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(54) **METHODS AND APPARATUS FOR INTELLIGENT WIRLESS TECHNOLOGY SELECTION**

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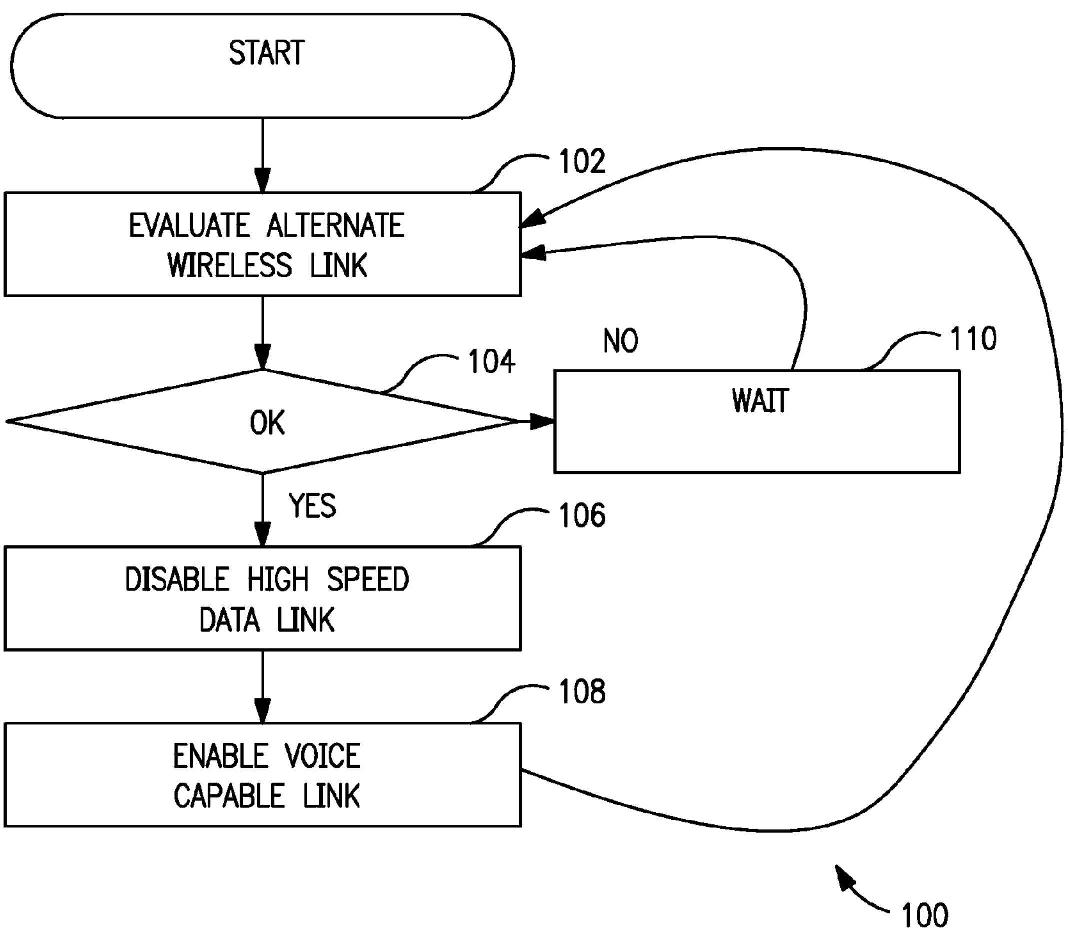
(57) **ABSTRACT**

Methods and apparatus for intelligently selecting and operating one or more air interfaces of a mobile wireless device for e.g., call setup time reduction. In one embodiment, operation of a high speed cellular interface is selectively adjusted or disabled or switched out when not required so as to minimize call setup times by, e.g., using a different cellular interface to receive pages. In one implementation, the wireless device includes a high-speed cellular interface, a lower-speed cellular interface, and a WLAN (e.g., Wi-Fi) interface.



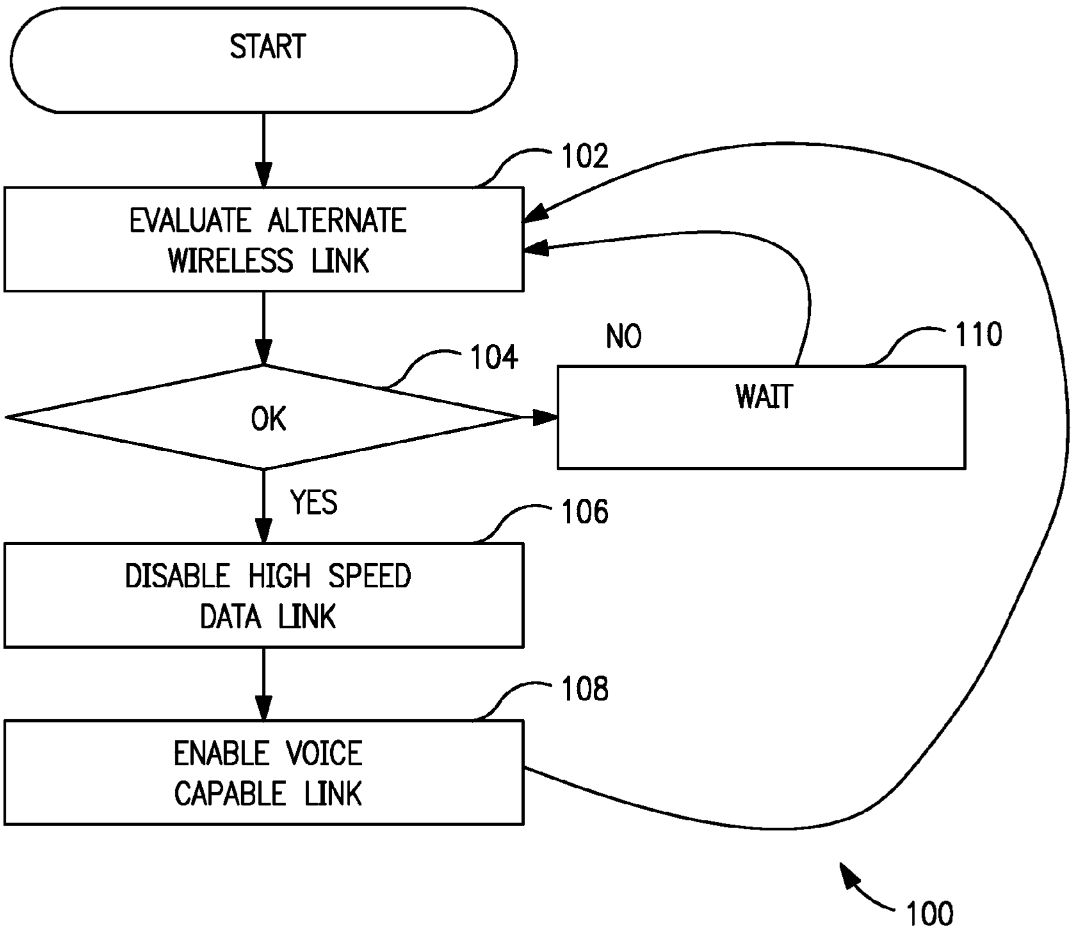

START
102
EVALUATE ALTERNATE WIRELESS LINK
104
OK
NO
WAIT
110
YES
106
DISABLE HIGH SPEED DATA LINK
108
ENABLE VOICE CAPABLE LINK
100

