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Marcellino et al.

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(54) **MANAGING NOTIFICATION SERVICE CONNECTIONS AND DISPLAYING ICON BADGES**

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(73) Assignee: **Apple Inc.**, Cupertino, CA (US)

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(22) Filed: **Mar. 9, 2012**

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(60) Provisional application No. 61/059,703, filed on Jun. 6, 2008.

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H04M 3/00 (2006.01)

(52) **U.S. Cl.** **455/418**; 455/550.1; 455/403; 709/206

(58) **Field of Classification Search** 455/418, 455/550.1, 403; 709/206
See application file for complete search history.

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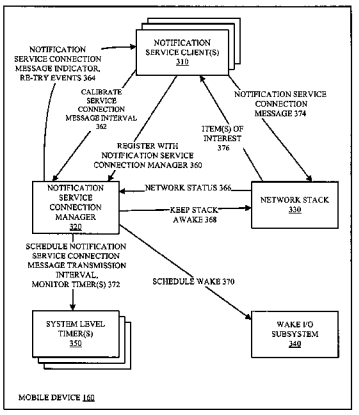
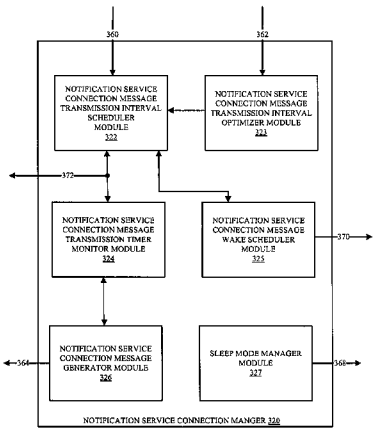
(57) **ABSTRACT**

A method and apparatus to manage notification service connections. In one embodiment of the invention, a mobile device schedules a notification service connection message transmission interval for each of a plurality of notification service connections. The mobile device also associates a notification service connection message transmission window with each notification service connection message transmission interval. The mobile device synchronizes transmission of notification service connection messages based on overlapping notification service connection message transmission windows. Responsive to receiving a notification message on one of the notification service connections, an icon badge is displayed on the mobile device for the appropriate application.

30 Claims, 15 Drawing Sheets





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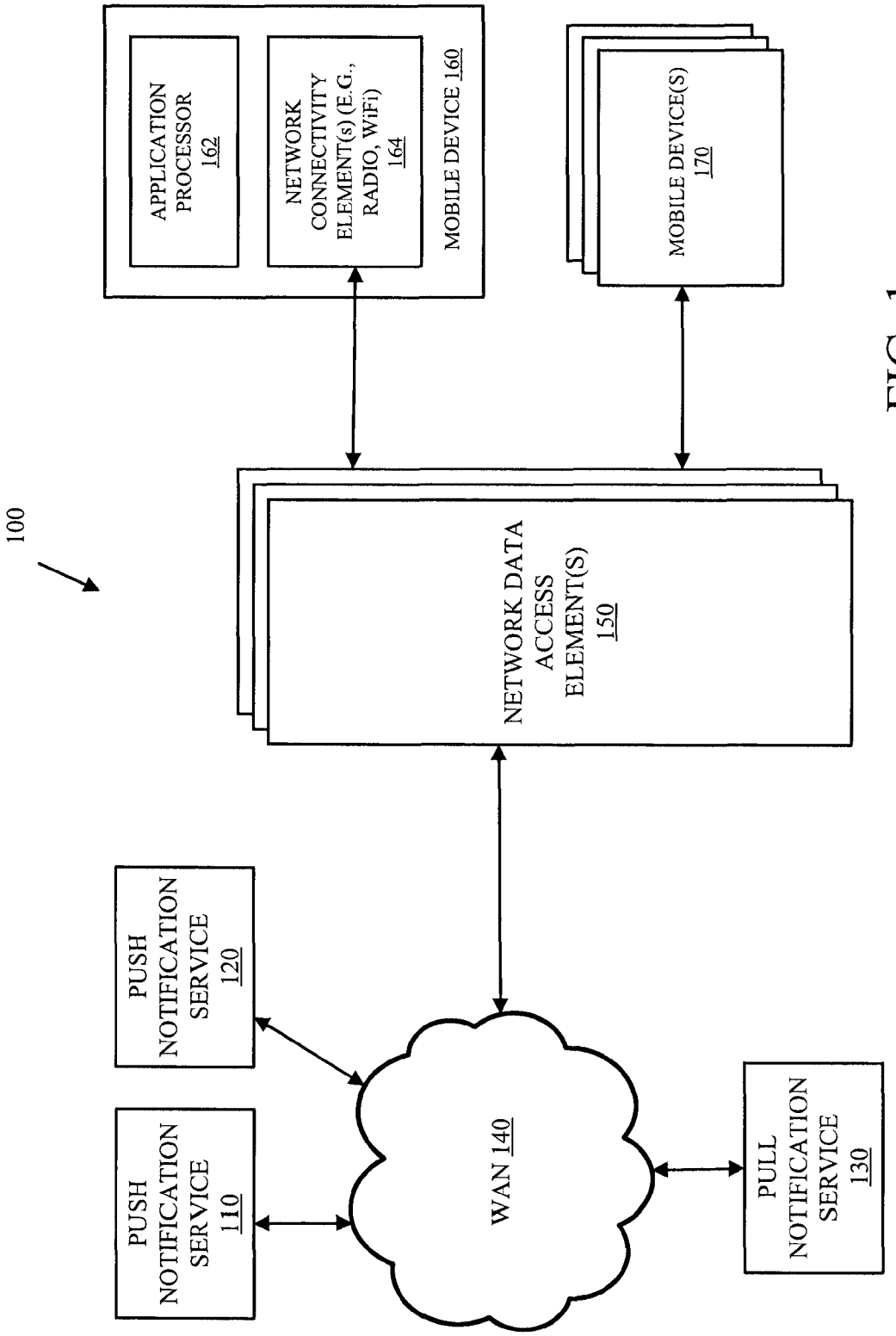
100
APPLICATION PROCESSOR 162
NETWORK CONNECTIVITY ELEMENT(s) (E.G., RADIO, WiFi) 164
MOBILE DEVICE 160
MOBILE DEVICE(S) 170
NETWORK DATA ACCESS ELEMENT(S) 150
PUSH NOTIFICATION SERVICE 120
PUSH NOTIFICATION SERVICE 110
WAN 140
PULL NOTIFICATION SERVICE 130

FIG. 1

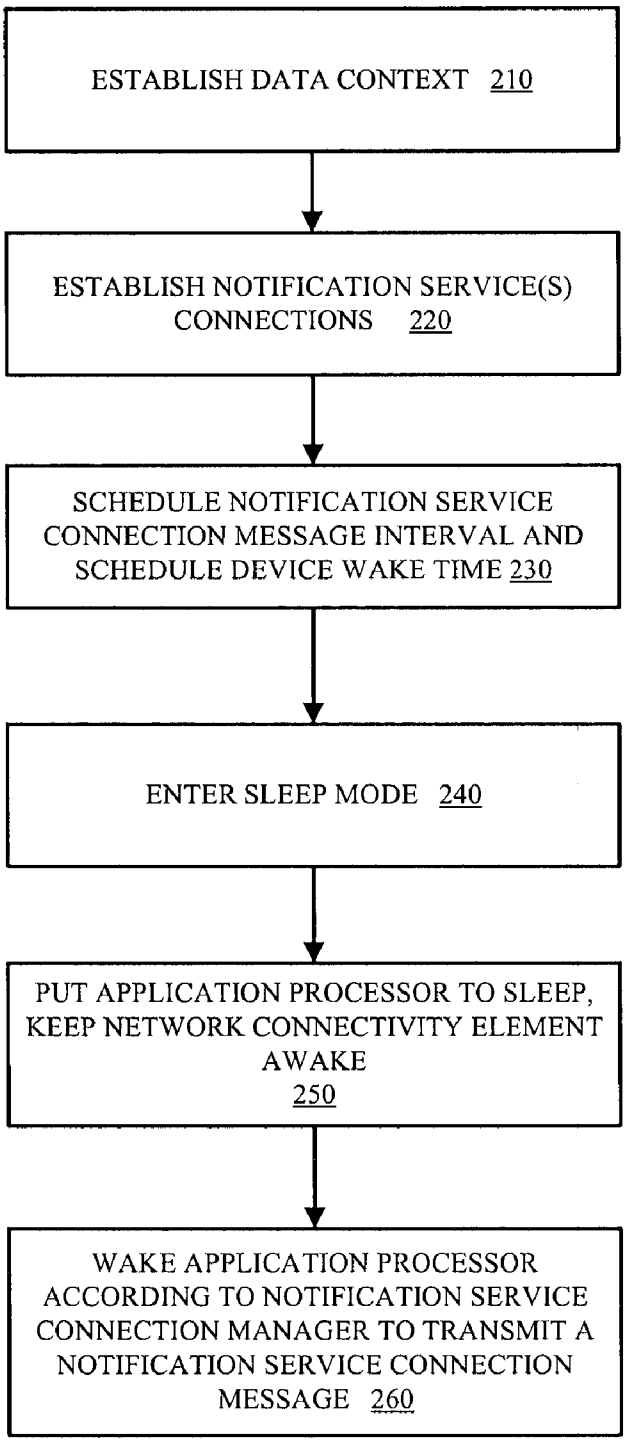
ESTABLISH DATA CONTEXT 210
ESTABLISH NOTIFICATION SERVICE(S) CONNECTIONS 220
SCHEDULE NOTIFICATION SERVICE CONNECTION MESSAGE INTERVAL AND SCHEDULE DEVICE WAKE TIME 230
ENTER SLEEP MODE 240
PUT APPLICATION PROCESSOR TO SLEEP, KEEP NETWORK CONNECTIVITY ELEMENT AWAKE 250
WAKE APPLICATION PROCESSOR ACCORDING TO NOTIFICATION SERVICE CONNECTION MANAGER TO TRANSMIT A NOTIFICATION SERVICE CONNECTION MESSAGE 260

FIG. 2

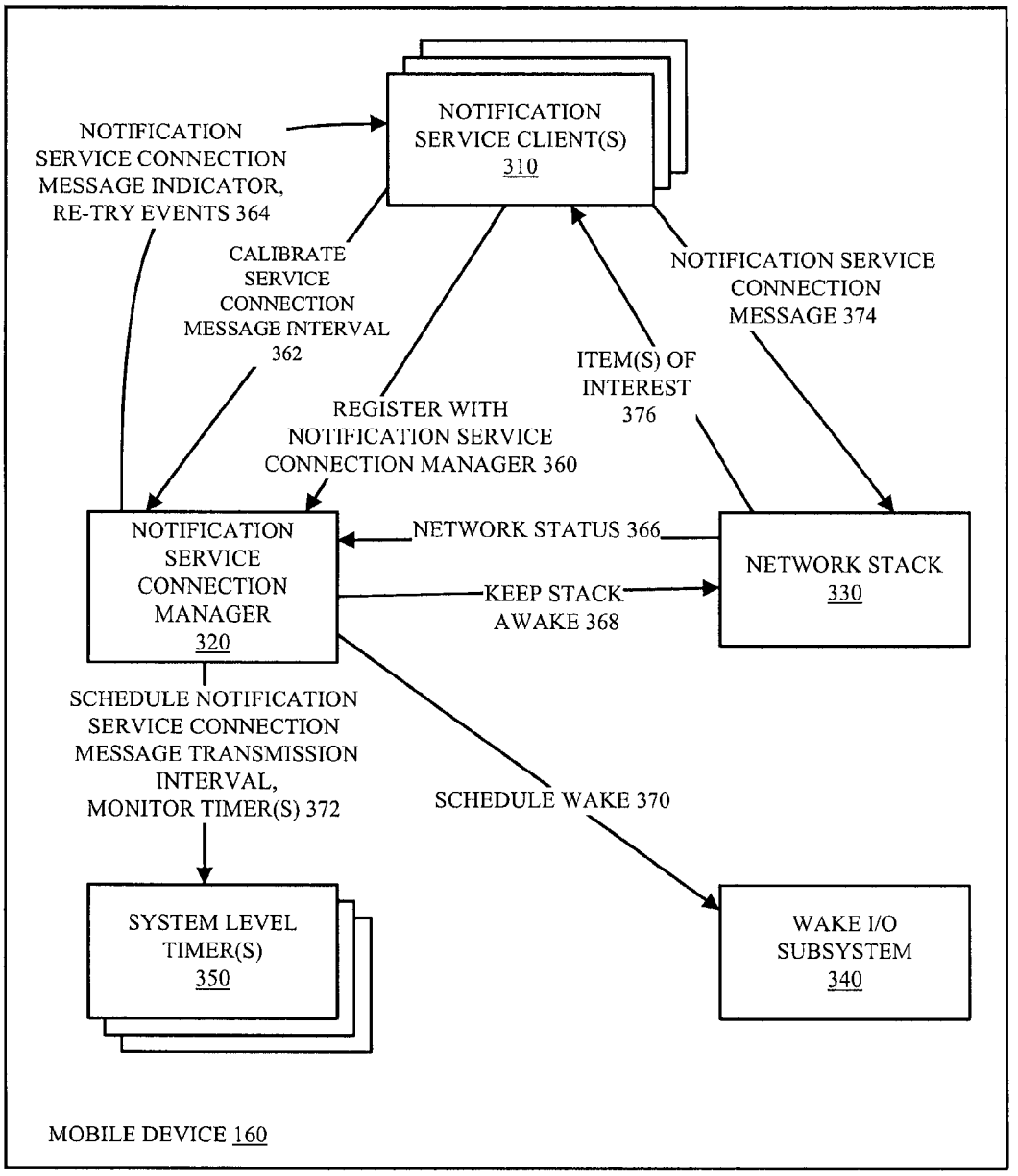
NOTIFICATION SERVICE CLIENT(S) 310
NOTIFICATION SERVICE CONNECTION MESSAGE INDICATOR, RE-TRY EVENTS 364
CALIBRATE SERVICE CONNECTION MESSAGE INTERVAL 362
REGISTER WITH NOTIFICATION SERVICE CONNECTION MANAGER 360
ITEM(S) OF INTEREST 376
NOTIFICATION SERVICE CONNECTION MESSAGE 374
NOTIFICATION SERVICE CONNECTION MANAGER 320
NETWORK STATUS 366
KEEP STACK AWAKE 368
NETWORK STACK 330
SCHEDULE NOTIFICATION SERVICE CONNECTION MESSAGE TRANSMISSION INTERVAL, MONITOR TIMER(S) 372
SCHEDULE WAKE 370
SYSTEM LEVEL TIMER(S) 350
WAKE I/O SUBSYSTEM 340
MOBILE DEVICE 160

