US 20110117963A1

(19) United States

(12) Patent Application Publication

(10) Pub. No.: US 2011/0117963 A1

Wang et al.

(43) Pub. Date: May 19, 2011

(54) METHOD AND SYSTEM FOR A FAST CELL RECOVERY ON SUSPENDED VIRTUAL MODEMS WITHIN A MULTI-SIM MULTI-STANDBY COMMUNICATION DEVICE

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(21) Appl. No.: **12/819,014**

(22) Filed: **Jun. 18, 2010**

Related U.S. Application Data

(60) Provisional application No. 61/261,922, filed on Nov. 17, 2009.

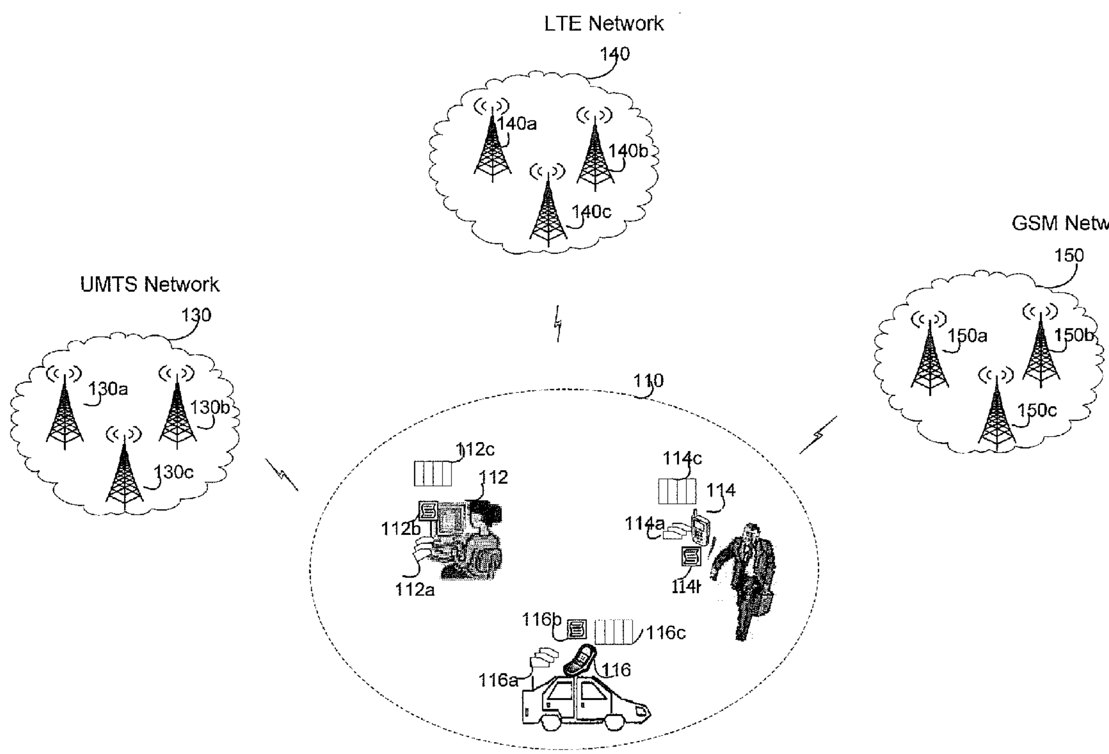
Publication Classification

(51) **Int. Cl.**
H04B 1/38 (2006.01)

(52) **U.S. Cl.** **455/558**

(57) **ABSTRACT**

A multiple-subscriber identity module (multi-SIM) multi-standby communication device comprises a single radio resource unit shared by a plurality of virtual modems (VMs). A first VM in an active state monitors its own associated cells and cells associated with remaining VMs in a suspended state. The active VM measures signal strength on available cells to track cell information such as cell quality and cell timing information for associated cells for the first active VM and for the remaining suspended VMs. When the suspended VMs are resumed, the single radio resource unit is synchronized to corresponding serving cells in an order determined based on the tracked cell timing information. With a synchronized serving cell, a suspended VM may bypass cell selection or reselection and directly camp on its serving cell. Otherwise, the suspended VM performs a cell selection or reselection selectively based on tracked cell information for a cell to camp on.



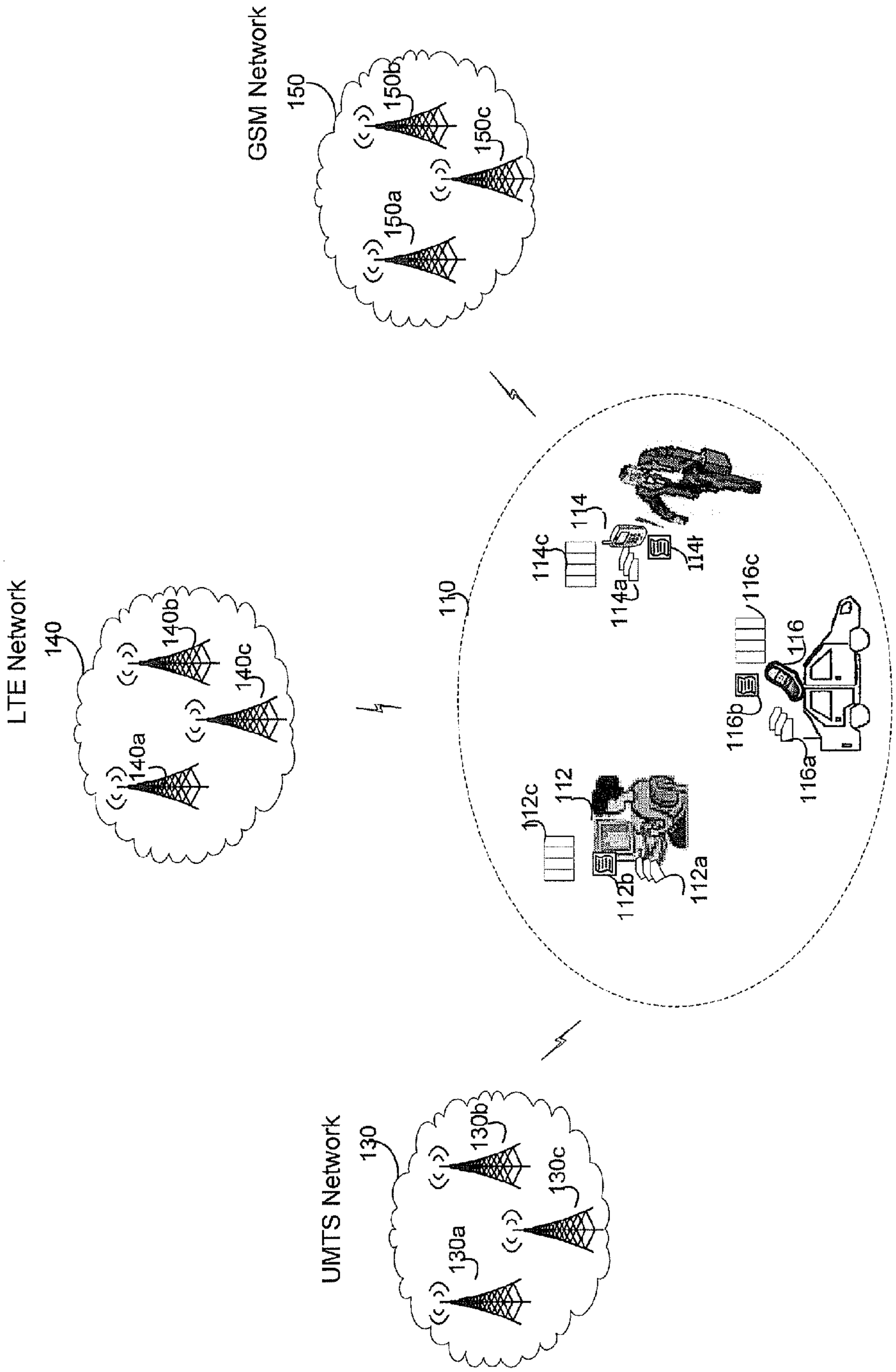

GSM Network
150
150a
150b
150c
LTE Network
140
140a
140b
140c
UMTS Network
130
130a
130b
130c
110
112
112a
112b
112c
114
114a
114c
116
116a
116b
116c

