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(54) Title: METHODS, SYSTEMS, AND COMPUTER READABLE MEDIA FOR PROVISIONING A DIAMETER BINDING REPOSITORY

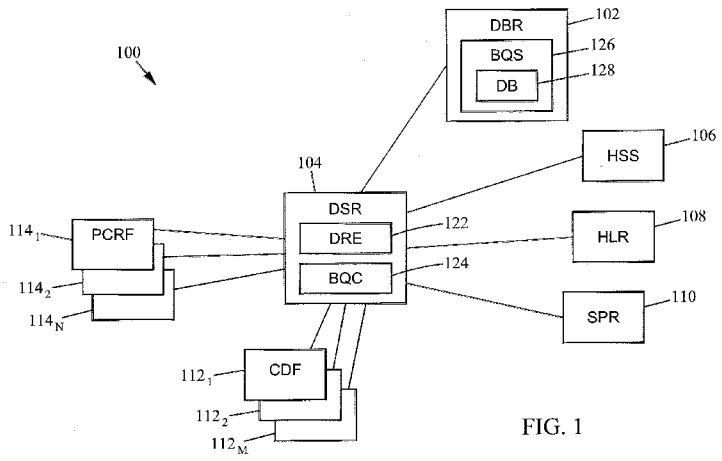

FIG. 1

(57) Abstract: Methods, systems, and computer readable media for for provisioning a Diameter binding repository (DBR) 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. The method also includes selecting a network service node from a plurality of network service nodes configured to process the Diameter signaling message and querying a subscriber data management (SDM) node using the mobile subscriber related information to obtain additional information associated with the mobile subscriber. The method further includes generating Diameter binding record information using the mobile subscriber related information, the additional information, and an identifier corresponding to the selected network service node and providing the Diameter binding record information to a Diameter binding repository.

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DESCRIPTION

METHODS, SYSTEMS, AND COMPUTER READABLE MEDIA FOR PROVISIONING A DIAMETER BINDING REPOSITORY

PRIORITY CLAIM

This application claims the benefit of U.S. Provisional Patent Application Serial No. 61/439,672 filed February 4, 2011; the disclosure of which is incorporated herein by reference in its entirety.

TECHNICAL FIELD

The subject matter described herein relates to enhancing Diameter binding records that associate mobile subscribers with network service nodes. More specifically, the subject matter relates to methods, systems, and computer readable media for provisioning a Diameter binding repository.

BACKGROUND

At present, problems exist with the assignment of Diameter-based network service nodes to Diameter signaling messages associated with a common signaling transaction and/or mobile subscriber. Namely, there are difficulties associated with the identification and correlation of subsequently received Diameter signaling messages to the initially received Diameter signaling message transaction. As a consequence, Diameter signaling messages received at a Diameter routing node may not be forwarded to the same network service node assigned to an existing Diameter signaling message transaction that is associated with a particular mobile subscriber.

Accordingly, a need exists for improved methods, systems, and computer readable media provisioning a Diameter binding repository.

SUMMARY

Methods, systems, and computer readable media for provisioning a Diameter binding repository are disclosed. One exemplary 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. The method also includes selecting a network service node from a plurality of network service nodes configured to process the Diameter signaling message and querying a subscriber data management (SDM) node using the mobile subscriber related information to obtain additional information associated with the mobile subscriber. The method further includes generating Diameter binding record information using the mobile subscriber related information, the additional information, and an identifier corresponding to the selected network service node and providing the Diameter binding record information to a Diameter binding repository. 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 provisioning a Diameter binding repository 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 provisioning a Diameter binding repository according to an embodiment of the subject matter described herein;

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

Figure 3 is an exemplary table depicting Diameter binding record data used to designate a network service node according to an embodiment of the subject matter described herein;

Figure 4 is a flow chart illustrating a process for provisioning a Diameter binding repository according to an embodiment of the subject matter described herein;

Figure 5 is a message sequence diagram illustrating an alternative process for provisioning a Diameter binding repository according to an embodiment of the subject matter described herein; and

Figure 6 is a flow chart illustrating an alternative process for provisioning a Diameter binding repository 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 provisioning a Diameter binding repository. 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 either assign one of a plurality of network service nodes to process the received Diameter signaling message or determine whether a network service node is already assigned (or "bound") to the mobile subscriber. The DSR node may also be configured to query a subscriber data management (SDM) node in order to

obtain additional mobile subscriber information that may be used to create or enhance a Diameter binding record in a Diameter binding repository (DBR). As used herein, a Diameter 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 enhanced Diameter binding records may be used to forward Diameter signaling messages (associated with the same mobile subscriber) subsequently received at the DSR node to an appropriate network service node with greater efficiency. 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 provision a Diameter binding repository (DBR). In one embodiment, system **100** includes a Diameter routing node, e.g., 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, 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 message received by DSR **104** include a credit control request (CCR) message, an accounting request (ACR) message, an update location request (ULR) message, a Diameter mobility management message, and a Diameter charging message. In one embodiment, the Diameter-based signaling message may be sent to the Diameter routing node by a network node (not shown) such as, for example, a policy and charging enforcement

function (PCEF) node, a gateway GPRS support node (GGSN), 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 and receive) Diameter-based signaling messages to 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), and a call session control function (CSCF) node.

System **100** may also include a plurality of subscriber data management (SDM) nodes, such as a subscriber profile repository (SPR) **110**, a home subscriber server (HSS) **106**, and home location register (HLR) **108**. An SDM node is a designated network node configured to store and/or maintain additional mobile subscriber information, such as identifiers and service and policy profile information associated with the mobile subscriber. An SDM node may be queried by DSR **104** for the additional mobile subscriber information (e.g., identifiers). Other exemplary SDM nodes include a policy and charging rules function (PCRF) 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 database **128**. In one embodiment, binding database **128** may be

configured to store Diameter binding records that provide associations (e.g., Diameter-related bindings, mappings, links, etc.) of mobile subscriber identifiers and assigned network service nodes. Exemplary Diameter-related bindings stored by DBR **102** may include, but are not limited to, a Diameter session binding, 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 (e.g., IMS charging ID) to-network service node associations, and the like. In the embodiments illustrated herein, DBR **102** is shown as being a stand-alone entity, such as a network node, a server, an application, or a database that is located separate from the Diameter signaling router. 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 **104** without departing from the scope of the present subject matter.

Figure 2 illustrates an exemplary Diameter based message sequence diagram that depicts the provisioning of a Diameter binding repository 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 an international mobile subscriber identity (IMSI) associated with a mobile subscriber.

After receiving the Diameter request message, DSR **104** may execute a network service node selection algorithm in order to select one of the plurality of network service nodes. In one embodiment, DSR **104** may utilize a CDF selection algorithm (e.g., a software module executed by a hardware processor in DSR **104**) that when executed designates one CDF node (e.g., CDF node $\mathbf{112}_1$) from the plurality of CDF nodes CDFs $\mathbf{112}_{1...m}$ to process the received CCR message.

In one embodiment, DSR **104** may also be configured to extract 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. As previously indicated above, CCR message **201** includes IMSI information that is extracted from the message **201** by DSR **104**.

