(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
26 July 2012 (26.07.2012)

WIPO | PCT

(10) International Publication Number
WO 2012/100057 A2

(51) International Patent Classification:
H04L 12/28 (2006.01) *H04L 29/06* (2006.01)
H04L 12/58 (2006.01)

(21) International Application Number:
PCT/US2012/021874

(22) International Filing Date:
19 January 2012 (19.01.2012)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
61/435,102 21 January 2011 (21.01.2011) US

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(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— *without international search report and to be republished upon receipt of that report (Rule 48.2(g))*

(54) **Title**: METHODS, SYSTEMS, AND COMPUTER READABLE MEDIA FOR SCREENING DIAMETER MESSAGES WITHIN A DIAMETER SIGNALING ROUTER (DSR) HAVING A DISTRIBUTED MESSAGE PROCESSOR ARCHITECTURE

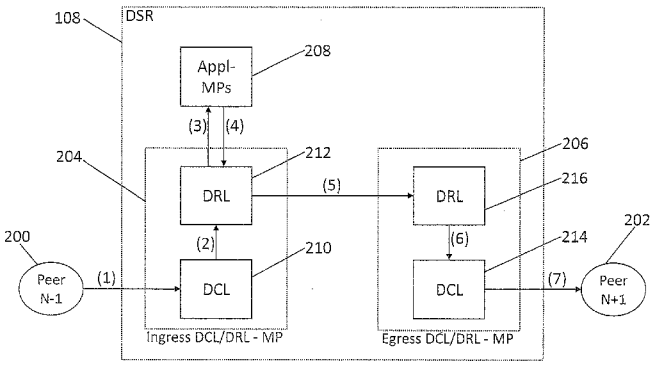

FIG. 2

(57) **Abstract**: According to one aspect, the subject matter described herein includes a method for screening Diameter messages within a Diameter signaling router (DSR) having a distributed message processor architecture. The method includes steps occurring at a DSR comprising a plurality of Diameter message processors, each configured to perform at least one Diameter function. The steps include receiving, at an ingress Diameter message processor of the Diameter message processors, a Diameter message from a Diameter peer node. The steps also include identifying, at a Diameter application message processor of the Diameter message processors, a Diameter message screening rule associated with the received Diameter message. The steps further include performing, at the Diameter application message processor of the Diameter message processors, a screening function associated with the identified Diameter message screening rule on the received Diameter message.

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DESCRIPTION

METHODS, SYSTEMS, AND COMPUTER READABLE MEDIA FOR SCREENING DIAMETER MESSAGES WITHIN A DIAMETER SIGNALING ROUTER (DSR) HAVING A DISTRIBUTED MESSAGE PROCESSOR ARCHITECTURE

PRIORITY CLAIM

This application claims the benefit of U.S. Provisional Patent Application Serial No. 61/435,102, filed January 21, 2011; the disclosure of which is incorporated herein by reference in its entirety.

TECHNICAL FIELD

The subject matter described herein relates to screening Diameter messages within a Diameter signaling router (DSR) having a distributed message processor architecture. More specifically, the subject matter relates to methods, systems, and computer readable media for screening Diameter messages within a DSR having a distributed message processor architecture.

BACKGROUND

The Diameter protocol is a next generation authentication, authorization, and accounting (AAA) protocol. The Diameter base protocol is defined in IETF RFC 3588, the disclosure of which is incorporated by reference herein in its entirety. Commonly used within the Internet multimedia subsystem (IMS) architecture, the Diameter protocol was derived from the remote authentication dial-in user service (RADIUS) protocol. Historically, the RADIUS protocol was employed by Internet service providers (ISPs) to provide a secure communication channel between an ISP's access server and a secure location where user credential information was stored, e.g., a lightweight directory access protocol (LDAP) server. While the RADIUS protocol provided a standardized AAA exchange protocol, the emergence of new technologies and applications necessitated the development of a protocol capable of meeting ever-changing demands.

Diameter aims to extend the standardized approach of RADIUS while providing expanded functionality and remaining open to future development.

As the prevalence of the Diameter protocol increases within providers' telecommunication networks, many providers are turning to distributed architectures for processing and routing the accompanying increase in volume of Diameter message traffic. While a distributed architecture may offer a provider advantages such as load balancing and redundancy, it also presents various issues. One such issue is providing for the screening of Diameter messages within such a distributed architecture.

Accordingly, a need exists for methods, systems, and computer readable media for screening Diameter messages within a DSR having a distributed message processor architecture.

SUMMARY

According to one aspect, the subject matter described herein includes a method for screening Diameter messages within a Diameter signaling router (DSR) having a distributed message processor architecture. The method includes steps occurring at a DSR comprising a plurality of Diameter message processors, each configured to perform at least one Diameter function. The steps include receiving, at an ingress Diameter message processor of the Diameter message processors, a Diameter message from a Diameter peer node. The steps also include identifying, at a Diameter application message processor of the Diameter message processors, a Diameter message screening rule associated with the received Diameter message. The steps further include performing, at the Diameter application message processor of the Diameter message processors, a screening function associated with the identified Diameter message screening rule on the received Diameter message.

According to another aspect, the subject matter described herein includes a system for screening Diameter messages within a DSR having a distributed message processor architecture. The system includes a DSR. The DSR includes an ingress Diameter message processor configured to receive a Diameter message from a Diameter peer node. The DSR also

includes a Diameter application message processor configured to identify a Diameter message screening rule associated with the received Diameter message and perform a screening function associated with the identified Diameter message screening rule on the received Diameter message.

As used herein, the term "node" refers to a physical computing platform including one or more processors and memory.

The subject matter described herein can be implemented in software in combination with hardware and/or firmware. For example, the subject matter described herein may be implemented in software executed by one or more processors. In one exemplary implementation, the subject matter described herein may 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

The subject matter described herein will now be explained with reference to the accompanying drawings of which:

Figure 1 is a network diagram illustrating an exemplary network environment for screening Diameter messages within a DSR having a distributed message processor architecture according to an embodiment of the subject matter described herein;

Figure 2 is a block diagram illustrating an exemplary distributed DSR architecture for screening Diameter messages within a DSR having a distributed message processor architecture according to an embodiment of the subject matter described herein;

Figure 3 is a message flow diagram illustrating an exemplary message sequence in which an update location request (ULR) message is screened and discarded by a DSR having a distributed message processor architecture according to an embodiment of the subject matter described herein;

Figure 4 is a message flow diagram illustrating an exemplary message sequence in which a ULR message is screened and a screening event notification message is generated and communicated to a network operations center (NOC) node by a DSR having a distributed message processor architecture according to an embodiment of the subject matter described herein;

Figure 5 is a message flow diagram illustrating an exemplary message sequence in which a ULR message is screened, modified, and communicated to a home subscriber server (HSS) node by a DSR having a distributed message processor architecture according to an embodiment of the subject matter described herein;

Figure 6 is a set of exemplary application level screening rule tables for screening Diameter messages within a DSR having a distributed message processor architecture according to an embodiment of the subject matter described herein;

Figure 7 is a set of exemplary message level screening rule tables for screening Diameter messages within a DSR having a distributed message processor architecture according to an embodiment of the subject matter described herein;

Figure 8 is a set of exemplary message attribute value pair (AVP) level rule tables for screening Diameter messages within a DSR having a distributed message processor architecture according to an embodiment of the subject matter described herein;

Figure 9 is a set of exemplary message AVP value level screening rule tables for screening Diameter messages within a DSR having a distributed message processor architecture according to an embodiment of the subject matter described herein;

Figure 10 is an exemplary maximum rate rules table for screening Diameter messages within a DSR having a distributed message processor architecture according to an embodiment of the subject matter described herein; and

Figure 11 is a flow chart illustrating an exemplary process for screening Diameter messages within a DSR having a distributed message processor architecture according to an embodiment of the subject matter described herein.

