

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

MINDGEEK, S.A.R.L., MINDGEEK USA, INC., and
PLAYBOY ENTERPRISES, INC.

Petitioner

v.

SKKY INC.

Patent Owner

IPR2014-01236

PATENT 7,548,875

**DECLARATION OF PROFESSOR KEVIN C. ALMEROOTH IN
SUPPORT OF PATENT OWNER'S RESPONSE TO *INTER PARTES*
REVIEW OF UNITED STATES PATENT NO. 7,548,875**

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I, Kevin Almeroth, make the following Declaration pursuant to 28 U.S.C.

§ 1746:

I. INTRODUCTION

1. I make all of the statements in this Declaration of my own personal knowledge and in accord with 28 U.S.C. § 1746. I am a Professor in the Department of Computer Science at the University of California, Santa Barbara. I understand that I am submitting a declaration in connection with the above-referenced Inter Partes Review proceeding pending in the United States Patent and Trademark Office for U.S. Patent No. 7,548,875 (“the ’875 patent”).

2. Attached hereto as Appendix A is a true and correct copy of my current curriculum vitae (“CV”), which details my extensive work history in the computer science and computer engineering fields. I am currently a Professor in the Department of Computer Science at the University of California, Santa Barbara. At UCSB, I also hold faculty appointments and am a founding member of the Computer Engineering (CE) Program, Media Arts and Technology (MAT) Program, and the Technology Management Program (TMP). I have been a faculty member at UCSB since July 1997.

3. I hold three degrees from the Georgia Institute of Technology: (1) a Bachelor of Science degree in Information and Computer Science earned in June, 1992; (2) a Master of Science degree in Computer Science (with specialization in

Networking and Systems) earned in June, 1994; and (3) a Doctor of Philosophy (Ph.D.) degree in Computer Science (Dissertation Title: Networking and System Support for the Efficient, Scalable Delivery of Services in Interactive Multimedia System, minor in Telecommunications Public Policy) earned in June, 1997.

4. My involvement in the research community extends to leadership positions for several academic journals and conferences. I am the co-chair of the Steering Committee for the ACM Network and System Support for Digital Audio and Video (NOSSDAV) workshop and on the Steering Committees for the International Conference on Network Protocols (ICNP), ACM Sigcomm Workshop on Challenged Networks (CHANTS), and IEEE Global Internet (GI) Symposium. I have served or am serving on the Editorial Boards of IEEE/ACM Transactions on Networking, IEEE Transactions on Mobile Computing, IEEE Network, ACM Computers in Entertainment, AACE Journal of Interactive Learning Research (JILR), and ACM Computer Communications Review. I have co-chaired a number of conferences and workshops including the IEEE International Conference on Network Protocols (ICNP), IEEE Conference on Sensor, Mesh and Ad Hoc Communications and Networks (SECON), International Conference on Communication Systems and Networks (COMSNETS), IFIP/IEEE International Conference on Management of Multimedia Networks and Services (MMNS), the International Workshop On Wireless Network Measurement (WiNMee), ACM Sigcomm Workshop on

Challenged Networks (CHANTS), the Network Group Communication (NGC) workshop, and the Global Internet Symposium; and I have served on the program committees for numerous conferences.

5. I am an author or co-author of nearly 200 technical papers, published software systems, IETF Internet Drafts, and IETF Request for Comments (RFCs). The titles and subject matter of these technical papers are listed in full on my CV, attached at Appendix A.

6. I have been retained by Skky Inc. I am being compensated for my time spent in connection with this case at my standard rate of \$500 per hour. I have no financial stake in the outcome of this proceeding.

7. I am not a lawyer. However, counsel has advised me that, during *inter partes* review, claims of a patent are generally given their ordinary and customary meaning as understood by a person of ordinary skill in the art in question at the effective filing date of the patent.

8. In preparing my opinions, I have considered the following materials:

Previously Filed Materials:

Exhibit Number	Description
1001	U.S. Patent No. 7,548,875 (the “’875 patent”)
2001	File History of the ‘875 patent
1036	Declaration of Dr. Friedson submitted during prosecution of the ‘875 patent

Exhibit Number	Description
1017	U.S. Patent No. 7,065,342 (“Rolf”)
1009	Scott Hacker, MP3: The Definitive Guide, Mar. 2000 (“MP3 Guide”)
1015	OFDM/FM Frame Synchronization for Mobile Radio Data Communication, Aug. 1993 (“OFDM/FM”)
	Corrected Petition for Inter Partes Review of U.S. Patent No. 7,548,875 and all exhibits to which it cites (IPR2014-01236, Paper 4) (“Pet.”)
	Patent Owner’s Preliminary Response (IPR2014-01236)
	PTAB Order to Institute Inter Partes Review (IPR2014-01236, Paper 10)
1008	Declaration of Michael Kotzin and all exhibits to which he cites

Exhibits:

Exhibit Number	Description	Date Accessed	Filed/ Served
2006	Frodigh, Magnus, et al., <i>Future-Generation Wireless Networks</i> , IEEE Personal Communications, Oct. 2001 at 10-17.		Filed April 30, 2015
2007	Rappaport, T. S., et al. <i>Wireless Communications: Past Events and a Future Perspective</i> , IEEE Communications Magazine, May 2002 at 148-161.		Filed April 29, 2015
2008	Martone, Max, <i>Space-Time Open Architectures for Broadband Wireless Data Communications: Above the $\log_2(1+SNR)$ Bit/Sec/Hz Barrier</i> , Global Telecommunications Conference, 2000, vol. 1 at 203-207.		Filed April 29, 2015
2009	Vaughan-Nichols, Steven J., <i>OFDM: Back to the Wireless Future</i> , Computer, Dec. 2002 at 19-21.		Filed April 29, 2015
2010	Wight, Jim, <i>The OFDM Challenge</i> , EE Times, Oct. 2001, available at http://www.eetimes.com/document.asp?doc_id=1204333 .	3/10/2015	Filed April 29, 2015

Exhibit Number	Description	Date Accessed	Filed/ Served
2011	Ojanpera, Tero and Prasad, Ramjee, <i>An Overview of Air Interface Multiple Access for IMT-2000/UMTS</i> , IEEE Communications Magazine, Sept. 1998.		Filed April 29, 2015
2012	<i>iPod + iTunes Timeline</i> , Apple Press Info, 2001-2010, available at https://www.apple.com/pr/products/ipodhistory/	4/13/2015	Filed April 29, 2015
2013	<i>Apple iPod (Original/ Scroll Wheel) 5 GB, 10 GB Specs</i> , Every iPod.com, available at http://www.everymac.com/systems/apple/ipod/specs/ipod.html	4/13/2015	Filed April 29, 2015
2014	<i>Apple iPod touch (Original/ 1st Gen) 8, 16, 32 GB Specs</i> , Every iPod.com, available at http://www.everymac.com/systems/apple/ipod/specs/ipod-touch-specs.html	4/13/2015	Filed April 29, 2015
2015	<i>Nokia's classic mobile phones: in pictures</i> , The Telegraph, available at http://www.telegraph.co.uk/technology/nokia/8465809/Nokia-classic-mobile-phones-in-pictures.html?image=2	4/20/2015	Filed April 29, 2015
2016	<i>Nokia 3210 specifications and reviews</i> , Esato, available at http://www.esato.com/phones/Nokia-3210-6	4/13/2015	Filed April 29, 2015
2017	<i>Nokia 3210 Teardown</i> , iFixit, 2015, available at https://www.ifixit.com/Teardown/Nokia+3210+Teardown/11328	4/13/2015	Filed April 29, 2015
2018	<i>LTE Release 8 of 3GPP Mobile Standard</i> , 3GPP The Mobile Broadband Standard, available at http://www.3gpp.org/technologies/keywords-acronyms/98-lte	4/24/2015	Filed April 29, 2015
2019	Zyren, Jim, <i>Overview of the 3GPP Long Term Evolution Physical Layer</i> , available at http://www.freescale.com/files/wireless_comm/doc/white_paper/3GPPEVOLUTIONWP.pdf , July, 2007.		Filed April 29, 2015
2020	Phadke, Arun G., <i>Handbook of Electrical Engineering Calculations</i> , 1999 at 170.		Filed April 29, 2015

II. OPINION REGARDING A PERSON OF ORDINARY SKILL IN THE ART

9. A person of ordinary skill in the art relating to the technology of the '875 patent at the time at which the earliest provisional patent application to which the '875 patent claims priority would have the equivalent of a four-year degree from an accredited institution in computer science, computer engineering, electrical engineering or the equivalent and experience with, or exposure to, wireless communication systems and delivery of digital media. A person of ordinary skill in the art would also have approximately 1-2 years of professional experience with wireless communication systems and delivery of digital media. Additional graduate education could substitute for professional experience, while significant experience in the field might substitute for formal education.

10. In 2001, I would have met or exceeded the level of skill required by the above definition, and I am competent to opine as to the knowledge of a person of ordinary skill in the art as of that date.

III. NONOBVIOUSNESS

11. I understand that under 35 U.S.C. § 103, “[a] patent for a claimed invention may not be obtained, notwithstanding that the claimed invention is not identically disclosed as set forth in section 102, if the differences between the claimed invention and the prior art are such that the claimed invention as a whole would have been obvious before the effective filing date of the claimed invention to a person having ordinary skill in the art to which the claimed invention pertains.” When considering the issues of obviousness, I understand that I am to do the following:

- Determine the scope and content of the prior art;
- Ascertain the differences between the prior art and the claims at issue;
- Resolve the level of ordinary skill in the pertinent art; and
- Consider evidence of secondary indicia of non-obviousness (if available).

12. Obviousness is a determination of law based on underlying determinations of fact. These factual determinations include the scope and content of the prior art, the level of ordinary skill in the art, the differences between the claimed invention and the prior art, and secondary considerations of non-obviousness.

13. I understand that a reference may be combined with other references to disclose each element of the invention under § 103. I understand that a reference may

also be combined with the knowledge of a person of ordinary skill in the art, and that this knowledge may be used to combine multiple references. I further understand that a person of ordinary skill in the art is presumed to know the relevant prior art. I understand that the obviousness analysis may take into account the inferences and creative steps that a person of ordinary skill in the art would employ.

14. In determining whether a prior art reference could have been combined with other prior art or other information known to a person having ordinary skill in the art, I understand that the following principles may be considered:

- A combination of familiar elements according to known methods is likely to be obvious if it yields predictable results;
- The substitution of one known element for another is likely to be obvious if it yields predictable results;
- The use of a known technique to improve similar items or methods in the same way is likely to be obvious if it yields predictable results;
- The application of a known technique to a prior art reference that is ready for improvement, to yield predictable results;
- Any need or problem known in the field and addressed by the reference can provide a reason for combining the elements in the manner claimed;
- A person of ordinary skill often will be able to fit the teachings of multiple references together like a puzzle; and

- The proper analysis of obviousness requires a determination of whether a person of ordinary skill in the art would have a “reasonable expectation of success” – not “absolute predictability” of success – in achieving the claimed invention by combining prior art references.

15. I am informed that whether a prior art reference invalidates a patent claim as obvious is determined from the perspective of a person of ordinary skill in the art. While there is no requirement that the prior art contain an express suggestion to combine known elements to achieve the claimed invention, a suggestion to combine known elements to achieve the claimed invention may come from the prior art as a whole or individually, as filtered through the knowledge of one skilled in the art.

16. When a work is available in one field, design alternatives and other market forces can prompt variations of it, either in the same field or in another. If a person of ordinary skill in the art can implement a predictable variation and would see the benefit of doing so, that variation is likely to be obvious. In many fields, there may be little discussion of obvious combinations, and in these fields market demand – not scientific literature – may drive design trends. When there is a design need or market pressure and there are a finite number of predictable solutions, a person of ordinary skill in the art has good reason to pursue those known options.

17. It is my understanding that there is no rigid rule that a reference or combination of references must contain a “teaching, suggestion, or motivation” to

combine references. But, I understand that the “teaching, suggestion, or motivation” test can be a useful guide in establishing a rationale for combining elements of the prior art. This test poses the question as to whether there is an express or implied teaching, suggestion, or motivation to combine prior art elements in a way that realizes the claimed invention, and it seeks to counter impermissible hindsight analysis.

18. I understand that if a proposed modification would render the prior art invention being modified unsatisfactory for its intended purpose, then there is no suggestion or motivation to make the proposed modification. If the proposed modification or combination of the prior art would change the principle of operation of the prior art invention being modified, then the teachings of the references are not sufficient to render the claims *prima facie* obvious. Obviousness does not require absolute predictability; however, at least some degree of predictability is required. Evidence showing there was no reasonable expectation of success may support a conclusion of non-obviousness.

IV. THE '875 PATENT

A. Overview of the '875 Patent

19. The '875 patent is entitled, “Media Delivery Platform” and represents a substantial improvement in the ability to send rich media, for example, audio or video, to cellular telephones. The '875 patent claims priority to U.S. Provisional

Applications: 60/343,159, filed on Oct. 26, 2001; 60/312,450, filed Aug. 14, 2001; 60/303,115, filed July 3, 2001; and 60/301,681, filed June 27, 2001. *See* Ex. 1001, 1:1-13.

20. In 2000, cellular networks and cellular phones were fundamentally different than today. The sophisticated smartphones that receive and process streaming audio or video—now ubiquitous today—did not exist in 2000. Nor did cellular networks exist in 2000 that could support transmission of large amounts of data to enable reception of streaming audio or video at a cellular phone. In 2000, consumers typically could not use cellular phones to access content-rich audio and visual files from Internet servers.

21. Mr. John Mikkelsen and Dr. Robert Freidson recognized the limitations that existed in 2000 and invented both a cellular device and a cellular transmission method that provides rich media files like songs, movies, and image clips to consumers' cell phones by compressing, storing, and then transmitting to an improved mobile device.

22. The improved mobile device invented by Mr. Mikkelsen and Dr. Freidson connects wirelessly to a network and is capable of receiving compressed media and playing back that media for the user. Specifically, the '875 patent discloses a novel cellular phone that includes multiple processors. *See* Ex. 1001, 14:17-36; 14:46-63; and Figure 3.

23. Additionally, the improved method of transmitting rich media data to a cell phone, invented by Mr. Mikkelsen and Dr. Freidson, includes the novel approach of applying orthogonal frequency-division multiplex (OFDM) modulation to data transmitted over a cellular network. *See* Ex. 1001 16:60-17:59.

B. Claims under Review

24. Based upon my review of the Board's Institution Decision, I understand that claims 1-3, 5, 15-21, and 23 of the '875 patent are currently under review in view of Rolf and the MP3 Guide. I also understand that claim 22 is currently under review in view of Rolf, the MP3 Guide, and OFDM/FM. *See* Institution Decision, Paper 10 at p. 10. The challenged claims read as follows:

Claim 1:

A method of wirelessly delivering over the air one or more digital audio and/or visual files from one or more servers to one or more wireless device means comprising:

compressing said one or more digital audio and/or visual files, wherein said audio and/or visual files comprise one or more full or partial master recordings of songs, musical scores or musical compositions, videos or video segments, movies or movie segments, film or flu segments, one or more image clips, television shows, human voice, personal recordings, cartoons, film animation, audio and/or visual advertising content and combinations thereof, and wherein said compressing comprises normalizing, sampling and compressing said digital audio and/or visual files;

storing compressed audio and/or visual files in one or more storage mediums; and

transmitting to said wireless device means said compressed audio and/or visual files wirelessly over the air, with or without an Internet network.

Claim 2:

The method of claim 1 further comprising providing selection of the delivery of one or more and compressed digital audio files and/or visual files for playback on said device means.

Claim 3:

The method of claim 2 further comprising playing back of one or more of said selected compressed digital audio files and/or visual files.

Claim 5:

The method of claim 2 wherein said compressed digital audio and/or visual file may be selected for delivery from said wireless device means for play thereon without using an Internet connection.

Claim 15:

The method of claim 1 wherein a plurality of compressed digital audio files and/or visual files are delivered to and stored on the wireless device means.

Claim 16:

The method of claim 1 wherein said compression is MP3.

Claim 17:

The method of claim 1 wherein said compressed digital audio and/or visual is delivered through the Internet or other computer based system.

Claim 18:

The method of claim 1 wherein said compressed digital audio and/or visual file is delivered to said wireless device means

independent of an Internet connection or other computer based system.

Claim 19:

The method of claim 1 wherein said compressed digital audio and/or visual file is a personal recording or video.

Claim 20:

The method of claim 1 further comprising charging a fee based on the number of compressed digital audio and/or visual files delivered to said wireless device means for playback thereon or the duration of playback of said compressed digital audio and/or visual files.

Claim 21:

The method of claim 1 wherein the compressed digital audio and/or visual file is a segment of a full song, musical composition or other audio recording or visual recordings.

Claim 22:

The method of claim 1 comprising the use of OFDM.

Claim 23:

The method of claim 1 comprising transmitting optimized and compressed audio and/or visual files.

See Ex. 1001, claims 1-3, 5, 15-23.

V. Terminology

25. I understand that, for purposes of my analysis in this *inter partes* review proceeding, the terms appearing in the patent claims should be interpreted according to their “broadest reasonable construction in light of the specification of the patent in which it appears.” 37 C.F.R. § 42.100(b). In that regard, I understand that the best

indicator of claim meaning is its usage in the context of the intrinsic record as understood by a person of ordinary skill in the art at the time of the invention (“skilled practitioner” or “one of skill”).

26. I further understand that the words of the claims should be given their plain meaning unless that meaning is inconsistent with the patent specification or the patent’s history of examination before the Patent Office. I also understand that the words of the claims should be interpreted as they would have been interpreted by a skilled practitioner at the time of the invention was made (not today). I understand that the time the ’875 invention was made is at least the earliest priority date claimed in the patent. That date is June 27, 2001. I have been asked to provide my interpretation of the phrases of the ’875 patent as set forth below.

