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(54) Title: A DATA ROAMING OPTIMIZER

(57) Abstract: The present invention provides a solution to keep the data usage within a session as much as possible. It achieves this by steering the outbound roaming device back to the previous network A when the device is trying to switch network A to another network B while the usage by the outbound roaming device is below certain threshold in the current session. It also attempts to keep the session alive by sending alive packet to the VPMN SGSN when the usage by the outbound roaming device is below certain threshold in the current session and the session is about to be expired by the VPMN SGSN.



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A Data Roaming Optimizer

John Yue Jun Jiang and David Gillot

5 **Related Applications**

 This application claims priority from United States
Provisional Patent Application Serial No. 60/907,434 of
same title, filed April 2, 2007 and is related to United
10 States Patent Application entitled "Method And System For
Cellular Network Traffic Redirection" Application No.
10/635,804 filed on August 05, 2003, claiming priority
from August 05, 2002, now U.S. Patent No. 7,072,651 Both
of those related patent applications are incorporated
15 herein by this reference in their entirety.

Field of the Invention

 The present invention generally relates to mobile
communication. More specifically, the invention relates
20 to mobile communication corresponding to reduce data
roaming charges.

Background of the Invention

25 As increasing competition in mobile telecommunications
has been increasing in recent years, rates for voice
calling have been dropping. Partly in hopes of
compensating for lost revenue per user, operators of
public mobile telecommunications networks have
30 increasingly been deploying data and digital media. While

as of this writing, data revenue still accounts less than 10% of an operator's total revenue in general, providing data services is also more profitable than providing voice calling. Furthermore, mobile data services are
5 essential these days to many enterprise solutions such as machine to machine applications and email services.

To encourage usage, many mobile operators are offering a flat-fee price plan for enterprise customers. Often,
10 those flat-fee price plans even include international roaming, in regions with many national borders, or where certain operators do not provide nationwide coverage. Especially for certain machine-to-machine applications, such as truck and package tracking, this type of billing
15 plan is very attractive. This is also quite useful for international business travelers who use Blackberry, (or other similar mobile email services such as that now being promoted by Apple for its iPhone) but do not want to worry about roaming charges for emails.

20 While the flat fee plan works well in attracting enterprise customers, it could potentially provoke significant loss of roaming profits. This is because data roaming charges by operators of the visited public
25 mobile networks typically are based on a minimum number of bytes per session. If the roaming mobile devices change sessions too often before using a significant quantity of data services in the visited network, the home operator can end up owing more charges than
30 necessary to the visited network.

If the home operator is not offering a flat fee plan, the end subscriber would end up incurring the additional cost. One way or another, either the home operator or the home operator's subscribers lose, in the state of the art.

For example, assuming a visit operator charges data roaming at a minimum of 10K bytes per session. If a roaming device is only sending one byte per session for 10 sessions, despite only 10 bytes are sent, the visit operator would charge HPMN for 10*10K, 100K bytes.

Therefore there is a need in the art for a system, method and computer program product capable of optimizing the use of data services while roaming, to aid a roaming user, or his home network, to utilize a visited network's minimum billing threshold for roaming data services optimally.

Summary of Invention

In a previous awarded patent, U.S. Patent No. 7,072,651 to Jiang, et al., the inventors introduce a system and a method that can influence an outbound roamer's registration at which VPMN network in a country. The present invention comprises an improvement upon such state-of-the-art traffic redirection systems, by assisting an outbound roamer in continuing to use a roaming data services session with a current visited network, even when that user has not utilized much data during that session.

An embodiment of the present invention introduces a "keep-alive" mechanism in an outbound roamer's session, such that a data session with the visited network is maintained, even when the use that the roamer initiated is below the visited network's threshold, and the VPMN SGSN would otherwise expire that session.

Yet another embodiment of the present invention relating to data transmission in batches, provides for informing a roaming handset that a threshold minimum data threshold must be must be approached or reached prior to causing the handset to transmit data.

Brief Description of the Figures

Figure 1 depicts a system architecture of a DataRoamingOptimizer (DRO) solution under the present invention.

Figure 2 illustrates a normal GPRS PDP context activation and data transfer procedure under the present invention.

Figure 3 illustrates a network-initiated PDP context activation procedure under the present invention.

Figure 4 shows a signal flow for integrating the present invention in traffic redirection.

Figure 5 illustrates a signal flow of another embodiment of the present invent for maintaining a roaming data session.

Detailed Description of the Invention

Figure 1 shows a system architecture of an embodiment of the present invention for optimizing data usage at a visited network while roaming, also named DataRoamingOptimizer (DRO) solution for the purposes of this teaching.

The system architecture comprises a probe at the IP interface Gp in front of the HPMN GGSN (and/or Gi interface behind the HPMN GGSN) and an SS7 (or Sigtran or other standard signaling language)-based traffic steering application ("Traffic Redirection" or "TR") conducted either in an in-signaling path mode or according to a passive monitoring or other approach. The probe can inform the Data Roaming Optimizer of the amount of one or more variables corresponding to a roamer's data usage, including without limitation: the roamer's current or overall data usage, IMSI, APN, IP address in a current data session.

