

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

ADVANCED MICRO DEVICES, INC. AND PENSANDO SYSTEMS, INC.,

Petitioners

v.

CONCURRENT VENTURES, LLC AND XTREAMEDGE, INC.,

Patent Owner.

Case No. IPR2025-00479

U.S. Patent 10,944,634

Declaration of Mark E. Crovella

TABLE OF CONTENTS

I.	OVERVIEW OF THE TECHNOLOGY.....	4
II.	THE '634 PATENT.....	5
	A. Overview	5
	B. Prosecution History	6
	C. Priority Date	7
	D. Challenged Claims	7
III.	LEVEL OF ORDINARY SKILL IN THE ART	7
IV.	CLAIM CONSTRUCTION	9
	A. “geographical area”	9
V.	INVALIDITY GROUNDS.....	10
	A. Ground 1: Claims 1–20 Are Rendered Obvious in View of Erskine.....	11
	1. U.S. Patent No. 7,742,499 (“Erskine”) (Ex-1004)	11
	2. Independent Claims 1, 8, 15	13
	3. Dependent Claims 2, 9, 16.....	38
	4. Dependent Claims 3, 10, 17.....	48
	5. Dependent Claims 4, 11, 18.....	51
	6. Dependent Claims 5, 12, 19.....	53
	7. Dependent Claims 6, 13, 20.....	56
	8. Dependent Claims 7, 14.....	59
	B. Grounds 2 and 3: Claims 1–20 Are Rendered Obvious in View of Scherzer and Gillett.....	63

1.	U.S. Patent No. 8,000,276 (“Scherzer”) (Ex-1005).....	63
2.	U.S. Patent No. 9,661,553 (“Gillett”) (Ex-1006)	64
3.	Independent Claims 1, 8, 15	66
4.	Dependent Claims 2, 9, 16.....	91
5.	Dependent Claims 3, 10, 17.....	99
6.	Dependent Claims 4, 11, 18.....	101
7.	Dependent Claims 5, 12, 19.....	103
8.	Dependent Claims 6, 13, 20.....	106
9.	Dependent Claims 7, 14.....	108
VI.	BACKGROUND AND QUALIFICATIONS.....	110
A.	Compensation.....	112
B.	Materials and Other Information Considered	112
VII.	UNDERSTANDING OF THE LAW	113
VIII.	RESERVATION OF RIGHTS.....	113
	APPENDIX 1: CURRICULUM VITAE OF MARK E. CROVELLA	115
	APPENDIX 2: MATERIALS CONSIDERED IN THE PREPARATION OF THIS DECLARATION.....	138
	APPENDIX 3: CHALLENGED CLAIMS	139
	APPENDIX 4: UNDERSTANDING OF THE LAW	146

I, Mark E. Crovella, declare as follows:

1. I am a Professor in the Department of Computer Science, and a member of the Faculty of Computing & Data Sciences, where I am the Chair of Academic Affairs, at Boston University. I have prepared this report as an expert witness retained by Advanced Micro Devices, Inc. and Pensando Systems, Inc. In this report I give my opinions as to whether certain claims of U.S. Patent No. 10,944,634 (“the ’634 patent”) are invalid. I provide technical bases for these opinions as appropriate.

2. This report contains statements of my opinions formed to date and the bases and reasons for those opinions. I may offer additional opinions based on further review of materials in this case, including opinions and/or testimony of other expert witnesses. I make this declaration based upon my own personal knowledge and, if called upon to testify, would testify competently to the matters contained herein.

I. OVERVIEW OF THE TECHNOLOGY

3. Since the 1990s, client-server architecture has become a widely adopted model in networking and telecommunications. By 2018, this architecture was ubiquitous and well-established. It was the backbone of countless systems, from cloud computing and mobile applications to video streaming and enterprise networks.

4. Similarly, by 2018, establishing network connections based on information regarding past connections was explored in the field, including in mobile networks, Wi-Fi systems, and Voice over IP (VoIP) services. For example, in VoIP systems, leveraging information from prior calls was a known way to enhance call routing and quality, and initiating network connections based on information from past connections was also known. *See infra* §V.A.

II. THE '634 PATENT

A. Overview

5. The '634 patent relates to “[a] method for network connection optimization.” Ex-1001, Abstract. The method includes “collecting, at a first endpoint device ... parameter values for determination of effective bandwidth of network connections to further endpoint devices” and “determining that a next network connection from the first endpoint device to a second endpoint device matches a past network connection or a geographical area or a network topology area of the past network connection.” *Id.*

6. The '634 patent does not purport to invent network communication or the networking frames and protocols that it references, which it admits was preexisting. Ex-1001, Abstract, 1:6-29. Nor does the patent purport to invent generic network components such as tuning servers (also described as tuner servers). *See generally* '634 patent.

7. The purportedly inventive concept of the '634 patent is determining that a next network connection matches a geographical area of a past network connection. Ex-1001, Abstract. By doing so, the '634 patent claims to reduce time delays in setting up network connections and “increase communication efficiency.” Ex-1001, 1:6-29. However, as explained above, this idea was known and applied in the field well before the '634 patent. *Supra* §I.

B. Prosecution History

8. The '634 patent was allowed after two Office Actions, which present §102 and §103 rejections based on U.S. Patent Application Publication No. 2008/0080458 (“Cole”), U.S. Patent Application Publication No. 2005/0254435 (“Moakley”), U.S. Patent Application Publication No. 2009/0209349 (“Padhye”), and U.S. Patent Application Publication No. 2006/0133307 (“Fukasawa”). Ex-1002, 000067-81, 000106-127. In response to the second Office Action, the Applicant did not dispute the Examiner’s finding that Cole discloses determining that a next network connection matches a geographical area of a past network connection. Ex-1002, 000107-113, 000146-150. Rather, the Applicant distinguished Cole by arguing that it does not disclose that the determining is performed by a server distinct from the endpoint devices. Ex-1002, 000146-147.

C. Priority Date

9. The application that issued as the '634 patent was filed on July 15, 2018, claiming priority to itself. For purpose of this IPR, I have analyzed obviousness using a priority date of July 15, 2018, without providing any opinions on whether the patent is entitled to this priority date.

D. Challenged Claims

10. I understand that Petitioners are challenging the validity of claims 1–20 of the '634 patent in the Petition for Inter Partes Review to which this declaration will be attached. Those claims are reproduced in Appendix 3. While this Petition and declaration are directed to the challenged claims, I have considered all claims 20 of the '634 patent, as well as portions of the '634 patent prosecution history in forming my opinions.

III. LEVEL OF ORDINARY SKILL IN THE ART

11. I have analyzed the '634 and determined that the field of the patent is networking and telecommunications. *See, e.g.*, Ex-1001, 1:33-56 (“[A] method for network connection optimization is provided.”), Abstract.

12. In determining the characteristics of a hypothetical person of ordinary skill in the art (“POSITA”) of the '634 patent at the time of the claimed invention, I considered several things, including various prior art techniques relating to networking and telecommunications, the type of problems that such techniques gave rise to, and the rapidity with which innovations were made. I also considered

the sophistication of the technologies involved, and the educational background and experience of those actively working in the field at the time. I also considered the level of education that would be necessary to understand the '634 patent. Finally, I placed myself back in the relevant period of time and considered the engineers and programmers that I have worked with and managed in the field of networking and telecommunications.

13. I came to the conclusion that a person of ordinary skill in the field of art of the '634 patent would have been a person with a bachelor's degree in electrical engineering, computer science, computer engineering, or a similar field with at least two years of experience in networking and telecommunications or a person with a master's degree in electrical engineering, computer science, computer engineering, or a similar field with a specialization in networking and telecommunications. A person with less education but more relevant practical experience may also meet this standard.

14. In the relevant timeframe (*supra* §II.C), a POSITA would have known and had the skills necessary to program and build systems that meet all limitations of the challenged claims, including the following:

- Designing and using systems that include endpoint devices (e.g., client devices) and servers for establishing network connections and data transfer;

- Recognizing and applying the client-server architecture; and
- Using and applying concepts from known telecommunication and networking frameworks, protocols and standards, including TCP/IP, IEEE 802.11, VoIP, cellular systems and other known frameworks and standards.

IV. CLAIM CONSTRUCTION

15. For purposes of this inter partes review, I have considered the claim language, specification, and portions of the prosecution history, to determine the meaning of the claim language as it would have been understood by a person of ordinary skill in the art at the time of the invention. The “plain and ordinary meaning” or *Phillips* standard has traditionally been applied in district court litigation, where a claim term is given its plain and ordinary meaning in view of the specification from the view point of a person of ordinary skill in the art.

16. I have applied the *Phillips* standard in my analysis. Unless otherwise stated, I have applied the plain and ordinary meaning to claim terms.

A. “geographical area”

17. In the parallel district court case, Petitioners requested claim construction for the term “geographical area” and proposed a construction of “a physical place such as an apartment complex, neighborhood, city, or state,” which is supported by the intrinsic evidence and presented in view of Patent Owner’s

infringement positions. However, it is my understanding that construction of the term is not necessary in this proceeding because the relied upon teachings of the prior art references are consistent with examples of “geographical area” included in the ’634 patent specification. For example, the ’634 specification includes examples of “geographical area” such as “an apartment complex, neighborhood, or city ... or state” (Ex-1001, 2:50-3:10) and the relied upon art includes examples of “geographical area” such as “geographically distinct zone” (*e.g.*, Ex-1004, 2:59-3:10) and “geographical location [such as] home, office” (*e.g.*, Ex-1005, 10:8-31).

V. INVALIDITY GROUNDS

18. There are a number of patents and publications that constitute prior art to the ’634 patent. I have reviewed and considered the prior art discussed in this section, along with the materials listed in Appendix 2.

19. Based on my review and analysis of the materials cited herein, my opinions regarding the understanding of a POSITA in the relevant timeframe, and my training and experience, it is my opinion that the challenged claims of the ’634 patent are invalid in view of the following grounds:

Grounds	Claims	Statutory Basis	Prior Art
1	1–20	§ 103	Erskine
2	1–20	§ 103	Scherzer
3	1–20	§ 103	Scherzer in view of Gillett

A. Ground 1: Claims 1–20 Are Rendered Obvious in View of Erskine

20. It is my opinion that a POSITA would have found Claims 1–20 obvious based on the teachings of Erskine.

1. U.S. Patent No. 7,742,499 (“Erskine”) (Ex-1004)

21. I have reviewed the Erskine reference. I understand that Erskine was not cited or considered during prosecution of the ’634 patent, based primarily on the fact that Erskine is not cited on the face of the patent, nor have I seen the reference discussed in the prosecution history.

22. Erskine was filed on August 18, 2005 and issued on June 22, 2010. Based on the priority date of July 15, 2018 of the ’634 patent, I understand Erskine is prior art to the ’634 patent under post-AIA §102(a).

23. Erskine concerns quality of calls over a packet-based communications network and “relates generally to communication systems, and more particularly to an apparatus and method for adaptive bandwidth management for Voice-Over-IP (VOIP) networks.” Ex-1004, 1:6-26, 1:34-42, Fig. 1:

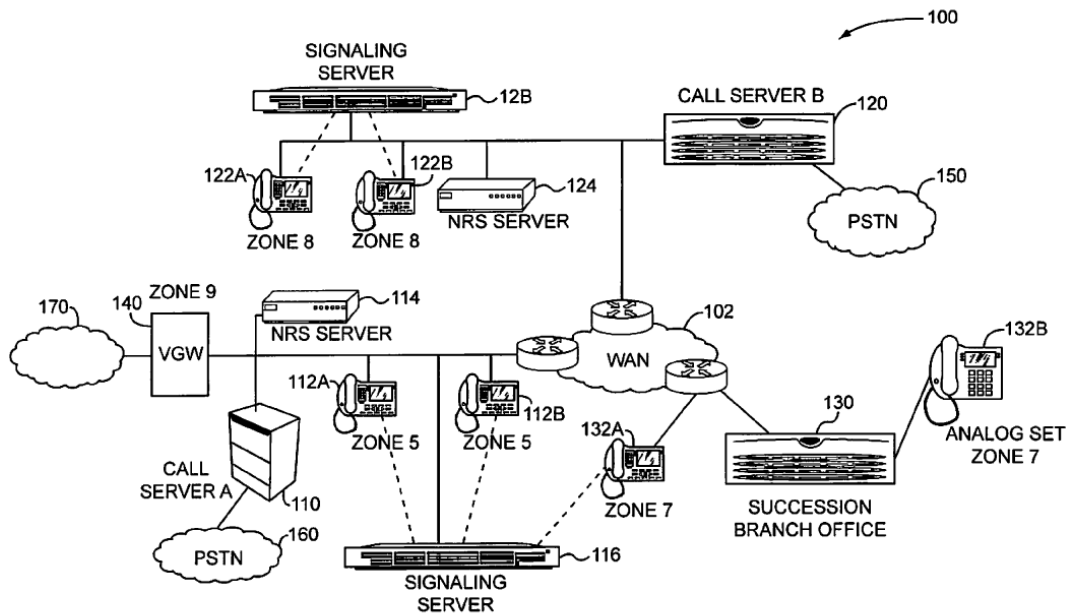


FIG. 1

24. Erskine teaches a communications network system that has various communication devices, where the communication devices collect information such as QoS parameters for bandwidth determination. Ex-1004, 3:44-67, 4:51-5:13, 8:52-67, 9:37-59, 10:26-62, Fig. 1. Erskine teaches “bandwidth zone[s] [that are] generally defined as a geographically distinct zone within the network.” Ex-1004, 2:59-3:10. The connections between the communication devices across different bandwidth zones are facilitated by their respective call servers. *E.g.*, Ex-1004, 4:1-20, 1:61-2:5. The call servers consult a QoS data structure table and determine whether a next call between the communication devices can be initiated over a specific interzone link. *E.g.*, Ex-1004, 4:65-5:14, 6:55-7:25, 9:37-10:2, Figs. 1, 2.

25. Erskine is in the same field of endeavor as the '634 patent (networking and telecommunications). *See supra* §III; *e.g.*, Ex-1004, 1:6-9 (“The present invention relates generally to communication systems, and more particularly to an apparatus and method for adaptive bandwidth management for Voice-Over-IP (VOIP) networks.”), 1:34-42.

2. Independent Claims 1, 8, 15

1[pre] A method for network connection optimization, comprising: 8[pre] A tangible, non-transitory, computer-readable media having instructions thereupon which, when executed by a processor, cause the processor to perform a method comprising: 15[pre] A network connected device, comprising: one or more processors, coupled to a network port and configurable to:

26. I understand that a preamble generally does not state a claim limitation. However, to the extent that Patent Owner argues that the preamble states a limitation, Erskine teaches the preambles of claims 1, 8, and 15.

27. Erskine teaches¹ **a method for network connection optimization.** Erskine concerns quality of calls over a packet-based communications network and teaches “*a method* for adaptive bandwidth management for Voice-Over-IP (VOIP) networks.”² Ex-1004, 1:6-9, 1:13-26, 1:34-42 (“In accordance with one embodiment of the present invention, there is provided *a method* of adaptive

¹ Throughout this petition, Petitioners use “teach” to encompass “teach or suggest,” consistent with the obviousness analysis set forth in *KSR*.

² All annotations/emphasis added unless otherwise noted.

bandwidth management for a packet-based communications network.”), 2:22-24, Figs. 1, 3. To improve and optimize network connection, Erskine uses “[a]daptive bandwidth management based upon quality of serv[ice] (QoS) measurement between two zones [] to dynamically raise or lower the maximum allowable bandwidth limit for the link between the two zones.” Ex-1004, Abstract.

28. Erskine teaches **a tangible, non-transitory, computer-readable media having instructions** (e.g., computer program) **thereupon which, when executed by a processor, causing the processor to perform its method.** For example, Erskine teaches that “*a computer program performing one or more of [its] methods is embodied on a computer readable medium and operable to be executed by a processor.*” Ex-1004, 1:57-60, 11:16-27.

29. Erskine utilizes **a network connected device** (e.g., call server) to facilitate communications over the network. Ex-1004, 4:1-20 (“The call servers 110, 120 and branch office 130 (and VGW 140) facilitate communication by and/or between the communication devices 112, 122, 132 (and any devices coupled to the PSTN 160, 170 or the VGW 140) over the network 102.”), 2:35-3:29, 3:37-43. Erskine’s call server **comprises one or more processors.** Ex-1004, 1:61-2:5 (“*A processor of the call server processes the received QoS information and the call setup message, and determines whether to accept or reject the new call over the communications link between the first zone and the second zone.*”), 3:11-

29 (“The call servers 110, 120, the SBO 130, and the VGW 140 each include *one or more controllers or processors*, memory, logic circuitry, and interfacing circuitry to interface to the network 102.”).

30. The call server is **coupled to a network port**, through which it connects and communicates with other devices over the network. *E.g.*, Ex-1004, 1:61-2:5 (“[T]here is provided a call server having a network interface. The network interface receives quality of serv[ice] (QoS) information about an active communications link between a first zone and a second zone in a packet-based communications network, and further receives a call setup message from a first communications device requesting a new call over the communications link between the first zone and the second zone.”), 2:35-58, 4:1-20, Fig. 1. To the extent Patent Owner argues that Erskine does not explicitly disclose that the call server is coupled to a network port, a POSITA would have found this obvious because since the 1980s, network ports have been critical and commonly used components in communications networks, allowing servers and other networked devices to establish connections for data transmission and communication. *See* Ex-1004, 4:1-20 (“Each of the call servers 110, 120, the branch office 130 and the VGW 140 may be constructed or configured from any suitable hardware, software, firmware, or combination thereof for facilitating communication by communication devices over a network. The general configuration, functioning and

operation of such components are readily known to those of ordinary skill in the art.”).

31. Erskine further teaches that, as explained below, the network connected device (e.g., call server) is **configured to** perform operations recited in claims 1, 8, and 15. *Infra* §§V.A.2[1a-c]/[8a-c]/[15a-c]. Erskine therefore teaches the preambles of claims 1, 8, and 15.

[1a]/[8a]/[15a] collect[ing], at a first endpoint device coupled to [a]/[the] network, parameter values for determination of bandwidth of network connections to further endpoint devices;
--

32. Erskine teaches limitations [1a], [8a], and [15a]. Erskine teaches a **first endpoint device** (e.g., communication device). For example, Erskine teaches a communication device that is part of its communications network system. Ex-1004, 3:44-4:20 (“The communication devices 112, 122, 132 are coupled to the respective call server 110, 120 (or branch office 130) and are thus coupled to the network 102. Similarly, one or more communication devices[] are coupled to the voice gateway 140 via the network 170.”), 3:11-29, Fig. 1:

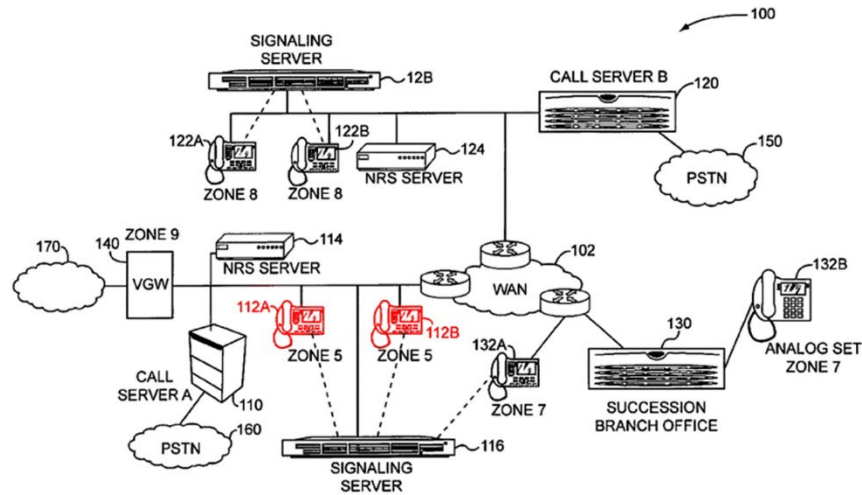


FIG. 1

33. Erskine’s communication devices are endpoint devices that “represent devices utilized by users or subscribers during communication sessions over the network,” including, for example, “telephones, videophones, computers, personal digital assistants, and the like.” Ex-1004, 3:44-67. The communication devices are **coupled to a network** via the call servers. *E.g.*, Ex-1004, 4:1-20 (“The communication devices 112, 122, 132 are coupled to the respective call server 110, 120 (or branch office 130) and are thus coupled to the network 102.”), 2:35-58 (“The network 102 may include one or more local area networks (“LAN”), metropolitan area networks (“MAN”), wide area networks (“WAN”), all or portions of a global network such as the Internet, or any other communication system or systems at one or more locations, or combination of these.”).

34. Erskine further teaches that the first endpoint device (e.g., a communication device) is connected to **further endpoint devices** (e.g., other

communications devices) over the network. *E.g.*, Ex-1004, 3:44-67 (“During a communication session (such as a telephone or videophone call or conference), the communication devices 112, 122, 132 communicate with each other (and/or other devices via the PSTN or VGW 140) through the network 102. In this way, the communication devices 112, 122, 132 may exchange audio, video, graphical, or other information during a communication session.”), 9:37-59, 10:26-62, Fig. 1:

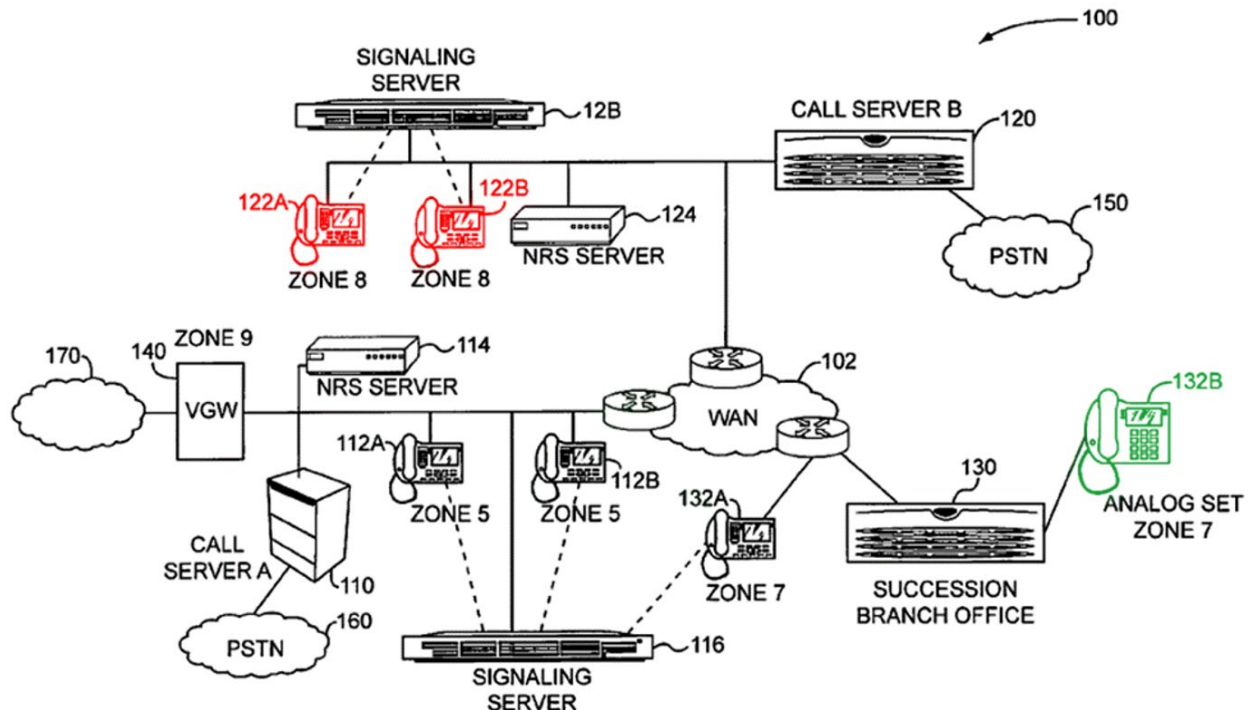


FIG. 1

35. Erskine teaches that the connections between the communication devices are facilitated by their respective call servers. *E.g.*, Ex-1004, 4:1-20 (“The call servers 110, 120 and branch office 130 (and VGW 140) facilitate

communication by and/or between the communication devices 112, 122, 132 (and any devices coupled to the PSTN 160, 170 or the VGW 140) over the network 102. ... Each of the call servers 110, 120, the branch office 130 and the VGW 140 may be constructed or configured from any suitable hardware, software, firmware, or combination thereof for facilitating communication by communication devices over a network.”), 1:61-2:5.

36. Erskine’s teachings regarding the communication devices fall within the scope of “endpoint devices” recited by the ’634 patent. The ’634 patent specification confirms this by describing the term broadly. *E.g.*, Ex-1001, 2:50-3:10 (“Endpoints and servers are described herein as network-connected (or connectable) devices that optimize network connections.”), 3:11-25 (“Each endpoint 103, 105 could be a wireless or wired device, for example with a processor and memory (see FIG. 2) that can couple to a network, e.g., personal computer, server, storage system, personal digital assistant (PDA), touchpad computer, smart phone, IoT (Internet of things) device, etc. In a bidirectional network connection, both endpoints 103, 105 can transmit and receive.”), Figs. 1, 3.

37. Erskine further teaches **collecting at a first endpoint device** (e.g., a communication device) **parameter values** (e.g., QoS parameters) **for determination of bandwidth of network connections to further endpoint**

devices (e.g., other communication devices). Erskine teaches collecting **parameter values** such as QoS parameters (e.g., “packet loss, latency, jitter and R factor”)³ at a first endpoint device (e.g., communication device), by generating, monitoring, detecting, and calculating the parameters. Ex-1004, 4:51-64 (*“The communications devices 112, 122, 132 (including VGWs) monitor, detect and/or calculate one or more various QoS parameters at the device, including packet loss, latency, jitter and R factor. Other parameters providing information about the communications session and/or link may be utilized, as desired.”*), 4:65-5:13 (*“[T]he QoS information includes QoS alarms generated by the communications devices (and possibly VGWs) and transmitted to the appropriate signaling server and passed to the corresponding call server.”*), 8:52-67 (*“The QoS information may take the form of QoS measurements made at one or more points in the interzone link, and in one embodiment, the QoS information takes the form of QoS alarm information generated by individual communications devices involved in active communication sessions across the interzone link.”*).

38. Erskine’s QoS parameters are **for determination of bandwidth of network connections** between the communication devices. As an initial matter, Erskine discloses communications between communication devices coupled to

³ Patent Owner’s Infringement Contentions confirm that Erskine’s teachings regarding the QoS parameters satisfy the recited “parameter values,” where Patent Owner alleged that “parameters like bytes and packet exchange, delays, jitter, and bandwidth” satisfy the term. Ex-1007, 000003.

different zones (also described as “network bandwidth zones”), where a zone represents a “geographically distinct zone within the network.” Ex-1004, 2:59-3:10 (“As shown, the system 100 may be divided into network bandwidth zones. A bandwidth zone is generally defined as a geographically distinct zone within the network 102. Typically, the zones may be organized or configured (or aligned) in accordance with the main call management components in the system 100—i.e., call servers, branch offices, and/or voice gateways. ... Thus, various communications devices are coupled or assigned to, or lie within, the respective network bandwidth zone.”), 4:21-40 (“Between each respective bandwidth zone, a transmission or communications link is provided through which data communications are transmitted between the zones.”).

39. For example, as illustrated in Figure 1, communication devices 112a and 112b are coupled with Zone 5, and communicate with communication devices 122a and 122b coupled with Zone 8 by calling 122a and 122b. Ex-1004, 9:37-59 (“[C]all setup (and/or call processing) for a new call from the communication device 112a (in Zone 5) to the communication device 122b (in Zone 8) will now be generally described (peer to peer). In one embodiment, the communication devices 112a and 122b are IP phones. The communication device 112a originates the call. The source call server 110 determines the destination of the call (using NRS servers and/or some other method). The destination call server 120 determines

whether there exists enough bandwidth available for a call between Zone 5 and Zone 8. Similarly, the source call server 110 determines whether there exists enough bandwidth available for the same call. If the determinations conclude that enough bandwidth exists, then the call is connected and the call proceeds conventionally.”), Fig. 1:

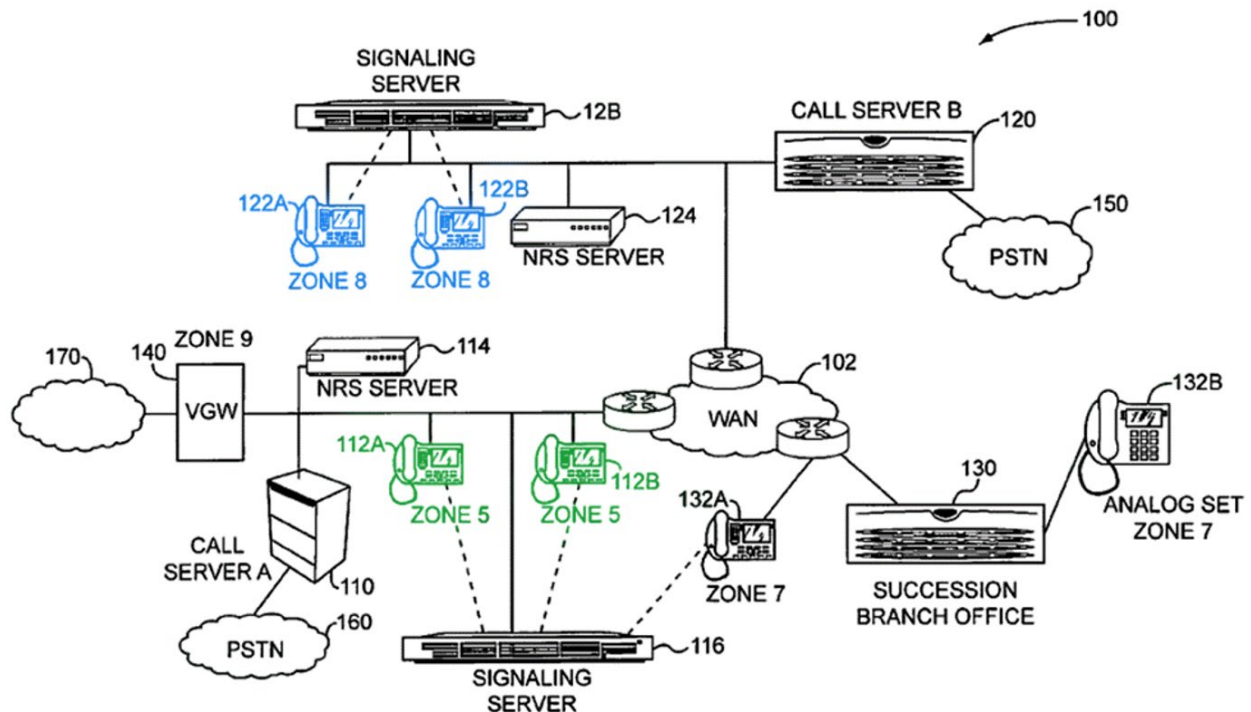


FIG. 1

40. Erskine teaches that the QoS parameters are for determination of bandwidth of connections between the communication devices across various zones. Erskine is directed to adaptive bandwidth management for packet-based communications networks such as VoIP networks. Ex-1004, 1:6-9, 1:34-42.

