving, or transmitting and receiving simultaneously in said plurality of different bands"

77. It is my opinion that Wen discloses this claim.

78. As I described for Claim 1, Wen teaches that a plurality of transceivers may use the common antenna at the same time. EX1004, Claim 1 ("plurality of wireless radio frequency transceivers (35a-35n) ... ***operat[e] [] the patch antenna at respective different operating frequency bands of said operating wireless radio frequency transceivers at the same time***"), [0027] ("Furthermore, the device may also include a controller selectively operating at least some of the wireless RF transceivers to advantageously use the common antenna at a same time."), [0031] ("Furthermore, the device 30 may also include a controller 36 that selectively operates at least some (i.e., two or more) of the wireless RF transceivers 35a-35n to advantageously use the common antenna 33 at a same time."). Wen explains that "at the same time" means there is at least "some overlap in time." *Id.*, [0031].

79. A POSITA would understand that two or more transceivers at different frequencies may be used for transmitting and/or receiving at two or more frequencies, *e.g.*, when two transceivers 'operate' an antenna at the same time, the

antenna may be transmitting on two different bands, receiving on two different bands, or transmitting and receiving on two different bands.

E. Claim 5: “The wireless device of claim 1 wherein said mobile device is selected from the group consisting of computers, telephones, portable computing or communication devices, games, wireless post it notes, wireless memory media, RFID tags, vehicles, clothing, personal data assistants and navigation assistants”

80. It is my opinion Wen discloses this claim.

81. As I described for Claim 1, Wen teaches a mobile wireless communication device.

82. Wen explains that such devices may be “multi-function devices” including “**cellular telephones**.” EX1004, [0002]. Wen describes methods and systems for a mobile wireless communication device to connect and communicate via “a cellular network and/or wireless local area network (LAN).” *Id.*, [0030].

X. Ground II: Wen in View of Ella Renders Obvious Claims 4 and 17

83. It is my opinion that Wen discloses a wireless device comprising a multiband antenna and transceivers, as I discussed in Ground I. Ella discloses tuners for impedance matching in a wireless device such as Wen’s. In my opinion, a POSITA would have been motivated to apply Ella’s teachings regarding tuners to Wen’s wireless device, as I explain below.

A. Ella (EX1005)

84. U.S. Patent No. 7,786,819 (“Ella”) was filed on August 31, 2007, published on March 5, 2009, and issued on August 31, 2010. I understand that it qualifies as prior art.

85. Ella discloses a tuner for “an antenna element operable in a first frequency band and a second frequency band.” EX1005, Abstract. The tuner may be implemented in a “mobile cellular telephone.” *Id.*, 4:15-18. The tuner comprises a “matching circuit” and two “variable reactance component[s].” *Id.*, 1:39-56. A “controller” determines “optimum ratios of second reactance values to first reactance values” based on the frequency bands of the antenna. *Id.* The tuner is connected to “an antenna arrangement” and a “transceiver” and “configured to adaptively tune ... one or more antenna elements in the antenna arrangement.” *Id.*, 4:19-29, Fig. 1. The tuner is “able to compensate for changes in the impedance of a dual band antenna element and optimize the antenna in both resonant frequency bands.” 7:30-37.

B. Motivation to Combine

86. In my opinion, a POSITA would have been motivated to add a tuner and controller, as taught by Ella, to Wen’s wireless device, and would have reasonably expected the combination to succeed.

87. First, in my opinion, tuners were well known in the art and were commercially available prior to August 2008. As an example, U.S. Pat. No.

8,583,065 (“Ben-Bassat”), filed in June 2007, discloses that “antenna tuning circuits are in **widespread use today**” and used to “allow[] [an antenna] to operate over a wide range of frequencies” and adjust the impedance of the antenna to “minimize[] the SWR [standing wave ratio] and maximize[] power transfer through the antenna system.” EX1010, 1:51-2:9. In my opinion, a POSITA would have known that tuners are frequently used in RF systems to match the impedance at the antenna to the impedance of a transmitter, receiver, or transmitter in order to achieve well-known benefits, such as improving power transfer, minimizing distortion, and preventing overheating. Accordingly, it is also my opinion that adding tuners associated with Wen’s transceivers would have entailed nothing more than the use of a known technique (*i.e.*, tuners for impedance matching) to improve similar devices (*i.e.*, Wen’s wireless device and associated transceivers) in the same way.

88. Second, in my opinion, Ella provides express motivations to combine. In particular, Ella identifies two advantages associated with its tuning apparatus and associated controller. EX1005, 1:51-2:9. First, Ella discloses that its invention “provide[s] an advantage” because it “provide[s] adaptive tuning of an antenna element.” *Id.*, 7:21-23. Specifically, Ella discloses detecting “changes in impedance of an antenna element and then reactively compensate for the changes in impedance.” *Id.*, 7:23-25. This “result[s] in the device operating more efficiently (since the electrical energy supplied to the antenna element will be maximized) and

effectively (the signal strength of the antenna element may be improved).” *Id.*, 7:25-

29. Second, Ella discloses that its invention provides an additional advantage because it is “able to compensate for changes in the impedance of a **dual band** antenna element and optimize the antenna in **both resonant frequency bands**.” *Id.*, 7:30-33. Therefore, in my opinion, a POSITA would have thus been particularly motivated to use a tuner and controller as taught by Ella with Wen’s multiband antenna in order to optimize performance in the plurality of frequency bands used by the antenna.

89. In addition, it is my opinion that Wen, Ella, and the ’763 patent are all analogous art because they are directed to the same technological subject matter, namely radio frequency (RF) components for wireless devices. EX1001, Abstract (describing “wireless devices” that “use a single physical structure (e.g., an antenna) for transmission and reception of many different bands”); EX1004, Abstract (describing a “mobile wireless communications device” with “a common antenna” and “a plurality of wireless radio frequency (RF) transceivers ... coupled to ... the common antenna” with “respective different operating frequency”); EX1005, 1:10-13 (“invention” relates to “a portable radio telephone”), 4:15-29 (describing the tuning “apparatus” in the context of a “mobile cellular phone” with an “antenna arrangement”).

90. Finally, in my opinion, a POSITA would have reasonably expected the combination to succeed. As I noted above, tuners were well known and commercially available prior to the '763 patent. *Id.*; EX1010, 1:51-2:9. In my opinion, a POSITA would have been capable of adding a tuner and controller as taught by Ella for impedance matching between Wen's multiband antenna and transceivers using routine engineering skills, the same skills a POSITA would regularly use in circuit design and RF system implementation, to achieve predictable results.

C. Claim 4:

- 1. 4[a]: "The wireless device of claim 1 further comprising:
one or more tuners associated with one or more
transmitters, receivers or transceivers of said plurality of
transmitters, receivers or transceivers"**

91. In my opinion, Wen discloses tuning the operating frequencies of the common antenna. In particular, Wen discloses selectively connecting the wireless RF transceivers to corresponding feed points on the common antenna in order to "tune[]" the antenna "to provide operation" at specific frequencies. EX1004, [0039].

92. In my opinion, it would have been obvious to a POSITA in view of Ella to add a tuner between Wen's antenna and Wen's transceivers to improve antenna tuning and provide impedance matching. For example, Ella discloses an "apparatus" in a mobile device "configured to adaptively tune [an] antenna element ... so that it efficiently resonates in two predetermined resonant frequency bands." EX1005,

5:54-56. Ella discloses tuning apparatus comprises a “first variable reactance component 22, a matching circuit 24, a second variable reactance component 26, a detector 28 and a controller 30.” *Id.*, 4:40-44, Fig. 2:

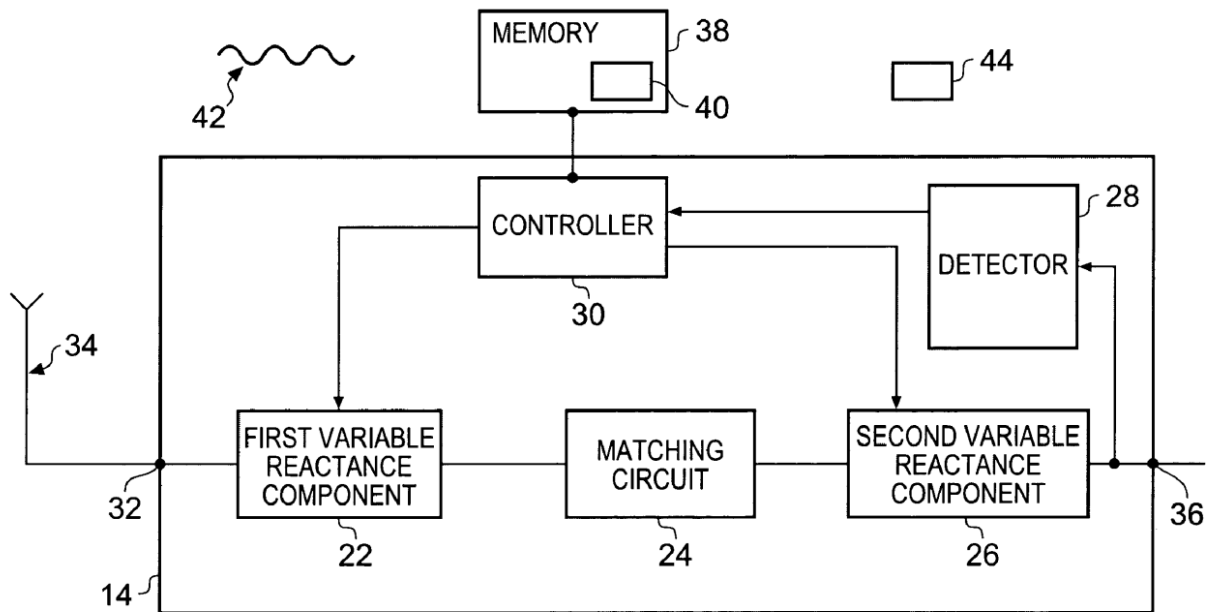


Fig. 2

93. In my opinion, Ella’s apparatus is a **tuner** as the term is used in the claims of the ’763 patent because (1) it adaptively tunes the antenna, *see id.*, and (2) it matches the impedance of the antenna to the transceiver by “compensat[ing] for changes in the impedance of a dual band antenna element and optimiz[ing] the antenna in both resonant frequency bands,” *id.*, 7:30-33. The ’763 patent also describes its tuners as being used to “provide a good impedance match for each of the transceivers.” EX1001, 5:22-30.

