

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

CISCO SYSTEMS, INC.
Petitioner,

v.

OPTIMNET LLC,
Patent Owner.

U.S. Patent No.

U.S. Patent No. 9,313,101

Issue Date: April 12, 2021

METHOD OF CONTROLLING TRAFFIC BY TIME-BASED POLICY

Inter Partes Review No.: IPR2026-00321

DECLARATION OF MARK. E CROVELLA IN SUPPORT OF
PETITIONS FOR INTER PARTES REVIEW OF
U.S. PATENT NO. 9,313,101.

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I, Mark E. Crovella, declare as follows:

I. INTRODUCTION

1. I am over the age of eighteen (18) and otherwise competent to make this Declaration.

2. I have been retained by Cisco Systems, Inc. (Petitioner) as an independent, technical expert consultant in this proceeding before the United States Patent and Trademark Office (USPTO). I am being compensated at my rate of \$700 per hour for my services. No part of my compensation is dependent on my opinions or on the outcome of this proceeding. I have no financial interest in any of the parties to this proceeding.

3. This Declaration is in support of the Petition for *inter partes* review involving U.S. Patent 9,313,101 (the “’101 Patent”) (EX-1001), entitled “METHOD OF CONTROLLING TRAFFIC BY TIME-BASED POLICY” and listing Sang Wang Kim, Joon Kyung Lee, Dong Won Kang, Wang Bong Lee, Sang Kil Park, SingSik Yoon, and Jong Dae Park as the inventors.

4. For the purposes of this *inter partes* review as I discuss later, I have been instructed to assume that the effective filing date of the Claims of the ’101 Patent challenged by the Petitioner in *inter partes* reviews is no earlier than April 18, 2012.

5. I understand that, according to USPTO records, the '101 Patent is currently assigned to Optimnet LLC ("Patent Owner"). I assume for purposes of this proceeding that Optimnet LLC is the patent owner.

6. The '101 Patent is generally directed to a method of setting a traffic control policy in which a time of day is determined and used in combination with packet header information to execute the traffic control policy. I am familiar with the technology described in the '101 Patent as of the earliest possible priority date of April 18, 2012, the filing date of Korean Patent Application No. 10-2012-0040556.

7. In preparing this Declaration, I have reviewed the '101 Patent (EX-1001) its prosecution history (EX-1002), as well as the patents and documents cited herein, and I have considered these documents in light of the general knowledge in the art as of April 18, 2012. In formulating my opinions, I have relied upon my experience in the relevant art. I have also considered the viewpoint of a person of ordinary skill in the art ("POSITA") in the relevant field, as of April 18, 2012, who I describe below (§ V.D). For convenience, the materials I considered in arriving at my opinions are listed in Appendix A.

8. I have been asked to provide my technical expertise, analysis, insights and opinions regarding the '101 Patent and relevant references that form

the basis of the arguments set forth in the accompanying Petitions for *inter partes* review of the '101 Patent.

9. As described in detail below, I offer the following opinions in this Declaration with respect to the '101 Patent:

- A POSITA would have found Claims 1-6 are unpatentable over Mo in view of Peng and a POSITA would have been motivated to combine the teachings of these references.

10. Unless otherwise indicated, the emphasis in quotations has been added.

II. QUALIFICATIONS

11. My qualifications for forming the opinions set forth in this declaration are summarized here and explained in more detail in my *curriculum vitae*, which is included as Appendix B. Appendix B also includes a list of my publications and patents.

12. I received a Ph.D. in Computer Science from the University of Rochester in October 1994. I also received a Master of Science degree in Computer Science in 1991, a Bachelor of Science degree from State University of New York at Buffalo in 1990 and a Bachelor of Science Degree from Cornell University in 1992.

13. For the last 17 years I have been Professor in the Department of computer Science at Boston University and Department Chair from 2013-2018. I was an Associate Professor between 2000 and 2006 and an Assistant Professor between 1994 and 2000.

14. Starting in 2022, I have been a Professor on the Faculty of Computing & Data Sciences at Boston University, of which I was one of the founding members. I presently serve as Chair of Academic Affairs for the Faculty of Computing & Data Sciences. I was also a Data Science Faculty Fellow between 2019 and 2022.

15. My career in the area of computing and data analysis began in 1984 when I started work at Calspan Corporation in Buffalo., NY where I was eventually a Senior Computer Scientist. Between 2000 and April 2002, I was the Chief Architect for Webmanage Technologies of Chelmsford, MA. Webmanage was later acquired by Network Appliance for which I was a Technical Director. Between February 2012 and August 2014, I also served as Chief Scientist at Guavus Inc, a telecom analytics company.

16. Furthermore, I have served as a legal consultant for a number of companies. I have testified in Federal courts, the PTAB, and the ITC on behalf of leading companies such as Apple, Sony, Yahoo, RPX, Fortinet, Hulu, Netflix, Amazon, Samsung and Cisco.

17. I have been awarded several United States patents, including the following examples:

U.S. Pat. No.	Title
10,027,347,	Methods for storing and reading digital data on a set of DNA strands
8,869,276	Method and Apparatus for Whole-Network Anomaly Diagnosis and Method to Detect and Classify Network Anomalies Using Traffic Feature Distributions
8,533,167,	Compressed Set Representation for Sets as Measures in OLAP Cubes
7,747,741	Method and Apparatus for Dynamic Resource Discovery and Information Distribution in a Data Network
7,346,682	System for Creating and Distributing Prioritized List of Computer Nodes Selected as Participants in a Distribution Job
6,993,587	Method and Apparatus for Election of Group Leaders in a Distributed Network
6,748,447	Method and Apparatus for Scalable Distribution of Information in a Distributed Network
6,718,361	Method and Apparatus for Reliable and Scalable Distribution of Data Files in Distributed Networks
6,370,584	Distributed Routing
6,223,205	Method and Apparatus for Assigning Tasks in a Distributed Server System

18. Based on my above-described over three decades of experience in Computing and Data Sciences and the acceptance of my publications (200+) and professional recognition by societies in my field, I believe that I am qualified to be an expert in the field of computer network protocol technology.

19. Based on my experience described above, and as indicated in my *curriculum vitae*, I am qualified to provide the following opinions with respect to the patents in this case. Additionally, I am at least a person having ordinary skill in the art as of the priority date of the '101 Patent.

III. RELEVANT LEGAL STANDARDS

20. I do not provide any legal opinions in this Declaration. I have been informed and understand that certain legal standards are to be applied by technical experts in forming opinions regarding the meaning and validity of patent claims. I have been asked to provide my opinions regarding whether the claims of the ' XXX Patent would have been obvious to a person having ordinary skill in the art at the time of the alleged invention, in light of the prior art.

21. I have been informed and understand that a patent claim is not patentable as obvious (a requirement I understand to be governed by a statute, 35 U.S.C. § 103) if the differences between the patent claim and the prior art are such that the claimed subject matter as a whole would have been obvious at the time the claimed invention was made to a person having ordinary skill in the relevant art. Obviousness, as I have been informed and understand, is based on the scope and content of the prior art, the differences between the prior art and the claim, the level of ordinary skill in the art, and, to the extent that they exist, certain objective indicia of non-obviousness.

22. I understand that objective indicia can be important evidence regarding whether a patent is obvious or nonobvious, if it has an appropriate nexus to the claimed invention, i.e., is a result of the merits of a claimed invention (rather than the result of design needs or market-pressure advertising or similar activities). Such indicia include: commercial success of products covered by the patent claims; a long-felt need for the invention; failed attempts by others to make the invention; copying of the invention by others in the field; unexpected results achieved by the invention as compared to the closest prior art; praise of the invention by the infringer or others in the field; the taking of licenses under the patent by others; expressions of surprise by experts and those skilled in the art at the making of the invention; the patentee proceeded contrary to the accepted wisdom of the prior art, and, the contemporaneous development of the subject matter claimed by others.

23. I have been informed that whether there are any relevant differences between the prior art and the claimed invention is to be analyzed from the view of a person of ordinary skill in the relevant art at the time of the invention. As such, my opinions below as to a person of ordinary skill in the art are as of the time of the invention, even if not expressly stated as such; for example, even if stated in the present tense.

24. In analyzing the relevance of the differences between the claimed invention and the prior art, I have been informed that I must consider the

impact, if any, of such differences on the obviousness or non-obviousness of the invention as a whole, not merely some portion of it. The person of ordinary skill faced with a problem is able to apply his or her experience and ability to solve the problem and also look to any available prior art to help solve the problem.

25. I have been informed that a precise teaching in the prior art directed to the subject matter of the claimed invention is not needed. I have been informed that one may take into account the inferences and creative steps that a person of ordinary skill in the art would have employed in reviewing the prior art at the time of the invention. For example, if the claimed invention combined elements known in the prior art and the combination yielded results that were predictable to a person of ordinary skill in the art at the time of the invention, then this evidence would make it more likely that the claim was obvious. On the other hand, if the combination of known elements yielded unexpected or unpredictable results, or if the prior art teaches away from combining the known elements, then this evidence would make it more likely that the claim that successfully combined those elements was not obvious.

26. I have been informed and understand that there are recognized, exemplary, rationales for combining or modifying references to show obviousness of claimed subject matter. Some of the rationales include the following: combining prior art elements according to known methods to yield predictable results; simple

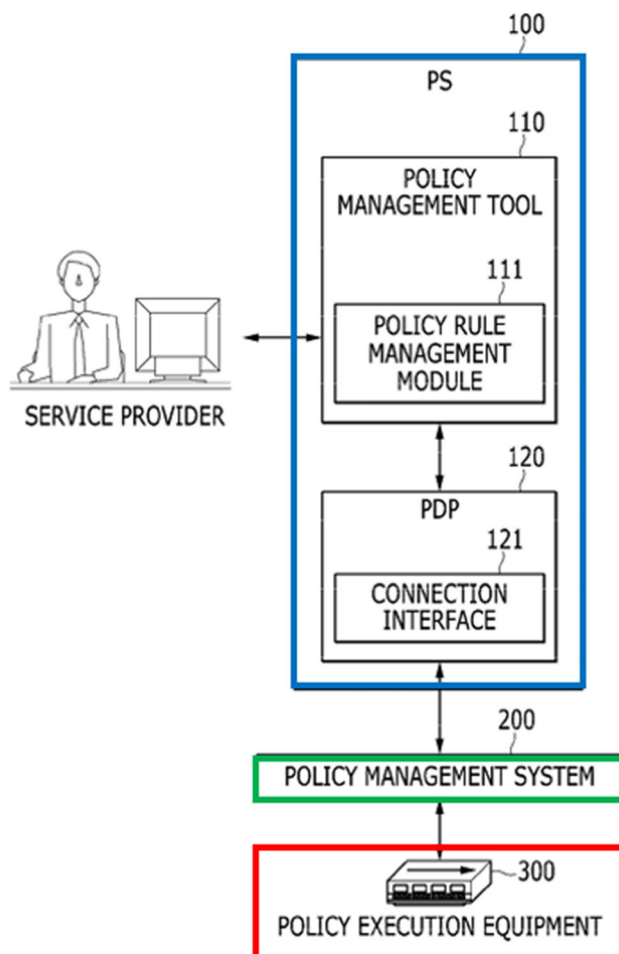
substitution of one known element for another to yield predictable results; use of a known technique to improve a similar device (method or product) in the same way; applying a known technique to a known device (method or product) ready for improvement to yield predictable results; choosing from a finite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

IV. OVERVIEW

27. The '101 Patent is directed to a method of setting a traffic control policy in which a time of day is determined and used in combination with packet header information to execute the traffic control policy.

28. FIG. 1 of the '101 Patent illustrates one embodiment of an architecture for performing a time-based traffic policy. A time-based policy is set at a policy server (PS) 100 (blue) and can be executed in policy execution equipment (PEE) 300 (red) via a policy management system (PMS) 200 (green).

FIG. 1



29. However, it was known to set a traffic control policy in which a time of day is determined and used in combination with packet header information to execute the traffic control policy. For example, the Mo reference discloses setting a traffic control policy that provides for quality of service (QoS) based on a time of day in combination with packet header information to execute the QoS traffic control policy.

