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(54) **Title**: METHODS, SYSTEMS, AND COMPUTER READABLE MEDIA FOR INTER-MESSAGE PROCESSOR STATUS SHARING

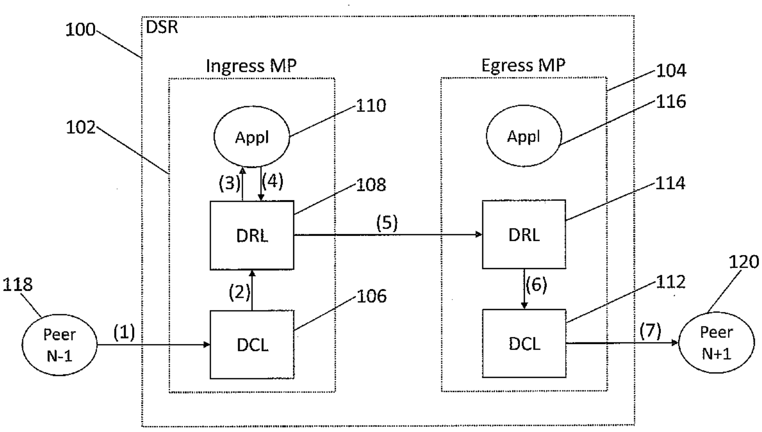

FIG. 1

(57) **Abstract**: According to one aspect, the subject matter described herein includes a method of operating a Diameter signaling router (DSR) for routing Diameter messages. The method includes steps occurring at a DSR comprising a plurality of Diameter message processors, each configured to perform at least one Diameter function. The method also includes detecting, at a first of the plurality of Diameter message processors, a change in status relating to the at least one Diameter function. The method further includes communicating, by the first of the plurality of Diameter message processors and to a second of the plurality of Diameter message processors, an indication of the change in status.

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DESCRIPTION

METHODS, SYSTEMS, AND COMPUTER READABLE MEDIA FOR INTER-MESSAGE PROCESSOR STATUS SHARING

PRIORITY CLAIM

This application claims the benefit of U.S. Provisional Patent Application Serial No. 61/304,310, filed February 12, 2010; the disclosure of which is incorporated herein by reference in its entirety.

STATEMENT OF INCORPORATION BY REFERENCE

The disclosures of each of the following commonly-owned, co-pending U.S. Patent Applications filed on February 11, 2011 are hereby incorporated herein by reference in their entireties:

"Methods, Systems, And Computer Readable Media For Inter-Diameter-Message Processor Routing," Attorney Docket No. 1322/399/2 (Serial No. not yet assigned);

"Methods, Systems, And Computer Readable Media For Source Peer Capacity-Based Diameter Load Sharing" Attorney Docket No. 1322/399/3 (Serial No. not yet assigned);

"Methods, Systems, And Computer Readable Media For Providing Priority Routing At A Diameter Node," Attorney Docket No. 1322/399/5 (Serial No. not yet assigned);

"Methods, Systems, And Computer Readable Media For Providing Peer Routing At A Diameter Node," Attorney Docket No. 1322/399/6/2 (Serial No. not yet assigned);

"Methods, Systems, And Computer Readable Media For Providing Origin Routing At A Diameter Node," Attorney Docket No. 1322/399/7 (Serial No. not yet assigned);

"Methods, Systems, And Computer Readable Media For Providing Local Application Routing At A Diameter Node," Attorney Docket No. 1322/399/8 (Serial No. not yet assigned);

"Methods, Systems, And Computer Readable Media For Answer-Based Routing Of Diameter Request Messages," Attorney Docket No. 1322/399/9 (Serial No. not yet assigned);

"Methods, Systems, And Computer Readable Media For Performing Diameter Answer Message-Based Network Management At A Diameter Signaling Router (DSR)," Attorney Docket No. 1322/399/10 (Serial No. not yet assigned);

"Methods, Systems, And Computer Readable Media For Multi-Interface Monitoring And Correlation Of Diameter Signaling Information," Attorney Docket No. 1322/399/11 (Serial No. not yet assigned);

"Methods, Systems, And Computer Readable Media For Diameter Protocol Harmonization," Attorney Docket No. 1322/399/12 (Serial No. not yet assigned);

"Methods, Systems, And Computer Readable Media For Diameter Network Management," Attorney Docket No. 1322/399/13 (Serial No. not yet assigned); and

"Methods, Systems, And Computer Readable Media For Diameter Application Loop Prevention," Attorney Docket No. 1322/399/14 (Serial No. not yet assigned).

TECHNICAL FIELD

The subject matter described herein relates to inter-message processor status sharing. More specifically, the subject matter relates to methods, systems, and computer readable media for inter-message processor status sharing.

BACKGROUND

The Diameter protocol is a next generation authentication, authorization, and accounting (AAA) protocol. The Diameter base protocol is defined in IETF RFC 3588, the disclosure of which is incorporated by reference herein in its entirety. Commonly used within the Internet multimedia subsystem (IMS) architecture, the Diameter protocol was derived from the remote authentication dial-in user service (RADIUS) protocol.

Historically, the RADIUS protocol was employed by Internet service providers (ISPs) to provide a secure communication channel between an ISP's access server and a secure location where user credential information was stored, e.g., a lightweight directory access protocol (LDAP) server. While the RADIUS protocol provided a standardized AAA exchange protocol, the emergence of new technologies and applications necessitated the development of a protocol capable of meeting ever-changing demands. Diameter aims to extend the standardized approach of RADIUS while providing expanded functionality and remaining open to future development.

The above-referenced Diameter RFC does not specify an architecture for Diameter routing or processing nodes. Likewise, the RFC does not specify a method for inter-processor communication when a Diameter element includes a distributed architecture. Accordingly, a need exists for methods, systems, and computer readable media for inter-message processor status sharing.

SUMMARY

According to one aspect, the subject matter described herein includes a method of operating a Diameter signaling router (DSR) for routing Diameter messages. The method includes steps occurring at a DSR comprising a plurality of Diameter message processors, each configured to perform at least one Diameter function. The method also includes detecting, at a first of the plurality of Diameter message processors, a change in status associated with the at least one Diameter function. The method further includes communicating, by the first of the plurality of Diameter message processors and to a second of the plurality of Diameter message processors, an indication of the change in status.

According to another aspect, the subject matter described herein includes a system for routing Diameter messages. The system includes a Diameter signaling router including first and second Diameter message processors, each configured to implement at least one Diameter function. The first Diameter message processor is configured to detect a change in status associated with the at least one Diameter function and communicate,

to the second Diameter message processor, an indication of the change in status.

As used herein, the term “Diameter connection layer (DCL)” refers to a layer of the Diameter stack that implements Diameter transport connections.

As used herein, the term “Diameter routing layer (DRL)” refers to a layer of the Diameter stack which implements Diameter routing.