A. “wireless device means”

27. Claim 1 recites, in its preamble, a method of wirelessly delivering files “to one or more wireless device means.” The final step of claim 1 requires “transmitting *to said wireless device means* said compressed audio and/or visual files wirelessly over the air, with or without an Internet network” (emphasis added).

28. I understand both Petitioner and Patent Owner contend that “wireless device means” is a means-plus-function limitation that is to be interpreted in

accordance with 35 U.S.C. § 112, ¶ 6¹. I understand a means-plus-function claim allows a patentee to express a term as “a means or step for performing a specified function without the recital of structure, material, or acts in support thereof.”

35 U.S.C. § 112, ¶ 6. I understand that a patentee’s use of the term “means” within a claim creates a rebuttable presumption that the claim is a means-plus-function claim. I understand the first step in construing a means-plus-function limitation is to identify the function explicitly recited in the claims. I also understand the second step in construing a means-plus-function limitation is to identify the corresponding structure in the specification that performs the claimed function.

29. Under the Petitioner’s and Patent Owner’s contention that “wireless device means” is subject to 35 U.S.C. § 112, ¶ 6, a Skilled Practitioner would understand the function of “wireless device means” to be “to request, wirelessly receive, and process a compressed audio and/or visual file.” The language of the claim provides this function, together with the context provided by the intrinsic record.

30. That is, the preamble states that the claim is a “method of wirelessly delivering over the air one or more digital audio and/or visual files from one or more servers to one or more wireless device means.” Ex. 1001, 33:114-16. Furthermore, the claim requires that the digital audio and/or visual files are compressed and then

¹ Section 4(c) of the Leahy-Smith America Invents Act (“AIA”) re-designated 35 U.S.C. § 112, ¶ 6 as 35 U.S.C. § 112(f). Pub. L. No. 112-29, 125 Stat. 284, 296 (2011).

transmitted wirelessly to the wireless device means. *Id.* 33:17-32. Thus, in order for files to be received by the wireless device means, the wireless device means must request, then wirelessly receive, then process the received compressed digital audio and/or visual files.

31. Throughout the specification, the function of requesting, receiving, and processing compressed digital audio and/or visual files is discussed. *See e.g.*, Ex. 1001, 2:49-58, 12:47-50, 32:51-54. Additionally, the prosecution history is consistent with the function of request, receive, and process as set forth above. For example, in response to a rejection based on Rolf, Patent Owner stated, “Rolf in particular does not teach or disclose how to produce a wireless cellular device that could receive, wirelessly, digitally compressed rich media, as selected and on demand, for storage on the wireless cellular device for playback as desired.” Ex. 1006 at 3. Moreover, Dr. Freidson’s declaration also discloses that the wireless device means receives “compressed data wirelessly on demand from a server and play[s] back the received content...” Ex. 1036, ¶ 12. A Skilled Practitioner would understand that “on demand from a server” means the wireless device makes a request for the compressed data. Likewise, a Skilled Practitioner would understand that “Play[s] back the received content” means process the compressed data.

32. For these reasons, a Skilled Practitioner, operating under the assumption

that the term “wireless device means” is subject to 35 U.S.C. § 112, ¶ 6, would find the function of “wireless device means” to be “to request, wirelessly receive, and process a compressed audio and/or visual file.”

33. A Skilled Practitioner, operating under the assumption that the term “wireless device means” is subject to 35 U.S.C. § 112, ¶ 6, would understand the structure of “wireless device means” to be “a device capable of receiving data over a cellular communications network and having multiple processors wherein one or more processors is primarily dedicated for processing the compressed audio and/or visual data and is operatively connected to non-volatile and volatile memory, bootstrap, analog interface, and a digital interface or equivalents thereof.” A Skilled Practitioner would arrive at this determination for the same reasons set forth below regarding the meaning of “wireless device means” absent 35 U.S.C. § 112, ¶ 6.

34. I understand the Board determined that “wireless device means” is not a means-plus-function limitation and therefore not governed by § 112, ¶ 6. *See* PTAB Order to Institute *Inter Partes* Review (IPR2014-01236, Paper 10 at 7). I understand that for the purposes of their decision, the Board stated that “wireless device means” requires no further construction. *Id.*

35. I am aware that for purposes of *inter partes* review, the “broadest reasonable interpretation” standard should be applied to claim language. It is my understanding

that “broadest reasonable interpretation” does not mean broadest *possible* interpretation, but an interpretation consistent with how the term is commonly used in the art and consistent with the intrinsic record.

36. Applying the Board’s direction that the term “wireless device means” requires no further construction beyond broadest reasonable interpretation, I note that the phrase “wireless device means” is not a term of art. The inventors acted as their own lexicographer. Therefore, I turn to the plain claim language, specification, and file history to interpret how a Skilled Practitioner would interpret the phrase “wireless device means.”

37. Under the broadest reasonable interpretation, a Skilled Practitioner would understand “wireless device means” to mean “a device capable of receiving data over a cellular communications network and having multiple processors, wherein one or more processors is primarily dedicated to processing compressed audio and/or visual files.”

1. The “wireless device means” of the ’875 invention is a device capable of receiving data over a cellular network

38. The ’875 specification discloses a wireless device means with either an attached accessory unit or an embedded chip for receiving compressed rich media over a cellular network. Ex. 1001, 13:33-34. In the primary wireless embodiments (accessory unit or an embedded chip), it is clear that a cellular phone is used, and thus

clear that a cellular network employed. *Id.* 15:36-37 (Sound clip transmitted “through the phone line of the network to the cellular service provider 208” and then “to the cellular phone 202.”) Another embodiment includes the i-Pod™ type device. In this embodiment a device having audio processing capabilities similar to an i-Pod includes the added functionality of being able to receive rich media wirelessly over a cellular network. *See* 29:65-67 (“A device for downloading and listening to music files, which is similar to a walkman type I-pod™ device, [] uses the same delivery method as described for the cellular phone...”).

39. During prosecution, Dr. Friedson set forth how he modified a cellular phone with novel hardware and functionality in order for his prototype to receive rich media over a cellular network. *See* Ex. 1036 at ¶¶ 4, 7.

40. The Examiner recognized the importance of the cellular infrastructure to the invention, stressing in the reasons for allowance the importance of “such a wireless cellular device” for delivery of rich media either through an audio channel or data channel of a cellular network. Ex. 1002 at 8.

41. For these reasons, a Skilled Practitioner would understand “wireless device means” to include a device capable of receiving data over a cellular communications network.

2. The “wireless device means” of the ’875 invention comprises multiple processors

42. A Skilled Practitioner would also understand the “wireless device means” to include multiple processors. In the preferred embodiment, one processor was located within the cellular phone and the second processor was either embedded in a chip within the cellular phone or included in an accessory unit coupled to the cellular phone. Ex. 1001, 14:14-22.

43. The Examiner explicitly noted the nature of the “wireless device means” during prosecution:

Support for wireless device means is found in the specification, for example, on page 14, line 5 et seq., therein referring to Figs. 2 and 3 (at least page 14, line 6 through page 15, line 4), and others, and inclusive of “board 203” which includes the “main blocks” recited in page 14, lines 23-25 and the following supporting disclosure.

’875 File History, Ex. 1002, Notice of Allowance at 2-3.

44. I note that this portion of the specification cited by the Examiner describes the wireless device as being comprised of two components, which are illustrated in Figure 2 of the ’875 patent:

1. a cellular phone, ’875 patent, Ex. 1001 at 14:13-19 (“FIG. 2 is a schematic diagram of a wireless transmission 15 system 200 for a cellular phone 202”); and

2. an attached accessory unit or embedded chip, *id.* at 14:19-22

(“Although the system 200 is described as incorporating an accessory unit, it should be understood that a chip performing the same functions of the board may instead be embedded in the phone itself[.]”)

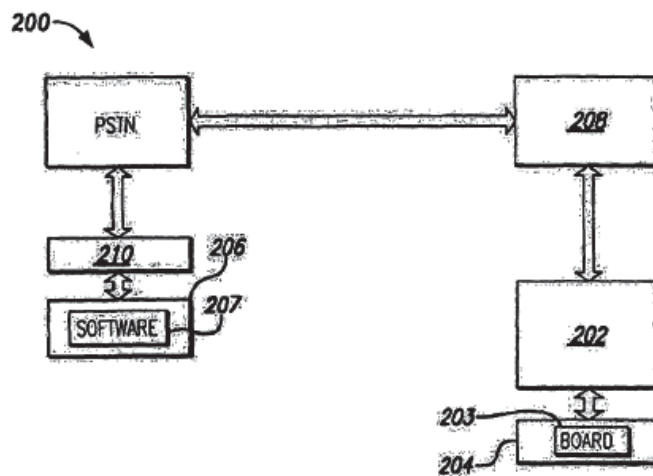


FIG. 2

Figure 2, '875 patent

45. The cellular phone, noted as a key component by the Examiner and as described in the intrinsic record, includes its own processor. As described in the background section, a popular cellular phone at the time of the invention was the Nokia 3210. A Skilled Practitioner would be aware that such a cellular phone included a single processor. A Skilled Practitioner would know that the processor of conventional cellular phones at the time of the invention needed a processor to process the digital data in the telecommunications and perform various functions of a

cellular phone, like general telephone controls, navigating the phone menu, and inputting a phone number. At the time of the invention, almost all phones, cellular or landline, included a processor to handle the computational tasks associated with telecommunications.

46. In the case of the Nokia 3210, the processor was a Texas Instruments MAD2PRI microcontroller. *See* section VI.A. In fact, at the time of the invention, nearly all phones, cellular or landline, included a processor to handle the computational tasks associated with telecommunications. Ex. 2004 at 4. Without a processor, cellular phones, such as the Nokia 3210, would not be able to perform their advertised functions.

47. The accessory unit or embedded chip, as noted as a second key component by the Examiner and as described in the intrinsic record, includes a second processor. Ex. 1001 at 14:46-63 (“processor 300”). Dr. Friedson’s prototype, as described in his declaration during prosecution, also includes at least two processors: one processor in the conventional cellular phone; and the second processor in the printed circuit board, which was dedicated to processing the data associated with compressed audio and/or visual files. Ex. 1036 at ¶ 5. The second processor in the preferred embodiments is a digital signal processor. ’875, Ex. 1001 at 14:46-47; 18:46-50; 22:21-26; 23:43-47. For at least these reasons, a Skilled Practitioner would understand the “wireless device

means” to include at least two processors.

48. I note the Board discounts the notion that “wireless device means” should be limited to multiple processors, stating “[a]lternative embodiments of ‘wireless device means,’ [] are not described as having multiple processors.” PTAB Order to Institute *Inter Partes* Review (IPR2014-01236, Paper 10 at 8, citing “i-Pod™ type listening device 1802” at ’875, Ex. 1001 at 30:49-51. I disagree with the Board. What is described in the specification is an i-Pod™ *type* device, not an i-Pod™ itself. This is made clear by the fact that i-Pods™ at the time of the ’875 invention did not have wireless capabilities, while the i-Pod™ *type* device described in the ’875 specification did. More specifically, an i-Pod™ is not a “wireless device means” as described in the specification and file history.

49. Apple’s iPod™ was originally released in October 2001²; just shortly after Mr. Mikkelsen and Dr. Freidson conceived of their invention. The original iPods did not have wireless capabilities; they required a FireWire *wired* connection in order to receive compressed digital audio files³. This wired connection existed between the i-Pod™ and a computer running the iTunes software. This wired connection was neither an Internet connection nor a cellular connection. In fact, no Internet connection was required in order for audio files to be downloaded to the i-Pod™ via

² See, Ex. 2012, *iPod + iTunes Timeline*, Apple Press Info, 2001-2010, available at <https://www.apple.com/pr/products/ipodhistory/>

³ See, Ex. 2013, *Apple iPod (Original/ Scroll Wheel) 5 GB, 10 GB Specs*, Every iPod.com, available at <http://www.everymac.com/systems/apple/ipod/specs/ipod.html>

the wired connection. For example, a user could use their computer to copy audio from a user's CD to their wired i-Pod device.

50. Wireless capabilities for handheld music devices such as iPods were not available until the first iPod Touch™ was released in September 2007⁴—roughly six years *after* the '875 invention was conceived.

51. It is clear that what is described as an embodiment in the '875 specification is not an i-Pod™ device itself, but a device having similar characteristics, but additional wireless functionality. Indeed, this is made clear in the specification when the inventors describe the i-Pod™ type embodiments as “us[ing] the *same* delivery method as described for the cellular phones.” ('875 patent, Ex. 1001 at 29:66-67 (emphasis added).) Later, the specification describes that the i-Pod™ type includes the ability for media files to be “downloaded wirelessly to the device 1802.” ('875 patent, Ex. 1001 at 30:53-54.)

52. A Skilled Practitioner at the time of the invention would understand that the wireless component of the “i-Pod™ type device” embodiment would be implemented in the same manner as the cellular phone embodiment. That is, a Skilled Practitioner would understand that the i-Pod™-type device would include multiple processors: one processor typical for an i-Pod™ device; *and at least* an additional

⁴ See, Ex. 2014, *Apple iPod touch (Original/1st Gen) 8, 16, 32 GB Specs*, Every iPod.com, available at <http://www.everymac.com/systems/apple/ipod/specs/ipod-touch-specs.html>

processor for receiving the wirelessly transmitted compressed audio and/or visual files (as described in the accessory unit or embedded chip embodiments of the cellular phone description, which is more than was included in an i-Pod™ at the time of the invention). *See* '875 patent, Ex. 1001 at 14:14-26. Thus, the specification's reference to "i-Pod™-type listening device" does not suggest that the patented method and device could be performed by a device with a single processor. Nor does the specification suggest that the patented device and method *could* be performed on a conventional i-Pod™ contemporaneous to the invention. Only an i-Pod™ properly modified according to the specification could be a "wireless device means."

53. For these reasons, a Skilled Practitioner would understand "wireless device means" to include "a device capable of receiving data over a cellular communications network and having multiple processors."

3. The "wireless device means" includes one or more processors primarily dedicated to processing the data in a compressed audio and/or visual file

54. The '875 invention, as outlined above, conceived of at least two processors: one processor for general cellular phone functionality and a second processor primarily dedicated to processing the data in a compressed audio and/or visual file. Processor 300, a component of accessory board 203, is a dedicated digital signal processor found within the wireless device means. Ex. 1001. Figure 2 and Figure 3.

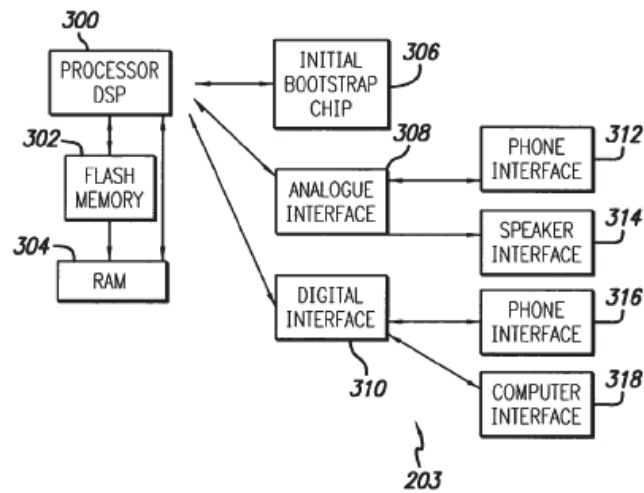


FIG. 3

Figure 3, '875 Patent, Ex. 1001

55. The secondary processor receives compressed rich media. Ex. 1001 at 14:51-63. The secondary processor supports selection, downloading, and playback. *See Id.* at 12:47-50; 21:14-17. The secondary processor can take the form of a “microchip” embedded within the phone itself, or as a component of an accessory unit. *Id.* at 14:16-22. Specifically, the secondary processor in the preferred embodiments is a digital signal processor. '875, Ex. 1001 at 14:46-47; 18:46-50; 22:21-26; 23:43-47. A Skilled Practitioner would appreciate that a digital signal processor is a type of specialized processor with architecture that is designed for carrying out particular *operations* on data as opposed to general-purpose processors designed to merely rearrange stored data. Examples of specialized operations for which digital signal processors are well-suited include: multimedia processing like audio and video coding

and decoding; and multimedia storage and playback, to name a few. Additionally, digital signal processors are well-suited for mathematical-specific functions like the computation of Fast Fourier-Transforms as exemplified in a preferred embodiment of the invention to process OFDM modulated signals. '875, 17:22-24 (“To increase computation efficiency, a Fast Fourier Transform is employed to convert sub-channel symbols from frequency to time area.”)

56. Dr. Friedson’s declaration describes the prototype of the ’875 invention. *See* Ex. 1036. Dr. Friedson added a printed circuit board to a conventional cellular phone, the printed circuit board functioned as a wireless mp3 player. *Id.* at ¶ 5. The processor in this circuit board addressed the limited processing resources found in conventional cellular phones at the time of the invention, allowing the “wireless device means” to receive and play back a compressed audio and/or visual file.

B. “segment of a full song, musical composition or other audio recording or visual recordings”

57. Claim 21 recites that the compressed digital audio and/or visual file is “a segment of a full song, musical composition or other audio recording or visual recordings.” ’875 patent, Ex. 1001 claim 21. It is my understanding the Board provided no direction beyond broadest reasonable interpretation as to the meaning of this phrase. *See* PTAB Order to Institute *Inter Partes* Review (IPR2014-01236, Paper 10).

58. A Skilled Practitioner would understand this to mean a *playable portion* of a song, musical composition or other audio recording or visual recordings. For example, the '875 specification discusses using portions (also referred to as “clips” or “snippets” in the specification) of audio recordings as the ring notification sound on a cellular phone. *See* '875 patent, Ex. 1001 at 2:1-3; 3:4-8; 3:39-45; 5:18-45; 5:17-6:39; and 12:47-50. Specifically, the '875 patent states:

An electronic device according to the present invention may also have the ability to receive clips which are directly transmitted onto the electronic device via audio or visual broadcasts. The user of an electronic device may program the device to sound a specified broadcast as an alert sound. For example, *a sound segment from a live radio show (i.e., a sports show or a commercial) may be used to ring a cellular phone by either the caller or the callee.*

'875 patent, Ex. 1001 at 7:17-24 (emphasis added).