30. FIG. 1 of Mo illustrates an embodiment of an architecture for implementing a time-based traffic policy for QoS based on the 3GPP specifications that was very similar to the architecture described in the '101 Patent:

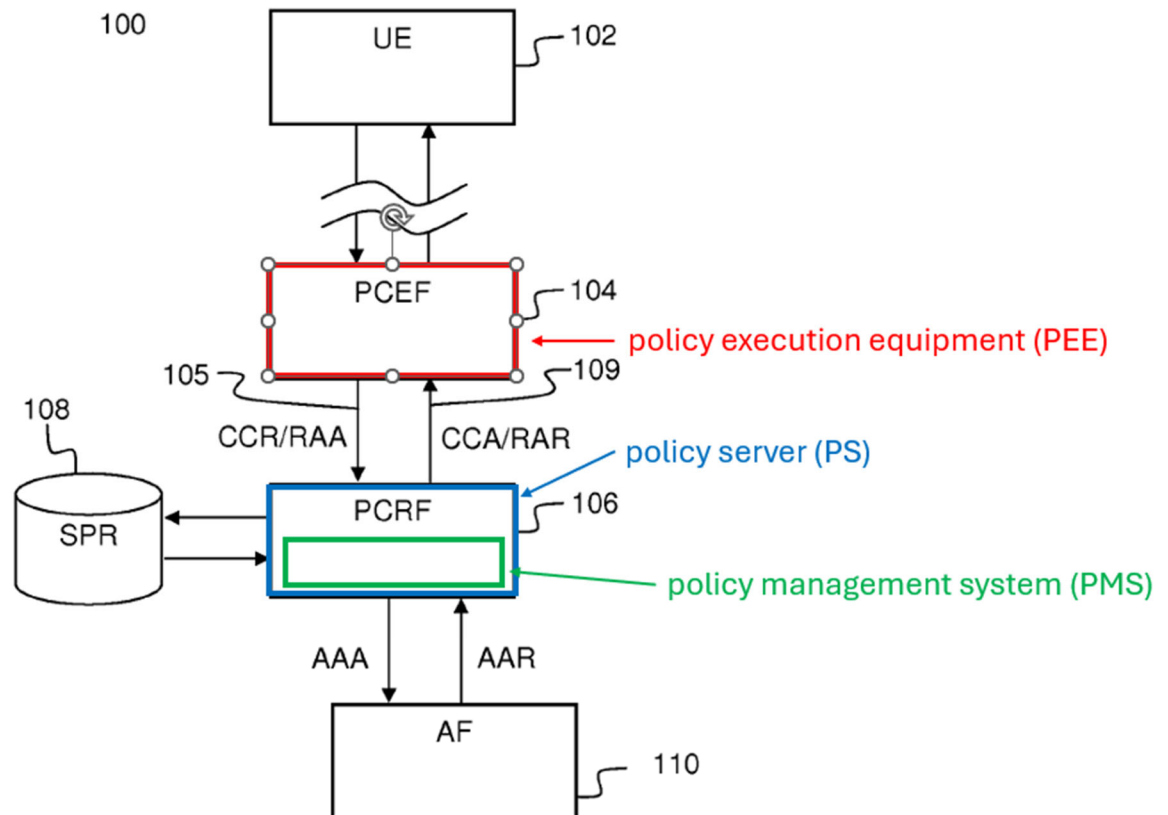


FIG. 1

31. The Peng reference describes the flexibility provided by the 3GPP architecture that allowed the traffic control policy to be executed at the Policy and Charging Rules Function (PCRF) 106 (blue) or the Policy and Charging Enforcement Function (PCEF) 104 (red).

32. Thus, the Challenged Claims are unpatentable over Mo alone, or in view of Peng.

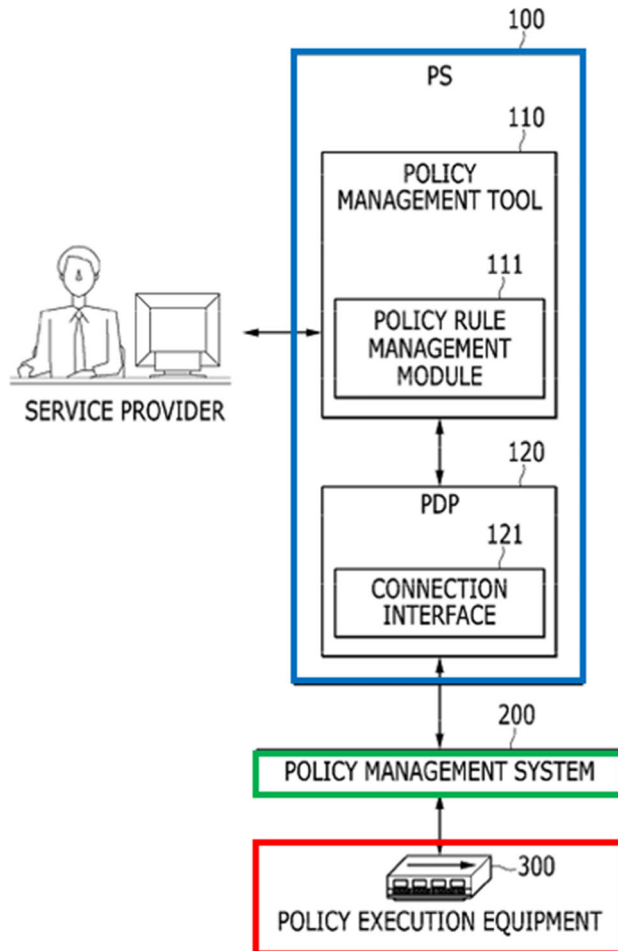
V. BACKGROUND

A. Overview of the '101 Patent

33. The '101 Patent is directed to a method of setting a traffic control policy in which a time of day is determined and used to execute the traffic control policy. EX-1001 1:15-20. The '101 Patent describes that one problem in the prior art is that traffic was typically controlled based only on the information in a packet header, such as the 5-tuple (source IP address, destination IP address, source port, destination port, and protocol) or 7-tuple (source IP address, destination IP address, source port, destination port, protocol, input port number, and signature). EX-1001 1:21-38. The '101 Patent describes that such a policy limited the control of network traffic. EX-1001 1: 40-43. As a solution, the '101 Patent proposed controlling network traffic by adding a time condition to policy settings that controls traffic. EX-1001 1:48-52.

34. FIG. 1 of the '101 Patent illustrates one embodiment of an architecture for performing a time-based traffic policy. A time-based policy is set at a policy server (PS) 100 (blue) and can be executed in policy execution equipment (PEE) 300 (red) via a policy management system (PMS) 200 (green).

FIG. 1



35. A network service provider uses a policy rule management module 111 to set a time-based policy. A time-based policy may combine information (5-tuple, 7-tuple, etc.) that is included in a packet, a traffic flow form, and a time condition. For example, in a specific time zone, a policy that allows traffic of a specific IP address may be set, and during a specific period, a policy that determines total traffic that uses a specific port or address may be set. The time-based policy that is set at the policy rule management module 111 can be

converted to policy management system transfer syntax at a policy decision point (PDP) 120, and transmitted to the policy management system (PMS) 200. EX-1001 3:8-33.

36. The PMS 200 stores the received time-based policy at a database and synchronizes the time-based policy in real time. The PMS 200 parses the received time-based policy to a structure appropriate for the PEE 300, and transmits the parsed time-based policy to each PEE 300. EX-1001 3:36-42.

37. The PMS 200 is connected to the PEE 300, which is described as hardware that executes a policy that controls traffic. EX-1001 3:33-35. As the time-based policy is executed in the PEE 300, a time condition is reflected to a traffic control and thus a related application service can be provided. EX-1001 3:48-50.

38. The '101 Patent describes that the step of determining an execution time point of a time-based policy to which a time condition is reflected may be determined at the PS, the PMS or the PEE. EX-1001 3:51-53.

39. The Patent issued with six claims. Independent Claim 1 is directed to determining if the execution point of the time-based policy has arrived at the PS. Independent Claim 3 is directed to downloading the time-based policy at the PSM. Independent Claim 6 is directed to downloading the time-based policy at the PEE.

B. Priority Date of the Challenged Claims

40. The '101 Patent claims priority to April 18, 2012. EX-1001.

Solely for the purposes of this IPR, I have been instructed to assume the priority dates for the Patents are October 2, 2003.

C. Claim Construction

41. I have been informed to give each claim term in the Challenged Claims its plain and ordinary meaning in this proceeding. It is my opinion that no specific construction of any claim term is required because the prior art I have relied upon meets each of the claim terms under any reasonable construction.

D. Level of Ordinary Skill in the Art

42. A Person of Ordinary Skill in the Art ("POSITA") in April 2012 would have been someone knowledgeable and familiar with network traffic policies. A POSITA would have gained knowledge of these concepts through a mixture of training and work experience, such as by having at least a bachelor's degree in electrical engineering or computer sciences, or related field, and at least two to three years of training or additional work experience in the area of network traffic control. Additional hands-on and design experience could compensate for less formal education, and vice versa. The knowledge and skill of a POSITA is further reflected in the prior art references themselves, as well as the State of the Art, discussed below.

E. State of the Art

43. In this section I describe the state of the art as of the Priority Date. This section, and the expert testimony and documentary evidence cited, provide additional factual support for the general knowledge, common understanding and skill of a POSITA at the Priority Date. This section provides additional factual support and motivation to modify and combine the teachings in the references, and further demonstrates why doing so would involve a reasonable expectation of success.

1. It was known to centrally determine time-based policy execution at a PCRF and to execute the schedule at enforcement nodes using standardized “time-of-day” procedures

44. By 2012, the 3GPP Policy and Charging Control (PCC) specifications had standardized explicit “time-of-day” mechanisms that allowed a central Policy and Charging Rules Function (PCRF) to determine when a policy should take effect while relying on local clocks in enforcement points to execute that timing. In particular, 3GPP TS 29.212 defined the Revalidation-Time Attribute-Value Pair (AVP) (AVP code 1042), which specifies the Network Time Protocol (NTP) time before which the PCEF must re-request PCC rules and causes the PCEF to trigger a PCRF interaction upon a REVALIDATION_TIMEOUT event, thereby enabling the PCRF to centrally schedule a future re-contact by the enforcement node. *See* EX-1006 §5.3.41. The same specification defined the Rule-

Activation-Time AVP (AVP code 1043), which indicates the NTP time at which the PCEF must set a PCC rule active, and the Rule-Deactivation-Time AVP (AVP code 1044), which indicates the NTP time at which the PCEF must stop enforcing a rule; critically, the specification expressly states that “PCC Rule Activation or Deactivation will not generate any CCR commands with Charging-Rule-Report since PCRF is already aware of the state of the rules,” confirming that local time-gating at the PCEF produces no additional control-plane signaling at the moment of transition. EX-1006 §§4.5.13; 5.3.42-43. The 3GPP-MS-TimeZone AVP, if available, may be used by the PCRF to derive the Rule-Activation-Time and Rule-Deactivation-Time. EX-1006 §4.5.13.

45. The same time-of-day procedures were mirrored for the Bearer Binding and Event Reporting Function (BBERF) over the Gxx reference point. EX-1006 §4.5.13. The 3GPP PCC specifications expressly provide that if the PCRF includes Rule-Activation-Time and/or Rule-Deactivation-Time when provisioning PCC rules to the PCEF, the PCRF shall set the same activation and deactivation times when provisioning the corresponding QoS rules to the BBERF, and that the BBERF shall set the QoS rule active or inactive after that time. EX-1006 §4a.5.13. This ensured consistent local-time gating across both enforcement points while keeping the timing determination centralized at the PCRF.

46. The PCC stage-2 architecture in 3GPP TS 23.203 positioned the PCRF as the policy decision element and the PCEF as the enforcement element, while allocating the Event Reporting Function (ERF)—which performs event trigger detection and reporting of occurred events to the PCRF—to either the PCEF, the BBERF (if applicable), or the TDF for solicited application reporting. EX-1007 §6.1.4. The standardized event triggers included time-contextual triggers, including UE_TIME_ZONE_CHANGE (Event-Trigger value 25), which caused the PCEF to report a change in the time zone of the UE’s current location to the PCRF along with the new value in the 3GPP-MS-TimeZone AVP, further confirming that, as of the Priority Date, the PCRF centrally selected time schedules while enforcement nodes executed those schedules with local clocks and reported relevant time-contextual changes. EX-1004 §5.3.7.

