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Potkonjak

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(54) **USER PROFILE-BASED WIRELESS DEVICE SYSTEM LEVEL MANAGEMENT**

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G06F 9/50 (2006.01)
(Continued)

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

(58) **Field of Classification Search**
CPC H04L 67/22
(Continued)

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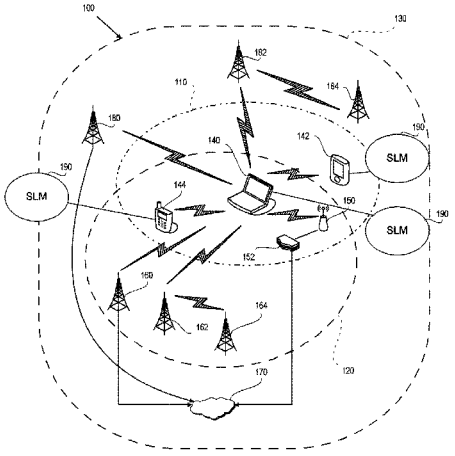
(57) **ABSTRACT**

Techniques for user profile-based system level management (SLM) and creation of system level agreements of a wireless device are generally disclosed. In some examples, a predictor may be provided to predict a future task to be performed by a wireless device, including resource requirements, based at least in part on a profile of a user and at least one of a profile of a communication partner of the user, an operational recommendation, a performance model or a current state. An optimizer/analyzer may be provided to generate a plurality of instructions to configure the wireless device, based at least in part on the predicted future task and resource requirement, and a quality of service requirement of the wireless device, in anticipation of having to perform the predicted task. In various examples, the predictor and the
(Continued)



optimizer/analyzer may form a local or a remotely disposed system level manager.

20 Claims, 10 Drawing Sheets

Related U.S. Application Data

continuation of application No. 12/433,700, filed on Apr. 30, 2009, now Pat. No. 8,667,109.

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H04W 8/24	(2009.01)
H04W 28/24	(2009.01)
H04W 72/00	(2009.01)
H04L 29/08	(2006.01)
H04W 24/00	(2009.01)

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

CPC ***H04L 67/306*** (2013.01); ***H04L 67/34*** (2013.01); ***H04W 8/18*** (2013.01); ***H04W 8/245*** (2013.01); ***H04W 28/24*** (2013.01); ***H04W 72/00*** (2013.01); *H04W 24/00* (2013.01)

(58) **Field of Classification Search**

USPC 709/203, 217, 219, 220, 223, 224

See application file for complete search history.

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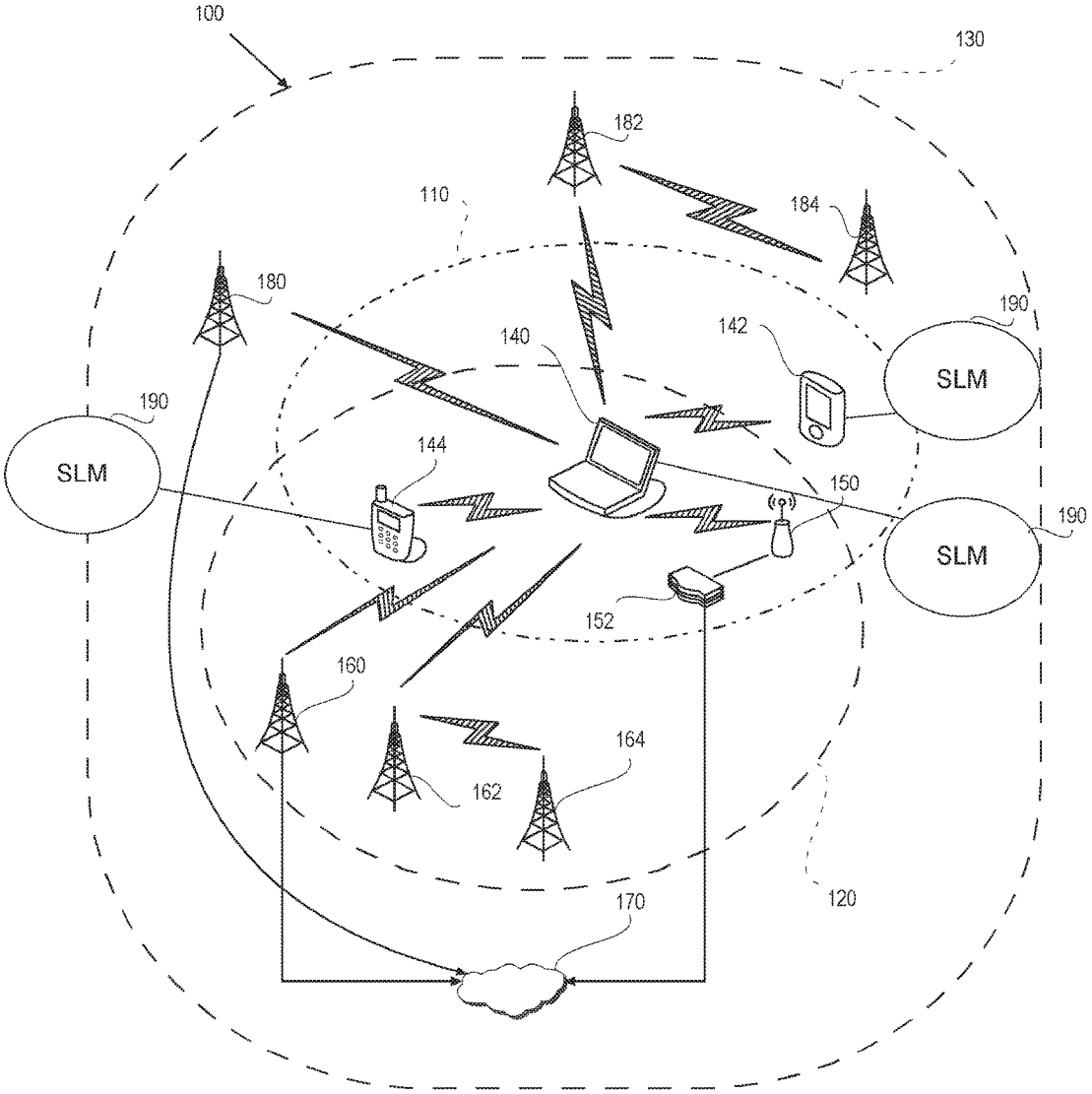
100
130
182
110
184
180
190
140
142
SLM
190
144
SLM
150
190
SLM
152
160
164
162
120
170