59. The specification also makes clear that these “segments” or portions are playable. For example, the “clips” or “snippets” function as “ring notifications” or “alerts” on the cellular phone. *See supra*. In order for these segments or portions of a file to serve as alerts, the segments necessarily must be *playable* segments.

60. For these reasons, a Skilled Practitioner would understand “segment of a full song, musical composition or other audio recording or visual recordings” to mean a “playable portion of a full song, musical composition or other audio recording or visual recordings that is playable on the device.”

VI. PRIOR ART CITED BY THE BOARD

A. U.S. Patent No. 7,065,342

61. U.S. Pat. No. 7,065,342 to Devon Rolf, titled “System and Mobile Cellular Telephone Device for Playing Recorded Music,” was filed Nov. 22, 2000 and issued June 20, 2006 (“Rolf”). Ex. 1017. Rolf discloses a system and method for wirelessly transmitting music to a conventional cellular phone. Rolf, Ex. 1017, Abstract; 1:17-21. Rolf teaches using a “well known,” “conventional wireless communication device,” *i.e.*, a cell phone, to receive the transmitted music data. *Id.* at 7:59-60 and 4:65-67.

62. Indeed, Rolf discloses a conventional cellular phone with the exception of the additional component of a buffer and a player for playing music received at the cellular phone. Rolf, Ex. 1017 at 7:49-64. Specifically, Rolf states:

With additional reference to FIG. 4, wireless communications device 12 has *a processor 20*. Connected to processor 20 are an input (such as a keypad 22), a display 24, a memory 26, a microphone 32, a speaker 34, and a port 36. Additionally, a DTMF encoder/decoder (or just an encoder, if desired) 38, and a transceiver 40, and antenna 42 are connected as shown. Additionally, wireless communications device may have a bay 43 for receiving a memory cartridge or stick, such as a flash memory unit. Furthermore, device 12 has an external speaker port (e.g., for ear plugs or headphones) 44. *The construction of conventional wireless communications devices, such as cellular phones, is well known.*

Id. at 7:49-60 (emphasis added).

63. Rolf is focused on the services provided to the cellular phone, *i.e.*, the service of music to a cell phone. Rolf does not disclose or suggest the underlying protocols, especially at the physical layer, for transmitting the music data.

64. Rolf is not interested in altering the state-of-the-art in standardized wireless communications protocols. Rolf explicitly discloses transmitting the music data “via a packet switch network [] such as by a next or third-generation wireless communications network.” *Id.* at 3:22-25. Rolf provides no explicit motivation to use anything other than a standard Internet “cellular communications link.” *Id.*

65. By way of background, in 1999, a conventional cellular phone as contemplated by Rolf would include the bestselling cellular phone, the Nokia 3210. The Nokia 3210 sold approximately 160 million units over its lifetime⁵.

66. The Nokia 3210 communicated on a 2G network⁶. It included a monochromatic graphic display, a single processor⁷, and had no ability to receive and process rich media files⁸. Specifically, the Nokia 3210 could only receive and play monophonic ringtones. *See* Nokia 3210 User Manual, 1999, at 65.



Nokia 3210, circa

⁵ *See*, Ex. 2015, *Nokia's classic mobile phones: in pictures*, The Telegraph, available at <http://www.telegraph.co.uk/technology/nokia/8465809/Nokias-classic-mobile-phones-in-pictures.html?image=2>

⁶ *See* Ex. 2016, *Nokia 3210 specifications and reviews*, Esato, available at <http://www.esato.com/phones/Nokia-3210-6>

⁷ Texas Instruments MAD2PRI Microcontroller (ARM Based), *See* Ex. 2017, *Nokia 3210 Teardown*, iFixit, 2015, available at <https://www.ifixit.com/Teardown/Nokia+3210+Teardown/11328>

⁸ *See* Ex. 2016, *Nokia 3210 specifications and reviews*, Esato, available at <http://www.esato.com/phones/Nokia-3210-6>

67. The structure of the popular Nokia 3210 is consistent with the wireless communications device described by Rolf. That is, Rolf described a wireless communications device with a single processor. Rolf, Ex. 1017, Figure 4; 7:49-50.

68. Dr. Kotzin argues that a Skilled Practitioner would understand that Rolf taught using the voice channel of an “analog cellular such as AMPS.” Kotzin Decl. at 72. This is not correct. Rather, Rolf specifically teaches that his invention should be deployed, not on an analog cellular network such as AMPS, but on a cellular Internet link, via a “next – or third-generation wireless communications networks.” Rolf, Ex. 1017, 3:23-25.

[T]he wireless communications link established between the wireless communications device and the central facility is a cellular communications link and, more particularly, is an Internet link. In other words, the encoded music and/or informational data is preferably transmitted via a packet switch network, and particularly is preferably transmitted at transmission speeds greater than 50 KHz, such as by a next- or third-generation wireless communications network.

Rolf, Ex. 1017, 3:17-25.

69. A Skilled Practitioner, at the time of the '875 invention, would understand that “next- or third-generation” was beyond that what was used for the “conventional” cellular phone taught by Rolf. As detailed above, a “conventional cellular phone” as taught by Rolf was, for example, a Nokia 3210 that communicated on a digital 2G network, not an analog network such as AMPS. Therefore, Rolf taught

transmission of data, not over an analog channel as asserted by Dr. Kotzin, but over a digital data channel.

B. Scot Hacker, *MP3: The Definitive Guide*

70. MP3: The Definitive Guide (“The MP3 Guide”) has a copyright date of 2000. The MP3 Guide discloses methods for MP3 creation and MP3 playback principles. MP3 Guide, Ex. 1009, at viii.

71. In addition to outlining MP3 formatting and playback methods, the MP3 Guide details devices capable of playing back MP3 files. *See generally* Ex. 1009. These MP3 playback devices are capable of being loaded with the user’s choice of MP3 files. Ex. 1009 at 227, Table 6-1. These devices all share the common characteristic of requiring a wired connection to a network in order for new MP3 files to be loaded onto the device. Examples of wired connections include serial, USB, or parallel cables. *Id.* Notably, none of the devices disclosed in MP3 Guide are cellular phones. *Id.* at 230. There is a discussion of future plans by Ericsson to launch a cellular phone with MP3 capabilities, but no details regarding the structure or details of the Ericsson cellular phone are disclosed.

C. OFDM/FM Frame Synchronization for Mobile Radio Data

72. OFDM/FM Frame Synchronization for Mobile Radio Data Communication (“OFDM/FM”) by William D. Warner and Cyril Leung was published August 1993. The OFDM/FM paper describes an experimental setup to

test a particular frame synchronization technique for data modulated using orthogonal frequency-division multiplex modulation (OFDM). *See* Ex. 1015.

1. Orthogonal Frequency-Division Multiplexing

73. Per way of background, orthogonal frequency-division multiplex (OFDM) modulation is a method of transmitting data in parallel, over a series of sub-channels that overlap without interfering. Dr. Kotzin states that OFDM was commonly used in the '90s. Kotzin Decl. at 72. However, Dr. Kotzin's declaration overstates the use of OFDM in the cellular field at the time of invention, especially when compared to other, early applications of OFDM, such as ADSL and wireless LANs. At the time of the invention, the use of OFDM on cellular networks was anything but routine.

74. While OFDM was used at the time of the '875 invention in some applications, Dr. Kotzin fails to point out that these applications all share a common feature not shared by cellular networks, that of non-mobile transmitters and receivers⁹. Once receivers become mobile (as is common in the case of a cellular phone receiver), the signal transmitted by the transmitter will be subject to a Doppler shift. That is, the frequency of the received signal at the cellular phone receiver will either be shifted higher or lower, depending on whether the cellular phone receiver is traveling towards the transmitter or away from the transmitter. It is incumbent upon the cellular phone receiver to compensate for this Doppler shift. The more complex

⁹ Dr. Kotzin mentions OFDM in use in cable modems (ADSL), video broadcasting (DAV/DVB), and telephone line modems, and wireless LANS. Kotzin Decl. at 16.

the modulation scheme, the more complex the methods must be at the receiver to compensate for a Doppler shift.

75. One significant drawback to using OFDM techniques in mobile environments is solving the problem of intercarrier-interference (ICI) caused by Doppler shift. In applications such as television broadcast or wireless LANs there is little Doppler shift, if any. In cellular network applications, receivers can commonly be traveling 60+ mph, creating high Doppler shifts and delays in the signal that dramatically increase the complexity of interpreting the transmitted signal at the cellular phone receiver. Tellingly, around the time of the '875 invention, OFDM was considered by experts for cellular networks, but was ultimately rejected. By as late as 2001, there was no clear picture as to what modulation scheme would be used in even future, fourth-generation mobile systems¹⁰. In addition to the Doppler shift and signal delay problems associated with OFDM, other drawbacks associated with OFDM would have been known to a Skilled Practitioner.

- OFDM inherently has a relatively large peak-to-average power ratio (PAPR), which tends to reduce the power efficiency of RF amplifiers. [] [O]utput peak clipping generates out of band radiation due to intermodulation distortion;¹¹
- Multicarrier systems, such as OFDM are inherently more susceptible to frequency offset and phase noise. Frequency jitter and Doppler shift between the transmitter and receiver causes

¹⁰ Ex. 2006, Frodigh, Magnus, et al., *Future-Generation Wireless Networks*, IEEE Personal Communications, Oct. 2001 at 10-17.

¹¹ Ex. 2007, Rappaport, T. S., et al. *Wireless Communications: Past Events and a Future Perspective*, IEEE Communications Magazine, May 2002 at 148-161.

intercarrier interference (ICI) which degrades the system performance unless appropriate compensation techniques are implemented;¹² and

- Market-leading CDMA-based vendors and carriers (which did not use OFDM) were expected to fight to maintain their large customer base¹³ and thus, resisted change to a fundamentally different modulation methodology, such as OFDM.

76. Around the time of the '875 invention, researchers were actively developing technologies other than OFDM that could meet the demand for high-speed mobile data without the drawbacks of the peak-to-average power ratio problem of OFDM—one example being the STREAM™ (Spatial Transmission with Radio Enhanced Adaptive Modulation) technique.¹⁴

77. Kotzin's statement that OFDM was "widespread" in its use in "wireless LANS (e.g., 802.11a)" is an overstatement. At the time of the '875 invention, OFDM for 802.11a had been adopted as a standard, but by as late as 2001 there still remained significant challenges to designing the hardware for its implementation. Specifically, in 2001, 5-GHz OFDM WLAN modems faced the key design challenges of: power consumption, linearity, image rejection, phase distortion and phase noise.¹⁵

78. As noted by Warner and Leung, "proper design of a synchronization scheme for OFDM/FM requires knowledge of the characteristics of the FM radio

¹² *Id.*

¹³ Ex. 2009, Vaughan-Nichols, Steven J., *OFDM: Back to the Wireless Future*, Computer, Dec. 2002 at 19-21.

¹⁴ Ex. 2008, Martone, Max, *Space-Time Open Architectures for Broadband Wireless Data Communications: Above the $\log_2(1+SNR)$ Bit/Sec/Hz Barrier*, Global Telecommunications Conference, 2000, vol. 1 at 203-207.

¹⁵ Ex. 2010, Wight, Jim, *The OFDM Challenge*, EE Times, Oct. 2001, available at http://www.eetimes.com/document.asp?doc_id=1204333.

transmitter-receiver (transceiver) used.” Ex. 1015 at 303. Thus, the testing environment included identical ICOM-SAT transceivers. *Id.* A relatively low operating frequency of 144.15 MHz was used. *Id.* The synchronization techniques were used in a pure ALOHA fading environment in which, due to the pure ALOHA environment, each OFDM frame was synchronized independently. *Id.* at 304. Due to the limited spectrum, the bandwidth overhead was small. *Id.* These test parameters are highly idealized conditions using simplistic signal models. Data resulting from such experiments provide little if any insight on real world data transmission, instead relating to the paper’s principle challenge of achieving frame synchronization.

79. The “pure” nature of the ALOHA network means that if data is ready to be sent on the network, it is sent. If the message collides with another transmission on the network, the data is resent. Put another way, in a pure ALOHA network a station will transmit its data even if the channel is already occupied by another station, hence collisions between data can and do occur.

80. This access method is distinguishable from time-based networks that require synchronization. Contrary to pure ALOHA, these time-based networks transmit data in a pre-defined, and typically uniquely assigned, timeslot resulting in a reduction of collisions between data transmitted on the network. Cellular networks such as 2G or 3G use time-based network designs, requiring transmission of data at particular time slots. Time-based network architectures have higher theoretical

throughputs at high loads as compared to networks like pure ALOHA. While ALOHA networks may be sufficient for simple, low throughput data transmission, a Skilled Practitioner would not seek to use ALOHA protocols to transmit rich media files.

81. Further, the OFDM/FM paper applies its frame synchronization technique in an environment with bit error rates (BER) as low as 1×10^{-5} and as high as 1×10^{-1} . Ex. 1015, Figure 18. The BER determines how effective the transmission system is. Generally, speech requires a BER better than 10^{-6} . Ex. 2020, Handbook of Electrical Engineering Calculations, 1999, at 170. Such a relatively high BER would likely require error control techniques to be implemented at the receiver in order for complex data to be successfully received at a receiver.

VII. ANALYSIS OF PETITIONERS' OBVIOUSNESS POSITIONS

A. Section 103(a): Rolf in View of MP3 Guide

82. Petitioner applies the teachings of Rolf and MP3 Guide in a proposed ground of obviousness as to claims 1-3, 5, 15-21, and 23. *See* Corrected Petition for *Inter Partes* Review of U.S. Patent No. 7,548,875 (“Pet.,” Paper 4).

1. Rolf does not disclose or teach the wireless device means disclosed and claimed in the '875 Patent

83. As detailed above, the meaning of the phrase “wireless device means” when viewed in light of the claims, specification, and file history, dictates that

“wireless device means” means “a device capable of receiving data over a cellular communications network and having multiple processors, wherein one or more processors is primarily dedicated to processing compressed audio and/or visual files.”

84. Rolf does not disclose a “wireless device means” of the ’875 claims. Specifically, Rolf does not disclose or teach multiple processors. As detailed above, Rolf discloses a “conventional wireless communications device, such as cellular phones” circa November 1999. Rolf, Ex. 1017 at 7:49-60; (Rolf claiming priority to Provisional Appl. No. 60/167,179, filed Nov. 23, 1999). Conventional cellular phones around the time of November 1999 included only a single processor. The single processor would be a general purpose processor within the device, responsible for handling telecommunications, such as phone calls, requesting, receiving, and transferring data received by the device, processing selections from the user for the device to perform various functions, and other processes.

85. Rolf’s wireless communications device and the Nokia 3210 exemplify a simplistic cellular phone of the late 1990s over which Mr. Mikkelsen and Dr. Friedson sought to improve. Specifically, cellular phones of this era were limited to delivering “...‘ring tones’ with an electronic chime or ring tone rather than an actual recorded song, human voice, or musical composition.” *See* ’875 patent, Ex. 1001 at 1:34-38. Furthermore, their general purpose processor was not a processor primarily dedicated to any particular purpose in the device. Thus, the processor of Rolf is not primarily

dedicated to processing compressed multimedia data.

86. In his declaration, Dr. Kotzin states that the “mobile communications device disclosed in Rolf is the same structure and performs the same function as the ‘wireless device means’ in claim 1. Kotzin Decl. at 39. I disagree. As recognized by the Examiner during prosecution, the conventional cellular phone of Rolf is not equivalent in structure or function to the *unconventional* wireless device means of claim 1 of the ’875 invention. In the Notice of Allowance, the Examiner noted that Rolf “discloses use of a mobile cellular telephone.” Ex. 1002 at 9. With that, the Examiner recognized that Rolf “do[es] not provide teachings and suggestions that would lead one of ordinary skill in the art to implement wireless device means as supported by the instant disclosure and supporting declaration under 37 CFR 1.132.” *Id* at 8-9. For these reasons, Rolf does not disclose or suggest a “wireless device means” as claimed in claim 1 and its dependents.

87. The MP3 Guide does not cure this deficiency in Rolf. As detailed above, the MP3 Guide only discloses loading MP3 music onto devices using wired connections. Nothing in the MP3 Guide discloses the structure of a cellular phone or the like, much less “the *wireless* device means” of claim 1¹⁶ that can receive “compressed audio and/or visual files *wirelessly* over the air.” Ex. 1001, Claim 1

¹⁶ Rolf in combination with MP3 Guide does not teach the “wireless device means” in either claim construction scenario. That is, under the Petitioner’s and Patent Owner’s contention that § 112, ¶ 6 applies, a Skilled Practitioner would not find Rolf or MP3 Guide alone or in combination to teach the “wireless device means.” Alternatively, applying the Board’s instruction that § 112, ¶ 6 does not apply, a Skilled Practitioner would not find Rolf or MP3 Guide alone or in combination to teach the “wireless device means.” See section V.A. for a Skilled Practitioner’s understanding of “wireless device means” in both scenarios.

(emphasis added). Therefore, Rolf in combination with the MP3 Guide does not teach or suggest all the limitations included in claims 1-3, 5, 15-21, and 23 of the '875 patent.

2. **The combination of Rolf and MP3 Guide does not disclose the delivery of a compressed audio and/or visual file to a “wireless device means” independent of an Internet connection or other computer based system (Claim 18).**

88. Petitioner applies the teachings of Rolf and the MP3 Guide in a proposed ground of obviousness as to dependent claim 18. *See* Pet. at 31. Dependent claim 18 depends from claim 1 and adds the additional limitation that the compressed audio and/or visual file is delivered to the wireless device means independent of the Internet.