2. It was known to perform policy determinations at enforcement nodes to reduce signaling, supported by “outsourced” versus “provisioned” policy models

47. Before April 2012, it was also known that some policy determinations could be performed at the enforcement node to reduce control-plane signaling and decision latency.

48. For example, the IETF policy framework (RFC 2753) defined a Policy Decision Point (PDP) and a Policy Enforcement Point (PEP), with two complementary execution models: in an “outsourced” model, relying on the COPS protocol (RFC 2748), the PEP requests and receives per-event decisions from the PDP over a stateful, reliable channel; in a “provisioned” model, using COPS-PR (RFC 3084), the PDP proactively provisions policy data—organized in Policy Information Bases (PIBs)—for the PEP to enforce locally until updated. EX-1008 §4 (pp. 5–7); EX-1009 §§4.4–4.5 (p. 32); EX-1010 §1 (pp. 3–4). RFC 3198 standardized the terminology for these constructs, defining “outsourced policy” as an execution model where a PEP delegates a decision for a specific policy event to an external component and “provisioned policy” as an execution model where network elements are pre-configured, based on policy, prior to processing events, with configuration pushed to the network device. EX-1011 (pp. 7, 11–12). Mapped to PCC, dynamic PCRF-provided PCC rules delivered over Gx correspond to the outsourced model, while predefined PCC rules residing at the PCEF that the PCRF merely activates or deactivates correspond to the provisioned model. As of the April 2012, 3GPP TS 23.203 and TS 29.212 supported both patterns: the PCRF could install dynamic rules using a Charging-Rule-Definition AVP within a Charging-Rule-Install AVP or activate predefined rules by referencing them within a Charging-Rule-Name AVP, and the PCEF could be provisioned with the event

triggers and attributes needed to operate with minimal further roundtrips. EX-1007 §6.2.2; EX-1006 §4.5.2, §5.3.2.

49. The same split-placement logic extended beyond pure timing to detection and metering. It was known to localize service-instance detection and usage metering at the PCEF, while keeping arbitration and rule synthesis at the PCRF, thereby reducing per-event latency without sacrificing cross-session consistency. EX-1006 §4.5.2.5. The 3GPP usage-monitoring control in TS 29.212 §§4.5.16–4.5.17 standardized this cadence: the PCRF requests monitoring by providing Monitoring-Key AVPs (EX-1006 §5.3.59) and threshold values within a Usage-Monitoring-Information AVP (EX-1006 §5.3.62) and by subscribing to a USAGE_REPORT event trigger (Event-Trigger value 29, EX-1006 §5.3.7); the PCEF measures traffic and reports accumulated usage when a threshold is reached, the PCRF explicitly requests a report, or when the last PCC rule associated with a monitoring key is removed.

3. It was known to enforce time-based conditions at the edge with synchronized device clocks and to distribute policy control across servers when needed

50. As of April 2012, it was well-known to evaluate time conditions locally at the edge using device clocks and to rely on the Network Time Protocol (NTP) for clock discipline. Enterprise routers implemented time-based access lists that permitted or denied traffic during named absolute or periodic time

ranges, an approach that minimized central signaling but required accurate, consistent device time to avoid configuration drift and inconsistent behavior across the network. EX-1012 pp. 1-4, 6-7. NTPv4 specified the synchronization protocol, on-wire timestamp format, and clock discipline algorithms used to keep network devices' clocks within microseconds to milliseconds of reference time at practical poll intervals, thereby supplying the time substrate for reliable edge-local evaluation of time conditions. EX-1013 §§1, 4, 10–11.

51. At the same time, it was known to distribute policy control across multiple servers when load, domain boundaries, or governance considerations required it, while coordinating timing across those servers. For example, inter-domain policy-server designs exchanged policy control information that included explicit start and release times for QoS controls and performed regular time calibration among servers, again assuming disciplined clocks for time-sensitive policy activation. EX-1014 [0016]– [0017]; [0026]; [0034]–[0036] (setting time information, start time (304a) and release time (304b), and time calibration process using NTP).

52. It was also known to combine central policy intent with edge execution by translating high-level, device-independent policies into device-specific rules and provisioning them to heterogeneous enforcement devices using standardized control channels. QoS policy systems performed this translation and

distribution using COPS and COPS-PR (EX-1009 §§4.4–4.5; EX-1010 §1), enabling central administrators to specify, adjust, or schedule policies—including time-conditioned ones—while relying on edge devices to classify, mark, queue, and police traffic according to local device capabilities. The DiffServ service-class configuration guidelines further documented the operator practice of provisioning class-based QoS enforcement at edge devices, and recognized that high-precision timing streams such as NTP itself warranted careful class treatment to maintain clock accuracy. EX-1015 §5.2.

Figure 4 provides a summary of DiffServ QoS mechanisms that SHOULD be used for the defined service classes that are further detailed in Sections 3 and 4 of this document. According to what applications/services need to be differentiated, network administrators can choose the service class(es) that need to be supported in their network.

Service Class	DSCP	Conditioning at DS Edge	PHB Used	Queuing	AQM
Network Control	CS6	See Section 3.1	RFC2474	Rate	Yes
Telephony	EF	Police using sr+bs	RFC3246	Priority	No
Signaling	CS5	Police using sr+bs	RFC2474	Rate	No
Multimedia Conferencing	AF41 AF42 AF43	Using two-rate, three-color marker (such as RFC 2698)	RFC2597	Rate	Yes per DSCP
Real-Time Interactive	CS4	Police using sr+bs	RFC2474	Rate	No
Multimedia Streaming	AF31 AF32 AF33	Using two-rate, three-color marker (such as RFC 2698)	RFC2597	Rate	Yes per DSCP
Broadcast Video	CS3	Police using sr+bs	RFC2474	Rate	No
Low-Latency Data	AF21 AF22 AF23	Using single-rate, three-color marker (such as RFC 2697)	RFC2597	Rate	Yes per DSCP
OAM	CS2	Police using sr+bs	RFC2474	Rate	Yes
High-Throughput Data	AF11 AF12 AF13	Using two-rate, three-color marker (such as RFC 2698)	RFC2597	Rate	Yes per DSCP
Standard	DF	Not applicable	RFC2474	Rate	Yes
Low-Priority Data	CS1	Not applicable	RFC3662	Rate	Yes

Figure 4. Summary of QoS Mechanisms Used for Each Service Class

EX-1015 Figure 4.

4. It was known that PCC operated at the service data flow level, with the PCRF provisioning authorized QoS to the PCEF for enforcement at per-rule, per-bearer, and per-APN granularities

53. The PCC architecture operated at the granularity of individual service data flows, each identified by a service data flow template composed of service data flow filters. 3GPP TS 23.203 specified that a service data flow filter may “be a pattern for matching the IP 5 tuple (source IP address, destination IP address, source port number, destination port number, protocol ID of the protocol above IP),” with values left unspecified in the filter matching any corresponding value in a packet. EX-1007 §6.3. The specification defined an IP-CAN bearer as “[a]n IP transmission path of defined capacity, delay and bit error rate” and defined a “binding” as “[t]he association between a service data flow and the IP-CAN bearer...transporting that service data flow.” EX-1007 §3.1. The binding mechanism associated each service data flow, defined in a PCC rule by means of its SDF template, to the IP-CAN bearer deemed to transport that flow; as the specification stated, “[t]he binding mechanism is the procedure that associates a service data flow (defined in a PCC and QoS rule, if applicable, by means of the SDF template), to the IP-CAN bearer deemed to transport the service data flow.” EX-1007 §6.1.1. More specifically, the bearer binding step created the association “between service data flow(s) and the IP-CAN bearer which have the same QoS class identifier and ARP,” meaning that SDFs sharing the same QoS class were

grouped onto a common bearer. EX-1007 §6.1.1.4. Once bound to a bearer, the PCEF enforced the authorized QoS and mapped it to access-specific parameters; in the specification's terms, "[t]he authorized QoS information is mapped by the PCEF to IP-CAN specific QoS attributes." The specification further defined the authorized QoS at the bearer level as the combination of the authorized QoS of the individual service data flows carried on that bearer: "[i]n case of an aggregation of multiple service data flows within one IP-CAN bearer (e.g. for GPRS a PDP context), the combination of the 'Authorised QoS' information of the individual service data flows is the 'Authorised QoS' for the IP-CAN bearer." EX-1007 §3.1. Thus, the IP-CAN bearer served as the transport container for one or more 5-tuple-identified service data flows, the bearer's QoS was derived from the aggregate of those flows' individual authorizations, and the PCEF applied the SDF templates—i.e., the 5-tuple filters—on a per-bearer basis to detect which packets belonged to which service data flow. EX-1007 §6.2.2.

54. The Gx protocol specified how the PCRF provisioned these policies to the PCEF. 3GPP TS 29.212 §4.5.2 provided that "[f]or each request from the PCEF or upon the unsolicited provision the PCRF shall provision zero or more PCC rules," using either a PULL procedure (in response to a PCEF request, via a CC-Answer) or a PUSH procedure (unsolicited, via an RA-Request). EX-1006 §4.5.2. At the per-rule level, the specification stated that "[t]he PCRF can

provide the authorized QoS for a PCC rule to the PCEF” and that “[f]or a PCRF-provided PCC rule, the ‘Authorized QoS’ shall be encoded using a QoS-Information AVP within the Charging-Rule-Definition AVP of the PCC rule,” with the mandate that “[i]f ‘Authorized QoS’ is provided for a PCC rule, the PCEF shall enforce the corresponding policy.” EX-1006 §4.5.2.4.

55. The PCRF could also provision authorized QoS at broader scopes. At the APN level, “[t]he authorized QoS per APN shall be provisioned at RAR or CCA command level using the QoS-Information AVP including the APN-Aggregate-Max-Bitrate-UL AVP and/or the APN-Aggregate-Max-Bitrate-DL AVP.” EX-1006 §4.5.5.7; §4a.5.10.3. At the IP-CAN bearer level, the QoS-Information AVP indicated “the authorized QoS for...an IP CAN bearer (when appearing at CCA or RAR command level),” and “[t]he Bearer Identifier AVP shall be included as part of the QoS-Information AVP if the QoS information refers to an IP CAN bearer initiated by the UE and the PCRF performs the bearer binding.” EX-1006 §5.3.16. *Mo* expressly noted these multiple scopes, observing that the 3GPP specifications provided authorized QoS “at the Internet Protocol Connectivity Access Network (IP-CAN) bearer level, at the QoS Class Identifier (QCI) level and the service flow level,” confirming that a POSITA understood the PCRF’s authorized QoS as operating across a hierarchy of granularities before the Priority Date. EX-1004 [0004].