Figure 2 illustrates a normal GPRS PDP context activation and data transfer procedure. And Figure 3 shows a network-initiated PDP context activation procedure, both under the present invention.

When an outbound roamer is changing network from a visited network A to a visited network B because of any of the following, operating a DRO under the present invention, a traffic steering application can continue to reject the device's registration at any VPMN other than the previous one, until some thresholds are satisfied.

- The A-network is losing coverage
- The A-network has low signal reception
- 5 • The roaming device is automatically switching networks due to SIM preference to B-network over A-network
- The roaming device is automatically switching networks due to handset preference to B-network over A-network
- 10 • A switch in visited networks is being initiated for any other reason, especially if the roamer is still located within the visited network's country or geographic area of operations.

Figure 4 depicts another signal flow for integrating DRO with traffic redirection under the present invention. When an outbound roaming device is registered at a VPMN and the session data usage is below a certain threshold as detected by probe 110, HPMN traffic steering application TR 108 will reject the VPMN registration (GSM or GPRS) at 440 until some conditions are satisfied according to calculation 460. These conditions can include any of various thresholds with respect to retrials at a VPMN outbound roaming device's registration.

25

An aim of integrating DRO with traffic redirection under the present invention is to reject an outbound roamer's registration at a new VPMN, so as to give the device a chance to come back to the old VPMN and continue the same data session as when that usage the previous VPMN remained below an optimal threshold.

30

Figure 5 illustrates a signal flow of another embodiment of the present invention aimed at leaving data usage ongoing within the same session at a single VPMN until the optimal threshold is reached. This embodiment addresses a case in which an outbound roamer is not using much data for a long time and the VPMN SGSN would otherwise have aborted the current session.

DRO in Figure 5 maintains a table of optimal WASP session duration or rating information with respect to different VPMNs. When an outbound roamer's data session is about to expire at a VPMN SGSN and the data usage is still below a certain threshold according to calculation 530, then at 515 DRO can send a network-initiated live packet to the roaming device just to keep the data session alive. In a normal implementation, the roaming subscriber won't notice very much effects from his handset receiving the live packet.

Referring again to Figure 1, another embodiment of the present invention is related to data transmission in batch mode. In this embodiment, DRO 106 provides the roaming user's handset with information that the handset can be caused to transmit data in batches that fulfill a predetermined threshold of the VPMN that the user is registered with. For example, the handset may be informed that data will not be transmitted until a batch of data of a predetermined size is approached or reached. Thus, the handset will not transmit data until the predetermined threshold is approached or reached. Alternatively, upon an attempt to register the user's

handset at another VPMN, that registration may be permitted and the data accumulated will be ready for transmission depending on the predetermined threshold of the other VPMN.

5

Other Variations

10 Provided above for the edification of those of ordinary skill in the art, and not as a limitation on the scope of the invention, are detailed illustrations of a scheme for facilitating exchange of one or more signaling messages between a client network and an HSRP network. Numerous variations and modifications within the spirit
15 of the present invention will of course occur to those of ordinary skill in the art in view of the embodiments that have been disclosed. For example, the present invention is implemented primarily from the point of view of GSM mobile networks as described in the embodiments. However,
20 the present invention may also be effectively implemented on GPRS, 3G, CDMA, WCDMA, WiMax etc., or any other network of common carrier telecommunications in which end users are normally configured to operate within a "home" network to which they normally subscribe, but have the
25 capability of also operating on other neighboring networks, which may even be across international borders.

The examples under the two-node SPRS of the present invention detailed in the illustrative examples contained
30 herein are described using terms and constructs drawn largely from GSM mobile telephony infrastructure. However, use of these examples should not be interpreted

as limiting the invention to those media. The two-node
SPRS and method can be of use and provided through any
type of telecommunications medium, including without
limitation: (i) any mobile telephony network including
5 without limitation GSM, 3GSM, 3G, CDMA, Wimax, VoIP,
HSDPA, SIP, IMS, WCDMA or GPRS, satellite phones or other
mobile telephone networks or systems; (ii) any so-called
WiFi apparatus normally used in a home or subscribed
network, but also configured for use on a visited or non-
10 home or non-accustomed network, including apparatus not
dedicated to telecommunications such as personal
computers, Palm-type or Windows Mobile devices; (iii) an
entertainment console platform such as Sony Playstation,
PSP or other apparatus that are capable of sending and
15 receiving telecommunications over home or non-home
networks, or even (iv) fixed-line devices made for
receiving communications, but capable of deployment in
numerous locations while preserving a persistent
subscriber id such as the eye2eye devices from Dlink; or
20 telecommunications equipment meant for voice over IP
communications such as those provided by Vonage or
Packet8.

In describing certain embodiments of the system under
25 the present invention, this specification follows the
path of a telecommunications call, from a calling party
to a called party. For the avoidance of doubt, such a
call can be a normal voice call, in which the subscriber
telecommunications equipment is also capable of visual,
30 audiovisual or motion-picture display. Alternatively,
those devices or calls can be for text, video, pictures
or other communicated data.

