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(54) **EVENT NOTIFICATION IN A HYBRID NETWORK**

(75) Inventors: **Vibhor Julka**, San Diego, CA (US); **Erik Colban**, San Diego, CA (US)

(73) Assignee: **Telefonaktiebolaget L M Ericsson (publ)**, Stockholm (SE)

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(51) **Int. Cl.**

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H04L 12/54	(2013.01)
H04L 1/18	(2006.01)
H04L 12/64	(2006.01)
H04W 8/24	(2009.01)
H04Q 3/00	(2006.01)
H04W 68/12	(2009.01)

(52) **U.S. Cl.**

CPC ***H04W 8/245*** (2013.01); ***H04Q 3/0045*** (2013.01); *H04Q 2213/13098* (2013.01); *H04Q 2213/13296* (2013.01); *H04Q 2213/13396* (2013.01); *H04W 68/12* (2013.01)

(58) **Field of Classification Search**

USPC 370/328, 331, 352–353, 356, 360; 455/560

See application file for complete search history.

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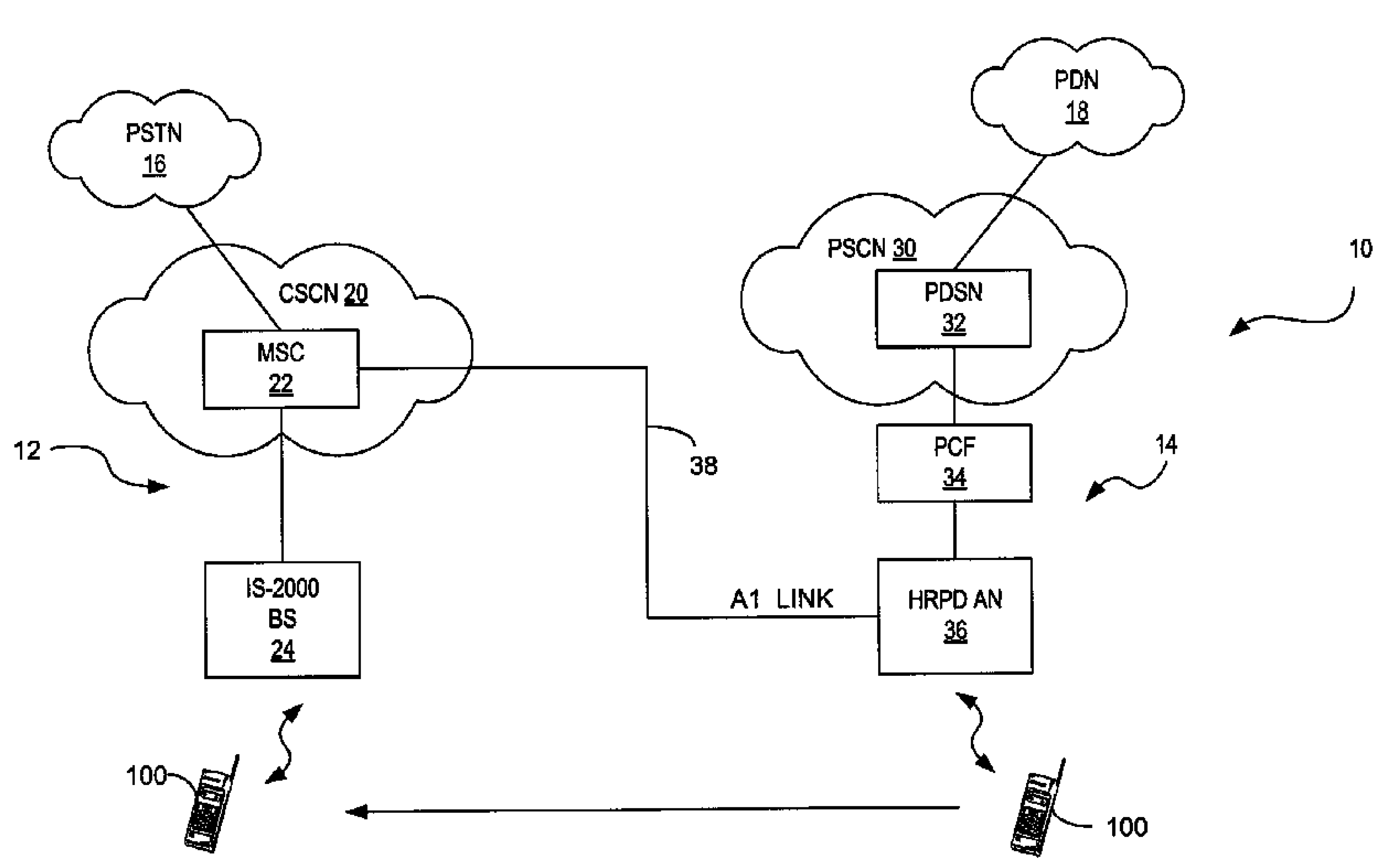
Primary Examiner — Brandon Renner

(74) *Attorney, Agent, or Firm* — Coats & Bennett, PLLC

(57) **ABSTRACT**

When a mobile station requests circuit services notifications through a packet switched network, a mobile switching center sets a forwarding indicator. When the MSC detects an event indicative of a change in the status of the mobile station, the MSC sends an event notification to the packet switched network if the forwarding indicator is set to true. In the packet switched network, the base station can use the event notifications to manage communication resources used for packet data communications with the mobile station.