FIG. 3A

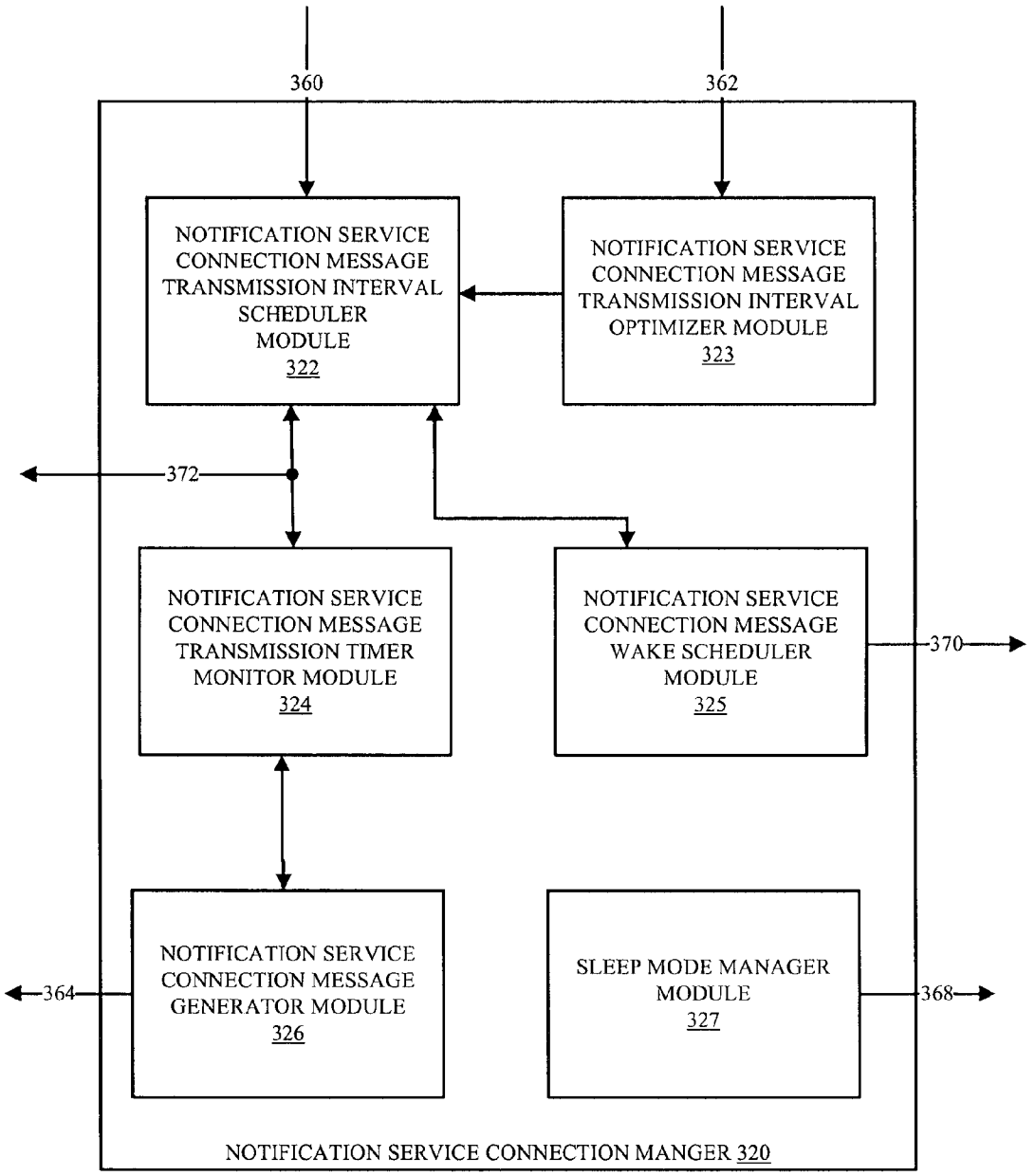
360
362
NOTIFICATION SERVICE CONNECTION MESSAGE TRANSMISSION INTERVAL SCHEDULER MODULE 322
NOTIFICATION SERVICE CONNECTION MESSAGE TRANSMISSION INTERVAL OPTIMIZER MODULE 323
372
NOTIFICATION SERVICE CONNECTION MESSAGE TRANSMISSION TIMER MONITOR MODULE 324
NOTIFICATION SERVICE CONNECTION MESSAGE WAKE SCHEDULER MODULE 325
370
364
NOTIFICATION SERVICE CONNECTION MESSAGE GENERATOR MODULE 326
SLEEP MODE MANAGER MODULE 327
368
NOTIFICATION SERVICE CONNECTION MANGER 320

FIG. 3B

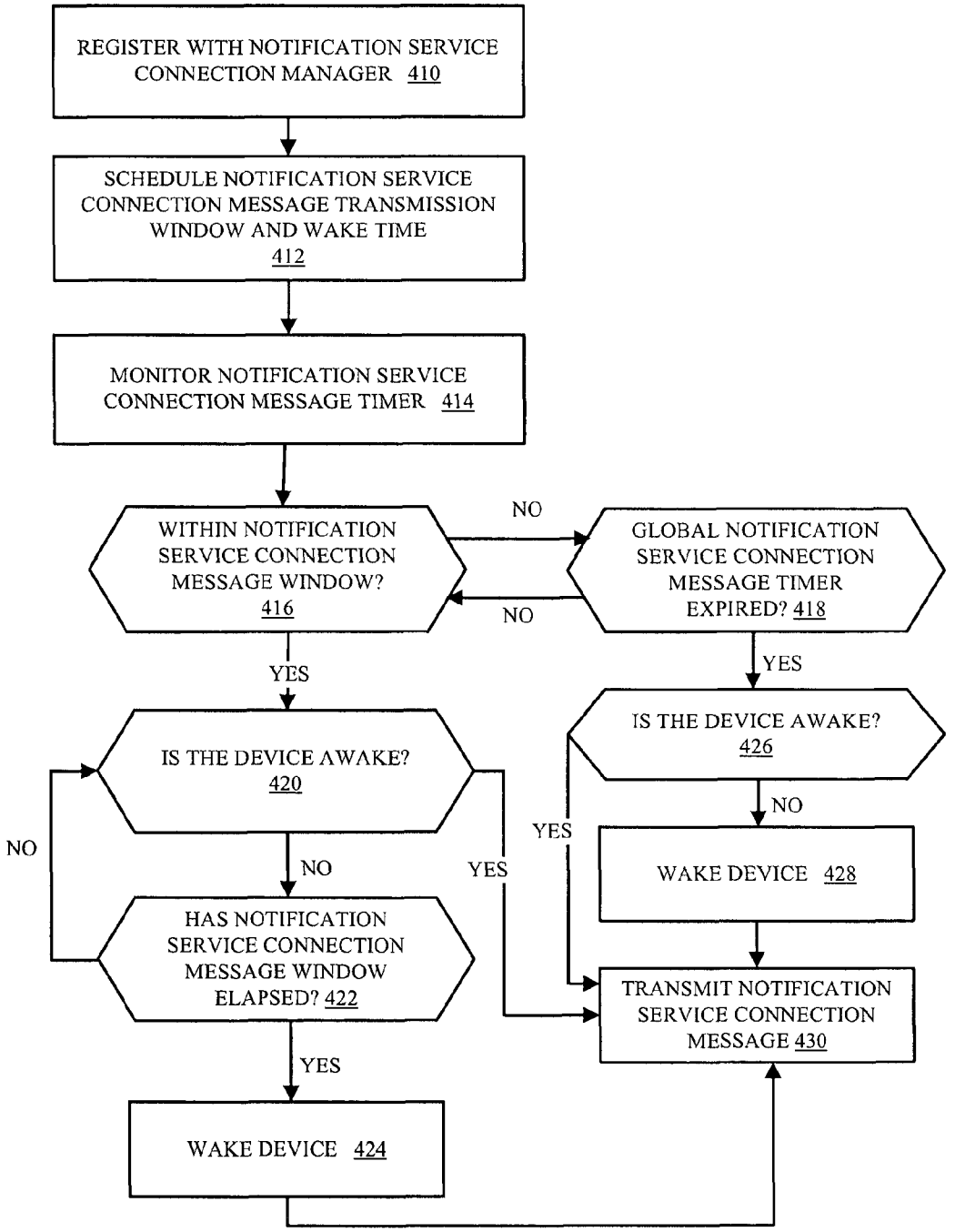
REGISTER WITH NOTIFICATION SERVICE CONNECTION MANAGER 410
SCHEDULE NOTIFICATION SERVICE CONNECTION MESSAGE TRANSMISSION WINDOW AND WAKE TIME 412
MONITOR NOTIFICATION SERVICE CONNECTION MESSAGE TIMER 414
WITHIN NOTIFICATION SERVICE CONNECTION MESSAGE WINDOW? 416
NO
GLOBAL NOTIFICATION SERVICE CONNECTION MESSAGE TIMER EXPIRED? 418
NO
YES
YES
IS THE DEVICE AWAKE? 420
IS THE DEVICE AWAKE? 426
NO
NO
YES
YES
NO
WAKE DEVICE 428
HAS NOTIFICATION SERVICE CONNECTION MESSAGE WINDOW ELAPSED? 422
TRANSMIT NOTIFICATION SERVICE CONNECTION MESSAGE 430
YES
WAKE DEVICE 424

FIG. 4

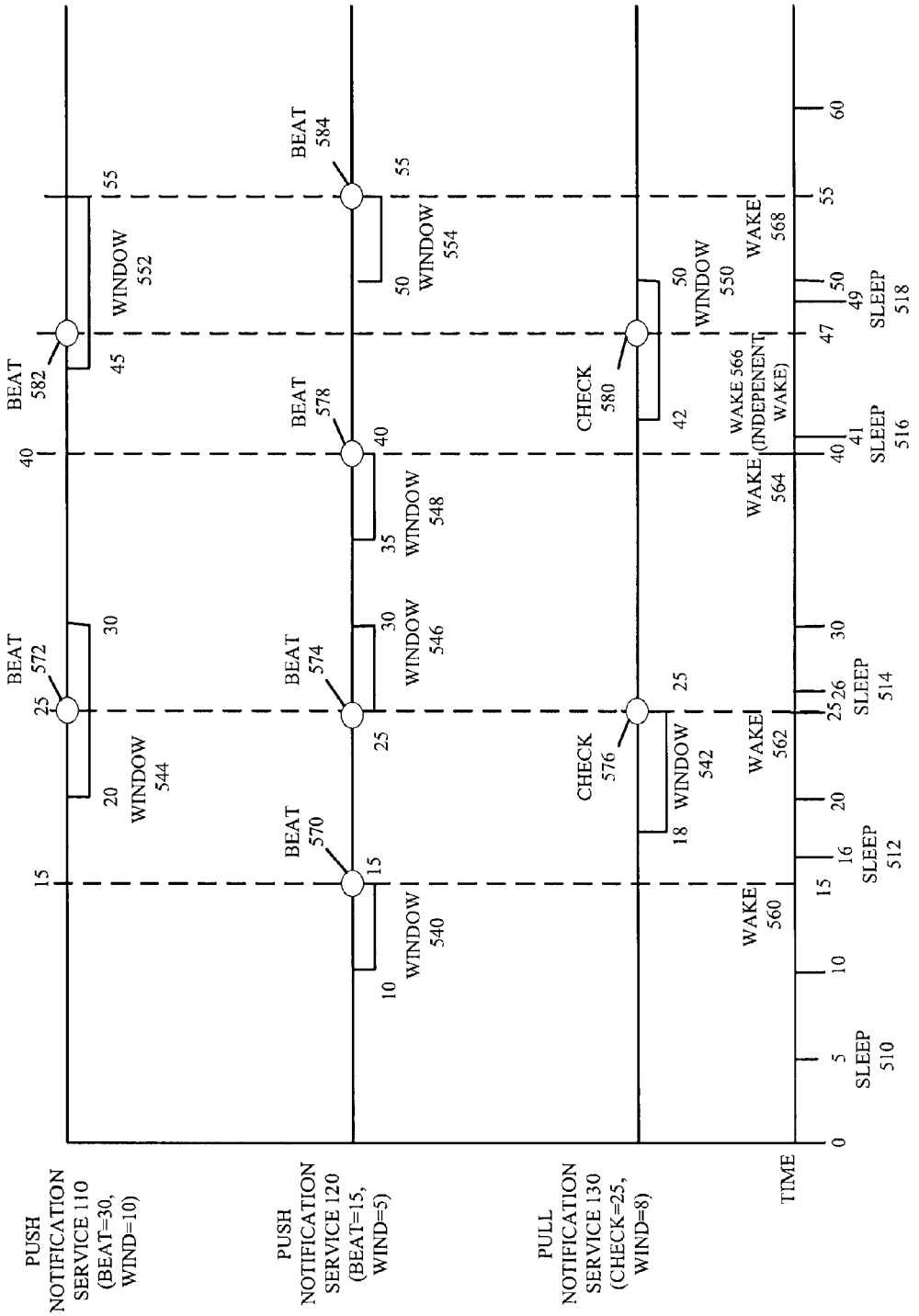
PUSH NOTIFICATION SERVICE 110 (BEAT=30, WIND=10)
PUSH NOTIFICATION SERVICE 120 (BEAT=15, WIND=5)
PULL NOTIFICATION SERVICE 130 (CHECK=25, WIND=8)
TIME
0
5
10
15
20
25
30
35
40
45
50
55
60
SLEEP 510
SLEEP 512
SLEEP 514
SLEEP 516
SLEEP 518
WAKE 560
WAKE 562
WAKE 564
WAKE 566 (INDEPENENT WAKE)
WAKE 568
WINDOW 540
WINDOW 542
WINDOW 544
WINDOW 546
WINDOW 548
WINDOW 550
WINDOW 552
WINDOW 554
BEAT 570
BEAT 572
BEAT 574
BEAT 578
BEAT 582
BEAT 584
CHECK 576
CHECK 580

FIG. 5

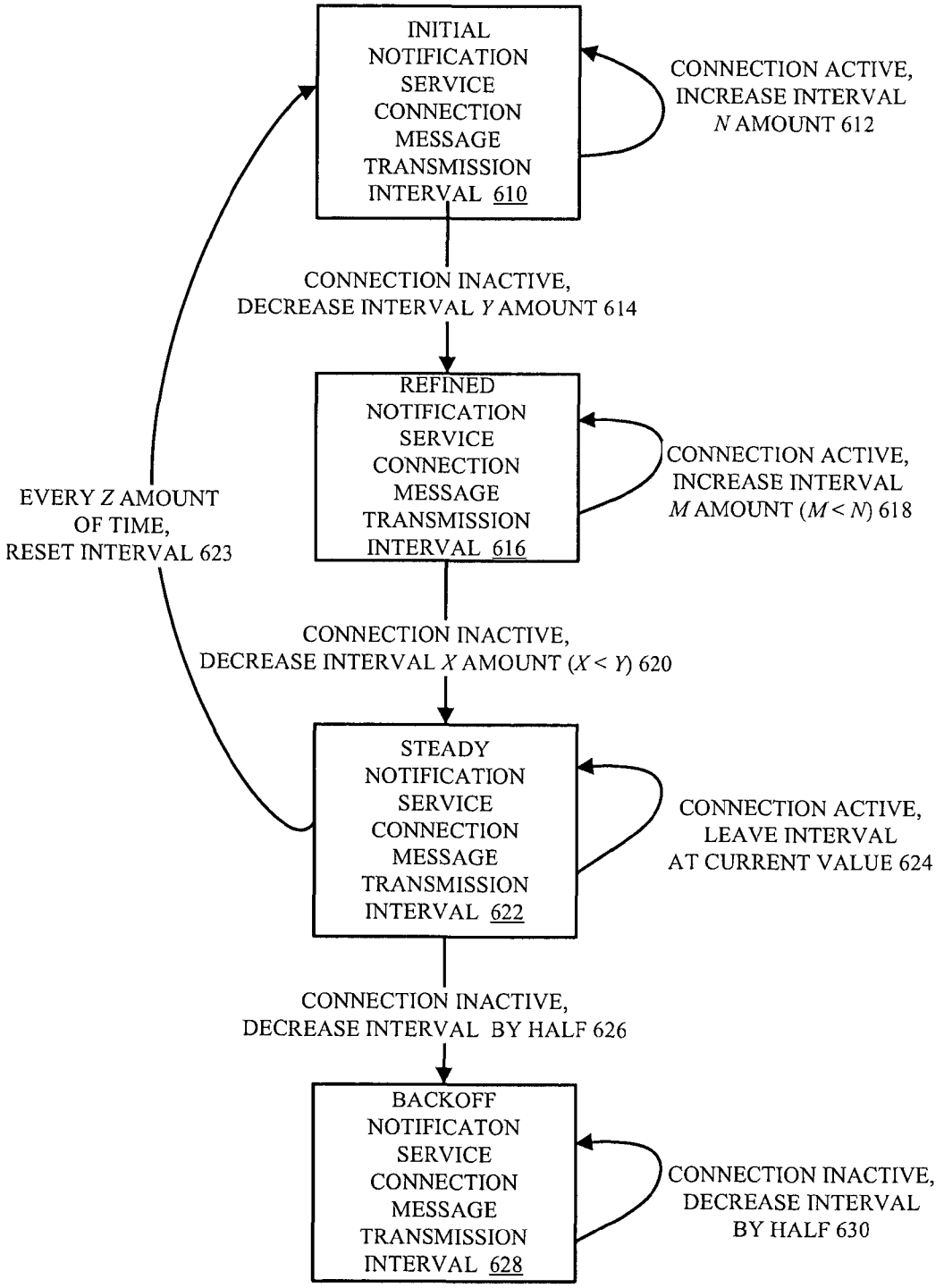
INITIAL NOTIFICATION SERVICE CONNECTION MESSAGE TRANSMISSION INTERVAL 610
CONNECTION ACTIVE, INCREASE INTERVAL N AMOUNT 612
CONNECTION INACTIVE, DECREASE INTERVAL Y AMOUNT 614
REFINED NOTIFICATION SERVICE CONNECTION MESSAGE TRANSMISSION INTERVAL 616
CONNECTION ACTIVE, INCREASE INTERVAL M AMOUNT (M < N) 618
EVERY Z AMOUNT OF TIME, RESET INTERVAL 623
CONNECTION INACTIVE, DECREASE INTERVAL X AMOUNT (X < Y) 620
STEADY NOTIFICATION SERVICE CONNECTION MESSAGE TRANSMISSION INTERVAL 622
CONNECTION ACTIVE, LEAVE INTERVAL AT CURRENT VALUE 624
CONNECTION INACTIVE, DECREASE INTERVAL BY HALF 626
BACKOFF NOTIFICATON SERVICE CONNECTION MESSAGE TRANSMISSION INTERVAL 628
CONNECTION INACTIVE, DECREASE INTERVAL BY HALF 630