Figure 1

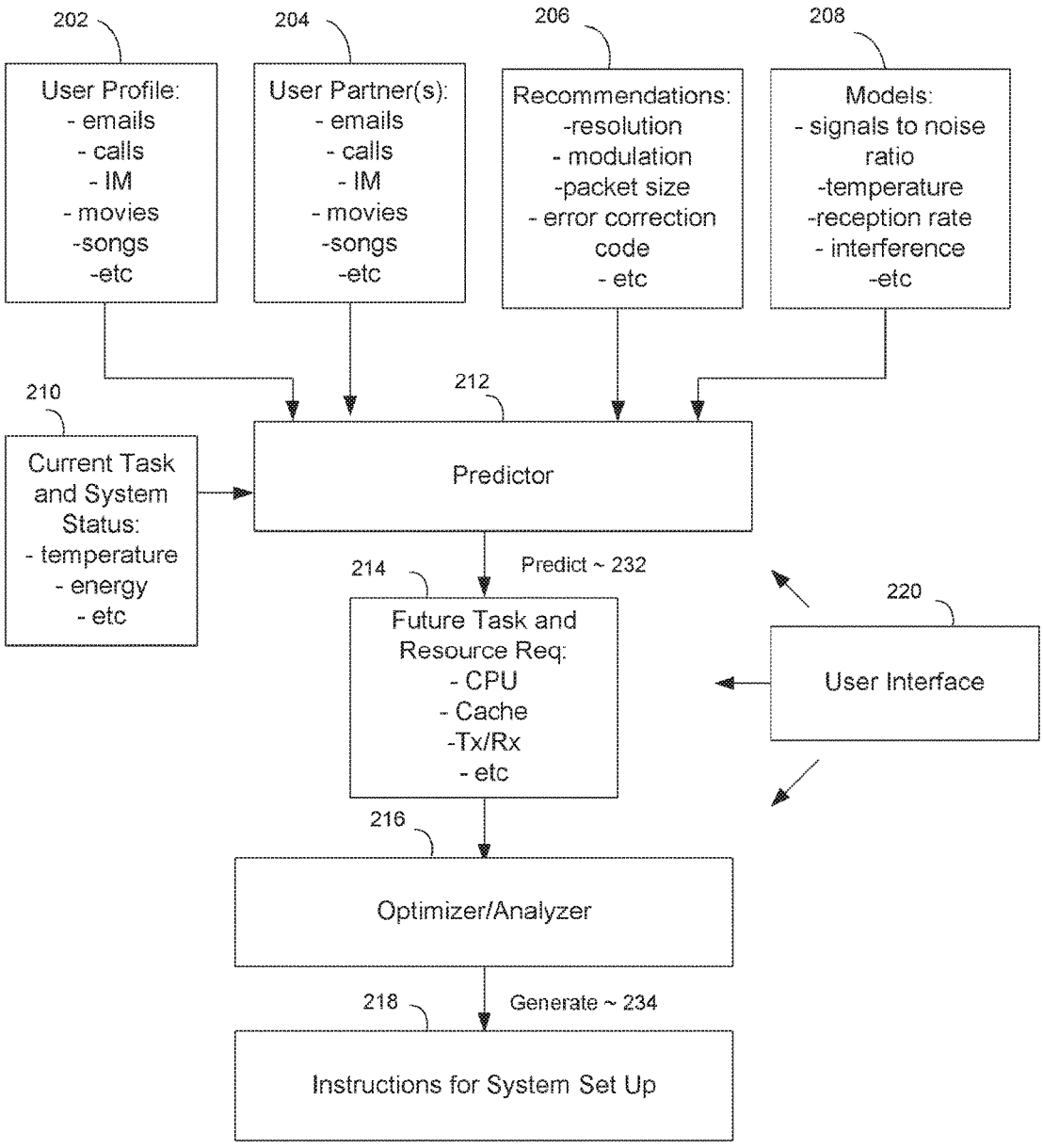
202
User Profile:
- emails
- calls
- IM
- movies
-songs
-etc
204
User Partner(s):
- emails
- calls
- IM
- movies
-songs
-etc
206
Recommendations:
-resolution
- modulation
-packet size
- error correction code
- etc
208
Models:
- signals to noise ratio
-temperature
-reception rate
- interference
-etc
210
Current Task and System Status:
- temperature
- energy
- etc
212
Predictor
214
Predict ~ 232
Future Task and Resource Req:
- CPU
- Cache
-Tx/Rx
- etc
220
User Interface
216
Optimizer/Analyzer
218
Generate ~ 234
Instructions for System Set Up