Erskine teaches that “[e]ach link between two respective zones has an initial maximum interzone bandwidth that is used as a baseline to calculate a dynamic bandwidth limit between the two bandwidth zones.” Ex-1004, 4:30-40. The initial maximum interzone bandwidth may be reduced to a lower value (e.g., a fraction of the initial value) due to a degrading QoS. *E.g.*, Ex-1004, Abstract (“When QoS between two zones degrades, the allowable bandwidth for new calls between the two zones is lowered to a point that assists in increasing the QoS back to an acceptable level (i.e., by blocking new calls or rerouting them”), 4:30-50 (“If the QoS between the two bandwidth zones is degrading, then the maximum interzone bandwidth between those two zones is reduced as a percentage of the initial value (or prior maximum interzone bandwidth value).”), 8:21-27 (“the sliding maximum interzone bandwidth value is a fraction of the configured interzone bandwidth (max allowable) for the link.”).

41. Erskine refers to this lower value as a “sliding maximum interzone bandwidth,” and uses it to determine whether new calls between two zones can be initiated or not. Ex-1004, 4:30-40 (“This new value is used as the new maximum interzone bandwidth, may be referred to as a ‘sliding maximum’ interzone bandwidth, and is used for purposes of allowing/disallowing or redirecting any new calls between the two zones.”), 1:43-60. For example, when a communication device in a zone requests for calls to another communication device in another

zone, Erskine “determines whether the bandwidth necessary for the new call added to the current bandwidth would exceed the sliding maximum interzone bandwidth for that link.” Ex-1004, 6:55-7:3, 8:36-51, 9:51-59. If the sum of the bandwidth necessary for the new call and the current bandwidth is within the sliding maximum interzone bandwidth for that link, the call proceeds; otherwise, the call is blocked or alternative routing is initiated. Ex-1004, 8:36-51 (“In response to any new call setup requests for calls between Zone 5 and Zone 3, the call server 110 (Zone 5) determines whether the bandwidth necessary for the new call added to the current bandwidth would exceed the sliding maximum interzone bandwidth for that link. If within the limit, the call proceeds (at least to allow the call server in Zone 3 to make a similar determination). If not, the call is blocked or alternative routing is initiated, if desired.”), 6:55-7:3, 9:51-59.

42. Erskine therefore relies on the sliding maximum interzone bandwidth to determine that only calls of a bandwidth that fit within the sliding maximum interzone bandwidth can be initiated for that link. For example, in the scenario where the sum of the bandwidth necessary for the new call and the current bandwidth is within the sliding maximum interzone bandwidth for that link, the sliding maximum interzone bandwidth is used to determine that the call can be initiated with a specific bandwidth (e.g., bandwidth necessary for the new call). Erskine thus teaches that the sliding maximum interzone bandwidth is used for

determination of bandwidth of network connections from a communication device to other communication devices.

43. Erskine teaches that the sliding maximum interzone bandwidth is determined, configured, and adjusted based on the QoS parameters. Ex-1004, 4:41-50 (“Various QoS parameters may be used in configuring the sliding maximum interzone bandwidth, such that the available bandwidth may be reduced to a lower level or raised to a higher level, at the same or different rates.”), 4:51-64 (“The communications devices 112, 122, 132 (including VGWs) monitor, detect and/or calculate one or more various QoS parameters at the device, including packet loss, latency, jitter and R factor. Other parameters providing information about the communications session and/or link may be utilized, as desired. The QoS parameters and information, in one or more formats, is transmitted to the call server associated with that particular communications device. This QoS information may be transmitted directly to the call server (e.g., raw information or using QoS alarms) or to the signaling server (or other device in the system) and then forwarded to the call server. The QoS information is then used to adjust the then current sliding maximum interzone bandwidth based upon the QoS information, as appropriate.”), 4:65-5:13, 5:38-6:54.

44. As an example, Erskine determines the sliding maximum interzone bandwidth using the QoS factor, which is calculated based on the QoS parameters.

Ex-1004, 4:65-5:13 (“An algorithm may be used to calculate a QoS factor which defines the relative quality being experienced on the link between the two network bandwidth zones. The QoS factor may be based upon the actual received QoS information, and perhaps other parameters. In this embodiment, an algorithm applies weights to one or more of the following to calculate the QoS factor: type of alarm (e.g., packet loss, latency, jitter, R factor, etc.); value of exceeded unacceptable threshold; alarms per hour, call rate; programmed interzone bandwidth limits; existing QoS factor. The QoS factor is then used to calculate (or recalculate) the sliding maximum interzone bandwidth[.]”), 5:14-28 (“In general terms, as the QoS degrades (i.e., QoS alarms are generated and reported), the QoS factor is calculated (or recalculated) which results in an update to the sliding maximum interzone bandwidth.”), 5:38-6:54 (“The QoS Factor is a percentage that is used to determine the allowable bandwidth between zones.”), 4:41-64. Erskine thus teaches that the parameter values (e.g., QoS parameters)—based on which the sliding maximum interzone bandwidth are determined, configured, and adjusted—are used for determination of bandwidth of network connections to further endpoint devices (e.g., communication devices in other zones).

45. For reasons explained above, Erskine teaches limitations [1a]/[8a]/[15a].

[1b]/[8b] determining at a tuner server,

[15b] determine at the network connected device acting as a tuner server,

distinct from the first endpoint device and the further endpoint devices, that a next network connection from the first endpoint device to a second endpoint device matches a geographical area of a past network connection; and

46. Erskine teaches limitations [1b], [8b], and [15b]. First, Erskine teaches a **tuner server** (e.g., call server). As explained above, Erskine teaches a call server that facilitates communications between communication devices across various zones. *Supra* §§V.A.2[1pre-a]/[8pre-a]/[15pre-a]; Ex-1004, 4:1-20, 2:35-3:29, 3:37-43, Fig. 1:

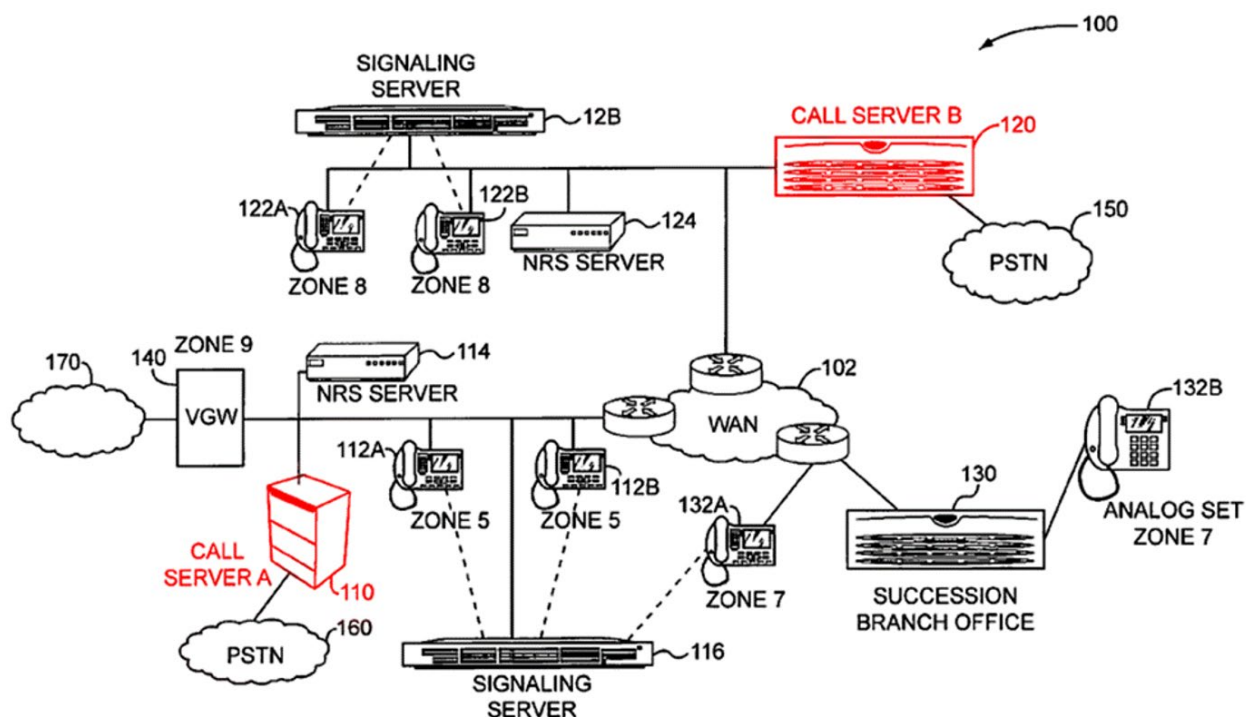


FIG. 1

47. Erskine’s call server is a network connected device. *Supra* §V.A.2[1pre]/[8pre]/[15pre]; Ex-1004, 4:1-20, 2:35-3:29, 3:37-43. Moreover, as explained below, the call server employs adaptive bandwidth management to optimize QoS performance and improve network congestion, maintains and incorporates knowledge of the network topology, and handles routing/rerouting of interzone calls. *Infra* §V.A.8. The ’634 patent specification, which describes the tuner/tuning server and its functionalities broadly, confirms that Erskine’s teachings regarding the call server fall within the recited “tuner server.” *See, e.g.*, Ex-1001, 4:51-5:15, 6:10-38. The call server thus is **a network connected device acting as a tuner server.**⁴

48. Erskine’s call servers and communication devices are distinct, separate components that perform their respective roles in the network. *E.g.*, Ex-1004, 3:11-29, 3:44-4:20, Fig. 1. The call server is thus **distinct from the first endpoint device** (e.g., communication device) **and the further endpoint devices** (e.g., communication devices in other zones).

49. Erskine **determines at the call server that a next network connection from the first endpoint device** (e.g., communication device in a zone) **to a second endpoint device** (e.g., communication device in another zone)

⁴ I note and understand the ’634 patent specification uses the term “tuner server” and “tuning server” interchangeably. *E.g.*, Ex-1001, 2:13-18, 2:50-3:10, 4:35-5:16, 5:65-6:22, Figs. 3, 5.

matches a geographical area of a past network connection. Erskine teaches that the corresponding call server (e.g., source call server) for the communication device that initiates a call to a communication device in another zone has “knowledge of both the source zone and the destination zone.” Ex-1004, 6:55-7:3.

In the process of establishing a call between the communication devices, the call server (e.g., source call server) consults a QoS data structure to determine if the call can be accommodated. *E.g.*, Ex-1004, 6:55-7:10 (“With knowledge of both the source zone and the destination zone, the source call server consults a QoS data structure (as shown in FIG. 2 and described further below) to determine if an additional call can be accommodated (or allowed) across the interzone link.”), 7:64-8:51, 9:37-10:2, Fig. 2:

SOURCE		DESTINATION		QoS FACTOR	CONFIGURED INTERZONE B/W	SLIDING MAXIMUM B/W	ACTUAL INSTANTANEOUS B/W USED	AVERAGE CALLS/HOUR
ZONE	VPNI	ZONE	VPNI		Kbps	Kbps	Kbps	CALLS/HR
5	33	8	34	100	1000	1000	384	4110
5	33	4	33	100	1000	1000	750	6954
5	33	3	38	45	1000	450	128	1500
5	33	7	44	100	1000	1000	128	1201
5	33	9**	59	100	1000	1000	600	7123
7	44	8	34	100	256	256	109	189
7	44	4	33	100	256	256	0	45
7	44	3	38	55	256	141	128	75
7	44	5	33	100	256	256	128	1201
7	44	9**	59	100	256	256	128	120

FIG. 2

50. In this process, as illustrated in the first row of the table in Figure 2, the call server consults the QoS data structure and determines that a next network connection (e.g., a call) from a communication device (e.g., communication device 112a in Zone 5) to another communication device (e.g., communication device 122a in Zone 8) is to be initiated and established over the link between Zone 5 and Zone 8. Ex-1004, 9:37-10:2 (“In a first example, call setup (and/or call processing) for a new call from the communication device 112a (in Zone 5) to the communication device 122b (in Zone 8) will now be generally described (peer to peer). In one embodiment, the communication devices 112a and 122b are IP phones. The communication device 112a originates the call. The source call server 110 determines the destination of the call (using NRS servers and/or some other method).”), 6:55-7:25, 7:64-8:51, Fig. 2, Fig. 1:

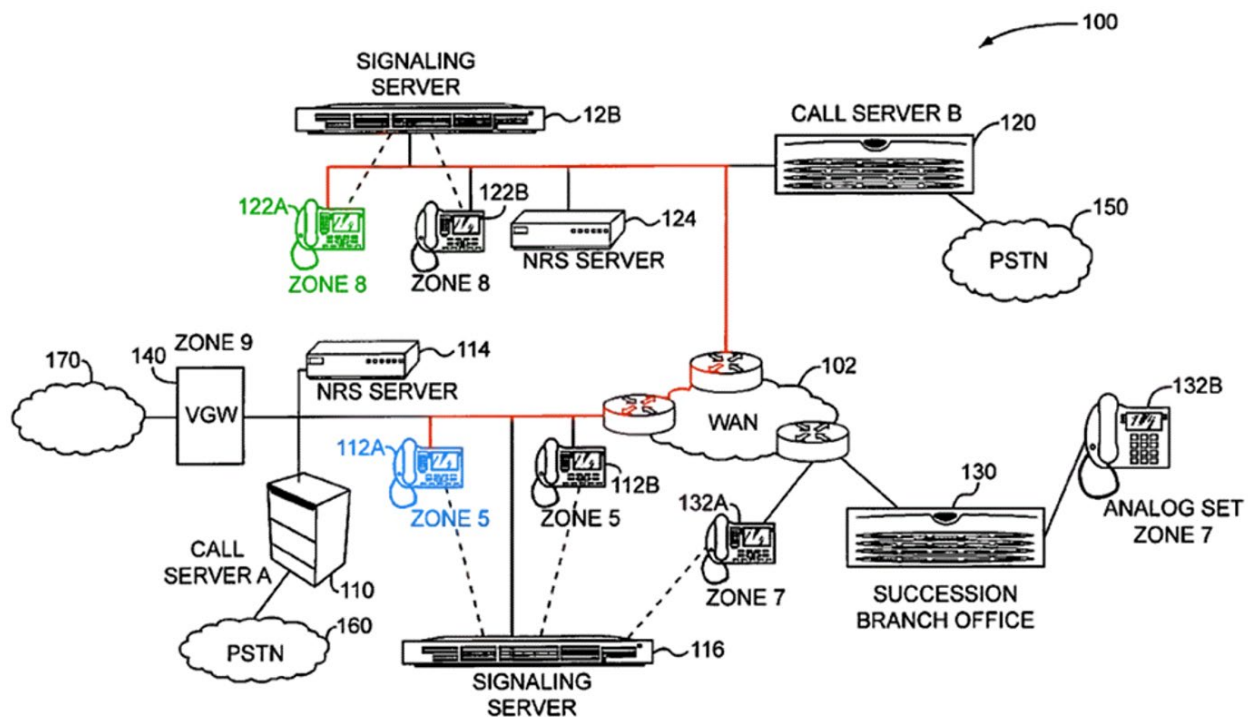


FIG. 1

51. Here, the call established over the link between Zone 5 and Zone 8 represents a **past network connection**. Erskine teaches that the call server “maintains its own QoS data structure table for all the interzone links from its own zone[.]” Ex-1004, 7:11-25, 7:64-8:10, Fig. 2. This includes at least interzone links over which calls have been established in the past. For example, the table in Figure 2 contains information such as “average calls per hour,” which a POSITA would have understood to be based on past network connections (e.g., past calls). Ex-1004, 4:65-5:14, 5:65-67, 6:21-34, 8:11-20, Fig. 2. Erskine therefore teaches that, in the scenario where a link between two zones (e.g., link between Zone 5 and

Zone 8) has been used to establish a past network connection (e.g., a past call), the call over the link represents a past network connection.

52. In addition, a POSITA would have found it obvious for the table in Figure 2 to include links over which calls have been established before. This is because it was well-known that call servers facilitating communications between devices typically kept records of past connections for purposes such as network management and optimization. Indeed, Erskine explains that the table in Figure 2 “may be referred to as a network bandwidth zone management table” and Erskine teaches using the table to further its method of adaptive network bandwidth management, which entails adapting past bandwidth allocations. *E.g.*, Ex-1004, Abstract, 7:11-25, 7:64-8:10.

53. Erskine teaches that Zone 5 and Zone 8 each represents a “geographically distinct zone.” Ex-1004, 2:59-3:10 (“A bandwidth zone is generally defined as a geographically distinct zone within the network 102.”), Abstract (“A packet-based communications system or network is configured into multiple geographically distinct network bandwidth zones having interzone communications links with a configured maximum bandwidth.”), 2:59-3:10 (“Typically, the zones may be organized or configured (or aligned) in accordance with the main call management components in the system 100—i.e., call servers, branch offices, and/or voice gateways.”). A call over the link between two zones

(e.g., Zone 5 and Zone 8) thus teaches a geographical area of a past network connection.

54. By consulting the QoS data structure table and determining that a next call is to be initiated over the link between two zones that matches a link identified in the table (e.g., Zone 5 and Zone 8), the call server determines that the next call **matches a geographical area of a past network connection**. The '634 patent specification confirms that Erskine's teachings satisfy the limitation by broadly describing the process of "matching." *E.g.*, Ex-1001, 4:13-17 ("The processor 204 could compare the next network connection 210 to previous network connections 210, 212, 214, *for example by examining the parameters 208 in memory 206, and find that the next network connection 210 matches a previous network connection 210.*"), 5:34-37.

55. In short, Erskine teaches determining at a tuner server (e.g., call server) that a next network connection (e.g., a call) from the first endpoint device (e.g., communication device 112a in Zone 5) to a second endpoint device (e.g., communication device 122a in Zone 8) matches a geographical area of a past network connection (e.g., a call over the link between Zone 5 and Zone 8).

56. For reasons explained above, Erskine teaches limitations [1b]/[8b]/[15b].

[1c]/[8c]/[15c] initiat[ing] the next network connection, from the first endpoint device to the second endpoint device, based on the determination at [the tuner server]/[the network connected device acting as the tuner server], with a transmission bandwidth based on the parameter values for the past network connection.

57. Erskine teaches limitations [1c]/[8c]/[15c]. First, Erskine teaches **initiating the next network connection from the first endpoint device to the second endpoint device** by initiating a call from a communication device to a communication device in another zone. As explained above, Erskine teaches initiating a call from the first endpoint device (e.g., communication device in a zone) to the second endpoint device (e.g., communication device in another zone) when the bandwidth of the call fits within the sliding maximum interzone bandwidth. *Supra* §V.A.2[1a]/[8a]/[15a]; Ex-1004, 8:36-51 (“In response to any new call setup requests for calls between Zone 5 and Zone 3, the call server 110 (Zone 5) determines whether the bandwidth necessary for the new call added to the current bandwidth would exceed the sliding maximum interzone bandwidth for that link. If within the limit, the call proceeds (at least to allow the call server in Zone 3 to make a similar determination).”), 3:44-67, 6:55-7:3, 9:51-59.

58. Erskine further teaches initiating the call **based on the determination at the tuner server** (e.g., call server) ([1c], [8c]). As explained above, Erskine teaches that in the process of initiating a call, the call server determines that the call matches a geographical area of a past network connection (e.g., a call over the

link between Zone 5 and Zone 8) and determines that the call can proceed if the bandwidth necessary for the call added to the current bandwidth is within the sliding maximum interzone bandwidth for that link. *Supra* §V.A.2[1b]/[8b]/[15b]; Ex-1004, 4:65-5:14, 5:65-67, 6:21-34, 6:55-7:25, 7:64-8:51, 9:37-10:2, Figs. 1, 2. Erskine thus teaches initiating the call based on the determination at the tuner server (e.g., call server). Moreover, as explained above, Erskine also teaches a network connected device acting as tuner server. *Supra* §V.A.2[1b]/[8b]/[15b]. Erskine thus teaches initiating the call based on the **determination at the network connected device acting as the tuner server** ([15c]).

59. Furthermore, Erskine teaches initiating the call **with a transmission bandwidth based on the parameter values for the past network connection**. As explained above, Erskine determines that a call is to be initiated if the bandwidth necessary for the call added to the current bandwidth is within the sliding maximum interzone bandwidth for that link. *Supra* §V.A.2[1a]/[8a]/[15a]; Ex-1004, 6:55-7:3, 8:36-51, 9:51-59. In this way, the call proceeds with a bandwidth determined based on the sliding maximum interzone bandwidth for that link. Moreover, as explained above, the sliding maximum interzone bandwidth is determined based on the QoS parameters. *Supra* §V.A.2[1a]/[8a]/[15a]; Ex-1004, 4:41-5:13, 5:38-6:54. Erskine therefore teaches initiating a call with a bandwidth determined based on the QoS parameters.

60. Erskine further teaches that the QoS parameters are for the past network connection. As explained above, Erskine teaches a past network connection (e.g., call over the link between Zone 5 and Zone 8). *Supra* §V.A.2[1b]/[8b]/[15b]; Ex-1004, 4:65-5:14, 5:65-67, 6:21-34, 7:11-25, 7:64-8:20, Fig. 2. As shown in the table in Figure 2, the link between Zone 5 and Zone 8 pertains to QoS parameters for the link, such as the QoS parameters that are used to determine the QoS factor of the link. Ex-1004, 4:41-64 (“The communications devices 112, 122, 132 (including VGWs) monitor, detect and/or calculate one or more various QoS parameters at the device, including packet loss, latency, jitter and R factor.”), 4:65-5:13 (“An algorithm may be used to calculate a QoS factor which defines the relative quality being experienced on the link between the two network bandwidth zones. The QoS factor may be based upon the actual received QoS information, and perhaps other parameters. In this embodiment, an algorithm applies weights to one or more of the following to calculate the QoS factor: type of alarm (e.g., packet loss, latency, jitter, R factor, etc.); value of exceeded unacceptable threshold; alarms per hour, call rate; programmed interzone bandwidth limits; existing QoS factor.”), 5:38-6:54, Fig. 2:

SOURCE		DESTINATION		QoS FACTOR	CONFIGURED INTERZONE B/W	SLIDING MAXIMUM B/W	ACTUAL INSTANTANEOUS B/W USED	AVERAGE CALLS/HOUR
ZONE	VPNI	ZONE	VPNI		Kbps	Kbps	Kbps	CALLS/HR
5	33	8	34	100	1000	1000	384	4110
5	33	4	33	100	1000	1000	750	6954
5	33	3	38	45	1000	450	128	1500
5	33	7	44	100	1000	1000	128	1201
5	33	9**	59	100	1000	1000	600	7123
7	44	8	34	100	256	256	109	189
7	44	4	33	100	256	256	0	45
7	44	3	38	55	256	141	128	75
7	44	5	33	100	256	256	128	1201
7	44	9**	59	100	256	256	128	120

FIG. 2

61. Because the QoS parameters are for the past network connection, Erskine thus teaches initiating the next network connection (e.g., a call), from the first endpoint device (e.g., communication device) to the second endpoint device (e.g., communication device in another zone), based on the determination at the tuner server/the network connected device acting as the tuner server (e.g., call server), with a transmission bandwidth based on the parameter values (e.g., QoS parameters) for the past network connection (e.g., call over the link between Zone 5 and Zone 8). Erskine therefore teaches limitations [1c]/[8c]/[15c].

3. Dependent Claims 2, 9, 16⁵

[2a]. The method of claim 1, further comprising:

[9a]. The method of claim 8, further comprising:

[16a]. The network connected device of claim 15, wherein the one or more processors are configurable to:

send[ing] the parameter values for determination of bandwidth[,] from the first endpoint device, to the tuner server that is configured to receive further parameter values for determination of bandwidth of network connections from a plurality of endpoint devices;

62. Erskine teaches the method according to claims 1 and 8, and the network connected device of claim 15. *Supra* §V.A.2. As explained below, Erskine further teaches the additional limitations of claims 2, 9, and 16.

63. As explained above, Erskine teaches parameter values (e.g., QoS parameters) for determination of bandwidth. *Supra* §V.A.2[1a]/[8a]/[15a]; Ex-1004, 1:43-60, 4:30-5:13, 5:38-7:3, 8:36-51, 9:51-59, Figs. 1, 2. Erskine further teaches **sending the parameters values** (e.g., QoS parameters) **from the first endpoint device** (e.g., communication device in a zone) **to the tuner server** (e.g., call server). *E.g.*, Ex-1004, 4:51-5:13 (“The communications devices 112, 122, 132 (including VGWs) monitor, detect and/or calculate one or more various QoS parameters at the device, including packet loss, latency, jitter and R factor. ... *The*

⁵ I understand that Petitioners contend that claim 16 is indefinite in their preliminary proposed claim constructions in the parallel district court litigation. To the extent the claim is deemed not to be indefinite, my declaration herein explains how Grounds 1–3 render the claim obvious.

QoS parameters and information, in one or more formats, is transmitted to the call server associated with that particular communications device. This QoS information may be transmitted directly to the call server (e.g., raw information or using QoS alarms) or to the signaling server (or other device in the system) and then forwarded to the call server.”), 8:52-67 (“[T]he QoS information may be communicated directly to the call server, or to one or more other network devices (such as a signaling server) before reaching the call server.”).

64. Erskine further teaches that the call server **receives further parameter values for determination of bandwidth of network connections from a plurality of endpoint devices**. As explained above, Erskine teaches the QoS parameters received from the communication device are used by the call server for determination of bandwidth of connections between communication devices across various zones. *Supra* §V.A.2[1a]/[8a]/[15a]; Ex-1004, 4:30-5:13, 5:38-7:3, 8:36-51, 9:51-59. Erskine teaches that a call server may be coupled to and associated with a plurality of communication devices. Ex-1004, 3:11-29 (“The call server 110 has coupled thereto communication devices 112a, 112b, a network resolution (NRS) server 114, and a signaling server 116. Similarly, the call server 120 has coupled thereto communication devices 122a, 122b, a network resolution (NRS) server 124, and a signaling server 126.”), 11:9-15 (“[E]ach call server,

branch office and gateway may be coupled to any number of communication devices[.]”), 4:1-20, 4:51-64, 7:11-25, 8:28-35, Fig. 1:

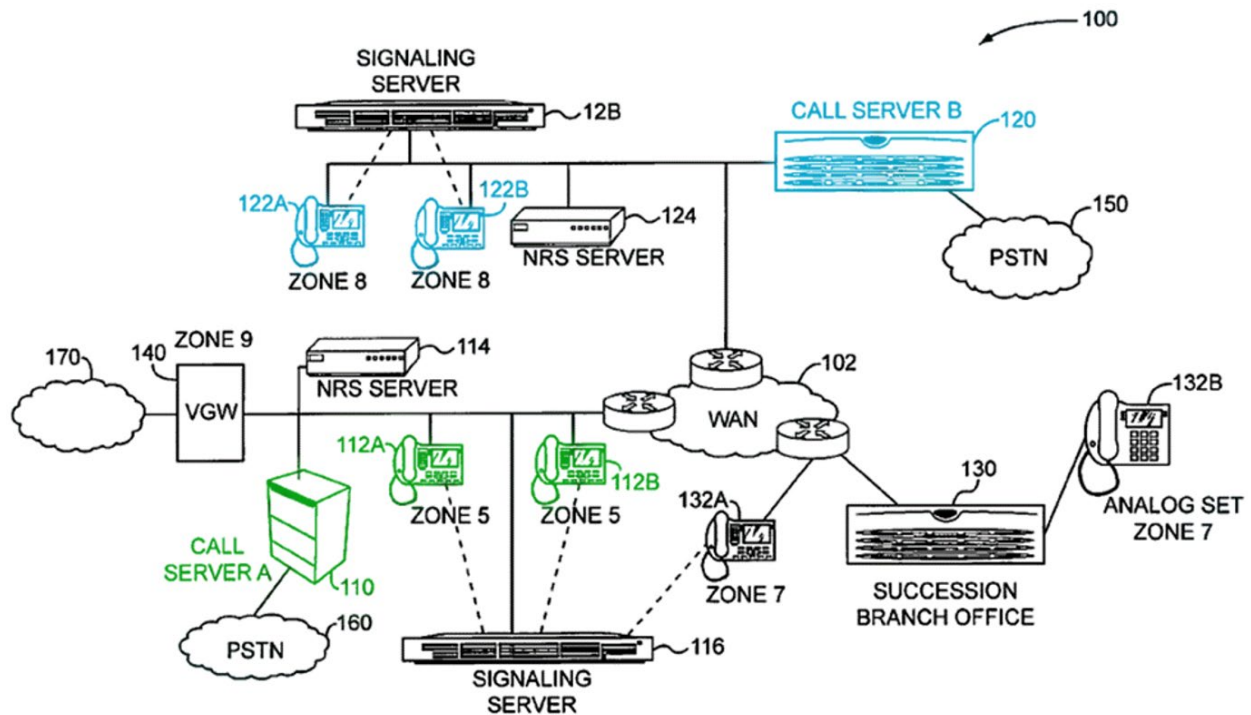


FIG. 1

65. The call server facilitates communications for the plurality of communication devices coupled to it, including, for example, initiating calls from these communication devices to communication devices in other zones. *E.g.*, Ex-1004, 4:1-20 (“The call servers 110, 120 and branch office 130 (and VGW 140) facilitate communication by and/or between the communication devices 112, 122, 132 (and any devices coupled to the PSTN 160, 170 or the VGW 140) over the network 102.”), 7:11-25 (“The sliding maximum interzone bandwidth is calculated

by each call server based upon the QoS information the call server receives from its corresponding communication devices and other call processing information.”), 8:28-35.

66. In this process, the call server receives QoS parameters from the plurality of communication devices coupled to it. *E.g.*, Ex-1004, 4:51-5:13 (“The communications devices 112, 122, 132 (including VGWs) monitor, detect and/or calculate one or more various QoS parameters at the device, including packet loss, latency, jitter and R factor. ... The QoS parameters and information, in one or more formats, is transmitted to the call server associated with that particular communications device.”), 8:28:35 (“[T]he call server 110 only receives real-time QoS information from its own corresponding communications devices, and not from communication devices within Zone 3 (in this case, the call server responsible for Zone 3 may be receiving any QoS alarms from its own corresponding devices).”), Fig. 1.

67. Erskine teaches the call server receiving **further parameter values** (e.g., one or more QoS parameters) from the communication devices coupled to it. As explained above, Erskine teaches various QoS parameters such as “packet loss, latency, jitter and R factor” and “[o]ther parameters providing information about the communications session and/or link may be utilized,” each of which is received by the call server. *Supra* §V.A.2[1a]/[8a]/[15a]; *e.g.*, Ex-1004, 4:51-64 (“*The*

communications devices 112, 122, 132 (including VGWs) monitor, detect and/or calculate one or more various QoS parameters at the device, including packet loss, latency, jitter and R factor. Other parameters providing information about the communications session and/or link may be utilized, as desired.”), 4:65-5:13, 8:52-

67.⁶ The '634 patent specification confirms that Erskine's teachings satisfy the limitation. Ex-1001, 6:39-7:4 (“These parameter values can be obtained from the stored parameter values for network connection bandwidth received from the endpoints, in the action 602. Alternatively, one or more further parameter values can be derived from stored or obtained parameter values in some embodiments.”).

