IN THE UNITED STATES DISTRICT COURT
FOR THE DISTRICT OF DELAWARE

NEC CORPORATION,	)	
	)	
Plaintiff,	)	
	)	C.A. No. 22-987-CJB
v.	)	
	)	
PELOTON INTERACTIVE, INC.,	)	
	)	
Defendant.	)	

DECLARATION OF DR. KEVIN C. ALMEROTH REGARDING CLAIM CONSTRUCTION OF U.S. PATENT NOS. 8,752,101, 8,909,809, AND 9,769,427

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I. Introduction

1. My name is Kevin C. Almeroth, and I have been retained by Defendant Peloton Interactive, Inc. ("Peloton") as an expert witness in the above-captioned proceeding to opine on claim construction regarding U.S. Patent No. 8,752,101 (the "'101 Patent"), U.S. Patent No. 8,909,809 (the "'809 Patent"), and U.S. Patent No. 9,769,427 (the "'427 Patent") (collectively, the "Asserted Patents").

2. My opinions provided herein are based on my years of education, research and experience, as well as my investigation and study of relevant materials and materials that I was asked to consider (identified below). Further, I may also consider additional documents and information in forming any necessary opinions, including documents that may not yet have been provided to me.

3. My analysis of the materials produced in this matter is ongoing, and I will continue to review any new material as it is provided. This declaration represents only those opinions that I have formed to date. I reserve the right to revise, supplement, or amend my opinions below based on new information and on my continuing analysis of the materials already provided.

4. I am being compensated on a per-hour basis for my time spent working on issues in this case at the rate of $800 an hour. My compensation does not depend on the outcome of this matter or the opinions that I express.

II. Background and Qualifications

5. I am currently a Professor Emeritus in the Department of Computer Science at the University of California, Santa Barbara (UCSB). While at UCSB, I held faculty appointments and was a founding member of the Computer Engineering (CE) Program, Media Arts and Technology (MAT) Program, and the Technology Management Program (TMP). I also served as

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the Associate Director of the Center for Information Technology and Society (CITS) from 1999 to 2012. I have been a faculty member at UCSB since July 1997.

6. I hold three degrees from the Georgia Institute of Technology: (1) a Bachelor of Science degree in Information and Computer Science (with minors in Economics, Technical Communication, and American Literature) earned in June 1992; (2) a Master of Science degree in Computer Science (with specialization in Networking and Systems) earned in June 1994; and (3) a Doctor of Philosophy (Ph.D.) degree in Computer Science (Dissertation Title: Networking and System Support for the Efficient, Scalable Delivery of Services in Interactive Multimedia System, minor in Telecommunications Public Policy) earned in June 1997. During my education, I took a wide variety of courses as demonstrated by my minor. My undergraduate degree also included a number of courses more typical of a degree in electrical engineering including digital logic, signal processing, and telecommunications theory.

7. One of the major concentrations of my research over the past 30+ years has been the delivery of multimedia content and data between computing devices, including through various network architectures. In my research, I have studied large-scale content delivery systems, and the use of servers located in a variety of geographic locations to provide scalable delivery to hundreds or thousands of users simultaneously. I have also studied smaller-scale content delivery systems in which content is exchanged between individual computers and portable devices. My work has emphasized the exchange of content more efficiently across computer networks, including the scalable delivery of content to many users, mobile computing, satellite networking, delivering content to mobile devices, and network support for data delivery in wireless networks.

8. In 1992, the initial focus of my research was on the provision of interactive functions (e.g., VCR-style functions like pause, rewind, and fast-forward) for near video-on-demand systems in cable systems; in particular, how to aggregate requests for movies at a cable head-end and then how to satisfy a multitude of requests using one audio/video stream broadcast to multiple receivers simultaneously. This research has continually evolved and resulted in the development of techniques to scalably deliver on-demand content, including audio, video, web documents, and other types of data, through the Internet and over other types of networks, including over cable systems, broadband telephone lines, and satellite links.

9. An important component of my research has been investigating the challenges of communicating multimedia content, including video, between computers and across networks including the Internet. Although the early Internet was used mostly for text-based, non-real time applications, the interest in sharing multimedia content, such as video, quickly developed. Multimedia-based applications ranged from downloading content to a device to streaming multimedia content to be instantly used. One of the challenges was that multimedia content is typically larger than text-only content, but there are also opportunities to use different delivery techniques since multimedia content is more resilient to errors. I have worked on a variety of research problems and used a number of systems that were developed to deliver multimedia content to users. One content-delivery method I have researched is the one-to-many communication facility called "multicast," first deployed as the Multicast Backbone, a virtual overlay network supporting one-to-many communication. Multicast is one technique that can be used on the Internet to provide streaming media support for complex applications like video-on-demand, distance learning, distributed collaboration, distributed games, and large-scale wireless

communication. The delivery of media through multicast often involves using Internet infrastructure, devices and protocols, including protocols for routing and TCP/IP.

10. Starting in 1997, I worked on a project to integrate the streaming media capabilities of the Internet together with the interactivity of the web. I developed a project called the Interactive Multimedia Jukebox (IMJ). Users would visit a web page and select content to view. The content would then be scheduled on one of a number of channels, including delivery to students in Georgia Tech dorms delivered via the campus cable plant. The content of each channel was delivered using multicast communication.

11. In the IMJ, the number of channels varied depending on the capabilities of the server including the available bandwidth of its connection to the Internet. If one of the channels was idle, the requesting user would be able to watch their selection immediately. If all channels were streaming previously selected content, the user's selection would be queued on the channel with the shortest wait time. In the meantime, the user would see what content was currently playing on other channels, and because of the use of multicast, would be able to join one of the existing channels and watch the content at the point it was currently being transmitted.

12. The IMJ service combined the interactivity of the web with the streaming capabilities of the Internet to create a jukebox-like service. It supported true Video-on-Demand when capacity allowed, but scaled to any number of users based on queuing requested programs. As part of the project, we obtained permission from Turner Broadcasting to transmit cartoons and other short-subject content. We also connected the IMJ into the Georgia Tech campus cable television network so that students in their dorms could use the web to request content and then view that content on one of the campus's public access channels.

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13. More recently, I have also studied issues concerning how users choose content, especially when considering the price of that content. My research has examined how dynamic content pricing can be used to control system load. By raising prices when systems start to become overloaded (*i.e.*, when all available resources are fully utilized) and reducing prices when system capacity is readily available, users' capacity to pay as well as their willingness can be used as factors in stabilizing the response time of a system. This capability is particularly useful in systems where content is downloaded or streamed on-demand to users.

14. As a parallel research theme, starting in 1997, I began researching issues related to wireless devices and sensors. In particular, I was interested in showing how to provide greater communication capability to "lightweight devices," *i.e.*, small form-factor, resource-constrained (*e.g.*, CPU, memory, networking, and power) devices. Starting in 1998, I published several papers on my work to develop a flexible, lightweight, battery-aware network protocol stack. The lightweight protocols we envisioned were similar in nature to protocols like Bluetooth, Universal Plug and Play (UPnP) and Digital Living Network Alliance (DLNA).

15. From this initial work, I have made wireless networking—including ad hoc, mesh networks and wireless devices—one of the major themes of my research. My work in wireless networks spans the protocol stack from applications through to the encoding and exchange of data at the data link and physical layers.

16. At the application layer, even before the large-scale "app stores" were available, my research looked at building, installing, and using apps for a variety of purposes, from network monitoring to support for traditional computer-based applications (*e.g.,* content retrieval) to new applications enabled by ubiquitous, mobile devices. For example, my research has looked at developing applications for virally exchanging and tracking "coupons" through

"opportunistic contact" among mobile wireless devices (*i.e.,* communication among devices moving into communication range with each other). In many of the courses I have taught there is a project component. Through these projects I have supervised numerous efforts to develop new "apps" for download and use across a variety of mobile platforms.

17. Toward the middle of the protocol stack, my research has also looked to build wireless infrastructure support to enable communication among a set of mobile devices unaided by any other kind of network infrastructure. These kinds of networks are useful either in challenged network environments (e.g., when a natural disaster has destroyed existing infrastructure) or when suitable support for network communication never existed. The deployment of such networks (or even the use of traditional network support) are critical to support services like disaster relief, catastrophic event coordination, and emergency services deployment.

18. Yet another theme is monitoring wireless networks, in particular different variants of IEEE 802.11 compliant networks, to (1) understand the operation of the various protocols used in real-world deployments, (2) use these measurements to characterize use of the networks and identify protocol limitations and weaknesses, and (3) propose and evaluate solutions to these problems. I have successfully used monitoring techniques to study wireless data link layer protocol operation and to improve performance by enhancing the operation of such protocols. For wireless protocols, this research includes functions like network acquisition and channel bonding.

19. One theme in my wireless network research has been cross-layer solutions and innovations. As mentioned above, with greater wireless device use and network support, we envisioned new application paradigms and services, for example, when mobile devices come into

contact with each other. Instead of relying on existing infrastructure to relay communication, the devices are able to discover each other and communicate directly. Other examples include discovering and using location information to enhance users' experiences. Network support and novel applications use a variety of network architectures supporting users on foot, in vehicles, and across varying terrains and environments. Finally, we studied how communication efficiency can be supported through intelligent handoffs as well as location and movement prediction.

20. Protecting networks, including their operation and content, has been an underlying theme of my research almost since the beginning of my research career. Starting in 2000, I have been involved in several projects that specifically address security, network protection, and firewalls. After significant background work, a team on which I was a member successfully submitted a $4.3M grant proposal to the Army Research Office (ARO) at the Department of Defense to propose and develop a high-speed intrusion detection system. Key aspects of the system included associating streams of packets and analyzing them for viruses and other malware. Once the grant was awarded, we spent several years developing and meeting the milestones of the project. A number of my students worked on related projects and published papers on topics ranging from intrusion detection to developing advanced techniques to be incorporated into firewalls. I have also used firewalls, including their associated malware detection features, in developing techniques for the classroom to ensure that students are not distracted by online content.

21. My recent work ties some of the various threads of my past research together. I have investigated content delivery in online social networks and proposed reputation management systems in large-scale social networks and marketplaces. On the content delivery side, I have looked at issues of caching and cache placement, especially when content being

shared and the cache has geographical relevance. We were able to show that effective caching strategies can greatly improve performance and reduce deployment costs. Our work on reputation systems showed that reputations have economic value, and as such, creates a motivation to manipulate reputations. In response, we developed a variety of solutions to protect the integrity of reputations in online social networks. The techniques we developed for content delivery and reputation management were particularly relevant in peer-to-peer communication and recommendations for downloadable "apps."

22. As an important component of my research program, I have been involved in the development of academic research into available technology in the market place. One aspect of this work is my involvement in the Internet Engineering Task Force (IETF). The IETF is a large and open international community of network designers, operators, vendors, and researchers concerned with the evolution of the Internet architecture and the smooth operation of the Internet. I have been involved in various IETF groups including many content delivery-related working groups like the Audio Video Transport (AVT) group, the MBone Deployment (MBONED) group, Source Specific Multicast (SSM) group, the Inter-Domain Multicast Routing (IDMR) group, the Reliable Multicast Transport (RMT) group, the Protocol Independent Multicast (PIM) group, etc. I have also served as a member of the Multicast Directorate (MADDOGS), which oversaw the standardization of all things related to multicast in the IETF. Finally, I was the Chair of the Internet2 Multicast Working Group for seven years.

23. My involvement in the research community extends to leadership positions for several academic journals and conferences. I am the co-chair of the Steering Committee for the ACM Network and System Support for Digital Audio and Video (NOSSDAV) workshop and on the Steering Committees for the International Conference on Network Protocols (ICNP), ACM

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Sigcomm Workshop on Challenged Networks (CHANTS), and IEEE Global Internet (GI) Symposium. I have served or am serving on the Editorial Boards of IEEE/ACM Transactions on Networking, IEEE Transactions on Mobile Computing, IEEE Network, ACM Computers in Entertainment, AACE Journal of Interactive Learning Research (JILR), and ACM Computer Communications Review. I have co-chaired a number of conferences and workshops including the IEEE International Conference on Network Protocols (ICNP), IEEE Conference on Sensor, Mesh and Ad Hoc Communications and Networks (SECON), International Conference on Communication Systems and Networks (COMSNETS), IFIP/IEEE International Conference on Management of Multimedia Networks and Services (MMNS), the International Workshop On Wireless Network Measurement (WiNMee), ACM Sigcomm Workshop on Challenged Networks (CHANTS), the Network Group Communication (NGC) workshop, and the Global Internet Symposium, and I have served on the program committees for numerous conferences.

24. Furthermore, in the courses I taught at UCSB, a significant portion of my curriculum covered aspects of the Internet and network communication including the physical and data link layers of the Open System Interconnect (OSI) protocol stack, and standardized protocols for communicating across a variety of physical media such as cable systems, telephone lines, wireless, and high-speed Local Area Networks (LANs). The courses I have taught also cover most major topics in Internet communication, including data communication, multimedia encoding, and mobile application design. My research and courses have covered a range of physical infrastructures for delivering content over networks, including cable, Integrated Services Digital Network (ISDN), Ethernet, Asynchronous Transfer Mode (ATM), fiber, and Digital Subscriber Line (DSL). For a complete list of courses I have taught, see my curriculum vitae (CV).

25. In addition, I co-founded a technology company called Santa Barbara Labs that was working under a sub-contract from the U.S. Air Force to develop very accurate emulation systems for the military's next generation internetwork. Santa Barbara Labs' focus was in developing an emulation platform to test the performance characteristics of the network architecture in the variety of environments in which it was expected to operate, and, in particular, for network services including IPv6, multicast, Quality of Service (QoS), satellite-based communication, and security. Applications for this emulation program included communication of a variety of multimedia-based services, including video conferencing and video-on-demand.

26. In addition to having co-founded a technology company myself, I have worked for, consulted with, and collaborated with companies for nearly 30 years. These companies range from well-established companies to start-ups and include IBM, Hitachi Telecom, Turner Broadcasting System (TBS), Bell South, Digital Fountain, RealNetworks, Intel Research, Cisco Systems, and Lockheed Martin.

27. Through my graduate education, leadership with CITS, involvement in TMP, role in the development of the Internet2 infrastructure, and consulting with ISPs, I have gained a strong understanding in the role of the Internet in our society and the challenges of deploying large-scale production networking infrastructure. CITS, since its inception, has looked at the role of the Internet in society, including how the evolution of technology have created communication opportunities and challenges, including, for example through disruptive technologies like P2P. TMP looks to focus on non-purely technical issues, including, for example, state-of-the-art business methods, strategies for successful technology commercialization, new venture creation, and best practices for fostering innovation. Through my industry collaborations and Internet2 work, I have developed significant experience in the

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challenges of deploying, monitoring, managing, and scaling communication infrastructure to support evolving Internet services like streaming media, conferencing, content exchange, social networking, and e-commerce.

28. I am a Member of the Association of Computing Machinery (ACM) and a Fellow of the Institute of Electrical and Electronics Engineers (IEEE).

29. Additional details about my employment history, fields of expertise, courses taught, and publications are further included in my CV attached as **Appendix 1** to this declaration.

III. Legal Standard

30. I am not a legal expert and offer no legal opinions. I have been informed and am aware of the following general principles of patent law to be considered in formulating my opinions on certain claim terms. I have applied these principles to the facts disclosed in my Declaration.

A. General Claim Construction

31. The legal principles set forth in this declaration were provided to me by counsel. A purpose of claim construction is to determine the meaning and scope of patent claims asserted to be infringed. In trial court litigation, patent claims are generally given the meaning that the terms would have to a person of ordinary skill in the art in question as of the earliest claimed priority date.

32. In rendering opinions, an expert must consider the patent claims and prior art from the perspective of a person of ordinary skill in the art. To determine the appropriate level of skill of a person of ordinary skill in the art, the following factors may be considered: (a) the types of problems encountered by those working in the field and prior art solutions thereto; (b) the sophistication of the technology in question and the rapidity with which inventions occur in the

field; (c) the educational level of active workers in the field; and (d) the educational level of the inventor.

33. The person of ordinary skill in the art is deemed to read the claim term 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 specification, and the patent's prosecution history. When construing the claims of a patent, the principal considerations are the plain language of the claim (including the surrounding claim language and context), the patent specification and the prosecution history (if in evidence), which are called, collectively, the "intrinsic evidence." While a claim is to be read in light of the specification, one must generally avoid importing limitations into the claim from the specification. The prosecution history can often inform the meaning of the claim by demonstrating how the inventor understood the invention and whether the inventor limited the invention in the course of prosecution, making the claim scope narrower than it would otherwise appear to be. Representations that the patent holder makes to the Patent Trial & Appeals Board ("PTAB") in the context of inter partes review ("IPR") of a patent may also be relevant to the interpretation of a patent's claims, and such representations are also considered part of the intrinsic record.

B. Construction of Means-Plus-Function Limitations

34. I understand that claim elements may be expressed as a means for performing a recited function. I further understand that for such a means-plus-function element, the element is to be construed to cover the corresponding structure, material, or acts described in the patent specification for performing that function and equivalents thereof. Thus, I understand that in the case of a means-plus-function element, the scope of the claim element is limited to only structure that is both actually disclosed in the patent specification and clearly linked to the claimed function(s).

35. I understand that even if a claim element does not use the word "means," such a claim element should still be treated as a means-plus-function element if a POSITA would understand that the claim element recites a function and that the words of the claim do not recite sufficiently definite structure for performing the claimed function(s).

36. I understand that if a claim element is found to be a means-plus-function claim element, there is a two-part analysis that involves: (1) identifying the function(s) and (2) identifying the corresponding structure from the specification that performs the function.

37. I further understand that a structure in the specification can qualify as a "corresponding structure" only if the specification clearly links that structure to the function specified in the claim. I understand that features that do not actually perform the recited function, or are unnecessary to perform the claimed function or merely enable the pertinent structure to operate as intended, do not constitute corresponding structure and so do not serve as claim limitations. I understand that if a corresponding structure for a means-plus-function element cannot be identified in the specification, then the claim is indefinite.

38. I also understand that the knowledge of a POSITA cannot be used to create a disclosure of structure for a means-plus-function element when the patent specification does not otherwise provide a sufficiently definite disclosure of corresponding structure that is clearly linked to performing the claimed function(s).

39. I further understand that when there are multiple claimed functions, the corresponding structure must be clearly linked to and be sufficiently definite for performing all such claimed functions.

40. I understand that when a patent fails to disclose sufficiently definite structure for performing the claimed function(s) of a means-plus-function element, the claims (and their dependents) in which such means-plus-function element appears are invalid.

C. Indefiniteness

41. I am aware that 35 U.S.C. § 112, ¶ 2 requires that a patent must conclude with one or more claims "particularly pointing out and distinctly claiming subject matter which the applicant regards as his invention." I am also aware that 35 U.S.C. § 282 states that the claims of an issued patent are presumed valid. I understand that a party challenging the validity of a claim on the ground of indefiniteness must prove by clear and convincing evidence that the claim is indefinite.

42. In ruling on a claim of patent indefiniteness, a court determines whether those skilled in the art would understand what is claimed when the claim is read in light of the specification. A claim satisfies the definiteness requirement if one skilled in the art would understand the bounds of the claim when read in light of the specification. Conversely, a claim is indefinite if, when read in light of the specification and prosecution history, it fails to inform with reasonably certainty those skilled in the art about the scope of the invention.

IV. Materials Considered

43. I have reviewed the Asserted Patents and their file histories. I have also reviewed the Joint Claim Construction Chart filed by the parties and the evidence cited therein. I have also reviewed NEC's infringement contentions for the Asserted Patents. To the extent I have consulted additional materials, I identify such materials below.

V. Technical Background

44. The Asserted Patents relate generally to the delivery of media over a network. More specifically, the Asserted Patents discuss specific kinds of systems and methods involving

the delivery and receipt of media for playback at various bit rates (the ’101 and ’809 Patents) and dynamic advertisement insertion into requested media (the ’427 Patent). This section provides an overview of technology relevant for the ’101 and the ’809 Patents.

A. Encoding and Bit Rate

45. When media is transmitted in a continuous manner to a receiving device for playback in such a manner that playback can commence before all data is received, this is frequently referred to as “streaming.” Media has been streamed in the Internet for at least thirty years, well before the priority date of the NEC patents. Early examples include streaming protocols such as RTP (“Real-Time Transport Protocol)—a transport protocol first drafted in 1993 and first adopted as RFC 1889—RTMP (“Real-Time Messaging Protocol”)—used at the time as a proprietary streaming protocol for Adobe Flash—and RTSP (“Real-Time Streaming Protocol”)—a streaming protocol first drafted in 1996 by, among others, the progenitor of what is now known as RealNetworks, and first adopted as RFC 2326.

46. Streaming media is often not viewed in the same format in which it was originally captured (e.g., through use of video recording technologies). After media is first captured, it is generally encoded (and likely compressed) into a more manageable format than the original media content. When media is encoded, a choice is made as to the “quality” of the resulting encoded data. One method of measuring this quality is through the “bit rate” of the output media (also identified in the ’101 Patent as the “code rate”). The bit rate refers to the number of “bits” (a unit measurement of data) processed for playback per unit of time. Further, the same original media content can be encoded at different bit rates where one encoded version has more bits processed for playback per second than the other. Generally, a higher bit rate is understood to convey a higher quality of media, as there are more bits available to express the original content for a given period of time. The bit rate of the encoded data is distinct from the rate at which data

may be able to be transferred across a computer network, for example, from an application server to a user device. The transfer bit rate typically depends on the constraints of the devices involved in the transmission, their network constraints, and the constraints of the intermediary network infrastructure. The transfer bit rate is also referred to by other names, such as communication bandwidth or network bandwidth. For example, the '101 Patent refers to transfer bit rate as communication speed B_n.

47. While a higher bit rate version of a particular piece of media may generally be considered preferable due to its higher quality, a recipient device may not be able to accommodate that bit rate version. For example, a recipient device's bandwidth capacity limits the amount of data it can download in a given unit of time. If the recipient device does not have sufficient bandwidth, the result can be the interruption of playback and the need to pause for "buffering," where a user may have to wait for more data to be received in order to continue viewing the streamed media content. Thus, in these circumstances, a lower bit rate version of a media file may be preferable as it allows for media to be played continuously without interruption.

48. Because network conditions between a transmitter (e.g., server) and the recipient device can change over time, the "preferred" bit rate may similarly change over time, *e.g.,* the media bit rate that is for the highest quality encoding and can be transferred over a network such that there is no interruption in playback. For example, a recipient device may begin receiving streamed content during a period of poor network conditions where it experiences low download speeds. As a result, a lower bit rate version of a given media file may be more preferable at that moment, as this would allow the recipient device to playback media without interruption.

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However, network conditions may improve as streaming continues, at which point the recipient device would be able to handle a higher bit rate version of the media without buffering.

B. Adaptive Streaming

49. Adaptive bit rate streaming offers a solution to this problem. The media content (e.g., movie) is broken up into individual segments of content data. Each segment may be encoded at a different bit rate (or code rate). The segments are transmitted sequentially and are also played sequentially. For example, a video could be broken up into 6-second chunks, where multiple copies of each chunk are encoded at different bit rates. Each chunk is sent sequentially and played in the same sequence. In this way, if a recipient device is currently receiving streaming media at a given bit rate and determines that either a higher or lower bit rate would be preferable, it can "switch" to that bit rate by requesting that future segments be sent at the preferred bit rate version of the media. Typically, the bit rate cannot be changed for a unit smaller than a chunk. Adaptive bit rate technologies have been in practice for over twenty years. Examples of adaptive bit rate streaming exist at least as early as 1999 and were well-known to the public through companies such as Move Networks by at least 2005. *See, e.g.*, U.S. Patent No. 6,389,473; Abdelhak Bentaleb et al., *A Survey on Bitrate Adaptation Schemes for Streaming Media Over HTTP*, 21 IEEE COMMC'NS SURVS. TUTORIALS 562 (2019).

VI. Priority Dates

50. The '101 Patent claims priority to a foreign application filed on November 5, 2009. The '809 Patent claims priority to a foreign application filed on January 27, 2009. The '427 Patent claims priority to a foreign application filed on November 18, 2008. The opinions I have expressed in this declaration are based on the assumption that these priority dates are the dates of inventions of the Asserted Patents. I have not been asked to opine on whether there is evidence to support these dates as the dates of invention.

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VII. Level of Ordinary Skill in the Art

51. I understand that in the IPR petition for the ’101 Patent, Peloton has offered the following definition of a POSITA for the ’101 Patent: a POSITA at the time of the alleged invention would have a bachelor’s degree, or equivalent, in electrical engineering, computer science, a related field, and 2-3 years’ experience researching, designing, or developing content delivery systems and related hardware, software, and firmware, or equivalent experience. One having less education but more practical experience, or more education and less experience, might also meet this standard.

52. I understand that in the IPR petition for the ’427 Patent, Peloton has offered the following definition of a POSITA for the ’427 Patent: a POSITA in the field of the ’427 Patent at the time of the alleged invention would have had a bachelor’s degree, or equivalent, in electrical engineering, computer science, or a related field, and 2-3 years of experience researching, designing, or developing content delivery systems and related hardware, software, and firmware, or equivalent experience. A person having less education but more relevant practical experience, or more education and less experience, might also meet this standard.

53. I have reviewed the above two definitions for the ’101 Patent and the ’427 Patent and I agree with them. Further, the definition of a POSITA for the ’101 Patent is appropriate for the ’809 Patent that discloses similar subject matter and the date of the alleged invention of the ’809 Patent falls within the same time range as the alleged invention of the ’101 Patent. As of the dates of the alleged inventions of the three patents, I met the requirements of the POSITA for each of the three patents.

VIII. The ’101 Patent

A. Overview

1. Goal

54. The ’101 Patent discloses methods to ensure that multiple client devices (or reception devices) can start reproducing content (e.g., a movie) at a predetermined start time. The technique can be applied to a single client device also. The system changes the code rate (or the bit rate) of the content data being transmitted to the client device from the server to ensure that the client device has enough content data in the buffer to start reproducing the content without stalling.

55. A client device contacts a server when a user wants to reproduce content on the client device (e.g., watch a movie). In response, the server starts a session and notifies all client devices. Interested client devices inform the server that they are interested by transmitting a session participation request. The server then ascertains when the reproduction of the content will start (a reproduction start time) (i.e., time at which the movie will start playing) and notifies all interested client devices. The server then starts transmitting content data (i.e., portions of the movie) to the participating client devices and the content data is stored in the buffer of each client device. The system keeps track of how much time remains before the reproduction of content must begin (i.e., remaining time before the movie start). Each client also ascertains how much content data is present in the buffer (i.e., the playback duration of the data in the buffer). The system then adapts the bit rate to ensure that each of the client devices has sufficient content data in its buffer when it starts to reproduce content. The bit rate of the content data being transmitted to a client device may be reduced to increase the playback time of the content data in the buffer, but at the expense of quality. Likewise, the bit rate of the content data may be increased to improve the quality, but at the expense of playback time.

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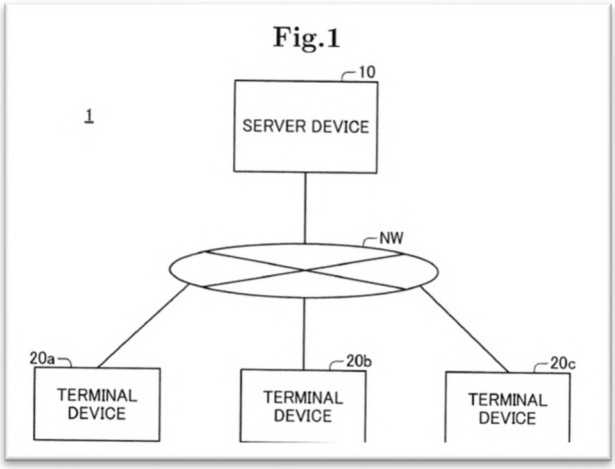
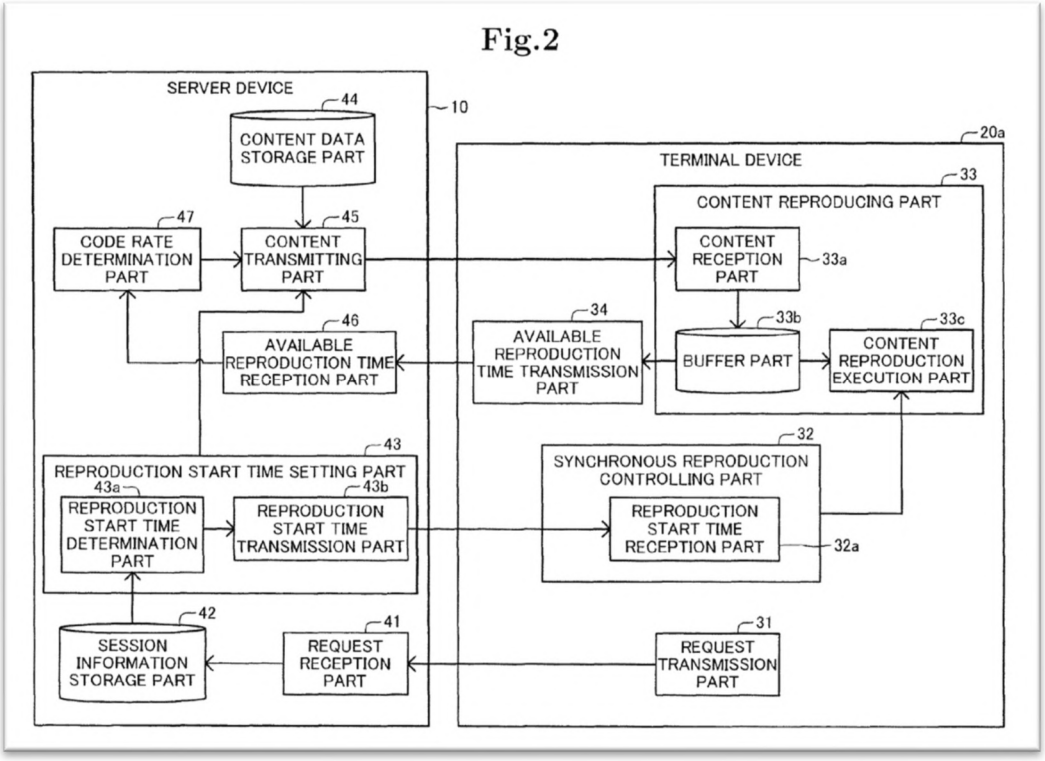
2. System and method to update the code rate before content is reproduced

56. Figure 1 (below) depicts a distribution system that includes a server device (a transmission device) 10 and a plurality of terminal devices (or reception devices) 20a, 20b and 20c. The server device 10 and the terminal devices 20a to 20c can communicate with each other via the Internet NW. The server device 10 is equipped with a central processing unit (CPU) and a storage device (a memory and a hard disk drive (HDD)). The respective terminal devices 20a to 20c can be personal computers, or similar devices. The terminal devices 20a to 20c are each equipped with a CPU, a storage device, an input device, and an output device. The output device has a display. '101 Patent, 5:12-45. The specification confirms that the functions of server device 10 can be realized by a CPU executing a program stored in storage. *Id.*, 5:24-26. The functions of a client device can also be realized by a CPU executing a program stored in storage. *Id.*, 5:43-45.