94. In my opinion, Ella's tuner is also ***associated with*** a transceiver. For example, as illustrated in Figure 1 (reproduced below), Ella's tuner (*i.e.*, apparatus 14) is connected to and associated with transceiver 16. EX1005, 4:19-29, Fig. 1:

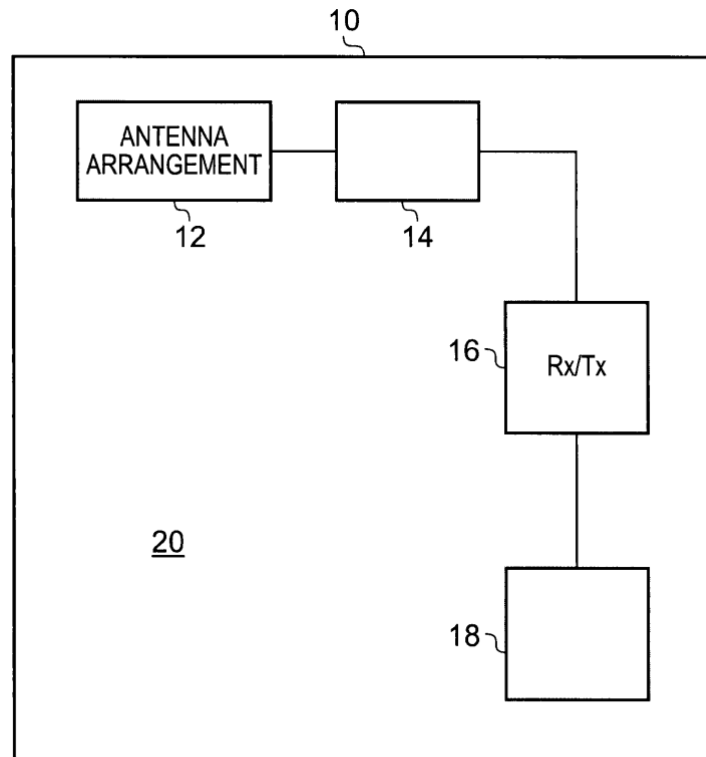


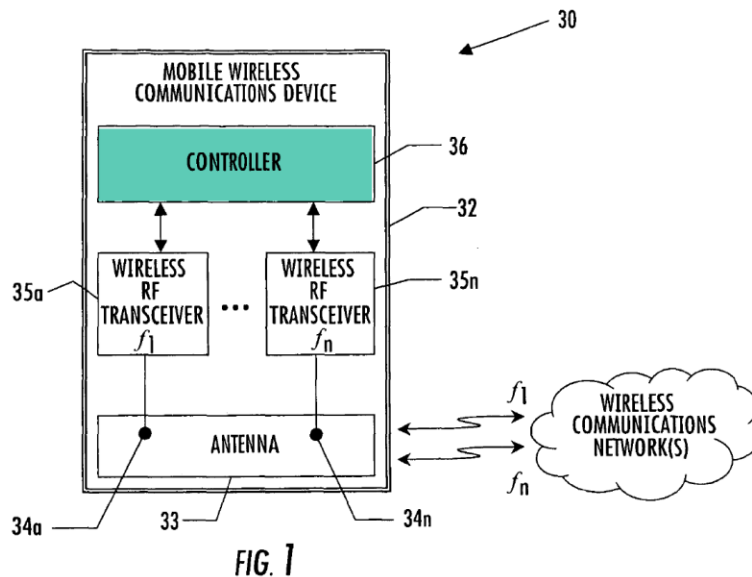
Fig. 1

95. Ella similarly describes the “second interface” of the tuning apparatus as “connectable to the transceiver.” *Id.*, 4:51-57.

96. In my opinion, a POSITA would have been motivated to apply Ella's teachings regarding tuners to Wen's transceivers, and would have reasonably expected the combination to succeed, for the reasons I describe in Section X.B above.

2. 4[b]: “a controller for controlling tuning of the tuner for said at least one antenna to operate in said plurality of different bands”

97. In my opinion, Wen discloses “*a controller 36* that selectively operates at least some (*i.e.*, two or more) of the wireless RF transceivers 35a-35n to advantageously use the common antenna 33 at a same time,” whereas these “transceivers 35a-35n” are “coupled to respective ones of the signal feed points 34a-34n of the common antenna 33.” EX1004, [0031].



98. In my opinion, it would have been obvious to a POSITA in view of Ella to use Wen’s controller to digitally control a tuner (as disclosed by Ella, see Limitation 4[a]), or to add a separate controller to control each such tuner. In particular, Ella discloses that its tuning apparatus (*tuner*) is “connected to” a “*controller*” that is “operable to control the first variable reactance component ...

and the second variable reactance component” in the tuner. EX1005, 5:34-42; see also *id.*, Fig. 2:

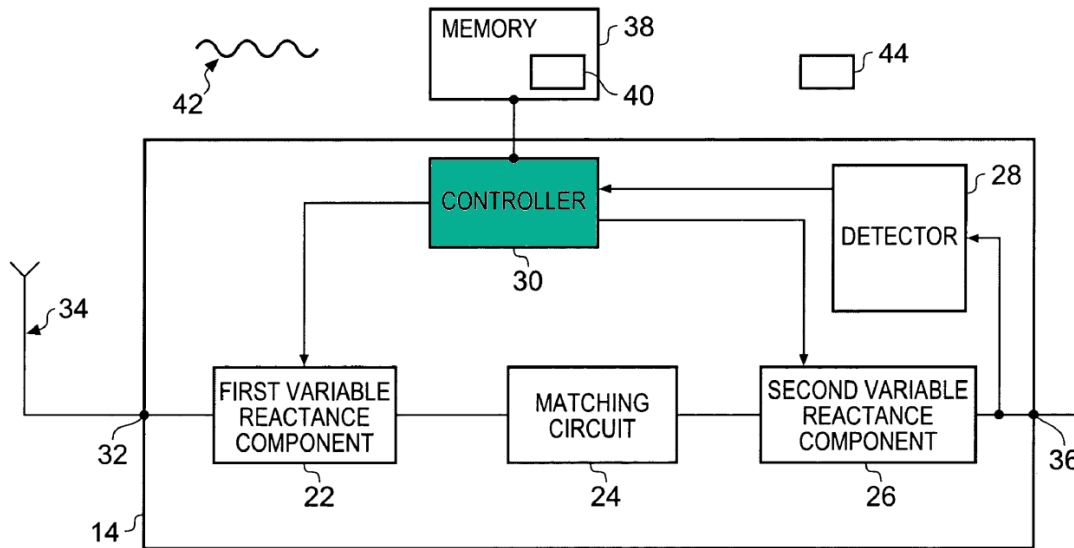


Fig. 2

The controller “*control[s] the operation*” of the [tuning] apparatus,” including to “adaptively *tune the antenna element*” to “efficiently resonate[] in two predetermined resonant frequency bands” (*i.e., operate in said plurality of different bands*). *Id.*, 5:43-46, 5:54-7:8, Fig. 3.

99. In my opinion, a POSITA would have been motivated to apply Ella’s teachings regarding tuners to Wen’s transceivers, and would have reasonably expected the combination to succeed for the reasons I describe in Section X.B above.

D. Claim 17

1. 17[pre]: “A wireless device component, comprising a tuner or a set of tuners or controller or other circuitry configurable to be coupled to at least one antenna and a plurality of transmitters, receivers, or transceivers that

operate at one or more frequency bands, wherein said at least one antenna is used by said plurality of transmitters, receivers or transceivers in a plurality of different bands”

100. In my opinion, Wen discloses the “[a] **wireless device component**” requirement of this limitation for the same reasons I provide above for Limitation 1[pre] in Ground I. Wen’s wireless device includes components such as antennas and transceivers, as I explain for Limitations 1[a] and 1[b] in Ground I above.

101. In my opinion, Wen discloses the “**comprising a tuner or a set of tuners or controller or other circuitry configurable to be coupled to at least one antenna and a plurality of transmitters, receivers, or transceivers**” requirement of this limitation. In particular, Wen discloses a *controller coupled to an antenna and a plurality of transceivers*, as I explain for Limitation 1[d] in Ground I above. See EX1004, Fig. 1 (showing controller (36) coupled to wireless RF transceivers 35a-35n and antenna 33), [0027] (controller “selectively operat[es] at least some of the wireless RF transceivers to ... use the common antenna at a same time”). Alternatively, in my opinion, Wen and Ella render obvious a tuner coupled to at least one antenna and a plurality of transceivers, as I explain for Limitation 4[a] above.

102. In my opinion, Wen discloses the “**at least one antenna and a plurality of transmitters, receivers, or transceivers that operate at one or more frequency bands**” requirement of this limitation. In particular, Wen discloses at *least one antenna*, as I explain for Limitation 1[a] in Ground I, and *a plurality of*

transceivers, as I explain for Limitation 1[b] in Ground I above. The antenna operates at *multiple frequency bands*, and each transceiver operates at *a different respective frequency band*, as I explain for Limitation 1[c] in Ground I above.

103. In my opinion, Wen discloses the “**wherein said at least one antenna is used by said plurality of transmitters, receivers or transceivers in a plurality of different bands**” requirement of this limitation for the same reasons I provide above for Limitation 1[c] in Ground I.

2. 17[a]: “**wherein said at least one antenna is one or more of an actively tuned antenna, and is tuned by one or more passive elements which are selected or interconnected using electronic control**”

104. For at least the same reasons I explained above for Limitation 1[d] in Ground I, which I incorporate herein by reference, it is my opinion that Wen discloses and renders obvious this limitation.

XI. GROUND III: Wen in View of Ella and Govind Renders Obvious Claims 6-15

105. It is my opinion that Wen discloses a wireless device comprising a multiband antenna and transceivers, as described in Ground I. Ella discloses tuners for impedance matching in a wireless device such as Wen’s, as described in Ground II. Govind further discloses *multiband* transceivers, specifically. In my opinion, in the combined system, Wen’s transceivers are substituted with one or more multiband

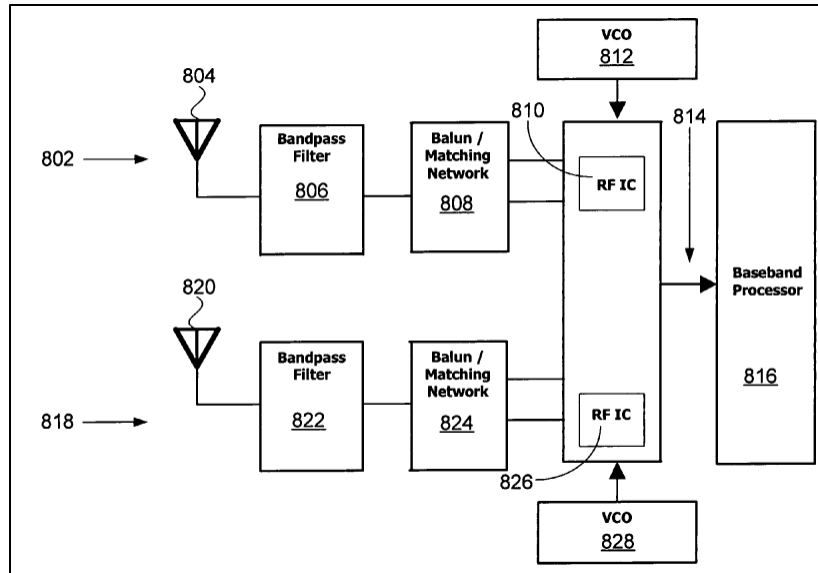
transceivers, as taught by Govind, and tuners are added for each transceiver, as taught by Ella.

A. Govind (EX1008)

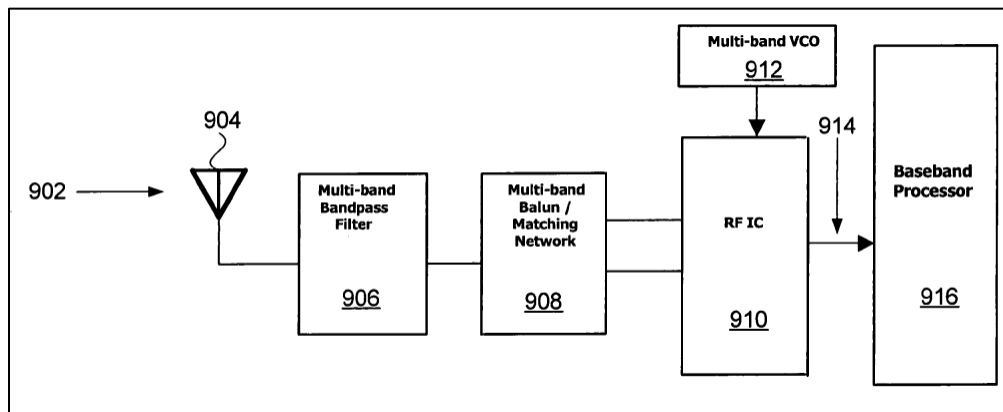
106. U.S. Pat. No. 7,489,914 (“Govind”) was filed on April 25, 2005 and published on November 10, 2005. I understand that it qualifies as prior art.

107. Govind discloses “multi-band, multimode integrated RF transceiver topologies” that enable “a multi-band transceiver” to operate at “a first frequency and a second frequency different from the first frequency.” EX1008, 2:8-47. For example, Govind describes “an RF multi-band oscillator for simultaneously generating oscillation signals at a first frequency and a second frequency for a multi-band transceiver.” *Id.* The multiband transceiver may be connected to “a multi-band antenna.” *Id.*, 17:17-31.