Since the QoS parameters are for determination of bandwidth of connections between communication devices (*supra* §§V.A.2[1b-c]/[8b-c]/[15b-c]), Erskine thus teaches that the call server **receives further parameter values for determination of bandwidth of network connections from a plurality of endpoint devices.**

68. Moreover, as explained above, Erskine teaches that the network connected device (e.g., call server) has one or more processors. *Supra* §V.A.2[15pre]. These processors are configurable to perform the operations

⁶ Patent Owner's Infringement Contentions confirm that Erskine's teachings regarding the QoS parameters satisfy the recited “further parameter values,” alleging that “parameters such as bytes and packet exchange, delays, jitter and bandwidth ... are sent from the first endpoint device to the tuner server[, which] is configured to receive each of the parameters values, ‘further parameter values.’” Ex-1007, 000004.

performed by the call server, including operations discussed above. Ex-1004, 1:61-2:5, 3:11-29, 4:1-20. Erskine therefore teaches limitation [16a]. For reasons explained above, Erskine teaches limitations [2a]/[9a]/[16a].

[2b]/[9b]/[16b] send[ing], from the first endpoint device to the tuner server, connection information for the next network connection, wherein the tuner server performs the determining and derives one or more parameter values for the transmission bandwidth; and

69. Erskine teaches limitations [2b]/[9b]/[16b]. Erskine teaches **sending from the first endpoint device** (e.g., communication device) **to the tuner server** (e.g., call server), **connection information for the next network connection** (e.g., a call setup message that requests a new call). For example, Erskine teaches a communication device sending a request for a new call to the call server. Ex-1004, 1:61-2:5 (“[T]here is provided a call server having a network interface. The network interface ... *receives a call setup message from a first communications device requesting a new call over the communications link* between the first zone and the second zone.”), 9:37-59 (“[C]all setup (and/or call processing) for a new call from the communication device 112 *a* (in Zone 5) to the communication device 122 *b* (in Zone 8) will now be generally described (peer to peer). In one embodiment, the communication devices 112 *a* and 122 *b* are IP phones. The communication device 112 *a* originates the call.”), 1:34-42 (“*A request for a new call* is received between the two zones, and the new call is rejected in response to

the received QoS information.”), 9:15-26 (“At a step 308, *a request for new call setup is received at the call server.*”), 8:36-51. The call setup message and the request for a new call constitute **connection information** since they provide information about establishing a network connection between two communication devices.⁷

70. Erskine further teaches that **the tuner server** (e.g., call server) **performs the determining and derives one or more parameter values** (e.g., sliding maximum interzone bandwidth) **for the transmission bandwidth**. As explained above, the call server determines that calls between communication devices are initiated with a bandwidth that fits within the sliding maximum interzone bandwidth for that link. *Supra* §V.A.2[1c]/[8c]/[15c]; e.g., Ex-1004, 4:65-5:14, 5:65-67, 6:21-34, 6:55-7:25, 7:64-8:51, 9:37-10:2, Figs. 1, 2. In this process, the call server derives one or more parameter values (e.g., sliding maximum interzone bandwidth) for the transmission bandwidth. For example, as explained above, the call server uses QoS parameters received from the

⁷ The '634 patent specification confirms that Erskine's teachings satisfies the recited “connection information” by describing the term broadly. *E.g.*, Ex-1001, 4:35-50 (“FIG. 3 depicts endpoints 103, 105, 107, 109 sending parameters 208 relating to network connections to a tuning server 302, and the tuning server 302 sending bandwidth information 308 to one of the endpoints 103 in response to receiving *connection information 306 about a next network connection 304 from that endpoint 103.*”), 6:10-38 (“[T]he tuning server receives connection information from an endpoint, for a next network connection to be made by that endpoint”), 4:51-5:16.

communication devices, such as R-factor, packet loss, delay and jitter, to calculate and derive the sliding maximum interzone bandwidth, based on which the bandwidth for a new call is determined. *Supra* §V.A.2[1a]/[8a]/[15a]; *e.g.*, Ex-1004, 4:30-5:13, 5:38-7:3, 8:36-51, 9:51-59. Erskine therefore teaches limitations [2b]/[9b]/[16b].

[2c]/[9c]/[16c] receiv[ing], at the first endpoint device, from the tuner server, the one or more [parameter] values for the transmission bandwidth.

71. Erskine teaches limitations [2c]/[9c]/[16c].⁸ As explained above, Erskine teaches that the call server determines whether a new call between communication devices can be initiated or not. *Supra* §V.A.2; *e.g.*, Ex-1004, 8:36-51, 3:44-67, 6:55-7:3, 9:51-59. Erskine further teaches that when a new call is to proceed, the communication device receives information from the call server, confirming that the call can be initiated.⁹ *E.g.*, Ex-1004, 3:44-67, 6:55-7:3, 8:36-51, 9:51-59.

⁸ I note that “the one or more para values” of claim 2 of the ’634 patent appears to be a typographical error. Ex-1001, 14:26. My analysis assumes that the claim recites “parameters values” instead of “para values.”

⁹ Patent Owner’s Infringement Contentions confirm that Erskine’s teachings satisfy the limitation. PO alleged that the limitation is satisfied where, in the process of initiating a next connection, the accused tuner server “forwards the relevant packet to initiate the next network connection from the first endpoint device (*e.g.*, a server) to the second endpoint device (*e.g.*, another server), ... In this process, ... the first endpoint device receives the parameter values for the transmission bandwidth.” Ex-1007, 000005-6.

72. A POSITA would have found it obvious that the information received at the communication device from the call server includes information such as the sliding maximum interzone bandwidth because in the process of initiating a new call, the communication device would have received information pertaining to transmission bandwidth for it to initiate the call with a suitable bandwidth. For example, Erskine teaches that the communication devices may include a “camera and/or a display to capture and play video information,” and that a communication session may include a “videophone call,” and that the communication devices may exchange “audio, video, graphical, or other information during a communication session.” Ex-1004, 3:44-67. It was well-known and a POSITA would have understood that the exchange of video can occur at different rates based on the choice of encoding scheme, and it would have been obvious to a POSITA that knowledge of the sliding maximum interzone bandwidth would be needed by the communication device in order to ensure that the encoding scheme used for the video did not allow the transmission to exceed the available bandwidth. Erskine therefore teaches limitations [2c]/[9c]/[16c].

73. In addition, since Erskine focuses on enhancing QoS performance for network communications, a POSITA would have found receiving information such as the sliding maximum interzone bandwidth at the communication devices obvious such that the communication device would operate within specific

bandwidth limits to maintain call quality. Ex-1004, Abstract (“When QoS between two zones degrades, the allowable bandwidth for new calls between the two zones is lowered to a point that assists in increasing the QoS back to an acceptable level (i.e., by blocking new calls or rerouting them).”), 1:13-30 (“By measuring the actual QoS network performance parameters at appropriate locations using known QoS factors in real-time, new calls may be limited and/or redirected, thereby providing the desired or needed quality for existing calls and future calls.

Accordingly, there is needed an apparatus and method for using real-time QoS information from one or more points in the network to adapt the bandwidth limit relative to network performance”), 7:26-40 (“Real-time QoS measurements and call processing information at each end may, therefore, indicate one end has a higher/lower QoS than the other end, or the configured bandwidth at each end may be different, etc.”).

74. Moreover, Erskine teaches rerouting calls over an alternative link when a new call is rejected. Ex-1004, Abstract, 6:55-7:10, 8:21-9:26, Fig. 3. A POSITA would have found it obvious that the communication device would have received information pertaining to transmission bandwidth (e.g., sliding maximum interzone bandwidth) in this process, allowing it to initiate the call over an alternative link and adapt to the characteristics of the new route. *E.g.*, Ex-1004, 4:30-40 (“This new value is used as the new maximum interzone bandwidth, may

be referred to as a ‘sliding maximum’ interzone bandwidth, and is used for purposes of allowing/disallowing or redirecting any new calls between the two zones.”), 6:55-7:10, 8:21-9:26. Erskine therefore teaches limitations [2c]/[9c]/[16c].

4. Dependent Claims 3, 10, 17

- 3. The method of claim 1, wherein the initiating is executed by the first endpoint device.**
- 10. The method of claim 8, wherein the initiating is executed by the first endpoint device.**
- 17. The network connected device of claim 15, wherein the initiating is executed by the first endpoint device and wherein the first endpoint device is contained within the network connected device.**

75. Erskine teaches the method according to claims 1 and 8, and the network connected device of claim 15. *Supra* §V.A.2. Erskine further teaches the additional limitations of claims 3, 10, and 17.

76. First, as explained above, the call server determines whether a call can be initiated. *Supra* §§V.A.2[1a-b]/[8a-b]/[15a-b]; Ex-1004, 4:65-5:14, 5:65-67, 6:21-34, 6:55-7:25, 7:64-8:51, 9:37-10:2, Figs. 1, 2. A POSITA would have understood that Erskine’s teachings include at least two scenarios—the initiating is executed by the communication device, or by the call server. Erskine teaches that, in the scenario where **the initiating is executed by the first endpoint device** (e.g., communication device) (claims 3, 10, 17), the communication device originates the

call to the communication device in another zone. *Supra* §§V.A.2[1a]/[8a]/[15a], V.A.2[1c]/[8c]/[15c]; Ex-1004, 9:37-59 (“[T]he communication devices 112a and 122b are IP phones. The communication device 112a originates the call.”), 10:26-38 (“The communication device 112a originates the call.”), 3:44-67, 6:55-7:3, 8:36-51.

77. Erskine further teaches that **the first endpoint device** (e.g., communication device) **is contained within the network connected device** (e.g., call server) (claim 17). As explained above, Erskine teaches that the network connected device (e.g., call server) and the first endpoint device (e.g., communication device associated with the call server) are distinct, separate components that perform their respective roles. *Supra* §V.A.2[1b]/[8b]/[15b]; e.g., Ex-1004, 3:11-29, 3:44-4:20. While Erskine teaches that two components are distinct, its teachings include at least two scenarios: (1) the communication device is integrated into the call server, where the two components share the same physical housing; (2) the communication device is located as a physically independent component outside the call server.¹⁰

78. Indeed, Erskine teaches that the communication devices are associated with the call servers, and the phrase “associated with” includes “contain” or “be[ing] contained within.” Ex-1004, 4:51-64 (“The QoS parameters and

¹⁰ Erskine explains that the configuration shown in Fig. 1 is only “one exemplary configuration.” *See* Ex-1004, 2:28-3:10.

information, in one or more formats, is transmitted to the call server associated with that particular communications device.”), 11:28-44 (“The phrases ‘associated with’ and ‘associated therewith,’ as well as derivatives thereof, may mean to include, be included within, interconnect with, *contain*, *be contained within*, connect to or with, couple to or with, be communicable with, cooperate with, interleave, juxtapose, be proximate to, be bound to or with, have, have a property of, or the like.”).

79. Moreover, a POSITA would have recognized the benefits of having the configuration in the first scenario—that the communication device is within the same housing as the call server. For example, combining both components in a single unit would have eliminated the need for separate physical installations, reducing the time and effort required for deployment. In addition, maintenance tasks would have been streamlined since both components are housed together, making them accessible at the same location. Moreover, since communication between the communication device and the call servers happens internally, such configuration may reduce delays associated with external network links and minimize communication latency. Erskine thus teaches claims 3, 10, and 17.

5. Dependent Claims 4, 11, 18

4. The method of claim 1,

11. The method of claim 8,

18. The network connected device of claim 15,

wherein the determining and the initiating are executed external to the first endpoint device and communicated to the first endpoint device.

80. Erskine teaches the method according to claims 1 and 8, and the network connected device of claim 15. *Supra* §V.A.2. Erskine further teaches the additional limitations of claims 4, 11, and 18.

81. First, as explained above, Erskine's teachings include the scenario where **the determining is executed** by the call server. *Supra* §V.A.2. Erskine further teaches the example scenario where **the initiating is executed** by the call server. *Supra* §V.A.4. For example, Erskine teaches that the call server establishes and initiates the call between communication devices by monitoring the traffic between the communication devices (*see infra* §§V.A.6, V.A.7), determining that a new call can proceed when the bandwidth of the call fits within the sliding maximum interzone bandwidth, and rerouting the call if desired (*supra* §V.A.2).

82. Moreover, Erskine teaches that the call server is **external to the first endpoint device** (e.g., communication device). As explained above, Erskine's teachings include the scenario where the call server and the communication device are physically separate components performing their respective roles. *Supra*

§§V.A.2[1b]/[8b]/[15b], V.A.4; Ex-1004, 3:11-29, 3:44-4:20, Fig. 1. The call server is external to the communication device in this example scenario.

83. Erskine further teaches that the call server **communicates** the determining and initiating **to the first endpoint device** (e.g., communication device). A POSITA would have found this obvious because the communication device would have originated the call to a communication device in another zone only after being informed by the call server that the call may proceed. *E.g.*, Ex-1004, 8:21-51, 9:37-50. In this process, the call server would have communicated to the communication device about the determining and initiating. Erskine therefore teaches claims 4, 11, and 18.

6. Dependent Claims 5, 12, 19

5. The method of claim 1, further comprising:

12. The method of claim 8, further comprising:

19. The method of claim 15, further comprising the network connected device configurable to:

monitor[ing] network traffic between the first endpoint device and the second endpoint device; and

adjust[ing] the transmission bandwidth based on the monitoring.

84. Erskine teaches the method according to claims 1 and 8, and the network connected device of claim 15.¹¹ *Supra* §V.A.2. Erskine further teaches the additional limitations of claims 5, 12, and 19.

85. Erskine teaches that the call server **monitors network traffic between the first endpoint device** (e.g., communication device) **and the second endpoint device** (e.g., communication device in another zone). As explained above, Erskine teaches that the allowable bandwidth for calls between communication devices may be affected by a degrading QoS. *Supra* §V.A.2[1a]/[8a]/[15a]; Ex-1004, Abstract, 4:30-50, 8:21-27. Erskine teaches that the call server measures and monitors the QoS performance, where the call server receives and processes real-time QoS parameters and information, and determines whether a call can proceed. *Supra* §§V.A.2[1a-c]/[8a-c]/[15a-c]; e.g., Ex-1004,

¹¹ I note that the “method of claim 15” recited in claim 19 of the ’634 patent appears to be a typographical error. Ex-1001, 16:31. The correct term should be “network connected device of claim 15.”

8:53-67 (“The QoS information may take the form of QoS measurements made at one or more points in the interzone link, ... Described previously, the QoS information may be communicated directly to the call server, or to one or more other network devices (such as a signaling server) before reaching the call server. As will be appreciated, the QoS information/measurements are real-time (or substantially real-time) measurements.”), 6:55-7:10, 7:26-40, 7:64-8:51, 9:37-10:2, Fig. 2. The call server therefore monitors network traffic between the communication devices in this process.

86. Erskine further teaches that the call server **adjusts the transmission bandwidth based on the monitoring**. As explained above, Erskine teaches that the call server monitors the QoS performance and uses the received QoS parameters and information to determine, configure, and adjust the sliding maximum interzone bandwidth. *Supra* §V.A.2[1a]/[8a]/[15a]; Ex-1004, 4:51-64 (“This QoS information may be transmitted directly to the call server (e.g., raw information or using QoS alarms) or to the signaling server (or other device in the system) and then forwarded to the call server. The QoS information is then used to adjust the then current sliding maximum interzone bandwidth based upon the QoS information, as appropriate.”), 4:65-5:28, 5:38-6:54.

87. In this process, based on the monitoring, the call server adjusts the transmission bandwidth, including, for example, by reducing the allowable

bandwidth between the communication devices in order to maintain an acceptable QoS, or, alternatively, allocating zero bandwidth for the call. Ex-1004, 5:14-28 (“Depending on the desired algorithm, the allowable bandwidth between two network bandwidth zones (for a communications link therebetween) is reduced in order to preserve or maintain an acceptable QoS between the two zones.”), 4:41-64 (“Various QoS parameters may be used in configuring the sliding maximum interzone bandwidth, such that the available bandwidth may be reduced to a lower level or raised to a higher level, at the same or different rates. Not only may the magnitude be changed, but the rate of change may also be adjusted.”), Abstract (“Adaptive bandwidth management based upon quality of server (QoS) measurement between two zones is utilized to dynamically raise or lower the maximum allowable bandwidth limit for the link between the two zones. When QoS between two zones degrades, the allowable bandwidth for new calls between the two zones is lowered to a point that assists in increasing the QoS back to an acceptable level (i.e., by blocking new calls or rerouting them).”), 5:38-6:54, 9:51-59.

88. PO’s Infringement Contentions confirm that Erskine’s teachings satisfy this limitation, where PO alleged that the load balancing functionalities of the accused products—similar to Erskine’s disclosures regarding adjusting

allowable bandwidth for the connections—satisfy the claim. *See* Ex-1007, 000007, 000008. Erskine therefore teaches claims 5, 12, and 19.

7. Dependent Claims 6, 13, 20¹²

6. The method of claim 1, further comprising:

13. The method of claim 8, further comprising:

20. The network connected device of claim 15, further comprising the network connected device configurable to:

monitor[ing] network traffic between the first endpoint device and the second endpoint device;

transmitt[ing] data associated with the network traffic from the first endpoint to the [tuner server]/[network connected device];

determin[ing], at the [tuner server]/[network connected device], an adjustment to the transmission bandwidth is desired;

receiv[ing] data for adjusting the transmission bandwidth from the [tuner server]/[network connected device]; and

adjust[ing] the transmission bandwidth responsive to the receiving.

89. Erskine teaches the method according to claims 1 and 8, and the network connected device of claim 15. *Supra* §V.A.2. Erskine further teaches the additional limitations of claims 6, 13, and 20. First, as explained above, Erskine teaches **monitoring network traffic between the first endpoint device and the**

¹² I understand that Petitioners contend that claim 20 is indefinite in their preliminary proposed claim constructions in the parallel district court litigation. To the extent the claim is deemed not to be indefinite, my declaration herein explains how Grounds 1–3 render the claim obvious.

second endpoint device and adjusting the transmission bandwidth. *Supra* §V.A.6.

90. Erskine further teaches **transmitting data associated with the network traffic from the first endpoint** (e.g., the communication device) **to the tuner server/network connected device** (e.g., call server). For example, as explained above, the communication device collects QoS parameters and transmit them to the call server for determination of interzone transmission bandwidth. *Supra* §§V.A.2[1a-c]/[8a-c]/[15a-c], V.A.6; e.g., Ex-1004, 6:55-7:10, 7:64-8:51, 9:37-10:2, Fig. 2. A POSITA would have recognized that the QoS parameters (e.g., packet loss, latency, jitter and R factor) are **data associated with the network traffic** because they relate to network traffic, specify the network performance criteria, and are used for network traffic management.

91. Erskine further teaches that, upon receiving the QoS parameters, the call server **determines that an adjustment to the transmission bandwidth is desired**. For example, as explained above, when the network's QoS performance is degrading, the call server determines that the transmission bandwidth needs to be adjusted (e.g., reduced) to maintain QoS performance and call quality. *Supra* §V.A.4; e.g., Ex-1004, Abstract ("Adaptive bandwidth management based upon quality of server (QoS) measurement between two zones is utilized to dynamically raise or lower the maximum allowable bandwidth limit for the link between the

two zones. When QoS between two zones degrades, the allowable bandwidth for new calls between the two zones is lowered to a point that assists in increasing the QoS back to an acceptable level (i.e., by blocking new calls or rerouting them).”), 5:14-28 (“Depending on the desired algorithm, the allowable bandwidth between two network bandwidth zones (for a communications link therebetween) is reduced in order to preserve or maintain an acceptable QoS between the two zones.”), 4:41-64 (“Various QoS parameters may be used in configuring the sliding maximum interzone bandwidth, such that the available bandwidth may be reduced to a lower level or raised to a higher level, at the same or different rates.”), 5:38-6:54, 9:51-59.

92. Erskine further teaches **receiving data for adjusting the transmission bandwidth** (e.g., QoS factor) **from the tuner server/network connected device** (e.g., call server) **and adjusting the transmission bandwidth responsive to the receiving**. For example, as explained above, the call server calculates and derives the QoS factor, in response to which the transmission bandwidth is adjusted. *Supra* §V.A.2[1a]/[8a]/[15a]; e.g., Ex-1004, 4:65-5:13 (“An algorithm may be used to calculate a QoS factor which defines the relative quality being experienced on the link between the two network bandwidth zones. The QoS factor may be based upon the actual received QoS information, and perhaps other parameters. In this embodiment, an algorithm applies weights to one or more of the

following to calculate the QoS factor: type of alarm (e.g., packet loss, latency, jitter, R factor, etc.); value of exceeded unacceptable threshold; alarms per hour, call rate; programmed interzone bandwidth limits; existing QoS factor. The QoS factor is then used to calculate (or recalculate) the sliding maximum interzone bandwidth[.]”), 5:14-28 (“In general terms, as the QoS degrades (i.e., QoS alarms are generated and reported), the QoS factor is calculated (or recalculated) which results in an update to the sliding maximum interzone bandwidth. ... Depending on the desired algorithm, the allowable bandwidth between two network bandwidth zones (for a communications link therebetween) is reduced in order to preserve or maintain an acceptable QoS between the two zones.”), 1:34-60 (“[T]he method ... lowers the maximum bandwidth value to a sliding maximum interzone bandwidth value in response to the received QoS information[.]”), 4:41-64, 5:38-6:54, 9:51-59. For reasons explained above, Erskine teaches claims 6, 13, and 20.

8. Dependent Claims 7, 14

7. The method of claim 6,

14. The method of claim 13,

wherein the tuner server incorporates knowledge of a network topology for the determining.

93. Erskine teaches the method according to claims 6 and 13. *Supra* §V.A.7. Erskine further teaches the additional limitations of claims 7 and 14.

94. As explained above, Erskine teaches that the call server employs adaptive bandwidth management to optimize QoS performance, improve network congestion, and determine bandwidth needed for interzone communications. *Supra* §V.A.2; e.g., Ex-1004, Abstract (“Adaptive bandwidth management based upon quality of serv[ice] (QoS) measurement between two zones is utilized to dynamically raise or lower the maximum allowable bandwidth limit for the link between the two zones. When QoS between two zones degrades, the allowable bandwidth for new calls between the two zones is lowered to a point that assists in increasing the QoS back to an acceptable level (i.e., by blocking new calls or rerouting them).”), 3:37-43 (“[T]he call servers 110, 120 also include functionality to interface and allow manage/control calls from/to the communications devices within the network 102 to/from devices in the PSTN.”), 1:34-42, 4:1-20.

95. A POSITA would have understood that, in doing so, the call server maintains and **incorporates knowledge of the network topology**, including, for example, information regarding source/destination zones across the network, and information regarding interzone bandwidth. *E.g.*, Ex-1004, 6:55-7:3 (“With knowledge of both the source zone and the destination zone, the source call server consults a QoS data structure (as shown in FIG. 2 and described further below) to determine if an additional call can be accommodated (or allowed) across the interzone link.”), 9:60-10:2 (“As will be appreciated, each call server stores

information (as illustrated in FIG. 2) about the current interzone bandwidth usage, QoS Factors, and sliding maximum for each interzone link. This information is reflected from the viewpoint of that particular call server. In other embodiments, each call server may synchronize its data structure information with information from the other call servers, or a central data structure may be maintained. In such case, only one call server (either source or destination) may need to make the available bandwidth determination.”), 7:11-25 (“[E]ach call server maintains its own QoS data structure table for all the interzone links from its own zone, and for any other zone in which an endpoint does not support the concept of adaptive bandwidth management zones, such as succession branch offices (SBOs) or SRGs.”).

96. In addition, Erskine teaches that the call server handles routing/rerouting of interzone calls, where it “communicate[s] with NRS servers which function to assist in the resolution of unknown addresses.” Ex-1004, 3:11-29 (“The call server 110 has coupled thereto communication devices 112 *a*, 112 *b*, a network resolution (NRS) server 114, and a signaling server 116. ... Call servers (and perhaps other components) communicate with NRS servers which function to assist in the resolution of unknown addresses (e.g., in the H.323 protocol and Session-Initiated-Protocol (SIP)).”), 9:37-50 (“The source call server 110 determines the destination of the call (using NRS servers and/or some other

method).”), 8:36-51 (“In response to any new call setup requests for calls between Zone 5 and Zone 3, the call server 110 (Zone 5) determines whether the bandwidth necessary for the new call added to the current bandwidth would exceed the sliding maximum interzone bandwidth for that link. If within the limit, the call proceeds (at least to allow the call server in Zone 3 to make a similar determination). If not, the call is blocked or alternative routing is initiated, if desired.”), 6:55-7:10, 9:15-26, 10:3-38, Figs. 1, 3. A POSITA would have understood and found it obvious that the call server incorporates knowledge of the network topology from its interaction with the NRS server. For example, by querying the NRS server and determining the destinations of calls, the call server would have incorporated network topology related information and used the information for call routing and handling.

97. The ’634 patent specification confirms that Erskine’s teachings regarding the call server satisfy the limitation. Ex-1001, 4:51-5:16 (“It should be appreciated that the tuning server 302 has a higher level view of the network traffic and not only offloads the calculations but can also incorporate knowledge of the higher level view of the network topology to enhance congestion control over/among the network(s).”). Erskine therefore teaches claims 7, 14.

B. Grounds 2 and 3: Claims 1–20 Are Rendered Obvious in View of Scherzer and Gillett

1. U.S. Patent No. 8,000,276 (“Scherzer”) (Ex-1005)

98. I have reviewed the Scherzer reference. I understand that Scherzer was not cited or considered during prosecution of the '634 patent, based primarily on the fact that Scherzer is not cited on the face of the patent, nor have I seen the reference discussed in the prosecution history.

99. Scherzer was filed on May 3, 2007 and issued on August 16, 2011. Based on the priority date of July 15, 2018 of the '634 patent, I understand Scherzer is prior art to the '634 patent under post-AIA §102(a).

100. Scherzer “relates to wireless services and wireless access points.” Ex-1005, 1:13-14. It teaches “enhancing connectivity to radio access points.” Ex-1005, 2:51-4:32. Scherzer teaches a client/server system that contains various clients. Ex-1005, 5:9-46, Fig. 1:

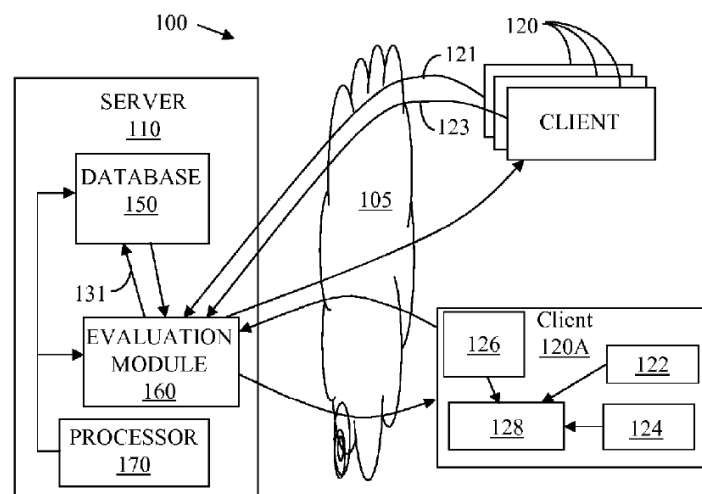


Figure 1

The client connects to a wireless network via access points and thereby further connects with other devices in the network. Ex-1005, 3:44-54, 10:32-67, 12:21-64. Scherzer teaches that the client collects parameter values such as backhaul quality for determination of network bandwidth. *E.g.*, Ex-1005, 7:49-62 (“[T]he following parameters are collected and reported by clients as a result of a ‘measurement trip’: Backhaul quality (estimated bandwidth connection to Internet); ...”), 9:5-20.

101. Scherzer further teaches a server that facilitates communications for the clients over the network. Ex-1005, Abstract, 2:42-50, 5:34-46, 6:4-45, Fig. 1. The server sends to the client information regarding a preferred access point for the location where the client is, while the client connects to the access point and furthers connects with other clients via the access point. *E.g.*, Ex-1005, Abstract, 2:42-3:21, 5:9-33, 5:58-6:27, 6:59-7:23, Fig. 2.

102. Scherzer is in the same field of endeavor as the ’634 patent (networking and telecommunications). *See supra* §III; *e.g.*, Ex-1005, 1:13-14 (“The subject invention relates to wireless services and wireless access points.”).

2. U.S. Patent No. 9,661,553 (“Gillett”) (Ex-1006)

103. I have reviewed the Gillett reference. I understand that Gillett was not cited or considered during prosecution of the ’634 patent, based primarily on the fact that Gillett is not cited on the face of the patent, nor have I seen the reference discussed in the prosecution history.

104. Gillett was filed on July 14, 2015 and issued on May 23, 2017. Based on the priority date of July 15, 2018 of the '634 patent, I understand Gillett is prior art to the '634 patent under post-AIA §102(a).

105. Gillett is directed to network connections and communications, where the mobile terminals gain access to the network through access points. *E.g.*, Ex-1006, Abstract, 2:3-26, 7:46-8:14, Fig. 1.

106. Gillett teaches that a user terminal connects and communicates with another user terminal via access points. *E.g.*, Ex-1006, 7:46-52 (“Still referring to FIG. 1, a plurality of mobile user terminals 102 are arranged to communicate over the networks 101, 103 and/or 106.”), 7:53-8:14, 8:28-53, Fig. 1. Gillett teaches that a user terminal connecting and communicating with another user terminal via access points by performing a VoIP call, sending/receiving IM messages, or transferring files. *E.g.*, Ex-1006, 6:62-67, 7:46-8:14, 8:28-53, 9:57-10:5, Fig. 1.

107. Gillett is in the same field of endeavor as the '634 patent (networking and telecommunications). *See supra* §III; *e.g.*, Ex-1006, Abstract, 2:3-26.

3. Independent Claims 1, 8, 15

1[pre]. A method for network connection optimization, comprising:

8[pre]. A tangible, non-transitory, computer-readable media having instructions thereupon which, when executed by a processor, cause the processor to perform a method comprising:

15[pre]. A network connected device, comprising: one or more processors, coupled to a network port and configurable to:

108. I understand that a preamble generally does not state a claim limitation. However, to the extent that Patent Owner argues that the preamble states a limitation, Ground 2 (Scherzer) and Ground 3 (Scherzer and Gillett) teach the preambles of claims 1, 8, and 15.

109. Scherzer teaches **a method for network connection optimization**. Scherzer “relates to wireless services and wireless access points.” Ex-1005, 1:13-14. Scherzer teaches “a *method* for connecting a wireless user terminal to an Internet,” “a *method* for enhancing connectivity to radio access points,” and “a *method* for improving wireless connectivity to the Internet by utilizing a social network.” Ex-1005, 2:51-4:32.