In one embodiment, DSR **104** may utilize the extracted mobile subscriber related information to generate a request message to be sent to a subscriber data management (SDM) node, such as subscriber profile repository (SPR) **110**. SPR **110** may be configured to store "additional" identifier data associated with a plurality of mobile subscribers. Examples of additional mobile subscriber information include parameters and identifier information such as Diameter session-identifiers, a user-name identifier, a user Internet protocol (IP) identifier, an IP multimedia subsystem (IMS) private identity (IMPI) identifier, an IMS public identity (IMPU) identifier, a session initiation protocol (SIP) uniform resource identifier (URI), an IMS charging identifier, a mobile station international subscriber directory number (MSISDN) identifier, a mobile/dialable number identifier, a session identifier, an international mobile subscriber identity (IMSI) identifier, a mobile subscriber directory number (DN) identifier, a globally unique temporary identifier (GUTI), a serving MSC address, visitor location register (VLR) number, a serving General Packet Radio Service (GPRS) support node (SGSN) address, an SGSN number information, a visited mobile country code (MCC), an mobile network code (MNC), a user-name attribute value pair (AVP), a network access identifier (NAI), a serving location area code, a

serving cell identification information, mobile subscriber geo-location coordinate information, and tracking area information.

As depicted in Figure 2, SPR **110** may receive a subscriber profile request message **202** from DSR **104** that contains the extracted mobile subscriber related information, e.g. an IMSI parameter/identifier associated with the mobile subscriber. In one embodiment, SPR **110** may be configured to cross-reference the received IMSI with a listing of mobile subscriber identifiers (e.g., a list of IMSIs). If the cross-referencing process results in locating an entry in SPR **110** that matches the extracted IMSI, SPR **110** may access the a plurality of other identifiers (i.e., additional mobile subscriber information) associated with the mobile subscriber. SPR **110** may then generate a subscriber profile answer message **203** including the additional mobile subscriber information and subsequently route answer message **203** to DSR **104**. In one embodiment, the additional mobile subscriber information may include parameters/identifiers such as a user-name, a user IP address, an IMPI, and an IMPU associated with the mobile subscriber.

As depicted in Figure 2, DSR **104** receives subscriber profile answer message **203** containing the additional mobile subscriber information from SPR **110**. DSR **104** may then use the received additional mobile subscriber information along with the network service node selection information (e.g., CDF $\mathbf{112}_1$) and the mobile subscriber related information (i.e., the IMSI) extracted from the Diameter signaling message to generate Diameter binding record information for the received Diameter signaling message. Specifically, the Diameter binding record information may serve as an association of the selected network service node to both the mobile subscriber information and the additional mobile subscriber information. For instance, using the same example above, the Diameter binding record information may associate CDF $\mathbf{112}_1$ to the extracted IMSI and the obtained user-name, user IP address, IMPI, and IMPU.

As shown in Figure 2, DSR **104** sends a provisioning message **204** to DBR **102**. Notably, provisioning message **204** may comprise a DBR initial binding message that includes the Diameter binding record information generated by DSR **104**. Upon receiving the Diameter binding record

information, DBR **102** either generates a new Diameter binding record or updates an existing Diameter binding record. If DBR **102** already contains an existing Diameter binding record, DBR **102** compares the received Diameter binding record information with the data in the existing Diameter binding record and updates the record accordingly. For example, DBR **102** may compare the mobile subscriber related identifiers included in the Diameter binding record information with the mobile subscriber identifiers contained in the existing Diameter binding record. Any data or identifier included in the Diameter binding record information but not listed in the Diameter binding record is then added as new data element entries to the existing Diameter binding record. For instance, using the example above, DBR **102** may already include a binding record that associates CDF $\mathbf{112_1}$ to the extracted IMSI and a user-name and user IP address. However, DBR **102** may determine that the existing binding record does not include the IMPI and the IMPU. As a result, DBR **102** may be configured to add the IMPI and the IMPU to the existing Diameter binding record, such that the binding record includes at least the association of CDF $\mathbf{112_1}$ to the IMSI, the user-name, the user IP address, the IMPI, and the IMPU (i.e., the existing binding record may be previously provisioned with other mobile subscriber information not associated with the extracted mobile subscriber related information and the additional mobile subscriber information from the SDM).

Alternatively, if DBR **102** does not include an existing Diameter binding record, then DBR **102** may be configured to generate a new Diameter binding record that includes the elements contained in Diameter binding record information provided by DSR **104**. For example, DBR **102** may simply generate a Diameter binding record that associates CDF $\mathbf{112_1}$ to the IMSI, the user-name, the user IP address, the IMPI, and the IMPU.

As depicted in Figure 2, DSR **104** then routes a Diameter signaling message **205**, towards the selected network service node, i.e., CDF $\mathbf{112_1}$. In one embodiment, Diameter signaling message **205** is the same message (i.e., CCR message **201**) that was initially received by DSR **104**. Although Figure 2 depicts message **205** being sent after the Diameter binding record is created or updated, message **205** may be sent at any time after DSR **104**

receives message **201**. In an alternate embodiment, DSR **104** may insert some or all of the additional mobile subscriber information received from the SDM into Diameter signaling message **205**. After modifying the Diameter signaling message, DSR **104** may route the modified message to or towards the network service node indicated in the DBR answer message **204**.

By operating in the manner illustrated in Figure 2, DSR **104** is able to provision DBR **102** with a plurality of bindings or associations for a plurality of received Diameter signaling messages. Notably, DBR **102** is configured to maintain network service binding records that include substantially more mobile subscriber information elements and/or parameters that are normally contained in a single Diameter signaling message. In one embodiment, the additional mobile subscriber information elements (e.g., AVP values or parameters) may be used as correlation keys by DSR **104** when analyzing/correlating a subsequently received Diameter signaling message to determine which network service node should receive and process the signaling message.

For example, after receiving, assigning (i.e., selecting a network service node), and routing the first received Diameter signaling message to CDF **112**$_1$, DSR **104** may subsequently receive a second Diameter signaling message that contains at least one of the same mobile subscriber information elements (e.g., AVP values or parameters) as the first Diameter signaling message. However, the second Diameter signaling message may also contain information elements that differ from the information elements included in the first Diameter request message. In one embodiment, DSR **104** is configured to analyze the information elements in the received second Diameter message and use the analysis/information in conjunction with the additional mobile subscriber information previously provided by the SDM (e.g., SPR **110**). Namely, DSR **104** uses the information elements in the second Diameter signaling message to correlate the second Diameter signaling message with a previously received first Diameter signaling message. Once the correlation process has been performed by DSR **104**, DSR **104** may utilize at least a portion of the mobile subscriber information contained in the second Diameter signaling message along with some or all

of the additional mobile subscriber information to query DBR **102** for Diameter binding record information. After using the received information from DSR **104** to access the Diameter binding records stored in database **128**, DBR **102** may then provide the preferred network service node identifier (e.g., CDF $\mathbf{112_1}$) to DSR **104** in an answer message.

In an alternate embodiment, DSR **104** may insert some or all of the additional mobile subscriber information received from the SDM into the second Diameter signaling message. After modifying the second Diameter signaling message, DSR **104** may then route the modified message to or towards the network service node indicated in the DBR response message.

In one embodiment, a network charging function node may include an online charging system (OCS) node or offline charging system (OFCS) node. In one embodiment, an OCS node may utilize the MCC and MNC information to respond to credit control request (CCR) messages sent by policy and charging enforcement function (PCEF) nodes. As used herein, the term online charging refers to real-time management of pricing and payment processes conducted by a network charging function node (such as CDF node **112**). Online charging systems are aware of each mobile subscriber's service use and account balance in real time. In one embodiment, an OCS node may be configured to customize the pricing, service delivery and marketing communication for each mobile subscriber based on the subscriber usage and current balances.