57. Figure 2 (below) depicts the distribution system 1 along with a server device 10 and a terminal device 20a that reproduces content received from a server 10. The server device 10 includes a reproduction start time setting part 43 that determines when the reproduction of code begins. *Id.*, 5:63-6:2. The server device also includes a code rate determination part 47 that

determines the code rate of the content transmitted from the server 10 to the terminal 20a. *Id.*, 5:58-62. The terminal device 20a includes a content reproducing part 33 that receives content, stores content, and reproduces content. *Id.* It also includes a synchronous reproduction controlling parts 32 and a request transmission part 31. *Id.*



58. Figure 3 (below) illustrates how the distribution system operates described in the '101 Patent operates. When a user wants to reproduce content (i.e., play a movie), the terminal device 2a transmits a session start request (step s101) to server 10. *Id.*, 6:40-47. The server 10 provides a transmit session ID to the terminal devices 20a and 20b (step s102). Each terminal in turn transmits ***a session participation request*** (steps s103 and s104) to the server 10. *Id.*, 7:14-19. In response, the server 10 transmits a reproduction start time (step s106) to the terminal devices (i.e., the time when the movie will start). When determining the reproduction start time, the server 10 takes into account any criteria (i.e., time needed to prepare to start playing the

movie) that are specific to each client device. *Id.*, 7:26-8:5. The server 10 then starts to transmit content data (i.e., portions of the movie) to the terminal devices 20a and 20b. *Id.* In turn, the terminal devices transmit the available reproduction time (i.e., playback time for portion of movie downloaded by the terminal device) to the server (steps s107 and s108), and the server updates the code rate of the content (i.e., portions of the movie) accordingly (step s109). The manner in which the code rate is updated is described later. If the amount in the buffer is below the target amount, the system may decrease the code rate for subsequent segments to increase the playback time of the content in the buffer at the expense of video quality. Similarly, increasing the code rate for subsequent segment increase the video quality at the expense of lowering the playback time. At the predetermined time both terminal devices start to reproduce content (i.e., start the movie) (steps s110a and s110b).

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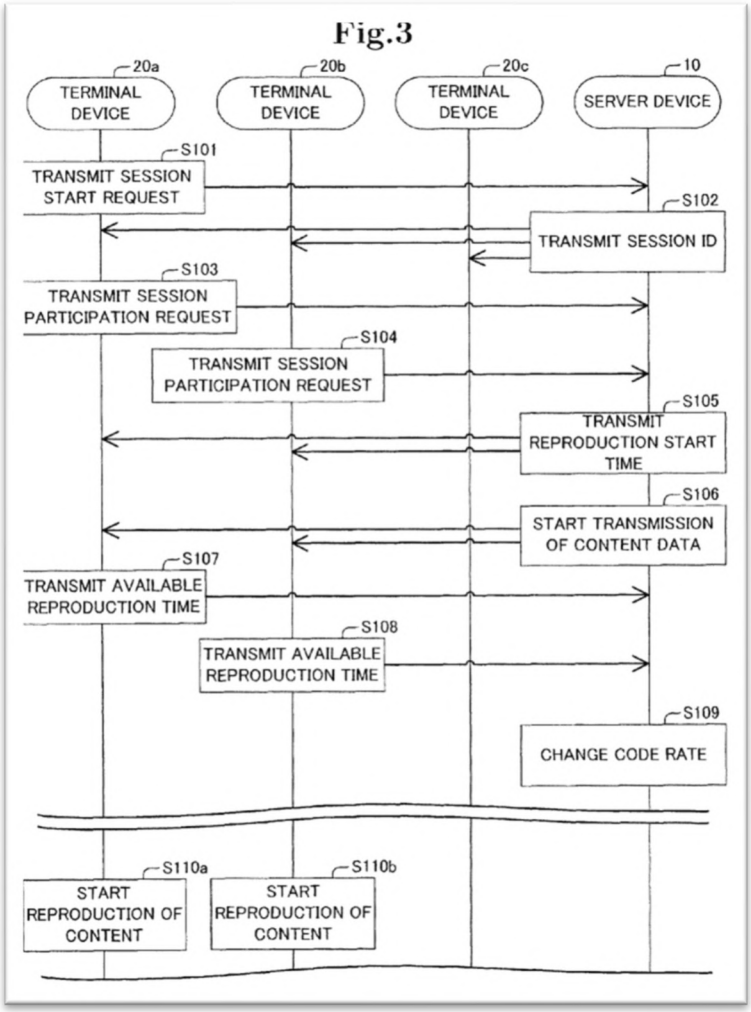
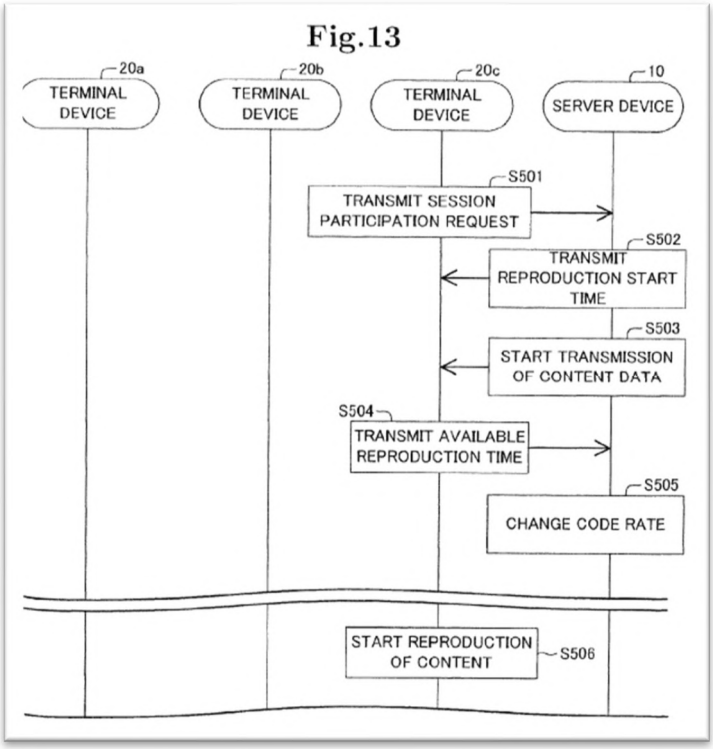


59. Figure 3 stops when the reproduction time arrives before the purpose of the '101 Patent is to ensure that there is sufficient content in the buffer when the reproduction begins at the specified time. The '101 Patent does not address what occurs thereafter because that is beyond the invention.

60. Figure 13 (below) shows that the terminal 20c must perform the same steps if it wants to reproduce the same content as terminal devices 20a and 20b. *Id.*, 17:2-18:22. The terminal device 20c transmits a session participation request to the server device 10 (step s501). The server device 10 transmits a reproduction start time (step s502) and starts to transmit content data (s503). In response to available response time received from the terminal device 20c (step

s504), the server device 10 updates the code rate (step s505). Finally, the predetermined time arrives, and the terminal device 20c starts to reproduce content (step s506). As with Figure 3, Figure 13 also does not address any steps after reproduction starts because that is beyond the scope of the invention disclosed in the '101 Patent.



61. Figure 4 and Figure 6 (below) depict the steps executed at the server device 10 and at the terminal device 20 respectively. *Id.*, 11:28-13:32. With respect to Figure 4, upon reception of the session start request from the terminal device 20a, the server device 10 executes a transmission control program shown by the flowchart. The server calculates the reproduction start time while taking into consideration device-dependent parameters for each terminal device 20 and transmits the reproduction start time to each terminal device (steps s202-s205). If a terminal device 20 is joining a session that has an earlier start time (e.g., terminal device 20 in Figure 13), the service determines the transmission start position (steps s206 and s207). The

server starts transmission of content data (step s208). It also monitors and updates the code rate for each terminal device (step s209). After step s209, the flow chart in Figure 4 executes the "return" step, i.e., ends or exits.

62. In addition, the server 20 may specify a target available reproduction time (T_d) (i.e., target buffer amount) that specifies the amount of the reproduction time that a terminal device 20 must have at reproduction start time. The target time (T_d) is based on the amount of content data stored in the storage device. The purpose of the '101 Patent is to manage the code rate of content data to ensure that amount of content data that represents target time (T_d) is available to the reception device when it starts to reproduce content at the predetermined time. The target time (T_d) may be set for each terminal device or the terminal device itself may provide the value.

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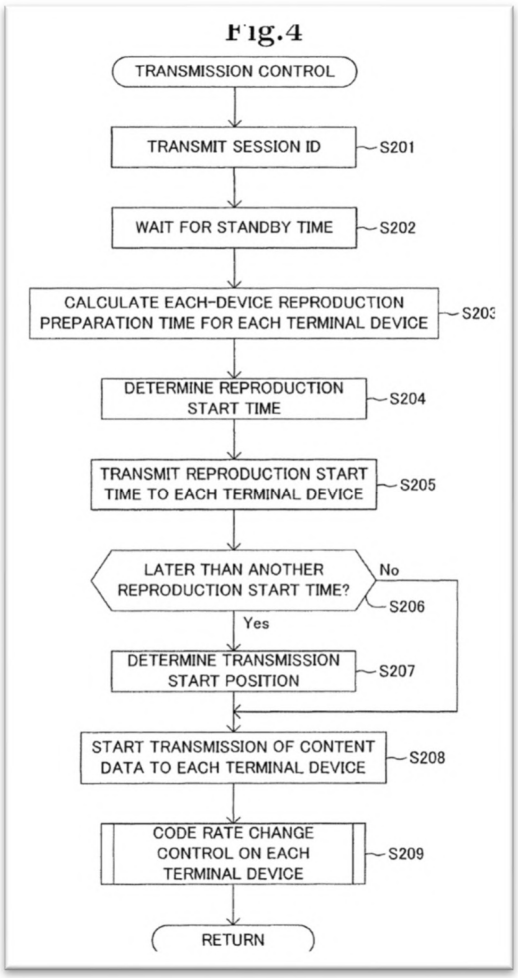
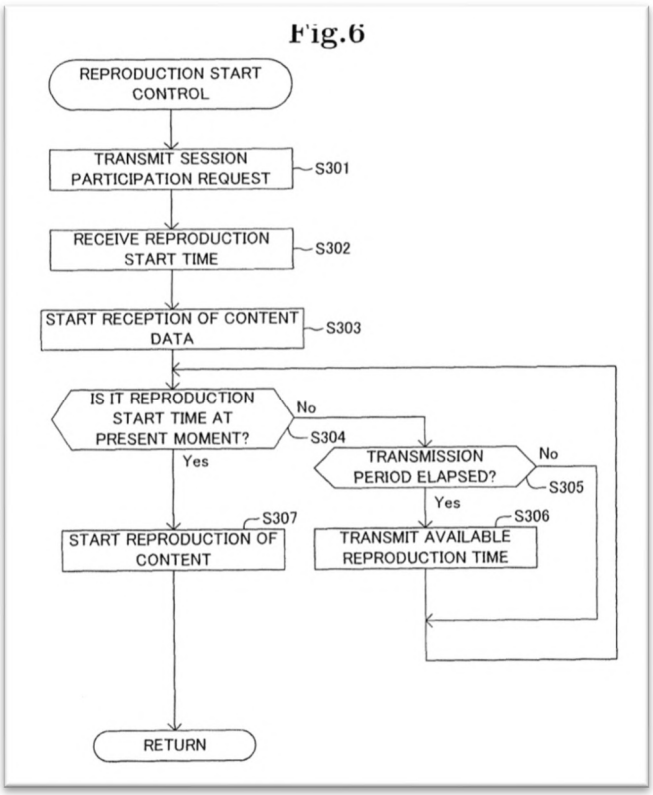


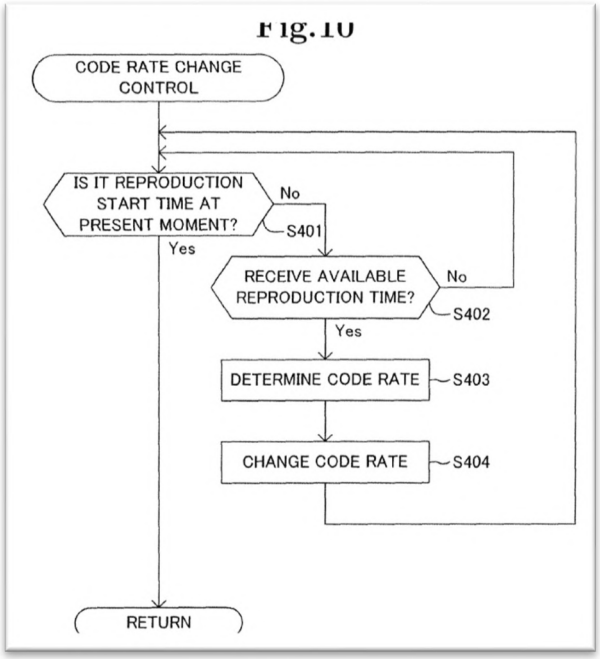


63. With respect to Figure 6 (above), when a user of the terminal device 20a inputs a session participation instruction, the terminal device 20a executes a reproduction start control program shown by the flowchart. *Id.*, 11:28-13:32. The terminal device 20a transmits a session participation request to the server device 10 (step s301) and receives a reproduction start time from the server 10 (step s302) along with content data (step s303). The terminal device 20 continues to monitor time and communicates the available reproduction time to the server 10 (steps s305 and s306). Finally, at the arrival of the predetermined time, the terminal device 20

starts to reproduce content (step s307). After step s307, the flow chart in Figure 6 executes the "return" step, i.e., ends or exits.

3. Algorithm for changing the code rate before reproduction start time and transmitting the code rate

64. Figure 10 (below) depicts how the code rate is changed by the server 10 while the content is being played. '101 Patent, 13:33-14:35. As shown in Figure 10, the server 10 checks whether the reproduction start time has arrived (step s401). If the current time equals the reproduction start time, the server 10 exits the flow chart and does not update the code rate. After server executes the "return" step, i.e., ends or exits because once the reproduction has started, the scope of the '101 Patent ends and the specification does not address what happens thereafter. However, if the current time is prior to the reproduction start time, the server 10 receives the available reproduction time from the terminal devices 20, determines the new code rate and changes it (steps s402, s403 and s404). The server 10 returns to the start of the flow chart to repeat the steps until the time to start reproducing the time arrives.



65. The ’101 Patent explains how the code rate is determined by code rate determining part 47 in the server 10. *Id.*, 10:13-59. The code rate determining part 47 ensures that the code rate becomes smaller when the difference between the target available reproduction time and the available reproduction time decreases more slowly than the remaining time, and becomes larger when the difference between the target available reproduction time and the available reproduction time decreases faster than the remaining time. *Id.*

66. The code rate determining part 47 calculates the recent communication speed (B_n) during a period between the present moment (t_n) and a prior moment (t_{n-1}) based on an equation (4). *Id.*, 10:24-43. The communication speed reflects the rate at which data is being downloaded by the terminal device (i.e., the network bandwidth at the terminal device).

Equation 4: $B_n = (T_n - T_{n-1})*r_n/(t_n - t_{n-1})$

67. In Equation 4, terminal device calculates the communication speed or the rate (B_n) based on the amount of content data received between two moments of time (the present moment (t_n) and a prior moment (t_{n-1})). In the equation, T_n denotes the available reproduction time (i.e., amount of content data in the buffer) at time t_n and T_{n-1} denotes the available reproduction time (i.e., amount of content data in the buffer) at a prior time t_{n-1}. Finally, r_n denotes the code rate of the content data that was transmitted between time t_n and t_{n-1}. *Id.*

68. After determining the communication speed (B_n), the code rate determining part 47 determines the code rate (r_{n+1}) of the data to be transmitted where code rate (r_n) represents the code rate of the data being transmitted. *Id.*, 10:44-59.

Equation 5: $r_{n+1} = B_n * (t_s - t_n)/(T_d - T_n)$

69. In the equation above, t_s represents the predetermined start time and t_n represents the current time. Thus, ($t_s - t_n$) represents the remaining time before reproduction starts. In the

equation, T_d represents the target available reproduction time (i.e., the target amount of content data in the buffer) and T_n represents the available reproduction time (i.e., the amount of content data presently in the buffer). The difference of the two ($T_d - T_n$) captures by how much the available reproduction time T_n is below the target T_d. The product of the ratio $(t_s - t_n)/(T_d - T_n)$ and the communication speed B_n provides the updated bit rate r_{n+1} that is employed during next transmission of content data. *Id.* In addition to disclosing how the code rate is updated, the specification also discloses that the updated code rate is conveyed to the terminal devices. '101 Patent, 10:6-11:10. That part of the specification explains, having determined the new code rate, what steps the system would take to transmit the content to the terminal devices.

B. Opinion regarding claim terms

1. "reproduction start time set as time at which the reception device starts reproduction of the content"/" reproduction start time set as time to start reproduction of the content" ('101 Patent, claims 1, 11, 16, 21, 22, 26)

Peloton's Proposed Construction	NEC's Proposed Construction
"reproduction start time set as time that the reception device having transmitted a session participation request first starts reproduction of the content"	Plain and Ordinary Meaning

70. I understand that Peloton has proposed the following construction for the "reproduction start time" term.

> reproduction start time set as time that the reception device having transmitted a session participation request first starts reproduction of the content

71. Based on my review of the claims, the specification and the history of the '101 Patent, I conclude that Peloton's construction is correct.

a) Peloton's proposed construction mirrors the scope of the invention described in the '101 Patent

72. As mentioned above, the purpose of the invention disclosed in the '101 Patent is to update the code rate of content data being transmitted from the server to a terminal before the reproduction of the content begins. While portions of content are being transmitted to the terminal, the system updates the code rate to ensure that a target amount of content data is present in the buffer of the terminal when reproduction starts. Once reproduction starts, the purpose of the '101 Patent ends and, as a result, the specification does not address such a scenario. Moreover, when discussing background art, the specification states that "during a period between start of reception of content data by the reception device and reproduction start time, the available reproduction time ***gradually increases from 0***." '101 Patent, 2:4-7 (emphasis added). This shows that the buffer in the terminal device is empty (i.e., zero) when the process starts and that the content is being transmitted by the server device for the first time. Therefore, the term "reproduction start time" as employed in the claims of the '101 Patent refers to the start time when the content (e.g., a movie) is first played after server starts to transmit the content to the terminal. It refers to one instant of time when the content is first played and not a series of time instants when portions of content (i.e., content data or segments) are sequentially played by the terminal device. Thus, the term in the claims implies one reproduction time. As further discussed below, the figures and specification depict one reproduction start time.

73. The specification describes how the process of transmitting content from the server device to the terminal device is started. In response to a request for content from a terminal device, the server transmits a session ID to terminal devices. Interested terminal devices respond by sending a ***session participation request*** to the server device. The server then transmits the requested content data to the interested terminal devices and continues to update the

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code rate ***until reproduction starts***. As described in the context of Figure 3 and Figure 13, the server device ascertains the reproduction start time ***after*** receiving participation requests from the terminal devices. As is clear from the specification, the reproduction start time is the time when the ***first portion*** of the content is reproduced by the terminal device. Thus, the "reproduction start time" is set as time that the reception device having transmitted a session participation request ***first*** starts reproduction of the content.

74. Because the purpose of the '101 Patent is to ensure that one or more terminal devices can start reproduction of the content at a predetermined time, the discussion in the specification stops when reproduction starts and does not address what the system is supposed to do after reproduction starts. For instance, Figure 3 stops when the two terminal devices perform the "Start of Reproduction of Content" step (steps s110a and s110b). Similarly, Figure 13 stops when the third terminal starts to reproduce content (step 506). Figure 6 shows the program executed by a terminal device. In step s304, the terminal checks whether it is time to start reproduction of content. If so, the program exits (i.e., executes the "return" step) mirroring the scope of the '101 Patent. Figure 10 is the program executed by the server to update the code rate. As is the case with other figures, the server also checks whether the present moment coincides with the reproduction start time. If so, the program executing at the server also exits by performs the "return" step. None of the figure or the specification discuss what the system does after reproduction of content starts because that is beyond the scope of the '101 Patent.

75. As discussed in the Technical Background section, the content (e.g., a movie) is broken up into individual segments of content data. Each segment is sequentially transmitted to the terminal device and reproduced by the terminal device in that sequence. Peloton's construction clarifies that the technique of the '101 Patent ***applies before*** the first segment of

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content is played (i.e., when the movie starts) and that the technique does ***not apply*** to the code rate for any segment that is downloaded after reproduction of first segment starts (i.e., after the movie has started).

76. As described in the ’101 Patent, the process of playing content on a terminal device begins when a user selects a content to play on the terminal. *See, e.g.,* Figure 3, step s101. The terminal device communicates a request to play the content selected by the user. The server device starts a session identified by session ID and notifies all terminal devices. Interested devices transmit a ***session participation request*** to the server. Only those devices that sent the participation request receive the reproduction start time and the selected content from the server. The specification defines the reproduction start time as the “time that a terminal device having transmitted the session participation request starts reproduction of content.” *Id.*, 7:17-19; *see also* 8:53-58, 9:18-21, Figures 3 and 13. Figure 3 confirms that the “reproduction start time” and the content are provided only to those terminals that transmitted ***a session participation request***. Thus, Peloton’s construction clarifies that the “reproduction start time” is not any start time but a specific time that occurs after a terminal submits the request.

77. As discussed above, the terminal devices join a session initiated by a server after transmitting a session participation request. The server starts to transmit content after receiving the request from the terminal. The terminal eventually starts to play content. Therefore, Peloton’s proposed construction (“reproduction start time set as time that the reception device having transmitted a session participation request first starts reproduction of the content”) of the term listed above mirrors the scope of the ’101 Patent.

b) The ’101 Patent does not disclose how to update the bit rate after reproduction start time

78. The ’101 Patent does not address how the code rate is updated after reproduction starts (i.e., after the movie has started). Figure 3 depicts the steps performed by the server 10. Though the flow chart in Figure 3 depicts how the server 10 updates the code rate while the content data is being transmitted before reproduction starts, it does not discuss how to update the code rate once the reproduction starts (i.e., the movie starts). Likewise, the flow chart in Figure 6 depicts that the terminal device 20 continues to transmit available reproduction time to the server 10 before reproduction starts but does not transmit such information once reproduction starts. Because the system (or the server device) does not update the bit rate after reproduction starts, the client device does not need to send any information to the server that is needed to calculate the updated bit rate.

79. Similarly, Figure 10 depicts how the code rate is updated and shows that the patent does not update the bit rate once reproduction starts (i.e., the movie starts). The flow chart in Figure 10 checks whether the current time equals reproduction start time. If the answer is yes, the flow chart exits without updating the code rate. The flow chart updates the code rate only if the current time is prior to the reproduction start time. None of the figures and none of the embodiment in the specification discuss how to update the code rate once reproduction starts.

80. Thus, when reviewing the specification of the ’101 Patent, a POSA would not find any disclosure (e.g., a flow chart or an equation) that describes how to update the code rate after reproduction starts. In fact, besides not describing how to update the code rate, the ’101 Patent does not disclose any type of updating after reproduction start time.

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c) Techniques disclosed in the ’101 Patent to update the code rate do not work once reproduction starts

81. The techniques disclosed in the ’101 Patent would fail if applied after the reproduction start time. In the independent claims, the distribution system updates the code rate by balancing two competing factors**:** remaining time and available reproduction time. As the current time approaches the reproduction start time, the value of the remaining time decreases. However, in parallel, as content data is being received by the terminal device, the available reproduction time (i.e., playback time for the content in the buffer) gets larger as more content is received. Because reproduction has not yet started, the buffer does not deplete. The rate at which the available reproduction time increases (i.e., amount of content data in buffer increases) is a function of both the code rate and the communication rate. A higher communication rate implies more content data can be downloaded in the same period of time. Opposite is true at a lower communication rate. Likewise, lower code rate implies less content data is needed for the same playback time as opposed to data coded at a higher code rate. The system cannot control the communication rate but can control the code rate. Thus, the system evaluates the current situation and responds by altering the code rate as needed.

82. Once reproduction has started, the two competing factors collapse into one because both the “remaining time” and “available reproduction time” measure the same value (amount of content in the buffer) and result in the same value. As mentioned above, the “available reproduction time” measures the playback time for the content presently in the buffer. That remains true even after reproduction starts. However, once reproduction starts, “remaining time” also measures the content presently in the buffer. As discussed in the Technical Background section, the content is broken up into individual segments of content data. Each segment may be coded at a different code rate. When the code rate is updated, the next segment

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is transferred with the new code rate. The change in code rate cannot be applied to any portion smaller than the segment. As shown in Figures 3 and 13, the reproduction start time of the first segment of the content (i.e., the time when the first segment of a movie starts) at each terminal is pre-determined by the server before the server starts to transmit content to the terminals. However, the start time of the second segment (or any other intermediate segment) is not set by the server. The second segment will be reproduced once the first segment has finished. Thus, when determining the code rate for the second segment that is yet to be downloaded, the value of "remaining time" will measure the amount of content data in the buffer. Once the data in the buffer (i.e., part of the first segment that has not yet been reproduced) is consumed, then the second segment will be played. Thus, in this scenario both the "remaining time" and "available reproduction time" measure the amount of data in the buffer.

83. Suppose, content consists of three segments A, B, C where each segment is 3-second long. Further suppose segments A and B are in the buffer of a terminal device and the system is ascertaining the code rate for segment C, which the server is about to transmit to the terminal. At that time, the available reproduction time will be 6 seconds since the buffer consists of segments A and B, each of which is 3-second long. The remaining time before reproduction start time for segment C will also be 6 seconds because segment C will be played immediately after segments A and B have been played, which would take 6 seconds since each segment is 3-second long. Thus, both available reproduction time and remaining time before reproduction start time measure the same value (i.e., the amount of content data in the buffer in terms of its time duration).

84. The specification specifically warns that determining code rate "based on ***only*** the available reproduction time" will lead to the code rate being set "extremely small immediately

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after the reception device starts reception of the content data" or code rate being set "extremely high immediately before the reproduction start time." '101 Patent, 2:4-13. Neither situation is desirable.

85. Equation (5) (the only equation that describes how to update the code rate) fails under NEC's interpretation of the claims. Equation (5) reads:

$$\mathbf{r_{n+1} = B_n * (t_s - t_n)/(T_d - T_n)}$$

where $\mathbf{t_s}$ denotes the reproduction start time, $\mathbf{t_n}$ denotes the time at the present moment, $\mathbf{T_d}$ is the target available reproduction time, and $\mathbf{T_n}$ is the available reproduction time.

86. The equation yields a sensical value when used to calculate the updated code rate (r_{n+1}) before reproduction of content (e.g., movie) has started. As discussed above, the goal of the technique disclosed in the '101 Patent is to ensure that the terminal device's available reproduction time T_n (i.e., amount of content data in the buffer) reaches the target T_d by the time reproduction starts (i.e., by the time t_n reaches t_s). When a server device first starts to transmit content data to a terminal device before a content (e.g., movie) starts, the denominator ($T_d - T_n$) in Equation (5) is a positive number because the target T_d would be set as a positive number and "the available reproduction time [T_n] gradually increases from 0." '101 Patent, 2:4-7. As time passes (i.e., t_n increases) and more content data is added to the buffer (i.e., T_n increases), both the denominator ($T_d - T_n$) and the numerator ($t_s - t_n$) decrease. As the present time reaches the reproduction start time (t_n reaches t_s), the available reproduction time also reaches the target (T_n reaches T_d), and the process ends after having achieved its goal. Throughout the process, the equation continues to yield a sensical value because the denominator ($T_d - T_n$) and the numerator ($t_s - t_n$) decrease together, balancing each other. In addition, the equation continues to yield a positive value because the reproduction start time is greater than the present time (i.e., $T_s > T_n$)

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and the target available reproduction time is greater than the available reproduction time (i.e., $t_s > t_n$) until reproduction starts.

87. On the other hand, the equation breaks down and yields a non-sensical value when used to calculate the updated code rate (r_{n+1}) after reproduction of content (e.g., movie) has started. Once reproduction has started, the target available reproduction time T_s will not continue to be greater than the available reproduction T_n. The available reproduction time T_n will fluctuate as some of the content data in the buffer will be used up as the content is being played and additional content data is received and added to the buffer. As the communication speed between the server device and the terminal device fluctuates, the available reproduction time will be sometimes greater than the target ($T_n > T_d$), sometimes equal to the target ($T_n = T_d$), and sometimes less than the target ($T_n < T_d$). When the available reproduction time is greater than the target, the denominator in Equation (5) becomes a negative number, and the equation would yield a negative code rate. A POSA would understand that this result is nonsensical since there is no such thing as a negative code rate. Moreover, if the available reproduction time is equal to or slightly less than the target, the denominator in the equation becomes zero or a very small value, and the equation would yield a code rate that is extremely high that could even reach infinity. It is nonsensical that the equation would yield such a high code rate when the buffer level is at an ideal state of being very close to the target. Therefore, if the invention of the '101 Patent includes updating the code rate while content is being reproduced, then the specification does not teach a POSA how to update the bit rate in such a situation. The technique to update the code rate would not be able to reliably predict what code rate to employ for the next segment that is being transmitted.