110. Scherzer teaches **a tangible, non-transitory, computer-readable media having instructions** (e.g., software program) **thereupon which, when executed by a processor, causing the processor to perform its method**. For example, Scherzer teaches that its system may be implemented using software program. Ex-1005, 13:54-14:17 (“Those skilled in the art will appreciate that many

different combinations of hardware, software, and firmware will be suitable for practicing the present invention. For example, the described methods and systems may be implemented in a wide variety of programming or scripting languages, such as Assembler, C/C++, perl, shell, PHP, Java, etc.”).

111. Scherzer’s system contains a processor to perform its method. For example, Scherzer teaches that the server of the system includes a processor that controls the database, evaluation module, and communication with the client. Ex-1005, 5:34-46 (“A processor 170 controls the operations of the database 150 and evaluation module 160, and communication with the clients 120.”), 3:55-67 (“According to further aspects of the invention, a system for enhancing connectivity to radio access points is provided, comprising: ... and a processor sending updates to each of the clients, said updates comprising.”), Fig. 1:

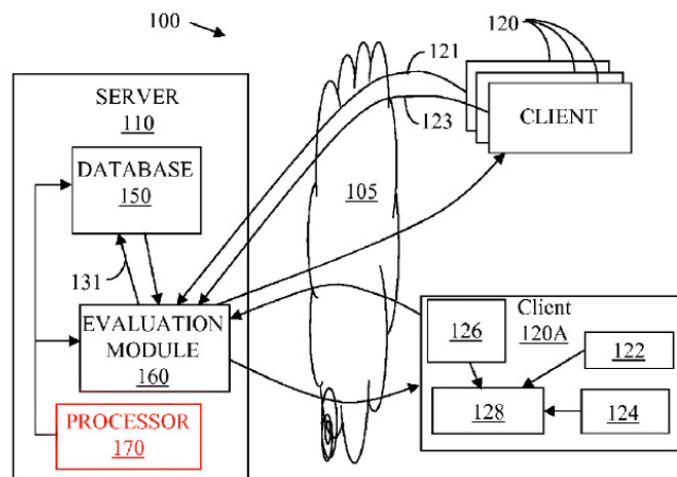


Figure 1

112. Moreover, a POSITA would have found it obvious that Scherzer's system contains a processor to perform its method because it was well-known that a processor was the central component responsible for executing instructions that enable a system's functionalities and operations. Scherzer therefore teaches [8pre].

113. Scherzer utilizes **a network connected device** (e.g., server) to facilitate communications for the clients over the network. *E.g.*, Ex-1005, Abstract ("An improved connectivity to radio access point is enabled by a server that includes a database storing data about various radio access points, and an evaluation module evaluating the quality of connection to each of the access points. Clients receive updates about relevant access points from the server and use the information to connect to the preferred access point. The clients also check connectivity to other access points in the vicinity, and report the findings to the server. The server uses the reports to update its database, and send corresponding updates to the clients."), 2:42-50, 5:34-46, 6:4-45, Fig. 1. Scherzer's server **comprises one or more processors**. Ex-1005, 5:34-46 ("Server 110 also includes an evaluation module 160, which evaluates accessibility and bandwidth of various AP's, and stored the information as an update in database 150, as shown by arrow 131. A processor 170 controls the operations of the database 150 and evaluation module 160, and communication with the clients 120."), Fig. 1.

114. The server is **coupled to a network port**, through which it connects and communicates with clients and other devices over the network. *E.g.*, Ex-1005, Abstract (“The server uses the reports to update its database, and send corresponding updates to the clients.”), 3:22-29 (“The method may further comprise transmitting the first set of data to a service server over the Internet. The method may further comprise transmitting the third set of data from the service server to the user terminal.”), 5:34-46 (“In FIG. 1, various clients 120 and 120A communicate with server 110 via network 105, such as the Internet.”), 2:42-50, Fig. 1. To the extent Patent Owner argues that Scherzer does not explicitly disclose that the server is coupled to a network port, a POSITA would have found this obvious because since the 1980s, network ports have been critical and commonly used components in communications networks, allowing servers and other networked devices to establish connections for data transmission and communication. *See* Ex-1005, 13:54-14:17 (“[I]t should be understood that processes and techniques described herein are not inherently related to any particular apparatus and may be implemented by any suitable combination of components. Further, various types of general purpose devices may be used in accordance with the teachings described herein. It may also prove advantageous to construct specialized apparatus to perform the method steps described herein. The present invention has been described in relation to particular examples, which are

intended in all respects to be illustrative rather than restrictive. Those skilled in the art will appreciate that many different combinations of hardware, software, and firmware will be suitable for practicing the present invention.”).

115. Scherzer further teaches that, as explained below, the network connected device (e.g., server) is configured to perform operations recited in claims 1, 8, and 15. *Infra* §§V.B.3[1a-c]/[8a-c]/[15a-c]. Grounds 2 and 3 therefore teach the preambles of claims 1, 8, and 15.

[1a]/[8a]/[15a] collect[ing], at a first endpoint device coupled to [a]/[the] network, parameter values for determination of bandwidth of network connections to further endpoint devices;
--

116. Grounds 2 and 3 teach limitations [1a], [8a], and [15a]. Scherzer teaches **a first endpoint device** (e.g., client). Scherzer teaches a client/server system that contains various clients. *E.g.*, Ex-1005, 5:9-33 (“The system employs client/server architecture: each user operates a radio client that, besides connecting to the radio network, executes radio measurements and report to the network server that shares this information with other user’s clients.”), 5:34-46 (“In FIG. 1, various clients 120 and 120A communicate with server 110 via network 105, such as the Internet.”), Fig. 1:

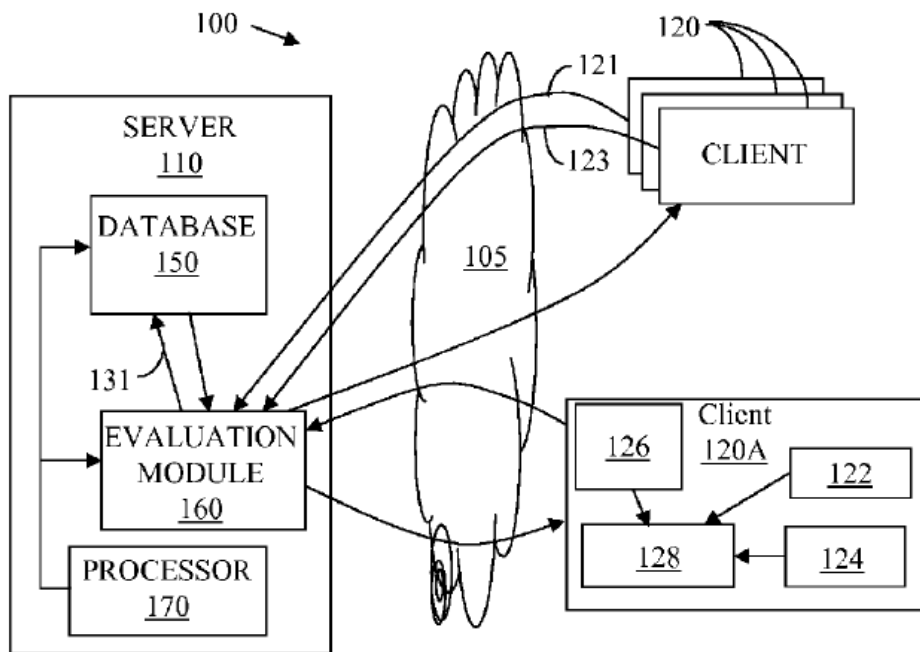


Figure 1

117. Scherzer’s client is an endpoint device that represents a user terminal such as a user’s device. *E.g.*, Ex-1005, 5:9-33 (“[M]ethods and apparatus are provided that closely integrate historical data discovered by users’ community (such as WiFi ‘hot spots’ locations and quality), with real time data acquired by individual users. *Each user’s device executes a program (e.g., a client)* that uses the combined data to find usable radio resources and establish Internet connection through them.”), 2:51-3:29 (“According to aspects of the invention, a method for connecting a wireless user terminal to an Internet is disclosed[.]”), Fig. 1.

118. The client is **coupled to a network**. *E.g.*, Ex-1005, 5:34-46 (“FIG. 1 is a general schematic illustrating a system layout according to an embodiment of

the invention. In FIG. 1, *various clients 120 and 120A communicate with server 110 via network 105, such as the Internet.*”), 4:17-32, 5:9-33, Fig. 1.

119. Scherzer further teaches that the first endpoint device (e.g., client) is connected to **further endpoint devices** (e.g., other clients) in the network. *E.g.*, Ex-1005, 5:9-33 (“The system employs client/server architecture: each user operates a radio client that, besides connecting to the radio network, executes radio measurements and report to the network server that shares this information with other user’s clients.”), 5:34-46, 6:46-58, Fig. 1. As explained below, a POSITA would have understood and found it obvious that this includes at least the scenario where a client connects to other clients via access points.

120. First, Scherzer teaches that the client connects to a wireless network via access points and thereby further connects with other devices in the network. *E.g.*, Ex-1005, 10:32-67 (“Connecting to wireless network starts by scanning the neighborhood for candidate connections (802.11 scan). The 802.11 scan produces a list of access points in reach; for each intercepted access point radio signal strength indication (RSSI) is provided along with type of security status. The connection process will exploit the radio resource information in its memory. Next, the client selects the most favorable access point for connection[.]”), 12:21-64 (“The user generally is able to access the Internet 305 by connecting device 320 to access point 370d wirelessly. As is known, access point 370d operates to a certain range,

which may generally allow other users to receive the signal of access point 370d.”), 3:44-54, 6:46-58.

121. A POSITA would have understood and found this obvious because access points have been well-known and widely used as intermediaries that connect multiple devices such as client devices to a shared network infrastructure, which were designed to facilitate data exchange between the connected devices. Such functionality is a fundamental characteristic of networks employing access points, as they not only provide internet access but also support intra-network communication, enabling tasks such as file sharing, collaborative work, and resource access. *See, e.g.*, Ex-1008, 5:39-47 (“For example, the network architecture 122 may include network device 124, network device 126, and network device 128. The network devices 124, 126, or 128 may be any system or device having communications capabilities to relay data between the device 110 and the network 130. Example networking devices may include access points, routers, signal transceivers, etc.”), 4:43-50, Fig. 1. For example, it was well-known that in wireless communication, infrastructure mode allows clients communicate with each other via access points, which manage and relay data between connected devices. Ex-1009,¹³ 000580-582, Fig. 7.1; Ex-1010, 6:48-55 (“Conventional Wi-Fi

¹³ I have personal experience with the book titled “Computer Networking – A Top-Down Approach” (authored by Kurose and Ross) and have maintained records of using the book, including earlier versions, since at least 2012. These records

networks include an access point to which are connected one or more computers and peripheral devices by wired and wireless connections. Wi-Fi networks are typically set up as infrastructure networks, where the access point is a central hub to which Wi-Fi capable devices are connected. The devices do not communicate directly with one another, but communicate indirectly through the access point.”); Ex-1011, 1:57-59 (“Meanwhile, in the infrastructure mode, there is a fixed entity called an access point (AP) that bridges all data between the STAs associated with the AP.”); Ex-1012, 1:20-24 (“Some wireless networks are configured as managed or infrastructure networks, using an access point to control communications between devices on the network.”). A POSITA would therefore have recognized that an endpoint device (e.g., a client device) may interact with other endpoint devices (e.g., other clients) in the network via access points, as this reflects standard network behavior.

122. To the extent Scherzer does not explicitly disclose a client connecting with other clients in the network via access points, Gillett teaches endpoint devices connecting with each other via access points. Gillett is directed to network connections and communications, where mobile terminals gain access to the network through access points. *E.g.*, Ex-1006, Abstract, 2:3-26, 7:46-8:14, Fig. 1.

confirm my familiarity with its content and demonstrate that the book was publicly accessible and in use at that time.

123. Gillett teaches an endpoint device (e.g., user terminal) connects and communicates with another endpoint device (e.g., another user terminal) via the access point. *E.g.*, Ex-1006, 7:46-52 (“Still referring to FIG. 1, a plurality of mobile user terminals 102 are arranged to communicate over the networks 101, 103 and/or 106. The user terminals 102 may comprise for example laptop computers, tablets or other mobile terminals such as mobile phones. Each user terminal 102 comprises one or more transceivers for accessing the one or more networks 101, 103, 106.”), 7:53-8:14 (“Each user terminal 102 comprises a short-range wireless transceiver (e.g. wi-fi) for accessing the Internet 101 via the wireless access points 106. In some places, a WLAN may be formed of a single short-range access point 106. ... Either way, a mobile terminal 102 connecting to one of the local access points 106 is provided with a route for accessing the internet 101.”), 8:28-53, Fig. 1.

124. For example, Gillett teaches that a user terminal connecting and communicating with another user terminal via access points by performing a VoIP call, sending/receiving IM messages, or transferring files. *E.g.*, Ex-1006, 9:57-10:5 (“Further, the processing apparatus 112 on the mobile terminal 102 will be arranged to perform scanning processes via its local transceiver 115 and cellular transceiver 114, to scan for availability of WLANs and the WWAN respectively. This means the communication client application running on the processing

apparatus 112 can be kept aware of what networks are available for internet access, and hence select one of the WLANs or select between a WLAN and WWAN as a means for accessing the internet 101, e.g. *for performing a real-time VoIP call with another user terminal 102 over the internet 101. Other examples are to view a website or send an email via a server of the internet 101, or send or receive an IM message or file transfer to or from another user 102.*”), 8:28-53 (“Each user terminal 102 further comprises a memory 110 such as an electronic erasable and programmable memory ... Further, the communications code comprises a communication client application for *performing communications such as voice or video calls with other user terminals 102 over the Internet 103, via the short-range wireless transceiver 115 and wireless access points 106; and/or via the cellular wireless transceiver 114, base stations 104 and controller stations 105 of the cellular network 103 as discussed above.*”), 6:62-67, 7:46-8:14, Fig. 1:

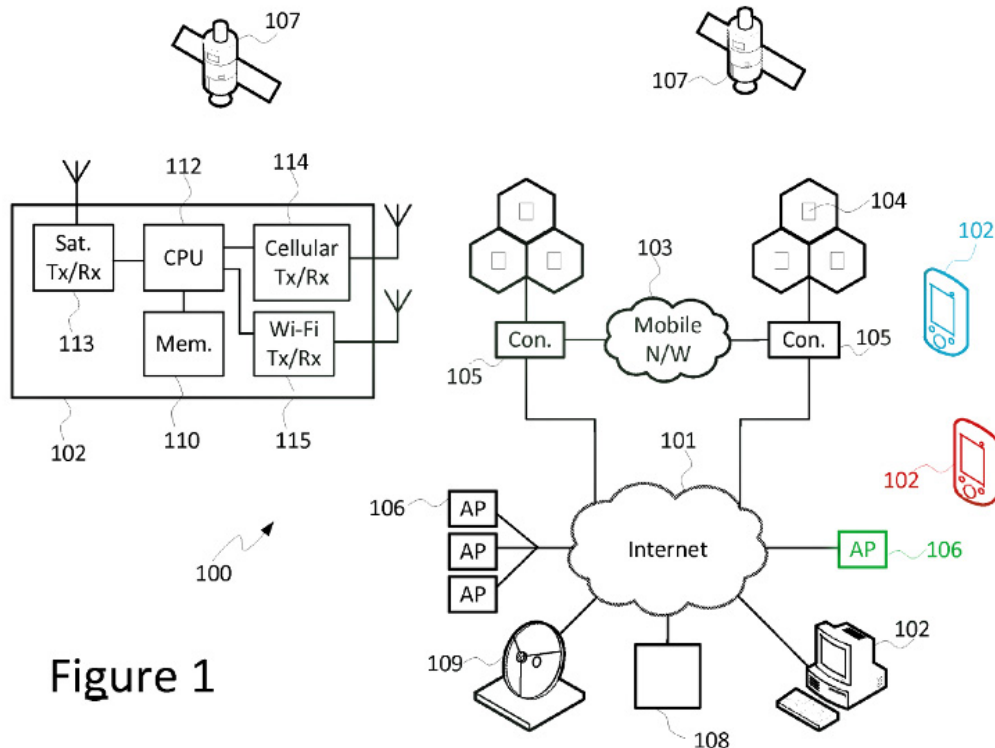


Figure 1

125. Scherzer and Gillett’s teachings satisfy “endpoint device” as the term is used in the ’634 patent. The ’634 patent specification confirms this by describing the term broadly. *E.g.*, Ex-1001, 2:50-3:10 (“Endpoints and servers are described herein as network-connected (or connectable) devices that optimize network connections.”), 3:11-25 (“Each endpoint 103, 105 could be a wireless or wired device, for example with a processor and memory (see FIG. 2) that can couple to a network, e.g., personal computer, server, storage system, personal digital assistant (PDA), touchpad computer, smart phone, IoT (Internet of things) device, etc. In a bidirectional network connection, both endpoints 103, 105 can transmit and receive.”), Figs. 1, 3.

126. A POSITA would have found it obvious and been motivated to apply Gillett's teachings with Scherzer such that a first endpoint device (e.g., client) connects to further endpoint devices (e.g., other clients) via access points. This would not have changed the principle of operation of either reference. A POSITA would have been motivated to apply Gillett's teachings regarding user terminals connecting and communicating with each other via access points to Scherzer because doing so would have allowed the access points to coordinate traffic and distribute load effectively, ensuring efficient communication and reducing data collisions. In addition, doing so would have enabled adding more clients to the network without requiring direct client-to-client configuration, thereby improving network scalability. Last but not least, it would have provided extended range for the inter-clients connections, where the clients do not need to be within direct range of each other as long as they are within range of the access points.

127. Furthermore, as explained above, Scherzer teaches the client connects to a wireless network via access points and contemplates the scenario where the client further connects with other devices in the network via the access point. *E.g.*, Ex-1005, 3:44-54, 5:9-46, 10:32-67, 12:21-64, Fig. 1. Gillett expressly describes the scenario where a user terminal connects and communicates with another user terminal via access points. *E.g.*, Ex-1006, 6:62-67, 7:46-8:14, 8:28-53, 9:57-10:5, Fig. 1. Thus, a POSITA would have found Gillett's teachings regarding user

terminals connecting and communicating with each other via access point to be readily applicable to Scherzer. Doing so would have been nothing more than applying a known technique (e.g., Gillet's teachings regarding user terminals connecting and communicating with each other via access points) to a known system (e.g., Scherzer's client/server system) to yield predictable results. Since clients connecting and communicating with each other via access points was conventional and well-known and Scherzer contemplates the scenario explicitly taught by Gillett, a POSITA would have had a reasonable expectation of success in combining Scherzer and Gillett.

128. Scherzer, as well as the combination of Scherzer and Gillett, further teaches **collecting at the first endpoint device (e.g., client) parameter values for determination of bandwidth of network connections to further endpoint devices** (e.g., other clients). For example, Scherzer teaches that the client collects parameter values such as backhaul quality. *E.g.*, Ex-1005, 7:49-62 (“[T]he following parameters are *collected and reported by clients* as a result of a ‘measurement trip’: *Backhaul quality (estimated bandwidth connection to Internet)*; ...”), 9:5-20. Scherzer teaches radio resources such as Wi-Fi access points that provide internet access to the clients. *E.g.*, Ex-1005, 6:46-58 (“[I]ndividual user’s clients exploit gaps in traffic communication to execute radio measurements on radio resources (ex. WiFi access points) in their neighborhood

(i.e., resources ‘in reach’) to evaluate their ability to provide broadband access.”), 5:9-33 (“Each user’s device executes a program (e.g., a client) that uses the combined data to find usable radio resources and establish Internet connection through them.”). Scherzer teaches that the client collects and reports the backhaul quality as a result of a measurement trip, through which the client conducts radio resource survey and collects relevant information. Ex-1005, 7:24-48 (“[N]etwork clients continuously collect radio resources information. Each active user terminal should be able to conduct radio resources survey whenever it is in use. This is achieved by ‘measurement trips’: the client is directed to associate with an AP other than the one used for current Internet connection, and conduct data acquisition as described below. These ‘trips’ are executed while no time-sensitive traffic is performed, so as to avoid degradation of the user's experience, as described below.”).

129. A POSITA would have understood that backhaul quality is for determination of bandwidth of network connections to other clients because it represents estimated bandwidth of the client’s connection to the internet, which constrains the bandwidth available for the connections between the clients. As explained above, Scherzer, as well as the combination of Scherzer and Gillett, teaches the scenario where the clients connect to each other via access points. A POSITA would have understood that in this scenario, the bandwidth of the

connection of a client's connection to other clients is limited and determined by the bandwidth of the client's internet connection. For example, the maximum bandwidth for communication between a client and other clients is limited by the bandwidth allocated by the access point to the client.

130. The prosecution history of the '634 patent confirms that Scherzer and Gillett's teachings satisfy this limitation. During prosecution, the Examiner found that teachings of prior art Cole render the limitation of "collecting, at a first endpoint device coupled to a network, parameter values for determination of bandwidth of network connections to further endpoint devices" obvious. Specifically, the Examiner relied on Cole's teachings where a mobile device establishes connection to a remote network via a communication interface, similar to Scherzer and Gillett's teachings where the client connects to internet and other clients through access points. Ex-1002, 000108-113. The applicant did not dispute that Cole's teachings satisfy this limitation and only argued that Cole fails to disclose another limitation of claim 1. Ex-1002, 000146-147. Therefore, for reasons explained above, Grounds 2 and 3 teach limitations [1a]/[8a]/[15a].

[1b]/[8b] determining at a tuner server,
[15b] determine at the network connected device acting as a tuner server,
distinct from the first endpoint device and the further endpoint devices, that a
next network connection from the first endpoint device to a second endpoint
device matches a geographical area of a past network connection; and

131. Grounds 2 and 3 teach limitations [1b], [8b], and [15b]. First, Scherzer teaches **a tuner server** (e.g., server). As explained above, Scherzer teaches a server that facilitates communications for the clients over the network. *Supra* §§V.B.3[1pre-a]/[8pre-a]/[15pre-a]; Ex-1005, Abstract, 2:42-50, 5:34-46, 6:4-45, Fig. 1:

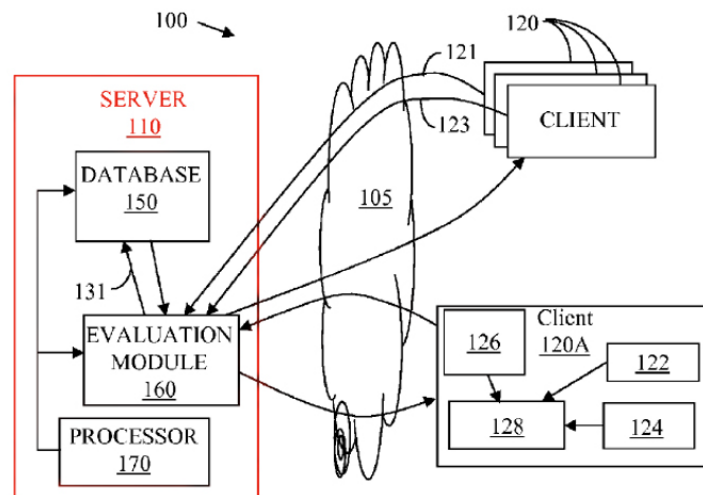


Figure 1

132. Moreover, as explained above, Scherzer's server is a network connected device. *Supra* §§V.B.3[1pre]/[8pre]/[15pre]; Ex-1005, Abstract, 2:42-50,

5:34-46, 6:4-45. Scherzer's server thus is **a network connected device acting as a tuner server.**¹⁴

133. Scherzer's server and clients are distinct, separate components that perform their respective roles in the network. *E.g.*, Ex-1005, 2:42-50, 5:9-46, 6:4-27. The server is thus **distinct from the first endpoint device** (e.g., client) **and the further endpoint devices** (e.g., other clients).

134. Scherzer, as well as the combination of Scherzer and Gillett, **determines at the server that a next network connection from the first endpoint device** (e.g., client) **to a second endpoint device** (e.g., another client) **matches a geographical area of a past network connection.** First, as explained above, Grounds 2 and 3 teach **a next network connection from the first endpoint device** (e.g., client) **to a second endpoint device** (e.g., another client) established via access points. For example, Scherzer teaches that the client queries a database to obtain information regarding a preferred access point for the location where the client is and connects to the access point and other clients if the access point is available. *E.g.*, Ex-1005, 5:9-33 ("Each user's device executes a program (e.g., a client) that uses the combined data to find usable radio resources and establish

¹⁴ I note and understand that the '634 patent specification uses the term "tuner server" and "tuning server" interchangeably. *E.g.*, Ex-1001, 2:13-18, 2:50-3:10, 4:35-5:16, 5:65-6:22, Figs. 3, 5. The '634 patent specification describes the tuner/tuning server and its functionalities very broadly, thereby confirming that Scherzer's teachings regarding the server fall within the recited "tuner server." *See, e.g.*, Ex-1001, 4:51-5:15, 6:10-38.

Internet connection through them.”), 5:58-6:27 (“In order to connect to a broadband network, in Step 200 the client 120A queries its local database 124 to obtain the best available AP for the particular location the clients is located at. At Step 210 the client inspects all available radio signals in the area. Then, at Step 220 the client checks whether the preferred AP for that location is available. If not, the next best AP is selected and again it is checked whether that one is available, and so on, until at Step 230 the client connects to an AP.”), 6:59-7:23 (“This determined data is selectively transferred to individual clients. The clients use this data to update their local radio resources database 124, so as to enable selecting the best radio resource available and executing quick connection.”), 2:42-3:21, Abstract, Fig. 2.

135. Scherzer further teaches that the client selects and connects to the preferred access point to connect with another device (e.g., another client) based on information from the server. *E.g.*, Ex-1005, 2:42-50 (“Clients receive updates about relevant access points from the server and use the information to connect to the preferred access point.”), 2:51-3:29 (“[A] method for connecting a wireless user terminal to an Internet is disclosed, comprising: generating a third set of data from the second set of data; and combining the first and third sets of data to select preferred radio resource for connection. ... The method may further comprise

transmitting the third set of data from the service server to the user terminal.”), Abstract, 5:58-6:45, Fig. 2.

136. In the process of providing the client information regarding the preferred access point, the server **determines** that a next network connection from the client to another client via the access point **matches a geographical area of a past network connection**. Scherzer teaches that the server includes a database that stores data regarding various access points, including “data on all radio access points (WiFi and others) that have been discovered or registered by the users community.” *E.g.*, Ex-1005, 2:42-50, 5:34-46, 6:28-45, 8:64-9:20, Abstract, Fig. 1.

137. For each client, the server transmits selected data from its database to the client, where the “selected data for each of the clients may correspond to access points in a geographical proximity to the corresponding client.” *E.g.*, Ex-1005, 3:30-43, 3:55-67 (“[A] system for enhancing connectivity to radio access points is provided, comprising: ... sending updates to each of the clients, said updates comprising selected data from the database, said selected data relates to access points in a selected geographical region. The selected geographical region may comprise a locale in which each client is present. The selected geographical region may comprise a locale indicated by each client.”), 11:28-50 (“The network server uses the clients’ reports to determine AP accessibility and potential service quality. ... These entries are stored at the network server database 150 based on location

coordinates sorted to ‘wireless regions.’ Radio resources regions are geographical areas such as cities, parks, groups of cities, states and other geographical areas of interest.”), 6:28-45, 6:59-66.

138. Moreover, the selected data transmitted from the server to the client includes data for **a past network connection**, such as historical data about access points used to establish a past connection. *E.g.*, Ex-1005, 5:34-46 (“Server 110 includes database 150, which stores historical data about radio broadband access resources.”), 8:64-9:20 (“The radio resource database 150 stores data on all radio access points (WiFi and others) that have been discovered or registered by the users community. ... The database 150 includes list of APs reported during previous scans, measurement trips, and user AP registration (user registering an AP can set the percentage bandwidth that can be shared).”), 13:13-40 (“[L]ocation of mobile devices may be a repeatable event. For example, many users may frequent a specific restaurant or coffee shop. Therefore, it is very likely that previous users visited the same establishment and the client on their mobile device sent a report about the connectivity to the access point from that specific location. Thus, when the server determines the location of the mobile device of the user, the server may present a ranking of the access point with respect to the specific location of the mobile device. Receiving ranking from many users about various AP’s in the

vicinity of the user may be very helpful in establishing a connection when many APs are available.”).

139. A POSITA would have understood that, in the process of providing the client selected data regarding access points within the client’s geographical proximity, including historical data for access points that have been used to establish a past connection, Scherzer’s server determines that the client’s next connection (e.g., connection to another client) via the access points matches a geographical area of a past network connection (e.g., geographical area of a past network connection established via the access points). Therefore, for reasons explained above (*see also supra* §V.B.3[1a]/[8a]/[15a] (explaining motivation to combine Scherzer and Gillett)), Grounds 2 and 3 teach limitations [1b]/[8b]/[15b].

[1c]/[8c]/[15c] initiat[ing] the next network connection, from the first endpoint device to the second endpoint device, based on the determination at [the tuner server]/[the network connected device acting as the tuner server], with a transmission bandwidth based on the parameter values for the past network connection.
--

140. Grounds 2 and 3 teach limitations [1c]/[8c]/[15c]. First, as explained above, Grounds 2 and 3 teach **initiating the next network connection from the first endpoint device to the second endpoint device** via access points. *Supra* §§V.B.3[1a-b]/[8a-b]/[15a-b].

141. Scherzer further teaches initiating the connection **based on the determination at the tuner server** (e.g., server) ([1c], [8c]). As explained above,

Scherzer, as well as the combination of Scherzer and Gillett, teaches the server determining that the client's connection to another client via the access points matches a geographical area of a past network connection and transmitting selected data to the client, based on which the client selects a preferred access point for initiating a connection. *Supra* §§V.B.3[1a-b]/[8a-b]/[15a-b]. Grounds 2 and 3 thus teach initiating the connection based on the determination at the server. Moreover, as explained above, Scherzer teaches a network connected device acting as tuner server. *Supra* §V.B.3[1b]/[8b]/[15b]. Grounds 2 and 3 thus teach initiating the call based on the **determination at the network connected device acting as the tuner server** ([15c]).

142. Furthermore, Scherzer, as well as the combination of Scherzer and Gillett, teaches initiating the connection **with a transmission bandwidth based on the parameter values for the past network connection**. As explained above, Scherzer teaches that the client collects parameter values such as backhaul quality. *Supra* §V.B.3[1a]/[8a]/[15a]; Ex-1005, 7:49-62, 9:5-20. Scherzer teaches utilizing the backhaul quality and analyzing the backhaul performance when selecting the preferred access point. Ex-1005, 3:15-21 (“In the method, selecting the preferred radio resource may comprise analyzing at least one of: ... backhaul performance[.]”), 9:29-53 (“For example, when the terminal knows which of multiple APs has a good backhaul it can select the right AP for connection, thereby

avoiding connection testing and ‘re-tries’.”), 8:64-9:20 (“The above information is used to build and expand the radio resource database 150. The database 150 includes list of APs reported during previous scans, measurement trips, and user AP registration (user registering an AP can set the percentage bandwidth that can be shared). Each database entry is indexed by SSID and MAC address and may include: Backhaul quality (estimated bandwidth connection to Internet)[.]”), 7:49-62.

