

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

MOTOROLA SOLUTIONS, INC.

Petitioner

v.

STA GROUP LLC

Patent Owner

Inter Partes Review No.: IPR2024-0207

U.S. Patent No. 8,145,249 B2

**DECLARATION OF DR. SAYFE KIAEI IN SUPPORT OF PETITION
FOR *INTER PARTES* REVIEW OF U.S. PATENT NO. 8,145,249 B2**

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	[13pre] A system for providing a push-to-talk proxy media service, comprising:	
	[25pre] A system for providing a push-to-talk proxy media service, comprising:	50
2.	[1a] receiving a plurality of monitored push-to-talk communication streams over a high bandwidth connection, each monitored push-to-talk communication stream comprising audio communications from a plurality of users;	
	[13a] an interface operable to receive a plurality of monitored push-to-talk communication streams over a high bandwidth connection, each monitored push-to-talk communication stream comprising audio communications from a plurality of users;	
	[25a] means for receiving a plurality of monitored push-to-talk communication streams over a high bandwidth connection, each monitored push-to-talk communication stream comprising audio communications from a plurality of users;	51
3.	[1b] mixing the plurality of monitored push-to-talk communication streams into a mixed communication stream such that the audio communications communicated in each of the monitored push-to-talk communication streams can be heard on the mixed stream; and	
	[13b] a mixer coupled to the interface and operable to mix the plurality of monitored push-to-talk communication streams into a mixed communication stream such that the audio communications	

communicated in each of the monitored push-to-talk communication streams can be heard on the mixed stream; and

[25b] means for mixing the plurality of monitored push-to-talk communication streams into a mixed communication stream such that the audio communications communicated in each of the monitored push-to-talk communication streams can be heard on the mixed stream; and 54

4. [1c] transmitting the mixed communication stream to a user endpoint over a low bandwidth connection.

[13c] a processor operable to transmit the mixed communication stream to a user endpoint over a low bandwidth connection.

[25c] means for transmitting the mixed communication stream to a user endpoint over a low bandwidth connection. 56

C. Claims 2 and 14.....58

1. Claim 2. The method of claim 1, wherein each of the push-to-talk communication streams comprises communications from a respective virtual talk group comprising a plurality of endpoints of different communication networks.

Claim 14. The system of claim 13, wherein each of the push-to-talk communication streams comprises communications from a respective virtual talk group comprising a plurality of endpoints of different communication networks. 58

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1. [3pre] The method of claim 2:

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Claim 18. The system of claim 14, wherein at least one of the virtual talk groups comprises a plurality of endpoints of different communication networks whose communications are bridged.....65

H. Claims 7 and 19

Claim 7. The method of claim 1, wherein receiving a plurality of monitored push-to-talk communication streams comprises receiving eight monitored push-to-talk communication streams.

Claim 19. The system of claim 13, wherein an interface operable to receive a plurality of monitored push-to-talk communication streams comprises an interface operable to receive eight monitored push-to-talk communication streams. 65

I. Claims 9 and 21 67

1. [9pre] The method of claim 1:

[21pre] The system of claim 13, wherein: 67

2. [9a] further comprising receiving from the user endpoint a selection of a group of the push-to-talk communication streams for mixing; and

[21a] the interface is further operable to receive from the user endpoint a selection of a group of the push-to-talk communication streams for mixing; and 67

3. [9b] wherein mixing the plurality of monitored push-to-talk communication streams into a mixed communication stream comprises mixing the selected group of the push-to-talk communication streams into a mixed communication stream.

	[21b] a processor operable to mix the plurality of monitored push-to-talk communication streams into a mixed communication stream comprises a processor operable to mix the selected group of the push-to-talk communication streams into a mixed communication stream.	68
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media service, comprising:

[15pre] The system of claim 14: 83

2. [1a] receiving a plurality of monitored push-to-talk communication streams over a high bandwidth connection, each monitored push-to-talk communication stream comprising audio communications from a plurality of users;

[13a] an interface operable to receive a plurality of monitored push-to-talk communication streams over a high bandwidth connection, each monitored push-to-talk communication stream comprising audio communications from a plurality of users;

[25a] means for receiving a plurality of monitored push-to-talk communication streams over a high bandwidth connection, each monitored push-to-talk communication stream comprising audio communications from a plurality of users; 84

3. [1b] mixing the plurality of monitored push-to-talk communication streams into a mixed communication stream such that the audio communications communicated in each of the monitored push-to-talk communication streams can be heard on the mixed stream; and

[13b] a mixer coupled to the interface and operable to mix the plurality of monitored push-to-talk communication streams into a mixed communication stream such that the audio communications communicated in each of the monitored push-to-talk communication streams can be heard on the mixed stream; and

[25b] means for mixing the plurality of monitored push-to-talk communication streams into a mixed communication stream such that the audio communications communicated in each of the monitored

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	[13c] a processor operable to transmit the mixed communication stream to a user endpoint over a low bandwidth connection.	
	[25c] means for transmitting the mixed communication stream to a user endpoint over a low bandwidth connection.	89
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1. [9pre] The method of claim 1:

[20pre] The system of claim 13, wherein: 93

2. [9a] further comprising receiving from the user endpoint a selection of a group of the push-to-talk communication streams for mixing; and

[21a] the interface is further operable to receive from the user endpoint a selection of a group of the push-to-talk communication streams for mixing; and 94

3. [9b] wherein mixing the plurality of monitored push-to-talk communication streams into a mixed communication stream comprises mixing the selected group of the push-to-talk communication streams into a mixed communication stream.

[21b] a processor operable to mix the plurality of monitored push-to-talk communication streams into a mixed communication stream comprises a processor operable to mix the selected group of the push-to-talk communication streams into a mixed communication stream. 94

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endpoint for the user.

Claim 24. The system of claim 13, wherein the processor is further operable to present functionality indicators for a user at the user endpoint in the same manner as if the plurality of monitored push-to-talk communication streams had been individually transmitted over a high bandwidth connection to the user endpoint and mixed at the user endpoint for the user.....95

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Claim 14. The system of claim 13, wherein each of the push-to-talk communication streams comprises communications from a respective virtual talk group comprising a plurality of endpoints of different communication networks. 100

C. Claims 3 and 15.....100

1. [3pre] The method of claim 2:

[15pre] The system of claim 14: 100

2. [3a] wherein the mixed communication stream comprises a first communication of a first virtual talk group; and

[15a] wherein the mixed communication stream comprises a first communication of a first virtual talk group; and 101

3. [3b] further comprising transmitting an identification of the first virtual talk group when transmitting the mixed communication stream comprising the first

communication.

[15b] wherein the processor is further operable to transmit an identification of the first virtual talk group when transmitting the mixed communication stream comprising the first communication. 101

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1. Claim 4. The method of claim 2, wherein the plurality of monitored push-to-talk communication streams are received over the high bandwidth connection from an interoperability system operable to configure each virtual talk group to facilitate communications among its member endpoints.

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	[22b] a user communication; and.....	105
3.	[10b] a selection of a plurality of virtual talk groups of the respective virtual talk groups; and	
	[22c] a selection of a plurality of virtual talk groups of the respective virtual talk groups; and	106
4.	[10c] transmitting the received user communication to the selected plurality of virtual talk groups over the high bandwidth connection.	
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LIST OF EXHIBITS

Exhibit No.	Description
1001	U.S. Patent No. 8,145,249
1002	Declaration of Dr. Sayfe Kiaei (this document)
1003	File History of U.S. Pat. No. 8,145,249
1004	U.S. Patent No. 8,121,057 (“Botha”)
1005	U.S. Pat. Pub. No. 2003/0182001 (“Radenkovic”)
1006	U.S. Pat. No. 7,580,706 (“Koren”)
1007	U.S. Pat. Pub. No. 2002/0097746 (“McDonald”)
1008	U.S. Pat. No. 6,647,020
1009	T. G. Ekstrom, "Site hand off operation in a SmartZone system," Proceedings of IEEE Vehicular Technology Conference (VTC), Stockholm, Sweden, 1994, pp. 106-110 vol.1, doi: 10.1109/VETEC.1994.345134
1010	U.S. Pat. No. 5,081,669 (“Slaninka”)
1011	U.S. Pat. Pub. No. 2005/0239486 (“D’Avello”)
1012	U.S. Pat. No. 6,882,856 (“Alterman”)
1013	U.S. Pat. No. 6,404,861
1014	U.S. Pat. Pub. No. 2005/0125553
1015	De Smet & Stichele, “Subband Based MPEG Audio Mixing for Internet Streaming Applications, 2001 IEEE Int’l Conf. on Acoustics, Speech and Signal Processing Proceedings, pages 1393-1396
1016	Zhihong Qian, “Audio Mixers for Centralized VoIP Conferencing, thesis submitted to Ottawa Carleton Institute for Electrical and Computer Engineering, Carleton University, May 2003

1. I, Dr. Sayfe Kiaei, have been engaged by Motorola Solutions, Inc. as an independent expert in this IPR. I expect to testify concerning the subjects outlined in this report.

2. As part of that engagement, I have been asked to provide analysis and expert opinions on U.S. Pat. No. 8,145,249 (the “249 patent”).

3. I am being compensated for the time I have spent on this matter at the rate of \$475 per hour. My compensation does not depend in any way upon the outcome of this proceeding.

4. In reaching the conclusions described herein, I have considered the documents and materials identified in the Index of Exhibits that is attached to this report, in addition to any materials cited in this report. My opinions are also based upon my education, training, research, knowledge, and personal and professional experience.

5. Based on my review of the 249 patent and its prosecution history, the other materials I have considered, and my knowledge and experience, my opinions are as follows:

- Claims 1-7, 9, 13-19, 21, 25, 38 and 39 are unpatentable due to obviousness based on Botha in view of the knowledge of a POSITA

- Claims 1, 7-9, 12-13, 19-21, 24, 25, 38, 39 are unpatentable due to obviousness based on Radenkovic and McDonald in view of the knowledge of a POSITA
- Claims 2-6, 10-11, 14-18 and 22-23 are unpatentable due to obviousness based on Radenkovic, McDonald and Koren in view of the knowledge of a POSITA

I. BACKGROUND AND QUALIFICATIONS

A. Qualifications

6. A full description of my educational background, professional achievements, qualifications, and publications in the past 30+ years are set forth more fully in my curriculum vitae, which is attached to this Declaration as Exhibit

A. Here, I provide a brief summary of my background and qualifications.

7. I received my Ph.D. in Electrical and Computer Engineering from Washington State University in 1987. My dissertation research areas was in signal processing, communication system and networks. I have several patents and over 100 journal and international conference publications. I have graduated over 70 MS and PhD students working under my supervision on their thesis, and many of them are professors in academia or have senior positions in industry. My research is funded by various sources, including industry and federal agencies, such as NSF, USAID, DARPA, JPL, and NASA.

8. Since 2001, I have held the position of Motorola¹ Endowed Chair Professor in communication and RF system at the School of Electrical, Computer, and Energy Engineering at Arizona State University (“Arizona State”) in Tempe, Arizona.

9. I am also the Director of the National Science Foundation Center, Connection One. Connection One is a research center focused on developing wireless communication system and networking technologies.

10. I have been involved in research, teaching, and developing products in the areas of communications, networking, wireless systems, satellite systems, analog and digital circuits, linear and switching power management integrated circuits (PMIC), sensors, electronics, and related areas for the last 30 years.

11. From 1987 to 1993, I was an assistant/associate professor at Oregon State University (“Oregon State”).

12. From 1997 to 2002, I was also an adjunct professor at the University of Texas at Austin.

¹ This position refers to a historical endowment established in 1998 for supporting communication, manufacturing, and supply chain programs at Arizona State. The objective of this endowment was to strengthen Arizona State’s capabilities in these technologies. Three other Arizona State professors have this endowment title in manufacturing, communication, and supply management. I do not receive any funding from Motorola and have not since I joined Arizona State.

13. At Oregon State, the University of Texas, and Arizona State, I taught courses in the areas of communication systems; wireless systems; networks; systems and circuits; digital integrated circuits, including HDL, Verilog, and VHDL; digital signal processing; and related areas. At Arizona State, I also developed a new course on wireless transceiver systems. I have been doing research in the wireless communication and transceiver design for 2G-5G, SATCOM, Networking, WiFi, and wireless sensors since I joined Arizona State in 2001. My research has been funded by the National Science Foundation, DOD, DARPA, and industry in the wireless communication system.

14. I have been involved in research, teaching, and developing products in the areas of communication system, 2-way radios, Land-Mobile radio systems, cellular systems, GPS, location, RF Integrated circuits, Analog and Digital Integrated Circuits, HDL, Verilog, VHD, communications, digital signal processing, and related areas for the last 30 years starting with the first generation of mobile phones. I have also worked on second generation (2G) and third generation (3G) mobile phone technologies including GSM, EDGE, IS-95, 1X CDMA, UMTS, Wide band CDMA, GPS, Bluetooth, and related areas. These terms all refer to leading mobile phone standards and technologies, which enjoyed widespread use in mobile telephone networks throughout the world. I have also worked on other wireless data communication technologies including Bluetooth,

the global positioning system (GPS), Wireless local area networks (LAN) (often known as WiFi), and related areas.

15. I have written and reviewed software code in HDL, Assembly, C, C++, DSP code, and MATLAB for processors. I have written, debugged, and reviewed software code for DSL, embedded microprocessors, and processors used for both wireline and wireless transceivers at Motorola, ASU, and as an expert witness.

16. From 1993–2002 I worked at Motorola and worked at the Land-mobile products Sector (LMPS) Wireless integrated Technology Center. This group was responsible for the design and development of system, architecture, DSP, analog, and RF integrated circuits for 1G (AMPS, Digital AMPS), 2-way radios, 2G (GSM, EDGE), and 3G (CDMA, WCDMA / UMTS, CDMA2000) transceiver. The products were Motorola flip phone, Razor, iDEN, etc.

17. At Motorola, I worked in the Land-Mobile Products Sector (LMPS) and cellular group. I have designed and contributed to the design of many communications wireless systems including 2-way radios, trucking systems, 2-way radios, land-mobile products, satellite communications, cellular systems, GPS and Bluetooth.

18. I represented Motorola and regularly attended many standards including ITU (International Telecommunication Unit), ETSI (European

Telecommunications Standards Institute), and other standards as a technical expert. I also worked on the interaction of the Iridium satellite system with the cellular and LAN system networking.

19. I have over 200 journal and conference publications, 9 patents (and applications), and standards contributions. Several of these patents and publications are in the areas of communications, networking and radio systems. At Oregon State, UT, and Arizona State, I taught courses and researched in the areas of communication system, cellular system, land-mobile communication system, analog and digital integrated circuits, power management integrated circuits (PMIC), communication systems; radio frequency (“RF”) systems and circuits; (“RFID”); magnetic and electronic sensors; including HDL, Verilog, and VHDL; digital signal processing; and related areas. The list of my publications is included in my resume in Exhibit A.

20. I have been an active member of IEEE communication, radio frequency, and networking societies since 1985 and have published, organized sessions, and been on various IEEE committees. I am an IEEE Fellow, which is the highest level of IEEE membership awarded by the IEEE directors to recognize a high level of demonstrated extraordinary accomplishments. The IEEE Fellow Award is a special recognition for members with extraordinary accomplishments in the IEEE technical fields. To ensure that the recognition is extraordinary, the total

number of recipients each year cannot exceed 0.1% of the total higher grade membership. The IEEE is the Institute of Electrical and Electronics Engineers, the world's largest association of technical professionals whose objectives include the educational and technical advancement of electrical and electronic engineering, telecommunications, computer engineering, and related disciplines.

21. I am a member of the IEEE Circuits and Systems Society, IEEE Solid State Circuits Society, IEEE Signal Processing Society, and IEEE Communication Society. I am also a member of the IEEE RF and Microwave committees, IEEE Low Power Symposium Committee, and IEEE Fellow Selection Committee. I was one of the key organizers establishing the IEEE Radio Frequency Integrated Circuits (RFIC) symposium in 1995, and I have been on the executive and technical committees of RFIC for the last 16 years.

22. I have received several awards including the Carter Best Teacher Award, the IEEE Darlington Award (which is given for the best technical paper on circuits and systems in the IEEE Circuits and Systems Society), and the Motorola 10X Rapid Design Cycle Reduction Award.

B. Materials Reviewed

23. In preparing this declaration, I have reviewed and/or considered at least the documents cited in the List of Exhibits and the documents referenced in this declaration. I have also reviewed the prosecution history of the 249 patent.

II. RELEVANT LEGAL STANDARDS

24. I am not an attorney. For the purposes of this declaration, I have been informed by counsel for Petitioner about certain aspects of the law that are relevant to forming my opinions. My understanding of the law is as follows.

A. Burden of Proof

25. I understand that a petitioner in an IPR must demonstrate unpatentability by a preponderance of the evidence. I understand preponderance means more likely than not in this context.

B. Legal Standards for Prior Art

26. I understand that a patent or other publication must first qualify as prior art before it can be used to invalidate a patent claim.

27. I understand that a U.S. or foreign patent qualifies as prior art to an asserted patent if the date of issuance of the patent is prior to the invention of the asserted patent.

28. I further understand that a printed publication, such as an article published in a magazine or trade publication, qualifies as prior art to an asserted patent if the date of publication is prior to the invention of the asserted patent.

29. I understand that a U.S. or foreign patent also qualifies as prior art to an asserted patent if the date of issuance of the patent is more than one year before the filing date of the asserted patent.

30. I further understand that a printed publication, such as an article published in a magazine or trade publication, constitutes prior art to an asserted patent if the publication occurs more than one year before the filing date of the asserted patent.

31. I also understand that U.S. patents and U.S. patent application publications qualify as prior art to the asserted patent if the application for the patent or patent application publication was filed in the United States before the invention of the asserted patent.

C. Person of Ordinary Skill in the Art

32. I understand that my assessment of the claims of the 249 patent and the teachings of the prior art and my analysis and opinions herein must be undertaken from the perspective of what would have been known or understood by a person having ordinary skill in the art, reading the 249 patent on its priority date and in light of the specification and file history of the 249 patent. I refer to such a person as a “POSITA.”

33. I further understand that in determining the level of ordinary skill in the art, I may consider factors including:

- (a) the type of problems encountered in the art or field of invention,
- (b) prior art solutions to those problems,
- (c) the rapidity with which innovations are made,

(d) sophistication of the technology, and

(e) the educational level of active workers in the field.

34. I understand that a person of ordinary skill in the art is not a specific real individual, but rather a hypothetical individual having the qualities reflected by the factors above. This hypothetical person has knowledge of all prior art in the relevant field and takes from each reference what it would teach to a person having the skills of a POSITA.

D. Anticipation

35. I understand that a patent claim may be “anticipated” if each element of that claim is present either explicitly or inherently in a single prior art reference, and that the elements should be arranged in the reference as in the claim. I understand that for a claimed limitation to be inherently present, the prior art reference need not expressly disclose the limitation, therefore long as the claimed limitation necessarily flows from a disclosure in the reference.

E. Obviousness

36. I understand that a patent claim can be considered to have been obvious to a person of ordinary skill in the art at the time of the claimed invention. This means that, even if all of the requirements of a claim are not found in a single prior art reference, the claim is not patentable if the differences between the prior

art and the subject matter in the claim would have been obvious to a person of ordinary skill in the art at the time of the claimed invention.

37. 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.

38. 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 such as commercial success, long-felt but unresolved needs, failure of others, etc.

39. I understand that an obviousness evaluation can be based on a combination of multiple prior art references.

40. I also understand that the prior art references themselves may provide a suggestion, motivation, or reason to combine, but other times the nexus linking two or more prior art references is simple common sense.

41. I further understand that obviousness analysis recognizes that market demand, rather than scientific literature, often drives innovation, and that a motivation to combine references may be supplied by the direction of the marketplace.

42. I understand that if a technique has been used to improve one device, and a person of ordinary skill in the art would recognize that it would improve similar devices in the same way, using the technique is obvious unless its actual application is beyond his or her skill.

43. I also understand that practical and common sense considerations should guide a proper obviousness analysis, because familiar items may have obvious uses beyond their primary purposes. I further understand that a person of ordinary skill in the art looking to overcome a problem will often be able to fit together the teachings of multiple publications. I understand that obviousness analysis therefore takes into account the inferences and creative steps that a person of ordinary skill in the art would employ under the circumstances.

44. I understand that a particular combination may be proven obvious merely by showing that it was obvious to try the combination. For example, when there is a design need or market pressure to solve a problem and there are a finite number of identified, predictable solutions, a person of ordinary skill has good reason to pursue the known options within his or her technical grasp because the result is likely the product not of innovation but of ordinary skill and common sense.

45. The combination of familiar elements according to known methods is likely to be obvious when it does no more than yield predictable results. When a

work is available in one field of endeavor, design incentives and other market forces can prompt variations of it, either in the same field or a different one. If a person of ordinary skill can implement a predictable variation, the patent claim is likely obvious.

46. It is further my understanding that a proper obviousness analysis focuses on what was known or obvious to a person of ordinary skill in the art, not just the patentee. Accordingly, I understand that any need or problem known in the field of endeavor at the time of invention and addressed by the patent can provide a reason for combining the elements in the manner claimed.

47. I understand that a proposed obviousness combination does not need to be the preferred, or most desirable, combination available, in order to render a claim obvious. Instead, there must be something that suggests the desirability of the proposed combination, not necessarily something that suggests that the proposed combination is the most desirable combination available.

48. Similarly, I understand that for purposes of obviousness, when a motivating benefit comes at the expense of another benefit, that does not nullify the proposed obviousness combination or modification. Likewise, a proposed obviousness combination does not fail merely because it may be inferior to other systems used for the same use.

49. I also understand that a determination of obviousness based on teachings from multiple references does not require an actual, physical substitution of elements between the multiple references. Likewise, the test for obviousness is not whether the features of a secondary reference may be bodily incorporated into the structure of the primary reference. Instead, the test is whether a claim is rendered obvious by the teachings of the prior art as a whole.

50. I understand that a claim can be obvious in light of a single reference, without the need to combine references, if the elements of the claim that are not found explicitly or inherently in the reference can be supplied by the common sense of one of skill in the art.

51. I understand that in considering obviousness, I should keep in mind that a person of ordinary skill in the art has ordinary creativity and is not an automaton.

52. I understand that in considering obviousness, it is improper to determine obviousness using the benefit of hindsight derived from the patent being considered.

53. I understand that secondary indicia of 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 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) taking of licenses under the patent by others; (6) deliberate copying of the invention; (7) failure of others to find a solution to the long felt need; and (8) skepticism by experts.

54. 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.

55. In sum, my understanding is that prior art teachings are properly combined where a person of ordinary skill in the art having the understanding and knowledge reflected in the prior art and motivated by the general problem facing the inventor, would have been led to make the combination of elements recited in the claims. Under this analysis, the prior art references themselves, or any need or problem known in the field of endeavor at the time of the invention, can provide a reason for combining the elements of multiple prior art references in the claimed manner.

F. Priority/Written Description

56. I understand that it is elementary patent law that a patent application is entitled to the benefit of the filing date of an earlier filed application only if the disclosure of the earlier application provides support for the full scope of the claims of the later application, as required by 35 U.S.C. § 112. I understand that

when a priority claim involves a chain of priority documents, each application in the chain leading back to the earlier application must comply with the written description requirement of 35 U.S.C. § 112. I understand that, to satisfy the written description requirement of 35 U.S.C. § 112, the disclosure of the earlier filed application must convey with reasonable clarity to those skilled in the art that, as of the filing date sought, the inventor was in possession of the invention. I understand that a prior application that merely renders the later-claimed invention obvious is not sufficient to meet the written description requirement—it must describe the claimed invention with all its limitations. Similarly, I understand that it is not sufficient for purposes of the written description requirement of § 112 that the disclosure, when combined with the knowledge in the art, would lead one to speculate as to modifications that the inventor might have envisioned, but failed to disclose.

57. I understand that even when each element may be individually described in the specification, the lack of adequate description of their combination renders those claimed combinations invalid under Section 112. I understand that it is not enough that applicant show where each claimed element resides in the earliest filed application but applicant must also provide support for the linkage of the claimed elements creating the embodiment. Petitioner's counsel has informed that a patent owner cannot show written description support by picking and

choosing claim elements from different embodiments that are never linked together in the specification. I understand that a description that merely renders the invention obvious does not satisfy the written description requirement.

III. THE 249 PATENT

A. Overview of the 249 Patent

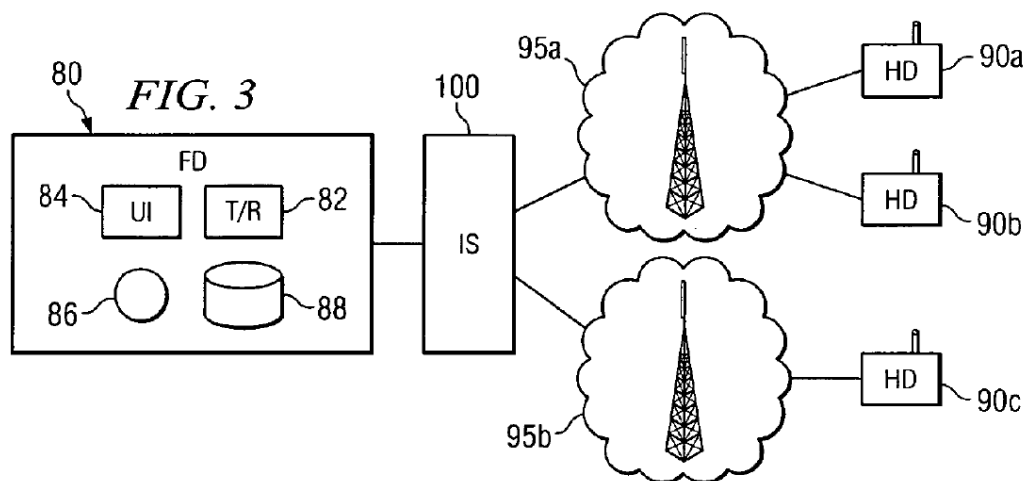
58. The 249 discloses that public and private groups, such as police and firefighters, often employ communications systems (e.g., land mobile radios communicating through push-to-talk, or “PTT,” technology) with different communications technologies, which makes communication among endpoints of such different communications system difficult. EX1001, 1:24-45. Land mobile radios are typically half-duplex (“HD”) endpoints that cannot support both outgoing and incoming communications at the same time. EX1001, 1:41-45. This is in contrast to full-duplex (“FD”) endpoints, such as phones (such as mobile phones), which can support both outgoing and incoming communications at the same time. EX1001, 3:34-53. In such HD PTT systems, an endpoint can only transmit or receive at any one time and only one party can talk at any one time. Thus, a user must “control the floor” by pressing or otherwise activating a PTT button on an endpoint device, which sends a signal to the other PTT endpoints on the same channel to inform them that the user who as pushed the PTT button has control of the floor. *Id.* Many networks such as police and fire utilize through

push-to-talk land mobile radio communication technologies. The communications among different endpoints of different networks such as endpoints of different police, fire or other security networks may be difficult. EX1001, 1:27-32.

59. The 249 patent is directed toward solutions to the problem of facilitating communications among endpoints on such different communications systems. In one embodiment relevant to this IPR, the solution involves a method for providing a “push-to-talk proxy media service” that includes “receiving a plurality of monitored push-to-talk communication streams over a high bandwidth connection and mixing the plurality of monitored push-to-talk communication streams into a mixed communication stream” and “transmitting the mixed communication stream to a user endpoint over a low bandwidth connection.” EX1001, 2:21-28.