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d) NEC's interpretation of the term is incorrect

88. I understand that NEC believes that content can have multiple reproduction start times. Content consists of multiple segments (or portions of content). Under NEC's view, a content will have multiple reproduction start times where each segment has an associated start time. The specification does not support such an interpretation. The figures and the specification consistently depict only one reproduction start time for content. They do not depict multiple start times for content. When the reproduction of content first starts, the purpose of the '101 Patent ends and, thus, the patent does not address what occurs after reproduction starts. Under NEC's view, if the invention and the claims cover the time frame after reproduction starts, then the system must continue to update the code rate after reproduction starts. However, the patent does not discuss updating the code rate after reproduction starts. In fact, as described above, Figure 10 (which depicts how the code rate is updated) stops when it is time to start reproduction. Moreover, as described above, Equation (5) yields reliable results only before reproduction starts. It cannot reliably provide updated code rate after reproduction has started. Also, the claims require calculating the updated code rate based on two distinct variables (i.e, the remaining time before reproduction start time and the available reproduction time). As explained above, under NEC's interpretation of the term, the two variables would measure the same value – amount of content data in the buffer after content has started playing. The patent specifically warns against determining updated code rate based only on the amount of content in the buffer. Finally, in the '101 Patent, the reproduction start time is pre-determined for each terminal device by the server device. That can be achieved when content first starts to play. After the first segment is played, the start time of the subsequent segments cannot be determined beforehand by the server. Moreover, the specification does not disclose how to determine the start time after reproduction

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first starts. Thus, NEC's interpretation of the term is not supported by the specification of the '101 Patent.

2. "content" ('101 and '809 Patents)

Peloton's Proposed Construction	NEC's Proposed Construction
video and/or audio	Plain and Ordinary Meaning *Alternatively: video and/or audio*

89. I understand that Peloton proposes that the term should be construed as "video and/or audio" as it is used in the '101 Patent and the '809 Patent. I agree with Peloton's proposal and also conclude that, in the context of the claims of the two NEC patents, the term "content" refers to an entire video or audio and not to segments or portions of such video or audio. To treat "content" as referring to a portion of a movie or an audio would be akin to conflating "content" with "content data."

a) Peloton's construction is correct and supported by the specification

90. The manner in which the term "content" is used in both the '101 Patent and the '809 Patent supports Peloton's proposal. The term refers to the artistic work as a whole that has been transmitted from the server. The specification states that "the transmission device transmits content data representing content (video, audio, etc.) to each of the reception devices." '101 Patent, 1:23-25. Figure 3 treats between content data and content differently. Content data refers to a portion of content whereas content refers to the entire artistic work (e.g., movie) The figure depicts that content data (and not content) being downloaded from the server device prior to the reproduction start time. At the reproduction start time, the figure refers to "start reproduction of ***content***," not content data. Other figures of the '101 Patent also treat content data and content

differently. *See, e.g.,* Figure 6 and Figure 13. In other places, the specification treats content as the movie or audio:

> The content data storage part 44 of the server device 10 stores (accumulates) a plurality of content data in advance. Each of the content data is data representing one of a ***plurality of contents (e.g., information representing video and/or audio)***. The content data storage part 44 stores, as the content data representing the respective contents, a plurality of content data in each of which the content is coded with a code rate varying with the content.

'101 Patent, 7:1-8 (emphasis added).

91. Finally, the definition of "code rate" that NEC and Peloton agreed to also differentiates content data and content:

> a rate representing the data amount (the data size, e.g., the number of bytes) of ***content data for reproducing content*** at constant speed (reproducing content at lx speed) for a unit time (e.g., one second).

'101 Patent, 7:8-11 (emphasis added).

92. Thus, "content" which refers generally to the entire movie or a song.

b) NEC's interpretation of the term is incorrect.

93. I understand that NEC disputes that that the term content refers to an entire video or audio and argues that content could refer to portions of a video or an audio. As mentioned above, content (e.g., a movie) consists of portions of content (i.e., segments of a movie). Under NEC's view each portion of content (or each segment) will be the movie. And, the movie will first start whenever a portion of content is played. NEC equates content with content data but the specification of the '101 Patent does not support such as view. For example, in Figures 3,6 and 13, the specification refers to both content and content data. When discussing reproduction start times, it explicitly refers to content and not content data. On the other hand, when discussing transmission of content from server to terminal, it refers to content data and not content. NEC's

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view that each content data (or a segment) will have a reproduction start time is premised on its belief that the '101 Patent continues to operate after reproduction first starts. NEC's premise is incorrect for the reasons enumerated in the section regarding the "reproduction start time" term above.

3. "content transmitting unit" ('101 Patent, claims 1, 16, 21)

Peloton's Proposed Construction	NEC's Proposed Construction
Means-plus-function term governed by 35 U.S.C. § 112, ¶ 6 Functions: *See* Joint Claim Construction Chart, ECF No. 82, at 11-14 Corresponding Structure: A central processing unit (CPU) programmed to carry out the algorithm disclosed in the '101 Patent as follows: • Claim 1: 10:60-11:10 • Claims 16, 21: 10:7-11:10	Plain and Ordinary Meaning not subject to 35 U.S.C. § 112, ¶ 6

a) "Content transmitting unit" is a means-plus-function term

94. The claims here ascribe two specific functions to the term "content transmitting unit": (1) "***transmitting*** content data . . . to the reception device," and (2), **"*chang[ing]*** the code rate of the [content] data." *See* '101 Patent, cls. 1, 16, and 21 (emphases added).

95. As of the priority date of the '101 Patent, "content transmitting unit" was not a term of art. A review of extrinsic evidence confirms that the term lacks a well-known meaning that connotes structure. None of the technical dictionaries define the term "code rate determining unit." *See* Microsoft Computer Dictionary 5th Ed. (2002); Wiley Electrical and Electronics Engineering Dictionary (2004). Further, a POSITA would not recognize the term as connoting sufficient structure for performing both of these functions. To the extent the term implies any structure, it would be limited to transmitting content. A person of ordinary skill would understand that such structure would only transmit content, but would not change the code rate

of the content data. The remainder of the limitation that follows the term "content transmitting unit" is also functional. It simply states the two functions ascribed to the unit and does not impart sufficient structure to perform the claimed functions.

96. In addition, I see that the term uses the word "unit" instead of "means," it is otherwise structured in the traditional means-plus-function format—in other words, it follows the format of "unit" + "for" + (statement of function(s))). This supports my view that "content transmitting unit" is a means-plus-function term.

97. I note that the claimed "content transmitting unit" is a part of another claimed component, the "transmission device." '101 Patent, cls. 1, 16, and 21. In my opinion, this does not lend any support to a person of ordinary skill in understanding the term "content transmitting unit" as connoting structure. If anything, in my opinion, the fact that the claims recite a "*transmission device*" that includes a "*transmitting unit*" creates ambiguity regarding the specific structure for each of the two claimed components, because both terms are generic terms that may be understood as being related to the function of transmitting.

98. I further note the claims contemplate that the "content transmitting unit," as part of the "transmitting" function, provides an output "to the reception device." *See* '101 Patent, cls. 1, 16, and 21. However, this output connection does not provide sufficient structural support for the "content transmitting unit" itself.

99. Further, the written description and figures of the '101 Patent treat the "content transmitting unit" simply as a black box that performs the recited functions of transmitting content data and changing in the code rate of the content data, untied to any particular structure or a call of structures. None of the figures depict a "content transmitting unit." However, the specification discloses a similar term, "content transmitting *part*," which is shown in Figure 2 as

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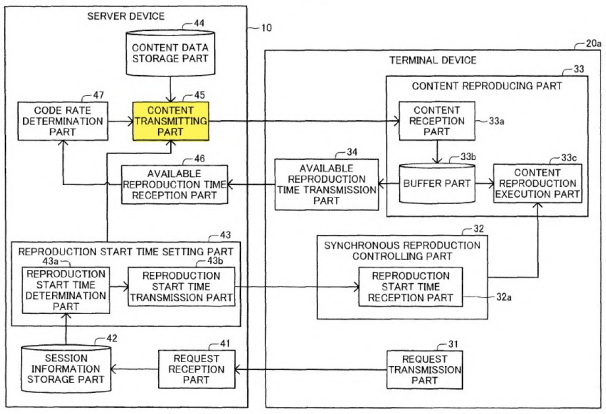
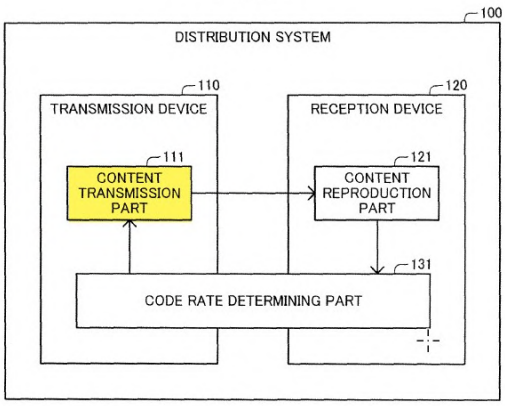
a generic, empty box that is part of the server device, lacking internal components. '101 Patent, 8:46-52 (emphasis added). The specification also discloses a "content *transmission part*," shown in Figure 16, likewise as a generic, empty box that is part of the transmission device, lacking internal components. *Id.*, 18:66-19:21 (emphasis added). Figures 2 and 16 are shown below.

Fig.2



'101 Patent, Figure 2

Fig.16



'101 Patent, Figure 16

100. As further mentioned below, the '101 Patent discloses that the claimed functions can be performed by a CPU and discloses an algorithm. However, that disclosure does not demonstrate that the "content transmitting unit" was reasonably well known to POSA so as to connote a particular structure or a class of structures for performing both recited functions.

101. While the specification does not mention a "content transmitting *unit*," it repeatedly describes a "content transmitting *means*," which is described as being synonymous with the content transmitting *part*. *See, e.g.*, '101 Patent, 5:66-67 (emphasis added). Specifically, the specification ascribes the exact same functional language to the "content transmitting *means*" as the claims at issue ascribe to the "content transmitting *unit*" term. For instance, the "Summary" section discloses a "content transmitting *means*" as part of a distribution system at 2:30-49, then as part of a transmission device 3:13-25, and then as part of program at 3:33-41 (emphasis added). "Content transmitting means" is also recited numerous times elsewhere parts

of the specification, including for example at 20:30-40, 22:3-11, and 22:43-51, again attributing the same functional language as the "unit" term. Thus, a POSA reading the specification would conclude that, within the context of the '101 Patent, the words "unit" and "means" are synonymous, and therefore interchangeable.

102. Similarly, I note that claims 27 and 28 of the '101 Patent recite a "content transmitting *means*" in a distribution system and in a transmission device, respectively. Likewise, claim 1 and 16 recite a "content transmitting *unit*" in a distribution system and in a transmission device, respectively. Both sets of claims employ the same functional limitations for the "means" terms and for the "unit" terms, respectively. In my opinion, this further suggests that a POSA reading '101 Patent would conclude that the words "unit" and "means" are synonymous and interchangeable in the context of this patent.

103. For additional context, I have reviewed the file history for the '101 Patent, which indicates that the claims at issue were originally drafted to recite "content transmitting means," but the applicant amended certain pending claims to change the word "means" to "unit" and left the relevant functional language intact. D.I. 83 (Ex. 4) at 213-223 ('101 Patent File History, May 3, 2012 Preliminary Amendment). However, whether or not the word "means" or "unit" is used, the fact that the same functional language is ascribed to both "content transmitting means" and "content transmitting unit" indicates that a POSA would understand both terms to connote insufficient structure. Put differently, simply swapping the word "means" for "unit" does not lend any more structural support to the "unit" term.

104. Thus, it is my understanding that the term "content transmitting unit" is a means-plus-function term that requires disclosure of corresponding structure.

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b) Corresponding structure for the claimed function

105. I understand that Peloton proposes that the following structure is the corresponding structure for claim 1:

> a central processing unit (CPU) programmed to carry out the algorithm disclosed at 10:60-11:10

106. I understand that Peloton proposes that the following structure as the corresponding structure for claims 16 and 21:

> a central processing unit (CPU) programmed to carry out the algorithm disclosed the algorithm is disclosed at 10:7-11:10.

107. In claims 16 and 21, the "content transmitting unit" changes the code rate and also transmits the content data with the updated code rate. Likewise, the "content transmitting unit" in claim 1, both changes the code rate and also transmits the content with the new code rate. In all cases, this algorithm disclosed on columns 10 and 11 of the '101 Patent entails changing the code rate to the code rate determined based on the available reproduction time information, as claimed; as to claims 16 and 21, the disclosed algorithm includes additional detail to account for the definition of "remaining time before reproduction start time" which is embedded within the "changing" function recited for those claims. When discussing the disclosure of the '101 Patent above, I explained in detail how the algorithm functions, and the equations used to update the code rate as disclosed in the specification and shown in relevant figures. I also addressed the additional functionality required to transmit the code rate is disclosed at 10:60-11:10 of the '101 Patent. I incorporate that discussion in this section. I agree that the structure identified by Peloton is sufficient to perform both functions ascribed to the "content transmitting unit" as used in claims 1, 16 and 21 (i.e., the transmitting" function as well as the "chang[ing]" function). Thus, I agree with Peloton's identification of corresponding structure for the term "content transmitting unit."

4. "code rate determining unit" ('101 Patent, claims 1, 2, 4, 22, 23, 25, 26)

Peloton's Proposed Construction	NEC's Proposed Construction
Means-plus-function term governed by 35 U.S.C. § 112, ¶ 6 Functions: *See* Joint Claim Construction Chart, ECF No. 82, at 6–10 Corresponding Structure: A central processing unit (CPU) programmed to carry out the algorithm disclosed in the '101 Patent at 10:7–59	Plain and Ordinary Meaning not subject to 35 U.S.C. § 112, ¶ 6

a) "Code rate determining unit" term is a means-plus-function term

108. The claims specify that the function of "code rate determining unit" is to "determine the code rate based on a remaining time before reproduction start time . . . and based on an available reproduction time."[1] *See* '101 Patent, cls. 1, 22, 26.

109. As of the priority date of the '101 Patent, the term "code rate determining unit" was not a term of art that would connote a definite meaning as the name of the structure. Appending the word "determining" before "unit" simply implies that the function is to determine something, but does not designate particular structure. Nor does further appending "code rate" before "determining unit," which only conveys *what* is being determined. Thus, to a person of ordinary skill in the art, the modifier "code rate determining," which precedes the word "unit," connotes only function; it is equivalent to says "unit for determining code rate." Put differently, the term is not reasonably well understood by persons of ordinary skill in the art as referring to a particular structure or a class of structures. Thus, as of the priority date of the '101 Patent, there

[1] The dependent claims specify additional details regarding the "value" that the "unit" must determine (claims 2 and 23), or the frequency with which the determination must be made (claims 4 and 25). In my opinion, neither of these details which connote to a person of ordinary skill any more structure than the independent claims.

were no commonly understood structures that could perform the functions that a "code rate determining unit" is required to perform. I note that the '809 Patent, which I discuss further below, ascribes similar functionality to the term "bit rate changing unit," which further suggests to a person of ordinary skill that neither term is functional.

110. A review of extrinsic evidence confirms that the term lacks a well-known meaning that connotes structure. None of the technical dictionaries define the term "code rate determining unit." *See* Microsoft Computer Dictionary 5th Ed. (2002); Wiley Electrical and Electronics Engineering Dictionary (2004). A search of U.S. patents in the U.S. Patent and Trademark Office's database, https://ppubs.uspto.gov/pubwebapp/, indicates that, aside from the '101 Patent, the term appears in only other 6 patent families. The rare appearance of this term in U.S. patents confirms that, as of the priority date of the '101 Patent, there were no commonly understood structures that could perform the functions ascribed to the "code rate determining unit" here.

111. The remainder of the limitation that follows the term "code rate determining unit" is also functional. It simply describes the function of the unit, and specifies two values (a "remaining time before reproduction start time, and an "available reproduction time") that the determination must be "based on." The language does not impart any structure to perform the claimed function. While the claim term mentions a "storage device," this only conveys structure related in regards to the content data upon which the determination that is ultimately performed by the determination unit is "based." However, neither the claims, nor the specification, contemplate a direct link between the storage device and the "code rate determining unit." Accordingly, the "storage device" lends no structure to the claim term.

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112. I note that the claims contemplate that the "content transmitting unit" (discussed in the previous section) receives an output from, or relies upon the function performed by, the "code rate determining unit." See '101 Patent, cls. 1, 16, and 21. However, to the extent this implies an input/output connection between these elements, this does not provide sufficient structural support for the "code rate determining unit" itself.

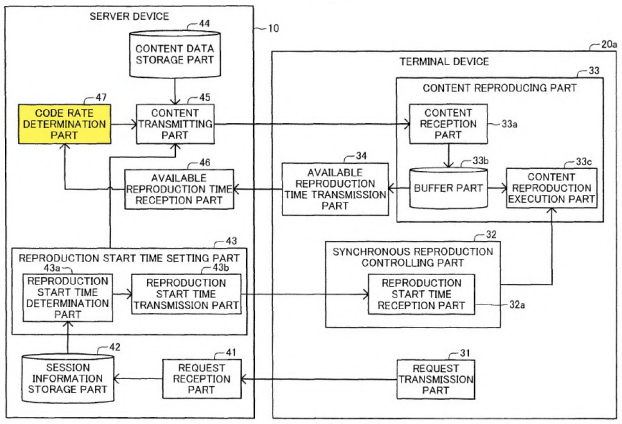
113. Further, I note that, apart from this claim term, the remainder of the claims are largely directed at routine and conventional functions for content transmission and playback.[2] This suggests to me that the novelty of the claims—to the extent there is any—lies in the "code rate determining unit" term.

114. In addition, while the term uses the word "unit" instead of "means," it is otherwise structured in the traditional means-plus-function format—in other words, it follows the format of "unit" + "for" + (statement of function(s))). This supports my view that "code rate determining unit" is a means-plus-function term.

115. Further, the written description and figures of the '101 Patent treat the "code rate determining unit" simply as a black box that performs the recited function, untied to any particular structure or a call of structures. None of the figures depict a "code rate determining unit." However, the specification discloses a similar term, "code part determining *part*," which is shown in Figures 2 and 16, in both cases as a generic, empty box that is part of the server device (in Figure 2) or is part of the transmission and/or reception device (Figure 16), and lacking internal components. '101 Patent, 10:13-23, 19:10-18. Figures 2 and 16 are shown below, this time highlighting the "code rate determining part."

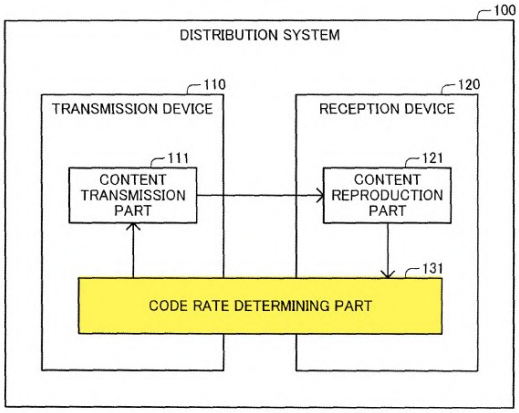
[2] That is not to say that the term "content transmitting unit" was recognized as a known structure for performing both of the ascribed functions (i.e., transmitting and changing the code rate), for the reasons I discussed above.

Fig.2



'101 Patent, Figure 2

Fig.16



'101 Patent, Figure 16

116. As further mentioned below, the '101 Patent discloses that the claimed function can be performed by a CPU and discloses an algorithm. However, that disclosure does not demonstrate that the "code rate determining unit" was reasonably well known to a POSA so as to connote a particular structure or a class of structures for performing both recited functions.

117. While the specification does not mention a "code rate determining *unit*." However, it repeatedly describes a "code rate determining *means*" (approximately 19 times) which is described as being synonymous with the code rate determining *part*. *See, e.g.*, '101 Patent, 6:1-2. Specifically, the specification ascribes the exact same functional language to the "code rate determining *means*" as the claims at issue ascribe to the "code rate determining unit." For instance, the "Summary" section discloses a "code rate determining *means*" as part of a transmission device at 2:39-46, as part of program at 4:4-10, and then as part of the reception device at 3:52-57. "Code rate determining means" is also recited numerous times elsewhere parts of the specification, including for example at 19:10-18, again attributing the same functional language as the "unit" term. Thus, as I discussed in §VIII.B.3 above, a POSA reading the specification would conclude that, within the context of the '101 Patent, the words "unit" and "means" are synonymous, and therefore interchangeable.

118. Similarly, I note that claims 27 and 28 of the '101 Patent recite a "code rate determining *means*" in a distribution system and in a transmission device, respectively. Likewise, claim 1 and 16 recite a "content transmitting *unit*" in a distribution system and in a transmission device, respectively. Both sets of claims employ the same functional limitations for the "means" terms and for the "unit" terms, respectively. In my opinion, this further suggests that a POSA reading '101 Patent would conclude that the words "unit" and "means" are synonymous and interchangeable in the context of this patent.

119. For additional context, the file history for the '101 Patent indicates that the claims at issue were originally drafted to recite "code rate determining means," but the applicant amended certain pending claims to change the word "means" to "unit" and left the relevant functional language intact. D.I. 83 (Ex. 4) at 213-223 ('101 Patent File History, May 3, 2012 Preliminary Amendment). However, whether or not the word "means" or "unit" is used, the fact that the same functional language is ascribed to both "code rate determining means" and "code rate determining unit" indicates that a POSA would understand both terms to connote insufficient structure. Again, simply swapping the word "means" for "unit" does not lend any more structural support to the "unit" term.

120. Thus, it is my understanding that the term "code rate determining unit" is a means-plus-function term that requires disclosure of accompanying data.

b) Corresponding structure for the claimed function

121. I understand that Peloton proposes that the following structure is the corresponding structure for claim 1:

> a central processing unit (CPU) programmed to carry out the algorithm disclosed in the '101 Patent, 10:7-59.

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122. As mentioned above, code rate determining part 47 in Figure 2 (which corresponds to the claimed "code rate determining unit") updates the current code rate based on system conditions. Specifically, part 47 uses equation 4 to calculate the communication speed B_n. It then determines the modified code rate r_{n+1} using equation 5. The new code rate is employed to transmit further content. The specification clarifies that the abovementioned steps of determining the new code rate can be programmed and executed on a CPU. *See, e.g.*, '101 Patent, 18:54-57. When discussing the disclosure of the '101 Patent above, I explained in detail how the algorithm and the equations to update the code rate operate through the disclosure in the specification and relevant figures. I incorporate that discussion in this section. Based on my review, I agree that Peloton has identified sufficient structure to implement the functions ascribed to the "code rate determining unit." Accordingly, I agree with Peloton's identification of corresponding structure for the term "code rate determining unit."

IX. The '809 Patent

A. Overview

1. Goal

123. When a client device plays content (e.g., a movie), the content data for the content is downloaded from the server device and stored in a buffer of the client device before it is played. The '809 Patent discloses a technique to ensure that a sufficient amount of content data is present in the buffer of the client to avoid underflow or overflow. The patent specifies a preset target amount of content that should be present in the buffer when the content is being played by the client device. The patent discloses updating that bit rate of the content data being transmitted to ensure that the specified amount of content data is present in the buffer of the client device. The bit rate is periodically updated by a "correction amount" based on the amount of the content in the buffer and the preset target amount. If the amount of the content in the buffer falls below

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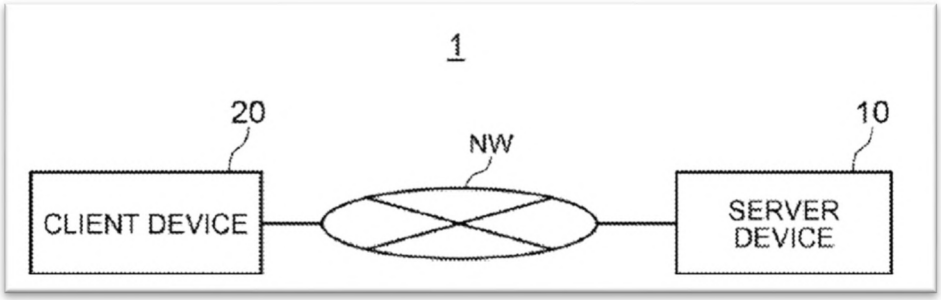
the target amount, the bit rate may be lowered by a correction amount. On the other hand, if the amount in the buffer exceeds the target amount, the bit rate may be increased by a correction amount. The patent discloses that the magnitude of correction amount is further dictated by a predetermined correction amount reducing range. When the bit rate is updated, the patent calculates a predetermined range and checks whether the current bit rate falls within that predetermined range. If the current bit rate is within that range, the magnitude of the correction amount is reduced.

2. System and method to update the bit rate to maintain a target amount of content in the buffer

124. Figure 1 (below) depicts a delivery system 1 that includes a server device 10 and a client device 20. The server device 10 and the client device 20 communicate with each other through a communication network NW (e.g., the Internet). '809 Patent, 5:8-27.



125. Figure 2 (below) shows a block diagram of a client device 20 and a block diagram of a server device 10. The specification describes the functions of various components of the client and server devices. *Id.*, 5:28-51. For example, the server device 10 transmits content to client device 20 though the content transmitter 12. The client device 20 receives content through the content receiver 21, stores it in the content buffer unit 22 and reproduces through content transmission reproduction unit 23. As depicted in Figure 2, the client device 20 has additional components that are defined by their functions. For example, reception rate acquisition unit 24

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acquires the rate at which the client device receives content data, remaining reproduction time acquisition unit 25 calculates the playback duration of the content data in the buffer, and reproducing speed acquisition unit 26 calculates the rate at which the client device is reproducing the content (e.g., normal speed, fast forward, or slow motion). *Id.* The client device 20 gathers and shares such information with the server device 10. Based on the information provided by the client device 20, the server device 10 updates the bit rate through, as the name indicates, the bit rate calculation unit 14. *Id.*, 5:52-7:35.

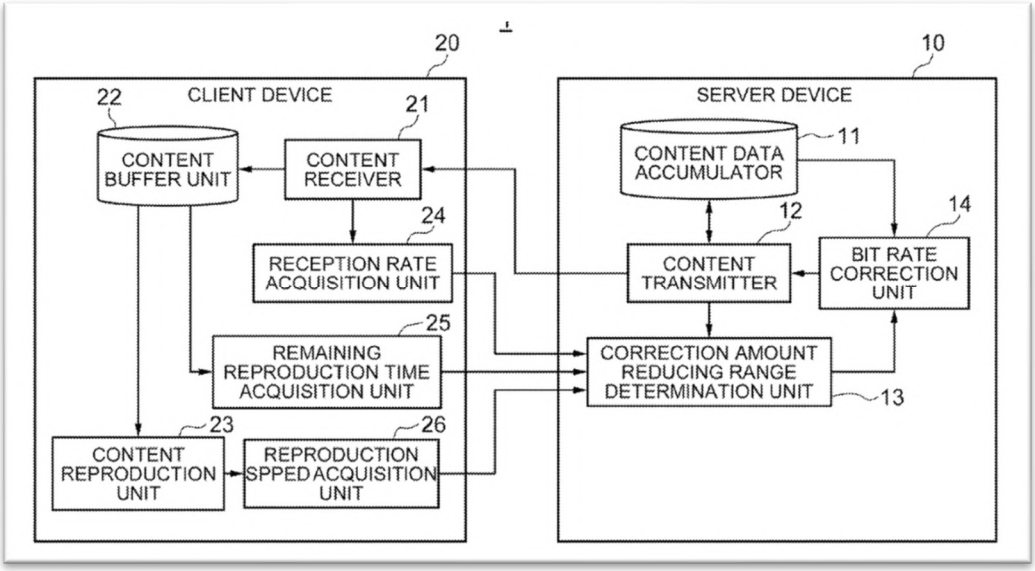


Figure 2

126. In addition, as shown in Figure 2, server device 10 also has a correction amount reducing range determination unit 13 that determines the range to be considered when updating the bit rate. *Id.* The correction amount reducing range determination unit 13 receives information from the client device 20, such as, the reception rate, the remaining reproduction time, and the reproduction speed ratio. Based on the information and a preset target value for the remaining reproduction time, the correction amount reducing range determination unit 13 determines an upper limit and a lower limit of the correction amount reducing range. *Id.*, 7:24-35.

127. The specification mentions that the functions of the server device 10 can be realized by a CPU executing a program stored in the storage device. *Id.*, 5:15-17. Likewise, functions of the client device 20 can be realized as a CPU executing a program represented by Figure 5 of the patent. *Id.*, 5:49-51.

128. Figure 3 (below) illustrates the relationship between the values that are used to determine the correction amount reducing range according to the '809 Patent:

- T_r: a target value for preset remaining reproduction time (i.e., the target amount of content in the buffer).
- T_p: a remaining reproduction time (i.e., the actual amount of content in the buffer).
- e_p: a remaining reproduction time difference (i.e., the difference between T_r and T_p).
- τ: a period of time it takes to increase or decrease remaining reproduction time T_p to reach a target value T_r.
- Δx: a rate of change of remaining reproduction time T_p.