FIG. 1

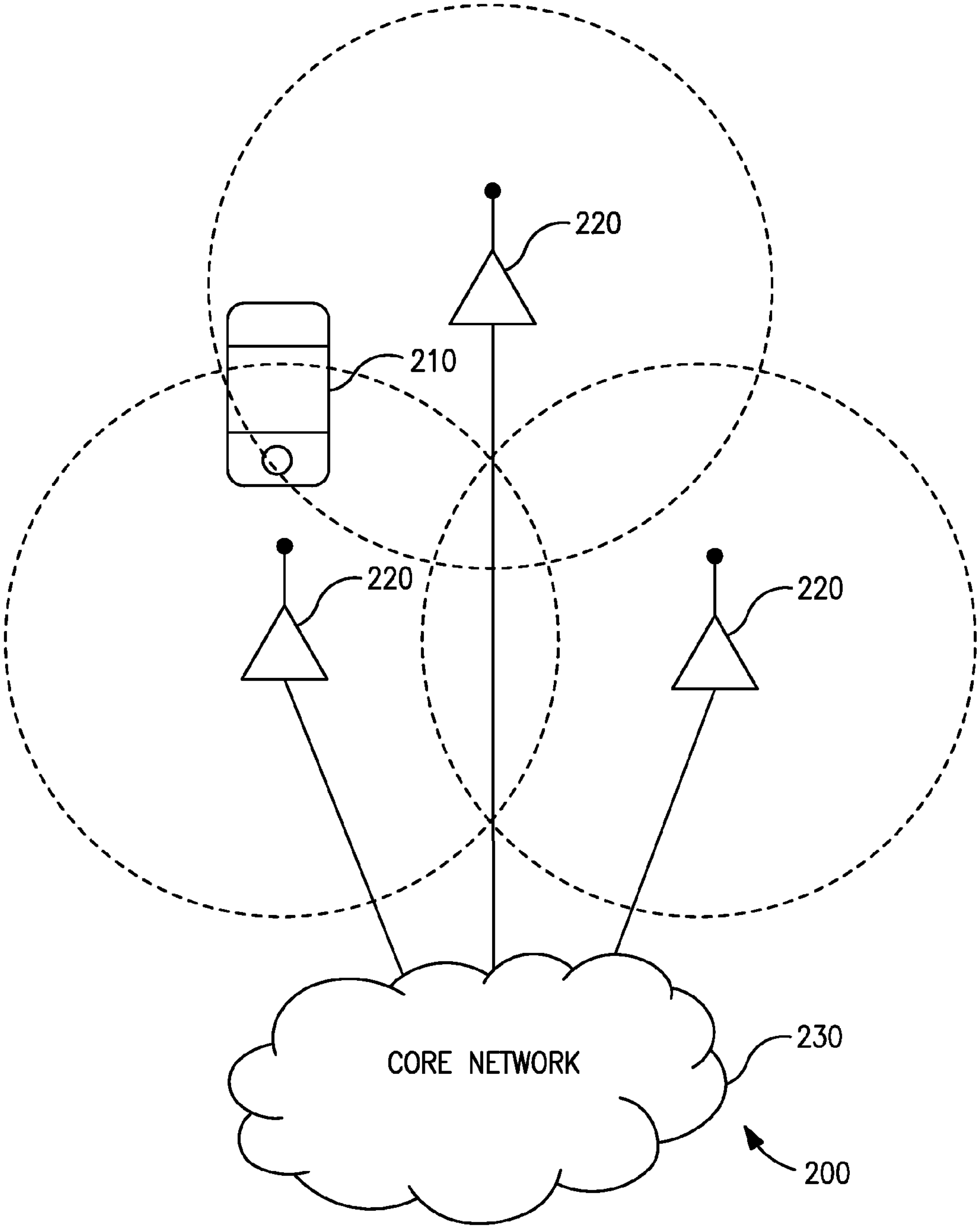


FIG. 2

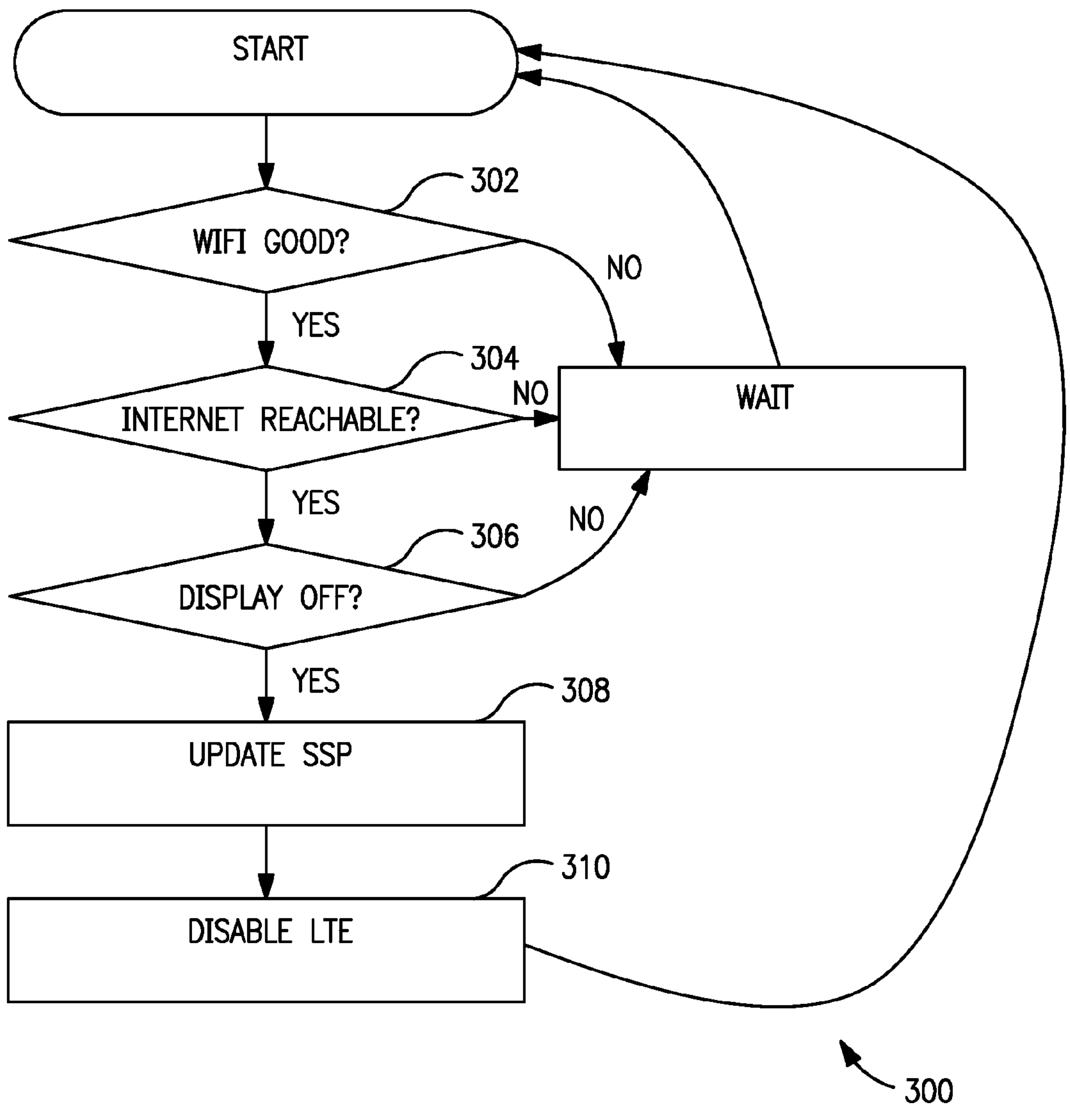

START
302
WIFI GOOD?
NO
YES
304
NO
INTERNET REACHABLE?
WAIT
YES
306
NO
DISPLAY OFF?
YES
308
UPDATE SSP
310
DISABLE LTE
300

FIG. 3

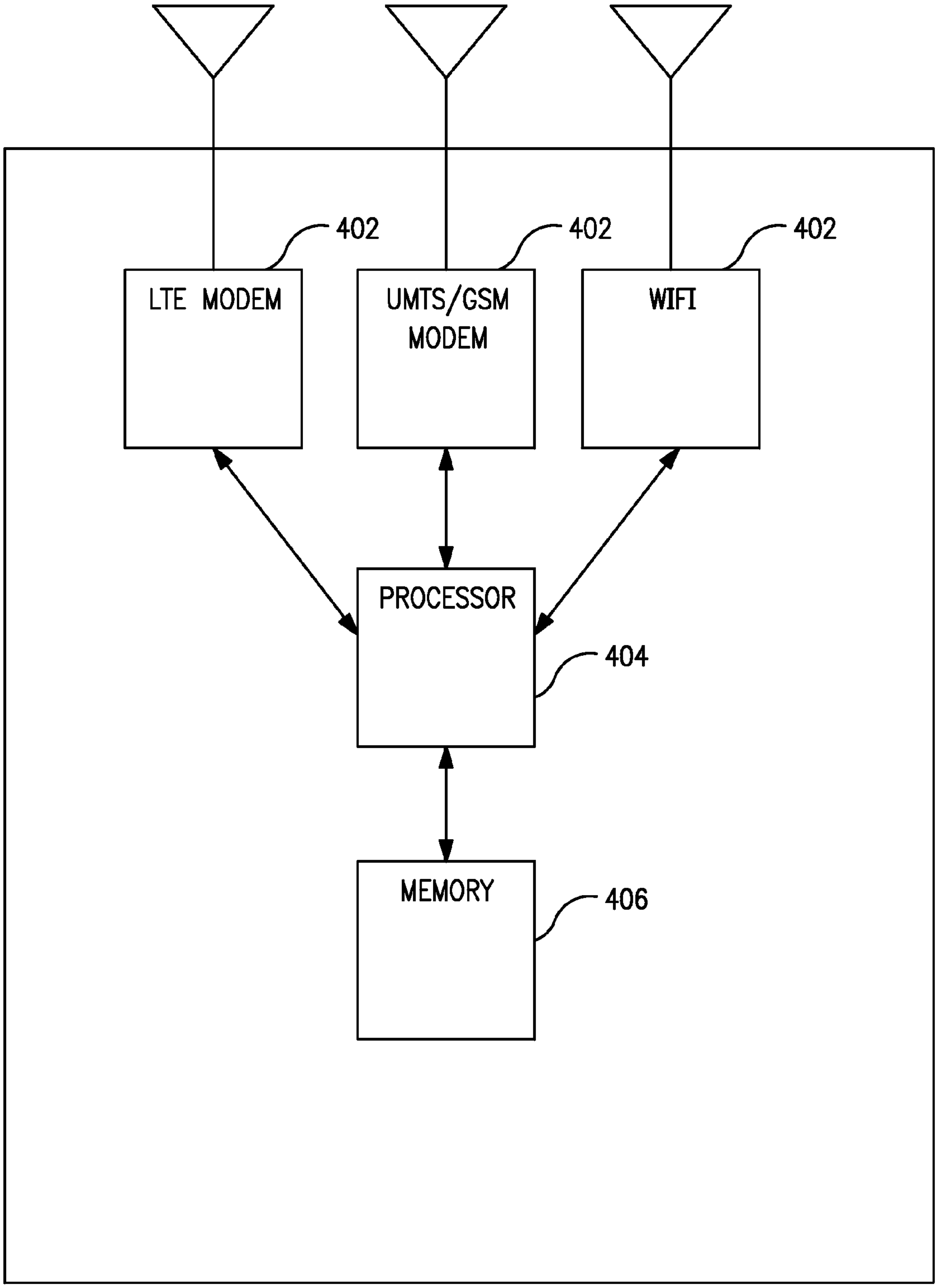

402
402
402
LTE MODEM
UMTS/GSM
MODEM
WIFI
PROCESSOR
404
MEMORY
406

FIG. 4

METHODS AND APPARATUS FOR INTELLIGENT WIRELESS TECHNOLOGY SELECTION

PRIORITY

[0001] This application claims priority to co-owned and co-pending U.S. provisional patent application Ser. No. 61/599,338 filed Feb. 15, 2012 of the same title, which is incorporated herein by reference in its entirety.