DETAILED DESCRIPTION

Methods, systems, and computer readable media for screening Diameter messages within a DSR having a distributed message processor architecture are provided. Figure 1 is a network diagram illustrating an exemplary network environment for screening Diameter messages within a DSR having a distributed message processor architecture according to an embodiment of the subject matter described herein. Referring to Figure 1, network environment **100** may include one or more user equipment (UE) nodes. For example, network environment **100** may include UE **102**. UE **102** may be any device capable of communicating within network environment **100**, for example, a mobile handset, smart phone, tablet computer, laptop computer, etc. UE **102** may utilize one or more nodeBs or enhanced nodeBs (eNodeBs) to communicate within network environment **100**. For example, UE **102** may utilize eNodeB **104** to communicate within network environment **100**. eNodeB **104** may be operative to communicate with one or more mobility management entity (MME) nodes. For example, eNodeB **104** may be operative to communicate with MME node **106**. MME node **106** may be configured to track one or more UEs, for example UE **102**, within network environment **100**, and may communicate information (e.g., mobility-related information) to one or more other nodes within network environment **100**, for example via Diameter messages. Network environment **100** or a subsection thereof, may employ one or more DSR nodes for routing Diameter messages. For example, network environment **100** may include DSR node **108**. DSR node **108** may utilize a distributed

architecture and may include one or more Diameter message processors, each of which may be configured to perform one or more Diameter functions. DSR node **108** may be operative to communicate with one or more other nodes within network environment **100**. For example, DSR node **108** may be operative to communicate with HSS node **110**. HSS node **110** may maintain subscriber-related information, such as user identification information, control information for user authentication and authorization, location information, and/or user profile data. DSR node **108** may also be operative to communicate with network operations center (NOC) node **112**. NOC node **112** may be a central control point for network environment **100** or a portion thereof, and may thus send and/or receive one or messages related to network status from various nodes within network environment **100** (e.g., DSR node **108**). As will be discussed in greater detail below, in accordance with embodiments of the subject matter described herein, DSR node **108** may be configured to perform one or more screening functions on Diameter messages within network environment **100**.

Figure 2 is a block diagram illustrating an exemplary distributed DSR architecture for screening Diameter messages within a DSR having a distributed message processor architecture according to an embodiment of the subject matter described herein. Referring to Figure 2, DSR node **108** may be operative to communicate with one or more Diameter peer nodes. For example, DSR node **108** may be operative to communicate with Diameter peer nodes **200** and **202**. Diameter peer nodes **200** and **202** may be any Diameter nodes capable of communicating with DSR node **108**. For example, Diameter peer node **200** may correspond to MME node **106** and Diameter peer node **202** may correspond to HSS node **110**. DSR node **108** may utilize a distributed architecture and may include one or more message processors for performing one or more Diameter functions. For example, DSR node **108** may include Diameter message processors **204**, **206**, and **208**. Each of Diameter message processors **204**, **206**, and **208** may be configured to perform one or more Diameter functions for Diameter messages processed by DSR node **108**. For example, Diameter message processor **204** may be configured as an ingress Diameter message

processor, Diameter message processor **206** may be configured as an egress Diameter message processor, and Diameter message processor **208** may be configured as a Diameter application message processor. As an ingress Diameter message processor, Diameter message processor **204** may include Diameter connection layer (DCL) **210** and Diameter routing layer (DRL) **212**. DCL **210** may be a software layer of the Diameter stack that implements Diameter transport connections for inbound Diameter messages and DRL **212** may be a software layer of the Diameter stack that implements Diameter routing for inbound Diameter messages. Similarly, as an egress Diameter message processor, Diameter message processor **206** may include DCL **214** and DRL **216**. DCL **214** may be a software layer of the Diameter stack that implements Diameter transport connections for outbound Diameter messages and DRL **216** may be a software layer of the Diameter stack that implements Diameter routing for outbound Diameter messages.

As indicated above, Diameter message processor **208** may be configured as a Diameter application message processor. In accordance with embodiments of the subject matter described herein, Diameter message processor **208** may be configured to screen Diameter messages within DSR node **108**. For example, in an exemplary routing scenario, at step 1, DSR node **108** may receive, via a communication interface (not illustrated), an inbound Diameter message from Diameter peer node **200**. The inbound Diameter message may be received via ingress Diameter message processor **204**'s DCL **210**. At step 2, the Diameter message may be forwarded to ingress Diameter message processor **204**'s DRL **212** for any required inbound Diameter routing functions. At step 3, DRL **212** may forward the Diameter message to Diameter application message processor **208**. Diameter application message processor **208** may be dedicated to performing one or more Diameter screening functions. As will be described in greater detail below, Diameter application message processor **208** may identify one or more Diameter message screening rules associated with the received Diameter message. In some embodiments, Diameter application message processor **208** may be configured to identify one or more screening

rules associated with the received Diameter message based on one or more of a Diameter connection over which the received Diameter message was received, a Diameter session of which the received Diameter message is a part, an origin host associated with the received Diameter message, an origin realm associated with the received Diameter message, a source Internet protocol (IP) address associated with the received Diameter message, a destination host associated with the received Diameter message, a destination realm associated with the received Diameter message, a Diameter connection over which the received Diameter message will be sent, a destination IP address to which the received Diameter message will be sent, a Diameter application identifier associated with the received Diameter message, a Diameter message command code associated with the received Diameter message, an attribute value pair (AVP) code associated with the received Diameter message, and an AVP data value associated with the received Diameter message.

Having identified one or more screening rules associated with the received Diameter message, Diameter application message processor **208** may perform one or more screening functions associated with the one or more identified Diameter message screening rules on the received Diameter message. For example, Diameter application message processor **208** may discard the received Diameter message, may modify the received Diameter message, and/or may update one or more usage or measurement statistics associated with the received Diameter message. Having performed one or more Diameter screening functions on the received Diameter message, at step 4, Diameter application message processor **208** may forward the Diameter message back to ingress Diameter message processor **204**'s DRL **212**. At step 5, ingress Diameter message processor **204**'s DRL **212** may forward the Diameter message to egress Diameter message processor **206**'s DRL **216** which may perform any required egress routing functions. At step 6, DRL **216** may forward the Diameter message to egress Diameter message processor **206**'s DCL **214** for communication, at step 7, to Diameter peer node **202**.

Figure 3 is a message flow diagram illustrating an exemplary message sequence in which a ULR message is screened and discarded by a DSR having a distributed message processor architecture according to an embodiment of the subject matter described herein. Referring to Figure 3, at step 1, MME node **106** may transmit a ULR message (e.g., a ULR message associated with UE **102**) to HSS node **110**. En route to HSS node **110**, the ULR message may be routed through DSR node **108**. Having received the ULR message, at step 2, DSR node **108** may perform screening and validation processing for the ULR message. For example, DSR node **108**'s Diameter application message processor **208** may identify a Diameter message screening rule associated with the ULR message from among one or more Diameter message screening rules stored in Diameter screening and validation rules database **300**. As will be described in greater detail below, the identified Diameter message screening rule(s) may specify one or more screening functions to perform on a received Diameter message matching one or more parameters specified by the rule(s). For example, Diameter application message processor **208** may identify a Diameter message screening rule that specifies that Diameter messages received from origin host "MME1.epc.mnc02.mcc505.3gppnetwork.org" (i.e., Diameter messages received from MME node **106**) should be discarded. At step 3, Diameter application message processor **208** may perform the screening function specified by the identified Diameter message screening rule(s). For example, Diameter application message processor **208** may discard the ULR message from MME node **106**, rather than routing the ULR message to HSS node **110**.

As will be described in greater detail below, in some embodiments Diameter application message processor **208** may identify a Diameter message screening rule that specifies that one or more usage or measurement statistics associated with the identified Diameter message screening rule should be updated. For example, Diameter application message processor **208** may identify a Diameter message screening rule from Diameter message screening and validation rules database **300** that specifies that when a Diameter message associated with MME node **106** is

received by DSR **108**, a current receipt rate associated with the identified Diameter message screening rule should be updated to reflect receipt of the Diameter message. In some embodiments, the identified Diameter message screening rule may specify a maximum receipt rate for Diameter messages associated with the Diameter message screening rule. Such a Diameter message screening rule may further specify a screening function that should be performed when the current receipt rate exceeds the maximum receipt rate for the Diameter message screening rule. For example, a Diameter message screening rule may specify that when the current receipt rate exceeds the maximum receipt rate for the Diameter message screening rule, any Diameter messages associated with the Diameter message screening rule should be discarded. DSR node **108** may be operative to communicate with a usage and measurement statistics database **302** for storing usage and measurement statistics (e.g., current receipt rates) and/or maximum receipt rates.