Figure 2

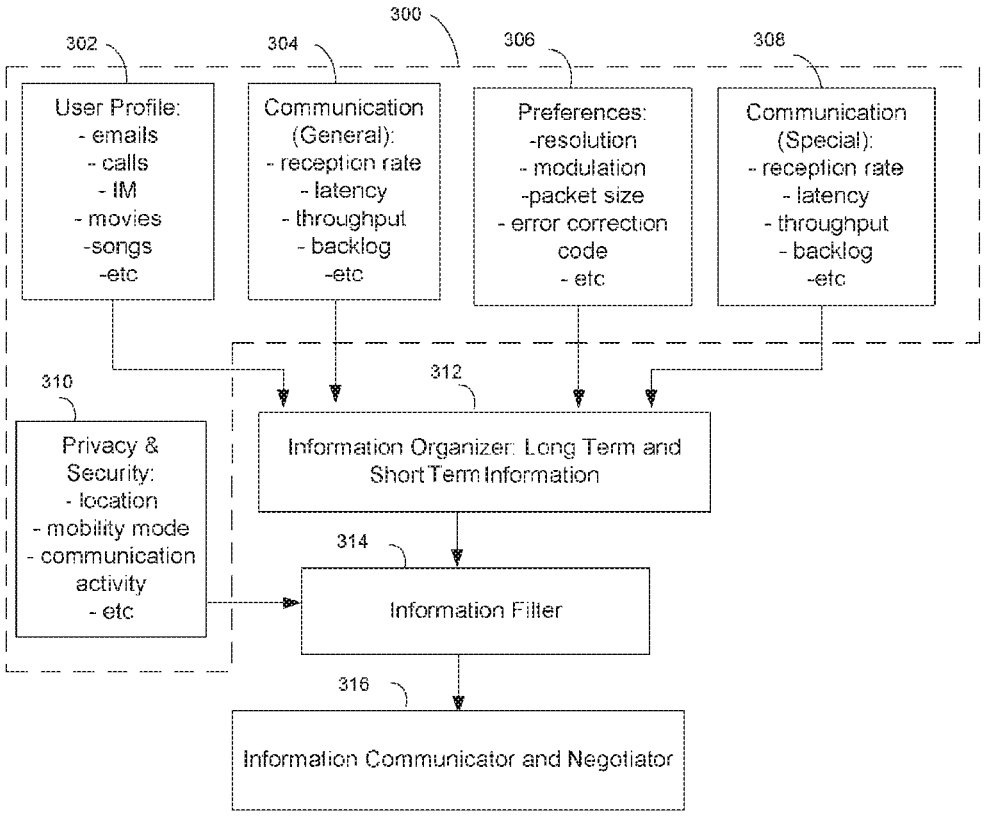
300
302
304
306
308
User Profile:
- emails
- calls
- IM
- movies
-songs
-etc
Communication (General):
- reception rate
- latency
- throughput
- backlog
-etc
Preferences:
-resolution
- modulation
-packet size
- error correction code
- etc
Communication (Special):
- reception rate
- latency
- throughput
- backlog
-etc
310
312
Privacy & Security:
- location
- mobility mode
- communication activity
- etc
Information Organizer: Long Term and Short Term Information
314
Information Filter
316
Information Communicator and Negotiator

