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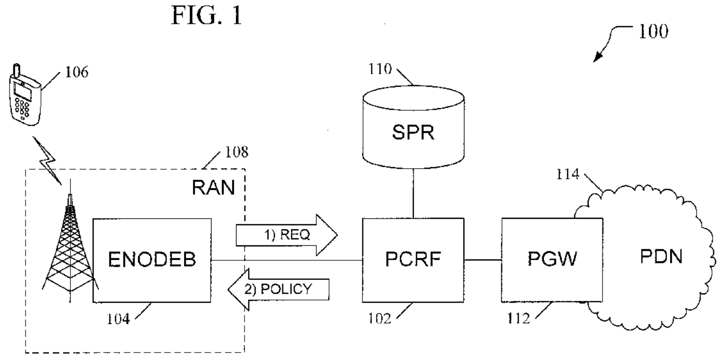
(54) Title: METHODS, SYSTEMS, AND COMPUTER READABLE MEDIA FOR DYNAMICALLY CONTROLLING CONGESTION IN A RADIO ACCESS NETWORK

FIG. 1



(57) Abstract: Methods, systems, and computer readable media for dynamically controlling congestion in a radio access network are disclosed. According to one aspect, a system for dynamically controlling congestion in a radio access network includes a policy and charging rules function (PCRF) for receiving, from a node for communicating with user equipment via a radio access network, admission requests, and, in response to receiving the admission requests, installing, on the node, subscriber-specific policies to control congestion in the radio access network.

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DESCRIPTION

METHODS, SYSTEMS, AND COMPUTER READABLE MEDIA FOR DYNAMICALLY CONTROLLING CONGESTION IN A RADIO ACCESS NETWORK

PRIORITY CLAIM

This application claims the benefit of U.S. Provisional Patent Application Serial No. 61/671,691, filed July 14, 2012; the disclosure of which is incorporated herein by reference in its entirety.

TECHNICAL FIELD

The subject matter described herein relates to methods and systems for controlling congestion in telecommunications networks. More particularly, the subject matter described herein relates to methods, systems, and computer readable media for dynamically controlling congestion in a radio access network.

BACKGROUND

Wireless operators are struggling to cope with the data deluge in their networks, and make sure that the wireless spectrum is prioritized to suit their business objectives. The mobile network operator is being pressured both from the increased amount of access (e.g., the rate of growth of smartphone adoption) and the increased amount of data flow (e.g., the rate of growth in data use in the network) in the mobile network. Previous methods of offsetting increases in capital expenditures and operating expenditures by using operator-owned services are not as effective as they used to be in a voice-service dominated world.

In addition to this, there is a new class of devices, called Machine to Machine devices (M2M). This class of devices has mobility profiles very different from the mobility profiles that the operator was used to in the cellular (human) networks of yesterday. As a result, many operators have to try to reduce the cost-per-bit for the network and simplify the mobile network infrastructure further than it has evolved into in 3GPP Release 8. 3GPP Release 8 has already flattened the network hierarchy, removed many

3GPP specific protocols, and made the network more akin to IP networks, but this can be improved further.

To this end, the wireless operator currently has no mechanism for performing admission-control-like activities based on information provided by core network elements and higher layers, such as subscriber/device information, application and service information, quota usage, the access point name (APN) / data packet network (PDN) being accessed, etc., at the software entity performing the Radio Resources Control (RRC). Being able to do so would allow the operator to gate the use of radio resources in the radio access network (RAN) in a manner that prefers one request for admission to use dedicated radio resources over the other, and would satisfy an emerging requirement that the operator needs for providing differentiated services in the network.

Accordingly, there exists a need for methods, systems, and computer readable media for dynamically controlling congestion in a radio access network.

SUMMARY

According to one aspect, the subject matter described herein includes a system for dynamically controlling congestion in a radio access network. The system includes a policy and charging rules function (PCRF) for receiving, from a node for communicating with user equipment via a radio access network, admission requests, and, in response to receiving the admission requests, installing, on the node, subscriber-specific policies to control congestion in the radio access network.

According to another aspect, the subject matter described herein includes a method for dynamically controlling congestion in a radio access network. The method includes, at a policy and charging rules function (PCRF), receiving admission requests from a node for communicating with user equipment via a radio access network, and, in response to receiving the admission requests, installing, on the node, subscriber-specific policies to control congestion in the radio access network.

The subject matter described herein can be implemented in software in combination with hardware and/or firmware. For example, the subject matter described herein can be implemented in software executed by a processor. In one exemplary implementation, the subject matter described herein can be implemented using a non-transitory computer readable medium having stored thereon computer executable instructions that when executed by the processor of a computer control the computer to perform steps. Exemplary computer readable media suitable for implementing the subject matter described herein include non-transitory computer-readable media, such as disk memory devices, chip memory devices, programmable logic devices, and application specific integrated circuits. In addition, a computer readable medium that implements the subject matter described herein may be located on a single device or computing platform or may be distributed across multiple devices or computing platforms.