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

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

BRIEF DESCRIPTION OF THE DRAWINGS

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

Figure 1 is a block diagram illustrating an exemplary DSR architecture including full stack message processors (MPs) for routing Diameter messages according to an embodiment of the subject matter described herein;

Figure 2 is a block diagram illustrating an exemplary DSR architecture including dedicated Diameter connection layer (DCL) MPs for routing Diameter messages according to an embodiment of the subject matter described herein;

Figure 3 is a block diagram illustrating an exemplary DSR architecture including dedicated DCL/DRL and application MPs for routing Diameter messages according to an embodiment of the subject matter described herein;

Figure 4 is a network diagram illustrating an exemplary Diameter networking environment which implements independent Diameter message processing nodes for routing Diameter messages between Diameter nodes and does not utilize inter-MP status sharing;

Figure 5 is a network diagram illustrating an exemplary network that includes a DSR which includes multiple MPs for routing Diameter messages utilizing inter-message processor status sharing according to an embodiment of the subject matter described herein;

Figure 6 is a message flow diagram illustrating inter-MP status sharing according to an embodiment of the subject matter described herein; and

Figure 7 is a flow chart illustrating an exemplary process for operating a DSR for routing Diameter messages according to an embodiment of the subject matter described herein.

DETAILED DESCRIPTION

Methods, systems, and computer readable media for inter-MP status sharing are provided.

A DSR may be any suitable entity for routing or relaying Diameter signaling messages between Diameter nodes. For example, a DSR may be a long term evolution (LTE) signaling router, an LTE Diameter signaling router, a Diameter signaling agent, a Diameter proxy agent, a Diameter relay agent, a Diameter routing agent, a Diameter translation agent, or a Diameter redirect agent. A DSR may include functionality for processing various messages. In one embodiment, a DSR may communicate with various

Diameter nodes via one or more 3rd generation partnership project (3GPP) LTE communications interfaces. In another embodiment, a DSR may communicate with various Diameter nodes via one or more other (e.g., non-LTE) communications interfaces. For example, a DSR may communicate with Internet protocol (IP) multimedia subsystem (IMS) nodes, such as call session control functions (CSCFs), using IMS-related interfaces.

In one embodiment, a DSR may include multiple MPs, where each MP is a distinct message processing module of a distributed computing platform, a computing blade in a blade-based distributed computing platform, a processing core element associated with a single or multi-core computing device, or a virtual node instantiated on a single physical message processing/computing device. As such, a DSR may be located in a single distinct geographic location and communicate via an internal communications network, or may include multiple MPs located in geographically diverse locations and communicating via an external communications network.

As a logical entity, a DSR is extremely scalable, and may be designed according to multiple architectural options. A first architecture option may include where each MP supports a full Diameter stack that includes a DCL, a DRL, and an application layer. A second architecture option may include a DCL that runs on dedicated MPs, with routing and application layers either combined on MPs or each having dedicated MPs. A third architecture option may include a Diameter stack (DCL/DRL) that runs on dedicated MPs, with local Diameter applications running on separate dedicated MPs. Each of these exemplary architecture options will now be described in greater detail below with respect to Figures 1, 2, and 3.

Figure 1 is a block diagram illustrating an exemplary DSR architecture including full stack MPs for routing Diameter messages according to an embodiment of the subject matter described herein. Referring to Figure 1, DSR **100** may include ingress MP **102** for receiving Diameter messages from peers and egress MP **104** for transmitting Diameter messages to peers. Ingress MP **102** and egress MP **104** may each include a DCL, DRL, and one or more applications. For example, ingress MP **102** may include DCL **106**, DRL **108**, and application **110**. Likewise, egress MP **104** may include DCL **112**, DRL **114**, and application **116**. In order to communicate between ingress MP **102** and egress MP **104**, DRL **108** of ingress MP **102** may be operable to communicate with DRL **114** and DCL **112** of egress MP **104**. Additionally, DRLs **108** and **114** may each be operable to communicate with DCLs **106** and **112** and applications **110** and **116**, respectively.

In an exemplary Diameter message routing scenario, peer N-1 **118** may send a Diameter message to DSR **100**. The Diameter message may be received by DCL **106** of ingress MP **102**. Ingress messages may be processed completely on ingress MP **102** up through the selection of a next-hop peer for the Diameter message by DRL **108**. Continuing the exemplary scenario above, DCL **106** may pass the Diameter message to DRL **108**.

If application processing is required, ingress DRL **108** may forward the Diameter message to a Diameter message processor hosting a local application(s). For example, DRL **108** may forward the Diameter message to an MP hosting local application **110**, which processes the message and returns the message to DRL **108**. It is appreciated that the application distribution function may not be required.

Next, ingress DRL **108** may forward the Diameter message to egress DRL **114** for forwarding to the local DCL queue **112**. Egress DCL **112** may then transmit the Diameter message to peer N+1 **120**.

In an additional exemplary Diameter message routing scenario (not illustrated), peer N-1 **118** may send a Diameter message to DSR **100**. The Diameter message may be received by DCL **106** of ingress MP **102**. DCL **106** may forward the message to DRL **108**. If application processing is required, ingress DRL **108** may forward the Diameter message to local application **110**, which processes the message and returns the message to DRL **108**. Next, ingress DRL **108** may forward the Diameter message to egress DCL **112**, which may then transmit the Diameter message to peer N+1 **120**.

In an additional exemplary Diameter message routing scenario (not illustrated), peer N-1 **118** may send a Diameter message to DSR **100**. The Diameter message may be received by DCL **106** of ingress MP **102**. DCL

106 may pass the Diameter message to DRL **114** of egress MP **104**. If application processing is required, egress DRL **114** may forward the Diameter message to local application **116**, which processes the message and returns the message to DRL **114**. Next, egress DRL **114** may forward the Diameter message to egress DCL **112**, which may then transmit the Diameter message to peer N+1 **120**.

Figure 2 is a block diagram illustrating an exemplary DSR architecture including dedicated Diameter connection layer DCL MPs for routing Diameter messages according to an embodiment of the subject matter described herein. In contrast to the full stack-per MP embodiment shown in Figure 1, the embodiment shown in Figure 2 includes dedicated DCL MPs. Referring to Figure 2, DSR **100** may include DCL-MP **200** for receiving Diameter messages from peers and DCL-MP **208** for transmitting Diameter messages to peers. Similarly, DSR **100** may include DRL-MP **202** and DRL-MP **206** for receiving Diameter messages from peers and for transmitting Diameter messages to peers. In contrast to a full stack-per MP embodiment (Figure 1), application-MP **204** may be associated with DRL-MP **202** and may not have a corollary associated with DRL-MP **206**. Nevertheless, application-MP **204** may be operable to communicate with either or both of DRL-MPs **202** and **206**. Like Figure 1, DRL-MPs **202** and **206** may each be operable to communicate with one another and with DCL-MPs **200** and **208**.

Therefore, in an exemplary Diameter message routing scenario analogous to the one described above with respect to Figure 1, peer N-1 **118** may send Diameter messages to DSR **100**. Ingress Diameter messages may be received by DCL-MP **200**, which may distribute the Diameter messages (e.g., request messages) to DRL-MP **202** based on various factors including, but not limited to, the availability, transactions per second (TPS) capacity, and congestion status of DRL-MP **202** as compared with other DRL-MPs (not shown in their entirety).

DRL-MP **202** may determine whether application processing is required. If application processing is required, ingress DRL-MP **202** may distribute the request messages to Appl-MP **204** (also based on its availability, TPS capacity, and congestion status).

Ingress DRL-MP **202** may then select a next-hop peer for the messages and ingress DRL-MP **202** may forward the messages to egress DRL-MP **206**. Egress DRL-MP **206** may then forward the messages to egress DCL-MP **208** (highest degree on inter-MP communication) for delivery to peer N+1 **120** selected by DRL-MP **202**.