60. The 249 patent discloses an interoperability system (“IS”) to facilitate interoperable communication sessions between and among various communication devices, such as endpoints of radio communication networks and endpoints of IP networks such as PDAs, IP phones and laptops. EX1001, 3:25-30. The IS can connect communications between HD and FD endpoints, including land mobile radios (“LMRs”), cellular phones, IP phones, personal computers, PDAs, PSTN (public switched telephone network) phones, video monitors, etc., using Internet Protocol. EX1001, 4:58-64. The IS may control gateways (which may be part of

the IS) in order to map radio frequencies of mobile radios to IP addresses for communication to other types of radio endpoints or IP devices. One embodiment of an IS 100 including a floor control proxy for facilitating communications between multiple HD LMRS 90a,b of one radio network 95a (e.g., as may be used by firefighters), HD LMR 90c of a second radio network 95b (e.g., as may be used by police) and a FD endpoint 80 such as a PSTN or cellular phone is shown in Fig. 3 of the 249 patent below (EX1003, 10:30-13:46):



61. In Fig. 3 above, communications between endpoints 80, 90 travel through the IS 100. However, the 249 patent also discloses embodiments in which the communications do not pass through the IS 100 but instead travel through devices such as gateways and other network components controlled by the IS 100. EX1001, 10:16-20 and 10:39-42.

62. The 249 patent discusses concepts referred to as “talk groups” and “virtual talk groups.” The “talk group” term in the context of the 249 patent refers to a channel on a radio network that is used by a subgroup of users who sharing some common interest, such as a common functional responsibility and who typically coordinate actions amongst themselves without radio interference from other groups. For example, a police department radio system may include various talk groups of various users. EX1001, 9:42-53.

63. The 249 patent extends the talk group concept to “virtual talk groups” facilitated by an IS. The 249 patent virtual talk group allows a group of endpoints to communicate using a particular IP address, and the use of multicast IP addresses allows IS 20 to facilitate communications among communication devices and endpoints of various communication networks to provide audio, data, video and control network interoperability. Ex. 1001, 5:32-40. The 249 patent describes virtual talk groups as follows:

A virtual talk group (VTG) represents interoperability of a group of channels, for example, as an audio conference or meeting. A virtual talk group may include an associated virtual channel and an ID. Virtual channels may comprise an address, such as an IP address, associated with a virtual talk group through which users may access the virtual talk group and/or through which communications from VTG member endpoints are bridged . . .
As an example, a particular virtual talk group may comprise a

conference or meeting of the following: (1) a channel or other multicast path used by certain users of a police department's radio network, (2) a channel or other multicast path used by certain users of a fire department's radio network, (3) a channel or other multicast path used by certain users of a corporation's security radio network and (4) a plurality of users of IP-enabled endpoints such as IP phones, IP-enabled PDAs or PCs.

EX1001, 9:54-10:20.

B. Overview of the 249 Patent's File History

64. The independent claims originally filed for the application that led to the 249 patent were rejected by the examiner over the combination of Denman and Lillie. EX1003, 139-140 (4/14/2010 Final Rejection at 4-5). In response, the applicants amended claims 1, 13, and 25 to recite "each monitored push-to-talk communication stream comprising audio communications from a plurality of users" and "such that the audio communications communicated in each of the monitored push-to-talk communication streams can be heard on the mixed stream," and amended claim 38 to recite "each virtual talk group comprising a push-to-talk communication stream comprising communications from a plurality of endpoints of different communication networks" and argued that Denman and Lillie did not disclose these limitations. EX1003, 108-118, 121-123 (7/14/2010 Request For Continued Examination at 2-12, 15-17).

65. The examiner responded to these arguments by issuing a rejection over Denman, Lillie and Löppönen, relying on Löppönen for the disclosure of the limitations added by amendment. EX1003, 86-88 (2/4/2011 Non-final Rejection at 2-4). The applicants argued that Löppönen did not disclose these limitations because “even in the multi-group disclosure of *Löppönen*, ***the user still hears only one group at a time***. There is ***no disclosure*** in *Löppönen* of receiving a plurality of push-to-talk streams where each stream comprises audio communications from a plurality of users and ***mixing the streams into a mixed stream such that the audio communications can be heard on the mixed stream***.” EX1003, 76-77 (5/4/2011 Applicant Response at 15-16). While the examiner initially rejected this argument and issued another rejection, she later relented and allowed the claims with these amendments. EX1003, 48-49 (7/21/2011 Final Rejection at 2-3); 24 (11/21/2011 Interview Summary at 1).

C. Person of Ordinary Skill in the Art

66. Based on my analysis and review of the 249 patent, the prior art cited herein, and the ordinary skill factors defined in Section II.C ,a POSITA at the time of the earliest alleged priority of the 249 patent (November 4, 2005) would have had at least a B.S. degree in electrical engineering, computer science, or a similar field, plus approximately three years of industry in networking or communication systems, in particular address interoperability between different types of networks

and satellite communications. Additional education in the fields of electrical engineering or computer science, such as a masters or doctorate degree, could substitute for professional experience in the field. A person with less or different education but more relevant practical experience, or vice versa, may also meet this standard. The prior art also evidences the level of skill in the art.

IV. CLAIM CONSTRUCTION UNDER 37 C.F.R. § 42.104(B)(3)

67. I have been informed by counsel for Petitioner that the Challenged Claims are interpreted using the same claim construction standard that is used to construe the claim in a civil action in federal district court. I understand that this means that claim terms of a patent are given the ordinary and customary meaning the terms would have to a POSITA, in view of the description provided in the patent itself and the patent's file history. I understand that to determine how a POSITA would understand a claim term, one should look to those sources available that show what a POSITA would have understood the disputed claim language to mean. I understand that, in construing a claim term, one looks primarily to the intrinsic patent evidence, including the words of the claims themselves, the remainder of the patent, and the patent's prosecution history. I understand that extrinsic evidence, which is evidence external to the patent and the prosecution history, may also be useful in interpreting patent claims but that extrinsic evidence cannot be used to vary or contradict the meaning indicated by

the intrinsic patent evidence. I understand that words or terms should be given their ordinary and accepted meaning unless it appears that the inventors were using them to mean something else. In making this determination, the claims, the remainder of the patent, and the prosecution history are of paramount importance. Additionally, the patent and its prosecution history must be consulted to confirm whether the patentee has acted as its own lexicographer (i.e., provided its own special meaning to any disputed terms), or intentionally disclaimed, disavowed, or surrendered any claim scope.

68. I do not contend that these proposed constructions are complete constructions of these limitations or the claims for any other purpose, including for issues that have been or will be raised in the related litigation. Because the prior art asserted herein discloses or renders obvious devices and methods that are within the indisputable scope of the claims, it is not necessary to construe the outer bounds of the claims as part of these proceedings.

69. Any claim terms not listed below should be construed according to their plain and ordinary meaning to a POSITA at the time of the 249 patent.

A. “a high bandwidth connection” (claims 1, 13, 25 and 38)

70. The 249 patent does not define either the lower or upper boundary of a “high bandwidth connection” with reasonable certainty, and this limitation is therefore indefinite. However, the 249 patent makes clear that WAN and DSL

connections are not high bandwidth connections, but a commercial-grade LAN is. EX1001, 2:39-46 (distinguishing home DSL connection from a “high bandwidth LAN” in a company or other organization). This distinction is sufficient to resolve the challenges in this IPR.

B. “a low bandwidth connection” (claims 1, 13, 25 and 38)

71. The 249 patent does not define either the lower or upper boundary of a “low bandwidth connection” with reasonable certainty, and this limitation is therefore indefinite. However, the 249 patent refers to a WAN (wide area network) as a low bandwidth network and implies that low bandwidth communication such as WAN through the DSL connection is a low bandwidth connection. EX1001, 2:34-46 (referring to “a low bandwidth network, such as a WAN” and distinguishing home DSL connection from a “high bandwidth LAN” in a company or other organization). The person skilled in the art would have known that phone lines, and DSL systems operating using the phone lines, are low-bandwidth communication systems. This distinction is sufficient to resolve the challenges in this IPR, and the indefiniteness of this term therefore does not preclude institution of this IPR as discussed in the preceding section.

C. “means for receiving” (claim 25)

72. This is a means-plus-function limitation subject to construction under 35 U.S.C. § 112, sixth paragraph (pre-AIA). The recited function is “receiving a

plurality of monitored push-to-talk communication streams over a high bandwidth connection.” The corresponding structure disclosed in the specification is interface 51 of the interoperability system 50 of Fig. 2. EX1001, 7:40-47. A POSITA would have recognized this structure as what is known in the art as a network interface card (NIC), such as an Ethernet NIC.

D. “means for mixing” (claim 25)

73. This is a means-plus-function limitation subject to construction under 35 U.S.C. § 112, sixth paragraph (pre-AIA). The recited function is “mixing the plurality of monitored push-to-talk communication streams into a mixed communication stream such that the audio communications communicated in each of the monitored push-to-talk communication streams can be heard on the mixed stream.” The corresponding structure disclosed in the specification is mixer 223 of Fig. 5. EX1001, 17:60-65. From the description in the 249 patent specification, a POSITA would recognize mixer 223 as representing a known class of hardware and software suitable for mixing the communications streams as discussed therein, linear mixers that mix two or more streams by decoding them, linearly combining them (e.g., summing or averaging them) in the time domain, and then reencoding them. Such mixers were commonly used at the time of the 249 patent. *See, e.g.*, description of such linear mixers in EX1015 at 2 (native page 1394, Section 3.1, and Fig. 3); EX1016 at 74 (native page 57 Section 4.1 (discussing traditional linear

mixing for G.711 streams)). However, the 249 patent indicates that the scope of this term encompasses more than these structures known to a POSITA because the 249 patent states that the mixer 223 “may comprise **any** hardware, software, or encoded logic to provide its functionality.” EX1001, 17:64-65 (emphasis added). Thus, the scope of the “means for mixing” includes not only traditional mixing hardware and software known to a POSITA I discussed above, but also any other hardware and software techniques that can perform the functionality of the mixer 223 regardless of what technique is used. I have been instructed by counsel for Petitioner that I should perform my analysis of this limitation by comparing the known class of structures discussed above with the prior art analyzed herein, and I have done so herein.

E. “means for transmitting” (claim 25)

74. This is a means-plus-function limitation subject to construction under 35 U.S.C. § 112, sixth paragraph (pre-AIA). The recited function is “transmitting the mixed communication stream to a user endpoint over a low bandwidth connection.” The corresponding structure disclosed in the specification is interface 51 of the interoperability system 50 of Fig. 2. EX1001, 7:40-47. As discussed above, a POSITA would have recognized interface 51 as a NIC.

V. OVERVIEW OF THE PRIOR ART REFERENCES

75. I have been informed by counsel for Petitioner that the following documents are prior art to the 249 patent.

A. EX1004 – Botha

76. Botha, like the 249 patent, is directed toward enabling communications between different endpoints in disparate communications systems. EX1004, Abstract and 2:7-8. As shown in Fig. 1 reproduced below, these disparate systems and devices can include an IP telephone 120; personal computer or PDA 140 (not numbered in Fig. 1); audio input and output devices 150; digital, analog and/or cellular phones 160; server computer 170; and a land mobile radio system 180 including a plurality of mobile radios 180 – all communicating over channels 110 in the communication network 100 (EX1004, 11:55-12:3 and 2:27-3:11):

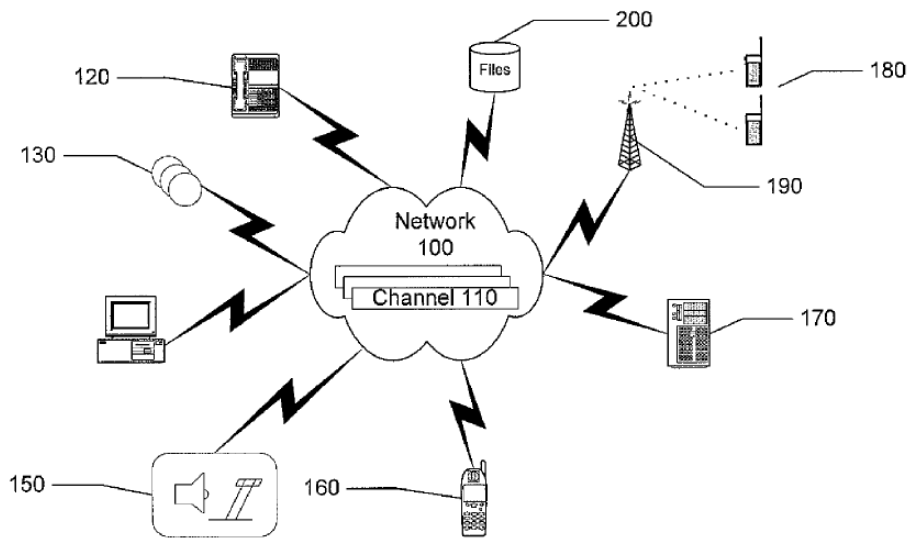


Fig. 1

77. Botha discusses a method which allows disparate communication devices to communicate with each other. The method includes converting, if needed, information communicated from any one of the communication devices into packets. Botha adds identification data for a particular IP session to the packets, which are placed on a communications network utilizing the internet protocol (“IP”), such as an internet or the public Internet. EX1004, 2:8-17. The session identification data corresponds to a “virtual channel” to which devices (or, as discussed further below, proxies for devices) that are interested in the communications can “tune” to receive packets corresponding to the virtual channel. EX1004, 7:7-28.

78. Botha discloses that a gateway 230 can be used to connect a non-packetized communications system or device (e.g., cellular phone 160) to a channel 110 on the network 100. For example, as illustrated in Fig. 2 below, Botha discloses that a gateway 230 is used to connect a two-way radio system with multiple two-way radios 180, 190 to a channel 110 in the network 100:

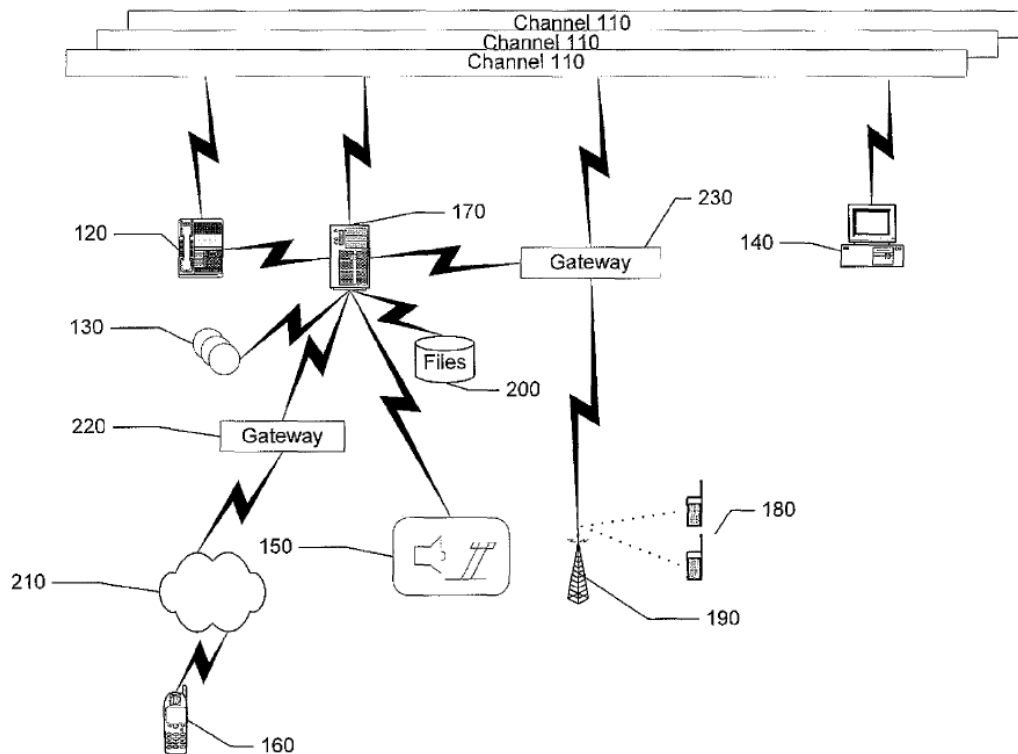


Fig. 2

EX1004, 13:63-14:10 and Fig. 9 (reproduced below); *see also* 13:36-54 and Fig. 8 (discussing use of gateway 220 to interface analog, digital or cellular phone 160 to channel 110 in network 100). The gateway 230 includes logic to allow it to communicate directly on the channels 110. EX1004, 14:6-10.

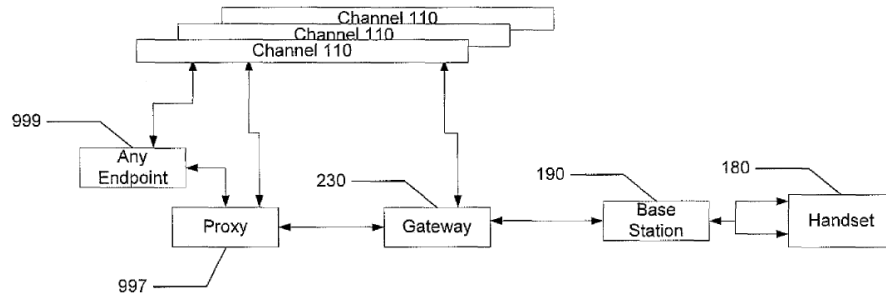


Fig. 9

79. Botha discloses that the channels 110 may be implemented using multicast technology in some embodiments. EX1004, 7:7-10. Multi-cast technology uses an IP address that is received by multiple recipients. EX1004, 7:7-21. In some embodiments, the session ID associated with a channel 110 is a combination of a multi-cast IP address and a port number. EX1004, 12:64-65. As disclosed in the 249 patent:

a “virtual” channel of one example embodiment is present by virtue of participants' packets that contain session identification (ID) or other ID information that identifies the particular multicast and/or unicast session or group that is associated with the participant. Thus, participants' devices or proxy devices can “tune” to **a virtual channel** by monitoring the network for particular packets having the relevant ID information and then receiving such packets. Other examples for determining the particular IP session for the packets include determining a transmitter source for each packet according to a network

address of the transmitter, data type transmitted by the transmitter, media type transmitted by the transmitter, and other pertinent information embedded in the packet or sent alongside the packet by the transmitter or its proxy. EX1004, 7:13-28

80. Embodiments of Botha's system work on a peer-to-peer model where communications from each speaker are output on a desired channel and each endpoint or a proxy for a plurality of endpoints performs a mixing function. EX1004, 6:15-30; 7:29-61; 8:1-12. In one example described in the 249 patent, a proxy that performs a mixing function for a conference system with four participants and two speakers outputs a single multicast stream rather than four unicast streams. EX1004, 7:42-61.

81. This proxy mixing can support a distributed conferencing functionality using a single channel 110 as a backbone. EX1004, 16:1-7. In such distributed conferencing, the network traffic generated by each proxy is an aggregation of the audio from each endpoint connected to that proxy, and as a result, the amount of traffic on a channel is a multiple of the number of proxies on the channel rather than the number of endpoints. EX1004, 16:42-53. For example, in a situation where four proxies were connected to a channel, multiple endpoints each call into a respective local proxy. The local proxy mixes the audio from each endpoint at that local proxy into a single multicast stream and outputs it on the channel. Thus, the total number of streams on the channel is equal to four – one

from each proxy. EX1004, 16:7-25 and 16:42:51. Using this technique, each endpoint at a local proxy would be heard not only by every other endpoint on the same local proxy, but also by all other participants on the other three proxies on the channel due to the use of a multicast channel added to the conference by each of the proxies. EX1004, 16:15-20. In the two-way radio context, streams placed on the channel by other proxies are similarly relayed to the two-way radio interface by the gateway device 230 to transmit the received data onto the airwaves for reception by the two-way radio endpoints, with real-time generation of signaling (e.g., audio tones) referred to as “keying” appropriate for a PTT two-way radio system by the local proxy. EX1004, 14:24-49.

82. The 249 patent also describes channel-to-channel bridging performed by a proxy device. Such channel-to-channel bridging can, for example, “allow different ‘talk groups’ on two-way radio systems to communicate between each other – for example, a UHF two-way radio system on one channel and a VHF two-way radio system on the other.” EX1004, 15:39-46. Other examples of the use of this bridging technology disclosed in the 249 patent include bridging channels managed by different entities, such as different law enforcement agencies, so that end-users within those entities are able to talk to each other regardless of the type of equipment they use. EX1004, 15:46-50.

B. EX1005 – Radenkovic

83. Radenkovic is directed toward methods and systems for providing audio services that employ selective mixing of audio streams corresponding to simultaneous speakers for distribution over a communication network such as packet data network. EX1005, ¶¶[[0001], [0002], [0011]-[0014]. The audio streams are selectively mixed depending on a variety of factors including available network bandwidth, relationships between audio sources, receiver quality of service requirements, and/or receiver capabilities. EX1005, ¶¶[[0025]-[0032].

84. The selective mixing can be accomplished by audio processor mixers 104 connected between internet access servers 106 to which user terminals 100 connect and the Internet 102 as shown in Fig. 1 below. EX1005, ¶[0048]. The audio processor mixers **104** are each capable of mixing a plurality of audio data streams received over the network. EX1005, ¶[0048].

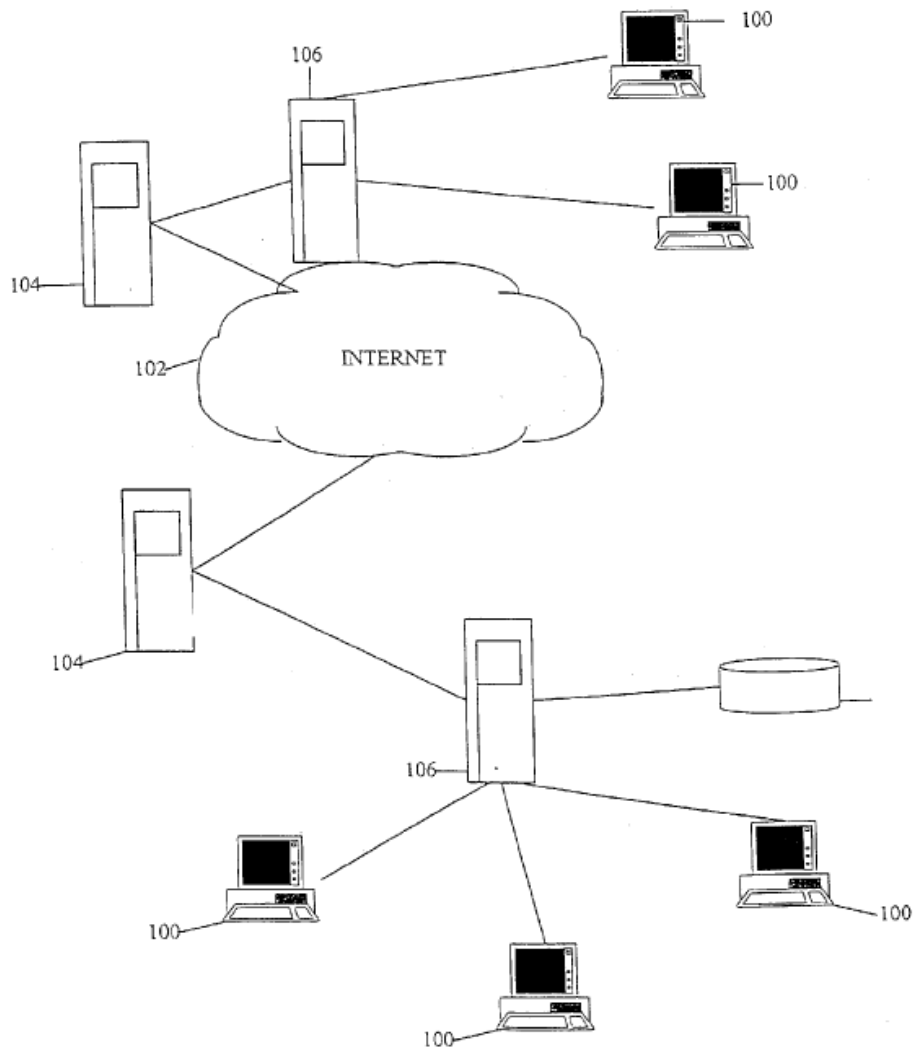


Figure 1

85. As illustrated in the logical network diagram of Fig. 2, the audio processor mixers 204 (104 in Fig. 1) connect sources 200 and sinks 202 in the network via audio data streams 206, where the same user device may be both a source 200 and a sink 202:

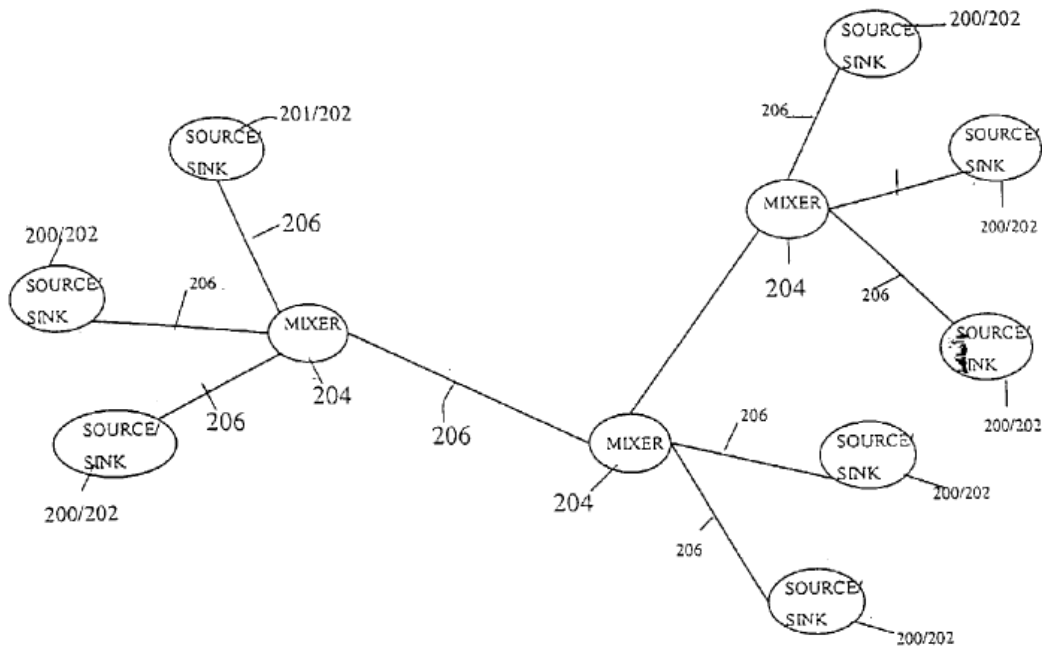


Figure 2

EX1005, ¶[0049]. The mixer 204 of Fig. 2 can be incorporated as mixer 304 into a router 300 as shown in Fig. 3. EX1005, ¶[0050]. The mixer 104/204/304 performs the selective mixing discussed above to create mixed streams, and those mixing decisions may be made dynamically. EX1005, ¶¶[0051]-[0053]. The congestion monitor 308 monitors congestion on the links 206 connecting the router 300 to sinks 202 to allow the router 300 to make those dynamic mixing decisions. EX1005, ¶[0050].