In the foregoing specification, specific embodiments of the present invention have been described. However, one of ordinary skill in the art will appreciate that various modifications and changes can be made without departing from the scope of the present invention as set forth in the claims below. Accordingly, the specification and the figures are to be regarded in an illustrative rather than a restrictive sense, and all such modifications are intended to be included within the scope of present invention. The benefits, advantages, solutions to problems, and any element(s) that may cause any benefit, advantage, or solution to occur, or to become more pronounced, are not to be construed as a critical, required, or essential feature or element of any or all of the claims.

APPENDIX

Acronym	Description
3G	Third generation of mobile
ACM	ISUP Address Completion Message
ANM	ISUP Answer Message
ANSI-41	American National Standards Institute #41
ATI	Any Time Interrogation
BCSM	Basic Call State Model
BSC	Base Station Controller
CAMEL	Customized Application for Mobile Enhanced Logic
CAP	Camel Application Part
CB	Call Barring
CC	Country Code
CDMA	Code Division Multiplexed Access
CdPA	Called Party Address
CgPA	Calling Party Address
CLI	Calling Line Identification
CSD	Circuit Switched Data
CSI	Camel Subscription Information
DPC	Destination Point Code
ERB	CAP Event Report Basic call state model
FPMN	Friendly Public Mobile Network
FTN	Forward-To-Number
GLR	Gateway Location Register
GMSC	Gateway MSC
GMSC-F	GMSC in FPMN
GMSC-H	GMSC in HPMN
GPRS	General Packet Radio System
GSM	Global System for Mobile
GSM SSF	GSM Service Switching Function
gsmSCF	GSM Service Control Function
GT	Global Title
HLR	Home Location Register
HLR-F	FPMN HLR
HLR-H	HPMN HLR
HPMN	Home Public Mobile Network
GTT	Global Title Translation
IAM	Initial Address Message
IDP	Initial DP IN/CAP message
IMSI	International Mobile Subscriber Identity
IMSI-H	HPMN IMSI

IN	Intelligent Network
INAP	Intelligent Network Application Part
INE	Interrogating Network Entity
IP	Internet Protocol
ISC	International Service Carrier
ISD	MAP Insert Subscriber Data
ISG	International Signal Gateway
ISTP	International STP
ISTP-F	ISTP connected to FPMN STP
ISTP-H	ISTP connected to HPMN STP
ISUP	ISDN User Part
ITR	Inbound Traffic Redirection
IVR	Interactive Voice Response
LU	Location Update
LUP	MAP Location Update
MAP	Mobile Application Part
MCC	Mobile Country Code
MCC	Mobile Country Code
ME	Mobile Equipment
MGT	Mobile Global Title
MMS	Multimedia Message Service
MMSC	Multimedia Message Service Center
MMSC-F	FPMN MMSC
MMSC-H	HPMN MMSC
MNC	Mobile Network Code
MO	Mobile Originated
MSC	Mobile Switching Center
MSISDN	Mobile Station International Subscriber Directory Number
MSISDN-F	FPMN MSISDN
MSISDN-H	HPMN MSISDN
MSRN	Mobile Station Roaming Number
MSRN-F	FPMN MSRN
MSRN-H	HPMN MSRN
MT	Mobile Terminated
MTP	Message Transfer Part
NDC	National Dialing Code
NP	Numbering Plan
NPI	Numbering Plan Indicator
O-CSI	Originating CAMEL Subscription Information
ODB	Operator Determined Barring
OTA	Over The Air
PRN	MAP Provide Roaming Number
PSI	MAP Provide Subscriber Information
RI	Routing Indicator

RNA	Roaming Not Allowed
RR	Roaming Restricted due to unsupported feature
RRB	CAP Request Report Basic call state model
SCCP	Signal Connection Control part
SCP	Service Control Point
SSP	Service Switch Point
SG	Signaling Gateway
SGSN	Serving GPRS Support Node
SGSN-F	FPMN SGSN
SIM	Subscriber Identity Module
SME	Short Message Entity
SM-RP-UI	Short Message Relay Protocol User Information
SMS	Short Message Service
SMSC	Short Message Service Center
SMSC-F	FPMN SMSC
SMSC-H	HPMN SMSC
SPC	Signal Point Code
SRI	MAP Send Routing Information
SRI-SM	MAP Send Routing Information For Short Message
SS	Supplementary Services
SS7	Signaling System #7
SSN	Sub System Number
SSP	Service Switch Point
STK	SIM Tool Kit Application
STP	Signal Transfer Point
STP-F	FPMN STP
STP-H	HPMN STP
TCAP	Transaction Capabilities Application Part
T-CSI	Terminating CAMEL Service Information
TP	SMS Transport Protocol
TR	Traffic Redirection
TT	Translation Type
UD	User Data
UDH	User Data Header
UDHI	User Data Header Indicator
USSD	Unstructured Supplementary Service Data
VAS	Value Added Service
VLR	Visited Location Register
VLR-F	FPMN VLR
VLR-H	HPMN VLR
VLR-V	VPMN VLR