89. Petitioner and Dr. Kotzin acknowledge that this limitation is not taught by Rolf; neither citing Rolf for support for this limitation. Data transmission under Rolf *requires* an Internet transmission. Rolf, Ex. 1017, 3:17-21. Rolf does not disclose any other means of establishing the wireless communications link. For these reasons, a Skilled Practitioner reviewing Rolf would not consider transmitting data independent the Internet.

90. Despite Rolf's specific and particular solution, Dr. Kotzin argues that Rolf in combination with the MP3 Guide teaches this limitation. I disagree. The MP3 Guide does not teach communicating wirelessly independent the Internet. Dr. Kotzin

points to the disclosure in MP3 Guide related to options for downloading MP3 files either “over the Web or through an FTP server¹⁷.” First, nowhere does MP3 Guide suggest that downloading should be done to a wireless device means.

91. Second, nowhere does MP3 Guide suggest that the FTP server would be accessible *independent* the Internet. An FTP server is just another computer based system that is most typically accessed via the Internet and used for file transfer. A Skilled Practitioner would read MP3 Guide and understand it to disclose downloading of MP3 files over a wired Internet connection over the Web or through an FTP server. Indeed, MP3 Guide explicitly teaches that an FTP server uses the Internet. MP3 Guide, Ex. 1009 at 368 (“File Transfer Protocol. One of the simplest (and oldest) methods of distributing data **on the Internet.**”) (emphasis added). *See also Id.* at 89 (“FTP, or file transfer protocol, **is the Internet’s most basic means of making files available for transfer** between a server and a client. . .”) (emphasis added). Accordingly, Rolf in view of MP3 Guide does not teach or suggest the limitations in claim 18.

3. Rolf in combination with the MP3 Guide also fails to teach or suggests a segment of a full song, musical composition or other audio recording or visual recordings (claim 21).

92. Petitioner applies the teachings of Rolf and the MP3 Guide in a proposed ground of obviousness as to dependent claim 21. *See* Pet. at 32-33. Dependent

¹⁷ The Web is a subset of servers that provide content using HTTP **over the Internet.**

claim 21 depends from claim 1 and adds the additional limitation that the compressed audio and/or visual file is a segment of a full song, musical composition or other audio recording or visual recordings.

93. Petitioner appears to assert that a “segment of a full song, musical composition or other audio recording or visual recordings” reads on a single song from an album. Pet. at 32. I disagree with Petitioner’s view of the term “segment.” In another approach, Petitioner improperly broadens the meaning of “segment” by asserting that just the title of a song and its memory address meet the limitation of “segment...” *Id.* at 33. Petitioner’s interpretation of the meaning of “segment...” in claim 21 is not consistent with a Skilled Practitioner’s understanding.

94. As detailed above in section V.B., a Skilled Practitioner would understand “a segment of a full song, musical composition or other audio recording or visual recordings” to mean “a playable portion of a full song, musical composition or other audio recording or visual recordings.” First, a single song from an album, as taught by Rolf, is not a playable portion of a full song, etc. A song from an album is a *full* song from an album comprising numerous full songs. Second, a title and a memory address, essentially metadata, are not playable portions. The purpose of the “address” is to identify the memory location of the recording in a digital storage locker. Pet. at 33. Similarly, the “title” information Rolf references is just additional, separate metadata, and not the audio and/or visual file itself. Recall that a purpose described in

the specification for the “segment” is to serve as a playable alert on a cellular phone. A song title and memory address cannot serve as a playable alert on a phone. A Skilled Practitioner would interpret a song title and memory address to be within the scope of the “segment” limitation of claim 21. Rolf does not contain any other disclosure relating to a playable segment of a full audio and/or visual file.

95. MP3 Guide does not address this deficiency in Rolf. Petitioner and Dr. Kotzin cite to the MP3 Guide’s disclosure that an MP3 file must first be made from “uncompressed audio”, typically stored as a WAV file, prior to encoding to form a corresponding MP3 file. Pet. at 33, citing Kotzin Decl. at ¶¶ 79-80, citing Ex. 1009 at 4. Petitioners speculate that since the MP3 Guide acknowledges that a WAV file can be modified prior to MP3 encoding, it necessarily follows that such a “modification” includes creating a “segment” or portion of that audio file. The only way to reach Petitioner and Dr. Kotzin’s conclusions is through hindsight.

96. There is no suggestion by MP3 Guide to modify a WAV file such that the uncompressed audio stored within it is no longer the full audio file, but a portion of that audio file. The only conclusion a Skilled Practitioner would draw from this portion of MP3 Guide is that prior to encoding an *entire* music file to MP3, the *entire* file must exist in an uncompressed format, which typically was a WAV file format. That is, one uncompressed audio file emerges from the encoding process as one compressed MP3 file. The encoding process of MP3 Guide does not disclose

segmenting the file into a smaller, playable portion.

97. For these reasons, Rolf in view of MP3 Guide does not disclose or suggest the limitations in claim 21.

B. Section 103(a): Rolf, MP3 Guide, and OFDM/FM

98. Petitioner applies the teachings of Rolf, the MP3 Guide, and the OFDM/FM article in a proposed ground of obviousness as to dependent claim 22. *See* Pet. at 55-56. Petitioner argues that a Skilled Practitioner, when considering how to transfer data over a cellular network, would have “considered and likely used OFDM as a tool to facilitate the transfer of data.” *Id.* at 56. I disagree with Petitioner’s conclusion and Dr. Kotzin’s analysis.

99. Claim 22 depends from claim 1. As I’ve articulated above, the combination of Rolf and the MP3 Guide fails to teach or suggest the limitations required in claim 1. For those reasons already stated, claim 22 is therefore not obvious. Claim 22 adds the additional limitation requiring that the transmission over the cellular network to the “wireless device means” be done using orthogonal frequency-division multiplex (OFDM) modulation. Assuming, *arguendo*, that Rolf and MP3 Guide teach or suggest every limitation of claim 1—they do not—the added combination of the OFDM/FM article fails to teach or suggest the limitations found in claim 22.

100. As detailed above, the OFDM/FM article describes a controlled, experimental study applying a particular synchronization scheme to facilitate OFDM

in a pure ALOHA network. OFDM/FM, Ex. 1015 at 302. Petitioner argues that “OFDM was a well-known method for transmitting data, including transmitting data over a cellular network.” Pet. at 56, citing Dr. Kotzin, ¶ 30. The Petitioner relies upon this misleading statement to then argue that it would have been obvious to combine the teachings of Rolf with the OFDM modulation technique of OFDM/FM to arrive at the invention embodied in claim 22. However, Petitioner’s foundation of its argument—namely that OFDM was a “well-known method for transmitting data...over a cellular network” is inaccurate.

101. At the time of the ’875 invention, 1G and 2G cellular networks did not use OFDM. Additionally, by the time of the ’875 invention extensive research had been undertaken to determine the best-suited air interface for the next-generation, 3G cellular networks. The International Telecommunications Union under the International Mobile Telecommunications-2000 (IMT-2000) moniker was instrumental in researching the best suited air interfaces for the 3G network. IMT-2000 considered W-CDMA, TDMA, OFDM, and hybrid systems¹⁸. As early as 1997, it was clear to researchers that OFDM would not be the selected air interface for 3G networks¹⁹. So while OFDM was known at the time of the ’875 invention, it was viewed by those of extraordinary skill in the art as not a viable solution for a mobile

¹⁸ Ex. 2011, Ojanpera, Tero and Prasad, Ramjee, *An Overview of Air Interface Multiple Access for IMT-2000/UMTS*, IEEE Communications Magazine, Sept. 1998.

¹⁹ *Id.*

cellular network due to its numerous drawbacks²⁰. That is, a Skilled Practitioner at the time of the invention would not consider OFDM to be an advantageous air interface for 3G cellular networks.

102. Dr. Kotzin argues that there are known advantages to OFDM and acknowledges only a few of OFDM's drawbacks. Kotzin Decl. at ¶ 29. I have outlined some of OFDM's shortcomings above in section VI.C.1. At the time of the '875 invention, Skilled Practitioners would have been aware of these drawbacks. Skilled Practitioners would also have been aware of the research undertaken to vet OFDM for next-generation mobile cellular networks, such as 3G. And, a Skilled Practitioner would have been aware that exceptionally skilled practitioners (IMT-2000) had chosen to reject OFDM for mobile cellular networks. Such knowledge would have lead a Skilled Practitioner at the time of the '875 invention to discount OFDM as an option for transmitting data to a wireless device over a mobile cellular network.

1. Rolf discloses a solution that doesn't suffer from the weakness nor is subject to the challenges associated with the methods outlined in OFDM/FM

103. Rolf teaches using a "next- or third-generation" cellular Internet link to transmit packets of encoded music data. There is no teaching or suggestion in Rolf that next- or third-generation cellular networks would not be sufficient for Rolf's purpose. At the time of the '875 invention, next or third-generation cellular Internet

²⁰ *Id.*

links were being designed with the explicit purpose of providing “high-bit-rate multimedia service.”²¹ A Skilled Practitioner, when reviewing Rolf, would simply not be motivated to look elsewhere for a solution to transmitting, for example MP3 audio, to a cellular phone. Rolf not only offers a solution, but dictates that transmitting on a 3G cellular network is preferred. As noted above, a 3G cellular network does not employ OFDM modulation. In fact, OFDM was considered by IMT-2000 during the standards-setting process for 3G cellular networks and was rejected. For these reasons, a Skilled Practitioner reviewing Rolf would not apply the OFDM/FM teachings.

104. The only way to arrive at the combination of Rolf and OFDM/FM is with hindsight. There literally exists dozens (if not more) air interface schemes other than OFDM that can be used and have been used for cellular networks. For example, the following table includes numerous air interfaces considered.

Air Interfaces²²			
CDMA²³	TDMA²⁴	OFDM²⁵	Hybrid
W-CDMA ²⁶ (ETSI ²⁷ , ARIB ²⁸ , TTA ²⁹ II)	ATDMA ³⁰	BDMA ³¹ (Gamma group in ETSI)	TD-CDMA ³²

²¹ Ex. 2011, Ojanpera, Tero and Prasad, Ramjee, *An Overview of Air Interface Multiple Access for IMT-2000/UMTS*, IEEE Communications Magazine, Sept. 1998.

²² Compiled from Ex. 2011, Ojanpera, Tero and Prasad, Ramjee, *An Overview of Air Interface Multiple Access for IMT-2000/UMTS*, IEEE Communications Magazine, Sept. 1998.

²³ Code-division multiple access

²⁴ Time-division multiple access

²⁵ Orthogonal frequency-division multiplexing

²⁶ Wideband code-division multiple access

²⁷ European Telecommunications Standards Institute

²⁸ Association for Radio Industry and Business

²⁹ Telecommunications Technology Association

³⁰ Advanced time-division multiple access

W-CDMA (Korea)	GSM ³³ -compatible ATDMA	---	CTDMA ³⁴
Wideband cdmaOne ³⁵ (TR45.5 ³⁶)	MTDMA ³⁷	---	ODMA ³⁸
FMA2 ³⁹	FMA1 ⁴⁰	---	---

105. OFDM was not implemented in a mobile cellular network until December 2008—7 years after the '875 invention—with the adoption of the LTE standard⁴¹. This much later adoption of OFDM technology to cellular data transmission (seven years after the '875 invention) illustrates that a Skilled Practitioner would not have considered modifying Rolf's teachings with OFDM modulation.

2. Choosing to modify Rolf in view of the teachings of OFDM/FM would require undue experimentation

106. As detailed in the above section, at the time of the invention, many other air interface, or transmission schemes, served as potential methods to transmit rich media files. There is no indication that a Skilled Practitioner would consider the OFDM modulation scheme over a pure ALOHA network as taught by OFDM/FM

³¹ Band-division multiple access explored by Gamma group in European Telecommunications Standards Institute

³² Time-division CDMA

³³ Global System for Mobile Communications

³⁴ Code time-division multiple access

³⁵ Also known as cdma2000

³⁶ Telecommunications Industry Association (U.S.) TR45.5 committee, responsible for IS-95 standardization

³⁷ Multimode and multimedia time-division multiple access

³⁸ Opportunity-driven multiple access

³⁹ FRAMES multiple access, wideband CDMA scheme

⁴⁰ FRAMES multiple access; wideband TDMA scheme

⁴¹ Ex. 2018, *LTE Release 8 of 3GPP Mobile Standard*, 3GPP The Mobile Broadband Standard, available at <http://www.3gpp.org/technologies/keywords-acronyms/98-lte>; *See also*, Ex. 2019, Zyren, Jim, *Overview of the 3GPP Long Term Evolution Physical Layer*, available at http://www.freescale.com/files/wireless_comm/doc/white_paper/3GPPEVOLUTIONWP.pdf, July, 2007.

any more viable than these other available schemes. Indeed, as discussed above, a Skilled Practitioner would consider the OFDM/FM teachings less viable than other options, such as TDMA and CDMA. This is particularly true since a Skilled Practitioner would have been aware of standards-settings bodies in the cellular network arena, for example, IMT-2000, vetting options such as GSM, TDMA, CDMA, and OFDM. Moreover, the Skilled Practitioner would have been aware of IMT-2000's ultimate rejection of OFDM as early as 1997 for 3G networks⁴². A Skilled Practitioner would have no motivation to experiment with all of these techniques, nor would he or she have a reasonable expectation that OFDM in an ALHOA environment would successfully transmit rich media files. Indeed, a Skilled Practitioner would recognize that such a combination would be inoperable. Thus, a Skilled Practitioner would not be motivated to modify Rolf according to the teachings of OFDM/FM.

107. Additionally, a Skilled Practitioner would have to perform undue experimentation to implement the pure ALOHA system disclosed in OFDM/FM on a device disclosed in Rolf. Rolf does not disclose the necessary transceivers to send or receive data on the pure ALOHA system in OFDM/FM. Moreover, the base stations necessary to transmit data to and from the device would need to be modified to be able to receive such a signal in a pure ALOHA system. There is no disclosure in

⁴² Ex. 2011, Ojanpera, Tero and Prasad, Ramjee, *An Overview of Air Interface Multiple Access for IMT-2000/UMTS*, IEEE Communications Magazine, Sept. 1998.

Rolf or OFDM/FM of a method for transmitting at a low enough error rate for the transmission of compressed multimedia data. A Skilled Practitioner would be left to conduct undue experimentation to render a system using the device of Rolf implementing the transmission modulation protocol of OFDM/FM to utilize OFDM in the data transmission.

3. Rolf and OFDM/FM are not combinable

108. As stated above, at the time of the invention, the use of OFDM on cellular networks was not routine, and in fact, had been rejected for consideration for the 3G air interface. Combining Rolf and OFDM/FM would not create predictable results. Moreover, there would be no expectation of success when combining the teachings of Rolf and OFDM/FM. The teachings of Rolf and the OFDM/FM paper are physically and technically incompatible. Structurally, the cellular device taught in Rolf would require dramatic changes to utilize OFDM transmission.

109. A Skilled Practitioner would not combine Rolf with the OFDM/FM paper due to the fact Rolf teaches a “conventional cellular phone” that operated using a “next- or third generation network.” Strictly speaking, a conventional cellular phone at the time of Rolf was a Nokia 3210 operating on a 2G network, or at a frequency of 800 MHz/1900 MHz. AMPS and 3G cellular networks operate in a similar frequency range. The OFDM/FM paper operates at a much lower frequency of 144 MHz. For this reason alone, the teachings of Rolf and OFDM/FM cannot be combined.


110. Moreover, to transmit MP3 data as taught by Rolf, a Skilled Practitioner would appreciate that a high-quality transmission system with a low BER, better than 1×10^{-6} would be required⁴³. The techniques taught in the OFDM/FM paper result in insufficiently high BER. A Skilled Practitioner would not consider combining the teachings of the OFDM/FM paper with Rolf, since such a combination would likely require additional error control techniques to be implemented on the receiver. Additional error control techniques applied at the receiver would increase the cost and complexity of the receiver design.

111. Another point of incongruity between Rolf and the OFDM/FM paper is the network architecture of each respective system. Again, Rolf teaches a cellular Internet link on a “next- or third-generation” network. Such a network transmits data at pre-determined time intervals or timeslots. This basic network architecture is incompatible with the pure ALOHA network infrastructure taught by Rolf, which transmits data whenever the data is ready, regardless of whether or not another station is transmitting data on the same channel. A Skilled Practitioner, when analyzing the two references would have no expectation of success when combining their teachings since the network infrastructures are incompatible. That is, 2G and 3G cellular networks as taught by Rolf, transmit data at predefined times, or timeslots, a methodology that reduces interference and increase throughput as compared to the

⁴³ See, Ex. 2020, Phadke, Arun G., *Handbook of Electrical Engineering Calculations*, 1999 at 170.

pure ALOHA network as taught by the OFDM/FM paper. A Skilled Practitioner would therefore not be motivated to combine the teachings of the OFDM/FM paper with Rolf.

I declare under penalty of perjury that the foregoing is true and correct.
Sworn to this 29th day of April 2015.