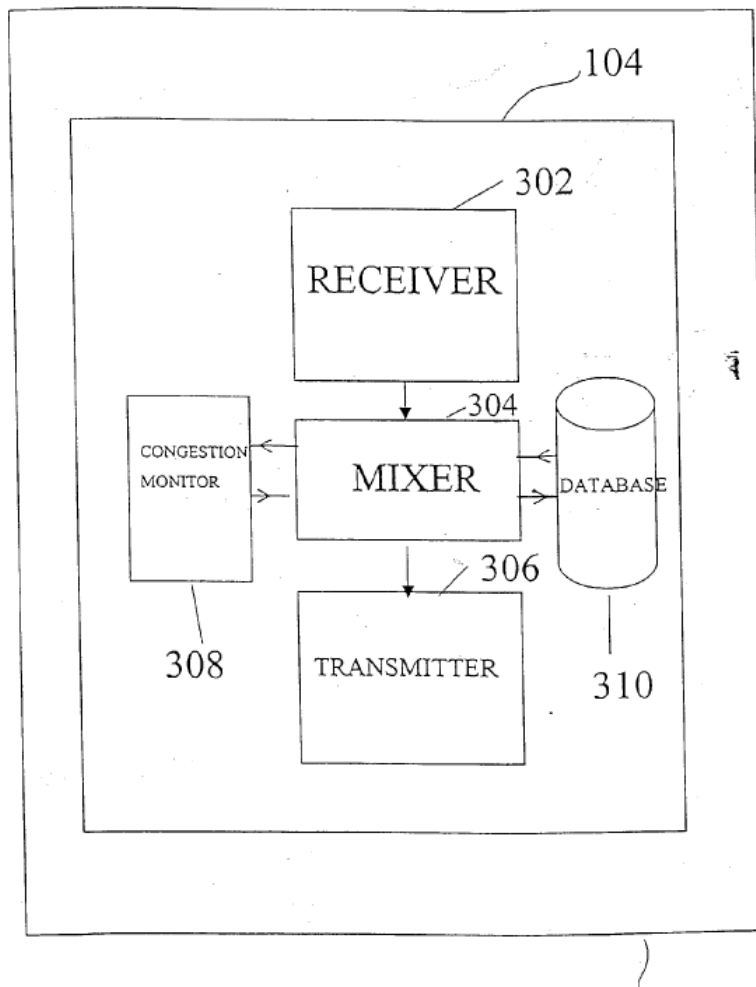
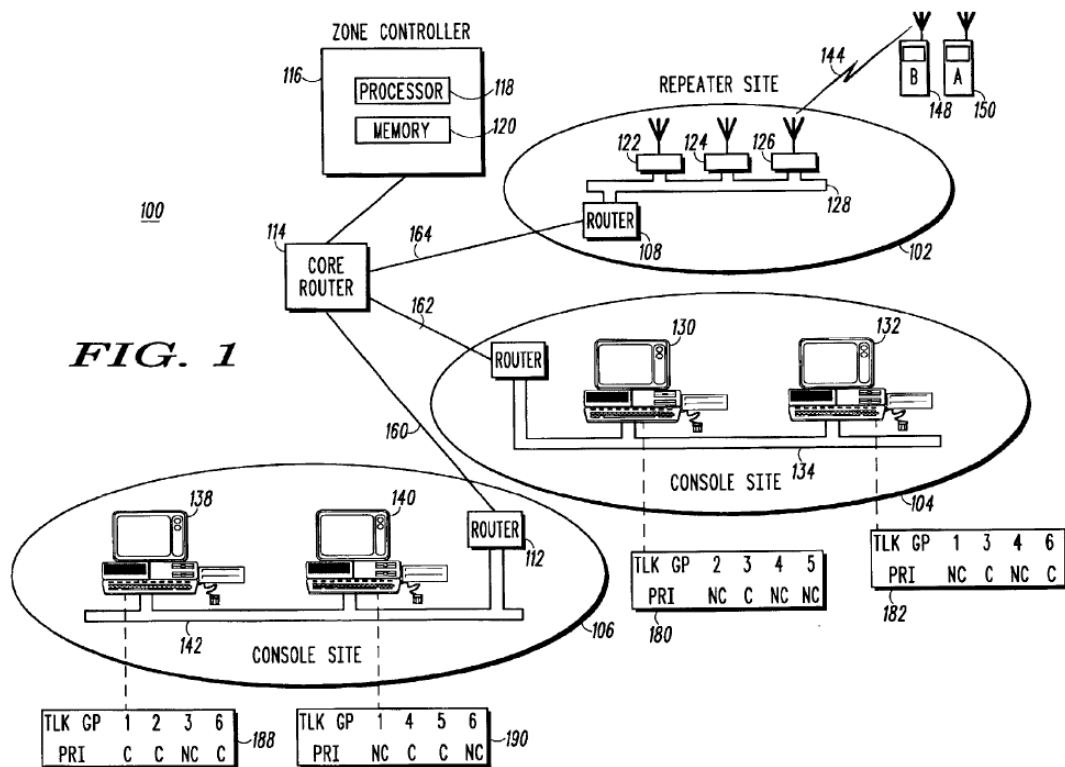


Figure 3 300

C. EX1007 – McDonald

86. McDonald is directed toward a system in which dispatch consoles monitor talkgroups including mobile radios. EX1007, ¶[0002]. An example of such a system is shown in Fig. 1, in which consoles 130, 132, 138, 140 at console sites 104, 106 that monitor talkgroups that include mobile radios 148, 150 connected to repeater sites 102. EX1007, ¶[0014].



In McDonald's system, a console 130-140 receives audio from mobile radios 148, 150 in talkgroups over a packet-based connection via the router 108 to the core router 114 to another router 112 at the console sites 104, 106 via links 160, 162 which have limited bandwidth, such as T1 or E1 links which are digital links typically used for packetized communications. EX1007, ¶¶[0004], [0014]-[0016]. The core router 114 is controlled by a zone controller 116. EX1007, ¶[0014]. The consoles 130-140 allow a console operator to select one or multiple talkgroups for monitoring, and to select a priority for each talkgroup. For example, a console 142 can select talkgroups with identification numbers 1, 2, 3 and 6 for monitoring, and to designate talkgroups 1, 2, and 6 as critical and talkgroup 3 as non-critical, as

shown in box 188. EX1007, ¶[0021]. These selections from the console are communicated to the zone controller119. EX1007, ¶¶[0010], [0021]. McDonald discloses that a console may select from up to 64 talkgroups for monitoring. EX1007, ¶[0004]. The monitoring can be passive or active. EX1007, ¶[0004]. McDonald discloses that it may not be possible to send audio streams from all selected talkgroups to a console due to limited bandwidth on links 160, 162, and thus no audio for a selected non-critical talkgroup may be received. EX1007, ¶¶[0010], [0020], [0032].

D. EX1006 – Koren

87. Koren is directed toward interoperability systems that use a packet data network such as the Internet to provide for communications between different radio systems used by local, state and federal authorities such as first responders, including both conventional and trunked two-way radio systems, as well as cellular and PSTN phones as shown in Fig. 1 below. EX1006, 1:16-61.

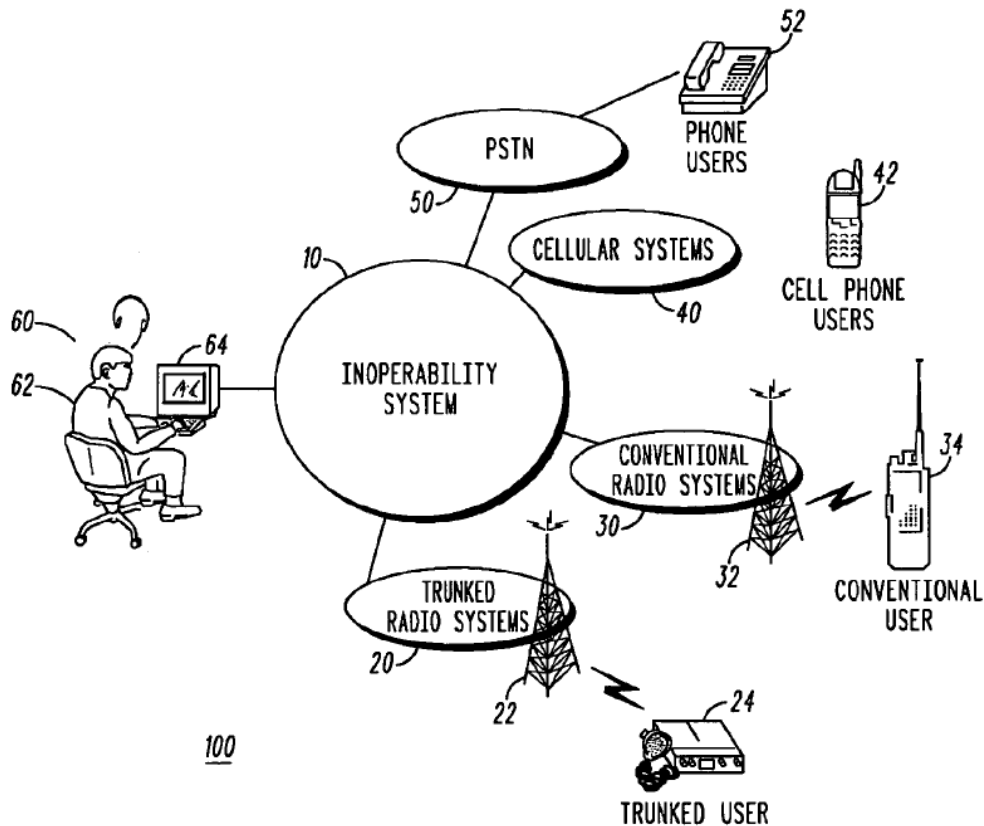


FIG. 1

E. EX1011 - D'Avello

88. D'Avello is directed toward controlling communications in a communications network and provides for user interfaces and associated functionality that allow a user to set up group conversations, set group member priorities, and control volumes of individual group members as shown below.

EX1011, ¶¶[0030], [0048], [0055].

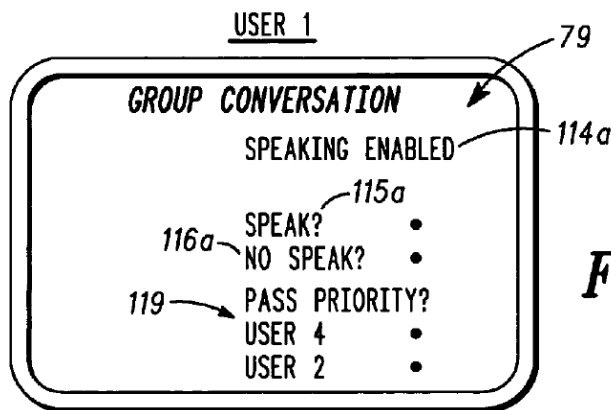


FIG. 5

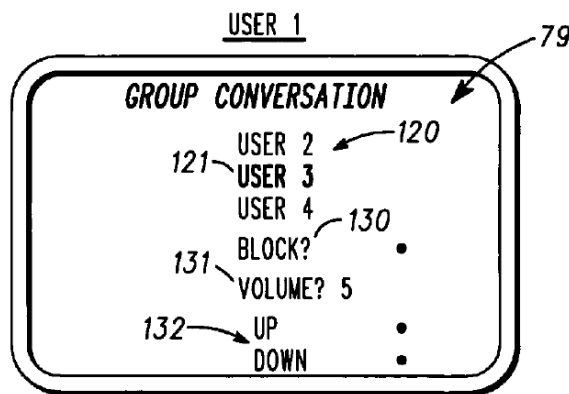


FIG. 8

VI. GROUND 1: CLAIMS 1-7, 9, 13-19, 21, 25, 38 AND 39 ARE OBVIOUS OVER BOTHA

A. Introduction

89. As I discuss above in Section IV.A, and incorporate here by reference, Botha discloses a method and systems that allow for endpoint devices in disparate communications systems to communicate with each other. EX1004, Abstract and 2:7-8. Of particular relevance for this Ground 1 analysis, Botha discloses embodiments in which communications between two different two-way radio

systems, such as communications between two different “talk groups” on different UHF and VHF two-way radio systems connected to a respective computer data network channels 110-A and 110-D, are bridged via a device 997 so that end-users within those different two-way radio systems may communicate with each as shown in Fig. 13:

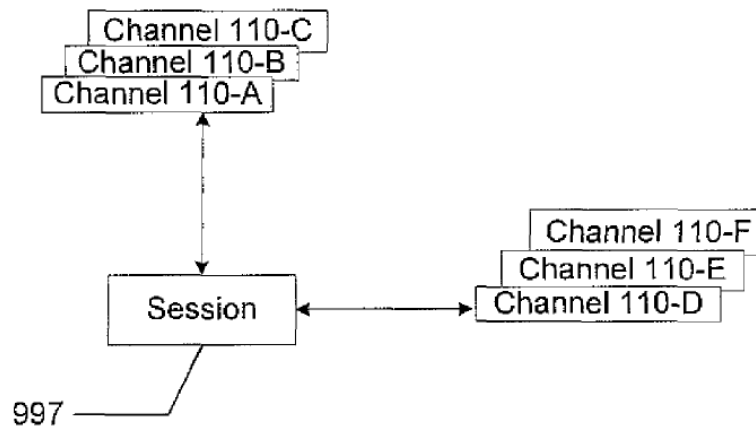


Fig. 13

EX1004, 3:27-31 and 15:39-58.

90. Botha further discloses that a two-way radio system 190 (basestation), which includes and monitors multiple endpoints 180 (PT radio handset), may be connected to a channel 110 via a gateway 230 to other communication systems

such as mobile phones, PDAs, computers, phones or “any endpoint” 999 as described in EX1004 at 13:63-14:10 and as shown in Figs. 2 and 9 below (annotated):

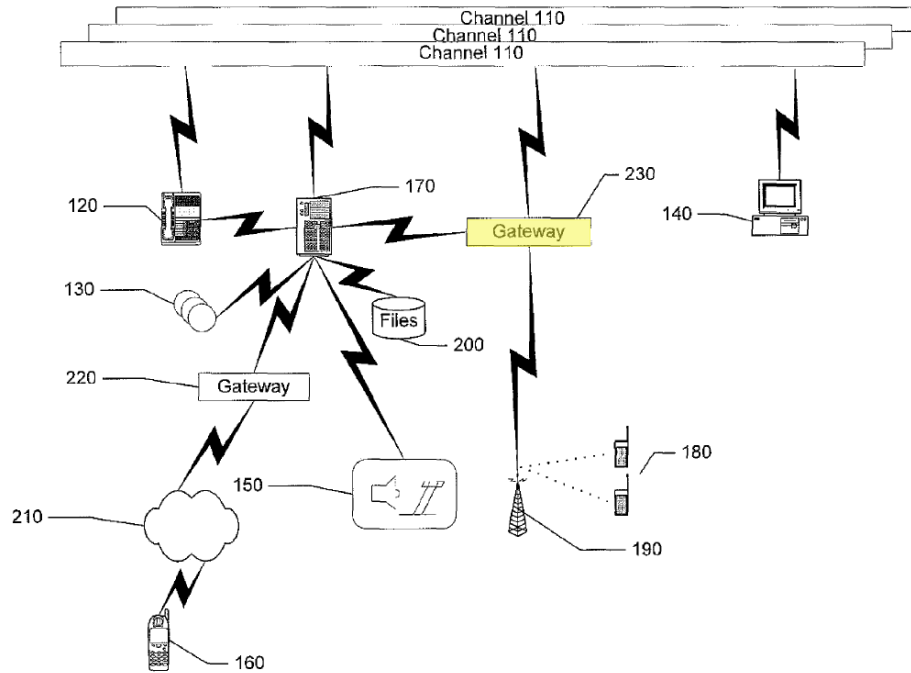


Fig. 2

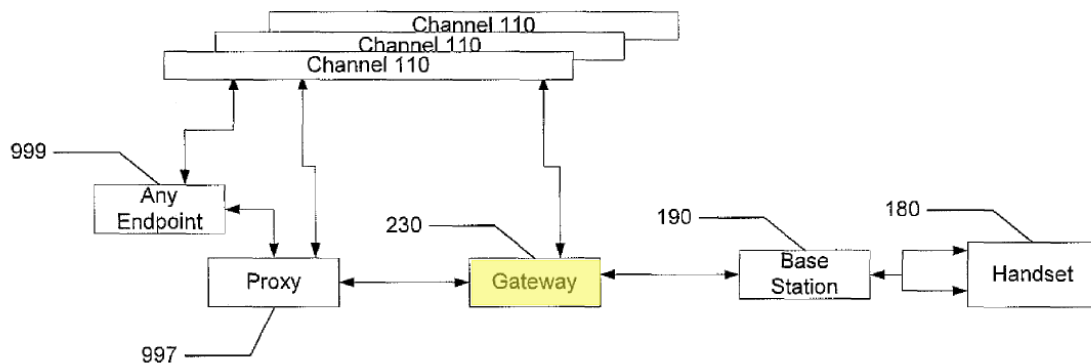


Fig. 9

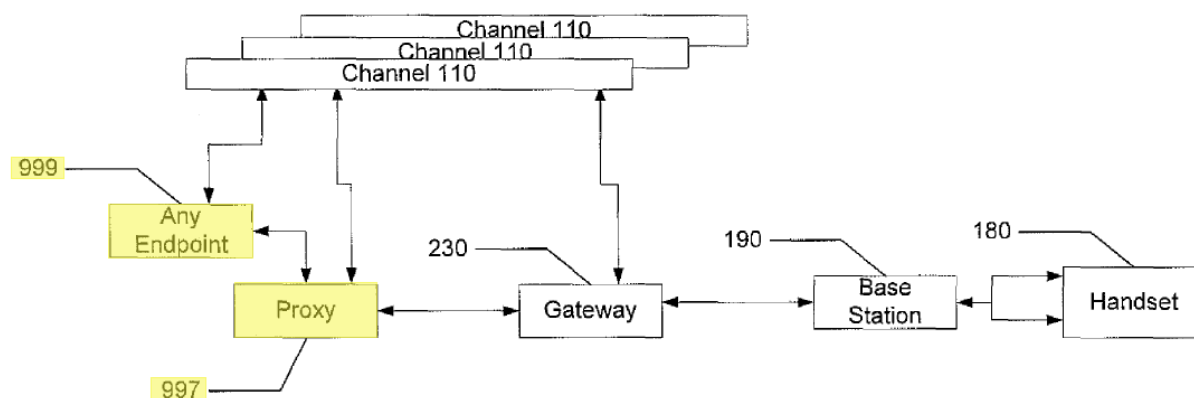
91. When a radio system 190 is connected to a channel 110 via a gateway 230 with an embodiment of the invention installed on the gateway 230, data (i.e., a communication stream) from the two-way radio system 190 is converted to digital data if necessary at the gateway 230 and transmitted to the channel 110. EX1004, 13:63-14:10. Data (i.e., a communications stream) from any other endpoint outside the two-way radio system that is connected to the channel 110 is relayed by the gateway 230 to the two-way radio system 190 for transmission over the airwaves to the endpoints 180 on that radio system. EX1004, 14:24-49. This transmission may include audio tones or other signaling (referred to in Botha as “keying”) generated by either the transmitting endpoint, a proxy device, or the gateway 230, and sent along with the communication stream to the radio system

190 for transmission over the airwaves. EX1004:14:24-15:4. Botha discloses that keying . . .

is accomplished through ... the real-time generation of a sequence of specific audio tones embedded into the data stream, on behalf of instructions delivered to the gateway device 230 from the proxy device 997, or by digital, analog, electrical, or mechanical signaling relayed to the two-way radio interface device by the gateway device. This “keying” of the radio causes the relayed data to be transmitted onto the airwaves and therefore propagate to subscriber devices such as portable two-way radios, base stations, consoles, repeaters, and all other devices capable of receiving the data stream over the airwaves (collectively 180).

EX1004, 14:24-40.

92. In the embodiments shown in Figs. 2 and 9 above, the radio system 190 and the respective endpoints 180 in one talk group connected to a channel 110 are also in communication with another endpoint 999 via a proxy 997 as shown in the annotated version of Fig. 9 below:



The endpoint 999 may be any endpoint, including an endpoint such as a cellular, digital or analog telephone. EX1004, 13:36-54. Such a phone 160 participates on a channel 110 by dialing into a gateway 220 via the public switched telephone network or “PSTN” 210 to a proxy 997, which proxies data to the channel 110 as shown in Fig. 8. *Id.* Botha also discloses that it is possible for a gateway 230 connected to a two way radio system 190 to communicate to a proxy for another endpoint in manners other than over a channel 110. For example, Botha discloses an alternative where a gateway 230 makes use of a signaled call using a protocol such as H.323, SIP or MCGP using a dial-in or dial-out connection. EX1004, 14:11-20. This technique is an alternative to establishing communications with an endpoint proxy via a channel 110 as shown in Fig. 8.

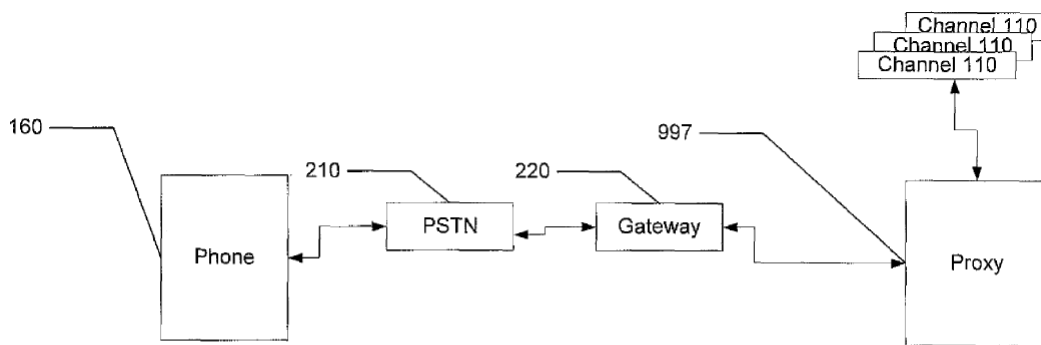


Fig. 8

93. The proxy 997 of Fig. 8 performs a mixing function. A communication stream from the phone 160 is bridged onto a channel 110 using “n-minus-x” mixing such that data (e.g., communication streams) from the device 160 is propagated to the channel 110 and an aggregate (i.e., mixed) communication stream corresponding to all other multicast or unicast streams on the channel is sent to the device (in this case, the phone 160) by the proxy 997. EX1004, 13:49-51 and 13:18-31.

94. Botha also explicitly teaches combinations of the embodiments disclosed in Botha, including but not limited to those embodiments I discussed above:

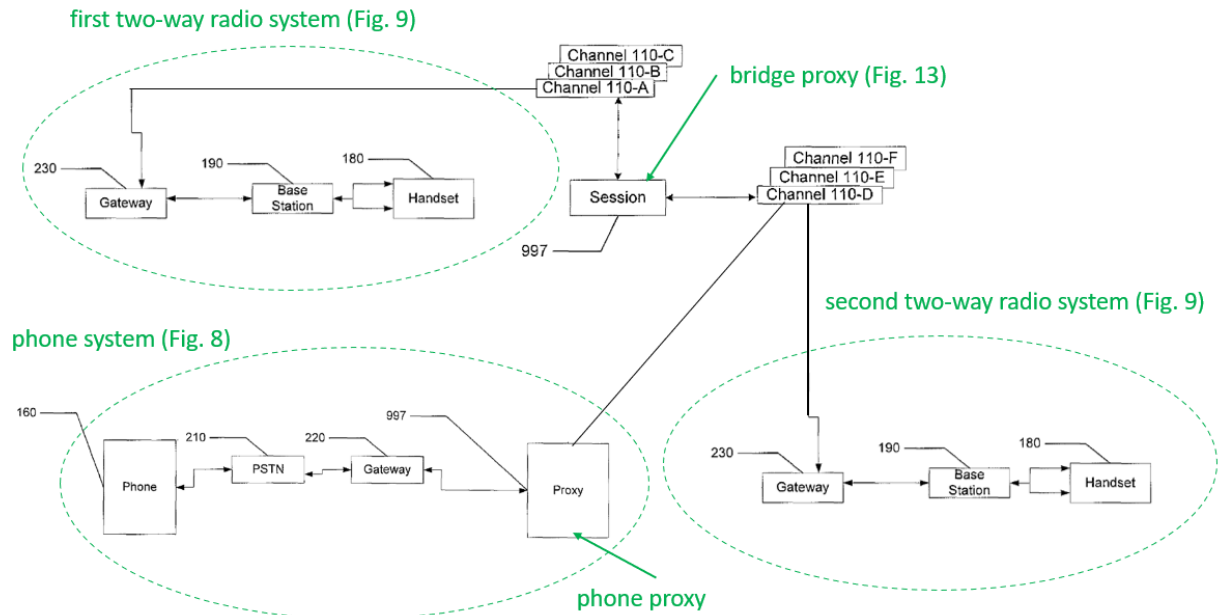
The flow may be of numerous, and potentially recursive, combinations of the channels’ participation in the operation being carried out on the device 997 including, but not limited to

direct channel-to-channel streaming, aggregation of data from one or more channels to one or more channels, conversion of data from one or more channels to one or more channels, translation of data from one or more channels to one or more channels, or any inclusive or exclusive combination thereof.

EX1004, 15:59-67; *see also* 8:28-31 (“It is noted that an embodiment of the invention is itself recursive in nature, in that the output of an instance of the invention may be input to another instance of the invention.”), and 11:55-12:3.

95. In light of Botha’s teaching to combine embodiments, a POSITA would have understood Botha as contemplating a wide variety of combined embodiments that would satisfy the limitations of the challenged claims. As one example, a POSITA would have found it obvious to configure a system with a proxy 997 such as shown in Fig. 13 configured to bridge communications streams between (a) PTT two-way radio endpoints 180 on a first two-way radio system 190 on a first communication channel 110A, (b) PTT two-way radio endpoints 180 on a second two-way radio system 190 on a second communication channel 110D, and (c) one or more telephones 160 connected to channel 110A, 110D or another channel 110 via the PSTN 210, a gateway 220 and another proxy 997 as shown in Fig. 8 configured to perform mixing of communications streams from the two radio systems 190 to the telephone 160 as described above. An illustration of such

an embodiment, which will be referred to herein as the Botha System, is shown in the block diagram below composed from parts of Figs. 8, 9 and 13:²



96. In such an embodiment of the Botha System, the phone proxy 997 to which the phone 160 is connected performs the mixing recited in limitation [1b], and includes the mixer recited in limitation [13b] and the “means for mixing” in limitation [25b].

97. A POSITA would have been motivated to configure the Botha System in the way described above in order to, for example, allow two (or more) different monitored PTT two-way radio systems, such as operated by different police and/or fire departments, to communicate with each other and with, for example, a civilian

² The gateway 230 in Fig. 9 can also directly connect to the proxy and other endpoints.

in need of assistance or a remote supervisor via a phone connection. A POSITA would have understood, or at least found obvious, that PTT two-way radio systems such as those operated by police and fire departments are monitored, for example by a dispatcher. A POSITA would further have understood how to configure each of the proxies 997, gateways 230 or other devices connected to the channels 110 to perform appropriate mixing as discussed in Botha at 7:29-56, 10:29-11:25, 13:17-62, 16:42-17:31, 18:8-46, and Figs. 15 and 21. A POSITA would have had a reasonable expectation of success in configuring a system such as described in Botha in this way because the gateways, mixers, proxies, computer channels and other devices and techniques disclosed in Botha were known to those of skill in the art and involved only routine skill.

B. Claims 1, 13 and 25

1. [1pre] A method for providing a push-to-talk proxy media service, comprising:

[13pre] A system for providing a push-to-talk proxy media service, comprising:

[25pre] A system for providing a push-to-talk proxy media service, comprising:

98. To the extent that the preambles are limiting, a Botha System includes them. The proxy 997 via which a phone 160 connects to a channel 110 to communicate with PTT radio systems 190 provides a push-to-talk proxy media

service. Alternatively, the proxy 997 that bridges channels 110-A and 110-D to which the two-way radio system 190 provide a push to talk proxy media service.