Figure 3 illustrates an exemplary table **300** depicting Diameter binding record data used for identifying a network service node according to an embodiment of the subject matter described herein. In one embodiment, table **300** may represent at least a portion of database **128** maintained at DBR **102**. Table **300** may include a plurality of mobile subscriber related identifiers **302-318** as column headers. For example, table **300** may include at least one column for each of: a Diameter session identifier **302**, a user name **304**, an IMPI identifier **308**, an IMPU identifier **310**, a SIP URI **312**, an NAI **314**, a mobile/dialable number **316**, and a user IP address **318**. Table **300** may also include a network service node column, such as a CDF identifier/address column **320**. Although ten columns are depicted in Figure

3, table **300** may include any number of columns associated with any type of identifier.

In one embodiment, DBR **102** may be configured to provision table **300**. Upon receiving a provisioning message that contains Diameter binding record information (e.g., message **204** in Figure 2), DBR **102** may add a new Diameter binding record to table **300**. For example, if DBR **102** received a provisioning message that contained Diameter biding record information that included a Diameter session identifier of "**678**", a SIP URI of "ttt", and a user IP address of "ZZZ" associated with "CDF 1", then DBR **102** may add the new Diameter binding record represented as the last line of table **300**.

Figure 4 is a flow chart illustrating a process **400** for provisioning a Diameter binding repository (DBR) according to an embodiment of the subject matter described herein. In block **402**, 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 **404**, one of a plurality of network service nodes is selected. In one embodiment, the received Diameter signaling message may be addressed to or directed toward an original network service node destination, such as CDF $\mathbf{112}_1$. In this scenario, DSR **104** selects/designates the address of the destination network service node as the appropriate node to process the received Diameter signaling message. In an alternate embodiment, DSR **104** may be configured to utilize a network service node selection module (e.g., a software algorithm that is executed by a hardware processor) to select one network service node from a plurality of network service nodes that are capable of servicing/processing the Diameter signaling message. For example, DSR **104** may select any one of CDF nodes $\mathbf{112}_{1...m}$ to process the CCR message received by DSR **104**.

In block **406**, 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 an IMSI associated with a particular mobile subscriber.

In block **408**, a subscriber data management (SDM) node is queried. In one embodiment, DSR **104** may generate a query or request message (e.g., a subscriber profile request message) that includes the extracted mobile subscriber related information. For example, DSR **104** may extract an IMSI 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 IMSI. DSR **104** may also be configured to send the request message including the IMSI to an SDM, such as SPR **110**.

In block **410**, additional mobile subscriber information is received from the SDM node. In one embodiment, DSR **104** receives a subscriber profile answer message that contains additional information related to the mobile subscriber from SPR **110** in response to the request message sent in block **408**. For example, SPR **110** may be configured to utilize the extracted mobile subscriber related information (e.g., IMSI) received in block **408** to access a local database or a storage medium that contains additional information associated with a plurality of mobile subscriber identifiers. Namely, SPR **110** may cross-reference the IMSI with a listing of mobile subscriber identifiers. If a matching entry is found (e.g., the IMSI matches one of the listed mobile subscriber identifiers in the database), then SPR **110** may access the additional information mapped to the matching mobile subscriber identifier and include the additional mobile subscriber information in an answer message (e.g., a subscriber profile answer message). SPR **110** may then send the answer message containing the additional mobile subscriber information to DSR **104**. In one embodiment, the additional mobile subscriber information included in the answer message may include a user IP address, an IMPI, and an IMPU associated with the mobile subscriber.

In block **412**, Diameter binding record information is generated. In one embodiment, DSR **104** uses the network service node selection information (e.g., address of CDF $\mathbf{112}_1$), the additional mobile subscriber

information obtained from SPR **110**, and the extracted mobile subscriber related information (e.g., the IMSI) to generate Diameter binding record information.

In block **414**, the Diameter binding record information is sent to a Diameter binding repository (DBR). In one embodiment, DSR **104** generates a DBR initial binding message that includes the Diameter binding record information and forwards the generated binding message to DBR **102**.

In block **416**, a Diameter binding record in the DBR is either updated or created. In one embodiment, DBR **102** utilizes the Diameter binding record information received from DSR **104** to update an existing Diameter binding record. For example, DBR **102** may compare the mobile subscriber related identifiers contained in received additional mobile subscriber information with the elements (e.g., identifiers) contained in the existing Diameter binding record. If there are any mobile subscriber related identifiers that do not match the elements contained in the existing Diameter binding record, those unmatched mobile subscriber related identifiers are added to the existing Diameter binding record. Alternatively, if DBR **102** does not include an existing Diameter binding record, then DBR **102** may be configured to generate a new Diameter binding record using the additional mobile subscriber information received from DSR **104**. For example, DBR **102** creates a new entry in binding database **128** that includes the additional mobile subscriber information.

In block **418**, the Diameter signaling message is routed towards the selected network service node. In one embodiment, DSR **104** routes the originally received Diameter signaling message (e.g., CCR message) to the network service node selected in block **404**. For example, DSR **104** may forward the received CCR message to CDF $\mathbf{112_1}$. Alternatively, the Diameter signaling message may be routed to CDF $\mathbf{112_1}$ at any time after the network service node is selected or determined (e.g., after block **404**).

Figure 5 illustrates an exemplary Diameter based message sequence diagram that depicts an alternative process for provisioning a Diameter binding repository according to an embodiment of the subject matter described herein. As shown in Figure 5, DSR **104** receives a Diameter

signaling message, i.e., CCR message **501**, which includes mobile subscriber related information. In this example, the mobile subscriber related information includes a user name and a session identifier (ID).

After receiving the Diameter request message, DSR **104** may execute a network service node selection algorithm in order to select one of the plurality of network service nodes. In one embodiment, DSR **104** may utilize a PCRF selection algorithm (e.g., a software module executed by a hardware processor in DSR **104**) that when executed designates one PCRF node (e.g., PCRF node $\mathbf{114_1}$) from the plurality of PCRF nodes $\mathbf{114_{1...n}}$ to process the received CCR message **501**.

In one embodiment, DSR **104** may also be configured to extract the mobile subscriber related information from the received Diameter signaling message. As indicated above, CCR message **501** includes user name and session ID information that is extracted from the message **501** by DSR **104**.

In one embodiment, DSR **104** may provide some or all of the mobile subscriber related information and an identifier corresponding to the selected network service node (e.g., PCRF node $\mathbf{114_1}$) to DBR **102** via a provisioning message **502** (e.g., a DBR initial binding message). Upon receipt of a provisioning message **502** containing the mobile subscriber related information, DBR **102** may utilize the mobile subscriber related information (e.g., user-name identifier and/or a session identifier) to generate a subscriber profile request message to a SDM node, such as SPR **110**.