143. The backhaul quality is associated with the past network connections. For example, it is collected and reported by the client “during previous scans [and] measurement trips,” through which the client conducts radio resource survey and collects relevant information regarding the access points, including access points that have been used to establish the past connections. *Supra* §V.B.3[1b]/[8b]/[15b]; Ex-1005, 9:5-20 (“The above information is used to build and expand the radio resource database 150. The database 150 includes list of APs reported during previous scans, measurement trips, and user AP registration (user registering an AP can set the percentage bandwidth that can be shared). Each database entry is indexed by SSID and MAC address and may include: Backhaul quality (estimated bandwidth connection to Internet)[.]”), 7:24-58. A POSITA would thus have understood that the backhaul quality is associated with the past network connections.

144. Scherzer teaches that each access point has a corresponding bandwidth. Ex-1005, 5:34-46 (“Server 110 also includes an evaluation module 160, which evaluates accessibility and *bandwidth of various AP’s*, and stored the information as an update in database 150, as shown by arrow 131.”), 9:5-20 (“The database 150 includes list of APs reported during previous scans, measurement trips, and user AP registration (user registering an AP can set *the percentage bandwidth that can be shared*). Each database entry is indexed by SSID and MAC address and may include: Backhaul quality (estimated bandwidth connection to Internet); ... and, Percentage allowable shared bandwidth.”), 12:21-49 (“When the owner registers access point 370d as member of the social network, the owner may specify *the amount of bandwidth the owner is willing to allocate to third parties who are in the vicinity of the access point 370d.*”), 7:39-58. Scherzer therefore teaches initiating the next network connection via a preferred access point based on the determination at the server, where the preferred access point has a corresponding bandwidth based on the backhaul quality. For reasons explained above, Grounds 2 and 3 teach limitations [1c]/[8c]/[15c].

4. Dependent Claims 2, 9, 16

[2a]. The method of claim 1, further comprising:

[9a]. The method of claim 8, further comprising:

[16a] The network connected device of claim 15, wherein the one or more processors are configurable to:

send[ing] the parameter values for determination of bandwidth[,] from the first endpoint device, to the tuner server that is configured to receive further parameter values for determination of bandwidth of network connections from a plurality of endpoint devices;

145. Grounds 2 and 3 teach the method according to claims 1 and 8, and the network connected device of claim 15. *Supra* §V.B.3. As explained below, Grounds 2 and 3 further teach the additional limitations of claims 2, 9, and 16.

146. As explained above, Scherzer teaches parameter values (e.g., backhaul quality) for determination of bandwidth. *Supra* §V.B.2[1a]/[8a]/[15a]; Ex-1005, 7:49-62, 9:5-20. Scherzer further teaches **sending the parameters values** (e.g., backhaul quality) **from the first endpoint device** (e.g., client) **to the tuner server** (e.g., server). For example, Scherzer teaches that the client collects and reports the backhaul quality to the server, which stores the received information in the radio resource database. *E.g.*, Ex-1005, 8:64-9:20 (“The radio resource database 150 stores data on all radio access points (WiFi and others) that have been discovered or registered by the users community. ... The above information is used to build and expand the radio resource database 150. The database 150 includes list of APs

reported during previous scans, measurement trips, and user AP registration (user registering an AP can set the per centage bandwidth that can be shared). Each database entry is indexed by SSID and MAC address and may include: Backhaul quality (estimated bandwidth connection to Internet)[.]”), 7:49-58 (“According to an embodiment of the invention, the following parameters are collected and reported by clients as a result of a ‘measurement trip’: Backhaul quality (estimated bandwidth connection to Internet)[.]”), 5:34-46 (“Server 110 also includes an evaluation module 160, which evaluates accessibility and bandwidth of various AP’s, and stored the information as an update in database 150, as shown by arrow 131. A processor 170 controls the operations of the database 150 and evaluation module 160, and communication with the clients 120.”), 6:28-45 (“The server 110 uses the measurements from the clients to update the database 150. In this manner, the data base 150 is enhanced and continuously updated to include up to date data on any AP’s that were newly put to service, modified, or removed from service.”), Fig. 1.

147. Scherzer further teaches that the server **receives further parameter values for determination of bandwidth of network connections from a plurality of endpoint devices**. Scherzer teaches that the server communicates with **a plurality of endpoint devices** (e.g., a plurality of clients) and receives information such as backhaul quality from the plurality of clients. Ex-1005, 3:55-

67 (“[A] system for enhancing connectivity to radio access points is provided, comprising: a connectivity database; an evaluation module receiving connectivity reports *from a plurality of clients* and storing the reports in the connectivity database[.]”), 5:34-46 (“In FIG. 1, various clients 120 and 120A communicate with server 110 via network 105, such as the Internet.”), 5:47-57 (“Updates in the form of connectivity reports are sent to server 110 from each of the clients 120, as shown by arrows 121, 123. The updates include data collected when each client attempts to connect to an access point.”), 3:30-43, 7:49-58, 8:64-9:20.

148. Scherzer teaches that the server receives **further parameter values** from the clients coupled to it. For example, the server receives estimated location of the clients from the clients. Ex-1005, 8:64-9:20 (“The database 150 includes list of APs reported during previous scans, measurement trips, and user AP registration (user registering an AP can set the per centage bandwidth that can be shared). Each database entry is indexed by SSID and MAC address and may include: ... Estimated location (when the client determined its own location)[.]”), 7:49-58 (“[T]he following parameters are collected and reported by clients as a result of a ‘measurement trip’: ... Estimated location (i.e., when the client determined its own location).”). The estimated location for a client is a parameter for determination of bandwidth of network connections because it is used to determine the preferred access points in the geographical proximity of the client, which has a

corresponding bandwidth. *Supra* §V.B.3[1c]/[8c]/[15c]; e.g., Ex-1005, 5:58-6:3 (“In order to connect to a broadband network, in Step 200 the client 120A queries its local database 124 to obtain the best available AP for the particular location the clients is located at. At Step 210 the client inspects all available radio signals in the area. Then, at Step 220 the client checks whether the preferred AP for that location is available. If not, the next best AP is selected and again it is checked whether that one is available, and so on, until at Step 230 the client connects to an AP.”), 3:30-43 (“The selected data for each of the clients may correspond to access points in a geographical proximity to the corresponding client. The selected data for a corresponding client may correspond to access points in a vicinity of a geographical location indicated by the corresponding client.”), 10:8-31 (“To expedite wireless Internet access, radio resource information that has been accumulated and processed at the network server must be distributed to user terminals (clients). According to an embodiment of the invention, the distribution to clients is made of only information that is relevant to each specific client. According to one specific example, relevant radio resource information is distributed based on the client’s geographical location. ... Thereafter, the client executes the processes described herein to obtain data about radio resources in that specific geographical location. Additionally, as described above, the user may indicate a specific geographical location for AP update.”).

149. As another example, the server receives percentage allowable shared bandwidth from the clients. Ex-1005, 8:64-9:20 (“The database 150 includes list of APs reported during previous scans, measurement trips, and user AP registration (user registering an AP can set the per centage bandwidth that can be shared). Each database entry is indexed by SSID and MAC address and may include: ... Percentage allowable shared bandwidth.”), 5:47-57. A POSITA would have understood that the percentage allowable shared bandwidth constitutes a parameter value for determination of bandwidth of network connections because it sets a limit on the bandwidth allowable for a connection and is thereby used to determine the bandwidth of a network connection.¹⁵ The ’634 patent specification confirms that Scherzer’s teachings satisfy the limitation. Ex-1001, 6:39-7:4 (“These parameter values can be obtained from the stored parameter values for network connection bandwidth received from the endpoints, in the action 602. Alternatively, one or more further parameter values can be derived from stored or obtained parameter values in some embodiments.”).

150. Moreover, as explained above, Scherzer teaches that the network connected device (e.g., server) has one or more processors. *Supra* §V.B.3[15pre].

¹⁵ Patent Owner’s Infringement Contentions confirm that Scherzer’s teachings regarding the estimated locations of clients and percentage allowable shared bandwidth satisfy the recited “further parameter values,” alleging that “parameters such as bytes and packet exchange, delays, jitter and bandwidth ... are sent from the first endpoint device to the tuner server[, which] is configured to receive each of the parameters values, ‘further parameter values.’” Ex-1007, 000004.

These processors are configurable to perform the operations performed by the server, including operations discussed above. Ex-1005, 5:34-46, 3:55-67, Fig. 1. Scherzer therefore teaches limitation [16a]. For reasons explained above, Grounds 2 and 3 teach limitations [2a]/[9a]/[16a].

[2b]/[9b]/[16b] send[ing], from the first endpoint device to the tuner server, connection information for the next network connection, wherein the tuner server performs the determining and derives one or more parameter values for the transmission bandwidth; and

151. Grounds 2 and 3 teach limitations [2b]/[9b]/[16b]. Scherzer teaches **sending from the first endpoint device (e.g., client) to the tuner server (e.g., server), connection information for the next network connection.** For example, Scherzer teaches that the client sends to the server a set of data “to analyze radio resources in reach.” Ex-1005, 2:51-3:4 (“[A] method for connecting a wireless user terminal to an Internet is disclosed, comprising: generating *first set of data* by using the user terminal to analyze radio resources in reach; ... for each radio source, the first set of data may comprise at least one of: i. Network name; ii. MAC address; iii. Received signal strength and variance over time; iv. Encryption status; v. Internet connection available capacity; vi. Access protocol response times; vii. Gateway IP address; viii. DNS address; ix. Occupied IP addresses; x. Captive portal credentials; xi. Connection Technology.”), 3:22-29 (“The method may further comprise transmitting the first set of data to a service server over the

Internet.”). Here, the first set of data constitutes connection information for the network connection because it is used to analyze radio resource in reach. In particular, the first set of data is combined with another set of data “to select preferred radio resource for connection.” Ex-1005, 2:51-3:29. The first set of data therefore constitutes **connection information for the next network connection** because it is used to select the preferred access point, through which the next network connection is established.¹⁶

152. Scherzer further teaches that **the tuner server (e.g., server) performs the determining and derives one or more parameter values for the transmission bandwidth**. As explained above, Scherzer teaches that the server determines that the next network connection is established via a preferred access point that has a corresponding bandwidth. *Supra* §V.B.3[1c]/[8c]/[15c]. Scherzer further teaches that the server derives parameter values for the transmission bandwidth. For example, the server generates and transmits a set of data to the client “to select preferred radio resource for connection.” Ex-1005, 2:51-3:4 (“[A]

¹⁶ The ’634 patent specification confirms that Scherzer’s teachings satisfies the recited “connection information” by describing the term broadly. *E.g.*, Ex-1001, 4:35-50 (“FIG. 3 depicts endpoints 103, 105, 107, 109 sending parameters 208 relating to network connections to a tuning server 302, and the tuning server 302 sending bandwidth information 308 to one of the endpoints 103 in response to receiving connection information 306 about a next network connection 304 from that endpoint 103.”), 6:10-38 (“[T]he tuning server receives connection information from an endpoint, for a next network connection to be made by that endpoint”), 4:51-5:16.

method for connecting a wireless user terminal to an Internet is disclosed, comprising: ... generating a third set of data from the second set of data; and combining the first and third sets of data to select preferred radio resource for connection.”), 3:5-14 (“The third set of data may comprise at least one of: i. Location ii. Internet accessibility iii. Long term behavioral statistics comprising: Percentage of availability[;] Signal strength variance[;] Available bandwidth[;] iv. Name of owner, V. Owner profile; vi. Password.”), 3:22-29 (“The method may further comprise transmitting the third set of data from the service server to the user terminal.”). Here, the third set of data sent by the server to the client constitutes **parameter values for the transmission bandwidth** because it is used to select the preferred access point, which has a corresponding transmission bandwidth. Moreover, a POSITA would have understood that the third set of data constitutes parameter values for the transmission bandwidth because it includes parameter values for determination of transmission bandwidth of network connections such as available bandwidth. Grounds 2 and 3 therefore teach limitations [2b]/[9b]/[16b].

[2c]/[9c]/[16c] receiv[ing], at the first endpoint device, from the tuner server, the one or more [parameter] values for the transmission bandwidth.
--

153. As explained above, the first endpoint device (e.g., client) receives from the tuner server (e.g., server) the one or more parameter values for the

transmission bandwidth (e.g., third set of data).¹⁷ Grounds 2 and 3 therefore teach limitations [2c]/[9c]/[16c].

5. Dependent Claims 3, 10, 17

- 3. The method of claim 1, wherein the initiating is executed by the first endpoint device.**
- 10. The method of claim 8, wherein the initiating is executed by the first endpoint device.**
- 17. The network connected device of claim 15, wherein the initiating is executed by the first endpoint device and wherein the first endpoint device is contained within the network connected device.**

154. Grounds 2 and 3 teach the method according to claims 1 and 8, and the network connected device of claim 15. *Supra* §V.B.3. Grounds 2 and 3 further teach the additional limitations of claims 3, 10, and 17.

155. First, as explained above, Scherzer’s server determines that the next network connection is established via a preferred access point that has a corresponding bandwidth. *Supra* §V.B.3[1c]/[8c]/[15c]. A POSITA would have understood that Scherzer’s teachings include at least two scenarios—the initiating is executed by the client, or by the server. Scherzer, as well as the combination of Scherzer and Gillett, teaches that, in the scenario where the initiating is executed

¹⁷ I note that “the one or more para values” of claim 2 of the ’634 patent appears to be a typographical error. Ex-1001, 14:26. My analysis assumes that the claim recites “parameters values” instead of “para values.”

by the first endpoint device (e.g., client) (claims 3, 10, 17), the client connects to another client via the preferred access point. *Supra* §V.B.3[1c]/[8c]/[15c].

156. Scherzer further teaches that **the first endpoint device** (e.g., client) **is contained with the network connected device** (e.g., server) (claim 17). As explained above, Scherzer teaches that the network connected device (e.g., server) and the first endpoint device (e.g., client) are distinct, separate components that perform their respective roles. *Supra* §V.B.3[1b]/[8b]/[15b]; e.g., Ex-1005, 2:42-50, 5:9-46, 6:4-27. While Scherzer teaches that two components are distinct, its teachings include at least two scenarios: (1) the client is integrated into the server, where the two components share the same physical housing; (2) the client is located as a physically independent component outside the server.¹⁸

157. Moreover, a POSITA would have recognized the benefits of having the configuration in the first scenario—that the client is within the same housing as the server. For example, combining both components in a single unit would have eliminated the need for separate physical installations, reducing the time and effort required for deployment. In addition, maintenance tasks would have been streamlined since both components are housed together, making them accessible at the same location. Moreover, since communication between the client and the server happens internally, such configuration may reduce delays associated with

¹⁸ Scherzer explains that the configurations shown in its figures are merely exemplary. *See* Ex-1005, 4:36-50, 14:3-17.

external network links and minimize communication latency. Grounds 2 and 3 thus teach claims 3, 10, and 17.

6. Dependent Claims 4, 11, 18

4. The method of claim 1,

11. The method of claim 8,

18. The network connected device of claim 15,

wherein the determining and the initiating are executed external to the first endpoint device and communicated to the first endpoint device.

158. Grounds 2 and 3 teach the method according to claims 1 and 8, and the network connected device of claim 15. *Supra* §V.B.3. Grounds 2 and 3 further teach the additional limitations of claims 4, 11, and 18.

159. First, as explained above, Scherzer's teachings include the scenario where **the determining is executed** by the server. *Supra* §V.B.3. Scherzer further teaches the example scenario where **the initiating is executed** by the server. *Supra* §V.B.5. For example, Scherzer teaches that the server initiates the network connections by determining quality and accessibility of available access points, sending relevant updates to the client, based on which the client selects a preferred access point for the next network connection. *Supra* §V.B.3[1c]/[8c]/[15c]; Ex-1005, 2:42-3:21, 5:9-33, 5:58-6:27, 6:59-7:23, Abstract, Fig. 2.

160. Moreover, Scherzer teaches that the server is **external to the first endpoint device** (e.g., client). As explained above, Scherzer's teachings include

the scenario where the server and the client are physically separate components performing their respective roles. *Supra* §§V.B.3[1b]/[8b]/[15b], §V.B.5; Ex-1005, 2:42-50, 5:9-46, 6:4-27, Fig. 1. The server is external to the communication device in this example scenario.

161. Scherzer further teaches that the server **communicates** the determining and initiating **to the first endpoint device** (e.g., client). For example, as explained above, the server determines determining quality and accessibility of available access points and sends relevant updates to the client. *E.g.*, Ex-1005, Abstract (“The server uses the reports to update its database, and send corresponding updates to the clients.”), 2:42-50, 12:21-13:40. In this process, the server communicates the determining and initiating to the client. Grounds 2 and 3 therefore teach claims 4, 11, and 18.

7. Dependent Claims 5, 12, 19

5. The method of claim 1, further comprising:

12. The method of claim 8, further comprising:

19. The method of claim 15, further comprising the network connected device configurable to:

monitor[ing] network traffic between the first endpoint device and the second endpoint device; and

adjust[ing] the transmission bandwidth based on the monitoring.

162. Grounds 2 and 3 teach the method according to claims 1 and 8, and the network connected device of claim 15.¹⁹ *Supra* §V.B.3. Grounds 2 and 3 further teach the additional limitations of claims 5, 12, and 19.

163. Scherzer, as well as the combination of Scherzer and Gillett, teaches that the server **monitors network traffic between the first endpoint device** (e.g., client) **and the second endpoint device** (e.g., another client). For example, Scherzer teaches that the server receives information regarding network traffic from the clients, including “Internet connection available capacity.” Ex-1005, 2:51-3:29 (“[A] method for connecting a wireless user terminal to an Internet is disclosed, comprising: generating first set of data by using the user terminal to analyze radio resources in reach ... the first set of data may comprise at least one of: ... Internet connection available capacity; ... The method may further comprise

¹⁹ I note that the “method of claim 15” recited in claim 19 of the ’634 patent appears to be a typographical error. Ex-1001, 16:31. The correct term should be “network connected device of claim 15.”

transmitting the first set of data to a service server over the Internet.”). Moreover, the server “continuously update[s]” its database “to include up to date data on any [access points] that were newly put to service, modified, or removed from service.”

Ex-1005, 6:28-45 (“The server 110, on the other hand, continuously receives measurements from various clients that are connected to access points.

The server 110 uses the measurements from the clients to update the database 150.

In this manner, the database 150 is enhanced and continuously updated to include up to date data on any AP’s that were newly put to service, modified, or removed from service.”). During this process, the server continuously tracks traffic behavior and connection variations. A POSITA would thus have understood that, by receiving information such as Internet connection available capacity and continuously updating its database with information about access points used to connect the clients, the server monitors network traffic because it gathers and analyzes information regarding the various access points, including data regarding which access points are active, how they are being used, the connections established through them, and potential congestion points.

164. Scherzer further teaches the server **adjusting the transmission bandwidth based on the monitoring**. For example, Scherzer teaches that based on information provided by the server, the clients “automatically switch connection to a better radio resource.” Ex-1005, 6:59-7:23 (“[C]lients are able to: a) Establish

control signaling with network servers; b) Allow individual client to select the best radio connection; ... and, e) If current connection quality gets below minimum level, automatically switch connection to a better radio resource. In most cases, connection is established without any user intervention: once user initiates a network-based application (e.g., access to websites, playing games through the web, using IM, sharing files, making IP call, etc.), the system executes automatic Internet connection (AutoConnect). The automatic connection can be implemented by continuously or periodically executing the loop of Step 235 of FIG. 2.”), 5:58-6:27, 11:28-50, Fig. 2. Since each access point has a corresponding bandwidth (*supra* §V.B.3[1c]/[8c]/[15c]), the server therefore adjusts the bandwidth by updating clients regarding available access points and enabling the clients to automatically switch connection to a better access point that has better bandwidth performance. Grounds 2 and 3 therefore teaches claims 5, 12, and 19.

8. Dependent Claims 6, 13, 20

6. The method of claim 1, further comprising:

13. The method of claim 8, further comprising:

20. The network connected device of claim 15, further comprising the network connected device configurable to:

monitor[ing] network traffic between the first endpoint device and the second endpoint device;

transmitt[ing] data associated with the network traffic from the first endpoint to the [tuner server]/[network connected device];

determin[ing], at the [tuner server]/[network connected device], an adjustment to the transmission bandwidth is desired;

receiv[ing] data for adjusting the transmission bandwidth from the [tuner server]/[network connected device]; and

adjust[ing] the transmission bandwidth responsive to the receiving.

165. Grounds 2 and 3 teach the method according to claims 1 and 8, and the network connected device of claim 15. *Supra* §V.B.3. Grounds 2 and 3 further teach the additional limitations of claims 6, 13, and 20. First, as explained above, Grounds 2 and 3 teach **monitoring network traffic between the first endpoint device and the second endpoint device and adjusting the transmission bandwidth**. *Supra* §V.B.7.

166. Scherzer further teaches **transmitting data associated with the network traffic from the first endpoint (e.g., client) to the tuner server/network connected device (e.g., server)**. For example, as explained above,

the client collects backhaul quality and transmits the data to the server. *Supra* §§V.B.3[1a-c]/[8a-c]/[15a-c]. A POSITA would have recognized that the backhaul quality (e.g., estimated bandwidth connection to Internet) is **data associated with the network traffic** because it relates to network traffic, specifies the capacity of the connection to handle data flows, and is used for network traffic management.

167. Scherzer further teaches that, upon receiving the backhaul quality reported by the clients, the server **determines that an adjustment to the transmission bandwidth is desired**. For example, as explained above, the server receives backhaul quality reported by clients, determines that the network connection is established via a preferred access point (*supra* §§V.B.3[1a, c]/[8a, c]/[15a, c]) and enables the clients to automatically switch connection to a better access point that has better bandwidth performance when “current connection quality gets below minimum level” (*supra* §V.B.8; Ex-1005, 5:58-6:27, 6:59-7:23, 11:28-50, Fig. 2). The server in this process determines that an adjustment to the transmission bandwidth is desired.

168. Furthermore, as explained above, Scherzer teaches that the server generates and transmits a set of data to the client “to select preferred radio resource for connection.” *Supra* §V.B.4; Ex-1005, 2:51-3:14, 3:22-29. Upon receiving the data, the client selects and switches to a preferred access point, which has a corresponding transmission bandwidth. *Supra* §V.B.4; Ex-1005, 2:51-3:14, 3:22-

29, 5:58-6:27, 6:59-7:23, 11:28-50, Fig. 2. Scherzer thus teaches **receiving data for adjusting the transmission bandwidth from the tuner server/network connected device (e.g., server) and adjusting the transmission bandwidth responsive to the receiving**. For reasons explained above, Grounds 2 and 3 teach claims 6, 13, and 20.

9. Dependent Claims 7, 14

7. The method of claim 6,
14. The method of claim 13,
wherein the tuner server incorporates knowledge of a network topology for the determining.

169. Grounds 2 and 3 teach the method according to claims 6 and 13.

Supra §V.B.8. Grounds 2 and 3 further teach the additional limitations of claims 7 and 14.

170. As explained above, Scherzer teaches that the server receives reports from clients and maintains a database that contains information for various access points, including accessibility and bandwidth of the access points. *Supra* §V.B.3[1b]/[8b]/[15b]; Ex-1005, 5:34-46 (“Server 110 includes database 150, which stores historical data about radio broadband access resources. Server 110 also includes an evaluation module 160, which evaluates accessibility and bandwidth of various AP’s, and stored the information as an update in database 150, as shown by arrow 131.”), 6:28-45 (“The server 110, on the other hand,

continuously receives measurements from various clients that are connected to access points. The server 110 uses the measurements from the clients to update the database 150. In this manner, the database 150 is enhanced and continuously updated to include up to date data on any AP's that were newly put to service, modified, or removed from service."), 2:42-50, 8:64-9:20, Abstract, Fig. 1.

171. A POSITA would have understood that, in this process, the server maintains and **incorporates knowledge of the network topology**, including, for example, information regarding available access points in the network. *E.g.*, Ex-1005, Abstract, 5:9-33 ("The system employs client/server architecture: each user operates a radio client that, besides connecting to the radio network, executes radio measurements and report to the network server that shares this information with other user's clients."), 6:46-58 ("The client's measurements reports are relayed to network server, so that the historical radio resources database (i.e., slow varying data) is gradually expanded and updated at the network server."), 13:13-26 ("[W]hen the server determines the location of the mobile device of the user, the server may present a ranking of the access point with respect to the specific location of the mobile device."), 5:34-46, 6:28-45, 2:42-50. Grounds 2 and 3 therefore teach claims 7 and 14.

VI. BACKGROUND AND QUALIFICATIONS

172. This section contains a summary of my educational background, career history, publications, and other relevant qualifications. My full curriculum vitae is attached as Appendix 1 to this declaration.

173. I am a Professor in the Department of Computer Science, and in the Faculty of Computing and Data Science, at Boston University. From 2013 to 2018, I served as Chair of the Department of Computer Science. I currently serve as Chair of Academic Affairs for the Faculty of Computing and Data Sciences.

174. I earned an undergraduate degree in Biology from Cornell University, which I received in 1982. I received a master's degree in Computer Science from the University of Buffalo in 1989. I received a Ph.D. in Computer Science from the University of Rochester in 1994. The subject of my Ph.D. thesis was "Performance Prediction and Tuning of Parallel Programs."

175. In 1994, I joined the faculty of Boston University, initially as an Assistant Professor of Computer Science. I was promoted to the rank of Associate Professor in 2000 and became a full Professor in 2006. From 2013 to 2018, I served as Chair of the Department of Computer Science.

176. I have been pursuing research in the area of computer networking since 1994. I have conducted research in a variety of areas related to the Internet and the World Wide Web. Among other areas, I have studied the efficient design

of Web servers and content distribution systems; I have studied the statistical properties of Internet traffic; and I have made extensive measurements of Internet infrastructure and the behavior of Internet protocols.

177. I have been involved in the design and development of software for mobile devices, including design of user interfaces, the management of processes on mobile devices, and the management of network traffic on mobile devices. I have built mobile applications that have been distributed widely, e.g., via the Apple App Store and the Google Play Store.

178. I regularly teach courses that cover aspects of computer systems and computer networks, such as Operating Systems, Introduction to Computer Systems, and Computer Networking.

179. From 2007 to 2009, I was the Chair of ACM SIGCOMM (the Special Interest Group in Computer Communication), the main professional organization for scientists in the field of computer networking. I am a past editor of principal journals in the field of networking: *Computer Communication Review*, *IEEE/ACM Transactions on Networking*, *Computer Networks*, and *IEEE Transactions on Computers*.

180. My work in the field of computer networking is highly cited. In 2010, I was elected a Fellow of the ACM “for contributions to the measurement and analysis of networks and distributed systems.” I was elected a Fellow of the IEEE

in 2011 with the same contribution citation. I currently hold a Duan Family Fellowship at Boston University.

181. I am co-author of Internet Measurement: Infrastructure, Traffic, and Applications (Wiley Press, 2006) and I am the author of over two hundred research papers. According to Google Scholar, my work has been cited by over 30,000 other publications. Also, according to Google Scholar, as of March 2014, only nine other researchers worldwide are more cited in the area of computer systems. I hold ten U.S. Patents derived from my Internet-related research.

A. Compensation

182. For my efforts in connection with the preparation of this declaration I have been compensated at my standard rate for this type of consulting activity. My compensation is in no way contingent on the results of these or any other proceedings relating to the above-captioned patent.

B. Materials and Other Information Considered

183. I have considered information from various sources in forming my opinions. I have reviewed and considered each of the exhibits listed in the attached Appendix 2 (Materials Considered in the Preparation of This Declaration) in forming my opinions.

VII. UNDERSTANDING OF THE LAW

184. I am not an attorney. In forming my opinions in this Declaration, I applied the relevant legal principles provided to me by counsel, which are summarized in Appendix 4.

VIII. RESERVATION OF RIGHTS

185. My opinions are based upon the information that I have considered to date. I am unaware of any evidence of secondary considerations with respect to the '634 Patent that would render any of the challenged claims non-obvious. I reserve the right, however, to supplement my opinions in the future to respond to any arguments raised by the owner of the '634 Patent and to take into account new information that becomes available to me.

186. I declare that all statements made herein of my knowledge are true, and that all statements made on information and belief are believed to be true, and that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code.

Executed on January 29, 2025.

By:

A handwritten signature in black ink, appearing to read "Mark Crovella". The signature is fluid and cursive, with the first name "Mark" and last name "Crovella" clearly distinguishable.

Mark Crovella, Ph.D.

APPENDIX 1: CURRICULUM VITAE OF MARK E. CROVELLA

MARK E. CROVELLA

Duan Family Fellow
Professor, Computer Science
Professor, Faculty of Computing and Data Sciences

Boston University
665 Commonwealth Ave.
Boston, MA 02215

Date of Birth: October 28, 1959
Location: Buffalo, New York, USA
Nationality: USA

Current as of January 24, 2025

EDUCATION

Ph.D. Computer Science, University of Rochester, October 1994.
M.S. University of Rochester, May 1991.
M.S. State University of New York at Buffalo, May 1990.
B.S. Cornell University, May 1982.

PROFESSIONAL EXPERIENCE

Professor Department of Computer Science, Boston University, 2006 to present. **Department Chair** 2013 – 2018; **Associate Professor** 2000 – 2006; **Assistant Professor** 1994 – 2000. On leave 2000 – 2001.

Professor Faculty of Computing & Data Sciences, Boston University, 2022 to present. **Duan Family Fellow** 2024 – present; **Chair of Academic Affairs** 2022 – present; **Founding Faculty Member**, 2020 – 2022; **Data Science Faculty Fellow** 2019 – 2022.

Affiliated Faculty Department of Electrical and Computer Engineering, Graduate Program in Bioinformatics, Center for Information Systems and Engineering, and Division of Systems Engineering, Boston University.

Chief Scientist Guavus, Inc., February 2012 to August 2014.

Visiting Faculty Laboratoire d'Informatique de Paris 6 (LIP6); 2003 – 2004 and 2018 – 2019; INRIA Paris 2018 – 2019; Laboratory of Information, Networking and Communication Sciences (LINCS) Paris 2018 – 2019.

Technical Director Network Appliance, Tewksbury, MA. November 2000 to April 2002.

Chief Architect Webmanage Technologies, Chelmsford, MA. May 2000 to acquisition by Network Appliance in November 2000.

Lead Research Scientist epicRealm, Inc., Richardson, TX. January to May 2001.

Senior Computer Scientist Calspan Corporation, Buffalo, NY. August 1984 to August 1994.

HONORS

Duan Family Faculty Fellow, 2024, Boston University.

Distinguished Alumni Award, 2017, University at Buffalo, Department of Computer Science and Engineering.

