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(54) **Title**: METHODS, SYSTEMS, AND COMPUTER READABLE MEDIA FOR ENRICHING A DIAMETER SIGNALING MESSAGE

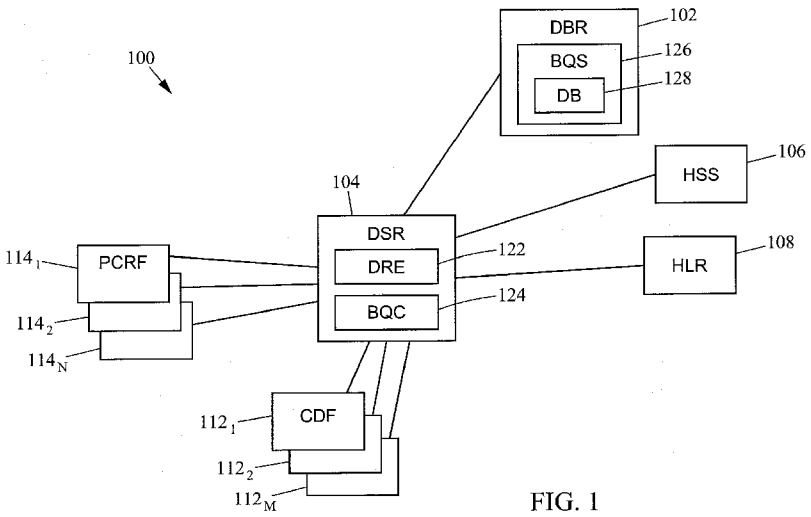

FIG. 1

(57) **Abstract**: Methods, systems, and computer readable media for enriching a Diameter signaling message are disclosed. In one example, the method comprises receiving, at a Diameter routing node, a Diameter signaling message that is associated with a mobile subscriber and includes mobile subscriber related information and querying a Diameter binding repository (DBR) using the mobile subscriber related information to select a network service node from a plurality of network service nodes configured to process the Diameter signaling message. The method further includes obtaining DBR information associated with the mobile subscriber from the DBR, wherein the DBR information includes an identifier associated with the selected network service node and modifying the Diameter signaling message to include at least a portion of the DBR information.

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DESCRIPTION

METHODS, SYSTEMS, AND COMPUTER READABLE MEDIA FOR ENRICHING A DIAMETER SIGNALING MESSAGE

PRIORITY CLAIM

This application claims the benefit of U.S. Provisional Patent Application Serial No. 61/448,953 filed March 3, 2011; the disclosure of which is incorporated herein by reference in its entirety.

TECHNICAL FIELD

The subject matter described herein relates to modifying Diameter signal messages with information associated mobile subscribers. More specifically, the subject matter relates to methods, systems, and computer readable media for enriching a Diameter signaling message.

BACKGROUND

At present, problems exist with the assignment of Diameter-based network service nodes to Diameter signaling messages associated with a common mobile subscriber. Namely, there are hindrances associated with the communication between the Diameter-based network service nodes. For instance, a network service node may require additional information (e.g., a network address) of another network service node that is servicing a Diameter based message associated with the common mobile subscriber. In such a scenario, the network service node is compelled to create and transmit query messages to database nodes that store the additional network service node information. These query messages generate unnecessary traffic and consume network resources. Thus, the pre-emptive provisioning of additional network service node information in a manner that does not generate unnecessary network traffic is desirable by network operators.

Accordingly, a need exists for improved methods, systems, and computer readable media for enriching a Diameter signaling message.

SUMMARY

Methods, systems, and computer readable media for enriching a Diameter signaling message are disclosed. In one exemplary embodiment, the method comprises receiving, at a Diameter routing node, a Diameter signaling message that is associated with a mobile subscriber and includes mobile subscriber related information and querying a Diameter binding repository (DBR) using the mobile subscriber related information to select a network service node from a plurality of network service nodes configured to process the Diameter signaling message. The method further includes obtaining DBR information associated with the mobile subscriber from the DBR, wherein the DBR information includes an identifier associated with the selected network service node and modifying the Diameter signaling message to include at least a portion of the DBR information. As used herein, the term "node" refers to a physical computing platform including one or more hardware processors and associated memory.

The subject matter described herein may 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 a processor. In one exemplary implementation, the subject matter described herein for enriching a Diameter signaling message may be implemented using a non-transitory computer readable medium to having stored thereon executable instructions that when executed by the processor of a computer control the processor to perform steps. Exemplary non-transitory computer readable media suitable for implementing the subject matter described herein include chip memory devices or disk memory devices accessible by a processor, 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 computing platform or may be distributed across plural 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 block diagram illustrating a system for enriching a Diameter signaling message according to an embodiment of the subject matter described herein;

Figure 2 is a message sequence diagram illustrating the enriching of a Diameter signaling message according to an embodiment of the subject matter described herein;

Figure 3 is a message sequence diagram illustrating the enriching of a Diameter signaling message with additional mobile subscriber related session information according to an embodiment of the subject matter described herein;

Figure 4 is a message sequence diagram illustrating the enriching of a plurality of Diameter signaling messages according to an embodiment of the subject matter described herein;

Figure 5 is an exemplary table depicting binding record data used to designate a network service node according to an embodiment of the subject matter described herein; and

Figure 6 is a flow chart illustrating a method for enriching a Diameter signaling message according to an embodiment of the subject matter described herein.

DETAILED DESCRIPTION

The subject matter described herein includes methods, systems, and computer readable media for enriching a Diameter signaling message. As used herein, the term Diameter refers to the authentication, authorization, and accounting (AAA) protocol utilized by telecommunications and computer networks as defined by RFC 3588. In one embodiment, the present subject matter includes a Diameter signaling routing (DSR) node that receives a Diameter signaling message associated with a particular mobile subscriber. The received Diameter signaling message may also require processing from a particular type of network service node, such as a network charging function node (e.g., a charging data function (CDF), a policy and charging rules function (PCRF), etc.). Upon receiving the Diameter signaling message, the DSR node may be configured to query a Diameter binding

repository (DBR) to determine a preferred network service node to process the received Diameter signaling message. In one embodiment, the query message triggers the DBR to check stored binding records to determine whether a preferred network service node is already assigned (or "bound") to the mobile subscriber. As used herein, a binding record may include an electronic record that includes one or more associations formed between assigned network service nodes and mobile subscriber information (e.g., identifiers). Accordingly, the DBR may obtain and provide DBR information stored in the binding records to the DSR. The DSR may subsequently modify Diameter signaling messages directed toward the preferred network service node to include at least a portion of the received DBR information. Therefore, preferred network service nodes may be provided with an enriched Diameter signaling message that contains additional mobile subscriber information, additional session identifiers associated with a mobile subscriber, and identification/identity/address information associated with other network service nodes supporting the mobile subscriber. In one embodiment, the present subject matter may be implemented in a Long Term Evolution (LTE) network and/or Internet protocol Multimedia Subsystem (IMS) network. Alternatively, the present subject matter may be deployed in other network implementations without departing from the scope of the present subject matter.