21 Claims, 6 Drawing Sheets



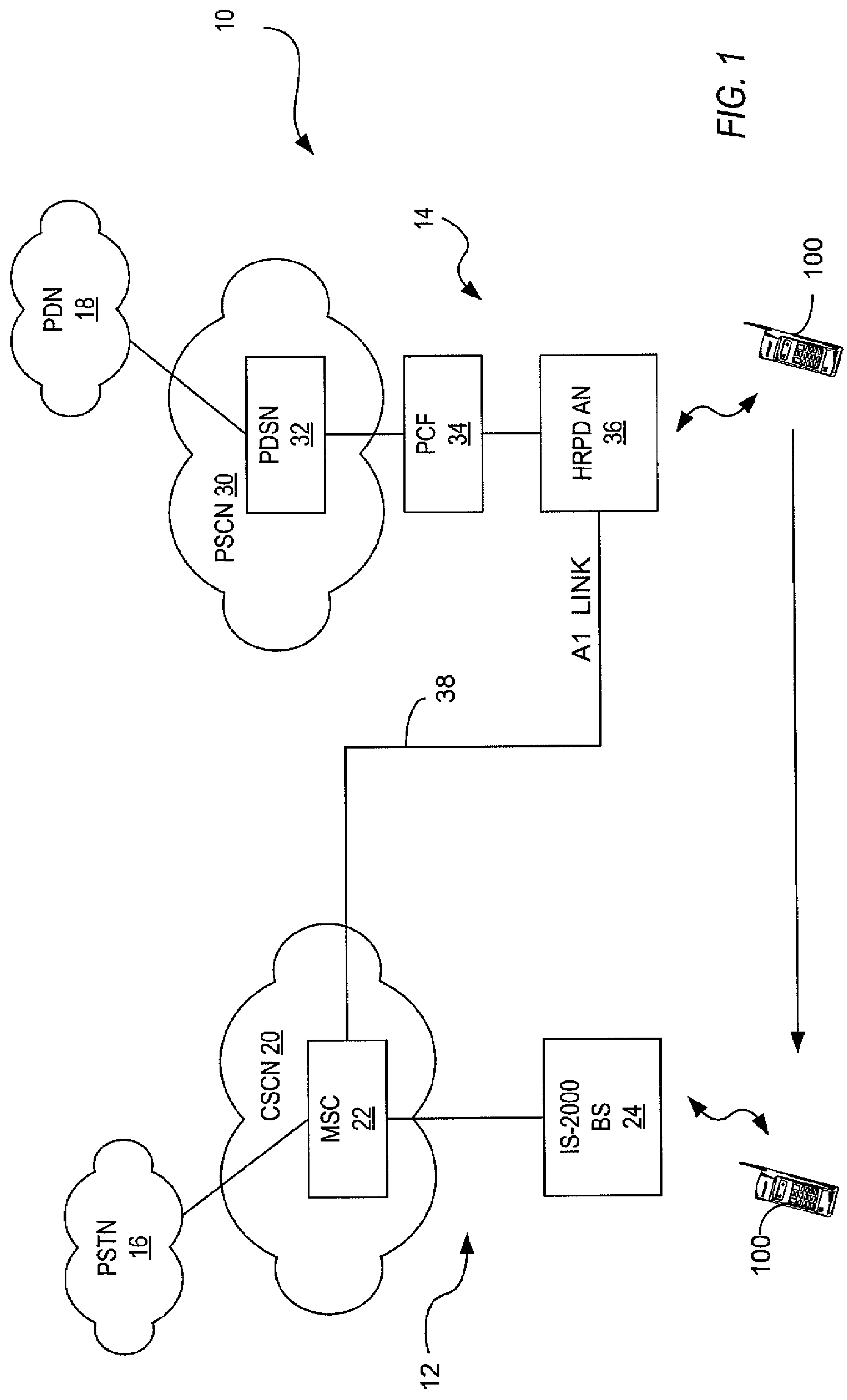
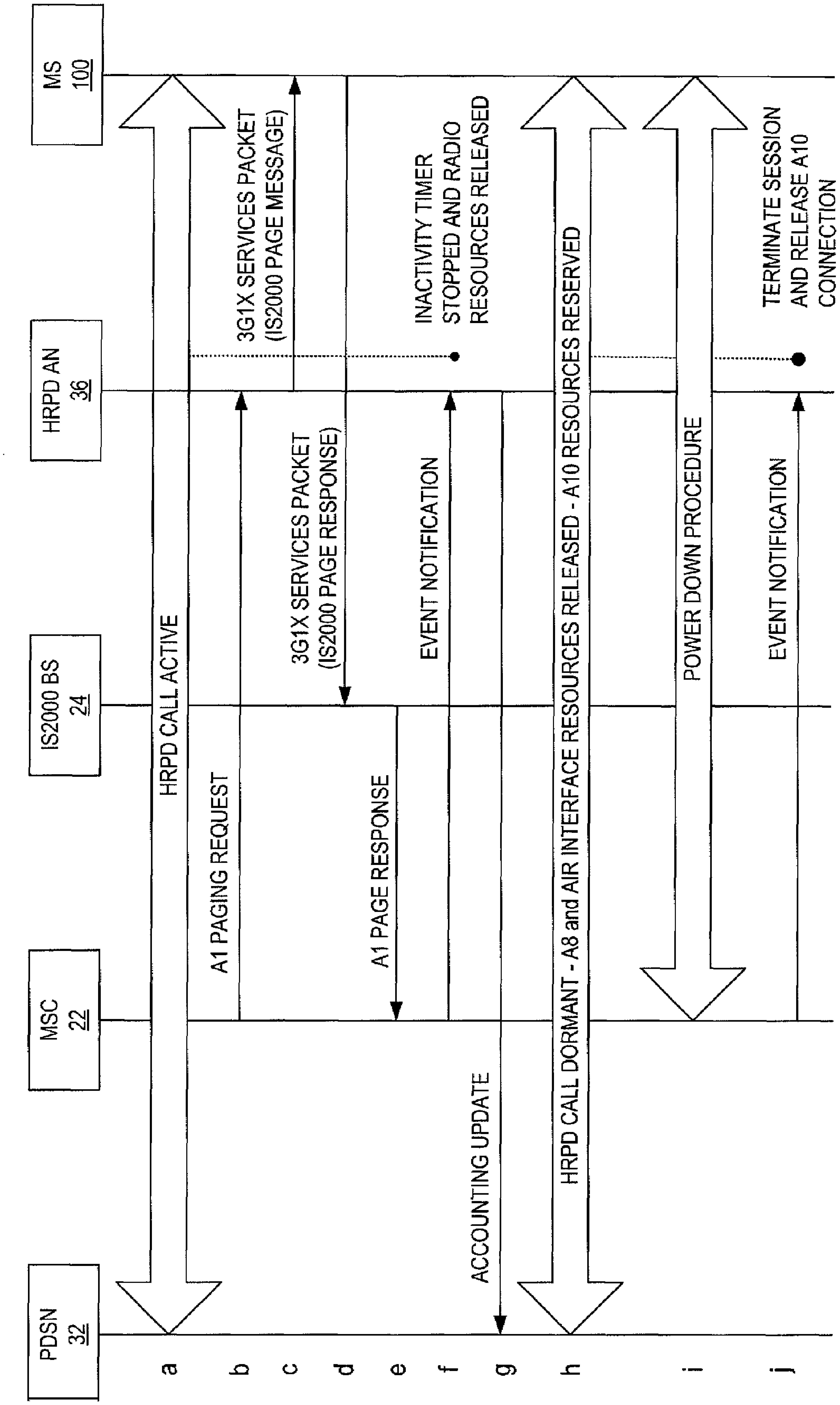