108. Govind describes different multiband transceiver embodiments. For example, “FIGS. 14 and 15 are illustrative of two respective approaches in which multi-band transceivers can be implemented according to an embodiment of the present invention.” EX1008, 16:53-17:17. Figure 14 (below) shows “an exemplary multi-band receiver portion of a transceiver that uses multiple single-band paths, each of which may be selectable using switches.” *Id.*



Id., Fig. 14. Figure 15 (below) shows an alternative “multi-band transceiver that uses only a single multi-band path.”



Id., Fig. 15.

B. Motivation to Combine

109. In my opinion, a POSITA would have been motivated to add a tuner and controller, as taught by Ella, to Wen’s wireless device, and would have reasonably expected the combination to succeed for the reasons I describe in Section X.B above.

110. In my opinion, a POSITA would have further been motivated to add multiband transceivers, as taught by Govind, to Wen's wireless device, and would have reasonably expected the combination to succeed.

111. First, in my opinion, multiband transceivers were well known in the art and were commercially available prior to August 2008. As an example, Int. Pub. No. WO 2005/029720 ("Leenaerts"), published on March 31, 2005, discloses that multiband transceivers were already in use, noting that "[r]elatively recent, multi-band transceivers and accordingly multi-band receivers and multi-band transmitters have been considered," offering the advantage of being able to "work with signals situated in different bands and being adapted to different communication protocols." EX1009, 1:11-15. Further, the '763 patent similarly acknowledges that "it is possible to purchase multi-band transceiver chips for popular wireless standards where different antenna ports are provided for various RF output bands." EX1001, 6:54-57. Accordingly, it is my opinion that replacing the plurality of transceivers connected to Wen's multiband antenna with one or more multiband transceivers would have been a simple substitution of known elements with predictable results.

112. Second, in my opinion, Wen provides an express motivation to combine. In particular, Wen teaches that "as the functionality of cellular communications devices continues to increase, so too does the demand for ***smaller devices which are easier and more convenient for users to carry.***" EX1004, [0003].

Specifically, one “challenge” in reducing device size is “the relatively limited amount of space available for the antenna,” particularly “where multi-frequency band operation is required.” Therefore, it is my opinion that a POSITA would have thus been motivated to look to multiband transceivers to reduce the number and size of transceiver components necessary to support multiple frequency bands.

113. Third, in my opinion, Govind provides a similar express motivation to combine. In particular, Govind discloses using multiband transceivers in systems with “a multi-band antenna ... for receiving signals in various frequency ranges.” EX1008, 17:17-31. Specifically, Govind discloses multiband transceivers that “can be reused at different frequency ranges, thereby reducing the number of components required.” *Id.*, 2:8-13. Thus, Govind’s approach allows for “optimization of space and power requirements,” “reduced power consumption,” and “lower costs,” among other advantages. *Id.*, 21:48-57. In my opinion, a POSITA would have understood that these improvements are particularly beneficial for mobile devices, where size, power consumption (*i.e.*, battery life), and cost are all important design factors.

114. In addition, in my opinion, Wen, Ella, Govind, and the ’763 patent are all analogous art because they are directed to the same technological subject matter, namely radio frequency (RF) components for wireless devices that operate in multiple frequency bands. EX1001, Abstract (describing “wireless devices” that “use a single physical structure (e.g., an antenna) for transmission and reception of

many different bands”); EX1004, Abstract (describing a “mobile wireless communications device” with “a common antenna” and “a plurality of wireless radio frequency (RF) transceivers ... coupled to ... the common antenna” with “respective different operating frequency”); EX1008, 1:23-27 (invention relates to “RF single-band and multi-band transceivers ... for use in radio frequency (RF) applications”).

115. Finally, in my opinion, a POSITA would have reasonably expected the combination to succeed. As I noted above, multiband transceivers were well known and commercially available prior to the '763 patent. EX1009, 1:11-15; EX1001, 6:54-57. In my opinion, a POSITA would have been capable of replacing Wen’s plurality of transceivers with one or more multiband transceivers using routine engineering to achieve predictable results. In addition, because Wen’s controller and antenna are already configured to operate using multiple frequency bands, it is also my opinion that it would have been trivial for a POSITA to integrate multiband transceivers into Wen’s system.

C. Claim 6:

1. 6[pre]: “A wireless device, comprising”

116. For at least the same reasons I explained above for Limitation 1[pre] in Ground I, which I incorporate herein by reference, it is my opinion that Wen discloses and renders obvious this limitation.

2. 6[a]: “one or more antennas”

117. For at least the same reasons I explained above for Limitation 1[a] in Ground I, which I incorporate herein by reference, it is my opinion that Wen discloses and renders obvious this limitation.

3. 6[b]: “at least one multiband transmitter, receiver or transceiver”

118. It is my opinion that Wen renders this limitation obvious in view of Govind. In my opinion, it would have been obvious to a POSITA to use a multiband transceiver in Wen’s system based on Govind.

119. In particular, Govind discloses “multi-band, multimode integrated RF transceiver topologies” which enable a “a ***multi-band transceiver***” to operate at “a first frequency and a second frequency different from the first frequency.” EX1008, 2:8-13, 2:21-31. Govind discloses that the multi-band transceiver comprises voltage controlled oscillators (VCOs) “for simultaneously generating oscillation signals at a first frequency and a second frequency for a multi-band transceiver” that may be connected to “a multi-band antenna ... for receiving signals in various frequency ranges.” *Id.*, 2:8-20, 2:32-47, 17:17-31.

120. For the reasons I discussed above in Section XI.B, it is my opinion that a POSITA would have been motivated to apply Govind’s teachings regarding multi-band transceivers to Wen’s wireless device, and would have reasonably expected the combination to succeed.

4. 6[c]: “a tuner associated with said at least one multiband transmitter, receiver, or transceiver”

121. For at least the same reasons I explained above for Limitation 4[a] in Ground II, which I incorporate herein by reference, it is my opinion that Wen in view of Ella discloses and renders obvious this limitation.

5. 6[d]: “a controller for controlling tuning of the tuner to a plurality of different bands”

122. For at least the same reasons I explained above for Limitation 4[b] in Ground II, which I incorporate herein by reference, it is my opinion that Wen in view of Ella discloses and renders obvious this limitation.

6. 6[e]: “wherein at least one antenna of said one or more antennas is used by said at least one multiband transmitter, receiver or transceiver in a plurality of different bands”

123. As I discussed above, Wen discloses a multiband antenna that is used by a plurality of transceivers in a plurality of different bands, as I explain for Limitation 1[c] in Ground I. Wen discloses that the transceivers is connected to a feed point on one of the leg portions of the antenna where each feed point may operate at a plurality of frequency bands. EX1004, [0039]-[0040] (first feed point “provide[s] operation at 900 MHz, 1800 MHz, and 5 GHz”; third feed point “is also used for three operating frequency bands, which are 2.1 GHz, 5.2 GHz, and 5.8 GHz”); [0034]-[0035].

124. In my opinion, it would have been obvious to a POSITA to substitute a multiband transceiver, as taught by Govind, for one or more of Wen’s transceivers,

particularly those transceivers connected to a feed point that is used for multiple frequency bands. For example, Govind discloses “a **multi-band transceiver**” that operates at “a first frequency and a second frequency different from the first frequency.” EX1008, 2:8-13, 2:21-31. Govind discloses that its multi-band transceiver may be connected to “a multi-band antenna ... for receiving signals in various frequency ranges.” *Id.*, 17:17-31.

125. For the reasons discussed above in Section XI.B, it is my opinion that a POSITA would have been motivated to apply Govind’s teachings regarding multi-band transceivers to Wen’s wireless device, and would have reasonably expected the combination to succeed.

7. **6[f]: “wherein said at least one antenna is one or more of an actively tuned antenna, and; is tuned by one or more passive elements which are selected or interconnected using electronic control”**

126. For at least the same reasons I explained above for Limitation 1[d] in Ground I, which I incorporate herein by reference, it is my opinion that Wen discloses and renders obvious this limitation.

- D. Claim 7: The wireless device of claim 6 said at least one antenna is used for transmitting, receiving, or transmitting and receiving simultaneously in said plurality of different bands.**

127. For at least the same reasons I explained above for Claim 3 in Ground I, which I incorporate herein by reference, it is my opinion that Wen discloses and renders obvious Claim 7.

- E. Claim 8: The wireless device of claim 6 wherein said mobile device is selected from the group consisting of computers, telephones, portable computing or communication devices, games, wireless post it notes, wireless memory media, RFID tags, vehicles, clothing, personal data assistants and navigation assistants.**

128. For at least the same reasons I explained above for Claim 5 in Ground I, which I incorporate herein by reference, it is my opinion that Wen discloses and renders obvious Claim 8.

- F. Claim 9: The wireless device of claim 6 wherein said passive elements are comprised of either or both lumped or distributed elements.**

129. For at least the same reasons I explained above for Claim 2 in Ground I, which I incorporate herein by reference, it is my opinion that Wen discloses and renders obvious Claim 9.

G. Claim 10

- 1. 10[pre]: “A wireless device, comprising”**

130. As I explained above for Limitations 6[pre] in Ground III, which I incorporate herein by reference, Wen discloses this limitation.

- 2. 10[a]: “at least one multiband antenna”**

131. As I explained above for Limitations 6[a] and 6[e] in Ground III, which I incorporate herein by reference, Wen in view of Govind discloses and renders obvious at least one multiband antenna that operates in a plurality of frequency bands.

3. **10[b]: “at least one multiband transmitter, receiver or transceiver”**

132. As I explained above in Limitations 6[b] in Ground III, which I incorporate herein by reference, Wen in view of Govind discloses and renders obvious this limitation.

4. **10[c]: “a tuner associated with said at least one multiband transmitter, receiver, or transceiver, said tuner matching said at least one multiband antenna to said at least one multiband transmitter, receiver or transceiver in a plurality of different bands simultaneously”**

133. As I discussed above, Wen in view of Ella renders obvious the **“a tuner associated with said at least one multiband transmitter, receiver, or transceiver”** requirement of this limitation for the same reasons I provide above for Limitation 6[c] in Ground III.

134. In my opinion, Wen in view of Ella and Govind renders obvious the **“said tuner matching said at least one multiband antenna to said at least one multiband transmitter, receiver or transceiver in a plurality of different bands simultaneously”** requirement of this limitation. As I discussed above for Limitation 6[b], it would have been obvious to a POSITA to substitute multiband transceivers for Wen’s transceivers in view of Govind. In my opinion, it would further have been obvious to a POSITA to use a tuner to match the impedance of the antenna and an associated transceiver in view of Ella for the same reasons I provide above for Limitation 6[c]. In particular, Ella expressly discloses that its tuning

apparatus matches the impedance of the transceiver to a multiband antenna in two bands (*i.e.*, ***a plurality of different bands***) ***simultaneously***. EX1005, 7:30-37 (“[E]mbodiments of the present invention provide an advantage in that they are able to compensate for changes in the impedance of a dual band antenna element and optimize the antenna in both resonant frequency bands.”), 7:59-8:50 (discussing selection of parameters to optimize operation for two frequency bands). Accordingly, it is my opinion that in the combined system, the tuners would match the multiband antenna to at least one transceiver in a plurality of different bands simultaneously.

H. Claim 11: “The mobile device of claim 10 wherein said at least one antenna is used for transmitting, receiving, or transmitting and receiving simultaneously in said plurality of different bands”

135. For at least the same reasons I explained above for Claim 7 in Ground III, which I incorporate herein by reference, it is my opinion that Wen discloses and renders obvious Claim 11.