Figure 1 depicts an exemplary system **100** that includes a number of various network elements that may be utilized to enrich a Diameter signaling message. In one embodiment, system **100** includes a Diameter routing node, e.g., a DSR **104**, configured to receive a Diameter signaling message that is associated with a mobile subscriber. Although Figure 1 illustrates the use of a DSR, any network node that is configured to route Diameter signaling messages may be utilized without departing from the scope of the subject matter. For example, the network node may also include a Diameter routing agent (DRA), a Diameter proxy agent (DPA), a Diameter relay agent, a Diameter translation agent, a Diameter redirect agent, and the like. In one embodiment, DSR **104** includes a Diameter routing engine (DRE) **122** that may be configured to route Diameter signaling messages between various

Diameter nodes on various Diameter interfaces including, but not limited to, the Gy, Ro, Rf, and S6a interfaces. Exemplary Diameter-based signaling messages received by DSR **104** include credit control request (CCR) messages, accounting request (ACR) messages, update location request (ULR) messages, Diameter mobility management messages, and Diameter charging messages. In one embodiment, Diameter signaling messages received by the Diameter routing node may be sent by a network node (not shown) such as, for example, a policy and charging enforcement function (PCEF) node, a gateway GPRS support node (GGSN), a mobility management entity (MME), and a public data network (PDN) gateway. DSR **104** may also include a binding query client (BQC) **124** that is configured to communicate (e.g., send query/request messages and receive answer/response messages) with one or more DBRs (e.g., DBR **102**).

In one embodiment, the Diameter signaling message received by DSR **104** may originally be destined or addressed to a network service node that is capable of processing the Diameter signaling message. Although Figure 1 depicts an exemplary plurality of network service nodes to which the Diameter signaling message may be routed, such as CDFs $\mathbf{112}_{1...m}$ and PCRFs $\mathbf{114}_{1...n}$, any other type of network service node(s) configured for servicing a Diameter signaling message may be utilized in system **100** without departing from the scope of the present subject matter. For example, the network service node may include a policy and charging rules function (PCRF) node, a network charging node (e.g., a charging data function (CDF), a charging trigger function (CTF), a charging gateway function (CGF)), an online charging system (OCS) node, an offline charging system (OFCS) node, a home subscriber server (HSS) node, a home location register node (HLR), an AAA node, and a call session control function (CSCF) node.

In Figure 1, system **100** further includes a Diameter binding repository (DBR) **102** that comprises a binding query server (BQS) **126** that hosts a binding record database **128**. In one embodiment, binding record database **128** may be configured to store binding records that comprise associations (e.g., Diameter-related bindings, mappings, links, etc.) between mobile

subscriber identifiers and assigned network service nodes. Exemplary Diameter-related bindings stored by DBR **102** may include, but are not limited to, Diameter session bindings, Diameter session-identifier-to-network service node associations, Diameter end-to-end identifier-to-network service node associations, mobile subscriber identifier-to-network service node associations, charging identifier-to-network service node associations, and the like. In one embodiment, a charging identifier may include an IMS charging ID. An exemplary binding record database **128** is described in Figure 5 below.

In the embodiments illustrated herein, DBR **102** is shown as being a stand-alone entity, such as a network node, a computer, a server, an application, or a database that is located separate from a DSR **104**. However, DBR **102** may be co-located within a DSR or co-located within any other network node in other embodiments (not shown). Although only a single DSR and a single DBR are shown in Figure 1, the present subject matter may include additional DSRs and DBRs that are communicatively connected to DSR **104** and DBR **102** without departing from the scope of the present subject matter.

Figure 2 illustrates an exemplary Diameter based message sequence diagram that depicts the enriching of a Diameter signaling message according to an embodiment of the subject matter described herein. As shown in Figure 2, DSR **104** receives a Diameter signaling message, i.e., credit control request (CCR) message **201**, which includes mobile subscriber related information. In this example, the mobile subscriber related information includes a user name (e.g., "User Name X") and a session identifier (e.g., "Session ID_1"). In one embodiment, the session identifier serves as an identifier for a communications session to be established between the network node sending the CCR message (e.g., a PCEF) and the network service node that is ultimately selected to process the CCR message.

In one embodiment, DSR **104** may be configured to extract the mobile subscriber related information from the received Diameter signaling message. Examples of mobile subscriber related information extracted from

a Diameter signaling message include, but not limited to, Diameter session identifier information, user-name information, international mobile subscriber identity (IMSI) information, IMS private identity (IMPI) information, IMS public identity (IMPU) information, session initiation protocol (SIP) uniform resource identifier (URI) information, network access identifier (NAI) information, mobile/dialable number information, mobile subscriber directory number information, IMS charging identifier information, mobile station international subscriber directory number (MSISDN) information, and user Internet protocol (IP) address information. Returning to Figure 2, CCR message **201** includes a user name and a session identifier that is extracted by DSR **104**.

In one embodiment, DSR **104** may also be configured to insert the extracted mobile subscriber related information into a DBR query message. For example, DSR **104** may generate a DBR query message **202** that is used to request the identity and/or address of a network service node capable of processing CCR message **201**. In one embodiment, DSR **104** is configured to insert the user name and session identifier information extracted from message **201** into query message **202**.

As depicted in Figure 2, DBR **102** may receive, from DSR **104**, DBR query message **202** which contains the extracted mobile subscriber related information, e.g., the session identifier and user name identifier associated with the mobile subscriber. In one embodiment, DBR **102** may be configured to cross-reference the received user name identifier with a listing of mobile subscriber identifiers stored in binding records contained in record database **128**, which contains a plurality of binding records. If the cross-referencing process results in locating an entry that matches the extracted user name identifier, DBR **102** may obtain the DBR information contained in the binding record that is associated with the matching entry. In one embodiment, a binding record contains a user IP address, an IMPI, an IMPU, a user name identifier, and an associated network service node identifier/identity/address. If the extracted user name identifier matches the user name identifier in this particular binding record, then DBR **102** may obtain the network service node identifier (e.g., an identifier identifying CDF identifier $\mathbf{112}_1$) that is bound to the user name identifier. DBR **102** may also

obtain the plurality of other identifiers stored in the same binding record and that are associated with the mobile subscriber (i.e., the matching user name). For example, DBR **102** may obtain the user IP address, IMPI, and IMPU from the binding record.

After obtaining the DBR information from record database **128**, DBR **102** may then generate a DBR response message **203** that includes the DBR information and subsequently routes response message **203** to DSR **104**. As indicated in Figure 2, the DBR information may include parameters/identifiers such as a network service node identity/address (e.g., identifier for CDF $\mathbf{112_1}$), a user-name identifier, a user IP address, an IMPI, and an IMPU associated with the mobile subscriber.

Figure 2 further depicts DSR **104** receiving DBR response message **203** which contains the DBR information from DBR **102**. DSR **104** may then use the received DBR information along with the network service node identifier information (e.g., CDF $\mathbf{112_1}$) to modify/enrich the originally received Diameter based CCR message **201**. Specifically, DSR **104** inserts at least a portion (e.g., some or all) of the DBR information into the original CCR message **201** such that a modified CCR message **204** is generated. As indicated in Figure 1, CCR message **201** is modified such that a user IP address, an IMPI, and an IMPU are added to the original session identifier and user name contained in message **201**, which results in a modified CCR message **204**. DSR **104** may also be configured to use the obtained network service node identifier (i.e., CDF identifier contained in message **203**) to address and route message **204** to CDF $\mathbf{112_1}$. In an alternate embodiment, DSR **104** may be configured to generate a completely new CCR message, which includes some or all of the DBR information, instead of modifying the originally received CCR message **201**.

Figure 3 illustrates an exemplary Diameter based message sequence diagram that depicts the enriching of a Diameter signaling message with additional mobile subscriber related session information according to an embodiment of the subject matter described herein. As shown in Figure 3, DSR **104** receives a Diameter signaling message, i.e., credit control request (CCR) message **301**, which includes mobile subscriber related information.