BRIEF DESCRIPTION OF THE DRAWINGS

Preferred embodiments of the subject matter described herein will now be explained with reference to the accompanying drawings, wherein like reference numerals represent like parts, of which:

Figure 1 is a block diagram illustrating an exemplary system for dynamically controlling congestion in a radio access network according to an embodiment of the subject matter described herein;

Figure 2 is a signaling message flow diagram illustrating exemplary signaling messages communicated according to an embodiment of the subject matter described herein;

Figure 3 is a flow chart illustrating an exemplary process for dynamically controlling congestion in a radio access network according to an embodiment of the subject matter described herein; and

Figure 4 is a block diagram illustrating an exemplary node for implementing congestion control in a radio access network according to an embodiment of the subject matter described herein.

DETAILED DESCRIPTION

In accordance with the subject matter disclosed herein, systems, methods, and computer readable media are provided for controlling congestion in a radio access network. Reference will now be made in detail to exemplary embodiments of the present invention, examples of which are illustrated in the accompanying drawings. Wherever possible, the same reference numbers will be used throughout the drawings to refer to the same or like parts.

Radio access networks are positioned between the mobile device and the core network. The core network includes a policy control infrastructure, which in conventional networks does not interact with the RAN directly. The Policy control infrastructure has access to subscriber and device information via its communication with the subscriber provisioning systems such as a subscriber profile repository (SPR) or home subscriber server (HSS), and also may have application and service sensitivity using the interaction with any deep packet inspection (DPI) devices in the core network. In addition, the Policy infrastructure may also have access to information about network conditions, RAN load, etc. The subject matter described herein extends the reach of the policy control infrastructure into the RAN.

The methods and systems described in the subject matter disclosed herein tie the admission control functions already existing in the RAN infrastructure in the operator network (e.g., in the eNodeB) with the intelligence in the Policy infrastructure, to perform admission control functions in the RAN in a dynamic fashion. For example, using subscriber tier information, the operator can allow or disallow the access of the radio resources by subscribers whose tier is lower than a threshold which is set by the operator. RAN vendors have balked at controlling congestion in the radio waves because controlling network congestion reduces the need for their product.

Bringing the level of awareness and intelligence into the RAN as described herein is unprecedented but useful—operators of conventional networks are unable to gate the admission of call processing based on the subscriber’s tier and/or device. This level of control, however, is possible with the methods and systems described herein. Moreover, this action can be completely dynamic, with the Policy infrastructure sending a policy command to the RAN infrastructure to start throttling when the Policy infrastructure notices that the RAN gear is overloaded, and then remove the policy when the Policy infrastructure notices that the network has resumed normal or reduced load levels. This level of service differentiation at the access side is unprecedented but warranted because the operator pays many billions of dollars every year in spectrum charges, but unfortunately spends a lot of money in managing signaling congestion owing to subscribers of all tiers, which has the negative effect of diluting the operator ROI.

The benefits described above may be further enhanced when the RAN gear operates as a policy enforcement point controlled by the core network, which makes possible a rich suite of QoS, access control, application and service awareness at the access layer.

Figure 1 is a block diagram illustrating an exemplary system for dynamically controlling congestion in a radio access network according to an embodiment of the subject matter described herein.

In one embodiment, a system **100** for controlling congestion in a radio access network includes a policy and charging rules function (PCRF) **102** that receives, from a node for communicating with user equipment via a radio access network, admission requests, and in response to receiving the admission requests, installs on the node subscriber-specific policies to control congestion in the radio access network.

In the embodiment illustrated in Figure 1, for example, PCRF **102** may receive admission requests (message 1) from an evolved node B (eNodeB) **104** for communicating with user equipment, such as UE **106**, via a radio access network (RAN) **108**. In response to receiving the admission requests, PCRF **102** may install on eNodeB **104** subscriber-specific policies (message 2) to control congestion in RAN **108**. In alternative embodiments, PCRF **102** may receive admission requests from, and install subscriber-specific policies to, other nodes that communicate with user equipment via RAN **108**.

PCRF **102** may communicate with other nodes as part of the process of controlling congestion in the radio access network. In the embodiment illustrated in Figure 1, for example, PCRF **102** may query a subscriber profile register (SPR) **110** that holds subscriber profile information to get information about a particular subscriber. System 100 may include a packet data network gateway (PGW) **112**, which is the interface towards a packet data network (PDN) **114**. PCRF **102** may provide subscriber specific policies or policy instructions to PGW **112** as well. An example operation of this system is shown in Figure 2.