10
PDN
18
PSCN 30
PDSN
32
14
PCF
34
HRPD AN
36
100
A1 LINK
38
CSCN 20
MSC
22
IS-2000
BS
24
PSTN
16
100
12

FIG. 1



MS 100
HRPD AN 36
IS2000 BS 24
MSC 22
PDSN 32
a
b
c
d
e
f
g
h
i
j
HRPD CALL ACTIVE
A1 PAGING REQUEST
3G1X SERVICES PACKET (IS2000 PAGE MESSAGE)
3G1X SERVICES PACKET (IS2000 PAGE RESPONSE)
A1 PAGE RESPONSE
EVENT NOTIFICATION
INACTIVITY TIMER STOPPED AND RADIO RESOURCES RELEASED
ACCOUNTING UPDATE
HRPD CALL DORMANT - A8 and AIR INTERFACE RESOURCES RELEASED - A10 RESOURCES RESERVED
POWER DOWN PROCEDURE
EVENT NOTIFICATION
TERMINATE SESSION AND RELEASE A10 CONNECTION

FIG. 2

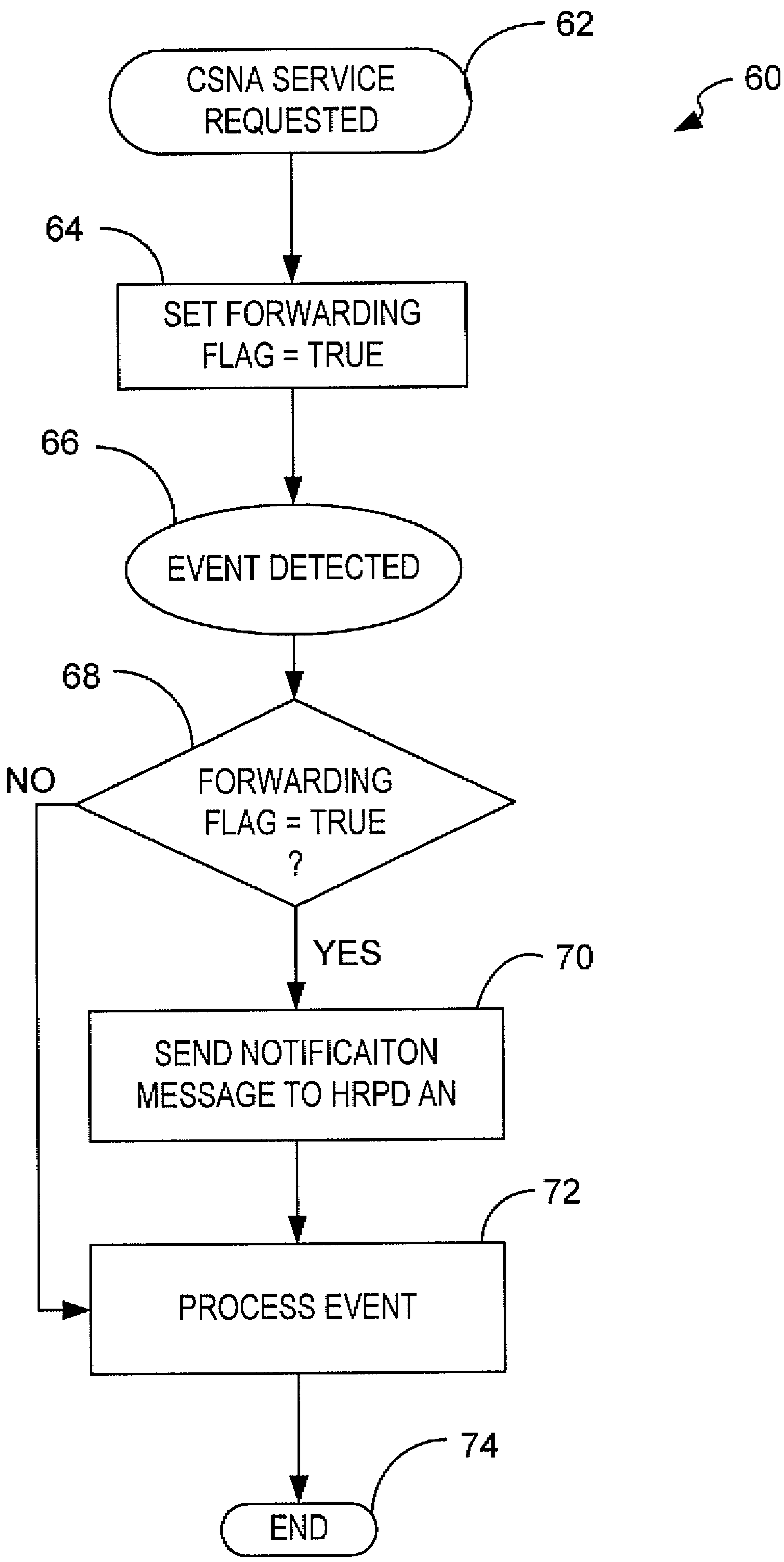

62
60
CSNA SERVICE REQUESTED
64
SET FORWARDING FLAG = TRUE
66
EVENT DETECTED
68
NO
FORWARDING FLAG = TRUE ?
YES
70
SEND NOTIFICAITON MESSAGE TO HRPD AN
72
PROCESS EVENT
74
END