Figure 3

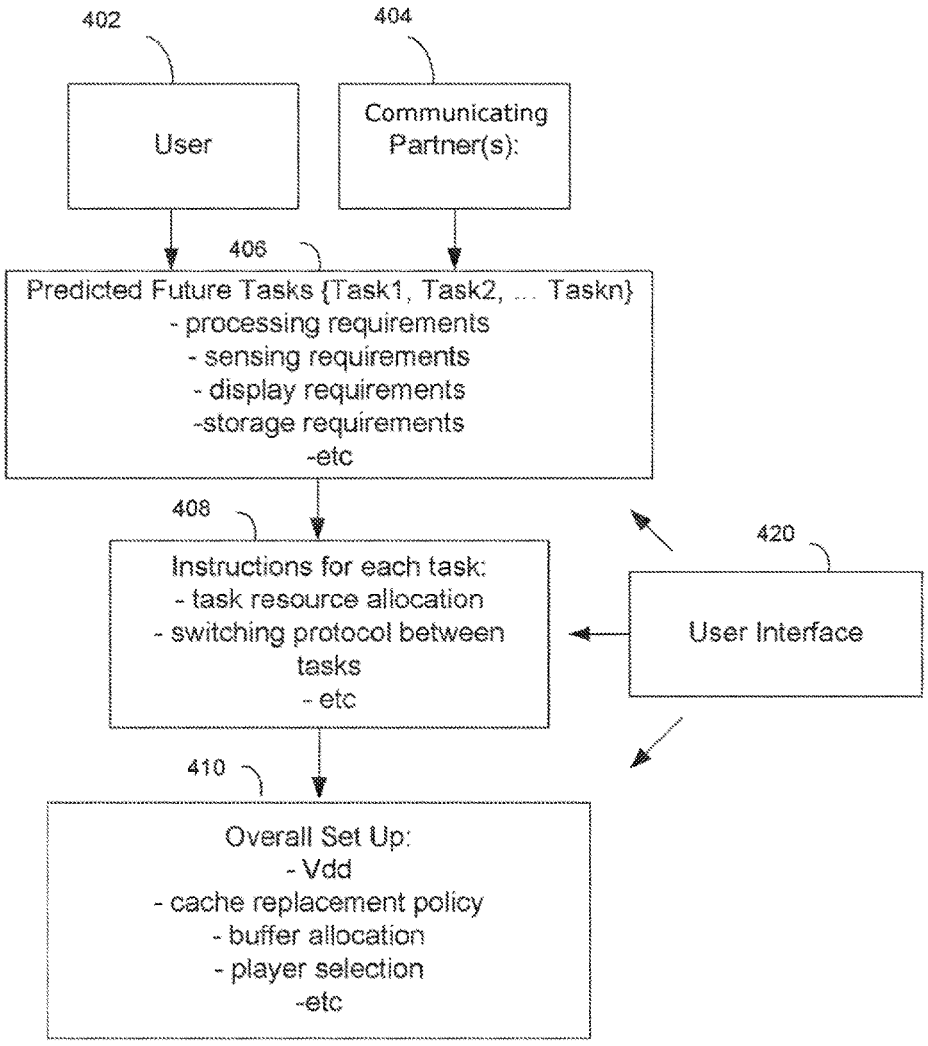
402
404
User
Communicating Partner(s):
406
Predicted Future Tasks {Task1, Task2, ... Taskn}
- processing requirements
- sensing requirements
- display requirements
-storage requirements
-etc
408
Instructions for each task:
- task resource allocation
- switching protocol between tasks
- etc
420
User Interface
410
Overall Set Up:
- Vdd
- cache replacement policy
- buffer allocation
- player selection
-etc

Figure 4

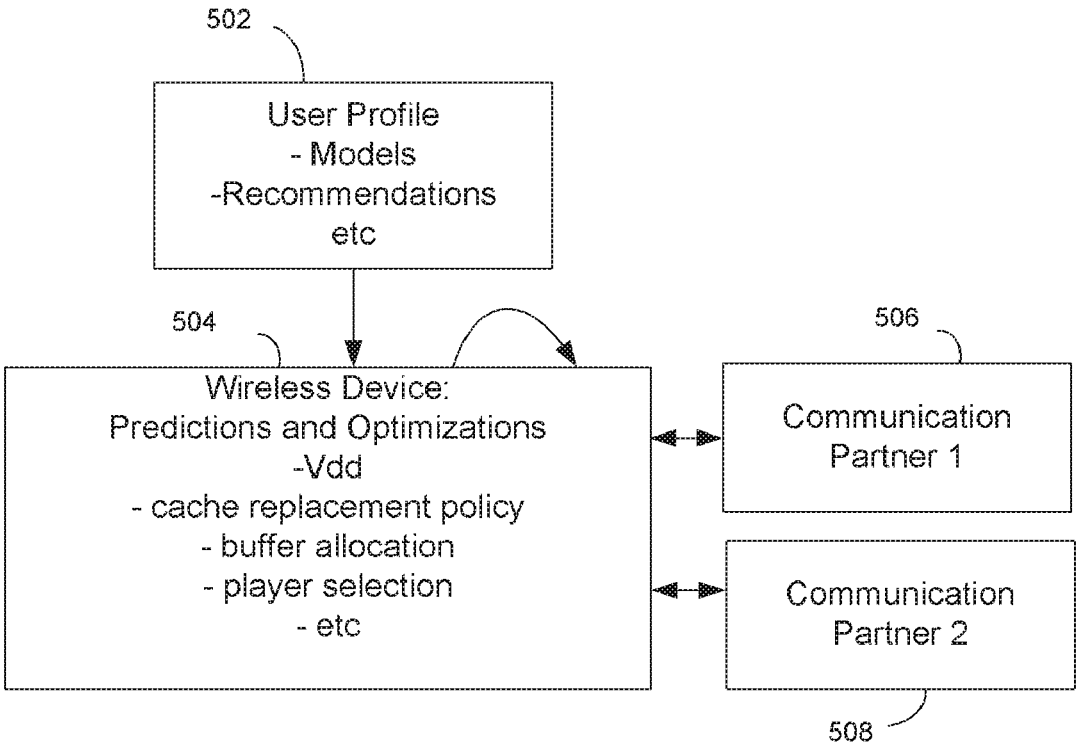
502
User Profile
- Models
-Recommendations
etc
504
Wireless Device:
Predictions and Optimizations
-Vdd
- cache replacement policy
- buffer allocation
- player selection
- etc
506
Communication Partner 1
Communication Partner 2
508