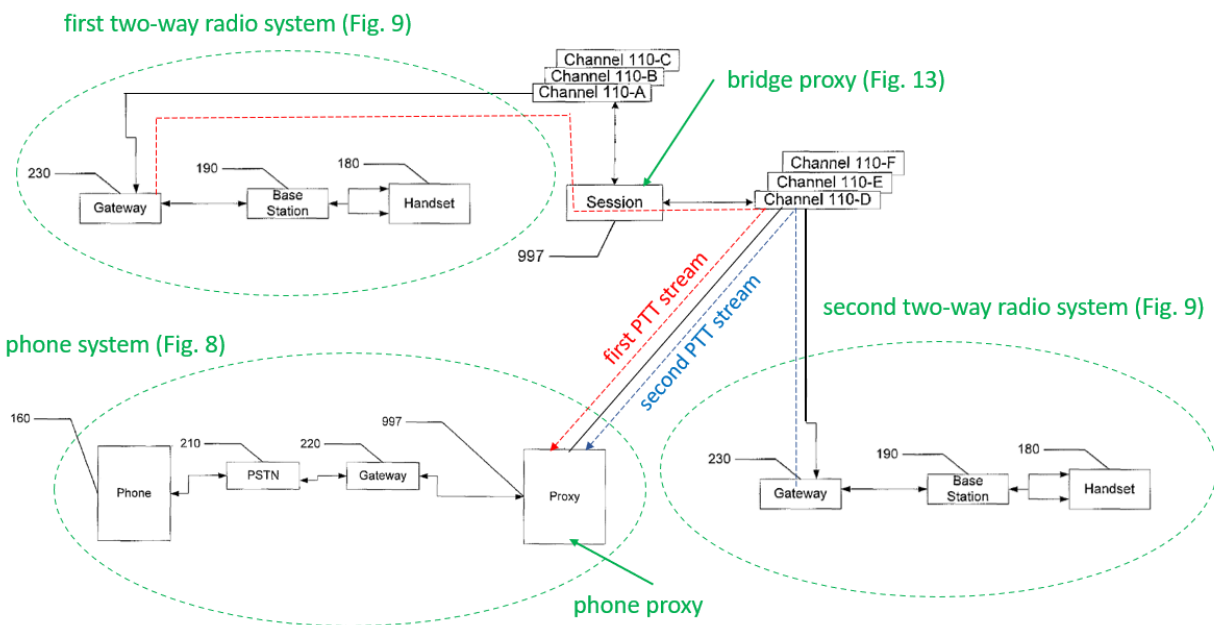
2. **[1a] receiving a plurality of monitored push-to-talk communication streams over a high bandwidth connection, each monitored push-to-talk communication stream comprising audio communications from a plurality of users;**

[13a] an interface operable to receive a plurality of monitored push-to-talk communication streams over a high bandwidth connection, each monitored push-to-talk communication stream comprising audio communications from a plurality of users;

[25a] means for receiving a plurality of monitored push-to-talk communication streams over a high bandwidth connection, each monitored push-to-talk communication stream comprising audio communications from a plurality of users;

99. The Botha System includes these limitations. As discussed above in the Introduction to Ground 1, the Botha system includes two PTT two-way radio systems 190. EX1004, 15:39-46. Each radio system 190 includes a plurality of PTT two-way radios 180 that communicate in a virtual “talk group.” EX1004, 14:39-40 (referring to “all other devices capable of receiving the data stream over the airwaves (collectively 180)”) and 14:61-67; *see also* Fig. 2 (showing multiple PTT two-way radios 180 connected to radio communications system 190). In the Botha System, the data is sent from the two-way radio system (collectively 190 and 180) through a gateway device 230 to convert analog or digital data received from a two-way radio interface device 190 into a packetized data stream, such as a

multicast stream, and then transmitted over the network on a channel 110 to other endpoints. EX1004, 13:63-14:6. The streams from each of these channels are received at a phone proxy 997 to which the phone 160 is connected as shown in the annotated Botha System diagram below. EX1004, 13:49-51 and 13:18-31. Thus, the phone proxy 997 to which the phone 160 is connected receives at least two multicast streams, each stream including push-to-talk communications from a plurality of endpoints 180 monitored by a respective radio system 190.



100. Botha discloses a connection between a proxy and a channel implemented on a LAN. EX1004, 17:9-11. A LAN is a high bandwidth connection as discussed in Section IV.C. A POSITA would have understood or found obvious in view of this disclosure that the phone proxy 997 in the Botha System would be connected to the channel 110-D via a LAN. This is because, as a

practical matter, the phone proxy and at least some of the devices that implement and that are connected to the channels 110 would be in the same physical structure and would be connected to an Internet Service Provider via a LAN in that structure. When the phone proxy 997 in the figure above is connected to channel 110-D via a LAN, the phone proxy 997 receives the two multicast streams, each stream including push-to-talk communications from a plurality of endpoints 180 monitored by a respective radio system 190, over a high bandwidth connection as required by these limitations.

101. Regarding limitation [25a], a POSITA would have recognized or found obvious that the phone proxy 997 discussed above would include a network interface card (“NIC”) because NICs were ubiquitous at the time of the 249 patent and were known to a POSITA as being suitable for connecting a proxy to a network. *E.g.*, EX1014, ¶[0045]. Such a NIC performs the identical function recited in limitation [25a] and is at least equivalent structure to the interface 51 of the 249 patent.

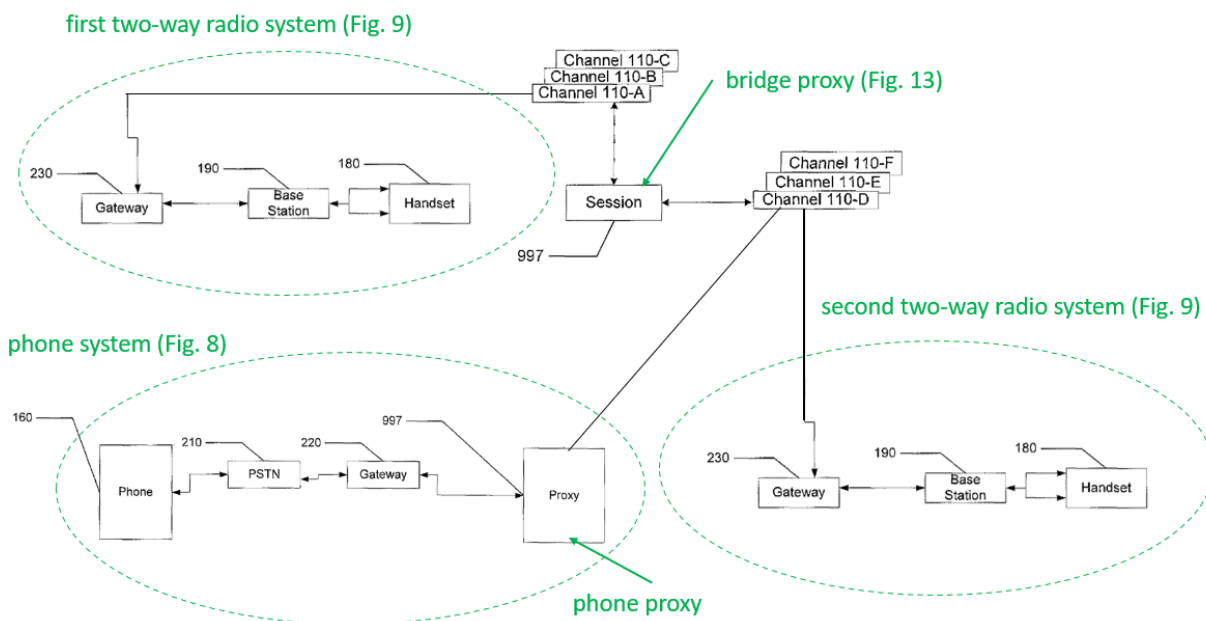
3. **[1b] mixing the plurality of monitored push-to-talk communication streams into a mixed communication stream such that the audio communications communicated in each of the monitored push-to-talk communication streams can be heard on the mixed stream; and**

[13b] a mixer coupled to the interface and operable to mix the plurality of monitored push-to-talk communication streams into a mixed communication stream such that the audio communications communicated in each of the monitored push-to-talk communication streams can be heard on the mixed stream; and

[25b] means for mixing the plurality of monitored push-to-talk communication streams into a mixed communication stream such that the audio communications communicated in each of the monitored push-to-talk communication streams can be heard on the mixed stream; and

102. The Botha System includes these limitations. The Botha System mixes the first and second monitored push-to-talk communication streams into a mixed communication stream such that the audio communications communicated in each of the monitored push-to-talk communication streams can be heard on the mixed stream. In the Botha System, the data from the first PTT two-way system 190 connected to channel 110-A streams into the phone proxy 997 via the gateway 230 and the bridge proxy 997, and the data from the second PTT two-way radio system 190 connected to channel 110-D streams into the phone proxy 997 via the bridge proxy 997. Botha teaches that the proxy 997 to which the data is sent bi-directionally from one endpoint to another. EX1004, 13:5-11. The phone proxy 997 connected to the phone 160, or alternatively the gateway 220 (the location of

the mixing function is a design choice), creates an aggregate/mixed communication stream corresponding to all other multicast or unicast streams on the channel 110 and sends that stream to the phone 160 via the PSTN 210. EX1004, 13:49-51 and 13:18-31; 10:29-11:25.



103. In the Botha System, the multicast streams include a stream from each of the radio systems 190 (e.g. the UHF and VHF radios systems), each of which monitors PTT communications from a plurality of endpoints 180. This allows each of the endpoints 180 on both of these first and second PTT radio systems 190 and the phone 160 to connect to form a virtual talkgroup. EX1004, 15:39-50. As discussed in Section III.D.4, the PSTN 210 is a low bandwidth connection as that term is used in the 249 patent. The POSITA would have known that the communication via phone lines and DSL are low-bandwidth communication.

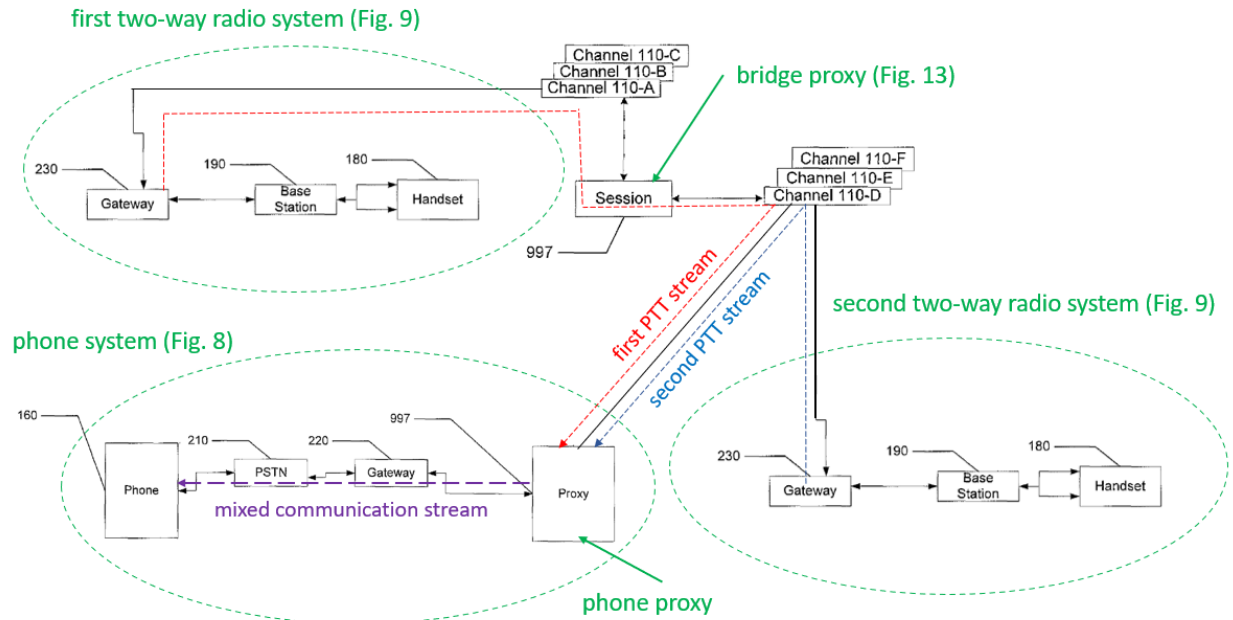
104. Regarding limitation [25b], a POSITA would have recognized Botha's "N minus 1" and "N minus x" mixing as described at EX1004, 10:47-11:25 and Fig. 21 performing the identical function of the "means for mixing" of this limitation, and as being at least equivalent structure to class of known structures recognized to a POSITA as corresponding to the mixer 223 of the 249 patent. See discussion of linear mixing in Botha at EX1004, 10:53-58 ("In one example, embodiment N comprises the sum of pulse code modulation (PCM) samples from each participant's audio (or other signal), and therefore, the N minus x quantity represents the sum of all of their PCM samples minus the PCM samples of the participant(s) that are to be excluded.").

4. [1c] transmitting the mixed communication stream to a user endpoint over a low bandwidth connection.

[13c] a processor operable to transmit the mixed communication stream to a user endpoint over a low bandwidth connection.

[25c] means for transmitting the mixed communication stream to a user endpoint over a low bandwidth connection.

105. The Botha System includes these limitations. In the Botha system, the mixed communication stream is transmitted from the phone proxy 997 via the gateway 220 (or alternatively from the gateway 220 if it is configured to perform the mixing function) over the low-bandwidth connection to the phone 160 as shown in the annotated Botha System diagram below:



See, e.g., EX1004, Fig. 8 discussion in the Introduction to Ground 1. As discussed in Section III.D.4, DSL is a low bandwidth connection, and since DSL is implemented over the PSTN, the PSTN 210 is also a low bandwidth connection as that term is used in the 249 patent. The proxy 997 and/or the gateway 220 can be implemented using a processor, such as user and server computers, single board computers, and custom designed computer circuitry. EX1004, 7:57-61.

106. Regarding limitation [25c], the NIC discussed above for limitation [25a] would also perform the identical function recited in limitation [25c] for the “means for transmitting” and is at least equivalent structure to the interface 51 of the 249 patent.

C. Claims 2 and 14

- 1. Claim 2. The method of claim 1, wherein each of the push-to-talk communication streams comprises communications from a respective virtual talk group comprising a plurality of endpoints of different communication networks.**

Claim 14. The system of claim 13, wherein each of the push-to-talk communication streams comprises communications from a respective virtual talk group comprising a plurality of endpoints of different communication networks.

107. This claim is obvious over Botha. As discussed above, in the Botha System, a multi-cast communication stream on a first channel 110-A includes audio from a plurality of endpoints on one two-way radio system 190, and a multi-cast communication stream on a second channel 110-D includes audio from a second two-way radio system 190.

108. Botha's channels 110 are not limited to a communications stream from a single two-way radio system 190. Botha also discloses a "distributed conferencing" concept that uses a single channel as a backbone onto which multiple proxies 997-A through 997-D (some of which are in different physical locations) transmit multicast streams. EX1004, 16:1-25 and Fig. 22:

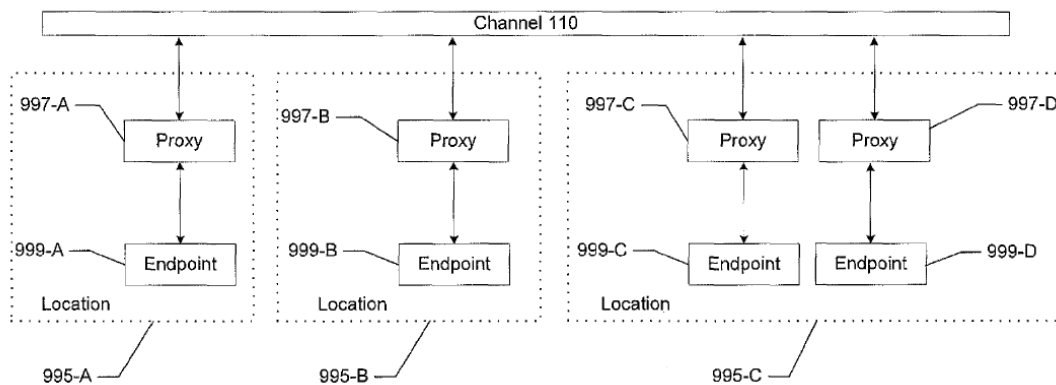
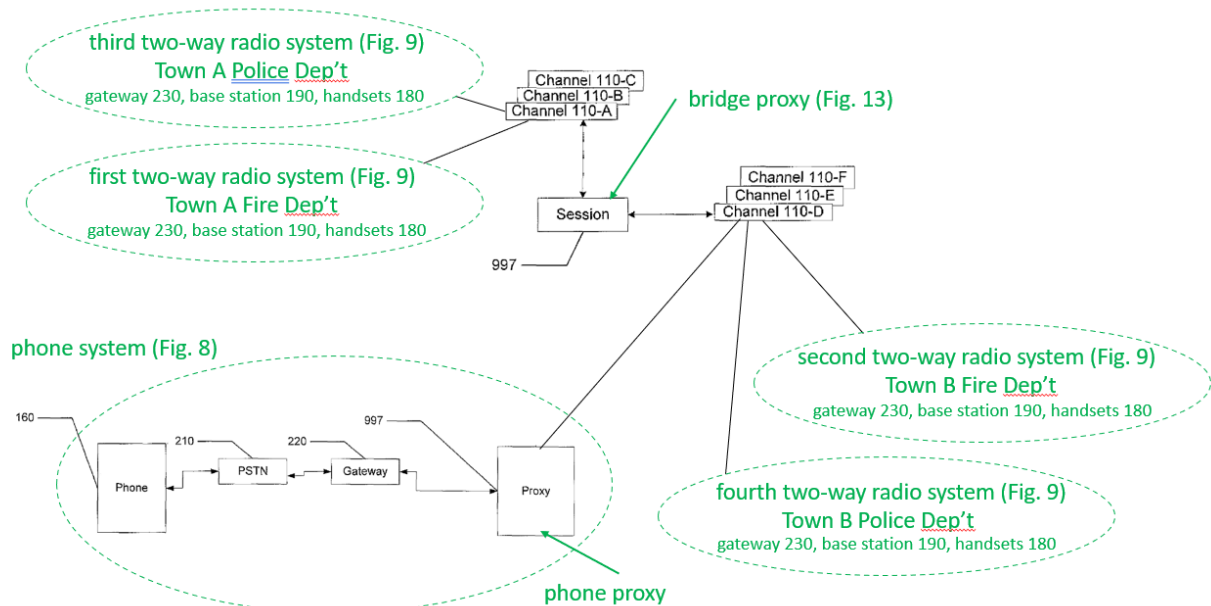


Fig. 22

109. In light of this disclosure, a POSITA would have found it obvious to connect multiple two-way radio systems 190 onto each of the channels in the Botha System as shown in the modified Botha System block diagram below (the “Extended Botha System”).



110. For example, a POSITA would have found it obvious to connect disparate police and fire department two-way radio systems 190 for one town A to channel 110-A in the Extended Botha System to form a first virtual talkgroup, and to connect disparate police and fire department two-way radio systems 190 from another neighboring town B on another channels 110-D in the Extended Botha system to form a second talkgroup. Each such channel 110-A and 110-D thereby constitutes a virtual talk group that includes a plurality of endpoints 180 from each of disparate radio systems 190 on that channel. A POSITA would have understood that disparate radio systems connected to a single channel constitute a virtual talkgroup as that term is used in the 844 patent (see discussion of virtual talkgroups in Section III.A). A POSITA would have been motivated to do so in order to enable communications between these first responders.

111. A POSITA would also have found it obvious to bridge these multiple channels 110-A, 110-D together via a proxy 997 as shown in Fig. 17. A POSITA would have found it obvious and been motivated to do so, for example, in order to facilitate coordination among first responders in an emergency situation involving residents from such neighboring towns. Such a configuration of the Botha System is envisioned by Botha at 15:59-67, which teaches that the communications streams on the channels 110 may be numerous and recursive, and which also discloses communications among talk groups in different law-enforcement

agencies across geographical boundaries such as mountain ranges and oceans at 15:39-58. In such a configuration of the Botha system, the proxy 997 that bridges channels 110-A and 110-D receives PTT communications streams from multiple channels 110 with each such stream comprising communications from a virtual talk group comprising a plurality of endpoints on different radios systems 190.

D. Claims 3 and 15

1. [3pre] The method of claim 2:

[15pre] The system of claim 14:d

112. *See* §VI.C (Claim 2).

2. [3a] wherein the mixed communication stream comprises a first communication of a first virtual talk group; and

[15a] wherein the mixed communication stream comprises a first communication of a first virtual talk group; and

113. *See supra* §VI.B.2 As discussed above for limitations [1b], [13b] and [25b], the audio from each of the radio systems 190 in the Botha System (and the Extended Botha System) are mixed into a multicast stream by the phone proxy 997 (or alternatively the gateway 220) to which the phone 160 is connected. This mixed stream, which constitutes a virtual talk group including all of the endpoints in the radio systems 190, includes at least a first communication from at least one endpoint in at least one of the radio systems 190.

3. **[3b] further comprising transmitting an identification of the first virtual talk group when transmitting the mixed communication stream comprising the first communication.**

[15b] wherein the processor is further operable to transmit an identification of the first virtual talk group when transmitting the mixed communication stream comprising the first communication.

114. *See supra* §VI.B.3 As discussed above for limitations [1c], [13c] and [25c], the phone proxy 997 that mixes the communications from the radio systems 190 into a stream for the phone 160 and will send that stream to the gateway 220. Botha further discloses that channels 110 are virtual and are identified using a session ID or other identification that is sent along with the packet by a proxy. EX1004, 7:28. To the extent not disclosed in Botha, it would have been obvious to a POSITA to include the session ID with the packets sent to the gateway 220 in order to allow the gateway 220 (or software-implemented virtual instances of the gateway running on a single physical machine) to identify the particular session so that the gateway 220 could service multiple phones (not shown in the diagrams above) on different sessions.

E. Claims 4 and 16

Claim 4. The method of claim 2, wherein the plurality of monitored push-to-talk communication streams are received over the high bandwidth connection from an interoperability system operable to configure each virtual talk group to facilitate communications among its member endpoints.

Claim 16. The system of claim 14, wherein the plurality of monitored push-to-talk communication streams are received over the high bandwidth connection from an interoperability system operable to configure each virtual talk group to facilitate communications among its member endpoints.

115. As discussed above in the Introduction for Ground 1, in the Botha System, each gateway 230 that is connected to the radio systems 190 includes logic that facilitates signaling referred to as “keying” that is transmitted to the radio system 190 for transmission over the airwaves to the endpoints 180 in that system. EX1004, 14:24-49. This keying can include “changing frequencies and talk groups on the two-way radio, switching between high and low power transmission levels, selecting individual or groups of repeaters, and so forth,” which serves to facilitate communication among member endpoints in a virtual talk group. EX1004, 14:61-67. The combination of gateways 230 and, in some embodiments, any proxy device that sends keying instructions to the gateways for transmission to the radio systems 190, collectively constitute an interoperability system that facilitates interoperability between the disparate radio systems 190 and the phone 160 in the Botha System. The phone proxy 997 receives the communications stream from the

gateways 230 via a high bandwidth LAN connection to the channels 110 as discussed above for limitation [1a].

F. Claims 5 and 17

Claim 5. The method of claim 2, wherein at least one of the virtual talk groups comprises a plurality of endpoints of different communication networks whose communications are mapped to a multicast IP address or SIP dialed nailed connection.

Claim 17. The system of claim 14, wherein at least one of the virtual talk groups comprises a plurality of endpoints of different communication networks whose communications are mapped to a multicast IP address or SIP dialed nailed connection.

116. As discussed above in the Introduction for Ground 1 for the Botha System, and in the Extended Botha System discussed above for claim 2, one of the channels 110-D includes a phone 160 and a radio system 190 with PTT two-way radio endpoints 180. To the extent not disclosed in Botha, a POSITA would have found it obvious to configure the proxy 997 that bridges that channel 110 to the other channel 110 to perform a mixing function that aggregates the two streams (one from the phone 160 and one from the radio system 190, as well as any other stream on that channel) into a single multicast stream with a multicast IP address for transmission onto the other channel 110 and reception by whatever entities choose to “tune in” to that channel. EX1004, 10:29-11:25 and 16:54-17:31 and Fig. 23; *see also* 7:42-50.

G. Claims 6 and 18

Claim 6. The method of claim 2, wherein at least one of the virtual talk groups comprises a plurality of endpoints of different communication networks whose communications are bridged.

Claim 18. The system of claim 14, wherein at least one of the virtual talk groups comprises a plurality of endpoints of different communication networks whose communications are bridged.

117. In the Botha System discussed above in the Introduction to Ground 1, one of the channels includes a phone 160 and a radio system 190 that together form a virtual talk group. The phone 160 and the endpoints 180 of the radio system 190 are endpoints of different communications networks, i.e., a radio network and the PSTN.

H. Claims 7 and 19

Claim 7. The method of claim 1, wherein receiving a plurality of monitored push-to-talk communication streams comprises receiving eight monitored push-to-talk communication streams.

Claim 19. The system of claim 13, wherein an interface operable to receive a plurality of monitored push-to-talk communication streams comprises an interface operable to receive eight monitored push-to-talk communication streams.

118. See claims 1 and 13 above. As discussed above, Botha shows multiple PTT communication streams interfacing with the channel and other streams via the proxy. Furthermore, as discussed above in §VI.C (Claim 2), Botha discloses a “distributed conferencing” concept that allows proxies for multiple

systems to connect to each other via the channel 110. EX1004, 16:1-25 and Fig. 22:

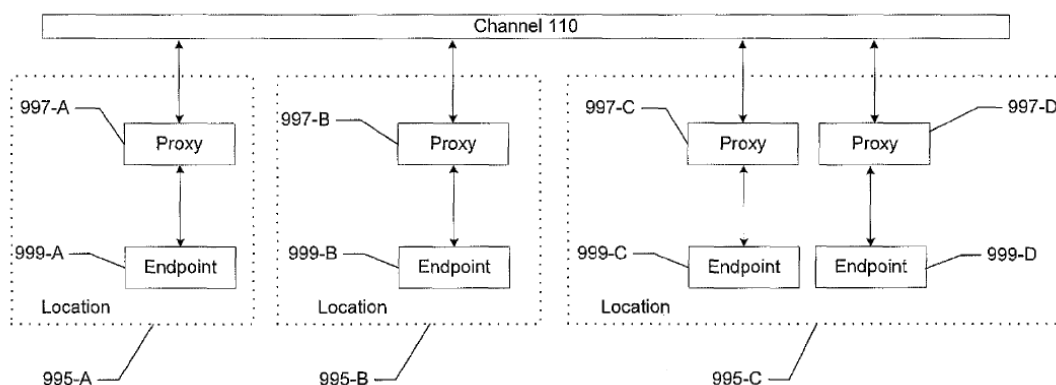


Fig. 22

119. Botha discloses that the system of Fig. 22 is scalable and any number of proxies can connect (i.e., “tune”) to the channel. *Id.* A POSITA would further have recognized that each such proxy can be connected to a respective radio system 190 with its own set of endpoints 180. In such a distributed conferencing embodiment with nine connected proxies, each proxy would receive a multicast stream with the audio from a respective radio system from each of the eight other proxies, each of which would constitute a monitored push-to-talk communications stream. EX1004, 16:42-53. The system shown in Botha enables receiving a plurality of monitored push-to-talk communication streams comprises receiving eight monitored push-to-talk communication streams.

I. Claims 9 and 21

1. [9pre] The method of claim 1:

[21pre] The system of claim 13, wherein:

120. *See* § VI.B (Claim 1).

2. [9a] further comprising receiving from the user endpoint a selection of a group of the push-to-talk communication streams for mixing; and

[21a] the interface is further operable to receive from the user endpoint a selection of a group of the push-to-talk communication streams for mixing; and

121. Botha discloses that an end user computing device allows a user to monitor multiple channels 110 simultaneously and to direct the media (e.g., audio) from any of those channels to one or more rendering systems 250 (such as speakers or a computer display) connected to the computing device 140 in a channel-by-channel basis. EX1004, 12:4-15 and 20:39-46. A POSITA would have found it obvious to modify the Botha System by including such an end user computer for use by, e.g., a dispatcher, to allow the user to select streams from those channels for mixing and output to, e.g., speakers as taught by Botha.