I. Claim 12: “The wireless device of claim 10 wherein said mobile device is selected from the group consisting of computers, telephones, portable computing or communication devices, games, wireless post it notes, wireless memory media, RFID tags, vehicles, clothing, personal data assistants and navigation assistants”

136. For at least the same reasons I explained above for Claim 8 in Ground III, which I incorporate herein by reference, it is my opinion that Wen discloses and renders obvious Claim 12.

J. Claim 13

1. 13[pre]: “A wireless portable device, comprising”

137. To the extent the preamble is limiting, as I discussed above for Limitation 6[pre], Wen discloses a **wireless device**. Further, Wen discloses **portable wireless devices**, including cellular telephones and handheld wireless communication devices, as I explain for Claim 8 above.

2. 13[a]: “one or more antennas radiating or receiving electromagnetic energy at particular frequency bands, at least one of said one or more antennas radiating or receiving electromagnetic energy at a plurality of particular frequency bands;

138. As I discussed above for Limitation 6[a], Wen discloses **one or more antennas**. Specifically, Wen discloses an antenna that sends and receives signals at a **plurality of particular frequency bands**. See Limitation 6[e] (antenna is used by transceivers in a plurality of different bands); EX1004, [0039]-[0040] (antenna includes a first feed point that “provide[s] operation at 900 MHz, 1800 MHz, and 5 GHz” and a third feed point “used for three operating frequency bands, which are 2.1 GHz, 5.2 GHz, and 5.8 GHz”), [0048] (mobile device “may send and receive communication signals” via the antennas). In my opinion, a POSITA would have understood that antennas receive communication signals by **receiving electromagnetic energy** at particular frequency bands, and that antennas transmit communication signals **by radiating electromagnetic energy** at particular frequency bands.

3. **13[b]: “one or more components selected from the group consisting of receivers, transmitters and transceivers, said one or more components connected to said at least one of said one or more antennas”**

139. As I discussed above, Wen discloses ***one or more transceivers*** that are ***connected to the one or more antennas*** for the same reasons I provide above for Limitations 1[b] and 1[c] in Ground I. Moreover, Govind discloses multiband transceivers.

4. **13[c]: “at least one of said one or more components transmits or receives electromagnetic energy simultaneously at two or more of said plurality of particular frequency bands, or two or more components transmit or receive electromagnetic energy simultaneously at two or more of said plurality of particular frequency bands”**

140. As I described above for Limitation 13[b], Wen discloses one or more transceivers (*i.e.*, ***components***). In my opinion, a POSITA would have understood that transceivers send and receive signals by ***transmitting and receiving electromagnetic energy***, respectively.

141. In my opinion, Wen discloses the **“two or more components transmit or receive electromagnetic energy simultaneously at two or more of said plurality of particular frequency bands”** requirement of this limitation. In particular, Wen discloses a plurality (*i.e.*, ***two or more***) transceivers, each operating (*i.e.*, sending or receiving) in a different frequency bands for the same reasons I provide above for Limitation 1[b] in Ground I. Accordingly, it is my opinion that

Wen's transceivers collectively operate in a ***plurality of frequency bands***. In addition, Wen also discloses that multiple transceivers may use the common antenna at different frequency bands "at the same time" (*i.e.*, ***simultaneously***), as I explain for Claim 3 in Ground I. See EX1004, [0031].

142. In my opinion, Wen renders obvious the "**at least one of said one or more components transmits or receives electromagnetic energy simultaneously at two or more of said plurality of particular frequency bands**" requirement of this limitation. In my opinion, it would have been obvious to a POSITA to use a multiband transceiver in Wen's system based on Govind for the same reasons I provide above for Limitation 6[b]. In my opinion, a ***multiband*** transceiver transmits and receives in two or more frequency bands simultaneously, as I explain for Limitation 6[b] above.

K. Claim 14: "The wireless portable device of claim 13 wherein said wireless portable device is selected from the group consisting of computers, telephones, personal data assistants, and navigation assistants"

143. For at least the same reasons I explained above for Claim 8 in Ground III, which I incorporate herein by reference, it is my opinion that Wen discloses and renders obvious Claim 14.

L. Claim 15: "The wireless portable device of claim 13 further comprising one or more tuners which match electromagnetic

energy at a particular frequency band to only one of said one or more components”

144. In my opinion, Wen in view of Ella renders this limitation obvious. As I discussed above for Limitation 6[c], it would have been obvious to a POSITA to use a tuner to match the impedance of the antenna and an associated transceiver in view of Ella. Specifically, Ella discloses that its tuning apparatus (*tuners*) match the resonant frequencies of the antenna (*i.e., match electromagnetic energy at a particular frequency band*) to the associated transceiver (*only one of said one or more components*). EX1005, (“[E]mbodiments of the present invention ... are able to compensate for changes in the impedance of a dual band antenna element and optimize the antenna in *both resonant frequency bands*.”).

XII. GROUND IV: Wen in View of Ella, Govind, and Vlahos Renders Claim 16 Obvious

145. It is my opinion that Wen, Ella, and Govind collectively disclose and render obvious a wireless device comprising a multiband antenna, multiband transceivers, and tuners, as described in Ground III. Furthermore, Vlahos discloses filters and similar elements to provide RF isolation for different components.

A. Vlahos (EX1013)

146. U.S. Pat. No. 5,926,751 (“Vlahos”) was filed on February 19, 1997 and issued on July 20, 1999. I understand that it qualifies as prior art.

147. Vlahos discloses a “method and apparatus” that “enables a communication device ... to operate in multiple bands.” EX1013, Abstract. The

device includes a “transceiver” comprising a “transmitter” that “transmits through an antenna” and a “receiver” for “[i]nformation received by the communication device’s antenna.” *Id.*, 2:25-31, Fig. 1. The receiver includes “separate path[s] ... for each band,” each comprising a “preselector filter,” a “preamplifier” that “provide[s] isolation ... from transmitter energy and other spurious frequencies,” and a “combination filter.” *Id.*, 2:51-3:2. An “LC trap circuit” is also used to “filter the input RF signals (for each band).” *Id.*, 3:29-33.

B. Motivation to Combine

148. In my opinion, a POSITA would have been motivated to add a tuner and controller, as taught by Ella, and multiband transceivers, as taught by Govind, to Wen’s wireless device, and would have reasonably expected the combination to succeed for the reasons I describe in Section XI.B above.

149. In my opinion, furthermore, a POSITA would have been motivated to include filters and other RF isolation components, as taught by Vlahos, in Wen’s wireless device, and would have reasonably expected the combination to succeed.

150. First, it is my opinion that the need for RF isolation in multi-band wireless communication systems would have been well understood by a POSITA. RF isolation and filtering for transmitters and receivers in wireless devices long predates the ’763 patent, as evidenced at least by its disclosure in Vlahos over a decade earlier. Specifically, the ’763 patent acknowledges that the “key to proper

operation” of a transceiver is to “provide sufficient RF isolation,” and notes that “RF filtering and overload protection” is already available in “commercially available wireless transceivers in various popular bands.” EX1001, 5:30-37. Accordingly, in my opinion, adding RF isolation and filtering to Wen represents the use of a known technique with predictable results.

151. Second, in my opinion, Vlahos provides an express motivation to combine. In particular, Vlahos discloses that its filters and other isolation circuitry “provide isolation ... from transmitter energy and other spurious frequencies.” EX1013, 2:59-65. In my opinion, a POSITA would have understood that absent such filtering and isolation, the transmitter energy and other spurious frequencies may interfere with proper operation of a receiver. It is also my opinion that a POSITA would have understood that filtering and isolation circuitry is particularly important in a multiband system, where different components within the system are configured to receive or transmit signals at different frequencies, which increase the risk of interference.

152. In addition, like Wen, Ella, Govind, and the '763 Patent, Vlahos is analogous art because it is directed to RF components for wireless devices that operate in multiple frequency bands. EX1013, Abstract (“A method and apparatus enables a communication device ... to operate in multiple bands.”).

153. Finally, in my opinion, a POSITA would have reasonably expected the combination to succeed. As I have noted above, RF isolation techniques were standard, well known, and commercially available prior to the '763 Patent. EX1001, 5:30-37. In my opinion, a POSITA would have been capable of adding filters and isolation circuitry to Wen's transceivers using routine engineering to achieve predictable results.

C. Claim 16: "The wireless portable device of claim 13 further comprising isolation means for isolating said one or more components from more than one particular frequency band of said plurality of frequency bands"

154. As I have discussed above, this is a means-plus-function limitation with the function "isolating said one or more components from more than one particular frequency band of said plurality of frequency bands" and corresponding structure "circuitry that provides overload protection, shielding, and/or filters out unwanted bands."

155. In my opinion, it would have been obvious to a POSITA in view of Vlahos to use isolation circuitry to filter unwanted bands for each transceiver in Wen's system, as modified by Ella and Govind.

156. In particular, Vlahos discloses several types of circuitry for filtering out unwanted frequency bands. For example, Vlahos disclose that its receiver includes "separate path[s] ... for each band." 2:51-54. Vlahos disclose that each path includes a "preselector filter" that only passes RF signals in a specific frequency

band. *Id.*, 2:54-60. Vlahos discloses that each path also includes a “preamplifier” with an “enable line” that “controls a transistor to provide isolation ... from transmitter energy and other spurious frequencies.” *Id.*, 2:60-65. Vlahos discloses that each path also includes a “combination filter” that further filters the received signal before it is output to a mixer. *Id.*, 2:65-3:6. In addition, Vlahos discloses an “LC trap circuit” in the mixer that further “filter[s] the input RF signals (for each band).” *Id.*, 3:29-33; *see also* EX1001, 5:42-47 (describing the use of an “RF Trap” to provide isolation).

157. For the reasons I have discussed above in Section XII.B, in my opinion, a POSITA would have been motivated to apply Vlahos’s teachings regarding filtering and isolation to Wen’s wireless device, and would have reasonably expected the combination to succeed.

XIII. GROUND V: Rubinshteyn in View of Wen Renders Claims 1-3 and 5 Obvious

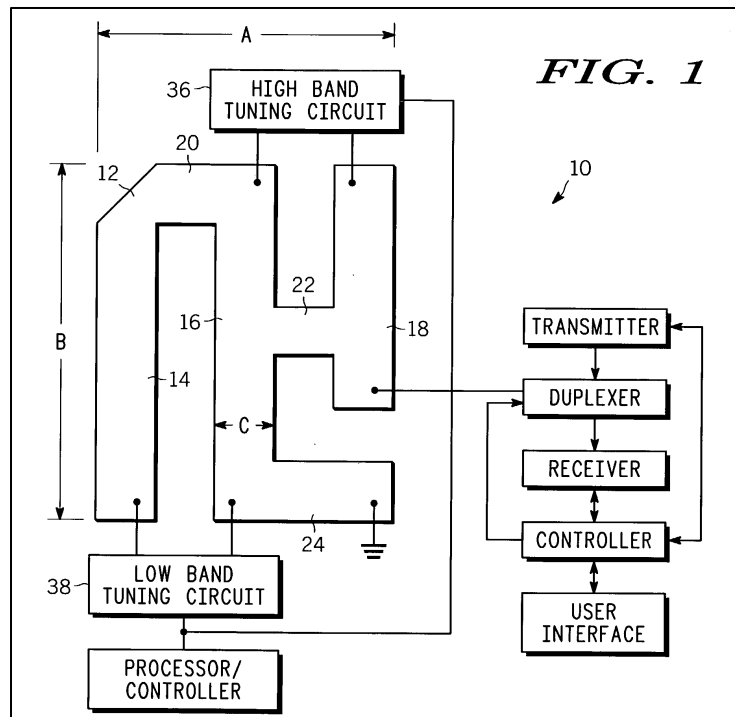
158. It is my opinion that Rubinshteyn discloses a wireless device comprising an antenna and a multiband transceiver that operate in multiple frequency bands. To the extent PO argues that Rubinshteyn does not disclose a plurality of transmitters, receivers, or transceivers, it is my opinion that Wen discloses connecting a plurality of transceivers to a multiband antenna. In my opinion, a POSITA would have been motivated to apply Wen’s teachings regarding multiple transceivers to Rubinshteyn’s wireless device, as detailed below.