FIG. 6

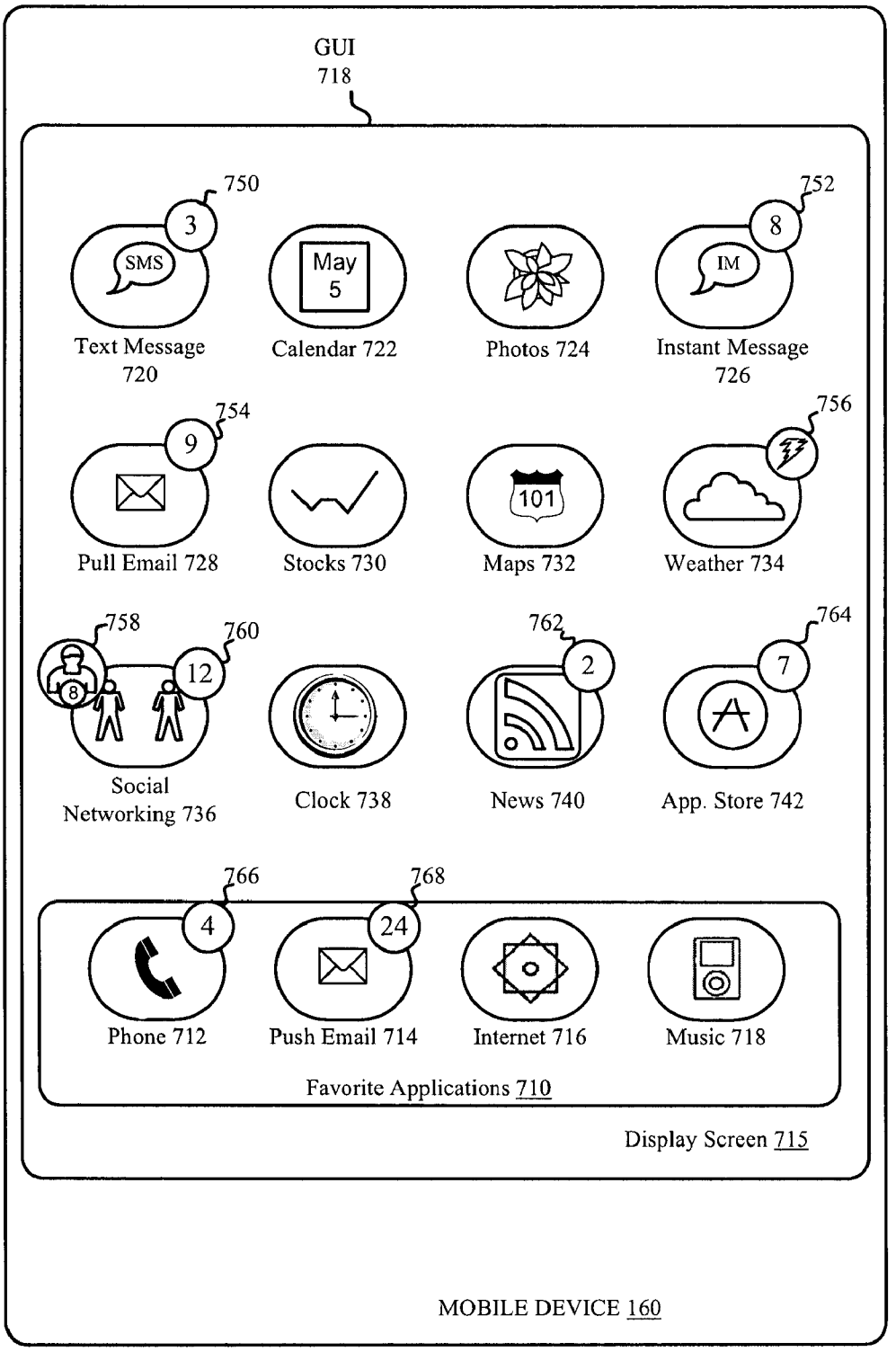
GUI
718
750
3
SMS
Text Message
720
May
5
Calendar 722
Photos 724
752
8
IM
Instant Message
726
754
9
Pull Email 728
Stocks 730
101
Maps 732
756
Weather 734
758
8
760
12
Social
Networking 736
Clock 738
762
2
News 740
764
7
App. Store 742
766
4
Phone 712
768
24
Push Email 714
Internet 716
Music 718
Favorite Applications 710
Display Screen 715
MOBILE DEVICE 160

FIG. 7

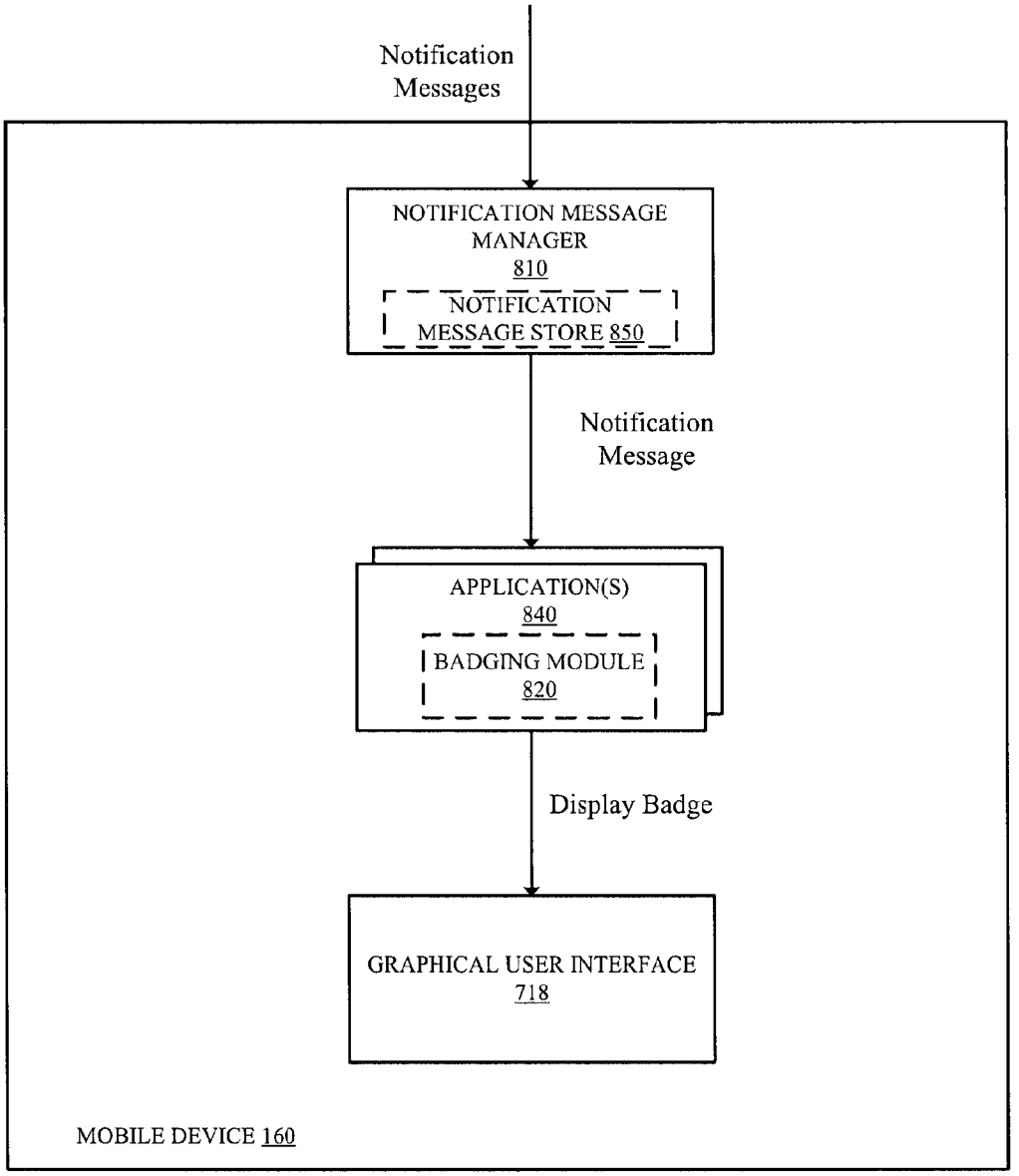
Notification Messages
NOTIFICATION MESSAGE MANAGER 810
NOTIFICATION MESSAGE STORE 850
Notification Message
APPLICATION(S) 840
BADGING MODULE 820
Display Badge
GRAPHICAL USER INTERFACE 718
MOBILE DEVICE 160

FIG. 8

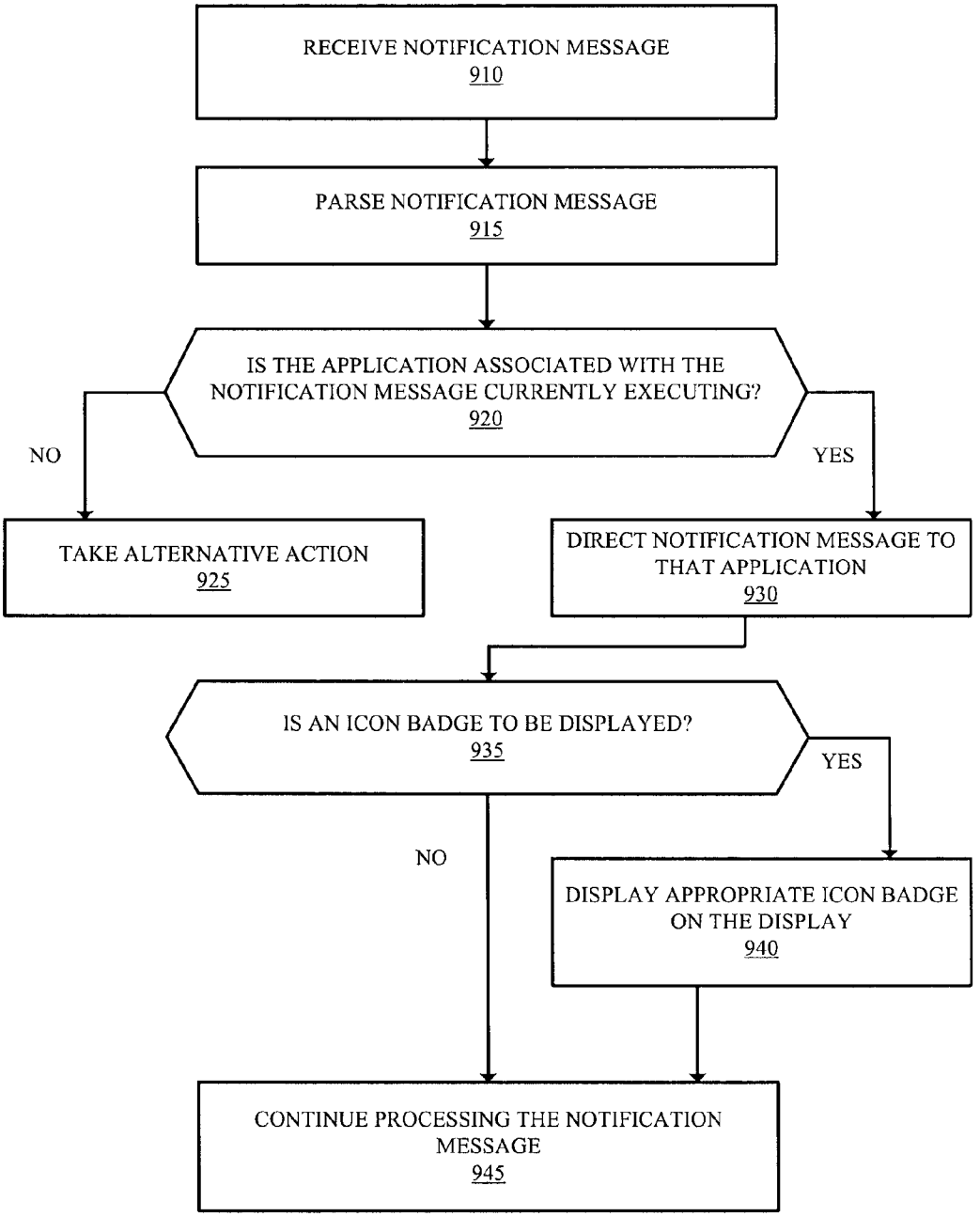
RECEIVE NOTIFICATION MESSAGE
910
PARSE NOTIFICATION MESSAGE
915
IS THE APPLICATION ASSOCIATED WITH THE NOTIFICATION MESSAGE CURRENTLY EXECUTING?
920
NO
YES
TAKE ALTERNATIVE ACTION
925
DIRECT NOTIFICATION MESSAGE TO THAT APPLICATION
930
IS AN ICON BADGE TO BE DISPLAYED?
935
YES
NO
DISPLAY APPROPRIATE ICON BADGE ON THE DISPLAY
940
CONTINUE PROCESSING THE NOTIFICATION MESSAGE
945

FIG. 9

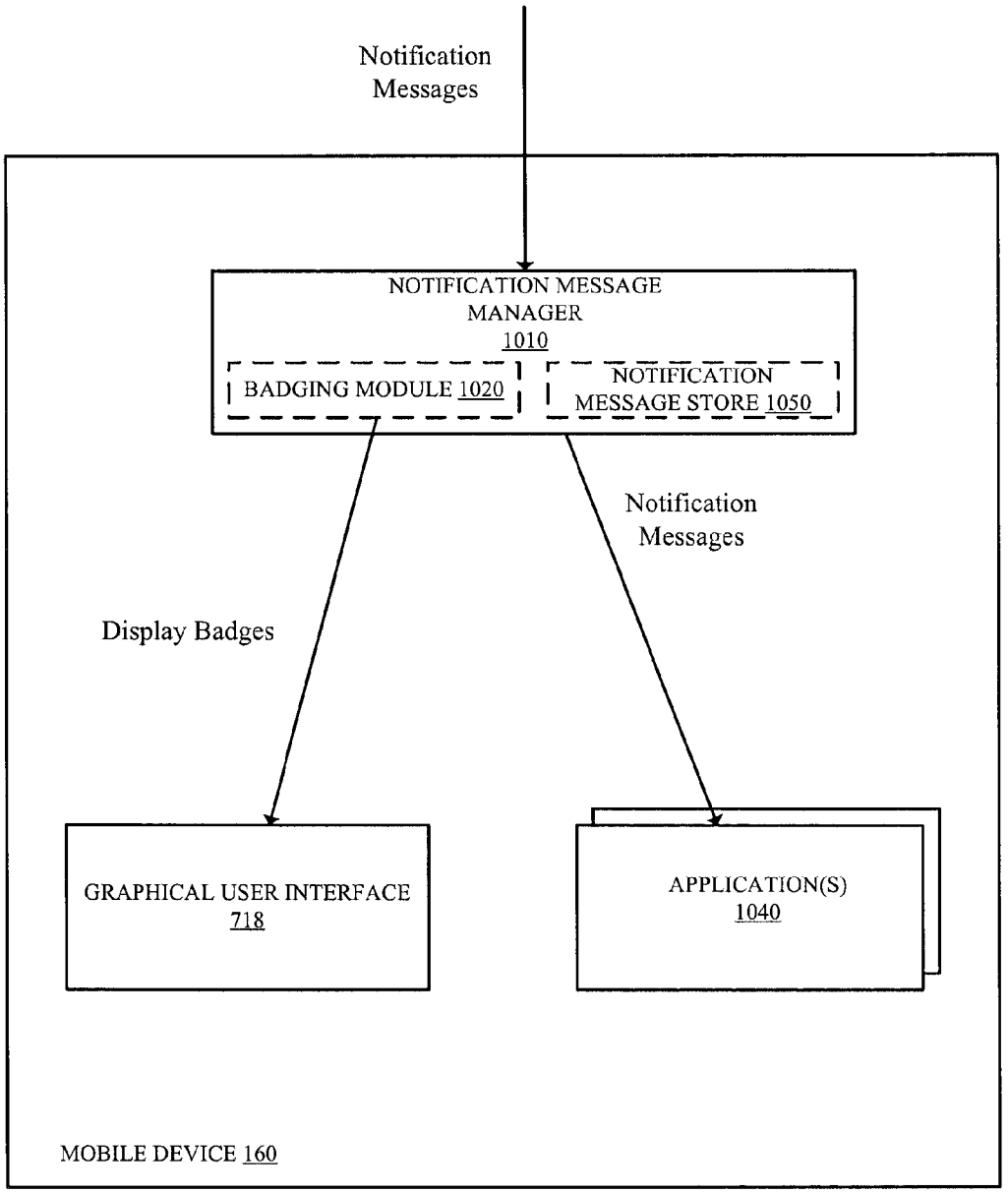
Notification Messages
NOTIFICATION MESSAGE MANAGER 1010
BADGING MODULE 1020
NOTIFICATION MESSAGE STORE 1050
Notification Messages
Display Badges
GRAPHICAL USER INTERFACE 718
APPLICATION(S) 1040
MOBILE DEVICE 160