Dr. Kevin C. Almeroth

APPENDIX A

Kevin C. Almeroth

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Education

- Ph.D.** June 1997 *Georgia Institute of Technology* Computer Science
Dissertation Title: Networking and System Support for the Efficient, Scalable Delivery of Services in Interactive Multimedia Systems
Minor: Telecommunications Public Policy
- M.S.** June 1994 *Georgia Institute of Technology* Computer Science
Specialization: Networking and Systems
- B.S.** June 1992 *Georgia Institute of Technology* Information and Computer Science
(high honors) *Minors:* Economics, Technical Communication, American Literature

Employment History

Professor	Department of Computer Science University of California Santa Barbara, CA	Jul 2005 -- present
Associate Dean	College of Engineering University of California Santa Barbara, CA	Mar 2007 -- Aug 2009
Vice Chair	Department of Computer Science University of California Santa Barbara, CA	Jul 2000 -- Nov 2005
Associate Professor	Department of Computer Science University of California Santa Barbara, CA	Jul 2001 -- Jun 2005
Assistant Professor	Department of Computer Science University of California Santa Barbara, CA	Jul 1997 -- Jun 2001
Graduate Researcher	Broadband Telecommunications Center Georgia Center for Adv Telecom Tech Atlanta, GA	Sep 1996--Jun 1997
Graduate Intern	IBM T.J. Watson Research Labs Hawthorne, NY	Jun 1995--Sep 1995

Support Specialist	Office of Information Technology Georgia Institute of Technology Atlanta, GA	Sep 1995--Jun 1997
Research Assistant	College of Computing Georgia Institute of Technology Atlanta, GA	Jan 1994--Mar 1994
Graduate Intern	Hitachi Telecommunications Norcross, GA	Jun 1992--Sep 1992

Industry Technical Advising

Board of Directors	The New Media Studio Santa Barbara, CA	Nov 2006 -- present
Co-Founder & Chairman of the Board	Santa Barbara Labs, LLC Santa Barbara, CA	Sep 2007 -- Dec 2009
Board of Advisors	Techknowledge Point Santa Barbara, CA	May 2001 -- Dec 2007
Technical Advisory Board	Occam Networks, Inc. Santa Barbara, CA	May 2000 -- Dec 2010
Board of Advisors	Airplay Inc. San Francisco, CA	Jun 2005 -- Aug 2009
Consultant	Lockheed Martin Corporation San Jose, CA	Nov 1999 -- Jun 2009
Board of Advisors	Santa Barbara Technology Group Santa Barbara, CA	Sep 2000 -- Dec 2004
Board of Directors	Virtual Bandwidth, Inc. Santa Barbara, CA	Nov 2000 -- Jun 2001
Board of Advisors & Affiliated Scientist	Digital Fountain San Francisco, CA	Jan 2000 -- Dec 2001
Senior Technologist	IP Multicast Initiative, Stardust Forums Campbell, CA	Jun 1998 -- Dec 2000

I. Teaching

A. Courses Taught

CS 176A	Intro to Computer Communication Networks	Fall 1997, Fall 1998, Fall 2002, Fall 2003, Fall 2004, Spring 2005, Spring 2006, Spring 2007, Spring 2008, Fall 2008, Fall 2009, Fall 2010, Fall 2011, Fall 2012, Fall 2013, Fall 2014
CS 176B	Network Computing	Winter 2000, Winter 2001, Winter 2002, Winter 2012, Winter 2014, Winter 2015
MAT 201B	Media Networks and Services	Fall 1999, Fall 2000, Fall 2001, Fall 2003
CS 276	Distributed Computing and Computer Networks	Winter 1999, Spring 2000, Fall 2002, Fall 2005

CS 290I	Networking for Multimedia Systems	Winter 1998, Spring 1999, Fall 2004, Winter 2010
CS 595N	Technology and Society	Winter 2005, Fall 2005, Spring 2006, Fall 2006, Spring 2007, Fall 2007, Spring 2008, Fall 2008, Spring 2009
CS 595N	Economic Systems Seminar	Winter 2004, Spring 2004, Winter 2005, Spring 2005
CS 595N	Networking Seminar	Winter 1999, Fall 1999, Winter 2003
CS 595N	Wireless Networking & Multimedia Seminar	Fall 2000
CS 595I	Systems Design and Implementation Seminar	Fall 1999, Fall 2000, Winter 2001, Spring 2001, Winter 2002, Spring 2002

B. Other Teaching Experience

- *The Evolution of Advanced Networking Services: From the ARPAnet to Internet2*, Instructor, Summer 2001. Short course taught at Escuela de Ciencias Informatica (ECI) sponsored by the Universidad de Buenos Aires.
- *Johns Hopkins Center for Talented Youth*, Instructor, Summer 1994. CTY is a program to teach gifted high school students the fundamentals of computer science.
- *Georgia Institute of Technology*, Graduate Teaching Assistant, Sep 1994--Sep 1996. Worked as a TA for 12 quarters teaching 7 different courses (4 undergraduate and 3 graduate).

C. Ph.D. Students Advised [14 graduated]

14. Daniel Havey
Research Area: *Throughput and Delay on the Packet Switched Internet*
Date Graduated: Winter 2015
First Position: Microsoft
13. Lara Deek (co-advised with E. Belding)
Research Area: *Resource-Efficient Wireless Systems for Emerging Wireless Networks*
Date Graduated: Summer 2014
First Position: Post Doc, UIUC
12. Mike Wittie
Research Area: *Towards Sustained Scalability of Communication Networks*
Date Graduated: Summer 2011
First Position: Assistant Professor, Montana State University
11. Allan Knight
Research Area: *Supporting Integration of Educational Technologies and Research of Their Effects on Learning*
Date Graduated: Summer 2009
First Position: Research Scientist, Citrix Online
10. Hangjin Zhang
Research Area: *Towards Blended Learning: Educational Technology to Improve and Assess Teaching and Learning*
Date Graduated: Spring 2009
First Position: Microsoft
9. Gayatri Swamynathan
Dissertation Title: *Towards Reliable Reputations for Distributed Applications*
Date Graduated: Spring 2008
First Position: Zynga
8. Amit Jardosh (co-advised with E. Belding)
Dissertation Title: *Adaptive Large-Scale Wireless Networks: Measurements, Protocol Designs, and Simulation Studies*
Date Graduated: Fall 2007
First Position: Yahoo!

7. Khaled Harras
Dissertation Title: *Protocol and Architectural Challenges in Delay and Disruption Tolerant Networks*
Date Graduated: Summer 2007
First Position: Assistant Professor, Carnegie Mellon University
6. Krishna Ramachandran (co-advised with E. Belding)
Dissertation Title: *Design, Deployment, and Management of High-Capacity Wireless Mesh Networks*
Date Graduated: Winter 2006
First Position: Research Scientist, Citrix Online
5. Robert Chalmers
Dissertation Title: *Improving Device Mobility with Intelligence at the Network Edge*
Date Graduated: Summer 2004
First Position: President and CEO, Limbo.net
4. Prashant Rajvaidya
Dissertation Title: *Achieving Robust and Secure Deployment of Multicast*
Date Graduated: Spring 2004
First Position: President and CTO, Mosaic Networking
3. Sami Rollins
Dissertation Title: *Overcoming Resource Constraints to Enable Content Exchange Applications in Next-Generation Environments*
Date Graduated: Spring 2003
First Position: Assistant Professor, Mount Holyoke College
2. Srinivasan Jagannathan
Dissertation Title: *Multicast Tree-Based Congestion Control and Topology Management*
Date Graduated: Spring 2003
First Position: Consultant, Kelly & Associates
1. Kamil Sarac
Dissertation Title: *Supporting a Robust Multicast Service in the Global Infrastructure*
Date Graduated: Spring 2002
First Position: Assistant Professor, UT-Dallas

D. M.S. Students Advised (Thesis/Project Option) [19 graduated and 1 current]

20. Greg Parsons
Research Area: *Drone-Based Mesh Networks*
Date Started: Fall 2014
19. Neer Shey
Research Area: *Analyzing Content Distribution Through Opportunistic Contact for Smart Cellular Phones*
Date Graduated: Spring 2010
18. Camilla Fiorese
Research Area: *Analysis of a Pure Rate-Based Congestion Control Algorithm*
Date Graduated: Summer 2009
17. Brian Weiner
Research Area: *Multi-Socket TCP: A Simple Approach to Improve Performance of Real-Time Applications over TCP*
Date Graduated: Fall 2007
16. Avijit Sen Mazumder
Research Area: *Facilitating Robust Multicast Group Management*
Date Graduated: Fall 2005
15. Rishi Matthew
Thesis Title: *Providing Seamless Access to Multimedia Content on Heterogeneous Platforms*
Date Graduated: Summer 2004
14. Camden Ho
Research Area: *Tools and Techniques for Wireless Network Management*
Date Graduated: Spring 2004
13. Amit Jardosh (co-advised with E. Belding)
Research Area: *Realistic Environment Models for Mobile Network Evaluation*
Date Graduated: Spring 2004
12. Nitin Solanki
Research Area: *SongWand: A Wireless Barcode Scanner Using Bluetooth Technology*

- Date Graduated: Winter 2004
11. Vrishali Wagle (co-advised with E. Belding)
Research Area: *An Ontology-Based Service Discovery Mechanism*
Date Graduated: Winter 2004
 10. Uday Mohan
Thesis Title: *Scalable Service Discovery in Mobile Ad hoc Networks*
Date Graduated: Spring 2003
 9. Krishna Ramachandran
Thesis Title: *Ubiquitous Multicast*
Date Graduated: Spring 2003
 8. John Slonaker
Thesis Title: *Inductive Loop Signature Acquisition Techniques*
Date Graduated: Spring 2002
 7. Mohammad Battah
Thesis Title: *Dedicated Short-Range Communications Intelligent Transportation Systems Protocol (DSRC-ITS)*
Date Graduated: Spring 2002
 6. Kevin Vogel
Thesis Title: *Integrating E-Commerce Applications into Existing Business Infrastructures*
Date Graduated: Spring 2001
 5. Sami Rollins
Thesis Title: *Audio Xml: Aural Interaction with XML Documents*
Date Graduated: Winter 2000
 4. Andy Davis
Thesis Title: *Stream Scheduling for Data Servers in a Scalable Interactive TV System*
Date Graduated: Spring 1999
 3. David Makofske
Thesis Title: *MHealth: A Real-Time Graphical Multicast Monitoring Tool*
Date Graduated: Winter 1999
 2. Prashant Rajvaidya
Thesis Title: *MANTRA: Router-Based Monitoring and Analysis of Multicast Traffic*
Date Graduated: Winter 1999
 1. Alex DeCastro (co-advised with Yuan-Fang Wang)
Thesis Title: *Web-Based Collaborative 3D Modeling*
Date Graduated: Winter 1998

E. Teaching Awards

2006-2007 UCSB Academic Senate Distinguished Teaching Award
 2004-2005 Computer Science Outstanding Faculty Member
 2000-2001 UCSB Spotlight on Excellence Award
 1999-2000 Computer Science Outstanding Faculty Member (co-recipient)
 1998-1999 Computer Science Outstanding Faculty Member (co-recipient)
 1997-1998 Computer Science Outstanding Faculty Member

II. Research

A. Journal Papers, Magazine Articles, Books, and Book Chapters

61. L. Deek, E. Garcia-Villegas, E. Belding, S.J. Lee, and K. Almeroth, "[Intelligent Channel Bonding in 802.11n WLANs](#)," *IEEE Transactions on Mobile Computing*, vol. 13, num. 6, pp. 1242-1255, June 2014.
60. H. Zhang and K. Almeroth, "[Alternatives for Monitoring and Limiting Network Access to Students in Network-Connected Classrooms](#)," *Journal of Interactive Learning Research (JILR)*, vol. 24, num. 3, pp. 237-265, July 2013.

59. M. Tavakolifard and K. Almeroth, "[A Taxonomy to Express Open Challenges in Trust and Reputation Systems](#)," *Journal of Communications*, vol. 7, num. 7, pp. 538-551, July 2012.
58. M. Tavakolifard and K. Almeroth, "[Social Computing: An Intersection of Recommender Systems, Trust/Reputation Systems, and Social Networks](#)," *IEEE Network*, vol. 26, num. 4, pp. 53-58, July/August 2012.
57. M. Tavakolifard, K. Almeroth, and P. Ozturk, "[Subjectivity Handling of Ratings for Trust and Reputation Systems: An Abductive Reasoning Approach](#)," *International Journal of Digital Content Technology and its Applications (JDCTA)*, vol. 5, num. 11, pp. 359-377, November 2011.
56. R. Raghavendra, P. Acharya, E. Belding and K. Almeroth, "[MeshMon: A Multi-Tiered Framework for Wireless Mesh Network Monitoring](#)," *Wireless Communications and Mobile Computing (WCMC) Journal*, vol. 11, num. 8, pp. 1182-1196, August 2011.
55. A. Knight and K. Almeroth, "[Automatic Plagiarism Detection with PAIRwise 2.0](#)," *Journal of Interactive Learning Research (JILR)*, vol. 22, num. 3, pp. 379-400, July 2011.
54. V. Kone, M. Zheleva, M. Wittie, B. Zhao, E. Belding, H. Zheng, and K. Almeroth, "[AirLab: Consistency, Fidelity and Privacy in Wireless Measurements](#)," *ACM Computer Communications Review*, vol. 41, num. 1, pp. 60-65, January 2011.
53. G. Swamynathan, K. Almeroth, and B. Zhao, "[The Design of a Reliable Reputation System](#)," *Electronic Commerce Research Journal*, vol. 10, num. 3-4, pp. 239-270, December 2010.
52. P. Acharya, A. Sharma, E. Belding, K. Almeroth and K. Papagiannaki, "[Rate Adaptation in Congested Wireless Networks through Real-Time Measurements](#)," *IEEE Transactions on Mobile Computing*, vol. 9, num. 11, pp. 1535-1550, November 2010.
51. R. Raghavendra, E. Belding, K. Papagiannaki, and K. Almeroth, "[Unwanted Link Layer Traffic in Large IEEE 802.11 Wireless Networks](#)," *IEEE Transactions on Mobile Computing*, vol. 9, num. 9, pp. 1212-1225, September 2010.
50. H. Zhang and K. Almeroth, "[Moodog: Tracking Student Activity in Online Course Management Systems](#)," *Journal of Interactive Learning Research (JILR)*, vol. 21, num. 3, pp. 407-429, July 2010.
49. R. Chertov and K. Almeroth, "[Qualitative Comparison of Link Shaping Techniques](#)," *International Journal of Communication Networks and Distributed Systems*, vol. 5, num. 1/2, pp. 109-129, July 2010.
48. A. Knight and K. Almeroth, "[Fast Caption Alignment for Automatic Indexing of Audio](#)," *International Journal of Multimedia Data Engineering and Management*, vol. 1, num. 2, pp. 1-17, April-June 2010.
47. K. Harras and K. Almeroth, "[Scheduling Messengers in Disconnected Clustered Mobile Networks](#)," *Ad Hoc & Sensor Wireless Networks*, vol. 9, num. 3-4, pp. 275-304, March-April 2010.
46. A. Jardosh, K. Papagiannaki, E. Belding, K. Almeroth, G. Iannaccone, and B. Vinnakota, "[Green WLANs: On-Demand WLAN Infrastructures](#)," *ACM Journal on Mobile Networks and Applications (MONET)*, vol. 14, num. 6, pp. 798-814, December 2009.
45. M. Wittie, K. Harras, K. Almeroth, and E. Belding, "[On the Implications of Routing Metric Staleness in Delay Tolerant Networks](#)," *Computer Communications Special Issue on Delay and Disruption Tolerant Networking*, vol. 32, num. 16, pp. 1699-1709, October 2009.
44. K. Harras, L. Deek, C. Holman, and K. Almeroth, "[DBS-IC: An Adaptive Data Bundling System for Intermittent Connectivity](#)," *Computer Communications Special Issue on Delay and Disruption Tolerant Networking*, vol. 32, num. 16, pp. 1687-1698, October 2009.
43. S. Karpinski, E. Belding, K. Almeroth, and J. Gilbert, "[Linear Representations of Network Traffic](#)," *ACM Journal on Mobile Networks and Applications (MONET)*, vol. 14, num. 4, pp. 368-386, August 2009.
42. K. Harras and K. Almeroth, "[Controlled Flooding in Disconnected Sparse Mobile Networks](#)," *Wireless Communications and Mobile Computing (WCMC) Journal*, vol. 9, num. 1, pp. 21-33, January 2009.
41. R. Mayer, A. Stull, K. DeLeeuw, K. Almeroth, B. Bimber, D. Chun, M. Bulger, J. Campbell, A. Knight, and H. Zhang, "[Clickers in College Classrooms: Fostering Learning with Questioning Methods in Large Lecture Classes](#)," *Contemporary Educational Psychology*, vol. 34, num. 1, pp. 51-57, January 2009.
40. A. Knight, K. Almeroth, and B. Bimber, "[Design, Implementation and Deployment of PAIRwise](#)," *Journal of Interactive Learning Research (JILR)*, vol. 19, num. 3, pp. 489-508, July 2008.