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BACKGROUND OF THE INVENTION

[0003] 1. Field of Invention

[0004] The present invention relates generally to the field of wireless communication, and data networks. More particularly, in one exemplary aspect, the invention is directed to methods and apparatus for intelligently selecting device wireless access technology based on e.g., prevailing device and network operating conditions.

[0005] 2. Description of Related Technology

[0006] Within telecommunications, devices having multiple air interfaces (e.g., 2G/3G, LTE/LTE-A) will seek to maximize the efficiency of the wireless network. Specifically, a cellular device will always use the available network with the highest speed. For example, a device that has a Global System for Mobile Communications (GSM) connection (2G) will always handover to a Universal Mobile Telecommunications System (UMTS) connection (3G) when possible. This behavior ensures that limited network resources are being most efficiently used.

[0007] Recent standards, such as the Long Term Evolution (LTE), LTE-Advanced (LTE-A) cellular standards provide very high data rates. However, LTE standards are data only; i.e., LTE does not natively handle voice traffic. As a brief aside, voice traffic is very sensitive to time delay (latency). Data only technologies (e.g., LTE, CDMA-1XDO, etc.) offer much faster data rates, but cannot guarantee latency requirements that would be required to support voice traffic. Consequently, many data-only technologies are paired with a voice-capable technology, specifically to handle voice calls. At all other times, the data-only technology is used, thereby at least ostensibly optimizing the overall network operation. However, in the case of call setup time, the foregoing approach is less than optimal, since a device "camped" on the data only (e.g., LTE) interface will need to hand over to the voice capable technology before setting up a voice call, thereby increasing latency and reducing overall user experience with the device.

[0008] Additionally, artisans of ordinary skill in the related arts will recognize that overall power consumption can have significant impact on user experience for mobile device consumers. Devices which consume less power can operate longer and have greater standby longevity; thus, metrics such as so-called "battery life", "standby time" and "talk time" are critical factors that consumers consider when purchasing new equipment.

SUMMARY OF THE INVENTION

[0009] The present invention provides, inter alia, improved apparatus and methods for intelligent selection and operation of radio area technologies within a mobile device.

[0010] In one aspect of the present invention, a mobile apparatus is disclosed. In one embodiment, the apparatus includes: a cellular wireless transceiver operable in at least first and second modes; a second wireless transceiver; a processor in signal communication with the cellular and second transceivers; and logic in communication with the processor. In one variant, the logic is configured to: determine if the second transceiver is operating; when it is determined that the second transceiver is operating, operate the cellular wireless transceiver in the first mode; and when it is determined that the second transceiver is not operating, operate the cellular wireless transceiver in the second mode. The operation of the cellular wireless transceiver in the first mode reduces call setup time as compared to operation in the second mode.

[0011] In another variant, the first mode comprises an idle mode of a code division multiple access (CDMA)-based wireless technology; the second mode comprises an idle mode of a Long Term Evolution (LTE)-based wireless technology; and the second interface comprises a wireless LAN (WLAN) interface.

[0012] In another embodiment, the apparatus includes: a first cellular wireless interface operable in at least first and second modes; a second cellular wireless interface operable in at least first and second modes; a local area wireless transceiver; a processor in signal communication with the first and second cellular interfaces and the local area transceiver; and logic in communication with the processor. In one variant, the logic is configured to: determine when the local area transceiver is in a designated state; and when it is determined that the local area transceiver is in the designated state, cause a transition from the first cellular interface operating in its first mode to the second cellular interface operating in its first mode. The transition reduces subsequent voice call setup time as compared to operation of the first cellular wireless interface in its first mode.

[0013] In yet another embodiment, the apparatus includes a first cellular wireless interface having at least an idle or standby mode; a second cellular wireless interface having at least an idle or standby modes; a third wireless interface having high-speed data capability; a processor in signal communication with the first and second cellular interfaces and the third interface; and logic in communication with the processor. In one variant, the logic is configured to: receive a communication from an external entity indicating that the third interface is at least connected; and based at least in part on said communication: (i) cause the second cellular interface to operate in its idle or standby mode and receive any voice call pages; and (ii) cause the first cellular interface to be temporarily disabled from receiving the any voice call pages.

[0014] In another aspect of the invention, a method of reducing voice call setup time in a mobile wireless device is disclosed. In one embodiment, the mobile device has at least first and second cellular radio access technologies and a non-cellular radio access technology, and the method includes selectively utilizing the second cellular access technology in place of the first when the non-cellular access technology is enabled. The second technology can receive indications of incoming voice calls, and can set up such calls via the second technology faster than said first cellular access technology can.

[0015] In a third aspect of the invention, a wireless system is disclosed. In one embodiment, the system includes at least one base station and at least one wireless mobile device. The mobile device is configured to implement reduced call setup time and enhanced user experience through "intelligent" operation of the cellular air interfaces.

[0016] In a fourth aspect of the invention, a computer readable apparatus is disclosed. In one embodiment, the apparatus includes a storage medium having a computer program disposed thereon, the program configured to, when executed, implement cellular interface management for enhanced call setup behavior on a mobile device (e.g., one with 4G and 3G interfaces, and WLAN).

[0017] In a fifth aspect of the invention, methods and apparatus for enhancing user experience of a mobile device are disclosed. In one embodiment, the user experience is enhanced through reduced latency in voice call setup operations. This is accomplished in one implementation by leveraging the aforementioned "intelligent" management of the radio access technologies of the device such that data (rate) requirements are met, yet voice call setup times are optimized through selective disabling of the high speed data interface when the latter is not required to meet the aforementioned requirements.

[0018] Other features and advantages of the present invention will immediately be recognized by persons of ordinary skill in the art with reference to the attached drawings and detailed description of exemplary embodiments as given below.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] FIG. **1** is a logical flow diagram depicting one embodiment of a generalized method for selectively operating radio access technologies of a mobile device in accordance with the present invention.

[0020] FIG. **2** is a logical block diagram illustrating one exemplary Long Term Evolution (LTE) cellular network useful with various aspects of the present invention.

[0021] FIG. **3** is a logical flow diagram illustrating one exemplary implementation of the generalized methodology of FIG. **1**, in the context of the LTE/LTE-A network of FIG. **2**.