FIG. 10

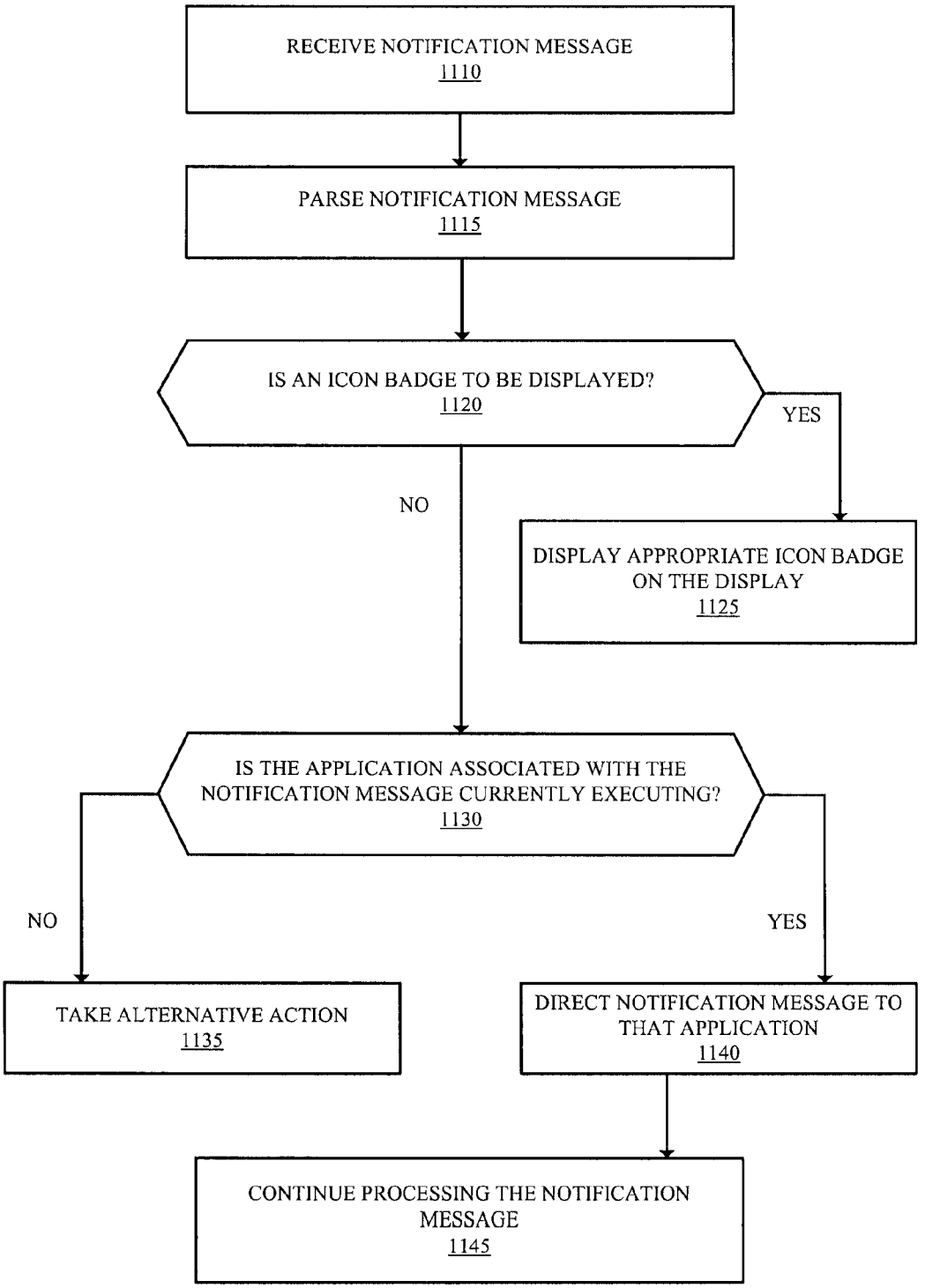
RECEIVE NOTIFICATION MESSAGE
1110
PARSE NOTIFICATION MESSAGE
1115
IS AN ICON BADGE TO BE DISPLAYED?
1120
YES
NO
DISPLAY APPROPRIATE ICON BADGE ON THE DISPLAY
1125
IS THE APPLICATION ASSOCIATED WITH THE NOTIFICATION MESSAGE CURRENTLY EXECUTING?
1130
NO
YES
TAKE ALTERNATIVE ACTION
1135
DIRECT NOTIFICATION MESSAGE TO THAT APPLICATION
1140
CONTINUE PROCESSING THE NOTIFICATION MESSAGE
1145

FIG. 11

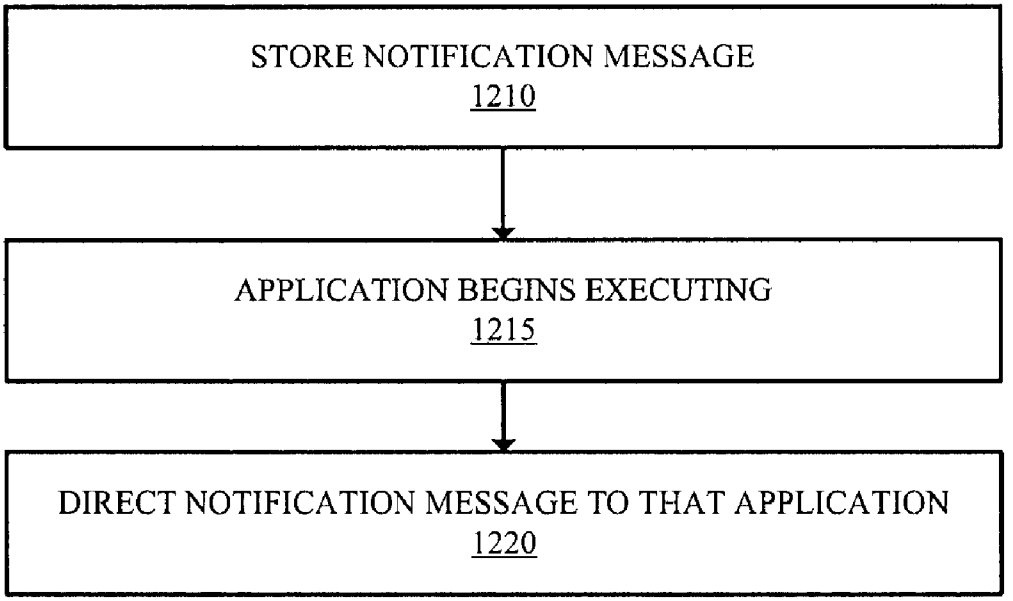
STORE NOTIFICATION MESSAGE
1210
APPLICATION BEGINS EXECUTING
1215
DIRECT NOTIFICATION MESSAGE TO THAT APPLICATION
1220

FIG. 12

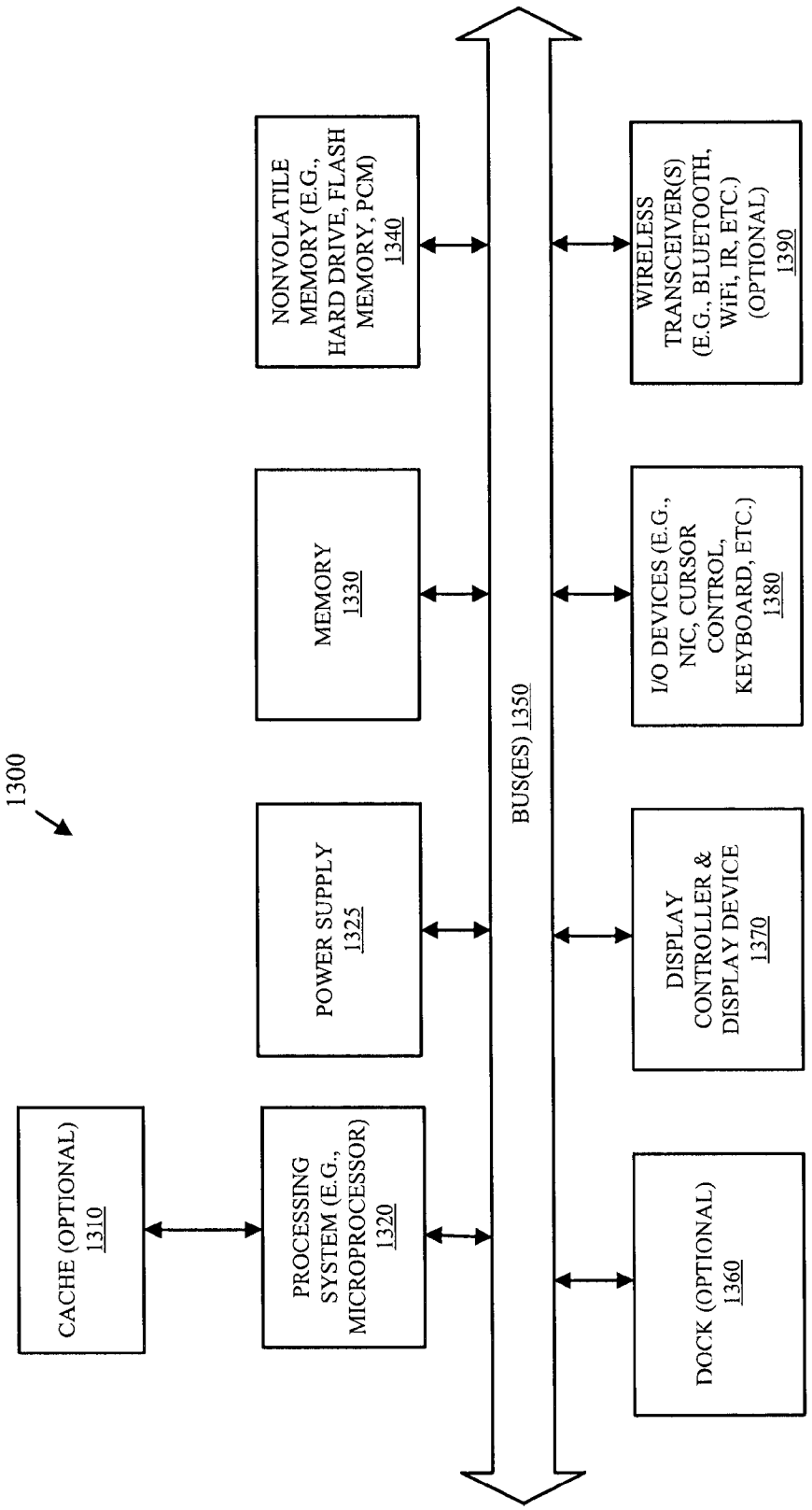
1300
CACHE (OPTIONAL) 1310
PROCESSING SYSTEM (E.G., MICROPROCESSOR) 1320
POWER SUPPLY 1325
MEMORY 1330
NONVOLATILE MEMORY (E.G., HARD DRIVE, FLASH MEMORY, PCM) 1340
BUS(ES) 1350
DOCK (OPTIONAL) 1360
DISPLAY CONTROLLER & DISPLAY DEVICE 1370
I/O DEVICES (E.G., NIC, CURSOR CONTROL, KEYBOARD, ETC.) 1380
WIRELESS TRANSCEIVER(S) (E.G., BLUETOOTH, WiFi, IR, ETC.) (OPTIONAL) 1390

FIG. 13

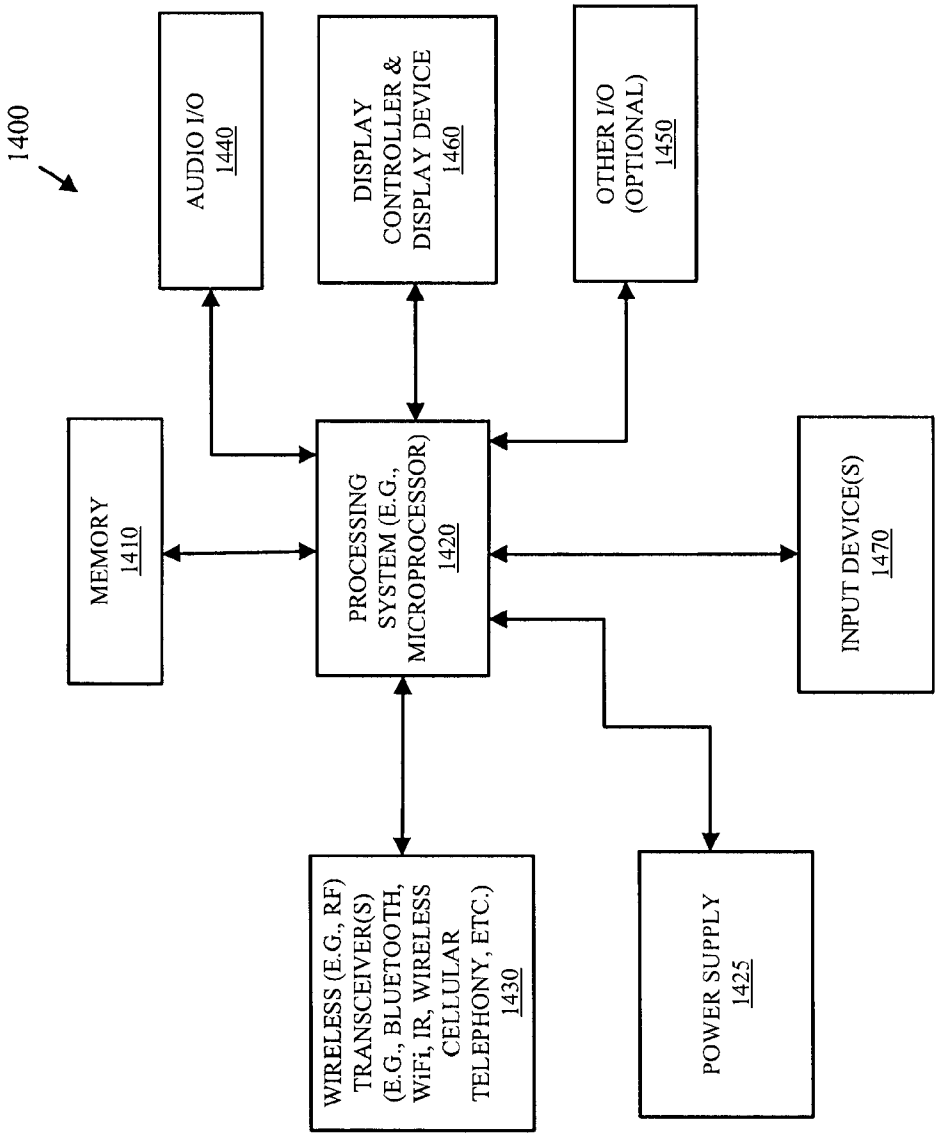
1400
AUDIO I/O
1440
DISPLAY CONTROLLER & DISPLAY DEVICE
1460
OTHER I/O (OPTIONAL)
1450
MEMORY
1410
PROCESSING SYSTEM (E.G., MICROPROCESSOR)
1420
INPUT DEVICE(S)
1470
WIRELESS (E.G., RF) TRANSCEIVER(S) (E.G., BLUETOOTH, WiFi, IR, WIRELESS CELLULAR TELEPHONY, ETC.)
1430
POWER SUPPLY
1425

FIG. 14

MANAGING NOTIFICATION SERVICE CONNECTIONS AND DISPLAYING ICON BADGES

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a divisional of U.S. application Ser. No. 12/433,709, filed Apr. 30, 2009 now U.S. Pat. No. 8,135,392, which is a continuation-in-part of U.S. application Ser. No. 12/198,037, filed Aug. 25, 2008, which claims the benefit of U.S. Provisional Application No. 61/059,703, filed Jun. 6, 2008, which are each hereby incorporated by reference in their entireties.