Figure 2 is a signaling message flow diagram illustrating exemplary messages communicated according to an embodiment of the subject matter described herein. Figure 2 illustrates wireless congestion control within a telecommunications network, and will be described with reference to the system illustrated in Figure 1.

During operation, eNodeB **102** receives requests from wireless subscribers of all types, who are requesting access to network services via RAN **106**. In the embodiment illustrated in Figure 2, eNodeB **102** receives such a request **200**, e.g., a signaling message from user equipment of a bronze subscriber who wants to initiate a video call. In response to receiving request **200**, eNodeB **102** and PCRF **108** communicate with each other (signals **202**) to determine the policy to apply for that subscriber. During this process, PCRF **108** may query SPR **110** for subscriber information, which SPR **110** provides to PCRF **108** (signals **204**.) PCRF **108** may communicate subscriber-specific policy instructions to PGW **112** as well (signals **206**.) The signaling messages **200**, **202**, **204**, and **206** are representative of signaling messages exchanged between eNodeB **102**, PCRF **108**, SPR **110**, and PGW **112**, and illustrate the point that subscribers and devices of all types are allowed to set up a video call. That is, eNodeB **102** responds to every request by initiating signaling traffic to PCRF **108**.

At some point, however, PCRF **108** may send an admission control policy instruction (message **208**) to eNodeB **102** for the purpose of controlling wireless congestion. In the scenario illustrated in Figure 2, for example, message **208** may instruct eNodeB **102** to allow video calls to be made only by subscribers of certain tiers and/or using certain equipment. Box **210** indicates the time of operation during which wireless congestion control is in effect.

In the embodiment illustrated in Figure 2, several admission requests are received by eNodeB **102**. The first is message **212**, sent by a Gold Tier subscriber attempting to place a video call. Since Gold Tier customers are allowed to place video calls, this admission request is allowed (box **214**) and eNodeB **102**, PCRF **108**, SPR **110**, and PGW **112** engage in their usual interactions (signals **216**, **218**, and **220**.)

The next admission request, message **222**, is from a Bronze Tier subscriber attempting to make a video call. Since the congestion control policy currently in effect at eNodeB **112** prohibits this, the request is denied (box **224**). As a result, the usual interaction between eNodeB **102**, PCRF **108**, SPR **110**, and PGW **112** is avoided, which reduces wireless congestion.

A third admission request, message **226**, is from a Silver Tier subscriber also attempting to make a video call. In this example, this is also allowed by the current congestion policy (box **228**), and eNodeB **102**, PCRF **108**, SPR **110**, and PGW **112** interact with each other (signals **230**, **232**, and **234**.) In one embodiment, the Silver Tier subscriber may be allowed to make a video call, but with limits on bandwidth, video resolution, quality, etc.

A fourth admission request, message **236**, is from a Bronze Tier subscriber wanting to connect to the network with a web browser. In the example illustrated in Figure 2, this request is also denied (box **238**), illustrating the principle that lower-tier subscribers may be severely limited by the congestion control polices provided by PCRF **108** and put into effect at eNodeB **102**.

At some point, PCRF **108** issues yet another change of policy (message **240**), such as to allow all calls, e.g., to revoke the congestion control measures previously in effect. This is indicated by the termination of box **210**. Subsequent admission requests are processed without restriction. For example, a Silver Tier subscriber successfully places a video call (messages **242**, **244**, **246**, and **248**), and a Bronze Tier subscriber can now do the same (messages **250**, **252**, **254**, and **256**.)

Thus, Figure 3 illustrates the ability to dynamically control signaling costs in a mobile network. For example, PCRF **102** may apply a congestion control policy to eNodeB **104** in response to some trigger condition, such as a detected increase in admission requests. For example, PCRF **102** may apply congestion control in response to detecting that admission requests exceed a threshold rate or change of rate, in response to detecting relative percentages of requests by subscribers of different tiers, and so on. Likewise, these thresholds used to trigger application of a control policy by PCRF **102** may dynamically change or be statically set based on time of day, day of week, or other conditions. This flexibility allows PCRF **102** to dynamically apply congestion control to during peak usage hours, for example. Other examples include applying congestion control in response to detecting or being notified of other conditions, such as local or national emergencies or special events, etc.

By installing the policy to a node in the radio access network, signaling congestion due to lower tier subscribers can be reduced because the wireless access throttles and denies access right at the call processing stage for lower tier subscribers, thus preserving valuable wireless resources for higher tier subscribers. However, it should be noted that the same mechanism may be used to provide static congestion control, e.g., by installing policies on eNodeB **104** that instruct it to apply bronze tier throttling policies between 05:00PM and 10:00PM every day, regardless of traffic conditions.