Figure 5

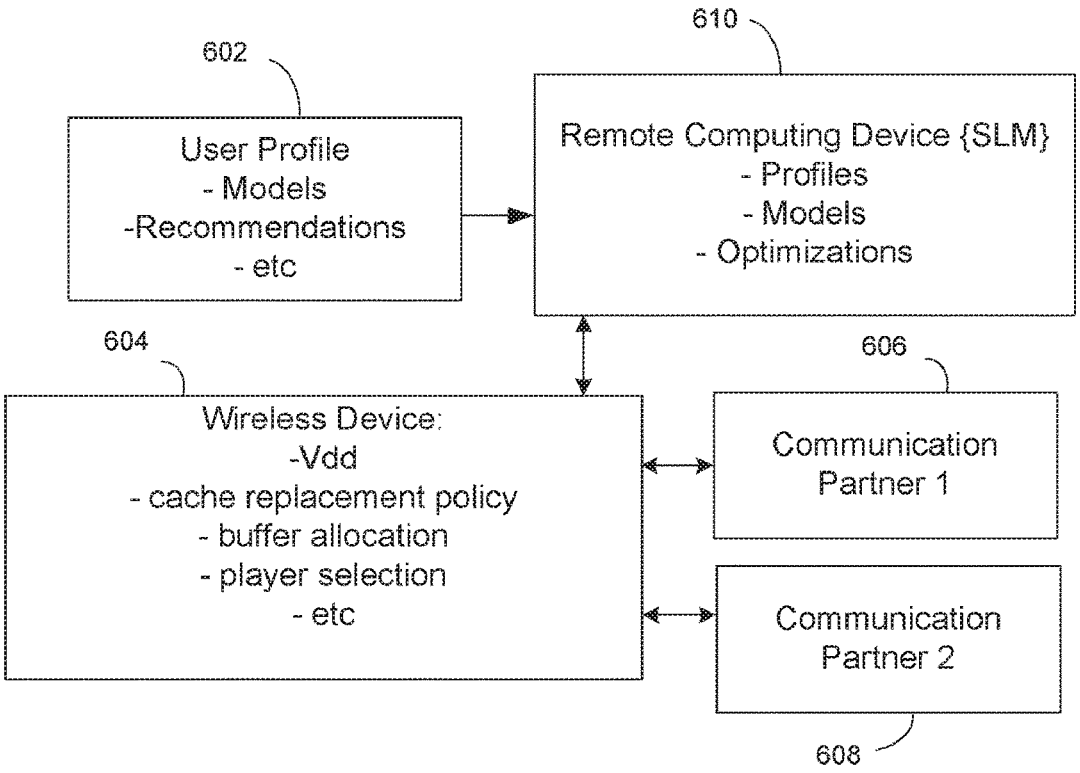
602
User Profile
- Models
-Recommendations
- etc
610
Remote Computing Device {SLM}
- Profiles
- Models
- Optimizations
604
Wireless Device:
-Vdd
- cache replacement policy
- buffer allocation
- player selection
- etc
606
Communication Partner 1
Communication Partner 2
608