39. A. Garyfalos and K. Almeroth, "[Coupons: A Multilevel Incentive Scheme for Information Dissemination in Mobile Networks](#)," *IEEE Transactions on Mobile Computing*, vol. 7, num. 6, pp. 792-804, June 2008.
38. I. Sheriff, K. Ramachandran, E. Belding, and K. Almeroth, "[A Multi-Radio 802.11 Mesh Network Architecture](#)," *ACM Journal on Mobile Networks and Applications (MONET)*, vol. 13, num. 1-2, pp. 132-146, April 2008.
37. M. Bulger, R. Mayer, K. Almeroth, and S. Blau, "[Measuring Learner Engagement in Computer-Equipped College Classrooms](#)," *Journal of Educational Multimedia and Hypermedia*, vol. 17, num. 2, pp. 129-143, April 2008.
36. G. Swamynathan, B. Zhao, and K. Almeroth, "[Exploring the Feasibility of Proactive Reputations](#)," *Concurrency and Computation: Practice and Experience*, vol. 20, num. 2, pp. 155-166, February 2008.
35. G. Swamynathan, B. Zhao, K. Almeroth, and H. Zheng, "[Globally Decoupled Reputations for Large Distributed Networks](#)," *Advances in Multimedia*, vol. 2007, pp. 1-14, 2007.
34. R. Mayer, A. Stull, J. Campbell, K. Almeroth, B. Bimber, D. Chun and A. Knight, "[Overestimation Bias in Self-reported SAT Scores](#)," *Educational Psychology Review*, vol. 19, num. 4, pp. 443-454, December 2007.
33. P. Namburi, K. Sarac and K. Almeroth, "[Practical Utilities for Monitoring Multicast Service Availability](#)," *Computer Communications Special Issue on Monitoring and Measurement of IP Networks*, vol. 29, num. 10, pp. 1675-1686, June 2006.
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C. Workshop Papers (refereed)

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33. M. Tavakolifard, K. Almeroth, and J. Gulla, "[Does Social Contact Matter? Modelling the Hidden Web of Trust Underlying Twitter](#)," *ACM International Workshop on Social Recommender Systems (SRS)*, Rio de Janeiro, BRAZIL, May 2013.
32. D. Johnson, E. Belding, K. Almeroth and G. van Stam, "[Internet Usage and Performance Analysis of a Rural Wireless Network in Macha, Zambia](#)," *ACM Networked Systems for Developing Regions (NSDR) Workshop*, San Francisco, California, USA, June 2010.
31. D. Havey, R. Chertov, and K. Almeroth, "[Wired Wireless Broadcast Emulation](#)," *International Workshop on Wireless Network Measurement (WiNMee)*, Seoul, Korea, June 2009.
30. R. Raghavendra, P. Acharya, E. Belding, and K. Almeroth, "[MeshMon: A Multi-Tiered Framework for Wireless Mesh Network Monitoring](#)," *ACM Mobihoc Wireless of the Students, by the Students, for the Students Workshop (S3)*, New Orleans, Louisiana, USA, May 2009.
29. G. Swamynathan, C. Wilson, B. Boe, B. Zhao, and K. Almeroth, "[Do Social Networks Improve e-Commerce: A Study on Social Marketplaces](#)," *ACM Sigcomm Workshop on Online Social Networks (WOSN)*, Seattle, Washington, USA, August 2008.
28. R. Raghavendra, E. Belding, and K. Almeroth, "[Antler: A Multi-Tiered Approach to Automated Wireless Network Management](#)," *IEEE Workshop on Automated Network Management (ANM)*, Phoenix, Arizona, USA, April 2008.
27. S. Karpinski, E. Belding, and K. Almeroth, "[Towards Realistic Models of Wireless Workload](#)," *International Workshop on Wireless Network Measurement (WiNMee)*, Limassol, CYPRUS, April 2007.
26. K. Harras, M. Wittie, K. Almeroth, and E. Belding, "[ParaNets: A Parallel Network Architecture for Challenged Networks](#)," *IEEE Workshop on Mobile Computing Systems and Applications (HotMobile)*, Tucson, Arizona, USA, February 2007.
25. H. Caituiro-Monge, K. Almeroth, M. del Mar Alvarez-Rohena, "[Friend Relay: A Resource Sharing Framework for Mobile Wireless Devices](#)," *ACM International Workshop on Wireless Mobile Applications and Services on WLAN Hotspots (WMASH)*, Los Angeles, California, September 2006.

24. G. Swamynathan, Ben Y. Zhao and K. Almeroth, "[Exploring the Feasibility of Proactive Reputations](#)," *International Workshop on Peer-to-Peer Systems (IPTPS)*, Santa Barbara, California, USA, February 2006.
23. G. Swamynathan, Ben Y. Zhao and K. Almeroth, "[Decoupling Service and Feedback Trust in a Peer-to-Peer Reputation System](#)," *International Workshop on Applications and Economics of Peer-to-Peer Systems (AEPP)*, Nanjing, CHINA, November 2005.
22. K. Ramachandran, M. Buddhikot, G. Chandranmenon, S. Miller, E. Belding, and K. Almeroth, "[On the Design and Implementation of Infrastructure Mesh Networks](#)," *IEEE Workshop on Wireless Mesh Networks (WiMesh)*, Santa Clara, California, USA, September 2005.
21. A. Jardosh, K. Ramachandran, K. Almeroth and E. Belding, "[Understanding Link-Layer Behavior in Highly Congested IEEE 802.11b Wireless Networks](#)," *Sigcomm Workshop on Experimental Approaches to Wireless Network Design and Analysis (EWIND)*, Philadelphia, Pennsylvania, USA, August 2005.
20. A. Sen Mazumder, K. Almeroth and K. Sarac, "[Facilitating Robust Multicast Group Management](#)," *Network and Operating System Support for Digital Audio and Video (NOSSDAV)*, Skamania, Washington, USA, June 2005.
19. Y. Sun, I. Sheriff, E. Belding and K. Almeroth, "[An Experimental Study of Multimedia Traffic Performance in Mesh Networks](#)," *MobiSys International Workshop on Wireless Traffic Measurements and Modeling (WitMeMo)*, Seattle, Washington, USA, June 2005.
18. K. Ramachandran, K. Almeroth and E. Belding, "[A Framework for the Management of Large-Scale Wireless Network Testbeds](#)," *International Workshop on Wireless Network Measurement (WiNMe)*, Trentino, ITALY, April 2005.
17. A. Garyfalos, K. Almeroth and K. Sanzgiri, "[Deployment Complexity Versus Performance Efficiency in Mobile Multicast](#)," *International Workshop on Broadband Wireless Multimedia: Algorithms, Architectures and Applications (BroadWiM)*, San Jose, California, USA, October 2004.
16. C. Ho, K. Ramachandran, K. Almeroth and E. Belding, "[A Scalable Framework for Wireless Network Monitoring](#)," *ACM International Workshop on Wireless Mobile Applications and Services on WLAN Hotspots (WMASH)*, Philadelphia, Pennsylvania, USA, October 2004.
15. A. Garyfalos, K. Almeroth and J. Finney, "[A Hybrid of Network and Application Layer Multicast for Mobile IPv6 Networks](#)," *International Workshop on Large-Scale Group Communication (LSGC)*, Florence, ITALY, October 2003.
14. A. Garyfalos, K. Almeroth and J. Finney, "[A Comparison of Network and Application Layer Multicast for Mobile IPv6 Networks](#)," *ACM Workshop on Modeling, Analysis and Simulation of Wireless and Mobile Systems (MSWiM)*, San Diego, California, USA, September 2003.
13. S. Jagannathan, and K. Almeroth, "[Pricing and Resource Provisioning for Delivering E-Content On-Demand with Multiple Levels-of-Service](#)," *International Workshop on Internet Charging and QoS Technologies (ICQT)*, Zurich, SWITZERLAND, October 2002.
12. S. Rollins, K. Almeroth, D. Milojicic, and K. Nagaraja, "[Power-Aware Data Management for Small Devices](#)," *Workshop on Wireless Mobile Multimedia (WoWMoM)*, Atlanta, GA, USA, September 2002.
11. K. Almeroth, S. Bhattacharyya, and C. Diot, "[Challenges of Integrating ASM and SSM IP Multicast Protocol Architectures](#)," *International Workshop on Digital Communications: Evolutionary Trends of the Internet (IWDC)*, Taormina, ITALY, September 2001.
10. K. Sarac and K. Almeroth, "[Scalable Techniques for Discovering Multicast Tree Topology](#)," *Network and Operating System Support for Digital Audio and Video (NOSSDAV)*, Port Jefferson, New York, USA, June 2001.
9. P. Rajvaidya, K. Almeroth and K. Claffy, "[A Scalable Architecture for Monitoring and Visualizing Multicast Statistics](#)," *IFIP/IEEE International Workshop on Distributed Systems: Operations & Management (DSOM)*, Austin, Texas, USA, December 2000.
8. S. Jagannathan, K. Almeroth and A. Acharya, "[Topology Sensitive Congestion Control for Real-Time Multicast](#)," *Network and Operating System Support for Digital Audio and Video (NOSSDAV)*, Chapel Hill, North Carolina, USA, June 2000.
7. K. Sarac and K. Almeroth, "[Supporting the Need for Inter-Domain Multicast Reachability](#)," *Network and Operating System Support for Digital Audio and Video (NOSSDAV)*, Chapel Hill, North Carolina, USA, June 2000.
6. D. Makofske and K. Almeroth, "[MHealth: A Real-Time Multicast Tree Visualization and Monitoring Tool](#)," *Network and Operating System Support for Digital Audio and Video (NOSSDAV)*, Basking Ridge New Jersey, USA, June 1999.

5. K. Almeroth and Y. Zhang, "[Using Satellite Links as Delivery Paths in the Multicast Backbone \(MBone\)](#)," *ACM/IEEE International Workshop on Satellite-Based Information Services (WOSBIS)*, Dallas, Texas, USA, October 1998.
4. M. Ammar, K. Almeroth, R. Clark and Z. Fei, "[Multicast Delivery of Web Pages OR How to Make Web Servers Pushy](#)," *Workshop on Internet Server Performance (WISP)*, Madison, Wisconsin, USA, June 1998.
3. K. Almeroth and M. Ammar, "[Prototyping the Interactive Multimedia Jukebox](#)," *Mini-conference on Multimedia Appliances, Interfaces, and Trials--International Conference on Communications (ICC)*, Montreal, Quebec, CANADA, June 1997.
2. K. Almeroth and M. Ammar, "[Collection and Modeling of the Join/Leave Behavior of Multicast Group Members in the MBone](#)," *High Performance Distributed Computing Focus Workshop (HPDC)*, Syracuse, New York, USA, August 1996.
1. K. Almeroth and M. Ammar, "[The Role of Multicast Communication in the Provision of Scalable and Interactive Video-On-Demand Service](#)," *Network and Operating System Support for Digital Audio and Video (NOSSDAV)*, Durham, New Hampshire, USA, April 1995.

D. Non-Refereed Publications

8. K. Almeroth, E. Belding, M. Buddhikot, G. Chandranmenon, S. Miller, and K. Ramachandran, "[Infrastructure Mesh Networks](#)," *U.S. Patent Application US20070070959 A1*, September 2005.
7. K. Almeroth, R. Caceres, A. Clark, R. Cole, N. Duffield, T. Friedman, K. Hedayat, K. Sarac, M. Westerlund, "[RTP Control Protocol Extended Reports \(RTCP XR\)](#)," *Internet Engineering Task Force (IETF) Request for Comments (RFC) 3611*, November 2003.
6. Z. Albanna, K. Almeroth, D. Meyer, and M. Schipper, "[IANA Guidelines for IPv4 Multicast Address Allocation](#)," *Internet Engineering Task Force (IETF) Request for Comments (RFC) 3171*, August 2001.
5. B. Quinn and K. Almeroth, "[IP Multicast Applications: Challenges and Solutions](#)," *Internet Engineering Task Force (IETF) Request for Comments (RFC) 3170*, September 2001.
4. K. Almeroth, L. Wei and D. Farinacci, "[Multicast Reachability Monitor \(MRM\) Protocol](#)," *Internet Engineering Task Force Internet Draft*, July 2000.
3. K. Almeroth and L. Wei, "[Justification for and use of the Multicast Reachability Monitor \(MRM\) Protocol](#)," *Internet Engineering Task Force Internet Draft*, March 1999.
2. K. Almeroth, "[Managing IP Multicast Traffic: A First Look at the Issues, Tools, and Challenges](#)," IP Multicast Initiative White Paper, San Jose, California, USA, February 1999.
1. K. Almeroth, K. Obraczka and D. De Lucia, "[Pseudo-IP: Providing a Thin Network Protocol for Semi-Intelligent Wireless Devices](#)," *DARPA/NIST Smart Spaces Workshop*, Gaithersburg, Maryland, USA, July 1998.

E. Released Software Systems

19. **A Multi-radio Wireless Mesh Network Architecture** -- <http://moment.cs.ucsb.edu/tic/>. Released December 1, 2006 (with K. Ramachandran, I. Sheriff, and E. Belding). The software as part of a multi-radio wireless mesh network that includes a Split Wireless Router that alleviates the interference that can occur between commodity radios within a single piece of hardware. The second is server software to perform channel assignment and communicate the assignments throughout the mesh network.
18. **AODV-Spanning Tree (AODV-ST)** -- <http://www.cs.ucsb.edu/~krishna/aodv-st/>. Released September 1, 2006 (with K. Ramachandran and E. Belding). AODV-ST is an extension of the well-known AODV protocol specifically designed for wireless mesh networks. The advantages of AODV-ST over AODV include support for high throughput routing metrics, automatic route maintenance for common-case traffic, and low route discovery latency.
17. **The Multicast Detective** -- http://www.nmsl.cs.ucsb.edu/mcast_detective/. Released September 1, 2005 (with A. Sen Mazumder). The multicast detective is a robust solution to determine the existence and nature of multicast service for a particular user. By performing a series of tests, a user can determine whether there is network support for multicast, and consequently, whether a

multicast group join is likely to succeed.

16. **AutoCap: Automatic and Accurate Captioning** -- <http://www.nmsl.cs.ucsb.edu/autocap/>. Released August 1, 2005 (with A. Knight). AutoCap is a software system that takes as input an audio/video file and a text transcript. AutoCap creates captions by aligning the utterances in the audio/video file to the transcript. For those words that are not recognized, AutoCap estimates when the words were spoken along with an error bound that gives the content creator an idea of caption accuracy. The result is a collection of accurately time-stamped captions that can be displayed with the video.
15. **PAIRwise Plagiarism Detection System** -- <http://cits.ucsb.edu/pair/>. Released July 1, 2005 (with A. Knight). PAIRwise is a plagiarism detection system with: (1) an easy-to-use interface for submitting papers, (2) a flexible comparison engine that allows intra-class, inter-class, and Internet-based comparisons, and (3) an intuitive graphical presentation of results.
14. **DAMON Multi-Hop Wireless Network Monitoring** -- <http://moment.cs.ucsb.edu/damon/>. Released October 1, 2004 (with K. Ramachandran and E. Belding). DAMON is a distributed system for monitoring multi-hop mobile networks. DAMON uses agents within the network to monitor network behavior and send collected measurements to data repositories. DAMON's generic architecture supports the monitoring of a wide range of protocol, device, or network parameters.
13. **Multicast Firewall** -- <http://www.nmsl.cs.ucsb.edu/mafia/>. Released June 1, 2004 (with K. Ramachandran). MAFIA, a multicast firewall and traffic management solution, has the specific aim of strengthening multicast security through multicast access control, multicast traffic filtering, and DoS attack prevention.
12. **AODV@IETF Peer Routing Software** -- <http://moment.cs.ucsb.edu/aodv-ietf/>. Released November 1, 2003 (with K. Ramachandran and E. Belding). One of the first large-scale efforts to run the Ad hoc On demand Distance Vector (AODV) routing protocol in a public space (at the Internet Engineering Task Force (IETF)). The implementation includes a daemon that runs on both the Linux and Windows operating systems.
11. **Mobility Obstacles** -- <http://moment.cs.ucsb.edu/mobility/>. Released September 1, 2003 (with A. Jardosh, E. Belding, and S. Suri). The topology and movement of nodes in ad hoc protocol simulation are key factors in protocol performance. In this project, we have developed ns-2 simulation plug-ins that create more realistic movement models through the incorporation of obstacles. These obstacles are utilized to restrict both node movement and wireless transmissions.
10. **mwalk** -- <http://www.nmsl.cs.ucsb.edu/mwalk/>. Released December 1, 2000 (with R. Chalmers). Mwalk is a collection of Java applications and Perl scripts which re-create a global view of a multicast session from mtrace and RTCP logs. Users to the site can download mwalk, examine the results of our analysis, or download data sets for use in simulations dependent on multicast tree characteristics.
9. **MANTRA2** -- <http://www.nmsl.cs.ucsb.edu/mantra/>. Released December 1, 1999 (with P. Rajvaidya). This new version of MANTRA focuses on the visualization of inter-domain routing statistics. Working in conjunction with the Cooperative Association for Internet Data Analysis (CAIDA) we have developed advanced collection and visualization techniques.
8. **MRM** -- <http://www.nmsl.cs.ucsb.edu/mrm/>. Released October 1, 1999 (with K. Sarac). MRM is the Multicast Reachability Protocol. We have implemented an end-host agent that responds to MRM Manager commands. Our end-host agent works in conjunction with Cisco routers to detect and isolate multicast faults.
7. **MANTRA** -- <http://www.nmsl.cs.ucsb.edu/mantra/>. Released January 1, 1999 (with P. Rajvaidya). MANTRA is the Monitoring and Analysis of Traffic in Multicast Routers. It uses scripts to collect and display data from backbone multicast routers.
6. **SDR Monitor** -- <http://www.nmsl.cs.ucsb.edu/sdr-monitor/>. Released January 1, 1999 (with K. Sarac). The SDR Monitor receives e-mail updates from participants containing information about observed sessions in the MBone. A global view of multicast reachability is then constructed.
5. **The MHealth tool** -- <http://www.nmsl.cs.ucsb.edu/mhealth/>. Released September 1, 1998 (with D. Makofske). The mhealth tool graphically visualizes MBone multicast group trees and provides 'health' information including end-to-end losses per receiver and losses on a per hop basis. The implementation required expertise in Java, the MBone tools, and Unix.
4. **The MControl tool** -- <http://www.nmsl.cs.ucsb.edu/mcontrol/>. Released August 1, 1998 (with D. Makofske). Mcontrol is a tool to provide VCR-based interactivity for live MBone sessions. The implementation required expertise in Java, the MBone tools, and Unix.
3. **Interactive Multimedia Jukebox (IMJ)** -- <http://imj.ucsb.edu/>. Released October 1, 1996. The IMJ combines the WWW and the MBone conferencing tools to provide a multi-channel video jukebox offering both instructional and entertainment programming on a wide scale. The implementation required expertise in HTML, Perl, C, the MBone tools, and Unix.

2. *Mlisten* -- <http://www.cc.gatech.edu/computing/Telecomm/mbone/>. Released September 1, 1995. A tool to continuously collect MBone multicast group membership information including number and location of members, membership duration, and inter-arrival time for all audio and video sessions. The implementation required expertise in C, Tcl/Tk, the MBone tools, and UNIX socket programming.
1. *Audio-on-Demand (AoD)*. March 1, 1995. A server/client prototype to demonstrate interactivity in near VoD systems. The AoD server provides songs-on-demand and VCR-like functions via multicast IP over Ethernet. The implementation required expertise in C, OpenWindows programming, UNIX socket programming, and network programming.