In this example, the mobile subscriber related information includes a user name (e.g., "User Name X") and a session identifier (e.g., "Session ID_1"). In one embodiment, the session identifier serves as an identifier for a communications session to be established between the node sending the CCR message and the network service node that is ultimately selected to service the CCR message. In one embodiment, DSR **104** may be configured to extract the mobile subscriber related information from the received CCR message **301**, such as the user name identifier/identity and a session identifier.

In one embodiment, DSR **104** may also be configured to insert the extracted mobile subscriber related information into a DBR query message. For example, DSR **104** may generate a DBR query message **302** that is used to request the identity, identifier, and/or address of a network service node capable of processing CCR message **301**. In one embodiment, DSR **104** is configured to insert the user name and session identifier information extracted from message **301** into query message **302**.

As depicted in Figure 3, DBR **102** may receive, from DSR **104**, DBR query message **302** which contains the extracted mobile subscriber related information, e.g., the session identifier and user name identifier associated with the mobile subscriber. In one embodiment, DBR **102** may be configured to cross-reference the received user name identifier with a listing of mobile subscriber identifiers stored in binding records contained in record database **128** (depicted in Figure 1). If the cross-referencing process results in locating an entry that matches the extracted user name identifier, DBR **102** may obtain the DBR information contained in the associated binding record that corresponds with the matching entry. For example, DBR **102** may obtain the network service node identifier (e.g., CDF identifier $\mathbf{112}_1$), identity, or address that is bound to the matching user name identifier in the binding record. DBR **102** may also obtain a plurality of the other identifiers/parameters stored in the same binding record and that are associated with the mobile subscriber. For example, the binding record may indicate that a user IP address, an IMPI, and an IMPU are associated with the user name identifier.

In addition, DBR **102** may also obtain a second session identifier that identifies an established communications session between a second network service node (e.g., "PCRF_1") and another Diameter network node seeking to obtain information regarding the mobile subscriber. For example, DBR **102** may obtain the session identifier "Session ID_2" and the network service node identifier "serving PCRF_1" from the same aforementioned binding record in database **128**. In this example, "PCRF_1" has been previously designated to provide service or process information for a querying Diameter node that requested information regarding the mobile subscriber associated with "User Name X".

After obtaining the DBR information from database **128**, DBR **102** may then generate a DBR response message **303** that includes the DBR information and subsequently route response message **303** to DSR **104**. As indicated in Figure 3, the DSR information may include parameters/identifiers such as a first network service node identity/address (e.g., identifier for CDF **112**$_1$), a user-name identifier, a user IP address, an IMPI, and an IMPU associated with the mobile subscriber. Notably, message **303** may also include the second session identifier and the second network service node identifier/identity.

Figure 3 further depicts DSR **104** receiving DBR response message **303** which contains the DBR information from DBR **102**. DSR **104** may then use the received DBR information along with the network service node identifier information (e.g., an identifier associated with CDF **112**$_1$) to modify the originally received Diameter based CCR message **301**. Specifically, DSR **104** may insert at least a portion (e.g., some or all) of the DBR information into the original CCR message **301** such that a modified CCR message **304** is generated. As indicated in Figure 1, CCR message **301** is modified such that a user IP address, an IMPI, and an IMPU is added to the original session identifier and user name contained in message **301**, which results in a modified CCR message **304**. DSR **104** may also be configured to use the obtained network service node identifier (i.e., CDF identifier contained in message **303**) to address and route message **204** to CDF **112**$_1$. The DBR information may also include the second session identifier (e.g.,

"Session ID_2") and second network service node identifier/identity (e.g., "PCRF_1"). By providing the second network service node and session information to the first network service node, i.e. CDF **112$_1$**, the present subject matter is pre-emptively providing known network service node information to CDF **112$_1$** so that CDF **112$_1$** does not need to query a third party node or database if CDF **112$_1$** needs to communicate with or otherwise know the identity of other network service nodes processing other Diameter signalling messages associated with the mobile subscriber. In an alternate embodiment, DSR **104** may generate a completely new CCR message, which includes some or all of the DBR information, instead of modifying the originally received CCR message **301**.

Figure 4 illustrates an exemplary Diameter based message sequence diagram that depicts the enriching of a plurality of Diameter signaling messages according to an embodiment of the subject matter described herein. As shown in Figure 4, DSR **104** receives a Diameter signaling message, i.e., credit control request (CCR) message **401**, which includes mobile subscriber related information. In this example, the mobile subscriber related information includes a user name (e.g., "user name X") and a session identifier (e.g., "Session ID_1"). In one embodiment, the session identifier serves as an identifier for a communications session to be established between the node sending the CCR message and the network service node that is ultimately selected/designated to process the CCR message.

After receiving CCR message **401**, DSR **104** may be configured to generate a DBR request message **402**. In one embodiment, DSR **104** extracts one or more mobile subscriber identifiers from the received message **401** and inserts one or more of the extracted mobile subscriber identifiers into the generated DBR request message. In this example, DSR **104** extracts the user name identifier from CCR message **401** and subsequently generates a DBR request message **402**. DSR **104** may then insert the user name identifier into the generated DBR request message **402** prior to sending the request message to DBR **102**. Although DBR **102** is shown in Figure 4 to be co-located with DSR **104**, DBR **102** may be hosted

by a separate standalone network element without departing from the scope of the present subject matter.

Upon receiving DBR request message **402**, DBR **102** uses the user name identifier contained in message **402** to access and cross-referencing one or more binding records (e.g., Diameter-based binding records). For example, after cross-referencing the user name identifier (e.g., "User Name X") with the binding records stored in record database **128** (shown in Figure 1), DBR **102** determines that the preferred network service node to process the CCR message associated with the mobile subscriber is CDF **112**$_1$. DBR **102** then generates a DBR response message **403** that includes an identifier or address of CDF **112**$_1$. Afterwards, DBR **102** sends the message **403** to DSR **104**.

After DBR response message **403** is received by DSR **104**, DSR **104** may then forward the original CCR message to the network service node designated in response message **403**. As shown in Figure 4, modified CCR message **404** (which is a modified CCR message **401**) is sent to CDF **112**$_1$ for processing.

Figure 4 also illustrates the DSR **104** subsequently receiving a Diameter message A **405** that includes a second unique session identifier (e.g., "Session ID_2"), a user name (e.g., "User Name X"), and an IMS public identity associated with the original mobile subscriber. In response to receiving Diameter message **405**, DSR **104** then accesses a local database (or a co-located DBR **102** as shown in Figure 4) to determine a preferred network service node to process Diameter message A **405**. In one embodiment, Diameter message A **405** may include another CCR message, an ACR message, an ULR message, a Diameter mobility management message, or a Diameter charging message. Although not shown in Figure 4, DSR **104** may be configured to utilize a DBR request message (similar to message **402** described above) to query DBR **102** to determine a preferred network service node to process Diameter message A **405**. In addition determining that PCRF **114**$_1$ is the preferred network service node to process Diameter message A **405** (e.g., by cross-referencing the user name with entries contained in the binding records), DBR **102** may also provide the

previously determined network service node identification information and associated session identifier information. For example, DBR **102** may provide DSR **104** with the first session identifier (i.e., "Session ID_1") and the first network service node identifier (i.e., "CDF_1" identifying CDF **112_1**) because the same user name identifier "User Name X" was used to designate CDF **112_1** as a preferred network service node for previously received CCR message **401**.

After acquiring the DBR information, DSR **104** modifies the original Diameter message **405** to include the first session identifier and the first network service node identifier/identity. Namely, DSR **104** may modify the original Diameter message **405** to create a modified Diameter message A' **406** that includes the "Session ID_1" session identifier and the "serving CDF_1" identifier (which identifies CDF **112_1**). DSR **104** may then route modified Diameter message A' **406** to PCRF **114_1** (as identified by a network service node identifier obtained from DBR **102**).