[0022] FIG. **4** is a functional block diagram illustrating one embodiment of a mobile wireless user device in accordance with the present invention.

[0023]

DETAILED DESCRIPTION OF THE INVENTION

[0024] Reference is now made to the drawings, wherein like numerals refer to like parts throughout.

Overview—

[0025] In one salient aspect of the invention, methods and apparatus for intelligently selecting and operating one or more air interfaces (also known as radio access technologies or RATs) of a mobile wireless device for e.g., power optimization and/or enhanced call setup are disclosed. In one embodiment, operation of a high-speed cellular data interface is selectively adjusted or disabled when not required so as to minimize power consumption within the device, while not adversely impacting user experience. In one implementation, the wireless device includes the LTE/LTE-A high-speed cellular interface, a lower-speed 2G or 3G cellular interface, and a WLAN (e.g., Wi-Fi) interface. Depending on the status of the WLAN interface and other operational considerations such as mode of the device display, the high-speed interface is selectively disabled so as to mitigate unnecessary power consumption by that interface when its capacity is not required.

[0026] In one variant, the selection of radio access technology is conducted autonomously by the mobile device, without aid from the host cellular or WLAN network(s). In another variant, one or more of the networks participates in the selection process.

[0027] Various embodiments of the invention also improve voice call (e.g., Circuit Switched Fall Back or CFSB) setup time in certain scenarios. Existing mobile devices are configured to remain camped on LTE/LTE-A when not in use; this significantly lengthens call set-up time for voice calls (i.e., the mobile device must handover to a voice-capable technology, since LTE is a data-only technology). Thus, in one aspect of the present invention, the mobile device connects to the WLAN interface for data operations, but remains camped on a voice-capable network for voice data. By camping on a voice-capable network, the mobile device can quickly initiate a voice call while still maintaining the requisite level of data service.

Description of Exemplary Embodiments

[0028] Exemplary embodiments of the present invention are now described in detail. While these embodiments are primarily discussed in the context of cellular networks including without limitation, second generation (2G) and third generation (3G) Universal Mobile Telecommunications System (UMTS) wireless networks, Long Term Evolution (LTE/LTE-A) fourth generation (4G) wireless networks, and WLANs such as those compliant with IEEE Std. 802.11, it will be recognized by those of ordinary skill that the present invention is not so limited.

[0029] In fact, the various aspects of the invention are useful in and readily adapted to any wireless network (or combination thereof) that can benefit from intelligent management of air interface or RAT selection and operation, as described herein.

Methods—

[0030] FIG. **1** illustrates one embodiment of a generalized method **100** for selecting and managing RATs within a wireless mobile device according to the invention.

[0031] As shown in FIG. **1**, the method **100** starts by evaluating the status of an alternate high speed data link to that of the cellular data interface (step **102**). In one embodiment, the alternate link is a WLAN (e.g., Wi-Fi) interface of the mobile device, and the primary (cellular) link is the LTE interface. If the WLAN interface is determined to be available and in operation (discussed in greater detail below) per step **102**, then the method proceeds to step **104**, wherein the status of one or more operational parameters are evaluated. In one implementation, these other operational parameters include the status of the display device (e.g., touch screen device) of the mobile user device, and the presence of any background data transfers or operations within the device. Assuming that the display is not in use, and there are no background data transfers under way, the method then proceeds to step **106**, wherein the cellular data interface is temporarily disabled, and replaced instead with the high speed alternate data link. Additionally, in some embodiments, the device may preemptively handover to a voice-capable cellular connection (step **108**).

[0032] If the aforementioned checks of step **104** do not pass (e.g., the display is active), then the method proceeds to step **110**, wherein a wait period is invoked before the method is re-entered again at step **102** (or alternately, the method is placed in a wait state until it is triggered by an event, such as activity associated with the WLAN connection indicating that the WLAN has recently changed states, or as yet another alternative the display has entered a sleep or inactive mode). It will be appreciated from the foregoing that any number of different logical scenarios or criteria can be employed consistent with the invention in order to re-enter the method **100**.

[0033] In one exemplary embodiment, the foregoing determination is performed as part of a regular link evaluation. In some variants, the link evaluation may be performed on a periodic basis. In other common embodiments, link evaluation may be performed on an aperiodic basis; common examples of aperiodic schemes include, without limitation: opportunistically, event triggered, user triggered, application triggered, etc.

Example Operation—

[0034] In the following discussion, an exemplary cellular radio system is described that includes a network of radio cells each served by a transmitting station, known as a cell site or base station (BS). The radio network provides wireless communications service for a plurality of user equipment (UE) transceivers. The network of BSs working in collaboration allows for wireless service which is greater than the radio coverage provided by a single serving BS. The individual BSs are connected to a Core Network, which includes additional controllers for resource management and in some cases access to other network systems (such as the Internet, other cellular networks, etc.).

[0035] FIG. **2** illustrates one exemplary Long Term Evolution (LTE) cellular network **200**, with user equipment (UEs) **210**, operating within the coverage of the Radio Access Network (RAN) provided by a number of base stations (BSs) **220**. The LTE base stations are commonly referred to as "Evolved NodeBs" (eNBs). The Radio Access Network (RAN) is the collective body of eNBs along with the Radio Network Controllers (RNC). The user interfaces to the RAN via the UE, which in many typical usage cases is a cellular phone or smartphone. However, as used herein, the terms "UE", "client device", and "user device" may include, but are not limited to, cellular telephones, smartphones (such as for example an iPhone™ manufactured by the Assignee hereof), personal computers (PCs) and minicomputers, whether desktop, laptop, or otherwise, as well as mobile devices such as handheld computers, PDAs, personal media devices (PMDs), or any combinations of the foregoing.

[0036] Each of the eNBs **220** are directly coupled to the Core Network **230** e.g., via broadband access. Additionally, in some networks the eNBs may coordinate with one another, via secondary access. The Core Network provides both routing and service capabilities. For example, a first UE connected to a first eNB can communicate with a second UE connected to a second eNB, via routing through the Core Network. Similarly, a UE can access other types of services e.g., the Internet, via the Core Network.

[0037] Referring now to FIG. **3**, one particular variant of the method **100** (shown in FIG. **1** herein) is described in the exemplary context of the aforementioned LTE network of FIG. **2**. Specifically, in this case, the high-speed cellular interface (e.g., LTE or LTE-A) is temporarily disabled, and the device "camps" on the indigenous **3**G interface of the mobile UE in one of the following conditions: (i) an active association to a Wi-Fi access point (AP) exists (step **302**), and the Internet is reachable (step **304**); (ii) the mobile device display is off (not being utilized) (**306**), and no active data transfers are occurring in the background; and/or (iii) a blanket turn-off or other operation override is asserted with respect to the LTE/LTE-A interface (such as during a prescribed time period).