In an additional exemplary Diameter message routing scenario (not illustrated), peer N-1 **118** may send Diameter messages to DSR **100**. Ingress Diameter messages may be received by DCL-MP **200**, which may distribute the Diameter messages (e.g., request messages) to DRL-MP **202** based on various factors including, but not limited to, the availability, TPS capacity, and congestion status of DRL-MP **202** as compared with other DRL-MPs (not shown in their entirety). DRL-MP **202** may determine whether application processing is required. If application processing is required, ingress DRL-MP **202** may distribute the request messages to Appl-MP **204** (also based on its availability, TPS capacity, and congestion status). Ingress DRL-MP **202** may then select a next-hop peer for the messages and ingress DRL-MP **202** may forward the messages to egress DCL-MP **208** for delivery to peer N+1 **120** selected by DRL-MP **202**.

In an additional exemplary Diameter message routing scenario (not illustrated), peer N-1 **118** may send Diameter messages to DSR **100**. Ingress Diameter messages may be received by DCL MP **200**, which may distribute the Diameter messages (e.g., request messages) to DRL-MP **206** based on various factors including, but not limited to, the availability, TPS capacity, and congestion status of DRL-MP **206** as compared with other DRL-MPs (not shown in their entirety). DRL-MP **206** may determine whether application processing is required. If application processing is required, DRL-MP **206** may distribute the request messages to Appl-MP **204** (also based on its availability, TPS capacity, and congestion status). DRL-MP **206** may then select a next-hop peer for the messages and DRL-MP **206** may forward the messages to egress DCL-MP **208** for delivery to peer N+1 **120** selected by DRL-MP **206**.

Figure 3 is a block diagram illustrating an exemplary DSR architecture including dedicated DCL/DRL and application MPs for routing Diameter messages according to an embodiment of the subject matter described herein. It may be appreciated that Figure 3 represents a hybrid approach between the full stack per MP of Figure 1 and the dedicated DCL/DRL/application-MPs of Figure 2. Referring to Figure 3, in an exemplary Diameter message routing scenario, peer N-1 **118** may send a Diameter message to DSR **100**. The Diameter message may be received by DCL **106** of ingress MP **102**. The Diameter message may be processed completely on ingress MP **102** up through the selection of a destination peer for the Diameter message by DRL **108**. DCL **106** may then pass the Diameter message to DRL **108**.

If application processing is required, ingress DRL **108** may forward the Diameter message to local application(s). For example, DRL **108** may forward the Diameter message to local application **204**, which may process the message and return the message to DRL **108**.

Next, ingress DRL **108** may forward the Diameter message to egress DRL **114** for forwarding to the local DCL queue **112**. Egress DCL **112** may then transmit the Diameter message to peer N+1 **120**.

In an additional exemplary Diameter message routing scenario (not illustrated), peer N-1 **118** may send a Diameter message to DSR **100**. The Diameter message may be received by DCL **106** of ingress MP **102**. The Diameter message may be processed completely on ingress MP **102** up through the selection of a destination peer for the Diameter message by DRL **108**. DCL **106** may then pass the Diameter message to DRL **108**. If application processing is required, ingress DRL **108** may forward the Diameter message to local application(s). For example, DRL **108** may forward the Diameter message to local application **204**, which may process the message and return the message to DRL **108**. Next, ingress DRL **108** may forward the Diameter message to DCL **112** which may then transmit the Diameter message to peer N+1 **120**.

In an additional exemplary Diameter message routing scenario (not illustrated), peer N-1 **118** may send a Diameter message to DSR **100**. The Diameter message may be received by DCL **106** of ingress MP **102**. DCL **106** may then pass the Diameter message to DRL **114**. If application processing is required, DRL **114** may forward the Diameter message to local application(s). For example, DRL **114** may forward the Diameter message to local application **204**, which may process the message and return the message to DRL **114**. Next, DRL **114** may forward the Diameter message to DCL **112** which may then transmit the Diameter message to peer N+1 **120**.

Irrespective of the architectural option implemented, utilization of a DSR may benefit from the ability of the individual MPs to share change in their respective statuses. Exemplary MP status information may include, but is not limited to, status information associated with one or more Diameter connections hosted / serviced by the MP, status information associated with one or more Diameter signaling routes serviced by the MP, status information associated with one or more SCTP associations hosted / serviced by the MP, status information associated with one or more Diameter peer nodes serviced by / accessed via the MP, status information associated with one or more TCP sockets hosted / serviced by the MP, status information associated with one or more Internet protocol addresses hosted / serviced by the MP, status information associated with one or more database resources hosted / serviced by the MP, and status information associated with one or more Diameter applications hosted by / serviced by / accessed via the MP. Exemplary types of status information may include, but are not limited to, availability status information, congestion status information, active / standby status information, in-service/out-of-service status information, failure state status information, software version status information, hardware version status information, firmware version status information, upgrade status information, message processing / transaction rate status information. The sharing of such “peer status” may, for example, be utilized by the ingress MP to determine the status of route lists, route groups, and routes which are prerequisite to route selection. In other embodiments a local MP may share its congestion status in order to aide its peers in routing. For example, if an egress MP is experiencing critical congestion, inter-MP status sharing may allow ingress MP to take this into consideration during route selection. Figures 4 and 5 illustrate an exemplary benefit of utilizing inter-MP status sharing in such a scenario.

Figure 4 is a network diagram illustrating an exemplary Diameter networking environment which implements independent Diameter message processing nodes for routing Diameter messages between Diameter nodes and does not utilize inter-MP status sharing. Referring to Figure 4, network **400** includes Diameter peer nodes **402**, **404**, and **406**. Diameter peer nodes **404** and **406** are in a common Diameter realm **408**. Network **400**, further includes independent Diameter message processing nodes **410**, **412**, and **414**. A Diameter connection **416** exists between Diameter peer node **402** and Diameter message processing node **410**. Similarly, Diameter connection **418** exists between Diameter peer node **404** and Diameter message processing node **412**; Diameter connection **420** exists between Diameter peer node **406** and Diameter message processing node **414**; and Diameter connection **422** exists between Diameter peer node **404** and Diameter message processing node **414.**

As Figure 4 illustrates, Diameter messaging processing node **410** is load sharing messages coming from Diameter peer node **402** and destined for Diameter realm **408** between Diameter message processing nodes **412** and **414** at a 50/50 ratio. A route failure exists along Diameter connection **418**. While Diameter message processing node **412** may be aware of the route failure along Diameter connection **418**, Diameter message processing node **410** remains unaware. Without knowledge of the route failure along Diameter connection **418**, Diameter message processing node **410** continues to load share half of the messages from Diameter peer node **402** and destined for Diameter realm **408** to Diameter message processing node **412**. Operating network **400** in such a manner results in half of the routing attempts performed by Diameter message processing node **410** failing and having to be rerouted.