FIG. 1

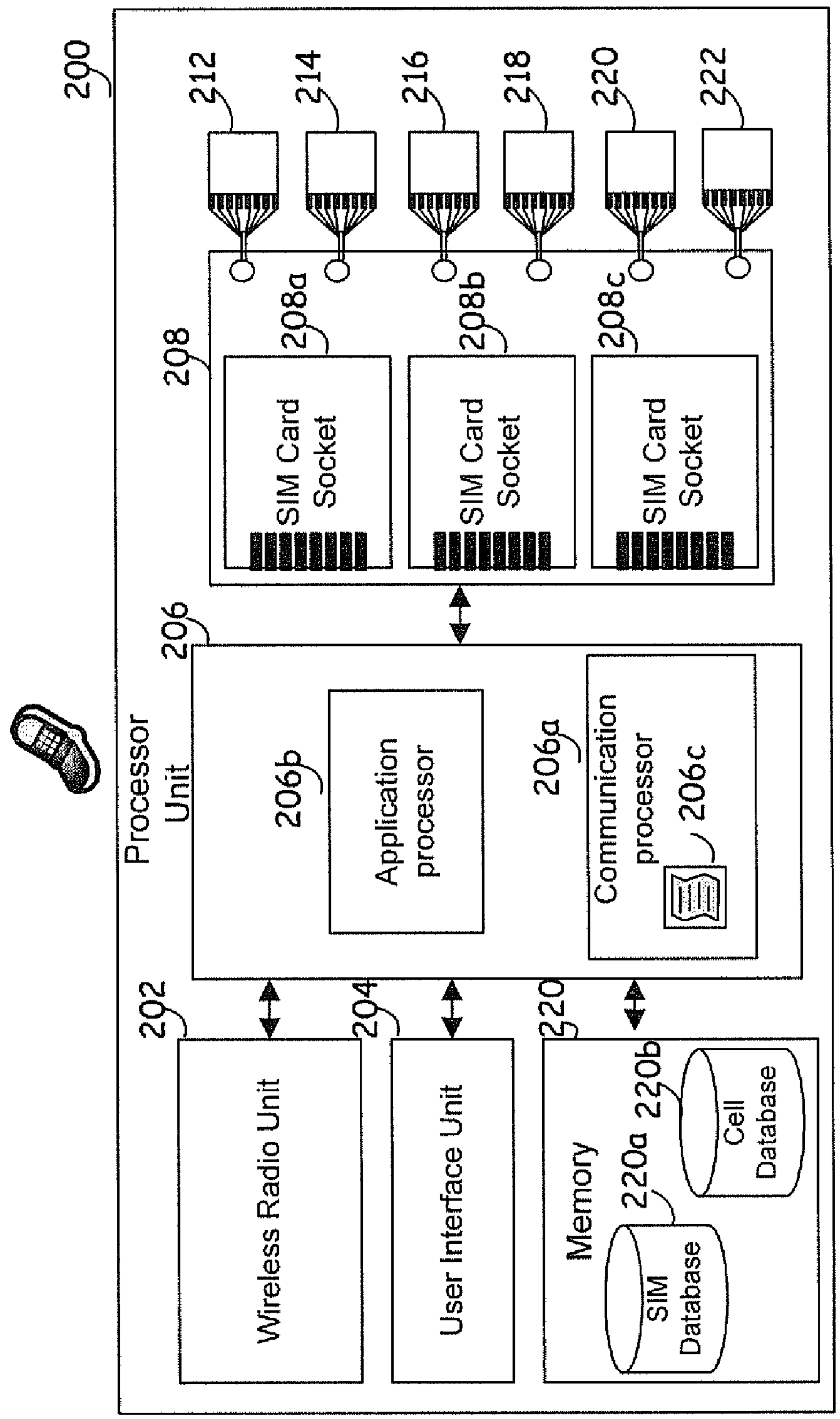

200
212
214
216
218
220
222
208
208a
208b
208c
SIM Card Socket
SIM Card Socket
SIM Card Socket
206
Processor Unit
206b
Application processor
206a
Communication processor
206c
202
Wireless Radio Unit
204
User Interface Unit
220
Memory
220a
220b
SIM Database
Cell Database

FIG. 2

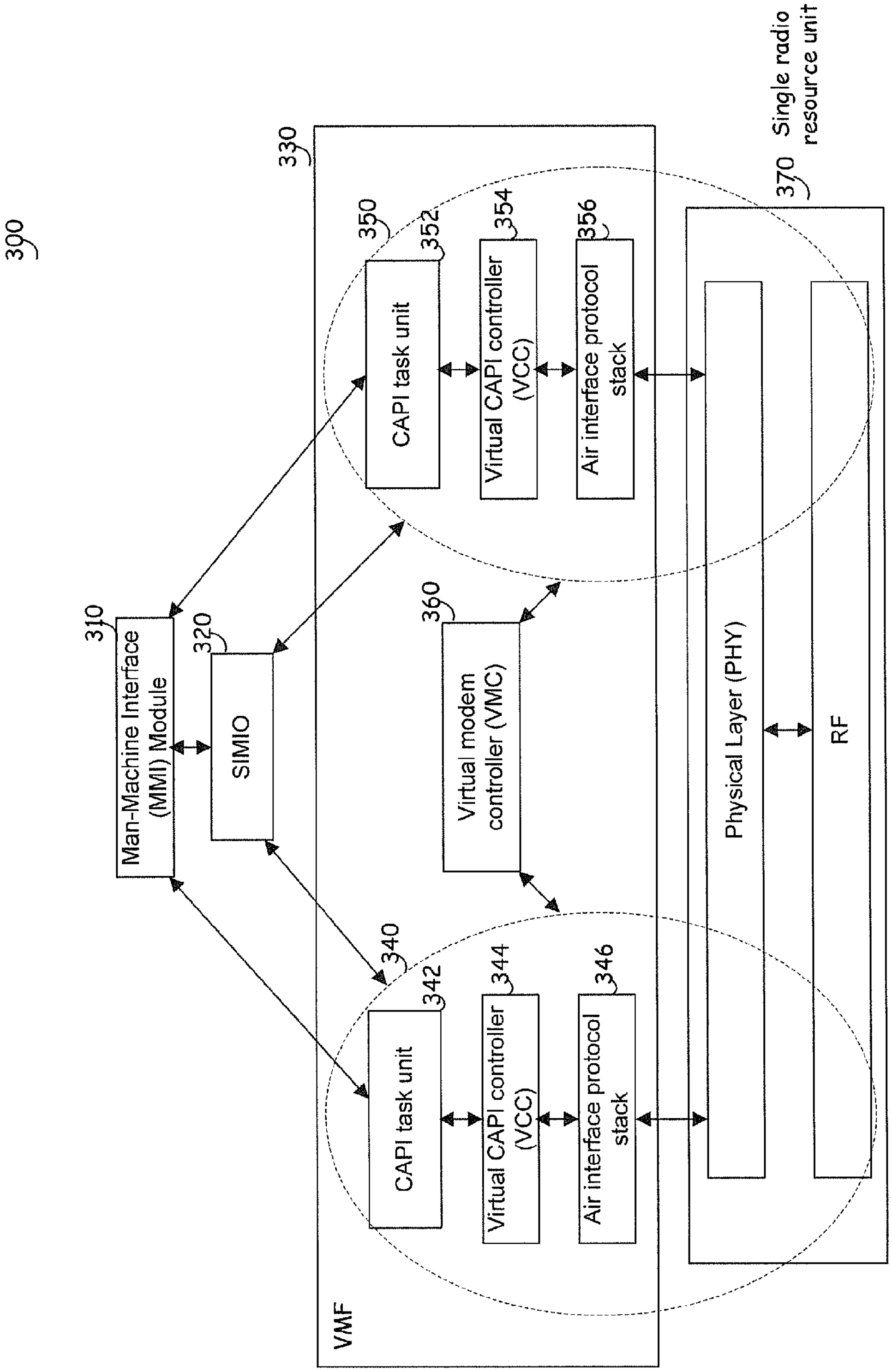

300
310
Man-Machine Interface (MMI) Module
320
SIMIO
330
VMF
340
342
CAPI task unit
344
Virtual CAPI controller (VCC)
346
Air interface protocol stack
350
352
CAPI task unit
354
Virtual CAPI controller (VCC)
356
Air interface protocol stack
360
Virtual modem controller (VMC)
370
Single radio resource unit
Physical Layer (PHY)
RF

FIG. 3

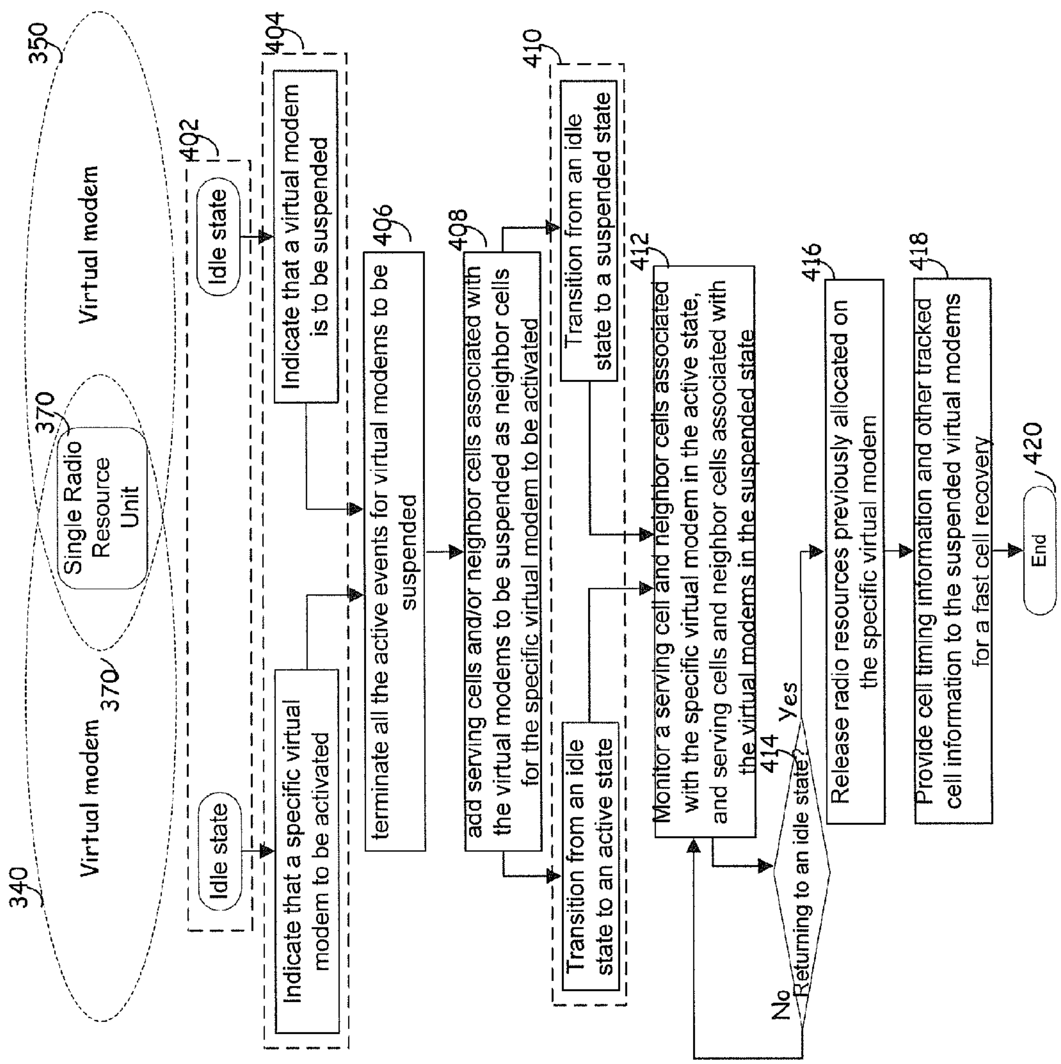

340
350
370
Virtual modem
Virtual modem
Single Radio Resource Unit
402
Idle state
Idle state
404
Indicate that a specific virtual modem to be activated
Indicate that a virtual modem is to be suspended
406
terminate all the active events for virtual modems to be suspended
408
add serving cells and/or neighbor cells associated with the virtual modems to be suspended as neighbor cells for the specific virtual modem to be activated
410
Transition from an idle state to an active state
Transition from an idle state to a suspended state
412
Monitor a serving cell and neighbor cells associated with the specific virtual modem in the active state, and serving cells and neighbor cells associated with the virtual modems in the suspended state
414
Returning to an idle state?
No
Yes
416
Release radio resources previously allocated on the specific virtual modem
418
Provide cell timing information and other tracked cell information to the suspended virtual modems for a fast cell recovery
420
End