[0038] In one particular implementation, the active association with a Wi-Fi AP must minimally exceed a stability threshold i.e., a minimum length of time that the association has existed (so as to provide a hysteresis of sorts, and avoid inter alia a "ping pong" effect wherein the LTE interface is disabled, the Wi-Fi association then becomes disestablished or inoperative, and accordingly the LTE interface must be reestablished).

[0039] In addition, as referenced above, the availability or "reachability" of the Internet may be assessed to ensure that the mobile device can in fact access the Internet via the WLAN association. Reachability can be tested in any number of different ways, such as by probing one or more IP addresses, registering to a known domain, etc. For example, a mobile device may be required to indicate its IP address to the core network, such that the core network can route data accordingly (i.e., the mobile device's pushed data can be routed via an IP address).

[0040] Moreover, the received Wi-Fi signal strength and/or other channel parameter(s) can be evaluated. In one such scheme, fuzzy, deterministic, or other variables are specified (e.g., "good", "moderate", and "poor" thresholds or criteria), and these thresholds may also be user- or device-configurable e.g., via a Graphical User Interface (GUI), or via logic present within the mobile device). For instance, in one implementation, a Wi-Fi signal strength (e.g., Received Signal Strength Indication (RSSI) of a measured Wi-Fi beacon) value above a designated threshold ("good") for a prescribed period of time (e.g., G_Timer) will enable the Wi-Fi interface. Similarly, an RSSI value below a separate designated threshold ("moderate") for another period of time (e.g., M_timer) will enable the LTE link. By adjusting the appropriate timers and threshold values, the mobile device can associate with Wi-Fi APs easily (low RSSI "good" threshold for a short duration) or only during very good reception (high RSSI "good" threshold for a long duration), and switch frequently (high RSSI "moderate" threshold) or less frequently (low RSSI "moderate" threshold).

[0041] Moreover, with respect to the display activity and/or background data transfers, a hysteresis may be applied as well, such that the display must be off for a predetermined time, and/or data transfers must have ceased for a predetermined period of time, before the LTE interface will be disabled.

[0042] The foregoing "hysteresis" functions, while effective at mitigating deleterious effects on user experience resulting from the device logic "jumping" back and forth between LTE-enabled and LTE-not enabled modes, may also be applied based on criteria other than time (or in combination with temporal considerations). For example, the hysteresis may be event-driven, such as where the occurrence of an event once a particular state has been entered can be used as the basis for allowing the LTE-disable logic described above to proceed. In one such example, the Wi-Fi interface, once verified to be associated with an AP, may be required to transmit or receive a certain volume of data (or at a certain rate) before it is deemed to be "active" for purposes of the LTE enable/disable logic. As another example, a prescribed number of probes must be successfully sent and responded to before the LTE-disable function is enabled. As yet another example, an accelerometer within the device (if so equipped) must indicate no motion of the device (thereby ostensibly indicating no user interaction with the device), or a prescribed pattern of movement (e.g., consistent with a user walking with the device in their bag or pocket) before the logic is enabled.

[0043] It will also be appreciated that other aspects of the operation or use of the mobile device can be considered. For instance, in one alternate implementation, the presence or absence of an internally or externally generated "keep awake" or other signal or message (from e.g., other supervisory logic within the mobile device, or from the host LTE network infrastructure) is considered in determining whether to disable the LTE interface. In one such case, the core network may instruct the mobile device to a particular technology based on a so-called NSET signal. For example, the core network may force a UE to camp on a UMTS network, even where an LTE network may exist.

[0044] Furthermore, it is further appreciated that various modifications of the foregoing aspects may implement a wide range of considerations, including without limitation: signaling load, latencies due to RAT switching, IP continuity (i.e., during the switching process the device may not have continuous IP access), etc. Other factors or considerations in implementing the logic or "intelligence" of the invention include for example and without limitation: (i) whether or not the mobile device is connected to an external power supply, such as a wired or wireless battery charger; (ii) when no 2G or 3G is present (thereby effectively providing the device with no LTE alternative); (iii) when no 3G is present, but 2G is available (or vice versa); (iv) when the 2G/3G system is "roaming" (roaming subscriber costs may be considered); (v) the presence or availability of signal strength indications (e.g., signal bars) and technology indicators (banners) on the mobile device GUI.

[0045] While the foregoing discussion has been described a particular family of interrelated technologies (e.g., GSM (2G), WCDMA(3G), LTE(4G)); it is further appreciated that various aspects of the present invention are equally applicable to other technology families such as e.g., CDMA 1×, CDMA 1× EV-DO, LTE; GSM, eHRPD, and LTE (GHL), WiMAX (802.16), etc.

[0046] Moreover, it should be further noted that whereas the foregoing technology families are likely implementations, the aforementioned relationship between technologies is merely incidental, and not required for practice thereof.

[0047] Additionally, it is appreciated that in certain operational contexts, IP continuity can be maintained even while the device transitions between RATs; for example, IP continuity can be maintained for: (i) GSM, WCDMA, and LTE (GWL); and (ii) GSM, eHRPD, and LTE (GHL). Specifically, the core network can ensure that IP transactions are not interrupted even where the underlying RAT is changing.

[0048] Accordingly, in one salient aspect of the invention, the radio access technology RAT) is intelligently selected by the mobile device (or in alternate embodiments, a network entity) so as optimize power consumption and hence battery performance (including standby time) within the mobile device (step **308**). The present invention is particularly useful in LTE devices, which consume significant amounts of electrical power by substantially always maintaining their baseband connected to the serving network, even when not required for high speed data transfers (for example, when an alternative data network such as Wi-Fi is available).

[0049] For example, consider devices that automatically implement a system selection preference (SSP) of GSM, WCDMA, LTE (abbreviated GWL) or GSM, eHRPD, LTE (abbreviated GHL). During operation, the device will select the highest speed RAT available to them, unless the network operator specifies otherwise (where the network operator controls one or more of the available RATs). Thus, a GWL device will automatically camp on the LTE network, if the LTE network is available. Unfortunately, while the application processor is asleep, the cellular baseband processor may still be registered to the host LTE network, even though the data connection is dormant or disconnected. Moreover, since the device is still "camped" on the LTE network, the LTE modem must periodically wake up to perform measurements, etc. This periodic wake up consumes appreciable amounts of electrical power in the mobile device. Finally, since LTE is a data-only technology, any voice call (received or initiated) requires the mobile device to handover to a voice-capable network.