Figure 3 is a flow chart illustrating an exemplary process for dynamically controlling signaling costs in a mobile network according to an embodiment of the subject matter described herein. This process will now be described with reference to Figures 1 and 3.

At step **300**, a policy and charging rules function receives admission requests from a node for communicating with user equipment via a radio access network. For example, PCRF **102** may receive an admission request from UE **106** via eNodeB **104** in RAN **108**.

At step **302**, in response to receiving the admission requests, subscriber-specific policies to control congestion in the radio access network are installed on the node. For example, PCRF **102** may install subscriber-specific policies onto eNodeB **102** to control congestion in RAN **108**. The policies to control congestion in RAN **108** are then implemented by eNodeB **102**.

Using PCRF **102** to provide wireless congestion control via policies subscriber specific policies provided to a node in the radio access network such as eNodeB **104** allows that RAN node to operate as a policy and charging enforcement function (PCEF) and gives network operators high levels of control over the signaling and data traffic that enters the core network via the radio access network. Examples of wireless congestion control that can be implemented in this manner include, but are not limited to, imposing access limits, signaling limits, or data limits based on subscriber tier, time of day, device time, or other conditions.

Figure 4 is a block diagram illustrating an exemplary node for implementing congestion control in a radio access network according to an embodiment of the subject matter described herein. In the embodiment illustrated in Figure 4, node **400** includes one or more communications interfaces **402** for sending and receiving messages (e.g., via a Gx interface, Gxx interface, S1 interface, S7 interface, Sp interface, an extensible markup language (XML) interface, a session initiation protocol (SIP) interface, a SOAP interface, or a hypertext transfer protocol (HTTP) interface or others).

Node **400** may include a policy control module **404**, which may be communicatively coupled with a data storage entity **406**. Policy control module **404** may be any suitable entity (e.g., software executing on a processor) for performing one or more aspects of the subject matter described herein, such as implementing congestion control in a radio access network. Node **400** may access (read from and/or write information to) data storage entity **406**. Data storage entity **406** may be any suitable entity (e.g., a computer readable medium or memory) for storing various data.

In one embodiment, node **400** may be a policy and charging rules function, or PCRF. Node **400** may receive admission requests via communications interface(s) **402** from a node for performing admission control functions in a radio access network. These admission requests may be processed by policy control module **404**. In response to receiving the admission requests, policy control module **404** may retrieve subscriber-specific policies to control congestion in the radio access network from data storage entity **406** as needed, and install the appropriate policies onto the node for performing admission control functions in the radio access network. Node **400** may determine the appropriate policies to install based on information such as, but not limited to, network conditions, subscriber tiers, device types, location, time of day, QoS requirements, QoE requirements, service agreements, and/or other information.

It will be appreciated that the above description is for illustrative purposes and that node **400** may include additional and/or different modules or components.

It will be understood that various details of the subject matter described herein may be changed without departing from the scope of the subject matter described herein. Furthermore, the foregoing description is for the purpose of illustration only, and not for the purpose of limitation.

CLAIMS

What is claimed is:

1. A system for controlling congestion in a radio access network, the system comprising:

a policy and charging rules function (PCRF) for:

receiving admission requests from a node for performing admission control functions in a radio access network; and

in response to receiving the admission requests, installing, on the node, subscriber-specific policies to control congestion in the radio access network.

2. The system of claim 1 wherein the node comprises an evolved node B (eNodeB) for communicating with user equipment via the radio access network.

3. The system of claim 1 wherein the node functions as a policy control and enforcement function (PCEF).

4. The system of claim 1 wherein the PCRF is configured to install on the node congestion control policies to implement subscriber tiers in the radio access network.

5. The system of claim 1 wherein the PCRF is configured to install on the node congestion control policies to manage congestion in the radio access network based on time of day.

6. The system of claim 1 wherein the PCRF is configured to install on the node congestion control policies to manage congestion in the radio access network based on device type.

7. The system of claim 1 wherein the PCRF is configured to install congestion control policies in the radio access network based on network conditions, including congestion.

8. The system of claim 1 wherein the PCRF is configured to install congestion control policies to manage congestion in the radio access

network based on quality of service (QoS) requested by an application on a user equipment (UE).

9. A method for controlling congestion in a radio access network the method comprising:

at a policy and charging rules function (PCRF):

receiving admission requests from a node for performing admission control functions in a radio access network; and

in response to receiving the admission requests, installing, on the node, subscriber-specific policies to control congestion in the radio access network.

10. The method of claim 9 wherein the node comprises an evolved node B (eNodeB) for communicating with user equipment via the radio access network.

11. The method of claim 9 wherein the node functions as a policy control and enforcement function (PCEF).

12. The method of claim 9 wherein installing subscriber-specific policies comprises installing congestion control policies to implement subscriber tiers in the radio access network.