VMSC	Visited Mobile Switching Center
VMSC-F	FPMN VMSC
VMSC-H	HPMN VMSC
VMSC-V	VPMN VMSC
VPMN	Visited Public Mobile Network
WAP	Wireless Access Protocol
SPRS	Signal Packet Relay System
HSRP	Host Supported Roaming Partner
IREG	International Roaming Expert Group
TADIG	Transfer Accounting Data International Group
TAP	Transfer Accounting Procedure
CS	Circuit Switched
PRD	Permanent Reference Document
GSMA	GSM Association
GSM	Global System For Mobile
IR	IREG
AA	International Roaming Agreement
BARG	Billing Accounting and Roaming Group
BA	BARG
OC	Open Connectivity

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- 15 GSM 378 on CAMEL
Digital cellular telecommunications system (Phase 2+);

Customized Applications for Mobile network Enhanced Logic
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Stage 2
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GSM 978 on CAMEL Application protocol
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(CAMEL);

10

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(GSM 09.78 version 7.1.0 Release 1998)
Signalling procedures and the Mobile Application Part
(MAP)
(Release 1999)

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20

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30

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GSM 29060 on GPRS GTP 1

5 GSM 978 on CAMEL Application Protocol

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GSM 23120 MAP procedures in GLR

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7 - ISDN user part

- 10 enhancements for the support of Number Portability.

Claims

1. A method of optimizing data usage by a user of a
5 Home Public Mobile Network (HPMN) roaming in a first
Visited Public Mobile Network (VPMN), the HPMN having a
Data Roaming Optimizer (DRO), the first VPMN having a
predetermined threshold, the method comprising:
determining information regarding the user's data
10 usage in the first VPMN;
providing the information to the DRO;
detecting, at the HPMN, an attempt to register the
user at a second VPMN; and
rejecting the attempt to register the user at the
15 second VPMN if the predetermined threshold of the first
VPMN has not been reached.

2. The method of claim 1, wherein the predetermined
threshold is a data usage threshold.
20

3. The method of claim 1, wherein the predetermined
threshold is a data session duration threshold.

4. A method of optimizing data usage by a user of a
25 Home Public Mobile Network (HPMN) roaming in a first
Visited Public Mobile Network (VPMN), the HPMN having a
Data Roaming Optimizer (DRO), the first VPMN having a
predetermined data session duration threshold, the user
having a handset, the method comprising:
30 providing the predetermined data session duration
threshold to the DRO; and

transmitting, to the user's handset, a network-initiated live packet when the predetermined data session duration threshold has not been reached.

5 5. A method of optimizing data usage by a user of a Home Public Mobile Network (HPMN) roaming in a first Visited Public Mobile Network (VPMN), the HPMN having a Data Roaming Optimizer (DRO), the first VPMN having a predetermined data batch size threshold, the user having a
10 handset, the method comprising:

 determining information regarding the user's data usage in the first VPMN;

 providing the information to the DRO; and

 allowing transmission of data from the user's handset
15 when the predetermined data batch size threshold is approached.

 6. The method of claim 1, wherein the information regarding the user's data usage in the first VPMN is
20 selected from a group consisting of data usage, data session duration, and data batch size.

 7. The method of claim 1, wherein the information regarding the user's data usage in the first VPMN is
25 determined via a probe.

 8. The method of claim 1, wherein the attempt to register the user at the second VPMN is rejected via traffic redirection.
30

 9. The method of claim 8, wherein the traffic redirection is selected from a group consisting of passive

monitoring traffic redirection and in-signaling path mode traffic redirection.

10. A system for optimizing data usage of a user of a
5 Home Public Mobile Network (HPMN) roaming in a first Visited Public Mobile Network (VPMN), the HPMN having a Data Roaming Optimizer (DRO), the first VPMN having a predetermined threshold, the system comprising:

a determination module for determining information
10 regarding the user's data usage in the first VPMN;

a transmission module for providing the information to the DRO;

a detection module for detecting, at the HPMN, an attempt to register the user at a second VPMN; and

15 a rejection module for rejecting the attempt to register the user at the second VPMN if the predetermined threshold of the first VPMN has not been reached.

11. The system of claim 10, wherein the predetermined
20 threshold is a data usage threshold.

12. The system of claim 10, wherein the predetermined threshold is a data session duration threshold.

25 13. A system for optimizing data usage by a user of a Home Public Mobile Network (HPMN) roaming in a first Visited Public Mobile Network (VPMN), the HPMN having a Data Roaming Optimizer (DRO), the first VPMN having a predetermined data session duration threshold, the user
30 having a handset, the system comprising:

a providing module for providing the predetermined data session duration threshold to the DRO; and

a transmission module for transmitting, to the user's handset, a network-initiated live packet when the predetermined data session duration threshold has not been reached.

5

14. A system for optimizing data usage by a user of a Home Public Mobile Network (HPMN) roaming in a first Visited Public Mobile Network (VPMN), the HPMN having a Data Roaming Optimizer (DRO), the first VPMN having a predetermined data batch size threshold, the user having a handset, the system comprising:

a determination module for determining information regarding the user's data usage in the first VPMN;

a transmission module for providing the information to the DRO;

a transmission module for allowing transmission of data from the user's handset when the predetermined data batch size threshold is approached.