5. It was known that the PCRF combined operator-facing policy definition with protocol-specific rule translation and database access, mirroring the functional split between a policy server and a policy management system

56. The PCC architecture as described in *Peng* positions the PCRF as “the core network element for policy decision,” whose “decision condition mainly originates from the AF and SPR (user subscription) as well as some policy rule conditions configured locally by the PCRF.” EX-1005 at 2:1-3. FIG. 1 of *Peng* illustrates the PCRF as the recipient of source data from the AF and the SPR:

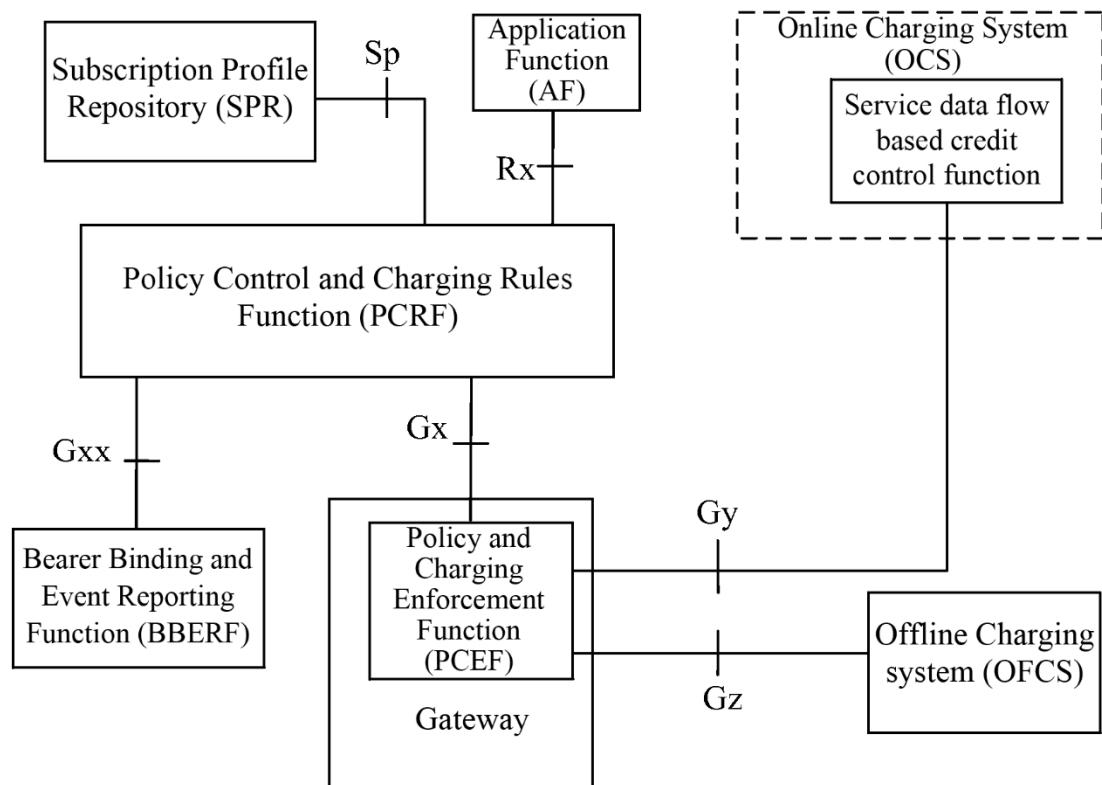


Figure 1

57. The 3GPP specifications confirmed this dual-source design. 3GPP TS 29.212 §4.4.1 provided that the PCRF's PCC rule decisions "may be based on one or more of the following: Information obtained from the AF via the Rx reference point," "Information obtained from the PCEF via the Gx reference point," "Information obtained from the SPR via the Sp reference point," and "Own PCRF pre-configured information." EX-1006 §4.4.1. 3GPP TS 23.203 similarly provided that the PCRF "should for an IP-CAN session derive, from IP-CAN specific restrictions, operator policy and SPR data, the list of permitted QoS class identifiers and associated GBR and MBR limits for the IP-CAN session." EX-1007 §6.2.1.0. For the operator-defined component, 3GPP TS 23.203 expressly recognized locally configured operator policy as an input to the PCRF's decisions, stating that the PCRF "should for an IP-CAN session derive, from IP-CAN specific restrictions, operator policy and SPR data, the list of permitted QoS class identifiers and associated GBR and MBR limits for the IP-CAN session." EX-1007 §6.2.1.0. The Stage 3 Gx specification likewise listed "Own PCRF pre-configured information" among the PCRF's decision bases. EX-1006 §4.4.1. For the subscription-based component, the SPR "contains all subscriber/subscription related information needed for subscription-based policies and IP-CAN bearer level PCC rules by the PCRF." EX-1007 §6.2.4. The PCRF could "request subscription information from the SPR" at IP-CAN session establishment, request

notifications on changes, and “retain subscription information relevant for PCC decisions” until session termination. EX-1007 §6.2.1.2.

58. Thus, the PCRF encompassed both an operator-facing configuration function—receiving and storing operator-defined policies and subscription-based rules—and a network-facing decision function that applied those policies to individual sessions and service data flows.

59. The operator-facing configuration function of the PCRF corresponded to what a POSITA would have recognized as a policy server (PS) role: defining and creating—i.e., “setting,” in the terminology of the ’101 Patent—the rules that govern subscriber treatment, as the specification states that “a time-based policy is set at a policy server (PS) 100,” and that “[a] network service provider first connects to a policy management tool 110 and sets a time-based policy using a policy rule management module 111.” EX-1001 3:11-16. This “setting” step in the ’101 Patent aligns with the standardized inputs the PCRF uses— “operator policy and SPR data”—to determine permitted QoS. EX-1007 §6.2.1.0. The SPR, accessible to the PCRF via the Sp reference point, “contains all subscriber/subscription related information needed for subscription-based policies and IP-CAN bearer level PCC rules by the PCRF.” EX-1007 §6.2.4. The PCRF could request subscription information from the SPR at IP-CAN session establishment, request notifications on changes, and retain subscription

information relevant for PCC decisions until session termination. EX-1007

§6.2.1.2. In addition, time conditions and other policy parameters could be “pre-configured locally by the PCRF” when not drawn from the SPR. EX-1005, Claim 4 (“the time condition is received by the PCRF from a subscription profile repository or pre-configured locally by the PCRF”). Delsesto confirmed the same pattern, describing the PCRF as “a centralized node that can act as a policy decision point” that “may take operator defined service policies, subscription information pertaining to a user, and other data into account to build policy decisions” formulated as PCC rules. EX-1016 [0022].

60. The network-facing function of the PCRF—translating policy decisions into the proper protocol syntax for delivery to the PCEF over a standardized interface and accessing stored rule databases—corresponded to what a POSITA would have recognized as a policy management system (PMS) role. The Gx reference point was built on the Diameter protocol, an IETF-defined authentication, authorization, and accounting (AAA) signaling framework specified in RFC 3588, which 3GPP adopted as the base for policy and charging control communications; as TS 29.212 §5.1 stated, “[t]he Gx application is defined as a vendor specific Diameter application” in which “the PCRF acts as a Diameter server” and “[t]he PCEF acts as the Diameter client.” EX-1006 §5.1; IETF RFC 3588 (2003). The PCRF provisioned PCC rules to the PCEF by encoding them as

Diameter Attribute-Value Pairs (AVPs)—the protocol’s standard data elements for carrying structured parameters—within Charging-Rule-Install and Charging-Rule-Definition structures transmitted over Gx using Credit-Control-Answer and Re-Auth-Request commands, as described in 3GPP TS 29.212 §4.5.2 (provisioning procedures); §§5.3.2, 5.3.4, 5.3.6 (pp. 60–61) (AVP definitions). The PCRF could also reference predefined rules already resident at the PCEF rather than transmitting full rule definitions; as TS 29.212 §4.5.2 specified, “[t]o activate or deactivate a PCC rule that is predefined at the PCEF, the PCRF shall provision a reference to this PCC rule within a Charging-Rule-Name AVP.” EX-1006 §4.5.2; §5.3.6 (“For PCC rules pre-defined at the PCEF it uniquely identifies a PCC rule within the PCEF.”). The stage-2 architecture confirmed this approach at a higher level of abstraction: “The dynamic PCC rules are provisioned by the PCRF via the Gx reference point, while the predefined PCC rules are directly provisioned into the PCEF and only referenced by the PCRF.” EX-1007 §6.3.1. Delsesto further showed that when the enforcement node did not support the full Gx protocol, the PCRF adapted its protocol syntax accordingly, using a “Gx-Lite” subset of the Diameter application to install predefined or dynamic charging rules at a service node. EX-1016 [0028], [0038] (installing “Default Traffic” and “P2P Traffic” charging rules via Gx-Lite CCA-I message).

61. This combination of operator-facing policy definition and network-facing rule translation within a single policy server was well established before PCC. Gai disclosed a QoS policy server in which a network administrator selected high-level, device-independent traffic templates and location-specific policies through a graphical user interface, and the policy server then translated those high-level policies into device-specific classification, behavioral, and configuration rules. EX-1017 6:2–25, 12:6-18. The policy server included a policy translator that accessed an organization-based repository and a DHCP server to resolve user identities and IP addresses, a policy rule generating engine that performed algorithmic transformations on data structures to produce executable rules, a device-specific filter entity that selected the subset of rules appropriate for each intermediate device based on its reported capabilities, and a communication engine that exchanged those rules with the devices using the COPS protocol. EX-1017 13:63-14:39; 17:49–62 (propagation via COPS). In PCC terms, Gai’s policy translator and rule generating engine performed the PS function of defining and creating rules from administrator input and converting those rules into a representation suitable for transfer—corresponding to the ‘101 Patent’s step of i.e., “converting, by the PS, the policy to PMS transfer syntax” (EX-1001 5:46–49). Gai’s device-specific filter then performed the PMS function of adapting the rules to each enforcement device’s capabilities—corresponding to the ‘101 Patent’s step

of “parsing, by the PMS, the time-based policy to a structure that is appropriate for the PEE” (EX-1001 2:19-21)—while the communication engine performed the PMS function of delivering those device-appropriate rules to the to the enforcement nodes via COPS. Ex-1017 7:11-29; 17:49-62 (propagation via COPS). A POSITA would have recognized that the 3GPP PCRF’s combination of operator policy configuration, SPR-based subscription retrieval, Diameter AVP encoding, and activation of predefined PCC rules providing a Charging-Rule-Name AVP that uniquely identifies the pre-installed rule at the PCEF (EX-1006 §4.5.2; §5.3.6) replicated this same functional split in the standardized PCC context.

VI. IDENTIFICATION OF HOW CLAIMS ARE UNPATENTABLE

A. Ground 1: Claims 1-6

62. Challenges to the ’101 Patent.

Ground	Claims	Basis	Reference
1	1-6	§ 103	Mo alone, or in view of Peng

1. The Mo Reference

63. Mo is directed to network traffic control in a packet switching communications network, and in particular quality of service (QoS) control. EX-1004 [0001]. Mo identified that one problem in prior art QoS control in wireless networks, was that subscribers who use the network heavily may create network

congestion, preventing other subscribers from receiving their desired QoS. A similar problem may occur during certain time periods when many users attempt to receive high bandwidth services. Mo proposed as a solution the good and fair control of network traffic by managing the QoS of a subscriber based on each subscribers' usage and time-of-day information, thereby providing a fine-grained control on network traffic. EX-1004 [0028].

64. FIG. 1 of Mo illustrates one embodiment of an architecture for implementing a time-based traffic policy for QoS:

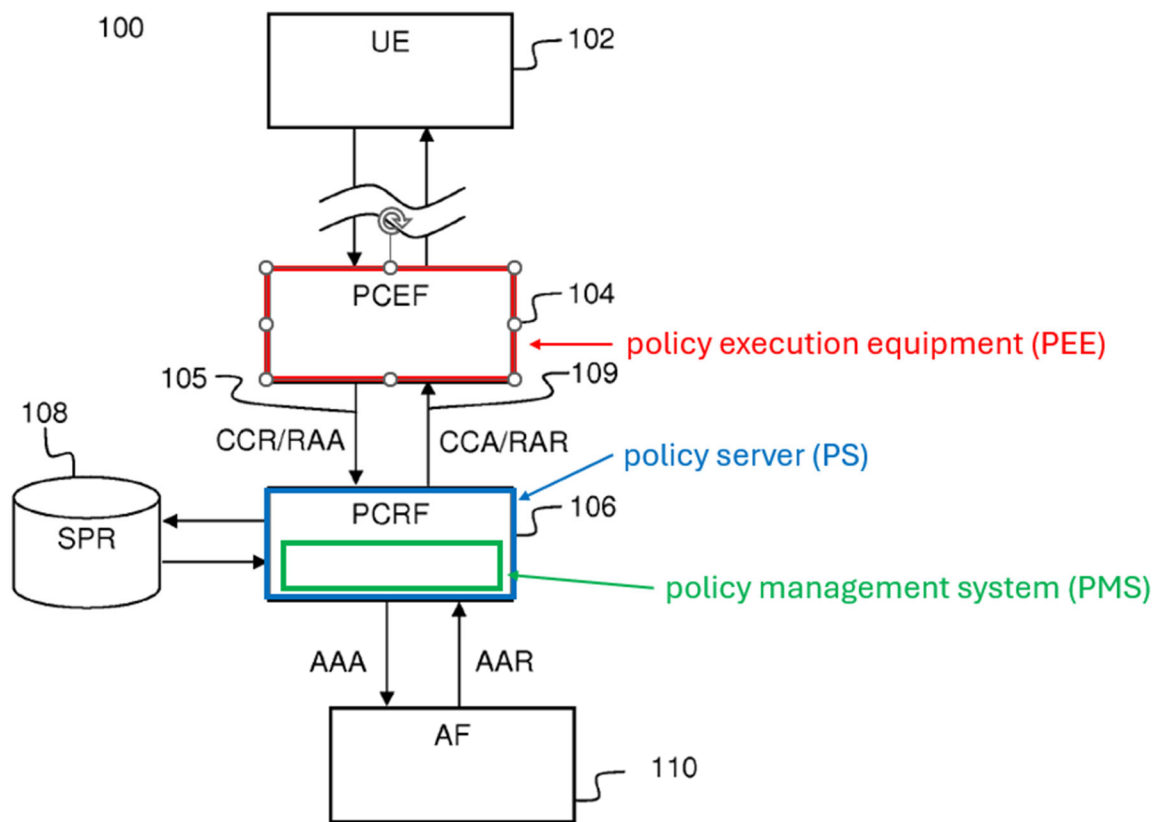


FIG. 1

65. The Policy and Charging Rules Function (PCRF) 106 (blue) for a 3GPP-compliant packet data network is configured to receive from a Policy and Charging Enforcement Function (PCEF)104 (red), a subscriber UE 102 usage level. The PCRF monitors the usage of the subscriber by adding the amount of usage to a record of an accumulated usage of the subscriber. The PCRF also determines a current time period and authorizes a QoS for the subscriber based at least on the usage of the subscriber and the current time period. The PCRF transmits an authorization message to the PCEF indicating the QoS that the network should provide to the subscriber. EX-1004 [0007].