13. The method of claim 9 wherein installing subscriber-specific policies comprises installing congestion control policies to manage congestion in the radio access network based on time of day.

14. The method of claim 9 wherein installing subscriber-specific policies comprises installing congestion control policies to manage congestion in the radio access network based on device type.

15. The method of claim 9 wherein installing subscriber-specific policies comprises installing congestion control policies in the radio access network based on network conditions, including congestion.

16. The method of claim 9 wherein installing subscriber-specific policies comprises installing congestion control policies to manage congestion

in the radio access network based on quality of service (QoS) requested by an application on a user equipment (UE).

17. A non-transitory computer readable medium having stored thereon executable instructions that when executed by the processor of a computer control the computer to perform steps comprising:

receiving, at a policy and charging rules function (PCRF), admission requests from a node; and

in response to receiving the admission requests, installing subscriber-specific policies on the node to control congestion in the radio access network.

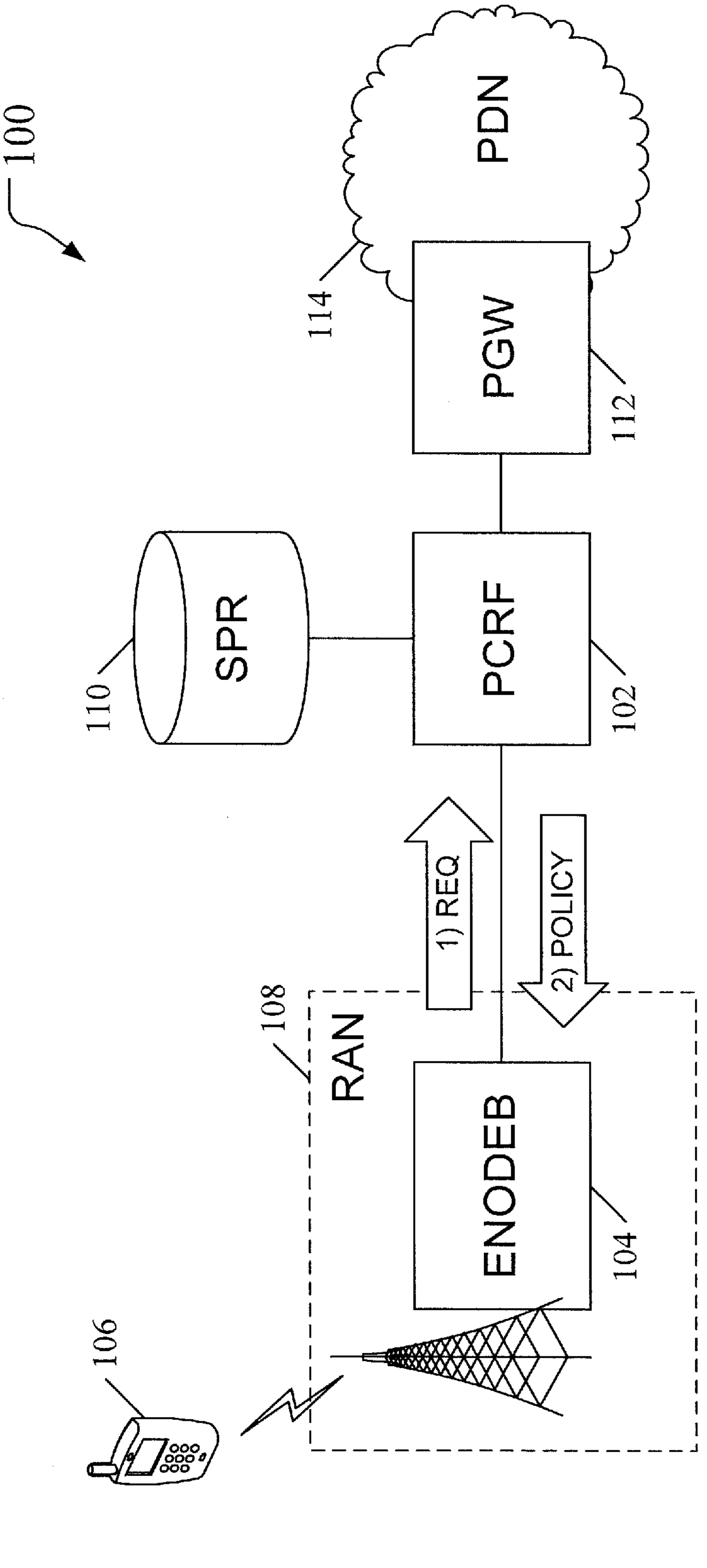
100
PDN
114
PGW
112
SPR
110
PCRF
102
1) REQ
2) POLICY
108
RAN
ENODEB
104
106