FIG. 4

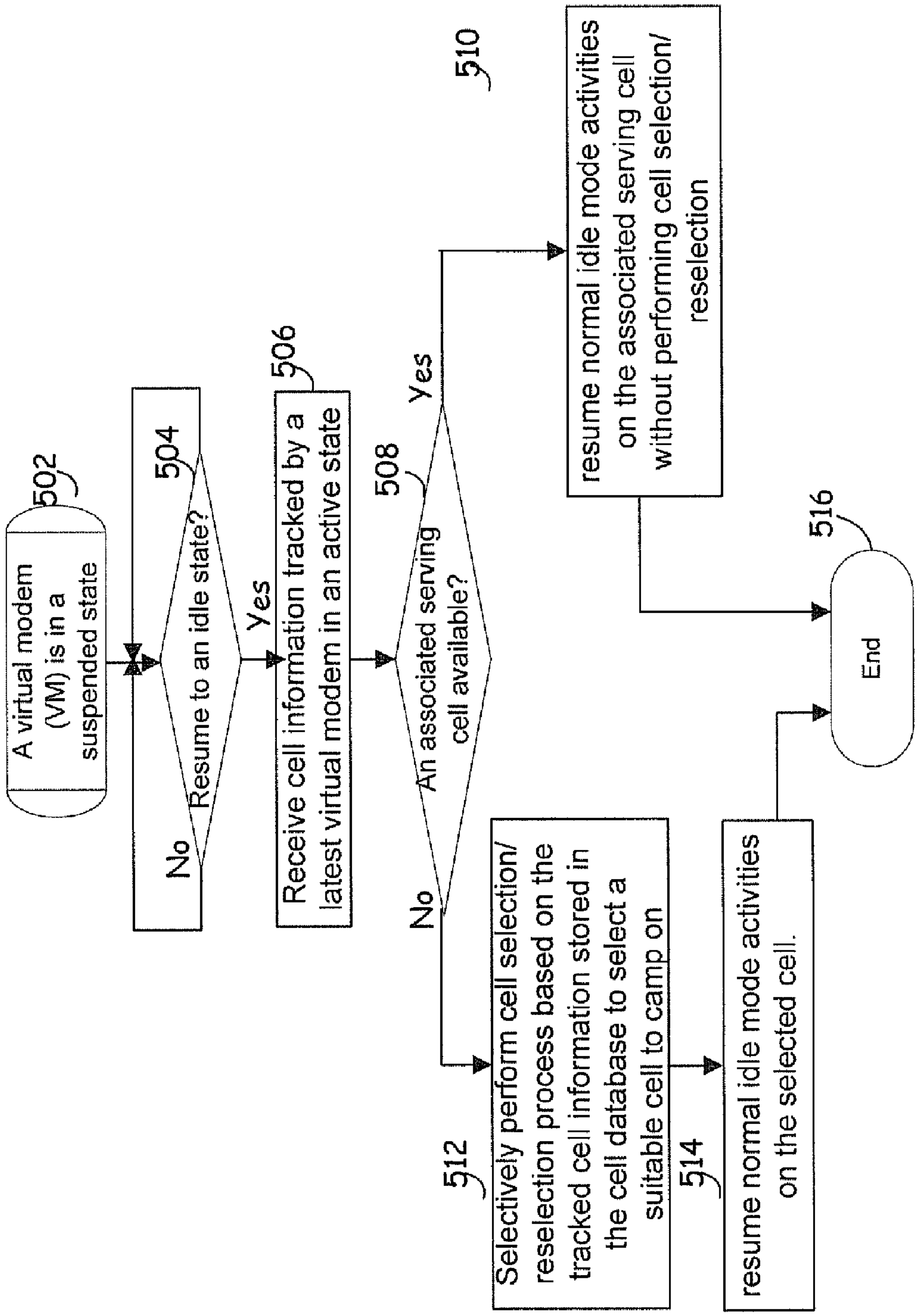

A virtual modem (VM) is in a suspended state
502
Resume to an idle state?
504
Yes
No
Receive cell information tracked by a latest virtual modem in an active state
506
An associated serving cell available?
508
Yes
No
resume normal idle mode activities on the associated serving cell without performing cell selection/ reselection
510
Selectively perform cell selection/ reselection process based on the tracked cell information stored in the cell database to select a suitable cell to camp on
512
resume normal idle mode activities on the selected cell.
514
End
516

FIG. 5

METHOD AND SYSTEM FOR A FAST CELL RECOVERY ON SUSPENDED VIRTUAL MODEMS WITHIN A MULTI-SIM MULTI-STANDBY COMMUNICATION DEVICE

CROSS-REFERENCE TO RELATED APPLICATIONS/INCORPORATION BY REFERENCE

[0001] This patent application makes reference to, claims priority to and claims the benefit from U.S. Provisional Patent Application Ser. No. 61/261,922 filed on Nov. 17, 2009.

[0002] This application makes reference to:

[0003] U.S. application Ser. No. 12/816,782 filed on Jun. 16, 2010,

[0004] U.S. application Ser. No. 12/816,835 filed on Jun. 16, 2010,

[0005] U.S. application Ser. No. ______ (Attorney Docket No. 21191 US02) filed on even date herewith, and

[0006] U.S. application Ser. No. ______ (Attorney Docket No. 21193US02) filed on even date herewith.

[0007] Each of the above stated applications is hereby incorporated herein by reference in its entirety.

FIELD OF THE INVENTION

[0008] Certain embodiments of the invention relate to communication systems. More specifically, certain embodiments of the invention relate to a method and system for a fast cell recovery on suspended virtual modems within a multi-SIM multi-standby communication device.

BACKGROUND OF THE INVENTION

[0009] With the development of mobile communication systems, mobile devices may utilize various mobile communication techniques such as, for example, global system for mobile communications (GSM), Universal Mobile Telecommunications System (UMTS), Long Term Evolution (LTE) network and wireless local area network (WLAN) to receive desired services. In instances where a mobile device subscribes to a communication network, subscriber information may be required to identify the mobile device to the network for various network services such as authentication, accounting, billing and security services. The subscriber information may be stored in a subscriber identity module (SIM) card inserted in the mobile device. A SIM card is a card or a chip installed in the mobile device providing information to identify the subscriber carrying the mobile device to networks.

[0010] Further limitations and disadvantages of conventional and traditional approaches will become apparent to one of skill in the art, through comparison of such systems with some aspects of the present invention as set forth in the remainder of the present application with reference to the drawings.

BRIEF SUMMARY OF THE INVENTION

[0011] A method and/or system for a fast cell recovery on suspended virtual modems within a multi-SIM multi-standby communication device, substantially as shown in and/or described in connection with at least one of the figures, as set forth more completely in the claims.

[0012] These and other advantages, aspects and novel features of the present invention, as well as details of an illustrated embodiment thereof, will be more fully understood from the following description and drawings.

BRIEF DESCRIPTION OF SEVERAL VIEWS OF THE DRAWINGS

[0013] FIG. **1** is a diagram illustrating an exemplary communication system that is operable to support fast cell recovery for suspended virtual modems within a multi-SIM multi-standby communication device, in accordance with an embodiment of the invention.

[0014] FIG. **2** is a block diagram illustrating an exemplary multi-SIM multi-standby communication device that is operable to support a fast cell recovery for suspended virtual modems, in accordance with an embodiment of the invention.

[0015] FIG. **3** is a block diagram illustrating an exemplary multi-instance virtual modem approach to concurrently handle multi-instance tasks on a multi-SIM multi-standby communication device, in accordance with an embodiment of the invention.

[0016] FIG. **4** is a block diagram illustrating exemplary steps that may be performed by a multi-SIM multi-standby communication device to track serving cells and/or neighbor cells associated with virtual modems in a suspended state via a virtual modem in an active state, in accordance with an embodiment of the invention.

[0017] FIG. **5** is a flow chart illustrating exemplary steps that may be performed by a virtual modem in a suspended state for a fast cell recovery utilizing cell information tracked by a virtual modem in an active state, in accordance with an embodiment of the invention.

DETAILED DESCRIPTION OF THE INVENTION

[0018] Certain embodiments of the invention may be found in a method and system for a fast cell recovery on suspended virtual modems within a multi-SIM multi-standby communication device. In various embodiments of the invention, a multiple-subscriber identity module (multi-SIM) multi-standby communication device comprises a single radio resource unit providing open system interconnect (OS) layer **1**, namely, physical layer (PHY), and RF, for example, functionalities. The single radio resource unit is shared by a plurality of virtual modems (VMs) implemented in a virtual modem architecture (VMA). The VMA is deployed on the single radio resource unit to handle operations in a multi-standby mode. The VMA comprises a plurality of virtual modems (VMs), a virtual modem framework (VMF) and a virtual modem controller (VMC). Each of the VMs is uniquely associated with a single one of a plurality of SIM cards that are coupled to the multi-SIM multi-standby communication device. Each of the VMs may operate in one of a plurality of VM states, comprising, for example, an active state, an idle state and a suspended state. In instances where a first VM is operating in an active state and one or more remaining ones of the plurality of VMs are operating in a suspended state, the first VM operating in the active state may be operable to monitor its own serving cell and/or one or more neighbor cells, and serving cells and/or neighbor cells associated with remaining ones of the plurality of VMs that are operating in the suspended state. In this regard, the serving cells and/or neighbor cells associated with the one or more remaining ones of the plurality of VMs that are operating in the suspended state may be added as neighbor cells for the first VM operating in the active state. Signal strength may be measured by the first VM operating in the active state on its own serving cell and/or one or more neighbor cells, and serving cells and/or neighbor cells associated with the one or more remaining ones of the plurality of VMs operating in the suspended state. The cell signal strength measurements may be utilized to determine cell quality of corresponding cells. Cell quality of a cell may be calculated or estimated utilizing received power information such as, for example, received power, signal-to-noise ratio (SNR) and/or signal-to-interference-noise ratio (SINR), of reference signals such as pilot signals and/or synchronization signals that are assigned by a network to the cell. The first VM operating in the active state may be operable to track cell information such as cell timing information for its own serving cell and/or one or more neighbor cells, and the added serving cells and/or neighbor cells associated with the one or more remaining ones of the plurality of VMs operating in the suspended state based on the corresponding cell signal strength measurements. The tracked cell information may be stored in a database to be shared by a plurality of VMs in the VMA for a fast cell recovery, for example. In instances where the first VM operating in the active state returns to an idle state, the one or more suspended VMs may resume normal idle mode operation. In this regard, the single radio resource unit may synchronize to the serving cells associated with the suspended VMs in an order that may be determined based on the tracked cell timing information. A suspended VM may bypass cell selection or reselection and directly camp on an associated serving cell if the associated serving cell is still synchronized. Otherwise, a cell selection or reselection may be selectively performed by the suspended VM based on the tracked cell information in order to quickly identify a suitable cell to camp on.