A. Rubinshteyn (EX1006)

159. U.S. Pat. Pub. No. 2004/0125027 (“Rubinshteyn”) was filed on December 27, 2002, and was published July 1, 2004. I understand that it qualifies as prior art.

160. Rubinshteyn teaches a wireless communication device having a planar, tunable antenna with a low band element and a high band element designed to “resonate[] at two different center frequencies simultaneously, which permits simultaneous operation of the device at two different frequencies,” allowing *“reception or transmission of RF signals...at two different frequencies simultaneously.”* EX1006, [0016]. The low band element and high band element are each connected to, respectively, a low band tuning circuit and high band tuning circuit on the antenna that “electronically alter the frequencies at which the elements...resonate” by selectively coupling a capacitive reactance or “a combination of a capacitive reactance and an inductive reactance” between predetermined points on the antenna. *Id.*, [0028]. A processor or controller is connected to both the high and low band tuning circuits to “independently control [both] circuits to tune the antenna...to multiple pairs of high band and low band frequencies.” *Id.*

161. Rubinshteyn Figure 1 illustrates one embodiment of such tunable planar antenna with connected elements such as tuning circuits and controller:



Id., Fig. 1.

B. Motivation to Combine

162. It is my opinion that a POSITA would have found it obvious to modify the device in Rubinshteyn to include a plurality of transmitters, receivers, or transceivers, as taught by Wen. In my opinion, a POSITA would have been motivated to do so, could have accomplished the modification through a simple substitution of known components, and would have reasonably expected the combination to succeed.

163. First, in my opinion, both single-band and multiband transceivers were well known in the art and were commercially available prior to August 2008. See EX1009, 1:11-15 (“A vast majority of the transceivers are built for being used in only one band, the more the bands the more transceivers. Relatively recent, multi-

band transceivers and accordingly multi-band receivers and multi-band transmitters have been considered.”). I note that the ’763 patent acknowledges that both single-band and multi-band transceivers were known in the prior art. EX1001, 4:60-5:2 (describing prior art devices using “different band transceivers”), 6:54-57 (“[I]t is possible to purchase multi-band transceiver chips for popular wireless standards where different antenna ports are provided for various RF output bands.”). Accordingly, in my opinion, using a plurality of transceivers with Rubinshteyn’s multiband antenna would have been a simple substitution of known elements with predictable results.

164. Second, in my opinion, a POSITA would have understood that single-band transmitters, receivers, or transceivers, and multi-band transmitters, receivers, and transceivers, are the two known alternatives available to a system designer in a multiband wireless system. Accordingly, it is also my opinion that it would have been obvious to a POSITA to try from among these two finite number of well-known and predictable solutions. Further, a POSITA would have understood that selecting between multiband transceivers or a plurality of single-band transceivers in a multiband wireless device may depend on design constraints. In particular, Govind discloses that multiband transceivers may present “difficulties in power consumption, compatibility, interference, and integration.” EX1008, 1:48-50. Govind discloses a multi-band transceiver that “may satisfy one or more of these

issues,” *Id.*, 2:1-4, but design constraints may nevertheless limit a particular device to use a plurality of single-band transceivers.

165. In my opinion, adding multiple transceivers into Rubinshteyn’s wireless device represents a simple substitution of Rubinshteyn’s individual multiband receiver and transmitter for a plurality of transmitters, receivers, or transceivers. A POSITA would have capable of implementing this change using routine engineering to achieve predictable results. In addition, because Rubinshteyn’s antenna is already configured to operate using multiple frequency bands, it would have been trivial for a POSITA to use a plurality of transceivers instead of a single multiband transceiver in connection with the multiband antenna.

166. Finally, Rubinshteyn, Wen, and the ’763 patent each represent disclosures directed to improvements in multiband antennas and related components in wireless devices. EX1001, Abstract (describing “wireless devices” that “use a single physical structure (e.g., an antenna) for transmission and reception of many different bands”); EX1004, Abstract (describing a “mobile wireless communications device” with “a common antenna” and “a plurality of wireless radio frequency (RF) transceivers ... coupled to ... the common antenna” with “respective different operating frequency”); EX1006, [0016] (describing a “tunable antenna” in a “wireless communication device” that “can operate at multiple frequencies”).

C. Claim 1

1. 1[pre]: “A wireless device, comprising”

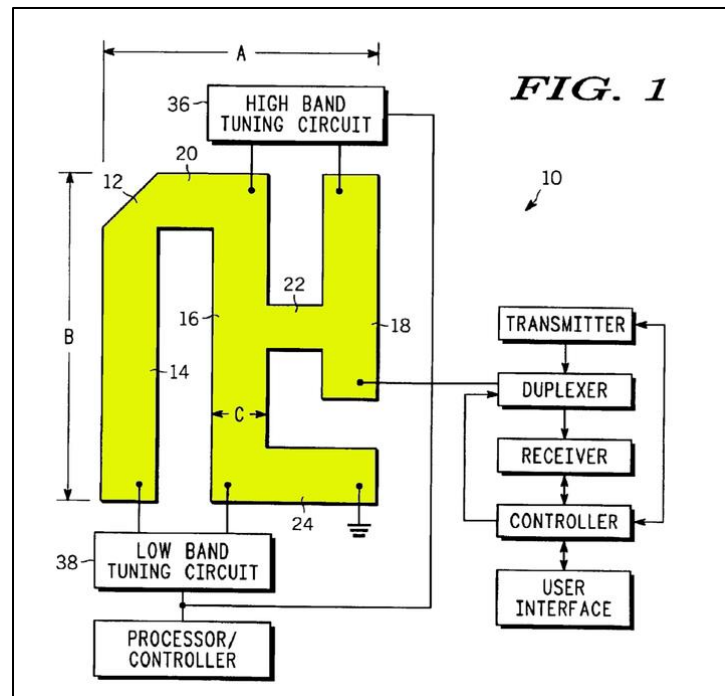
167. It is my opinion that, to the extent the preamble is limiting, Rubinshteyn discloses a wireless device.

168. Rubinshteyn discloses “tunable, multiple-frequency planar antennas for *wireless communication devices*.” EX1006, [0001].

2. 1[a]: “one or more antennas”

169. It is my opinion that Rubinshteyn discloses this limitation.

170. Rubinshteyn describes that “the present disclosure concerns a wireless communication device that has a planar, tunable *antenna*.” Further, Rubinshteyn teaches multiband antenna capable of “simultaneous operation of the device at two different frequencies.” EX1006, [0016]. The antenna comprises a “high band element” and a “low band element” that “is simultaneously resonant at a lower frequency than the high band element.” *Id.*, [0022], [0016]. Below is Figure 1 where the antenna (12, 14, 16, 18, 18, 20, 22, 24) is annotated in yellow.



Id., Fig. 1.

3. **1[b]: “a plurality of transmitters, receivers or transceivers that operate in one or more frequency bands”**

171. It is my opinion that Rubinshteyn discloses or renders obvious at least one multiband transmitter and receiver.

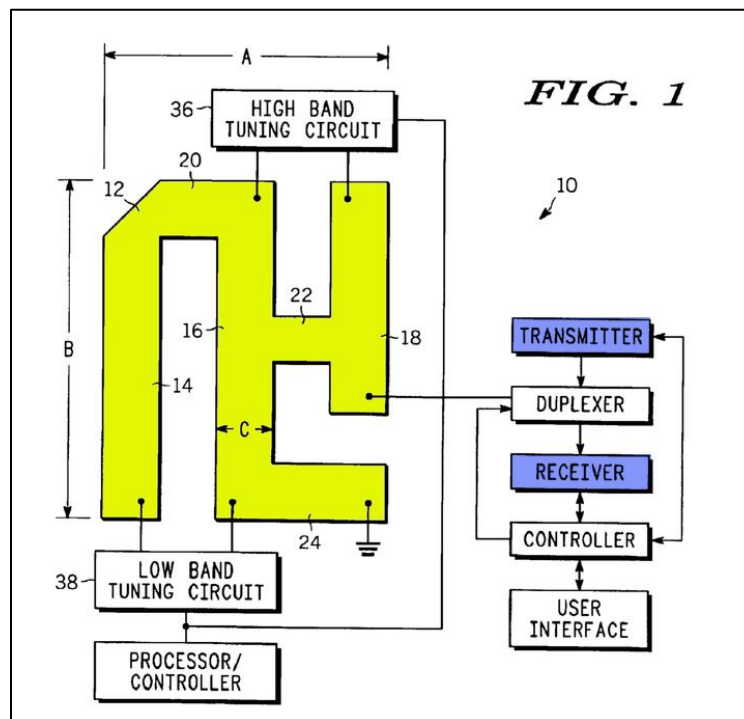
172. Rubinshteyn teaches:

The **low band element 26** and the **high band element 28** share **a common RF input point**, which is located at the lower end of the third longitudinal element 18 and which is **connected to a duplexer**, as shown in FIG. 1. The duplexer is **connected to a transmitter and a receiver**.

EX1006, [0022]. The transmitter and receiver are capable of operating in two frequency bands (high and low) through the high band and low band antenna elements simultaneously. *E.g.*, EX1006, [0016] (“In particular, the antenna is

designed such that it resonates at two different center frequencies simultaneously, which permits simultaneous operation of the device at two different frequencies. That is, reception or transmission of RF signals may be performed at two different frequencies simultaneously.”). A POSITA would understand that a transmitter and receiver capable of simultaneous operation in two frequencies to be a multiband transmitter and multiband receiver

173. Figure 1 shows the transmitter (blue) and the receiver (blue) associated with the antenna elements (yellow).



Id., Fig. 1.

174. Accordingly, Rubinshteyn teaches a plurality of components (receivers, transmitters, or transceivers) that operate in different bands, the multiband transmitter and multiband receiver.

175. To the extent PO argues this limitation requires a plurality of receivers, a plurality of transmitters, or a plurality of transceivers, it is my opinion that it would have been obvious to a POSITA to use a plurality of transceivers, rather than a single multiband transmitter and receiver, as taught by Wen. In particular, Wen discloses “a **plurality** of wireless radio frequency (RF) **transceivers** carried by the housing and coupled to respective ones of the signal feed points of [a] common antenna.” EX1004, [0027]. “Each wireless RF transceiver preferably has a **respective different operating frequency** associated therewith.” *Id.*, [0031]; *see also id.*, [0039] (example with antenna “tuned to provide operation at 900 MHz, 1800 MHz, and 5 GHz via a selective connection of appropriate wireless RF transceivers”). Thus, each transceiver **operates in at least one frequency band**, and the plurality of transceivers **operate in multiple frequency bands** (at least one per transceiver) (*i.e.*, **operate in one or more frequency bands**). Wen’s transceivers are illustrated in Figure 1, annotated below, where the plurality of transceivers are elements 35a-35n and their corresponding frequencies of operation are f_1 - f_n :

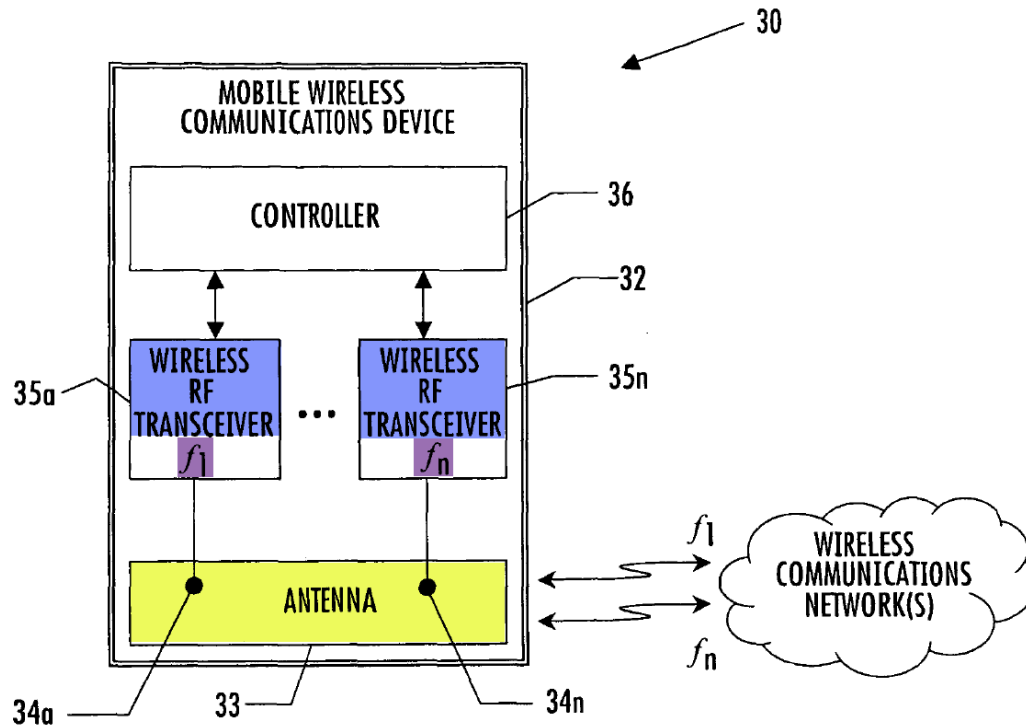


FIG. 1

EX1004, Fig. 1.