Innovator of the Year, 2014, Boston University.

IETF/IRTF Applied Networking Research Prize for “Routing State Distance: A Path-based Metric for Network Analysis,” ACM Internet Measurement Conference (IMC), 2012.

Best Student Paper Award for “Intrusion as (Anti)social Communication: Characterization and Detection,” ACM SIGKDD Conference on Knowledge Discovery and Data Mining (KDD) 2012.

IEEE Fellow, 2011, “For contributions to the measurement and analysis of networks and distributed systems.”

ACM Fellow, 2010, “For contributions to the measurement and analysis of networks and distributed systems.”

ACM SIGMETRICS Test of Time Award for “Self-Similarity in World Wide Web Traffic: Evidence and Possible Causes,” (with Azer Bestavros). One of the three inaugural Test of Time Awards given by SIGMETRICS in 2010. The award is given for a paper published between 1973 and 1999 that has had the greatest impact over the subsequent period.

CNRS Fellowship, Centre National de la Recherche Scientifique (Department Sciences et Technologies de l’Information et de la Communication), for 2003-2004 academic year as Visiting Associate Professor at Laboratoire d’Informatique de Paris 6 (LIP6).

NSF CAREER Award, 1995.

ARPA Fellowship in High Performance Computing, 1993-1994.

DARPA Parallel Processing Fellowship, 1992-1993.

EDITORIAL BOARDS

Steering Committee, IEEE Transactions on Network Science and Engineering, 2016–2019.

Editor, Computer Communication Review, 2005 – 2008.

Editor, Computer Networks, 2004 – 2005.

Editor, IEEE/ACM Transactions on Networking, 2000 – 2006.

Editor, IEEE Transactions on Computers, 2000 – 2004.

FUNDING

“Large Scale Analysis of Configurations and Management Practices in the Domain Name System,” NSF CISE/CNS NeTS Medium, 10/1/23 – 9/30/26, \$525,000.

“Methods for Active Measurement of the Domain Name System,” NSF CISE/CNS IMR, 10/1/23 - 9/30/26, \$256,463.

Google Research Award, 10/1/20, \$30,000.

“Traveling Back to the Future: Using Network Science to Unravel Evolutionary Conserved RNA Binding Proteins and Complexes Associated with Disease,” BU Hariri Institute Research Incubation Award, 2/9/18, \$35,280.

“Analytic Tools for Evolving Path-based Networks,” NSF CISE/CNS NeTS Small, 8/15/16 – 7/31/19, \$499,951.

“Structural Matrix Completion for Data Mining Applications,” NSF CISE/III Small, 9/1/14 – 8/31/17, \$499,702 with 1 other PI.

“Understanding Communication Strategies for Ad Hoc Networks,” NSF CISE/CNS NeTS Small, 8/1/11 – 7/31/14, \$390,853.

“Information and Software Assurance: A Coordinated Approach to Cyber-Situation Awareness Based on Traffic Anomaly Detection,” DoD ARO, 9/1/2011 - 8/31/2015, \$800,000 with 3 other PIs.

“Securing the Open Softphone,” NSF CISE/CNS TC Large, 7/1/10 – 6/30/15, \$2,992,896, with 8 other PIs. REU Supplement, 4/13/11 – \$73,125.

“New Directions in Network Dimensionality Reduction for Routing and Beyond,” NSF CISE/CNS NeTS Small, 7/1/10 – 6/30/13, \$450,000.

“Wide-Aperture Traffic Analysis for Internet Security,” NSF CISE/CNS TC Medium, 9/1/09 – 8/31/13, \$723,053, with 2 other PIs.

- Sponsoring Advisor for Postdoctoral Fellow under the *Computing Innovations Fellowship Program*, NSF CIF, 9/1/09 – 8/31/11, \$267,500.
- “Passive Methods for Internet Topology Discovery,” National Geospatial Intelligence Agency, 8/1/09 – 7/31/12, \$360,000.
- “Instrumentation and Measurement for GENI,” NSF/BBN, 8/1/08 – 8/31/11, \$80,932
- “Whole-Network Anomaly Diagnosis,” Intel, 1/1/05 – 12/31/07, \$158,000.
- “Coordinate Systems for the Internet,” NSF CISE/ANI, 8/15/03 – 7/31/06, \$222,035.
- “Collaborative Research: Modular Strategies for Global internetwork Monitoring,” with 6 other PIs, NSF CISE/CCR ITR, 9/1/03 – 8/31/08, \$1,994,513.
- “Research Support for IP Network Characterization,” Sprint Advanced Technology Laboratories, 9/1/03 – 8/31/04, \$29,592.
- “Research Support for IP Network Characterization,” with 3 other PIs, Sprint Advanced Technology Laboratories, 9/1/02 – 8/31/03, \$80,000.
- “A Control Theoretic Approach to the Design of Internet Traffic Managers,” with 3 other PIs, NSF CISE/ANIR, 9/1/01 – 8/31/05, \$719,994.
- “Diagnosis and Control of Network Variability by Massively Accessed Servers,” with 2 other Principal Investigators, NSF CISE/ANI, 9/1/00 – 8/31/05, \$1,210,768.
- “Wide Area Web Measurement,” GTE Laboratories, 9/1/00 – 8/31/01, \$20,000.
- “Wide Area Web Measurement,” Xerox PARC, 9/1/99 – 8/31/00, \$15,000.
- “COMMONWEALTH: Architecture and Protocols for Scalable WWW Service,” with 2 other Principal Investigators, NSF CISE/CCR Experimental Software Systems, 7/15/97 – 6/30/00, \$590,087.
- “Research Support for Network Performance Characterization, Analysis, and Evaluation,” Principal Investigator, Hewlett-Packard Company, 9/1/96 – 9/1/97: \$69,404. Renewed for 9/1/97 – 9/1/98: \$88,154. Renewed for 9/1/98 – 9/1/99: \$29,873.
- “Practical Performance Prediction for Parallel Programmers,” Principal Investigator, NSF CISE/CCR CAREER, 9/1/95 – 5/31/98, \$91,066
- “Research Infrastructure for Parallel and Distributed Systems: Real-Time, Multimedia, and High-Performance,” with 4 other Principal Investigators, NSF CISE Institutional Infrastructure, \$874,019
- “Research Instrumentation for Real-Time, Multimedia and High-Performance Computing in Distributed Systems,” with 4 other Principal Investigators, NSF CISE IGR, \$142,744
- “Graduate Assistantships in High Performance Computing,” with 5 other Principal Investigators, US Dept. of Education, 9/1/95 – 8/31/98, \$354,645

PROFESSIONAL AFFILIATIONS

Association for Computing Machinery (Fellow)
 IEEE (Fellow)
 ACM SIGCOMM and SIGMETRICS
 IEEE Computer Society and Communication Society

INVITED CONFERENCE TALKS

- Invited Speaker, *TMA Experts Summit*, Paris, June 18, 2019.
- Invited Panelist, *The 3rd Future Network Development Conference*, Nanjing, China, May 22, 2019.
- Keynote Speaker, *IEEE Workshop on Data Science for Networking (DS4N)*, Boston, MA, December 14, 2017.
- Invited Panelist, *CSE 50th Anniversary Celebration*, University at Buffalo, Department of Computer Science and Engineering, September 30, 2017.

- Keynote Speaker, *DATANET 16: Workshop on Data-Driven Networking*, Arizona State University, May 13, 2016.
- Invited Speaker, *Workshop on Mathematics of Data Analysis in Cybersecurity*, ICERM, Brown University, October 24, 2014.
- Invited Speaker, *51st Annual Allerton Conference on Communication, Control, and Computing*, University of Illinois at Urbana-Champaign, October 3, 2013.
- Invited Speaker, *Network Links: Connecting Social, Communication and Biological Network Analysis*, Institute for Mathematics and its Applications (IMA), Minneapolis, MN, February 29, 2012.
- Invited Speaker, *Statistics of Networks Workshop*, Isaac Newton Institute for Mathematical Sciences, Cambridge, UK, June 24-25, 2010.
- Keynote Speaker, *NetEval 2009 Workshop, The First Workshop on Performance Evaluation of Next-Generation Networks*, Boston, MA, April 26, 2009.
- Keynote Speaker, *2006 Euro-NGI Workshop on Visions of Future Generation Networks (EuroView2006)*, Würzburg, Germany, August 1, 2006.
- Invited Speaker, *Maryland Hybrid Networks Center*, Advanced Networks Colloquium Series, University of Maryland, December 16, 2005.
- Keynote Speaker, *Workshop on End-to-End Monitoring Techniques and Services (E2EMON)*, Nice, France, May 15, 2005.
- Invited Speaker, *Workshop on Internet Measurement, Modeling, and Analysis*, Statistical Research Center for Complex Systems (SRCCS), Seoul National University, Seoul, South Korea, January 11, 2005.
- Invited Speaker, *Workshop on Measurement, Modeling and Analysis of the Internet*, Institute for Mathematics and its Applications (IMA), Minneapolis, MN, January 12, 2004.
- Keynote Speaker, *First Workshop on Performance of Computational Systems and Communication*, part of the XXII Congress of the Brazilian Computer Society, Florianopolis, Brazil, July 18, 2002.
- Invited Speaker, Institute for Pure and Applied Mathematics (IPAM) Program on Large Scale Communication Networks, Los Angeles, CA, March 18-22, 2002.
- Invited Speaker, *DIMACS Workshop on Internet and WWW Measurement, Mapping and Modeling*, New Brunswick, NJ, February 13-15, 2002.
- Invited Speaker, *Workshop on Job Scheduling Strategies for Parallel Processing*, Cambridge, MA, June 16, 2001.
- Invited Speaker, *COST 257 Final Conference*, Würzburg, Germany.
- Invited Plenary Speaker, *Performance Tools 2000: The 11th International Conference on Modelling Techniques and Tools for Computer Performance Evaluation*, Schaumburg, Illinois, March 27 - 31, 2000.
- Invited Speaker, *Institute for Mathematics and Its Applications Workshop: "Scaling Phenomena in Communication Networks"*, Minneapolis, MN, October 22-24, 1999.
- Invited Speaker, Boston University Minority Engineers' Society, 2nd Annual Technical Exposition, Boston, MA, April 10, 1999.
- Invited Speaker, Workshop on Intelligent Internet Infrastructure, IBM T.J. Watson Laboratory, Yorktown Heights, NY, March 22, 1999.
- Invited Speaker, Workshop on Architectures, Performance, and Applications in Globally Distributed Web Services, Federal University of Minas Gerais (UFMG), Belo Horizonte, Brazil, March 11 - 12, 1998.
- Invited Speaker, Long-Range Dependence and Self-Similar Network Traffic Session, Winter Simulation Conference, Atlanta, GA, Dec. 7-10, 1997
- Invited Speaker, DIMACS/NSF Workshop on "End-to-End Network Modeling and Simulations," Princeton University, Princeton, NJ, October 23-25, 1997.

Invited Panelist, Hot Topic Session On Traffic Characterization, ITC-15, Washington DC, June 22-27, 1997

Invited Speaker, IFIP Working Group 7.3 Workshop, June 19-20, Orcas Island, WA.

Invited Panelist, "Engineering Implications of Long-Range Dependence in Teletraffic Data," MASCOTS '97, January 1997, Haifa, Israel

Invited Speaker, Applied Probability Session of Informs, the Operations Research Society, May 1997, San Diego, CA.

Invited Speaker, Joint Research Conference on Statistics in Quality, Industry and Technology, May 29-31 1996, NIST, Gaithersburg, MD. Sponsored by the *American Statistical Association*, the *Institute of Mathematical Statistics*, E. I. du Pont, and the *National Institute of Standards and Technology*.

PROFESSIONAL ACTIVITIES

Chair, Scientific Advisory Board of the Max Plank Institute for Software Systems, 2024.

Scientific Advisory Board of the Max Plank Institute for Software Systems, 2016 – 2025.

Member, IETF/IRTF Applied Networking Research Prize Selection Committee, 2014 – 2016.

Executive Steering Committee of the Hariri Institute for Computing and Computational Science & Engineering, 2011 – 2014, 2024 – present.

Member of the External Review Visiting Committee for the Department of Computer Science at Amherst College, February 2013.

Organized Workshop: "GPU Programming with CUDA" at Boston University, July 24, 2012.

Member, SIGCOMM Rising Star Award Selection Committee, 2011.

Chair, SIGCOMM Test of Time Award Selection Committee, 2011.

Team Mentor for Conrad Awards, Cyber Security Challenge 2011.

External Judge for FCC's Open Internet Apps Challenge, 2011.

General Co-Chair, CoNEXT 2011.

Internet2 perfSONAR Workshop, Executive Committee, 2010.

Chair, ACM SIGCOMM 2007–2009.

Program Co-Chair, IFIP Networking 2010.

Internet2 Network Research Strategic Planning Team, 2009-present.

Internet2 Network Research Review Committee, <http://www.internet2.edu/networkresearch/nrrc.html>, 2009-present.

Advisory Board of CRAWDAD (Community Resource for Archiving Wireless Data At Dartmouth).

Steering Committee, Passive and Active Measurement Workshop (PAM), 2004-2006.

General Chair, Passive and Active Measurement Workshop (PAM) 2005.

Steering Committee, Internet Measurement Conference, 2003-2007.

ACM SIGCOMM Executive Committee, Award Committee Chair, 2003-2006. b

Program Committee Chair, Internet Measurement Conference 2003.

Co-organizer (with C. Lindemann and M. Reiser), Workshop on Internet Performance Modeling, Dagstuhl Castle, Germany, September 26-29, 1999.

Co-organizer (with five others), BU/NSF Workshop on Internet Measurement, Instrumentation, and Characterization; Boston University, August 30, 1999.

Tutorials Chair, SIGMETRICS '99, Atlanta GA.

Program Committees:

- SIGCOMM: 2002, 2006, 2008, 2012, 2017

- SIGMETRICS: 1999, 2000, 2002, 2007, 2009, 2010, 2011, 2012, 2014, 2015, 2016
- CoNEXT: 2005, 2007, 2010, 2011
- Internet Measurement Conference: 2002, 2004, 2007, 2010, 2012, 2015, 2017, 2018, 2020, 2022
- ICDM: 2018
- The Web Conference: 2000, 2001, 2002, 2019, 2022 (Senior PC Member)
- KDD: 2017, 2023
- Intelligent Systems for Molecular Biology (ISMB): 2015, 2017
- First IMC Workshop on Internet Visualization: 2012
- Performance: 2011
- Passive and Active Measurement Workshop (PAM): 2009, 2010
- Infocom: 2009 (TPC Area Chair), 2010 (TPC Area Chair)
- IFIP Networking: 2009
- NetEval: 2009
- HotMetrics: 2008
- E2EMON: 2007
- First Workshop on Experimental Computer Science: 2007
- Workshop on Mining Network Data (MineNet-06): 2006
- Workshop on Large Scale Network Inference: 2005
- 6th Global Internet Symposium: 2001
- 6th International Workshop on Web Caching and Content Distribution: 2001
- Workshop on Caching, Coherence and Consistency: 2001
- Workshop on Network-Related Data Management: 2001
- ITC Specialist Seminar on IP Traffic Management and Modeling: 2000
- SPIE Performance and Control of Network Systems Conference: 1998, 1999
- 18th International Conference on Distributed Computing Systems (ICDCS-98): 1998
- Third IEEE Workshop on Services in Distributed and Networked Environments (SDNE '96): 1996

COURSE TEXTS AND MATERIALS

- “Linear Algebra, Geometry, and Computation,” Electronic Text, one-semester course on Linear Algebra from a Computer Science standpoint. 2015-2022. Available at <http://mcrovella.github.io/CS132-Geometric-Algorithms>. Includes contributions from Wayne Snyder.
- “Computational Tools for Data Science,” Electronic Text, one-semester course on applied methods in machine learning using Python. 2021-2022. Available at <http://mcrovella.github.io/CS506-Computational-Tools-for-Data-Science>. Includes contributions from Evimaria Terzi and George Kollios.

TUTORIALS AND SHORT COURSES

- “Data Mining for Measurement Data,” presented at the 5th PhD School on Traffic Monitoring and Analysis, associated with the 7th International Workshop on Traffic Monitoring and Analysis, Barcelona, April 21-22, 2015. Available at <https://github.com/mcrovella/mining-low-dim-network-data>.
- “Traffic Modeling: Methods and Results for Single Links and Whole Networks,” presented at SIGCOMM 2004, Portland OR.
- “Traffic Modeling,” short course presented at Aalborg University, February 2, 2004.
- “Performance Characteristics of World Wide Web Information Systems,” presented at SIGMETRICS '97, Seattle WA, June 1997; SIGMETRICS '98, Madison WI, June 1998; and Performance Tools '98, Palma de Mallorca, Spain, September 1998.

CONSULTING

Member of the Technical Advisory Board, Guavus, Inc. 2006 to 2017.

Consultant, Fujitsu Laboratories of America, Sunnyvale, CA. 2002 to 2004.

Consultant and Expert Witness, in litigation cases involving software patents, software trade secrets, and intellectual property. Ongoing.

Member of the Technical Advisory Board, epicRealm, Inc., Richardson, TX. March 2000 to May 2001.

Consultant and Member of the Technical Advisory Board, WebManage Technologies, Inc., Chelmsford MA. July 1999 to November 2000.

Founder and Principal Technical Officer, Commonwealth Network Technologies, Inc., Boston MA. Incorporated April 27, 1998; acquired by WebManage Technologies, October 12, 1999.

Consultant and Member of the Technical Advisory Board, VitalSigns Software Inc., Santa Clara, CA; acquired by International Network Services, Inc.; now part of Lucent. November 1996 to October 1999.

PATENTS

Methods for Storing and Reading Digital Data on a Set of DNA Strands, US Patent # 10,027,347, issued July 17, 2018.

Method and Apparatus for Whole-Network Anomaly Diagnosis and Method to Detect and Classify Network Anomalies Using Traffic Feature Distributions, US Patent # 8,869,276, issued October 21, 2014.

Compressed Set Representation for Sets as Measures in OLAP Cubes, US Patent # 8,533,167, issued September 10, 2013.

Method and Apparatus for Dynamic Resource Discovery and Information Distribution in a Data Network, US Patent # 7,747,741, issued June 29, 2010.

System for Creating and Distributing Prioritized List of Computer Nodes Selected as Participants in a Distribution Job, US Patent # 7,346,682, issued March 18, 2008.

Method and Apparatus for Election of Group Leaders in a Distributed Network, US Patent # 6,993,587, issued January 31, 2006.

Method and Apparatus for Scalable Distribution of Information in a Distributed Network, US Patent # 6,748,447, issued June 8, 2004.

Method and Apparatus for Reliable and Scalable Distribution of Data Files in Distributed Networks, US Patent # 6,718,361, issued April 6, 2004. European Patent # EP1305924 issued March 31, 2010.

Distributed Routing, US Patent # 6,370,584, issued April 9, 2002.

Method and Apparatus for Assigning Tasks in a Distributed Server System, US Patent # 6,223,205, issued April 24, 2001.

DOCTORAL STUDENTS

Ahmed Youssef, Ph.D. June 2023. “Computational Methods to Uncover Cell State Proteomes and Profile Protein Interaction Dynamics.” Co-advised with Andrew Emili.

Bashir Rastegarpanah, Ph.D. August 2021. “Tools for Responsible Decision-Marking in Machine Learning.”

Larissa Spinelli, Ph.D. June 2019. “Empirical Studies of Factors Affecting Opinion Dynamics.”

Giovanni Comarela, Ph.D. July 2017. “On the Dynamics of Interdomain Routing in the Internet.”

Natali Ruchansky, Ph.D. August 2016. “Matrix Completion with Structure.” Co-advised with Evimaria Terzi.

Andrej Cvetkovski, Ph.D. May 2013. "Graph Embeddings for Low-Stretch Greedy Routing."

Gonca Gürsun, Ph.D. March 2013. "Inferring Hidden Features in the Internet."

Vijay Erramilli, Ph.D. December 2008. "Forwarding in Mobile Opportunistic Networks."

Nahur Fonseca, Ph.D. December 2008. "Stochastic Modeling Applied to Detection Problems in Network Protocols and Traffic."

Anukool Lakhina, Ph.D. August 2006. "Network-Wide Traffic Analysis: Methods and Applications."

Jun Liu, Ph.D. August 2002. "Characterizing Network Elements and Paths Using Packet Loss Behavior."

Paul Barford, Ph.D. June 2000. "Modeling, Measurement and Performance of World Wide Web Transactions."

Robert L. Carter, Ph.D. January 1998. "Performance Measurement and Prediction in Packet-Switched Networks: Techniques and Applications."

OTHER DOCTORAL STUDENTS ADVISED

Mengfei Cao, Ph.D. August 2016, "New Graph Metrics Improve Network-based Protein Function Prediction" Tufts University, Member of the Committee.

Bimal Viswanath, Ph.D. April 2016, "Towards Trustworthy Social Computing Systems." Universität des Saarlandes, Member of the Committee.

Yonjun Liao, Ph.D., January 2013, "Learning to Predict End-to-End Network Performance." Université de Liège, Belgium, Member of the Jury.

Diana Zeaiter Joumblatt, Ph.D., December 2012, "Prediction of User Dissatisfaction with Internet Application Performance at End-Hosts." Université Pierre et Marie Curie, Rapporteur.

Chrisil Arackaparambil, Ph.D., July 2011, "Anomaly Detection in Network Streams Through a Distributional Lens." Dartmouth College, Member of the Examining Committee.

Italo Cunha, Ph.D., July 2011, "Tracking Internet Routes and Path Reachability for Network Tomography." Université Pierre et Marie Curie (U. Paris VI), Rapporteur.

Hung Nguyen, Ph.D., February 2008, "User-level Internet Tomography and Overlay Routing." Ecole Polytechnique Fédérale de Lausanne (EPFL), Rapporteur.

Benoit Donnet, Ph.D., September 2006, "Algorithms for Large-Scale Topology Discovery." Université Pierre et Marie Curie (U. Paris VI), Président du Jury.

David Chua, Ph.D. (Mathematics), May 2006, "Statistical Analysis for Whole Networks." Second Reader.

Stilian Stoev, Ph.D. (Mathematics) May 2005.

Abhishek Kumar, Ph.D., October 2005, "Network Data Streaming: Algorithms for Network Monitoring and Coordination." Georgia Tech, Committee Member.

Marjan Bozinovski, Ph.D., May 2004, "Fault-Tolerant Platforms for IP-Based Session Control Systems." Aalborg University, Committee Member.

Artur Ziviani, Ph.D. December 2003, "Qualité de Service et Localisation d'Hotes." University of Paris VI, Examineur.

Liang Guo, Ph.D. April 2003, "Size-Aware Scheduling of TCP Flows." Second Reader.

Alberto Medina, Ph.D. March 2003, "Practical Estimation of Internet Traffic Demands." Third Reader.

Vladas Pipiras, Ph.D. (Mathematics) April 2002, "Symmetric Stable Self-Similar Processes." Third Reader.

Khaled A. Harfoush, Ph.D. November 2001, "A Framework for End-to-End Characterization of Metric-Induced Network Topologies." Committee Member.

Santiago M. Pericas-Geertsen, Ph.D. November 2001, "XML-Fluent Mobile Agents." Committee Member.

- Alia K. Atlas**, Ph.D. August 1998, “Statistical Rate Monotonic Scheduling.” Second Reader.
- Ghulam Bhatti**, Ph.D. January 1998, “Parallel and Distributed Discrete Event Simulation: An Event-Reservation Approach.” Second Reader.
- Sulaiman Mirdad**, Ph.D. June 1997, “WebWave: Globally Load-Balanced, Fully-Distributed Caching”. Second Reader.
- Gi Tae Kim**, Ph.D. June 1997, “Framework for Adaptive Forward Erasure Recovery (AFER) for Fault-Tolerant Real-Time Communications”. Second Reader.
- Carlos Cunha**, Ph.D. June 1997, “Trace Analysis and its Application to Performance Enhancements of Distributed Information Systems”. Second Reader.
- Susan Nagy**, Ph.D. April 1997, “Admission Control and Scheduling Strategies for Real-Time Database Systems”. Second Reader.
- Vadim Teverovksy**, Ph.D. February 1997 (Mathematics), “Detection and Estimation of Long-Range Dependence.” Third Reader.
- Euthimios Panagos**, Ph.D. May 1995, “Client-Based Logging: A New Paradigm for Distributed Transaction Management”. Third Reader.

MASTERS STUDENTS

- Megan Hacker**, M.S. May 2012, “Methods for Pairing Mobile Devices Through Shared Sensing”
- Lauren Walters**, MSc. May 2004, “A Web Browsing Workload Model for Simulation,” University of Cape Town, South Africa, external examiner.
- Alan Charbonneau**, M.A. May 2003, “Simulation of an SJF Proxy”
- Iana Vitkova**, M.A. May 2003, “Simulation of an SJF Proxy”
- Robert Frangioso**, M.A. Sept 2002, “Connection Scheduling in Web Servers”
- Xiaohui Zhang**, M.S. May 1999, “Cachability of Web Objects”
- Scott Harrison**, M.S. May 1998, “DPR Monitor: A Web-based DPR Network Monitoring Tool”
- Stanley Gambarin**, M.S. May 1997, “Implementing a Single-Process Non-Multithreaded World Wide Web Server”
- Kostas Magoutis**, M.S. May 1996, “Economies of Scale In Partitioned Disk Caches with Self-Similar References”
- Fred Bierhaus**, M.S. May 1996, “Improving Interactive Traffic Through the EQL Driver”

BOOKS

- M. Crovella and B. Krishnamurthy, “Internet Measurement: Infrastructure, Traffic, and Applications,” John Wiley and Sons, 2006, 512 pp.

BOOKS EDITED

- M. Crovella and L. M. Feeney and D. Rubenstein (editors), “Proceedings of the 9th International IFIP TC 6 Networking Conference,” Springer-Verlag, 410pp, 2010.

JOURNAL ARTICLES

- Hui Peng, Sergei Kotelnikov, Megan E. Egbert, Shany Ofaim, Grant C. Stevens, Sadhna Phanse, Tatiana Saccon, Mikhail Ignatov, Shubham Dutta, Zoe Istace, Mohamed Taha Moutaoufik, Hiroyuki Aoki, Neal Kewalramani, Jianxian Sun, Yufeng Gong, Dzmitry Padhorny, Gennady Poda, Andrey Alekseenko, Kathryn A. Porter, George Jones, Irina Rodionova, Hongbo Guo, Oxana Pogoutse, Suprama Datta, Milton Saier, Mark Crovella, Sandor Vajda, Gabriel Moreno-Hagelsieb, John Parkinson, Daniel Segre, Mohan Babu, Dima Kozakov, and Andrew Emili, “Ligand interaction landscape of transcription factors and essential enzymes in *E. coli*,” *Cell*, 2025.

- A. Youssef, I. Paul, M. Crovella, and A. Emili, “DESP: Demixing Cell State Profiles from Dynamic Bulk Molecular Measurements,” *Cell Reports Methods*, 2024.
- L. Salamatian, S. Anderson, J. Matthews, P. Barford, W. Willinger, and M. Crovella, “A Manifold View of Connectivity in the Private Backbone Networks of Hyperscalers,” *Communications of the ACM*, August 2023.
- N. Kewalramani, A. Emili, M. Crovella, “State-of-the-Art Computational Methods to Predict Protein-Protein Interactions with High Accuracy and Coverage,” *Proteomics*, 2023.
- A. Youssef, F. Bian, P. Havugimana, M. Crovella, and A. Emili, “Dynamic Remodeling of *Escherichia coli* Interactome in Response to Environmental Perturbations,” *Proteomics*, 2023.
- L. Salamatian, S. Anderson, J. Mathews, P. Barford, W. Willinger, and M. Crovella, “A Manifold View of Connectivity in the Private Backbone Networks of Hyperscalers,” *Communications of the ACM*, Research Highlights, 6(7), July 2023.
- J. Jung, M. Guo, M. Crovella, J.G. McDaniel, and K.M. Warkentin. “Frog Embryos Use Multiple Levels of Temporal Pattern in Risk Assessment for Vibration-Cued Hatching,” *Animal Cognition*, 2022.
- J. N. Law, K. Akers, N. Tasnina, C. M. Della-Santina, S. Deutsch, M. Kshirsagar, J. Klein-Seetharaman, M. Crovella, P. Rajagopalan, S. Kasif, and T. M. Murali, “Interpretable Network Propagation with Application to Expanding the Repertoire of Human Proteins that Interact with SARS-CoV-2,” *GigaScience*, 10(12), December 2021.
- D. Lancour, J. Dupuis, R. Mayeux, J. Haines, M. Pericak-Vance, G. Schellenberg, M. Crovella, L. Farrer, and S. Kasif, “Analysis of Brain Region-Specific Co-Expression Networks Reveals Clustering of Established and Novel Genes Associated with Alzheimer Disease,” *Alzheimer’s Research & Therapy*, 2020.
- J. Fan, X. C. Li, M. Crovella, and M. D. M. Leiserson, “Matrix (Factorization) Reloaded: Flexible Methods for Imputing Genetic Interactions with Cross-Species and Side Information,” *OUP Bioinformatics*, 2020.
- A. Ramirez, S. Dankel, B. Rastegarpanah, W. Cai, R. Xue, M. Crovella, Y.-H. Tseng, R. Kahn, and S. Kasif, “Single-Cell Transcriptional Networks in Differentiating Preadipocytes Suggest Drivers Associated with Tissue Heterogeneity,” *Nature Communications*, 2020.
- J. Fan, A. Cannistra, I. Fried, T. Lim, T. Schaffner, M. Crovella, B. Hescott, and M.D.M. Leiserson, “Functional Protein Representations from Biological Networks Enable Diverse Cross-Species Inference,” *Nucleic Acids Research*, 2019.
- D. Lancour, A. Naj, R. Mayeux, J. L. Haines, M. A. Pericak-Vance, G. C. Schellenberg, M. Crovella, L. A. Farrer, and S. Kasif, “One for All and All for One: Improving Replication of Genetic Studies through Network Diffusion,” *PLoS Genetics*, Vol 14, April 2018.
- A. Cvetkovski and M. Crovella, “Low-stress Data Embedding in the Hyperbolic Plane Using Multidimensional Scaling,” *Applied Mathematics and Information Sciences*, Vol 11, Number 1, January 2017.
- A. Cvetkovski and M. Crovella, “Multidimensional Scaling in the Poincaré Disk,” *Applied Mathematics and Information Sciences*, Vol 10, Number 1, January 2016.
- M. Cao, H. Zhang, J. Park, N. Daniels, M. Crovella, L. Cowen, and B. Hescott, “Going the Distance for Protein Function Prediction: A New Distance Metric for Protein Interaction Networks,” *PLoS One*, Vol 8, Number 10, October 2013.
- A. Cvetkovski and M. Crovella, “On the Choice of a Spanning Tree for Greedy Embedding of Network Graphs,” *Networking Science*, February 2013.
- B. Donnet, P. Raoult, T. Friedman, and M. Crovella, “Deployment of an Algorithm for Large-Scale Topology Discovery,” *IEEE Journal on Selected Areas in Communications, Special Issue on Sampling the Internet*, Vol 24, Number 12, December 2006.