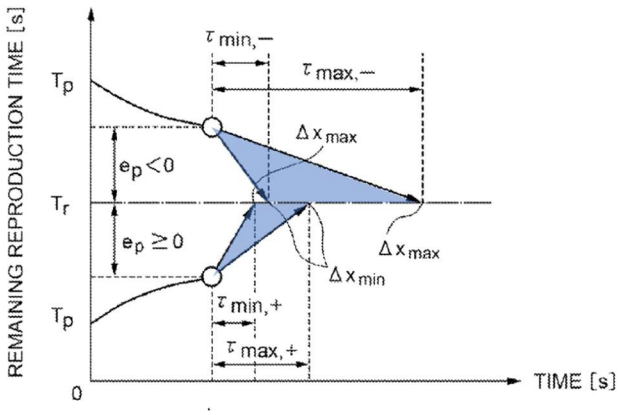


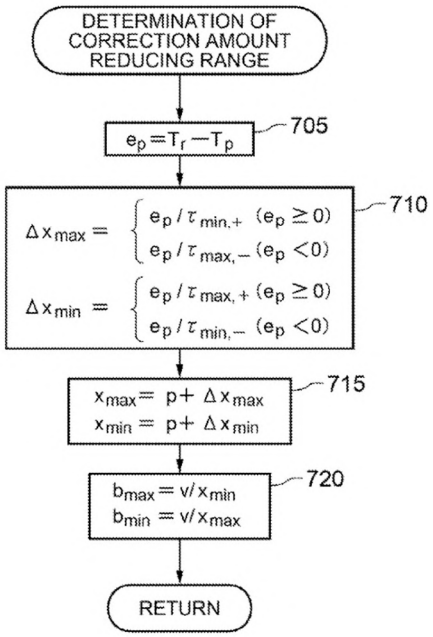
Figure 3 (annotated)

129. In Figure 3 above, the lower half of the graph depicts when the content in the buffer is below the preset target value (i.e., $e_p > 0$) whereas the upper half depicts when the content in the buffer is above the preset target value (i.e., $e_p < 0$). If the bit rate of content data being currently transmitted is within a correction amount reducing range, no correction or only a small correction needs to be made to the bit rate, because Δx (the rate of change of remaining reproduction time) would fall between Δx_{min} and Δx_{max} (i.e., inside the area shaded blue above)

and remaining reproduction time T_p is expected to reach a preset target value T_r within an acceptable time (i.e., between minimum and maximum τ) without any correction.

130. The flow chart in Figure 7 illustrates how the correction amount reducing range is determined:

FIG. 7



131. As shown in block 705 of Figure 7, the correction amount reducing range determination unit 13 first calculates a remaining reproduction time difference e_p [seconds] using the equation below. *Id.*, 7:36-45.

Equation (1): $e_p = T_r - T_p$

132. In the equation (1), as discussed above, T_r denotes a target value for preset remaining reproduction time, and T_p denotes a remaining reproduction time provided by the client device. Subsequently, as shown in block 710 of Figure 7, the correction amount reducing range determination unit 13 calculates time rates of change (time differential values) of

remaining reproduction time Δx_{max} and Δx_{min} according to the following equations (2) to (5). *Id.*, 7:46-8:8.

Equation (2): $\Delta x_{max} = e_p/\tau_{min+}$ (when $e_p \geqq 0$)

Equation (3): $\Delta x_{max} = e_p/\tau_{max-}$ (when $e_p < 0$)

Equation (4): $\Delta x_{min} = e_p/\tau_{max+}$ (when $e_p \geqq 0$)

Equation (5): $\Delta x_{min} = e_p/\tau_{min-}$ (when $e_p < 0$)

133. In Equations 2 to 5 above, τ_{min+} and τ_{max+} are time constants that are employed to calculate Δx values when the content in the buffer T_p is short of the target amount T_r. On the other hand, τ_{max-} and τ_{min-} are time constants that are employed to calculate Δx values when the content in the buffer T_p is in excess of the target amount T_r. *Id.* Conceptually, Δx represents the rate at which T_p changes. A positive Δx value means that T_p is increasing; conversely, a negative Δx value means T_p is decreasing.

134. With respect to the lower half of Figure 3, Δx is shown to be a positive value because the goal is to increase T_p towards T_r when T_p is lower than T_r. Δx_{max} represents the rate at which T_p must decrease to ensure that the content in the buffer T_p matches the target amount T_r after a minimum requisite time τ_{min+}. Δx_{min} represents the rate to achieve that goal after a maximum requisite time τ_{max+}.

135. With respect to the upper half of Figure 3, Δx is shown to be a negative value because the goal is to decrease T_p towards T_r when T_p is higher than T_r. Δx_{min} represents the rate at which T_p must decrease to ensure that the content in the buffer T_p matches the target amount T_r after a minimum requisite time τ_{min-}. Δx_{max} represents the rate to achieve that goal after a maximum requisite time τ_{max-}. The variables Δx_{max} and Δx_{min} represent the same concept in the upper half of Figure 3 but the roles are reversed because e_p is a negative value.

136. As shown in block 715 of Figure 7 and in Equations 6 and 7 below, the correction amount reducing range determination unit 13 then calculates media flow rates x_{max} and x_{min} based on Δx_{max} and Δx_{min} discussed above and the reproduction speed ratio p provided by the client device. *Id.*, 8:9-22. As mentioned above, reproduction speed ratio p represents the rate at which the client devices reproduce the content (e.g., normal speed or slow speed).

Equation (6): $x_{max} = p + \Delta x_{max}$

Equation (7): $x_{min} = p + \Delta x_{min}$

137. Conceptually, x represents how much content data (in terms of its playback duration) must be downloaded per unit time such that the content can be played at a speed of p while changing the buffer content amount T_p at a rate of Δx.

138. Subsequently, as shown in block 720 of Figure 7, the correction amount reducing range determination unit 13 calculates an upper limit b_{max} and a lower limit b_{min} of the correction amount reducing range based on the calculated media flow rates x_{max} and x_{min} using the following equations. *Id.*, 8:22-44.

Equation (8): $b_{max} = v / x_{min}$

Equation (9): $b_{min} = v / x_{max}$

139. In the above equations, v denotes a reception rate of the content data (in terms of file size per unit time) transmitted by the server device and received by the client device. Accordingly, b_{max} (or b_{min}) represents the bit rate at which the content should be encoded to achieve the media flow rate of x_{min} (or x_{max}), given a reception rate of v.

140. After determining the correction amount reducing range as shown in Figure 7, a correction amount for correcting a bit rate of content data transmitted by the server device is calculated. The flow chart in Figure 8 illustrates how the correction amount is calculated:

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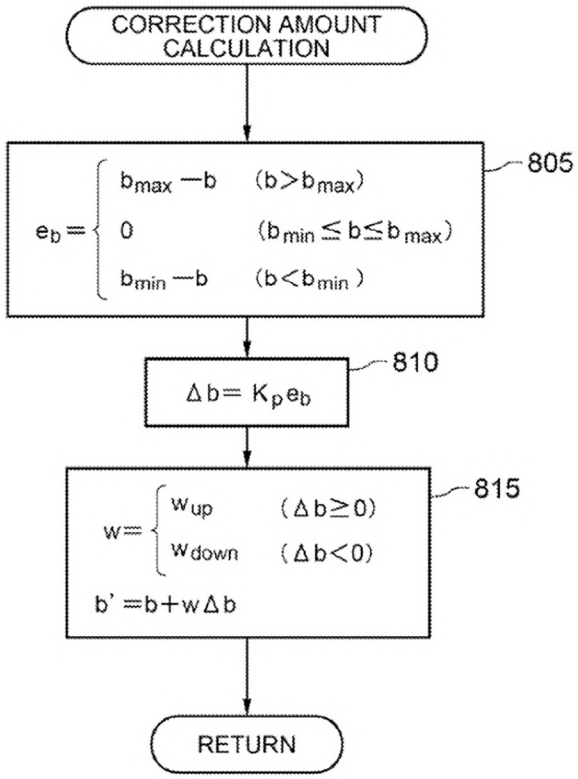
FIG. 8



141. As shown in block 805 of Figure 8 and in Equations 19-21 below, the bit rate b of the content data currently transmitted by the content transmitter is compared to the upper limit b_{max} and the lower limit b_{min} of the correction amount reducing range. If the bit rate b is outside the correction amount reducing range, then a bit rate difference e_b is the difference between either the upper limit b_{max} or the lower limit b_{min} and bit rate b (i.e., $b_{max} - b$ or $b_{min} - b$). On the other hand, if the bit rate b is within the correction amount reducing range, then the bit rate difference e_b is presumed to be zero:

Equation (19): $e_b = b_{max} - b$ (if $b > b_{max}$)

Equation (20): $e_b = 0$ (if $b_{min} \leq b \leq b_{max}$)

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Equation (21): $e_b = b_{min} - b$ (if $b<b_{min}$)

'809 Patent, 13:19-21.

142. Subsequently, as shown in block 810 of Figure 8 and in Equation 22 below, a correction amount baseline value Δb is calculated by multiplying the bit rate difference e_b with proportional gain K_p. Notably, since the bit rate difference e_b is zero when the bit rate b is within the correction amount reducing range, the correction amount baseline value Δb would also be zero when the bit rate b is withing the correction amount reducing range.

Equation (22): $\Delta b = K_p * e_b$

143. Subsequently, as shown in block 815 of Figure 8 and in Equations 24, 26, and 27, a correction amount $w*\Delta b$ is calculated by multiplying the correction amount baseline value Δb with a coefficient w. The coefficient w can differ based on whether the correction amount baseline value Δb is a positive number or a negative number. A bit rate b' of content data to be transmitted is calculated by adding $w*\Delta b$ to the bit rate b of the content data currently transmitted. Notably, since the correction amount baseline value Δb is zero when the bit rate b is within the correction amount reducing range, the correction amount $w*\Delta b$ would also be zero when the bit rate be is within the correction amount reducing range.

Equation (24): $b' = b + w*\Delta b$

Equation (26): $w = w_{up}$ (when $\Delta b \geq 0$)

Equation (27): $w = w_{down}$ (when $\Delta b<0$)

Id., 14:3-22.

144. The '809 Patent also describes modifications to the methods discussed above for determining a correction amount reducing range and calculating a bit rate correction amount. Similar to the methods discussed above, the modified methods compare the bit rate b of content

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data currently transmitted with a correction amount reducing range for calculating a bit rate b' of content data to be transmitted from then on. *Id.*, 19:4-21:10.

145. The '809 Patent also explains the operation of the delivery system 1. First, in response to an instruction from a user, the client device 20 transmits a content transmission request to the server device 10 specifying content data the client devices wants to play. The server device 10 responds by transmitting the content data requested by the client device 20 . While receiving the content data transmitted by the server device 10, the client device 20 stores received data of the content data in the storage device and reproduces content based on the stored data. *Id.*, 15:33-42.

146. In addition, the client device provides certain information to the server device (as shown in Figure 5) and the server updates the bit rate based on the information received from the client (shown in Fig. 6). As shown in Figure 5, the CPU of the client device 20 executes steps 510 to 525 of the flowchart in Figure 5 after the correction cycle expires (step 505). At that time, the CPU in the client device 20 acquires remaining reproduction time T_p (step 510), a reception rate v (step 515), a reproduction speed and a reproduction speed ratio p (step 520). The CPU then transmits to the information to the server device 10 (step 525). *Id.*, 15:43-64.

147. On the other hand, the CPU of the server device 10 waits until receiving information from the client device 20 (step 605), and once the server device 10 receives the information, the CPU determine the correction amount reducing range (step 610), calculates the new bit rate (step 615) and then updates the bit rate (step 620). *Id.*, 15:65-16:8. After the bit rate has been updated, the updated bit rate is transmitted to the server device. The patent discloses the steps to perform that at 21:57-62 by specifying the protocol to achieve that.

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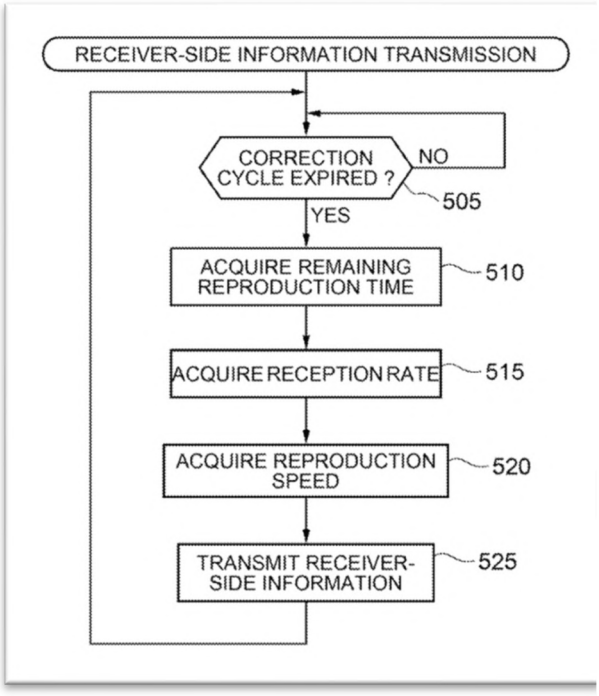

Figure 5

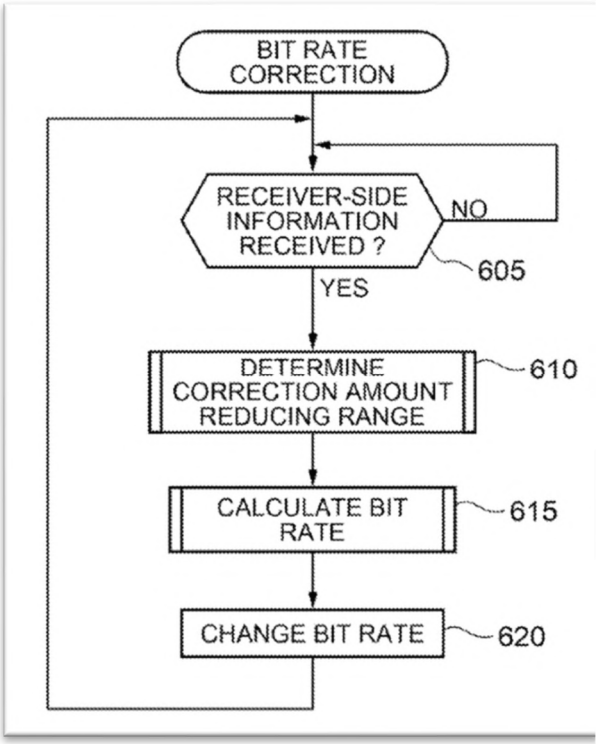

Figure 6

B. Opinions on claim terms

1. "the bit rate" ('809 Patent, claims 1, 14, 18, 22, 26, 30)

Peloton's Proposed Construction	NEC's Proposed Construction
"the bit rate of the content data currently transmitted"	Plain and Ordinary Meaning Alternatively: the bit rate of the content data to be transmitted

148. Claims 1, 14, 18, 22, 26, and 30 of the '809 Patent recite "the bit rate" as shown below:

- "correcting ***the bit rate*** of the content data transmitted by the server device"

  (claims 1, 14, 26, 30)

- "correcting ***the bit rate*** of content data transmitted to the client device" (claims 18, 22)
- "changing ***the bit rate*** based on the calculated correction amount" (claims 1, 18, 22, 26, 30)
- "changing ***the bit rate*** of the content data transmitted by the server device based on the calculated correction amount" (claim 14)
- "when ***the bit rate*** is within [a/the] predetermined correction amount reducing range" (claims 1, 14, 18, 22, 26, 30)
- "when ***the bit rate*** is not within a predetermined correction amount reducing range" (claim 14)

149. The parties dispute which bit rate "the bit rate" refers to. Peloton proposes that it refers to "the bit rate of the content data currently transmitted" (i.e., the bit rate the server device is currently using to transmit the content data before applying any correction amount). On the other hand, NEC proposes that it refers to "the bit rate of the content data to be transmitted" (i.e., the bit rate that the server device will use to transmit the content data in the future). I agree with Peloton's proposed construction.

150. The claim language shows that "the bit rate" is the preexisting bit rate that is currently being used before making any correction or change to it. The claims refer to "the bit rate" as something that will be "corrected" or "changed" by the claimed apparatus or method. The claims also refer to "the bit rate" as an input that will be compared to a "correction amount reducing range" when calculating a correction amount that will be used to determine a new bit rate for transmitting the content data from then on. Therefore, a POSITA would understand that

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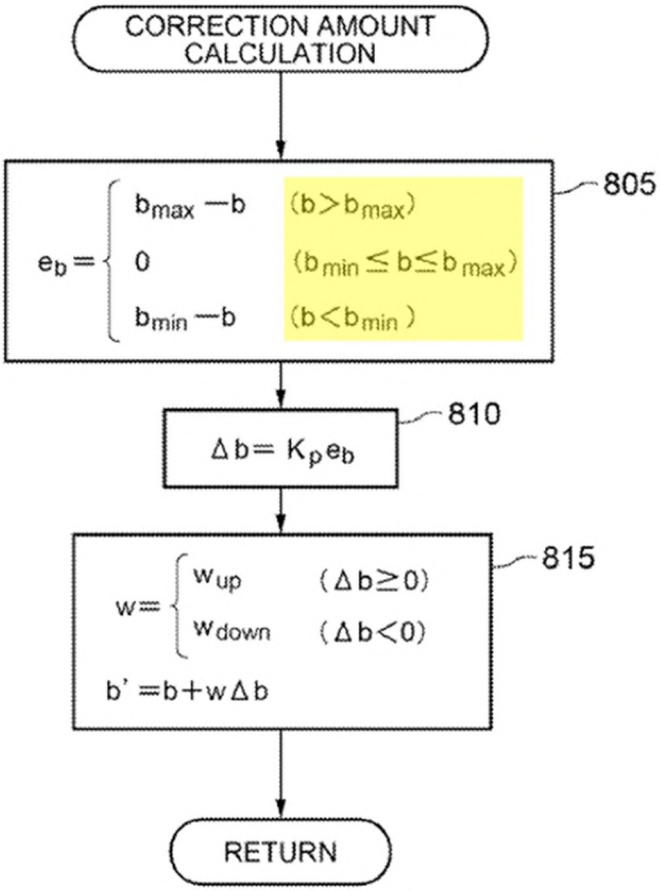
the "bit rate" is the bit rate that the server device is currently using to transmit the content data before applying any correction amount.

151. Further, the specification shows that when a bit rate is compared to a "correction amount reducing range," the bit rate that is used for the comparison is the bit rate of the content data currently transmitted. As discussed in Section IX.A.2 above, in block 805 of Figure 8 and Equations 19-21, a bit rate b is compared to the upper limit b_{max} and the lower limit b_{min} of a correction amount reducing range:

FIG. 8



$$e_b = b_{max} - b \text{ (if } b > b_{max}\text{)} \quad (19)$$

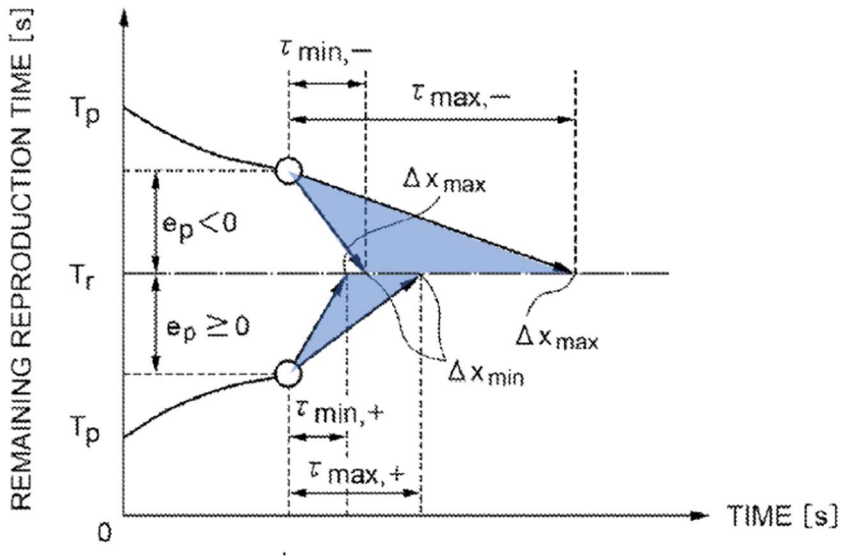
$$e_b = 0 \text{ (if } b_{min} \leq b \leq b_{max}\text{)} \quad (20)$$

$$e_b = b_{min} - b \text{ (if } b < b_{min}\text{)} \quad (21)$$

'809 Patent, Fig. 8, 13:21-26.

152. The specification clearly shows that this bit rate b that is compared to the correction amount reducing range is the bit rate of the content data currently transmitted. *See, e.g.*, *id.*, 13:27-30 (emphasis added) ("More specifically, when ***the bit rate b of the content data currently transmitted*** by the content transmitter 12 is smaller than the lower limit b_{min}, the bit rate correction unit 14 calculates a value $b_{min}-b$ by subtracting the bit rate b from the lower limit b_{min}, as the bit rate difference $e_b(=b_{min}-b)$."); 16:36-39 (emphasis added) ("Firstly, in step 805, the CPU calculates a bit rate difference e_b based on a bit rate b of content data being ***currently transmitted***, and the calculated upper limit b_{max} and lower limit b_{min} (step 805).").

153. A POSA would understand that in this patent, the bit rate of the content data currently transmitted is compared to the correction amount reducing range. As discussed in Section IX.A.2 above and shown in Figure 3 below, when the bit rate of the content data currently transmitted is within the correction amount reducing range, the rate of change of remaining reproduction time Δx would fall between Δx_{min} and Δx_{max} (i.e., inside the area shaded blue below):

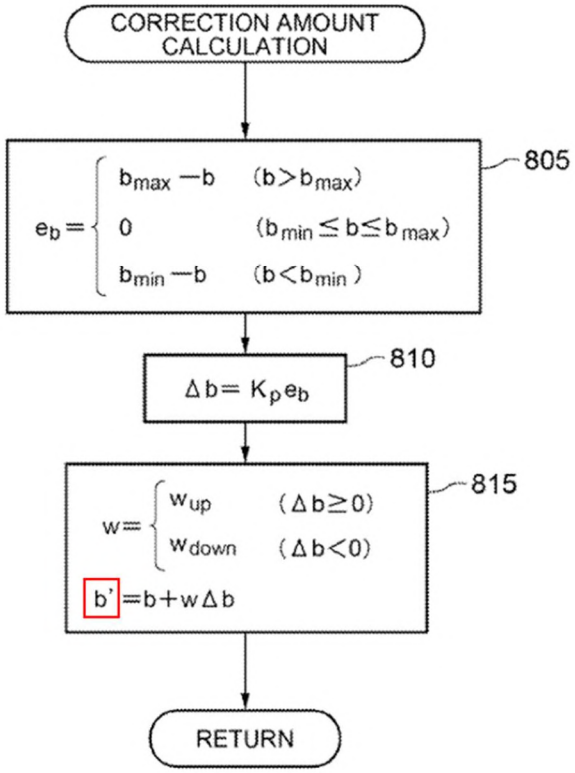


'809 Patent, Fig. 3 (annotated). Accordingly, the remaining reproduction time T_p is expected to reach the target value T_r within an acceptable time (between minimum and maximum τ) without any correction. Therefore, when the bit rate b of the content data currently transmitted is within the correction amount reducing range in block 805 of Figure 8 and Equation 20, the bit rate difference e_b is set to zero, which "corresponds to setting of the correction amount for the bit rate to zero." *Id.*, 13:39-42.

154. In fact, the specification differentiates "the bit rate b of the content data currently transmitted," *id.*, 13:27-31, from the "bit rate b' of content data transmitted by the server device 10 from then on." *Id.*, 13:66-14:2; *see also id.*, 16:43-47 (emphasis added) ("The CPU then calculates ***a bit rate b' of content data to be transmitted*** by the server device 10 from then on, on the basis of ***the bit rate b of the content data being currently transmitted*** and the calculated correction amount baseline value Δb (step 815)."). Whereas the bit rate b of the content data currently transmitted is compared to the correction amount reducing range during the correction amount calculation process, the bit rate b' of content data to be transmitted is only the output of

the correction amount calculation process, as shown in block 815 of Figure 8 and Equation 24 reproduced below:

FIG. 8



$$b' = b + w \cdot \Delta b \qquad (24)$$

Id., Fig. 8, 14:3. Importantly, the bit rate b' of content data to be transmitted is not compared to the correction amount reducing range in block 805 of Figure 8. Therefore, a POSITA would understand that "the bit rate" that is compared to the "correction amount reducing range" in the asserted claims of the '809 Patent is the bit rate b of the content data currently transmitted and not the bit rate b' of the content data to be transmitted.

155. Another embodiment in the specification confirms this understanding. The specification discloses the following equations in which the bit rate b is compared to the upper limit b_{max} and the lower limit b_{min} of a correction amount reducing range:

$$e_b=F_{Sup}(b)\ (b>b_{max}) \quad (37)$$

$$e_b=F_k(b)\ (b\in B_{Lim}(k),k=1, 2, \ldots, n-2) \quad (38)$$

$$e_b=F_{Inf}(b)\ (b<b_{min}) \quad (39)$$

Id. at 20:29-34. Referring to these equations, the specification states that "when ***the bit rate b of the content data currently transmitted*** by the server device 10 is within the correction amount reducing range, the bit rate difference e_b=0." *Id.*, 20:49-51 (emphasis added). The specification further states that the bit rate difference e_b calculated in Equations 37-39 will be used to calculate the bit rate b' of content data to be transmitted. *Id.*, 20:55-57 ("The method of calculating a bit rate b' of content data to be transmitted from then on based on the bit rate difference e_b is as described above."). Accordingly, a POSITA would understand that "the bit rate" that is compared to the "correction amount reducing range" in the asserted claims of the '809 Patent is the bit rate b of the content data currently transmitted and not the bit rate b' of the content data to be transmitted.

156. If "the bit rate" is understood as "the bit rate of the content data to be transmitted," then the claims' scope would include a bit rate correction amount calculation procedure that is not disclosed anywhere in the specification. As discussed above, the specification describes correction amount calculation procedures that compares the bit rate b of the content data currently transmitted. It does not disclose any correction amount calculation procedure in which the bit rate b' of content data to be transmitted is used as an input for the calculation.

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157. Therefore, "the bit rate" means "the bit rate of the content data currently transmitted."

2. "the calculated correction amount" ('809 Patent, claims 1, 18, 22, 26, 30)

Peloton's Proposed Construction	NEC's Proposed Construction
Indefinite under 35 U.S.C. § 112, ¶ 2	Not indefinite: Plain and Ordinary Meaning

158. Each of the apparatus claims 1, 18, 22, 26, and 30 specify either a "bit rate changing unit" (claims 1, 18, and 22) or a "bit rate change request transmission unit" (claims 26 and 30) that is ascribed the function of "changing the bit rate based on ***the calculated correction amount***." As written, however, these claims contemplate circumstances in which two distinct "correction amounts" will be "calculated." As a result, it is not clear to a person of ordinary skill what the term "the calculated correction amount" refers to. For this reason, the scope of the apparatus claims cannot be reasonably certain, and the claims are indefinite.

159. For context, in each of the claims at issue, the second-to-last limitation specifies that the bit rate changing unit "***calulat[es]***, according to a predetermined correction amount calculation procedure, ***a correction amount*** for correcting the bit rate of the content data transmitted by the server device based on the acquired remaining reproduction time and a preset target value . . ." I will refer to this first calculated correction amount as "***the Procedure Calculation.***" However, the last limitation in each of the claims specifies that, under a certain condition, a second "correction amount" is "calculated." Specifically, "when the bit rate is within a predetermined correction amount reducing range," then "the bit rate changing unit" is further "configured to ***calculate***…***a correction amount*** having a smaller magnitude than a magnitude of the correction amount calculated according to the correction amount calculation procedure." I will refer to this second calculated correction amount as "***the Smaller-Magnitude Calculation.***"

Notably, based on the way the claims are drafted, the Procedure Calculation is required to be performed regardless of whether or not the bit rate it falls within some "predetermined correction amount reducing range." Accordingly, in the event that the bit rate ***is*** within a "reducing range," it is unclear which of these two "calculated correction amounts" (*i.e.*, the Procedure Calculation or the Smaller-Magnitude Calculation) will be employed for the purpose of "changing the bit rate." I understand that if a term appearing in a claim is drafted in an unclear manner, such that it may be interpreted as referring to either one of two distinct terms recited elsewhere in the claim, then the claim may be invalid for indefiniteness for lacking proper antecedent basis. In my opinion, that is the circumstances here: when the claim recites "***the*** calculated correction amount," it is unclear which of the two calculations is being referenced.

160. Based on my review of the other claims, it appears that the unclear language used in the apparatus claims at issue was an intentional drafting choice by the applicant. For context, while claim 1 is directed to a "***delivery system***," claim 14 is directed to a "***delivery method applicable to a delivery system***," and recites method steps that are largely identical to the limitations of claim 1. In both claims, the Smaller-Magnitude Calculation is only made when the bit rate ***is within*** the reducing range. Importantly, in claim 14, the Procedure Calculation is only made when the bit rate is ***not within*** the predetermined correction amount reducing range, whereas in claim 1, the Procedure Calculation is not so confined. This difference is reflected in the following table:

Claim 1, excerpted (representative)	Claim 14, excerpted
. . . a bit rate changing unit for calculating, according to a predetermined correction amount calculation procedure, a	. . . when the bit rate is not within a predetermined correction amount reducing range, calculating a correction amount for

correction amount for correcting the bit rate of the content data transmitted by the server device based on the acquired remaining reproduction time and a preset target value so as to approximate the remaining reproduction time to the target value, and changing the bit rate based on the calculated correction amount, the bit rate changing unit being configured to calculate, *when the bit rate is within a predetermined correction amount reducing range*, a correction amount having a smaller magnitude than a magnitude of the correction amount calculated according to the correction amount calculation procedure.	correcting the bit rate of the content data transmitted by the server device according to a predetermined correction amount calculation procedure based on the acquired remaining reproduction time and a preset target value so as to approximate the remaining reproduction time to the target value, and *when the bit rate is within the correction amount reducing range*, calculating a correction amount for correcting the bit rate of the content data transmitted by the server device based on the acquired remaining reproduction time and the target value so as to approximate the remaining reproduction time to the target value, the correction amount having a smaller magnitude than a magnitude of the correction amount calculated according to the correction amount calculation procedure; and changing the bit rate of the content data transmitted by the server device based on the calculated correction amount.