3. **[9b] wherein mixing the plurality of monitored push-to-talk communication streams into a mixed communication stream comprises mixing the selected group of the push-to-talk communication streams into a mixed communication stream.**

[21b] a processor operable to mix the plurality of monitored push-to-talk communication streams into a mixed communication stream comprises a processor operable to mix the selected group of the push-to-talk communication streams into a mixed communication stream.

122. See limitations [9a] and [21a] immediately above. A POSITA would have found it obvious to mix the streams selected by the user, e.g., in the manner discussed at 10:29-11:9, for output to a rendering system such as a speaker.

J. Claim 38

1. **[38pre] A method for providing a push-to-talk proxy media service, comprising:**

123. See §VI.B.1, limitation [1a].

2. **[38a] receiving from a user endpoint over a low bandwidth connection:**

124. The Extended Botha System includes this limitation. As discussed in the Introduction to Ground 1, a phone 160 (a user endpoint) in the Botha System (and the Extended Botha System) is connected to a gateway 220 via the PTSN, which is a low bandwidth connection for the reasons discussed in Section V.B.4, in the Botha System.

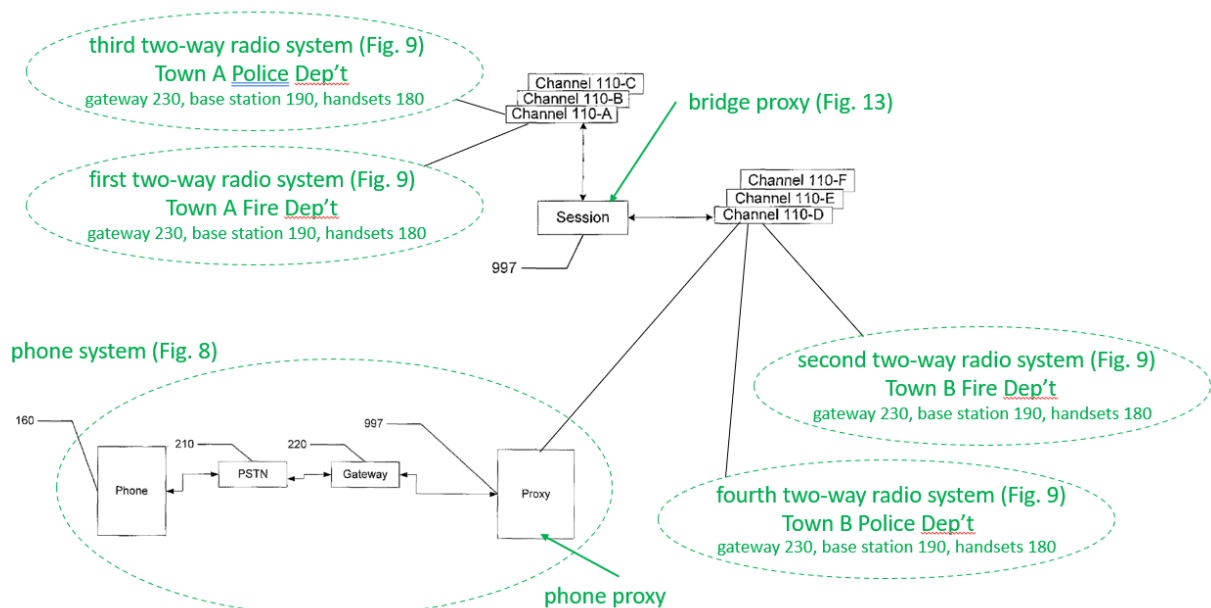
3. [38b] a user communication; and

125. The Extended Botha System includes this limitation. Audio communication from the phone 160 (“user communication”) is received, via the PSTN 210 and gateway 220, at the proxy 997.

4. [38c] a selection of a plurality of virtual talk groups, each virtual talk group comprising a push-to-talk communication stream comprising communications from a plurality of endpoints of different communication networks, each push-to-talk communication stream comprising audio communications from a plurality of users; and receiving from a user endpoint over a low bandwidth connection;

126. The Extended Botha System renders obvious this limitation. As shown in the Extended Botha System diagram below, a phone 160 connects via the gateway 220 in order to participate in a virtual talk group on a channel 110-D.

EX1004, 13:36-62.



Botha teaches that participants' devices or proxy devices can “tune in” to a virtual channel by monitoring the network for particular packets having the relevant ID information and then receiving such packets:

The system of one embodiment works by allowing participants on a conference to “tune in” to a “channel” using multicast, and receive and transmit audio directly across the multicast without requiring a centralized mixer. The audio mixing is performed at the endpoint itself by the end device itself or a proxy acting on its behalf. In an embodiment, a physical “channel” is not per se generated. Rather, a “virtual” channel of one example embodiment is present by virtue of participants' packets that contain session identification (ID) or other ID information that identifies the particular multicast and/or unicast session or group that is associated with the participant. Thus, participants' devices or proxy devices can “tune” to a virtual channel by monitoring the network for particular packets having the relevant ID information and then receiving such packets.

EX1004, 7:10-25.

127. Botha does not explicitly disclose how a user of the phone 160 makes the selection of a virtual talk group, but two ways in which this selection could be accomplished would have been obvious to a POSITA: using a particular phone number for a particular virtual talk group, or allowing a user to issue a voice command or press a particular key on the phone keypad to make the selection. In

both cases, the user selection is received over the PSTN 210. As discussed above for claim 2, it would have been obvious to a POSITA for each channel to include communication streams from multiple virtual talk groups on multiple two-way radio systems 190. In such an embodiment of the Botha System, the user's selection would result in the user being joined to an aggregated virtual talk group comprising a plurality of virtual talk groups on each channel, each including audio communications from a plurality of endpoints 180 in at least two disparate PTT radio systems 190.

5. [38d] transmitting the received user communication to each of the selected plurality of virtual talk groups over a high bandwidth connection.

128. The Extended Botha System modified as discussed for limitation [38c] renders this limitation obvious. In the Extended Botha System, audio communications from a user on a phone 160 are received at the phone proxy 997, which is connected to and transmits those communications over a channel 110-D, which Botha discloses can be a high bandwidth channel on a LAN. EX1004, 16:66-17:1.

K. Claim 39. The method of claim 38, further comprising transmitting to the user endpoint an identification of the selected plurality of virtual talk groups when transmitting the received user communication to the selected plurality of virtual talk groups.

129. The Extended Botha System renders this claim obvious. As discussed in Section VI.D.3, Botha discloses sending session IDs together with communications streams on the channels 110. Botha further discloses that the gateway 230 to which the radio system 190 is connected is configured to send “keying” signals to the radio system 190 for transmission to the endpoints 180, and that these keying signals include in some embodiments instructions to change talk groups. EX1004, 14:24-67. Such a keyed instruction constitutes an identification of an aggregated virtual talk group that includes a plurality of selected virtual talk groups as discussed above for limitation [38c].

130. Furthermore, Botha discloses transmission of the identification of the virtual talk group:

In an embodiment, a physical “channel” is not per se generated. Rather, a “virtual” channel of one example embodiment is present by virtue of participants' packets that contain session identification (ID) or other ID information that identifies the particular multicast and/or unicast session or group that is associated with the participant. Thus, participants' devices or proxy devices can “tune” to a virtual channel by monitoring the network for particular packets having the relevant ID information

and then receiving such packets. Other examples for determining the particular IP session for the packets include determining a transmitter source for each packet according to a network address of the transmitter, data type transmitted by the transmitter, media type transmitted by the transmitter, and other pertinent information embedded in the packet or sent alongside the packet by the transmitter or its proxy.

EX1004,7:10-28.

VII. GROUND 2: - CLAIMS 1, 7-9, 12-13, 19-21, 24, 25, 38 AND 39 ARE OBVIOUS OVER THE COMBINATON OF RADENKOVIC AND MCDONALD

A. Introduction

131. As discussed above in Section IV.B, Radenkovic discloses a system for providing audio services in which mixers 104/204/304 in devices such as routers 300 selectively mix audio streams from “sources” for distribution to “sinks” (i.e., consumers of audio data) over a packet data network such as the Internet. In Radenkovic’s system, an audio source **200** transmits one or more audio data streams to a respective parent mixer node **204**. The mixer 204 then forwards the received audio data stream or streams directly to the other connected nodes to the sinks. Radenkovic system uses a hybrid approach in which the end-point sink receives each of the data streams either in the original un-mixed state or as part of a new mixed stream. EX1005, ¶[0049]. Radenkovic discloses that the selection of streams to be mixed may be performed dynamically. EX1005,

¶¶[0017], [0049], [0053]. Among the reasons why audio streams may be mixed before transmission to a sink include limited network bandwidth available for transmission to the sink. EX1005, ¶¶[0017], [0025], [0062]. Streams may be selected for mixing based on their priorities/significance, with low priority streams being mixed before higher priority streams. EX1005, ¶¶[0029], [0063].

132. Radenkovic's dynamic mixing combines the benefits of both peer-to-peer and total mixing audio services. If there is sufficient bandwidth, Radenkovic's system delivers peer-to-peer (i.e., unmixed) audio streams to each listener. As bandwidth becomes restricted, the audio streams are mixed to minimize the bandwidth. EX1005 [¶0079].

133. McDonald relates to a plurality of communication units such as mobile or portable radio units and PTT systems that are geographically distributed among various repeater sites and console sites. The communication units wirelessly communicate with the repeater sites and each other, and are often logically divided into various subgroups or talkgroups. EX1007, ¶[0002].

134. McDonald's radio system may be trunked or non-trunked. In trunked systems, or in mixed trunked and conventional systems, there is usually provided a central controller (sometimes called a "zone controller") for allocating communication resources among multiple sites. EX1007 ¶[0002]. Trunked radio systems are automated, and the zone controller assigns the channels to a logical

talkgroup. When any user in that talkgroup wishes to communicate with another user in the talkgroup, an idle radio channel is found automatically by the system. This improves the spectral efficiency, and allows multiple simultaneous unrelated conversations can occur on a channel, making use of the otherwise idle time between conversations. A trunked system coordinates all the activity of the radios in the system and sends packets of data to enable one talkgroup to talk together, regardless of frequency. Trunked systems are used in fire departments, police departments, and other services, who all share the frequency range allocated to a city, county, or other political subdivision.

135. In a trunked radio system, it is possible to have multiple calls coming to a single dispatcher or console. In McDonald's system, talkgroups are assigned a priority level to ensure that communication between critical units is maintained. For example, there could be multiple simultaneous communication between the dispatcher and the users in the talkgroup, and the system can prioritize the emergency calls to allow them to be connected while the other calls are muted.

136. McDonald discloses an embodiment of a communication system consisting of a plurality of sites **102, 104, 106** that are coupled, via respective router elements **108, 110, 112** to a core router element **114**. Each site has multiple consoles 130-140 which can be wireless or wireline consoles. The core router 114 is controlled by and coupled to a zone controller **116**. The zone controller **116** may

be linked, through the packet network, to zone controllers of other communication zones. EX1007, ¶[0014]. The zone controller **116** allocates communication units of bandwidth on the console site links **160, 162** connecting the sites to the routers. EX1007, ¶¶[0015], [0020].

137. The communication links **160, 162** between the sites have a limited bandwidth that may not accommodate all of the data streams. The zone controller can manage the bandwidth of the data stream call units between different sites. The use of call counts (units of bandwidth) ensures that the zone controller will not over-subscribe the links. However, as has been noted, it is possible that the available bandwidth (call counts) may be consumed by relatively low priority calls (e.g., passively monitored talkgroups), causing relatively high priority calls (e.g., actively monitored “critical” talkgroups) to be busied. McDonald teaches methods for identifying consoles and/or talkgroups as critical so that calls for critical talkgroups/consoles may be established on a priority basis over less critical calls. EX1007 ¶[20].

138. As I discussed above, McDonald discloses that consoles 132-140 can select audio streams from talkgroups including mobile radios 148-150 for monitoring, can assign priorities to those streams and transmit those priorities to the zone controller 116. EX1007, ¶[0021]. McDonald discloses that the monitoring can be active or passive. EX1007, ¶[0004]. McDonald further

discloses that it may not be possible to transmit audio streams from all of the selected talkgroups to a console 132-140 due to bandwidth limitations. EX1007, ¶¶[0020], [0032].

139. There is a clear motivation to combine the data stream mixing process of Radenkovic with the bandwidth selection and prioritization method of McDonald. It would have been obvious to a POSITA to address the problem of insufficient bandwidth of the links 160-164 to transit individual audio streams for all of the talkgroups selected by McDonald's dispatcher by implementing the hybrid selective dynamic mixing technique disclosed in Radenkovic to allow audio from all talkgroups selected at a console to be received at that console. In situations where there was not sufficient bandwidth to transmit all selected audio streams individually via the links 160-164 of McDonald, a POSITA would have found it obvious to dynamically mix two or more (depending on the available bandwidth) selected non-critical talkgroup audio streams into a single audio stream as taught by Radenkovic. This allows the mixed audio stream to be transmitted on the links when the bandwidth is limited.

140. Using the combination of McDonald and Radenkovic, in unicast or multi-cast data transmission, multiple audio streams of the two or more non-critical talkgroups may be mixed and sent via the links when the bandwidth is limited. In such cases, each talkgroup may implement its own floor control for its

own members, but nothing precludes members in different talkgroups from speaking at the same time, and a POSITA would have understood that this would happen from time to time in such a system because the communications in the different talkgroups are not coordinated. Furthermore, in situations such as police department usage of such radio systems, external events (e.g., shift changes, lunch breaks, emergency situations), mixing multiple talkgroups into a single audio stream will surely result in that single stream including audio with speakers from the different talkgroups speaking at the same time during part of the stream.

141. Mixing audio streams from two or more talkgroups that results in a single mixed stream with multiple speakers speaking simultaneously might sound counter-intuitive to one not skilled in the art, but a POSITA would have found it obvious. It was known in the art as reflected in McDonald that a console operator would listen to multiple talkgroups at the same time at the operator's console.

EX1007, ¶[0004]. Human beings have the cognitive ability to hear multiple conversations at the same time and selective focus on one of them when something of interest is heard as anyone who has ever been in a party or a meeting with multiple conversations occurring around them is familiar. In the context of land mobile radio systems, it was known in the art that audio from multiple talkgroups designated as non-priority could be mixed at an operator console and input to a single speaker (e.g., a non-priority speaker). *E.g.*, EX1010 (“Slalinka”), 2:60-66,

4:7-11; 4:67-5:4. In a situation in which the available bandwidth is not sufficient to send all desired talkgroups to a console where they could be mixed by the console and reproduced on such a single speaker, mixing two or more streams together at a router for transmission over the bandwidth-limited link as in Radenkovic's hybrid dynamic mixing technique serves as a substitute for such mixing at the console.

142. The zone controller of McDonald determines a monitoring status of one of the sites requesting participation in the call. For those sites that are non-critical, the zone controller determines if enough bandwidth is available to the non-critical console site. If bandwidth is available, the zone controller will include the non-critical console site into the call EX1007 ¶[0032]. However, if the zone controller determines that there is not enough bandwidth to support the non-critical consoles at the site will not be included in the call, but will be added into the call when bandwidth becomes available. Using the mixing method described by Radenkovic, multiple data streams can be mixed together to efficiently utilize the bandwidth. The dynamic or distributed partial mixing of Radenkovic combines the use of mixing audio services and delivery of independent audio streams to each listener, giving maximum individual flexibility and control over what users hear. As bandwidth becomes restricted the distributed partial mixing scheme moves incrementally towards a totally mixed (minimum bandwidth) service, thereby

preserving a useful level of audio communication when there is not enough bandwidth in the McDonald system to allow for all low-priority data streams to be transmitted over the links 160-164 individually.

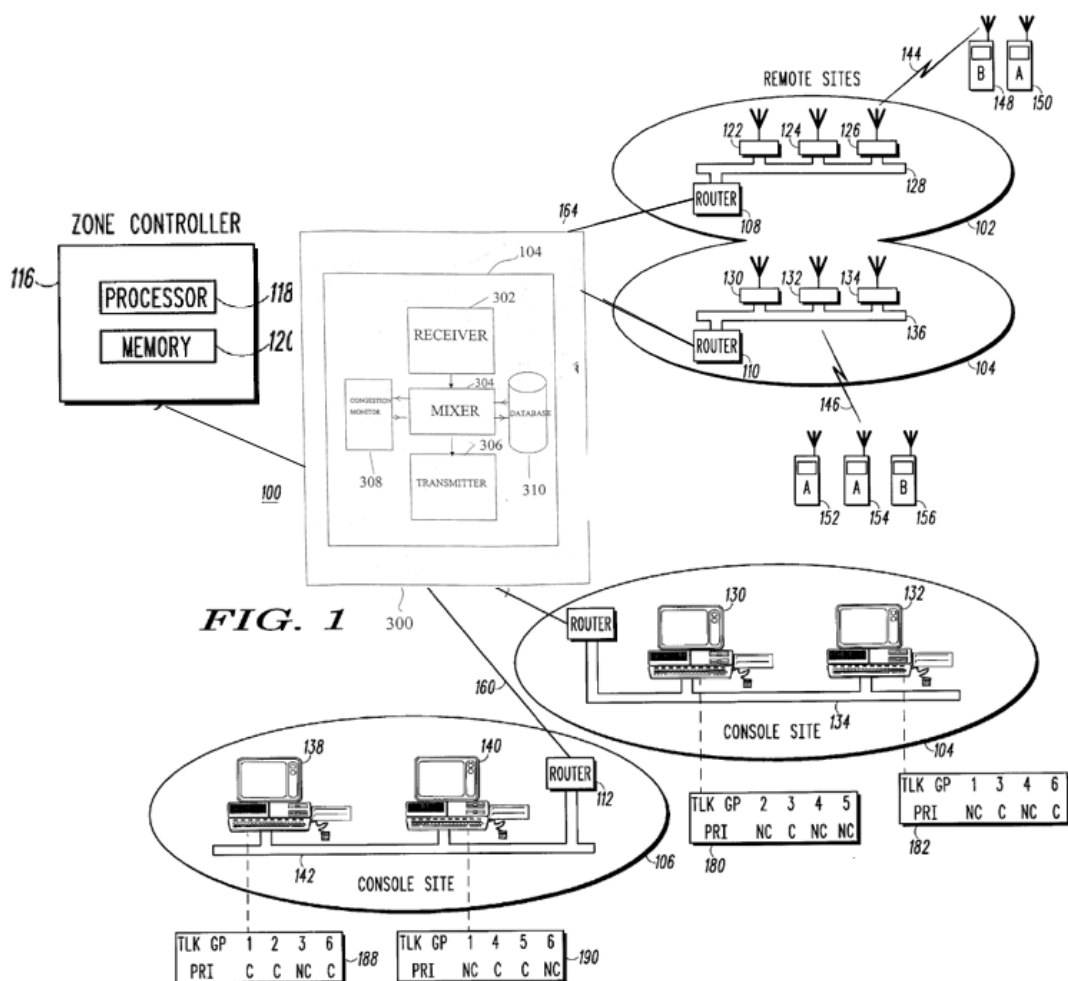
143. Combining these two teachings, the overall system is adaptive, can handle lower bandwidth links, can react to network congestion; supports dynamic load balancing between different distributed components of the audio service; readily supports heterogeneous networks and different end user terminal capabilities; and is adaptive to varying application requirements. Ex1006, ¶[0079]-[0080].

144. I will illustrate the advantage of this combination Radenkovic and McDonald with a trivial example for clarity. Assume a console site having two operator consoles linked to a core router that implements Radenkovic's dynamic hybrid mixing via a single link that, at the relevant time, has sufficient bandwidth to accommodate only three audio streams. Further assume that there are four active talkgroups numbered 1 through 4, that the first console has designated talkgroup 1 as critical and talkgroups 3 and 4 as non-critical, and that the second console has designated talkgroup 2 as critical and talkgroups 3 and 4 as non-critical. Without Radenkovic's dynamic hybrid mixing technique, given the bandwidth limitation, McDonald's system would transmit audio streams for the two critical talkgroups 1 and 2, and one of either talkgroup 3 or 4, over the link,

but not transmit audio for the other low-priority talkgroup. However, when modified in accordance with Radenkovic's teaching, the modified system transmits separate audio streams for talkgroups 1 and 2 and a mixed stream with the audio for talkgroups 3 and 4 (a total of three streams) over the link. The result is that both consoles 3 and 4 receive audio for all of their selected talkgroups.

145. A POSITA would have found it obvious to combine Radenkovic's and McDonald's teachings by, for example, using the router 300 as taught by Radenkovic as a core router 114 as disclosed in McDonald, and configuring the zone controller as taught by McDonald to transmit the selected talkgroups and priorities to the core router to enable the core router to mix streams as necessary to transmit audio from all selected talkgroups to the console. The router 300 as taught by Radenkovic includes a mixer and other circuitry such as a congestion monitor, etc. A POSITA would have been motivated to do so in order to allow a dispatcher to hear and monitor audio from all talkgroups of interest that were selected by the console operator. A POSITA would have had a reasonable expectation of success combining the teachings of Radenkovic and McDonald in this manner involved techniques that were known to those of skill in the art and required only ordinary skill. This combination of Radenkovic and McDonald is referred to herein as a "Mixed McDonald System." A notional block diagram illustrating a Mixed McDonald system, which was formed by combining parts of

drawings from EX1005, EX1007 and EX1008 (EX1008 is introduced and explained below), is shown below. However, the challenges in this Ground 2 should not be understood to be limited to the precise components and configuration illustrated in the figure or as a bodily incorporation of Radenkovic's router as a direct replacement for McDonald's core router, but rather should be understood to be based on the combined teachings of Radenkovic and McDonald. For example, the zone controller 116 may be incorporated into the router 300 in the figure below.



The Mixed McDonald System renders obvious claims challenged in Ground 2 as demonstrated below.

B. Claims 1, 13 and 25

1. **[1pre] A method for providing a push-to-talk proxy media service, comprising:**

[13pre] A system for providing a push-to-talk proxy media service, comprising:

[15pre] The system of claim 14:

146. To the extent that the preambles are limiting, the Mixed McDonald System includes them or, at a minimum, renders them obvious. The router with the mixer in the Mixed McDonald System provides a proxy media service for audio streams transmitted from a radio system site 102. McDonald discusses a trunked radio system which is a push-to-talk radio system.

In trunked systems, or in mixed trunked and conventional systems, there is usually provided a central controller (sometimes called a “**zone controller**”) for allocating communication resources among multiple sites. The central controller may reside within a single device or multiple devices and may be located at a fixed equipment site or may be distributed among the repeater or console sites.

EX1007, ¶[0002].

147. McDonald does not explicitly disclose that the mobile radios 148, 150 are push-to-talk devices, but a POSITA would have recognized them as such in

view of the descriptions in McDonald of consoles as SMARTZONE™ consoles and of activating a PTT (push-to-talk) switch at such a console to indicate a desire to source payload (i.e., speak) on a talkgroup call. EX1007, ¶¶[0004], [0013]. The Motorola SMARTZONE™ system is a trunked radio push-to-talk multi-site communication system have the ability to accomplish site hand-offs without needing the fixed end equipment to notify it when to switch to another site. EX1009, 11.

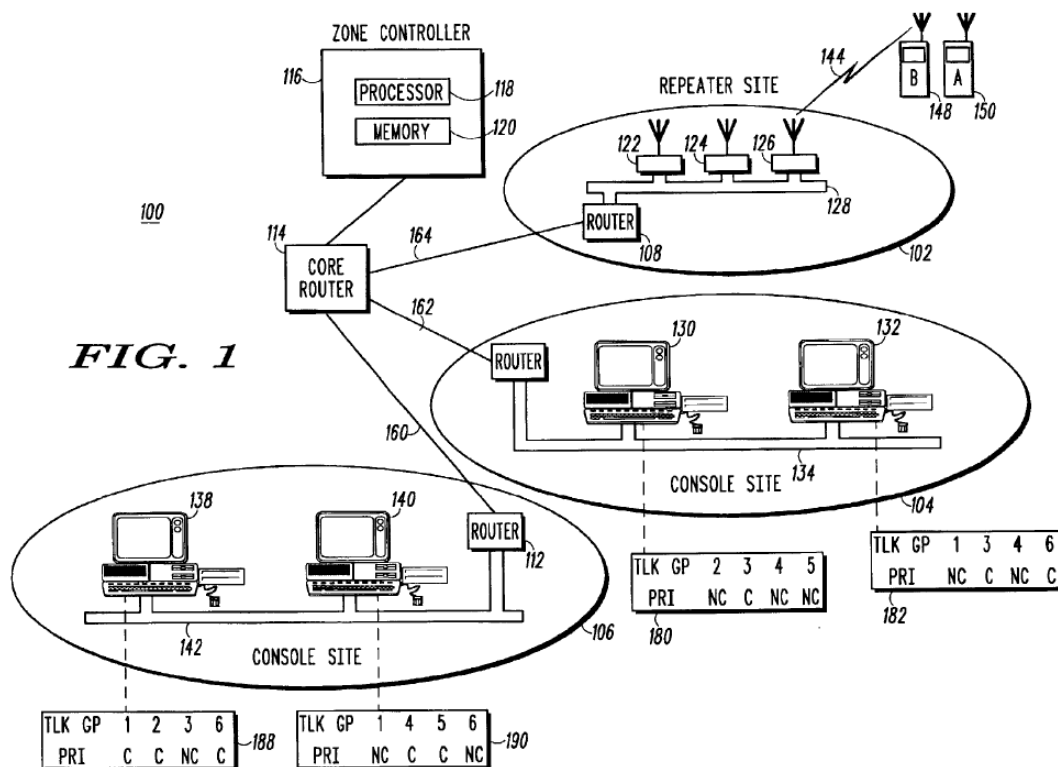
2. **[1a] receiving a plurality of monitored push-to-talk communication streams over a high bandwidth connection, each monitored push-to-talk communication stream comprising audio communications from a plurality of users;**

[13a] an interface operable to receive a plurality of monitored push-to-talk communication streams over a high bandwidth connection, each monitored push-to-talk communication stream comprising audio communications from a plurality of users;

[25a] means for receiving a plurality of monitored push-to-talk communication streams over a high bandwidth connection, each monitored push-to-talk communication stream comprising audio communications from a plurality of users;

148. The Mixed-McDonald System includes and/or renders obvious these limitations. McDonald expressly discloses the transmission of a push-to-talk communication stream corresponding to a plurality of radios 148, 150 in a talk group having a talk group identifier from a router 108 at radio system site 102 to a core router 114. EX1007, ¶[0015] as shown in Fig. 1. The PTT radios 148 and

150 in communication with the repeaters are connected via a high-bandwidth ethernet connection to the router 108 and core router 114. EX1007, ¶[0015]. A POSITA would have understood that the ethernet connection to the router is a high-bandwidth connection.



The router 108, the core router 114 and the consoles 132-140 and router 112 at sites 104, 106 are all IP host devices capable of sending IP datagrams/packets over the network. EX1007, ¶[0018].

149. The console sites 130, 132, 138 and 140 are connected with “talkgroups” to receive the payloads which can be from the PTT radios 148, 150 via the routers 108 and 114.