This application is related to co-pending U.S. patent application Ser. No. 12/042,307, entitled "Automatic Notification System and Process" filed on Mar. 4, 2008.

BACKGROUND

1. Field

Embodiments of the invention relate to the field of mobile device processing; and more specifically, to managing notification service connections of mobile devices and displaying icon badges.

2. Background

Users of a mobile device (e.g., laptop, palmtop, portable media player, smartphone, multimedia mobile phone, mobile gaming systems such as a "Gameboy", etc.) may subscribe to one or more notification services that may periodically send notification messages to the mobile device. For example, users may subscribe to one or more "push" email services (e.g., MobileMe, Microsoft Exchange ActiveSync, push-IMAP, Yahoo! Push, etc.) or other push services (e.g., update/upgrade services, news services, weblog services, podcast services, social networking services, or other types of services that send notification messages to the mobile devices). Notification messages typically represent events of interest which are typically defined by the applications (e.g., new email indicator, new news item indicator, new podcast indicator, change of online status of a social networking friend, etc.).

In the case of a push email service, for example, the email server may automatically transmit email messages and/or calendar updates to the email client on the mobile device for the user without the user requesting the item. In other words, the user does not request (poll) the email server for email messages or other items of interest. Thus, a push notification service is a persistent notification service. In order to maintain a push notification service, the mobile device periodically refreshes the connection to the push notification service (e.g., by transmitting a ping message to the push server).

In addition, users may subscribe to one or more "pull" services, such as "pull" email services (e.g., IMAP, POP3). In a pull email service, a user periodically checks (polls) the email server to determine if there is new email messages. If there are new email messages, they are then downloaded to the client. Many email clients support an automatic configuration of a poll interval. For example, a user of the mobile device may configure a poll interval of 10 minutes for a POP3 email account (thus the email client automatically polls the email server every 10 minutes to check for new email messages). In addition, notification services may be configured to provide network wide (e.g., Internet wide) event notification messages to multiple subscribers, where notification services may be automatically discovered by one or more subscribers and/or publishers, which is described in U.S. patent application Ser. No. 12/042,307, entitled "Automatic Notification System and Process", filed on Mar. 4, 2008, which is hereby incorporated by reference in its entirety.

A mobile device establishes a data context (e.g., a Packet Data Protocol (PDP) context) with one or more network elements that provide data services to the mobile device (e.g., Internet Protocol traffic from the Internet) over a network (e.g., a cellular network such as a Generic Packet Radio Services (GPRS) network, and/or a Local Area Network (LAN)). The data context is a logical association between the mobile device and the network elements, and includes information relating to routing (e.g., IP address information), Quality of Service (QoS), billing, authentication, etc. Since maintaining a data context consumes network resources of the network elements, the one or more servers may teardown a data context associated with a mobile device if the mobile device is not actively using the data context. For example, if the mobile device is turned off (and thus is not using the data context and not contacting the network elements), the network elements may teardown the data context after some time of not receiving information from the mobile device. The mobile device may periodically refresh the data context to keep the data context connection up.

In order to conserve battery life, a mobile device may enter into a reduced power mode when not connected to a constant power supply and not actively being used (e.g., an idle state). This is typically referred to as "sleep" mode. The sleep mode of particular mobile devices may be different depending on the characteristics of the mobile device. For example, in the case where the mobile device has network access, (e.g., cellular access, WiFi access, etc.), a sleep mode may include temporally putting the main processor to sleep and turning off the display, yet keeping the radio stack in an operable function.

Thus, while in sleep mode, an exemplary mobile device may continue to receive phone calls and/or items of interest from notification services (e.g., email messages from a push email service and/or from a pull email service). Once received, the mobile device may be awakened to process those phone calls and/or notifications. For example, a mobile device awakes after receiving a phone call while in sleep mode so a user may answer the phone call. Additionally, typical mobile devices typically cannot refresh the data context while in sleep mode (thus, a mobile device typically needs to be awake to refresh a data context).

BRIEF DESCRIPTION OF THE DRAWINGS

The invention may best be understood by referring to the following description and accompanying drawings that are used to illustrate embodiments of the invention. In the drawings:

FIG. **1** illustrates an exemplary computing environment according to one embodiment of the invention;

FIG. **2** illustrates an exemplary flow for a mobile device establishing notification service connections and scheduling notification service connection message transmission intervals according to one embodiment of the invention.

FIG. **3**A is a block diagram illustrating a framework of an exemplary mobile device to manage notification service connections according to one embodiment of the invention;

FIG. **3**B is a block diagram illustrating an exploded view of the notification service connection manager of FIG. **3**A according to one embodiment of the invention;

FIG. **4** is a flow diagram illustrating managing notification service connections according to one embodiment of the invention;

FIG. **5** is an exemplary graph illustrating a mobile device synchronizing transmission of notification service connection messages based on overlapping notification service connection message transmission windows according to one embodiment of the invention;

FIG. **6** is an exemplary state diagram illustrating optimizing notification service connection message intervals according to one embodiment of the invention;

FIG. **7** illustrates an exemplary graphical user interface of the mobile device according to one embodiment of the invention;

FIG. **8** is a block diagram that illustrates an exemplary architecture of the mobile device to process notification messages according to one embodiment of the invention;

FIG. **9** is a flow diagram illustrating exemplary operations for processing notification messages according to one embodiment of the invention;

FIG. **10** is a block diagram that illustrates an alternative exemplary architecture of the mobile device to process notification messages according to one embodiment of the invention;

FIG. **11** is a flow diagram illustrating exemplary operations for processing notification messages according to one embodiment of the invention;

FIG. **12** is a flow diagram illustrating exemplary operations when an application associated with the notification message is not currently executing according to one embodiment of the invention;

FIG. **13** is a block diagram illustrating an exemplary mobile device according to one embodiment of the invention; and

FIG. **14** is a block diagram illustrating an exemplary mobile device according to one embodiment of the invention.

DETAILED DESCRIPTION

In the following description, numerous specific details are set forth. However, it is understood that embodiments of the invention may be practiced without these specific details. In other instances, well-known circuits, structures and techniques have not been shown in detail in order not to obscure the understanding of this description. In other instances, control structures, gate level circuits and full software instruction sequences have not been shown in detail in order not to obscure the invention. Those of ordinary skill in the art, with the included descriptions, will be able to implement appropriate functionality without undue experimentation.

References in the specification to "one embodiment", "an embodiment", "an example embodiment", etc., indicate that the embodiment described may include a particular feature, structure, or characteristic, but every embodiment may not necessarily include the particular feature, structure, or characteristic. Moreover, such phrases are not necessarily referring to the same embodiment. Further, when a particular feature, structure, or characteristic is described in connection with an embodiment, it is submitted that it is within the knowledge of one skilled in the art to effect such feature, structure, or characteristic in connection with other embodiments whether or not explicitly described.

In the following description and claims, the terms "coupled" and "connected," along with their derivatives, may be used. It should be understood that these terms are not intended as synonyms for each other. "Coupled" is used to indicate that two or more elements, which may or may not be in direct physical or electrical contact with each other, cooperate or interact with each other. "Connected" is used to indicate the establishment of communication between two or more elements that are coupled with each other.

The techniques shown in the figures can be implemented using code and data stored and executed on one or more electronic devices (e.g., a mobile device (e.g., laptop, palmtop, portable media player, smartphone, multimedia mobile phone, mobile gaming system, etc.), a non-mobile device (e.g., desktop computer, workstation, server, etc.). Such electronic devices store and communicate (internally and with other electronic devices over a network) code and data using machine-readable media, such as machine storage media (e.g., magnetic disks; optical disks; random access memory; read only memory; flash memory devices) and machine communication media (e.g., electrical, optical, acoustical or other form of propagated signals—such as carrier waves, infrared signals, digital signals, etc.). In addition, such electronic devices typically include a set of one or more processors coupled to one or more other components, such as a storage device, one or more user input/output devices (e.g., a keyboard, a keypad, a touchscreen, and/or a display), and one or more network connections. The coupling of the set of processors and other components is typically through one or more busses and bridges (also termed as bus controllers). The storage device and signals carrying the network traffic respectively represent one or more machine storage media and machine communication media. Thus, the storage device of a given electronic device typically stores code and/or data for execution on the set of one or more processors of that electronic device. Of course, one or more parts of an embodiment of the invention may be implemented using different combinations of software, firmware, and/or hardware.

A method and apparatus for managing notification service connections is described. In one embodiment of the invention, a mobile device (e.g., laptop, palmtop, portable media player, smartphone, multimedia mobile phone, mobile gaming systems such as a "Gameboy", etc.) includes one or more notification service clients (e.g., push notification service clients (e.g., push email clients such as .Mac, Microsoft Exchange, push-IMAP, Yahoo! Push, etc., update/upgrade services, news services, weblog services, podcast services, etc.) and/or pull notification service clients (e.g., pull email clients such as POP3, IMAP, etc.)). For each notification service client, the mobile device independently schedules a notification service connection message transmission interval and sets a notification service connection message transmission timer. In addition, a notification service connection message transmission window is associated with each notification service connection message transmission interval and is based on the value of the notification service connection message transmission interval. Upon a notification service connection message transmission timer expiring for a particular notification service client, the mobile device transmits a notification service connection message for that notification service, and also transmits a notification service connection message for each other notification service whose notification service connection message transmission window overlaps that expiring transmission timer. The mobile device resets the notification service connection message transmission timer for each notification service upon transmitting a notification service connection message.

In one embodiment of the invention, for each notification service connection, the mobile device schedules a time to wake the mobile device, if the mobile device is in sleep mode, in order to transmit a notification service connection message. If the mobile device is awake at a certain time, or is awakened during a scheduled wake at a certain time, the mobile device transmits a notification service connection message for each

notification service whose notification service connection message transmission window overlaps that certain time. The mobile device resets the notification service connection message transmission timer for each notification service after transmitting a notification service connection message.

FIG. **1** illustrates an exemplary computing environment **100** according to one embodiment of the invention. The computing environment **100** includes the mobile devices **160** and **170** which are each coupled with one or more network data access elements **150**. The network data access element(s) **150** may be part of various types of networks in different embodiments of the invention, including cellular networks (e.g., Global System for Mobile Communications (GSM), Enhanced Data Rates for GSM Evolution (EDGE), General Packet Radio Service (GPRS), Code Division Multiple Access (CDMA), Universal Mobile Telecommunications System (UMTS), or other cellular networks), Local Area Networks (LANs), etc. For example, if the network data access element(s) **150** are part of a GSM network, the network data access element(s) **150** may include one or more of base transceiver stations (BTSs), Base Station Controllers (BSCs), Mobile Switching Centers (MSCs), Serving GPRS Support Nodes (SGSNs), etc. As another example, if the network data access element(s) **150** are part of a LAN, the network data access element(s) **150** may include one or more network switches, routers, hubs, modems, etc.

The mobile device **160** includes the application processor **162** and the network connectivity element(s) **164** (e.g., wireless network connectivity elements (e.g., radio network connectivity elements for cellular telephony, WiFi network connectivity elements), wired network connectivity elements (e.g., wired network interface controller(s) (NICs))). The mobile device **160** communicates with the network data access element(s) **150** via the network connectivity element(s) **164**, through a data context (e.g., a PDP context). The Wide Area Network (WAN) **140** (e.g., the Internet) is coupled with the network data access elements **150**. The push notification services **110** and **120** and the pull notification service **130** are coupled with the WAN **140**. According to one embodiment of the invention, a user of the mobile device **160** accesses and uses the push notification services **110** and **120** and the pull notification service **130** (the push notification services **110** and **120** and the pull notification service **130** provide items of interest for the user). For example, the push notification service **110** may be providing a personal push email account for the user of the mobile device **160** while the push notification service **120** may be providing a work push email account for the user of the mobile device **160**. As another example, the pull notification service **130** may be providing an organizational pull email account (e.g., POP3 email account, webmail account, etc.) for the user of the mobile device **160**.

In one embodiment of the invention, the application processor **162** is the central processor of the mobile device **160**. For example, the application processor **162** processes the operating system(s) of the mobile device **160** (the operating system is not illustrated in FIG. **1** in order not to obscure understanding of the invention), and any applications running on the mobile device **160**. Other well known features of mobile devices are not illustrated in FIG. **1** in order not to obscure understanding of the invention, including input/output devices, memory(ies), power supply, displays, etc.

According to one embodiment of the invention, the mobile device **160** is capable of entering into a reduced power mode, known as "sleep mode". For example, if the mobile device **160** is not coupled with a constant power supply (e.g., not plugged into an electrical outlet), the mobile device **160** may periodically enter into sleep mode to conserve battery life of the device. The mobile device **160** may enter sleep mode in a number of different ways, including after a period of inactivity (e.g., 30 minutes of inactivity) and/or directly by command from a user (e.g., a user may issue a command to the mobile device **160** to enter into sleep mode). It will be understood that other mechanisms of entering into sleep mode are within the scope of the invention.

During sleep mode, according to one embodiment of the invention, the mobile device **160** temporarily disables the application processor **162** (the application processor **162** may consume virtually no power when temporarily disabled). It should be understood that if the application processor **162** is disabled, the operating system and applications of the mobile device **160** are also disabled. However, according to one embodiment of the invention, at least some of the network connectivity element(s) **164** are not temporarily disabled. In other words, at least some of the network connectivity element(s) **164** may continue to receive information from the network data access elements **150**, and use power. For example, if the mobile device **160** has the capability of receiving phone calls and/or text messages (e.g., Short Message Service (SMS) messages) the mobile device **160** may keep awake a radio connectivity element during sleep mode in order to receive phone calls and/or text messages. If the mobile device **160** disabled the radio connectivity element, for example, a user of the mobile device **160** would not be able to receive a phone call and/or text message (e.g., a phone call may instead be forwarded to voice mail if supported). It should be understood that in order to process those received phone calls and/or text messages (e.g., in order for a user to answer an incoming phone call), the mobile device **160** awakens from sleep mode (e.g., re-enables the application processor **162**).

In addition, according to one embodiment of the invention, the mobile device **160** includes the capability of receiving items of interest from the push notification services **110-120** during sleep mode. For example, at least some of the network connectivity element(s) **164** have the capability of receiving the items of interest from the push notification services **110** and **120** during sleep mode (e.g., email messages, calendar updates, weather updates, stock updates, etc.). In one embodiment of the invention, a radio network connectivity element receives the items of interest sent from the push notification services **110** and **120** during sleep mode. Thus, during sleep mode, if the push notification services **110** and **120** provide push email service for a user of the mobile device **160**, the mobile device **160** may receive email messages from the push notification services **110** and **120**. According to one embodiment of the invention, the mobile device **160** awakens from sleep mode to process items of interest received during sleep mode.

While in some embodiments of the invention WiFi network connectivity elements are awake and functioning during sleep mode (and capable of receiving items of interest from the push notification services **110** and **120**), in alternative embodiments of the invention WiFi network connectivity elements are put to sleep during sleep mode. Typically a radio network connectivity element uses less power than a WiFi network connectivity element. Thus, keeping a WiFi network connectivity element awake during sleep mode causes a greater amount of power to be depleted than compared to keeping a radio network connectivity element awake. Thus, in some embodiments of the invention, the mobile device **160** may receive items of interest from the push notification services **110** and **120** during sleep mode via a WiFi network connectivity element, while in other embodiments of the

invention the mobile device **160** does not receive items of interest during sleep mode via the WiFi network connectivity element.