As depicted in Figure 5, SPR **110** then receives a subscriber profile request message **503** from DBR **102** which contains the extracted mobile subscriber related information, e.g., a user name and/or session ID associated with the mobile subscriber. SPR **110** may be configured to cross-reference the user-name contained in received subscriber profile request message **503** with a listing of mobile subscriber identifiers (e.g., a list of mobile subscriber user-names). If the cross-referencing process results in locating an entry in SPR **110** that matches the user-name, SPR **110** may access a plurality of other associated identifiers (i.e., additional mobile subscriber information) corresponding with the mobile subscriber. In one embodiment, the identifiers or additional mobile subscriber information

associated with a user-name entry may include a user IP address, an IMS private identity (IMPI), and an IMS public identity (IMPU) associated with the mobile subscriber. For example, SPR **110** may cross-reference the user-name with the entry listings of a local database. If a user-name entry that matches the extracted user-name is found in the local database in SPR **110**, then SPR **110** may access a user IP address, an IMPI, and an IMPU that are associated/grouped with the matched user-name. SPR **110** may then generate a subscriber profile answer message **504** that includes the additional mobile subscriber information (e.g., user-name, user IP address, IMPI, and IMPU) and routes the subscriber profile answer message **504** to DBR **102**.

As depicted in Figure 5, DBR **102** receives the subscriber profile answer message **504** containing the additional mobile subscriber information from SPR **110**. DBR **102** may then use the received additional mobile subscriber information along with the network service node selection information (e.g., PCRF $\mathbf{114_1}$) and the mobile subscriber related information to generate Diameter binding record information. In one embodiment, the received additional mobile subscriber information may be used to enhance the received additional mobile subscriber information and the network service node selection information subscriber to generate an enhanced Diameter binding record or update/enhance an existing Diameter binding record.

For example, if DBR **102** already contains an existing Diameter binding record, DBR **102** may compare the received additional mobile subscriber information, the network service node selection, and/or the mobile subscriber related information with the data in the existing binding record and update the Diameter binding record accordingly. For example, DBR **102** may compare the mobile subscriber related identifiers contained in received additional mobile subscriber information with the elements (e.g., mobile subscriber identifiers) contained in the existing Diameter binding record. If there are any mobile subscriber related identifiers that do not match the elements contained in the existing Diameter binding record, those unmatched mobile subscriber related identifiers are added to the existing

Diameter binding record. Alternatively, if DBR **102** does not include an existing Diameter binding record, then DBR **102** may be configured to generate a new Diameter binding record using the additional mobile subscriber information received from SPR **110**.

As depicted in Figure 5, DSR **104** then routes a Diameter signaling message **505**, towards the selected network service node, i.e., PCRF **114_1**. In one embodiment, Diameter signaling message **505** is the same message (i.e., CCR message **501**) that was initially received by DSR **104**. Although Figure 5 depicts message **505** being sent after DBR **102** creates or updates the Diameter binding record, message **505** may be sent at any time after DSR **104** receives message **501**. In an alternate embodiment, DSR **104** may insert some or all of the additional mobile subscriber information received from the SDM into Diameter signaling message **505**. After modifying the Diameter signaling message, DSR **104** may route the modified message to or towards the network service node indicated in the DBR answer message **504**.

In one embodiment, after receiving, assigning (i.e., selecting a network service node), and routing the Diameter request message to PCRF **114_1**, DSR **104** may receive a second Diameter-based request message that contains one or more of the same information elements (e.g., AVP values or parameters) as the first Diameter signaling message described above. However, the second Diameter request message may also contain different information elements that vary from the information elements included in the first Diameter signaling message. In one embodiment, DSR **104** is configured to analyze the information elements in the received second Diameter message and use the analysis/information in conjunction with the additional mobile subscriber information previously provided by the SDM (e.g., SPR **110**). Namely, DSR **104** uses the information elements in the second Diameter message to correlate the second Diameter message with a previously received Diameter message, such as CCR message **501** shown in Figure 5. Once the correlation process has been performed by DSR **104**, DSR **104** may use at least a portion of the information contained in the second Diameter message along with some or all of the additional,

correlated SDM-provided information to query DBR **102** for Diameter binding record information.

In one embodiment, if the information elements contained in the second Diameter message are different from those information elements contained in the first Diameter message, DSR **104** may be configured to determine that the first Diameter message and the second Diameter message are related and/or correlated. For example, correlation of the two Diameter signaling messages may be based on the "correlation key" information provided, at least in part, by the SDM (e.g., SPR **110**, HSS, **106**, and HLR **108**). DSR **104** may then use at least a portion of this information to query DBR **102**, which in turn may be configured to respond with the appropriate network service node (e.g., a CDF, a PCRF node, etc.) to which the second Diameter message should be routed.

In an alternate embodiment, DSR **104** may insert some or all of the additional mobile subscriber information received from the SDM into the second Diameter signaling message. After modifying the second Diameter signaling message, DSR **104** may then route the modified message to or towards the network service node indicated in the DBR response message.

Figure 6 is a flow chart illustrating a process **600** for an alternate method for provisioning a Diameter binding repository (DBR) 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 Diameter based node (e.g., a PCEF).

In block **604**, one of a plurality of network service nodes is selected. In one embodiment, the received Diameter signaling message may be addressed to or directed toward an original network service node destination, such as PCRF $\mathbf{114}_1$. In this scenario, DSR **104** selects/designates the addressed network service node as the appropriate node to process the received Diameter signaling message. In an alternate embodiment, DSR **104** may be configured to utilize a network service node selection module (e.g., a software algorithm that is executed by a hardware

processor) to instead select one network service node from a plurality of network service nodes that are capable of processing/servicing the Diameter signaling message. For example, any one of PCRF nodes **$114_{1...n}$** may be able to process a CCR message received by DSR **104**.

In block **606**, 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 at a user-name identifier and session identifier.

In block **608**, the extracted mobile subscriber related information is provided to a DBR. In one embodiment, DSR **104** generates a provisioning message or a DBR initial binding message that includes the extracted mobile subscriber related information and an identifier corresponding to the selected network service node (determined in block **604**). The provisioning message containing the extracted mobile subscriber related information and network service node identifier may then be provided to DBR **102**.

In block **610**, a subscriber data management (SDM) node is queried. In one embodiment, DBR **102** may generate a query message that includes at least a portion of the extracted mobile subscriber related information. For example, suppose DBR **102** obtains a user-name identifier associated with a mobile subscriber from the received DBR initial binding message. DBR **102** may then be configured to generate a subscriber profile request message that includes the extracted user-name identifier. DBR **102** may also be configured to send the request message including the user-name identifier to an SDM, such as SPR **110**.

In block **612**, additional mobile subscriber information is received from the SDM node. In one embodiment, DBR **102** receives a subscriber profile answer message that contains additional information related to the mobile subscriber from SPR **110** in response to the subscriber profile request message sent in block **608**. For example, SPR **110** may be configured to utilize the extracted mobile subscriber related information (e.g., user-name identifier) received in block **608** to access a database or a storage medium containing additional mobile subscriber information associated with a

plurality of mobile subscriber identifiers. Namely, SPR **110** may cross-reference the user-name identifier with a listing of mobile subscriber identifiers. If a match is found (e.g., the user-name identifier matches one of the listed mobile subscriber identifiers in the SPR database), then SPR **110** may access the additional mobile subscriber information mapped to the matching mobile subscriber identifier and includes at least a portion of the additional mobile subscriber information in an answer message. For example, the database in SPR **110** may contain an entry that associates a user IP address, an IMS private identity, and an IMS public identity with the user-name identifier. After finding a match for the user-name identifier, SPR **110** would then generate a subscriber profile answer message containing all of these elements (i.e., mobile subscriber related identifiers). SPR **110** may then be configured to send the answer message containing the additional mobile subscriber information to DBR **102**.