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161. By including the additional highlighted, underlined language above (which is missing from the apparatus claims), method claim 14 avoids a situation in which two correction amounts may be calculated. I understand that Courts cannot rewrite the claims in order to avoid a finding of indefiniteness, particularly where (as here) the language appears to have been an intentional drafting choice by the applicant.

162. Based on the way the apparatus claims have been drafted, if a bit rate in a given delivery system fell within some "predetermined range," a person of ordinary skill would not know which of the two "calculated corrected correction amounts"—*i.e.*, the Procedure Calculation or the Smaller-Magnitude Calculation—must be employed "for changing the bit rate" in order to fall within the scope of the claims. Accordingly, in my opinion, the claims at issue are indefinite.

3. "bit rate changing unit" ('809 Patent, claims 1, 2, 8, 13, 18-20, 22-24)

Peloton's Proposed Construction	NEC's Proposed Construction
Means-plus-function term governed by 35 U.S.C. § 112, ¶ 6 Functions: *See* Joint Claim Construction Chart, ECF No. 82, at 19–27 Corresponding Structure: A central processing unit (CPU) programmed to carry out the algorithm disclosed in the '809 Patent as follows: "[T]he correction amount for the bit rate is calculated according to a procedure using the equations (1) to (9), the equation (19), the equation (21), the equation (22), and the equations (24) to (27),"15:5–9, which is also disclosed in Figures 7 and 8. These equations can be modified with Equations (28)–(42) as specified in 19:4–21:10.	Plain and Ordinary Meaning not subject to 35 U.S.C. § 112, ¶ 6

163. Based on my review, the claims, specification, and file history of the '809 Patent bear strong similarities to that of the '101 Patent, as it relates to the analysis of the means-plus-function terms in dispute. For that reason, my analysis for the "unit" terms of the '809 Patent

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largely mirrors my analysis for the "unit" terms of the '101 Patent. For the term "bit rate changing unit," the analysis is particularly similar to my above analysis for "code rate determining unit." *See* Section XIII.B.4.

a) "Bit rate changing unit" is a means-plus-function term

164. The claims of the '809 Patent that recites "bit rate changing unit" (claims 1, 18, and 22) ascribe two functions to that term: (1) "***calculating***" one or two "correction amount[s]"—specifically, the "Procedure Calculation" and the "Smaller-Magnitude Calculation" that I described above (*see* Section IX.B.2)[3] and (2) "***changing*** the bit rate based on the calculated correction amount." '809 Patent, cls. 1, 18, 22.[4] I have reviewed the Joint Claim Construction Chart that lists Peloton's proposal regarding the functions ascribed to "bit rate changing unit" as employed in both independent and dependent claims of the '809 Patent and concur with Peloton's proposed functions.

165. As of the priority date of the '809 Patent, the term "bit rate changing unit" was not a term of art that would connote a definite meaning as the name of the structure. Appending the word "*changing*" before unit simply implies that the function is to change something, and does not designate any particular structure. Nor does further appending the words "*bit rate*"

[3] As I discussed in Section IX.B.2, however, in my opinion the term "the calculated correction amount" is indefinite. That said, analysis I provide here for the term "bit rate changing unit" presumes that the term is somehow found to be sufficiently definite.

[4] The asserted dependent claims of the '809 Patent ascribe additional functions to the bit rate changing unit: "determin[ing] the correction amount reducing range based on [an] acquired reproduction speed" (claim 8); "set[ting] the correction amount to zero when a bit rate of content data being transmitted by the server device is within the correction amount reducing range" (claim 13); "determin[ing] the correction amount reducing range based on the received reception rate, the received remaining reproduction time, and the target value" (claims 19, 23); and "narrow[ing] the correction amount reducing range as the received remaining reproduction time approaches the target value" (claim 24). *Id.*, cls. 8, 13, 19, 23-24. In my opinion, these additional functions do not connote to a person of ordinary skill any more structure than the independent claims. Instead, if anything, they further demonstrate the term "bit rate changing unit" serves as a black box for performing the one or more functions ascribed to the term.

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before "changing unit," which only conveys *what* is being changed. Thus, to a person of ordinary skill in the art, the modifier "bit rate changing," which precedes the word "unit," connotes only function; it is equivalent to saying "unit for changing the bit rate". Put differently, term is not reasonably well understood by persons of ordinary skill in the art to refer to a particular structure or a class of structures.

166. A review of extrinsic evidence confirms that the term does not have a commonly known meaning that denotes structure. None of the technical dictionaries define the term "bit rate changing unit." *See* Microsoft Computer Dictionary 5th Ed. (2002); Wiley Electrical and Electronics Engineering Dictionary (2004). A search of U.S. patents in the U.S. Patent and Trademark Office's database, https://ppubs.uspto.gov/pubwebapp/, indicates that the term only appears in 4 other patent families. One such patent, U.S. 8,848,782 assigned to Sony, makes reference to a "*sum bandwidth* bit rate changing unit," which (in a circular fashion) is said be for "changing the sum bandwidth bit rate." This "unit" in the Sony patent does not perform the functions that the claimed "bit rate changing unit" claimed in the '809 Patent must perform. A singular reference to a "sum bandwidth bit rate changing unit" in one patent (excluding patents assigned to NEC) confirms that, as of the priority date of the '809 Patent, there were no commonly understood structures that could perform the functions ascribed to the "bit rate changing unit" here.

167. The remainder of the limitation that follows the term "bit rate changing unit" is also functional. It simply states the functions of the unit and does not impart any structure to perform the claimed functions. While the claims specify that the "Procedure Calculation" (one of the two potential calculations) is based on the "acquired remaining reproduction time" and a "preset target value," and that the "Smaller-Magnitude Calculation" (the other potential

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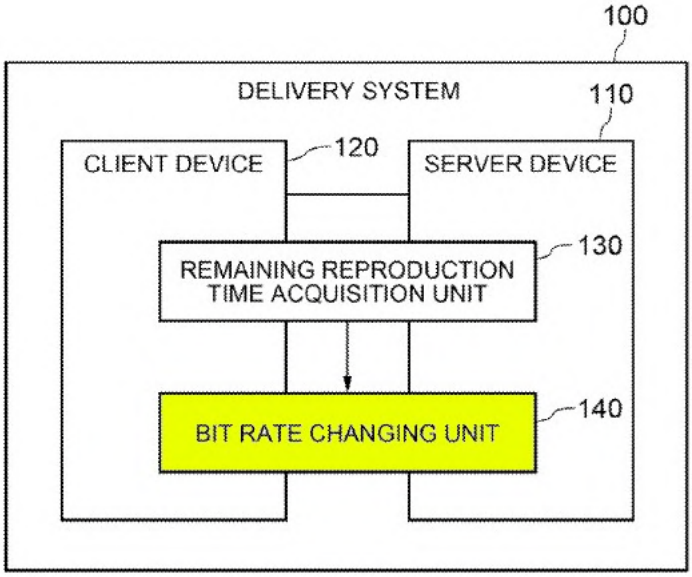
calculation) may be reduced in certain circumstances, '809 Patent, cls. 1, 18, 22, none of this language specifies structure for performing either calculation. There are no commonly understood structures for performing the ascribed functions.

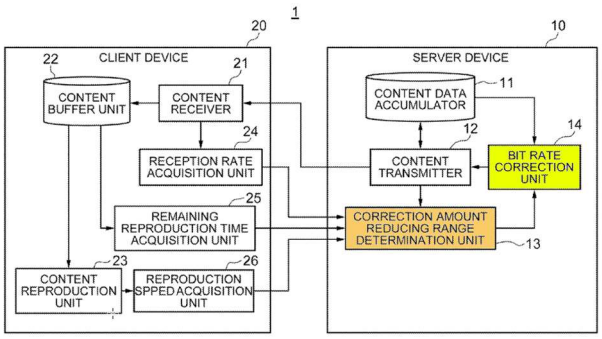
168. I further note that, like the "unit" terms for the '101 Patent, the "unit" terms for the '809 Patent use the word "unit" instead of "means," but are otherwise structured in the traditional means-plus-function format—following the format of "unit" + "for" + (statement of function(s))). This supports my view that "bit rate changing unit" is likewise a means-plus-function term.

169. The written description and figures in the '809 Patent also treat the "bit rate changing unit" simply as a black box for performing the recited functions. A "bit rate changing unit" only appears in Figure 12—as a generic, empty box that is part of the client device or the server device, lacking internal components in all cases, further confirming the black-box treatment of the disputed term.

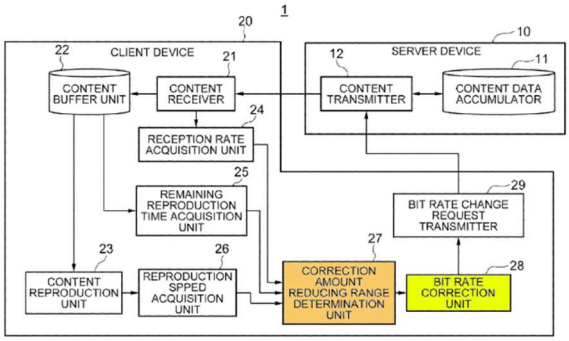


'809 Patent, Figure 12

170. The specification and figures also disclose a similar term, "bit rate *correction* unit." The specification describes this "unit" as being "*part of* [the] bit rate changing *means*," and as performing the function of "calculat[ing] a correction amount for correcting a bit rate." '809 Patent, 5:35-36, 13:12-20. The "bit rate correction unit" is shown in Figures 2 and 11 (highlighted yellow), in both cases also as a black box lacking internal components.



'809 Patent, Figure 2



'809 Patent, Figure 11

171. As seen above, Figures 2 and 11 also show yet another generic box—"*correction amount reducing range determination* unit" (highlighted orange). The specification describes this unit as being, somehow, "part of" four separate *means*: the "bit rate changing means, remaining reproduction time receiving means, reception rate receiving means, [and] reproduction speed receiving means." '809 Patent, 5:31-35. In my opinion, none of the specification disclosures provide structural clarity to the "bit rate changing unit," nor do they prove that the term was reasonably known to POSA to connote a definite structure. If anything, the descriptions and the figures add to the confusion.

172. To summarize, the sole reference to "bit rate changing unit" in the specification merely reiterates the functional language present in the claims. '809 Patent, 22:37-52. As further mentioned below, the '809 Patent discloses that the claimed function can be performed by a CPU and discloses an algorithm. However, that disclosure does not prove that the structure associated

with the unit was reasonably well known to POSA so as to connote a particular structure or a class of structures.

173. The ’809 Patent specification also repeatedly describes a “bit rate changing means” (approximately 66 times) and ascribes to it the exact same functional language that the claims ascribe to the “bit rate changing unit.” For example, the “Summary” section of the patent describes a “bit rate changing *means*” three times—first, as part of a delivery system at 2:2-14; second, as part of a sever device at 2:58-3:4; and third, as part of a program comprising instructions at 3:16-29—using the same functional language that is employed by the claims. The specification mirrors the same functional description of the “means” at 25:35-47 and again at 26:15-28.[5] The “*unit*” term is described only once and in the context of the Third Embodiment at 22:37-51, but importantly, it employs the same functional language that is used for the “means” term. Thus, as with the ’101 Patent, a POSA reading the specification would conclude that, within the context of the ’809 Patent, the words “unit” and “means” are synonymous, and therefore interchangeable.

174. Similarly, I note that claims 34 and 35 of the ’809 Patent recite a “bit rate changing *means*” in a delivery system and in a server device respectively. Likewise, claims 1 and 18 recite a “bit rate changing *unit*” in a delivery system and in a server device respectively. Both sets of claims employ the same functional limitations for the “unit” terms and for the “means”

[5] The specification also discloses embodiments that ascribe additional functions to the “bit rate changing means”— “determin[ing] the correction amount reducing range based on [an] acquired reproduction speed” (*e.g.*, ’809 Patent, 23:65-67); “set[ting] the correction amount to zero when a bit rate of content data being transmitted by the server device is within the correction amount reducing range” (*e.g.*, *id.*, 24:36-39); “determin[ing] the correction amount reducing range based on the received reception rate, the received remaining reproduction time, and the target value” (*e.g.*, *id.*, 23:8-12); and “narrow[ing] the correction amount reducing range as the received remaining reproduction time approaches the target value” (*e.g.*, *id.*, 23:15-18).

terms. In my opinion, this further suggests that a POSA reading '809 Patent would conclude that the words "unit" and "means" are synonymous and interchangeable in the context of this patent.

175. For additional context, the file history for the '809 Patent (similar to that of the '101 Patent) indicates that the claims at issue were originally drafted to recite "bit rate changing means," but the applicant amended certain pending claims to change the word "means" to "unit" and left the relevant functional language intact. D.I. 83 (Ex. 5) at 843-55 ('809 Patent File History, Preliminary Amendment). As with the '101 Patent "unit" terms, whether or not the word "means" or "unit" is used, the fact that the same functional language is ascribed to both "bit rate changing means" and "bit rate changing unit" indicates that a POSA would understand both terms to connote insufficient structure. Stated differently, simply swapping the word "means" for "unit" does not lend any more structural support to the "unit" term.

176. Thus, it is my understanding that the term "bit rate changing unit" is a means-plus-function term that requires disclosure of corresponding structure.

b) Corresponding structure for the claimed function

177. I understand that Peloton has proposed that the following structure as disclosed in the specification is sufficient to perform the functions ascribed to the "bit rate changing unit."

> A central processing unit (CPU) programmed to carry out the algorithm disclosed in the '809 Patent as follows: "[T]he correction amount for the bit rate is calculated according to a procedure using the equations (1) to (9), the equation (19), the equation (21), the equation (22), and the equations (24) to (27)," 15:5-9, which is also disclosed in Figures 7 and 8. These equations can be modified with Equations (28)-(42) as specified in 19:4-21:10.

178. As mentioned above, the '809 patent mentions that the functions attributed to a server unit and a client device can be realized by a CPU executing a program stored in the storage device. I have summarized above the equations (in particular, equations 1 through 9, 19,

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21, 22, and 24) that are employed in the specification to change the bit rate. I have also summarized above that these equations are mirrored in the flow charts depicted in Figures 7 and 8. I have also summarized above that the '809 Patent discloses another embodiment that employs a few constants used in calculating the bit rate. That embodiment is described through equation 28 to 42. When discussing the disclosure of the '809 Patent above, I explained in detail how the algorithm and the equations to update the bit rate operate through the disclosure in the specification and relevant figures. I incorporate that discussion in this section. Thus, I agree that the structure identified by Peloton is sufficient to perform the functions of the "bit rate changing unit." As such, I agree with Peloton's identification of corresponding structure for "bit rate changing unit."

4. "bit rate change request transmission unit" ('809 Patent, claims 26, 27, 30, 31)

Peloton's Proposed Construction	NEC's Proposed Construction
Means-plus-function term governed by 35 U.S.C. § 112, ¶ 6 Functions: *See* Joint Claim Construction Chart, ECF No. 82, at 28–33 Corresponding Structure: A central processing unit (CPU) programmed to carry out the algorithm disclosed in the '809 Patent as follows: The structure for the "bit rate changing unit" and 21:57–62	Plain and Ordinary Meaning not subject to 35 U.S.C. § 112, ¶ 6

179. The term "bit rate change *request transmission* unit" appears in claims 26 and 30, which are directed "client device[s]." These claims are analogous to claims 18 and 22, which are directed to "server device[s]," and include the term "bit rate changing unit." According to the '809 Patent, in the client devices, a request is transmitted to the server to make the necessary bit rate change. Accordingly, the "bit rate change request transmission unit," along with my analysis

for that term, is analogous to the "bit rate changing unit" and my corresponding analysis for that term.

a) "Bit rate change request transmission unit" is a means-plus-function term

180. The claims of the '809 Patent that recite "bit rate change request transmission unit" (claims 26 and 30) ascribe two distinct functions to the "bit rate change request transmission unit" term—(1) "***calculating***" one or two "correction amount[s]"—again, the "Procedure Calculation" and the "Smaller-Magnitude Calculation," identical to the "calculating" function ascribed to the "bit rate changing unit" (*see* Sections IX.B.2-3)[6] and (2) "***transmitting*** a bit rate change request for changing the bit rate" to the server device. '809 Patent, cls. 26 and 30.[7] I have reviewed the Joint Claim Construction Chart that lists Peloton's proposal regarding the functions ascribed to "bit rate change request transmission unit" as employed in both independent and dependent claims of the '809 Patent and concur with Peloton's proposed functions.

181. As of the priority date of the '809 Patent, the term "bit rate change request transmission unit" was not a term of art that would connote a definite meaning as the name of the structure. Similar to "bit rate changing unit" discussed above, to a person of ordinary skill in the

[6] As I discussed in Section IX.B.2, however, in my opinion the term "the calculated correction amount" is indefinite. As with "bit rate changing unit," the analysis I provide here for the term "bit rate change request transmission unit" presumes that the term is somehow found to be sufficiently definite.

[7] Dependent claims 27 and 31 ascribe an additional function to the bit rate change request transmission unit: "determin[ing] the correction amount reducing range based on the received reception rate, the received remaining reproduction time, and the target value." In my opinion, this additional function does not connote to a person of ordinary skill any more structure than the independent claims. Instead, if anything, they further demonstrate the term "bit rate change request transmission unit" serves as a black box for performing the one or more functions ascribed to the term.

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art, the modifier "*bit rate change request transmission*," which precedes the word "unit," connotes only function; it is equivalent to saying "unit for transmitting a request to change the bit rate." Put differently, term is not reasonably well understood by persons of ordinary skill in the art to refer to a particular structure or a class of structures. To the extent the term implies any structure, it would be limited to structure for transmitting a request. A person of ordinary skill would not understand such structure to include any structure to calculating the specified "correction amounts."

182. As with "bit rate changing unit," a review of extrinsic evidence confirms that the term lacks a well-known meaning that connotes structure. None of the technical dictionaries define the term "bit rate change request transmission unit." *See* Microsoft Computer Dictionary 5th Ed. (2002); Wiley Electrical and Electronics Engineering Dictionary (2004). A search of U.S. patents in the U.S. Patent and Trademark Office's database, https://ppubs.uspto.gov/pubwebapp/, indicates that the term does not appear in any other patents, thereby confirming that the term was coined by the inventors or by NEC. The absence of any mention of a "bit rate change request transmission unit" in any patents (excluding patents assigned to NEC) confirms that, as of the priority date of the '809 Patent, there were no commonly understood structures that could perform the functions ascribed to the "bit rate change request transmission unit" here.

183. The remainder of the limitation that follows the term "bit rate changing unit" is also functional. It simply states the functions of the unit and does not impart any structure to perform the claimed functions. As with the claims reciting the "bit rate changing unit" (claims 1, 18, and 22), the claims reciting "bit rate change request transmission unit" (claims 26 and 30) specify that the "Procedure Calculation" (one of the two potential calculations) is based on the

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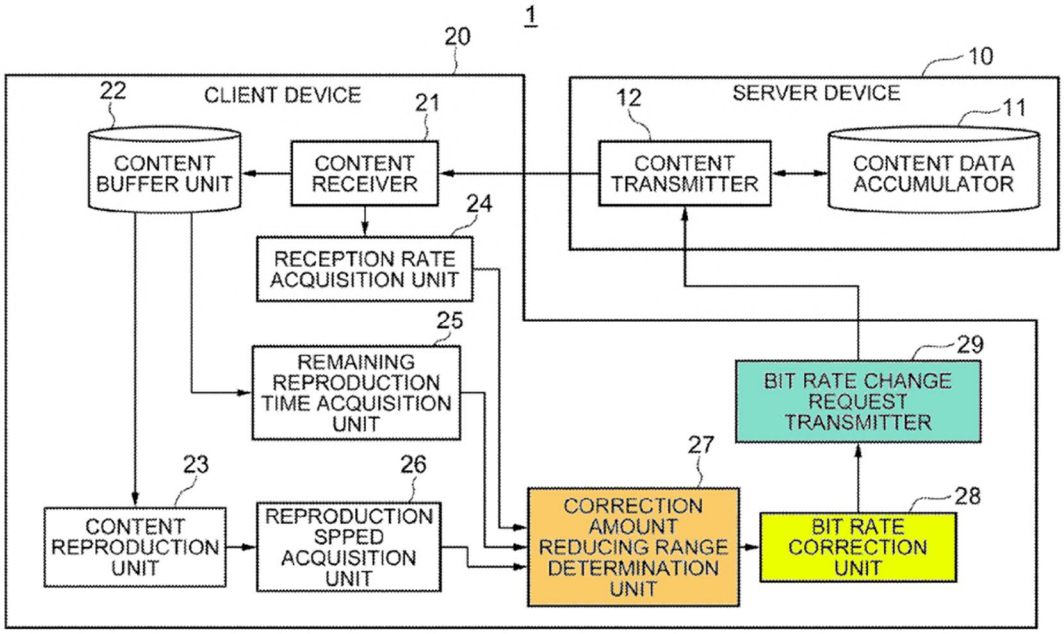
"acquired remaining reproduction time" and a "preset target value," and that the "Smaller-Magnitude Calculation" (the other potential calculation) may be reduced in certain circumstances. '809 Patent, cls. 26, 30. But again, none of this language specifies structure for performing either calculation. There are no commonly understood structures for performing both ascribed functions.

184. I further note that, while the term uses the word "unit" instead of "means," it is otherwise structured in the traditional means-plus-function format—following the format of "unit" + "for" + (statement of function(s))). Again, this supports my view that "bit rate change request transmission unit" is likewise a means-plus-function term.

185. The written description and figures in the '809 Patent likewise treat the "bit rate change request transmission unit" as functional rather than structural. For context, the specification does not mention a "bit rate change request transmission *unit*," but it repeatedly describes a "bit rate change request transmission *means*" (approximately 11 times) and ascribes the same functional language to the "means" term as the claims at issue ascribe to the "unit" terms. For instance, the "Summary" section discloses a "bit rate change request transmission *means*" as part of a client device at 3:43-57 and then as part of program at 4:4-20. The Third embodiment of the specification also describes the term at 26:66-27:13 and again at 27:50-65.[8] This further confirms that a POSA would find the words "unit" and "means" are synonymous, and therefore interchangeable, within the context of the '809 Patent.

[8] The specification also discloses embodiments that ascribe an additional function to the "bit rate change request transmission means"—"determin[ing] the correction amount reducing range based on the received reception rate, the received remaining reproduction time, and the target value." *E.g.*, '809 Patent, 27:17-21.

186. Importantly, the specification explains that the analogous "bit rate change request transmission *means*," actually includes *three* black components—the "correction amount reducing range determination unit 27," the "bit rate correction unit 28," and the "bit rate change request transmitter 29." *See* '809 Patent, 21:32-36. Figure 11 shows all three components (orange, yellow, and green, respectively)—each one depicted as a generic, empty box that is part of the client device, lacking internal components. '809 Patent, 21:47-50.



'809 Patent, Figure 11

187. In my opinion, the fact that each component corresponds to a function ascribed to the claimed "bit rate change request transmission unit" (*i.e.,* the two "calculations," and the transmission) and that each component is depicted as a "black box" in Figure 11, underscores that disputed term is non-structural, or at least that it connotes insufficient structure to perform the ascribed functions. Further to the extent that Figure 11 implies input or output connections related to the "bit rate change request transmission unit," this does not provide sufficient structural support for the disputed term.

188. As further mentioned below, the ’809 Patent discloses that the claimed function can be performed by a CPU and discloses an algorithm. However, that disclosure does not demonstrate that the structure associated with the “bit rate change request transmission unit” was reasonably well known to POSA so as to connote a particular structure or a class of structures.

189. I also note that claim 36 of the ’809 Patent recites a “bit rate change request transmission *means*” in a client device. Likewise, claim 26 recites a “bit rate changing *unit*” in a client device. Both claims employ the same functional limitations for the “means” term and for the “unit” term, respectively. In my opinion, this further suggests that a POSA reading ’809 Patent would conclude that the words “unit” and “means” are synonymous and interchangeable in the context of this patent.

190. Further, as with “bit rate changing unit,” the file history for the ’809 Patent indicates that the claims at issue were originally drafted to recite “bit rate changing means,” but the applicant amended certain pending claims to change the word “means” to “unit” and left the relevant functional language intact. D.I. 83 (Ex. 5) at 843-55 (’809 Patent File History, Preliminary Amendment). As with the previous disputed “unit” terms, the fact that the same functional language is ascribed to both “bit rate change request transmitting means” and “bit rate change request transmitting unit” indicates that a POSA would understand both terms to connote insufficient structure, as simply swapping the word “means” for “unit” does not lend any more structural support to the “unit” term.

191. Thus, it is my understanding that the term “bit rate changing unit” is a means-plus-function term that requires disclosure of corresponding structure.

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b) Corresponding structure for the claimed function

192. I understand that Peloton has proposed that the following structure as disclosed in the specification is sufficient to perform the functions ascribed to "bit rate change request transmission unit."

> A central processing unit (CPU) programmed to carry out the algorithm disclosed in the '809 Patent as follows: The structure for the "bit rate changing unit" and 21:57-62.

193. To the extent the proposed structure implicates the structure for "bit rate changing unit," I have described above how the proposed structure is sufficient to perform the functions for that unit. However, the "bit rate change request transmission unit" has the additional function of transmitting the bit rate change request for changing the bit rate to the server device. The specification at 21:57-62 discloses a content transmitter configured to transmit content data to a client devices and specifies the various protocol that may be employed to effect that transmission. When discussing the disclosure of the '809 Patent above, I explained in detail how the algorithm and the equations to update the bit rate operate through the disclosure in the specification and relevant figures. I incorporate that discussion in this section. Based on my review, I conclude that the structure identified at 21:57-62 is sufficient to perform the transmit functions of the unit.

5. "remaining reproduction time acquisition unit" ('809 Patent, claims 1, 26, 30)

Peloton's Proposed Construction	NEC's Proposed Construction
Means-plus-function term governed by 35 U.S.C. § 112, ¶ 6 Functions: *See* Joint Claim Construction Chart, ECF No. 82, at 33–35 Corresponding Structure: A general purpose computer or microprocessor programmed to carry out the algorithm disclosed in the '809 Patent at 6:46–7:5	

a) "Remaining reproduction time acquisition unit" is a means-plus-function term

194. The claims of the '809 Patent specify that the function of the "remaining reproduction time acquisition unit" is to acquire "remaining reproduction time" based on "the data stored in the storage device." '809 Patent cls. 1, 26 and 30. I have reviewed the Joint Claim Construction Chart that lists Peloton's proposal regarding the functions ascribed to the "remaining reproduction time acquisition unit" as employed in the claims of the '809 Patent and concur with Peloton's proposed functions.

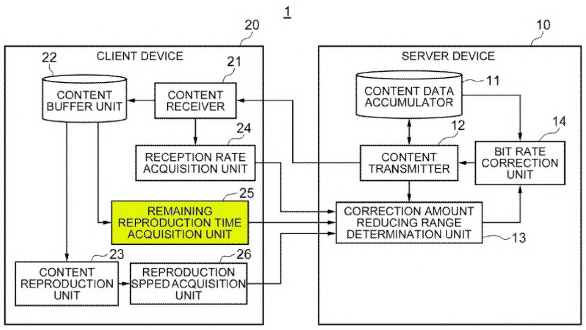
195. As of the priority date of the '809 Patent, the term "remaining reproduction time acquisition unit" was not a term of art that would connote a definite meaning as the name of the structure. To a person of ordinary skill in the art, the modifier "remaining reproduction time acquisition," which precedes the word "unit," connotes only function; it is equivalent to saying "unit for acquiring remaining reproduction time." Put differently, term is not reasonably well understood by persons of ordinary skill in the art to refer to a particular structure or a class of structures.

196. A review of extrinsic evidence confirms that the term lacks a well-known meaning that connotes structure. None of the technical dictionaries define the term "remaining reproduction time acquisition unit." *See* Microsoft Computer Dictionary 5th Ed. (2002); Wiley Electrical and Electronics Engineering Dictionary (2004). A search of U.S. patents in the U.S. Patent and Trademark Office's database, https://ppubs.uspto.gov/pubwebapp/, indicates that the term is used only by patents assigned to NEC, thereby confirming that the term was coined by the inventors or by NEC. The absence of any reference to a "remaining reproduction time acquisition unit" in any patents (excluding patents assigned to NEC) confirms that, as of the priority date of the '809 Patent, there were no commonly understood structures that could

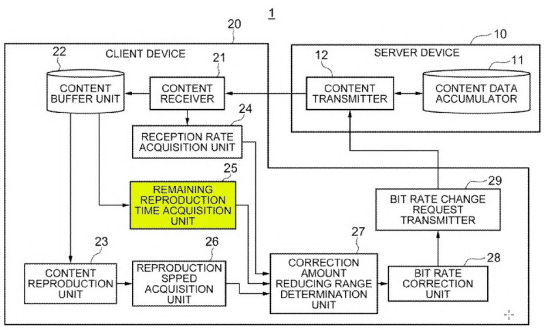
perform the functions ascribed to the "remaining reproduction time acquisition unit" here. The remainder of the limitation that follows the term "remaining reproduction time acquisition unit" is also functional. It simply states the functions of the unit and does not impart any structure to perform the claimed functions. I note that the claims specify that the remaining reproduction time is calculated based on "data stored in the storage device." '809, cls. 1, 26, 30. In my opinion, however, this language does not specify structure for performing the function of "acquiring." The additional language merely clarifies the structure in which data is stored—*i.e.*, storage device.