In a similar manner, Figure 4 illustrates the receiving of another Diameter message B **407** that includes a second unique session identifier (e.g., "Session ID_3"), a user name (e.g., "User Name X"), and an IMS private identity associated with the original mobile subscriber at DSR **104**. In response to receiving Diameter message **407**, DSR **104** then accesses a local database (or a co-located DBR **102** as shown in Figure 4) to determine a preferred network service node to process Diameter message B **407**. In one embodiment, Diameter message B **407** may include another CCR message, an ACR message, an ULR message, a Diameter mobility management message, or a Diameter charging message. Although not shown in Figure 4, DSR **104** may be configured to utilize a DBR request message (similar to message **402** described above) to query DBR **102** to determine a preferred network service node to process Diameter message B **407**. In addition to be used to determine that CSCF **412** is the preferred network service node to process Diameter message B **407**, DBR **102** may also provide previously determined DBR information, such as network service node identification information, associated session identifier information, and mobile subscriber identifier information. For example, DBR

102 may provide DSR **104** with the first session identifier (i.e., "Session ID_1"), the first network service node identifier (i.e., "CDF_1" identifying CDF **112_1**), the second session identifier (i.e., "Session ID_2"), the second network service node identifier (i.e., "PCRF_1" identifying PCRF **114_1**), and/or the IMPU originally received in message **405** because the same user name identifier "User Name X" was used to designate CDF **112_1** and PCRF **114_1** as preferred network service nodes for previously received CCR message **401** and Diameter message A **405**, respectively.

After acquiring the DBR information, DSR **104** may be configured to modify the original Diameter message **407** to include the first session identifier, the first network service node identifier/identity, and the IMPU identifier information associated with the mobile subscriber. Specifically, DSR **104** may modify original Diameter message **407** to create a modified Diameter message B' **408** that includes the "Session ID_1" session identifier, the "serving CDF_1" identifier (which identifies CDF **112_1**), and the IMPU. Although not shown in Figure 4, DSR **104** could have also included the second session identifier (i.e., "Session ID_2") and the second network service node identifier (i.e., "PCRF_1" identifying PCRF **114_1**) in modified Diameter message B' **408**. DSR **104** may then route modified Diameter message B' **408** to CSCF **412** (as identified by a network service node identifier obtained from DBR **102**). DSR **104** may also be configured to modify a received Diameter signaling message determined to be directed to a CDF to include information identifying a serving PCRF of the subscriber. In general, modifying a received Diameter signaling message based on results of a DBR lookup to communicate Diameter binding information regarding a first Diameter node of a first type to a second Diameter node of a second type different from the first type is intended to be within the scope of the subject matter described herein.

Figure 5 illustrates an exemplary table **500** depicting Binding record data used for identifying a network service node according to an embodiment of the subject matter described herein. In one embodiment, table **500** may represent at least a portion of database **128** maintained at DBR **102**. Table **300** may include a plurality of mobile subscriber related

identifiers **502**-**518** as column headers. For example, table **500** may include at least one column for each of: a Diameter session identifier **502**, a user name **504**, an IMPI identifier **508**, an IMPU identifier **510**, a SIP URI **512**, an NAI **514**, a mobile/dialable number **516**, and a user IP address **518**. Table **500** may also include a network service node column, such as a network service node identifier/address column **520**. Although ten columns are depicted in Figure 5, table **500** may include any number of columns associated with any type of identifier.

In some embodiments, binding record data may be used in determining, identifying, and/or selecting a network service node, e.g., to process a particular Diameter transaction or related Diameter messages. For example, binding record data may be used to route transactions associated with a particular user as identified by an IMSI value to a particular HSS as identified by an HSS identifier.

Figure 6 is a flow chart illustrating a process **600** for enriching a Diameter signaling message according to an embodiment of the subject matter described herein. In block **602**, a Diameter signaling message associated with a mobile subscriber is received. In one embodiment, DSR **104** receives a Diameter based request message, such as a CCR message, from a sending network node.

In block **604**, mobile subscriber related information is extracted from the Diameter signaling message. In one embodiment, DSR **104** is configured to extract mobile subscriber related information from the received CCR message. For example, extracted mobile subscriber related information may include a user name associated with a particular mobile subscriber and a session identifier.

In block **606**, a DBR node is queried. In one embodiment, DSR **104** may generate a query or request message (e.g., a DBR request message) that includes the extracted mobile subscriber related information. For example, DSR **104** may extract a user name and session identifier associated with a mobile subscriber from the received CCR message. DSR **104** may then be configured to generate a request or query message that includes the extracted user name and session identifier. DSR **104** may also

be configured to send the request message including the user name and session identifier to DBR **102**.

In block **608**, a binding record in DBR **102** is accessed to locate DBR information. In one embodiment, DBR **102** may compare or cross reference the user name identifier in the received DBR query message to with the elements (e.g., identifiers/parameters) contained in the binding records stored in record database **128**. Upon finding a matching element/entry in a binding record, DBR **102** generates a DBR answer message. DBR **102** may also be configured to insert additional DBR information that corresponds to the matching element in the binding record. For example, the DBR information may include a network service node associated with the mobile subscriber in addition to other mobile subscriber identifiers, network service node identifiers, and session identifiers. Also, if there are any mobile subscriber related identifiers that do not match the elements contained in the existing binding record, those unmatched mobile subscriber related identifiers may be added (i.e., provisioned to the existing binding record).

In block **610**, the DBR information is received at the DSR. In one embodiment, DSR **104** receives a DBR response message containing the DBR information.

In block **612**, the DSR modifies/enriches the Diameter signaling message with the DBR information. In one embodiment, DSR **104** modifies the originally received Diameter signaling message (i.e., the message received in block **602**) by inserting at least a portion of the received DBR information.

In block **614**, the modified Diameter signaling message is routed towards the selected/designated network service node. In one embodiment, DSR **104** routes the modified Diameter signaling message (e.g., CCR message) to the network service node associated with the network service node identifier provided by DBR **102**. For example, DSR **104** may forward the modified CCR message to CDF **112_1**.

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.

CLAIMS

What is claimed is:

1. A method for enriching a Diameter signaling message, the method comprising:

receiving, at a Diameter routing node, a Diameter signaling message that is associated with a mobile subscriber and includes mobile subscriber related information;

querying a Diameter binding repository (DBR) using the mobile subscriber related information to select a network service node from a plurality of network service nodes configured to process the Diameter signaling message;

obtaining DBR information associated with the mobile subscriber from the DBR, wherein the DBR information includes an identifier associated with the selected network service node; and

modifying the Diameter signaling message to include at least a portion of the DBR information.

2. The method of claim 1 comprising routing the modified Diameter signaling message to the selected network service node using the identifier associated with the selected network service node.

3. The method of claim 1 wherein the DBR is co-located with the Diameter routing node.

4. The method of claim 1 wherein the DBR is implemented on a network node separate from the Diameter routing node.

5. The method of claim 1 wherein the Diameter routing node includes a Diameter signaling router (DSR), a Diameter routing agent (DRA), a Diameter proxy agent (DPA), a Diameter redirect agent, a Diameter translation agent, or a Diameter relay agent.