Figure 4 is a message flow diagram illustrating an exemplary message sequence in which a ULR message is screened and a screening event notification message is generated and communicated to a NOC node by a DSR having a distributed message processor architecture according to an embodiment of the subject matter described herein. Referring to Figure 4, at step 1, MME node **106** may transmit a ULR message (e.g., a ULR message associated with UE **102**) to HSS node **110**. En route to HSS node **110**, the ULR message may be routed through DSR node **108**. Having received the ULR message, at step 2, DSR node **108** may perform screening and validation processing for the ULR message. For example, DSR node **108**'s Diameter application message processor **208** may identify a Diameter message screening rule associated with the ULR message from among one or more Diameter message screening rules stored in Diameter screening and validation rules database **300**. The identified Diameter message screening rule may specify, for example, that a current receipt rate for Diameter messages associated with MME node **106** should be updated to reflect receipt of the ULR message. The identified Diameter message screening rule may further specify a maximum receipt rate for Diameter

messages received from MME node **106**, and may specify a screening function that should be performed if the updated current receipt rate exceeds the specified maximum receipt rate. For example, the identified Diameter message screening rule may specify that if the updated receipt rate exceeds the specified maximum receipt rate, any additional Diameter messages received from MME node **106** (e.g., the received ULR message) should be discarded, a screening event notification message should be generated and communicated to NOC node **112**, and/or an error message should be generated and communicated to MME node **106** (e.g., an update location answer (ULA) message containing an error code).

Upon updating the current receipt rate associated with the identified Diameter message screening rule, Diameter application message processor **208** may determine that the current receipt rate associated with the identified Diameter message screening rule exceeds the maximum receipt rate specified by the identified Diameter message screening rule, and in response to making such a determination may perform the screening function(s) specified by the identified Diameter message screening rule. For example, at step 3, Diameter application message processor **208** may discard the ULR message received from MME node **106** rather than communicating it to HSS node **110**. At step 4, Diameter application message processor **208** may generate a screening event notification message (e.g., a screening event notification message indicating that DSR node **108** has exceeded its maximum receipt rate for messages associated with the identified Diameter message screening rule) and communicate the screening event notification message to NOC node **112**. At step 5, Diameter application message processor **208** may generate and communicate to MME node **106** a ULA message containing an error code (e.g., an error code indicating that the ULR message could not be communicated to HSS node **110**).

Figure 5 is a message flow diagram illustrating an exemplary message sequence in which a ULR message is screened, modified, and communicated to an HSS node by a DSR having a distributed message processor architecture according to an embodiment of the subject matter

described herein. Referring to Figure 5, at step 1, MME node **106** may transmit a ULR message (e.g., a ULR message associated with UE **102**) to HSS node **110**. En route to HSS node **110**, the ULR message may be routed through DSR node **108**. Having received the ULR message, at step 2, DSR node **108** may perform screening and validation processing for the ULR message. For example, DSR node **108**'s Diameter application message processor **208** may identify a Diameter message screening rule associated with the ULR message from among one or more Diameter message screening rules stored in Diameter screening and validation rules database **300**. The identified Diameter message screening rule may specify, for example, that Diameter messages associated with the Diameter message screening rule should be modified. For example, the identified Diameter message screening rule may specify that Diameter messages associated with the Diameter message screening rule have an AVP value changed, an AVP value added, and/or an existing AVP value deleted. Diameter application message processor **208** may perform the specified modification on the received ULR message and, at step 3, DSR **108** may forward the modified ULR message to HSS node **110**. Having received the modified ULR message, at step 4, HSS node **110** may generate and communicate to MME node **106** an associated ULA message.

Figure 6 is a set of exemplary application level screening rule tables for screening Diameter messages within a DSR having a distributed message processor architecture according to an embodiment of the subject matter described herein. Referring to Figure 6, table **600** may specify one or more application level "whitelist" rules. That is, table **600** may include one or more Diameter message screening rules that specify Diameter applications for which associated Diameter messages should be allowed and/or one or more screening functions that should be performed on the associated Diameter messages. For example, table **600** includes an entry specifying that Diameter messages having an origin host "MME_Visited"; an origin realm "Visited.net"; any destination host; a destination realm "Home.net"; and an application identifier "16777251", should be allowed and that usage and measurement logs should be updated to reflect receipt of such

messages. Table **600**, also includes an entry specifying that Diameter messages having an origin host "MME_Visited"; an origin realm "Visited.net"; any destination host; a destination realm "Home.net"; and an application identifier "16777267", should be allowed and no screening action need be performed.

Similarly, table **602** may specify one or more application level "blacklist" rules. That is, table **602** may include one or more Diameter message screening rules that specify Diameter applications for which associated Diameter messages should not be allowed and/or one or more screening functions that should be performed on the associated Diameter messages. For example, table **602** includes an entry specifying that Diameter messages having an origin host "MME_Visited"; an origin realm "Visited.net"; any destination host; a destination realm "Home.net"; and an application identifier "16777251", should not be allowed and that such messages should be discarded. Table **602**, also includes an entry specifying that Diameter messages having an origin host "MME_Visited"; an origin realm "Visited.net"; any destination host; a destination realm "Home.net"; and an application identifier "16777267", should not be allowed and such messages should be routed and the network operator notified.

Figure 7 is a set of exemplary message level screening rule tables for screening Diameter messages within a DSR having a distributed message processor architecture according to an embodiment of the subject matter described herein. Referring to Figure 7, table **700** may specify one or more message level "whitelist" rules. That is, table **700** may include one or more Diameter message screening rules that specify Diameter message codes for which associated Diameter messages should be allowed and/or one or more screening functions that should be performed on the associated Diameter messages. For example, table **700** includes an entry specifying that Diameter messages having an origin host "MME_Visited"; an origin realm "Visited.net"; any destination host; a destination realm "Home.net"; an application identifier "16777251"; and any message code, should be allowed and that usage and measurement logs should be updated to reflect receipt of such messages. Table **700**, also includes an entry specifying that

Diameter messages having an origin host "MME_Visited"; an origin realm "Visited.net"; any destination host; a destination realm "Home.net"; an application identifier "16777251"; and a message code of "316", "318", or "321", should be allowed and no screening action need be performed.

Similarly, table **702** may specify one or more message level "blacklist" rules. That is, table **702** may include one or more Diameter message screening rules that specify Diameter message codes for which associated Diameter messages should not be allowed and/or one or more screening functions that should be performed on the associated Diameter messages. For example, table **702** includes an entry specifying that Diameter messages having an origin host "MME_Visited"; an origin realm "Visited.net"; any destination host; a destination realm "Home.net"; an application identifier "16777251"; and a message code "317", should not be allowed and that such messages should be discarded. Table **702**, also includes an entry specifying that Diameter messages having an origin host "MME_Visited"; an origin realm "Visited.net"; any destination host; a destination realm "Home.net"; an application identifier "16777251"; and a message code "322", should not be allowed and such messages should be routed and the network operator notified. Table **702**, further includes an entry specifying that Diameter messages having an origin host "MME_Visited"; an origin realm "Visited.net"; any destination host; a destination realm "Home.net"; an application identifier "16777267"; and any message code, should not be allowed and a reply with error message should be generated and communicated in response to such messages.

Figure 8 is a set of exemplary message AVP level rule tables for screening Diameter messages within a DSR having a distributed message processor architecture according to an embodiment of the subject matter described herein. Referring to Figure 8, table **800** may specify one or more AVP level "whitelist" rules. That is, table **800** may include one or more Diameter message screening rules that specify Diameter message AVP codes for which associated Diameter messages should be allowed and/or one or more screening functions that should be performed on the associated Diameter messages. For example, table **800** includes an entry specifying

that Diameter messages having an origin host "MME1"; an origin realm "Visited.net"; any destination host; a destination realm "Home.net"; an application identifier "16777251"; a message code "316"; and an AVP code "266", should be allowed and that usage and measurement logs should be updated to reflect receipt of such messages.