F. Tutorials, Panels and Invited Talks

- "Sensing and Opportunistic Delivery of Ubiquitous Video in Health Monitoring, On-Campus and Social Network Applications," Workshop on Mobile Video Delivery (MoViD), Chapel Hill North Carolina, USA, February 2012.
- "Medium Access in new Contexts: Reinventing the Wheel?," USC Invited Workshop on Theory and Practice in Wireless Networks, Los Angeles, California, USA, May 2008.
- "The Wild, Wild West: Wireless Networks Need a New Sheriff," University of Florida CISE Department Lecture Series, Gainesville, Florida, USA, February 2008.
- "Distinguishing Between Connectivity, Intermittent Connectivity, and Intermittent Disconnectivity," Keynote at the ACM MobiCom Workshop on Challenged Networks (CHANTS), Montreal, CANADA, September 2007.
- "The Three Ghosts of Multicast: Past, Present, and Future," Keynote at the Trans-European Research and Education Networking Association (TERENA) Networking Conference, Lynby, DENMARK, May 2007.
- "Multicast Help Wanted: From Where and How Much?," Keynote at the Workshop on Peer-to-Peer Multicasting (P2PM), Las Vegas, Nevada, USA, January 2007.
- "The Confluence of Wi-Fi and Apps: What to Expect Next," Engineering Insights, UC-Santa Barbara, Santa Barbara, California, USA, October 2006.
- "Challenges, Opportunities, and Implications for the Future Internet," University of Minnesota Digital Technology Center, Minneapolis, Minnesota, USA, September 2006.
- "Wireless Technology as a Catalyst: Possibilities for Next-Generation Interaction," Santa Barbara Forum on Digital Transitions, Santa Barbara, California, USA, April 2006.
- "Challenges and Opportunities in an Internet with Pervasive Wireless Access," University of Texas--Dallas Computer Science Colloquium, Dallas, Texas, USA, March 2006.
- "Challenges and Opportunities with Pervasive Wireless in the Internet," Duke University Computer Science Colloquium, Durham, North Carolina, USA, February 2006.
- "The Span From Wireless Protocols to Social Applications," Intel Research Labs, Cambridge, United Kingdom, December 2005.
- "The Internet Dot.Com Bomb and Beyond the Dot.Com Calm," CSE IGERT and Cal Poly Lecture Series, San Luis Obispo, California, USA, October 2005.
- "Panel: Directions in Networking Research," IEEE Computer Communications Workshop (CCW), Irvine, California, USA, October 2005.
- "Economic Incentives for Ad Hoc Networks," KAIST New Applications Seminar, Seoul, South Korea, March 2004.
- "New Applications for the Next Generation Internet," Citrix Systems, Santa Barbara, California, USA, March 2004.
- "PI: The Imperfect Pursuit of Pure Pattern," CITS Visions in Technology Series, Santa Barbara, California, USA, January 2004.
- "Panel: Core Networking Issues and Protocols for the Internet," National Science Foundation (NSF) Division of Advanced Networking Infrastructure and Research (ANIR) Principal Investigators Workshop, Washington DC, USA, March 2003.

- "Panel: Pricing for Content in the Internet," SPIE ITCOM Internet Performance and Control of Network Systems, Boston, Massachusetts, USA, July 2002.
- "The Technology Behind Wireless LANs," Central Coast MIT Enterprise Forum, Santa Barbara, California, USA, March 2002.
- "Lessons Learned in the Digital Classroom," Center for Information and Technology Brown Bag Symposium, Santa Barbara, California, USA, March 2002.
- "The Evolution of Advanced Networking Services: From the ARPANet to Internet2," California State University--San Luis Obispo CS Centennial Colloquium Series, San Luis Obispo, California, USA, February 2002.
- "Deployment of IP Multicast in Campus Infrastructures," Internet2 Campus Deployment Workshop, Atlanta, Georgia, USA, May 2001.
- "Multicast: Is There Anything Else to Do?," Sprint Research Retreat, Miami, Florida, USA, May 2001.
- "The Evolution of Next-Generation Internet Services and Applications," Government Technology Conference 2001 (GTC) for the Western Region, Sacramento, California, USA, May 2001.
- "I2 Multicast: Not WIDE-scale Deployment, FULL-scale Deployment," Closing Plenary, Internet2 Member Meetings, Washington, D.C., USA, March 2001.
- "Panel: Beyond IP Multicast," Content Delivery Networks (CDN), New York, New York, USA, February 2001.
- "Viable Multicast Pricing & Business Models for Wider-Scale Deployment," Content Delivery Networks (CDN), New York, New York, USA, February 2001.
- "IP Multicast: Modern Protocols, Deployment, and Management," Content Delivery Networks (CDN), New York, New York, USA, February 2001 & San Jose, California, USA, December 2001.
- "Under the Hood of the Internet," Technology 101: Technology for Investors, Center for Entrepreneurship & Engineering Management, November 2000.
- "Understanding Multicast Traffic in the Internet," (1) University of Virginia, (2) University of Maryland, and (3) Columbia University, September 2000.
- "The Bad, The Ugly, and The Good: The Past, Present, and Future of Multicast," Digital Fountain, San Francisco, California, USA, August 2000.
- "Implications of Source-Specific Multicast (SSM) on the Future of Internet Content Delivery," Occam Networks, Santa Barbara, California, USA, August 2000.
- "Introduction to Multicast Routing Protocols," UC-Berkeley Open Mash Multicast Workshop, Berkeley, California, USA, July 2000.
- "Efforts to Understand Traffic and Tree Characteristics," University of Massachusetts--Amherst Colloquia, Amherst, Massachusetts, USA, May 2000.
- "Monitoring Multicast Traffic," Sprint Research Retreat, Half Moon Bay, California, USA, April 2000.
- "What is the Next Generation of Multicast in the Internet?," HRL Laboratories, Malibu, California, USA, January 2000.
- "Mission and Status of the Center for Information Technology and Society (CITS)," Intel Research Council, Portland, Oregon, USA, September 1999.
- "Multicast at a Crossroads," IP Multicast Initiative Summits and Bandwidth Management Workshops, San Francisco, CA, USA, (1) October 1999; (2) February 2000; and (3) June 2000.
- "IP Multicast: Modern Protocols, Deployment, and Management," Network+Interop: (1) Las Vegas, Nevada, USA--May 2000; (2) Tokyo, JAPAN--June 2000; (3) Atlanta, Georgia, USA--September 2000; (4) Las Vegas, Nevada, USA--May 2001; (5) Las Vegas, Nevada, USA--May 2002.
- "IP Multicast: Practice and Theory" (w/ Steve Deering), Network+Interop: (1) Las Vegas, Nevada, USA--May 1999; (2) Tokyo, JAPAN--June 1999; and (3) Atlanta, Georgia, USA--September 1999.

- "Internet2 Multicast Testbeds and Applications," Workshop on Protocols for High Speed Networks (PfHSN), Salem, Massachusetts, USA, August 1999.
- "IP Multicast: Protocols for the Intra- and Inter-Domain," Lucent Technologies, Westford, Massachusetts, USA, August 1999.
- "Internet2 Multicast Testbeds and Applications," NASA Workshop: Bridging the Gap, Moffett Field, California, USA, August 1999.
- "The Evolution of Next-Generation Services and Applications in the Internet," Tektronix Distinguished Lecture Series, Portland, Oregon, USA, May 1999.
- "Multicast Applications and Infrastructure in the Next Generation Internet," CENIC 99 Workshop on Achieving Critical Mass for Advanced Applications, Monterey, California, USA, May 1999.
- "Multicast Traffic Monitoring and Analysis Work at UCSB" (w/ P. Rajvaidya), Workshop on Internet Statistics and Metrics Analysis (ISMA), San Diego, California, USA, April 1999.
- "How the Internet Works: Following Bits Around the World," Science Lite, Santa Barbara General Affiliates and Office of Community Relations, California, USA, February 1999.
- "Managing Multicast: Challenges, Tools, and the Future," IP Multicast Initiative Summit, San Jose, California, USA, February 1999.
- "The Future of Multicast Communication and Protocols," Internet Bandwidth Management Summit (iBAND), San Jose, California, USA, November 1998.
- "An Overview of IP Multicast: Applications and Deployment," (1) Workshop on Evaluating IP Multicast as the Solution for Webcasting Real-Time Networked Multimedia Applications, New York, New York, USA, July 1998; and (2) Satellites and the Internet Conference, Washington, D.C., USA, July 1998.
- "IETF Developments in IP Multicast," IP Multicast Initiative Summit, San Jose, California, USA, February 1998.
- "An Introduction to IP Multicast and the Multicast Backbone (MBone)" vBNS Technical Meeting sponsored by the National Center for Network Engineering (NLANR), San Diego, California, USA, February 1998.
- "Using Multicast Communication to Deliver WWW Pages" Computer Communications Workshop (CCW '97), Phoenix, Arizona, USA, September 1997.

G. Research Funding

- K. Almeroth, "Packet Scheduling Using IP Embedded Transport Instrumentation," Cisco Systems Inc., \$100,000, 3/1/13-8/31/14.
- K. Almeroth, E. Belding and S.J. Lee, "GOALI: Maximizing Available Bandwidth in Next Generation WLANs", National Science Foundation (NSF), \$101,088, 10/1/13-9/30/14.
- K. Almeroth and E. Belding, "GOALI: Intelligent Channel Management in 802.11n Networks," National Science Foundation (NSF), \$51,000, 10/1/10-9/30/11.
- B. Zhao, K. Almeroth, H. Zheng, and E. Belding, "NeTS: Medium: Airlab: Distributed Infrastructure for Wireless Measurements," National Science Foundation (NSF), \$700,000, 9/1/09-8/13/13.
- K. Almeroth, E. Belding and T. Hollerer, "NeTS-WN: Wireless Network Health: Real-Time Diagnosis, Adaptation, and Management," National Science Foundation (NSF), \$600,000, 10/1/07-9/30/10.
- K. Almeroth, "Next-Generation Service Engineering in Internet2," University Consortium for Advanced Internet Development (UCAID), \$1,254,000, 7/1/04-6/30/09 (reviewed and renewed each year).
- B. Manjunath, K. Almeroth, F. Bullo, J. Hespanha, T. Hollerer, C. Krintz, U. Madhow, K. Rose, A. Singh, and M. Turk, "Large-Scale Multimodal Wireless Sensor Network," Office of Naval Research Defense University Research Instrumentation Program (DURIP), \$655,174, 4/14/08-4/14/09.

- K. Almeroth and E. Belding, "Improving Robustness in Evolving Wireless Infrastructures," Intel Corporation, \$135,000, 7/1/06-6/30/09 (reviewed and renewed for second and third year).
- K. Almeroth and K. Sarac, "Bridging Support in Mixed Deployment Multicast Environments," Cisco Systems Inc., \$100,000, 9/1/07-8/31/08.
- K. Sarac and K. Almeroth, "Building the Final Piece in One-to-Many Content Distribution," Cisco Systems Inc., \$95,000, 9/1/06-8/31/07.
- E. Belding, K. Almeroth and J. Gibson, "Real-Time Communication Support in a Ubiquitous Next-Generation Internet," National Science Foundation (NSF), \$900,000, 10/1/04-9/30/07.
- K. Almeroth and K. Sarac, "Improving the Robustness of Multicast in the Internet," Cisco Systems Inc., \$80,000, 9/1/04-8/31/05.
- R. Mayer, B. Bimber, K. Almeroth and D. Chun, "Assessing the Pedagogical Implications of Technology in College Courses," Mellon Foundation, \$350,000, 7/1/04-6/30/07.
- B. Bimber, A. Flanagan and C. Stol, "Technological Change and Collective Association: Changing Relationships Among Technology, Organizations, Society and the Citizenry," National Science Foundation (NSF), \$329,175, 7/1/04-6/30/07.
- K. Almeroth and B. Bimber, "Plagiarism Detection Techniques and Software," UCSB Instructional Development, \$22,000, 7/1/04-6/30/05.
- K. Almeroth, "Student Travel Support for the 14th International Workshop on Network and Operating Systems Support for Digital Audio and Video (NOSSDAV)," National Science Foundation (NSF), \$10,000, 5/1/04-8/31/04.
- K. Almeroth, "An Automated Indexing System for Remote, Archived Presentations," QAD Inc., \$25,000, 5/1/04-6/30/05.
- K. Almeroth and M. Turk, "A Remote Teaching Assistant Support System," Microsoft, \$40,000, 1/1/04-6/30/05.
- K. Almeroth, "Supporting Multicast Service Functionality in Helix," Real Networks, \$30,000, 9/1/03-6/30/04.
- K. Almeroth and E. Belding, "Service Discovery in Mobile Networks," Nokia Summer Research Grant (U. Mohan), \$10,240, 7/1/03-9/30/03.
- K. Almeroth, D. Zappala, "Building a Global Multicast Service," Cisco Systems Inc., \$100,000, 1/1/03-indefinite.
- K. Almeroth, "Developing A Dynamic Protocol for Candidate Access Router Discovery," Nokia Graduate Student Fellowship (R. Chalmers), \$26,110, 9/01/02-6/30/03.
- B. Bimber and K. Almeroth, "The Role of Collaborative Groupware in Organizations," Toole Family Foundation, \$182,500 (\$20,000 cash plus \$162,500 in software), 9/1/02-indefinite.
- B. Manjunath, et al., "Digital Multimedia: Graduate Training Program in Interactive Digital Multimedia," National Science Foundation (NSF), \$2,629,373, 4/1/02-3/31/07.
- J. Green, K. Almeroth, et al., "Inquiry in the Online Context: Learning from the Past, Informing the Future," UCSB Research Across Disciplines, \$10,000, 9/1/01-8/31/02.
- K. Almeroth, "Monitoring and Maintaining the Global Multicast Infrastructure," Cisco Systems Inc., \$54,600, 7/1/01-indefinite.
- R. Kemmerer, K. Almeroth, et al., "Hi-DRA High-speed, Wide-area Network Detection, Response, and Analysis," Department of Defense (DoD), \$4,283,500, 5/1/01-4/30/06.
- A. Singh, K. Almeroth, et al., "Digital Campus: Scalable Information Services on a Campus-wide Wireless Network," National Science Foundation (NSF), \$1,450,000, 9/15/00-12/31/04.
- K. Almeroth, "Visualizing the Global Multicast Infrastructure," UC MICRO w/ Cisco Systems Inc., \$85,438, 7/1/00-6/30/02.
- H. Lee, K. Almeroth, et al., "Dynamic Sensing Systems," International Telemetering Foundation, \$260,000, 07/01/00-06/30/04.
- B. Bimber and K. Almeroth, "Funding for the Center on Information Technology and Society," \$250,000 from Dialogic (an Intel Company) and \$250,000 from Canadian Pacific.

- K. Almeroth, "CAREER: From Protocol Support to Applications: Elevating Multicast to a Ubiquitous Network Service," National Science Foundation (NSF), \$200,000, 9/1/00-8/31/04.
- K. Almeroth, "Characterizing Multicast Use and Efficiency in the Inter-Domain," Sprint Advanced Technology Laboratories, \$62,500, 3/1/00-indefinite.
- K. Almeroth, "Producing the Next Generation of Multicast Monitoring and Management Protocols and Tools," UC MICRO w/ Cisco Systems Inc., \$124,500, 7/1/99 - 6/30/01.
- K. Almeroth, "Utilizing Satellite Links in the Provision of an Inter-Wide Multicast Service," HRL Laboratories, \$20,000, 7/1/99 - indefinite.
- T. Smith, K. Almeroth, et al., "Alexandria Digital Earth Prototype," National Science Foundation, \$5,400,000, 4/1/99-3/31/04.
- V. Vesna, K. Almeroth, et al., "Online Public Spaces: Multidisciplinary Explorations in Multi-User Environments (OPS:MEME), Phase II," UCSB Research Across Disciplines, \$50,000, 9/1/98-8/31/99.
- K. Almeroth, "Techniques and Analysis for the Provision of Multicast Route Management," UC MICRO w/ Cisco Systems Inc., \$97,610, 7/1/98 - 6/30/00.
- K. Almeroth, "Capturing and Modeling Multicast Group Membership in the Multicast Backbone (MBone)," UC MICRO w/ Hughes Research Labs, \$19,146, 7/1/98 - 12/31/99.
- K. Almeroth, "Building a Content Server for the Next Generation Digital Classroom," UCSB Faculty Research Grant, \$5,000, 7/1/98-6/31/99.