66. For example, User Equipment 102 communicates with a Policy and Charging Enforcement Function (PCEF)104 (red), which can be part of a packet gateway to initiate a request for service. The PCEF generates a Credit Control Request (CCR) message, such as CCR 105, requesting an appropriate allocation of resources and forwards the request to Policy and Charging Rules Function (PCRF) node 106 (blue). The PCRF validates the message (its syntax, semantics) and then retrieves subscriber data from Subscription Profile Repository (SPR) 108, to determine if the subscriber is valid, and the subscriber's QoS Class Identifier (QCI) limit for the QCI specified in the request. SPR 108 may be a component of PCRF node 106 or may constitute an independent node within network 100. EX-1004 [0029].

67. Based on the event type, the PCRF node 106 returns a Credit Control Answer (CCA) message 109 to the PCEF 104 with the subscriber's QCI limit and authorization to establish a service. EX-1004 [0030]. Mo also describes that a reauthorization scheduler in the PCRF determines that a session must be reauthorized based on a change in current time period, wherein the PCRF reauthorizes the session by determining a new QoS based on the current time period. EX-1004 [0011].

68. FIG. 4 of Mo illustrates the operation of the re-authorization scheduler:

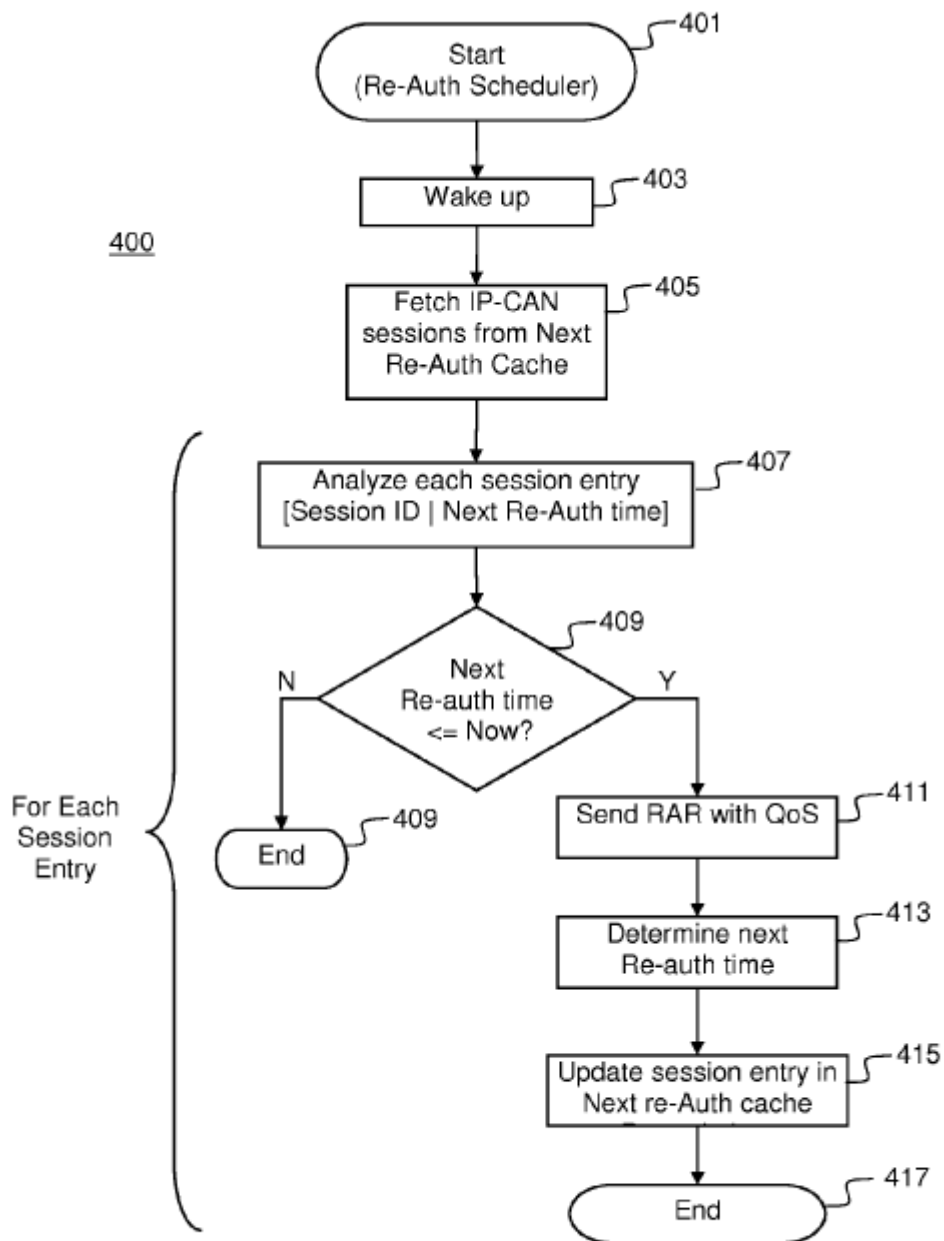


FIG. 4

69. FIG. 4 illustrates the basic control flow of an IP-CAN Session Re-Authorization Scheduler to schedule the re-authorization of the QoS for a session. EX-1004 [0045]. A POSITA understood that IP-CAN are network

entities and interfaces that provide the underlying IP transport connectivity for cellular access networks such as GPRS or EDGE, and also in some cases wireless local area networks (WLAN) or digital subscriber line (DSL) networks.

70. The process starts at step 401. At step 403 the IP-CAN Session Re-Authorization Scheduler wakes up, triggered by a time-of-day clock. At step 405, the Session Re-Authorization Scheduler fetches IP-CAN session entries from the Next Re-Authorization Cache that include the session ID and the Next Re-Authorization time. EX-1004 [0036], [0045]. At step 407 the Session Re-Authorization Scheduler analyzes each session entry. Step 409 determines if the Next Re-Authorization time of the session entry is now (or earlier), and if so, at step 411a Re-Authorization Request (RAR) message is sent to the gateway (PCEF) on interface GX, with the updated QoS. EX-1004 [0045].

71. At step 413, the Next Re-Authorization time is calculated and at step 415, the session entry is updated with the next Re-Authorization time in the Next Re-Authorization Cache. If there is no Next Re-Authorization time, the session entry is purged. The process ends at step 417. EX-1004 [0045] If at step 409, the Next re-authorization time is not now, then the session entry is ignored and it remains in the Next Re-Authorization Cache for later processing. EX-1004 [0045].

72. Thus, Mo describes a re-authorization scheduler in the PCRF that wakes on a time-of-day clock, retrieves sessions from a next-reauthorization cache, and sends Re-Authorization Requests with updated QoS at scheduled times—a direct instantiation of the standards’ revalidation and time-of-day procedures over the 3GPP PCC Gx Re-Auth-Request command as discussed above with respect to the State of the Art section. EX-1004 [0034]– [0045]; EX-1006 §5.6.4. A POSITA would have recognized this as an application of the standardized central-schedule/edge-execution pattern to time-based QoS policy.

2. The Peng Reference

73. Peng is directed to a network traffic policy control directed to QoS assurance and flow charging using a time condition. Peng discloses the same architecture described in Mo.

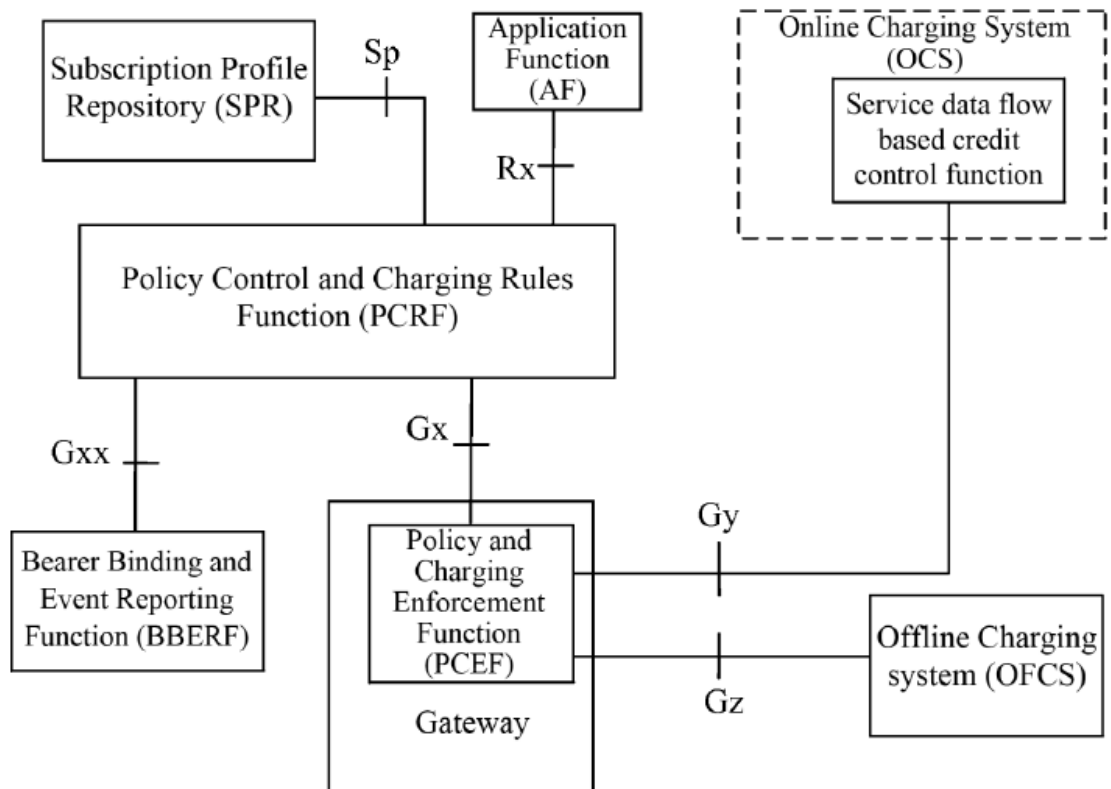


Figure 1

74. Peng discloses a service control policy that includes making a decision based on a time condition. Peng discloses that either the Policy Control and Charging Rules Function (PCRF) or the Policy and Charging Enforcement Function (PCEF) makes the decision based on a time condition. EX-1005 3:5-8. Peng expressly discloses time-conditioned policy control in which either the PCRF or the PCEF makes the determination, teaching that in a PCEF-centric approach the PCRF provides the time condition and prior cumulative time to the PCEF and the PCEF runs the timer and decides locally, which reduces Gx interactions but

requires conveying time-condition and cumulative-time state information to the edge, while a PCRF-centric approach aligns with existing 3GPP interface support at the cost of more frequent signaling. EX-1005 3:5-8. Peng discloses that a Subscription Profile Repository (SPR) containing information about all subscribed users is used by the PCRF to formulate subscription-based policies and IP-CAN bearer-level PCC rules. EX-1005 1:22-24.