Similarly, table **802** may specify one or more AVP level "blacklist" rules. That is, table **802** may include one or more Diameter message screening rules that specify Diameter message AVP codes for which associated Diameter messages should not be allowed and/or one or more screening functions that should be performed on the associated Diameter messages. For example, table **802** includes an entry specifying that Diameter messages having an origin host "MME1"; an origin realm "Visited.net"; any destination host; a destination realm "Home.net"; an application identifier "16777251"; a message code "316"; and an AVP code "1401", should not be allowed and that such messages should be modified to remove the AVP code.

Figure 9 is a set of exemplary message AVP value level screening rule tables for screening Diameter messages within a DSR having a distributed message processor architecture according to an embodiment of the subject matter described herein. Referring to Figure 9, table **900** may specify one or more AVP value level "whitelist" rules. That is, table **900** may include one or more Diameter message screening rules that specify Diameter message AVP values for which associated Diameter messages should be allowed and/or one or more screening functions that should be performed on the associated Diameter messages. For example, table **900** includes an entry specifying that Diameter messages having an origin host "vMME"; an origin realm "Visited.net"; any destination host; a destination realm "Home.net"; an application identifier "16777251"; a message code "316"; an AVP code "1407"; and an AVP value "20801", should be allowed and that usage and measurement logs should be updated to reflect receipt of such messages. Table **900** also includes an entry specifying that Diameter messages having an origin host "vMME"; an origin realm "Visited.net"; any destination host; a destination realm "Home.net"; an

application identifier "16777251"; a message code "316"; an AVP code "1032"; and an AVP value "E-UTRAN", should be allowed and that the network operator should be notified upon receipt of such messages.

Similarly, table **902** may specify one or more AVP value level "blacklist" rules. That is, table **902** may include one or more Diameter message screening rules that specify Diameter message AVP values for which associated Diameter messages should not be allowed and/or one or more screening functions that should be performed on the associated Diameter messages. For example, table **902** includes an entry specifying that Diameter messages having an origin host "vMME"; an origin realm "Visited.net"; any destination host; a destination realm "Home.net"; an application identifier "16777251"; a message code "316"; an AVP code "1407"; and an AVP value "20801", should not be allowed and that such messages should be modified to remove the AVP value. Table **902** also includes an entry specifying that Diameter messages having an origin host "vMME"; an origin realm "Visited.net"; any destination host; a destination realm "Home.net"; an application identifier "16777251"; a message code "316"; an AVP code "1032"; and an AVP value "E-UTRAN", should not be allowed and that such messages should be routed and the network operator notified.

Figure 10 is an exemplary maximum rate rules table for screening Diameter messages within a DSR having a distributed message processor architecture according to an embodiment of the subject matter described herein. Referring to Figure 10, table **1000** may specify one or more message level maximum receipt rate rules. That is, table **1000** may include one or more Diameter message screening rules that specify a maximum receipt rate for associated Diameter messages and/or one or more screening functions that should be performed on associated Diameter messages when the current receipt rate exceeds the specified maximum receipt rate. For example, table **1000** includes an entry specifying that Diameter messages having an origin host "MME_Visited"; an origin realm "Visited.net"; any destination host; a destination realm "Home.net"; an application identifier "16777251"; and a message code "322", have a

maximum receipt rate of 100 messages per second and that when the current receipt rate for associated messages exceeds 100 messages per second, associated messages should be routed and the network operator notified. Table **1000** also includes an entry specifying that Diameter messages having an origin host "MME_Visited"; an origin realm "Visited.net"; any destination host; a destination realm "Home.net"; an application identifier "16777267"; and any message code, have a maximum receipt rate of 500 messages per second and that when the current receipt rate for associated messages exceeds 500 messages per second, associated messages should be routed and the network operator notified.

Figure 11 is a flow chart illustrating an exemplary process for screening Diameter messages within a DSR having a distributed message processor architecture according to an embodiment of the subject matter described herein. The steps occur at a DSR comprising a plurality of Diameter message processors, each configured to perform at least one function. For example, the steps may occur at DSR **108**. Referring to Figure 11, in step **1100**, a Diameter message is received, at an ingress Diameter message processor of the Diameter message processors, from a Diameter peer node. For example, DSR node **108**'s ingress Diameter message processor **204** may receive a ULR message from MME node **106**. In step **1102**, a Diameter message screening rule associated with the received Diameter message is identified at a Diameter application message processor of the Diameter application message processors. For example, a Diameter message screening rule that specifies that Diameter messages received from MME node **106** should be discarded may be identified at Diameter application message processor **208**. In step **1104**, a screening function associated with the identified Diameter message screening rule is performed on the received Diameter message at the Diameter application message processor of the Diameter application message processors. For example, the received ULR message may be discarded at Diameter application message processor **208**.

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, as the subject matter described herein is defined by the claims as set forth hereinafter.

5

CLAIMS

What is claimed is:

1. A method for screening Diameter messages within a Diameter signaling router (DSR) having a distributed message processor architecture, the method comprising:

at a DSR comprising a plurality of Diameter message processors, each configured to perform at least one Diameter function:

receiving, at an ingress Diameter message processor of the Diameter message processors, a Diameter message from a Diameter peer node;

identifying, at a Diameter application message processor of the Diameter message processors, a Diameter message screening rule associated with the received Diameter message; and

performing, at the Diameter application message processor of the Diameter message processors, a screening function associated with the identified Diameter message screening rule on the received Diameter message.

2. The method of claim 1 comprising forwarding the Diameter message from the ingress Diameter message processor to the Diameter application message processor and forwarding the Diameter message from the Diameter application message processor to an egress Diameter message processor of the Diameter message processors.

3. The method of claim 1 wherein performing the screening function on the received Diameter message includes discarding the received Diameter message.

4. The method of claim 1 wherein performing the screening function on the received Diameter message includes modifying the received Diameter message and forwarding the modified Diameter message.

5. The method of claim 4 wherein modifying the received Diameter message includes at least one of adding new information to the received Diameter message and removing information from the received Diameter message.

6. The method of claim 4 wherein forwarding the modified Diameter message includes forwarding the modified Diameter message to at least one of a Diameter peer node and a home subscriber server (HSS) node.

7. The method of claim 1 wherein performing the screening function on the received Diameter message includes generating a screening event notification message regarding the received Diameter message and communicating the screening event notification message to a network operations center.

8. The method of claim 1 wherein performing the screening function on the received Diameter message includes generating an error message and communicating the generated error message to the Diameter peer node.

9. The method of claim 1 wherein performing the screening function on the received Diameter message includes generating an associated answer message to the received Diameter message and communicating the generated associated answer message to the Diameter peer node.

10. The method of claim 1 wherein performing the screening function on the received Diameter message includes recording or updating one or more usage or measurement statistics associated with the identified Diameter message screening rule to account for the received Diameter message.

11. The method of claim 10 wherein the identified Diameter message screening rule specifies a maximum receipt rate for Diameter messages associated with the Diameter message screening rule, wherein recording or updating the one or more usage or measurement statistics includes adjusting a current receipt rate of Diameter messages associated with the identified Diameter message screening rule to account for the received Diameter message, and wherein performing the screening function on the received Diameter message includes performing an additional screening function in response to the current receipt rate of Diameter messages associated

with the identified Diameter message screening rule exceeding the specified maximum receipt rate.

12. The method of claim 1 wherein identifying the Diameter message screening rule associated with the received Diameter message includes identifying the Diameter message screening rule associated with the received Diameter message based on at least one of a Diameter connection over which the received Diameter message was received, a Diameter session of which the received Diameter message is a part, an origin host associated with the received Diameter message, an origin realm associated with the received Diameter message, a source Internet protocol (IP) address associated with the received Diameter message, a destination host associated with the received Diameter message, a destination realm associated with the received Diameter message, a Diameter connection over which the received Diameter message will be sent, a destination IP address to which the received Diameter message will be sent, a Diameter application identifier associated with the received Diameter message, a Diameter message command code associated with the received Diameter message, an attribute value pair (AVP) code associated with the received Diameter message, and an AVP data value associated with the received Diameter message.

13. A system for screening Diameter messages within a Diameter signaling router (DSR) having a distributed message processor architecture, the system comprising:

a DSR comprising:

an ingress Diameter message processor configured to receive a Diameter message from a Diameter peer node; and

a Diameter application message processor configured to identify a Diameter message screening rule associated with the received Diameter message and perform a screening function associated with the identified Diameter message screening rule on the received Diameter message.