[0019] FIG. **1** is a diagram illustrating an exemplary communication system that is operable to support a fast cell recovery for suspended virtual modems within a multi-SIM multi-standby communication device, in accordance with an embodiment of the invention. Referring to FIG. **1**, there is shown a communication system **100**. The communication system **100** comprises a plurality of mobile devices **110**, of which multi-SIM multi-standby communication devices **112-116** are illustrated, a UMTS network **130**, a Long Term Evolution (LTE) network **140**, and a GSM network **150**.

[0020] A multi-SIM multi-standby communication device such as the multi-SIM multi-standby communication device **112** may comprise suitable logic, circuitry, interfaces and/or code that are operable to communicate or support various network services such as authentication, billing and/or security with a plurality of communication access networks such as, for example, the UMTS network **130**, the LTE network **140**, and the GSM network **150**. Multiple SIM cards such as SIM cards **112***a* may be inserted in the multi-SIM multi-standby communication device **112** whenever needed. The inserted SIM cards **112***a* may be coupled or connected with the multi-SIM multi-standby communication device **112** through one or more SIM card sockets or connections. The multi-SIM multi-standby communication device **112** may read or retrieve SIM identification information from the SIM cards **112***a* via the one or more SIM card sockets or connections. The retrieved SIM identification information may be stored within the multi-SIM multi-standby communication device **112** to support various network services such as authentication, billing and security whenever needed. In this regard, the multi-SIM multi-standby communication device **112** may be configured to activate the retrieved SIM identification information either on one SIM card at a time or on multiple SIM cards at the same time depending on implementation and/or device configuration. In instances where the retrieved SIM identification information is activated on one SIM card at a time, the multi-SIM multi-standby communication device **112** may operate in a single-standby mode. In instances where the retrieved SIM identification information is activated on two or more SIM cards at the same time, the multi-SIM multi-standby communication device **112** may operate in a multi-standby mode. In this regard, the multi-SIM multi-standby communication device **112** in a multi-standby mode may be operable to support multiple subscriptions at the same time. A user of the multi-SIM multi-standby communication device **112** may be allowed to utilize multiple numbers, multiple different service plans and/or one or more network carriers at the same time whenever the multi-SIM multi-standby communication device **112** is in a multi-standby mode. A single radio resource unit may comprise suitable logic, circuitry, interfaces and/or code that are operable to provide PHY and RF functionalities to support desired services on a communication device. For example, single radio resource unit **112***c*-**116***c* may be integrated into the multi-SIM multi-standby communication devices **112-116**, respectively, for PHY and RF support.

[0021] U.S. application Ser. No. 12/816,782, which is filed on June 16, 2010 provides detailed descriptions that a Virtual Modem Architecture (VMA) may be adopted over a single radio resource unit to support a multi-standby mode on a multi-SIM multi-standby communication device, and is hereby incorporated herein by reference in its entirety.

[0022] The multi-SIM multi-standby communication device **112** may deploy a VMA **112***b* over the single radio resource unit **112***c* to support operations in a multi-standby mode. The VMA **112***b* may be configured to concurrently handle multiple tasks or instances over the single radio resource unit **112***c*. Each task or instance is associated with one of the multiple SIM cards **112***a*. A task may also be called an instance of a process. An air interface protocol stack and/or a Common Application Programming Interface (CAPI) module may comprise multiple tasks. A collection of air interface protocol stack tasks and/or CAPI tasks associated with a single SIM card together with appropriate physical layer (PHY), DSP functionalities, and/or RF functionalities supported by the single radio resource unit **112***c* is referred to as a Virtual Modem (VM). Each VM in the VMA **112***b* may be assigned to handle instances related to one of the multiple SIM cards **112***a*. With regard to a particular VM in the VMA **112***b*, a cell may act as a serving cell or a neighbor cell.

[0023] A cell comprises a geographical area covered or served by a base station. A serving cell for the particular VM is a cell that is served by a base station to which the particular VM currently camps on. One or more neighbor cells may be associated with the particular VM. A neighbor cell for the particular VM is a neighbor of the serving cell of the particular VM. A neighbor cell for the particular VM is served by a base station to which the particular VM does not currently camp on. Each of the VMs in the VMA **112***b* may be assigned to handle instances related to one of the multiple SIM cards **112***a*. A VM may be placed or may operate in one of a plurality of VM states, comprising, for example, an active state, an idle state or a suspended state. In an active state, radio resources are assigned to the VM and a valid or active connection between a VM and an associated cell is established for data and/or voice communication. The VM may be allowed to utilize radio resources available in the single radio resource unit **112***c* to communicate or support services related to a specific SIM card. In an idle state, no valid or active connection between the VM and an associated cell is established; however, associated registration information is retained in the associated cell/network. In the idle state, the VM may be allowed to utilize limited radio resources available in the single radio resource unit **112***c* to monitor paging events and to perform normal idle mode activities such as cell selection/reselection. In a suspended state, a VM may be totally suspended from using radio resources available in the single radio resource unit **112***c*. Before entering the suspended state, the VM may need to suspend or abort procedures such as, for example, data transfer, operating band change and/or manual public land mobile network (PLMN) search, which are currently being executed on the VM.

[0024] The VMA **112***b* may be operable to arbitrate and/or resolve contention for radio resources via the transition of the VM among one or more of the three VM states. For example, the VMA **112***b* may ensure that at most one of the plurality of VMs in the VMA **112***b* is in the active state for a given time instant. In other words, no two or more VMs may be allowed to be in an active state at the same time. In this regard, the VMA **112***b* may be operable to suspend one or more of the plurality of VMs from using or sharing radio resources available in the single radio resource unit **112***c* to ensure an uninterrupted radio resource usage by a VM in an active state.

[0025] In various exemplary embodiments of the invention, serving cells and/or neighbor associated with the one or more VMs in a suspended state may be added as neighbor cells for the VM in the active state. In other words, the VM in the active state may be operable to monitor its own serving cell and/or one or more neighbor cells, and serving cells and/or neighbor cells associated with the one or more VMs in the suspended state. In this regard, the VM in the active state may be operable to measure signal strength on its own serving cell and/or one or more neighbor cells, and each of serving cells and/or neighbor cells associated with one of the VMs in the suspended state. In addition to the cell signal strength measurement, the VM in the active state may also track other cell information such as, for example, associated cellular frequencies, cells placed on particular cellular frequencies, and/or cell identities, for each of serving cells and/or neighbor cells associated with one of the VMs in the suspended state. The resulting cell signal strength measurements may indicate cell quality information. For example, a cell corresponding to the strongest cell signal strength measurement may be selected or utilized to support cell timing tracking performance, when needed. The VM in the active state may track or retrieve cell information such as cell timing information for its own serving cell, and serving and/or neighbor cells associated with the VMs in the suspended state based on the cell signal strength measurements. The tracked cell information such as, for example, cell measurements, cell timing information, associated cellular frequencies, possible cells on particular cellular frequencies and/or corresponding cell identities, may be shared among the VMs in the VMA. In this regard, the cell search time may be reduced for each of the VMs. Cell search results for a particular VM may be shared or utilized by other VMs for a fast cell recovery and/or for other procedures such as PLMN search and/or user selection of a particular PLMN.

[0026] In various exemplary embodiments of the invention, the retrieved cell timing information for serving and/or neighbor cells associated with the VMs in the suspended state may be utilized for a fast cell recovery on corresponding VMs in the suspended state. For example, after the VM in the active state returns to an idle state, a VM in the suspended state may be resumed for normal idle activities. In instances where a serving cell associated with the VM in the suspended state is still synchronized, the VM in the suspended state may directly camp on the associated serving cell for normal idle mode activities without performing cell selection or reselection. In instances where a serving cell associated with the VM in the suspended state is not synchronized, the VM in the suspended state may selectively perform cell selection/reselection based on tracked cell information such as cell signal strength measurements, cell timing information, cells on particular cellular frequencies and/or cell identity information. For example, the VM in the suspended state may perform cell selection/reselection for cells with high cell quality and/or for cells on particular cellular frequencies.

[0027] In various exemplary embodiments of the invention, the retrieved cell timing information may be utilized by the single radio resource unit **112***c* to arbitrate or resolve cell scheduling conflicts. For example, the single radio resource unit **112***c* may synchronize to cells in an order that is based on corresponding cell timing information so as to avoid scheduling conflicts.