Figure 5 is a network diagram illustrating an exemplary network that includes a DSR which includes multiple MPs for routing Diameter messages utilizing inter-MP status sharing according to an embodiment of the subject matter described herein. Referring to Figure 5, network **500** includes Diameter peer nodes **502**, **504**, and **506**. Diameter peer nodes **504** and **506** are in a common Diameter realm **508**. Network **500**, further includes DSR

510. DSR **510** may include multiple Diameter message processors. For example, DSR **510** includes Diameter message processors **512**, **514**, and **516**. A Diameter connection **518** exists between Diameter peer node **502** and DSR **510**'s Diameter MP **512**. Similarly, Diameter connection **520** exists between Diameter peer node **504** and DSR **510**'s Diameter MP **514**; Diameter connection **522** exists between Diameter peer node **506** and DSR **510**'s Diameter MP **516**; and Diameter connection **524** exists between Diameter peer node **504** and DSR **510**'s Diameter MP **516.**

As Figure 5 illustrates, DSR **510**'s Diameter MP **512** may load share messages coming from Diameter peer node **502** and destined for Diameter realm **508** between DSR **510**'s Diameter MPs **514** and **516**. Prior to a route failure along Diameter connection **520**, this load sharing may be at a 50/50 ratio (not illustrated). A route failure may arise along Diameter connection **520**. In accordance with an embodiment of the subject matter described herein, DSR **510**'s Diameter MP **514** may share information pertaining to its status (e.g., route failure exists along Diameter connection **520**) with its peer, DSR **510**'s Diameter MP **512**. In response, DSR **510**'s Diameter MP **512** may alter the load sharing ratio to 0/100 so that all Diameter messages from Diameter peer node **502** and destined for Diameter realm **508** are routed through DSR **510**'s MP **516**. Similarly, if and when the route failure along Diameter connection **520** is resolved, DSR **510**'s MP **514** may share information pertaining to its status (e.g., Diameter connection **520** "up") with its peer, DSR **510**'s Diameter MP **512**, which may then resume load sharing messages coming from Diameter peer node **502** and destined for Diameter realm **508** between DSR **510**'s Diameter MPs **514** and **516** at a 50/50 ratio (not illustrated). In an alternate example, when Diameter connection **520** fails, DSR **510**'s MP **512** may, upon learning of the change in status, redirect messages destined for Diameter peer node **504** to DSR **510**'s MP **516**.

In one embodiment, DSR **510** may include MP status database (DB) **526**. MP status DB **526** may be accessible to DSR **510**'s Diameter MPs **512**, **514**, and **516**. In accordance with an embodiment of the subject matter described herein, MP status DB **526** may be utilized for inter-MP status sharing. For example, in the above scenario, DSR **510**'s Diameter MP **514** may update MP status DB **526** to reflect the route failure along Diameter connection **520**. DSR **510**'s Diameter MP **512** may be configured to query MP status DB **526** and/or MP status DP **526** may be configured to broadcast/multicast status information to any or all of DSR **510**'s Diameter MPs.

Figure 6 is a message flow diagram illustrating inter-MP status sharing according to an embodiment of the subject matter described herein. Referring to the route failure scenario described above with respect to Figure 5, DSR **510**'s Diameter MP **512** is load sharing messages coming from Diameter peer node **502** and destined for Diameter realm **508** between DSR **510**'s Diameter MPs **514** and **516** at a 50/50 ratio. Referring to Figure 6, just prior to step 1, the route failure occurs along Diameter connection **520**. DSR **510**'s Diameter MP **514** detects the route failure along Diameter connection **520**. At step 1, DSR **510**'s Diameter MP **514** sends an inter-MP status message to its peer, DSR **510**'s Diameter MP **512**, communicating the change in its status as a result of the failure along Diameter connection **520**.

Figure 7 is a flow chart illustrating an exemplary process for operating a DSR for routing Diameter messages according to an embodiment of the subject matter described herein. Referring to Figure 7, in step **700**, a first Diameter message processor detects a change in status relating to a Diameter function performed by the Diameter message processor. For example, as set forth above, the first Diameter message processor may perform Diameter routing and may detect a change in status of a peer Diameter node or a connection that affects a Diameter route. In step **702**, the first Diameter message processor communicates an indication of the change in status to a second Diameter message processor. For example, the first Diameter message processor may send a message to the second Diameter message processor communicating the identity of the affected route and the route status to the second Diameter message processor. In an alternate implementation, the first Diameter message processor may update a central routing table or other data structure indicating the change in status.

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 of operating a Diameter signaling router (DSR) for routing Diameter messages, the method comprising:

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

detecting, at a first of the plurality of Diameter message processors, a change in status relating to the at least one Diameter function; and

communicating, by the first of the plurality of Diameter message processors and to a second of the plurality of Diameter message processors, an indication of the change in status.

2. The method of claim 1 wherein the change in status includes at least one of a change in operational status of a message processor, a change in operational status of a Diameter layer, a change in operational status of a Diameter peer node, a change in connection status of a Diameter peer node, a change in operational status of a Diameter application, and a change in connection status of a Diameter application.

3. The method of claim 1 comprising, in response to detecting the change in status, updating at least one of a routing table associated with the DSR, a routing database associated with the DSR, and a routing data structure associated with the DSR.

4. The method of claim 1 wherein at least one of the plurality of Diameter message processors is a distinct message processor for one of: implementing Diameter transport connections; implementing Diameter routing; or implementing Diameter applications.

5. The method of claim 1 wherein at least one of the plurality of Diameter message processors implements a layer for providing transport connections and a layer for performing Diameter routing.

6. The method of claim 1 wherein at least one of the plurality of Diameter message processors implements a layer for implementing

transport connections, a layer for performing Diameter routing, and a layer for providing Diameter applications.

7. The method of claim 1 wherein the Diameter message processors are interconnected via either an internal communications network or an external communications network.

8. The method of claim 1 wherein at least one of the plurality of Diameter message processors comprises one of:

a distinct message processing module of a distributed computing platform;

a computing blade in a blade-based distributed computing platform;

a processing core element associated with a single or multi-core computing device; and

a virtual node instantiated on a single physical message processing / computing device.

9. The method of claim 1 wherein communicating an indication of the change in status comprises updating at least one of a message processor status database associated with the DSR, a message processor status table associated with the DSR, and a message processor status data structure associated with the DSR.

10. The method of claim 9 wherein the at least one of the message processor status database associated with the DSR, the message processor status table associated with the DSR, and the message processor status data structure associated with the DSR is configured to broadcast/multicast status information to at least one of the plurality of Diameter message processors.

11. The method of claim 9 wherein at least one of the plurality of Diameter message processors is configured to query the at least one of the message processor status database associated with the DSR, the message processor status table associated with the DSR, and the message processor status data structure associated with the DSR.

12. A system for routing Diameter messages, the system comprising:

a Diameter signaling router including:

first and second Diameter message processors, each for implementing at least one Diameter function,

wherein the first Diameter message processor is configured to detect a change in status relating to the at least one Diameter function and communicate, to the second Diameter message processor, an indication of the change in status.

13. The system of claim 12 wherein the change in status includes at least one of a change in operational status of a message processor, a change in operational status of a Diameter layer, a change in operational status of a Diameter peer node, a change in connection status of a Diameter peer node, a change in operational status of a Diameter application, and a change in connection status of a Diameter application.

14. The system of claim 12 wherein at least one of the first and second Diameter message processors is configured to, in response to the change in status, update at least one of a routing table associated with the DSR, a routing database associated with the DSR, and a routing data structure associated with the DSR.

15. The system of claim 12 wherein at least one of the first Diameter message processor and the second Diameter message processor is a distinct message processor for one of: implementing Diameter transport connections; implementing Diameter routing; or implementing Diameter applications.