14. The system of claim 13 wherein the ingress Diameter message processor is configured to forward the Diameter message to the Diameter application message processor and wherein the Diameter application message processor is configured to forward the Diameter message to an egress Diameter message processor of the DSR.

15. The system of claim 13 wherein the Diameter application message processor is configured to perform the screening function on the received Diameter message by discarding the received Diameter message.

16. The system of claim 13 wherein the Diameter application message processor is configured to perform the screening function on the received Diameter message by modifying the received Diameter message and forwarding the modified Diameter message.

17. The system of claim 16 wherein modifying the received Diameter message includes at least one of adding new information to the received Diameter message and removing information from the received Diameter message.

18. The system of claim 16 wherein forwarding the modified Diameter message includes forwarding the modified Diameter message to at least one of a Diameter peer node and a home subscriber server (HSS) node.

19. The system of claim 13 wherein the Diameter application message processor is configured to perform the screening function on the received Diameter message by generating a screening event notification message regarding the received Diameter message and communicating the screening event notification message to a network operations center.

20. The system of claim 13 wherein the Diameter application message processor is configured to perform the screening function on the received Diameter message by generating an error message and communicating the generated error message to the Diameter peer node.

21. The system of claim 13 wherein the Diameter application message processor is configured to perform the screening function on the received Diameter message by generating an associated answer message to the received Diameter message and communicating the generated associated answer message to the Diameter peer node.

22. The system of claim 13 wherein the Diameter application message processor is configured to perform the screening function on the received Diameter message by recording or updating one or more usage or measurement statistics associated with the identified Diameter message screening rule to account for the received Diameter message.

23. The system of claim 22 wherein the identified Diameter message screening rule specifies a maximum receipt rate for Diameter messages associated with the Diameter message screening rule, wherein recording or updating the one or more usage or measurement statistics includes adjusting a current receipt rate of Diameter messages associated with the identified Diameter message screening rule to account for the received Diameter message, and wherein the Diameter application message processor is configured to perform the screening function on the received Diameter message by performing an additional screening function in response to the current receipt rate of Diameter messages associated with the identified Diameter message screening rule exceeding the specified maximum receipt rate.

24. The system of claim 13 wherein the Diameter application message processor is configured to identify the Diameter message screening rule associated with the received Diameter message based on at least one of a Diameter connection over which the received Diameter message was received, a Diameter session of which the received Diameter message is a part, an origin host associated with the received Diameter message, an origin realm associated with the received Diameter message, a source Internet protocol (IP) address associated with the received Diameter message, a destination host

associated with the received Diameter message, a destination realm associated with the received Diameter message, a Diameter connection over which the received Diameter message will be sent, a destination IP address to which the received Diameter message will be sent, a Diameter application identifier associated with the received Diameter message, a Diameter message command code associated with the received Diameter message, an attribute value pair (AVP) code associated with the received Diameter message, and an AVP data value associated with the received Diameter message.

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

at a DSR comprising a plurality of Diameter message processors, each configured to perform at least one Diameter function:

receiving, at an ingress Diameter message processor of the Diameter message processors, a Diameter message from a Diameter peer node;

identifying, at a Diameter application message processor of the Diameter message processors, a Diameter message screening rule associated with the received Diameter message; and

performing, at the Diameter application message processor of the Diameter message processors, a screening function associated with the identified Diameter message screening rule on the received Diameter message.