FIG. 3

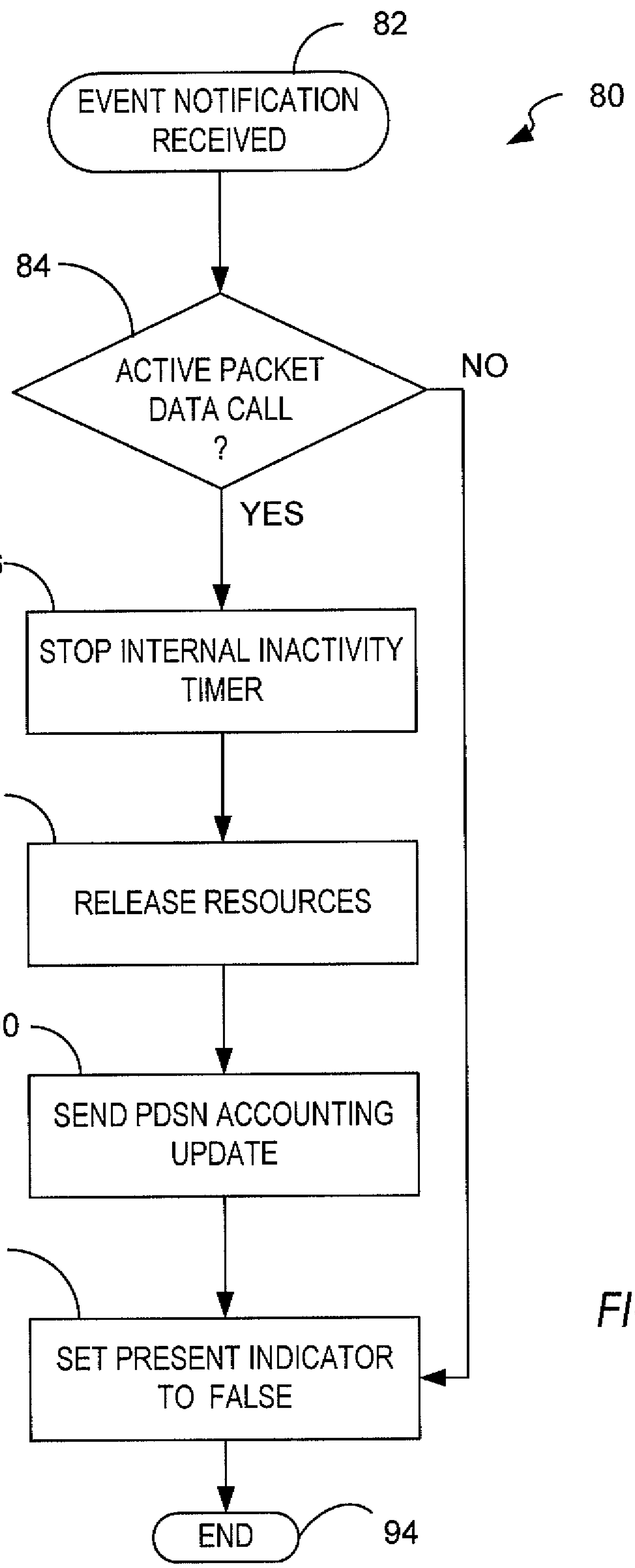
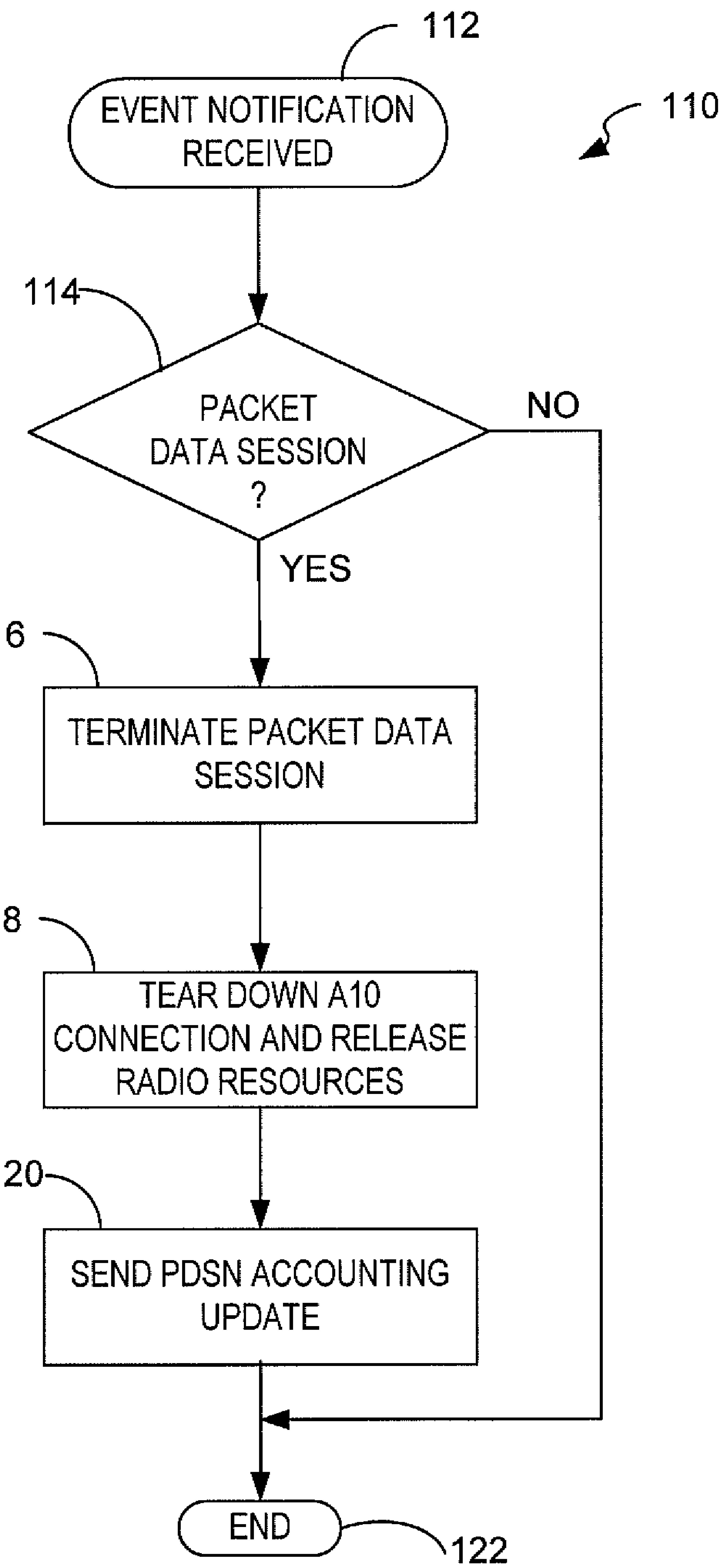

82
80
EVENT NOTIFICATION RECEIVED
84
ACTIVE PACKET DATA CALL ?
NO
YES
86
STOP INTERNAL INACTIVITY TIMER
88
RELEASE RESOURCES
90
SEND PDSN ACCOUNTING UPDATE
92
SET PRESENT INDICATOR TO FALSE
END
94

FIG. 4



112
EVENT NOTIFICATION RECEIVED
110
114
PACKET DATA SESSION ?
NO
YES
116
TERMINATE PACKET DATA SESSION
118
TEAR DOWN A10 CONNECTION AND RELEASE RADIO RESOURCES
120
SEND PDSN ACCOUNTING UPDATE
END
122