FIG. 1

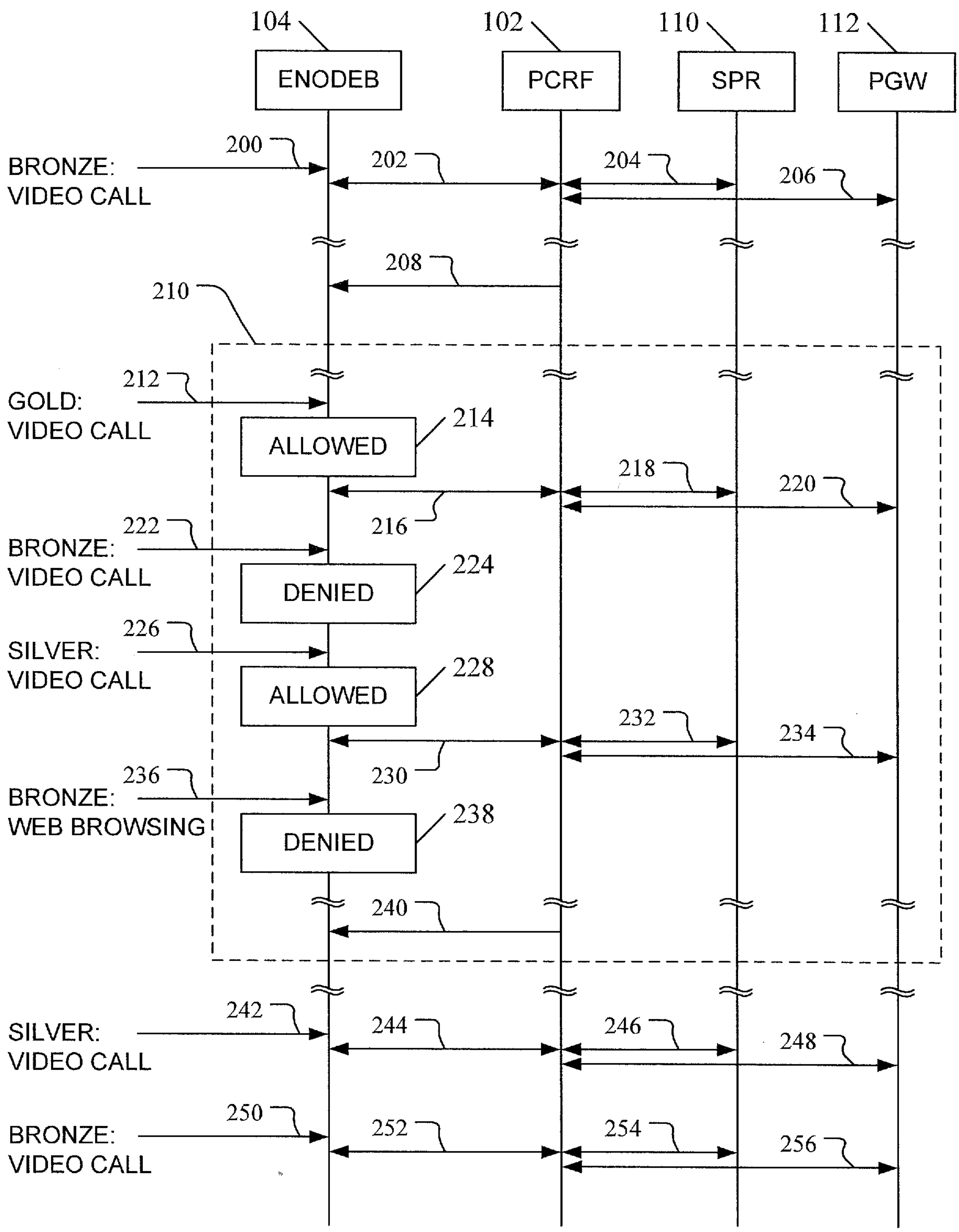
104
102
110
112
ENODEB
PCRF
SPR
PGW
200
BRONZE:
VIDEO CALL
202
204
206
208
210
212
GOLD:
VIDEO CALL
ALLOWED
214
216
218
220
222
BRONZE:
VIDEO CALL
DENIED
224
226
SILVER:
VIDEO CALL
ALLOWED
228
230
232
234
236
BRONZE:
WEB BROWSING
DENIED
238
240
242
SILVER:
VIDEO CALL
244
246
248
250
BRONZE:
VIDEO CALL
252
254
256