15. The system of claim 10, wherein the information regarding the user's data usage in the first VPMN is information selected from a group consisting of data usage, data session duration, and data batch size.

16. The system of claim 10, wherein the information regarding the user's data usage in the first VPMN is determined via a probe.

17. The system of claim 10, wherein the attempt to register the user at the second VPMN is rejected via traffic redirection.

18. The system of claim 17, wherein the traffic redirection is selected from a group consisting of passive monitoring traffic redirection and in-signaling path mode traffic redirection.

5

19. A computer program product for use with a computer, the computer program product comprising a computer usable medium having a computer readable program code stored thereon for optimizing data usage of a user of
10 a Home Public Mobile Network (HPMN) roaming in a first Visited Public Mobile Network (VPMN), the HPMN having a Data Roaming Optimizer (DRO), the first VPMN having a predetermined threshold, the computer program product performing the steps of:

15 determining information regarding the user's data usage in the first VPMN;

providing the information to the DRO;

detecting, at the HPMN, an attempt to register the user at a second VPMN; and

20 rejecting the attempt to register the user at the second VPMN if the predetermined threshold of the first VPMN has not been reached.

25

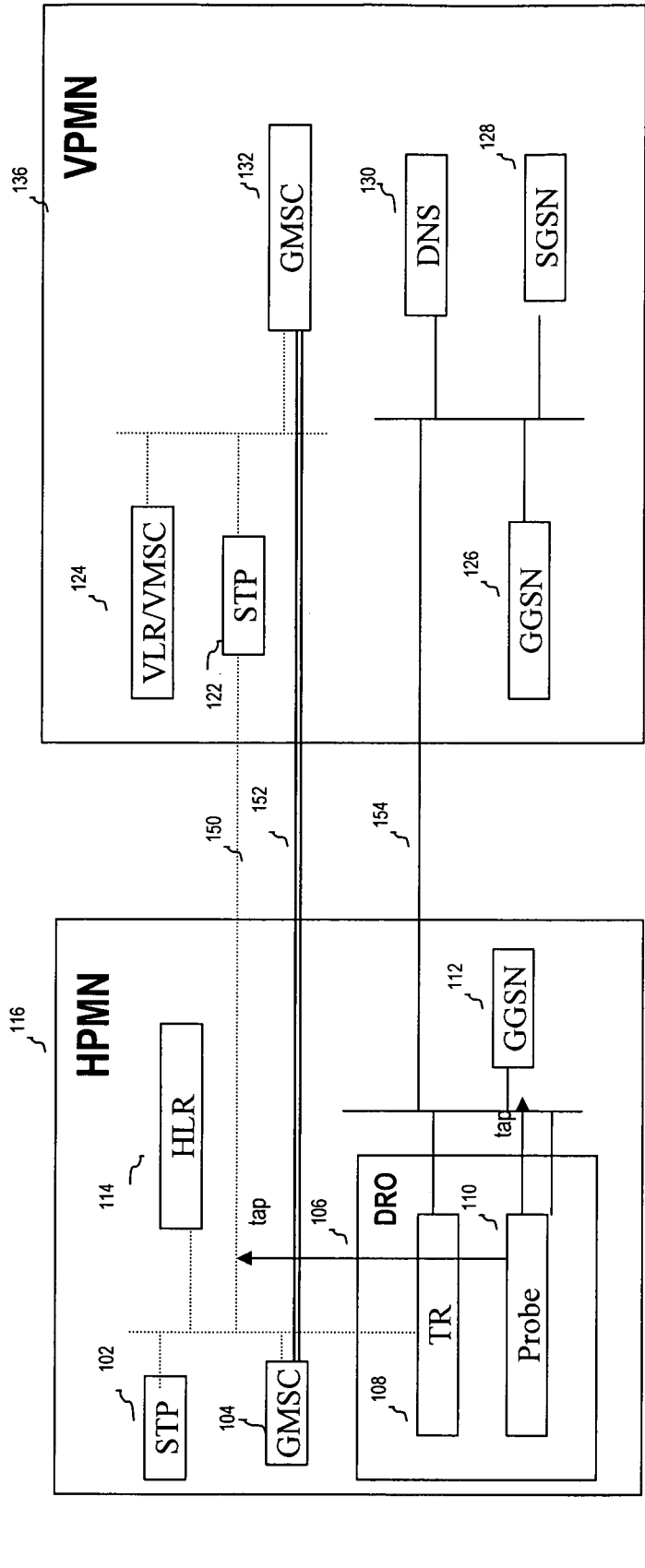


FIG. 1 Logical Architecture of Data Roaming Optimizer