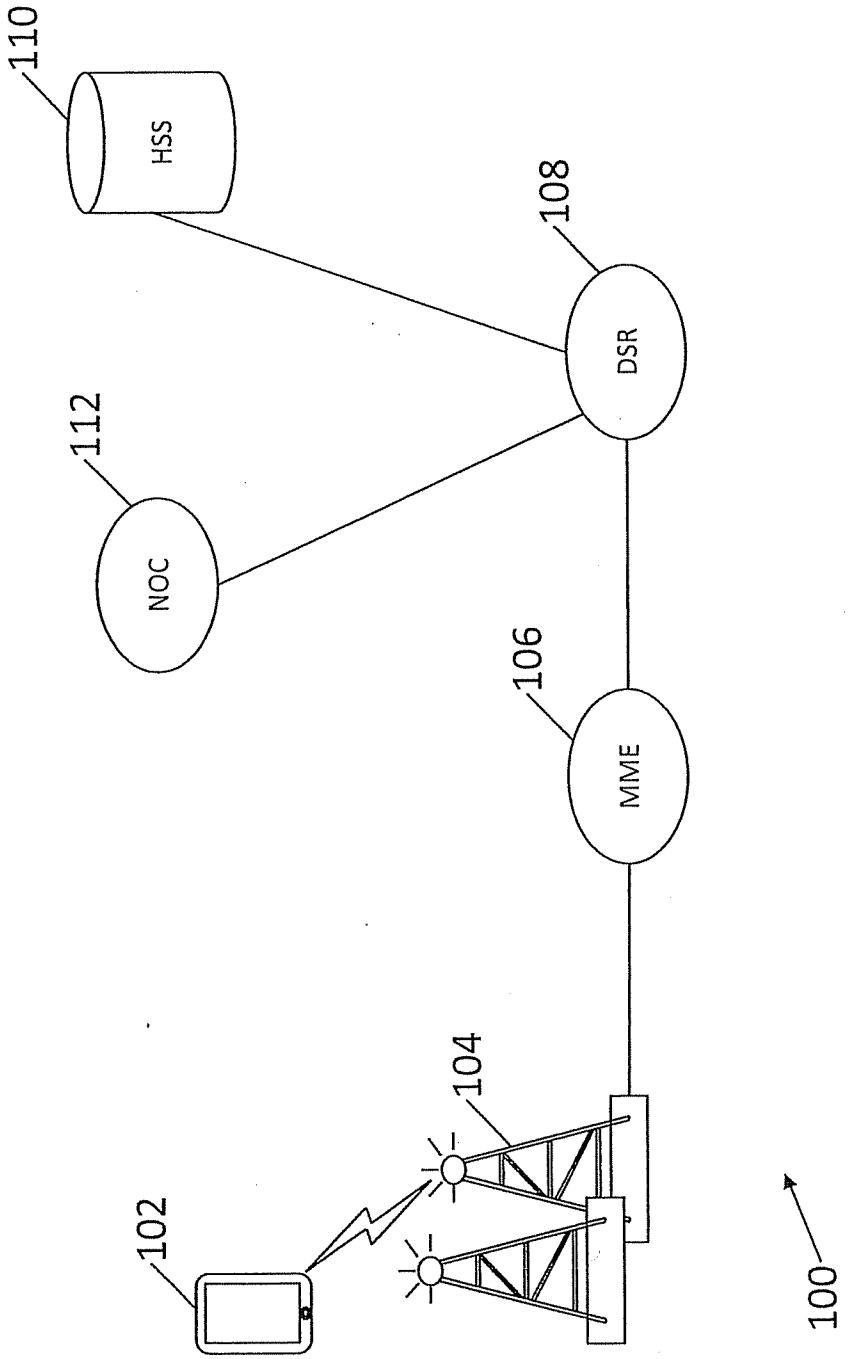

FIG. 1

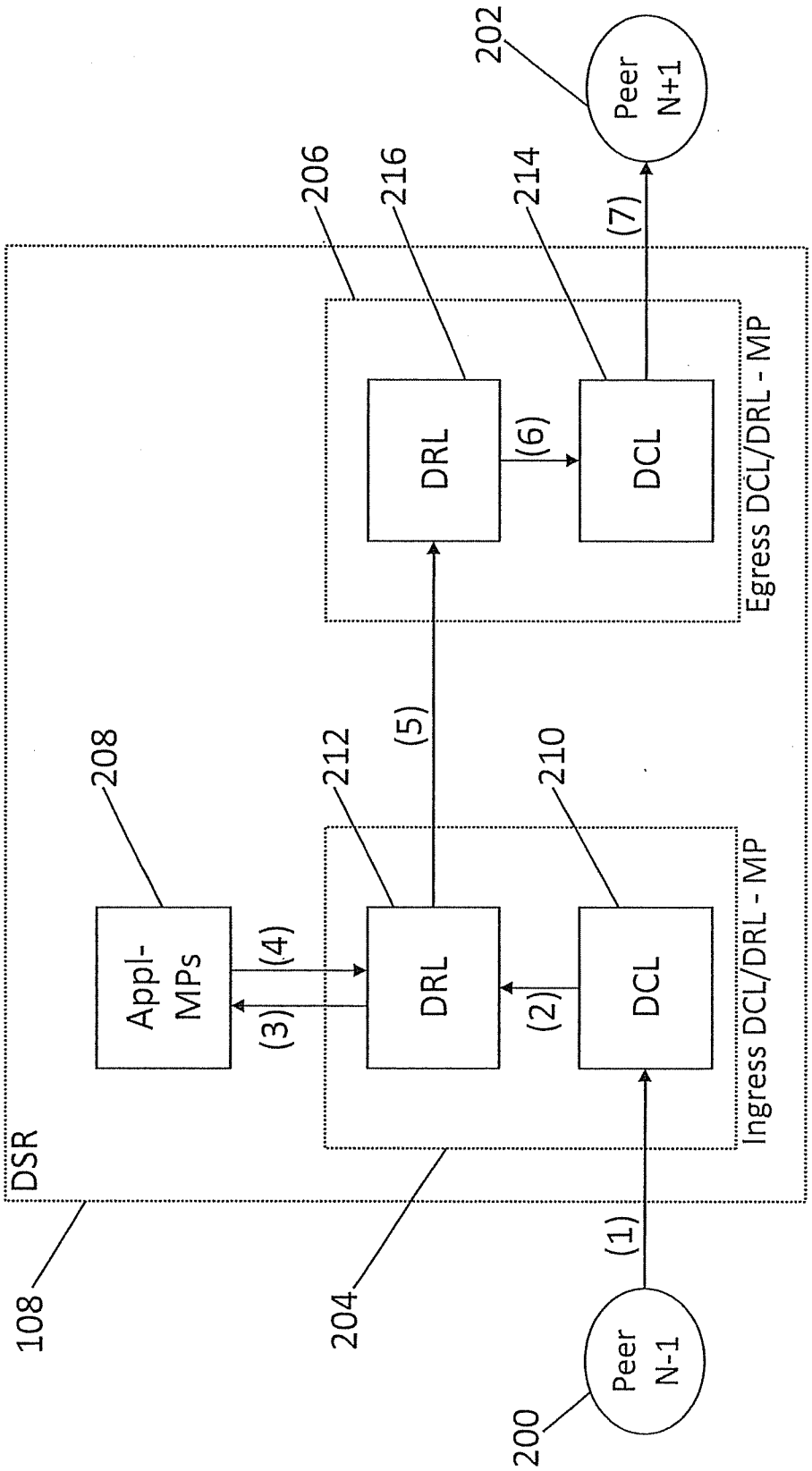
202
Peer N+1
206
216
214
(7)
DRL
(6)
DCL
Egress DCL/DRL - MP
208
212
210
(5)
Appl-MPs
(4)
(3)
DRL
(2)
DCL
Ingress DCL/DRL - MP
DSR
108
204
(1)
Peer N-1
200

FIG. 2

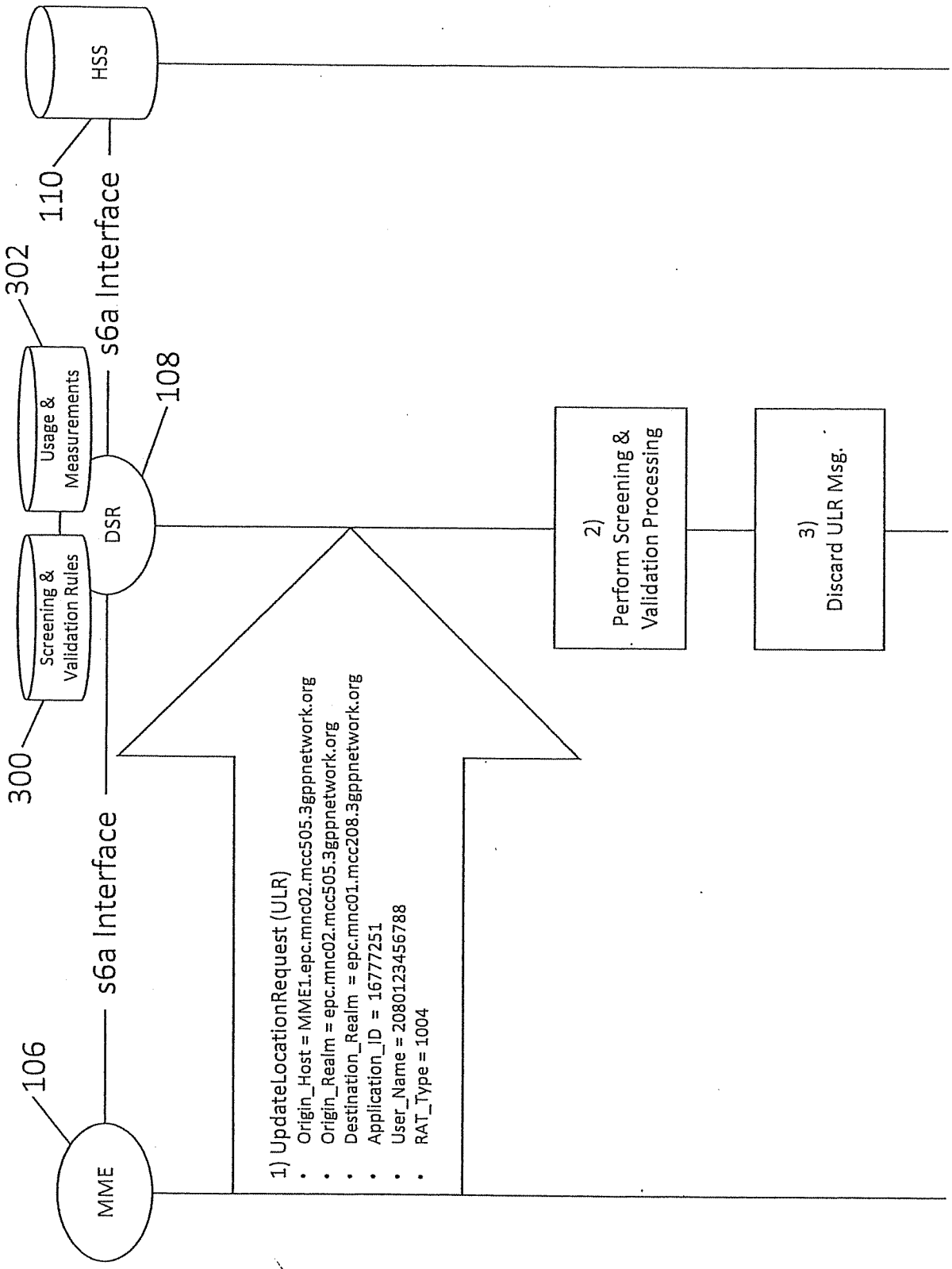
HSS
110
s6a Interface
302
Usage & Measurements
108
Screening & Validation Rules
DSR
300
s6a Interface
106
MME
1) UpdateLocationRequest (ULR)
Origin_Host = MME1.epc.mnc02.mcc505.3gppnetwork.org
Origin_Realm = epc.mnc02.mcc505.3gppnetwork.org
Destination_Realm = epc.mnc01.mcc208.3gppnetwork.org
Application_ID = 16777251
User_Name = 208012345678
RAT_Type = 1004
2) Perform Screening & Validation Processing
3) Discard ULR Msg.