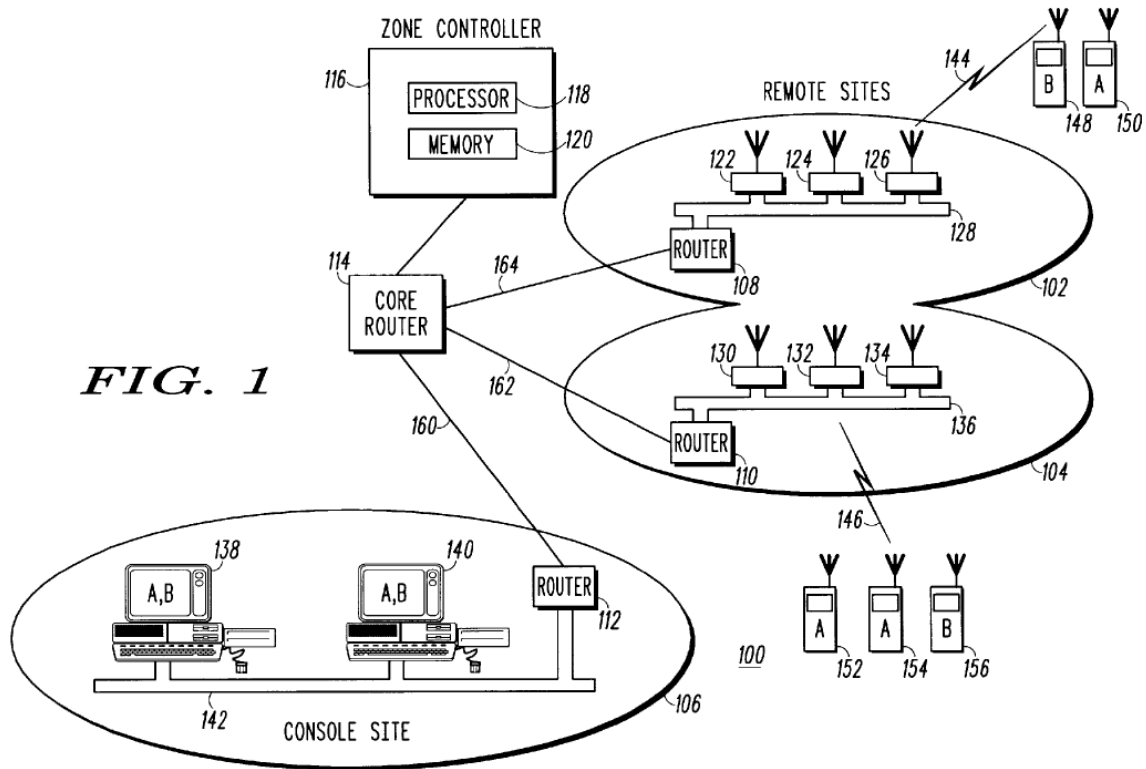
Console positions 130, 132, 138, 140 can affiliate with various talkgroups for monitoring purposes, that is to receive payload (e.g., audio, video, data) being communicated on the talkgroups, or to source payload for the talkgroups.

EX1007, ¶[0016]

The present disclosure has thus identified methods for establishing priority or critical talkgroups at console Sites, and for establishing calls based on the designated priority levels in a manner that allows for the limited bandwidth of console site links to be allocated on a priority basis for the talkgroups identified as critical. In this manner, console operators will be more likely to receive audio for high priority or critical calls.

EX1007, ¶[0035].

150. The description of the embodiment of Fig. 1 discloses the receipt of multiple audio streams from multiple talkgroups at router 114, but to the extent that Patent Owner argues that it does not, U.S. Patent No. 6,647,020 (which is incorporated by reference in its entirety in McDonald; EX1007, ¶[0003]) discloses the receipt of multiple streams on links 162, 164 from multiple talkgroups, each talkgroup including multiple radios 148-150 and 152-156, from multiple sites 102, 104:



EX1008, 6:21-47 and Fig. 1. A POSITA would have found it obvious to include multiple radio sites 102, 104 as taught in Fig. 1 of EX1008 and as shown in the notional block diagram of the Mixed McDonald System in the Introduction to Ground 2 above, and would further have found it obvious to include additional radio system sites that generate additional talkgroup streams connected to the router in the Mixed McDonald System in order to allow consoles in the Mixed McDonald System to monitor a larger number of radio talkgroups such as the four talkgroups at a single console as illustrated in boxes 180-190 of Fig. 1 of McDonald or more talkgroups.

151. Regarding limitation [25a], a POSITA would have recognized or found obvious that the core router 114 would include a network interface card (“NIC”) because NICs were ubiquitous at the time of the 249 patent and were known to a POSITA as being suitable for connecting a device such as a router to a network. See, e.g., discussion of NICs in EX1014, ¶[0045]. Such a NIC performs the identical function recited in this limitation and is at least equivalent structure to the interface 51 of the 249 patent.

3. **[1b] mixing the plurality of monitored push-to-talk communication streams into a mixed communication stream such that the audio communications communicated in each of the monitored push-to-talk communication streams can be heard on the mixed stream; and**

[13b] a mixer coupled to the interface and operable to mix the plurality of monitored push-to-talk communication streams into a mixed communication stream such that the audio communications communicated in each of the monitored push-to-talk communication streams can be heard on the mixed stream; and

[25b] means for mixing the plurality of monitored push-to-talk communication streams into a mixed communication stream such that the audio communications communicated in each of the monitored push-to-talk communication streams can be heard on the mixed stream; and

152. The Mixed McDonald System includes these limitations. As discussed in the Introduction to Ground 2, the core router in the Mixed McDonald system includes a mixer, e.g. the mixer 304 of Fig. 3 in Radenkovic. When the core router detects (e.g., via congestion monitor 308) that the bandwidth is not

sufficient to transmit audio streams from all selected talkgroups from the core router to a console, the mixer in the core router of the Mixed McDonald System is configured to mix two or more non-critical streams into a combined stream for passive monitoring at the console so that audio from all selected streams is transmitted from the core router to the console using the available bandwidth.

153. Regarding limitation [25b], a POSITA would have recognized Radenkovic's mixing as described at EX1005, ¶[0050] ("audio mixer component is arranged to average selected audio data streams to create a single combined audio stream comprising the same number of bits as each unmixed data stream") as performing the identical function of the "means for mixing" of this limitation, and as being at least equivalent structure to the class of known structures recognized by a POSITA as corresponding to the mixer 223 of the 249 patent. Such averaging is a type of linear mixing that is equivalent to a summation.

4. [1c] transmitting the mixed communication stream to a user endpoint over a low bandwidth connection.

[13c] a processor operable to transmit the mixed communication stream to a user endpoint over a low bandwidth connection.

[25c] means for transmitting the mixed communication stream to a user endpoint over a low bandwidth connection.

154. The Mixed McDonald System includes these limitations. As discussed above for limitation [1b], [13b], [25b], the mixed audio stream generated

by the mixer in the core router is transmitted from the core router to a console via a link. As discussed in McDonald at ¶[0004], these links to the consoles in the Mixed McDonald system are T1 links in some embodiments, which are low bandwidth connections as that term is used in the 249 patent. As discussed above in Section IV.B and IV.C, the 249 patent refers to DSL and WAN as low bandwidth connections. A T1 rate is roughly equivalent to T1 bandwidth, although DSL bandwidth does vary depending on distance of the endpoint to the local telco facility. See, e.g., EX1013, 7:2-14 (discussing bandwidths of 1.544 Mbps, symmetric DSL bandwidths of 1.1 Mbps, asymmetric DSL bandwidths of 7.62 Mbps and high-bit-rate DSL bandwidths at the 1.544 T1 rate). In contrast, much higher data rates are available on other technologies, such as 44.7 Mbps for T3 and 155 Mbps on a fiber optic OC-3c line. EX1013, 2:19-27.

155. Regarding limitation [25c], the NIC discussed above for limitation [25a] would also perform the identical function recited in limitation [25c] for the “means for transmitting” and is at least equivalent structure to the interface 51 of the 249 patent.

C. Claims 7 and 19.

- 1. [7] The method of claim 1, wherein receiving a plurality of monitored push-to-talk communication streams comprises receiving eight monitored push-to-talk communication streams.**

[19] The system of claim 13, wherein an interface operable to receive a plurality of monitored push-to-talk communication streams comprises an interface operable to receive eight monitored push-to-talk communication streams.

156. The Mixed McDonald System includes the limitations of these claims. See claims 1 and 13 in Ground 2 above. McDonald discloses that a console can select up to 64 talkgroups for monitoring. EX1007, ¶[0004]. It would have been obvious to a POSITA to configure a console to select eight non-critical talkgroups and to configure the mixer to mix those eight non-critical talkgroups on a single channel when required due to limited bandwidth as taught by Radenkovic. Radenkovic gives an example of mixing six simultaneous streams with certain bandwidth and audio stream encoding parameters, and from this example a POSITA would have recognized and found obvious that mixing eight streams was also possible using different bandwidth and/or encoding parameters. EX1007, ¶¶[0069]-[0080].

D. Claims 8 and 20

1. [8pre] The method of claim 1, further comprising:

[20pre] The system of claim 13, further comprising:

157. To the extent the preambles are limiting, the Mixed McDonald System includes them. *See supra* §VII.B (Claim 1).

2. [8a] receiving from the user endpoint volume instructions associated with at least one of the push-to-talk communication streams; and

[20a] the interface is further operable to receive from the user endpoint volume instructions associated with at least one of the push-to-talk communication streams; and

158. The Mixed McDonald System renders these limitations obvious. Radenkovic discloses that a mix of audio streams can be tailored to a user's taste, including "allowing the volume of particular speakers to be raised or lowered according to their relative importance, for example." EX1005, ¶[0007]. It would have been obvious to provide console operators with this same capability in the Mixed McDonald System by configuring the consoles in that system with a user-operable volume control for each selected talkgroup audio stream selected by the operator at that console, and to transmit the operator's volume setting for each stream to the core router, and to configure the mixer in the core router to perform the mixing in accordance with those volume control settings. A POSITA would have been motivated to do so in view of the teaching in Radenkovic at ¶[0007] of giving users the ability to control particular speaker volume in a mixed stream. A

POSITA would have had a reasonable expectation of success because adjusting volumes when mixing audio streams was well-known in the art and involved only routine skill.

3. **[8b] adjusting the volume of the at least one of the push-to-talk communication streams according to the instructions when mixing the plurality of monitored push-to-talk communication streams into a mixed communication stream.**

[20b] the mixer is further operable to adjust the volume of the at least one of the push-to-talk communication streams according to the instructions when mixing the plurality of monitored push-to-talk communication streams into a mixed communication stream.

159. The Mixed McDonald System renders these limitations obvious. *See* limitations [8a] and [20a] above.

E. Claims 9 and 21

1. **[9pre] The method of claim 1:**

[20pre] The system of claim 13, wherein:

160. To the extent the preambles are limiting, the Mixed McDonald System includes them. *See supra* §VII.B (Claim 1).

2. **[9a] further comprising receiving from the user endpoint a selection of a group of the push-to-talk communication streams for mixing; and**

[21a] the interface is further operable to receive from the user endpoint a selection of a group of the push-to-talk communication streams for mixing; and

161. The Mixed McDonald System includes or renders obvious these limitations. As discussed in the Introduction, McDonald discloses that the console (the claimed user endpoint of claims 1 and 13) transmits its selection of talkgroups and their priorities as either critical or non-critical to the zone controller, and a POSITA would have found it obvious to configure the zone controller to pass the selections and priorities to the core router, or to configure the console to transmit the selections and priorities to the core router. EX1007, ¶[0021].

3. **[9b] wherein mixing the plurality of monitored push-to-talk communication streams into a mixed communication stream comprises mixing the selected group of the push-to-talk communication streams into a mixed communication stream.**

[21b] a processor operable to mix the plurality of monitored push-to-talk communication streams into a mixed communication stream comprises a processor operable to mix the selected group of the push-to-talk communication streams into a mixed communication stream.

162. The Mixed McDonald System includes or renders obvious these limitations. As discussed in the Introduction, it would have been obvious to a POSITA to configure the core router in the Mixed McDonald system to mix audio

streams of selected non-critical talkgroups into a single stream for transmission to the console that selected them when available bandwidth does not permit all of the selected talkgroup streams to be transmitted to the console individually.

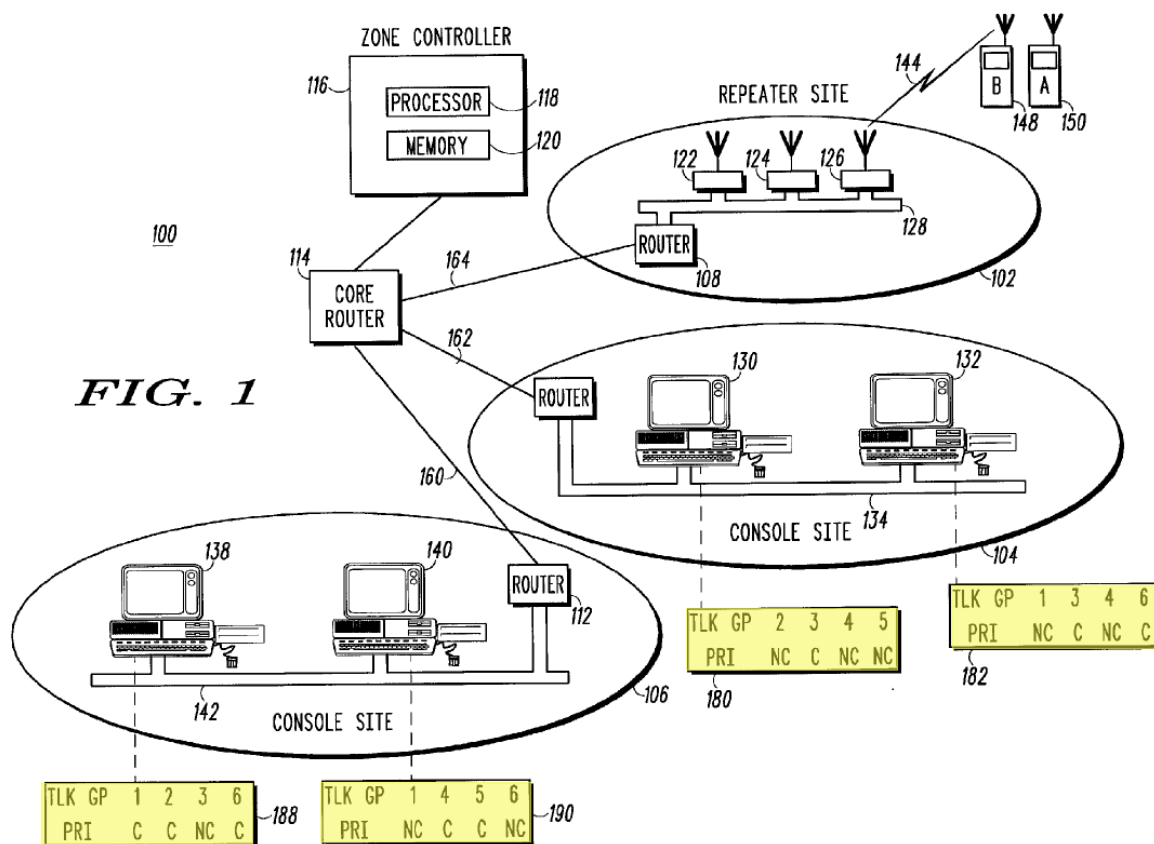
F. Claims 12 and 24.

- 1. Claim 12. The method of claim 1, further comprising presenting functionality indicators for a user at the user endpoint in the same manner as if the plurality of monitored push-to-talk communication streams had been individually transmitted over a high bandwidth connection to the user endpoint and mixed at the user endpoint for the user.**

Claim 24. The system of claim 13, wherein the processor is further operable to present functionality indicators for a user at the user endpoint in the same manner as if the plurality of monitored push-to-talk communication streams had been individually transmitted over a high bandwidth connection to the user endpoint and mixed at the user endpoint for the user.

163. The Mixed McDonald System includes or renders obvious these claims. See claims 1 and 13 above. McDonald discloses consoles 130-140 with indicators for, e.g., selected talkgroups and priorities. EX1007, ¶[0021] and Fig. 1, reference numerals 180-190 (annotations added). McDonald further discloses that these consoles are connected to the core router via low bandwidth T1 connections in some embodiments. EX1007, ¶[0004]; *see also* Ground 2 Introduction. A POSITA would have found it obvious to configure the Mixed McDonald System to provide the same functionality indicators at the consoles 130-140. A POSITA

would have been motivated to provide these functionality indicators and others at the console by the disclosure in McDonald discussed above and by the disclosure of providing controls at an endpoint for assigning priorities and volumes in D'Avello (EX1011, ¶¶[0048], [0055], and Figs. 5 and 8). Providing this functionality would provide the console with an ability similar to the Slaninka consoles that allow a user to control the volumes of the locally mixed talkgroups output to a speaker console for, e.g., non-priority talkgroups. EX1010, 2:42-66.



VIII. GROUND 3: CLAIMS 2-6, 10-11, 14-18 AND 22-23 ARE OBVIOUS OVER RADENKOVIC, MCDONALD AND KOREN

A. Introduction

164. Independent claims 1 and 13 are obvious over the combination of Radenkovic and McDonald and the Mixed McDonald System made obvious thereby for the reasons discussed in Ground 2. Claims 2 and 14, which depend from claims 1 and 13, and the other claims of Ground 3 that depend therefrom, are obvious over Radenkovic and McDonald and the Mixed McDonald System made obvious thereby, in view of Koren for the reasons explained below.

165. In the Mixed McDonald System, there are multiple radio sites, each generating at one communication stream corresponding to a talk group in which a plurality of mobile radio endpoints 148-156 participate. The mobile radios in these talk groups are all part of the same communication network. Claims 2 and 14 require that each of the communication streams for a virtual talk group include a plurality of endpoints from different communications networks. Koren discloses an interoperability server that allows the formation of virtual talk groups between different communications systems. EX1006, 3:26-51. An example is shown in such as between a conventional two-way radio system 30/220 and a trunked radio system 20/230 as shown in Figs. 1 and 2 of Koren reproduced below (annotations added). EX1006, 3:52-4:7, 5:41-6:30.

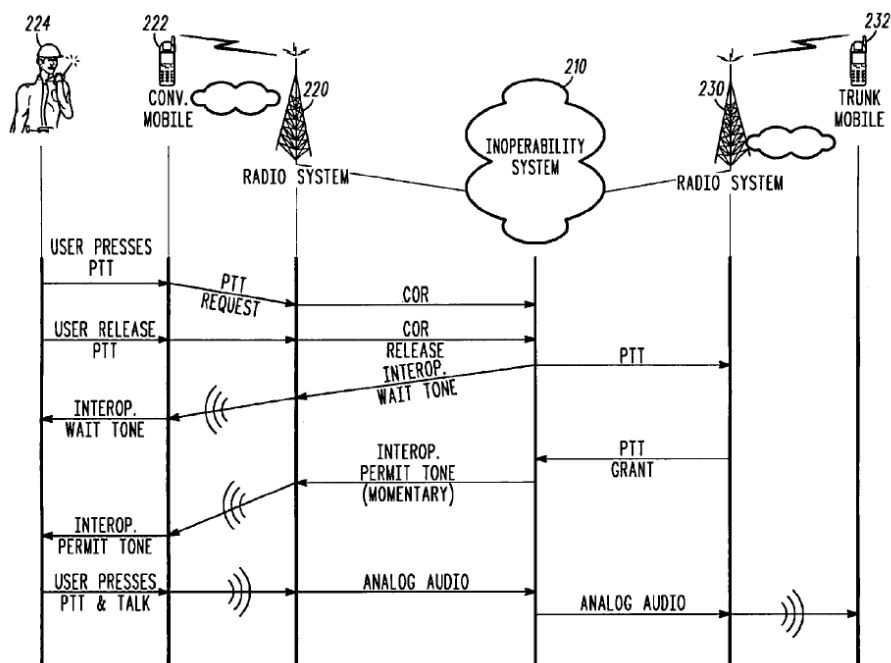
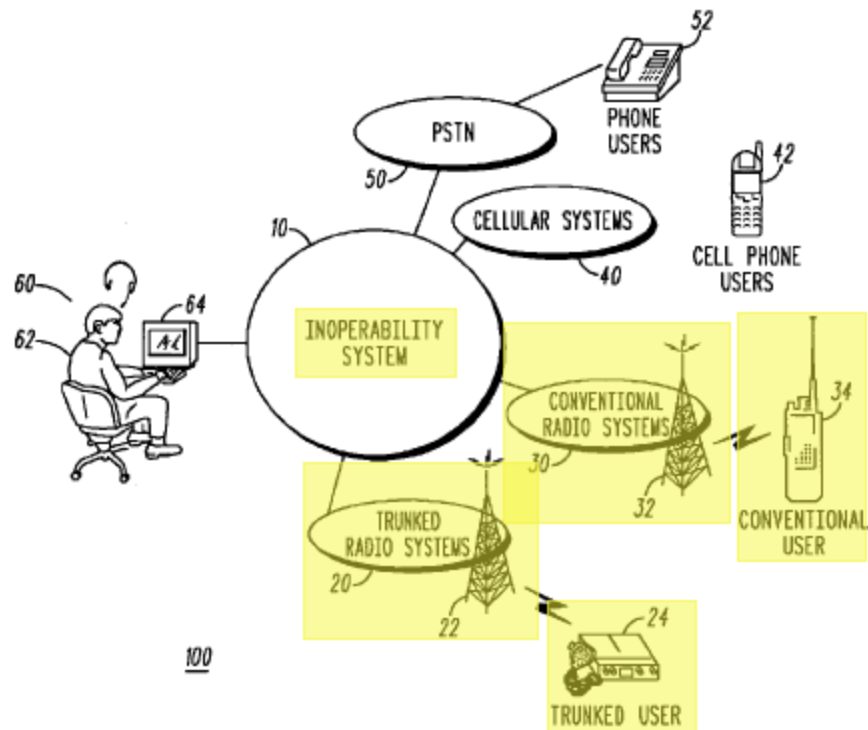


FIG. 2

166. A POSITA would have found it obvious to configure the operability system 10/110 to output an aggregated or mixed audio stream with the audio from

both radio system to the core router of the Mixed McDonald System for, e.g., transmission to monitoring consoles (e.g., multiple monitoring consoles as disclosed in the Mixed McDonald System, where multiple consoles are shown monitoring streams such as stream 4). A POSITA would have been motivated to do so because a POSITA would have understood that one of the disparate radio systems in the virtual talk group described above may not have any other connection to console in the Mixed McDonald system. Such an aggregated audio stream from the virtual talkgroup formed by the operability system 10/110 in the figures above constitutes “communications from a respective talk group comprising a plurality of endpoints of different communications networks” as recited in claims 2 and 14.

167. To the extent an interoperability dispatcher at console 64 of Fig. 1 in Koren is necessary for operation of the talkgroup in Fig. 2, a POSITA would have understood that such an operator console would be in addition to an operator console that selects, e.g., for passive monitoring, the mixed/aggregated audio stream output by the interoperability system 10. This is because, for example, Koren teaches that the operator at console 64 of Koren’s Fig. 1 above requires special training as an interoperability dispatcher. EX1006, 4:22-24.

B. Claims 2 and 14.

1. **Claim 2. The method of claim 1, wherein each of the push-to-talk communication streams comprises communications from a respective virtual talk group comprising a plurality of endpoints of different communication networks.**

Claim 14. The system of claim 13, wherein each of the push-to-talk communication streams comprises communications from a respective virtual talk group comprising a plurality of endpoints of different communication networks.

168. The Mixed McDonald System as modified to include virtual talkgroups between disparate radio systems as taught by Koren includes the limitations of these claims. As discussed above, a mixed/aggregated audio stream for the virtual talkgroup as illustrated in Fig. 2 of Koren input to the core router of the Mixed McDonald System constitutes “communications from a respective talk group comprising a plurality of endpoints of different communications networks” as recited in claims 2 and 14. A POSITA would have found it obvious to allow for a plurality of such streams in the Mixed McDonald System to allow a console therein to monitor the plurality of such talkgroup streams.

C. Claims 3 and 15

1. **[3pre] The method of claim 2:**

[15pre] The system of claim 14:

169. *See* Claims 2 and 14 above.

2. **[3a] wherein the mixed communication stream comprises a first communication of a first virtual talk group; and**

[15a] wherein the mixed communication stream comprises a first communication of a first virtual talk group; and

170. The Mixed McDonald System as modified to include virtual talkgroups between disparate radio systems as taught by Koren includes these limitations. As discussed in the Ground 3 Introduction, the communication session between a conventional two-way radio system 30/220 and a trunked radio system 20/230 as shown in Figs. 1 and 2 of Koren is a virtual talkgroup, and the mixed/aggregated communication stream including communications from two such virtual talkgroups sent from the core router to a monitoring console as discussed in connection with Claims 2 and 14 includes a communication from a first virtual talk group.

3. **[3b] further comprising transmitting an identification of the first virtual talk group when transmitting the mixed communication stream comprising the first communication.**

[15b] wherein the processor is further operable to transmit an identification of the first virtual talk group when transmitting the mixed communication stream comprising the first communication.

171. The Mixed McDonald System as modified to include virtual talkgroups between disparate radio systems as taught by Koren renders obvious these limitations. As discussed in McDonald, each talkgroup includes a talkgroup ID. EX1007, ¶[0023]. It would have been obvious to a POSITA to include a

talkgroup IDs for each talkgroup corresponding to the mixed/aggregated stream sent by the core router in order to allow that information to be displayed at the operator console. Doing so would allow an operator who is passively monitoring such streams to designate one of them as a critical stream for active monitoring as discussed in McDonald at ¶[0032].

D. Claims 4 and 16.

1. **Claim 4. The method of claim 2, wherein the plurality of monitored push-to-talk communication streams are received over the high bandwidth connection from an interoperability system operable to configure each virtual talk group to facilitate communications among its member endpoints.**

Claim 16. The system of claim 14, wherein the plurality of monitored push-to-talk communication streams are received over the high bandwidth connection from an interoperability system operable to configure each virtual talk group to facilitate communications among its member endpoints.

172. The Mixed McDonald System as modified to include virtual talkgroups between disparate radio systems as taught by Koren renders obvious the limitations of these claims. See claims 2 and 14 above. As discussed in the Ground 3 Introduction, it would have been obvious to a POSITA to configure Koren's interoperability system 10 to transmit a mixed/aggregated audio stream including audio from both endpoints of both radio systems 30/220 and 20/230a of that virtual talkgroup to the core router in the Mixed McDonald System. A

POSITA would further have found it obvious to configure the same interoperability system 10 to support a second virtual talkgroup, including audio communications from different channels of the same two radio systems or two different radio systems, and to transmit a second mixed/aggregated audio stream for the second virtual talkgroup, to the core router as discussed above for claims 2 and 14. A POSITA would further have found it obvious to transmit both mixed/aggregated audio streams from the interoperability system to the core router over the high bandwidth connection between the interoperability system and core router.

E. Claims 5 and 17.

- 1. Claim 5. The method of claim 2, wherein at least one of the virtual talk groups comprises a plurality of endpoints of different communication networks whose communications are mapped to a multicast IP address or SIP dialed nailed connection.**

Claim 17. The system of claim 14, wherein at least one of the virtual talk groups comprises a plurality of endpoints of different communication networks whose communications are mapped to a multicast IP address or SIP dialed nailed connection.

173. The Mixed McDonald System as modified to include virtual talkgroups between disparate radio systems as taught by Koren includes or renders obvious these limitations. See claims 2 and 14 above. The endpoints of virtual talkgroups formed by the interoperability server as taught by Koren are in different

communications networks as discussed in the Ground 3 Introduction. McDonald discloses the use of multicast addressing on streams sent to console sites. EX1007, ¶¶[0019], [0031]. To the extent not explicitly disclosed in McDonald, a POSITA would have found it obvious to use multicast addresses for audio streams sent from the core router to the consoles because those streams are sent to multiple consoles at multiple console sites 104, 106, and using multicast addressing conserves bandwidth because it avoids the need of sending multiple unicast streams to those multiple consoles. As a result of the use of multicast addressing on streams from the core router to the consoles, the communications from the endpoints of the virtual talkgroups are mapped to the multicast addresses used by the core router as required by these claims.

F. Claims 6 and 18.

1. **Claim 6. The method of claim 2, wherein at least one of the virtual talk groups comprises a plurality of endpoints of different communication networks whose communications are bridged.**

Claim 18. The system of claim 14, wherein at least one of the virtual talk groups comprises a plurality of endpoints of different communication networks whose communications are bridged.