In some embodiments of the invention, the mobile device **160** may use a combination of network connectivity elements to receive items of interest from the push notification services **110** and **120**. For example, the mobile device **160** may support receiving data information via a radio network connectivity element (e.g., through a cellular network) and/or via a WiFi network connectivity element (e.g., when connected at a home LAN). The user of the mobile device **160** may configure the mobile device **160** such that a WiFi network connectivity element is used when WiFi service is available (e.g., while connected at a home LAN and/or work LAN) and the radio network connectivity element is used when WiFi service is not available. Thus, in one embodiment of the invention, a radio network connectivity element and/or a WiFi network connectivity element may be used to receive items of interest from the push notification services **110** and **120** depending on which network connectivity element is providing data support. In addition, in one embodiment of the invention, a radio network connectivity element and/or a WiFi network connectivity element may be used to receive items of interest from the push notification services **110** and **120** during sleep mode depending on which network connectivity element was providing data support prior to entering into sleep mode (e.g., if within a LAN and the WiFi network connectivity element was receiving items of interest from the push notification services **110** and **120** while the mobile device **160** was awake, during sleep mode the WiFi network connectivity element stays awake to receive items of interest and the mobile device **160** places the radio network connectivity element to sleep).

In one embodiment of the invention, since a WiFi network connectivity element typically uses more power than a radio network connectivity element, regardless of which network connectivity element was providing data support prior to entering into sleep mode, the mobile device **160** puts the WiFi network connectivity element to sleep (e.g., temporarily disables the WiFi network connectivity element) and uses a radio network connectivity element to receive items of interest from the push notification services during sleep mode. For example, if the mobile device **160** is connected with the push notification services **110** and **120** via a LAN (e.g., a home LAN of the user) and the user issues a command to place the mobile device **160** into sleep mode, the mobile device **160** automatically transitions to connecting with the push notification services **110** and **120** via a cellular network (through a radio connectivity element) and places the WiFi connectivity element to sleep.

The persistent notification service connections (e.g., push notification services **110** and **120**) are periodically refreshed in order to maintain the persistency of the connections in some embodiments of the invention. For example, the push notification services **110** and **120** may timeout a connection to the mobile device **160** (thus stopping push notification services for the user) if the mobile device does not actively use that connection. Thus, in some embodiments of the invention, the mobile device **160** is required to communicate with the push notification services **110** and **120** in order to maintain its persistent connections. For example, at some periodic interval, the mobile device **160** transmits a notification service connection message to the push notification services **110** and **120** to refresh the connections. The notification service connection message informs the push notification services **110** and **120** that the mobile device **160** is still connected (and presumably wishes to continue to receive items of interest from the push notification services). It should be understood that refreshing the push notification connections informs the push notification service's servers that the mobile device wishes to remain connected to the service. In addition, refreshing the push notification connections informs each network element along the route to the push notification service's servers to maintain the connection (otherwise, e.g., a network element may clear the network resources associated with that connection). The notification service connection message may be a ping message or other keep alive message. The notification services may respond to a notification service connection message to notify the mobile device **160** that the connection is active. Thus, if the mobile device **160** does not receive a response from a notification service, the mobile device **160** may be required to re-establish the session with the notification service. It should be understood that in some embodiments of the invention, receipt of an item of interest from a notification service also refreshes the persistent notification service connection.

The interval of transmitting a notification service connection message may be different for individual notification services. For example, the push notification service **110** may cause a timeout of the connection if there is 30 minutes of no communication while the push notification service **120** may cause a timeout of the connection if there is 15 minutes of no communication. However, these timeout intervals are not static and may change dynamically depending on different network conditions. In addition, the notification services may not notify the mobile device that a timeout interval has been modified. Thus, the mobile device **160**, in an attempt to maintain the connection (without having to re-establish the connection), may transmit a notification service connection message within the known timeout interval. It will be understood that the mobile device **160** is required to be awake to transmit a notification service connection message to refresh and maintain a notification service connection.

In addition, in some embodiments of the invention, the mobile device **160** is required to periodically refresh the connection with the network data access element(s) **150** in order to maintain network data connectivity (e.g. such as NAT routers in the carrier's network, firewalls, or other network elements in the network). For example, since the data context consumes network resources, the network data access element(s) **150** may tear down the data context if it is not actively being used and/or has not been used in a certain amount of time (e.g., the data context is removed and the network resources of that data context are reallocated). It should be understood that if the data context is torn down, the mobile device **160** is not connected with any notification services. Of course, it should also be understood that the data context may be torn down for other reasons besides period of inactivity (e.g., if the location of the mobile device is out of range of the network, if the mobile device **160** is turned off, etc.). In other embodiments of the invention, the data context does not have to be refreshed by the mobile device **160**. Typically, the data context timeout interval is less than the notification service timeout interval. If the data context is up, a notification service connection message transmitted by the mobile device **160** to a notification service inherently refreshes the connection with the network data access element(s) **150**.

FIG. **2** illustrates an exemplary flow for a mobile device establishing notification service connections and scheduling notification service connection message transmission intervals according to one embodiment of the invention. The operations of FIG. **2** will be described with reference to the exemplary embodiment of FIGS. **1**, **3**A, and **4**. However, it should be understood that the operations of FIG. **2** can be performed by embodiments of the invention other than those

discussed with reference to FIGS. **1**, **3**A, and **4**, and the embodiments discussed with reference to FIGS. **1**, **3**A, and **4** can perform operations different than those discussed with reference to FIG. **2**.

At block **210**, the mobile device **160** establishes a data context. The data context may be established by any number of methods known in the art. From block **210**, flow moves to block **220** where the mobile device **160** establishes one or more notification services connections. For example, referring to FIG. **1**, the mobile device **160** establishes a connection with the push notification services **110** and **120** and the pull notification service **130**. In some embodiments of the invention, the connections are each Transmission Control Protocol (TCP) connections. Flow moves from block **220** to block **230**.

At block **230**, the mobile device schedules a notification service connection message transmission interval and schedules device wake times for each of the notification service connections. For example, the mobile device **160** may schedule a notification service connection message transmission interval of 30 minutes for the push notification service **110**, an interval of 15 minutes for the push notification service **120**, and an interval of 25 minutes for the pull notification service **130**. In addition, the mobile device **160** may schedule a wake time that coincides with those transmission intervals. Flow moves from block **230** to block **240**.

At block **240**, the mobile device **160** enters into sleep mode. As described previously, the mobile device **160** may enter sleep mode in a number of different ways, including after a period of inactivity (e.g., 30 minutes of inactivity) and/or directly by command from a user (e.g., a user may issue a command to the mobile device **160** to enter into sleep mode). Flow moves from block **240** to block **250**. At block **250**, the application processor of the mobile device is put to sleep and the network connectivity element(s) are kept awake, for example, to maintain the notification service connections. Flow moves from block **250** to block **260** where the application processor is wakened according to the notification service connection manager to transmit a notification service connection message.

FIG. **3**A illustrates a framework used by an exemplary mobile device managing notification service connections according to one embodiment of the invention. For example, the mobile device **160** uses the framework illustrated in FIG. **3**A to manage the connections to the push notification services **110** and **120** and the pull notification service **130**. The framework includes one or more notification service clients **310**. For example, with reference to FIG. **1**, there may be a total of three notification service clients **310** (e.g., a notification service client for the push notification service **110**, a notification service client for the push notification service **120**, and a notification service client for the pull notification service **130**). Each notification service client **310** individually is coupled with the service connection manager **320** and the network stack **330**. For example, in one embodiment of the invention, each notification service client is an independent process, and does not share memory with other notification service clients and/or does not communicate with other notification service clients. Each notification service client registers **360** with the notification service connection manager **320**.

The notification service connection manager **320** is coupled with one or more system level timers **350**, the network stack **330**, and the wake I/O subsystem **340**. The service connection manager **320** schedules a notification service connection message transmission interval with use of the system level timer(s) **350**, and monitors those timers, as indicated by numeral **372**. In addition, the service connection manager **320**, with use of the I/O subsystem **340**, schedules wakes of the mobile device in relation to the notification service connection message transmission interval, as indicated by number **370** (e.g., the wake may be scheduled at a time close to the end of the notification service connection message transmission interval), and associates a notification service connection message transmission window with the notification service connection message transmission interval. The service connection manager **320** also keeps the network stack **330** alive during a sleep mode of the mobile device, as indicated by numeral **368**.

The network stack **330** includes support for the network connectivity elements (e.g., radio connectivity element and/or WiFi connectivity element). The network stack **330** is used to communicate with the notification services (and with other entities throughout the network). The network stack **330** provides the notification service connection manager **320** with the status of the network, as indicated by numeral **366**. For example, the notification service connection manager **320** notifies the service connection manager **320** of network conditions (e.g., network congestion, statistics, etc.). In addition, the network stack **330** receives item(s) of interest from the network services and transmits them to the appropriate notification service client **310**, as indicated by numeral **376**. In addition, the network stack **330** notifies the notification service client **320** if a communication from one of the notifications services was received (e.g., if a reply to a notification service connection message transmission was received).

According to one embodiment of the invention, after a timer for a notification service connection has elapsed, the service connection manager **320** instructs the notification service client **310** to transmit a notification service connection message, and also notifies the notification service client **310** of any re-try events, as indicated by the number **364** (e.g., a re-try event may include re-establishing a dropped notification service connection). The notification service client **310**, with use of the network stack **330**, transmits notification service connection messages, as indicated by numeral **374**. In addition, the notification service client **310** may instruct the service connection manager **320** to calibrate the notification service connection message transmission interval, as indicated by number **362**. Calibrating the notification service connection message transmission interval is discussed in greater detail with reference to FIG. **6**.

FIG. **3**B is a block diagram illustrating an exploded view of the notification service connection manager **320** of FIG. **3**A according to one embodiment of the invention. The notification service connection manager **320** includes the notification service connection message transmission interval scheduler module **322**, the notification service connection message transmission interval optimizer module **323**, the notification service connection message transmission timer monitor module **324**, the notification service connection message wake scheduler module **325**, the notification service connection message generator module **326**, and the sleep mode manager module **327**.

According to one embodiment of the invention, the interval scheduler module **322** schedules the notification service connection message transmission intervals. In addition, the interval scheduler module associates a notification service connection message transmission window with the scheduled notification service connection message transmission intervals. The interval scheduler module **322** is coupled with the notification service connection message transmission timer monitor module **324**. In one embodiment of the invention, the timer monitor module monitors the one or more system level timer(s) **350** including a notification service connection mes-

sage transmission timer. The interval scheduler module **322** is also coupled with the notification service connection message wake scheduler module. According to one embodiment of the invention, the wake scheduler module **322** schedules wakes of the mobile device based on notification service connection message transmission intervals.

The timer monitor module **324** is coupled with the notification service connection message generator module **326**. According to one embodiment of the invention, the message generator module **326** alerts the notification service client(s) **310** to issue a notification service connection message. The interval optimizer module **323** is coupled with the interval scheduler module **322**. According to one embodiment of the invention, the interval optimizer module optimizes notification service connection message transmission intervals, which will be described in greater detail with reference to FIG. **6**. In one embodiment of the invention, the sleep mode manager **327** keeps the network stack **330** awake during a sleep mode.

FIG. **4** is a flow diagram illustrating managing notification service connections according to one embodiment of the invention. The operations of FIG. **4** will be described with reference to the exemplary embodiments of FIGS. **3**A and **5**. However, it should be understood that the operations of FIG. **4** can be performed by embodiments of the invention other than those discussed with reference to FIGS. **3**A and **5**, and the embodiments discussed with reference to FIGS. **3**A and **5** can perform operations different than those discussed with reference to FIG. **4**. FIG. **5** is an exemplary graph illustrating a mobile device synchronizing transmission of notification service connection messages based on overlapping notification service connection message transmission windows according to one embodiment of the invention.

According to one embodiment of the invention, each notification service client on a mobile device performs the operations of FIG. **4**, independently. At block **410**, a notification service client (e.g., a push notification service client or a pull notification service client) registers with a notification service connection manager. For example, with reference to FIGS. **3**A and **5**, the notification push notification services **110**, **120**, and the notification pull notification service **130** (each a notification service client **310**) each independently register with the notification service connection manager **360**. From block **410**, flow moves to block **412**.

At block **412**, the mobile device **160** schedules a notification service connection message transmission interval and a wake time in relation to the service connection message transmission interval for each notification service. However, as will be described later herein, the actual wake times of the mobile device for a particular notification service connection may differ depending on other notification services. According to one embodiment of the invention, the initial service connection message transmission interval for the persistent notification services (e.g., push notification services) is based on a notification service timeout value provided by each persistent notification service. For example, referring to FIG. **5**, the push notification service **110** includes a notification service timeout value of 30 minutes (thus, if the connection to the push notification service **110** is not used within a 30 minute time period, the push notification service **110** may remove that connection), and the push notification service **110** includes a notification service timeout value of 15 minutes. In order to simplify understanding of the invention, in FIG. **5**, the notification service connection message transmission intervals for the push notification services **110** and **120** coincide with the timeout value. For example, the notification service connection message transmission interval is 30 minutes for the push notification service **110** and 15 minutes for the push notification service **120**. However, it should be understood that the notification service connection message transmission interval may not coincide with the timeout value (e.g., the interval may be less than the timeout value). It should also be understood that in some embodiments of the invention, the notification service connection message transmission intervals may be optimized and may change over time, which will be described in greater detail with reference to FIG. **6**. In addition, in order to simply understanding of the invention, a default wake time for each notification service connection is scheduled at the end of the notification service connection message transmission interval. Also, throughout the discussion of FIG. **5**, transmission of a notification service connection message may be referred to as a "heartbeat" or simply a "beat" in reference to a notification service connection message sent to a persistent notification service (e.g., push services **110** and **120**).

Referring back to FIG. **4**, the mobile device **160** also associates a notification service connection message transmission window with the message transmission interval and sets one or more system timers associated with the message transmission interval. According to one embodiment of the invention, a notification service connection message transmission window is a portion of the message transmission interval where a notification service connection message may be transmitted. For example, if the mobile device is awake during any time within the window, the mobile device may transmit a notification service connection message. In FIG. **5**, the notification service connection message transmission windows are roughly a third of the notification service connection message transmission window. For example, the notification service connection message transmission window of the push notification service **110** is 10 minutes before a scheduled transmission of a beat message (e.g., the 10 minutes prior to the scheduled beat), the notification service connection message transmission window of the push notification service **120** is 5 minutes before a scheduled beat, and the notification service connection message transmission window of the pull notification service **130** is 8 minutes before a scheduled pull. Although FIG. **5** illustrates the notification push notification services **110** and **120** and the notification pull notification service **130** starting at the same time (e.g., at time **0**), it should be understood that this is for illustrative purposes and these notification services may start at different times. With reference to FIG. **5**, the push notification service **110** has an initial scheduled heartbeat and wake time at 30 minutes, the push notification service **120** has an initial scheduled heartbeat and wake time at 15 minutes, and the pull notification service **130** has an initial scheduled pull message and wake time at 25 minutes.

With reference to FIG. **4**, flow moves from block **412** to block **412** where the mobile device monitors service connection message timers (e.g., system level timers associated with each service connection) and flow moves to block **416**. For example, with reference to FIG. **5**, the mobile device monitors timers for the push notification services **110** and **120** and the pull notification service **130**. In FIG. **5**, at time **5**, the mobile device enters into sleep mode **510**. Thus, according to one embodiment of the invention, the application processor and the operating system are offline yet the network connectivity element remains awake.

At block **416**, the mobile device determines if the time is within a notification service connection message transmission window. If the time is not within a notification service connection message transmission window, then flow moves to block **418** where a determination is made whether a global

notification service connection message timer has expired. The global notification service connection message timer will be discussed in greater detail later herein. If time is within a notification service connection message transmission window, then flow moves to block **420** where a determination is made whether the mobile device is awake. If the device is awake, then flow moves to block **430** where the mobile device transmits a notification service connection message. If the mobile device is not awake (i.e., if in sleep mode), then flow moves to block **422** where a determination is made whether a notification service connection message transmission timer has elapsed. For example, referring to FIG. **5**, beginning at time **10**, the push notification service **120** is within the window **540**, and the mobile device **160** is not awake (it is in sleep mode). If the timer has not elapsed, then flow moves back to block **420**. If the timer has elapsed, then flow moves to block **424** where the mobile device is awakened and flow moves to block **430** where the mobile device transmits a notification service connection message.