16. The system of claim 12 wherein at least one of the first Diameter message processor and the second Diameter message processor implements a layer for providing transport connections and a layer for performing Diameter routing.

17. The system of claim 12 wherein at least one of the first Diameter message processor and the second Diameter message processor implements a layer for providing transport connections, a layer for performing Diameter routing, and a layer for providing Diameter applications.

18. The system of claim 12 wherein the first Diameter message processor and the second Diameter message processor are interconnected via either an internal communications network or an external communications network.

19. The system of claim 12 wherein at least one of the first Diameter message processor and the second Diameter message processor comprises one of:

a distinct message processing module of a distributed computing platform;

a computing blade in a blade-based distributed computing platform;

a processing core element associated with a single or multi-core computing device; and

a virtual node instantiated on a single physical message processing / computing device.

20. The system of claim 12 wherein the first Diameter message processor is configured to communicate the indication of the change in status by updating at least one of a message processor status database associated with the DSR, a message processor status table associated with the DSR, and a message processor status data structure associated with the DSR.

21. The system of claim 20 wherein the at least one of the message processor status database associated with the DSR, the message processor status table associated with the DSR, and the message processor status data structure associated with the DSR is configured to broadcast/multicast status information to at least one of the first Diameter message processor and the second Diameter message processor.

22. The system of claim 20 wherein at least one of the first Diameter message processor and the second Diameter message processor is configured to query the at least one of the message processor status database associated with the DSR, the message processor status

table associated with the DSR, and the message processor status data structure associated with the DSR.

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

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

detecting, at a first of the plurality of Diameter message processors, a change in status relating to the at least one Diameter function; and

communicating, by the first of the plurality of Diameter message processors and to a second of the plurality of Diameter message processors, an indication of the change in status.

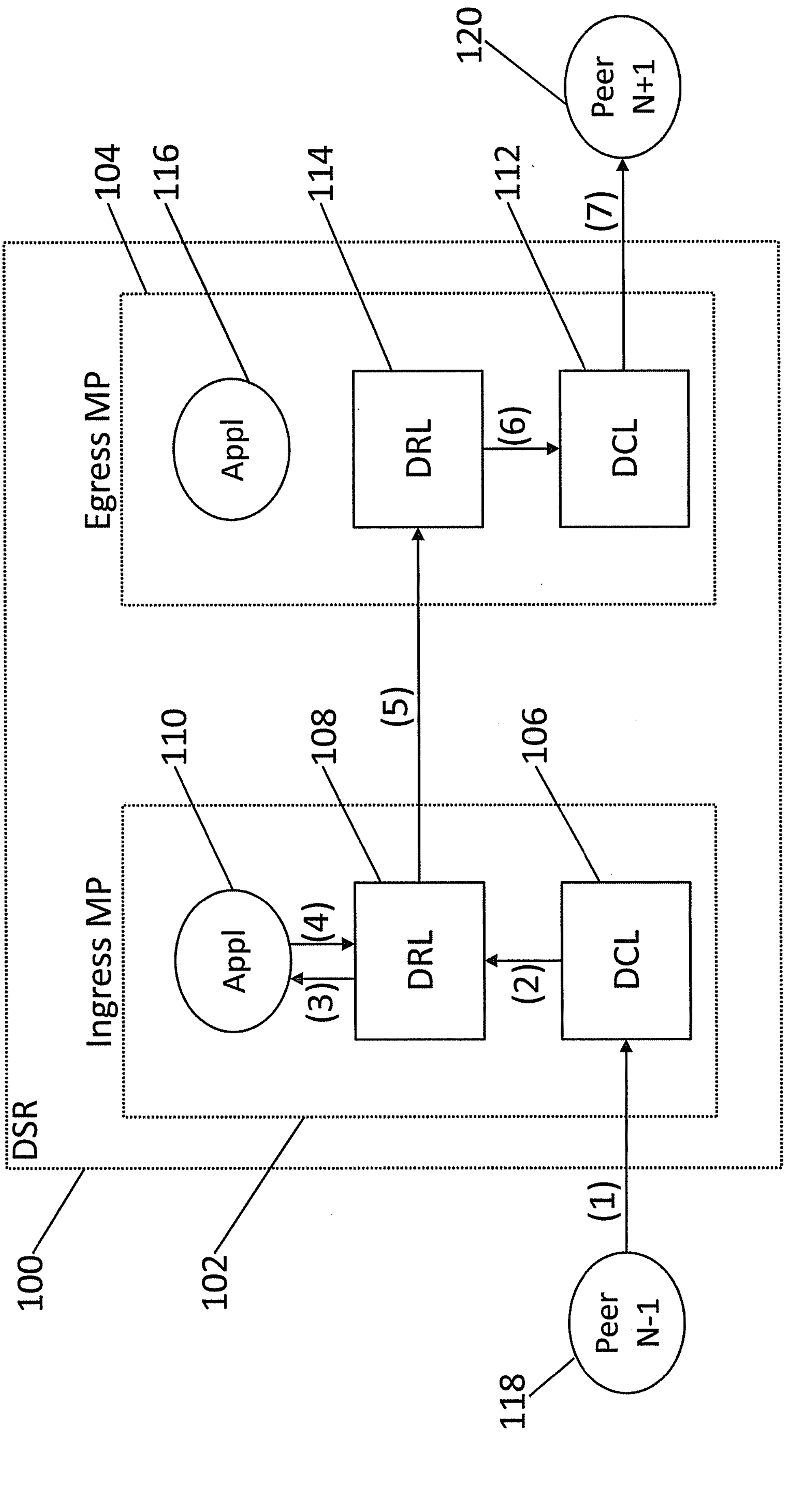
DSR
Ingress MP
Egress MP
Appl
DRL
DCL
Appl
DRL
DCL
Peer N-1
Peer N+1
(1)
(2)
(3)
(4)
(5)
(6)
(7)
100
102
104
106
108
110
112
114
116
118
120