197. As with all of the other terms involving a § 112, ¶ 6 dispute, while the term uses the word "unit" instead of "means," it is otherwise structured in the traditional means-plus-function format—following the format of "unit" + "for" + (statement of function(s))). This supports my view that "remaining reproduction time acquisition unit" is likewise a means-plus-function term.

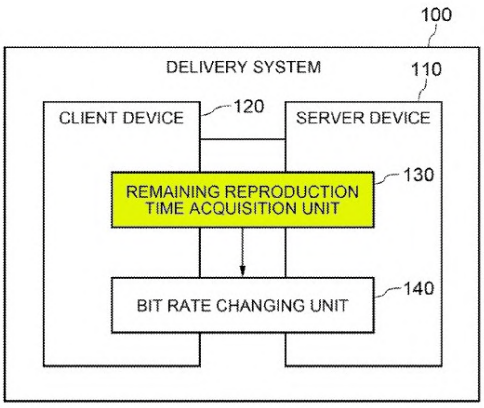
198. The '809 Patent treats the "remaining reproduction time acquisition unit" simply as a black box for performing the recited functions. The "remaining reproduction time acquisition unit" is shown in Figures 2, 11, and 12 (below, highlighted)— as a generic, empty box that is part of the client device and/or server device, lacking internal components in all cases, further confirming the black box treatment of the term.



'809 Patent, Figure 2



'809 Patent, Figure 11



’809 Patent, Figure 12

199. As further mentioned below, the ’809 Patent discloses that the claimed function can be performed by a CPU and discloses an algorithm. However, that disclosure does not demonstrate that the structure associated with the unit was reasonably well known to a POSA so as to connote a particular structure or class of structures.

200. The ’809 Patent specification also describes a “remaining reproduction time acquisition *means*” and ascribes to it the exact same functional language that the claims ascribe to the “remaining reproduction time acquisition *unit.*” For instance, the “Summary” section refers to the “remaining reproduction time acquisition *means*” three times—first as part of a delivery system at 1:64-2:2; second, as part of a client device at 3:38-43; and finally, as a program comprising instructions at 3:67-4:4—the same functional language that is employed by the claims at issue. The specification also describes a “remaining reproduction time acquisition *unit*” at 22:31-36 while employing the same language to describe the function. This further establishes that a POSA reading the specification would conclude that the words “unit” and “means” are synonymous, and therefore interchangeable, within the context of the ’809 Patent.

201. Similarly, I note that claims 34 and 35 of the ’809 Patent recite a “remaining reproduction time acquisition *means*” as part of a server device and a client device respectively.

Likewise, claims 1, 26 and 30 recite a "remaining reproduction time acquisition *unit*" in a delivery system and client device, respectively. Both sets of claims employ the same functional limitation for the "unit" terms and for the "means" terms. In my opinion, this further suggests that a POSA reading '809 Patent would conclude that the words "unit" and "means" are synonymous and interchangeable in the context of this patent.

202. Further, the file history for the '809 Patent indicates that the claims at issue were originally drafted to recite "remaining reproduction time acquisition means," but the applicant amended certain pending claims to change the word "means" to "unit" and left the relevant functional language intact. D.I. 83 (Ex. 5) at 843-55 ('809 Patent File History, Preliminary Amendment). As with all of the other "unit" terms at issue in this case, whether or not the word "means" or "unit" is used, the fact that the same functional language is ascribed to both "remaining reproduction time acquisition means" and "remaining reproduction time acquisition unit" indicates that a POSA would understand both terms to connote insufficient structure, and simply swapping the word "means" for "unit" does not lend any more structural support to the "unit" term.

203. Thus, it is my understanding that the term "bit rate changing unit" is a means-plus-function term that requires disclosure of corresponding structure.

b) Corresponding structure for the claimed function

204. I understand that Peloton has proposed that the following structure as disclosed in the specification is sufficient to perform the functions ascribed to "remaining reproduction time acquisition unit."

> A general purpose computer or microprocessor programmed to carry out the algorithm disclosed in the '809 Patent at 6:46-7:5.

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205. As mentioned above, the ’809 Patent mentions that the functions attributed to a server unit and a client device can be realized by a CPU executing a program stored in the storage device. The portion of the specification at 6:46-7:5 describes the structure that calculates the remaining production time based on the unreproduced content data in the buffer storage. The algorithm also takes into account the situation where the portions of content may have different bit rate. Different bit rates imply different playback time for the same amount of content data. In addition to providing exemplary values, the excerpt from specification also provides the calculations that need to be performed to calculate the remaining reproduction time. When discussing the disclosure of the ’809 Patent above, I explained in detail how the algorithm and the equations to update the bit rate operate through the disclosure in the specification and relevant figures. I incorporate that discussion in this section for larger context and to highlight the role “remaining reproduction time acquisition unit” plays. Based on my review, I conclude that the disclosed structure is sufficient to perform the functions of the “remaining reproduction time acquisition unit.”

X. The ’427 Patent

A. Overview

206. The ’427 Patent describes “a content delivery system transmitting content data representing content to user equipment.” ’427 Patent, 1:5-7. As the patent notes, content delivery systems including a content transmitter, content receiver, and a connection controller (embodied here as a SIP (Session Initiation Protocol) server) were already known at the time of the invention. *Id.*, 1:11-13.

207. According to the patent, an object of the invention was to “provide a content delivery system capable of solving the problem that it is impossible to cause a user to view the user’s desired content and/or advertisement content selected according to the user.” *Id.*, 1:48-52.

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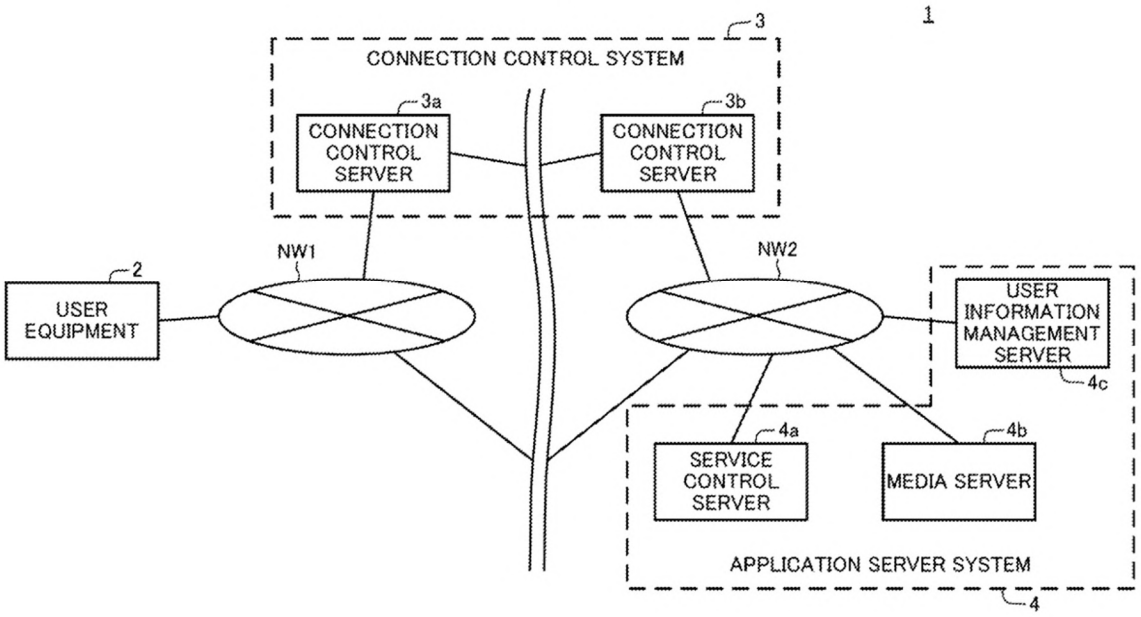
Specifically, the ’417 Patent describes systems and methods for providing dynamic advertisement insertion into delivered content.

208. Figure 1 presents a schematic configuration of a first preferred embodiment of this content delivery system for Video-on-Demand:

Fig.1



The figure identifies the user equipment (transmitting content requests), connection control system (acting as a sort of middle man helping to establish a connection), and the application server system (storing and transmitting the content requested by the user, as well as dynamically inserting advertisement content). *See id.*, 1:53-2:11.

209. The ’417 Patent describes a process by which the application server system selects advertisements to be inserted into the content requested by the user equipment. Figure 3 showcases what the patent identifies as “user basic information,” or, “a plurality of information sets consisting of advertisement attribute information and priority information representing priority levels (in this example, indicated by integer values which increase as the priority level rises).” *Id.*, 9:12-27.

Fig.3

ADVERTISEMENT ATTRIBUTE INFORMATION	PRIORITY INFORMATION
CAR	1
REAL ESTATE	2
TRAVEL	4
INSURANCE	5
CELL-PHONE	3
COFFEE	3
GADGET	4
⋮	⋮

In this way, the application server system can consult the user's known preferences in order to inform its choice as to what advertisements to insert into the requested content.

210. Once the application server system determines which advertisements should be inserted into the requested content, it uses this information to create a playlist which indicates the sequence in which the main (requested) content and advertisement content will be output. *Id.*, 6:57-62. The main content is split at various intervals and the advertisement content is inserted between these segments. The patent identifies these segments either using reproduction start positions and reproduction end positions, or by storing the main content in segments along the lines where advertisement content is to be inserted. *Id.*, 35:22-32.

211. Several examples are given of the first scheme, where the playlist contains the reproduction start positions and reproduction end positions indicating the sequence in which content will be played and the lines along which the main content is divided for inserting the advertisement content between segments. Figures 7-11 showcase an example playlist, e.g., "content1;0;300,adv1;0;30,content1;301;600,adv2;0;30, content1;601;900" being transmitted

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from the application server system to the user equipment through the connection control server using various pieces of a SIP "INVITE" message. *See id.*, Figs. 7-11. The playlist represents five portions of content, each separated by commas: a first portion of content1, adv1, a second portion of content1, adv2, and a third portion of content1. *Id*., 14:49-64. The two numbers adjoining each content portion, separated by semi-colons, represent the reproduction start positions and reproduction end positions of each content portion. The second portion of content1 starts reproduction where the first portion of content1 ended reproduction, as shown by the reproduction end position of "300" for the first portion, and the reproduction start position of "301" for the second portion. *Id.* Reproduction of content1 resumes again at reproduction start position "601" after adv2. The user equipment then uses this playlist in order to transmit its content viewing requests to the application server system. *Id*., 16:48-56.

B. Opinions on claim terms

1. "sub content" / "sub content data" ('427 Patent, claims 1, 4, 5, 14-18, 20, 22, 32, 34-36)

Peloton's Proposed Construction	NEC's Proposed Construction
"advertisement" / "advertisement data"	Plain and Ordinary Meaning Alternatively: content in addition to the main content / content data

a) Peloton's construction is correct and supported by the specification.

212. In my opinion, a person of ordinary skill in the art at the time of the invention would have understood the term "sub content" / "sub content data" as used in the '427 Patent to mean "advertisement" / "advertisement data." The invention is consistently described throughout the patent as relating to the insertion of advertisements into a content delivery system. This is seen in the abstract, through the figures, and the entirety of the specification, including all

embodiments. The term "sub content," or "sub content data," never appears anywhere outside of the claim language.

213. The first thing a person of ordinary skill in the art would see upon review of the '427 Patent is the cover page, which identifies the concept of dynamic advertisement selection central to the invention of the patent. *See* '427 Patent, Abstract ("The AP system (4) selects advertisement content based on advertisement selection information."). The abstract does not identify any "sub content" or "sub content data."

214. The patent also provides several statements of the invention itself of the '427 Patent that describe the central focus of advertisements. In each of the seven instances where the invention is described, the dynamic content selected by the application server system is described as advertisements only. *See id.*, 1:48-52 (". . . advertisement content selected according to the user."), 1:53-2:11 (". . . selected advertisement content data . . ."), 2:12-46 (same), 2:47-67 (same), 3:1-19 (same), 3:20-36 (same), 3:37-39 (". . . advertisement content selected according to the user."). The '427 Patent does not identify any "sub content" or "sub content data" when describing the invention.

215. The figures accompanying the '427 Patent also repeatedly identify the selection and transmission of advertisements in the invention. Figures 2, 14, and 17 identify the storage of advertisement information in the service control functions part of the application server system. Figure 3, as described above, identifies "advertisement attribute information" to be used by the application server system to determine what advertisements to insert into the main content. Figure 6, a sequence diagram showing the operation of the content delivery system, refers repeatedly to advertisement content. Figures 7–10 are example SIP "INVITE" messages used as part of the process to set up a session between the user equipment and the application server,

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which include a playlist indicating a sequence of main content and advertisement content to be output. The playlist refers to advertisements (indicated as, e.g., "adv1" and "adv2") that are included in this sequence in between segments of the main content ("content1" in Figures 7–10). The figures do not identify any "sub content" or "sub content data."

216. Each of the embodiments described in the specification is described in relation to the dynamic selection and insertion of advertisements. The majority of the specification is dedicated to describing what the patent identifies as the First Embodiment. *See id.*, 4:50-20:18. The First Embodiment is described with extensive reference to advertisements. *Id.* The same is true for each of the embodiments that follow. *See id.*, 20:22-21:9 (First Modification of the First Embodiment), 21:13-22:8 (Second Modification of the First Embodiment), 22:12–25:37 (Second Embodiment), 25:41-27:67 (Third Embodiment), 28:3-31:4 (Fourth Embodiment). The specification, including its description of each of these embodiments, does not identify any "sub content" or "sub content data."

217. Thus, it is my understanding that a person of ordinary skill in the art would understand that "sub content" / "sub content data" as used in the '427 Patent means "advertisement" / "advertisement data."

b) NEC's interpretation of the term is incorrect.

218. I understand that NEC disputes that that the term content refers to advertisements, or advertisement data, and argues that it should more broadly be understood as "content in addition to the main content" / "content data." This interpretation does not agree with the specification of the '427 Patent. As discussed above, the term "sub content" never appears once in the specification. Moreover, NEC presents no reason why a person of ordinary skill in the art would understand "sub content" to mean "content in addition to the main content." By contrast, advertisement content is referenced over 400 times throughout the specification, including in

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every embodiment, and in every statement broadly discussing the invention of the '427 Patent as a whole.

2. "sub content . . . is inserted in main content" ('427 Patent, claims 1, 14, 16, 18, 20, 22)

Peloton's Proposed Construction	NEC's Proposed Construction
"sub content . . . is placed in between main content"	Plain and Ordinary Meaning

a) Peloton's construction is correct and supported by the specification.

219. In my opinion, a person of ordinary skill in the art at the time of the invention would have understood the term "sub content . . . is inserted in main content" as used in the '427 Patent to mean "sub content . . . is placed in between main content." As I describe above in Section X.A, the order in which the advertisement content and the main content are output is conveyed via a playlist. The '427 Patent makes clear that the different content portions identified through the playlist are intended to be output one after the other in a sequence, where the advertisement content is placed in between the main content. The playlist I identify above, "content1;0;300,adv1;0;30,content1;301;600,adv2;0;30, content1;601;900," illustrates this. The main content requested by the user equipment, "content1," is segmented into three pieces: content1 from positions 0 to 300, content1 from positions 301 to 600, and content1 from positions 601 to 900. Two advertisements, adv1 and adv2, are placed in between the main content. *See id.*, 14:49-64.

220. The same is true for all embodiments of the invention. Where the invention does not rely on reproduction start and end positions to indicate where the advertisements should be inserted, it teaches physically storing the segmented portions of the main content separately to achieve the same effect. *See id.*, 35:22-32.

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b) NEC's interpretation of the term is incorrect.

221. I understand that NEC disputes that that the term content refers to sub content, or advertisements, being placed in between main content. Though NEC offers no explanation of its purported "plain and ordinary meaning" of the term, I understand that it has interpreted overlaying video and audio content together as "inserting" sub content in main content. This interpretation does not agree with the specification of the '427 Patent. As discussed above, the '427 Patent uses the term to describe the process of creating a dynamic playlist where advertisements break up, or are placed between, segments of main content. Any sort of "plain and ordinary meaning" that incorporates overlaying content does not adhere to the term's meaning as it is used in the '427 Patent. The patent teaches that a playlist of a *sequence* of main content and sub content—'427 Patent, 6:57-62—is created by the application server system, with either delineated reproduction start and end times to indicate where the advertisements are placed in between main content, or physical breaks delineated by separately maintained files to perform the same function—*id.*, 35:22-32. NEC provides no explanation as to why a person of ordinary skill in the art would have understood these teachings as conveying that "inserting" sub content in main content includes a process of overlaying different types of content.

I hereby certify that the facts set forth above are true and correct to the best of my personal knowledge, information, and belief, subject to the penalty of perjury.

Dated: December 1, 2023

By: Kevin C Almeroth
Kevin C. Almeroth, Ph.D.

Appendix 1

Kevin C. Almeroth

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Education

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

Employment History

Professor Emeritus	Department of Computer Science University of California Santa Barbara, CA	Nov 2020 -- present
Professor	Department of Computer Science University of California Santa Barbara, CA	Jul 2005 -- Oct 2020
Associate Dean	College of Engineering University of California Santa Barbara, CA	Mar 2007 -- Aug 2009
Vice Chair	Department of Computer Science University of California Santa Barbara, CA	Jul 2000 -- Nov 2005

Associate Professor	Department of Computer Science University of California Santa Barbara, CA	Jul 2001 -- Jun 2005
Assistant Professor	Department of Computer Science University of California Santa Barbara, CA	Jul 1997 -- Jun 2001
Graduate Researcher	Broadband Telecommunications Center Georgia Center for Adv Telecom Tech Atlanta, GA	Sep 1996--Jun 1997
Graduate Intern	IBM T.J. Watson Research Labs Hawthorne, NY	Jun 1995--Sep 1995
Support Specialist	Office of Information Technology Georgia Institute of Technology Atlanta, GA	Sep 1995--Jun 1997
Research Assistant	College of Computing Georgia Institute of Technology Atlanta, GA	Jan 1994--Mar 1994
Graduate Intern	Hitachi Telecommunications Norcross, GA	Jun 1992--Sep 1992
Undergraduate Intern	IBM Research Triangle Park, NC	Jun 1989--Sep 1989 Jun 1990--Sep 1990 Mar 1991--Sep 1991

Industry Technical Advising

Board of Directors	The New Media Studio Santa Barbara, CA	Nov 2006 -- present
Co-Founder & Chairman of the Board	Santa Barbara Labs, LLC Santa Barbara, CA	Sep 2007 -- Dec 2009
Board of Advisors	Techknowledge Point Santa Barbara, CA	May 2001 -- Dec 2007
Technical Advisory Board	Occam Networks, Inc. Santa Barbara, CA	May 2000 -- Dec 2010
Board of Advisors	Airplay Inc. San Francisco, CA	Jun 2005 -- Aug 2009
Consultant	Lockheed Martin Corporation San Jose, CA	Nov 1999 -- Jun 2009

Board of Advisors	Santa Barbara Technology Group Santa Barbara, CA	Sep 2000 -- Dec 2004
Board of Directors	Virtual Bandwidth, Inc. Santa Barbara, CA	Nov 2000 -- Jun 2001
Board of Advisors & Affiliated Scientist	Digital Fountain San Francisco, CA	Jan 2000 -- Dec 2001
Senior Technologist	IP Multicast Initiative, Stardust Forums Campbell, CA	Jun 1998 -- Dec 2000

I. Teaching

A. Courses Taught

CS 176A	Intro to Computer Communication Networks	Fall 1997, Fall 1998, Fall 2002, Fall 2003, Fall 2004, Spring 2005, Spring 2006, Spring 2007, Spring 2008, Fall 2008, Fall 2009, Fall 2010, Fall 2011, Fall 2012, Fall 2013, Fall 2014, Spring 2017, Spring 2018, Spring 2020, Fall 2020
CS 176B	Network Computing	Winter 2000, Winter 2001, Winter 2002, Winter 2012, Winter 2014, Winter 2015, Winter 2018, Winter 2019, Winter 2020
MAT 201B	Media Networks and Services	Fall 1999, Fall 2000, Fall 2001, Fall 2003
CS 276	Distributed Computing and Computer Networks	Winter 1999, Spring 2000, Fall 2002, Fall 2005, Fall 2018
CS 290I	Networking for Multimedia Systems	Winter 1998, Spring 1999, Fall 2004, Winter 2010
CS 595N	Technology and Society	Winter 2005, Fall 2005, Spring 2006, Fall 2006, Spring 2007, Fall 2007, Spring 2008, Fall 2008, Spring 2009
CS 595N	Economic Systems Seminar	Winter 2004, Spring 2004, Winter 2005, Spring 2005
CS 595N	Networking Seminar	Winter 1999, Fall 1999, Winter 2003, Winter 2019
CS 595N	Wireless Networking & Multimedia Seminar	Fall 2000
CS 595I	Systems Design and Implementation Seminar	Fall 1999, Fall 2000, Winter 2001, Spring 2001, Winter 2002, Spring 2002

B. Other Teaching Experience

- *The Evolution of Advanced Networking Services: From the ARPAnet to Internet2*, Instructor, Summer 2001. Short course taught at Escuela de Ciencias Informatica (ECI) sponsored by the Universidad de

Buenos Aires.

- *Johns Hopkins Center for Talented Youth*, Instructor, Summer 1994. CTY is a program to teach gifted high school students the fundamentals of computer science.

- *Georgia Institute of Technology*, Graduate Teaching Assistant, Sep 1994--Sep 1996. Worked as a TA for 12 quarters teaching 7 different courses (4 undergraduate and 3 graduate).

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

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

Date Graduated: Winter 2006
First Position: Research Scientist, Citrix Online

5. Robert Chalmers
Dissertation Title: *Improving Device Mobility with Intelligence at the Network Edge*
Date Graduated: Summer 2004
First Position: President and CEO, Limbo.net

4. Prashant Rajvaidya
Dissertation Title: *Achieving Robust and Secure Deployment of Multicast*
Date Graduated: Spring 2004
First Position: President and CTO, Mosaic Networking

3. Sami Rollins
Dissertation Title: *Overcoming Resource Constraints to Enable Content Exchange Applications in Next-Generation Environments*
Date Graduated: Spring 2003
First Position: Assistant Professor, Mount Holyoke College

2. Srinivasan Jagannathan
Dissertation Title: *Multicast Tree-Based Congestion Control and Topology Management*
Date Graduated: Spring 2003
First Position: Consultant, Kelly & Associates

1. Kamil Sarac
Dissertation Title: *Supporting a Robust Multicast Service in the Global Infrastructure*
Date Graduated: Spring 2002
First Position: Assistant Professor, UT-Dallas

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

19. Neer Shey
Research Area: *Analyzing Content Distribution Through Opportunistic Contact for Smart Cellular Phones*
Date Graduated: Spring 2010

18. Camilla Fiorese
Research Area: *Analysis of a Pure Rate-Based Congestion Control Algorithm*
Date Graduated: Summer 2009

17. Brian Weiner
Research Area: *Multi-Socket TCP: A Simple Approach to Improve Performance of Real-Time Applications over TCP*
Date Graduated: Fall 2007

16. Avijit Sen Mazumder
Research Area: *Facilitating Robust Multicast Group Management*
Date Graduated: Fall 2005

15. Rishi Matthew
Thesis Title: *Providing Seamless Access to Multimedia Content on Heterogeneous Platforms*
Date Graduated: Summer 2004

14. Camden Ho
Research Area: *Tools and Techniques for Wireless Network Management*
Date Graduated: Spring 2004

13. Amit Jardosh (co-advised with E. Belding)
Research Area: *Realistic Environment Models for Mobile Network Evaluation*
Date Graduated: Spring 2004

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

E. Teaching Awards

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

II. Research

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

62. L. Deek, E. Garcia-Villegas, E. Belding, S.J. Lee, and K. Almeroth, "A Practical Framework for 802.11 MIMO Rate Adaptation," Computer Networks, vol. 83, num. 6, pp. 332-348, June 2015.

61. L. Deek, E. Garcia-Villegas, E. Belding, S.J. Lee, and K. Almeroth, "Intelligent Channel Bonding in 802.11n WLANs," IEEE Transactions on Mobile Computing, vol. 13, num. 6, pp. 1242-1255, June 2014.

60. H. Zhang and K. Almeroth, "Alternatives for Monitoring and Limiting Network Access to Students in Network-Connected Classrooms," Journal of Interactive Learning Research (JILR), vol. 24, num. 3, pp. 237-265, July 2013.

59. M. Tavakolifard and K. Almeroth, "A Taxonomy to Express Open Challenges in Trust and Reputation Systems," Journal of Communications, vol. 7, num. 7, pp. 538-551, July 2012.

58. M. Tavakolifard and K. Almeroth, "Social Computing: An Intersection of Recommender Systems, Trust/Reputation Systems, and Social Networks," IEEE Network, vol. 26, num. 4, pp. 53-58, July/August 2012.

57. M. Tavakolifard, K. Almeroth, and P. Ozturk, "Subjectivity Handling of Ratings for Trust and Reputation Systems: An Abductive Reasoning Approach," International Journal of Digital Content Technology and its Applications (JDCTA), vol. 5, num. 11, pp. 359-377, November 2011.

56. R. Raghavendra, P. Acharya, E. Belding and K. Almeroth, "MeshMon: A Multi-Tiered Framework for Wireless Mesh Network Monitoring," Wireless Communications and Mobile Computing (WCMC) Journal, vol. 11, num. 8, pp. 1182-1196, August 2011.

55. A. Knight and K. Almeroth, "Automatic Plagiarism Detection with PAIRwise 2.0," Journal of Interactive Learning Research (JILR), vol. 22, num. 3, pp. 379-400, July 2011.

54. V. Kone, M. Zheleva, M. Wittie, B. Zhao, E. Belding, H. Zheng, and K. Almeroth, "AirLab: Consistency, Fidelity and Privacy in Wireless Measurements," ACM Computer Communications Review, vol. 41, num. 1, pp. 60-65, January 2011.

53. G. Swamynathan, K. Almeroth, and B. Zhao, "The Design of a Reliable Reputation System," Electronic Commerce Research Journal, vol. 10, num. 3-4, pp. 239-270, December 2010.

52. P. Acharya, A. Sharma, E. Belding, K. Almeroth and K. Papagiannaki, "Rate Adaptation in Congested Wireless Networks through Real-Time Measurements," IEEE Transactions on Mobile Computing, vol. 9, num. 11, pp. 1535-1550, November 2010.

51. R. Raghavendra, E. Belding, K. Papagiannaki, and K. Almeroth, "Unwanted Link Layer Traffic in Large IEEE 802.11 Wireless Networks," IEEE Transactions on Mobile Computing, vol. 9, num. 9, pp. 1212-1225, September 2010.

50. H. Zhang and K. Almeroth, "Moodog: Tracking Student Activity in Online Course Management Systems," Journal of Interactive Learning Research (JILR), vol. 21, num. 3, pp. 407-429, July 2010.

49. R. Chertov and K. Almeroth, "Qualitative Comparison of Link Shaping Techniques," International Journal of Communication Networks and Distributed Systems, vol. 5, num. 1/2, pp. 109-129, July 2010.

48. A. Knight and K. Almeroth, "Fast Caption Alignment for Automatic Indexing of Audio," International Journal of Multimedia Data Engineering and Management, vol. 1, num. 2, pp. 1-17, April-June 2010.

47. K. Harras and K. Almeroth, "Scheduling Messengers in Disconnected Clustered Mobile Networks," Ad Hoc & Sensor Wireless Networks, vol. 9, num. 3-4, pp. 275-304, March-April 2010.

46. A. Jardosh, K. Papagiannaki, E. Belding, K. Almeroth, G. Iannaccone, and B. Vinnakota, "Green WLANs: On-Demand WLAN Infrastructures," ACM Journal on Mobile Networks and Applications (MONET), vol. 14, num. 6, pp. 798-814, December 2009.

45. M. Wittie, K. Harras, K. Almeroth, and E. Belding, "On the Implications of Routing Metric Staleness in Delay Tolerant Networks," Computer Communications Special Issue on Delay and Disruption Tolerant Networking, vol. 32, num. 16, pp. 1699-1709, October 2009.

44. K. Harras, L. Deek, C. Holman, and K. Almeroth, "DBS-IC: An Adaptive Data Bundling System for Intermittent Connectivity," Computer Communications Special Issue on Delay and Disruption Tolerant Networking, vol. 32, num. 16, pp. 1687-1698, October 2009.

43. S. Karpinski, E. Belding, K. Almeroth, and J. Gilbert, "Linear Representations of Network Traffic," ACM Journal on Mobile Networks and Applications (MONET), vol. 14, num. 4, pp. 368-386, August 2009.

42. K. Harras and K. Almeroth, "Controlled Flooding in Disconnected Sparse Mobile Networks," Wireless Communications and Mobile Computing (WCMC) Journal, vol. 9, num. 1, pp. 21-33, January 2009.

41. R. Mayer, A. Stull, K. DeLeeuw, K. Almeroth, B. Bimber, D. Chun, M. Bulger, J. Campbell, A. Knight, and H. Zhang, "Clickers in College Classrooms: Fostering Learning with Questioning Methods in Large Lecture Classes," Contemporary Educational Psychology, vol. 34, num. 1, pp. 51-57, January 2009.

40. A. Knight, K. Almeroth, and B. Bimber, "Design, Implementation and Deployment of PAIRwise," Journal of Interactive Learning Research (JILR), vol. 19, num. 3, pp. 489-508, July 2008.

39. A. Garyfalos and K. Almeroth, "Coupons: A Multilevel Incentive Scheme for Information Dissemination in Mobile Networks," IEEE Transactions on Mobile Computing, vol. 7, num. 6, pp. 792-804, June 2008.

38. I. Sheriff, K. Ramachandran, E. Belding, and K. Almeroth, "A Multi-Radio 802.11 Mesh Network Architecture," ACM Journal on Mobile Networks and Applications (MONET), vol. 13, num. 1-2, pp. 132-146, April 2008.