176. For the reasons discussed above in Section XIII.B, it is my opinion that a POSITA would have been motivated to apply Wen's teachings regarding a plurality of transceivers to Rubinshteyn's wireless device, and would have reasonably expected the combination to succeed.

4. 1[c]: "wherein at least one antenna of said one or more antennas is used by said plurality of transmitters, receivers or transceivers in a plurality of different bands"

177. As I described above, Claim 1[a]-[b], Rubinshteyn discloses *at least one antenna* and it discloses *plurality of transmitters, receivers, or transceivers in a plurality of different bands*, the transmitter and receiver operating in a high band and a low band. The antenna is *used* by the transmitter and receiver to operate at

“two different center frequencies simultaneously.” EX1006, [0016]. A POSITA would understand that the transmitter and receiver, via the duplexer, are connected to, and use, the antenna to operate at various frequencies because “[t]he low band element 26 and the high band element 28 share a common RF input point, which ... is connected to a duplexer,” and subsequently “connected to [the] transmitter and a receiver.” EX1006, [0022].

178. It is my opinion that it would have been obvious to a POSITA to use a plurality of transceivers with a multiband antenna, rather than a single multiband transmitter and receiver, as taught by Wen, to the extent PO argues this limitation requires a plurality of receivers, a plurality of transmitters, or a plurality of transceivers. In particular, As I explained above for Limitation 1[b], Wen discloses a ***plurality of transceivers*** that operate in a ***plurality of different bands***. See EX1004, [0029] (example with “different operating frequencies ... within a range of about 900 MHz to 6 GHz”). Further, Wen discloses that the plurality of transceivers connect to (*i.e.*, ***use***) a single multiband ***antenna*** (*e.g.*, antenna 33) in a plurality of different bands (*e.g.*, transceivers 35a-35n operating in bands f_1 to f_n). EX1004, [0031], Fig. 1. Wen also discloses that “[t]he antenna 33 ... is ***shared*** by a ***plurality of wireless radio frequency (RF) transceivers 35a-35n*** (*e.g.*, cellular and/or wireless LAN transceivers)” and that “[e]ach wireless RF transceiver preferably has a respective ***different operating frequency associated therewith***.”

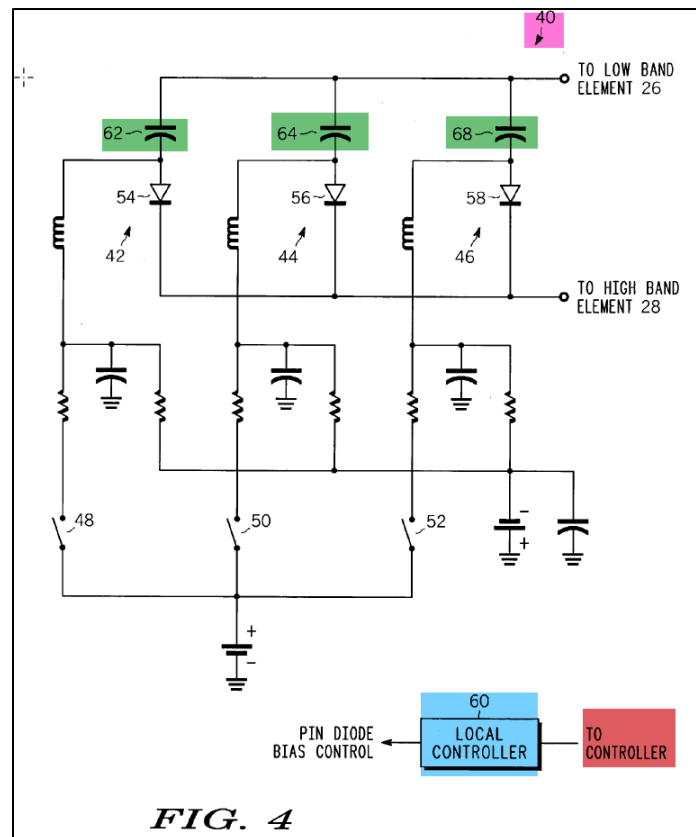
EX1004, [0031]; *see also id.*, [0039] (example where the antenna “provide[s] operation at 900 MHz, 1800 MHz, and 5 GHz via a selective connection of appropriate wireless RF transceivers 35”). Accordingly, in my opinion, the shared antenna is used in a **plurality of different bands**, *i.e.*, at least one for band for each of the plurality of transceivers.

179. For the reasons discussed above in Section XIII.B, in my opinion, a POSITA would have been motivated to apply Wen’s teachings regarding a plurality of transceivers to Rubinshteyn’s wireless device (including Rubinshteyn’s multiband antenna), and would have reasonably expected the combination to succeed..

5. **1[d]: “wherein said at least one antenna is one or more of a) an actively tuned antenna, and b) is tuned by one or more passive elements which are selected or interconnected using electronic control”**

180. It is my opinion that Rubinshteyn discloses at least prong (b) of Limitation 1[d] because Rubinshteyn’s antenna is tuned by one or more passive elements which are selected or interconnected using electronic control. Specifically, as I discussed below, Rubinshteyn’s antenna is tuned by using electronic control to select one or more passive elements in the form of capacitors and/or inductors. In my opinion, Rubinshteyn’s capacitors and inductors are passive elements because they have fixed electrical characteristics. *See* EX1006, [0035] (describing the relative capacitance of each capacitor and how to choose the capacitance).

181. As illustrated in Figure 4 annotated below, Rubinshteyn discloses a “high band tuning circuit” that includes “three capacitors 62, 64, 68” and “PIN diode[s] 54, 56, 58.” EX1006, [0030], Fig. 4. “[E]ach of the capacitors 62, 64, 68 may [also] be connected in parallel or in series with an inductor.” *Id.*, [0031]. Each capacitor “effectively alters the electrical length of the high band element, in this case, thus changing the center frequency at which the high band element is resonant [*i.e.*, **tuning** the high band element of the antenna].”



Id., Fig. 4.

182. Rubinshteyn discloses that the PIN diodes are controlled by switches 48, 50, and 52, so that when “one of the switches ... is closed, the corresponding

PIN diode ... couples the corresponding capacitor ... between the predetermined points of the antenna.” *Id.* In my opinion, the switches are thus used to ***select*** the capacitors and/or inductors (*i.e.*, the ***passive elements***). Rubinshteyn discloses that “eight different resonant center frequencies of the high band element can be provided” by activating different switches, different combinations of passive elements can be selected. EX1006, [0035], Fig. 5. In my opinion, the high band element can therefore be ***tuned*** to different frequency bands by selecting different combinations of passive elements. A similar approach can be used to tune the low band element. EX1006, [0036].

183. Rubinshteyn further discloses that a “controller can be connected to the high and low band tuning circuits ... to independently control the high and low band tuning circuits to tune the antenna 12 to multiple pairs of high band and low band frequencies.” EX1006, [0028]. In particular, a “local controller” can “independently control[] the switches 48, 50, 52” to “[c]hang[e] the center resonant frequency of one of the band elements” (*i.e.*, using ***electronic control***). *Id.*, [0034], [0036]; *see also id.*, [0036] (“[A] single local controller 60 can control the capacitance stages of both the high band tuning circuit and the low band tuning circuit.”).

D. Claim 2: “The wireless device of claim 1 wherein said passive elements are comprised of either or both lumped or distributed elements”

184. It is my opinion that Rubinshteyn discloses this claim.

185. As I described for Claim 1, Rubinshteyn teaches capacitors which are passive elements. A POSITA would have understood that Rubinshteyn’s capacitors and inductors are ***lumped elements*** because they are discrete components with electrical properties that are not determined by the length and width of the capacitor. See EX1012, 3-4 (defining “distributed” and “lumped” elements).

E. Claim 3: “The wireless device of claim 1 wherein said at least one antenna is used for transmitting, receiving, or transmitting and receiving simultaneously in said plurality of different bands”

186. As I described for Claim 1, Rubinshteyn discloses this claim and teaches a multiband antenna capable of operation “at **two different center frequencies simultaneously.**” EX1006, [0016]; *see also id.*, [0022] (“[T]he antenna 12 is resonant at two different center frequencies, which allows **operation in two bands simultaneously.**”). The antenna is “connected to a transmitter and a receiver,” and can therefore both ***transmit and receive*** simultaneously in the two operating frequency bands. *Id.*, [0022]; *see also id.*, cl. 20 (“receiving or transmitting signals at two different frequencies with a single antenna simultaneously”); See Limitation 1[a].

F. Claim 5: “The wireless device of claim 1 wherein said mobile device is selected from the group consisting of computers,

telephones, portable computing or communication devices, games, wireless post it notes, wireless memory media, RFID tags, vehicles, clothing, personal data assistants and navigation assistants”

187. Rubinshteyn teaches “[w]ireless communication devices” such as “*cellular telephone*” devices and other similar devices. EX1006, [0002].

XIV. GROUND VI: Rubinshteyn in View of Wen and Ella Renders Claims 4 and 17 Obvious

188. It is my opinion that Rubinshteyn discloses a wireless device comprising an antenna and a multiband transceiver that operate in multiple frequency bands. To the extent PO argues that Rubinshteyn does not disclose a plurality of transmitters, receivers, or transceivers, Wen discloses connecting a plurality of transceivers to a multiband antenna. Ella further discloses tuners for impedance matching in a wireless device such as Rubinshteyn’s. In my opinion, a POSITA would have been motivated to apply Wen’s teachings regarding multiple transceivers and Ella’s teachings regarding tuners to Rubinshteyn’s wireless device, as detailed below.

A. Motivation to Combine

189. In my opinion, a POSITA would have been motivated to include a plurality of transmitters, receivers, or transceivers, as taught by Wen, in Rubinshteyn’s wireless device, and would have reasonably expected the combination to succeed for the reasons I describe in Section XIII.B above.

190. In my opinion, a POSITA would have further been motivated to add a tuner and controller, as taught by Ella, to Rubinshteyn's wireless device, and would have reasonably expected the combination to succeed.