- D. Chua, E. Kolaczyk, and M. Crovella, "Network Kriging," *IEEE Journal on Selected Areas in Communications, Special Issue on Sampling the Internet*, 2006.
- B. Gueye, A. Ziviani, M. Crovella, and S. Fdida, "Constraint-Based Geolocation of Internet Hosts," *IEEE/ACM Transactions on Networking*, Vol 14, Number 6, December 2006.
- R. Fonseca, V. Almeida, and M. E. Crovella, "Locality in a Web of Streams," *Communications of the ACM*, 48(1), pp. 82–88, January 2005.
- M. Fayed, P. Krapivsky, J. Byers, M. Crovella, D. Finkel, and S. Redner, "On the Emergence of Highly Variable Distributions in the Autonomous System Topology," *Computer Communication Review*, 33(2), pp. 41–49, July 2003.
- A. Lakhina, J. W. Byers, M. E. Crovella, and I. Matta, "On the Geographic Location of Internet Resources," *IEEE Journal on Selected Areas in Communications, Special Issue on Internet and WWW Measurement, Mapping, and Modeling*, 2003.
- P. Barford and M. E. Crovella, "Critical Path Analysis of TCP Transactions," *IEEE/ACM Transactions on Networking*, 9 (3), pp. 238–248.
- M. E. Crovella, C. Lindemann, and M. Reiser, "Internet Performance Modeling: the state of the art at the turn of the century," *Performance Evaluation*, 42 (2–3), pp. 91–108, September 2000.
- R. L. Carter and M. E. Crovella, "On the Network Impact of Dynamic Server Selection," *Computer Networks*, 31 (23–24), pp. 2529–2558.
- M. Harchol-Balter, M. E. Crovella and C. D. Murta, "On Choosing a Task Assignment Policy for a Distributed Server System," *Journal of Parallel and Distributed Computing*, Special Issue on Software Support for Distributed Computing, September 1999.
- P. Barford and M. E. Crovella, "Measuring Web Performance in the Wide Area," *Performance Evaluation Review*, Special Issue on Network Traffic Measurement and Workload Characterization, August 1999.
- P. Barford, A. Bestavros, A. Bradley, and M. E. Crovella, "Changes in Web Client Access Patterns: Characteristics and Caching Implications," *World Wide Web*, Special Issue on World Wide Web Characterization and Performance Evaluation, 1999.
- M. E. Crovella and M. S. Taqqu, "Estimating the Heavy Tail Index from Scaling Properties," *Methodology and Computing In Applied Probability*, 1(1), 1999.
- M. E. Crovella and A. Bestavros, "Self-Similarity in World Wide Web Traffic: Evidence and Possible Causes," *IEEE/ACM Transactions on Networking*, 5(6):835–846, December 1997.
- R. L. Carter and M. E. Crovella, "Measuring Bottleneck Link Speed in Packet-Switched Networks," *Performance Evaluation*, 27&28:297–318, October 1996.
- L. A. Cowl, M. E. Crovella, T. J. LeBlanc, and M. L. Scott, "The Advantages of Multiple Parallelizations in Combinatorial Search," *Journal of Parallel and Distributed Computing*, special issue on Data-Parallel Algorithms and Programming, 21(1):110–123, April 1994.

BOOK CHAPTERS

- M. E. Crovella, M. S. Taqqu, and A. Bestavros, "Heavy-Tailed Probability Distributions in the World Wide Web," Chapter 1 of *A Practical Guide To Heavy Tails*, pages 3–25, Chapman & Hall, New York, 1998.
- M. E. Crovella and L. Lipsky, "Simulations with Heavy-Tailed Workloads," Chapter 3 of *Self-Similar Network Traffic and Performance Evaluation*, Wiley/Wiley-Interscience, 1999.
- K. Park, G. Kim and M. Crovella, "The Protocol Stack and its Modulation Effect on Self-Similar Traffic," Chapter 16 of *Self-Similar Network Traffic and Performance Evaluation*, Wiley/Wiley-Interscience, 1999.
- M. E. Crovella, "Performance Characteristics of the World Wide Web," in *White Book on Performance Evaluation*, Günter Haring, Christoph Lindemann, and Martin Reiser, editors, Springer-Verlag, 1999.

INVITED PAPERS

- M. E. Crovella, "Performance Evaluation with Heavy Tailed Distributions," in *Lecture Notes in Computer Science 1786*, Proceedings of the 11th International Conference on Modelling Tools and Techniques for Computer and Communication System Performance Evaluation (TOOLS '2000), pp. 1-9, March 2000. Revised version appeared in *Job Scheduling Strategies for Parallel Processing : 7th International Workshop*, pp. 1-10, June 16, 2001.

REFEREED CONFERENCE PAPERS

- A. Anderson, A. S. Mondal, P. Barford, M. Crovella, and J. Sommers, "An Elemental Decomposition of DNS Name-to-IP Graphs," *Proceedings of INFOCOM*, Vancouver, Canada, May 2024.
- G. Franco, M. Crovella, and G. Comarela, "Dependence and Model Selection in LLP: The Problem of Variants," *Proceedings of KDD*, Los Angeles, CA, August 2023.
- K. Quinn, E. Terzi, and M. Crovella, "Characterizing Covid Waves via Spatio-Temporal Decomposition," *Proceedings of KDD*, Washington DC, August 2022.
- L. Salamatian, S. Anderson, J. Matthews, P. Barford, W. Willinger, and M. Crovella, "Curvature-based Analysis of Network Connectivity in Private Backbone Infrastructures," *Proceedings of ACM SIGMETRICS / IFIP Performance*, Mumbai, India, June 2022.
- B. Rastegarpanah, K. P. Gummadi, and M. Crovella, "Auditing Black-Box Prediction Models for Data Minimization Compliance," *Proceedings of NeurIPS*, Online, December 2021. **Selected as a Spotlight Presentation (3% acceptance rate).**
- L. Amichi, A. Carneiro Viana, M. Crovella, and A. A. F. Loureiro, "From Motion Purpose to Perceptive Spatial Mobility Prediction," *Proceedings of ACM SIGSPATIAL*, Beijing, China, November 2021.
- G. Grassi, C. Barakat, M. Crovella, and R. Teixeira, "Leveraging Website Popularity Differences to Identify Performance Anomalies," *Proceedings of Infocom*, Online, May 2021.
- L. Amichi, A. Carneiro Viana, M. Crovella, and A. A. F. Loureiro, "Understanding Individuals' Proclivity for Novelty Seeking," *Proceedings of ACM SIGSPATIAL*, Online, November 2020.
- J. Fan, X. C. Li, M. Crovella, and M. D. M. Leiserson, "Matrix (Factorization) Reloaded: Flexible Methods for Imputing Genetic Interactions with Cross-Species and Side Information," *Proceedings of the 19th European Conference on Computational Biology*, Online, August 2020.
- B. Rastegarpanah, M. Crovella, and K. P. Gummadi, "Fair Inputs and Fair Outputs: the Incompatibility of Fairness in Privacy and Accuracy," *Proceedings of the Workshop on Fairness in User Modeling, Adaptation, and Personalization (FairUMAP)*, Online, July 2020.
- L. Spinelli and M. Crovella, "How YouTube Leads Privacy-Seeking Users Away from Reliable Information," *Proceedings of the Workshop on Fairness in User Modeling, Adaptation, and Personalization (FairUMAP)*, Online, July 2020.
- J. Law, M. Kshirsagar, M. Crovella, P. Rajagopalan, J. Klein-Seetharaman, S. Kasif and T. M. Murali, "A Network-Based Label Propagation Framework to Reposition Drugs for COVID-19 (Poster)," *Proceedings of RECOMB*, Online, June 2020.
- L. Amichi, A. Viana, M. Crovella, and A. A. F. Loureiro, "Mobility profiling: Identifying Scouters in the Crowd (Poster)," *Proceedings of the CoNEXT Student Workshop*, Orlando, FL, December 2019.
- B. Rastegarpanah, K. P. Gummadi, and M. Crovella, "Fighting Fire with Fire: Using Antidote Data to Improve Polarization and Fairness of Recommender Systems," *Proceedings of WSDM 2019*, Melbourne, Australia, February 2019.

- G. Comarela, R. Durairajan, P. Barford, D. Christenson, and M. Crovella, "Assessing Candidate Preference through Web Browsing History," *Proceedings of the ACM SIGKDD Conference on Knowledge Discovery and Data Mining (KDD)*, London, UK, August 2018. Press coverage: BU Today: <http://www.bu.edu/today/2018/better-election-predictions>.
- L. Spinelli and M. Crovella, "Unravelling the Dynamics of Online Ratings," *Proceedings of the 4th International Symposium on Social Media Mining and Analysis (SMMA 2018)*, Exeter, UK, June 2018.
- M.D.M. Leiserson, J. Fan, A. Cannistra, I. Fried, T. Lim, T. Schaffner, M. Crovella, and B. Hescott, "A Multi-Species Functional Embedding Integrating Sequence and Network Structure," *Proceedings of RECOMB*, Paris, France, April 2018.
- B. Rastegarpanah, K. Gummadi, and M. Crovella, "Exploring Explanations for Matrix Factorization Recommender Systems" (Position Paper), *FATREC Workshop on Responsible Recommendation*, Como Italy, August 2017.
- L. Spinelli and M. Crovella, "Closed-Loop Opinion Formation", *Proceedings of the 9th International ACM Web Science Conference (WebSci)*, Troy, NY, June 2017.
- N. Ruchansky, E. Terzi, and M. Crovella, "Targeted Matrix Completion," *Proceedings of the SIAM International Conference on Data Mining (SDM)*, Houston, TX, April 2017.
- C. Mavroforakis, D. Erdős, M. Crovella, and E. Terzi, "Active Positive-Definite Matrix Completion," *Proceedings of the SIAM International Conference on Data Mining (SDM)*, Houston, TX, April 2017.
- G. Comarela, E. Terzi, and M. Crovella, "Detecting Unusually-Routed ASes: Methods and Applications," *Proceedings of the ACM Internet Measurement Conference (IMC)*, Santa Monica, CA, November 2016.
- N. Ruchansky, M. Crovella, and E. Terzi, "Matrix Completion with Queries," *Proceedings of the ACM SIGKDD Conference on Knowledge Discovery and Data Mining (KDD)*, Sydney, Australia, August 2015.
- G. Comarela and M. Crovella, "Identifying and Analyzing High Impact Routing Events with PathMiner," *Proceedings of the ACM Internet Measurement Conference (IMC)*, Vancouver, BC, November 2014.
- B. Viswanath, M. A. Bashir, M. Crovella, S. Guha, K. Gummadi, B. Krishnamurthy, and A. Mislove, "Towards Detecting Anomalous User Behavior in Online Social Networks," *Proceedings of the 23rd USENIX Security Symposium*, San Diego, CA, August 2014.
- Y. Zhang, T. Lappas, M. Crovella, and E. Kolaczyk, "Online ratings: convergence towards a positive perspective?," *Proceedings of the International Conference on Acoustics, Speech, and Signal Processing (ICASSP)*, Florence, Italy, May 2014.
- G. Comarela, G. Gürsun, and M. Crovella, "Studying Interdomain Routing over Long Timescales," *Proceedings of the ACM Internet Measurement Conference (IMC)*, Barcelona, Spain, October 2013.
- L. Spinelli, M. Crovella and B. Eriksson, "AliasCluster: A Lightweight Approach to Interface Disambiguation," *Proceedings of the Global Internet Symposium*, Turin, Italy, April 2013.
- B. Eriksson and M. Crovella, "Understanding Geolocation Accuracy using Network Geometry," in *Proceedings of the Infocom 2013 Miniconference*, Turin, Italy, April 2013.
- J. M. Agosta, J. Chandrasekar, M. Crovella, N. Taft, and D. Ting, "Mixture Models of Endhost Network Traffic," in *Proceedings of the Infocom 2013 Miniconference*, Turin, Italy, April 2013.
- G. Gürsun, N. Ruchansky, E. Terzi, and M. Crovella, "Routing State Distance: A Path-based Metric for Network Analysis," in *Proceedings of the ACM Internet Measurement Conference (IMC)*, Boston, MA, November 2012. **Winner of a 2013 IETF/IRTF Applied Networking Research Prize.**
- G. Gürsun and M. Crovella, "On Traffic Matrix Completion in the Internet," in *Proceedings of the ACM Internet Measurement Conference (IMC)*, Boston, MA, November 2012.

- T. Lappas, M. Crovella, and E. Terzi, "Selecting a Characteristic Set of Reviews," in *Proceedings of the ACM SIGKDD Conference on Knowledge Discovery and Data Mining (KDD) 2012*, Beijing, China, August 2012.
- Q. Ding, N. Katenka, P. Barford, E. Kolaczyk, and M. Crovella, "Intrusion as (Anti)social Communication: Characterization and Detection," in *Proceedings of the ACM SIGKDD Conference on Knowledge Discovery and Data Mining (KDD) 2012*, Beijing, China, August 2012. **Best Student Paper Award.**
- G. Gürsun, N. Ruchansky, E. Terzi, and M. Crovella, "Inferring Visibility: Who's (not) Talking to Whom?," in *Proceedings of SIGCOMM 2012*, Helsinki, Finland, August 2012.
- B. Eriksson and M. Crovella, "Estimating Intrinsic Dimension Via Clustering," in *IEEE Statistical Signal Processing Workshop (SSP)*, Ann Arbor, MI, August 2012.
- C. Thomas, J. Sommers, P. Barford, D. Kim, A. Das, R. Segebre, M. Crovella, "A Passive Measurement System for Network Testbeds," in *Tridentcom 2012*, Thessaloniki, Greece, June 2012.
- G. Comarela, M. Crovella, V. Almeida and F. Benevenuto, "Understanding Factors that Affect Response Rates in Twitter," in *ACM Hypertext 2012*, Milwaukee, WI, June 2012.
- A. Cvetkovski and M. Crovella, "Low-Stretch Greedy Embedding Heuristics," in *Fourth International Workshop on Network Science for Communication Networks (NetSciCom 2012)*, Orlando, FL, March 2012.
- V. Manfredi, M. Crovella, and J. Kurose, "Understanding Stateful vs Stateless Communication Strategies for Ad hoc Networks," in *Proceedings of Mobicom 2011*, Las Vegas, NV, September 2011.
- G. Gürsun, M. Crovella, and I. Matta, "Describing and Forecasting Video Access Patterns," in *Proceedings of the Infocom 2011 Miniconference*, Shanghai, China, April 2011.
- V. Bharti, P. Kankar, L. Setia, G. Gürsun, and M. Crovella, "Inferring Invisible Traffic," in *Proceedings of CoNEXT 2010*, Philadelphia, PA, December 2010.
- J. Sommers, P. Barford and M. Crovella, "Router Primitives for Programmable Active Measurement," in *Workshop on Programmable Routers for Extensible Services of Tomorrow (PRESTO '09)*, Barcelona, Spain, August, 2009.
- A. Cvetkovski and M. Crovella, "Hyperbolic Embedding and Routing for Dynamic Graphs," in *Proceedings of Infocom 2009*, Rio de Janeiro, Brazil, April 2009.
- V. Erramilli and M. Crovella, "Forwarding in Opportunistic Networks with Resource Constraints," in *Proceedings of the Fourth ACM Workshop on Challenged Networks (CHANTS 08)*, San Francisco, CA, September, 2008.
- N. Fonseca, M. Crovella, and K. Salamatian, "Long Range Mutual Information," in *Proceedings of the First Workshop on Hot Topics in Measurement and Modeling of Computer Systems (Hotmetrics '08)*, Annapolis, MD, June, 2008.
- V. Erramilli, A. Chaintreau, M. Crovella, and C. Diot, "Delegation Forwarding," in *Proceedings of the 9th ACM International Symposium on Mobile Ad Hoc Networking and Computing (ACM MobiHoc)*, Hong Kong SAR, China, May 2008.
- P. Chhabra, C. Scott, E. D. Kolaczyk, and M. Crovella, "Distributed Spatial Anomaly Detection," in *Proceedings of Infocom 2008*, Phoenix, AZ, April 2008.
- V. Erramilli, A. Chaintreau, M. Crovella, and C. Diot, "Diversity of Forwarding Paths in Pocket Switched Networks," in *Proceedings of the ACM SIGCOMM Internet Measurement Conference*, San Diego, October, 2007.
- B. Eriksson, P. Barford, R. Nowak, and M. Crovella, "Learning Network Structure from Passive Measurements," in *Proceedings of the ACM SIGCOMM Internet Measurement Conference*, San Diego, October, 2007.
- V. Erramilli, M. Crovella, and N. Taft, "An Independent-Connection Model for Traffic Matrices," in *Proceedings of the ACM SIGCOMM Internet Measurement Conference*, Rio de Janeiro, October, 2006.

- X. Li, F. Bian, M. Crovella, C. Diot, R. Govindan, G. Iannaccone, and A. Lakhina, "Detection and Identification of Network Anomalies Using Sketch Subspaces," in *Proceedings of the ACM SIGCOMM Internet Measurement Conference*, Rio de Janeiro, October, 2006.
- A. Lakhina, M. Crovella, and C. Diot, "Detecting Distributed Attacks using Network-Wide Flow Traffic," in *Proceedings of FloCon 2005 Analysis Workshop*, New Orleans, LA, September, 2005.
- A. Lakhina, M. Crovella, and C. Diot, "Mining Anomalies Using Traffic Feature Distributions," in *Proceedings of ACM SIGCOMM*, Philadelphia, PA, August 2005.
- D. B. Chua, E. D. Kolaczyk, and M. Crovella, "A Statistical Framework for Efficient Monitoring of End-to-End Network Properties," (Poster) in *Proceedings of ACM SIGMETRICS*, Banff, Canada, June 2005.
- B. Donnet, P. Raoult, T. Friedman, and M. Crovella, "Efficient Algorithms for Large-Scale Topology Discovery," in *Proceedings of ACM SIGMETRICS*, Banff, Canada, June 2005.
- A. Soule, A. Lakhina, N. Taft, K. Papagiannaki, K. Salamatian, A. Nucci, M. Crovella, and C. Diot, "Traffic Matrices: Balancing Measurements, Inference and Modeling," in *Proceedings of ACM SIGMETRICS*, Banff, Canada, June 2005.
- B. Donnet, T. Friedman, and M. Crovella, "Improved Algorithms for Network Topology Discovery," in *Lecture Notes in Computer Science, Proceedings of the 2005 Passive and Active Measurement Workshop*, Boston, MA, March, 2005.
- D. B. Chua, E. D. Kolaczyk, and M. Crovella, "Efficient Monitoring of End-to-End Network Properties," in *Proceedings of Infocom 2005*, Miami, FL, March 2005.
- N. Fonseca and M. Crovella, "Bayesian Packet Loss Detection for TCP," in *Proceedings of Infocom 2005*, Miami, FL, March 2005.
- B. Gueye, A. Ziviani, M. Crovella, and S. Fdida, "Constraint-Based Geolocation of Internet Hosts," in *Proceedings of the ACM SIGCOMM Internet Measurement Conference*, Taormina, Italy, October 2004.
- A. Lakhina, M. Crovella, and C. Diot, "Characterization of Network-Wide Anomalies in Traffic Flows," in *Proceedings of the ACM SIGCOMM Internet Measurement Conference*, Taormina, Italy, October 2004.
- A. Lakhina, M. Crovella, and C. Diot, "Diagnosing Network-Wide Traffic Anomalies," in *Proceedings of ACM SIGCOMM*, Portland, OR, August 2004.
- A. Lakhina, M. Crovella, and C. Diot, "Exploring the Subspace Method for Network-Wide Anomaly Diagnosis," (Poster) in *Network Troubleshooting Workshop: Research, Theory and Operations*, Portland, OR, August 2004.
- A. Lakhina, K. Papagiannaki, M. Crovella, C. Diot, E. D. Kolaczyk, and N. Taft, "Structural Analysis of Network Traffic Flows," in *Proceedings of ACM SIGMETRICS / Performance 2004*, New York, NY, June 2004.
- L. Tang and M. E. Crovella, "A Geometric Exploration of the Landmark Selection Problem," in *Lecture Notes in Computer Science 3015, Proceedings of the 2004 Passive and Active Measurement Workshop (PAM2004)*, pp. 63–72, Juan-les-Pins, France, April 2004.
- L. Tang and M. E. Crovella, "Virtual Landmarks for the Internet," in *Proceedings of the 2003 Internet Measurement Conference*, Miami, Florida, October 2003.
- R. Fonseca, V. Almeida, M. E. Crovella, and B. Abrahão, "On the Intrinsic Locality Properties of Web Reference Streams," in *Proceedings of IEEE Infocom 2003*, San Francisco, California, April 2003.
- A. Lakhina, J. Byers, M. E. Crovella, and P. Xie, "Sampling Biases in IP Topology Measurements," in *Proceedings of IEEE Infocom 2003*, San Francisco, California, April 2003.
- M. E. Crovella and E. Kolaczyk, "Graph Wavelets for Spatial Traffic Analysis," in *Proceedings of IEEE Infocom 2003*, San Francisco, California, April 2003.

- J. Liu, I. Matta, and M. E. Crovella, "End-to-End Inference of Loss Nature in a Hybrid Wired/Wireless Environment," in *Proceedings of Modeling and Optimization in Mobile, Ad Hoc, and Wireless Networks (WiOpt'03)*, Sophia-Antipolis, France, March 2003.
- A. Lakhina, J. W. Byers, M. E. Crovella, and Ibrahim Matta, "On the Geographic Location of Internet Resources," (Extended Abstract) in *Proceedings of the ACM SIGCOMM Internet Measurement Workshop 2002*, Marseilles, France, November 2002.
- J. Liu and M. Crovella, "Using Loss Pairs to Discover Network Properties," in *Proceedings of the ACM SIGCOMM Internet Measurement Workshop 2001*, pp. 127–138, San Francisco, CA, November 2001.
- P. Barford, A. Bestavros, J. Byers, and M. Crovella, "On the Marginal Utility of Network Topology Measurements," in *Proceedings of the ACM SIGCOMM Internet Measurement Workshop 2001*, pp. 5–17, San Francisco, CA, November 2001.
- L. Guo, I. Matta, and M. E. Crovella, "How Does TCP Generate Pseudo-Self-Similarity?," in *Proceedings of MAS-COTS 2001*, Cincinnati, Ohio, August 2001.
- P. Barford and M. E. Crovella, "Critical Path Analysis of TCP Transactions," in *Proceedings of the 2000 ACM SIGCOMM Conference*, Stockholm, Sweden, pp. 127–138, September 2000. Also appeared by invitation as "Análisis de secuencia crítica de transacciones TCP" in *Proceedings of SIGCOMM Latin America*, San Antonio de Belén, Costa Rica, April 2001.
- M. E. Crovella, R. Frangioso, and M. Harchol-Balter "Connection Scheduling in Web Servers," in *1999 USENIX Symposium on Internet Technologies and Systems (USITS '99)*.
- P. Barford and M. E. Crovella, "A Performance Evaluation of Hyper Text Transfer Protocols," in *Proceedings of ACM SIGMETRICS '99*, pp. 188–197, Atlanta, Georgia, May 1999.
- A. Bestavros, M. E. Crovella, J. Liu, and D. Martin, "Distributed Packet Rewriting and its Application to Scalable Server Architectures," in *Proceedings of the Sixth International Conference on Network Protocols (ICNP '98)*, pp. 290–297, October, 1998.
- M. Harchol-Balter, M. E. Crovella, and C. D. Murta, "On Choosing a Task Assignment Policy for a Distributed Server System," in *Proceedings of Performance Tools '98, Lecture Notes in Computer Science*, No. 1469, pp. 231–242, September 1998.
- P. Barford and M. E. Crovella, "Generating Representative Web Workloads for Network and Server Performance Evaluation," in *Proceedings of ACM SIGMETRICS/Performance '98*, pp. 151–160, Madison, Wisconsin, July 1998.
- M. E. Crovella, M. Harchol-Balter, and C. D. Murta, "Task Assignment in a Distributed System: Improving Performance by Unbalancing Load," in *Proceedings of SIGMETRICS '98 (Poster paper)*, Madison, Wisconsin, July 1998.
- M. E. Crovella and P. Barford, "The Network Effects of Prefetching," in *Proceedings of IEEE Infocom '98, the Seventeenth Annual Joint Conference of the IEEE Computer and Communication Societies*, San Francisco, California, pp. 1232–1240, April 1998.
- M. E. Crovella and L. Lipsky, "Long-Lasting Transient Conditions in Simulations with Heavy-Tailed Workloads," in *Proceedings of the 1997 Winter Simulation Conference*, December 1997.
- K. Park, G. Kim, and M. E. Crovella, "On the Effect of Traffic Self-Similarity on Network Performance," in *Proceedings of the SPIE International Conference on Performance and Control of Network Systems*, November, 1997.
- P. Fiorini, L. Lipsky, and M. E. Crovella, "Consequences of Ignoring Self-Similar Data Traffic In Communications Modeling," In *Tenth International Conference on Parallel and Distributed Computing Systems (PDCS-97)*, New Orleans, LA, pp. 322–327, October 1997.

- R. L. Carter and M. E. Crovella, "Server Selection using Dynamic Path Characterization in Wide-Area Networks," in *Proceedings of IEEE Infocom '97, the Sixteenth Annual Joint Conference of the IEEE Computer and Communication Societies*, Kobe, Japan, April 1997.
- V. Almeida, A. Bestavros, M. Crovella, and A. de Oliveira, "Characterizing Reference Locality in the WWW," in *Proceedings of the Fourth International Conference on Parallel and Distributed Information Systems (PDIS '96)*, December 1996.
- K. Park, G. Kim, and M. E. Crovella, "On the Relationship Between File Sizes, Transport Protocols, and Self-Similar Network Traffic," in *Proceedings of the Fourth International Conference on Network Protocols (ICNP '96)*, pp. 171–180, October, 1996.
- R. L. Carter and M. E. Crovella, "Measuring Bottleneck Link Speed in Packet-Switched Networks," in *PERFORMANCE '96, the International Conference on Performance Theory, Measurement and Evaluation of Computer and Communication Systems*, October 1996.
- M. E. Crovella and A. Bestavros, "Self-Similarity in World Wide Web Traffic: Evidence and Possible Causes," in *Proceedings of the 1996 ACM SIGMETRICS International Conference on Measurement and Modeling of Computer Systems*, May 1996. **Winner of a 2010 ACM SIGMETRICS Test of Time Award.**
- M. E. Crovella and R. L. Carter, "Dynamic Server Selection in the Internet," In *Proceedings of the Third IEEE Workshop on the Architecture and Implementation of High Performance Communication Subsystems (HPCS '95)*, August 1995.
- A. Bestavros, R. L. Carter, M. E. Crovella, C. R. Cunha, A. Heddaya, and S. A. Mirdad, "Application-Level Document Caching in the Internet," In *Proceedings of the Second Workshop on Services in Distributed and Networked Environments (SDNE '95)*, June 1995.
- M. E. Crovella and T. J. LeBlanc, "Parallel Performance Prediction Using Lost Cycles Analysis," In *Proceedings of Supercomputing '94*, November, 1994.
- R. Bianchini, M. E. Crovella, L. Kontothanassis, and T. J. LeBlanc, "Software Interleaving," In *Proceedings of the 6th IEEE Symposium on Parallel and Distributed Processing*, October, 1994.
- M. E. Crovella and T. J. LeBlanc, "Performance Debugging using Parallel Performance Predicates," In *3rd ACM/ONR Workshop on Parallel and Distributed Debugging*, May, 1993, pp. 140-150.
- M. Crovella, R. Bianchini, T. LeBlanc, E. Markatos, and R. Wisniewski, "Using Communication-to-Computation Ratio in Parallel Performance Prediction and Program Design," *Proceedings of the Fourth IEEE Symposium on Parallel and Distributed Processing*, December 1992, pp. 238-245.
- M. Crovella, P. Das, C. Dubnicki, T. LeBlanc, and E. Markatos, "Multiprogramming on Multiprocessors," *Proceedings of the Third IEEE Symposium on Parallel and Distributed Processing*, December 1991, pp. 590–597, Also published as TR 385, Department of Computer Science, University of Rochester, February 1991 (revised May 1991).
- E. Markatos, M. Crovella, P. Das, C. Dubnicki, and T. LeBlanc, "The Effects of Multiprogramming on Barrier Synchronization," *Proceedings of the Third IEEE Symposium on Parallel and Distributed Processing*, December 1991, pp. 662-669. Also TR 380, University of Rochester Computer Science Department, May 1991.
- N. Bashir, M. Crovella, G. DeTitta, F. Han, H. Hauptman, J. Horvath, H. King, D. Langs, R. Miller, T. Sabin, P. Thuman and D. Velmurugan, "Parallel Solutions to the Phase Problem in X-Ray Crystallography," *Proceedings of The Fifth Distributed Memory Computing Conference*, IEEE Computer Society Press, 1990, pp. 513–521.
- M. Crovella, M. S. Summers, E. M. Camardo, and S. S. Weissman, "Exploiting a Restricted Application Domain in SDE Design," *Advance Working Papers of the Second International Workshop on Computer Aided Software Engineering*, IEEE Computer Society Press, July 1988, pp. 2-3–2-4.
- J. G. Neal and M. E. Crovella, "An Expert System for Tactical Support Jammer Configuration," *Proceedings of the 1987 IEEE National Aerospace and Electronics Conference (NAECON '87)*, May 1987, pp. 1308–1314.

J. G. Neal, M. E. Crovella, and C. Y. Thielman, "A Knowledge-Based Approach to an EW Mission Planning Task," *Proceedings of the Knowledge Based Information Systems Symposium (KBIS-87)*, SHAPE Technical Centre, The Hague, Netherlands, 1987.

J. G. Neal, D. F. Funke, and M. E. Crovella, "JAMEX: An Expert Advisor on Tactical Support Jammer Configuration," *Proceedings of the Second Annual Conference on Expert Systems in Government*, IEEE Computer Society Press, November 1986, pp. 383–394.

REFEREED PRESENTATIONS

I. Fried, A. Cannistra, C. Casey, A. Piel, T. Lim, M. Crovella, B. Hescott, "CANDL: Coarsely Aligning Networks with Diffusion and Landmarks," Theme Presentation, ISMB/ECCB, Dublin, July 2015.

UNREFEREED PUBLICATIONS

R. Canetti, A. Cohen, C. Conley, M. Crovella, S. L. Dogan, M. Gaboardi, W. Hartzog, R. Van Loo, C. T. Robertson, K. Baird Silbaugh, "National Telecommunications and Information Administration: Comments from Researchers at Boston University and the University of Chicago," Boston Univ. School of Law Research Paper No. 23-24, June 2023.

M. Crovella, "The Skillful Interrogation of the Internet," in *Computer Communication Review*, vol. 49, no. 3, October 2019.

kc Claffy, M. Crovella, T. Friedman, C. Shannon and N. Spring, "Community-oriented network measurement infrastructure (CONMI) workshop report," in *Computer Communication Review*, vol. 36, no. 2, pp. 41–48, April, 2006.