In block **614**, a Diameter binding record in the DBR is either updated or created. In one embodiment, DBR **102** utilizes the received additional mobile subscriber information to update an existing Diameter binding record. For example, the additional mobile subscriber information is simply added to the existing information in the Diameter binding record already stored in DBR **102**. Alternatively, if a Diameter binding record does not exist, DBR **102** utilizes the additional mobile subscriber information, the mobile subscriber related information, and the network service node identifier to create a new Diameter binding record. For example, DBR **102** creates a new entry in binding database **128** that includes the additional mobile subscriber information.

In block **616**, the Diameter signaling message is routed towards the selected network service node. In one embodiment, DSR **104** routes the originally received Diameter signaling message (e.g., CCR message) to the network service node selected in block **604**. For example, DSR **104** may forward the received CCR message to PCRF **114_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.

5

CLAIMS

What is claimed is:

1. A method for provisioning a Diameter binding repository, 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;

selecting a network service node from a plurality of network service nodes configured to process the Diameter signaling message;

querying a subscriber data management (SDM) node using the mobile subscriber related information to obtain additional information associated with the mobile subscriber;

generating Diameter binding record information using the mobile subscriber related information, the additional information, and an identifier corresponding to the selected network service node; and

storing the Diameter binding record information in a Diameter binding repository (DBR).

2. The method of claim 1 wherein the Diameter routing node generates the Diameter binding record information and provides the Diameter binding record information to the Diameter binding repository.

3. The method of claim 1 wherein the Diameter routing node provides the mobile subscriber related information and an identity of the selected service node to the Diameter binding repository and wherein the Diameter binding repository queries the subscriber data management node, obtains the additional information associated with the mobile subscriber, and generates the Diameter binding record.

4. The method of claim 2 wherein providing the Diameter binding record information includes updating an existing Diameter binding record stored in the DBR.

5. The method of claim 2 wherein providing the Diameter binding record information includes generating a new Diameter binding record that is stored in the DBR.

6. The method of claim 1 wherein the DBR is located within the Diameter routing node.

7. The method of claim 1 wherein the Diameter routing node includes at least one of: a Diameter signaling router (DSR), a Diameter routing agent (DRA), a Diameter proxy agent (DPA), a Diameter redirect agent, a Diameter translation agent, and a Diameter relay agent.

8. The method of claim 1 wherein the additional information associated with the mobile subscriber includes at least one of: Diameter session-identifier 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 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.

9. The method of claim 1 wherein the subscriber data management (SDM) node includes a subscriber profile repository (SPR) node, a network billing node, a home subscriber server (HSS) node, a home location register node (HLR), a policy and charging rules function (PCRF) node, or a call session control function (CSCF) node.

10. The method of claim 1 wherein each of the plurality of network service nodes includes at least one of: 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, and a home location register node (HLR).

11. The method of claim 1 wherein the Diameter 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.

12. 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.

13. The method of claim 1 comprising modifying the Diameter signaling message to include at least a portion of the additional information.

14. The method of claim 1 comprising routing the Diameter signaling message to the selected network service node.

15. A system for provisioning a Diameter binding repository, the system comprising:

a Diameter binding repository (DBR) configured to store Diameter binding records for binding Diameter signaling message information to Diameter transactions; 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 select a network service node from a plurality of network service nodes configured to process the Diameter signaling message, and to provide the mobile subscriber related information to the Diameter binding repository, wherein the Diameter binding repository is configured to obtain additional information regarding the mobile subscriber stored by a subscriber data management node and to store the mobile subscriber

related information and the additional information in a Diameter binding record.

16. The system of claim 15 wherein the Diameter routing node is configured to query the subscriber data management node to obtain the additional information regarding the mobile subscriber, to generate the Diameter binding record information, and to provide the Diameter binding record information to the Diameter binding repository.

17. The system of claim 15 wherein the Diameter binding repository is configured to query the subscriber data management node to obtain the additional information regarding the mobile subscriber and to generate the Diameter binding record.

18. The system of claim 15 wherein the DBR is configured to update an existing Diameter binding record stored in the DBR.

19. The system of claim 15 wherein the DBR is configured to generate and store a new Diameter binding record.

20. The system of claim 15 wherein the DBR is located within the Diameter routing node.

21. The system of claim 15 wherein the Diameter routing node includes at least one of: a Diameter signaling router (DSR), a Diameter routing agent (DRA), a Diameter proxy agent (DPA), a Diameter redirect agent, a Diameter translation agent, and a Diameter relay agent.

22. The system of claim 15 wherein the additional information associated with the mobile subscriber includes at least one of: Diameter session-identifier 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 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.

23. The system of claim 15 wherein the subscriber data management node includes a subscriber profile repository (SPR) node, a network charging function node, a billing node, an online charging system (OCS) node, an offline charging system (OFCS) node, a home subscriber server (HSS) node, a home location register node (HLR), a policy and charging rules function (PCRF) node, or a call session control function (CSCF) node.

24. The system of claim 15 wherein each of the plurality of network service nodes includes 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).

25. The system of claim 15 wherein the Diameter binding record information 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.

26. 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.

27. The system of claim 15 wherein the Diameter routing node is configured to modify the Diameter signaling message to include at least a portion of the additional information.

28. The system of claim 15 wherein the DSR is configured to route the Diameter signaling message to the selected network service node.

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;

selecting a network service node from a plurality of network service nodes configured to process the Diameter signaling message;

querying a subscriber data management (SDM) node using the mobile subscriber related information to obtain additional information associated with the mobile subscriber;

generating Diameter binding record information using the mobile subscriber related information, the additional information, and an identifier corresponding to the selected network service node; and

storing the Diameter binding record information in a Diameter binding repository.