3. Motivation to Combine

75. The '101 Patent, Mo and Peng are all directed to traffic control for a packet network that uses a traffic policy that includes a time condition and are thus analogous art. Mo and Peng disclose the same network architecture specified by 3GPP, including a PCRF and PCEF. Further, both Mo and Peng describe that the functions of the PCRF and the PCEF can be implemented in software, and the gateway can host the PCEF functionality. While Mo discloses that the PCRF makes a determination of whether the time condition is satisfied, Peng discloses that either the PCRF or the PCEF determines the time condition. Thus, a POSITA would be motivated expressly by the teaching of Peng to make this modification of the teachings of Mo to perform the determination and associated processes at the PCEF rather than the PCRF for at least two reasons. First, performing the time-condition determination at the PCEF reduced control-plane signaling between the PCEF and the PCRF. Peng expressly taught that in the PCEF cumulation/control

method, "[t]he PCEF analyzes the policy information, cumulates the time of the current session, and starts a timer in conjunction with the time condition to make decisions periodically," and that "[t]his method can reduce the number of signaling interactions on the Gx interface." EX-1005 at 7:16–18. By contrast, when the PCRF performed the same function centrally, "the PCRF...starts a timer based on a time condition to perform periodically the service policy control" and "issues the final decision information to the PCEF," requiring a Gx exchange at each timer expiration. EX-1005 at 7:10–12. Second, Peng emphasized deployment flexibility: "the implementation of this invention does not require modifications to the system architecture or current processing flow, making it easy to be implemented." EX-1005 at 12:24–25. Both reduced signaling overhead and straightforward deployability would have given a POSITA ample reason to adopt PCEF-side time-condition determination when modifying Mo's PCRF-centric design, with a reasonable expectation of success because both references operated on the same 3GPP PCC architecture and Gx interface. Therefore, this provides a more flexible solution compared to performing the determination only in the PCRF.

4. Detailed Application of Prior art reference 1 to the Challenged Claims

a. Claim 1

[1.0] A method of determining an execution time point of a time-based policy that controls traffic, the method comprising:

76. To the extent that the preamble is limiting, Mo discloses good and fair control of network traffic by managing the QoS of a subscriber based on each subscribers' usage and time-of-day information [*method of determining an execution time point of a time-based policy that controls traffic*], thereby providing a fine-grained control on network traffic. EX-1004 [0028].

[1.1] determining, by a policy server (PS) to which the policy is set, whether an execution time point of the policy arrives;

77. Mo discloses a control-plane method in which the Policy and Charging Rules Function (PCRF) schedules and authorizes QoS changes for a subscriber session based on time-of-day predicates. EX-1004, [0031]. Mo further describes that the PCRF includes re-authorization scheduler [*policy server*] which analyzes each session entry and determines if the Next Re-Authorization time of the session entry is now or earlier [*determining...whether an execution time point of the policy arrives*].

78. FIG. 2 explains that when the PCRF invokes rule sets, it identifies scheduled rule tables and caches affected session identifiers to be used

later for time-based re-authorization (step 207). EX-1004 FIG. 2. FIG. 4 illustrates a re-authorization scheduler which can be used to change the QoS of the session based on the time of day:

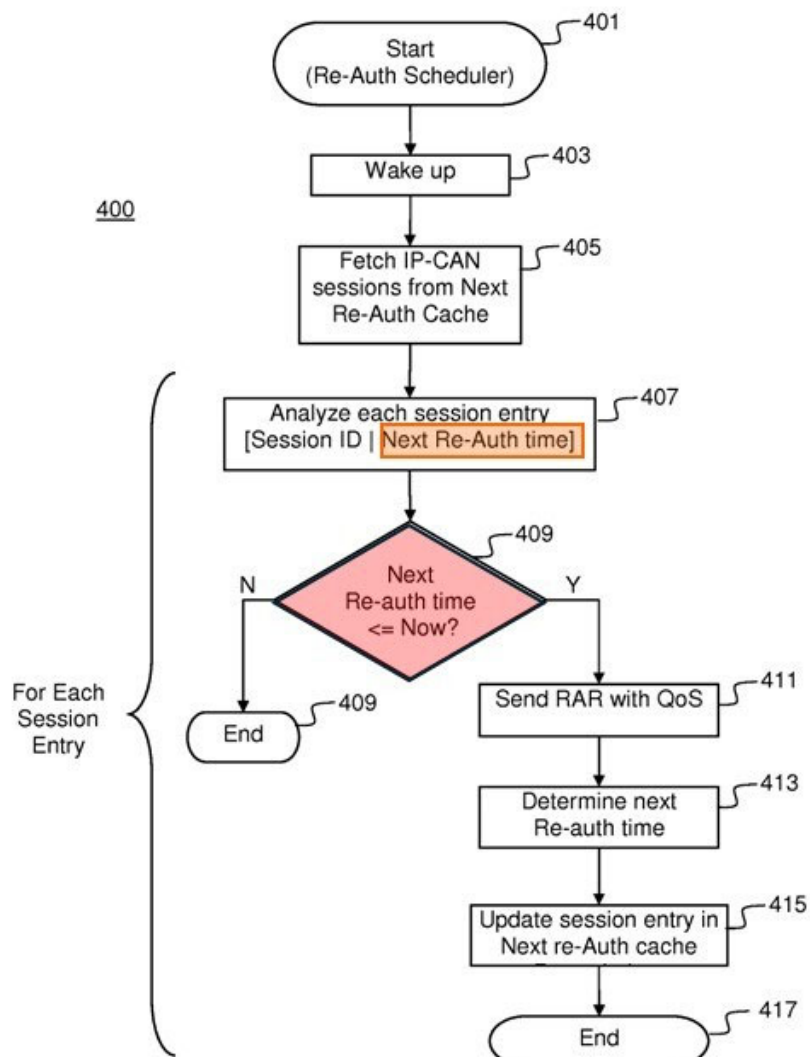


FIG. 4

EX-1004, FIG. 4.

79. In the re-authorization scheduler, the process starts at step 401 and at step 403 re-authorization scheduler wakes up, triggered by a time-of-day clock. At step 405 the re-authorization scheduler fetches session entries from the Next Re-Authorization Cache which was populated at step 207 and includes session ID and Next Re-authorization Time. EX-1004 [0034]- [0036]; [0045]. At step 407 the re-authorization scheduler analyzes each session entry include the Session ID and the Next Re-Authorization time (orange). At step 409, the re-authorization scheduler determines if the Next Re-Authorization Time of the session entry is now (or earlier) (red) [*whether an execution time point of the policy arrives*]. If so, at step 411, a Re-Authorization Request (RAR) message is sent to the PCEF hosted at gateway on interface Gx, with the updated QoS. At step 413 the Next Re-Authorization time is calculated and at step 415 the session entry is updated in the Next Re-Authorization Cache with the updated Next Re-Authorization time. If at step 409 the Next re-authorization time is not now, the session entry remains in the Next Re-Authorization Cache for later processing. EX-1004, [0045].

[1.2] continuing, if an execution time point of the policy does not arrive, to determine an execution time point of the policy; and

80. Mo discloses this limitation by specifying that in Step 409 if the Next Re-Authorization time is not now [*if an execution time point of the policy does not arrive*], the session entry is ignored and it remains in the Next

Re-Authorization Cache for later processing, and the cycle repeats itself starting at step 401, and then at step 407, the re-authorization scheduler analyzes each session entry to determine the Next Re-Authorization time [*continuing....to determine an execution time point of the policy*].

[1.3] transmitting, if an execution time point of the policy arrives, the policy to a policy management system (PMS), wherein the PMS is connected to policy execution equipment (PEE) that executes the policy, and wherein the execution time point reflects a time condition that is provided independently from the traffic,

81. Mo discloses this limitation by stating that when it is determined in step 409 the Next Re-Authorization time is now [*if an execution time point of the policy arrives*], a Re-Authorization Request (RAR) message is sent to the PCEF on interface Gx with the updated QoS [*transmitting... the policy to a policy management system (PMS)*]. EX-1004 [0045]. Mo discloses that the RAR can include a new QoS of a session and can be provided at the IP-CAN level. EX-1004 [0030]- [0031].

82. Mo further discloses that the Next Re-Authorization time [*wherein the execution time point reflects a time condition*] is stored in the Next Re-Authorization Cache during step 207 in FIG. 2 and is provided to the session re-authorization scheduler in step 407 [*that is provided independently from the traffic*]. EX-1004 [0036], [0045].

83. The PCRF includes software functionality [*PMS*] to translate the time-based policy so that a QoS rule can be installed on the gateway [*PEE*] to execute the QoS policy. EX-1004 [0003]. A POSITA would equate the PCRF's role with the claimed PMS and the gateway with the claimed PEE because the '101 Patent explains that the PMS is connected to the PEE 300, and parses the received time-based policy to a structure appropriate for the PEE. EX-1001 3:40-42. Further the '101 Patent describes that the PEE is the hardware that executes the policy to control traffic which a POSITA understood is the gateway disclosed in Mo [*wherein the PMS is connected to policy execution equipment (PEE) that executes the policy*]. EX-1001 3:33-34.

[1.4] wherein the time-based policy is set based on tuple information that is included in a packet from the traffic and the time condition by the policy server.

84. Mo discloses this limitation. Mo discloses QoS control in 3GPP-compliant packet data networks using the Policy and Charging Control (PCC) architecture. EX-1004 [0001]- [0002]. Mo further discloses controlling the QoS of a session containing many packet flows, or controlling the QoS of an individual packet flow. EX-1004 [0033]. As discussed in the State of the Art section, a POSITA understood that using PCC rules to control packet flow are based on tuple information contained in the packet headers. EX-1007 pp. 22, 27. Mo specifically describes that the RAR can include a new QoS of a session and

can be provided at the IP-CAN level, which a POSITA would understand includes a 5-tuple as described in the State of the Art. EX-1004 [0030]- [0031]; EX-1006 p.69.

85. Thus, a POSITA understood that Mo discloses using the re-authorization scheduler to control QoS using tuple information combined with Next Re-Authorization time [*wherein the time-based policy is set based on tuple information that is included in a packet from the traffic and the time condition by the policy server*].

b. Claim 2

[2] The method of claim 1, further comprising converting, by the PS, the policy to PMS transfer syntax and transmitting the PMS transfer syntax to the PMS.

86. Mo discloses this limitation. Mo discloses that the 3GPP standards define the format of service request messages and PCC rules. EX-1004 [0004]. Mo further discloses that the re-authorization scheduler at the PCRF [*PS*] sends the RAR message after it is properly formatted using software functionality [*PMS*] to the PCEF on interface Gx with the updated QoS. EX-1004 [0045]. As discussed in the State of the Art, a POSITA understood that the 3GPP standards defines the syntax to be used by the software functionality at the PCRF to convert the RAR message to the proper IP-CAN format to be transmitted over the GX interface to the PCEF [*converting, by the PS, the policy to PMS transfer syntax and*

transmitting the PMS transfer syntax to the PMS]. EX-1006 §5.1, §4.5.2, §§5.3.2, 5.3.4, 5.3.6; EX-1007 §6.3.1.

c. Claim 3

[3.0] A method of determining an execution time point of a time-based policy that controls traffic, the method comprising:

87. Mo discloses this limitation for the same reasons as discussed with respect limitation [1.0].

[3.1] downloading, by a policy management system (PMS) that is connected to a policy execution equipment (PEE) that executes the policy, the policy;

88. Mo discloses this limitation. At step 203 in FIG. 2, "the PCRF invokes a PCRF Rule Set using cascading Rule sets to establish the Authorized QoS including QoS Class Identifier (QCI) and bitrates for a wireless subscriber." EX-1004 [0035]. This invocation retrieves, from stored rule tables, the applicable time-conditioned QoS—including rules "that ha[ve] effect during a specific block of time, such as peak network load time for example 8:00 AM to 5:00 PM." EX-1004 [0034]. The PCRF then transmits the authorization to the PCEF via a CCA or RAR message for enforcement. EX-1004 [0030]. The '101 Patent itself uses "download" to describe transfers of policy representations between system components: FIG. 2 labels step S100 "DOWNLOAD PARSED POLICY" (the PMS-to-PEE transfer), and FIG. 3 labels step S200 "DOWNLOAD POLICY CONVERTED TO TRANSFER SYNTAX" (the PS-to-PMS

transfer). EX-1001 3:60–61; 4:40–42. A POSITA would have understood Mo's PCRF-to-PCEF provisioning of PCC rules over Gx—in which a data object containing the authorized QoS is transmitted from one network node to another for enforcement—as the same type of inter-node policy transfer that the '101 Patent calls "downloading." This understanding is consistent with the standardized provisioning model: "for each request from the PCEF or upon the unsolicited provision the PCRF shall provision zero or more PCC rules." EX-1006 §4.5.2; see also EX-1010 §1 (PDP proactively provisions policy data to PEP for enforcement).