191. First, it is my opinion that tuners were well known in the art and were commercially available prior to August 2008. For example, Ben-Bassat, filed in June 2007, discloses that "antenna tuning circuits are in **widespread use today**" and used to "allow[] [an antenna] to operate over a wide range of frequencies" and adjust the impedance of the antenna to "minimize[] the SWR [standing wave ratio] and maximize[] power transfer through the antenna system." EX1010, 1:51-2:9. Indeed, in my opinion, a POSITA would have known that tuners are frequently used in RF systems to match the impedance at the antenna to the impedance of a transmitter, receiver, or transmitter in order to achieve well-known benefits, such as improving power transfer, minimizing distortion, and preventing overheating. Accordingly, it is my opinion that adding tuners associated with Rubinshteyn's transmitter and receiver would have entailed nothing more than the use of a known technique to improve similar devices (*i.e.*, Rubinshteyn's wireless device and associated transmitter and receiver) in the same way.

192. Second, in my opinion, Ella provides express motivations to combine. In particular, Ella identifies two advantages associated with its tuning apparatus and associated controller. EX1005, 1:51-2:9. First, Ella discloses that its invention

“provide[s] an advantage” because it “provide[s] adaptive tuning of an antenna element.” *Id.*, 7:21-23. Specifically, Ella “detect[s] changes in impedance of an antenna element and then reactively compensate for the changes in impedance.” *Id.*, 7:23-25. This “result[s] in the device operating more efficiently (since the electrical energy supplied to the antenna element will be maximized) and effectively (the signal strength of the antenna element may be improved).” *Id.*, 7:25-29. Second, Ella discloses that its invention provides an additional advantage because it is “able to compensate for changes in the impedance of a **dual band** antenna element and optimize the antenna in **both resonant frequency bands**.” *Id.*, 7:30-33. In my opinion, a POSITA would have thus been particularly motivated to use a tuner and controller as taught by Ella with Rubinshteyn’s multiband antenna in order to optimize performance in the plurality of frequency bands used by the antenna.

193. In addition, it is my opinion that Rubinshteyn, Ella, and the ’763 patent are all analogous art because they are directed to the same technological subject matter, namely radio frequency (RF) components for wireless devices. EX1001, Abstract (describing “wireless devices” that “use a single physical structure (e.g., an antenna) for transmission and reception of many different bands”); EX1006, Abstract (describing a “mobile wireless communications device” with “electronically tunable planar antenna” connected to “tuning circuits [that] electronically change the resonant center frequency of the corresponding element”);

EX1005, 1:10-13 (“invention” relates to “a portable radio telephone”), 4:15-29 (describing the tuning “apparatus” in the context of a “mobile cellular phone” with an “antenna arrangement”).

194. Finally, in my opinion, a POSITA would have reasonably expected the combination to succeed. As I noted above, tuners were well known and commercially available prior to the ’763 patent. *Id.*; EX1010, 1:51-2:9. In my opinion, a POSITA would have been capable of adding a tuner and controller as taught by Ella to the receive path of Rubinshteyn’s transceivers using routine engineering to achieve predictable results.

B. Claim 4

- 1. 4[a]: “The wireless device of claim 1 further comprising:
one or more tuners associated with one or more
transmitters, receivers or transceivers of said plurality of
transmitters, receivers or transceivers”**

195. In my opinion, Rubinshteyn discloses tuning the operating frequencies of the antenna. In particular, as I have discussed in Ground V, Limitation 1[d], Rubinshteyn discloses “tuning circuits [that] can change one or both of the two center frequencies at which the antenna resonates.” EX1006, [0016]; *see also* Ground V, Limitation 1[d].

196. In my opinion, it would have been obvious to a POSITA in view of Ella to add a tuner between Rubinshteyn’s antenna and Rubinshteyn’s transmitter and receiver. Alternatively, in the combined Rubinshteyn-Wen system, it is my opinion

that it would have been obvious to a POSITA in view of Ella to add a tuner between each of the plurality of transceivers and Rubinshteyn's antenna. In particular, as I discussed above for Limitation 4[a] in Ground II, Ella discloses a tuner associated with a transceiver.

197. In my opinion, a POSITA would have been motivated to apply Ella's teachings regarding tuners to Rubinshteyn's transmitter and receiver, or to the Rubinshteyn-Wen plurality of transceivers, and would have reasonably expected the combination to succeed for the reasons I describe in Section XIV.A above.

2. 4[b]: "a controller for controlling tuning of the tuner for said at least one antenna to operate in said plurality of different bands"

198. As discussed above, Rubinshteyn discloses a ***controller*** that "independently control[s] the high and low band tuning circuits to tune the antenna 12 to multiple pairs of high band and low band frequencies." EX1006, [0028]; *see also* Ground V, Limitation 1[d].

199. As I discussed above, Ella discloses a controller that controls tuning of the tuners for the same reasons I provide above for Limitation 4[b] in Ground II. In my opinion, it would have been obvious to a POSITA in view of Ella to use Rubinshteyn's controller to digitally control tuners, or to add a separate controller to control each such tuner.

200. In my opinion, a POSITA would have been motivated to apply Ella's teachings regarding tuners to Rubinshteyn's transmitter and receiver, or to the Rubinshteyn-Wen plurality of transceivers, and would have reasonably expected the combination to succeed for the reasons I describe in Section XIV.A above.

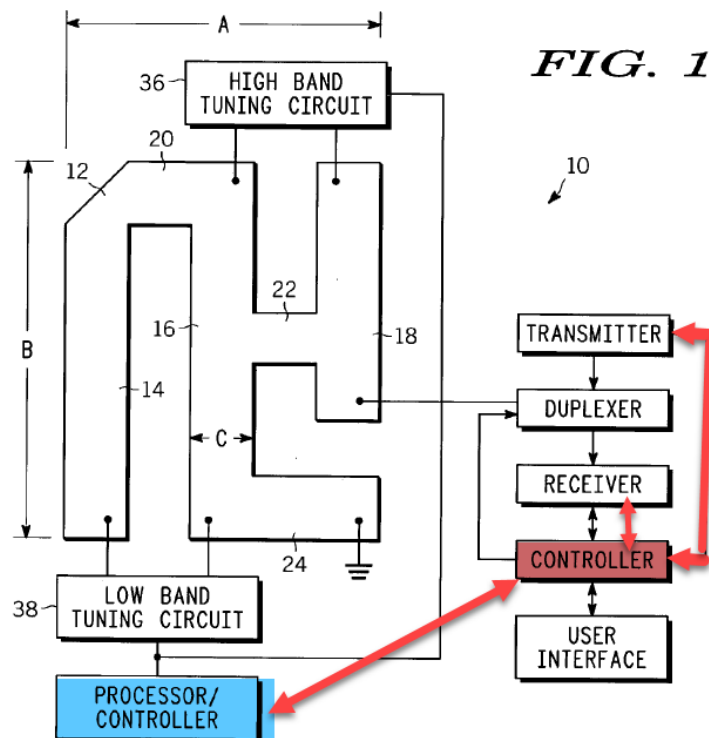
C. Claim 17

1. 17[pre] **"A wireless device component, comprising a tuner or a set of tuners or controller or other circuitry configurable to be coupled to at least one antenna and a plurality of transmitters, receivers, or transceivers that operate at one or more frequency bands, wherein said at least one antenna is used by said plurality of transmitters, receivers or transceivers in a plurality of different bands"**

201. As discussed above, Rubinshteyn discloses the **"[a] wireless device component"** requirement of this limitation for the same reasons I provide Limitation 1[pre] in for Ground V. The disclosed wireless device includes components such as antennas and transceivers, as I explain for Limitations 1[a] and 1[b] in Ground V above.

202. In my opinion, Rubinshteyn also discloses or renders obvious the **"comprising a tuner or a set of tuners or controller or other circuitry configurable to be coupled to at least one antenna and a plurality of transmitters, receivers, or transceivers"** requirement of this limitation. In particular, Rubinshteyn discloses or renders obvious a ***controller coupled to an antenna and a plurality of transmitters, receivers, or transceivers***. For example,

as illustrated in Figure 1, reproduced and annotated below, Rubinshteyn discloses a main controller ***coupled to*** a receiver and transmitter (*i.e.*, a ***plurality of transmitters, receivers, or transceivers***), and coupled to the antenna via a local controller. EX1006, Fig. 1, [0022], [0028]; *see also id.*, [0034] (disclosing the main controller controlling the local controller to control the switches in the tuning circuits).



203. It is my opinion that, to the extent PO argues this limitation requires a plurality of receivers, a plurality of transmitters, or a plurality of transceivers, it would have been obvious to a POSITA to use a plurality of transceivers, rather than a single multiband transmitter and receiver, as taught by Wen, as I explain for Limitation 1[b] in Ground V above.

204. Alternatively, it is also my opinion that Rubinshteyn (or Rubinshteyn and Wen) in view of Ella render obvious a tuner coupled to at least one antenna and a plurality of receivers or transceivers, as I explain for Limitation 4[a] above.

205. As discussed above, Rubinshteyn discloses, or Rubinshteyn and Wen render obvious the **“at least one antenna and a plurality of transmitters, receivers, or transceivers that operate at one or more frequency bands”** requirement of this limitation for the same reasons I provide above for Limitation 1[a] in Ground V. In particular, Rubinshteyn discloses, or Rubinshteyn and Wen render obvious, ***a plurality of transmitters, receivers, or transceivers***, as I explain for Limitation 1[b] in Ground V. The antenna operates at ***multiple frequency bands***, and the plurality of transmitters, receivers, or transceivers operate in one or more frequency bands, as I explain for Limitation 1[c] in Ground V.

206. As discussed above, Rubinshteyn discloses the **“wherein said at least one antenna is used by said plurality of transmitters, receivers or transceivers in a plurality of different bands”** requirement of this limitation for the same reasons I provide above for Limitation 1[c] in Ground V.

2. 17[a]: **“wherein said at least one antenna is one or more of an actively tuned antenna, and is tuned by one or more**

passive elements which are selected or interconnected using electronic control”

207. For at least the same reasons I explained above for Limitation 1[d] in Ground V, which I incorporate herein by reference, it is my opinion that Rubinshteyn in view of Wen discloses and renders obvious this limitation.

XV. GROUND VII: Rubinshteyn in View of Ella Renders Claims 6-15 Obvious

208. It is my opinion that Rubinshteyn discloses a wireless device comprising an antenna and a multiband transceiver that operate in multiple frequency bands. In particular, Ella discloses tuners for impedance matching in a wireless device such as Rubinshteyn's. In my opinion, a POSITA would have been motivated to apply Ella's teachings regarding tuners to Rubinshteyn's wireless device, as detailed below.

A. Motivation to Combine

209. In my opinion, a POSITA would have been motivated to add a tuner and controller, as taught by Ella, to Rubinshteyn's wireless device, and would have reasonably expected the combination to succeed for the reasons I describe in Section XIV.A above.

B. Claim 6

1. 6[pre]: “A wireless device, comprising”

210. For at least the same reasons I explained above for Limitation 1[pre] in Ground V, which I incorporate herein by reference, it is my opinion that Rubinshteyn in view of Wen discloses and renders obvious this limitation.

2. 6[a]: “one or more antennas”

211. For at least the same reasons I explained above for Limitation 1[a] in Ground V, which I incorporate herein by reference, it is my opinion that Rubinshteyn in view of Wen discloses and renders obvious this limitation.

3. 6[b]: “at least one multiband transmitter, receiver or transceiver”

212. For at least the same reasons I explained above for Limitation 1[b] in Ground V, which I incorporate herein by reference, it is my opinion that Rubinshteyn in view of Wen discloses and renders obvious this limitation.

4. 6[c]: “a tuner associated with said at least one multiband transmitter, receiver, or transceiver”

213. For at least the same reasons I explained above for Limitation 4[a] in Ground VI, which I incorporate herein by reference, it is my opinion that Rubinshteyn in view of Wen discloses and renders obvious this limitation.

5. 6[d]: “a controller for controlling tuning of the tuner to a plurality of different bands”

214. For at least the same reasons I explained above for Limitation 4[b] in Ground VI, which I incorporate herein by reference, it is my opinion that Rubinshteyn in view of Wen discloses and renders obvious this limitation.