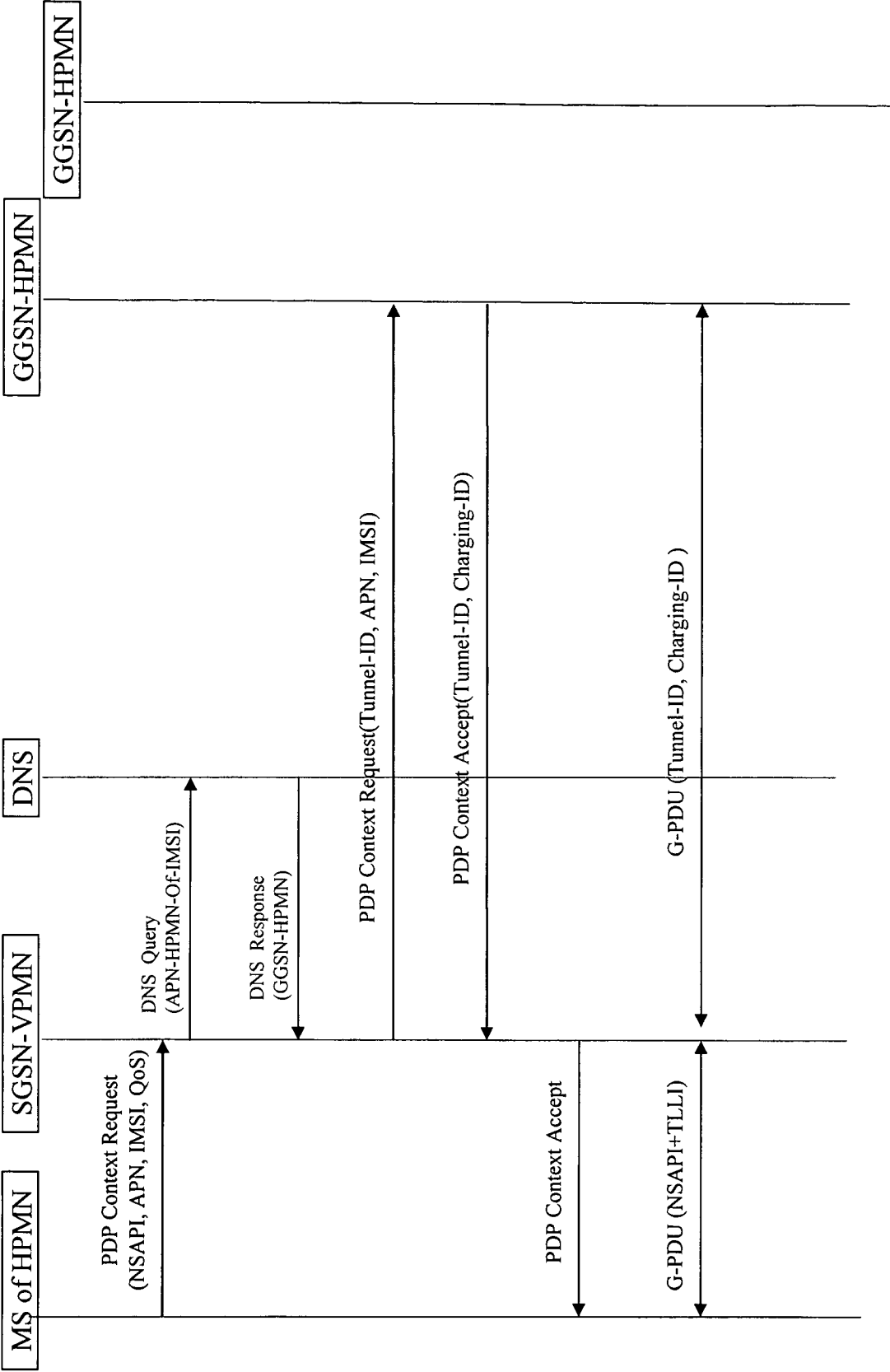


FIG. 2 Normal PDP activation and Packet Data Transfer

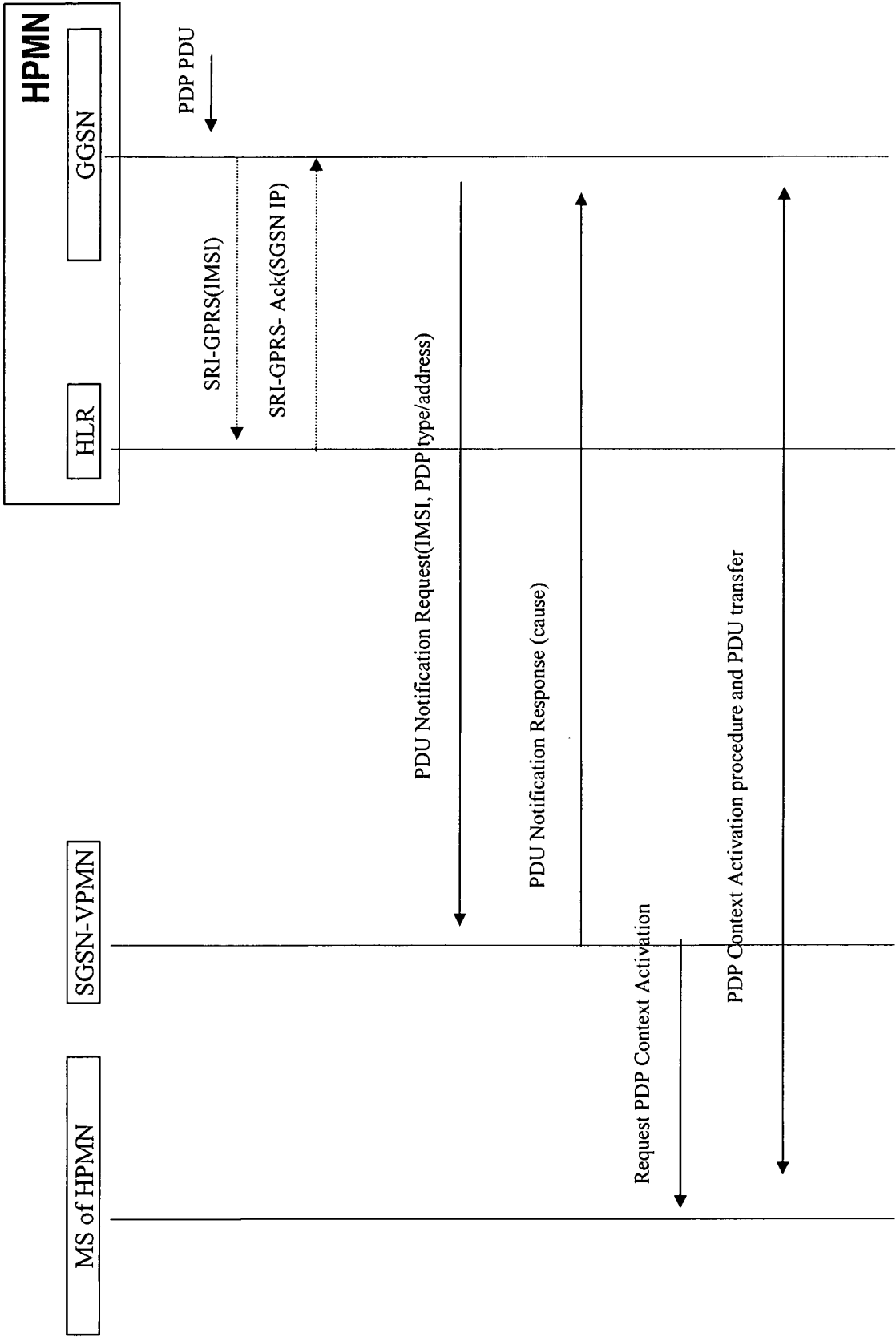


FIG. 3 Normal Network-initiated PDP activation and Packet Data Transfer

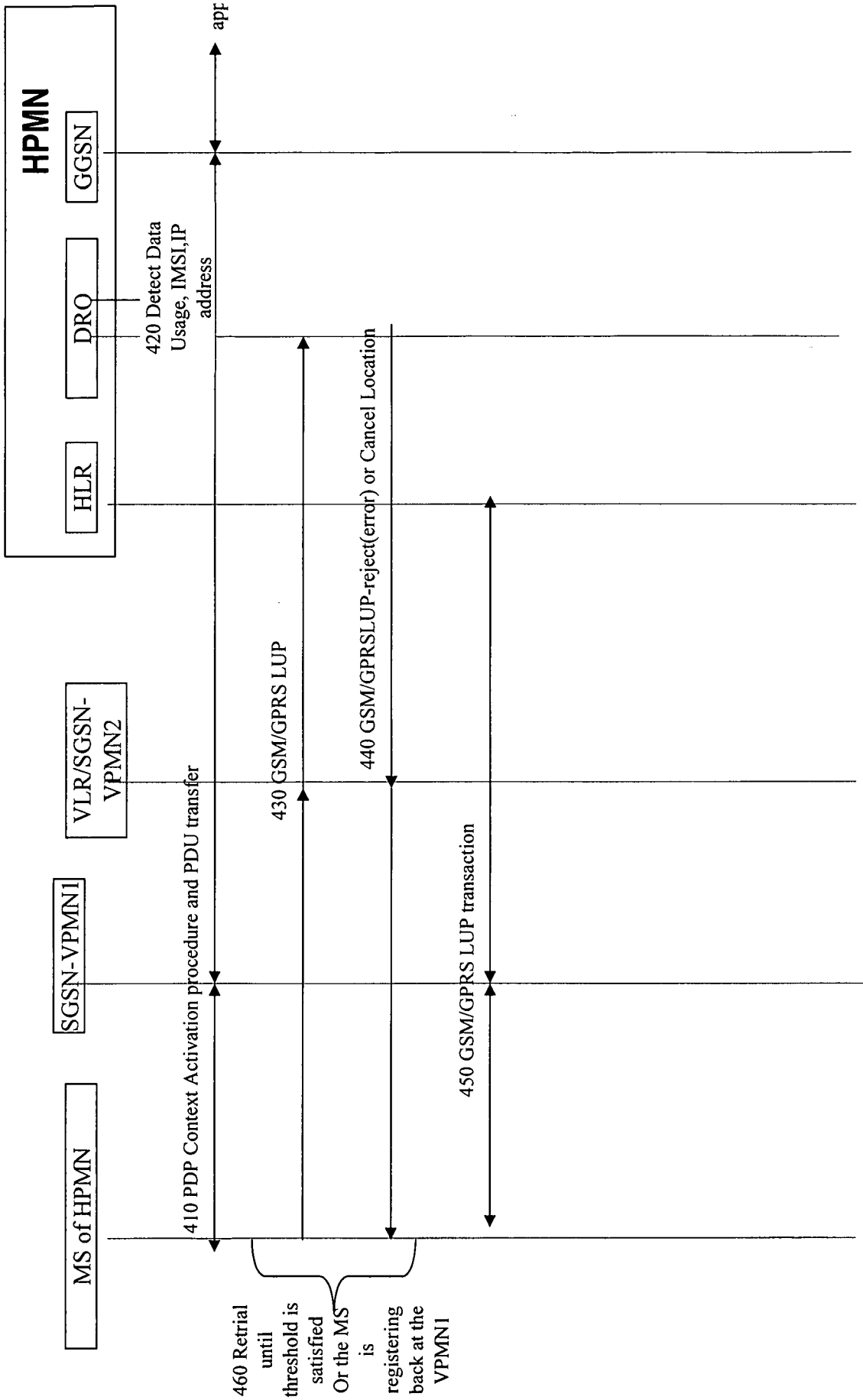


FIG.4 Traffic Steering of registration at a new network VPMN 2 to get back to the old network VPMN 1

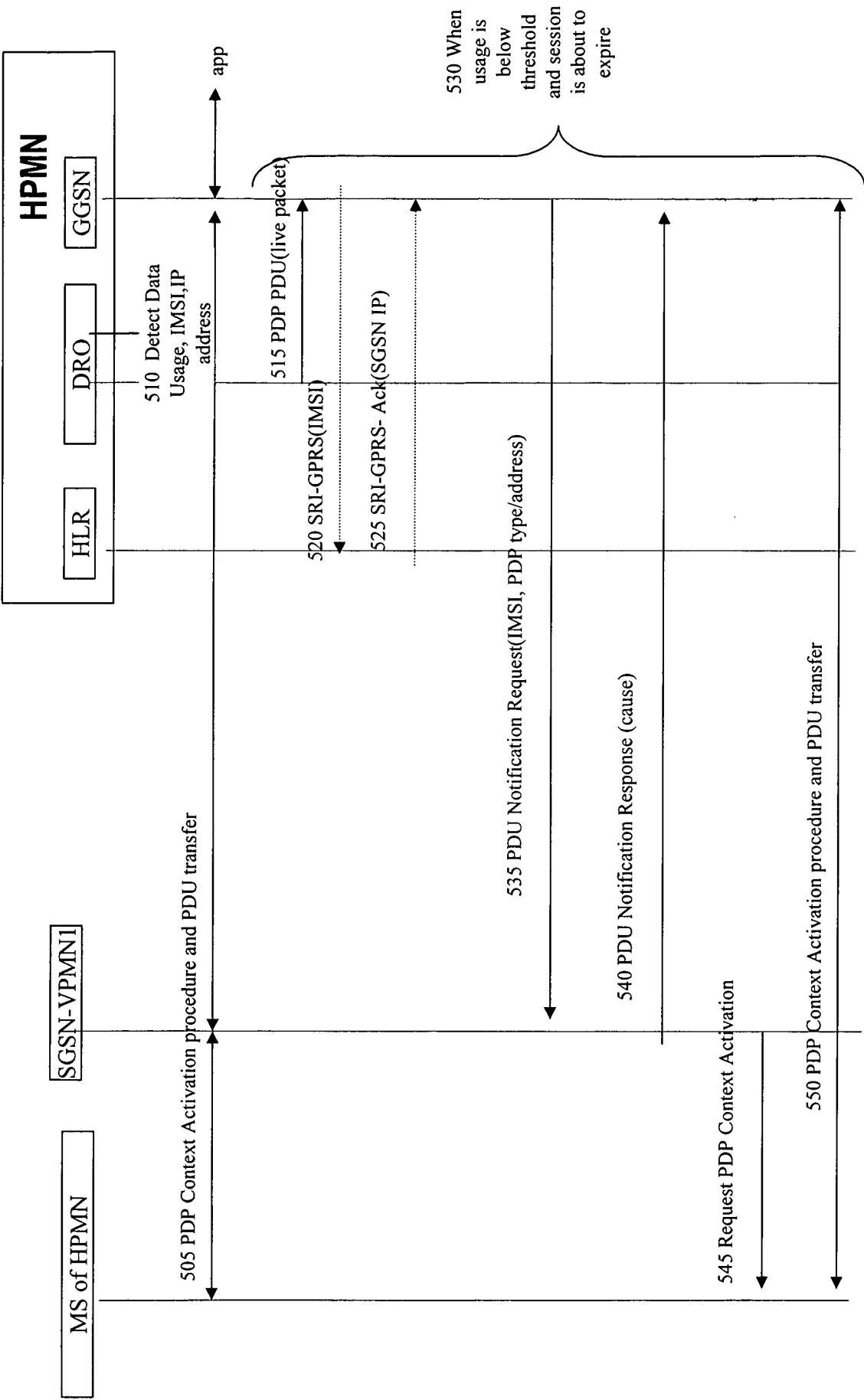


FIG.5 Keep session alive when usage is below threshold and the session is about to expire