6. The method of claim 1 wherein the DBR information associated with the mobile subscriber includes at least one of: Diameter session-identifier information, network service node identification information, user-name information, a user Internet protocol (IP) information, IP multimedia subsystem (IMS) private identity (IMPI) information, IMS public identity (IMPU) information, session initiation protocol (SIP)

uniform resource identifier (URI) information, IMS charging identifier information, mobile station international subscriber directory number (MSISDN) information, mobile/dialable number information, a session identifier, an international mobile subscriber identity (IMSI), a mobile subscriber directory number (DN), a globally unique temporary identifier (GUTI), a serving mobile switching center (MSC) address information, visitor location register (VLR) number information, serving General Packet Radio Service (GPRS) support node (SGSN) address information, SGSN number information, visited mobile country code (MCC) information, mobile network code (MNC) information, a user-name attribute value pair (AVP), a network access identifier (NAI), serving location area code information, serving cell identification information, mobile subscriber geo-location coordinate information, and tracking area information.

7. The method of claim 1 wherein each of the plurality of network service nodes includes: a network charging node, an online charging system (OCS) node, an offline charging system (OFCS) node, a charging trigger function (CTF) node, a charging gateway function (CGF) node, a charging data function (CDF) node, a policy and charging rules function (PCRF) node, a home subscriber server (HSS) node, or a home location register node (HLR).

8. The method of claim 1 wherein the network service node is selected by accessing at least one binding record stored in the DBR.

9. The method of claim 8 wherein the at least one binding record includes at least one of: a Diameter session binding, a Diameter session identifier-to-network service node association, a Diameter end to end identifier-to-network service node association, a subscriber identifier-to-network service node association, and a charging identifier-to-network service node association.

10. The method of claim 1 wherein receiving the Diameter signaling message includes receiving a credit control request (CCR) message, an accounting request (ACR) message, an update location request

(ULR) message, a Diameter mobility management message, or a Diameter charging message.

11. The method of claim 1 wherein the selected service node is of a first Diameter service type, wherein the DBR information identifies an additional Diameter node of a second Diameter service type different from the first Diameter service type, and wherein modifying the Diameter signaling message includes modifying the message to include identifying information for the additional service node.

12. The method of claim 11 comprising forwarding the Diameter signaling message to the selected service node.

13. The method of claim 12 wherein the selected service node comprises a policy and charging rules function (PCRF) and wherein the additional service node comprises a charging data function (CDF).

14. The method of claim 12 wherein the selected service node comprises a charging data function (CDF) and wherein the additional service node comprises a policy and charging rules function (PCRF).

15. A system for enriching a Diameter signaling message, the system comprising:

a Diameter binding repository (DBR) configured to store binding records; and

a Diameter routing node configured to receive a Diameter signaling message that is associated with a mobile subscriber and includes mobile subscriber related information, to query the DBR using the mobile subscriber related information to select a network service node from a plurality of network service nodes configured to process the Diameter signaling message, to obtain DBR information associated with the mobile subscriber from the DBR, wherein the DBR information includes an identifier associated with the selected network service node, and to modify the Diameter signaling message to include at least a portion of the DBR information.

16. The system of claim 15 wherein the Diameter routing node is configured to route the modified Diameter signaling message to the

selected network service node using the identifier associated with the selected network service node.

17. The system of claim 15 wherein the DBR is co-located with the Diameter routing node.

18. The system of claim 15 wherein the DBR is implemented on a network node separate from the Diameter routing node.

19. The system of claim 15 wherein the Diameter routing node includes a Diameter signaling router (DSR), a Diameter routing agent (DRA), a Diameter proxy agent (DPA), a Diameter redirect agent, a Diameter translation agent, or a Diameter relay agent.

20. The system of claim 15 wherein the DBR information associated with the mobile subscriber includes at least one of: Diameter session-identifier information, network service node identification information, user-name information, a user Internet protocol (IP) information, IP multimedia subsystem (IMS) private identity (IMPI) information, IMS public identity (IMPU) information, session initiation protocol (SIP) uniform resource identifier (URI) information, IMS charging identifier information, mobile station international subscriber directory number (MSISDN) information, mobile/dialable number information, a session identifier, an international mobile subscriber identity (IMSI), a mobile subscriber directory number (DN), a globally unique temporary identifier (GUTI), a serving mobile switching center (MSC) address information, visitor location register (VLR) number information, serving General Packet Radio Service (GPRS) support node (SGSN) address information, SGSN number information, visited mobile country code (MCC) information, mobile network code (MNC) information, a user-name attribute value pair (AVP), a network access identifier (NAI), serving location area code information, serving cell identification information, mobile subscriber geo-location coordinate information, and tracking area information.

21. The system of claim 15 wherein each of the plurality of network service nodes includes: a network charging node, an online charging system (OCS) node, an offline charging system (OFCS) node, a

charging trigger function (CTF) node, a charging gateway function (CGF) node, a charging data function (CDF) node, a policy and charging rules function (PCRF) node, a home subscriber server (HSS) node, or a home location register node (HLR).

22. The system of claim 15 wherein the network service node is selected by accessing at least one binding record stored in the DBR.

23. The system of claim 22 wherein the at least one binding record includes at least one of: a Diameter session binding, a Diameter session identifier-to-network service node association, a Diameter end to end identifier-to-network service node association, a subscriber identifier-to-network service node association, and a charging identifier-to-network service node association.

24. The system of claim 15 wherein the Diameter signaling message includes a credit control request (CCR) message, an accounting request (ACR) message, an update location request (ULR) message, a Diameter mobility management message, or a Diameter charging message.

25. The system of claim 15 wherein the selected service node is of a first Diameter service type, wherein the DBR information identifies an additional Diameter node of a second Diameter service type different from the first Diameter service type, and wherein the Diameter routing node is configured to modify the Diameter signaling message to include identifying information for the additional service node.

26. The system of claim 25 wherein the Diameter routing node is configured to forward the Diameter signaling message to the selected service node.

27. The system of claim 26 wherein the selected service node comprises a policy and charging rules function (PCRF) and wherein the function additional service node comprises a charging data function (CDF).

28. The system of claim 26 wherein the selected service node comprises a charging data function (CDF) and wherein the function additional service node comprises a policy and charging rules function (PCRF).

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

receiving, at a Diameter routing node, a Diameter signaling message that is associated with a mobile subscriber and includes mobile subscriber related information;

querying a Diameter binding repository (DBR) using the mobile subscriber related information to select a network service node from a plurality of network service nodes configured to process the Diameter signaling message;

obtaining DBR information associated with the mobile subscriber from the DBR, wherein the DBR information includes an identifier associated with the selected network service node; and

modifying the Diameter signaling message to include at least a portion of the DBR information.