37. M. Bulger, R. Mayer, K. Almeroth, and S. Blau, "Measuring Learner Engagement in Computer-Equipped College Classrooms," Journal of Educational Multimedia and Hypermedia, vol. 17, num. 2, pp. 129-143, April 2008.

36. G. Swamynathan, B. Zhao, and K. Almeroth, "Exploring the Feasibility of Proactive Reputations," Concurrency and Computation: Practice and Experience, vol. 20, num. 2, pp. 155-166, February 2008.

35. G. Swamynathan, B. Zhao, K. Almeroth, and H. Zheng, "Globally Decoupled Reputations for Large

Distributed Networks," Advances in Multimedia, vol. 2007, pp. 1-14, 2007.

34. R. Mayer, A. Stull, J. Campbell, K. Almeroth, B. Bimber, D. Chun and A. Knight, "Overestimation Bias in Self-reported SAT Scores," Educational Psychology Review, vol. 19, num. 4, pp. 443-454, December 2007.

33. P. Namburi, K. Sarac and K. Almeroth, "Practical Utilities for Monitoring Multicast Service Availability," Computer Communications Special Issue on Monitoring and Measurement of IP Networks, vol. 29, num. 10, pp. 1675-1686, June 2006.

32. R. Chalmers, G. Krishnamurthi and K. Almeroth, "Enabling Intelligent Handovers in Heterogeneous Wireless Networks," ACM Journal on Mobile Networks and Applications (MONET), vol. 11, num. 2, pp. 215-227, April 2006.

31. H. Lundgren, K. Ramachandran, E. Belding, K. Almeroth, M. Benny, A. Hewatt, A. Touma and A. Jardosh, "Experience from the Design, Deployment and Usage of the UCSB MeshNet Testbed," IEEE Wireless Communications, vol. 13, num. 2, pp. 18-29, April 2006.

30. R. Mayer, K. Almeroth, B. Bimber, D. Chun, A. Knight and A. Campbell, "Technology Comes to College: Understanding the Cognitive Consequences of Infusing Technology in College Classrooms," Educational Technology, vol. 46, num. 2, pp. 48-53, March-April 2006.

29. A. Garyfalos and K. Almeroth, "A Flexible Overlay Architecture for Mobile IPv6 Multicast," Journal on Selected Areas in Communications (JSAC) Special Issue on Wireless Overlay Networks Based on Mobile IPv6, vol. 23, num. 11, pp. 2194-2205, November 2005.

28. K. Sarac and K. Almeroth, "Monitoring IP Multicast in the Internet: Recent Advances and Ongoing Challenges," IEEE Communications, vol. 43, num. 10, pp. 85-91, October 2005.

27. K. Sarac and K. Almeroth, "Application Layer Reachability Monitoring for IP Multicast," Computer Networks, vol. 48, num. 2, pp. 195-213, June 2005.

26. A. Jardosh, E. Belding, K. Almeroth and S. Suri, "Real-world Environment Models for Mobile Network Evaluation," Journal on Selected Areas in Communications Special Issue on Wireless Ad hoc Networks, vol. 23, num. 3, pp. 622-632, March 2005.

25. S. Rollins and K. Almeroth, "Evaluating Performance Tradeoffs in a One-to-Many Peer Content Distribution Architecture," Journal of Internet Technology, vol. 5, num. 4, pp. 373-387, Fall 2004.

24. K. Sarac and K. Almeroth, "Tracetree: A Scalable Mechanism to Discover Multicast Tree Topologies in the Network," IEEE/ACM Transactions on Networking, vol. 12, num. 5, pp. 795-808, October 2004.

23. K. Sarac and K. Almeroth, "A Distributed Approach for Monitoring Multicast Service Availability," Journal of Network and Systems Management, vol. 12, num. 3, pp. 327-348, September 2004.

22. P. Rajvaidya, K. Ramachandran and K. Almeroth, "Managing and Securing the Global Multicast Infrastructure," Journal of Network and Systems Management, vol. 12, num. 3, pp. 297-326, September 2004.

21. P. Rajvaidya and K. Almeroth, "Multicast Routing Instabilities," IEEE Internet Computing, vol. 8, num. 5, pp. 42-49, September/October 2004.

20. D. Johnson, R. Patton, B. Bimber, K. Almeroth and G. Michaels, "Technology and Plagiarism in the

University: Brief Report of a Trial in Detecting Cheating," Association for the Advancement of Computing in Education (AACE) Journal, vol. 12, num. 3, pp. 281-299, Summer 2004.

19. R. Chalmers and K. Almeroth, "A Security Architecture for Mobility-Related Services," Journal of Wireless Personal Communications, vol 29, num. 3, pp. 247-261, June 2004.

18. B. Stiller, K. Almeroth, J. Altmann, L. McKnight, and M. Ott, "Pricing for Content in the Internet," Computer Communications, vol. 27, num. 6, pp. 522-528, April 2004.

17. S. Rollins and K. Almeroth, "Lessons Learned Deploying a Digital Classroom," Journal of Interactive Learning Research (JILR), vol. 15, num. 2, pp. 169-185, April 2004.

16. S. Jagannathan and K. Almeroth, "A Dynamic Pricing Scheme for E-Content at Multiple Levels-of-Service," Computer Communications, vol. 27, num. 4, pp. 374-385, March 2004.

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15. A. Garyfalos, K. Almeroth and J. Finney, "A Hybrid of Network and Application Layer Multicast for Mobile IPv6 Networks," *International Workshop on Large-Scale Group Communication (LSGC)*, Florence, ITALY, October 2003.

14. A. Garyfalos, K. Almeroth and J. Finney, "A Comparison of Network and Application Layer Multicast for Mobile IPv6 Networks," *ACM Workshop on Modeling, Analysis and Simulation of Wireless and Mobile Systems (MSWiM)*, San Diego, California, USA, September 2003.

13. S. Jagannathan, and K. Almeroth, "Pricing and Resource Provisioning for Delivering E-Content On-Demand with Multiple Levels-of-Service," *International Workshop on Internet Charging and QoS Technologies (ICQT)*, Zurich, SWITZERLAND, October 2002.

12. S. Rollins, K. Almeroth, D. Milojicic, and K. Nagaraja, "Power-Aware Data Management for Small Devices," *Workshop on Wireless Mobile Multimedia (WoWMoM)*, Atlanta, GA, USA, September 2002.

11. K. Almeroth, S. Bhattacharyya, and C. Diot, "Challenges of Integrating ASM and SSM IP Multicast Protocol Architectures," *International Workshop on Digital Communications: Evolutionary Trends of the Internet (IWDC)*, Taormina, ITALY, September 2001.

10. K. Sarac and K. Almeroth, "Scalable Techniques for Discovering Multicast Tree Topology," *Network and Operating System Support for Digital Audio and Video (NOSSDAV)* , Port Jefferson, New York, USA, June 2001.

9. P. Rajvaidya, K. Almeroth and K. Claffy, "A Scalable Architecture for Monitoring and Visualizing Multicast Statistics," *IFIP/IEEE International Workshop on Distributed Systems: Operations & Management (DSOM)*, Austin, Texas, USA, December 2000.

8. S. Jagannathan, K. Almeroth and A. Acharya, "Topology Sensitive Congestion Control for Real-Time Multicast," *Network and Operating System Support for Digital Audio and Video (NOSSDAV)* , Chapel Hill, North Carolina, USA, June 2000.

7. K. Sarac and K. Almeroth, "Supporting the Need for Inter-Domain Multicast Reachability," *Network and Operating System Support for Digital Audio and Video (NOSSDAV)* , Chapel Hill , North Carolina, USA, June 2000.

6. D. Makofske and K. Almeroth, "MHealth: A Real-Time Multicast Tree Visualization and Monitoring Tool," *Network and Operating System Support for Digital Audio and Video (NOSSDAV)* , Basking Ridge New Jersey, USA, June 1999.

5. K. Almeroth and Y. Zhang, "Using Satellite Links as Delivery Paths in the Multicast Backbone (MBone)," *ACM/IEEE International Workshop on Satellite-Based Information Services (WOSBIS)*, Dallas, Texas, USA, October 1998.

4. M. Ammar, K. Almeroth, R. Clark and Z. Fei, "Multicast Delivery of Web Pages OR How to Make Web Servers Pushy," *Workshop on Internet Server Performance (WISP)*, Madison, Wisconsin, USA, June 1998.

3. K. Almeroth and M. Ammar, "Prototyping the Interactive Multimedia Jukebox," *Mini-conference on Multimedia Appliances, Interfaces, and Trials--International Conference on Communications (ICC)*, Montreal, Quebec, CANADA, June 1997.

2. K. Almeroth and M. Ammar, "Collection and Modeling of the Join/Leave Behavior of Multicast Group Members in the MBone," *High Performance Distributed Computing Focus Workshop (HPDC)*, Syracuse, New York, USA, August 1996.

1. K. Almeroth and M. Ammar, "The Role of Multicast Communication in the Provision of Scalable and Interactive Video-On-Demand Service," *Network and Operating System Support for Digital Audio and Video (NOSSDAV)* , Durham, New Hampshire, USA, April 1995.

D. Non-Refereed Publications

8. K. Almeroth, E. Belding, M. Buddhikot, G. Chandranmenon, S. Miller, and K. Ramachandran, "Infrastructure Mesh Networks," *U.S. Patent Application US20070070959 A1*, September 2005.

7. K. Almeroth, R. Caceres, A. Clark, R. Cole, N. Duffield, T. Friedman, K. Hedayat, K. Sarac, M. Westerlund, "RTP Control Protocol Extended Reports (RTCP XR)," *Internet Engineering Task Force (IETF) Request for Comments (RFC) 3611*, November 2003.

6. Z. Albanna, K. Almeroth, D. Meyer, and M. Schipper, "IANA Guidelines for IPv4 Multicast Address Allocation," *Internet Engineering Task Force (IETF) Request for Comments (RFC) 3171*, August 2001.

5. B. Quinn and K. Almeroth, "IP Multicast Applications: Challenges and Solutions," *Internet Engineering Task Force (IETF), Request for Comments (RFC) 3170*, September 2001.

4. K. Almeroth, L. Wei and D. Farinacci, "Multicast Reachability Monitor (MRM) Protocol," *Internet Engineering Task Force Internet Draft*, July 2000.

3. K. Almeroth and L. Wei, "Justification for and use of the Multicast Reachability Monitor (MRM) Protocol," *Internet Engineering Task Force Internet Draft*, March 1999.

2. K. Almeroth, "Managing IP Multicast Traffic: A First Look at the Issues, Tools, and Challenges," IP Multicast Initiative White Paper, San Jose, California, USA, February 1999.

1. K. Almeroth, K. Obraczka and D. De Lucia, "Pseudo-IP: Providing a Thin Network Protocol for Semi-Intelligent Wireless Devices," *DARPA/NIST Smart Spaces Workshop*, Gaithersburg, Maryland, USA, July 1998.

E. Released Software Systems

19. ***A Multi-radio Wireless Mesh Network Architecture -- http://moment.cs.ucsb.edu/tic/.*** Released December 1, 2006 (with K. Ramachandran, I. Sheriff, and E. Belding). The software as part of a multi-

radio wireless mesh network that includes a Split Wireless Router that alleviates the interference that can occur between commodity radios within a single piece of hardware. The second is server software to perform channel assignment and communicate the assignments throughout the mesh network.

18. ***AODV-Spanning Tree (AODV-ST) -- http://www.cs.ucsb.edu/~krishna/aodv-st/.*** Released September 1, 2006 (with K. Ramachandran and E. Belding). AODV-ST is an extension of the well-known AODV protocol specifically designed for wireless mesh networks. The advantages of AODV-ST over AODV include support for high throughput routing metrics, automatic route maintenance for common-case traffic, and low route discovery latency.

17. ***The Multicast Detective -- http://www.nmsl.cs.ucsb.edu/mcast_detective/.*** Released September 1, 2005 (with A. Sen Mazumder). The multicast detective is a robust solution to determine the existence and nature of multicast service for a particular user. By performing a series of tests, a user can determine whether there is network support for multicast, and consequently, whether a multicast group join is likely to succeed.

16. ***AutoCap: Automatic and Accurate Captioning -- http://www.nmsl.cs.ucsb.edu/autocap/.*** Released August 1, 2005 (with A. Knight). AutoCap is a software system that takes as input an audio/video file and a text transcript. AutoCap creates captions by aligning the utterances in the audio/video file to the transcript. For those words that are not recognized, AutoCap estimates when the words were spoken along with an error bound that gives the content creator an idea of caption accuracy. The result is a collection of accurately time-stamped captions that can be displayed with the video.

15. ***PAIRwise Plagiarism Detection System -- http://cits.ucsb.edu/pair/.*** Released July 1, 2005 (with A. Knight). PAIRwise is a plagiarism detection system with: (1) an easy-to-use interface for submitting papers, (2) a flexible comparison engine that allows intra-class, inter-class, and Internet-based comparisons, and (3) an intuitive graphical presentation of results.

14. ***DAMON Multi-Hop Wireless Network Monitoring -- http://moment.cs.ucsb.edu/damon/.*** Released October 1, 2004 (with K. Ramachandran and E. Belding). DAMON is a distributed system for monitoring multi-hop mobile networks. DAMON uses agents within the network to monitor network behavior and send collected measurements to data repositories. DAMON's generic architecture supports the monitoring of a wide range of protocol, device, or network parameters.

13. ***Multicast Firewall -- http://www.nmsl.cs.ucsb.edu/mafia/.*** Released June 1, 2004 (with K. Ramachandran). MAFIA, a multicast firewall and traffic management solution, has the specific aim of strengthening multicast security through multicast access control, multicast traffic filtering, and DoS attack prevention.

12. ***AODV@IETF Peer Routing Software-- http://moment.cs.ucsb.edu/aodv-ietf/.*** Released November 1, 2003 (with K. Ramachandran and E. Belding). One of the first large-scale efforts to run the Ad hoc On demand Distance Vector (AODV) routing protocol in a public space (at the Internet Engineering Task Force (IETF)). The implementation includes a daemon that runs on both the Linux and Windows operating systems.

11. ***Mobility Obstacles -- http://moment.cs.ucsb.edu/mobility/.*** Released September 1, 2003 (with A. Jardosh, E. Belding, and S. Suri). The topology and movement of nodes in ad hoc protocol simulation are key factors in protocol performance. In this project, we have developed ns-2 simulation plug-ins that create more realistic movement models through the incorporation of obstacles. These obstacles are utilized to restrict both node movement and wireless transmissions.

10. ***mwalk -- http://www.nmsl.cs.ucsb.edu/mwalk/.*** Released December 1, 2000 (with R. Chalmers).

Mwalk is a collection of Java applications and Perl scripts which re-create a global view of a multicast session from mtrace and RTCP logs. Users to the site can download mwalk, examine the results of our analysis, or download data sets for use in simulations dependent on multicast tree characteristics.

9. ***MANTRA2 -- http://www.nmsl.cs.ucsb.edu/mantra/.*** Released December 1, 1999 (with P. Rajvaidya). This new version of MANTRA focuses on the visualization of inter-domain routing statistics. Working in conjunction with the Cooperative Association for Internet Data Analysis (CAIDA) we have developed advanced collection and visualization techniques.

8. ***MRM -- http://www.nmsl.cs.ucsb.edu/mrm/.*** Released October 1, 1999 (with K. Sarac). MRM is the Multicast Reachability Protocol. We have implemented an end-host agent that responds to MRM Manager commands. Our end-host agent works in conjunction with Cisco routers to detect and isolate multicast faults.

7. ***MANTRA -- http://www.nmsl.cs.ucsb.edu/mantra/.*** Released January 1, 1999 (with P. Rajvaidya). MANTRA is the Monitoring and Analysis of Traffic in Multicast Routers. It uses scripts to collect and display data from backbone multicast routers.

6. ***SDR Monitor -- http://www.nmsl.cs.ucsb.edu/sdr-monitor/.*** Released January 1, 1999 (with K. Sarac). The SDR Monitor receives e-mail updates from participants containing information about observed sessions in the MBone. A global view of multicast reachability is then constructed.

5. ***The MHealth tool -- http://www.nmsl.cs.ucsb.edu/mhealth/.*** Released September 1, 1998 (with D. Makofske). The mhealth tool graphically visualizes MBone multicast group trees and provides `health' information including end-to-end losses per receiver and losses on a per hop basis. The implementation required expertise in Java, the MBone tools, and Unix.

4. ***The MControl tool -- http://www.nmsl.cs.ucsb.edu/mcontrol/.*** Released August 1, 1998 (with D. Makofske). Mcontrol is a tool to provide VCR-based interactivity for live MBone sessions. The implementation required expertise in Java, the MBone tools, and Unix.

3. ***Interactive Multimedia Jukebox (IMJ) -- http://imj.ucsb.edu/.*** Released October 1, 1996. The IMJ combines the WWW and the MBone conferencing tools to provide a multi-channel video jukebox offering both instructional and entertainment programming on a wide scale. The implementation required expertise in HTML, Perl, C, the MBone tools, and Unix.

2. ***Mlisten -- http://www.cc.gatech.edu/computing/Telecomm/mbone/.*** Released September 1, 1995. A tool to continuously collect MBone multicast group membership information including number and location of members, membership duration, and inter-arrival time for all audio and video sessions. The implementation required expertise in C, Tcl/Tk, the MBone tools, and UNIX socket programming.

1. ***Audio-on-Demand (AoD)***. March 1, 1995. A server/client prototype to demonstrate interactivity in near VoD systems. The AoD server provides songs-on-demand and VCR-like functions via multicast IP over Ethernet. The implementation required expertise in C, OpenWindows programming, UNIX socket programming, and network programming.

F. Tutorials, Panels and Invited Talks

- "25th Anniversary Panel," Network and Operating System Support for Digital Audio and Video (NOSSDAV), Portland, Oregon, USA, March 2015.

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

California, USA, January 2004.

- "Panel: Core Networking Issues and Protocols for the Internet," National Science Foundation (NSF) Division of Advanced Networking Infrastructure and Research (ANIR) Principal Investigators Workshop, Washington DC, USA, March 2003.
- "Panel: Pricing for Content in the Internet," SPIE ITCom Internet Performance and Control of Network Systems, Boston, Massachusetts, USA, July 2002.
- "The Technology Behind Wireless LANs," Central Coast MIT Enterprise Forum, Santa Barbara, California, USA, March 2002.
- "Lessons Learned in the Digital Classroom," Center for Information and Technology Brown Bag Symposium, Santa Barbara, California, USA, March 2002.
- "The Evolution of Advanced Networking Services: From the ARPAnet to Internet2," California State University--San Luis Obispo CS Centennial Colloquium Series, San Luis Obispo, California, USA, February 2002.
- "Deployment of IP Multicast in Campus Infrastructures," Internet2 Campus Deployment Workshop, Atlanta, Georgia, USA, May 2001.
- "Multicast: Is There Anything Else to Do?," Sprint Research Retreat, Miami, Florida, USA, May 2001.
- "The Evolution of Next-Generation Internet Services and Applications," Government Technology Conference 2001 (GTC) for the Western Region, Sacramento, California, USA, May 2001.
- "I2 Multicast: Not WIDE-scale Deployment, FULL-scale Deployment," Closing Plenary, Internet2 Member Meetings, Washington, D.C., USA, March 2001.
- "Panel: Beyond IP Multicast," Content Delivery Networks (CDN), New York, New York, USA, February 2001.
- "Viable Multicast Pricing & Business Models for Wider-Scale Deployment," Content Delivery Networks (CDN), New York, New York, USA, February 2001.
- "IP Multicast: Modern Protocols, Deployment, and Management," Content Delivery Networks (CDN), New York, New York, USA, February 2001 & San Jose, California, USA, December 2001.
- "Under the Hood of the Internet," Technology 101: Technology for Investors, Center for Entrepreneurship & Engineering Management, November 2000.
- "Understanding Multicast Traffic in the Internet," (1) University of Virginia, (2) University of Maryland, and (3) Columbia University, September 2000.
- "The Bad, The Ugly, and The Good: The Past, Present, and Future of Multicast," Digital Fountain, San Francisco, California, USA, August 2000.
- "Implications of Source-Specific Multicast (SSM) on the Future of Internet Content Delivery," Occam Networks, Santa Barbara, California, USA, August 2000.
- "Introduction to Multicast Routing Protocols," UC-Berkeley Open Mash Multicast Workshop, Berkeley, California, USA, July 2000.

- "Efforts to Understand Traffic and Tree Characteristics," University of Massachusetts--Amherst Colloquia, Amherst, Massachusetts, USA, May 2000.
- "Monitoring Multicast Traffic," Sprint Research Retreat, Half Moon Bay, California, USA, April 2000.
- "What is the Next Generation of Multicast in the Internet?," HRL Laboratories, Malibu, California, USA, January 2000.
- "Mission and Status of the Center for Information Technology and Society (CITS)," Intel Research Council, Portland, Oregon, USA, September 1999.
- "Multicast at a Crossroads," IP Multicast Initiative Summits and Bandwidth Management Workshops, San Francisco, CA, USA, (1) October 1999; (2) February 2000; and (3) June 2000.
- "IP Multicast: Modern Protocols, Deployment, and Management," Networld+Interop: (1) Las Vegas, Nevada, USA--May 2000; (2) Tokyo, JAPAN--June 2000; (3) Atlanta, Georgia, USA--September 2000; (4) Las Vegas, Nevada, USA--May 2001; (5) Las Vegas, Nevada, USA--May 2002.
- "IP Multicast: Practice and Theory" (w/ Steve Deering), Networld+Interop: (1) Las Vegas, Nevada, USA--May 1999; (2) Tokyo, JAPAN--June 1999; and (3) Atlanta, Georgia, USA--September 1999.
- "Internet2 Multicast Testbeds and Applications," Workshop on Protocols for High Speed Networks (PfHSN), Salem, Massachusetts, USA, August 1999.
- "IP Multicast: Protocols for the Intra- and Inter-Domain," Lucent Technologies, Westford, Massachusetts, USA, August 1999.
- "Internet2 Multicast Testbeds and Applications," NASA Workshop: Bridging the Gap, Moffett Field, California, USA, August 1999.
- "The Evolution of Next-Generation Services and Applications in the Internet," Tektronix Distinguished Lecture Series, Portland, Oregon, USA, May 1999.
- "Multicast Applications and Infrastructure in the Next Generation Internet," CENIC 99 Workshop on Achieving Critical Mass for Advanced Applications, Monterey, California, USA, May 1999.
- "Multicast Traffic Monitoring and Analysis Work at UCSB" (w/ P. Rajvaidya), Workshop on Internet Statistics and Metrics Analysis (ISMA), San Diego, California, USA, April 1999.
- "How the Internet Works: Following Bits Around the World," Science Lite, Santa Barbara General Affiliates and Office of Community Relations, California, USA, February 1999.
- "Managing Multicast: Challenges, Tools, and the Future," IP Multicast Initiative Summit, San Jose, California, USA, February 1999.
- "The Future of Multicast Communication and Protocols," Internet Bandwidth Management Summit (iBAND), San Jose, California, USA, November 1998.
- "An Overview of IP Multicast: Applications and Deployment," (1) Workshop on Evaluating IP Multicast as the Solution for Webcasting Real-Time Networked Multimedia Applications, New York, New York, USA, July 1998; and (2) Satellites and the Internet Conference, Washington, D.C., USA, July 1998.

- "IETF Developments in IP Multicast," IP Multicast Initiative Summit, San Jose, California, USA, February 1998.
- "An Introduction to IP Multicast and the Multicast Backbone (MBone)" vBNS Technical Meeting sponsored by the National Center for Network Engineering (NLANR), San Diego, California, USA, February 1998.
- "Using Multicast Communication to Deliver WWW Pages" Computer Communications Workshop (CCW '97), Phoenix, Arizona, USA, September 1997.

G. Research Funding

- K. Almeroth, "Packet Scheduling Using IP Embedded Transport Instrumentation," Cisco Systems Inc., $100,000, 3/1/13-8/31/14.
- K. Almeroth, E. Belding and S.J. Lee, "GOALI: Maximizing Available Bandwidth in Next Generation WLANs", National Science Foundation (NSF), $101,088, 10/1/13-9/30/14.
- K. Almeroth and E. Belding, "GOALI: Intelligent Channel Management in 802.11n Networks," National Science Foundation (NSF), $51,000, 10/1/10-9/30/11.
- B. Zhao, K. Almeroth, H. Zheng, and E. Belding, "NeTS: Medium: Airlab: Distributed Infrastructure for Wireless Measurements," National Science Foundation (NSF), $700,000, 9/1/09-8/13/13.
- K. Almeroth, E. Belding and T. Hollerer, "NeTS-WN: Wireless Network Health: Real-Time Diagnosis, Adaptation, and Management," National Science Foundation (NSF), $600,000, 10/1/07-9/30/10.
- K. Almeroth, "Next-Generation Service Engineering in Internet2," University Consortium for Advanced Internet Development (UCAID), $1,254,000, 7/1/04-6/30/09 (reviewed and renewed each year).
- B. Manjunath, K. Almeroth, F. Bullo, J. Hespanha, T. Hollerer, C. Krintz, U. Madhow, K. Rose, A. Singh, and M. Turk, "Large-Scale Multimodal Wireless Sensor Network," Office of Naval Research Defense University Research Instrumentation Program (DURIP), $655,174, 4/14/08-4/14/09.
- K. Almeroth and E. Belding, "Improving Robustness in Evolving Wireless Infrastructures," Intel Corporation, $135,000, 7/1/06-6/30/09 (reviewed and renewed for second and third year).
- K. Almeroth and K. Sarac, "Bridging Support in Mixed Deployment Multicast Environments," Cisco Systems Inc., $100,000, 9/1/07-8/31/08.
- K. Sarac and K. Almeroth, "Building the Final Piece in One-to-Many Content Distribution," Cisco Systems Inc., $95,000, 9/1/06-8/31/07.
- E. Belding, K. Almeroth and J. Gibson, "Real-Time Communication Support in a Ubiquitous Next-Generation Internet," National Science Foundation (NSF), $900,000, 10/1/04-9/30/07.
- K. Almeroth and K. Sarac, "Improving the Robustness of Multicast in the Internet," Cisco Systems Inc., $80,000, 9/1/04-8/31/05.

- R. Mayer, B. Bimber, K. Almeroth and D. Chun, "Assessing the Pedagogical Implications of Technology in College Courses," Mellon Foundation, $350,000, 7/1/04-6/30/07.

- B. Bimber, A. Flanagin and C. Stol, "Technological Change and Collective Association: Changing Relationships Among Technology, Organizations, Society and the Citizenry," National Science Foundation (NSF), $329,175, 7/1/04-6/30/07.

- K. Almeroth and B. Bimber, "Plagiarism Detection Techniques and Software," UCSB Instructional Development, $22,000, 7/1/04-6/30/05.

- K. Almeroth, "Student Travel Support for the 14th International Workshop on Network and Operating Systems Support for Digital Audio and Video (NOSSDAV)," National Science Foundation (NSF), $10,000, 5/1/04-8/31/04.

- K. Almeroth, "An Automated Indexing System for Remote, Archived Presentations," QAD Inc., $25,000, 5/1/04-6/30/05.

- K. Almeroth and M. Turk, "A Remote Teaching Assistant Support System," Microsoft, $40,000, 1/1/04-6/30/05.

- K. Almeroth, "Supporting Multicast Service Functionality in Helix," Real Networks, $30,000, 9/1/03-6/30/04.

- K. Almeroth and E. Belding, "Service Discovery in Mobile Networks," Nokia Summer Research Grant (U. Mohan), $10,240, 7/1/03-9/30/03.

- K. Almeroth, D. Zappala, "Building a Global Multicast Service," Cisco Systems Inc., $100,000, 1/1/03-6/30/04.

- K. Almeroth, "Developing A Dynamic Protocol for Candidate Access Router Discovery," Nokia Graduate Student Fellowship (R. Chalmers), $26,110, 9/01/02-6/30/03.

- B. Bimber and K. Almeroth, "The Role of Collaborative Groupware in Organizations," Toole Family Foundation, $182,500 ($20,000 cash plus $162,500 in software), 9/1/02-8/30/07.

- B. Manjunath, et al., "Digital Multimedia: Graduate Training Program in Interactive Digital Multimedia," National Science Foundation (NSF), $2,629,373, 4/1/02-3/31/07.

- J. Green, K. Almeroth, et al., "Inquiry in the Online Context: Learning from the Past, Informing the Future," UCSB Research Across Disciplines, $10,000, 9/1/01-8/31/02.

- K. Almeroth, "Monitoring and Maintaining the Global Multicast Infrastructure," Cisco Systems Inc., $54,600, 7/1/01-6/30/02.

- R. Kemmerer, K. Almeroth, et al., "Hi-DRA High-speed, Wide-area Network Detection, Response, and Analysis," Department of Defense (DoD), $4,283,500, 5/1/01-4/30/06.

- A. Singh, K. Almeroth, et al., "Digital Campus: Scalable Information Services on a Campus-wide Wireless Network," National Science Foundation (NSF), 1,450,000, 9/15/00-12/31/04.

- K. Almeroth, "Visualizing the Global Multicast Infrastructure," UC MICRO w/ Cisco Systems Inc., $85,438, 7/1/00-6/30/02.

- H. Lee, K. Almeroth, et al., "Dynamic Sensing Systems," International Telemetering Foundation, $260,000, 07/01/00-06/30/04.

- B. Bimber and K. Almeroth, "Funding for the Center on Information Technology and Society," $250,000 from Dialogic (an Intel Company) and $250,000 from Canadian Pacific.

- K. Almeroth, "CAREER: From Protocol Support to Applications: Elevating Multicast to a Ubiquitous Network Service," National Science Foundation (NSF), $200,000, 9/1/00-8/31/04.