FIG. 5

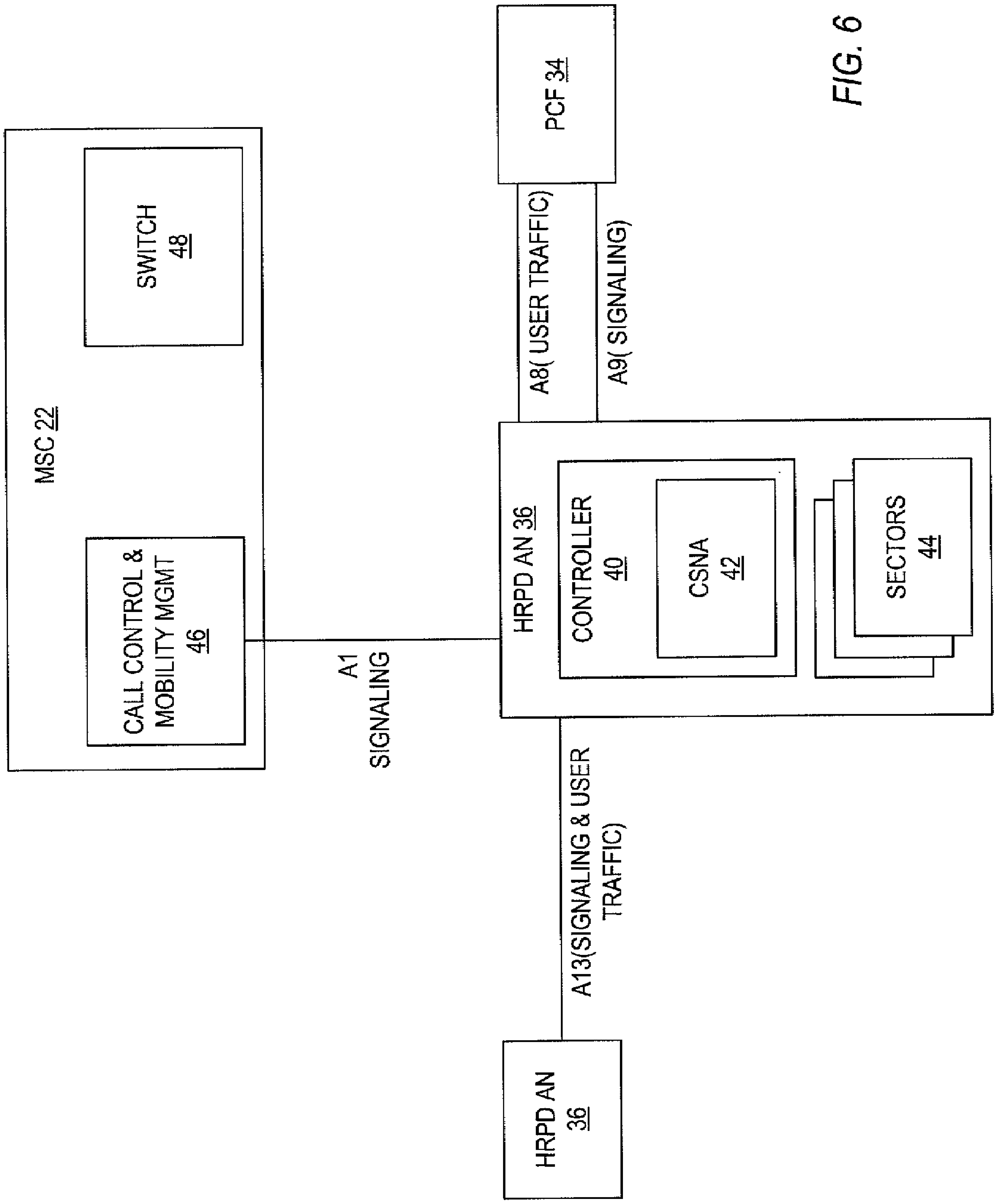

MSC 22
SWITCH 48
CALL CONTROL & MOBILITY MGMT 46
A1 SIGNALING
PCF 34
A8(USER TRAFFIC)
A9(SIGNALING)
HRPD AN 36
CONTROLLER 40
CSNA 42
SECTORS 44
A13(SIGNALING & USER TRAFFIC)
HRPD AN 36

FIG. 6

EVENT NOTIFICATION IN A HYBRID NETWORK

RELATED APPLICATIONS

This application is a divisional of U.S. patent application Ser. No. 11/094,951, filed Mar. 31, 2005, which claims priority to Provisional U.S. Patent Application 60/603,694 filed Aug. 23, 2004 and to Provisional U.S. Patent Application 60/652,585 filed Feb. 14, 2005, and which is incorporated herein by reference in its entirety.

BACKGROUND OF THE INVENTION

The present invention relates generally to the operation of mobile stations in a hybrid wireless communication network, and more particularly, to an event notification procedure to make more efficient use of network resources.

Cellular networks were originally developed to provide primarily voice services over circuit switched networks. The introduction of packet switched 2.5G and 3G networks enables network operators to provide data services as well as voice services. Eventually, network architecture is expected to evolve toward all-IP networks providing both voice and data services. However, network operators have a substantial investment in existing infrastructure and would therefore prefer to migrate gradually to an all-IP network architecture to allow them to continue to use their existing infrastructure. At the same time, network operators recognize that there is a demand for high rate packet-data services. In order to provide high-rate packet data services, network operators may deploy hybrid networks wherein a high data rate (HDR) network is overlaid on an existing circuit switched or packet switched network as a first step in the transition to an all IP-based network.

A hybrid network that combines two or more networks with different signaling protocols and different air interfaces complicates signaling and session management. One example of a hybrid network combines an IS2000 radio access network providing voice and packet data services with a data only network, such as an IS-856-A High Rate Packet Data (HRPD) access network, providing high rate packet data services. A mobile station with an active packet data session in the HRPD access network may need to switch to the IS2000 network to perform some task, such as answer a voice call. The mobile station may stop listening to the base station in the HRPD access network and, under current standards, is not required to inform the HRPD access network. After switching from the packet switched network to the circuit switched network, the mobile station could power down without returning to the packet switched network. In either scenario, the HRPD access network may assume that the mobile station is still present and listening, or that it may return, and consequently reserve resources to serve the no longer present mobile station. If the HRPD access network receives incoming packet data for the mobile station, the HRPD access network may attempt to deliver the data to the mobile station, which is no longer present. The attempt to deliver the packet data will fail and the HRPD access network will eventually deduce that the mobile station is no longer listening. At that point, the HRPD access network will release resources and update the packet data serving node for accounting purposes. The packet switched network may send a request to a Mobile Switching Center (MSC) to page the mobile station in the IS2000 network before releasing resources. If the mobile station has powered down, the attempts to page the mobile station will be futile and will unnecessarily consume network resources.

SUMMARY OF THE INVENTION

The present invention provides a method of managing a communication session with a mobile station in a hybrid network including a circuit switched network and a packet switched network. While operating in the packet switched network, the mobile station may request circuit services notifications through the packet data network. A mobile switching center (MSC) in the circuit switched network stores an indication that the mobile station is operating within the packet switched network and sends circuit services notifications to the mobile station via the packet switched network. According to various embodiments of the present invention, the MSC sends event notifications to the packet switched network responsive to predetermined events, such as a presence event or a power down event, indicating a change in the status of the mobile station. The packet switched network uses the event notifications to better manage network resources.

One event that may trigger the event notification procedure is the presence event. A presence event is an event that indicates that the mobile station is present in the network. A mobile station operating in the packet switched network may receive a circuit services notification, such as a page message, from the circuit services notification application (CSNA). In this case, the mobile station may switch to a carrier in the circuit switched network and send a page response or other message. When the MSC detects the mobile station in the circuit switched network and the mobile station has requested forwarding of circuit services notifications via the packet switched network, the mobile switching center sends an event notification message to the packet switched network indicating that the mobile station has been detected. If resources had been reserved for the mobile station, for example, to support an active packet data call, the packet switched network can release those resources, making them available for others to use. Further, the packet switched network may send an accounting update to a packet data serving node to update the accounting. Thus, the present invention facilitates early release of communication resources, which will increase system throughput and, therefore, system capacity.