[0050] Currently, device users only have gross control of LTE SSP (e.g., via an "Enable LTE" switch); however, this is essentially an "all or nothing" proposition, and does not account for myriad different operating conditions or scenarios. Accordingly, users must actively elect to increase power consumption and LTE link availability; the device does cannot perform this autonomously. Therefore, in one exemplary aspect of the invention, the LTE interface is disabled when high-speed data transfer (e.g., data rates that would necessitate use of the LTE air interface) is not necessary, or alternatively when such high data rates are achievable over another air interface such as a Wi-Fi or WiMAX interface of the mobile device (step **310**).

[0051] In one embodiment, a supervisory process (e.g., a "communication center" logic) will change system selection preferences according to a prescribed set of operating rules designed to optimize device power consumption while not significantly detracting from user experience or other operational attributes. For example, in one embodiment, the system selection logic is modified under a number of different operational scenarios, including: (i) when the application processor is awake and Wi-Fi is the primary network route; and (ii) before the application processor enters into low power mode. In one such embodiment, the supervisory process may further update the system selection preference (SSP) to allow LTE interface operation in cases such as when: (i) the display of the mobile device is unlocked after leaving low power mode; and/or (ii) if association with a Wi-Fi access point is lost for whatever reason.

WLAN/Cellular Co-Existence—

[0052] Currently, when Wi-Fi is the primary network route on the mobile device, the device baseband is still operating in a "data attached" state to the cellular network. Specifically, if a service requiring the interface (e.g., so-called "push" services) is active, (or is mandated for certain carriers/service providers) a cellular data connection is kept active through a data assertion. In particular, the system selection preference (SSP) will select the highest data capable network, such as LTE, which can consume significant amounts of power for link maintenance.

[0053] However, during such operation (i.e., when the user is not actively using the data connection), only low-throughput traffic will be used (e.g., push notifications). Consequently, the mobile device will remain in LTE, despite the relatively low data rate, and significantly higher power consumption (than alternative RATs). Technologies which are limited to lower data rates (such as those afforded by legacy 2G/3G cellular systems) are more than sufficient to service the required throughput of the device, whereas a Wi-Fi interface is available to the device for high data rate operations.

[0054] Accordingly, under various embodiments of the invention, after the mobile device associates with a WLAN access point or node (e.g., Wi-Fi AP), and the desired level of connectivity is verified to be available (e.g., access to the Internet is truly reachable as verified via a network probe or other such mechanism), the system selection preference (SSP) is set to disable the comparatively higher consumption high speed cellular interface (e.g., SSP is set to GW or GH, thereby removing LTE).

[0055] In one implementation, the device logic periodically or continuously monitors the availability of the WLAN interface (such as using the aforementioned probe technique). When availability of the WLAN interface is lost (or the Internet is no longer reachable), the device logic changes the SSP to re-enable the high speed cellular link (e.g., to GWL or GHL, thereby adding LTE).

[0056] In one exemplary embodiment of the present invention, a supervisory entity (such as a "communication center" or "CommCenter") monitors low-power mode (LPM) entry/exit, and display transitions (e.g., the display element powering on or off). In one variant, the supervisory entity limits baseband processor activity (e.g., reduces or disables wake up functionality for non-essential notifications) while the application processor is asleep; additionally serving system indications (e.g., notifications received from the core network) will not automatically wake the application processor.

[0057] In one embodiment of the current invention, an application processor entering low power mode (LPM) triggers the SSP preference to be set to a lower power cellular mode (e.g., 3G). In one such variant, the change in SSP preference does not interfere with so-called "dormancy" requests. Specifically, dormancy allows logical packet switched (PS) service to the network without a physical link (the physical link is taken down by the network to save network resources, but the device still maintains the device state as if there is a data connection), consequently re-establishing the physical link can be made much faster than starting a new session. Furthermore, in one variant, the application processor is further configured to ignore non-essential wake up events. For example, the application processor can be configured to ignore serving system signaling (e.g., QMI_NAS_SERVING_SYSTEM_IND) while in LPM.

[0058] In various embodiments of the invention, an application processor exiting low power mode (LPM) does not necessarily need to reset the SSP (e.g., re-enable LTE) to allow high speed data operation. For instance, if the device display never turns on, it is likely that only low-throughput data is required. Similarly, if the display is never unlocked, it is highly unlikely to have any high-speed data requests (certain real time data applications may be exceptions (e.g., video calls, etc.)). Finally, it is further appreciated that where the device is associated to a Wi-Fi access point, there is no need for high speed data service to be provided over the cellular data interface.

[0059] Finally, responsive to (i) the application processor being woken, (ii) the screen being unlocked or turned on, and/or (iii) a loss of Wi-Fi capability, the supervisory entity can restore the SSP to include high speed data services (re-enabling LTE) in order to provide high speed data capability. Moreover, it is further appreciated, that certain conditions, may not necessitate a change to SSP. For example, if the device is woken up and the screen unlock was merely to accept a mobile device voice call; the SSP rules may be left unchanged. For example, the supervisory entity may further assess usage (e.g., voice calls) before changing the SSP.

[0060] Apparatus—

[0061] Referring now to FIG. **4**, an exemplary user device **400** for intelligently selecting device wireless access technology based on e.g., prevailing device and network operating conditions is illustrated. As used herein, the term "user device" includes, but is not limited to cellular telephones, smartphones (such as for example an iPhone™) wireless-enabled tablet devices (such as for example an iPad™), or any combinations of the foregoing. While one specific device configuration and layout is shown and discussed herein, it is recognized that many other configurations may be readily implemented by one of ordinary skill given the present disclosure, the apparatus **400** of FIG. **4** being merely illustrative of the broader principles of the invention.

[0062] The apparatus **400** of FIG. **4** includes one or more transceivers **402**, a processor **404** and a computer readable memory **406**.