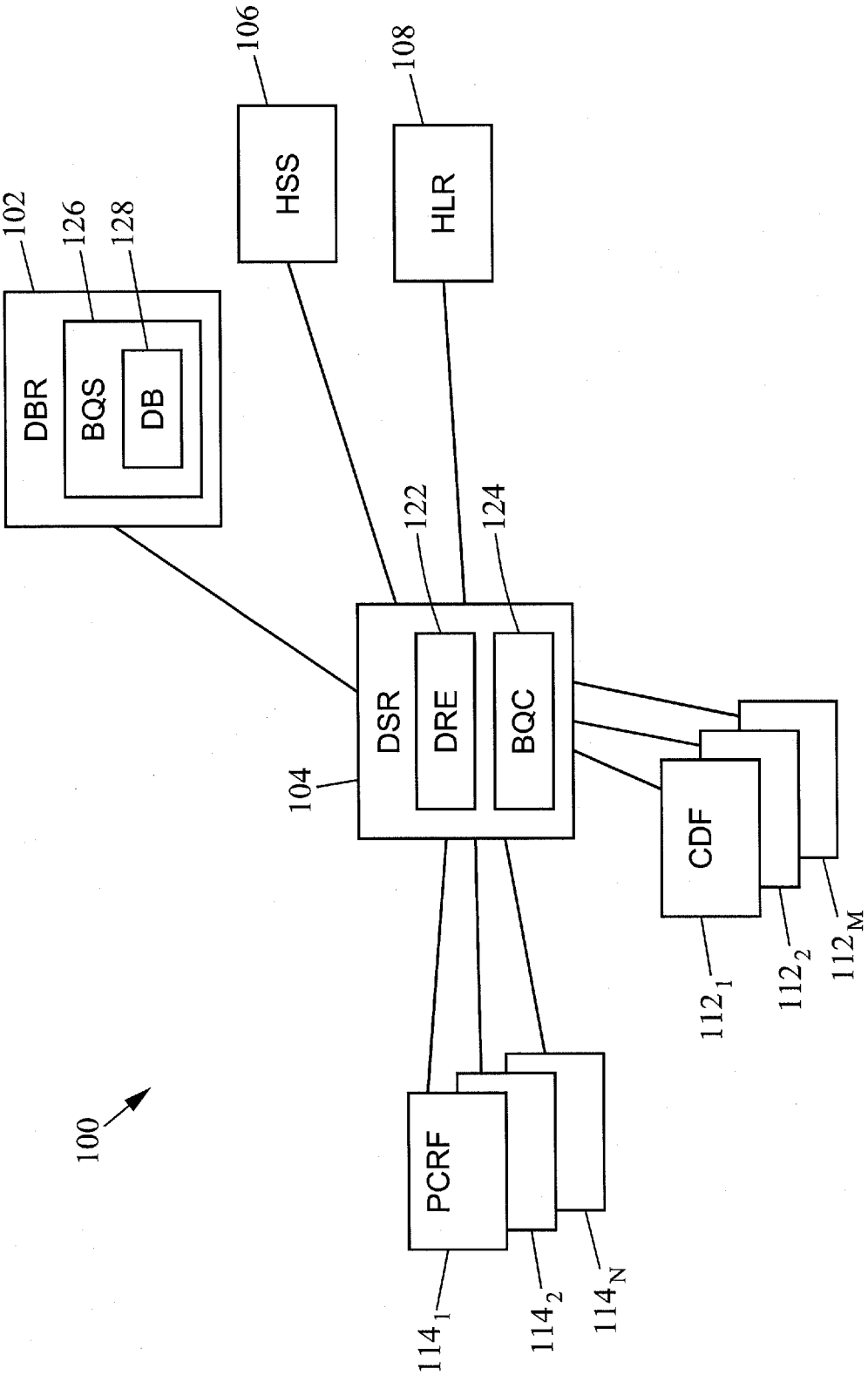
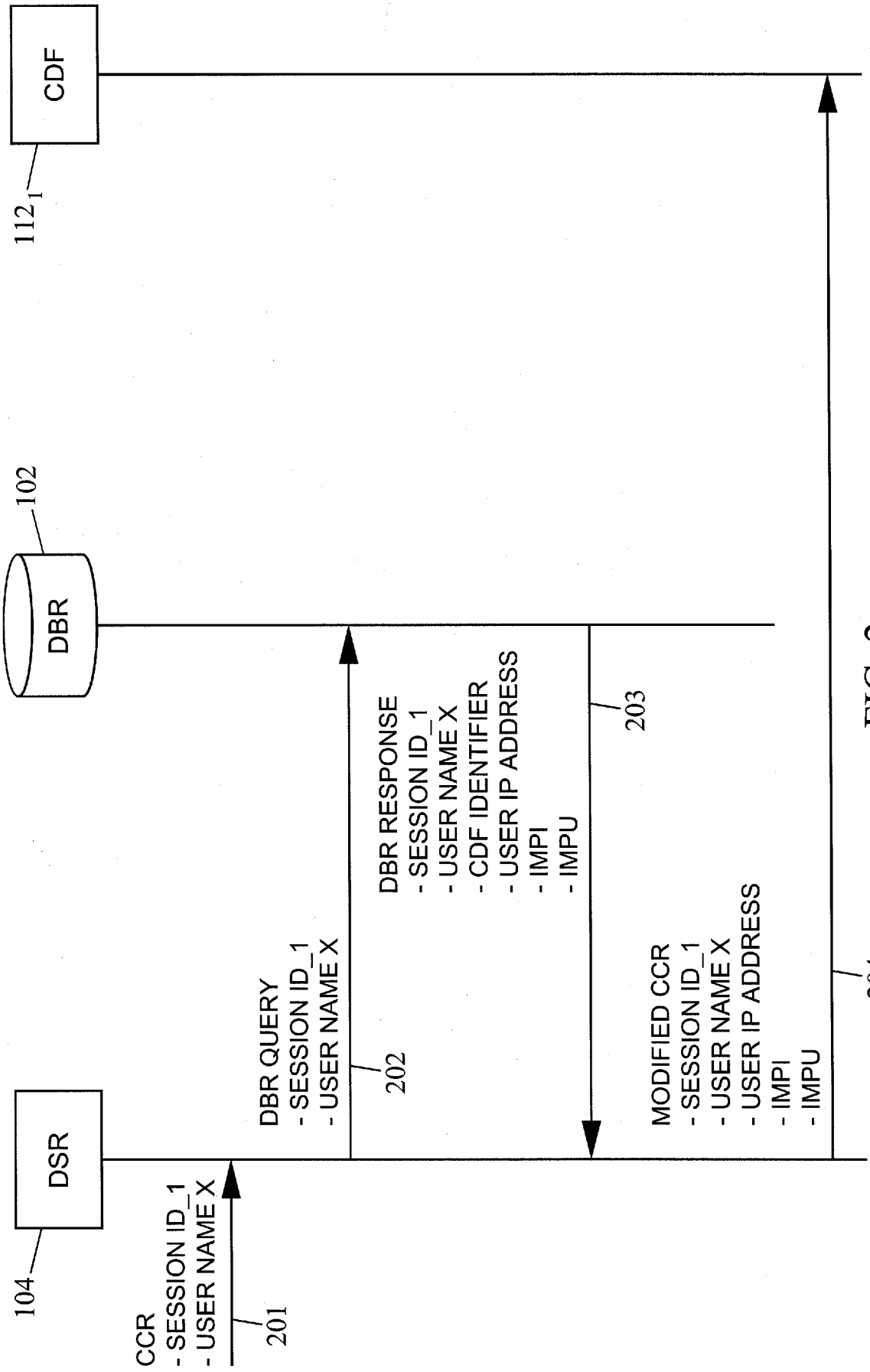