[3.2] storing the policy at a database that is included in the PMS;

89. Mo discloses this limitation. Mo discloses that in FIG. 2 at step 209, software functionality [PMS] at the PCRF stores the Authorized QoS so that the Authorized QoS can later be restored if it has been downgraded as a result of usage-based throttling. Mo describes that Subscription Profile Repository (SPR) 108 is accessible to the PCRF and is used to store subscriber data including the subscribers QCI limit and thus a POSITA would understand that the PCRF stores the authorized QoS in the SPR [*storing the policy at a database that is included in the PMS*]. EX-1004 [0029].

[3.3] determining whether an execution time point of the policy arrives;

90. Mo discloses this limitation for the same reason as discussed with respect to limitation [1.1].

[3.4] continuing, if an execution time point of the policy does not arrive, to determine an execution time point of the policy,

91. Mo discloses this limitation. Mo discloses this limitation for the same reason as discussed with respect to limitation [1.2].

[3.5] wherein the execution time point reflects a time condition that is provided independently from the traffic,

92. Mo discloses this limitation for the same reason as discussed with respect to limitation [1.3].

[3.6] wherein the time-based policy is set based on tuple information that is included in a packet from the traffic and the time condition by a policy server.

93. Mo discloses this limitation for the same reason as discussed with respect to limitation [1.4].

d. Claim 4

[4] The method of claim 3, further comprising parsing, before the transmitting of the policy to the PEE, by the PMS, the policy to a structure that is appropriate for the PEE.

94. Mo discloses this limitation. Mo discloses that the 3GPP standards define the format of service request messages and PCC rules. EX-1004 [0004]. The PCRF includes software functionality [PMS] to translate the time-based policy so that a QoS rule can be installed on the gateway [PEE] to execute the QoS policy. EX-1004 [0003]. As discussed in the State of the Art, a POSITA understood that the 3GPP standards defines the syntax to be used by the software

functionality at the PCRF to convert the RAR message to the proper IP-CAN format to be transmitted over the GX interface to the PCEF [*parsing, before the transmitting of the policy to the PEE, by the PMS, the policy to a structure that is appropriate for the PEE*]. EX-1006 §4.5.2.4, §4.5.5.0; EX-1007 §6.2.2.

e. Claim 5

[5] The method of claim 3, further comprising synchronizing a time-based policy that is stored at the PMS with the downloaded policy.

95. Mo discloses this limitation. For the reasons discussed with respect to limitation [3.2] Mo discloses that a re-authorization scheduler implemented at the PCRF can download PCC rules. Mo describes that one such rule is determining QoS of session using time of day information. EX-1004 [0035]. By storing the authorized QoS at the PCRF from Step 209 in FIG. 2 for a given time of day, the PCRF has synchronized the time-based policy that is stored with the downloaded PCC rule.

f. Claim 6

[6.0] A method of executing a time-based policy that controls traffic, the method comprising:

96. Mo discloses this limitation for the same reason as discussed with respect to limitation [1.0].

[6.1] downloading, by a policy execution equipment (PEE) that executes the policy, the policy;

97. Mo in view of Peng discloses this limitation. While Mo discloses that the software functionality at the PCRF performs this limitation, Peng discloses that this functionality related to a time condition performed by the PCRF, can likewise be performed by the PCEF [*PEE*]. For example, Peng discloses that using the same architecture as Mo, making a decision based on a time condition of a service control policy can be performed by the PCRF or the PCEF. EX-1005 3:5:8. Thus, Peng discloses that whether downloading the PCC rules is performed in the PCRF or the PCEF is just a design choice.

98. Thus, it would have been obvious to a POSITA to modify Mo to perform this limitation in the PCEF as taught by Peng. A POSITA would have been motivated to make such a modification for the same reasons stated in the Motivation to Combine section. In addition, this modification can be made by simply implementing the re-authorization scheduler in software at the PCEF. A POSITA would also be confident of the success of the combinations because the proposed modification would not result in rearrangement of the devices, topology, nor a deviation from their common and intended operation/uses. Allocating tasks among the various devices/components was a well understood and predictable endeavor. Thus, Mo as modified by Peng discloses that PCEF (hosted at the gateway) invokes a rule set using cascading rule sets to establish the authorized

QoS including QoS Class Identifier (QCI) and bitrates for a wireless subscriber
[downloading, by a policy management system (PMS) that is connected to a policy
execution equipment (PEE) that executes the policy, the policy.

***[6.2] determining whether an execution time point of the policy
arrives;***

99. Mo discloses this limitation for the same reason as discussed
with respect to limitation [1.1]. Further, Mo as modified by Peng discloses this
limitation as well, as discussed with respect to limitation [6.1] where a software
modification implements the re-authorization scheduler in software at the PCEF.

***[6.3] continuing, if an execution time point of the policy does not
arrive, to determine an execution time point of the policy,
wherein the execution time point reflects a time condition that is
provided independently from the traffic; and***

100. Mo discloses this limitation for the same reason as discussed
with respect to limitation [1.2]. Further, Mo as modified by Peng discloses this
limitation as well, as discussed with respect to limitation [6.1] where a software
modification implements the re-authorization scheduler in software at the PCEF.

***[6.4] executing, if an execution time point of the policy arrives,
the policy, wherein the time-based policy is set based on tuple
information that is included in a packet from the traffic and the
time condition by a policy server.***

101. Mo discloses this limitation for the same reason as discussed
with respect to limitations [1.3] and [1.4]. Further, Mo as modified by Peng

discloses this limitation as well, as discussed with respect to limitation [6.1] where a software modification implements the re-authorization scheduler in software at the PCEF.

CONCLUSION AND DECLARATION

My findings and opinions set forth in this Declaration are based on my work and examination to date. I may continue my examinations in view of additional documents or other factual evidence over the course of this proceeding that may necessitate supplementing and/or refining my opinions. I reserve the right to add to, alter, or delete my opinions and my Declaration upon discovery of additional information. I reserve the right to make such changes as necessary.

In signing this Declaration, I understand that the Declaration will be filed as evidence in a contested case before the Patent Trial and Appeal Board of the United States Patent and Trademark Office. I acknowledge that I may be subject to cross-examination in this case and that cross-examination will take place within the United States. If cross-examination is required of me, I will appear for cross-examination within the United States during the time allotted for cross-examination.

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

[SIGNATURE ON FOLLOWING PAGE]

Date: March 27, 2026

By:

A handwritten signature in black ink, appearing to read "Mark E. Crovella". The signature is written in a cursive, flowing style.

MARK. E CROVELLA

APPENDIX A – MATERIALS RELIED UPON

<i>Exhibit #</i>	<i>Description</i>
1001	U.S. Patent No. 9,313,101 (“’101 Patent”)
1002	Prosecution History of the ’101 Patent (“File History”)
1004	U.S. Pat. App. No. 2013/0231081 (“Mo”)
1005	Certified English Translation of WO 2010/094188 (“Peng”)
1006	3rd Generation Partnership Project (3GPP), "Policy and charging control over Gx/Sd reference point" (3GPP TS 29.212 version 10.5.0 Release 10), ETSI TS 129 212 V10.5.0 (January 2012), available at https://www.etsi.org/deliver/etsi_ts/129200_129299/129212/10.05.0_0_60/ts_129212v100500p.pdf
1007	3rd Generation Partnership Project (3GPP), "Policy and charging control architecture" (3GPP TS 23.203 version 9.9.0 Release 9), ETSI TS 123 203 V9.9.0 (June 2011), available at https://www.etsi.org/deliver/etsi_ts/123200_123299/123203/09.09.0_0_60/ts_123203v090900p.pdf
1008	R. Yavatkar et al., "A Framework for Policy-based Admission Control," IETF RFC 2753 (January 2000), available at https://www.rfc-editor.org/rfc/rfc2753
1009	D. Durham et al., "The COPS (Common Open Policy Service) Protocol," IETF RFC 2748 (January 2000), available at https://www.rfc-editor.org/rfc/rfc2748
1010	K. Chan et al., "COPS Usage for Policy Provisioning (COPS-PR)," IETF RFC 3084 (March 2001), available at https://www.rfc-editor.org/rfc/rfc3084
1011	A. Westerinen et al., "Terminology for Policy-Based Management," IETF RFC 3198 (November 2001), available at https://www.rfc-editor.org/rfc/rfc3198
1012	Cisco IOS “Time-Based Access Lists Using Time Ranges,” Release 12.0(1)
1013	D. Mills et al, "Network Time Protocol Version 4: Protocol and Algorithms Specification," IETF RFC 5905 (June 2010), available at https://www.rfc-editor.org/rfc/rfc5905

<i>Exhibit #</i>	<i>Description</i>
1015	JP 2002-374294 (Certified English translation)
1016	J. Babiarz et al., "Configuration Guidelines for DiffServ Service Classes," IETF RFC 4594 (August 2006), available at https://www.rfc-editor.org/rfc/rfc4594
1017	U.S. Pat. App. No. 2011/0225280 ("Delsesto")
	U.S. Patent No. 6,167,445 ("Gai")

APPENDIX B – RÉSUMÉ

MARK E. CROVELLA

Computer Science Department
Boston University
111 Cummington St
Boston, MA 02215
Office: (617) 353-8923
Department: (617) 353-8919

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

Current as of October 24, 2025

EDUCATION

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

SELECTED PROFESSIONAL EXPERIENCE

Professor Department of Computer Science, Boston University, 2006 to present. **Department Chair, Computer Science** 2013 – 2018; **Associate Professor** 2000 – 2006; **Assistant Professor** 1994 – 2000. On leave 2000 – 2001.
Professor Faculty of Computing & Data Sciences, Boston University, 2022 to present. **Chair of Academic Affairs, Faculty of Computing & Data Sciences** 2022 – present; **Founding Member, Faculty of Computing & Data Sciences**, 2020 – 2022; **Data Science Faculty Fellow** 2019 – 2022.
Chief Scientist Guavus, Inc., February 2012 to August 2014.
Technical Director Network Appliance, Tewksbury, MA. November 2000 to April 2002.
Chief Architect Webmanage Technologies, Chelmsford, MA. May 2000 to acquisition by Network Appliance in November 2000.
Senior Computer Scientist Calspan Corporation, Buffalo, NY. August 1984 to August 1994.

LEGAL CONSULTING

The following are all cases in which I provided consulting and provided a report or testified at trial or deposition.

Visual Networks v. Paradyne, 2005, District of Maryland.

Retained by Sughrue Mion, Washington DC on behalf of Visual Networks.
Provided Report on validity of Visual Networks patents.
Subject area: Communications networks.

Akamai Technologies and MIT v. Limelight Networks, 2007 - 2008, District of Massachusetts.

Retained by Choate, Hall and Stewart, Boston MA on behalf of Akamai.
Provided Infringement Report, Noninfringement Rebuttal, Deposition on expert reports, Testimony at trial (3 days).
Subject area: Content delivery networks.

Interval Research v. Apple, Google, AOL, et al, 2011, US PTO.

Retained by O'Melveny & Myers, San Francisco on behalf of Apple.
Provided expert report in support of re-examination claim.
Subject area: Web browsers.