[0063] The processing subsystem **404** includes one or more of central processing units (CPU) or digital processors, such as a microprocessor, digital signal processor, field-programmable gate array, RISC core, or plurality of processing components mounted on one or more substrates. The baseband processing subsystem is coupled to computer readable memory **406**, which may include for example SRAM, FLASH, SDRAM, and/or HDD (Hard Disk Drive) components. As used herein, the term "memory" includes any type of integrated circuit or other storage device adapted for storing digital data including, without limitation, ROM. PROM, EEPROM, DRAM, SDRAM, DDR/2 SDRAM, EDO/FPMS, RLDRAM, SRAM, "flash" memory (e.g., NAND/NOR), and PSRAM. The processing subsystem may also comprise additional co-processors, such as a dedicated graphics accelerator, network processor (NP), or audio/video processor. As shown processing subsystem **404** includes discrete components; however, it is understood that in some embodiments they may be consolidated or fashioned in a SoC (system-on-chip) configuration.

[0064] The processing subsystem **404** is adapted to receive one or more data streams from the one or more transceivers **402**. The processing subsystem also includes logic (as described above) for implementing selective enabling/disabling of the one or more radio transceivers in accordance with the methods describe above. In one variant, this logic is implemented in software adapted to run on the processing subsystem, although it will be appreciated that hardware or firmware (or any combinations of the foregoing) may be used with equal success consistent with the invention.

[0065] Myriad other schemes for intelligently selecting device wireless access technology will be recognized by those of ordinary skill given the present disclosure.

[0066] It will be recognized that while certain aspects of the invention are described in terms of a specific sequence of steps of a method, these descriptions are only illustrative of the broader methods of the invention, and may be modified as required by the particular application. Certain steps may be rendered unnecessary or optional under certain circumstances. Additionally, certain steps or functionality may be added to the disclosed embodiments, or the order of performance of two or more steps permuted. All such variations are considered to be encompassed within the invention disclosed and claimed herein.

[0067] While the above detailed description has shown, described, and pointed out novel features of the invention as applied to various embodiments, it will be understood that various omissions, substitutions, and changes in the form and details of the device or process illustrated may be made by those skilled in the art without departing from the invention. The foregoing description is of the best mode presently contemplated of carrying out the invention. This description is in no way meant to be limiting, but rather should be taken as illustrative of the general principles of the invention. The scope of the invention should be determined with reference to the claims

What is claimed is:

1. Mobile apparatus, comprising:

a cellular wireless transceiver operable in at least first and second modes;

a second wireless transceiver;

a processor in signal communication with the cellular and second transceivers; and

logic in communication with the processor and configured to:

determine if the second transceiver is operating;

when it is determined that the second transceiver is operating, operate the cellular wireless transceiver in the first mode; and

when it is determined that the second transceiver is not operating, operate the cellular wireless transceiver in the second mode;

wherein the operation of the cellular wireless transceiver in the first mode reduces call setup time as compared to operation in the second mode.

2. The apparatus of claim **1**, wherein the first mode comprises an idle mode of a code division multiple access (CDMA)-based wireless technology.

3. The apparatus of claim **1**, wherein the second mode comprises an idle mode of a Long Term Evolution (LTE)-based wireless technology.

4. The apparatus of claim **1**, wherein the second mode comprises an idle mode of a cellular wireless technology that is primarily utilized to provide high-speed data access for the mobile device.

5. The apparatus of claim **1**, wherein:

the first mode comprises an idle mode of a code division multiple access (CDMA)-based wireless technology;

the second mode comprises an idle mode of a Long Term Evolution (LTE)-based wireless technology; and

the second interface comprises a wireless LAN (WLAN) interface.

6. Mobile wireless apparatus, comprising:

a first cellular wireless interface operable in at least first and second modes;

a second cellular wireless interface operable in at least first and second modes;

a local area wireless transceiver;

a processor in signal communication with the first and second cellular interfaces and the local area transceiver; and

logic in communication with the processor and configured to:

determine when the local area transceiver is in a designated state; and

when it is determined that the local area transceiver is in the designated state, cause a transition from the first cellular interface operating in its first mode to the second cellular interface operating in its first mode;

wherein the transition reduces subsequent voice call setup time as compared to operation of the first cellular wireless interface in its first mode.

7. The apparatus of claim **6**, wherein the first mode and second mode of the first cellular interface comprise (i) an idle or standby mode; and (ii) an active or connected mode, respectively.

8. The apparatus of claim **7**, wherein:

the first cellular interface comprises a Long Term Evolution (LTE)-based wireless technology;

the second cellular interface comprises a code division multiple access (CDMA)-based wireless technology; and

the local area interface comprises a wireless LAN (WLAN) interface compliant with an IEEE-Std. 802.11 standard.

9. The apparatus of claim **7**, wherein the logic is configured such that the determination and causation of the transition are performed proactively upon the designated state being achieved.

10. The apparatus of claim **6**, wherein the designated state comprises association of the mobile apparatus via the local area interface to a base station or access point, and the logic is configured such that the causation of the transition is performed upon the designated state being achieved.

11. Mobile wireless apparatus, comprising:

a first cellular wireless interface having at least an idle or standby mode;

a second cellular wireless interface having at least an idle or standby modes;

a third wireless interface having high-speed data capability;

a processor in signal communication with the first and second cellular interfaces and the third interface; and

logic in communication with the processor and configured to:

receive a communication from an external entity indicating that the third interface is at least connected; and

based at least in part on said communication:

(i) cause the second cellular interface to operate in its idle or standby mode and receive any voice call pages; and

(ii) cause the first cellular interface to be temporarily disabled from receiving the any voice call pages.

12. The apparatus of claim **11**, wherein the communication is received by the apparatus via the third interface.

13. The apparatus of claim **11**, wherein the communication from an external entity indicating that the third interface is at least connected further includes information indicating that the third interface connection is operating at least to a prescribed level.

14. A method of reducing voice call setup time in a mobile wireless device having at least first and second cellular radio access technologies and a non-cellular radio access technology, the method comprising:

selectively utilizing the second cellular access technology in place of the first when the non-cellular access technology is enabled;

wherein the second technology can receive indications of incoming voice calls, and can set up such calls via the second technology faster than said first cellular access technology can.

15. The method of claim **14**, wherein the selectively utilizing comprises using the second cellular access technology in an idle mode.

16. The method of claim **15**, wherein:

the second cellular technology comprises a code division multiple access (CDMA)-based wireless technology;

the first cellular interface comprises a Long Term Evolution (LTE)-based wireless technology; and

the local area interface comprises a wireless LAN (WLAN) interface compliant with an IEEE-Std. 802.11 standard.

17. The method of claim **14**, further comprising reverting to use of said first cellular interface from said second access technology at least during periods when said non-cellular technology is not enabled.

18. The method of claim **14**, wherein the selectively utilizing comprises informing a network entity that said non-cellular access technology is enabled.

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