- K. Almeroth, "Characterizing Multicast Use and Efficiency in the Inter-Domain," Sprint Advanced Technology Laboratories, $62,500, 3/1/00-6/30/01.

- K. Almeroth, "Producing the Next Generation of Multicast Monitoring and Management Protocols and Tools," UC MICRO w/ Cisco Systems Inc., $124,500, 7/1/99 - 6/30/01.

- K. Almeroth, "Utilizing Satellite Links in the Provision of an Inter-Wide Multicast Service," HRL Laboratories, $20,000, 7/1/99 - 6/30/00.

- T. Smith, K. Almeroth, et al., "Alexandria Digital Earth Prototype," National Science Foundation, $5,400,000, 4/1/99-3/31/04.

- V. Vesna, K. Almeroth, et al., "Online Public Spaces: Multidisciplinary Explorations in Multi-User Environments (OPS:MEME), Phase II," UCSB Research Across Disciplines, $50,000, 9/1/98-8/31/99.

- K. Almeroth, "Techniques and Analysis for the Provision of Multicast Route Management," UC MICRO w/ Cisco Systems Inc., $97,610, 7/1/98 - 6/30/00.

- K. Almeroth, "Capturing and Modeling Multicast Group Membership in the Multicast Backbone (MBone)," UC MICRO w/ Hughes Research Labs, $19,146, 7/1/98 - 12/31/99.

- K. Almeroth, "Building a Content Server for the Next Generation Digital Classroom," UCSB Faculty Research Grant, $5,000, 7/1/98-6/31/99.

H. Research Honors and Awards

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

III. Service

A. Professional Activities

1. Society Memberships

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

2. Review Work for Technical Journals and Publishers

NSF CISE research proposals, IEEE/ACM Transactions on Networking, IEEE/ACM Transactions on Computers, IEEE/ACM Transactions on Communications, IEEE Transactions on Circuits and Systems for Video Technology, IEEE Transactions on Parallel and Distributed Systems, IEEE Transactions on Multimedia, IEEE Communications, IEEE Communications Letters, IEEE Network, IEEE Internet Computing, IEEE Multimedia, IEEE Aerospace & Electronics Systems Magazine, ACM Transactions on Internet Technology, ACM Transactions on Multimedia Computing, Communications and Applications, ACM Computing Surveys, ACM Computer Communications Review, ACM Computeres in Entertainment, ACM/Springer Multimedia Systems Journal, AACE Journal of Interactive Learning (JILR), International Journal of Computer Mathematics, Journal of Communications and Networks, Journal of Parallel and Distributed Computing, Journal of Network and Systems Management, Journal of High Speed Networking, Journal of Communications and Networks, Journal on Selected Areas in Communications, Journal of Wireless Personal Communications, Personal Mobile Communications, Annals of Telecommunications, International Journal of Wireless and Mobile Computing, Pervasive and Mobile Computing (PMC), Wireless Networks Journal, Computer Networks Journal, Cluster Computing, Computer Communications, Mobile Computing and Communications Review, Performance Evaluation, Software--Practice & Experience, Information Processing Letters, ACM Sigcomm, ACM Multimedia, ACM Network and System Support for Digital Audio and Video Workshop (NOSSDAV), ACM Sigcomm Workshop on the Economics of Peer-to-Peer Systems (P2PEcon), ACM Sigcomm Workshop on Challenged Networks (CHANTS), IEEE Infocom, IEEE Globecom, IEEE Global Internet (GI) Symposium, IEEE Globecom Automatic Internet Symposium, IEEE Globecom Internet Services and Enabling Technologies (IS&ET) Symposium, IEEE International Symposium on a World of Wireless, Mobile and Multimedia Networks (WoWMoM), IEEE International Conference on Network Protocols (ICNP), IEEE Conference on Sensor and Ad Hoc Communications and Networks (SECON), IEEE International Conference on Multimedia and Exposition (ICME), IEEE International Conference on Communications (ICC), IEEE International Conference on Parallel and Distributed Systems (ICPADS) IEEE International Symposium on High-Performance Distributed Computing (HPDC), IEEE International Conference on Distributed Computing Systems (ICDCS), IEEE International Workshop on Quality of Service (IWQoS),

IEEE/IFIP Network Operations and Management Symposium (NOMS), IFIP/IEEE International Symposium on Integrated Network Management (IM), IFIP/IEEE International Conference on Management of Multimedia Networks and Services (MMNS), IEEE Aerospace & Electronics Systems Magazine, SPIE Conference on Multimedia Computing and Networking (MMCN), IFIP Networking, IASTED International Conference on Information Systems and Databases (ISD), IASTED International Conference on Communications, Internet, and Information Technology, IASTED International Conference on Internet and Multimedia Systems and Applications (IMSA), IASTED International Conference on European Internet and Multimedia Systems and Applications (EuroIMSA), IASTED International Conference on Communications and Computer Networks (CCN), IASTED International Conference on Software Engineering and Applications (SEA), International Conference on Computer and Information Science (ICIS), International Association for Development of the Information Society (IADIS) International Conference on the WWW/Internet, Workshop on Network Group Communication (NGC), International Conference on Next Generation Communication (CoNEXT), International Conference on Parallel Processing (ICPP), International Conference on Computer Communications and Networks (IC3N), International Workshop on Hot Topics in Peer-to-Peer Systems (Hot-P2P), International Workshop on Wireless Network Measurements (WiNMee), International Workshop on Incentive-Based Computing (IBC), International Workshop on Multi-hop Ad Hoc Networks (REALMAN), International Workshop on Broadband Wireless Multimedia: Algorithms, Architectures and Applications (BroadWIM), International Packet Video (PV) Workshop, High Performance Networking Conference (HPN), International Parallel Processing Symposium (IPPS), International Symposium on Innovation in Information & Communication Technology (ISIICT), Workshop on Coordinated Quality of Service in Distributed Systems (COQODS), Pearson Education (Cisco Press) Publishers, Macmillan Technical Publishing, and Prentice Hall Publishers.

3. Conference Committee Activities

Journal/Magazine Editorial Board

IEEE Transactions on Mobile Computing (TMC): 2006-2011, 2017-2020 (Associate Editor-in-Chief)
IEEE Networking Letters: 2018-2021
IEEE Transactions on Network and Service Management (TNSM): 2015-2021
Journal of Network and Systems Management (JNSM): 2011-present
IEEE/ACM Transactions on Networking (ToN): 2003-2009, 2013-2017
ACM Computers in Entertainment: 2002-2015
IEEE Network: 1999-2012
AACE Journal of Interactive Learning Research (JILR): 2003-2012
IEEE Transactions on Mobile Computing (TMC): 2006-2011
ACM Computer Communications Review (CCR): 2006-2010

Journal/Magazine Guest Editorship

IEEE Journal on Selected Areas in Communications (JSAC) Special Issue on "Delay and Disruption Tolerant Wireless Communication", June 2008
Computer Communications Special Issue on "Monitoring and Measuring IP Networks", Summer 2005
Computer Communications Special Issue on "Integrating Multicast into the Internet", March 2001

Conference/Workshop Steering Committee

IEEE International Conference on Network Protocols (ICNP): 2007-present
ACM Sigcomm Workshop on Challenged Networks (CHANTS): 2006-present
IEEE Global Internet (GI) Symposium: 2005-2013, 2018-present
International Workshop on Network and Operating System Support for Digital Audio and Video (NOSSDAV): 2001-2020, 2005-2011 (chair), 2012-2020 (co-chair)
IFIP/IEEE International Conference on Management of Multimedia Networks and Services (MMNS): 2005-2009

Conference/Workshop Chair

International Conference on Communication Systems and Networks (COMSNETS): 2014 (co-chair)
ACM International Conference on Next Generation Communication (CoNext): 2013 (co-chair)
ACM RecSys News Recommender Systems (NRS) Workshop and Challange: 2013 (co-chair)
ACM Sigcomm Workshop on Challenged Networks (CHANTS): 2006 (co-chair)
IEEE International Conference on Network Protocols (ICNP): 2003 (co-chair), 2006
International Workshop on Wireless Network Measurements (WiNMee): 2006 (co-chair)
IFIP/IEEE International Conference on Management of Multimedia Networks and Services (MMNS): 2002 (co-chair)
International Workshop on Network and Operating System Support for Digital Audio and Video (NOSSDAV): 2002 (co-chair), 2003 (co-chair)
IEEE Global Internet (GI) Symposium: 2001 (co-chair), 2018 (co-chair)
International Workshop on Networked Group Communication (NGC): 2000 (co-chair)

Program Chair

International Conference on Computer Communication and Networks (ICCCN): 2015 (Track co-chair) International Conference on Communication Systems and Networks (COMSNETS): 2010
IEEE International Conference on Network Protocols (ICNP): 2008 (co-chair)
IEEE Conference on Sensor and Ad Hoc Communications and Networks (SECON): 2007 (co-chair)
IFIP Networking: 2005 (co-chair)

Posters/Demonstrations Chair

ACM Sigcomm: 2012 (co-chair)

Student Travel Grants Chair

ACM Sigcomm: 2010 (co-chair)

Publicity Chair

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

Keynote Chair

IEEE Infocom: 2005 (co-chair)

Local Arrangements Chair

Internet2 "Field of Dreams" Workshop: 2000

Tutorial Chair

ACM Multimedia: 2000
IEEE International Conference on Network Protocols (ICNP): 1999

Panel/Session Organizer

NSF ANIR PI 2003 Panel on "Core Networking Issues and Protocols for the Internet"
CCW 2001 Session on "Multicast/Peer-to-Peer Networking"
NOSSDAV 2001 Panel on "Multimedia After a Decade of Research"
NGC 2000 Panel on "Multicast Pricing"

Technical Program Committee

IEEE International Conference on Network Protocols (ICNP): 1999, 2000, 2001, 2003, 2004, 2005, 2006, 2007, 2008, 2009 (Area Chair), 2010 (Area Chair), 2011 (Area Chair), 2012 (Area Chair), 2013, 2014 (Area Chair), 2015 (Area Chair), 2016 (Area Chair), 2017 (Area Chair), 2018 (Area Chair), 2019 (Area Chair), 2020 (Area Chair), 2021 (Area Chair)
International Workshop on Network and Operating System Support for Digital Audio and Video (NOSSDAV): 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019
ACM Multimedia (MM): 2001, 2003, 2004, 2005 (short paper), 2006, 2007, 2008, 2008 (short paper), 2010, 2011, 2012, 2013, 2015, 2016, 2017, 2018, 2019, 2023
IEEE Conference on Sensor and Ad Hoc Communications and Networks (SECON): 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011 (Area Chair), 2012 (Area Chair), 2013, 2014 (Area Chair), 2015, 2016 (Area Chair), 2017, 2018, 2019
IEEE/IFIP Network Operations and Management Symposium (NOMS): 2004, 2006, 2010
IEEE Infocom: 2004, 2005, 2006, 2008, 2009, 2010 (Area Chair), 2011 (Area Chair), 2012 (Area Chair)
IFIP Networking: 2004, 2005, 2006, 2007, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2022
IEEE International Conference on Communications (ICC) Next Generation Networking and Internet Symposium (NGNI): 2018, 2019
ACM Workshop on Mobile Video (MoVid): 2014, 2015, 2016, 2017
ACM Student Research Competition (SRC) Grand Finals: 2014
Mobile and Social Computing for Collaborative Interactions (MSC): 2014
IEEE Conference on Communications and Network Security (CNS): 2013
IEEE International Symposium on a World of Wireless, Mobile and Multimedia Networks (WoWMoM): 2005, 2006, 2007, 2008, 2009, 2010
ACM Sigcomm Workshop on Challenged Networks (CHANTS): 2006, 2008, 2009, 2010, 2011, 2012, 2016, 2017, 2018, 2019
IEEE International Conference on Distributed Computing Systems (ICDCS): 2006, 2010, 2011, 2012, 2013
International Workshop on Wireless Network Measurements (WiNMee): 2006, 2008, 2010
ACM Sigcomm: 2004 (poster), 2008 (poster), 2010
IEEE International Conference on Computer Communication and Networks (IC3N): 2008, 2009, 2010, 2011, 2012
International Conference on Communication Systems and Networks (COMSNETS): 2009,

2010, 2011, 2012, 2013
International Conference on Sensor Networks (SENSORNETS): 2012
International Workshop on Social and Mobile Computing for Collaborative Environments (SOMOCO): 2012
Workshop on Scenarios for Network Evaluation Studies (SCENES): 2009, 2010, 2011
ACM Multimedia Systems (MMSys): 2010, 2011, 2012, 2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022
IEEE Internation Symposium on Multimedia (ISM): 2016
IEEE International Conference on Pervasive Computing and Communications (PerCom): 2010
IEEE Wireless Communications and Networking Conference (WCNC): 2010, 2011
ACM International Symposium on Mobility Management and Wireless Access (MobiWac): 2010, 2011
International Conference on Computing, Networking and Communications, Internet Services and Applications Symposium (ICNC-ISA): 2012, 2013
IEEE WoWMoM Workshop on Hot Topics in Mesh Networking (HotMesh): 2010, 2011, 2012, 2013
IEEE Workshop on Pervasive Group Communication (PerGroup): 2010
ACM International Conference on Next Generation Communication (CoNEXT): 2005, 2006, 2007, 2009, 2012
IEEE International Conference on Broadband Communications, Networks, and Systems (BroadNets) Wireless Communications, Networks and Systems Symposium: 2007, 2008, 2009
IEEE International Conference on Broadband Communications, Networks, and Systems (BroadNets) Internet Technologies Symposium: 2007, 2008, 2009
International Workshop on Mobile and Networking Technologies for Social Applications (MONET): 2008, 2009
Extreme Workshop on Communication-The Midnight Sun Expedition (ExtremeCom): 2009
IEEE International Workshop on Cooperation in Pervasive Environments (CoPE): 2009
International Workshop on the Network of the Future (FutureNet): 2009, 2010, 2011, 2012
IEEE International Conference on Multimedia and Exposition (ICME): 2010
SPIE Conference on Multimedia Computing and Networking (MMCN): 2004, 2008
ACM Sigcomm Workshop on the Economics of Networks, Systems, and Computation (NetEcon): 2008
IEEE International Conference on Communications (ICC): 2008
IEEE International Conference on Mobile Ad-hoc and Sensor Systems (MASS): 2008
IFIP/IEEE International Symposium on Integrated Network Management (IM): 2005, 2007
Global Internet (GI) Symposium: 2001, 2002, 2004, 2006, 2007, 2022, 2023
IEEE/ACM International Conference on High Performance Computing (HiPC): 2007
ACM International Symposium on Mobile Ad Hoc Networking and Computing (MobiHoc): 2007
IEEE Workshop on Embedded Systems for Real-Time Multimedia (ESTIMedia): 2007
IEEE/IFIP Wireless On Demand Network Systems and Services (WONS): 2007
IFIP/IEEE International Conference on Management of Multimedia Networks and Services (MMNS): 2001, 2002, 2003, 2004, 2005, 2006
IASTED International Conference on European Internet and Multimedia Systems and Applications (EuroIMSA): 2004, 2006
IEEE International Conference on Parallel and Distributed Systems (ICPADS): 2005, 2006
IEEE Globecom Internet Services and Enabling Technologies (IS&ET) Symposium: 2006

International Workshop on Incentive-Based Computing (IBC): 2006
IEEE International Workshop on Quality of Service (IWQoS): 2006, 2014, 2015
International Workshop on Multi-hop Ad Hoc Networks (REALMAN): 2006
IEEE Globecom Automatic Internet Symposium: 2005
ACM Sigcomm Workshop on the Economics of Peer-to-Peer Systems (P2PEcon): 2005
International Conference on Parallel Processing (ICPP): 2001, 2003, 2004
International Packet Video (PV) Workshop: 2002, 2003, 2004
IEEE International Symposium on High-Performance Distributed Computing (HPDC): 2004
International Workshop on Broadband Wireless Multimedia: Algorithms, Architectures and Applications (BroadWIM): 2004
International Symposium on Innovation in Information & Communication Technology (ISIICT): 2004
Workshop on Coordinated Quality of Service in Distributed Systems (COQODS): 2004
IASTED International Conference on Networks and Communication Systems (NCS): 2004
IASTED International Conference on Communications, Internet, and Information Technology (CIIT): 2004
IASTED International Conference on Internet and Multimedia Systems and Applications (IMSA): 2003, 2004
International Workshop on Networked Group Communication (NGC): 1999, 2000, 2001, 2002, 2003
International Association for Development of the Information Society (IADIS) International Conference on the WWW/Internet: 2003
International Conference on Computer and Information Science (ICIS): 2003
Human.Society@Internet: 2003
IASTED International Conference on Communications and Computer Networks (CCN): 2002
The Content Delivery Networks (CDN) Event: 2001
IP Multicast Initiative Summit: 1998, 1999, 2000
Corporation for Education Network Initiatives in California (CENIC): 1999
Internet Bandwidth Management Summit (iBAND): 1998, 1999

B. Technical Activities

1. Working Groups

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

2. Meeting Support Work

Internet Engineering Task Force MBone broadcasts: 1995-2005

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

C. University of California Committees

1. Department of Computer Science Committees

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

2. University Committees

Member, Campus Budget and Planning: 2013-2015
Faculty, Cognitive Science Program: 2006-2020
Faculty, Technology Management Program (TMP): 2003-2014
Faculty, Media Arts and Technology (MAT) Program: 1998-2014
Faculty, Computer Engineering Degree Program: 1998-2020
Steering Committee, Center for Information Technology and Society (CITS): 2012-2020
Associate Director, Center for Information Technology and Society (CITS): 1999-2012
Member, Campus Committee on Committees: 2010-2013
Member, Campus Income and Recharge Committee: 2010-2013
Member, College of Engineering Executive Committee: 2010-2012 (chair 2011-2012), 2014-2015 (chair 2014-2015)
Member, Distinguished Teaching Award Committee: 2009, 2010, 2011
Member, Campus Classroom Design and Renovation Committee: 2003-2010
Member, ISBER Advisory Committee: 2008-2011
Member, Fulbright Campus Review Committee: 2007
Member, Faculty Outreach Grant Program Review Committee: 2007
Executive Vice Chancellor's Information Technology Fee Committee: 2005-2006
Council on Research and Instructional Resources: 2003-2006
Executive Vice Chancellor's Working Group on Graduate Diversity: 2004-2005
Member, Engineering Pavillion Planning Committee: 2003-2005
Information Technology Board: 2001-2004

Executive Committee, Center for Entrepreneurship & Engineering Management (CEEM): 2001-2004

3. System Wide Committees

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

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

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

Cases in last 4 years I have been deposed or testified:

- Depositions in Inter Partes Review of U.S. Patent Nos. 9,369,741 (IPR2019-00231) and 9,621,956 (IPR201-00281) [Comcast Cable Communications, LLC v. Rovi Guides Inc.]. Finished 01/2020.
- A deposition and trial testimony in Certain Digital Video Receivers, Broadband Gateways, and Related Hardware and Software Components (US ITC Inv. No. 337-TA-1158) [Rovi Guides, Inc. v. Comcast Cable Communications, LLC]. Finished 01/2020.
- A deposition in Innovation Sciences, LLC v. Resideo Technologies, Inc. (4:18-cv-00475-ALM, E. D. Tex.). Finished 02/2020.
- Depositions and a claim construction tutorial in Blackberry Limited v. Facebook, Inc. and Snap, Inc. (2:18-cv-01844 GW(KSx) and 2:18-cv-02693-GW(KSx), C. D. Cal.). Finished 03/2020.
- A deposition in Inter Partes Review of U.S. Patent Nos. 9,912,983 (IPR2019-01306) [Resideo Technologies, Inc. v. Innovation Sciences, LLC]. Finished 05/2020.
- A deposition in Sprint Communications Company LP v. Charter Communications, Inc. et al. (17-1734-RGA, D. Del.). Finished 06/2020.
- Depositions in Inter Partes Review of U.S. Patent Nos. 9,369,741 (IPR2019-00231), 9,621,956 (IPR2019-00281), and 9,118,948 (IPR2019-01421) [Comcast Cable Communications, LLC v. Rovi Guides Inc.]. Finished 07/2020.
- Depositions and claim construction tutorial in Netfuel, Inc. v. Cisco Systems, Inc. (5:18-cv-2352-EJD, N. D. Cal). Finished 08/2020.
- A deposition in Inter Partes Review of U.S. Patent No. 9,663,659 (IPR2019-00992) [Cisco Systems, Inc. v. NetFuel, Inc.]. Finished 09/2020.
- A deposition in Monarch Network Solutions, LLC v. Cisco Systems, Inc. (2:20-cv-00015-JRG, E. D. Tex.). Finished 09/2020.
- A deposition in Finjan, Inc. v. Rapid7, Inc. (1:18-cv-01519-MN, D. Del.). Finished 09/2020.
- A deposition in Finjan, Inc. v. SonicWall, Inc. (5:17-cv-04467-BLF-HRL, N. D. Cal.). Finished 10/2020.
- Depositions and trial testimony in TQ Delta, LLC v. 2Wire, Inc. (1:13-cv-01835-RGA, D. Del.). Finished 11/2020.
- A deposition in Linksmart Wireless Technology, LLC v. Gogo, LLC and Panasonic Avionics Corp (8:18-cv-00654-JAK-JDE and 8:18-cv-00662-JAK-JDE). Finished 12/2020.
- A deposition and trial testimony in Certain Audio Players and Controllers, Components, Thereof and Products Containing the Same (ITC Inv. No. 337-TA-1191) [Sonos, Inc. v. Google LLC and Alphabet, Inc.]. Finished 02/2021.
- A deposition in Finjan, Inc. v. Cisco Systems, Inc. (5:17-cv-00072-BLF-SVK, N. D. Cal). Finished 02/2021.

- A deposition and trial testimony in Gigamon, Inc. v. Apcon, Inc. (2:19-cv-300-JRG, E. D. Tex.). Finished 04/2021.
- A deposition in Certain IP Camera Systems including Video Doorbells and Components Thereof (US ITC Inv. No. 337-TA-1242) [SkyBell Technologies, Inc., SB IP Holdings, LLC, and Eyetalk365, LLC v. SimpliSafe, Inc., Arlo Technologies, Inc., and Vivint Smart Home, Inc.]. Finished 09/2021.
- A deposition in Warner Records, Inc. et al. v. Charter Communications, Inc. (19-cv-00874-RBJ-MEH, D. Colo.). Finished 10/2021.
- A deposition and trial testimony in VideoShare, LLC v. Google LLC (6:19-cv-00663-ADA, W. D. Tex.). Finished 11/2021.
- A deposition in The Chamberlain Group, LLC v. Overhead Door Corp. (2:21-cv-0084, E. D. Tex.). Finished 12/2021.
- Depositions in Contour IP Holding, LLC v. GoPro, Inc. (17-cv-04738-WHO, N. D. Cal.). Finished 12/2021.
- A deposition in Chewy, Inc. v. International Business Machines Corporation (1:21-cv-1319-JSR, S. D.N.Y.). Finished 02/2022.
- A deposition in Flexiworld Technologies, Inc. v. Roku, Inc. (6:20-cv-00819-ADA, W. D. Tex.). Finished 02/2022.
- A deposition in Proven Networks, LLC v. NetApp, Inc. (6:20-cv-00369-ADA, W. D. Tex.). Finished 03/2022.
- Trial testimony in Two Way Media LTD v. Telefonica (517/2017-X, Barcelona, Spain). Finished 05/2022.
- A deposition and claim construction hearing testimony in Peloton Interactive, Inc. v. Icon Health and Fitness, Inc. (1:20-cv-00662-RGA, D. Del.). Finished 05/2022.
- Depositions in Icon Health and Fitness, Inc. v. Peloton Interactive, Inc. (20-1386-RGA, D. Del.). Finished 05/2022.
- A deposition and hearing testimony in UMG Recordings, Inc., et al. v. Bright House Networks, LLC (8:19-cv-00710-MSS-TGW, M. D. Fla.). Finished 05/2022.
- A deposition in Inter Partes Review of U.S. Patent Nos. 9,860,198 (IPR2021-00882) and 10,728,192 (IPR2021-00883) [Meta Platforms, Inc. v. Wrinkl Inc.]. Finished 06/2022.
- Depositions in Inter Partes Review of U.S. Patent Nos. 8,166,081 (IPR2021-01267), 8,688,028 (IPR2021-01303), 8,903,307 (IPR2021-01305), and 8,200,203 (IPR2021-01371) [Hyundai Motor America v. StratosAudio, Inc.]. Finished 08/2022.
- A deposition and trial testimony in Shopify, Inc. v. Express Mobile, Inc. (1:19-cv-00439-RGA, D. Del.). Finished 08/2022.
- Depositions in Inter Partes Review of U.S. Patent Nos. 9,291,475 (IPR2022-00708 and IPR2023-00031); 9,602,608 (IPR2022-00709); 7,484,008 (IPR2022-00857); and 6,832,283 (IPR2022-0970) [Toyota Motor Corp. and American Honda Motor Co, Inc. v. Intellectual Ventures II LLC]. Finished 02/2023.

- A deposition and trial testimony in Express Mobile, Inc. v. GoDaddy.com, LLC (1:19-cv-01937-RGA, D. Del.). Finished 03/2023.
- A deposition in Inter Partes Review of U.S. Patent No. 9,182,231 (IPR2022-00586) [Qualcomm Inc. v. FedEx Corporate Services, Inc.]. Finished 04/2023.
- Depositions and trial testimony in Sonos, Inc. v. Google LLC (6:20-cv-881-ADA, W. D. Tex.; 3:20-cv-06754-WHA, N. D. Cal.; and 3:21-cv-07559-WHA, N. D. Cal.). Finished 05/2023.
- Depositions and trial testimony in Personal Audio, LLC v. Google, Inc. (1:17-cv-01751-VAC-CJB, D. Del). Finished 06/2023.
- A deposition in Orckit Corp v. Cisco Systems, Inc. (2:22-cv-276, E. D. Tex.). Finished 06/2023.
- A deposition and trial testimony in Touchstream Technologies, Inc. v. Google, LLC (6:21-cv-00569-ADA, W. D. Tex.). Finished 07/2023.
- A deposition in Inter Partes Review of U.S. Patent No. 8,784,113 (IPR2022-01439) [Go1 Pty, Ltd. v. OpenSesame, Inc.]. Finished 09/2023.
- Depositions in Post-Grant Review of U.S. Patent No. 10,782,951 (PGR2021-00096) and 11,157,256 (PGR2022-00053) [IronSource Ltd. v. Digital Turbine, Inc.]. Finished 10/2023.
- A deposition and trial testimony in SB IP Holdings, LLC v. Vivint Smart Home, Inc. (4:20-cv-00886-ALM, E. D. Tex.). Finished 10/2023.
- Depositions and trial testimony in Alacritech, Inc. v. Centurylink Communications LLC; Winstron Corporation, Dell, Inc. (2:16-cv-693-RWS, 2:16-cv-692-RWS, 2:16-cv-695-RWS, E. D. Tex.). Finished 10/2023.
- A deposition in Inter Partes Review of U.S. Patent Nos. 9,503,498 (IPR2023-00185); 9,516,091 (IPR2023-00186); and 8,924,457 (IPR2023-00187) [Bright Data LTD v. Oxylabs, UAB]. Finished 11/2023.
- Trial testimony in GoodRx, Inc. v. Famulus Health LLC (01-23-000-5919, American Arbitration Association). Finished 11/2023.
- Depositions in TQ Delta, LLC v. AdTran, Inc. (14-cv-954-RGA, 15-cv-121-RGA, D. Del).
- A deposition in Motorola Solutions, Inc. v. Hytera Communications Corp. LTD (1:17-cv-01972, N. D. Ill.)
- Depositions and trial testimony in Luminati Networks Ltd. v. UAB Tesonet and UAB Metacluster LT (2:18-cv-00299-JRG, E. D. Tex.); Luminati Networks Ltd. v. Teso LT, UAB; Oxysales, UAB; and Metacluster LT, UAB, (2:19-cv-00395-JRG, E. D. Tex.); Luminati Networks Ltd. v. Code 200, UAB; Oxysales, UAB; and Metacluster LT, UAB (2:19-cv-00396-JRG, E. D. Tex.); Bright Data Networks Ltd. v. Tefincom S.A. (2:19-cv-00414-JRG, E. D. Tex.); Metacluster LT, UAB v. Bright Data Ltd. (2:23-cv-00011-JRG-RSP); Bright Data Ltd. v. Oxylabs, UAB (2:23-cv-00171-JRG-RSP).
- A deposition and trial testimony in Centripetal Networks, Inc. v. Cisco Systems, Inc. (2:18-cv-00094, E. D. Va.).
- A deposition in FirstFace Co, LTD v. Apple, Inc (3:18-cv-02245-JD, N. D. Cal.).

- A deposition in WebRoot, Inc. and Open Text, Inc. v. Trend Micro, Inc. (22-cv-00239-ADA-DTG, W. D. Tex.).
- A deposition in WSOU Investments, LLC v. Cisco Systems, Inc. (6:20-cv-00128-ADA, W. D. Tex.)
- A deposition in Entropic Communications LLC v. Charter Communications, Inc. (2:22-cv-00125-JRG, E. D. Tex.)
- A deposition in Zilkr Cloud Technologies, LLC v. Cisco Systems, Inc. (2:22-cv-00166-JRG-RSP, E. D. Tex.).
- A deposition in Inter Partes Review of U.S. Patent No. 8,072,968 (IPR2022-00890) [IBM Corp. v. Ebates Performance Marketing, Inc.].
- A deposition in Omnitracs, LLC v. Platform Science, Inc. (3:20-cv-0958-CAB-DDL, S. D. Cal.)
- Depositions in IBM Corp. v. Rakuten, Inc. and Ebates Performance Marketing, Inc. (21-461-VAC, D. Del.).
- A deposition in STA Group, LLC v. Motorola Solutions, Inc. (2:22-cv-00381-JRG-RSP, E. D. Tex.)