Straight Path IP Group v. Sony Et. Al., 2013, International Trade Commission and ED Virginia.
 Retained by Wolf Greenfield, Boston MA on behalf of Sony.
 Provided declarations in support of petitions for Inter Partes Review to USPTO.
 Subject area: Video streaming technology.
 Case number: 2:13-cv-00427.

PersonalWeb v. Microsoft and Yahoo!, 2013-2014, Eastern District of Texas.
 Retained by Haltom and Doan, and GreenbergTraurig on behalf of Yahoo!, and Microsoft.
 Provided Invalidity Report on PersonalWeb patents, Deposition.
 Subject area: Search engine technology.
 Case number: 6:12-CV-658, 6:12-CV-663.

RPX Corporation v. Cedatech Holdings, 2015, Patent Trial and Appeal Board.
 Retained by Wolf Greenfield, Boston MA on behalf of RPX.
 Provided declaration in support of petition for Inter Partes Review.
 Subject area: Web browser and media technology.
 Case number: IPR2015-00736.

Fortinet v. Sophos, 2015, Eastern District of Texas.
 Retained by Quinn Emanuel on behalf of Fortinet.
 Provided Reports on Invalidity and Noninfringement, Deposition.
 Subject area: Security products.
 Case number: 3:13-cv-05831-EMC.

RPX v. Applications In Internet Time, 2015, Patent Trial and Appeal Board.
 Retained by Wolf, Greenfield, Boston MA on behalf of RPX.
 Provided Declaration in Support of Petition for IPR, Deposition.
 Subject area: Application architecture.
 Case number: IPR2015-01750.

Akamai v. Limelight, 2016-2017, Patent Trial and Appeal Board.
 Retained by Choate, Hall & Stewart and WilmerHale, Boston, MA on behalf of Akamai.
 Provided Declarations in Support of Petition for IPR, Deposition.
 Subject area: Content delivery networks.
 Case number: IPR2016-01011.

Limelight v. Akamai, 2016-2017, Patent Trial and Appeal Board.
 Retained by WilmerHale, Boston MA on behalf of Akamai.
 Provided Declaration in Support of Patent Owner Preliminary Response.
 Subject area: Content delivery networks.
 Case number: IPR2016-01711.

Finjan v. Symantec, 2017, Northern District of California.
 Retained by Quinn Emanuel, Chicago IL on behalf of Symantec.
 Provided Damages Rebuttal Report, Deposition.
 Subject area: Security products.
 Case number: 4:14-cv-02998.

Sound View Innovations v. Hulu, 2017-2019, Central District of California.
 Retained by O'Melveny & Myers on behalf of Hulu, LLC.
 Provided Expert Reports on Noninfringement and Invalidity, Deposition.
 Subject area: Database Technology.
 Case number: LACV17-04146 JAK (PLAx).

RPX and Bank of America v. Publishing Technologies, 2018, PTAB.
 Retained by Winston & Strawn on behalf of RPX Corporation.
 Provided Declaration in support of Petition for Inter Partes Review.
 Subject area: Content Management System.
 Case number: IPR2018-01131 and IPR2018-01132.

Intellectual Ventures v. BITCO and Great West (Old Republic), 2015-2019, Eastern District of Texas.

Retained by Sidley Austin on behalf of BITCO and Great West.
Provided Expert Reports on Invalidity and Noninfringement, Deposition, Testimony at Trial.
Subject area: Web Technology.
Case number: 6:18-cv-00298.

Centripetal Networks, Inc. v. Cisco Systems, Inc., 2019, Eastern District of Virginia, Norfolk.
Retained by Duane Morris on behalf of Cisco.
Provided Expert Reports on Invalidity and Noninfringement, Deposition, Testimony at Trial.
Subject area: Security Products.
Case number: 2:18-cv-00094-HCM-LRL.

British Telecommunications PLC v. Fortinet LLC, 2019, PTAB.
Retained by Duane Morris on behalf of Fortinet.
Provided Declaration in Support of IPR.
Subject area: Distributed Network Management.
Case number: IPR2019-01323.

Express Mobile v. Magento (X.commerce), 2019, Northern District of California.
Retained by Sidley Austin on behalf of Magento.
Provided Expert Reports on Invalidity and Ensnarement, Deposition.
Subject area: Web Authoring Software.
Case number: 17-cv-02605-RS.

Ohio State Innovation Foundation v. Akamai, 2019, District of Massachusetts, PTAB.
Retained by Farella Braun & Martell on behalf of Akamai.
Provided Declaration in Support of IPR.
Subject area: Content Distribution and Prefetching.
Case number: 1:19-cv-11528.

Askeladden v. Lightwire, 2020, PTAB.
Retained by Wilmer Hale on behalf of Askeladden.
Provided Declaration in Support of IPR.
Subject area: Identity Management in E-commerce.
Case number: IPR2020-01415.

Broadcom Corporation and Avago Technologies International Sales Pte. Limited v. Netflix, Inc., 2020, Northern District of California.
Retained by Kecker, Van Nest & Peters on behalf of Netflix.
Provided Expert Reports on Invalidity and Non-infringement, Deposition.
Subject area: Video Streaming.
Case number: 3:20-cv-04677-JD.

CA, Inc. and Avago Technologies International Sales Pte. Limited v. Netflix Inc., 2020, Eastern District of Texas.
Retained by Kecker, Van Nest & Peters on behalf of Netflix.
Provided Expert Reports on Invalidity and Non-infringement; Declaration on Claim Construction.
Subject area: Video Streaming.
Case number: 2:21-CV-80-JRG-RSP.

Sable Networks Inc et al v. Juniper Networks, Inc., 2020, Western District of Texas.
Retained by Farella Braun + Martell, LLP on behalf of Juniper.
Provided Prior Art Search and Analysis.
Subject area: Network Switch Technology.
Case number: 6:20-cv-00524.

Sable Networks Inc et al v. Cloudflare, 2021, Western District of Texas.
Retained by Farella Braun + Martell, LLP on behalf of Cloudflare.
Provided Prior Art Search, Declaration in IPR.
Subject area: Network Switch Technology.
Case number: 6:21-cv-00261.

Eolas v. Amazon et al., 2021, Northern District of California.
Retained by Latham and Watkins, LLP on behalf of Amazon.
Provided Report on Invalidity, Deposition.
Subject area: Web Browser Technology.
Case number: 4-17-cv-03022.

RightQuestion, LLC v. Samsung Electronics Co., et al, 2021, Eastern District of Texas.
Retained by O'Melveny and Myers LLP on behalf of Samsung.
Provided IPR Declaration, Invalidity Report, Deposition.
Subject area: Authentication Management.
Case number: 2:21-cv-00238.

Ebates Performance Marketing, Inc. d/b/a Rakuten Rewards v. IBM, 2021-2022, PTAB.
Retained by GreenbergTraurig, LLP on behalf of Petitioner Ebates Performance Marketing, Inc.
d/b/a Rakuten Rewards.
Provided Declaration in Support of IPR, Deposition.
Subject area: Personalization Methods.
Case number: IPR2022-00438, IPR2022-00439.

Ebates Performance Marketing, Inc. d/b/a Rakuten Rewards v. IBM, 2021-2022, PTAB.
Retained by GreenbergTraurig, LLP on behalf of Petitioner Ebates Performance Marketing, Inc.
d/b/a Rakuten Rewards.
Provided Declaration in Support of IPR, Deposition.
Subject area: Authentication Methods.
Case number: IPR2022-00646.

IBM v. Rakuten, Inc. et al., 2022, District of Delaware.
Retained by GreenbergTraurig, LLP on behalf of Defendants.
Provided Declaration in Support of Claim Construction, Deposition.
Subject area: Networking Technologies.
Case number: 1:21-00461.

Repairify v. LKQ Corp. and Keystone Automotive Industries, Inc., 2022, Western District of Texas.
Retained by Irwin IP on behalf of Keystone.
Provided Expert Report on Technology, Deposition.
Subject area: Automotive Networking.
Case number: 6:21-cv-00819.

Lionra v. Cisco, 2022, PTAB.
Retained by Duane Morris on behalf of Cisco.
Provided Declaration in IPR, Deposition.
Subject area: Network Security.
Case number: IPR2023-00673.

Daedalus v. Samsung, 2022-2023, Eastern District of Texas.
Retained by O'Melveny and Myers LLP on behalf of Samsung.
Provided Consulting on Invalidity.
Subject area: Security Technology.
Case number: 2:22-cv-352.

Taasera v. Trend Micro, 2022-2023, Eastern District of Texas.
Retained by Duane Morris LLP on behalf of Trend Micro.
Provided Consulting on Invalidity, Noninfringement.
Subject area: Security Technology.
Case number: 2:21-cv-00441.

Lionra v. Cisco, 2023-2024, PTAB.
Retained by Haynes and Boone on behalf of Cisco.
Provided Declaration in IPR.
Subject area: Network Security.
Case number: IPR2024-00734.

Optimorphix v. Google, 2024, District of Delaware.
 Retained by Latham & Watkins on behalf of Google.
 Provided Consulting on Invalidity.
 Subject area: Network Communication.
 Case number: 1:23-cv-01065.

Headwater v. AT&T, 2024-2025, Eastern District of Texas.
 Retained by McKool Smith on behalf of AT&T.
 Provided Report on Invalidity, Deposition.
 Subject area: Network Communication.
 Case number: 2:23-cv-00397, -00398.

Nokia v. Amazon, 2024-2025, PTAB.
 Retained by SheppardMullin on behalf of Amazon.
 Provided Declaration in IPR.
 Subject area: Data Management Systems.
 Case number: IPR2024-01507.

B.E. Tech v. Google, 2023-2025, District of Delaware.
 Retained by Kecker, Van Nest, and Peters on behalf of Google.
 Provided Declaration in Claim Construction.
 Subject area: Electronic Advertising.
 Case number: 20-cv-622.

CloudByte v. Dell, 2024-2025, PTAB.
 Retained by Farella Braun and Martell on behalf of Dell.
 Provided Declaration in IPRs.
 Subject area: Network Routing.

Concurrent v. AMD, 2024-2025, PTAB.
 Retained by SheppardMullin on behalf of AMD.
 Provided Declaration in IPR, Deposition.
 Subject area: Network Communication.

Sandpiper v. Google, 2024-2025, Central District of California.
 Retained by Munger, Tolles & Olson on behalf of Google.
 Provided Declaration in Claim Construction, Deposition.
 Subject area: Streaming Content Delivery.
 Case number: 2:24-cv-03951.

Withrow v. Google, 2024-2025, Northern District of California.
 Retained by Kwun Bhansali Lazarus on behalf of Google.
 Provided Declaration in Claim Construction, Deposition.
 Subject area: Streaming Content Delivery.
 Case number: 5:24-cv-3202.

BrodTi v. Google, 2024-2025, PTAB.
 Retained by Cooley on behalf of Google.
 Provided Declaration in IPR, Deposition.
 Subject area: Internet Advertising.

BSD Crown v. Amazon, 2024-2025, N.D. of California.
 Retained by Perkins Coie on behalf of Amazon.
 Provided Report on Noninfringement.
 Subject area: Multimedia Quality of Service.

Bootler v. Google, 2025, PTAB.
 Retained by Wolf Greenfield on behalf of Google.
 Provided Declaration in IPR.
 Subject area: Networking, Data Management.

ACT v. Google, 2025, PTAB.

Retained by Latham & Watkins on behalf of Google.

Provided Declaration in IPR.

Subject area: Content Delivery Networks.

PATENTS HELD

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

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

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

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

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

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

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

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

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

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

SELECTED HONORS

Duan Family Fellow, 2024, Boston University

Innovator of the Year, 2014, Boston University.

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

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

FUNDING

Recipient of over 25 research grants from NSF, ARO, NGIA, Google, Sprint, GTE, Xerox, and Hewlett-Packard totalling over \$15 M.

SELECTED PROFESSIONAL ACTIVITIES

Scientific Advisory Board of the Max Planck Institute for Software Systems, 2016 – present.

General Co-Chair, CoNEXT 2011.

Chair, ACM SIGCOMM 2007–2009.

Program Co-Chair, IFIP Networking 2010.

Program Committee Chair, Internet Measurement Conference 2003.

BOOKS

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

PUBLISHED ARTICLES

Author of over 200 published articles in Computer Science, cited more than 30,000 times according to Google Scholar.