174. The Mixed McDonald System as modified to include virtual talkgroups between disparate radio systems as taught by Koren includes or renders obvious these limitations. See Introduction to Ground 3 and claims 2 and 14

above. Koren's interoperability system 10/110 bridges communications between the endpoints 34/222 and 24/232 of the different radio systems 22/230 and 32/220.

G. Claims 10 and 22

1. **[10pre] The method of claim 2, further comprising receiving from the user over the low bandwidth connection:**

[22pre] The system of claim 14, wherein:

[22a] the interface is operable to receive from the user over the low bandwidth connection:

175. See above §VIII.B (Claim 2); see also §VII.B.4 (limitations [1c] and [13c]).

2. **[10a] a user communication; and**

[22b] a user communication; and

176. The Mixed McDonald System as modified to include virtual talkgroups between disparate radio systems as taught by Koren includes or renders obvious these limitations. McDonald discloses that the consoles 130-140 can source payload (i.e., speak) on a call. EX1007, ¶¶[0004], [0013]. In the Mixed McDonald System, this speech communication from the operator would be transmitted to and received at the core router via the low bandwidth PSTN connection.

3. **[10b] a selection of a plurality of virtual talk groups of the respective virtual talk groups; and**

[22c] a selection of a plurality of virtual talk groups of the respective virtual talk groups; and

177. The Mixed McDonald System as modified to include virtual talkgroups between disparate radio systems as taught by Koren includes or renders obvious these limitations. *See above* §VII.E.2 (limitations [9a], [21a]) (discussing transmitting selections of talkgroups to the core router). Alternatively, the console may be configured to allow the console operator to select one or multiple talkgroups to which the communication is intended and to transmit those selections to the core router.

4. **[10c] transmitting the received user communication to the selected plurality of virtual talk groups over the high bandwidth connection.**

[22d] the processor is operable to transmit the received user communication to the selected plurality of virtual talk groups over the high bandwidth connection.

178. The Mixed McDonald System as modified to include virtual talkgroups between disparate radio systems as taught by Koren renders obvious these limitations. It would have been obvious to a POSITA to configure the core router to transmit an audio stream received from a console to talkgroups corresponding to the talkgroups selected by the console for monitoring. Alternatively, if the console were configured to transmit a selection of one or more

talkgroups for which a communication from the console operator is intended, it would have been obvious to a POSITA to configure the core router to transmit that communication to the selected talkgroups. One reason that this broadcast of the console operator's communication to the multiple talkgroups would be done is to allow a console operator to inform those multiple talkgroups of an event of common interest, such as a general emergency, or that the console operator is going off duty and will no longer be monitoring those talkgroups.

H. Claims 11 and 23.

1. **Claim 11. The method of claim 10, further comprising transmitting to the user endpoint an identification of the selected plurality of virtual talk groups when transmitting the received user communication to the selected plurality of virtual talk groups.**

Claim 23. The system of claim 22, wherein the processor is further operable to transmit to the user endpoint an identification of the selected plurality of virtual talk groups when transmitting the received user communication to the selected plurality of virtual talk groups.

179. *See above §VIII.G (Claims 10 and 22).* The Mixed McDonald System as modified to include virtual talkgroups between disparate radio systems as taught by Koren renders obvious these limitations. It would have been obvious to a POSITA to configure the core router to transmit an acknowledgement message including the identifications of the selected channels back to the console in response to receipt of the selection of the plurality of talkgroups from the console

so that operator can confirm that the mixer has received the instructions. Such acknowledgement messages are well-known in the art. *See, e.g.*, EX1012 (Alterman), 4:10-29.

IX. AVAILABILITY FOR CROSS-EXAMINATION

180. In signing this declaration, I recognize that the declaration will be filed as evidence in a contested case before the Patent Trial and Appeal Board of the United States Patent and Trademark Office. I also recognize that I may be subject to cross-examination in the case and that cross-examination will take place within the United States. If cross-examination is required of me, I will appear for cross-examination within the United States during a time as mutually agreed between the parties.

X. RIGHT TO SUPPLEMENT

181. I reserve the right to supplement my opinions in the future to respond to any arguments that the Patent Owner raises. This declaration represents only those opinions that I have formed to date. I reserve the right to revise, supplement, and/or amend my opinions stated herein based on new information that becomes available to me and on my continuing analysis of the materials already provided.

XI. CONCLUSION

182. I may utilize the documents cited and/or listed herein, or portions of those documents, as exhibits at any hearing or trial in this proceeding. I may further prepare and use exhibits that summarize portions of my testimony or key

terms or concepts presented therein, or other demonstrative exhibits, at any hearing or trial in this proceeding.

183. I reserve the right to supplement my testimony and this declaration in response to any judicial determinations, in response to the arguments expressed by the Patent Owner or the opinions of the Patent Owner's experts in this proceeding, and/or in light of additional evidence or testimony brought forth at trial or otherwise brought to my attention after the date of my signature below.

I hereby declare under penalty of perjury under the laws of the United States of America that the foregoing is true and correct, and that all statements made of my own knowledge are true and that all statements made on information and belief are believed to be true. I understand that willful false statements are punishable by fine or imprisonment or both. *See* 18 U.S.C. § 1004.



Dated: Jan 23-2024

Dr. Sayfe Kiaei

EXHIBIT A

Dr. Sayfe Kiaei
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Arizona State University, Tempe, AZ 85287
Sayfe@asu.edu

Sayfe Kiaei

Professor, Motorola Endowed Chair Professor

School of Electrical, Computer and Energy Engineering, Arizona State University, Tempe, AZ

FIELDS OF SPECIALIZATION

- **Integrated Circuits (IC):** Analog & Digital IC, Mixed-Signal IC, VLSI, Processor, ASIC, RFIC
- **Radio Frequency:** RF, Receiver, Transmitter, Synthesizer, Antenna, MIMO, RF system
- **Power Management:** Power Management IC, Battery Management, Energy System, Energy Management
- **Sensors:** RFID, ZIGBEE, BT, Custom Sensors, MICS, IOT, Bioelectronics, Bio-sensors, Hearing Aid sensors, Implanted devices electronics
- **Bio-Electronics:** Bio-Sensors, Hearing Aid, Implanted Bio-Electronics, Medical Implanted Communication System (MICS)
- **Signal Processing:** Digital Signal Processing, Adaptive Signal Processing, Video & Audio Signal Processing, Adaptive Audio Array processing, Audio and Acoustic & Speech processing
- **Wireless Communication Systems:** 1G-5G, 2-way radio, BT, WIFI, Sensors, ZIGBEE, wireless sensors
- **Wireline Communication System:** CABLE, DSL, Optical
- **Digital System:** VLSI, Processor, DSP processor

DEGREES

- **Ph.D.,** Electrical and Computer Engineering, Washington State University, 1987
- **M.S.,** Electrical and Computer Engineering, Washington State University, 1984
- **B.S.E.E.,** Electrical Engineering, Northeastern University, Washington State University, 1982

ACADEMIC POSITIONS

Fall 2001-Present: Professor, Motorola Endowed Chair Professor in Analog and RFIC School of Electrical, Computer and Energy Engineering, Arizona State University, Tempe, AZ

- **Professor:** Research and teaching in integrated circuits, RF circuits and systems, Communications, Wireless and Wireline transceiver, mixed-signal and Analog IC, Sensors, Power management IC, Signal processing, Bio-electronics, Signal Processing, Audio processing, GPS, wireless system
- **Research Projects:**
 - Analog and digital IC, Radio Frequency IC, RF transceiver
 - VLSI, Processor System Architecture, ASIC
 - Power Management IC, Battery Management & Sensing, Integrated Power Electronics
 - Digital Signal Processing, Audio processing, adaptive signal processing, Array processing, AI

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- Wireless communication system, wireless modems, 1G, 2G GSM, 3G CDMA, 4G LTE, 5G wireless mobile system, LTE, WiFi, Bluetooth, Wireless system standards
- Wireline Communication system and transceivers, MODEM standards, CABLE MODEM DOCIS, DSL
- Signal Processing, Digital Signal Processing, Adaptive Signal Processing
- Adaptive Audio Array processing, Audio and Acoustic & Speech processing,
- Sensors, Bio-electronics, Bio-sensors, Hearing Aid Electronics, Implanted devices electronics
- Research Funded by NSF, USAID, DARPA, JPL, NASA, Motorola Inc., Intel Inc., Broadcom, Qualcomm, Raytheon, General Dynamics, Texas Instruments, and over 10 other industries. List of Current significant research awards:
 - Center of Excellence for Energy (COE) in Egypt , Funding \$22.5M
 - Partnership Center for Energy systems, USAID, 2015-2020, \$18M. Principle Investigator
 - Solar Energy Development in ME, Private funds and World Bank, \$2M
 - Connection One NSF Center, Director, 2004-Present, Total funding \$5M, average annual funding over \$750K.

2021-Present, Director and PI, USAID, Center of Excellence for Energy (COE) in Egypt , Funding \$22.5M

- Director and PI: COE - Energy Center funded by the USAID.
 - USIAD Centers of Excellence for Energy (COE) - established the Center of Excellence for Energy (COE/E) in Egypt with funding and support from the United States Agency for International Development (USAID/Egypt) in November 2021. COE/E is a partnership between ASU-US and three Egyptian partner universities (EPUs): Ain Shams University (ASU-EG), Aswan University (AU), and Mansoura University (MU).

2004-2020, Director and founder of NSF IUCRC Center Connection One, School of Electrical, Computer, and Energy Engineering, Arizona State University, Tempe, AZ; <https://connectionone.org>

- The NSF Connection One Industry/University Cooperative Research Center was established the center in 2002 with focus on communication system, integrated Circuits and Systems, wireless system, RF, sensors, and related areas. The center has five university member with over 30 industrial members. Total funding over \$10M.

2014-2020, Director, USAID, US-PCASE: Center for Advance Studies in Energy, Funding \$18M. <https://uspcase.asu.edu/>

- **Director and PI:** PCASE - Partnership Center for Energy systems, Energy Center funded by the USAID.
- USIAD Centers for Advanced Studies in Energy program (USPCAS-E) is a partnership between Arizona State University and two leading Pakistani universities: the National University of Science and Technology (NUST) Islamabad and the University of Engineering and Technology in

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Peshawar (UET).

- PCASE has developed two new Graduate schools of Energy. Within 5 years, the center has over 1000 MS and PHD Students, with 14 new energy degrees in MS and PhD, two new building with 20+ energy labs in the power system, grid, power electronics, renewable energy, PV, Wind, Hydro, bio-fuel, fuel cell, batteries and storage, and thermal areas.

2008-2012: Associate Dean of Research, Ira A. Fulton Schools of Engineering, Arizona State University

Responsible for leading the research infrastructure, promoting and developing research programs with industry and federal agencies, leading large multi-university proposals, investing and providing seed funding to foster new research areas, and promoting graduate program in the college of engineering. Research Enterprise support included:

- Increase College of Engineering research funding from \$50M to over \$80M.
- Working with Vice President for Research, Dean's, and directors on University-wide research initiatives.
- Established the first NSF Engineering Research Center (ERC) at the ASU on Solar Energy QESST. Managed, organized and planned the ERC proposal process. ASU is the lead school partnering with MIT, Georgia Tech, U of Delaware, Cal-Tech, U of New Mexico, and UA.
- Lead several trans-disciplinary 4M research projects (4M: multi-million, multi-investigator, multi-disciplinary, multi-university grants) in energy, security, and related initiatives.
- Oversight of over 20 existing research centers in the college of Engineering.
- Engage with industry and federal government to establish new research collaborations.
- Organized workshops and supported proposals for NSF, NIH, DOE, DOD, DARPA, etc.
- Organized workshops for new assistant professors to apply for NSF CAREER Awards. ASU CAREER awards grew from 3 annual awards in 2008 to over 15 CAREER awards by 2012.
- Research Administration and pre-award proposal administration for the schools. Developed a decentralized research administration and advancement team for the Schools supporting 5 schools, 12 departments, over 220 engineering faculty, with funding over \$70M.
- Annual budget over \$7M for supporting research centers, seed funding for new center, cost sharing, proposal support, equipment and infrastructure support, graduate scholarships, and research administration.
- ADR Staffs included, Director of industrial and government liaison, Director of research administration, and 14 research advancement staff.
- Graduate Programs: Recruiting, Fellowships, marketing, outreach, coordination with departments

1997-2001, Adjunct Professor, Electrical and Computer Engineering Dept., The University of Texas, Austin, Texas, Taught graduate courses at UT Austin on Introduction to Telecommunication System and Digital Communications. Co-advised two Ph.D. program committees in IC design and Telecomm (while at Motorola)

1987-1993, NSF Center For Digital / Analog IC (CDADIC) Co-Director, NSF IUCRC Center director at Oregon State University. The CDADIC was established the center in 1987 with focus on integrated circuits at WSU, UW, and OSU with over 20 industrial members - <https://cdadic.oregonstate.edu/>

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1987-1993, Assistant / Associate Professor (Tenured) Electrical and Computer Engineering Department, Oregon State University, Corvallis, OR

- Research and classes in Electronics, DSP, Communication system and networks, Wireless systems, MODEMS. Graduated 30 MS and Ph.D. students.
- Faculty Chair, Computer Engineering Program, Developed a new Computer Engineering Program at OSU in 1987

INDUSTRIAL POSITIONS

1993-2001: Motorola Inc., Senior Member of Technical Staff, Personal Communication Sector, Austin, Texas - Worked projects related to wireless communications, two way radios, wireless networks, ADSL and MODEM RF, and related areas.

- **Motorola Cellular Division, Wireless Technology Center (WITC), 1997-2002.** Responsible for development of integrated circuits and systems for wireless handset. Lead number of projects including cellular (2G, 3G, 4G), wireless connectivity (Bluetooth and WIFI transceiver), GPS and location Receiver, wireless networks, 2-way radios and related areas. Worked on the development of various subcomponents including system design, link budget, RF front-end, RF receiver, RF transmitter, digital audio processing, audio processing, DSP, frequency synthesizer, ADC, DAC, filtering, analog front-end, power management, battery management, and baseband processor, baseband circuits and systems.
- **Motorola Semi-conductor products sector (SPS), Broadband Products Operations, 1995-1997,** Worked on the development of XDSL (ADSL, VDSL, G.lite), MODEM, and Optical broadband communication systems including OFDM, modulation, synchronization, equalization and the development of a single chip ADSL transceiver (*CopperGold[™]*). The transceiver contained Analog Front End (A/D, D/A, Hybrid), custom DSP, baseband processor, DMT, modulation/demodulation, FFT, IFFT, echo canceler, time domain equalizer, front-end constellation mapping, Trellis code modulation, Viterbi decoder), audio processing, DSP, signal processing, and an on-chip DSP core.
- **Land Mobile Products Sector LMPS 1993-1995,** Responsible for Wireless digital two-way radios, developed RFIC, RF receiver, RF transmitter, digital audio processing, audio custom IC, DSP, frequency synthesizer, ADC, DAC, hot spot wireless network, next generation of digital two-way radios, "*Talk about Radios*", Japanese cellular systems (PHS).
- **Standards,** Represented Motorola in various standards including 2G-4G, GPS, Bluetooth working group, WiFi, 802.11, and DSL standards including T1E1, International Telecommunication Unit (ITU), T1E1, ETSI, 3GPPP, Universal ADSL Working Group (UAWG), Bluetooth working group, G.Lite working group, etc.
- **University relations,** Responsible for the development of collaborative research programs with several universities. Responsible for funding research in the areas of Wireless Transceiver IC Design, RF, and mixed-signal and baseband system architecture.

1985-87: Member of Research Staff, Boeing Co., Bellevue, Wa, Flight Systems Research and Technology Center, summer. Design Engineer, Hardware and CAD tool development for system control.

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AWARDS

- IEEE Fellow 2004-Present
- IEEE Fellows CAS Committee Chair, 2009-2012
- Global Standards Award, For contributions in the International Telecommunication Unit (ITU) for Asymmetric Digital Subscriber Line (ADSL) G.Lite Standards. Motorola Inc., 1999.
- 10X Cycle Reduction Award, for development of new IC design process from DSP algorithm to IC layout, Motorola Inc., 1995.
- IEEE Darlington best paper Award, IEEE Circuits and Systems Society Best Paper Award, 1995. For “Characterization and Comparison of CMOS FSCL Circuits with Conventional CMOS for mixed-signal ICs,” Published at: *IEEE Trans. on Circuits and Systems II*, Sept. 93.
- Carter Best Teaching Award, College of Engineering Best Teacher Award, Oregon State University, 1992. For “*outstanding and inspirational teaching in the College of Engineering*”. Award is selected by the confidential vote of all of the undergraduate students in the College of Engineering among over 125 professors in the College.
- Industrial University Fellowship (IUF) Award, *National Science Foundation*, 1993.
- Research Initiation Award, *National Science Foundation*, 1990-93.
- Outstanding Graduate Student Scholarship, *Azur-Data Inc.* WSU, 1984

RESEARCH PROJECTS

Partial list of Research Awards (1987-Present):

- **2021-2026 – U.S. Agency for International Development (USAID)**
 - COE – Center of Excellence for Energy, PI and Director, \$22.5M.
- **2020-2022 - The National Science Foundation (NSF)**
 - SII Planning: Center for Next Generation Wireless Spectrum Sharing, PI, \$300K.
- **2002-2020 – The National Science Foundation (NSF) - Connection One**
 - Industry/University Cooperative Research Center (IUCRC), NSF contribution \$1.5M.
 - Annual Industry Contribution: Total over \$7M.
- **2015-2016 – The National Science Foundation (NSF)**
 - Integration of Smart Utility Grids with Dynamic Optical Communication Networks for Intelligent Distribution of Power Workload and Data in Disaster, \$200K
- **2015-2020 – U.S. Agency for International Development (USAID)**
 - PCASE – Center for Energy systems, PI and Director, \$18M.
- **2013-2014 NASA**
 - Arizona Space Grant Consortium, NASA: Goddard Space Flight Center, RADHARD

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electronics, \$200K

- **2012-2015 – Solar Energy, Private Donor**
 - Solar Energy Development on international projects, \$2M
- **2011-2014 – Semi-Conductor Research Corporation**
 - Self-Characterization for Calibration and Process Feedback of MEMS Devices, , \$300K
- **2011-2013 - The National Science Foundation (NSF)**
 - Microwave & RF Bio-Sensors for Vital Signs Monitoring Device Design, \$250K
- **2010-2011 – The National Science Foundation**
 - Adaptive Compensation of Analog circuits imperfections using DSP methods, \$150K,
- **2010-2011 – The National Science Foundation**
 - Autonomous Self-Healing Sensor Network Radio and Mixed-Signal Readout System Design National Science Foundation (NSF), \$300K
- **2010-2020 – The National Science Foundation (NSF), \$45M (**
 - QESST NSF ERC Center on Solar Energy, Co-PI as the Associate Dean of Research, Testbed Director
- **2010-2015 - The National Science Foundation (NSF)**
 - Research Experience for Undergraduate Students, total \$400K
- **2008-2013 - The Science Foundation of Arizona (SFAZ)**
 - PEPER- Photovoltaic Environmental Performance and Reliability for the Arizona-Wide Electric Grid, \$1.2M.
- **2008-2009 - The National Science Foundation (NSF)**
 - Micropower MICS Band RF Transceiver Design (C1/TI Enhancement Project), \$200K
- **2007-2011 – The National Science Foundation (NSF)**
 - Micro-Power Multi-Phase on-chip MEMS Hearing Aid, 2007-2011, \$500K.
- **2007-2009 - The National Science Foundation (NSF)**
 - High Efficiency Power Delivery and Front-End Module Design for Implantable Bio-Sensors \$480K
- **2005-2009 - The National Science Foundation (NSF)**
 - Cognitive MIMO Communications for Dynamic-Spectrum Wireless Networks \$150K
- **2005-2009 - The National Science Foundation (NSF)**
 - Autonomous Self-Healing Sensor Network Radio, , \$250K
- **2005-2008 BAE Systems**
 - Integrated on-chip Time Measurement Circuits LiDAR; \$650K
- **2005-2008 - Freescale Semiconductor**
 - PWM, Battery & Power management, \$150K

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- **2005-2006 - DOD: Defense Advanced Research Projects Agency (DARPA)**
 - Radhard by Design - MRC/DARPA, Total funding \$1.5M
- **2005-2010 - State of Arizona**
 - WINTECH- Wireless Integrated Nano Technology Center Support, 450K annually, total \$2.5M
- **2004-2005 – NASA**
 - Integration of Ultra-Low power RF CMOS, \$127K
- **2004-2008 – Deference Advance Research Project Agency (DARPA)**
 - Implanted Neural-Enabled Prostheses bio-sensor with Sensorimotor Integration, \$500K
- **2004-2008 – Deference Advance Research Project Agency (DARPA)**
 - Nano-Mechanical RF Band pass resonator for 2GHZ RF Applications, with JPL, \$2.2 M,
- **2003-2005 - DOD-ARMY-ARL: Army Research Office (ARO)**
 - Implanted Neuro-sensor, \$175K
- **2002-2005 - Intel Corporation**
 - Design of Multi-Standard RF Front-End Circuits for Cellular and WiFi, \$300K
- **2002 – SRC**
 - LOW POWER ULTRA - WIDE BAND GEOLACTION SYSTEMS, \$65K.
- **2001-2003 - SRC (Semi-conductors research Corp)**
 - Ultra-Wideband Transceivers for cellular and WiFi 802.11, \$225K
- **1987-1993 - The National Science Foundation**
 - Center for the Design of Analog/Digital IC's (CDADIC) 1987-1995, At Oregon State, \$1.5M
- **1992-1994 – Motorola LMPS**
 - Low Power IF processing for Direct Digital Transceivers, \$100K,
- **1993 - Hewlett-Packard**
 - Hewlett-Packard Faculty Chair position in Mixed-Signal IC, HP, \$500K
- **1992-1993 - The National Science Foundation**
 - National Science Foundation, Motorola Inc. Faculty Industry Fellowship, \$250K,
- **1992-1993 - The National Science Foundation**
 - National Science Foundation, Research Initiation Award (RIA) (same as current CAREER Award), Synthesis and Automatic Derivation of Multi-Rate VLSI Arrays for DSP Algorithms, \$320K.
- **1988-1992 – Center for the Design of Analog/Digital IC's (CDADIC)**
 - CDADIC, various projects on Low-Noise Source Coupled Logic (SCL), Mixed-Mode IC's, CDACIC \$350K.

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- **1988- Tektronix Inc.**
 - Decimation Filters for A/D Noise Enhancements, Tektronix, Inc., \$100K,
- **1987-1993 – DARPA, MOSIS, Tektronix, IT, Motorola**
 - Various grants for IC Fabrication (DARPA/MOSIS, VLSI)
 - Testing equipment (Tek, HP)
 - DSP system development (TI, Motorola)

PROFESSIONAL RECOGNITION

- IEEE Fellow, 2004-Present
- IEEE Fellow Committee Chair, CAS, 2008-2010
- IEEE Fellow Committee member, 2007-2010.
- IEEE Senior Member, 1993-Present, IEEE Member 1987-1992.
- IEEE Faculty Advisor, Oregon State University, 1987-1990
-
- **IEEE Editorials**
 - IEEE Microwave Magazine, Editor,
 - IEEE System Journal, Associate Editor, 2010-2011.
 - IEEE Transactions on VLSI, Associate Editor, Jan 2001-2008.
 - IEEE Communication Magazine, Editor, Feature Issues on “Circuits for Wireless and Wireline Communications,” April 1999.
 - IEEE Transactions on Microwave Theory and Techniques , editor, Special Issue on: "Radio Frequency IC Design,” Dec. 1998.
 - IEEE Transactions on Circuits and Systems-II, editor, Special Issue on: “Low-Power Wireless Communication Systems,” June 1997.
 - Associate Editor, IEEE Transactions on Circuits and Systems-II, 1993-1996.
 - *Editor and Reviewer for many IEEE journals and conferences*
 - *Founding member of IEEE RF Integrated Circuits Symposium*
 - *Associate Editor, IEEE Communications, Tutorial & Surveys Magazine, 2006-2009.*
-
- **Conference Organizations**
 - RFIC Executive Committee members, 2000-2017
 - RFIC Steering Committee Member, RFIC symposium, 1996-2017.
 - RFIC Founding member, 1995-96.
 - Technical Program Chair, IEEE International Sym. on Circuits and Systems, Phoenix, AZ, 2002.
 - ISSCC Admin Council, Conferences Committee 2000-2005.

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- General Chair, Radio Frequency IC (RFIC) Symposium, Seattle, WA, 2002.
- Technical Program Chair, RFIC Symposium, Phoenix, AZ, 2001.
- Finance Chair, RFIC symposium, Boston, MA, 2000.
- Publicity Chair, RFIC symposium, Los Angeles, CA, 1999.
- Transactions Chair, RFIC symposium, Baltimore, MD, 1998.
- General Chair, Int. Sym. on Low-Power Electronics and Design (ISLPED), Monterey, CA, 97.
- Executive Committee Member, Int. Symp. On Low-Power Electronics and Design, 96-2000.
- Technical Program Committee Member of the following conferences:
 - International Conference on Circuits and Systems: 1996, 2000, 2001, 2004-2008
 - RFIC Symposium, 1996-2018
 - Application Specific Array Processing (ASAP): 2000-2002
 - Technical Program Chair, Int. Sym. on Low-Power Electronics and Design, Monterey, CA, 96.
 - Arizona Telecom Comm (ATIC)
 - GLS VLSI 1998, Lafayette, Louisiana, 1998
 - VLSI Design 98, Chennai, India, Jan. 1998.
 - ICECS, Lisbon, Portugal, 98.
 - Application Specific Array Processing, 1995-97, 2000
 - Vehicular Technology Conference, 1995-97.
 - Inter. Conf. on Intelligent Information Systems, D.C., 1994-95.
 - IEEE Pacific Rim Conference on Communications & Computers, Victoria, BC, Canada, 1991.

Invited talks, Panelist, Session Chairs, Workshop Speaker

- Conference chair, Technical Program committee chair and TPC member, tutorials, workshops, session chair, etc. in RFIC, ISSCC, ISCAS, VLSI, ICASSP, Low-Power Symposium, ICC, Application Specific IC's, IMS, MTT, etc.

CONSULTANT

- Intel Inc. Chandler, AZ, 2002-2006: Development of 3G-4G Wireless transceiver.
- Sony Inc., San Diego, CA and Tokyo, Japan, 2002-2004: Review and development of various telecom cellular system architecture including 3G system architecture, and GPS system.
- Motorola Inc. 2002-2005: Supporting development of BT, WiFi, E911, GPS integrated circuits and systems for the cellular and mobile handsets.
- Hewlett Packard, Corvallis, OR – 1990-1993: Various project on development of custom analog and digital IC's for printer and inkjet system. Some of this work was under consultation, and some under various research grants with Oregon State University.
- Tektronix Inc, Beaverton, OR - 1988-1990: Design and Implementation of Data acquisition system for Spectrum analyzer, development of custom DSP algorithm for the Tektronix

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spectrum analyzer including system architecture, simulation, analysis, and design of oversampled data acquisition system.

- Boeing Commercial Aircraft, BCAC, Renton, WA - 1985-1987: Development of Airplane Controller Model, Simulation and Implementation of Flight control, Model reduction, and system control.