Another event that may be useful to report is the power down event. After switching from the packet switched network to the circuit switched network, the mobile station may power down without returning to the packet switched network. The packet switched network may continue to reserve resources, such as A10 connections, and store information for the mobile station in the event that the mobile station returns to the packet switched network. In this scenario, the MSC may send an event notification to the packet switched network to notify the packet switched network that the mobile station has powered down. The packet switched network can then release any resources reserved for the mobile station, such as A10 connections.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a block diagram of a hybrid network according to the present invention.

FIG. **2** is a call flow diagram illustrating an exemplary scenario using the event notification procedure according to the present invention.

FIG. **3** is a flow chart illustrating a procedure executed by the MSC to implement the session management procedure of the present invention.

FIG. **4** is a flow chart illustrating a procedure implemented by an HRPD access network to implement the session management procedure according to the present invention.

FIG. **5** is a flow chart illustrating another procedure implemented by an HRPD access network to implement the session management procedure according to the present invention.

FIG. **6** is a block diagram illustrating exemplary details of a mobile switching center and HRPD access network.

DETAILED DESCRIPTION OF THE INVENTION

Referring now to the drawings, the present invention will be described in the context of a hybrid network **10** providing both voice and data services to mobile stations **100**. In the exemplary embodiment shown herein, the hybrid network **10** comprises a combined network incorporating both an IS2000 radio access network (IS2000 RAN) **12** and an HRPD access network (IS856-A) **14**. The exemplary embodiment is intended to be illustrative only and those skilled in the art will appreciate that the present invention may be used in networks based on other network standards.

The IS2000 RAN **12** comprises one or more base stations **24** connected to a circuit switched core network (CSCN) **20**. The CSCN **20** provides primarily voice services and low rate data services, such as facsimile services, to the mobile stations **100**. The CSCN **20** includes a mobile switching center (MSC) **22** that provides a connection to the public switched telephone network (PSTN) **16**. The MSC **22** routes traffic between the PSTN **16** and the base stations **24**. The base stations **24** communicate with the mobile stations **100** over the air interface. The base stations **24** forward downlink traffic and signaling from the MSC **22** to the mobile stations **100**, and forward uplink traffic and signaling from the mobile stations **100** to the MSC **22**. In some embodiments, the IS2000 may also provide packet-switched services, though this capability is not material to the present invention and is not discussed further herein.

Also shown in FIG. **1** is an HRPD RAN **14**. The HRPD RAN **14** is a high data rate (HDR) network and may be combined with an IS2000 network to provide high speed packet data services. The IS856 standard is generally known as 1xEV-DO. The HRPD RAN **14** comprises one or more access networks (ANs) **36** for communicating with the mobile stations **100**, and a packet core function (PCF) **34** connecting the HRPD AN **36** to a packet switched core network (PSCN) **30**. The PSCN **30** includes a PDSN **32** that connects to a packet data network **18**, such as the Internet. The PDSN **32** establishes communication sessions with mobile stations **100** using, for example, the point-to-point protocol (PPP). The HRPD AN **36** forwards mobile terminated packet data from the PDSN **32** to the mobile stations **100**, and forwards mobile-originated packet data to the PDSN **32**.

When a mobile station **100** is operating within the IS856 network **14**, the mobile station **100** may still want to receive notifications from the MSC **22** relating to circuit switched services without having to periodically return to the IS2000 RAN **12** to receive such notifications. For example, mobile station **100** may want to receive paging messages over the IS856 air interface alerting the mobile station **100** to incoming voice calls. To that end, the HRPD AN **36** includes a 3G1x Circuit Services Notification Application (CSNA) **42**, which may be seen in FIG. **3**. Alternatively, the CSNA **42** could be located in the PCF **34**. The CSNA **42** provides circuit services notifications to mobile stations **100** over the IS856-A air interface. The CSNA **42** uses the Circuit Services Notification (CSN) protocol. The CSN protocol also ensures that the mobile station **100** stays registered with the CSCN **20** even when it is monitoring the IS856 packet data channel. The CSNA **42** is described in *cdma*2000 *High Rate packet Data Air Interface Specification,* 3GPP2 C.20024-A, Version 1.0 (March 2004), which is incorporated herein by reference. The mobile station **100** may request circuit services notifications from the HRPD RAN **14**, causing the CSNA **42** to notify the MSC **22** to send notification messages to the mobile station **100** via the HRPD RAN **14**. The CSNA **42** and mobile station **100** may configure a filter that allows notifications associated with only certain circuit switched services to be sent over the IS856 air interface.

When the mobile station **100** requests circuit services notifications from the IS856 network, the MSC **22** will be informed that the mobile station **100** has requested CSNA services and will send circuit services notifications to the mobile station **100** via the HRPD AN **36**. The CSNA **42** in the HRPD AN **36** receives the circuit services messages from the MSC **22**, and the CSNA **42** in turn provides circuit service notifications to the mobile station **100**.

In some scenarios, the circuit services notification sent to the mobile station **100** may cause the mobile station **100** to transition to the IS2000 RAN **12**. As one example, the CSNA **42** may receive a paging request message from the MSC **22** and send a page message to the mobile station **100** responsive to the paging request message causing the mobile station **100** to transition to the IS2000 RAN **12** to receive a voice call. In other scenarios, the mobile station **100** may autonomously transition to the IS2000 RAN **12**. For example, the mobile station **100** may transition to the IS2000 RAN **12** to originate a voice call.

Under the current IS856 standards, the mobile station **100** is not required to notify the HRPD AN **36** when it transitions to the IS2000 RAN **12**. If the mobile station **100** is engaged in an active packet data session, the HRPD AN **36** will continue to reserve radio resources for the active packet data session with the mobile station **100**. The PDSN **32** will forward packet data to the HRPD AN **36**, which will attempt to deliver the packet data to the mobile station **100**. The HRPD AN **36**, through the use of internal mechanisms such as inactivity timers, failed delivery attempts, etc., will eventually determine that the mobile station **100** is not longer listening on the IS856 carriers and will release the radio and communication resources that have been reserved for the mobile station **100**. The HRPD AN **36** may request the MSC to page the mobile station in the IS2000 RAN **12** and wait for a response from the mobile station **100** before releasing resources.

When the mobile station **100** transitions from the HRPD RAN **14** to the IS2000 RAN **12**, the radio and communications resources reserved for the mobile station **100** are not being used. Releasing reserved radio and communication resources as early as possible would improve overall throughput of the network, and therefore, increase system capacity. Further, releasing resources when the mobile station **100** transitions to the IS2000 network can reduce accounting discrepancies.