[0028] The UMTS network **130** may comprise suitable devices, circuitry, interfaces and/or code that are operable to provide data and/or voice services to various UMTS capable communication devices such as the multi-SIM multi-standby communication device **112** using UMTS technology. In this regard, the UMTS network **130** may be operable to authenticate users such as the multi-SIM multi-standby communication devices **112**-**116** for UMTS access utilizing SIM cards. A SIM card for UMTS is also known as universal subscribe identity module (USIM). Only authorized users may access the UMTS network **130**. The UMTS network **130** may be operable to check the validity of USIM identification information on one or more USIM cards coupled to, for example, the multi-SIM multi-standby communication device **112**. The UMTS network **130** may determine whether the multi-standby communication device **112** is allowed to access the UMTS network **130** for various network services such as, for example, authentication, accounting and/or billing services. The UMTS network **130** may comprise a plurality of base stations such as base stations **130***a*-**130***c* to communicate with associated communication device such as the multi-standby communication device **112**.

[0029] The LTE network **140** may comprise suitable devices, circuitry, interfaces and/or code that are operable to provide data and/or voice services to various LTE capable communication devices such as the multi-SIM multi-standby communication device **112** using LTE technology. In this regard, the LTE network **140** may be operable to authenticate users such as the multi-SIM multi-standby communication devices **112**-**116** for LTE access utilizing SIM cards. A SIM card for LTE is also known as Universal Integrated Circuit Card (UICC). Only authorized users may access the LTE network **140**. The LTE network **140** may be operable to check the validity of UICC identification information on one or more UICCs coupled to, for example, the multi-SIM multi-standby communication device **112**. The LTE network **140** may determine whether the multi-SIM multi-standby communication device **112** is allowed to access the LTE network **140** for various network services such as, for example, authentication, accounting and/or billing services. The LTE network **140** may comprise a plurality of base stations such as base stations **140***a*-**140***c* to communicate with associated communication device such as the multi-standby communication device **112**.

[0030] The GSM network **150** may comprise suitable devices, circuitry, interfaces and/or code that are operable to provide data and/or voice services to various GSM capable communication devices such as the multi-SIM multi-standby communication device **112** using GSM technology. In this regard, the GSM network **150** may be operable to authenticate users such as the multi-SIM multi-standby communication devices **112**-**116** for GSM access utilizing SIM cards. Only authorized users may access the GSM network **150**. The GSM network **150** may be operable to check the validity of SIM identification information on one or more SIM cards coupled to, for example, the multi-SIM multi-standby communication device **112**. The GSM network **150** may determine whether the multi-SIM multi-standby communication device **112** is allowed to access the GSM network **150** for various network services such as, for example, authentication, accounting and/or billing services. The GSM network **150** may comprise a plurality of base stations such as base stations **150***a*-**150***c* to communicate with associated communication device such as the multi-standby communication device **112**.

[0031] A base station may comprise suitable logic, circuitry, interfaces and/or code that are operable to manage and schedule communication resources in an uplink direction and/or downlink direction within a served geographic area, namely, a cell. The base station may be operable to receive and/or transmit radio frequency signals from and/or to communication devices such as the multi-standby communication device **112**-**116** using various air interface protocols. For example, the base stations **130***a*-**130***c*, the base stations **140***a*-**140***c* and the base stations **150***a*-**150***c* may be operable to utilize air interface protocols specified in the UMTS network **130**, the LTE network **140** and the GSM network **150**, respectively, to communicate with the multi-standby communication device **112**-**116**.

[0032] In an exemplary operation, a multi-SIM multi-standby communication device such as the multi-SIM multi-standby communication device **112** may be connected or coupled with multiple SIM cards such as the SIM cards **112***a* through one or more SIM card sockets or connections. SIM identification information on the multiple SIM cards may be utilized on one SIM card at a time and/or on multiple SIM cards at the same time depending on implementation. SIM identification information on each of the multiple SIM cards **112***a* may be communicated to the multi-SIM multi-standby communication device **112** through the one or more SIM card sockets. The multi-SIM multi-standby communication device **112** may operate in a single-standby mode or a multi-standby mode depending on device configuration and/or user preferences. A user of the multi-SIM multi-standby communication device **112** in a multi-standby mode may be allowed to utilize SIM identification information associated with each of the multiple SIM cards **112***a* to receive corresponding services at the same time.

[0033] In an exemplary embodiment of the invention, multiple numbers, multiple different service plans and/or one or more network carriers associated with each of the multiple SIM cards **112***a* may be utilized at the same time on the multi-SIM multi-standby communication device **112**. In this regard, the multi-SIM multi-standby communication device **112** may be operable to utilize the VMA **112***b* over the single radio resource unit **112***c* to support a multi-standby mode. The VMA **112***b* may be operable to receive services associated with the multiple SIM cards **112***a* at the same time. Each VM in the VMA **112***b* is assigned to serve one of the multiple SIM cards **112***a*. For a given time instant, a VM may be in one of the three VM states, namely, an active state, an idle stat and a suspended state. The VMA **112***b* may be configured to manage contention from associated VMs for radio resources available in the single radio resource unit **112***c*. For example, the VMA **112***b* may be operable to suspend one or more VMs from using radio resources available in the single radio resource unit **112***c* to ensure an uninterrupted radio resource usage by a VM in an active state. In this regard, serving cells and/or neighbor cells associated with the VMs in a suspended state may be added as neighbor cells for the VM in the active state. The VM in the active state may be configured to measure signal strength on its own serving cell and/or one or more neighbor cells, and serving cells and/or neighbor cells associated with each of the VMs in the suspended state. Cell information such as cell timing information, associated cellular frequencies and/or cell identity information may be tracked by the VM in the active state for its own serving cell and/or one or more neighbor cells, and serving cells and/or neighbor cells associated with the VMs in the suspended state based on the corresponding cell signal strength measurements. The retrieved cell information may enable a fast cell recovery on the VM in the suspended state, whenever needed. Furthermore, to avoid cell scheduling conflicts, the single radio resource unit **112***c* may manage operations of the VMs in the VMA **112***b* to quickly synchronize to related cells based on the retrieved cell timing information.

[0034] FIG. **2** is a block diagram illustrating an exemplary multi-SIM multi-standby communication device that is operable to support a fast cell recovery for suspended virtual modems, in accordance with an embodiment of the invention. Referring to FIG. **2**, there is shown a multi-SIM multi-standby communication device **200**. The multi-SIM multi-standby communication device **200** comprises a wireless radio unit **202**, a user interface unit **204**, a processor unit **206**, a SIM card controller **208** comprising SIM card sockets **208***a*-**208***c*, a plurality of SIM cards, of which SIM cards **212**-**222** are illustrated, and a memory **220**. The SIM cards **212**-**222** are coupled to the multi-SIM multi-standby communication device through the SIM card sockets **208***a*-**208***c*. The memory **220** comprises a SIM database **220***a* and a cell database **220***b*.

[0035] The wireless radio unit **202** may comprise suitable logic, circuitry, interfaces and/or code that may be operable to synchronize to various communication networks such as, for example, the LTE network **140** and the GSM network **150**, to communicate radio frequency signals. SIM identification information that is retrieved from one or more of the SIM cards **222**-**228** may be communicated via the wireless radio unit **202** to identify the multi-SIM multi-standby communication device **200** to network for desired network services such as accounting/billing services.

[0036] The user interface unit **204** may comprise suitable logic, circuitry, interfaces and/or code that may enable a user to interact with the multi-SIM multi-standby communication device **200**. For example, the user interface unit **204** may be operable to present the user with information on SIM cards available to the multi-SIM multi-standby communication device **200**. The user interface unit **204** may allow the user to enter a preferred SIM card selection and/or a desired application selection.

[0037] The processor unit **206** may comprise suitable logic, circuitry, interfaces and/or code that may be operable to manage and/or control operations of device components such as, for example, the wireless radio unit **202**, the user interface unit **204**, the SIM database **220***a*, and/or the SIM card controller **208**. For example, the processor unit **206** may be operable to coordinate and/or control operations of the SIM card controller **208** in response to a SIM card selection from the user interface unit **204**. The processor unit **206** may also be operable to run a specific application via the application processor based on an application selection from the user interface unit **204**.

[0038] The processor unit **206** may be operable to select one or more SIM cards based on user preferences and/or device configuration. The processor unit **206** may communicate the SIM card selection information to the SIM card controller **208** so that the selected one or more SIM cards may be connected to the SIM card sockets **208***a*-**208***c*, which are directly coupled with the processor unit **206**. The selected SIM cards may be actively connected to the SIM card controller **208** to enable downloading of corresponding SIM identification information into the SIM database **220***a* of the multi-SIM multi-standby communication device **200**. Notwithstanding, in accordance with various embodiments of the invention, after SIM identification information is downloaded from each of the selected SIM cards such as the SIM cards **212**-**222** into the SIM database **220***a* of the multi-SIM multi-standby communication device **200**, the SIM identification information corresponding to one or more of the plurality of SIM cards may be in an active state or in a standby state in the SIM database **220***a*. More specifically, at a given time instant, SIM identification information actually being utilized or applied to access corresponding services by the multi-SIM multi-standby communication device **200** is in an active state, otherwise, in a standby state.

[0039] In instances where the multi-SIM multi-standby communication device **200** is configured to operate in a single-standby mode, the processor unit **206** may communicate with the SIM database **220***a* to activate the stored SIM identification information related to one SIM card at a time. In other words, the multi-SIM multi-standby communication device **200**, in a single-standby mode, may be operable to utilize SIM identification information activated for a single SIM card at a time. In instances where the multi-SIM multi-standby communication device **200** is configured to operate in a multi-standby mode, the processor unit **206** may be operable to communicate with the SIM database **220***a* to activate the stored SIM identification information corresponding to multiple SIM cards such as the SIM cards **212**-**222** at the same time. Specifically, the multi-SIM multi-standby communication device **200**, in a multi-standby mode, may be operable to utilize SIM identification information activated for multiple SIM cards at the same time. In this regard, the processor unit **206** may be operable to allow a user of the multi-SIM multi-standby communication device **200** to utilize SIM identification information associated with each of the SIM cards **212**-**222** to receive corresponding services at the same time. For example, the user may therefore be allowed to utilize multiple numbers, multiple different service plans and/or network carriers associated with each of the multiple SIM cards **212**-**222** at the same time on the multi-SIM multi-standby communication device **200**. The processor unit **206** comprises a communication processor **206***a* and an application processor **206***b*.