100
102
126
128
DBR
BQS
DB
106
HSS
108
HLR
104
DSR
DRE
BQC
122
124
CDF
112_1
112_2
112_M
PCRF
114_1
114_2
114_N

FIG. 1


CDF
112 1
DBR
102
DSR
104
CCR
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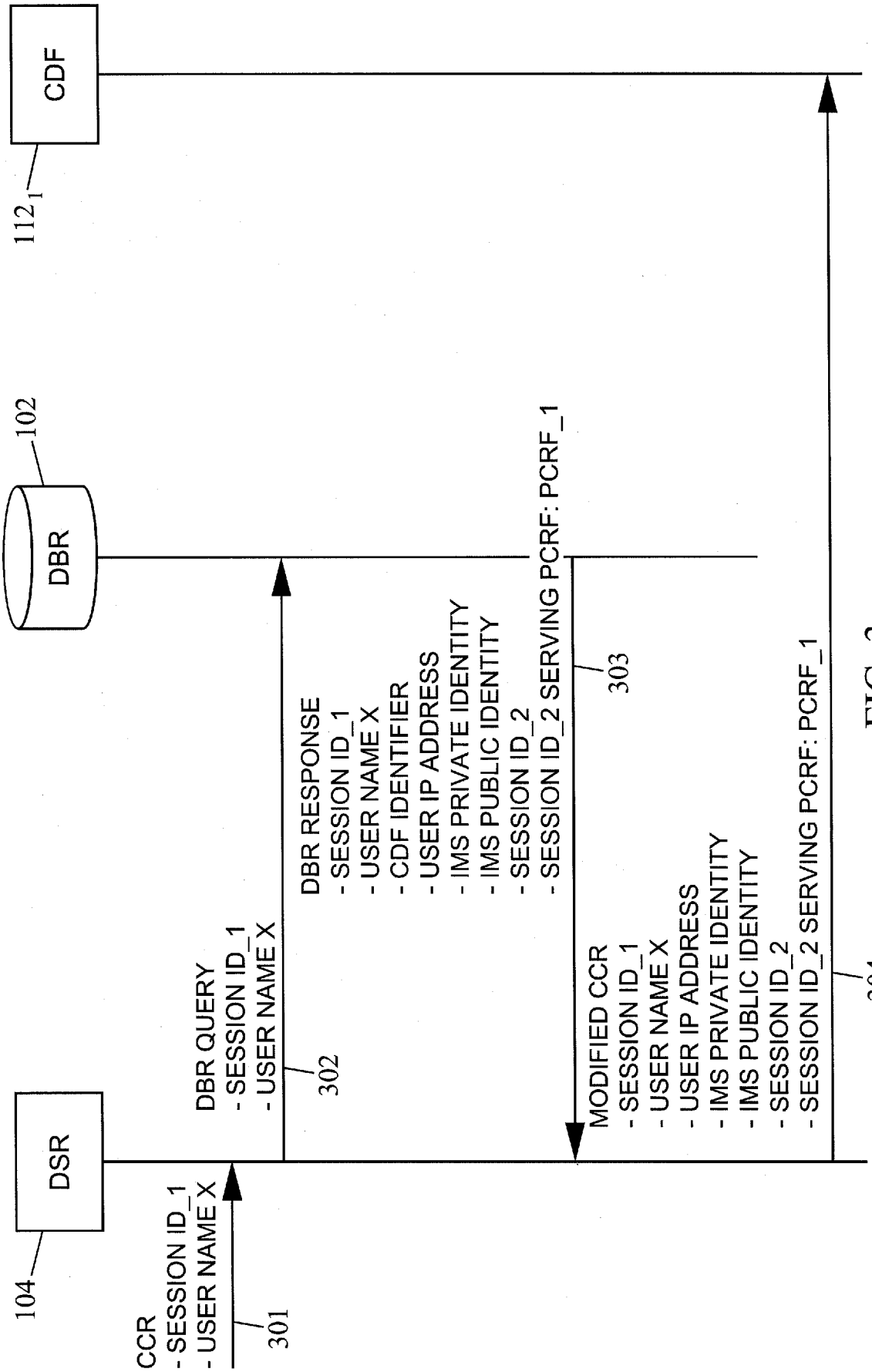
- USER NAME X
201
DBR QUERY
- SESSION ID_1
- USER NAME X
202
DBR RESPONSE
- SESSION ID_1
- USER NAME X
- CDF IDENTIFIER
- USER IP ADDRESS
- IMPI
- IMPU
203
MODIFIED CCR
- SESSION ID_1
- USER NAME X
- USER IP ADDRESS
- IMPI
- IMPU
204

FIG. 2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112_1
DBR
102
DSR
104
CCR
- SESSION ID_1
- USER NAME X
301
DBR QUERY
- SESSION ID_1
- USER NAME X
302
DBR RESPONSE
- SESSION ID_1
- USER NAME X
- CDF IDENTIFIER
- USER IP ADDRESS
- IMS PRIVATE IDENTITY
- IMS PUBLIC IDENTITY
- SESSION ID_2
- SESSION ID_2 SERVING PCRF: PCRF_1
303
MODIFIED CCR
- SESSION ID_1
- USER NAME X
- USER IP ADDRESS
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- IMS PUBLIC IDENTITY
- SESSION ID_2
- SESSION ID_2 SERVING PCRF: PCRF_1
304

FIG. 3

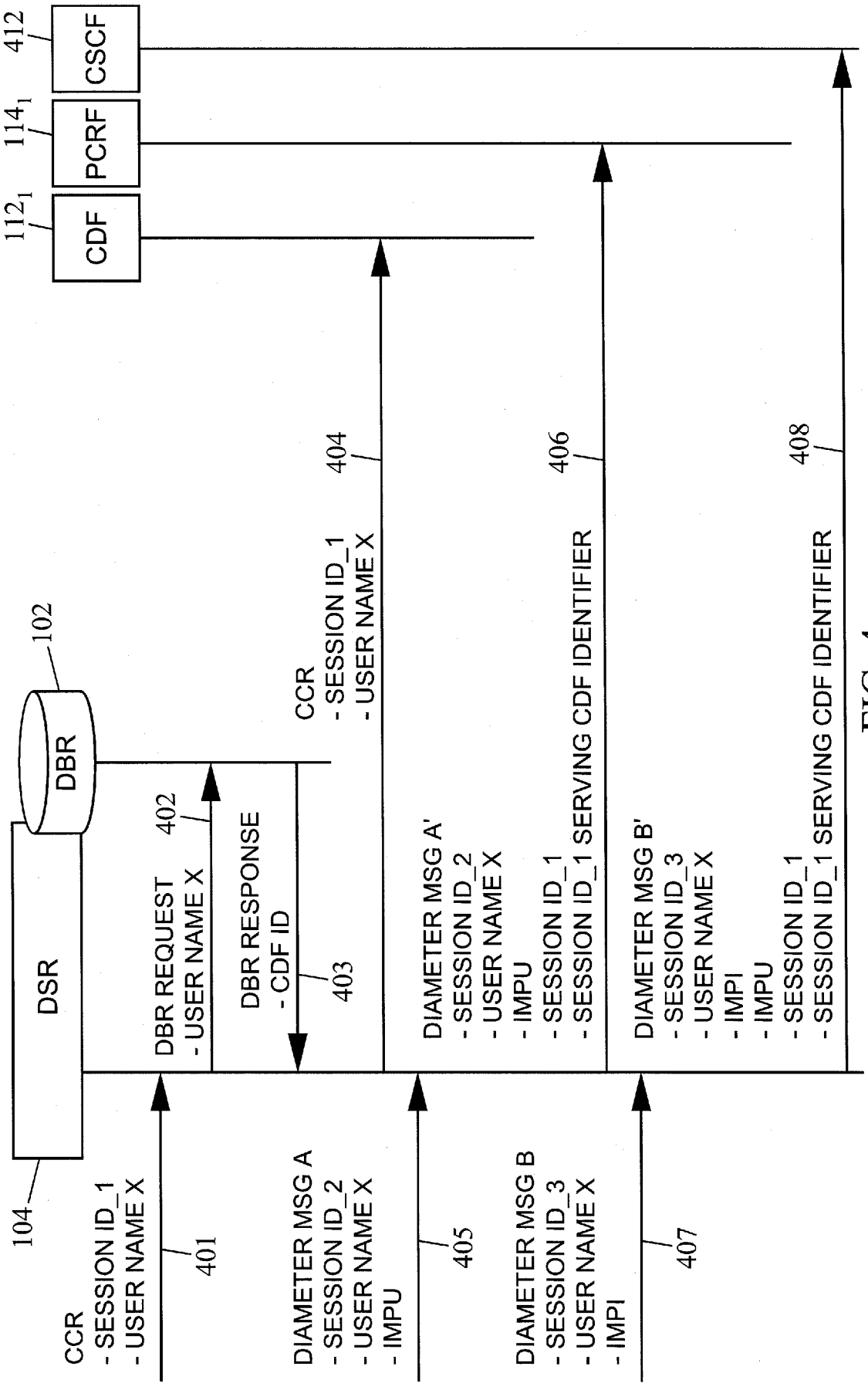
CDF
PCRF
CSCF
DBR
DSR
CCR
- SESSION ID_1
- USER NAME X
401
DBR REQUEST
- USER NAME X
402
DBR RESPONSE
- CDF ID
403
CCR
- SESSION ID_1
- USER NAME X
404
DIAMETER MSG A
- SESSION ID_2
- USER NAME X
- IMPU
405
DIAMETER MSG A'
- SESSION ID_2
- USER NAME X
- IMPU
- SESSION ID_1
- SESSION ID_1 SERVING CDF IDENTIFIER
406
DIAMETER MSG B
- SESSION ID_3
- USER NAME X
- IMPI
407
DIAMETER MSG B'
- SESSION ID_3
- USER NAME X
- IMPI
- IMPU
- SESSION ID_1
- SESSION ID_1 SERVING CDF IDENTIFIER
408
104
102
112_1
114_1
412