H. Research Honors and Awards

- IEEE Fellow Status, 2013
- Finalist for Best Paper Award, IEEE Conference on Sensor and Ad Hoc Communications and Networks (SECON), June 2008
- Best Paper Award, Passive and Active Measurement (PAM) Conference, April 2007
- Outstanding Paper Award, World Conference on Educational Multimedia, Hypermedia & Telecommunications (ED MEDIA), June 2006
- IEEE Senior Member Status, 2003
- Finalist for Best Student Paper Award, ACM Multimedia, December 2002
- Outstanding Paper Award, World Conference on Educational Multimedia, Hypermedia & Telecommunications (ED MEDIA), June 2002
- Computing Research Association (CRA) Digital Government Fellowship, 2001
- National Science Foundation CAREER Award, 2000
- Best Paper Award, 7th International World Wide Web Conference, April 1998

III. Service

A. Professional Activities

1. Society Memberships

Member, Association for Computing Machinery (ACM): 1993-present
 Member, ACM Special Interest Group on Communications (SIGComm): 1993-present
 Fellow, Institute of Electrical and Electronics Engineers (IEEE): 1993-present
 Member, IEEE Communications Society (IEEE ComSoc): 1993-present
 Member, American Society for Engineering Education (ASEE): 2003-2006

2. Review Work for Technical Journals and Publishers

NSF CISE research proposals, IEEE/ACM Transactions on Networking, IEEE/ACM Transactions on Computers, IEEE/ACM Transactions on Communications, IEEE Transactions on Circuits and Systems for Video Technology, IEEE Transactions on Parallel and Distributed Systems, IEEE Transactions on Multimedia, IEEE Communications, IEEE Communications Letters, IEEE Network, IEEE Internet Computing, IEEE Multimedia, IEEE Aerospace & Electronics Systems Magazine, ACM Transactions on Internet Technology, ACM Transactions on Multimedia Computing, Communications and Applications, ACM Computing Surveys, ACM Computer Communications Review, ACM Computers in Entertainment, ACM/Springer Multimedia Systems Journal, AACE Journal of Interactive Learning (JILR), International Journal of Computer Mathematics, Journal of Communications and Networks, Journal of Parallel and Distributed Computing, Journal of Network and Systems Management, Journal of High Speed Networking, Journal of Communications and Networks, Journal on Selected Areas in Communications, Journal of Wireless Personal Communications, Personal Mobile Communications, Annals of Telecommunications, International Journal of Wireless and Mobile Computing, Pervasive and Mobile Computing (PMC), Wireless Networks Journal, Computer Networks Journal, Cluster Computing, Computer Communications, Mobile Computing and Communications Review, Performance Evaluation, Software--Practice & Experience, Information Processing Letters, ACM Sigcomm, ACM Multimedia, ACM Network and System Support for Digital Audio and Video Workshop (NOSSDAV), ACM Sigcomm Workshop on the Economics of Peer-to-Peer Systems (P2PEcon), ACM Sigcomm Workshop on Challenged Networks (CHANTS), IEEE Infocom, IEEE Globecom, IEEE Global Internet (GI) Symposium, IEEE Globecom Automatic Internet Symposium, IEEE Globecom Internet Services and Enabling Technologies (IS&ET) Symposium, IEEE International Symposium on a World of Wireless, Mobile and Multimedia Networks (WoWMoM), IEEE International Conference on Network Protocols (ICNP), IEEE Conference on Sensor and Ad Hoc Communications and Networks (SECON), IEEE International Conference on Multimedia and Exposition (ICME), IEEE International Conference on Communications (ICC), IEEE International Conference on Parallel and Distributed Systems (ICPADS) IEEE International Symposium on High-Performance Distributed Computing (HPDC), IEEE International Conference on Distributed Computing Systems (ICDCS), IEEE International Workshop on Quality of Service (IWQoS), IEEE/IFIP Network Operations and Management Symposium (NOMS), IFIP/IEEE International Symposium on Integrated Network Management (IM), IFIP/IEEE International Conference on Management of Multimedia Networks and Services (MMNS), IEEE Aerospace & Electronics Systems Magazine, SPIE Conference on Multimedia Computing and Networking (MMCN), IFIP Networking, IASTED International Conference on Information Systems and Databases (ISD), IASTED International Conference on Communications, Internet, and Information Technology, IASTED International Conference on Internet and Multimedia Systems and Applications (IMSA), IASTED International Conference on European Internet and Multimedia Systems and Applications (EuroIMSA), IASTED International Conference on Communications and Computer Networks (CCN), IASTED International Conference on Software Engineering and Applications (SEA), International Conference on Computer and Information Science (ICIS), International Association for Development of the Information Society (IADIS) International Conference on the WWW/Internet, Workshop on Network Group Communication (NGC), International Conference on Next Generation Communication (CoNEXT), International Conference on Parallel Processing (ICPP), International Conference on Computer Communications and Networks (IC3N), International Workshop on Hot Topics in Peer-to-Peer Systems (Hot-P2P), International Workshop on Wireless Network Measurements (WinMee), International Workshop on Incentive-Based Computing (IBC), International Workshop on Multi-hop Ad Hoc Networks (REALMAN), International Workshop on Broadband Wireless Multimedia: Algorithms, Architectures and Applications (BroadWIM), International Packet Video (PV) Workshop, High Performance Networking Conference (HPN), International Parallel Processing Symposium (IPPS), International Symposium on Innovation in Information & Communication Technology (ISIICT), Workshop on Coordinated Quality of Service in Distributed Systems (COQODS), Pearson Education (Cisco Press) Publishers, Macmillan Technical Publishing, and Prentice Hall Publishers.

3. Conference Committee Activities

Journal/Magazine Editorial Board

IEEE/ACM Transactions on Networking (ToN): 2003-2009, 2013-present
Journal of Network and Systems Management (JNSM): 2011-present
ACM Computers in Entertainment: 2002-present
IEEE Network: 1999-2012
AACE Journal of Interactive Learning Research (JILR): 2003-2012
IEEE Transactions on Mobile Computing (TMC): 2006-2011
ACM Computer Communications Review (CCR): 2006-2010

Journal/Magazine Guest Editorship

IEEE Journal on Selected Areas in Communications (JSAC) Special Issue on "Delay and Disruption Tolerant Wireless Communication", June 2008

Computer Communications Special Issue on "Monitoring and Measuring IP Networks", Summer 2005

Computer Communications Special Issue on "Integrating Multicast into the Internet", March 2001

Conference/Workshop Steering Committee

IEEE International Conference on Network Protocols (ICNP): 2007-present

ACM Sigcomm Workshop on Challenged Networks (CHANTS): 2006-present

International Workshop on Network and Operating System Support for Digital Audio and Video (NOSSDAV):

2001-present, 2005-2011 (chair), 2012-present (co-chair)

IEEE Global Internet (GI) Symposium: 2005-2013

IFIP/IEEE International Conference on Management of Multimedia Networks and Services (MMNS): 2005-2009

Conference/Workshop Chair

International Conference on Communication Systems and Networks (COMSNETS): 2014 (co-chair)

ACM International Conference on Next Generation Communication (CoNext): 2013 (co-chair)

ACM RecSys News Recommender Systems (NRS) Workshop and Challenge: 2013 (co-chair)

ACM Sigcomm Workshop on Challenged Networks (CHANTS): 2006 (co-chair)

IEEE International Conference on Network Protocols (ICNP): 2003 (co-chair), 2006

International Workshop on Wireless Network Measurements (WiNMee): 2006 (co-chair)

IFIP/IEEE International Conference on Management of Multimedia Networks and Services (MMNS): 2002 (co-chair)

International Workshop on Network and Operating System Support for Digital Audio and Video (NOSSDAV): 2002 (co-chair), 2003 (co-chair)

IEEE Global Internet (GI) Symposium: 2001 (co-chair)

International Workshop on Networked Group Communication (NGC): 2000 (co-chair)

Program Chair

International Conference on Communication Systems and Networks (COMSNETS): 2010

IEEE International Conference on Network Protocols (ICNP): 2008 (co-chair)

IEEE Conference on Sensor and Ad Hoc Communications and Networks (SECON): 2007 (co-chair)

IFIP Networking: 2005 (co-chair)

Posters/Demonstrations Chair

ACM Sigcomm: 2012 (co-chair)

Student Travel Grants Chair

ACM Sigcomm: 2010 (co-chair)

Publicity Chair

IFIP/IEEE International Conference on Management of Multimedia Networks and Services (MMNS): 2004 (co-chair)

Keynote Chair

IEEE Infocom: 2005 (co-chair)

Local Arrangements Chair

Internet2 "Field of Dreams" Workshop: 2000

Tutorial Chair

ACM Multimedia: 2000

IEEE International Conference on Network Protocols (ICNP): 1999

Panel/Session Organizer

NSF ANIR PI 2003 Panel on "Core Networking Issues and Protocols for the Internet"

CCW 2001 Session on "Multicast/Peer-to-Peer Networking"

NOSSDAV 2001 Panel on "Multimedia After a Decade of Research"
NGC 2000 Panel on "Multicast Pricing"

Technical Program Committee

IEEE International Conference on Network Protocols (ICNP): 1999, 2000, 2001, 2003, 2004, 2005, 2006, 2007, 2008, 2009 (Area Chair), 2010 (Area Chair), 2011 (Area Chair), 2012 (Area Chair), 2013, 2014 (Area Chair)
International Workshop on Network and Operating System Support for Digital Audio and Video (NOSSDAV): 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014
ACM Multimedia (MM): 2001, 2003, 2004, 2005 (short paper), 2006, 2007, 2008, 2008 (short paper), 2010, 2011, 2012, 2013
IEEE Conference on Sensor and Ad Hoc Communications and Networks (SECON): 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011 (Area Chair), 2012 (Area Chair), 2013, 2014 (Area Chair)
IEEE/IFIP Network Operations and Management Symposium (NOMS): 2004, 2006, 2010
IEEE Infocom: 2004, 2005, 2006, 2008, 2009, 2010 (Area Chair), 2011 (Area Chair), 2012 (Area Chair)
IFIP Networking: 2004, 2005, 2006, 2007, 2010, 2011, 2012, 2013, 2014
ACM Workshop on Mobile Video (MoVid): 2014
ACM Student Research Competition (SRC) Grand Finals: 2014
Mobile and Social Computing for Collaborative Interactions (MSC): 2014
IEEE Conference on Communications and Network Security (CNS): 2013
IEEE International Symposium on a World of Wireless, Mobile and Multimedia Networks (WoWMoM): 2005, 2006, 2007, 2008, 2009, 2010
ACM Sigcomm Workshop on Challenged Networks (CHANTS): 2006, 2008, 2009, 2010, 2011, 2012
IEEE International Conference on Distributed Computing Systems (ICDCS): 2006, 2010, 2011, 2012, 2013
International Workshop on Wireless Network Measurements (WiNMe): 2006, 2008, 2010
ACM Sigcomm: 2008 (poster), 2010
IEEE International Conference on Computer Communication and Networks (IC3N): 2008, 2009, 2010, 2011, 2012
International Conference on Communication Systems and Networks (COMSNETS): 2009, 2010, 2011, 2012, 2013
International Conference on Sensor Networks (SENSORNETS): 2012
International Workshop on Social and Mobile Computing for Collaborative Environments (SOMOCO): 2012
Workshop on Scenarios for Network Evaluation Studies (SCENES): 2009, 2010, 2011
ACM Multimedia Systems (MMSys): 2010, 2011, 2012
IEEE International Conference on Pervasive Computing and Communications (PerCom): 2010
IEEE Wireless Communications and Networking Conference (WCNC): 2010, 2011
ACM International Symposium on Mobility Management and Wireless Access (MobiWac): 2010, 2011
International Conference on Computing, Networking and Communications, Internet Services and Applications Symposium (ICNC-ISA): 2012, 2013
IEEE WoWMoM Workshop on Hot Topics in Mesh Networking (HotMesh): 2010, 2011, 2012, 2013
IEEE Workshop on Pervasive Group Communication (PerGroup): 2010
ACM International Conference on Next Generation Communication (CoNEXT): 2005, 2006, 2007, 2009, 2012
IEEE International Conference on Broadband Communications, Networks, and Systems (BroadNets) Wireless Communications, Networks and Systems Symposium: 2007, 2008, 2009
IEEE International Conference on Broadband Communications, Networks, and Systems (BroadNets) Internet Technologies Symposium: 2007, 2008, 2009
International Workshop on Mobile and Networking Technologies for Social Applications (MONET): 2008, 2009
Extreme Workshop on Communication-The Midnight Sun Expedition (ExtremeCom): 2009
IEEE International Workshop on Cooperation in Pervasive Environments (CoPE): 2009
International Workshop on the Network of the Future (FutureNet): 2009, 2010, 2011, 2012
IEEE International Conference on Multimedia and Exposition (ICME): 2010
SPIE Conference on Multimedia Computing and Networking (MMCN): 2004, 2008
ACM Sigcomm Workshop on the Economics of Networks, Systems, and Computation (NetEcon): 2008
IEEE International Conference on Communications (ICC): 2008
IEEE International Conference on Mobile Ad-hoc and Sensor Systems (MASS): 2008
IFIP/IEEE International Symposium on Integrated Network Management (IM): 2005, 2007
Global Internet (GI) Symposium: 2001, 2002, 2004, 2006, 2007
IEEE/ACM International Conference on High Performance Computing (HiPC): 2007
ACM International Symposium on Mobile Ad Hoc Networking and Computing (MobiHoc): 2007
IEEE Workshop on Embedded Systems for Real-Time Multimedia (ESTIMedia): 2007
IEEE/IFIP Wireless On Demand Network Systems and Services (WONS): 2007
IFIP/IEEE International Conference on Management of Multimedia Networks and Services (MMNS): 2001, 2002,

2003, 2004, 2005, 2006
 IASTED International Conference on European Internet and Multimedia Systems and Applications (EuroIMSA): 2004, 2006
 IEEE International Conference on Parallel and Distributed Systems (ICPADS): 2005, 2006
 IEEE Globecom Internet Services and Enabling Technologies (IS&ET) Symposium: 2006
 International Workshop on Incentive-Based Computing (IBC): 2006
 IEEE International Workshop on Quality of Service (IWQoS): 2006, 2014
 International Workshop on Multi-hop Ad Hoc Networks (REALMAN): 2006
 IEEE Globecom Automatic Internet Symposium: 2005
 ACM Sigcomm Workshop on the Economics of Peer-to-Peer Systems (P2PEcon): 2005
 International Conference on Parallel Processing (ICPP): 2001, 2003, 2004
 International Packet Video (PV) Workshop: 2002, 2003, 2004
 IEEE International Symposium on High-Performance Distributed Computing (HPDC): 2004
 ACM Sigcomm: 2004 (poster)
 International Workshop on Broadband Wireless Multimedia: Algorithms, Architectures and Applications (BroadWIM): 2004
 International Symposium on Innovation in Information & Communication Technology (ISIICT): 2004
 Workshop on Coordinated Quality of Service in Distributed Systems (COQODS): 2004
 IASTED International Conference on Networks and Communication Systems (NCS): 2004
 IASTED International Conference on Communications, Internet, and Information Technology (CIIT): 2004
 IASTED International Conference on Internet and Multimedia Systems and Applications (IMSA): 2003, 2004
 International Workshop on Networked Group Communication (NGC): 1999, 2000, 2001, 2002, 2003
 International Association for Development of the Information Society (IADIS) International Conference on the WWW/Internet: 2003
 International Conference on Computer and Information Science (ICIS): 2003
 Human.Society@Internet: 2003
 IASTED International Conference on Communications and Computer Networks (CCN): 2002
 The Content Delivery Networks (CDN) Event: 2001
 IP Multicast Initiative Summit: 1998, 1999, 2000
 Corporation for Education Network Initiatives in California (CENIC): 1999
 Internet Bandwidth Management Summit (iBAND): 1998, 1999

B. Technical Activities

1. Working Groups

Internet2 Working Group on Multicast, Chair: 1998-2005
 IEEE Communications Society Internet Technical Committee (ITC), Conference Coordinator: 2000-2004
 IETF Multicast Directorate (MADDOGS), Member: 1999-2001
 IASTED Technical Committee on the Web, Internet and Multimedia, Member: 2002-2005
 Internet Engineering Task Force (IETF), various working groups: 1995-present

2. Meeting Support Work

Internet Engineering Task Force MBone broadcasts: 1995-2005
 Conference MBone broadcasts: Sigcomm '99, and '00
 Interop+Networld Network Operations Center (NOC) Team Member: 1995-1997
 ACM Multimedia technical staff: 1994

C. University of California Committees

1. Department of Computer Science Committees

Public Relations: 2005-2006 (chair 2005-2006), 2009-2011 (chair 2009-2011)

Strategic Planning: 2000-2002, 2003-2006, 2009-2011
 Undergraduate Advising and Affairs: 2006-2007, 2014-2015
 Vice Chair: 2000-2005
 Graduate Admissions: 2000-2005 (chair 2000-2005), 2011-2012
 Graduate Affairs: 2000-2005 (co-chair 2000-2005)
 Teaching Administration: 2000-2005
 Facilities: 1997-2001 (chair 1999-2000), 2006-2007
 External Relations: 1999-2002
 Computer Engineering Public Relations: 2011-2012
 Computer Engineering Awards: 2011-2012
 Computer Engineering Administration/Recruiting: 1998-2001
 Computer Engineering Lab and Computer Support: 1998-2001
 Faculty Recruiting: 1999-2002
 Graduate Advising: 1998-1999, 2000-2005

2. University Committees

Member, Campus Budget and Planning: 2013-2015
 Faculty, Cognitive Science Program: 2006-present
 Faculty, Technology Management Program (TMP): 2003-2014
 Faculty, Media Arts and Technology (MAT) Program: 1998-2014
 Faculty, Computer Engineering Degree Program: 1998-present
 Steering Committee, Center for Information Technology and Society (CITS): 2012-present
 Associate Director, Center for Information Technology and Society (CITS): 1999-2012
 Member, Campus Committee on Committees: 2010-2013
 Member, Campus Income and Recharge Committee: 2010-2013
 Member, College of Engineering Executive Committee: 2010-2012 (chair 2011-2012)
 Member, Distinguished Teaching Award Committee: 2009, 2010, 2011
 Member, Campus Classroom Design and Renovation Committee: 2003-2010
 Member, ISBER Advisory Committee: 2008-2011
 Member, Fulbright Campus Review Committee: 2007
 Member, Faculty Outreach Grant Program Review Committee: 2007
 Executive Vice Chancellor's Information Technology Fee Committee: 2005-2006
 Council on Research and Instructional Resources: 2003-2006
 Executive Vice Chancellor's Working Group on Graduate Diversity: 2004-2005
 Member, Engineering Pavillion Planning Committee: 2003-2005
 Information Technology Board: 2001-2004
 Executive Committee, Center for Entrepreneurship & Engineering Management (CEEM): 2001-2004

3. System Wide Committees

UCSB Representative to the Committee on Information Technology and Telecommunications Policy (ITTP): 2003-2005
 UCSB Representative to the Executive Committee, Digital Media Innovation (DiMI): 1998-2003

D. Georgia Tech Committees and Service (while a graduate student)

Graduate Student Body President: 1994-1995
 Georgia Tech Executive Board: 1994-1995
 Georgia Tech Alumni Association Executive Committee: 1994-1995
 Dean of Students National Search Committee: 1995
 Institute Strategic Planning Committee: 1994-1996