[0040] The communication processor **206***a* may comprise suitable logic, circuitry, interfaces and/or code that may be operable to utilize a VMA **206***c* over a single radio resource unit such as the single radio resource unit **112***c* associated with the wireless radio unit **202** to support a multi-standby mode. The VMA **206***c* is a multi-SIM multi-standby platform and comprises a virtual modem controller (VMC), a Virtual Model Framework (VMF) and a plurality of VMs. Each VM in the VMA **206***c* is assigned or related to one of the multiple SIM cards **212**-**222**. For a given time instant, a VM may operate in one of a plurality of VM states, namely, an active state, an idle state or a suspended state. To avoid radio resource conflicts, at most one of the VMs in the VMA **206***c* may be in an active state to transmit and/or receive traffic related to a corresponding SIM card. One or more VMs may be in an idle state at the same time depending on radio resources available in the single radio resource unit **112***c* for sharing. One or more VMs may be in a suspended state at the same time.

[0041] In various exemplary embodiments of the invention, the VMA **206***c* may be configured to add serving cells and/or neighbor cells associated with the one or more VMs in the suspended state as neighbor cells for the VM in the active state. The VM in the active state may be operable to monitor its own serving cell and/or one or more neighbor cells, and serving cells and/or neighbor cells associated with the one or more VMs in the suspended state. In this regard, the VM in the active state may be operable to measure signal strength on its own serving cell and/or one or more neighbor cells, and serving cells and/or neighbor cells associated with the VMs in the suspended state. The VM in the active state may also monitor or track other cell related information such as, for example, cell timing information, associated cellular frequencies associated, and/or corresponding cell identities, for each of serving cells and neighbor cells associated with the one of the VMs in the suspended state. Cell quality may be determined or identified based on the corresponding cell signal strength measurements. A cell with the strongest cell signal strength measurements may be selected or utilized to support or enhance cell timing tracking. The VM in the active state may be operable to track cell timing information for each available cell based on corresponding cell measurements. The cell signal strength measurements together with other cell information such as cell timing information, associated cellular frequencies, and/or cell identities may be stored in the cell database **220***b* where it may be shared by multiple VMs in the VMA **206***c*.

[0042] In various exemplary embodiments of the invention, the VMA **206***c* may be operable to utilize the tracked cell information to support a fast cell recovery on VMs in the suspended state. For example, in instances where a VM in a suspended state is resumed from the suspended state to an idle state for normal idle activities, with a synchronized serving cell, the VM in the suspended state may be operable to directly camp on its own serving cell without performing cell selection or cell reselection. In instances where a serving cell for the VM in the suspended state is not synchronized, a cell selection/reselection may be selectively performed by the VM in the suspended state utilizing the cell information such as cell measurements, cell timing information, associated cellular frequencies and/or cell identities stored in the cell database **220***b*. The resulting cell search results may be stored in the cell database **220***b* to be shared or utilized by other VMs for a fast cell recovery and/or other purposes such as PLMN search, when needed.

[0043] In various exemplary embodiments of the invention, the VMA **206***c* may be operable to communicate the tracked cell timing information with the single radio resource unit **112***c* to support cell scheduling. For example, the single radio resource unit **112***c* may be operable to determine a cell scheduling order for cell synchronization based on the tracked cell timing information. The cell scheduling order may comprise information such as when to synchronize to which cell in order to transmit and/or receive traffic related to a specific SIM card such as the SIM card **212**. The communication processor **206***a* may communicate the received data and/or voice traffic related to the SIM card **212** to the application processor **206***b* to support desired applications.

[0044] The application processor **206***b* may comprise suitable logic, circuitry, interfaces and/or code that may be operable to run various applications such as video and/or audio multimedia applications based on data and/or voice traffic received by the communication processor **206***a*. The application processor **206***b* may present applications to users through the user interface unit **204**.

[0045] The SIM card controller **208** may comprise suitable logic, circuitry, interfaces and/or code that may be operable to manage and/or control connections from multiple SIM cards such as the SIM cards **212**-**222** to the SIM card sockets **208***a*-**208***c*, which are directly coupled with the processor unit **206**. In this regard, the SIM card controller **208** may be operable to establish connections between the SIM cards **212**-**222** and the processor unit **206**. The SIM card controller **208** may be configured to switch SIM card connection from one to another as needed without re-booting the multi-SIM multi-standby communication device **200**.

[0046] A SIM card such as the SIM card **214** may comprise suitable logic, circuitry, interfaces and/or code that may be operable to store subscriber personal identification information such as, for example, operator network, phone number, activated services, billing, and credit information. The SIM card **214** may also store the user's identity for gaining access to the network and receiving calls, and user's personal information such as phone directory and received SMS messages. The SIM card **214** may be implemented as a small printed circuit board. The SIM card **214** may be inserted in a mobile device such as the multi-SIM multi-standby communication device **200** in order for the multi-SIM multi-standby communication device **200** to properly access a corresponding network. The SIM card **214** may be connected to the multi-SIM multi-standby communication device **200** via the SIM card controller **208**.

[0047] The memory **220** may comprise suitable logic, circuitry, interfaces and/or code that may be operable to store information such as executable instructions and data that may be utilized by the processor unit **206** and/or other device components such as, for example, the SIM database **208***a*. The SIM database **208***a* may comprise suitable logic, circuitry, interfaces and/or code that may be operable to record and/or store SIM identification information retrieved from one or more SIM cards such as the SIM cards **212**-**222**. The stored SIM identification information may be in an active state or in a standby state within the SIM database **220***a*. For a given time instant, only SIM identification information in an active state may be actually utilized or applied by the multi-SIM multi-standby communication device **200** to support desired network services such as accounting/billing services. Depending on device configuration, for a given time instant, SIM identification information in an active state may correspond to one or more SIM cards. The cell database **220***b* may comprise suitable logic, circuitry, interfaces and/or code that may be operable to record and/or store cell information such as, for example, cell measurements, cell timing information, associated cellular frequencies, cell identities, cell selection results by one or more VMs in the VMA **206***c*. The memory **220** may comprise RAM, ROM, low latency nonvolatile memory such as flash memory and/or other suitable electronic data storage.

[0048] In an exemplary operation, a multi-SIM multi-standby communication device such as the multi-SIM multi-standby communication device **200** may be connected or coupled to multiple SIM cards such as the SIM cards **212**-**222** through the SIM card controller **208**. The processor unit **206** may be operable to retrieve SIM identification information from the SIM cards **212**-**222**. The retrieved SIM identification information may be stored in the SIM database **220***a*. In instances where the multi-SIM multi-standby communication device **200** is configured to operate in a multi-standby mode, the communication processor **206***a* may communicate with the SIM database **220***a* to activate the stored SIM identification information corresponding to multiple SIM cards such as the SIM cards **212**-**222** at the same time. More specifically, the multi-SIM multi-standby communication device **200**, in a multi-standby mode, may utilize SIM identification information activated for the SIM cards **212**-**222** at the same time. A user of the multi-SIM multi-standby communication device **200** may therefore be allowed to receive data and/or voice services related to the SIM cards **212**-**222** at the same time. The communication processor **206***a* may run the VMA **206***c* over the single radio resource unit **112***c* to handle data and/or voice traffic through the wireless radio unit **202**. Radio resources available in the single radio resource unit **112***c* may be shared among the VMs in the VMA **206***c*. At most one of the VMs may be scheduled in the active state to transmit and/or receive data and/or voice traffic related to a corresponding SIM card. The VMA **206***c* may be configured to suspend one or more VMs to ensure an uninterrupted radio resource usage by a VM in an active state. The VM in the active state may be operable to monitor its own serving cell and/or one or more neighbor cells, and serving cells and/or neighbor cells associated with the VMs in a suspended state. Serving cells and/or neighbor cells associated with the VMs in the suspended may be added as neighbor cells for the VM in the active state. The VM in the active state may measure signal strength on its own serving cell and/or one or more neighbor cells, and serving cells and/or neighbor cells associated with the VMs in the suspended state. The VM in the active state may also track other cell related information such as, for example, cell timing information, associated cellular frequencies, cell identity information and/or cell selection results for each of the serving cells and/or the neighbor cells associated with the VMs in the suspended state. For example, the VM in the active state may be operable to track cell timing information for its own serving cell and serving cells associated with the VMs in the suspended state based on the corresponding cell signal strength measurements. A fast cell recovery may be achieved on the VMs in the suspended state based on the tracked cell timing information, without performing cell selection or cell reselection. Furthermore, the VMA **206***c* may coordinate or communicate with the single radio resource unit **112***c* to be synchronized to cells in an order indicated by corresponding cell timing information so as to receive data and/or voice traffic related to specific SIM cards such as the SIM card **212**. The communication processor **206***a* may communicate the received data and/or voice traffic to the application processor **206***b*. The application processor **206***b* may be operable to run various applications such as video and/or audio multimedia applications according to the received data and/or voice traffic and present to users through the user interface unit **204**.

[0049] FIG. **3** is a block diagram illustrating an exemplary multi-instance virtual modem approach to concurrently handle multi-instance tasks on a multi-SIM multi-standby communication device, in accordance with an embodiment of the invention. Referring to FIG. **3**, there is shown virtual modem architecture **300** utilized on the multi-SIM multi-standby communication device **200**, for example. The virtual modem architecture **300** comprises man-machine interface (MMI) module **310**, a SIMIO module **320**, a virtual modem framework (VMF) **330**, a virtual modem controller (VMC) **360**, and a single radio resource unit **370**.

[0050] The MMI module **310** may comprise suitable logic, interfaces and/or code that may be operable to provide interaction between a user of the multi-SIM multi-standby communication device **200** and one or more applications that are executed on the multi-SIM multi-standby communication device **200**.

[0051] The SIMIO module **320** may comprise suitable logic, interfaces and/or code that may be operable to manage access to SIM cards such as the SIM cards **212**-**222**.

[0052] The VMF **330** may comprise suitable logic, interfaces and/or code that may be operable to provide an enhancement to the Real Time Operating System. The VMF **330** may be deployed or implemented on the communications processor **206***a*.