FIG. 4

500

DIAMETER SESSION-ID 502	USER NAME 504	IMSI 506	IMPI 508	IMPU 510	SIP URI 512	NAI 514	MOBILE/ DIALABLE NUMBER 516	USER IP ADDRESS 518	SERVICE NODE IDENTIFIER/ ADDRESS 520
123	X	y						Z	CDF_1
345			XX					ZZ	PCRF_1
678	XXX				ttt			ZZZ	CDF_1

FIG. 5

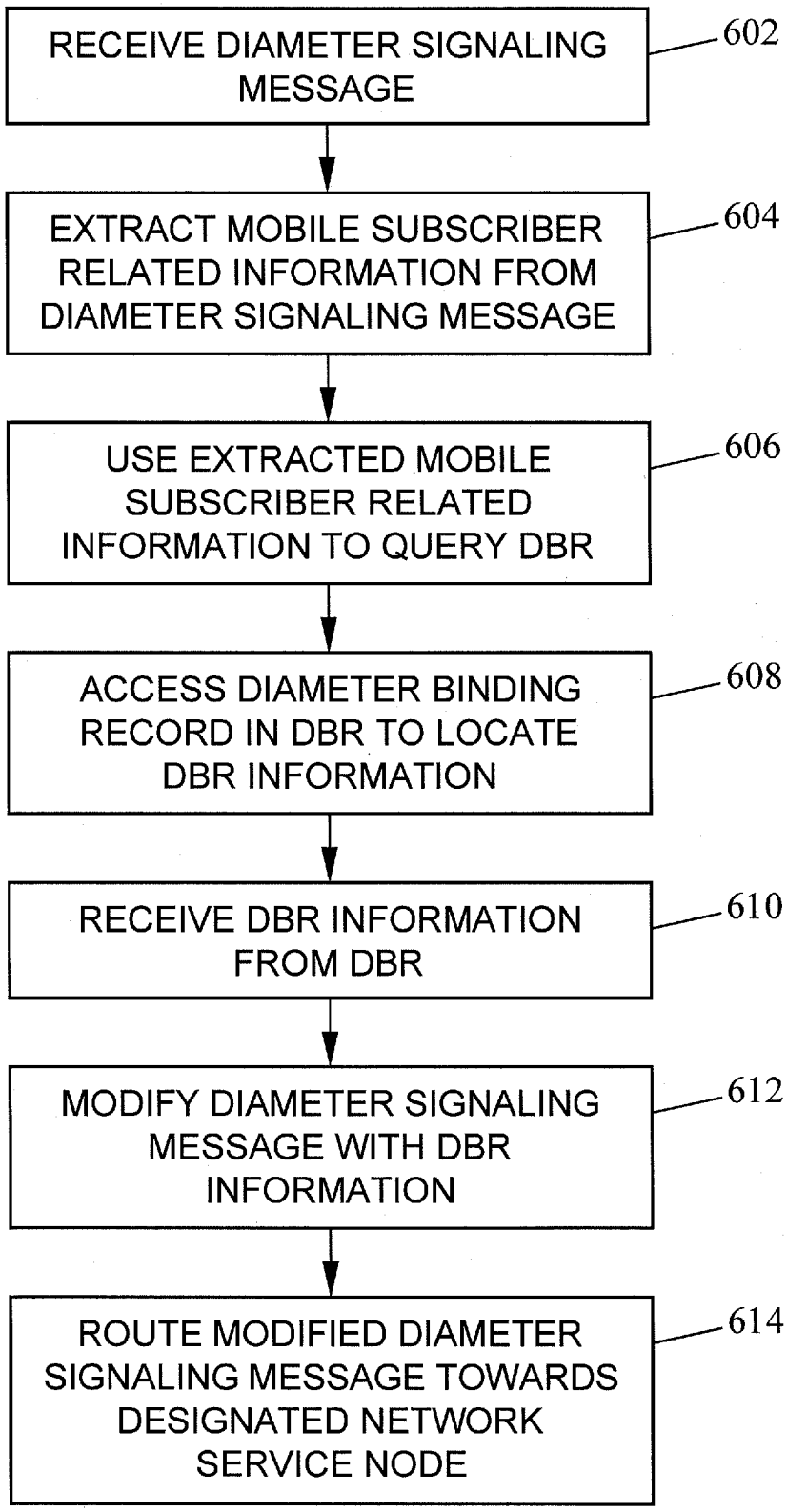
RECEIVE DIAMETER SIGNALING MESSAGE
602
EXTRACT MOBILE SUBSCRIBER RELATED INFORMATION FROM DIAMETER SIGNALING MESSAGE
604
USE EXTRACTED MOBILE SUBSCRIBER RELATED INFORMATION TO QUERY DBR
606
ACCESS DIAMETER BINDING RECORD IN DBR TO LOCATE DBR INFORMATION
608
RECEIVE DBR INFORMATION FROM DBR
610
MODIFY DIAMETER SIGNALING MESSAGE WITH DBR INFORMATION
612
ROUTE MODIFIED DIAMETER SIGNALING MESSAGE TOWARDS DESIGNATED NETWORK SERVICE NODE
614

FIG. 6

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2012/027736

A. CLASSIFICATION OF SUBJECT MATTER

H04W 8/02(2009.01)i, H04W 8/18(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 8/02; H04L 12/26; H04L 12/56

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: diameter signaling message , routing node

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2008-0039104 A1 (JIONGJIONG GU et al.) 14 February 2008 See claims 1-58 and figures 1-17.	1-29
A	US 2007-0297419 A1 (ANDERS H. ASKERUP et al.) 27 December 2007 See claims 1-25 and figures 1-2.	1-29
A	US 2009-0232011 A1 (JIJUN LI et al.) 17 September 2009 See claims 1-16 and figures 1-5.	1-29

☐ 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
12 JUNE 2012 (12.06.2012)	**12 JUNE 2012 (12.06.2012)**

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

Authorized officer
JUNG, Yun Seok
Telephone No. 82-42-481-8123

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2012/027736

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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		EP 2091185 A1	19.08.2009
		US 7894353 B2	22.02.2011
		WO 2008-098448 A1	21.08.2008