FIG. 1

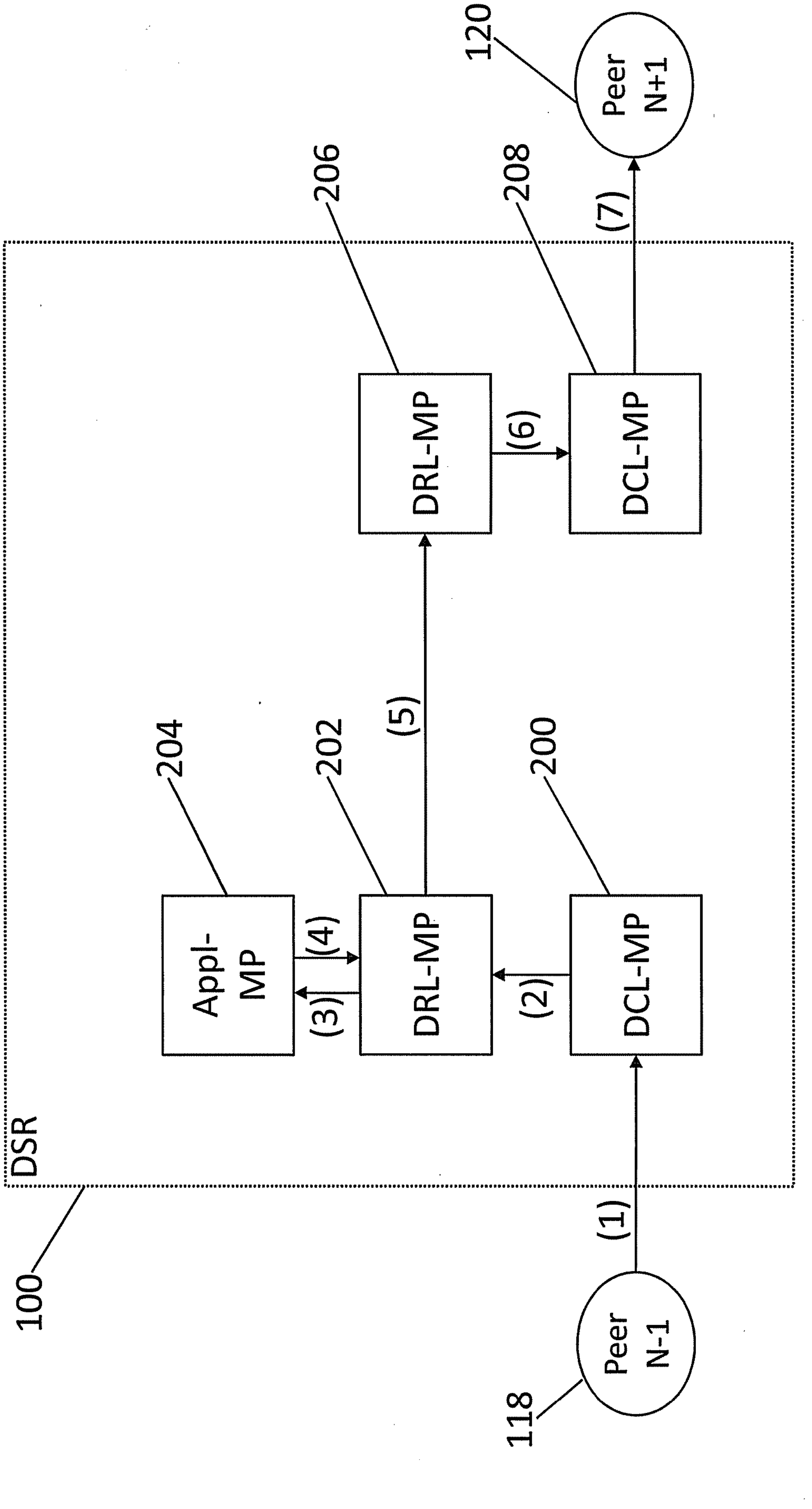
120
Peer
N+1
206
208
(7)
DRL-MP
(6)
DCL-MP
(5)
204
202
200
Appl-
MP
(4)
(3)
DRL-MP
(2)
DCL-MP
DSR
100
(1)
Peer
N-1
118

FIG. 2

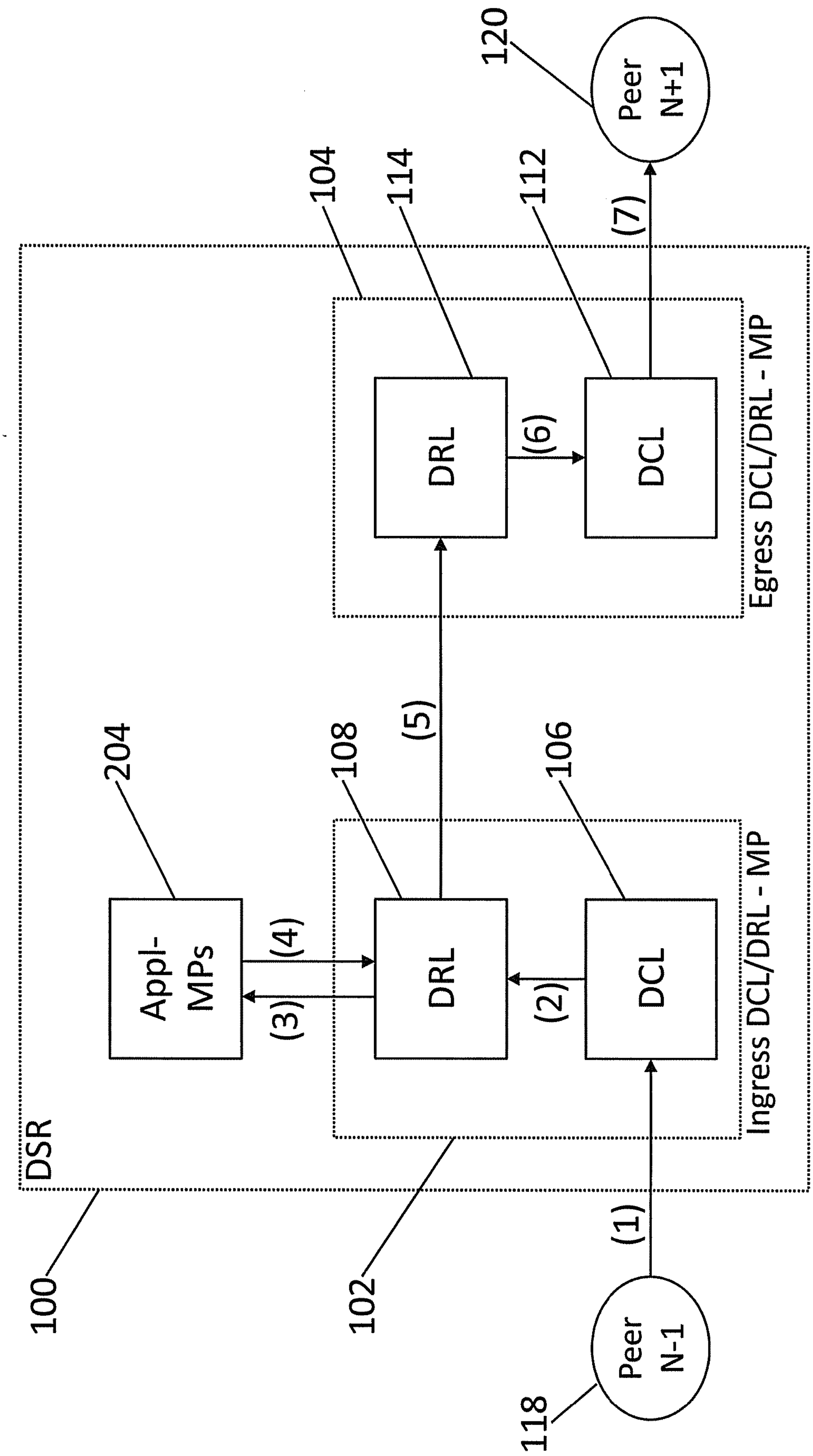
DSR
100
Ingress DCL/DRL - MP
102
Egress DCL/DRL - MP
104
Appl-MPs
204
DRL
108
DCL
106
DRL
114
DCL
112
Peer N-1
118
Peer N+1
120
(1)
(2)
(3)
(4)
(5)
(6)
(7)