[0053] A VM such as the VM **340** refers to an instance of an air interface protocol stack and/or its interface to the user, namely, a Common Application Programming Interface (CAPI), together with a single set of radio resources such as radio resources available in the single radio resource unit **370**. A VM such as the VM **340** may comprise suitable logic, interfaces and/or code that may be operable to handle instances, namely, CAPI tasks and/or air interface protocol stack instances, associated with one of the SIM cards **212**-**222**. Different VMs such as the VM **340** and the VM **350** may be configured to handle instances corresponding to two different SIM cards. For example, the VM **340** may handle instances related to the SIM card **212**, while the VM **350** may be assigned to handle instances related to the SIM card **214**. The plurality of VMs such as VMs **340**-**350** may be configured to share the same set of radio resources, namely, available radio resources in the single radio resource unit **370**. In this regard, multiple copies of global and static data may be maintained to be utilized by the VMs **340**-**350**, respectively. A VM such as the VM **340** may operate independently from other VMs and may be in one of the plurality of VM states, namely, an active state, an idle state and a suspended state. The VM **340** may comprise a CAPI task unit **342**, a VCC **344**, an air interface protocol stack **346** together with the single radio resource unit **370**. CAPI and/or stack operations within the VM **340** may be managed via the VCC **344**.

[0054] The CAPI task unit **342** may comprise suitable logic, interfaces and/or code that may be operable to process MMI or user requests. The CAPI task unit **342** comprises CAPI tasks related to a specific SIM card such as the SIM card **212**.

[0055] A VCC such as the VCC **344** may comprise suitable logic, interfaces and/or code that may be operable to perform admission control with the VMC **360** for the CAPI module **315** at the primitive levels. The VCC **344** is a dual-instance module for managing its own task or instance, and queuing messages. The VCC **344** may be operable to interact with the VMC **360** for radio resource requests associated with CAPI tasks in the CAPI task unit **342**. The VCC **344** may communicate with the air interface protocol stack **346** to coordinate stack operations corresponding to the CAPI tasks in the CAPI task unit **342**.

[0056] An air interface protocol stack such as the air interface protocol stack **346** may comprise suitable logic, interfaces and/or code that may be operable to provide air interface protocols to support various signaling operations. For example, in 3GPP standard, the stack **346** may comprise Non-Access-Stratum (NAS) protocols and Access-Stratum (AS) protocols to handle bearer level signaling and Radio Resource Control (RRC) signaling, respectively.

[0057] The VMC **360** may comprise suitable logic, interfaces and/or code that may be operable to coordinate requests for the usage of radio resources available in the single radio resource unit **370** among multiple associated VMs such as the VM **340** and the VM **350**. In this regard, the VMC **360** may be operable to resolve contention for radio resources by transitioning the VM **340** and the VM **350** between the three VM states. For example, the VMC **360** may be operable to ensure that at most one of the VM **340** and the VM **350** is in the active state for a given time instant. In this regard, the VMC **360** may suspend, for example, the VM **350** from using or sharing radio resources available in the single radio resource unit **370** in order to allow an uninterrupted radio resource usage by the VM **340**. The suspended VM **350** may be resumed whenever radio resources in the single radio resource unit **370** become available for sharing by the VM **350** to continue idle mode activities on the VM **350**.

[0058] The VMC **360** may be operable to coordinate the usage of the radio resources to support concurrent procedures initiated by the VM **340** and the VM **350**. For example, the VM **340** and the VM **350** each may be granted by the VMC **360** a portion of radio resources available in the single radio resource unit **370** to concurrently monitor paging events and/or to concurrently perform idle mode procedures or activities such as, for example, cell selection/reselection by sharing the single radio resource unit **370**.

[0059] The single radio resource unit **370** may comprise suitable logic, interfaces and/or code that may be operable to provide PHY and RF support.

[0060] In an exemplary operation, the MMI module **310** may interact between a user of the multi-SIM multi-standby communication device **200** and applications that are related to the SIM card **212** and the SIM card **214**, for example, inserted into the SIM card controller **208**. Tasks or instances related to the SIM card **212** and the SIM card **214** may be handled by the VM **340** and the VM **350**, respectively. The VMC **360** may coordinate the usage of radio resources available in the single radio resource unit **370** for sharing by the VM **340** and the VM **350**. For a given time instant, at most one of the VM **340** and the VM **350** may be allowed to use the single radio resource unit **370**. In other words, for a given time instant, at most one of the VM **340** and the VM **350** may operate in an active state to transmit and/or receive traffic related to a corresponding SIM card. The VM **340** and/or the VM **350** may be in an idle state whenever there is no intended traffic for corresponding SIM cards detected. In an idle state, the VM **340** and the VM **350** may be operable to concurrently perform paging monitoring and/or idle mode procedures such as cell reselecting by sharing radio resources available in the single radio resource unit **370**. For example, a VM such as the VM **340** in the idle state may be operable to check or detect an incoming traffic related to the SIM card **212** based on received paging messages. Upon detection of an intended traffic related to the SIM card **212**, the VM **340** may remain in the idle state if traffic related to other SIM cards such as the SIM card **214** is still being handled. Otherwise, the VMC **360** may transition the VM **340** from the idle state to an active state in order to transmit and/or receive the detected traffic related to the SIM card **212**.

[0061] FIG. **4** is a block diagram illustrating exemplary steps that may be performed by a multi-SIM multi-standby communication device to track serving cells and/or neighbor cells associated with virtual modems in a suspended state via a virtual modem in an active state, in accordance with an embodiment of the invention. Referring to FIG. **4**, the exemplary steps may start with step **402**. In step **402**, VMs such as the VM **340** and the VM **350** in the VMA **112***b* may be operating in an idle state. In step **404**, the VM **340** and the VM **350** are concurrently monitoring paging events so as to check or detect intended traffic related to, for example, the SIM card **212** and the SIM card **214**, respectively. In instances where an intended traffic related to the SIM card **212** is detected, the VM **340** may need to transition to an active state in order to transmit and/or receive the detected intended traffic. The VM **340** may communicate with the VMC **360** so as to indicate or signal the single radio resource unit **370** that the VM **340** should transition from the idle state to the active state. In order to guarantee the availability of radio resources by the VM **340** while it is in the active state, the VMC **360** may suspend other counterpart VMs such as the VM **350** in the VMF **330** in order to bar them from utilizing radio resources available in the single radio resource unit **370**. The VMC **360** may indicate or signal the single radio resource unit **370** that the VM **350** needs to transition from the idle state to the suspended state. In step **406**, the single radio resource unit **370** may be operable to terminate active events related to the VM **350** and release radio resources that were previously assigned to the VM **350** if any.

[0062] In step **408**, the VMA **112***b* may be operable to add serving cells and/or neighbor cells associated with the virtual modems to be suspended, for example, the VM **350**, as neighbor cells for the virtual modem to be activated such as the VM **240**. In step **410**, the VMA **112***b* may be operable to transition the VM **340** and the VM **350** from the idle state to the active state and the suspended state, respectively. In step **412**, the single radio resource unit **370** may be operable to monitor a serving cell associated with the VM **340** as well as serving cells and/or neighbor cells associated with the virtual modems in the suspended state, for example, the VM **350**. More specifically, the VM **340** may be operable to measure signal strength on its own serving cell and/or one or more neighbor cells, and the serving cell and/or the neighbor cells associated with the VM **350**. Other cell related information such as, for example, associated cellular frequencies, cell identity information and/or cell selection results for each of the serving cells and/or neighbor cells associated with the VMs in the suspended state may be monitored or tracked by the VM in the active state. For example, cell timing information may be tracked based on the corresponding cell signal strength measurements. The tracked cell information may be stored into the cell database **220***b* where it may be shared among VMs in the VMA **112***b* for a fast cell selection/reselection.

[0063] In step **414**, upon the completion of the communication on the detected intended traffic related to the SIM card **212**, the VMA **112***b* may determine whether the VM **340** should return to the idle state. In instances where the VM **340** needs to return to the idle state from the active state, the, in step **418**, the single radio resource unit **370** may be operable to release radio resources previously allocated on the VM **340**. In step **418**, the single radio resource unit **370** may be operable to provide the cell information tracked by the VM **340** to the suspended VMs such as the VM **350** for a fast cell recovery on the VM **350**. The exemplary steps may end in step **420**.

[0064] In step **414**, in instances where the VM **340** does not need to return to the idle state from the active state, the exemplary steps may return to step **412**.

[0065] FIG. **5** is a flow chart illustrating exemplary steps that may be performed by a virtual modem in a suspended state for a fast cell recovery utilizing cell information tracked by a virtual modem in an active state, in accordance with an embodiment of the invention. Referring to FIG. **5**, the exemplary steps may start with step **502**. In step **502**, a VM such as the VM **350** in a suspended state may be signaled by the VMC **360** to return from the suspended state to an idle state for resuming normal idle mode activities. In step **504**, the VM **350** may determine whether to transition to the idle state. In instances where the VM **350** need to transition from the suspended state to the idle state, then in step **506**, the VM **350** may inform the VMC **360** that the VM **350** needs to transition from the suspended state to the idle state, so that it may operate in normal idle mode and perform normal idle mode activities. The VM **350** then may receive cell information that is tracked by a last VM in the active state, for example, the VM **340**.

In step **508**, the VM **350** may be operable to determine whether a serving cell associated with the VM **350** is still available or synchronized. In instances where the serving cell associated with the VM **350** is synchronized, then in step **510**, the single radio resource unit **370** may directly camp on the serving cell associated with the VM **350** without performing cell selection or reselection to achieve a fast cell recovery. The exemplary steps may end in step **516**. In step **504**, in instances where it is determined that the VM **350** should not transition from the suspended state to the idle state, then the exemplary steps stay in step **504**.

[0066] In step **508**, in instances where the serving cell associated with the VM **350** is not synchronized, then in step **512**, the single radio resource unit **370** may be operable to initiate a cell selection or reselection process for the VM **350** so as to determine a suitable cell to camp on. In this regard, the VM **350** may be operable to communicate with the cell database **220***b* to selectively perform cell selection or reselection based on the tracked cell information such as cell measurements, associated cellular frequencies, cell identities and corresponding cell timing information. For example, the VM **350** may be configured to perform cell selection/reselection only for cells with high cell quality and/or for cells placed on particular cellular frequencies. In step **514**, the VM **350** may be operable to resume normal idle mode activities or procedures on the selected cell. The exemplary steps may end in step **516**.