According to the present invention, a method is provided for sending event notifications between the IS2000 RAN **12** and the HRPD RAN **14** to more efficiently manage resources. When the mobile station **100** registers with the HRPD RAN **14**, it may request forwarding of circuit services notifications through the HRPD RAN **14**. When the HRPD AN **36** receives a request for circuit services notifications via the HRPD RAN **14**, it notifies the MSC **22** via an A1 signaling link **38** that the mobile station **100** is operating within the IS 856 RAN **14**.

The MSC **22** stores an indication, referred to herein as the forwarding flag, indicating that the mobile station **100** is operating within the HRPD RAN **14**. This flag indicates that circuit services notifications should be forwarded to the mobile station **100** through the HRPD RAN **14**. The forwarding flag is also used to determine when event notifications should be sent by the MSC **22** to the HRPD RAN **14**. When the forwarding flag is set, the MSC **22** sends event notifications to the HRPD RAN **14** responsive to certain predetermined events.

One event that may trigger an event notification is a presence event. A presence event occurs when the IS2000 RAN **12** detects the mobile station **100** after the mobile station **100** has transitioned from the HRPD RAN **14**. When the MSC **22** detects the presence of a mobile station **100** after it has transitioned to the IS2000 RAN **12**, the MSC **22** sends an event notification to the HRPD RAN **14**. This situation may occur for example when the mobile station **100** involved in an active packet data session in the HRPD RAN **14** receives a circuit services notification, such as a page message. Responsive to the page message or other circuit services notification, the mobile station **100** transitions to the IS2000 RAN **12**. The mobile station **100** could also transition to the IS2000 RAN **12** on its own initiative, for example, to initiate a voice call. When the MSC **22** detects that the mobile station **100** has transitioned to the IS2000 RAN **12** and the forwarding flag is set, the MSC **22** sends an event notification message to the HRPD RAN **14** to notify the HRPD RAN **14** of the presence event. Upon receipt of the notification message from the MSC **22**, the HRPD RAN **14** can release resources reserved for the mobile station **100** and send an accounting update to the PDSN **32** to update accounting. In one exemplary embodiment, the HRPD RAN **14** places the packet data session in a dormant state responsive to the event notification. Thus, the HRPD RAN **14** may tear down its A8 connection and release any air interface resources reserved for the mobile station while maintaining the A10 connection to the PDSN **32**.

Another event that may trigger an event notification is referred to herein as the power down event. If the mobile station **100** powers down after transitioning to the IS2000 RAN **12**, the MSC **22** may send an event notification to the HRPD RAN **14** to notify that the mobile station **100** is no longer reachable. In response to the power down event notification, the HRPD RAN **14** terminates the packet data session and tear down the A10 connection to the PDSN **32**. Similarly, the HRPD RAN **14** may send an event notification to the IS2000 RAN **12** when the mobile station **100** powers down while present in the HRPD RAN **14**.

FIG. **2** is a call flow diagram illustrating how event notifications may be used. The call flow diagram is meant to be illustrative. Those skilled in the art will recognize that the present invention may be implemented in other procedures. The mobile station **100** establishes an active packet data call with the HRPD RAN **14** (step a). It is assumed that the mobile station **100** has requested CSNA services and that the MSC **22** has set the forwarding flag as previously described. While the mobile station **100** is involved in an active packet data call, the MSC **22** sends an A1 paging request to F the HRPD AN **36** (step b), and the HRPD AN **36** sends an IS2000 page message to the mobile station **100** encapsulated within a IS856-A air interface message (step c). The mobile station **100** transitions to the IS2000 RAN **12** and sends an IS2000 page response encapsulated within a IS856-A air interface message (step d). The IS2000 BS **24** receives the page response from the mobile station **100**, reformats the page response, and sends an A1 paging response to the MSC **22** (step e). The MSC **22** sends an event notification to the HRPD AN **36** indicating that the mobile station **100** has been detected in the IS2000 RAN **12** (step f). The HRPD RAN **14** stops its inactivity timer and releases radio and communication resources assigned to the mobile station **100**. The HRPD AN **36** also sends an accounting update to the PDSN **32** to update accounting for the packet data call (step g). At this point, the packet data call goes into a dormant state (step h). In the dormant state, the HRPD RAN **14** maintains a connection with the PDSN **32** for the packet data call but there is no communication channel established between the HRPD RAN **14** and the mobile station **100**. As is well known to those skilled in the art, the communication channel for the packet data call can be re-established at the initiative of either the HRPD RAN **14** or the mobile station **100**. Procedures for re-establishing the packet data calls are not material to the present invention.

The mobile station **100** powers down without returning to the HRPD RAN **14**. Before shutting down, the mobile station **100** and MSC **22** execute a power down procedure (step i). In one exemplary procedure, the mobile station **100** sends a power down indication to the IS2000 BS **24**, which in turn sends a Clear Request message to the MSC **22** to initiate call clearing. The MSC **22** sends a Clear Command message to the IS2000 BS **24**, which releases the resources allocated to the mobile station and sends a Clear Complete message with a power down indicator to the MSC **22**. In response to the Clear Complete message, the MSC **22** sends an event notification to the HRPD RAN **14** (step j) and the HRPD RAN **14** terminates the packet data session and releases the A10 connection to the PDSN **32**.

FIG. **3** is a flow diagram illustrating an exemplary notification procedure **60** implemented by the MSC **22**. The procedure **60** begins when the MSC **22** receives a request from the HRPD RAN **14** to send circuit services notifications to the mobile station **100** via the HRPD AN **36** (block **62**). The MSC **22** sets a forwarding flag to true (block **64**). When the MSC **22** subsequently detects an event (block **66**), it determines the setting of the forwarding flag (block **68**). The detected event may, for example comprises a presence event, power down event, or some other event. If the forwarding flag is set to true, the MSC **22** sends the HRPD RAN **14** an event notification (block **70**). The event notification includes an indication of the type of the event. The MSC **22** responds to the event normally as specified in applicable standards (block **72**) and the process ends (block **74**). If the forwarding flag is set to false (block **68**), the MSC **22** processes the received message from the mobile station **100** normally (block **72**).

FIG. **4** illustrates an exemplary resource management procedure **80** implemented by an HRPD RAN **14** for responding to a presence event. It is assumed that the mobile station **100** has requested CSNA services and that the presence flag at the HRPD AN **36** is set to true. The procedure begins when the HRPD AN **36** receives a notification that the mobile station **100** has been detected in the IS2000 RAN **12** (block **82**). The HRPD AN **36** determines if a packet data call is active (block **84**). If so, the HRPD AN **36** stops its internal inactivity timer (block **86**) and releases resources assigned to the mobile station **100** (block **88**). Additionally, the HRPD AN **36** sends an accounting update to the PDSN **32** (block **90**) and sets a presence flag equal to false (block **92**). The presence flag indicates whether the mobile station **100** is present and listening in the HRPD AN **36**. The HRPD AN **36** can use the presence flag to determine if it should attempt delivery of packet data over the IS856 air interface, or send a request to the MSC **22** to page the mobile station **100**. The HRPD AN **36** sets the presence flag to false (block **92**) and the procedure ends (block **94**).