FIG. 3

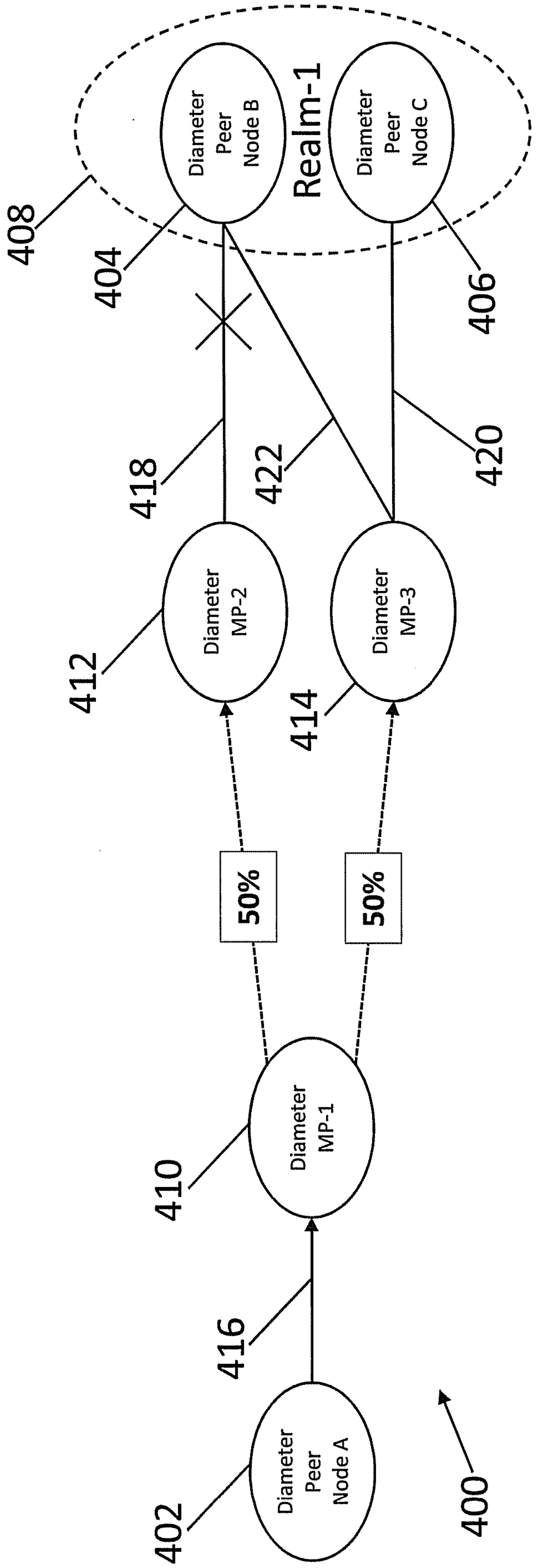
Diameter Peer Node A
402
416
Diameter MP-1
410
50%
50%
Diameter MP-2
412
Diameter MP-3
414
418
422
420
Diameter Peer Node B
404
Diameter Peer Node C
406
Realm-1
408
400

FIG. 4

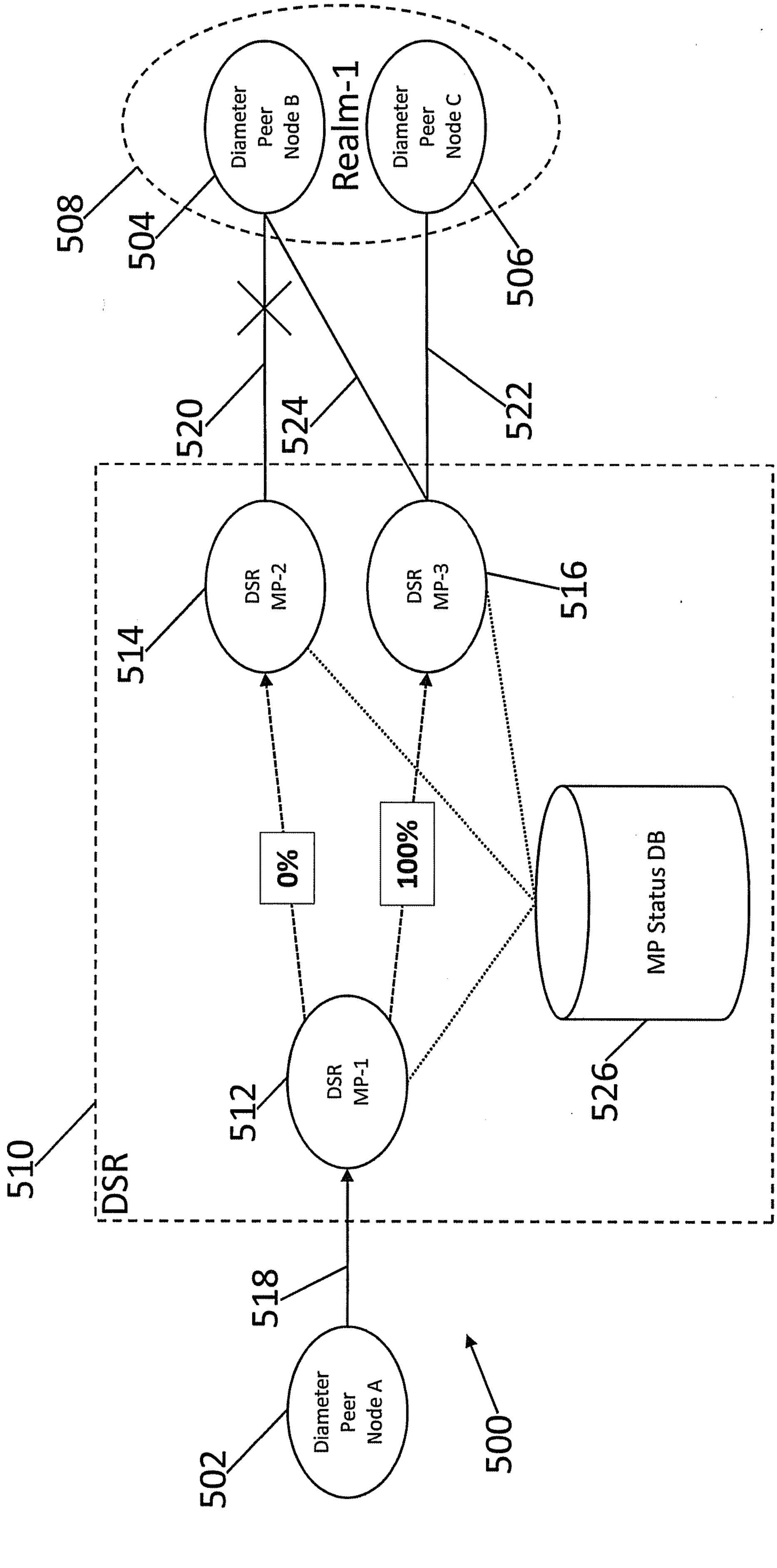
Diameter Peer Node A
502
500
518
DSR
510
DSR MP-1
512
0%
100%
DSR MP-2
514
DSR MP-3
516
MP Status DB
526
520
524
522
Diameter Peer Node B
504
Diameter Peer Node C
506
Realm-1
508