[0067] In various exemplary aspects of the method and system for a fast cell recovery on suspended virtual modems within a multi-SIM multi-standby communication device, a multi-SIM and multi-standby communication device such as the multi-SIM multi-standby communication device **200** comprises a single radio resource unit such as the single radio resource unit **370**. The single radio resource unit **370** provides PHY, DSP and/or RF functionalities that may be shared by a plurality of VMs such as the VM **340** and the VM **350** in the

VMA **112***b*, a platform deployed over the single radio resource unit **370**. Each of the VMs in the VMA **112***b* is uniquely associated with a single one of a plurality of SIM cards such as the SIM cards **212**-**222** that are coupled to the multi-SIM multi-standby communication device **200** through the SIM card controller **208**. Each of the VMs may operate in one of a plurality of VM states, namely, an active state, an idle state and a suspended state. In instances where a first VM such as the VM **340** is operating in an active state and one or more remaining ones of the plurality of VMs, for example, the VM **350**, in the VMA **112***b* are operating in a suspended state, the VM **340** in the active state may be operable to monitor its own serving cell and/or one or more neighbor cells, and serving cells and/or neighbor cells associated with the VMs that are operating in the suspended state. In this regard, the serving cells and/or the neighbor cells associated with VMs operating in the suspended state may be added as neighbor cells for the VM **340** that is operating in the active state.

[0068] The VM **340** may be operable to measure the signal strength on its own serving cell, and the serving cells and the neighbor cells that are associated with the VMs operating in the suspended state. The cell signal strength measurements may be utilized to determine cell quality of corresponding cells. For example, a cell corresponding to the strongest cell signal strength measurement may be selected or picked as the best cell associated with the multi-SIM and multi-standby communication device **200** for tracking cell timing information, for example. The VM **340** may be operable to track or retrieve cell information such as, for example, cell timing information, associated cellular frequencies, cell identity information and/or cell selection results, for its own serving cell and/or one or more neighbor cells, and each of the added serving cells and neighbor cells associated with one or more remaining ones of the plurality of VMs, for example, the VM **350**, operating in the suspended state based on the corresponding cell signal strength measurements. In instances where the VM **340** returns to an idle state from the active state, the single radio resource unit **370** may release radio resources that are previously assigned to the VM **340**.

[0069] The VMC **360** may then resume the suspended VMs such as the VM **350** for normal idle mode activities. In this regard, the VMC **360** may coordinate or manage operations of the single radio resource unit **370** such that the single radio resource unit **370** may synchronize to the serving cells associated with the suspended VMs. The synchronization may be performed in an order determined by the cell timing information that is tracked by the VM **340**. In instances where a serving cell associated with a suspended VM such as the VM **350** is still available in the tracked timing information, the VM **350** may bypass cell selection or cell reselection to achieve a fast cell recovery. More specifically, the VM **350** may directly camp on the associated serving cell without performing cell selection or cell reselection. Otherwise, the VM **350** needs to perform cell selection or reselection in order to identify a suitable cell to camp on. In this regard, the VM **350** may selectively perform cell selection/reselection based on tracked cell information such as cell signal strength measurements, cell timing information, associated cellular frequencies, cell identity information and/or cell selection results, for a fast cell selection/reselection. For example, the VM **350** may perform cell selection/reselection for cells with high cell quality and/or for cells placed on particular cellular frequencies.

[0070] Other embodiments of the invention may provide a non-transitory computer readable medium and/or storage medium, and/or a non-transitory machine readable medium and/or storage medium, having stored thereon, a machine code and/or a computer program having at least one code section executable by a machine and/or a computer, thereby causing the machine and/or computer to perform the steps as described herein for a fast cell recovery on suspended virtual modems within a multi-SIM multi-standby communication device.

[0071] Accordingly, the present invention may be realized in hardware, software, or a combination of hardware and software. The present invention may be realized in a centralized fashion in at least one computer system, or in a distributed fashion where different elements are spread across several interconnected computer systems. Any kind of computer system or other apparatus adapted for carrying out the methods described herein is suited. A typical combination of hardware and software may be a general-purpose computer system with a computer program that, when being loaded and executed, controls the computer system such that it carries out the methods described herein.

[0072] The present invention may also be embedded in a computer program product, which comprises all the features enabling the implementation of the methods described herein, and which when loaded in a computer system is able to carry out these methods. Computer program in the present context means any expression, in any language, code or notation, of a set of instructions intended to cause a system having an information processing capability to perform a particular function either directly or after either or both of the following: a) conversion to another language, code or notation; b) reproduction in a different material form.

[0073] While the present invention has been described with reference to certain embodiments, it will be understood by those skilled in the art that various changes may be made and equivalents may be substituted without departing from the scope of the present invention. In addition, many modifications may be made to adapt a particular situation or material to the teachings of the present invention without departing from its scope. Therefore, it is intended that the present invention not be limited to the particular embodiment disclosed, but that the present invention will include all embodiments falling within the scope of the appended claims.

What is claimed is:

1. A method for communication, the method comprising:

in a multiple-subscriber identity module (multi-SIM) multi-standby communication device comprising a single radio resource unit that is shared by a plurality of virtual modems:

when a first virtual modem of said plurality of virtual modems is operating in an active state and one or more remaining ones of said plurality of virtual modems are operating in a suspended state, monitoring, by said first virtual modem, a serving cell and/or one or more neighbor cells associated with said first virtual modem, and one or more serving cells and/or one or more neighbor cells which are associated with a corresponding one of said one or more remaining ones of said plurality of virtual modems that are operating in said suspended state.

2. The method according to claim **1**, comprising adding said one or more serving cells and/or said one or more neighbor cells associated with said one or more remaining ones of said plurality of virtual modems operating in said suspended state as neighbor cells for said first virtual modem operating in said active state.

3. The method according to claim **2**, comprising measuring signal strength on said serving cell and/or said one or more neighbor cells associated with said first virtual modem operating in said active state and said added one or more serving cells and/or said added one or more neighbor cells associated with said one or more remaining ones of said plurality of virtual modems operating in said suspended state.

4. The method according to claim **2**, comprising determining cell quality, when needed, for said serving cell and/or said one or more neighbor cells associated with said first virtual modem operating in said active state and said added one or more serving cells and/or said added one or more neighbor cells associated with said one or more remaining ones of said plurality of virtual modems operating in said suspended state.

5. The method according to claim **3**, comprising tracking timing information for each of said serving cell and/or said one or more neighbor cells associated with said first virtual modem operating in said active state and said added one or more serving cells and/or said added one or more neighbor cells associated with said one or more remaining ones of said plurality of virtual modems operating in said suspended state based on said measurement.

6. The method according to claim **5**, comprising synchronizing to said added one or more serving cells based on said tracked timing information when said one or more remaining ones of said plurality of virtual modems operating in said suspended state transition to an idle state.

7. The method according to claim **6**, comprising determining a cell order based on said tracked timing information for said synchronizing.

8. The method according to claim **7**, comprising synchronizing to each of said added one or more serving cells based on said determined cell order.

9. The method according to claim **6**, comprising if corresponding timing information for said added one or more serving cells is available in said tracked timing information, bypassing cell selection or cell reselection.

10. The method according to claim **6**, comprising if corresponding timing information for said added one or more serving cells is not available in said tracked timing information performing cell selection or cell reselection during said synchronization based on tracked cell information.

11. A system for communication, the system comprising:

one more processors and/or circuits for use in a multiple-subscriber identity module (multi-SIM) multi-standby communication device comprising a single radio resource unit that is shared by a plurality of virtual modems, said one or more processors and/or circuits being operable to:

when a first virtual modem of said plurality of virtual modems is operating in an active state and one or more remaining ones of said plurality of virtual modems are operating in a suspended state, monitor, by said first virtual modem, a serving cell and/or one or more neighbor cells associated with said first virtual modem, and one or more serving cells and/or one or more neighbor cells which are associated with a corresponding one of said one or more remaining ones of said plurality of virtual modems that are operating in said suspended state.

12. The system according to claim **11**, wherein said one or more processors and/or circuits being operable to add said one or more serving cells and/or one or more neighbor cells associated with said one or more remaining ones of said plurality of virtual modems operating in said suspended state as neighbor cells for said first virtual modem operating in said active state.

13. The system according to claim **12**, wherein said one or more processors and/or circuits being operable to measure signal strength on said serving cell and/or said one or more neighbor cells associated with said first virtual modem operating in said active state and said added one or more serving cells and/or said added one or more neighbor cells associated with said one or more remaining ones of said plurality of virtual modems operating in said suspended state.

14. The system according to claim **13**, wherein said one or more processors and/or circuits being operable to determine cell quality, when needed, for said serving cell and/or said one or more neighbor cells associated with said first virtual modem operating in said active state and said added one or more serving cells and/or said added one or more neighbor cells associated with said one or more remaining ones of said plurality of virtual modems operating in said suspended state.

15. The system according to claim **13**, wherein said one or more processors and/or circuits being operable to track timing information for each of said serving cell and/or said one or more neighbor cells associated with said first virtual modem operating in said active state and said added one or more serving cells and/or said added one or more neighbor cells associated with said one or more remaining ones of said plurality of virtual modems operating in said suspended state based on said measurement.

16. The system according to claim **15**, wherein said one or more processors and/or circuits being operable to synchronize to said added one or more serving cells based on said tracked timing information when said one or more remaining ones of said plurality of virtual modems operating in said suspended state transition to an idle state.

17. The system according to claim **16**, wherein said one or more processors and/or circuits being operable to determine a cell order based on said tracked timing information for said synchronizing.

18. The system according to claim **17**, wherein said one or more processors and/or circuits being operable to synchronize to each of said added one or more serving cells based on said determined cell order.

19. The system according to claim **16**, wherein said one or more processors and/or circuits being operable bypass cell selection or cell reselection if corresponding timing information for said added one or more serving cells is available in said tracked timing information.

20. The system according to claim **16**, wherein said one or more processors and/or circuits being operable to perform cell selection or cell reselection during said synchronization based on tracked cell information if corresponding timing information for said added one or more serving cells is not available in said tracked timing information.

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