FIG. **5** illustrates an exemplary procedure **110** implemented by the HRPD AN **36** for responding to a power down event. The procedure begins when the HRPD AN **36** receives an event notification from the MSC **22** indicating that the mobile station **100** has powered down (block **112**). The HRPD AN **36** determines if a packet data call session exists (block **114**). If so, the HRPD AN **36** terminates the packet data session (block **116**), tears down the A10 connection to the PDSN **32**, and releases radio resources (block **118**). Additionally, the HRPD AN **36** may send an accounting update to the PDSN **32** (block **120**) and the procedure ends (block **122**).

FIG. **6** illustrates an exemplary MSC **22** and HRPD AN **36** in more detail. The MSC **22** includes a call control and mobility management circuit **46** for call control handling and mobility management functions, and a switch **48** for routing user traffic. The AN **36** includes a controller **40** and one or more sectors **44**. The sectors **44** contain the radio equipment for communicating with the mobile stations **100**. The controller **40** comprises the control portion of the AN **36**. The controller **40** processes call control signaling and manages the radio and communication resources used by the sectors **44**. The controller **40** includes the CSNA **42**, which may be implemented in a processor programmed to carry out the functions of the CSNA **42**. The CSNA **42** exchanges signaling with the MSC **22** and provides the circuit services notifications to mobile stations **100** over the IS856 air interface. Signaling traffic between the controller **40** and the MSC **22** is carried over the A1 interface. The A8 and A9 interfaces carry user traffic and signaling, respectively, between the HRPD AN **36** and PCF **34**. The A13 interface transfers user traffic and signaling between HRPD ANs **36**.

In any case, those skilled in the art should appreciate that the present invention is not limited by the foregoing discussion, nor by the accompanying figures. Rather, the present invention is limited only by the following claims and their reasonable legal equivalents.

What is claimed is:

1. A method of managing communication resources in a hybrid network including a circuit switched network and a packet switched network, the method performed in a node within the packet switched network, the method comprising:

establishing packet data communications between said packet switched network and a mobile station over an access network that is distinct from an access network used for circuit switched communications between said circuit switched network and said mobile station, wherein said hybrid network combines said packet switched network and said circuit switched network with different signaling protocols and different air interfaces;

receiving an event notification at said node from said circuit switched network indicative of a change in the status of the mobile station; and

managing communication resources used for said packet data communications with the mobile station based on said event notification from said circuit switched network.

2. The method of claim **1** wherein the event notification indicates a presence of the mobile station in the circuit switched network.

3. The method of claim **1** wherein the event notification indicates that the mobile station has powered down.

4. The method of claim **1** wherein managing communication resources comprises releasing communication resources used for packet data communications with said mobile station.

5. The method of claim **4** further comprising notifying an accounting application accounting for the packet data communications that the communication resources were released.

6. The method of claim **1** further comprising receiving a request from said mobile station for circuit services notifications through said packet-switched network, and invoking a circuit services notification application responsive to said request to provide circuit services notifications to said mobile station.

7. The method of claim **1**, wherein the circuit-switched network and the packet-switched network include distinct radio access networks.

8. The method of claim **1**, wherein said node is within the packet switched network's access network, and wherein said receiving comprises receiving the event notification at said node from the circuit switched network's core network.

9. The method of claim **1**, wherein said node is within the packet switched network's access network, as distinct from the circuit switched network's access network, and wherein said receiving comprises receiving the event notification at said node from a mobile switching center in the circuit switched network's core network.

10. An access network for a packet-switched network included in a hybrid network that also includes a circuit switched network, comprising:

a radio base station supporting packet data communications with a mobile station; and

a controller including a signaling processor configured to:

route circuit services notifications from the circuit switched network to a mobile station while the mobile station is in the packet switched network, by encapsulating the circuit services notifications within messages conforming to an air interface for said packet switched network, as distinct from an air interface for said circuit switched network, wherein said hybrid network combines said packet switched network and said circuit switched network with different signaling protocols and different air interfaces,

receive an event notification indicative of the status of the mobile station from the circuit switched network; and

manage communication resources used for said packet data communications responsive to said event notification.

11. The access network of claim **10** wherein the event notifications comprise a notification message indicating that the mobile station is present in the circuit switched network.

12. The access network of claim **10** wherein the event notifications comprise a notification message indicating that the mobile station has powered down.

13. The access network of claim **10** wherein the signaling processor is further configured to release communication resources used for packet data communications with said mobile station responsive to said event notification.

14. The access network of claim **13** wherein the signaling processor is further configured to notify an accounting application accounting for the packet data communications that the communication resources were released.

15. The access network of claim **10**, wherein the circuit-switched network and the packet-switched network include distinct radio access networks.

16. A controller for a packet-switched network included in a hybrid network that also includes a circuit switched network, comprising:

a signaling processor configured to:

provide circuit services notifications to a mobile station while the mobile station is in the packet switched network, by encapsulating the circuit services notifications within messages conforming to an air interface for said packet switched network, as distinct from an air interface for said circuit switched network, wherein said hybrid network combines said packet switched network and said circuit switched network with different signaling protocols and different air interfaces;

receive an event notification from the circuit switched network indicative of a change in the status of the mobile station; and

manage communication resources used for said packet data communications responsive to said event notification message.

17. The controller of claim **16** wherein the event notification comprises a notification message indicating that the mobile station is present in the circuit switched network.

18. The controller of claim **16** wherein the event notification comprises a notification message indicating that the mobile station has powered down.

19. The controller of claim **16** wherein the signaling processor is further configured to release communication resources used for packet data communications with said mobile station responsive to said event notification.

20. The controller of claim **19** wherein the signaling processor is further configured to notify an accounting application accounting for the packet data communications that the communication resources were released.

21. The controller of claim **16**, wherein the circuit-switched network and the packet-switched network include distinct radio access networks.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 9,271,144 B2
APPLICATION NO. : 12/551073
DATED : February 23, 2016
INVENTOR(S) : Julka et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Specification

In Column 1, Line 7, delete "2005," and insert -- 2005, now Pat. No. 7,606,197, --, therefor.

In Column 5, Line 58, delete "to F the" and insert -- to the --, therefor.

Claims

In Column 8, Line 38, in Claim 10, delete "interfaces," and insert -- interfaces; --, therefor.

Signed and Sealed this
Twenty-sixth Day of July, 2016

Michelle K. Lee

Michelle K. Lee
Director of the United States Patent and Trademark Office