Referring to FIG. **5**, the notification service connection message transmission timer associated with the push notification service **120** elapses at time **15**. Thus, at time **15**, the mobile device **160** is wakened (represented by the dashed line wake **560**) and a notification service connection message is transmitted to the push notification service **120** in order to refresh the notification service connection (represented by the beat **570**). It should be understood that the mobile device **160** does not transmit a notification service connection message to the push notification service **110** or the pull notification service **130** during the wake time **560**. For example, the push notification service **110** has a beat interval of 30 minutes. Thus to refresh the connection to the push notification service **110**, a beat may be transmitted up to 30 minutes (i.e., the connection needs only be refreshed once every 30 minutes). If the mobile device **110** transmitted a beat to the push notification service **110** each and every time a beat was transmitted to the push notification service **120**, which has a beat interval of 15 minutes, effectively twice as many beat messages as necessary would be transmitted. Thus, according to one embodiment of the invention, the mobile device transmits notification service connection messages to a particular notification service only if it is awake during a notification service connection message transmission window for that particular notification service. Since the wake **560** does not overlap a notification service connection message transmission window for the push notification service **110** or the pull notification service **130**, the mobile device does not transmit notification service connection messages for those notification services in order to conserve bandwidth.

According to one embodiment of the invention, the mobile device resets the notification message transmission timer associated with a particular notification service upon transmitting a notification service connection message to the particular notification service. For example, the mobile device **160** resets the notification service connection message transmission timer for the push notification service **120** upon transmitting the beat message **570**.

At time **16**, the device enters sleep mode **512**. In other words, the mobile device **160** was awakened specifically to refresh the notification service connection to the notification push notification service **120** and the device reenters sleep mode in order to conserve battery resources. At time **25**, the notification service connection message transmission timer associated with the pull notification service **130** expires (e.g., the time period is at the end of the window **542**). Thus, at time **25**, the mobile device **160** is wakened (represented by the dashed line wake **562**) and a notification service connection message is transmitted to the pull notification service **130** in order to check for items of interest (represented by the check **576**). In addition, since the window **544** of the push notification service **110** overlaps the time of the wake **562** (the window **544** begins at time **20** and ends at time **30**), and the window **546** of the push notification service **120** overlaps the time of the wake **562** (the window **546** begins at time **25** and ends at time **30**), the mobile device **160** transmits a notification service connection message to the push notification service **110** (represented by the beat **572**) and transmits a notification service connection message to the push notification service **120** (represented by the beat **574**). Thus, during the wake **562**, the mobile device **160** transmits a notification service connection message to each of the push notification services **110** and **120** and the pull notification service **130**.

Since the mobile device **160** transmitted a notification service connection message to the push notification service **110**, the push notification service **120**, and the pull notification service **130**, according to one embodiment of the invention, the mobile device **160** resets the notification service connection message transmission timer, reschedules the notification service connection message transmission time and wake time, for each notification service. For example, instead of the push notification service **110** having a scheduled notification service connection message transmission time at time **60**, since a notification service connection message was transmitted to the push notification service **110** at time **25**, the mobile device **160** schedules a notification service connection message transmission at time **55**. As another example, instead of the push notification service **120** having a scheduled notification service connection message transmission time at time **45**, since a notification service connection message was transmitted to the push notification service **120** at time **25**, the mobile device **160** schedules a notification service connection message transmission at time **40**. At time **26**, the mobile device **160** enters into sleep mode **514**.

It should be understood that battery resources are conserved by synchronizing transmission of notification service connection messages based on overlapping notification service connection message transmission windows. For example, consolidating transmission of notification service connection messages for multiple notification services during a same wake period conserves battery resources. For example, waking a mobile device uses a significant amount of battery resources. Additionally, more battery resources are used when waking the device as compared with transmitting notification service connection messages. Thus, transmitting a notification service connection message to multiple notification services during the same wake period conserves battery resources (e.g., the mobile device is not independently awakened from sleep mode for each notification service connection message transmission). Thus, in some embodiments of the invention, synchronizing transmission of notification service connection messages based on overlapping notification service connection message transmission windows reduces the number of mobile device wakes needed, which reduces power consumption. It should be understood that the battery resource savings increase as the number of notification service clients increases.

In addition, while transmission of the notification service connection messages are not necessarily performed at their scheduled transmission time, (e.g., the notification service connection messages may be sent prior to their scheduled transmissions times), the deviance from the scheduled transmission time is low (e.g., typically the notification service connection message transmission window is approximately a third of the notification service connection message transmis-

sion interval). Thus, embodiments of the invention conserve bandwidth by transmitting notification service connection messages close to their scheduled transmission time.

At time **40**, the notification service connection message transmission timer associated with the push notification service **120** expires (e.g., the time period is at the end of the window **548**). Thus, at time **40**, the mobile device **160** is wakened (represented by the dashed line wake **564**) and a notification service connection message is transmitted to the push notification service **120** in order to refresh the push notification service **120** connection. Since the wake **564** does not overlap a notification service connection message transmission window for the push notification service **110** or the pull notification service **130**, the mobile device does not transmit notification service connection messages to those notification services in order to conserve bandwidth. At time **41**, the mobile device **160** enters into sleep mode **516**.

At time **47**, the mobile device **160** is awakened from the sleep mode **516** from an independent event (represented by independent wake **566**). There may be many causes of an independent wake, including user interaction (e.g., the user disables sleep mode), receiving an item of interest (e.g., receiving an email message from the push notification service **110**), receiving a phone call and/or text message, etc. Once awake, the mobile device determines whether the time is within any notification service connection message transmission window. For example, time **47** is within the window **552** for the push notification service **110** (which starts at time **45** and ends at time **55**) and within the window **550** for the pull notification service **130** (which starts at time **42** and ends at time **50**). Leveraging the fact that the mobile device is awake and within notification service connection message transmission windows, the mobile device transmits a notification service connection message to the push notification service **110** (represented by the beat **582**) to refresh the push notification service connection **110**, and transmits a notification service connection message to the pull notification service **130** (represented by the check **580**) to check for items of interest. In addition, while not illustrated in FIG. **5** for simplicity purposes, the mobile device **160** resets the notification service connection message transmission timer and reschedules the notification service connection message transmission time and wake for the push notification service **110** and the pull notification service **130**. At time **49**, the mobile device enters sleep mode **518**.

At time **55**, the notification service connection message transmission timer associated with the push notification service **120** expires (e.g., the time period is at the end of the window **554**). Thus, at time **55**, the mobile device **160** is wakened from the sleep mode **518** (represented by the dashed line wake **568**) and a notification service connection message is transmitted to the push notification service **120** to refresh the push notification service **120** connection (represented by the beat **584**). It should be noted that although the window **552** of the push notification service **110** originally would have overlapped the wake **568**, because the beat **582** was transmitted at time **47**, and the notification service connection message timer as reset and the notification service connection message transmission time rescheduled, the mobile device **160** does not transmit a notification service connection message to the push notification service **110**.

With reference to FIG. **4**, as described earlier, at block **418** a determination is made whether a global notification service connection message timer expired. According to one embodiment of the invention, the mobile device transmits a notification service connection message to each notification service at approximately the same time (e.g., within a minute of each other) at a periodic interval (e.g., 4 times a day). If the global notification service connection message timer expires, then flow moves to block **426** where a determination is made whether the mobile device is awake. If the mobile device is awake, then flow moves to block **430** where the mobile device transmits a notification service connection message to each notification service. If the mobile device is not awake, then flow moves to block **428** where the mobile device is awakened and flow moves to block **430** where the mobile device transmits a notification service connection message to each notification service.

Since multiple mobile devices may be accessing the same notification services through the same network (e.g., with reference to FIG. **1**, according to one embodiment of the invention the mobile device **160** and the mobile device(s) **170** are at least partially coupled with the same network access data element(s) **150**), the global notification service connection message timer is configured so that all of the mobile devices do not transmit a notification service connection message at the same time. According to one embodiment of the invention, these notification service connection message transmission times are randomized using a cryptographically secure pseudo-random number generator (and thus spread throughout the day). For example, a unique identifier of each mobile device (e.g., a universally unique identifier (UUID), a Media Access Control (MAC) address, etc.) modded over a given time interval to determine these global notification service connection message transmission times.

As described previously, in some embodiments of the invention, the notification service connection message transmission interval for persistent notification services (e.g., push notification services) may be optimized. In other words, in some embodiments of the invention, the message transmission interval is optimized in order to transmit the least amount of notification service connection messages for persistent notification services while remaining connected to the persistent notification services. FIG. **6** is an exemplary state diagram illustrating optimizing notification service connection message intervals according to one embodiment of the invention. At block **610**, an initial notification service connection message transmission interval is determined. For example, the initial notification service connection message transmission interval may be based on a timeout interval of a particular notification service. If the mobile device determines that the connection is active, the message transmission interval is increased by N amount **612** (e.g., 5 minutes). For example, the connection may be determined to be active if a reply message is received from the notification service.

If the mobile device determines that the connection is not active, the message transmission interval is decreased by Y amount **614** (e.g., 5 minutes), and enters a refined notification service connection message transmission interval **616**. If the mobile device determines that the connection is active, then the message transmission interval is increased by M amount, where M is less than N **618** (e.g., 2 minutes). If the mobile device determines that the connection is not active, then the message transmission interval is decreased by X amount, where Xis less than Y **620**.

After some time, connection message transmission interval enters into the steady notification service connection message transmission interval **622** state. When in this state, if the connection is active, the interval value remains at the current value **624**. In some embodiments of the invention, after a Z amount of time in the state **622** (e.g., after 8 hours), the connection message transmission interval is reset **623** to the initial notification service connection message transmission interval **610**, where the interval optimization process restarts.

Thus, if the notification service connection message transmission interval settles into a relatively high frequency message transmission interval (e.g., a message every 5 minutes), after some period of time the optimization process restarts in an attempt to determine the optimum transmission interval. However, if the connection is not active, the interval is decreased **626** (e.g., decreased by half), and the interval enters the backoff notification service connection message transmission interval **628**. When in the backoff state, if the connection is not active, the interval is decreased **630** (e.g., decreased by half).

It should be understood that if a notification service connection is not active, that connection needs to be reestablished. According to one embodiment of the invention, notification service connection retries are scheduled according to wake intervals. For example, with reference to FIG. **5**, if the beat **572** failed to refresh the connection to the push notification service **110** at time **25**, in one embodiment of the invention, the next wake the mobile device will attempt to reestablish the notification service connection. Thus, during the wake **564** at time **40**, the mobile device may attempt to reestablish the notification service connection to the push notification service **110**.

In one embodiment of the invention, some applications, responsive to receiving certain notification messages, cause one or more icon badges to be displayed on the graphical user interface of the display (typically in close proximity to the application icon of the application that received the notification message or overlapping that application icon). The icon badges may represent different things for different applications. Typically, the icon badges alert the user of the mobile device of one or more items of interest. For example, different icon badges may represent the number of unread email messages, the number of unread text messages, the number of installed applications which have an update, a number of social networking messages, a number of social networking friends currently online, a number of unread instant messages, a number of unread newsgroup items, a number of unread blog entries, a number of updated podcasts, weather alerts, etc. Icon badges may be numerals, graphics, text, animations, or any combination of numerals, graphics, text, and animations. In some embodiments, applications are programmed to specify whether they will use icon badging and/or the type of icon badging they will use.

As one example, push notification email services (e.g., MobileMe, Microsoft Exchange ActiveSync, push-IMAP, Yahoo! Push, etc.) and/or pull notification email services (e.g., POP3, IMAP, etc.) may display an icon badge (e.g., a numeral icon) which indicates the number of new email messages and/or an icon badge (e.g., a numeral icon) which indicates the number of unread email messages responsive to receiving notification messages that indicate email. Similarly, other applications that receive notification messages may display an icon badge. For example, for a social networking application, an icon badge which indicates the number of friends currently online and/or an icon badge which indicates the number of unread messages may be displayed.

FIG. **7** illustrates an exemplary graphical user interface **718** of the mobile device **160** according to one embodiment of the invention. As illustrated in FIG. **7**, the mobile device **160** includes the display screen **715**, which is currently displaying numerous application icons. Each application icon provides a launching point for a corresponding application. For example, the user may execute (run) a social networking application by selecting the social networking application icon **736**. In one embodiment, the display screen **715** is a touch screen. In one embodiment, the display screen illustrated in FIG. **7** is a home page (e.g., a starting page and/or application launching page) of the mobile device **160**.

The GUI **718** includes the favorite applications **710**, which is a collection of one or more application icons corresponding with applications that are used most often by the user of the mobile device **160** or have been set as favorites of the user of the mobile device **160**. The favorite applications **710** include the telephone application icon **712** (which allows users to make phone calls, listen to voicemails, etc.) push email application icon **714**, Internet application icon **716** (e.g., an Internet browser), and the music application icon **718** (which allows users to listen to music). Other application icons corresponding with applications on the GUI **718** include the text message application icon **710**, the calendar application icon **722**, the photos application icon **724**, the instant message application icon **726**, the pull mail application icon **728**, the stock ticker application icon **730**, the maps application icon **732**, the weather application icon **734**, the social networking application icon **736**, the clock application icon **738**, the news application icon **740** (the news application allows users to read newsfeeds and/or blog feeds (e.g., RSS feeds)), and the application store icon **742** (the application store allows users to download additional applications, or update currently installed applications, for the mobile device **160**). It should be understood that the number and type of application icons displayed on the display screen **715** is exemplary and a different number and/or types of application icons may be displayed. In addition, multiple applications may be grouped into a single application icon type in some embodiments. For example, while FIG. **7** illustrates a separate pull email application icon **728** and a separate push email application icon **714**, in some embodiments multiple email applications, whether they are push email applications or pull email applications, are grouped under a single email application icon.

Some of the applications may receive notification messages that cause icon badges to be displayed. The icon badges may be displayed in different locations relative to their corresponding application icons in different embodiments of the invention (e.g., overlapping the application icon, within a few pixels of the application icon, etc.). The icon badge **768**, which is represented as a numeral and overlaps the push email application icon **714**, may represent the number of unread email messages (e.g., twenty-four unread email messages) or the number of new email messages. Similarly, the icon badge **754**, which is represented as a numeral and overlaps the pull email application icon **728**, may represent the number of unread email messages (e.g., nine unread email messages) or the number of new email messages, the icon badge **750**, which is represented as a numeral and overlaps the text message application icon **720**, may represent the number of unread text messages (e.g., three text messages) or the number of new text messages, the icon badge **752**, which is represented as a numeral and overlaps the instant message application icon **726**, may represent the number of unread instant messages (e.g., eight unread instant messages) or the number of new instant messages, the icon badge **762**, which is represented as a numeral and overlaps the news application icon **740**, may represent the number of unread news items and/or blog items or the number of new news items and/or blog items, and the icon badge **764**, which is represented as a numeral and overlaps the application store application icon **742**, may represent the number of installed applications which currently has an update that may be downloaded and/or installed.

As illustrated in FIG. **7**, in one embodiment, some icon badges are not numerals. For example, the icon badge **756** is illustrated as a graphic (it may also be an animation). The icon

badge **756** overlaps the weather application icon **734** and may represent a severe weather alert. The user of the mobile device **160** may use the weather application that corresponds with the weather application icon **734** to set the location(s) they want to receive severe weather alerts on in one embodiment. In another embodiment, the severe weather alerts may correspond to the current location of the mobile device **160**. As an example, the current location of the mobile device may be determined through identifying a cellular base station coupled with the mobile device **160**, determining the GPS location of the mobile device **160**, etc. As illustrated in FIG. **7**, a lightning bolt graphic may represent that a severe thunderstorm alert has been issued. Other graphics may be displayed for different severe weather alerts (e.g., rain graphic for flooding watches/warnings, tornado graphic for tornado watches/warnings, snow graphic for blizzard watches/warnings, hurricane graphic for hurricane watches/warnings, etc.).