EXPERT WITNESS (Patent, IP)

Patent litigation, patent validity, IPR, expert reports, deposition, testimony, and trade secrets in the following areas (Complete list of cases available):

- Analog and Digital IC
- Radio Frequency Integrated Circuits
- Power Management, Battery Management, PMIC
- Wireless communication, 3G, 4G, OFDM, WiFi, 802.11, Bluetooth, and related areas
- Audio and acoustic signal processing, Audio Array processing
- Communication networks, Communication system
- Signal Processing, adaptive signal processing
- DSL, xDSL, VDSL, OFDM, Multi-Tone, and related areas
- Cable MODEM DOCIS MODEM, and related areas.
- Hearing AID
- Bio-Electronics, Heart monitoring system, Bi-sensors
- Satellite communications, Satellite Transceiver, ECHO and Multi-path cancelation circuits
- Wireline Communications, MODEM, Digital Subscriber Line, ADSL, VDSL, MODEM
- Wireless LAN, Wi-Fi, 802.11
- Bluetooth
- ZIGBEE
- GPS system, GPS receiver
- MEMS, Bulk Acoustic Wave Filters, SAW, MEMS resonators, MEMS accelerometer
- Wireless Standards (ITU, ETSI, 3GPPP, LTE) including AMPS, GSM, CDMA, WCDMA, LTE, 1G, 2G, 3G, 4G, BT, WiFi (802.11)
- Wireline standards including DSL, MODEM and DOCIS, and related standards ITU/ETSI

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PATENTS, PUBLICATIONS

• **Patents and Patent Applications**

ID	title	assignee	inventor/author
AU-2003222007-A8	Oscillator frequency correction in gps signal acquisition	Motorola Inc	Sayfe Kiaei, Thomas M King, George J Geier
WO-03093858-A3	Oscillator frequency correction in gps signal acquisition	Motorola Inc	Thomas M King, George J Geier, Sayfe Kiaei
WO-2004048909-A3	Compressed vector-based spectral analysis method and system for nonlinear rf blocks	Univ Arizona, Shahin Farahani, Sayfe Kiaei, Nazanin Darbanian	Shahin Farahani, Sayfe Kiaei, Nazanin Darbanian
US-2006226909-A1	Monolithic supply-modulated rf power amplifier and dc-dc power converter ic	Siamak Abedinpour, Sayfe Kiaei	Siamak Abedinpour, Sayfe Kiaei
US-7218085-B2	Integrated ZVS synchronous buck DC-DC converter with adaptive control	Arizona Board Of Regents	Siamak Abedinpour, Sayfe Kiaei
US-7372333-B2	Monolithic supply-modulated RF power amplifier and DC-DC power converter IC	Arizona Board Of Regents, Acting For And On Behalf Of Arizona State University	Siamak Abedinpour, Sayfe Kiaei
US-7528754-B1	Finite impulse response digital to analog converter	Arizona Board Of Regents	Bertan Bakaloglu, Sayfe Kiaei, Shahin Taleie
US-2018049703-A1	Wireless in-shoe physical activity monitoring	Timothy W. Markison, Sayfe Kiaei, Gary McCoy	Timothy W. Markison, Sayfe Kiaei, Gary McCoy
US-10264996-B2	Method and apparatus for wirelessly monitoring repetitive bodily movements	Sayfe Kiaei	Sayfe Kiaei
US-2019231226-A1	Method and apparatus for wirelessly monitoring repetitive bodily movements	Sayfe Kiaei	Sayfe Kiaei
US-10653337-B2	Local object detection system	Timothy W. Markison, Sayfe Kiaei, Gary McCoy	Timothy W. Markison, Sayfe Kiaei, Gary McCoy
US-2020266708-A1	Electronic circuit and method of controlling three-level switching converters	Arizona Board Of Regents On Behalf Of Arizona State University	Parisa Mahmoudidaryan, Sayfe Kiaei, Bertan Bakaloglu
US-11108325-B2	Electronic circuit and method of controlling three-level switching converters	Arizona Board Of Regents On Behalf Of Arizona State University	Parisa Mahmoudidaryan, Sayfe Kiaei, Bertan Bakaloglu
US11129547B2	Wireless in-shoe physical activity monitoring	Sigmasense LLC	Timothy W. Markison, Sayfe Kiaei, Gary McCoy

• **Standards Contributions**

1. "Spectral Compatibility of ADSL: Frequency Overlap vs. FDM," T1E1, Dec. 97.
2. "Echo Cancellation for G.Lite Universal ADSL," OFDM, Universal ADSL Working Group, Atlanta, GA, Jan 98.
3. "8-bit QAM Constellation effects on reach for universal ADSL," OFDM, Universal ADAL Working Group, Atlanta, GA, Jan 98.
4. "Trellis Code Modulation coding gain for OFDM," Universal ADSL Working Group, Atlanta, GA, Jan 98.
5. "Monte Carlo Modeling and simulation of twisted pair wiring for OFDM," Universal ADAL Working Group, Atlanta, GA, Jan 98.
6. "Overlap Upstream/Downstream spectral allocation for OFDM ADSL," International Telecommunication Unit, Chicago, March 98.
7. "Echo Cancellation for ADSL OFDM," International Telecommunication Unit, Antwerp, Belgium, 98.
8. "Performance of Echo Cancellation ADSL in OFDM system in the presence of Near End Cross Talk (NEXT)," International Telecommunication Unit, Honolulu, Hawaii, June 98.
9. Presentations and editorials at various XDSL and OFDM standards: ITU, ETSI, UAWG, and T1E1, 97-99.
10. Presentations and editorials at various 3G and 4G and wireless standards including ITU, 3GPP, 802.11, BT,

• **Books**

- "Design, Modeling and Testing of Data Converters, P Carbone, S Kiaei," F Xu - 2014 – Springer, © Springer-Verlag Berlin Heidelberg 2014

• **Refereed Journal Papers**

1. CMOS Full-Duplex Mixer-First Receiver With Adaptive Self-Interference Cancellation S. -A. Ayati; A. Alizadeh; S. Kiaei, IEEE Transactions on Circuits and Systems I, Jan 2021.
2. A 10-W X-Ban Class-F High-Power Amplifier in a 0.25m GaAs pHEMT Technology, A. Alizadeh; M. Yaghoobi; M. Meghdadi; A. Medi; S. Kiaei, IEEE Transactions on Microwave Theory and Techniques, Jan 2021.

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3. An X-Band Class-J Power Amplifier With Active Load Modulation to Boost Drain Efficiency
A. Alizadeh; S. Hassanzadehyamchi; A. Medi; S. Kiaei, IEEE Transactions on Circuits and Systems I: Sep 2020
4. In-Field Recovery of RF Circuits from Wearout Based Performance Degradation D. Chang; J. N. Kitchen; S. Kiaei; S. Ozev, IEEE Transactions on Emerging Topics in Computing, Jun 2020
5. A 50-V Isolation, 100-MHz, 50-mW Single-Chip Junction Isolated DC-DC Converter With Self-Tuned Maximum Power Transfer Frequency, C. Liu; D. Mandal; Z. Yao; M. Sun; J. Todsen; B. Johnson; S. Kiaei; B. Bakkaloglu, IEEE Transactions on Circuits and Systems II: Express Brief, May 2019
6. Wideband Hybrid Envelope Tracking Modulator With Hysteretic-Controlled Three-Level Switching Converter and Slew-Rate Enhanced Linear Amplifier, P. Mahmoudidaryan; D. Mandal; B. Bakkaloglu; S. Kiaei, IEEE Journal of Solid-State Circuits, 2019.
7. Low-Power/Low-Voltage Integrated CMOS Sense Resistor-Free Analog Power/Current Sensor Compatible With High-Voltage Switching DC-DC Converter, S. Singh; D. Mandal; B. Bakkaloglu; S. Kiaei IEEE Transactions on Circuits and Systems I, 2019
8. Adaptively Biased Output Cap-Less NMOS LDO With 19 ns Settling Time, D. Mandal; C. Desai; B. Bakkaloglu; S. Kiaei, IEEE Transactions on Circuits and Systems II: Express Briefs, 2019
9. Chirag Desai; Debashis Mandal; Bertan Bakkaloglu; Sayfe Kiaei, "A 1.66 mV FOM Output Cap-Less LDO With Current-Reused Dynamic Biasing and 20 ns Settling Time," IEEE Solid-State Circuits Letters Year: 2018, Volume: 1, Issue: 2, Pages: 50-53
10. Debashis Mandal ; Chirag Desai ; Bertan Bakkaloglu ; Sayfe Kiaei, Adaptively Biased Output Cap-Less NMOS LDO with 19 ns Settling-Time;; IEEE Transactions on Circuits and Systems II: Feb 2019
11. Ayati, Mandal, Bakkaloglu, Kiaei, "Integrated Quasi-Circulator With RF Leakage Cancellation for Full-Duplex Wireless Transceivers," IEEE Trans of Microwave theory and techniques, Dec 2017.
12. "A 50-mA 99.2% Peak Current Efficiency, 250-ns Settling Time Digital Low-Dropout Regulator With Transient Enhanced PI Controller", ChaiYong Lim ; Debashis Mandal ; Bertan Bakkaloglu ; Sayfe Kiaei; IEEE Transactions on Very Large Scale Integration (VLSI) Systems; Year: 2017, Volume: 25, Issue: 8; Pages: 2360 - 2370
13. Doohwang Chang; Jennifer N. Kitchen; Sayfe Kiaei; "Sule Ozev, In-field Recovery of RF Circuits from Wearout Based Performance Degradation", IEEE Transactions on Emerging Topics in Computing, 2017.
14. Edgar Martí-Arbona; Debashis Mandal; Bertan Bakkaloglu; Sayfe Kiaei, A High-Voltage-Compliant Current-to-Digital Sensor for DC-DC Converters in Standard CMOS Technology, IEEE Transactions on Power Electronics, 2017, Volume: 32, Issue: 3. Pp. 2180 - 2188
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17. Chang, D.; Kitchen, J.N.; Bakkaloglu, B.; Kiaei, S.; Ozev, S., "Monitor-Based In-Field Wearout Mitigation for CMOS LC Oscillators," in *IEEE Transactions on Device and Materials Reliability*, vol. 16, no. 2, pp. 183-193, 2016.
18. Chang, D.; Kitchen, J.N.; Bakkaloglu, B.; Kiaei, S.; Ozev, S., "Design-Time Reliability Enhancement Using Hotspot Identification for RF Circuits," in *IEEE transactions on Very Large Scale Integration (VLSI) Systems*, -vol. 24, no. 3, pp. 1179-1183, 2016

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19. Seungkee Min; Copani, T.; Kiaei, S.; Bakkaloglu, B., "A 90-nm CMOS 5-GHz Ring-Oscillator PLL With Delay-Discriminator-Based Active Phase-Noise Cancellation," *Solid-State Circuits, IEEE Journal of* , vol.48, no.5, pp.1151,1160, May 2013
20. Junghan Lee; Tino Copani; Terry Mayhugh Jr.; Bhaskar Aravind; Sayfe Kiaei; Bertan Bakkaloglu., "A 280 mW, 0.07% THD+N class-D audio amplifier using a frequency-domain quantizer," *Analog Integrated Circuits and Signal Processing*, 173-186, 2012.
21. Seungkee Min; Copali, T.; Kiaei, S.; Bakkaloglu, B.; , "A 90nm CMOS 5GHz ring oscillator PLL with delay-discriminator based active phase noise cancellation," *Radio Frequency Integrated Circuits Symposium (RFIC), 2012 IEEE*, pp. 173-176, 2012
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23. Copani, T.; Seungkee Min; Shashidharan, S.; Chakraborty, S.; Stevens, M.; Kiaei, S.; Bakkaloglu, B.; , "A CMOS Low-Power Transceiver With Reconfigurable Antenna Interface for Medical Implant Applications," *Microwave Theory and Techniques, IEEE Transactions on* , vol.59, no.5, pp.1369-1378, May 2011
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25. Lashkarian, N.; Nassiri-Toussi, K.; Jula, P.; Kiaei, S.; , "Performance Bound on Ergodic Capacity of MIMO Beam-Forming in Indoor Multi-Path Channels," *Communications, IEEE Transactions on* , vol.58, no.11, pp.3254-3264, November 2010
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31. Lyles, U. J.; Copani, T.; Bakkaloglu, B.; Kiaei, S.; , "An Injection-Locked Frequency-Tracking $\Sigma\Delta$ Direct Digital Frequency Synthesizer," *Circuits and Systems II: Express Briefs, IEEE Transactions on* , vol.54, no.5, pp.402-406, May 2007
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35. Abedinpour, S.; Bakkaloglu, B.; Kiaei, S.; , "A Multistage Interleaved Synchronous Buck Converter With Integrated Output Filter in 0.18 μ m SiGe Process," *Power Electronics, IEEE Transactions on* , vol.22, no.6, pp.2164-2175, Nov. 2007
36. Kitchen, J. N.; Deligoz, I.; Kiaei, S.; Bakkaloglu, B.; , "Polar SiGe Class E and F Amplifiers Using Switch-Mode Supply Modulation," *Microwave Theory and Techniques, IEEE Transactions on* , vol.55, no.5, pp.845-856, May 2007
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39. Pulse generation scheme for low-power low-complexity impulse ultra-wideband, Chen, X.; Kiaei, S.; *Electronics Letters*; Volume: 43 Issue: 1 Jan. 2007 ; Page(s): 44-45
40. Bandwidth extension technique for polar modulated RF transmitters ; Bakkaloglu, B.; Kiaei, S.; Dwyer, R.; *Electronics Letters*; Volume: 42 Issue: 8 13 April 2006 ; Page(s): 476- 478 ;
41. Frequency modulated bandpass SD chirp synthesizer for sensor applications; Chung, H.H.; Lyles, U.; Copani, T.; Bakkaloglu, B.; Kiaei, S.; *Electronics Letters*; Volume: 42 Issue: 16 August 3, 2006 ; Page(s): 917- 918
42. Radiation Hardened by Design RF Circuits Implemented in 0.13 mm CMOS Technology; Chen, W.; Pouget, V.; Gentry, G. K.; Barnaby, H. J.; Vermeire, B.; Bakkaloglu, B.; Kiaei, K.; Holbert, K. E.; Fouillat, P. ; *Nuclear Science, IEEE Transactions on* ; Volume: 53 Issue: 6 Part=1, Dec. 2006 ; Page(s): 3449-3454 ;
43. Analysis of Single Events Effects on Monolithic PLL Frequency Synthesizers ; Chung, H. H.; Chen, W.; Bakkaloglu, B.; Barnaby, H. J.; Vermeire, B.; Kiaei, S. ; *Nuclear Science, IEEE Transactions on* ; Volume: 53 Issue: 6 Part=1, Dec. 2006 ; Page(s): 3539-3543
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47. Frequency modulated bandpass SD chirp synthesizer for sensor applications; Chung, H.H.; Lyles, U.; Copani, T.; Bakkaloglu, B.; Kiaei, S.; *Electronics Letters*; Volume: 42 Issue: 16 August 3, 2006 ; Page(s): 917- 918
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50. "Channel Shortening For Discrete Multi-tone Transceivers To Maximize Channel Capacity" *OFDM and DSL*, G. Arslan, B. Evans, S. Kiaei; ; *IEEE Transactions for Signal Processing*, Vol 49; No. 12; Pp: 3123-3135. Dec 2001.
51. *Optimum equalization of multicarrier systems: a unified geometric approach, for OFDM* Lashkarian, N.; Kiaei, S. ; *IEEE Transactions on Communications*, Volume: 49 Issue: 10 , Oct. 2001 Page(s): 1762 –1769

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56. *Adaptive multiuser detector for asynchronous DS-CDMA in Rayleigh fading*; Dutta, A.K.; Kiaei, S. , *IEEE Transactions on Circuits and Systems II: Analog and Digital Signal Processing*, Volume: 44 Issue: 6 , June 1997; Page(s): 468 -472
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• **Conference Publications**

1. "Switching Battery Charger with Cascaded Two Loop Control Using Time-Based Techniques," ChaiYong Lim; Debashis Mandal; Bertan Bakkaloglu; Sayfe Kiaei, Published in: 2021 IEEE Applied Power Electronics Conference and Exposition (APEC), June 2021
2. 27.5 A 91%-Efficiency Envelope-Tracking Modulator Using Hysteresis-Controlled Three-Level Switching Regulator and Slew-Rate-Enhanced Linear Amplifier for LTE-80MHz Applications P. Mahmoudidaryan; D. Mandal; B. Bakkaloglu; S. Kiaei, 2019 IEEE International Solid- State Circuits Conference - (ISSCC), 2019
3. Integrated High-Efficiency Single-Inductor CCM Boost Converter for Multi-Junction PV Energy Harvesting, Q. Peng; D. Mandal; P. Mahmoudidaryan; B. Bakkaloglu; S. Kiaei, 2019 IEEE Applied Power Electronics Conference and Exposition (APEC), 2019
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122. "Systematic Derivation of Multi-Rate VLSI Arrays for the Solution of Toeplitz Matrices," IEEE Great Lakes Symposium on VLSI, March 1991. Proc. of IEEE Pacific Rim Conference on

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- Communications, Computers, and Signal Processing, Victoria, BC, Canada, pp. 623-626, May 1991. [S. Kiaei]
123. "CMOS Source-Couple Logic for Mixed-Mode VLSI," Proc. of International Symposium on Circuits and Systems, New Orleans, Louisiana, pp. 1608-1611, May 1990. [S. Kiaei, S.H. Chee, D. Allstot]
124. "VLSI Design of Multi-Rate Arrays," Proc. of International Conference on Acoustics, Speech, and Signal Processing, New Mexico, pp. 1049-1052, 1990. [L. Aihua, S. Kiaei]
125. "Comparison of Low-Noise Current-Mode Logic Circuits for High Performance Mixed-Mode Applications," Proc. of International Symposium on Circuits and Systems, New Orleans, Louisiana, May 1990. [S. H. Chee, S. Chow, S.S. Lee, S. Kiaei, D. Allstot]
126. "VLSI Design of Dynamically Reconfigurable Array Processors-DRAP," Proc. of International Conference on Acoustics, Speech, and Signal Processing, Glasgow, Scotland, 1989. [S. Kiaei, J. Durgham]
127. "VLSI Design of Bit/Serial Adaptive IIR Filters," Proc. of IEEE Pacific Conference on Communications, Computers, and Signal Processing, Victoria, Canada, pp. 650-652, June 1989. [R. Badyal, S. Kiaei]
128. "CCA Approach for ARMA Spectral Analysis," Proc. of IEEE International Symposium on Circuits and Systems, Portland, OR, pp. 1319-1322, May 1989. [S. Kiaei, L. Luo]
129. "Canonical Correlation Analysis (CCA) for ARMA Spectral Estimation," IEEE International Symposium on Circuits and Systems, May, 1989. [Kiaei, S.; Luo, L.]
130. "VLSI Implementation of Adaptive Bit/Serial IIR Filters," IEEE Pacific Rim Conference on Communications, Computers and Signal Processing, June 1989. [Badyal, R.; Kiaei, S.]
131. "VLSI design of WAP for Recursive Equations," VLSI Signal Processing, 1988. [S. Kiaei, U. Desai]
132. "Independent Data Flow Wavefront Array Processors for Recursive Equations," Proc. of 20th Annual Conference on Information Sciences and Systems, Princeton University, NJ, 1986. [S. Kiaei, U. Desai]
133. "A Stochastic Realization Approach to Reduced-Order Hierarchical Estimation," Proc. of 24th IEEE Conference on Dec., Ft. Lauderdale, FL, pp. 416-421, December 1985. [U. Desai, S. Kiaei]
134. "Hierarchical Estimation Algorithms," Proc. of IEEE Conference on Man, Cybernetics, and Systems, Tucson, AZ, October 1985. [U. Desai S. Kiaei]
135. "Approximation of Markovian Models with Non-Constant Parameters," Proc. of 23rd IEEE Conference on Dec., Las Vegas, NV, pp. 1642-1644, December 1984. [U. Desai, S. Banerjee, S. Kiaei]
136. "A Canonical Correlation Approach to Reduced-Order LQR Design," Proc. of 23rd IEEE Conference on Dec., Las Vegas, NV, pp. 1523-1528, December 1984. [U. Desai, S. Banerjee, S. Kiaei]

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• **GRADUATE STUDENT ADVISEES & RESEARCH PROJECT**

• ***(Partial list of Students graduated, current employment to the best of my knowledge)***

1. J. Durgam, VLSI Design of Dynamically Reconfigurable Array Processors, MSEE, 1988. Intel.
2. J. Gilbert, Minimization Techniques for PLAs, MSEE, 1988, Tektronix Inc.
3. L. Luo, CCA Methods for ARMA Spectral Estimation, MSEE, 1989. Berkeley Research Center
4. E. Zahl, Enhancement Methods for A/D Noise Reduction, MSEE, 1989. AT&T
5. L. Aihua, Synthesis of MRAs, MSEE, 1990. Intel.
6. F. Aslam, Image Restoration Methods, MSEE, 1990.
7. S.H. Chee, FSCL Circuits for Mixed-Mode IC's, MSEE, 1990. Linear Tech.
8. C. Dawson, MSEE, 1990. Boeing
9. A. Chow, Source-Coupled Logic ALU, MSEE, 1990. Intel
10. S. Maskai, Decimation Filters Using FSCL Circuits, MSEE, 1991. Intel
11. L. Louis, VLSI Implementation of Toeplitz Matrices, MSEE, 1991.
12. R. Badyal, Bit/Serial VLSI Design of IIR Filters, MSEE, 1992, HP
13. Lap Mui, Piece-Wise Linear Schedule for VLSI Arrays, MSEE, 1992. HP
14. S. Abdennadher, Adaptive Sigma-Delta Modulators, MSEE, 1992. Level One / Intel.
15. H. Bribech, Second Order Adaptive A/D Schemes, MSEE, 1992.
16. B. Hickman, MSEE, 92. Tektronix
17. M. Maleki, Current-Mode Flash A/D, MSEE, 1992. University of Oregon
18. Man Wong, Low-Noise Decimation Filter for Mixed-Mode ICs, MSEE, 1993, Motorola.
19. Anu Krishna Swamy, Low Noise IC Blocks for Mixed-mode IC's, MSEE, 1993, Ph.D., 1997.
20. Manu Srivastava, Comparison of Differential Logic (FSCL, CVSL, DSLL), MSEE, 1994, Intel.
21. Joel Oren, VLSI Design of Asynchronous FIR Filters, MSEE thesis, Feb. 1994. E-Systems.
22. Y. Zheng, VLSI Design and Synthesis of Multi-Rate Arrays, Ph.D. March 94, Hughes Research.
23. Satish Kulkarni, Low-Sensitivity Filters, MSEE, 1995, Motorola.
24. Amit Dutta, Multi-user Interference Cancellation, Ph.D, Dec. 97, Faculty, India.
25. Dwight Poplin, Multiplierless MPEG Decoder, MSEE, 1996. HP.
26. Maxim Scarpa, Adaptive I/Q Miss-match Correction for Direct Conversion Receivers, MSEE 1998.
27. Jeff McNeal, Sigma-Delta Frequency-to-Time Conversion, MSEE, 1998. Level One Comm.
28. Julia Vogel, Adaptive DC offset Cancellation, MSEE, 1998. Faculty in Germany.
29. Takao Inoue, MS, Echo Cancellation for ADSL, 1998. MSEE, The U of Texas at Austin.
30. Navid Lashkarian, Frequency off-set estimation and Synchronization of OFDM systems, Ph.D., June 1999. Broadcom Inc. & Faculty at UC San Jose.

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31. Guner Arslan, (co-advisor with B. Evans), "Fast Equalization for DMT systems, with applications to ADSL," Ph.D. The University of Texas at Austin, 2000
32. Salem Abdennadher, I/Q Mismatch Correction for RF Wireless transceivers, Ph.D., Level One Comm/Intel.
33. Can Sandalci, DSL Line Driver, Ph.D., 2001, Intel.
34. Dean Badillo, Low-Cost VCO Ring Oscillators, PhD, 2004, Intel, Chandler,
35. Siamak Abedinpour, PhD, 2005 Freescale, Tempe, Arizona
36. Hemanth Shivalingaiah, Multi-Band Low Noise Amplifiers, Ph.D., 2006, Intel,
37. Shahin Farahani, PhD, 2006, Qualcomm Inc,
38. Nazanin Darbanian, M.S. Freescale, Tempe, Arizona
39. *Joe Rutkowski, Joseph, MS, 2004, Phillips.*
40. *Chaudhuri, Bikram, Synthesizer, MS/PhD, MS 2004.*
41. *Zhang, Jiandong, MEMs, MEMS, December-04*
42. *Afsahi, Ali, MS/PHD, UC San Diego, QUALCOMM, Connection One*
43. *Chen, Xiaomin, UWB, PHD, 2007, SRC/Motorola*
44. *Jali, Hilda, Power Management, MS, June-05,*
45. *Xuejin Wang, RF Optimization, 2006 CAD tools, PhD, Neo-Linear*
46. *Umar Lyles, Power Amplifier, MS, 2006. Texas Instruments*
47. MS, Erika Munoz, RADHARD, 2007, Intel
48. Waleed Khali, (Co-Advisor), Professor at Ohio State
49. Jennifer Kitchen, PhD, 2009, Professor at ASU
50. Shahin Mehdizad Taleie, RFDAC, PhD, 2009, Qualcomm
51. Ilker Deligoz, PHD, 2009, Qualcomm
52. Hyung Kim, PhD, Jan 2010, Intel
53. Jung Le, PhD 2010, Intel, TI
54. Syed Naqvi, PhD, 2012, Intel.
55. Todd Martin, MS, 2011, TI
56. Seungkee Min, PhD, 2011, Intel
57. Ali Meamar, Post Doc, RFIC 2013
58. Hitesh Khunti, MS 2013, Qualcom
59. Debashis Mandal, Post Doc, Research faculty 2015-2018
60. Edgar Martinez, PhD, 2015, Qualcomm
61. Chirag Desai, MS, 2016, Qualcom
62. Sanjay Avasarala, MS, 2016

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- 63. Li Ming, MS, 2017
- 64. Qirong Peng, MS, 2017,
- 65. Yu Geng, PhD, 2018
- 66. Amir Ayati, PhD Aug 2018; Qualcomm
- 67. Pasisa Mahmoudi, PhD, May 2019, Qualcomm
- 68. Chai Yong, MS: 2015, PHD: 2019, Qualcomm
- 69. Shrikant Singh, MS: 2016, PhD, 2019, Movandi
- 70. Amir Alizadeh, Research Faculty 2019-Present
- 71. Ata S. PhD, 2021, Ata Sarrafinejad, PhD, 2021

UNIVERSITY COMMITTEES

- Various Committees at ASU, Oregon State University, etc.

INDUSTRY COMMITTEES

- Arizona Telecommunications and Information Council (ATIC), Board Member
- CAS Fellows Committee (ends December 31, 2006)
- *IEEE CAS Phoenix Chapter Organizers (the committee is in the process of determining new chair – current chair not active)*
- *Executive Committee, RFIC 2006.*
- *Technical Program Comm, IEEE RFIC 2006.*
- *Executive Committee, Conferences, International Solid State System's Conference.*
- *IEEE CAS Society, VLSI Technical Comm. Member*
- *Editorial Board, IEEE Communications Surveys & Tutorials*
- *Radio Frequency Integrated Circuits- RFIC 2006*
- *IEEE RF Integrated Circuits Conference, Committee Chair for two workshops*
- *International Microwave Symposium, IMS-MTT 2006*
- *Int. Symposium on Circuits and Systems - ISCAS 2006*
- *Wireless Networks & Emerging Technologies, WNET06*
- *Midwest Symposium on Circuits and System*
- *Arizona Governor IT Advisory Committee – GITA*
- *Arizona Telecom – ATIC*

INSTRUCTIONAL SUMMARY

- Digital IC Design, Analog IC Design, Advance CMOS Analog IC, VLSI, RFIC Design
- Wireless Transceiver Design, Wireless Communications, GPS, Telecomm Systems, Digital Communication

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- Signal Processing, Advance digital signal processing, Communication, Digital Communication, Digital Audio Processing, Adaptive array processing
- Computer Architecture, Microprocessor System Architecture, Pipeline Array Processing