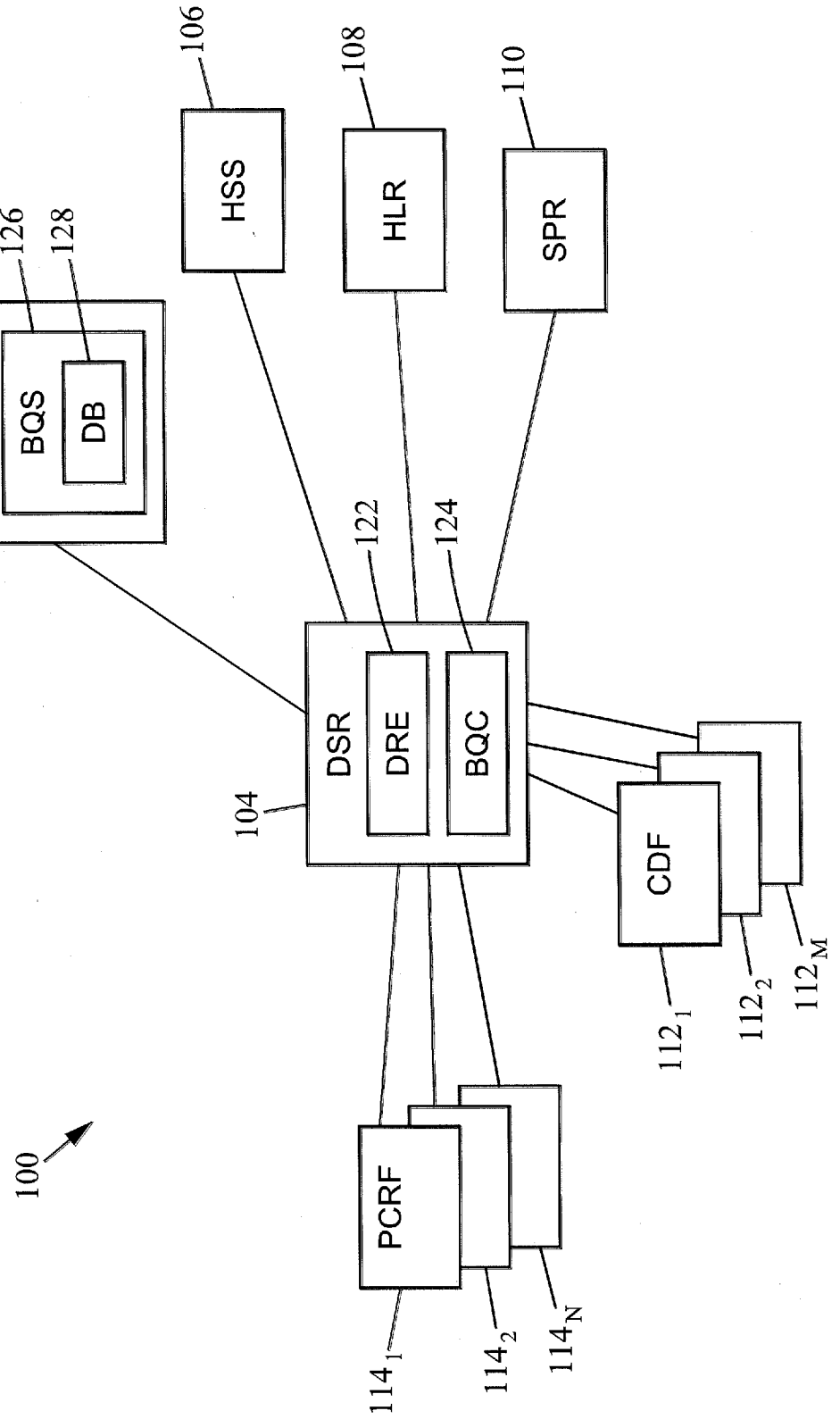
100
102
126
128
DBR
BQS
DB
106
HSS
108
HLR
110
SPR
104
DSR
DRE
BQC
122
124
CDF
112_1
112_2
112_M
PCRF
114_1
114_2
114_N

FIG. 1

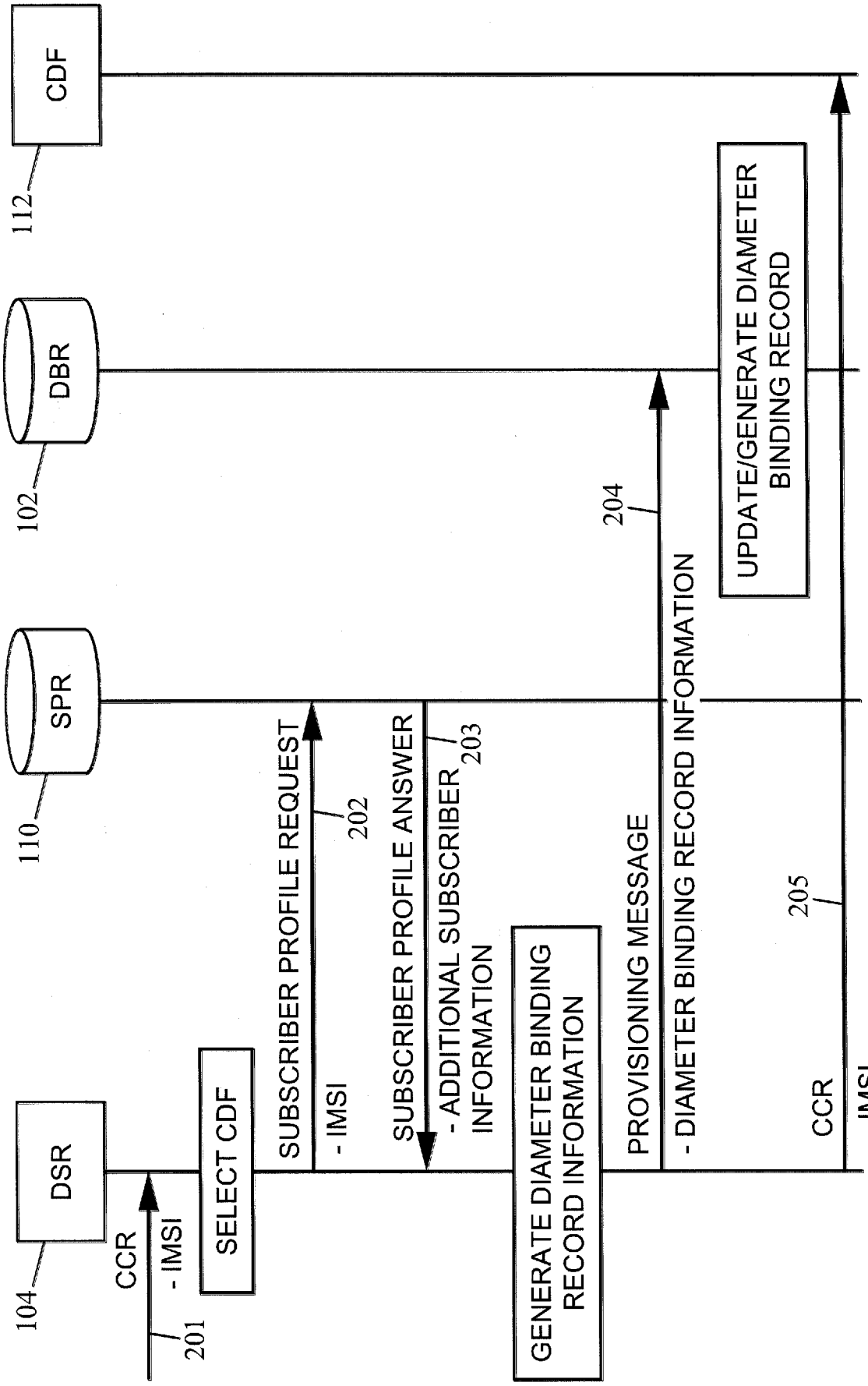
CDF
112
DBR
102
SPR
110
DSR
104
CCR
- IMSI
201
SELECT CDF
SUBSCRIBER PROFILE REQUEST
- IMSI
202
SUBSCRIBER PROFILE ANSWER
- ADDITIONAL SUBSCRIBER INFORMATION
203
GENERATE DIAMETER BINDING RECORD INFORMATION
PROVISIONING MESSAGE
- DIAMETER BINDING RECORD INFORMATION
204
UPDATE/GENERATE DIAMETER BINDING RECORD
CCR
- IMSI
205

FIG. 2

DIAMETER SESSION-ID 302	USER NAME 304	IMSI 306	IMPI 308	IMPU 310	SIP URI 312	NAI 314	MOBILE/ DIALABLE NUMBER 316	USER IP ADDRESS 318	CDF IDENTIFIER/ ADDRESS 320
123	X	y						Z	CDF_1
345			XX					ZZ	CDF_2
678	XXX				ttt			ZZZ	CDF_1