FIG. 5

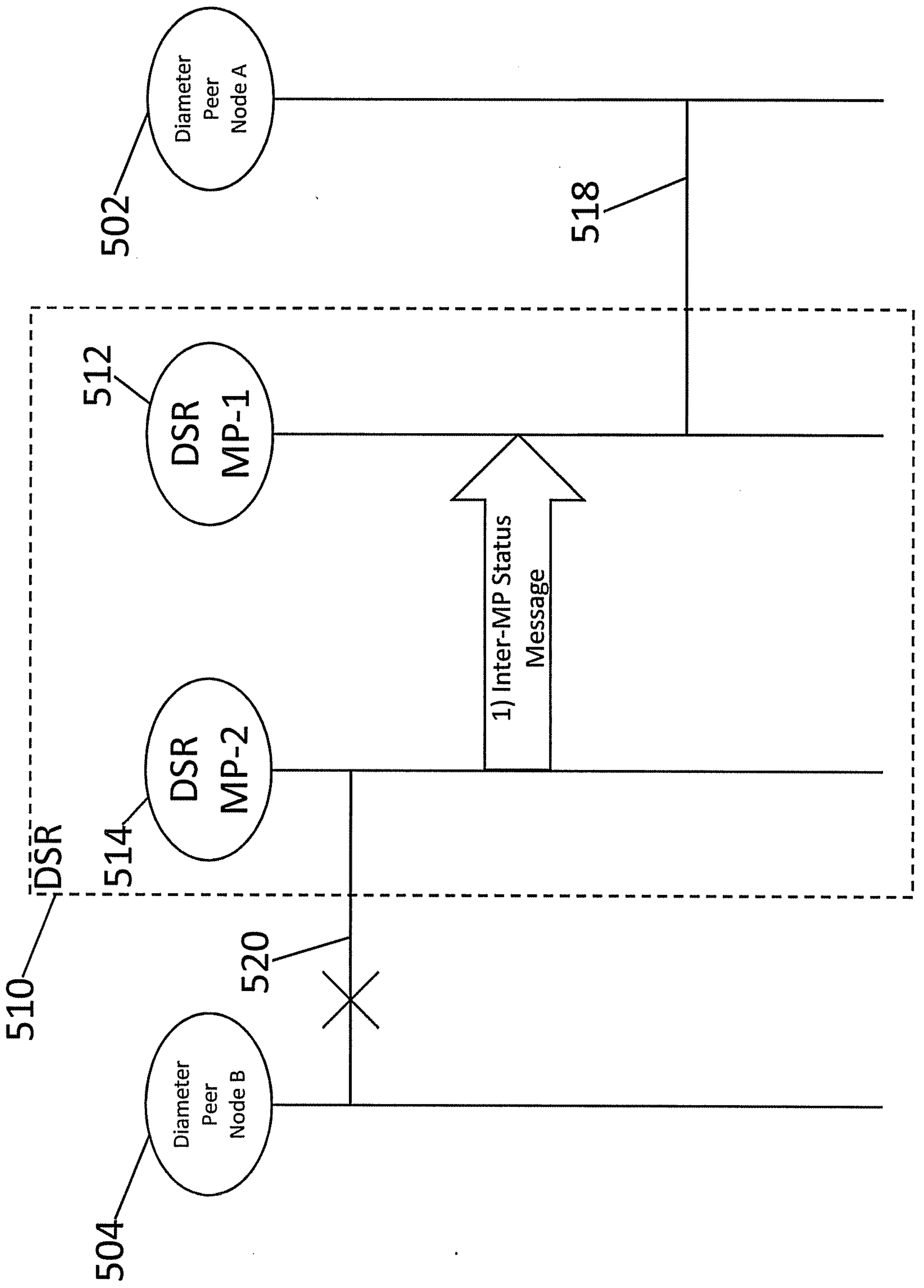
502
Diameter Peer Node A
518
512
DSR MP-1
1) Inter-MP Status Message
DSR MP-2
514
DSR
510
520
Diameter Peer Node B
504

FIG. 6

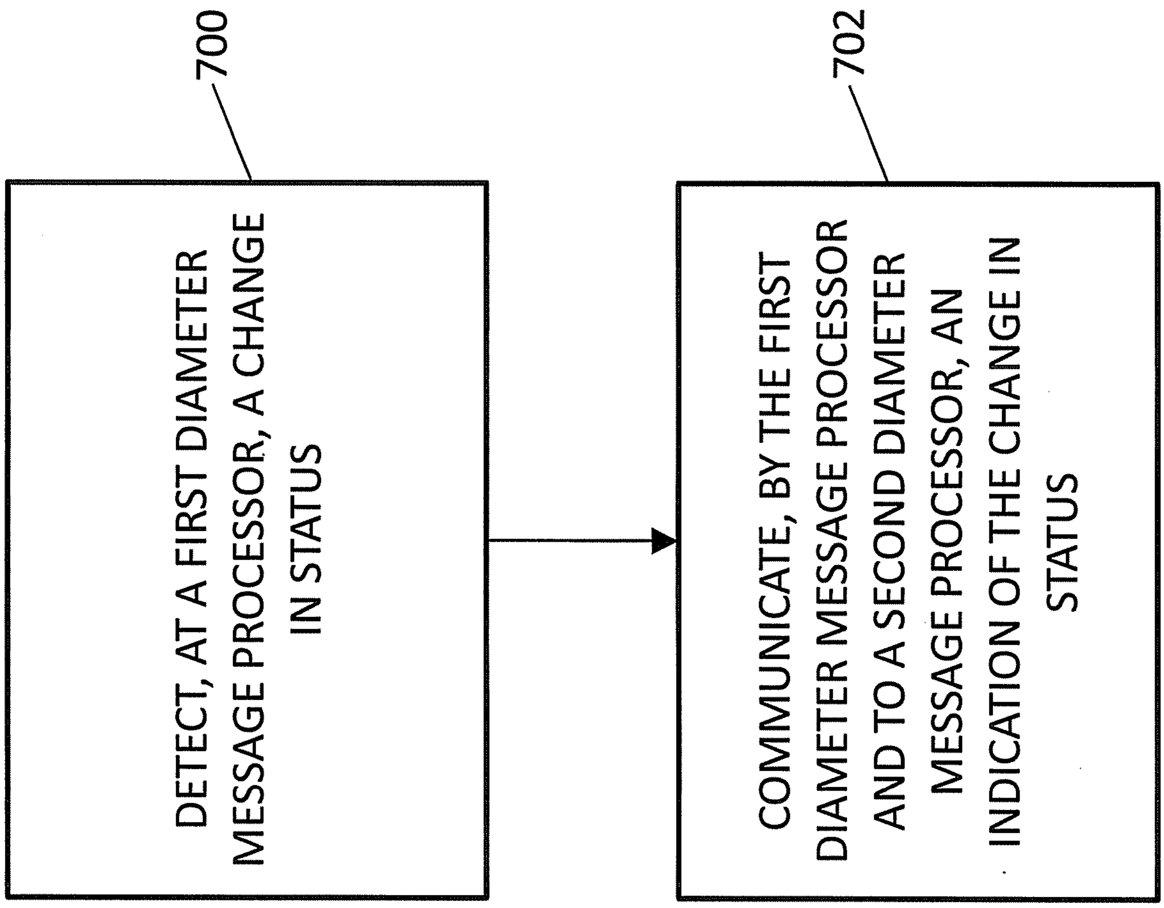
700
DETECT, AT A FIRST DIAMETER MESSAGE PROCESSOR, A CHANGE IN STATUS
702
COMMUNICATE, BY THE FIRST DIAMETER MESSAGE PROCESSOR AND TO A SECOND DIAMETER MESSAGE PROCESSOR, AN INDICATION OF THE CHANGE IN STATUS

FIG. 7