M. E. Crovella, "How Big is the Average Web Page?" in *Inclusions, the Arts of Mathematics*, Journal of the Mathematical Association of America Student Chapter at Boston University, May 1999.

T. J. LeBlanc, M. L. Scott, B. Marsh, E. Markatos, C. Dubnicki, M. Crovella, and T. Becker, "The Psyche Parallel Operating System," *IEEE TC on Operating Systems Newsletter*, vol. 6, no. 1, 1992, pp. 11-13.

TECHNICAL REPORTS

G. Grassi, C. Barakat, M. Crovella, and R. Teixeira, "Leveraging Website Popularity Differences to Identify Performance Anomalies," (Extended Version), Available at <https://hal.inria.fr/hal-03109717>, January 2021.

J. N. Law, N. Tasnina, M. Kshirsagar, J. Klein-Seetharaman, M. Crovella, P. Rajagopalan, S. Kasif, and T. M. Murali, "Identifying Human Interactors of SARS-CoV-2 Proteins and Drug Targets for COVID-19 using Network-Based Label Propagation," arXiv:2006.01968, June 2, 2020.

B. Rastegarpanah, M. Crovella, and K. P. Gummadi, "Fair Inputs and Fair Outputs: the Incompatibility of Fairness in Privacy and Accuracy," arXiv:2005.09209, May 19, 2020.

M.D.M. Leiserson, J. Fan, A. Cannistra, I. Fried, T. Lim, T. Schaffner, M. Crovella, and B. Hescott, "A Multi-Species Functional Embedding Integrating Sequence and Network Structure," bioRxiv, December 4, 2017.

J.-M. Agosta, J. Chandrasekar, M. Crovella, N. Taft, and D. Ting, "Mixture Models of Endhost Network Traffic," arxiv:1212.2744, December 13, 2012.

M. Hacker, M. Crovella, and L. Reyzin, "Secure Pairing of Mobile Devices," BUCS-TR-2012-011, May 16, 2012.

A. Cvetkovski and M. Crovella, "Multidimensional Scaling in the Poincare Disk," arxiv:1105.5332, May 26, 2011.

A. Lakhina, M. Crovella, and C. Diot, "Diagnosing Network-Wide Traffic Anomalies," BUCS-TR-2004-008, February 24, 2004. Also published as a Sprint Research Report.

- A. Lakhina, K. Papagiannaki, M. Crovella, C. Diot, E. D. Kolaczyk, and N. Taft, "Structural Analysis of Network Traffic Flows," BUCS-TR-2003-021, November 10, 2003. Also published as Sprint Research Report RR03-ATL-110708.
- M. Fayed, P. Krapivsky, J. Byers, M. Crovella, and D. Finkel, "On the Size Distribution of Autonomous Systems," BUCS-TR-2003-001, January 17, 2003.
- R. Fonseca, V. Almeida, M. E. Crovella, and B. Abrahão, "On the Intrinsic Locality Properties of Web Reference Streams," BUCS-TR-2002-022, July 15, 2002.
- A. Lakhina, J. Byers, M. E. Crovella, and P. Xie, "Sampling Biases in IP Topology Measurements," BUCS-TR-2002-021, July 15, 2002.
- M. E. Crovella and E. Kolaczyk, "Graph Wavelets for Spatial Traffic Analysis," BUCS-TR-2002-020, July 15, 2002.
- A. Lakhina, J. W. Byers, M. E. Crovella, and Ibrahim Matta, "On the Geographic Location of Internet Resources," BUCS-TR-2002-015, 2002.
- J. Liu, I. Matta, and M. E. Crovella, "End-to-End Inference of Loss Nature in a Hybrid Wired/Wireless Environment," BUCS-TR-2002-008, March 14, 2002.
- M. E. Crovella, R. Frangioso, and M. Harchol-Balter "Connection Scheduling in Web Servers," BUCS-TR-1999-003, March 31, 1999.
- M. Harchol-Balter, M. E. Crovella, and C. D. Murta, "On Choosing a Task Assignment Policy for a Distributed Server System," MIT Laboratory for Computer Science, MIT-LCS-TR-757, 1998.
- P. Barford and M. E. Crovella, "Generating Representative Web Workloads for Network and Server Performance Evaluation," BUCS-TR-1997-006, November 4, 1997.
- M. E. Crovella, M. Harchol-Balter, and C. D. Murta, "Task Assignment in a Distributed System: Improving Performance by Unbalancing Load," BUCS-TR-1997-018, October 31, 1997.
- M. Harchol-Balter, M. E. Crovella, and C. D. Murta, "To Queue or Not to Queue: When Queueing is Better Than Timesharing in a Distributed System," BUCS-TR-1997-017, October 31, 1997.
- K. Park, G. Kim, and M. E. Crovella, "On the Effect of Traffic Self-Similarity on Network Performance," CSD-TR 97-024, Dept. of Computer Sciences, Purdue University, July 1997.
- M. Crovella and P. Barford, "The Network Effects of Prefetching," BUCS-TR-97-002, February 7, 1997.
- K. Park, G. Kim, and M. E. Crovella, "On the Relationship Between File Sizes, Transport Protocols, and Self-Similar Network Traffic," BUCS-TR-96-016, August 7, 1996.
- V. Almeida, A. Bestavros, M. Crovella, and A. deOliveira, "Characterizing Reference Locality in the WWW," BUCS-TR-96-011, June 21, 1996.
- A. Bestavros, M. Chen, M. Crovella, A. Heddaya, S. Sclaroff, and J. Cowie, "Responsive Web Computing: Resource Management, Protocol Techniques, and Applications (A research statement)," BUCS-TR-96-008, March 21, 1996.
- R. L. Carter and M. E. Crovella, "Dynamic Server Selection Using Bandwidth Probing in Wide-Area Networks," BUCS-TR-96-007, Boston University Computer Science Department, March 18, 1996.
- R. L. Carter and M. E. Crovella, "Measuring Bottleneck Link Speed in Packet-Switched Networks," Technical Report BUCS-TR-96-006, Boston University Computer Science Department, March 15, 1996.
- M. E. Crovella and A. Bestavros, "Explaining World Wide Web Traffic Self-Similarity," Technical Report BUCS-TR-95-015 (Revised), Boston University Department of Computer Science, October 1995.
- M. E. Crovella, T. J. LeBlanc, and W. Meira Jr., "Performance Measurement and Modeling with the Lost Cycles Toolkit," Technical Report 580, University of Rochester Computer Science Department, June 1995.

- C. Cunha, A. Bestavros, and M. Crovella, "Characteristics of WWW Client-based Traces," Technical Report BUCS-TR-95-010, Boston University Department of Computer Science, April 1995.
- A. Bestavros, R. L. Carter, M. E. Crovella, C. R. Cunha, A. Heddaya, and S. A. Mirdad, "Application-Level Document Caching in the Internet," Technical Report BUCS-TR-95-002, Boston University Department of Computer Science, February 1995.
- M. E. Crovella, "Performance Prediction and Tuning of Parallel Programs," Technical Report 573 and Ph.D. Thesis, Computer Science Dept., U. Rochester, February 1995.
- M. E. Crovella and T. J. LeBlanc, "The Search for Lost Cycles: a New Approach to Parallel Program Performance Evaluation," Technical Report 479, University of Rochester Computer Science Department, December 1993.
- L. A. Crawl, M. E. Crovella, T. J. LeBlanc, and M. L. Scott, "Beyond Data Parallelism: The Advantages of Multiple Parallelizations in Combinatorial Search," Technical Report 92-80-06, December 1992, Department of Computer Science, Oregon State University. Revised version appears as Technical Report 451, U. Rochester Department of Computer Science, April 1993.
- R. Bianchini, M. E. Crovella, L. Kontothanassis, and T. J. LeBlanc, "Alleviating Memory Contention in Matrix Computations on Large-Scale Shared-Memory Multiprocessors," Technical Report 449, U. Rochester Computer Science Department, April 1993.
- R. Bianchini, M. E. Crovella, L. Kontothanassis, and T. J. LeBlanc, "Memory Contention in Scalable Cache-Coherent Multiprocessors," Technical Report 448, U. Rochester Computer Science Department, April 1993.
- D. Bergmark and M. Crovella, "Case Study in KSR Programming: Finding Outliers by the Minimum Volume Ellipsoid Method," Technical Report CTC92TR107, October 1992, Center for Theory and Simulation in Science and Engineering, Cornell University, Ithaca, NY 14853.

RECENT TALKS

"Beyond accuracy: understanding the performance of LLMs on exams designed for humans,"

- UFMG, Department of Computer Science, March 8, 2024.

"Estimating Traffic Flows that Can't Be Measured"

- Google Telemetry Seminar Series, May 17, 2021.

"Assessing Candidate Preference Through Web Browsing History"

- Sorbonne Université (UPMC) LIP6, April 15, 2019.
- INRIA Sophia-Antipolis, March 20, 2019.
- INRIA Saclay, December 13, 2018.
- INRIA Paris, November 8, 2018.
- LINC Laboratory, Paris, October 10, 2018.

"Human Behavior is Low Dimensional"

- TMA Experts Summit 2019, Paris, June 18, 2019.
- Chinese Academy of Sciences, Institute of Computing Technology, Beijing, May 20, 2019.
- Huawei Network AI Workshop, Paris, April 9, 2019.
- LINC Laboratory, Paris, February 13, 2019.
- Wesleyan University Department of Mathematics and Computer Science, April 13, 2017.
- IEEE Workshop on Data Science for Networking (DS4N), December 14, 2017.

"The Statistics of Human Activity and Implications for Security"

- BU Statistics Club, Professor Speaker Series, November 10, 2016.
- “Analyzing the Evolution of Internet Routing through Path Analysis”
- Cisco FAST Seminar Series, July 17, 2015.
 - Raytheon BBN Technologies, SDP Seminar, September 28, 2015.
- “Reversing the Curse of Dimensionality for Security Analysis”
- NYU Poly Department of Computer Science, December 5, 2014.
- “Anomaly Detection and Dimensionality Reduction”
- Workshop on Mathematics of Data Analysis in Cybersecurity, ICERM, Brown University, October 24, 2014.
- “Targeted Matrix Completion”
- 51st Annual Allerton Conference on Communication, Control, and Computing, University of Illinois at Urbana-Champaign, October 3, 2013.
- “Better Routing with Hyperbolic Geometry”
- Laboratory of Information, Networking and Communication Sciences (LINCS) Paris, December 19, 2012.
- “A Fine Grained Distance Metric for Small Worlds”
- Université de Liège, Liège Belgium, January 11, 2013.
 - Laboratory of Information, Networking and Communication Sciences (LINCS) Paris, Mar 20, 2012.
- “Inferring Invisible Traffic”
- Williams College, Dept. of Computer Science, Williamstown, MA, November 22, 2013.
 - Tufts University, Dept. of Computer Science, Medford, MA, November 7, 2013.
 - University of Miami, Dept. of Computer Science, Miami, FL, March 2, 2011.
 - International Computer Science Institute (ICSI), Berkeley, CA, July 20, 2010.
 - Statistics of Networks Workshop, Isaac Newton Institute for Mathematical Sciences, Cambridge, UK, June 24, 2010.
- “Network Monitoring: Challenges and Opportunities”
- Indian Institute of Technology (IIT), Delhi, India, June 9, 2008.
- “Exploiting Feature Distributions in Anomaly Diagnosis”
- Dartmouth, November 28, 2005.
 - MIT CSAIL-LIDS Networking and Systems Seminar, Cambridge MA, April 11, 2005.
- “Network Anomaly Diagnosis”
- Boston Area Networking and Networkers Annual Summit (BANANAS-2005), BBN Technologies, Cambridge MA, January 20, 2005.
- “Applying the Subspace Method to Network Traffic Analysis”
- Statistical Research Center for Complex Systems (SRCCS), Workshop on “Internet Measurement, Modeling, and Analysis,” Seoul National University, Seoul, South Korea, January 11, 2005.
 - Electronics and Telecommunications Research Institute (ETRI), Daejeon, South Korea, January 13, 2005.
- “Diagnosing Network-Wide Traffic Anomalies”

- Columbia University, Nov. 17, 2004.
- Workshop on Internet Signal Processing (WISP), CAIDA, Nov. 11, 2004.
- Ecole Normale Supérieure, Paris, Apr. 13, 2004.
- France Telecom R&D, Paris, Mar. 18, 2004.

“Structural Analysis of Network Traffic Flows”

- Project Metropolis Meeting, École Nationale Supérieure des Télécommunications de Bretagne (ENST), Rennes, Feb. 10, 2004.
- Institute for Mathematics and its Applications, Workshop on “Measurement, Modeling and Analysis of the Internet,” Minneapolis, MN, January 12, 2004.

“Virtual Landmarks for the Internet”

- Intel Research, Cambridge UK, October 1, 2003.
- Ecole Polytechnique Fédérale de Lausanne (EPFL), November 10, 2003.
- Laboratoire d’Informatique de Paris VI (LIP6), November 14, 2003.

“Sampling Biases in IP Topology Measurements”

- Séminaire Graphes, Réseaux et Modélisation, Laboratoire de Recherche en Informatique, Université d’Orsay, January 8, 2004.
- IBM T.J. Watson Labs, April 11, 2003.
- BU Statistics Colloquium, April 10, 2003.
- National Institute of Statistical Sciences, March 28, 2003.

APPENDIX 2: MATERIALS CONSIDERED IN THE PREPARATION OF THIS DECLARATION

Exhibit No.	Description
1001	U.S. Patent No. 10,944,634 to Beeson <i>et al.</i> (the '634 patent)
1002	Prosecution History for the '634 patent
1004	U.S. Patent No. 7,742,499 (“Erskine”)
1005	U.S. Patent No. 8,000,276 (“Scherzer”)
1006	U.S. Patent No. 9,661,553 (“Gillett”)
1007	Excerpts from Patent Owner’s Infringement Contentions for the '634 Patent
1008	U.S. Patent No. 9,693,276 (“Wuellner”)
1009	Computer Networking – A Top-Down Approach, Kurose, Ross (2017)
1010	U.S. Patent No. 8,554,970 (“Suumäki”)
1011	U.S. Patent No. 8,977,265 (“Lee”)
1012	U.S. Patent No. 9,775,182 (“Gupta”)

APPENDIX 3: CHALLENGED CLAIMS

1[pre] A method for network connection optimization, comprising:

[1a] collecting, at a first endpoint device coupled to a network, parameter values for determination of bandwidth of network connections to further endpoint devices;

[1b] determining at a tuner server, distinct from the first endpoint device and the further endpoint devices, that a next network connection from the first endpoint device to a second endpoint device matches a geographical area of a past network connection; and

[1c] initiating the next network connection, from the first endpoint device to the second endpoint device, based on the determination at the tuner server, with a transmission bandwidth based on the parameter values for the past network connection.

[2a] The method of claim 1, further comprising: sending the parameter values for determination of bandwidth; from the first endpoint device, to the tuner server that is configured to receive further parameter values for determination of bandwidth of network connections from a plurality of endpoint devices;

[2b] sending, from the first endpoint device to the tuner server, connection information for the next network connection, wherein the tuner server performs the

determining and derives one or more parameter values for the transmission bandwidth; and

[2c] receiving, at the first endpoint device, from the tuner server, the one or more para values for the transmission bandwidth.

3. The method of claim 1, wherein the initiating is executed by the first endpoint device.

4. The method of claim 1, wherein the determining and the initiating are executed external to the first endpoint device and communicated to the first endpoint device.

5. The method of claim 1, further comprising: monitoring network traffic between the first endpoint device and the second endpoint device; and adjusting the transmission bandwidth based on the monitoring.

6. The method of claim 1, further comprising: monitoring network traffic between the first endpoint device and the second endpoint device; transmitting data associated with the network traffic from the first endpoint to the tuner server; determining, at the tuner server, an adjustment to the transmission bandwidth is desired; receiving data for adjusting the transmission bandwidth from the tuner server; and adjusting the transmission bandwidth responsive to the receiving.

7. The method of claim 6, wherein the tuner server incorporates knowledge of a network topology for the determining.

8[pre] A tangible, non-transitory, computer-readable media having instructions thereupon which, when executed by a processor, cause the processor to perform a method comprising:

[8a] collecting, at a first endpoint device coupled to a network, parameter values for determination of bandwidth of network connections to further endpoint devices;

[8b] determining at a tuner server, distinct from the first endpoint device and the further endpoint devices, that a next network connection from the first endpoint device to a second endpoint device matches a geographical area of a past network connection; and

[8c] initiating the next network connection, from the first endpoint device to the second endpoint device, based on the determination at the tuner server, with a transmission bandwidth based on the parameter values for the past network connection.

[9a] The method of claim 8, further comprising: sending the parameter values for determination of bandwidth, from the first endpoint device, to the tuner

server that is configured to receive further parameter values for determination of bandwidth of network connections from a plurality of endpoint devices;

[9b] sending, from the first endpoint device to the tuner server, connection information for the next network connection, wherein the tuner server performs the determining and derives one or more parameter values for the transmission bandwidth; and

[9c] receiving, at the first endpoint device, from the tuner server, the one or more parameter values for the transmission bandwidth.

10. The method of claim 8, wherein the initiating is executed by the first endpoint device.

11. The method of claim 8, wherein the determining and the initiating are executed external to the first endpoint device and communicated to the first endpoint device.

12. The method of claim 8, further comprising: monitoring network traffic between the first endpoint device and the second endpoint device; and adjusting the transmission bandwidth based on the monitoring.

13. The method of claim 8, further comprising: monitoring network traffic between the first endpoint device and the second endpoint device; transmitting data associated with the network traffic from the first endpoint to the tuner server;

determining, at the tuner server, an adjustment to the transmission bandwidth is desired; receiving data for adjusting the transmission bandwidth from the tuner server; and adjusting the transmission bandwidth responsive to the receiving.

14. The method of claim 13, wherein the tuner server incorporates knowledge of a network topology for the determining.

15[pre] A network connected device, comprising: one or more processors, coupled to a network port and configurable to:

[15a] collect; at a first endpoint device coupled to the network; parameter values for determination of bandwidth of network connections to further endpoint devices;

[15b] determine at the network connected device acting as a tuner server, distinct from the first endpoint device and the further endpoint devices, that a next network connection from the first endpoint device to a second endpoint device matches a geographical area of a past network connection; and

[15c] initiate the next network connection, from the first endpoint device to the second endpoint device, based on the determination at the network connected device acting as the tuner server, with a transmission bandwidth based on the parameter values for the past network connection.

[16a] The network connected device of claim 15, wherein the one or more processors are configurable to: send the parameter values for determination of bandwidth, from the first endpoint device, to the tuner server that is configured to receive further parameter values for determination of bandwidth of network connections from a plurality of endpoint devices;

[16b] send, from the first endpoint device to the tuner server, connection information for the next network connection, wherein the tuner server performs the determining and derives one or more parameter values for the transmission bandwidth; and

[16c] receive, at the first endpoint device, from the tuner server, the one or more parameter values for the transmission bandwidth.

17. The network connected device of claim 15, wherein the initiating is executed by the first endpoint device and wherein the first endpoint device is contained within the network connected device.

18. The network connected device of claim 15, wherein the determining and the initiating are executed external to the first endpoint device and communicated to the first endpoint device.

19. The method of claim 15, further comprising the network connected device configurable to: monitor network traffic between the first endpoint device

and the second endpoint device; and adjust the transmission bandwidth based on the monitoring.

20. The network connected device of claim 15, further comprising the network connected device configurable to: monitor network traffic between the first endpoint device and the second endpoint device; transmit data associated with the network traffic from the first endpoint to the network connected device; determine, at the network connected device, an adjustment to the transmission bandwidth is desired; receive data for adjusting the transmission bandwidth from the network connected device; and adjust the transmission bandwidth responsive to the receiving.

APPENDIX 4: UNDERSTANDING OF THE LAW

I have applied the following legal principles provided to me by counsel in arriving at the opinions set forth in this report.

Legal Standard for Prior Art

I am not an attorney. I have been informed by attorneys of the relevant legal principles and have applied them to arrive at the opinions set forth in this declaration.

I understand that the petitioner for inter partes review may request the cancelation of one or more claims of a patent based on grounds available under 35 U.S.C. § 102 and 35 U.S.C. § 103 using prior art that consists of patents and printed publications.

Anticipation and Prior Art

I understand that § 102 specifies when a challenged claim is invalid for lacking novelty over the prior art, and that this concept is also known as “anticipation.” I understand that a prior art reference anticipates a challenged claim, and thus renders it invalid by anticipation, if all elements of the challenged claim are disclosed in the prior art reference. I understand the disclosure in the prior art reference can be either explicit or inherent, meaning it is necessarily present or implied. I understand that the prior art reference does not have to use the same words as the challenged claim, but all of the requirements of the claim must

be disclosed so that a person of ordinary skill in the art could make and use the claimed subject-matter.

In addition, I understand that § 102 also defines what is available for use as a prior art reference to a challenged claim.

Under § 102(a), a challenged claim is anticipated if it was patented or described in a printed publication in the United States or a foreign country before the challenged claim's date of invention.

Under § 102(b), a challenged claim is anticipated if it was patented or described in a printed publication in the United States or a foreign country more than one year prior to the challenged patent's filing date.

Under § 102(e), a challenged claim is anticipated if it was described in a published patent application that was filed by another in the United States before the challenged claim's date of invention, or was described in a patent granted to another that was filed in the United States before the challenged claim's date of invention.

I understand that a challenged claim's date of invention is presumed to be the challenged patent's filing date. I also understand that the patent owner may establish an earlier invention date and "swear behind" prior art defined by § 102(a) or § 102(e) by proving (with corroborated evidence) the actual date on which the

named inventors conceived of the subject matter of the challenged claim and proving that the inventors were diligent in reducing the subject matter to practice.

I understand that the filing date of a patent is generally the filing date of the application filed in the United States that issued as the patent. However, I understand that a patent may be granted an earlier effective filing date if the patent owner properly claimed priority to an earlier patent application.

I understand that when a challenged claim covers several structures, either generically or as alternatives, the claim is deemed anticipated if any of the structures within the scope of the claim is found in the prior art reference.

I understand that when a challenged claim requires selection of an element from a list of alternatives, the prior art teaches the element if one of the alternatives is taught by the prior art.

Legal Standard for Obviousness

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

I understand that obviousness must be determined with respect to the challenged claim as a whole.

I understand that one cannot rely on hindsight in deciding whether a claim is obvious.

I also understand that an obviousness analysis includes the consideration of factors such as (1) the scope and content of the prior art, (2) the differences between the prior art and the challenged claim, (3) the level of ordinary skill in the pertinent art, and (4) “secondary” or “objective” evidence of non-obviousness.

Secondary or objective evidence of non-obviousness includes evidence of: (1) a long felt but unmet need in the prior art that was satisfied by the claimed invention; (2) commercial success or the lack of commercial success of the claimed invention; (3) unexpected results achieved by the claimed invention; (4) praise of the claimed invention by others skilled in the art; (5) taking of licenses under the patent by others; (6) deliberate copying of the claimed invention; and (7) contemporaneous and independent invention by others. However, I understand that there must be a relationship between any secondary evidence of non-obviousness and the claimed invention.

I understand that a challenged claim can be invalid for obviousness over a combination of prior art references if a reason existed (at the time of the alleged invention) that would have prompted a person of ordinary skill in the art to combine elements of the prior art in the manner required by the challenged claim. I understand that this requirement is also referred to as a “motivation to combine,”

“suggestion to combine,” or “reason to combine,” and that there are several rationales that meet this requirement.

I understand that the prior art references themselves may provide a motivation to combine, but other times simple common sense can link two or more prior art references. I further understand that obviousness analysis recognizes that market demand, rather than scientific literature, often drives innovation, and that a motivation to combine references may come from market forces.

I understand obviousness to include, for instance, scenarios where known techniques are simply applied to other devices, systems, or processes to improve them in an expected or known way. I also understand that practical and common-sense considerations should be applied in a proper obviousness analysis. For instance, familiar items may have obvious uses beyond their primary purposes.

I understand that the combination of familiar elements according to known methods is obvious when it yields predictable results. For instance, obviousness bars patentability of a predictable variation of a technique even if the technique originated in another field of endeavor. This is because design incentives and other market forces can prompt variations of it, and predictable variations are not the product of innovation, but rather ordinary skill and common sense.

I understand that a particular combination may be obvious if it was obvious to try the combination. For example, when there is a design need or market

pressure to solve a problem and there are a finite number of identified, predictable solutions, a person of ordinary skill has good reason to pursue the known options within his or her technical grasp. This would result in something obvious because the result is the product not of innovation but of ordinary skill and common sense. However, I understand that it may not be obvious to try a combination when it involves unpredictable technologies.

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

It is my understanding that the Manual of Patent Examining Procedure §2143 sets forth the following as exemplary rationales that support a conclusion of obviousness:

- Combining prior art elements according to known methods to yield predictable results;
- Simple substitution of one known element for another to obtain predictable results;
- Use of known technique to improve similar devices (methods, or products) in the same way;

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

A person of ordinary skill in the art looking to overcome a problem will often use the teachings of multiple publications together like pieces of a puzzle, even though the prior art does not necessarily fit perfectly together. Therefore, I understand that references for obviousness need not fit perfectly together like puzzle pieces. Instead, I understand that obviousness analysis takes into account inferences, creative steps, common sense, and practical logic and applications that a person of ordinary skill in the art would employ under the circumstances.

I understand that a claim can be obvious in light of a single reference, if the elements of the challenged claim that are not explicitly or inherently disclosed in the reference can be supplied by the common sense of one of skill in the art.

I understand that obviousness also bars the patentability of applying known or obvious design choices to the prior art. One cannot patent merely substituting one prior art element for another if the substitution can be made with predictable results. Likewise, combining prior art techniques that are interoperable with respect to one another is generally obvious and not patentable.

In order for a claim to be found invalid based upon a modification or combination of the prior art, there must be reasonable expectation that a person of ordinary skill would have successfully modified or combined the prior art to arrive at the claimed arrangement. This does not mean that it must be certain that a person of ordinary skill would have been successful – the law only requires that the person of ordinary skill in the art would have perceived a reasonable expectation of success in modifying or combining the prior art to arrive at the claimed invention.

In sum, my understanding is that obviousness invalidates claims that merely recite combinations of, or obvious variations of, prior art teachings using understanding and knowledge of one of skill in the art at the time and motivated by the general problem facing the inventor at the time. Under this analysis, the prior art references themselves, or any need or problem known in the field of endeavor

at the time of the invention, can provide a reason for combining the elements of or attempting obvious variations on prior art references in the claimed manner.

Legal Standard for Claim Construction

I understand that before any invalidity analysis can be properly performed, the scope and meaning of the challenged claims must be determined by claim construction.

I understand that a patent may include two types of claims, independent claims and dependent claims. I understand that an independent claim stands alone and includes only the limitations it recites. I understand that a dependent claim depends from an independent claim or another dependent claim. I understand that a dependent claim includes all the limitations that it recites in addition to the limitations recited in the claim (or claims) from which it depends.

In comparing the challenged claims to the prior art, I have carefully considered the patent and its file history in light of the understanding of a person of skill at the time of the alleged invention.

I understand that to determine how a person of ordinary skill would have understood a claim term, one should look to sources available at the time of the alleged invention that show what a person of skill in the art would have understood disputed claim language to mean. It is my understanding that this may include what is called “intrinsic” evidence as well as “extrinsic” evidence.

I understand that, in construing a claim term, one should primarily rely on intrinsic patent evidence, which includes the words of the claims themselves, the remainder of the patent specification, and the prosecution history. I understand that extrinsic evidence, which is evidence external to the patent and the prosecution history, may also be useful in interpreting patent claims when the intrinsic evidence itself is insufficient. I understand that extrinsic evidence may include principles, concepts, terms, and other resources available to those of skill in the art at the time of the invention.

I understand that words or terms should be given their ordinary and accepted meaning unless it appears that the inventors were using them to mean something else or something more specific. I understand that to determine whether a term has special meaning, the claims, the patent specification, and the prosecution history are particularly important, and may show that the inventor gave a term a particular definition or intentionally disclaimed, disavowed, or surrendered claim scope.

I understand that the claims of a patent define the scope of the rights conferred by the patent. I understand that because the claims point out and distinctly claim the subject matter which the inventors regard as their invention, claim construction analysis must begin with and is focused on the claim language itself. I understand that the context of the term within the claim as well as other claims of the patent can inform the meaning of a claim term. For example, because

claim terms are normally used consistently throughout the patent, how a term is used in one claim can often inform the meaning of the same term in other claims. Differences among claims or claim terms can also be a useful guide in understanding the meaning of particular claim terms.

I understand that a claim term should be construed not only in the context of the particular claim in which the disputed term appears, but in the context of the entire patent, including the entire specification. I understand that because the specification is a primary basis for construing the claims, a correct construction must align with the specification.

I understand that the prosecution history of the patent as well as art incorporated by reference or otherwise cited during the prosecution history are also highly relevant in construing claim terms. For instance, art cited by or incorporated by reference may indicate how the inventor and others of skill in the art at the time of the invention understood certain terms and concepts. Additionally, the prosecution history may show that the inventors disclaimed or disavowed claim scope, or further explained the meaning of a claim term.

With regard to extrinsic evidence, I understand that all evidence external to the patent and prosecution history, including expert and inventor testimony, dictionaries, and learned treatises, can also be considered. For example, technical dictionaries may indicate how one of skill in the art used or understood the claim

terms. However, I understand that extrinsic evidence is considered to be less reliable than intrinsic evidence, and for that reason is generally given less weight than intrinsic evidence.

I understand that in general, a term or phrase found in the introductory words or preamble of the claim, should be construed as a limitation if it recites essential structure or steps, or is necessary to give meaning to the claim. For instance, I understand preamble language may limit claim scope: (i) if dependence on a preamble phrase for antecedent basis indicates a reliance on both the preamble and claim body to define the claimed invention; (ii) if reference to the preamble is necessary to understand limitations or terms in the claim body; or (iii) if the preamble recites additional structure or steps that the specification identifies as important.

On the other hand, I understand that a preamble term or phrase is not limiting where a challenged claim defines a structurally complete invention in the claim body and uses the preamble only to state a purpose or intended use for the invention. I understand that to make this determination, one should review the entire patent to gain an understanding of what the inventors claim they invented and intended to encompass in the claims.

I understand that 35 U.S.C. § 112 ¶ 6 created an exception to the general rule of claim construction called a “means plus function” limitation. These types of

terms and limitations should be interpreted to cover only the corresponding structure described in the specification, and equivalents thereof. I also understand that a limitation is presumed to be a means plus function limitation if (a) the claim limitation uses the phrase “means for”; (b) the “means for” is modified by functional language; and (c) the phrase “means for” is not modified by sufficient structure for achieving the specified function.

I understand that a structure is considered structurally equivalent to the corresponding structure identified in the specification only if the differences between them are insubstantial. For instance, if the structure performs the same function in substantially the same way to achieve substantially the same result. I further understand that a structural equivalent must have been available at the time of the issuance of the claim.