FIG. 3

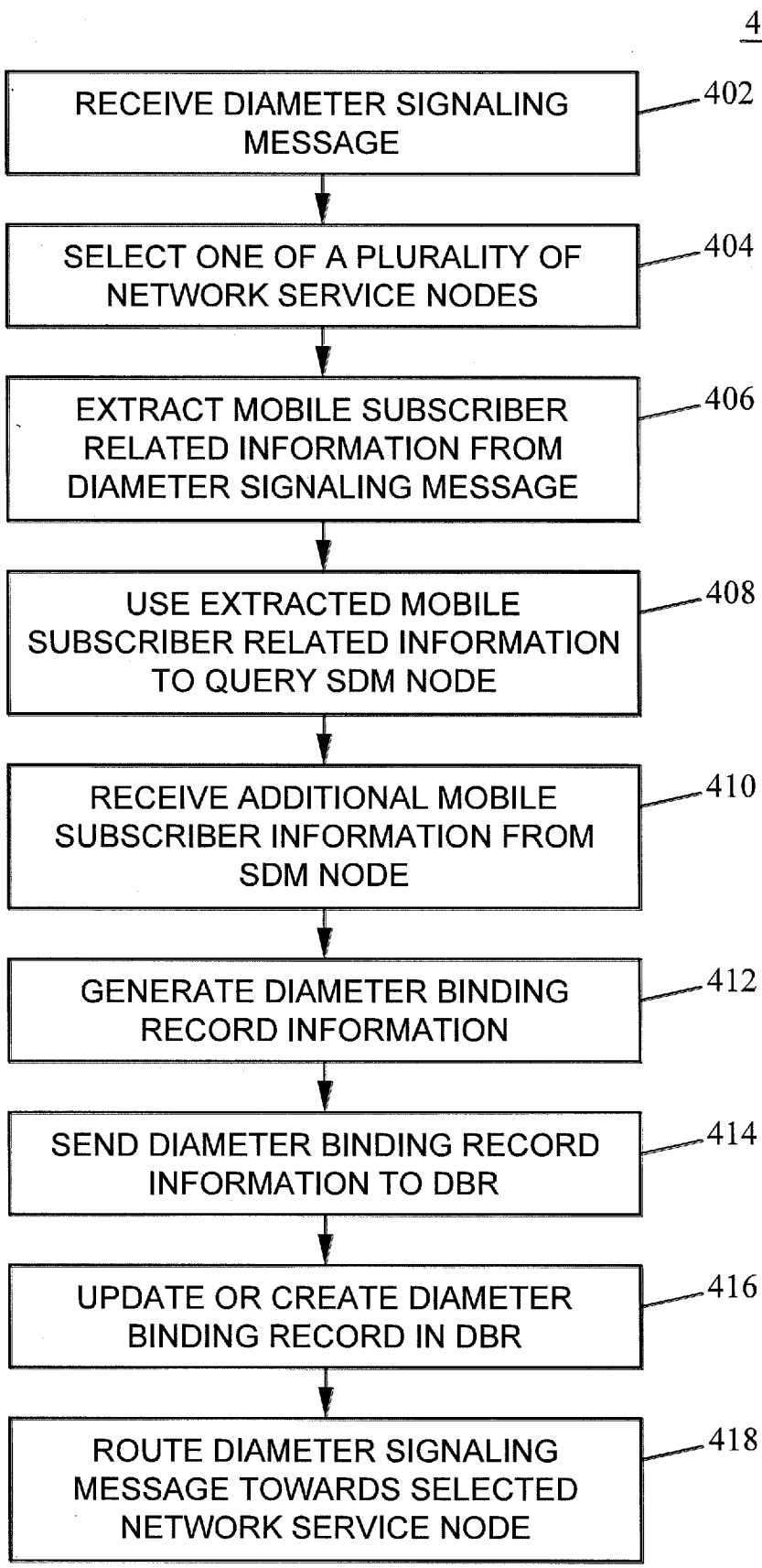
400
RECEIVE DIAMETER SIGNALING MESSAGE
402
SELECT ONE OF A PLURALITY OF NETWORK SERVICE NODES
404
EXTRACT MOBILE SUBSCRIBER RELATED INFORMATION FROM DIAMETER SIGNALING MESSAGE
406
USE EXTRACTED MOBILE SUBSCRIBER RELATED INFORMATION TO QUERY SDM NODE
408
RECEIVE ADDITIONAL MOBILE SUBSCRIBER INFORMATION FROM SDM NODE
410
GENERATE DIAMETER BINDING RECORD INFORMATION
412
SEND DIAMETER BINDING RECORD INFORMATION TO DBR
414
UPDATE OR CREATE DIAMETER BINDING RECORD IN DBR
416
ROUTE DIAMETER SIGNALING MESSAGE TOWARDS SELECTED NETWORK SERVICE NODE
418

FIG. 4

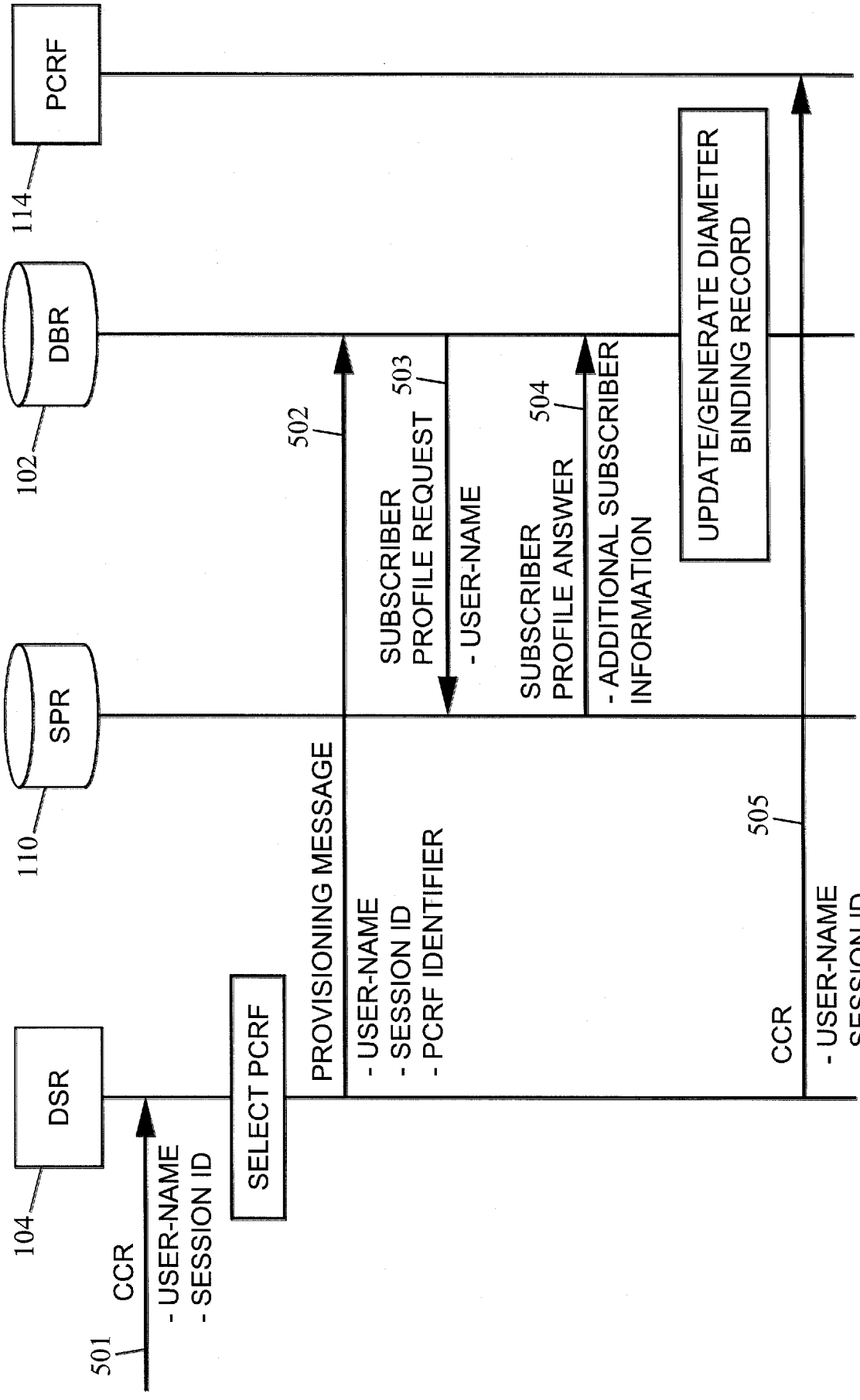
PCRF
114
DBR
102
SPR
110
DSR
104
501
CCR
- USER-NAME
- SESSION ID
SELECT PCRF
PROVISIONING MESSAGE
- USER-NAME
- SESSION ID
- PCRF IDENTIFIER
502
SUBSCRIBER PROFILE REQUEST
503
- USER-NAME
SUBSCRIBER PROFILE ANSWER
504
- ADDITIONAL SUBSCRIBER INFORMATION
UPDATE/GENERATE DIAMETER BINDING RECORD
505
CCR
- USER-NAME
- SESSION ID