Figure 6

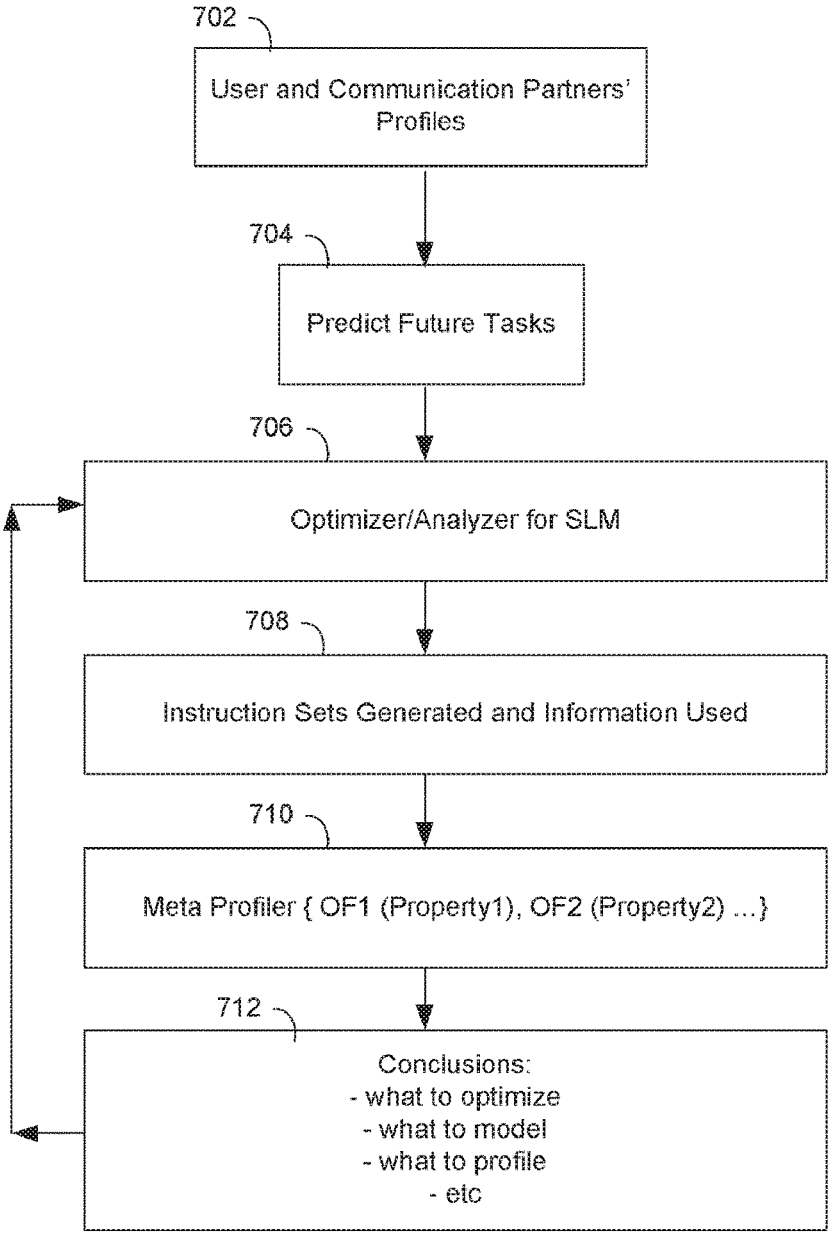
702
User and Communication Partners' Profiles
704
Predict Future Tasks
706
Optimizer/Analyzer for SLM
708
Instruction Sets Generated and Information Used
710
Meta Profiler { OF1 (Property1), OF2 (Property2) ...}
712
Conclusions:
- what to optimize
- what to model
- what to profile
- etc