FIG. 2

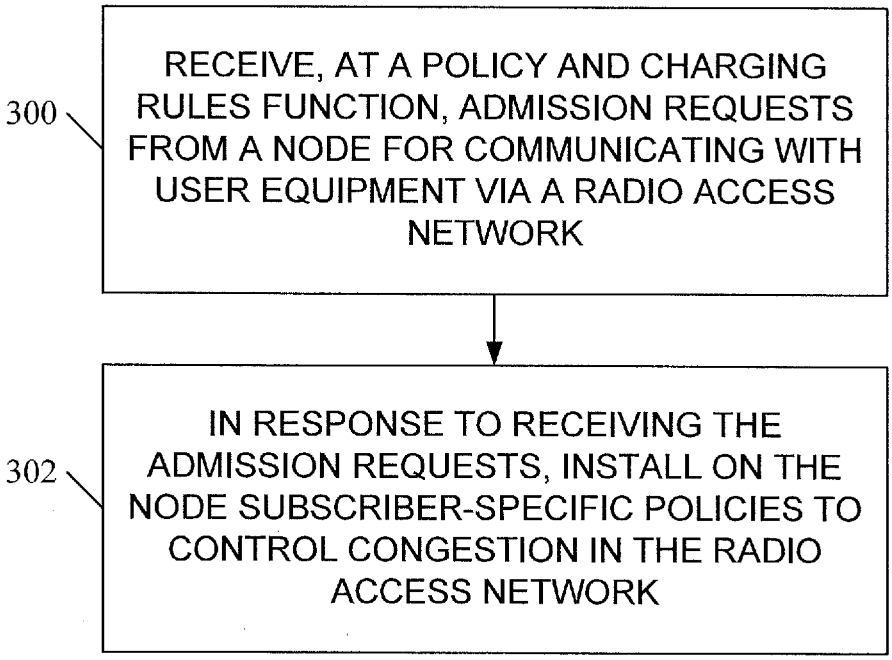
300
RECEIVE, AT A POLICY AND CHARGING RULES FUNCTION, ADMISSION REQUESTS FROM A NODE FOR COMMUNICATING WITH USER EQUIPMENT VIA A RADIO ACCESS NETWORK
302
IN RESPONSE TO RECEIVING THE ADMISSION REQUESTS, INSTALL ON THE NODE SUBSCRIBER-SPECIFIC POLICIES TO CONTROL CONGESTION IN THE RADIO ACCESS NETWORK

FIG. 3

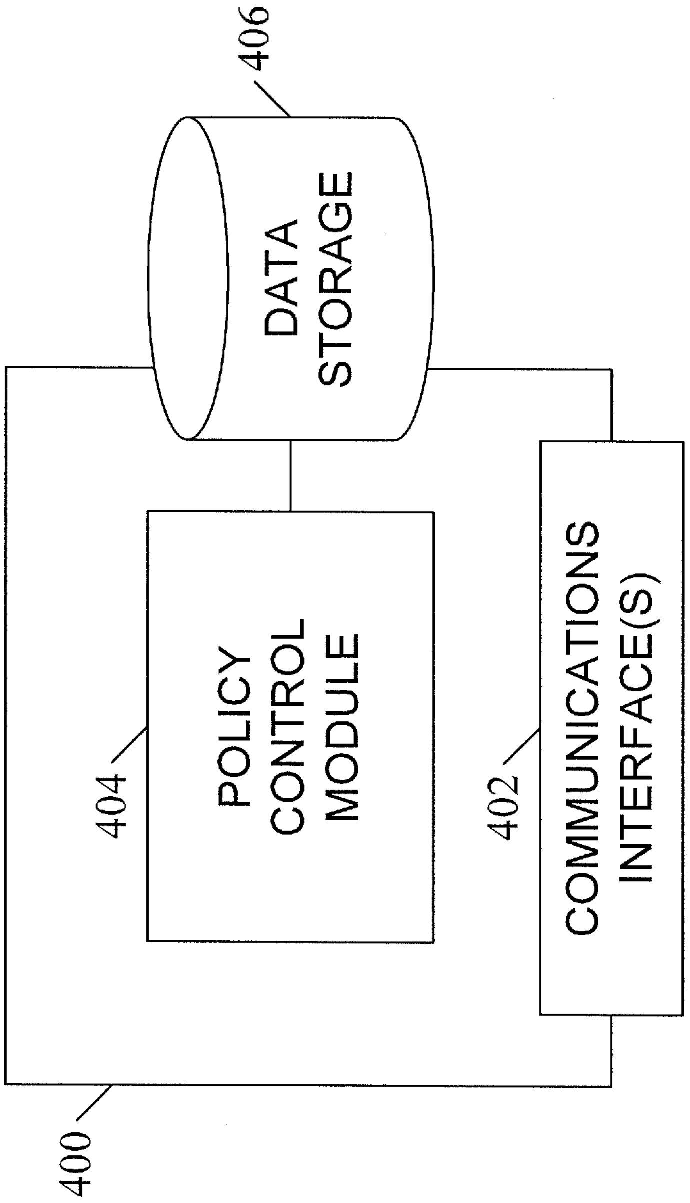
406
DATA STORAGE
404
POLICY CONTROL MODULE
402
COMMUNICATIONS INTERFACE(S)
400

FIG. 4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2013/050512

A. CLASSIFICATION OF SUBJECT MATTER

H04W 28/02(2009.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H04W 28/02; H04Q 7/38; H04Q 7/22; H04J 3/16; H04L 12/56; H04B 7/005