FIG. 5

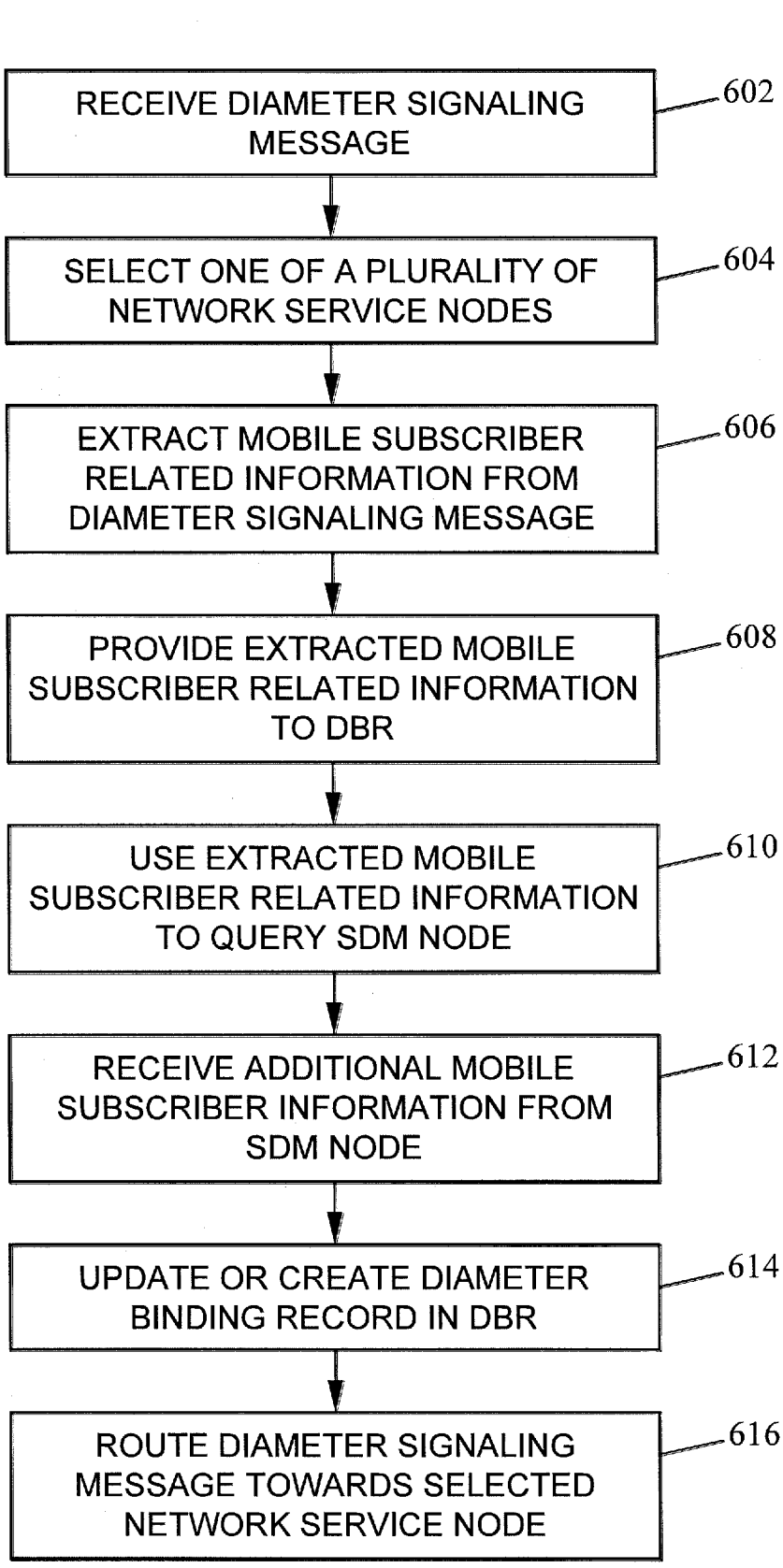
600
RECEIVE DIAMETER SIGNALING MESSAGE
602
SELECT ONE OF A PLURALITY OF NETWORK SERVICE NODES
604
EXTRACT MOBILE SUBSCRIBER RELATED INFORMATION FROM DIAMETER SIGNALING MESSAGE
606
PROVIDE EXTRACTED MOBILE SUBSCRIBER RELATED INFORMATION TO DBR
608
USE EXTRACTED MOBILE SUBSCRIBER RELATED INFORMATION TO QUERY SDM NODE
610
RECEIVE ADDITIONAL MOBILE SUBSCRIBER INFORMATION FROM SDM NODE
612
UPDATE OR CREATE DIAMETER BINDING RECORD IN DBR
614
ROUTE DIAMETER SIGNALING MESSAGE TOWARDS SELECTED NETWORK SERVICE NODE
616

FIG. 6

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2012/023971

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 , provisioning

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2009-0232011 A1 (JIJUN LI et al.) 17 September 2009 See claims 1-16 and figures 1-5.	1-29
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

☐ 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
11 JUNE 2012 (11.06.2012)	**11 JUNE 2012 (11.06.2012)**

Name and mailing address of the ISA/KR
Korean Intellectual Property Office
189 Cheongsa-ro, Seo-gu, Daejeon Metropolitan City, 302-701, Republic of Korea
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/US2012/023971

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		WO 2007-149330 A3	27.12.2007