FIG. 3

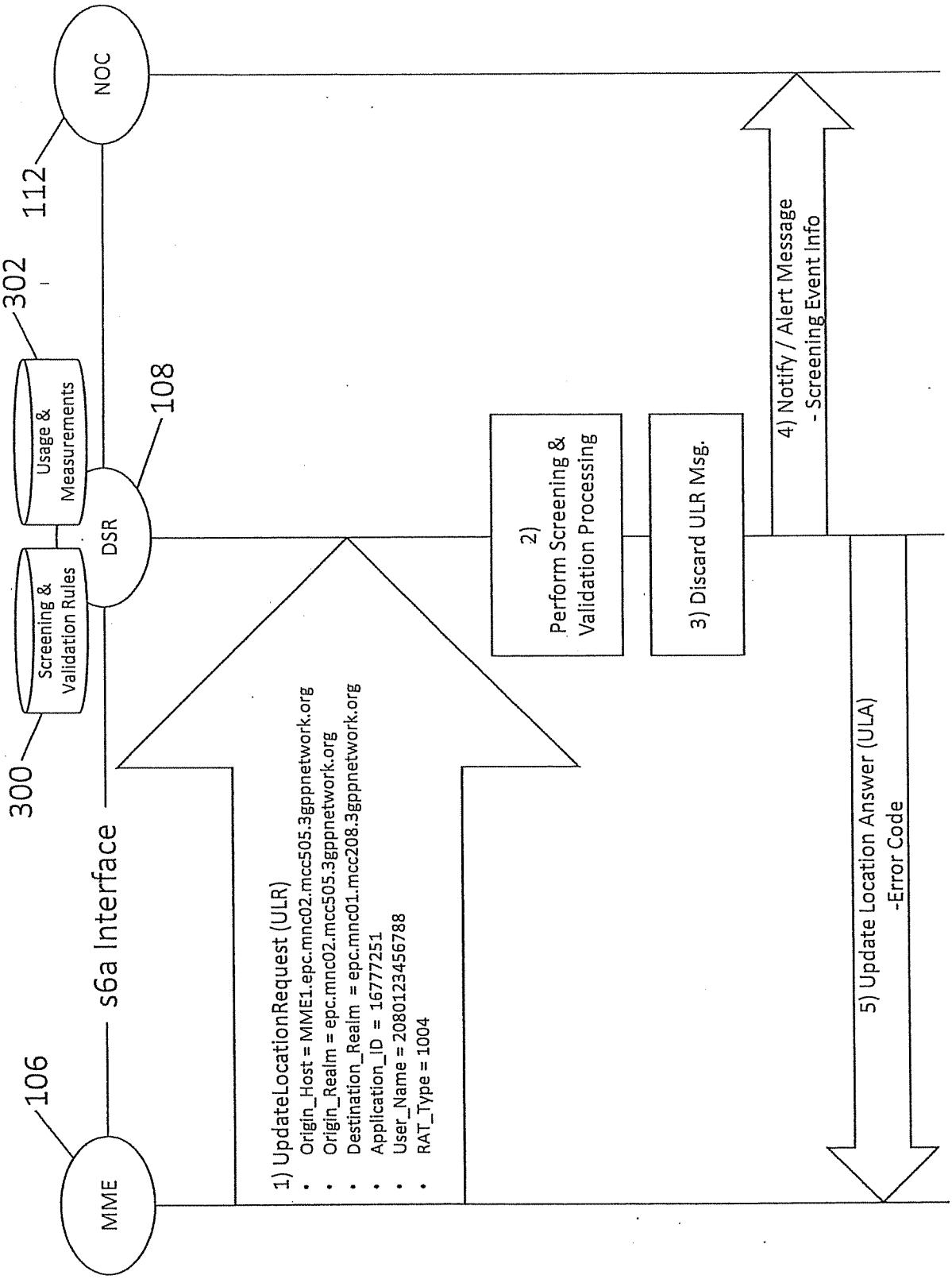
NOC
112
302
Usage & Measurements
108
DSR
Screening & Validation Rules
300
s6a Interface
106
MME
1) UpdateLocationRequest (ULR)
Origin_Host = MME1.epc.mnc02.mcc505.3gppnetwork.org
Origin_Realm = epc.mnc02.mcc505.3gppnetwork.org
Destination_Realm = epc.mnc01.mcc208.3gppnetwork.org
Application_ID = 16777251
User_Name = 2080123456788
RAT_Type = 1004
2) Perform Screening & Validation Processing
3) Discard ULR Msg.
4) Notify / Alert Message - Screening Event Info
5) Update Location Answer (ULA) -Error Code

FIG. 4

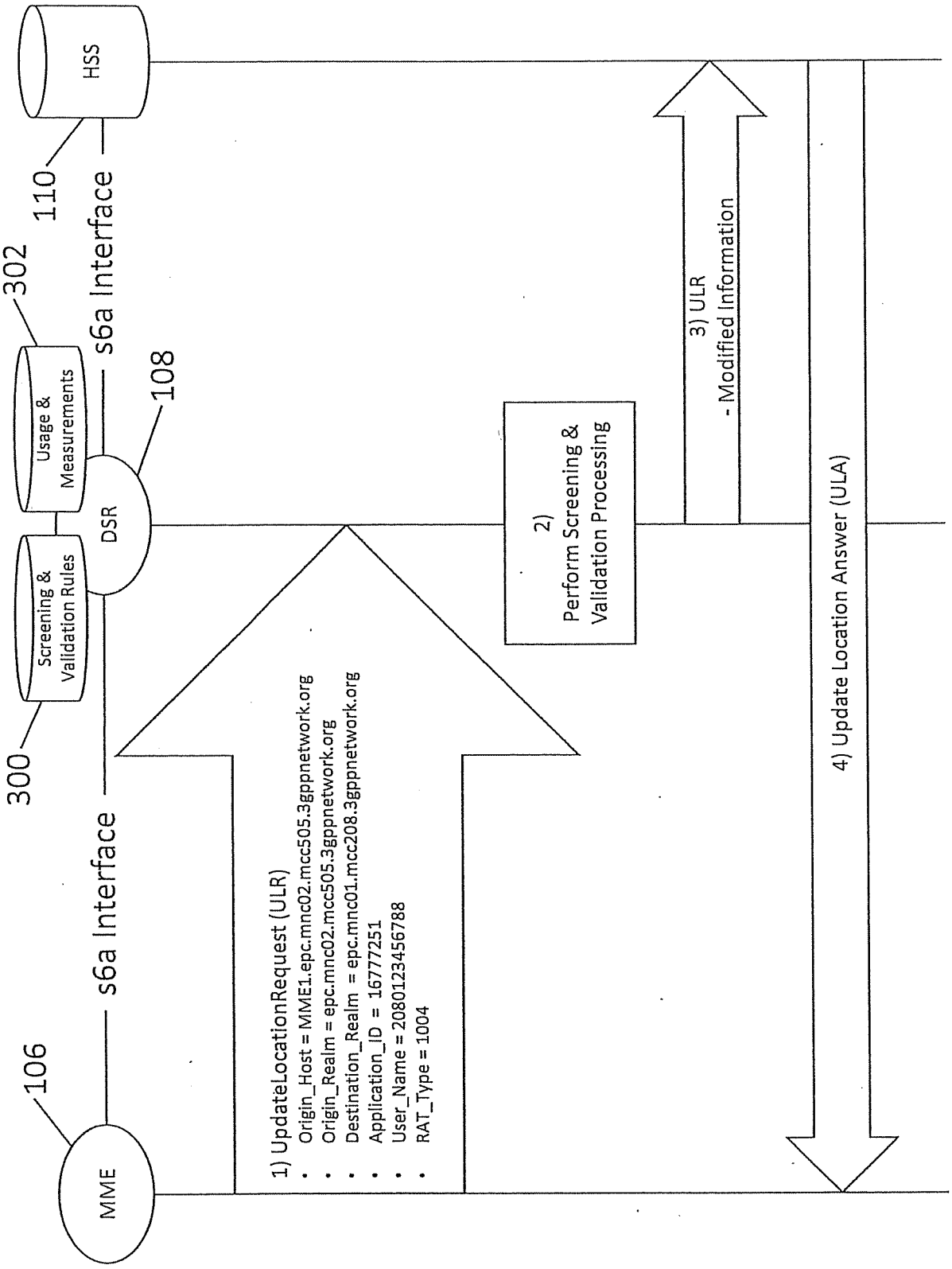
HSS
110
s6a Interface
302
Usage & Measurements
108
DSR
Screening & Validation Rules
300
s6a Interface
106
MME
1) UpdateLocationRequest (ULR)
Origin_Host = MME1.epc.mnc02.mcc505.3gppnetwork.org
Origin_Realm = epc.mnc02.mcc505.3gppnetwork.org
Destination_Realm = epc.mnc01.mcc208.3gppnetwork.org
Application_ID = 16777251
User_Name = 208012345678
RAT_Type = 1004
2)
Perform Screening & Validation Processing
3) ULR
- Modified Information
4) Update Location Answer (ULA)