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean utility models and applications for utility models
Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
eKOMPASS(KIPO internal) & Keywords: PCRF, admission request, dynamic subscriber-specific polices

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2011-0158090 A1 (YUSUN KIM RILEY et al.) 30 June 2011 See paragraphs [0034], [0039], [0049], [0133], [0146], [0156]-[0158]; claim 1 ; and figures 1, 7, 9.	1-17
Y	EP 0857399 B1 (TELEFONAKTIEBOLAGET LM ERICSSON (PUBL)) 12 May 2004 See paragraphs [0028]-[0040]; claim 1; and figure 1.	1-17
A	US 2012-0176894 A1 (XUEJUN CAI et al.) 12 July 2012 See paragraphs [0054]-[0061]; claim 17; and figure 4.	1-17
A	US 2009-0219946 A1 (BO LIU et al.) 03 September 2009 See paragraphs [0112]-[0117], [0124]-[0136]; claim 1; and figures 7-8.	1-17
A	US 2011-0165901 A1 (URI BANIEL et al.) 07 July 2011 See paragraphs [0028]-[0030], [0037]-[0043]; claim 1; and figures 1, 5.	1-17

☐ Further documents are listed in the continuation of Box C.   ☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents,such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
29 November 2013 (29.11.2013)	**02 December 2013 (02.12.2013)**

Name and mailing address of the ISA/KR
Korean Intellectual Property Office
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Facsimile No. +82-42-472-7140

Authorized officer
YANG, Jeong Rok
Telephone No. +82-42-481-5709

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2013/050512

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2011-0158090 A1	30/06/2011	CN 102907042 A	30/01/2013
		EP 2520045 A2	07/11/2012
		WO 2011-082035 A2	07/07/2011
		WO 2011-082035 A3	17/11/2011
EP 0857399 B1	12/05/2004	AU 1996-70047 B2	18/05/2000
		AU 1996-73550 B2	01/06/2000
		AU 1996-73551 B2	01/07/1999
		AU 7355196 A	15/05/1997
		CA 2235822 A1	01/05/1997
		CA 2235822 C	01/02/2005
		CA 2235829 A1	01/05/1997
		CA 2235829 C	19/04/2005
		CN 1092905 C	16/10/2002
		CN 1160978 C	04/08/2004
		CN 1201584 A	09/12/1998
		CN 1204443 A	06/01/1999
		CN 1204444 A	06/01/1999
		CN 1319393 C	30/05/2007
		DE 69632473 D1	17/06/2004
		DE 69632473 T2	19/05/2005
		EP 0852100 A1	08/07/1998
		EP 0852100 B1	12/05/2004
		EP 0857398 A1	12/08/1998
		EP 0857398 B1	28/04/2004
		EP 0857399 A1	12/08/1998
		JP 11-513868 A	24/11/1999
		JP 11-513869 A	24/11/1999
		JP 2000-500931 A	25/01/2000
		JP 3776458 B2	17/05/2006
		JP 4020332 B2	12/12/2007
		KR 10-0425256 B1	30/06/2004
		KR 10-0425257 B1	01/07/2004
		KR 10-1999-0045774 A	25/06/1999
		US 5742588 A	21/04/1998
		US 5757772 A	26/05/1998
		US 6097700 A	01/08/2000
		WO 97-11568 A1	27/03/1997
		WO 97-16039 A1	01/05/1997
		WO 97-16040 A1	01/05/1997
US 2012-0176894 A1	12/07/2012	CN 102668627 A	12/09/2012
		EP 2468033 A1	27/06/2012
		EP 2468033 A4	05/06/2013
		WO 2011-020208 A1	24/02/2011
US 2009-0219946 A1	03/09/2009	AT 521164 T	15/09/2011
		CN 101163091 A	16/04/2008
		CN 101163091 B	11/05/2011

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
		DK 2075978 T3	12/12/2011
		EP 2075978 A1	01/07/2009
		EP 2075978 A4	16/12/2009
		EP 2075978 B1	17/08/2011
		US 8477607 B2	02/07/2013
		WO 2008-043278 A1	17/04/2008
US 2011-0165901 A1	07/07/2011	CN 102948115 A	27/02/2013
		EP 2522102 A2	14/11/2012
		WO 2011-082090 A2	07/07/2011
		WO 2011-082090 A3	29/12/2011