Figure 7

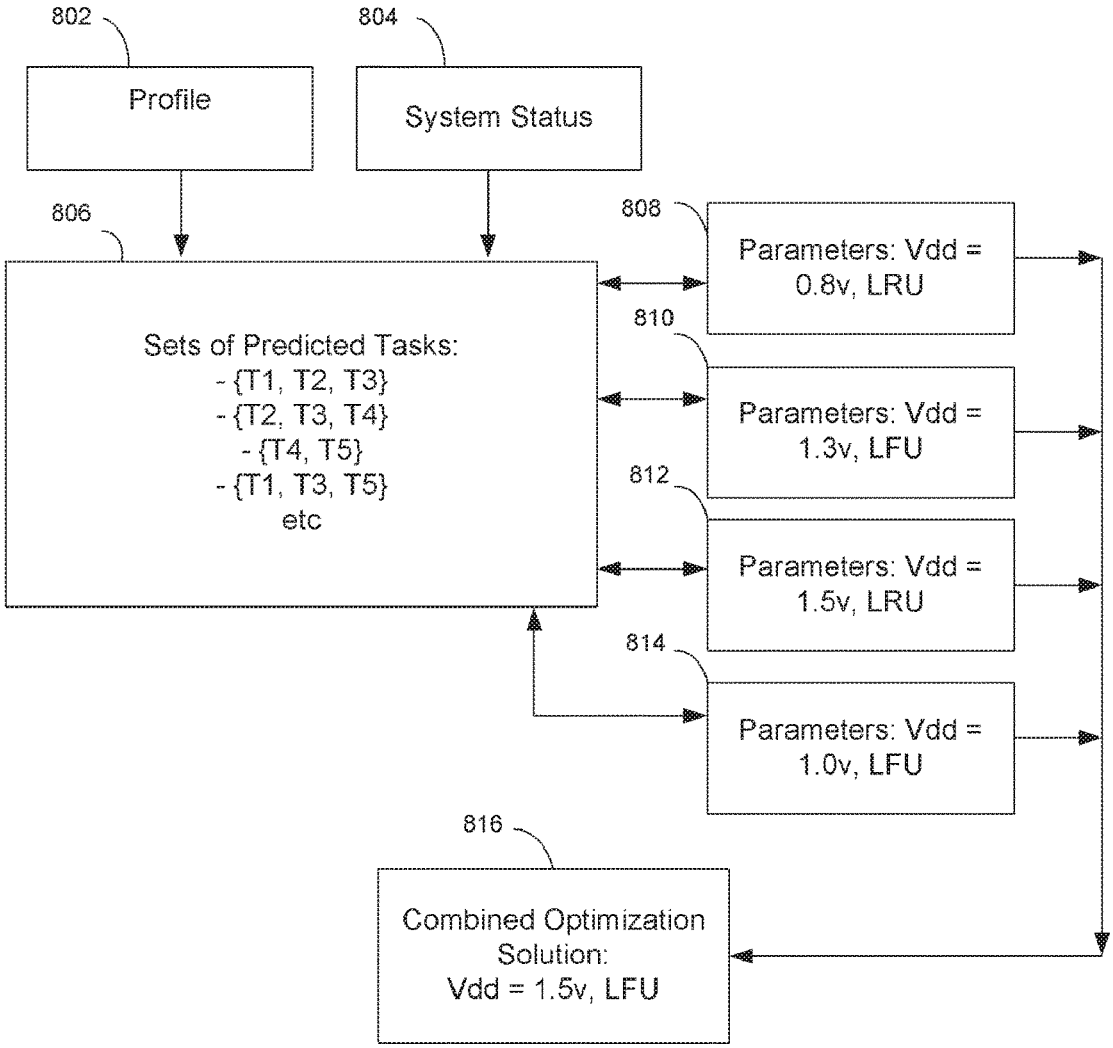
802
Profile
804
System Status
806
Sets of Predicted Tasks:
- {T1, T2, T3}
- {T2, T3, T4}
- {T4, T5}
- {T1, T3, T5}
etc
808
Parameters: Vdd = 0.8v, LRU
810
Parameters: Vdd = 1.3v, LFU
812
Parameters: Vdd = 1.5v, LRU
814
Parameters: Vdd = 1.0v, LFU
816
Combined Optimization Solution:
Vdd = 1.5v, LFU

Figure 8

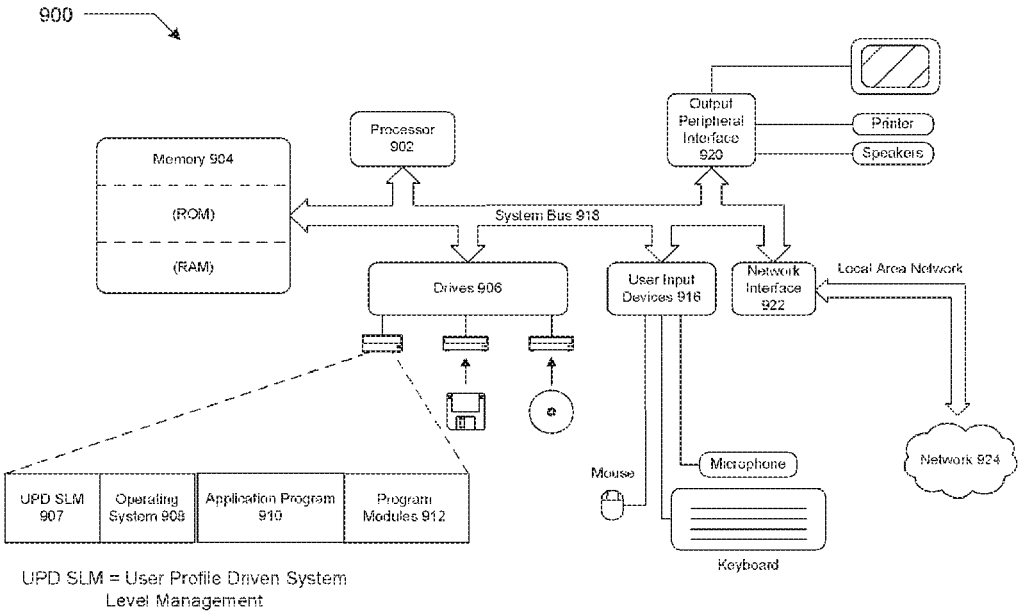
900
Processor 902
Memory 904
(ROM)
(RAM)
System Bus 918
Output Peripheral Interface 920
Printer
Speakers
Drives 906
User Input Devices 916
Network Interface 922
Local Area Network
Network 924
Microphone
Mouse
Keyboard
UPD SLM 907
Operating System 908
Application Program 910
Program Modules 912
UPD SLM = User Profile Driven System Level Management