FIG. 5

Application-Level Whitelist Rules

Origin Host	Origin Realm	Destination Host	Destination Realm	Whitelisted Application ID	Screening Action
MME_Visited	Visited.net	*	Home.net	16777251	Update Usage & Measurements Log
MME_Visited	Visited.net	*	Home.net	16777267	none

600

Application-Level Blacklist Rules

Origin Host	Origin Realm	Destination Host	Destination Realm	Blacklisted Application ID	Screening Action
MME_Visited	Visited.net	*	Home.net	16777251	Discard Message
MME_Visited	Visited.net	*	Home.net	16777267	Route And Notify Network Operator

602

FIG. 6

Message-Level Whitelist Rules

Origin Host	Origin Realm	Destination Host	Destination Realm	Application ID	Whitelisted Message Code(s) (e.g., Command Code)	Screening Action
MME_Visited	Visited.net	*	Home.net	16777251	*	Update Usage & Measurements Log
MME_Visited	Visited.net	*	Home.net	16777251	316, 318, 321	none

700

Message-Level Blacklist Rules

Origin Host	Origin Realm	Destination Host	Destination Realm	Application ID	Blacklisted Message Code(s) (e.g., Command Code)	Screening Action
MME_Visited	Visited.net	*	Home.net	16777251	317	Discard Message
MME_Visited	Visited.net	*	Home.net	16777251	322	Route And Notify Network Operator
MME_Visited	Visited.net	*	Home.net	16777267	*	Reply With Error Message

702

FIG. 7

Message_AVP-Level Whitelist Rules

Origin Host	Origin Realm	Destination Host	Destination Realm	Application ID	Whitelisted Message Code(s) (e.g., Command Code)	Whitelisted AVP Code(s)	Screening Action
MME1	Visited.net	*	Home.net	16777251	316	266	Update Usage & Measurements Log

800

Message_AVP-Level Blacklist Rules

Origin Host	Origin Realm	Destination Host	Destination Realm	Application ID	Blacklisted Message Code(s) (e.g., Command Code)	Blacklisted AVP Code(s)	Screening Action
MME1	Visited.net	*	Home.net	16777251	316	1401	Modify Message – Remove AVP

802

FIG. 8

Message_AVP_Value-Level Information Element Whitelist Rules

Origin Host	Origin Realm	Destination Host	Destination Realm	Application ID	Message Code (e.g., Command Code)	AVP Code	Permitted Value(s)	Screening Action
vMME	Visited.net	*	Home.net	16777251	316	1407	20801	Update Usage & Measurements Log
vMME	Visited.net	*	Home.net	16777251	316	1032	E-UTRAN	Notify Network Operator

900

Message_AVP_Value-Level Information Element Blacklist Rules

Origin Host	Origin Realm	Destination Host	Destination Realm	Application ID	Message Code (e.g., Command Code)	AVP Code	Prohibited Value(s)	Screening Action
vMME	Visited.net	*	Home.net	16777251	316	1407	20801	Modify Message – Remove AVP value
vMME	Visited.net	*	Home.net	16777251	316	1032	E-UTRAN	Route and Notify Network Operator

902

FIG. 9

Message-Level MaxRate Rules

Origin Host	Origin Realm	Destination Host	Destination Realm	Application ID	Message Code(s) (e.g., Command Code)	Maximum Receipt Rate (e.g., msg/sec)	Screening Action
MME_Visited	Visited.net	*	Home.net	16777251	322	100	Route And Notify Network Operator
MME_Visited	Visited.net	*	Home.net	16777267	*	500	Route And Notify Network Operator

1000

FIG. 10

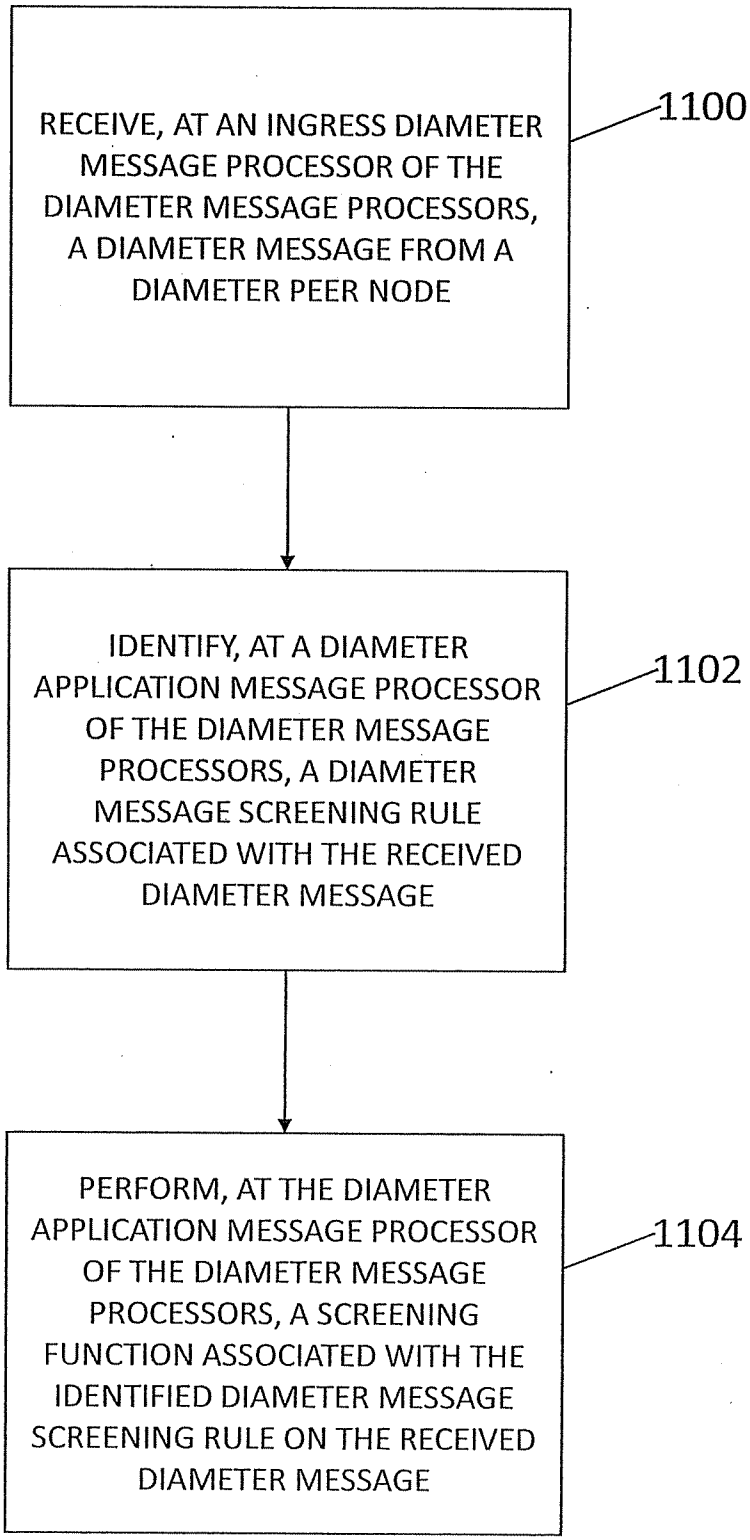
RECEIVE, AT AN INGRESS DIAMETER MESSAGE PROCESSOR OF THE DIAMETER MESSAGE PROCESSORS, A DIAMETER MESSAGE FROM A DIAMETER PEER NODE
1100
IDENTIFY, AT A DIAMETER APPLICATION MESSAGE PROCESSOR OF THE DIAMETER MESSAGE PROCESSORS, A DIAMETER MESSAGE SCREENING RULE ASSOCIATED WITH THE RECEIVED DIAMETER MESSAGE
1102
PERFORM, AT THE DIAMETER APPLICATION MESSAGE PROCESSOR OF THE DIAMETER MESSAGE PROCESSORS, A SCREENING FUNCTION ASSOCIATED WITH THE IDENTIFIED DIAMETER MESSAGE SCREENING RULE ON THE RECEIVED DIAMETER MESSAGE
1104

FIG. 11