In addition, some application icons may have multiple icon badges being displayed at any given time in some embodiments. For example, the icon badge **758** and the icon badge **760** each are associated with the social networking application icon **736** (and each overlap a portion of the social networking application icon **736**). The icon badge **758**, which is a combination of a graphic with a numeral, may be used to represent the current number of social networking contacts (e.g., friends) that are currently online (as illustrated in FIG. **7**, a total of eight contacts are currently online). The icon badge **760** may be used to represent the number of unread or new messages on the social networking application corresponding to the social networking application icon **736**.

Some of the applications with corresponding application icons illustrated in FIG. **7** correspond to push notification services and some correspond to pull notification services. For example, the push email application corresponding with the push email application icon **714** corresponds with a push notification service and the pull email application corresponding with the pull email application icon **728** corresponds with a pull notification service.

In some embodiments, icon badges may exist for application icons whose applications are not push applications or pull applications. For example, the icon badge **766**, which overlaps the telephone application icon **712** and may represent the number of voicemail messages, does not correspond with a push application or a pull application.

FIG. **8** is a block diagram that illustrates an exemplary architecture of the mobile device **160** to process notification messages according to one embodiment of the invention. FIG. **8** will be described with reference to the exemplary operations illustrated in FIG. **9**. However, it should be understood that the operations of FIG. **9** can be performed by embodiments of the invention other than those discussed with reference to FIG. **8**, and the embodiments discussed with reference to FIG. **8** can perform operations different than those discussed with reference to FIG. **9**. It should also be understood that the architecture illustrated in FIG. **8** is exemplary, and different architectures may be used in different embodiments.

As illustrated in FIG. **8**, the mobile device **160** includes the notification message manager **810**, one or more applications **840**, and the graphical user interface **718**. In one embodiment, the notification message manager **810**, the application(s) **840**, and the GUI **718** are each executed by the application processor **162** of the mobile device **160**. The notification message manager **810** receives notification messages from different notification services (e.g., the network connectivity element(s) **164** receive notification messages from the push notification services **110** and **120** and the pull notification service **130** and pass them to the notification message manager **810** for processing). The notification messages are directed to the appropriate applications for processing including determining whether to display an icon badge on the graphical user interface **718**.

With reference to FIG. **9**, at block **910**, the notification message manager **810** receives a notification message. Flow moves from block **910** to block **915**, where the notification message manager **810** parses the received notification message. In one embodiment, each notification message includes an application identifier which identifiers which application the notification message is for. Flow moves from block **915** to block **920**, where the notification message manager **810** determines whether the application associated with notification message is currently executing (running) on the mobile device **160**. If the application is currently running, then flow moves to block **930** where the notification message manager **810** directs the notification message to its application. Flow moves from block **930** to block **935**.

If the application is not currently running, then flow moves to block **925** where the notification message manager **810** takes alternative action (e.g., the notification message manager **810** causes the application to execute, the notification message manager **810** causes the notification message to be stored in the notification message store **850** of the mobile device **160** without it being processed by its corresponding application until that application is executed, the notification message manager **810** drops the notification message, etc.). For example, FIG. **12** is a flow diagram illustrating exemplary operations when the application associated with the notification message is not currently executing. At block **1210**, the notification message manager **810** causes the notification message to be stored in the notification message store **850**. Flow moves from block **1210** to block **1215**, where the application begins executing. Flow moves from block **1215** to block **1220**, where the notification message is directed to the application for further processing.

With reference back to FIG. **9**, at block **935**, the application **840** which corresponds which received the redirected notification message, determines whether an icon badge is to be displayed on the graphical user interface **718**. If an icon badge will be displayed, then flow moves to block **940** where the application **840** causes an appropriate icon badge to be displayed on the graphical user interface **718** for the application. In one embodiment, the application **840** uses the badging module **820** (e.g., a shared set of functions and data structures available to each of the application(s) **840**) to cause the icon badge to be displayed on the graphical user interface **718**. If an icon badge will not be displayed, then flow moves to block **945** where the application **840** continues processing the notification message. As used herein, displaying an icon badge includes creating an initial icon badge and/or updating an existing icon badge (e.g., incrementing a number of an existing icon badge).

FIG. **10** is a block diagram that illustrates an alternative exemplary architecture of the mobile device **160** to process notification messages according to one embodiment of the invention. FIG. **10** will be described with reference to the exemplary operations illustrated in FIG. **11**. However, it should be understood that the operations of FIG. **11** can be performed by embodiments of the invention other than those discussed with reference to FIG. **10**, and the embodiments discussed with reference to FIG. **10** can perform operations different than those discussed with reference to FIG. **11**. It should also be understood that the architecture illustrated in FIG. **10** is exemplary, and different architectures may be used in different embodiments.

As illustrated in FIG. **10**, the mobile device **160** includes the notification message manager **1010**, one or more applications **1040**, and the graphical user interface **718**. In one embodiment, the notification message manager **1010**, the application(s) **1040**, and the GUI **718** are each executed by the application processor **162** of the mobile device **160**. The notification message manager **1010** receives notification messages from different notification services (e.g., the network connectivity element(s) **164** receive notification messages from the push notification services **110** and **120** and the pull notification service **130** and pass them to the notification message manager **1010** for processing). The notification message manager **1010** determines whether to display icon badges on the graphical user interface **130**.

With reference to FIG. **11**, at block **1110**, the notification message manager **1010** receives a notification message. Flow moves from block **1110** to block **1115**, where the notification message manager **1010** parses the received notification message. In one embodiment, the notification message manager **1010** parses the notification message to determine the application associated with the notification message and the type of notification message (e.g., whether an icon badge should be displayed according to the notification message, etc.).

Flow moves from block **1115** to block **1120**, where the notification message manager **1010** determines whether an icon badge is to be displayed on the graphical user interface **1030** for the application. If an icon badge is to be displayed, then flow moves to block **1125** where the notification message manager **1010** causes an appropriate icon badge to be displayed on the graphical user interface **1030** of the mobile device **160**. For example, in one embodiment of the invention, the notification message manager **1010** uses the badging module **1020** to cause the icon badge to be displayed on the graphical user interface **1030**. If an icon badge is not going to be displayed (e.g., the type of notification message is not an icon badge), then flow moves to block **1130**.

At block **1130**, the notification message manager **1010** determines whether the application associated with the notification message is currently executing. If the application is not currently executing, then flow moves to block **1135** where alternative action is taken (e.g., the notification message is stored in the notification message store **1050** until the application is executed (e.g., as described in the operations of FIG. **12**), the notification message is dropped, etc.). If the application is currently executing, then flow moves to block **1140** where the notification message manager **1010** directs the notification message to the appropriate one of the application(s) **1040** (e.g., as determined by the application identifier included in the notification message). Flow moves from block **1140** to block **1145**, where that one of the application(s) **1040** continues processing the notification message.

In some embodiments, a user of the mobile device **160** may configure a setting to switch off/on icon badging for notification messages. In other embodiments, a user of the mobile device **160** may determine whether to receive icon badges notification messages for any of the applications that are installed on mobile device **160**.

FIG. **13** is a block diagram illustrating an exemplary computer system which may be used in some embodiments of the invention. For example, the exemplary architecture of the computer system **1300** may be included in the mobile device **160**. It should be understood that while FIG. **13** illustrates various components of a computer system, it is not intended to represent any particular architecture or manner of interconnecting the components as such details are not germane to the present invention. It will be appreciated that other computer systems that have fewer components or more components may also be used with the present invention.

As illustrated in FIG. **13**, the computer system **1300**, which is a form of a data processing system, includes the bus(es) **1350** which is coupled with the processing system **1320**, power supply **1325**, memory **1330**, and the nonvolatile memory **1340** (e.g., a hard drive, flash memory, Phase-Change Memory (PCM), etc.). The bus(es) **1350** may be connected to each other through various bridges, controllers, and/or adapters as is well known in the art. The processing system **1320** may retrieve instruction(s) from the memory **1330** and/or the nonvolatile memory **1340**, and execute the instructions to perform operations as described above. The bus **1350** interconnects the above components together and also interconnects those components to the optional dock **1360**, the display controller & display device **1370**, Input/Output devices **1380** (e.g., NIC (Network Interface Card), a cursor control (e.g., mouse, touchscreen, touchpad, etc.), a keyboard, etc.), and the optional wireless transceiver(s) **1390** (e.g., Bluetooth, WiFi, Infrared, etc.).

FIG. **14** is a block diagram illustrating an exemplary data processing system which may be used in some embodiments of the invention. For example, the data processing system **1400** may be a handheld computer, a personal digital assistant (PDA), a mobile telephone, a portable gaming system, a portable media player, or a handheld computer which may include a mobile telephone, a media player, and/or a gaming system. As another example, the data processing system **1400** may be a network computer or an embedded processing device within another device.

According to one embodiment of the invention, the exemplary architecture of the data processing system **1400** may be included in the mobile device **160**. The data processing system **1400** includes the processing system **1420**, which may include one or more microprocessors and/or a system on an integrated circuit. The processing system **1420** is coupled with a memory **1410**, a power supply **1425** (which includes one or more batteries) an audio input/output **1440**, a display controller and display device **1460**, optional input/output **1450**, input device(s) **1470**, and wireless transceiver(s) **1430**. It will be appreciated that additional components, not shown in FIG. **14**, may also be a part of the data processing system **1400** in certain embodiments of the invention, and in certain embodiments of the invention fewer components than shown in FIG. **14** may be used. In addition, it will be appreciated that one or more buses, not shown in FIG. **14**, may be used to interconnect the various components as is well known in the art.

The memory **1410** may store data and/or programs for execution by the data processing system **1400**. The audio input/output **1440** may include a microphone and/or a speaker to, for example, play music and/or provide telephony functionality through the speaker and microphone. The display controller and display device **1460** may include a graphical user interface (GUI). The wireless (e.g., RF) transceivers **1430** (e.g., a WiFi transceiver, an infrared transceiver, a Bluetooth transceiver, a wireless cellular telephony transceiver, etc.) may be used to communicate with other data processing systems. The one or more input devices **1470** allow a user to provide input to the system. These input devices may be a keypad, keyboard, touch panel, multi touch panel, etc. The optional other input/output **1450** may be a connector for a dock.

While the flow diagrams in the figures show a particular order of operations performed by certain embodiments of the invention, it should be understood that such order is exem-

plary (e.g., alternative embodiments may perform the operations in a different order, combine certain operations, overlap certain operations, etc.)

While the invention has been described in terms of several embodiments, those skilled in the art will recognize that the invention is not limited to the embodiments described, can be practiced with modification and alteration within the spirit and scope of the appended claims. The description is thus to be regarded as illustrative instead of limiting.

What is claimed is:

1. A method for managing a plurality of notification service connections, comprising:

scheduling a notification service connection message transmission interval for each of the plurality of notification service connections;

for each notification service connection message transmission interval, associating a notification service connection message transmission window with the notification service connection message transmission interval;

setting and monitoring a notification service connection message transmission timer for each of the plurality of notification service connections;

upon each notification service connection message transmission timer expiring, performing the following,

transmitting a notification service connection message for each notification service connection whose notification service connection message transmission window overlaps the expiration of the notification service connection message transmission timer, and

resetting the notification service connection message transmission timers associated with those notification service connections;

receiving a notification message from a notification service on one of the plurality of notification service connections, wherein the notification message is for an application installed on the mobile device; and

displaying an icon badge according to the notification message on a display of the mobile device for the application.

2. The method of claim **1**, wherein the icon badge overlaps an icon corresponding with the application.

3. The method of claim **1**, wherein the notification service corresponds to a push email service and the application is a push email application, and wherein the notification message alerts a user of the mobile device of new email, and wherein the icon badge indicates a number of unread email messages.

4. The method of claim **1**, wherein the application is one of the following: a push email application, a weather application, a text message application, an instant message application, a social networking application, an application store application, and a news application.

5. The method of claim **1**, wherein the application is not currently executing on the mobile device.

6. The method of claim **1**, wherein at least one of the plurality of notification services connections is providing a push notification service, wherein transmitting a notification service connection message to those connections providing push notification services includes transmitting a ping message.

7. The method of claim **1**, wherein at least one of the plurality of notification services connections is providing a pull notification service, wherein transmitting a notification service connection message to those connections providing pull notification services includes transmitting a polling message.

8. The method of claim **1**, wherein at least some of the notification service connection message transmission intervals are a different value.

9. The method of claim **1**, further comprising transmitting a notification service connection message for all notification service connections at a periodic interval, and resetting each notification service connection message transmission timer.

10. The method of claim **1**, further comprising optimizing the notification service connection message transmission interval.

11. The method of claim **1**, wherein the application is currently executing on the mobile device.

12. The method of claim **11**, wherein the application causes the icon badge to be displayed.

13. The method of claim **1**, further comprising:

scheduling a mobile device wake in relation to each notification service connection message transmission timer; and

prior to transmitting a notification service connection message, waking the mobile device if the mobile device is in sleep mode.

14. The method of claim **13**, further comprising:

if the mobile device is awake within a notification service connection message transmission window, transmitting a notification service connection message for that notification service connection and resetting the notification service connection message transmission timer associated with that notification service connection.

15. The method of claim **14**, wherein sleep mode of the mobile device includes a temporarily disabled application processor, and waking the mobile device includes re-enabling the application processor.

16. A machine-readable storage medium that provides instructions that, if executed by a processor, will cause said processor to perform operations for managing a plurality of notification service connections, said operations comprising:

scheduling a notification service connection message transmission interval for each of the plurality of notification service connections;

for each notification service connection message transmission interval, associating a notification service connection message transmission window with the notification service connection message transmission interval;

setting and monitoring a notification service connection message transmission timer for each of the plurality of notification service connections;

upon each notification service connection message transmission timer expiring, performing the following,

transmitting a notification service connection message for each notification service connection whose notification service connection message transmission window overlaps the expiration of the notification service connection message transmission timer, and

resetting the notification service connection message transmission timers associated with those notification service connections;

receiving a notification message from a notification service on one of the plurality of notification service connections, wherein the notification message is for an application installed on the mobile device; and

displaying an icon badge according to the notification message on a display of the mobile device for the application.

17. The machine-readable storage medium of claim **16**, wherein the icon badge overlaps an icon corresponding with the application.

18. The machine-readable storage medium of claim **16**, wherein the notification service corresponds to a push email service and the application is a push email application, and wherein the notification message alerts a user of the mobile device of new email, and wherein the icon badge indicates a number of unread email messages.

19. The machine-readable storage medium of claim **16**, wherein the application is one of the following: a push email application, a weather application, a text message application, an instant message application, a social networking application, an application store application, and a news application.

20. The machine-readable storage medium of claim **16**, wherein the application is not currently executing on the mobile device.

21. The machine-readable storage medium of claim **16**, wherein at least one of the plurality of notification services connections is providing a push notification service, wherein transmitting a notification service connection message to those connections providing push notification services includes transmitting a ping message.

22. The machine-readable storage medium of claim **16**, wherein at least one of the plurality of notification services connections is providing a pull notification service, wherein transmitting a notification service connection message to those connections providing pull notification services includes transmitting a polling message.

23. The machine-readable storage medium of claim **16**, wherein at least some of the notification service connection message transmission intervals are a different value.

24. The machine-readable storage medium of claim **16**, further comprising transmitting a notification service connection message for all notification service connections at a periodic interval, and resetting each notification service connection message transmission timer.

25. The machine-readable storage medium of claim **16**, further comprising optimizing the notification service connection message transmission interval.

26. The machine-readable storage medium of claim **16**, wherein the application is currently executing on the mobile device.

27. The machine-readable storage medium of claim **26**, wherein the application causes the icon badge to be displayed.

28. The machine-readable storage medium of claim **16**, further comprising:

scheduling a mobile device wake in relation to each notification service connection message transmission timer; and

prior to transmitting a notification service connection message, waking the mobile device if the mobile device is in sleep mode.

29. The machine-readable storage medium of claim **28**, further comprising:

if the mobile device is awake within a notification service connection message transmission window, transmitting a notification service connection message for that notification service connection and resetting the notification service connection message transmission timer associated with that notification service connection.

30. The machine-readable storage medium of claim **29**, wherein sleep mode of the mobile device includes a temporarily disabled application processor, and waking the mobile device includes re-enabling the application processor.

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