6. 6[e]: “wherein at least one antenna of said one or more antennas is used by said at least one multiband transmitter, receiver or transceiver in a plurality of different bands”

215. As I described for Claim 1, Ground V, and above, Claim 6[a]-[d], Ground VI, Rubinshteyn discloses a multiband antenna that is used by multiband transmitter and multiband transceiver to operate in at least two bands, the high and low band.

7. 6[f]: “wherein said at least one antenna is one or more of an actively tuned antenna, and; is tuned by one or more passive elements which are selected or interconnected using electronic control”

216. For at least the same reasons I explained for Limitation 1[d] in Ground V, which I incorporate herein by reference, it is my opinion that Rubinshteyn in view of Wen discloses and renders obvious this limitation.

C. Claim 7: The wireless device of claim 6 said at least one antenna is used for transmitting, receiving, or transmitting and receiving simultaneously in said plurality of different bands.

217. For at least the same reasons I explained above for Claim 3 in Ground V, which I incorporate herein by reference, it is my opinion that Rubinshteyn in view of Wen discloses and renders obvious Claim 7.

- D. Claim 8: The wireless device of claim 6 wherein said mobile device is selected from the group consisting of computers, telephones, portable computing or communication devices, games, wireless post it notes, wireless memory media, RFID tags, vehicles, clothing, personal data assistants and navigation assistants.**

218. For at least the same reasons I explained above for Claims 1 and 5 in Ground V, which I incorporate herein by reference, it is my opinion that Rubinshteyn in view of Wen discloses and renders obvious Claim 8.

- E. Claim 9: The wireless device of claim 6 wherein said passive elements are comprised of either or both lumped or distributed elements.**

219. For at least the same reasons I explained above for Claim 2 in Ground V, which I incorporate herein by reference, it is my opinion that Rubinshteyn in view of Wen discloses and renders obvious Claim 9.

- F. Claim 10:**

- 1. 10[pre]: “A wireless device, comprising”**

220. As I explained above in Limitations 6[pre], which I incorporate herein by reference, Rubinshteyn discloses this limitation.

- 2. 10[a]: “at least one multiband antenna”**

221. As I described for Limitations 6[a] and 6[e], which I incorporate herein by reference, Rubinshteyn discloses a multiband antenna that operates in a plurality of frequency bands.

3. **10[b]: “at least one multiband transmitter, receiver or transceiver”**

222. As I explained above in Limitations 6[e], which I incorporate herein by reference, Rubinshteyn discloses this limitation.

4. **10[c]: “a tuner associated with said at least one multiband transmitter, receiver, or transceiver, said tuner matching said at least one multiband antenna to said at least one multiband transmitter, receiver or transceiver in a plurality of different bands simultaneously”**

223. As I described for limitation 6[c], Rubinshteyn discloses **“a tuner associated with said at least one multiband transmitter, receiver, or transceiver.”**

224. In my opinion, Rubinshteyn also discloses at least one multiband transmitter, receiver, or transceiver, operating in a plurality of different bands simultaneously, and at least one multiband antenna.

225. In my opinion, Rubinshteyn in view of Ella renders the **“said tuner matching said at least one multiband antenna to said at least one multiband transmitter, receiver or transceiver in a plurality of different bands simultaneously”** requirement of this limitation obvious. In particular, as I have discussed in limitation 6[b], Rubinshteyn discloses a multiband antenna and a multiband transmitter and receiver. It is my opinion that, it would have been obvious to a POSITA to use a tuner to match the impedance of the antenna and an associated receiver or transmitter in view of Ella for the same reasons I provide above for

Limitation 6[c]. Furthermore, Ella expressly discloses that its tuning apparatus matches the impedance of a transceiver to a multiband antenna in two bands (*i.e., a plurality of different bands*) *simultaneously*. EX1005, 7:30-37 (“[E]mbodiments of the present invention provide an advantage in that they are able to compensate for changes in the impedance of a dual band antenna element and optimize the antenna in both resonant frequency bands.”), 7:59-8:50 (discussing selection of parameters to optimize operation for two frequency bands). Accordingly, it is my opinion that, in the combined system, the tuners would thus match the multiband antenna to at Rubinshteyn’s transmitter and receiver in a plurality of different bands simultaneously.

G. Claim 11: “The mobile device of claim 10 wherein said at least one antenna is used for transmitting, receiving, or transmitting and receiving simultaneously in said plurality of different bands”

226. For at least the same reasons I explained above for Claim 7 in Ground IV, which I incorporate herein by reference, it is my opinion that Rubinshteyn in view of Wen discloses and renders obvious Claim 11.

H. Claim 12: “The wireless device of claim 10 wherein said mobile device is selected from the group consisting of computers, telephones, portable computing or communication devices, games, wireless post it notes, wireless memory media, RFID tags,

vehicles, clothing, personal data assistants and navigation assistants”

227. For at least the same reasons I explained above for Claim 8 in Ground IV, which I incorporate herein by reference, it is my opinion that Rubinshteyn in view of Wen discloses and renders obvious Claim 12.

I. Claim 13:

1. 13[pre]: “A wireless portable device, comprising”

228. As I described for Claims 6[pre] and 8, to the extent the preamble is limiting, Rubinshteyn discloses a **wireless device**, and further discloses **portable wireless devices**, including cellular telephones and “land-mobile” devices (*i.e.*, two-way radios).

2. 13[a]: “one or more antennas radiating or receiving electromagnetic energy at particular frequency bands, at least one of said one or more antennas radiating or receiving electromagnetic energy at a plurality of particular frequency bands;”

229. As I described for Limitation 6[a], Rubinshteyn discloses **one or more antennas** that operates at particular frequency bands (*e.g.*, a high band and a low band). In particular, Rubinshteyn’s antenna sends and receives signals at a **plurality of particular frequency bands** for the same reasons I provide above for Limitation 6[e] (antenna is used by a multiband transmitter and a multiband receiver in a plurality of different bands). In my opinion, a POSITA would have understood that antennas receive communication signals by **receiving electromagnetic energy** at

particular frequency bands, and that antennas transmit communication signals **by radiating electromagnetic energy** at particular frequency bands.

3. **13[b]: “one or more components selected from the group consisting of receivers, transmitters and transceivers, said one or more components connected to said at least one of said one or more antennas”**

230. As I described for Limitation 6[b], Rubinshteyn discloses this limitation, e.g., Rubinshteyn teaches a multiband transmitter and receiver that are **connected to the one or more antennas**.

4. **13[c]: “at least one of said one or more components transmits or receives electromagnetic energy simultaneously at two or more of said plurality of particular frequency bands, or two or more components transmit or receive electromagnetic energy simultaneously at two or more of said plurality of particular frequency bands”**

231. As I described for Limitation 13[b], Rubinshteyn discloses a multiband transmitter and a multiband receiver. In my opinion, a POSITA would have understood that transmitters send signals by **transmitting electromagnetic energy**, and receivers receive signals by **receiving electromagnetic energy**, respectively.

232. In my opinion, Rubinshteyn discloses the **“at least one of said one or more components transmits or receives electromagnetic energy simultaneously at two or more of said plurality of particular frequency bands”** requirement of this limitation. In particular, Rubinshteyn discloses a multiband transmitter and a multiband receiver, which can transmit and receive (respectively) simultaneously in

at least two frequency bands (*i.e.*, a high band and a low band), as I explain for Limitation 6[b] above.

233. In my opinion, Rubinshteyn also discloses the “**two or more components transmit or receive electromagnetic energy simultaneously at two or more of said plurality of particular frequency bands**” requirement of this limitation. In particular, Rubinshteyn discloses two components (a transmitter and a receiver), each operating in at least two different frequency bands (*e.g.*, a high band and a low band, as I explain for Limitation 6[b] above. Accordingly, it is my opinion that Rubinshteyn’s transmitter and receiver together operate in a *plurality of frequency bands*. In addition, it is also my opinion that Rubinshteyn discloses that transmitter and receiver may use the antenna at different frequency bands simultaneously via the duplexer. EX1006, [0022].

J. Claim 14: “The wireless portable device of claim 13 wherein said wireless portable device is selected from the group consisting of computers, telephones, personal data assistants, and navigation assistants”

234. For at least the same reasons I explained above for Claim 8 in Ground VII, which I incorporate herein by reference, it is my opinion that Rubinshteyn in view of Wen discloses and renders obvious Claim 14.

K. Claim 15: “The wireless portable device of claim 13 further comprising one or more tuners which match electromagnetic

energy at a particular frequency band to only one of said one or more components”

235. It is my opinion that Rubinshteyn in view of Ella renders this limitation obvious. As I discussed above for Limitation 6[c], it would have been obvious to a POSITA to use a tuner to match the impedance of the antenna and an associated receiver in view of Ella. For example, Ella discloses that its tuning apparatus (*tuners*) match the resonant frequencies of the antenna (*i.e., match electromagnetic energy at a particular frequency band*) to the associated transceiver (*only one of said one or more components*). EX1005, (“[E]mbodiments of the present invention ... are able to compensate for changes in the impedance of a dual band antenna element and optimize the antenna in *both resonant frequency bands*.”).

XVI. GROUND VIII: Rubinshteyn in View of Ella and Vlahos Renders Claim 16 Obvious

236. It is my opinion that Rubinshteyn and Ella collectively disclose and render obvious a wireless device comprising a multiband antenna, multiband transceivers, and tuners, as described in Ground VII. Furthermore, Vlahos discloses filters and similar elements to provide RF isolation for different components.

A. Motivation to Combine

237. In my opinion, a POSITA would have been motivated to add a tuner and controller, as taught by Ella, to Rubinshteyn’s wireless device, and would have reasonably expected the combination to succeed for the reasons I describe in Section XV.A above.

238. In my opinion, a POSITA would have further been motivated to include filters and other RF isolation components, as taught by Vlahos, in Rubinshteyn's wireless device, and would have reasonably expected the combination to succeed.

239. First, it is my opinion that the need for RF isolation in multi-band wireless communication systems would have been well understood by a POSITA for the reasons I describe in Section XII.B above. EX1001, 5:30-37. In my opinion, adding RF isolation and filtering to Rubinshteyn represents the use of a known technique with predictable results.

240. Second, it is also my opinion that Vlahos provides an express motivation to combine. Vlahos discloses using filters and other isolation circuitry to "provide isolation...from transmitter energy and other spurious frequencies," EX1013, 2:59-65, which would otherwise interfere with a receiver, particularly in a multiband system for the reasons I describe in Section XII.B above.

241. Additionally, like Rubinshteyn, Ella, and the '763 patent, it is my opinion that Vlahos is analogous art because it is directed to RF components for wireless devices that operate in multiple frequency bands. EX1013, Abstract ("A method and apparatus enables a communication device ... to operate in multiple bands.").

242. Finally, in my opinion, a POSITA would have reasonably expected the combination to succeed. As I noted above, RF isolation techniques were standard,

well known, and commercially available prior to the '763 patent. EX1001, 5:30-37.

In my opinion, a POSITA would have been capable of adding filters and isolation circuitry to Rubinshteyn's transmitter and/or receiver using routine engineering to achieve predictable results.

B. Claim 16

243. As I have discussed above, this is a means-plus-function limitation with the function "isolating said one or more components from more than one particular frequency band of said plurality of frequency bands" and corresponding structure "circuitry that provides overload protection, shielding, and/or filters out unwanted bands," and equivalents.

244. In my opinion, it would have been obvious to a POSITA in view of Vlahos to use isolation circuitry to filter unwanted bands at least for Rubinshteyn's receiver. Vlahos discloses several types of circuitry for filtering out unwanted frequency bands, as I explain for Claim 16 in Ground IV.

245. For the reasons discussed above in Section XVI.A, it is my opinion that a POSITA would have been motivated to apply Vlahos's teachings regarding filtering and isolation to Rubinshteyn's wireless device, and would have reasonably expected the combination to succeed.

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

Dated: September 25, 2025

A handwritten signature in blue ink, appearing to read "Mark P. Mahon", is positioned above a horizontal line.

Mark P. 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