FIGURE 9

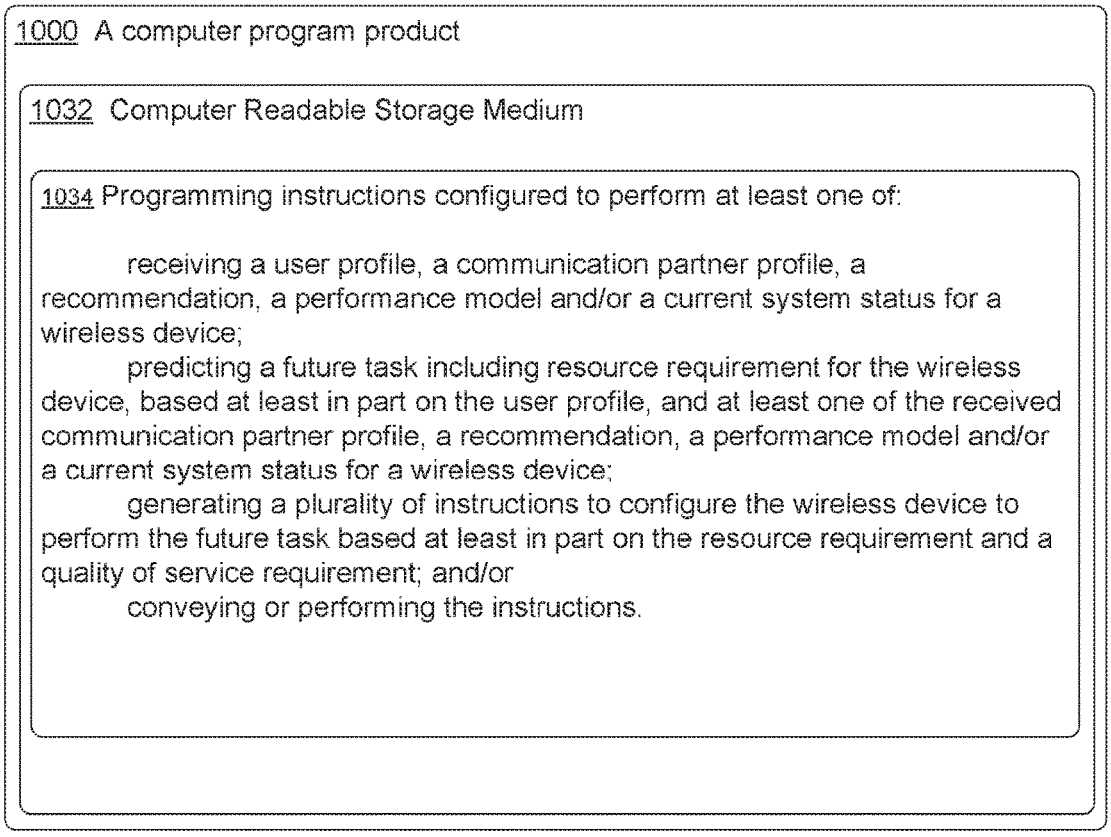
1000 A computer program product
1032 Computer Readable Storage Medium
1034 Programming instructions configured to perform at least one of:
receiving a user profile, a communication partner profile, a recommendation, a performance model and/or a current system status for a wireless device;
predicting a future task including resource requirement for the wireless device, based at least in part on the user profile, and at least one of the received communication partner profile, a recommendation, a performance model and/or a current system status for a wireless device;
generating a plurality of instructions to configure the wireless device to perform the future task based at least in part on the resource requirement and a quality of service requirement; and/or
conveying or performing the instructions.

Figure 10

USER PROFILE-BASED WIRELESS DEVICE SYSTEM LEVEL MANAGEMENT

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a Continuation application under 35 U.S.C. §120 of U.S. patent application Ser. No. 14/192,073, filed on Feb. 27, 2014, now U.S. Pat. No. 9,537,709, which is a Continuation application under 35 U.S.C. §120 of U.S. patent application Ser. No. 12/433,700, filed on Apr. 30, 2009, now U.S. Pat. No. 8,667,109. The disclosures of U.S. patent application Ser. No. 14/192,073 and U.S. patent application Ser. No. 12/433,700 are hereby incorporated herein by reference in their entireties.

BACKGROUND

Wireless communication networks are becoming increasingly popular these days. A typical wireless network may include plurality of wireless devices. Many wireless devices are increasingly configured with a variety of sensors such as camera, camcorder, GPS, compass, and thermometers. Traditionally, wireless devices employ operating systems that are not customized to the requirements and preferences of their users, environment and specific characteristics of the device, available resources, likely applications and workload, and so forth. Current approach to operating and management wireless devices may no longer be viable as the functions and complexities of the wireless devices continue to increase.

BRIEF DESCRIPTION OF THE DRAWINGS

Subject matter is particularly pointed out and distinctly claimed in the concluding portion of the specification. The foregoing and other features of the present disclosure will become more fully apparent from the following description and appended claims, taken in conjunction with the accompanying drawings. Understanding that these drawings depict only several embodiments in accordance with the disclosure and are, therefore, not to be considered limiting of its scope, the disclosure will be described with additional specificity and detail through use of the accompanying drawings:

FIG. **1** schematically illustrates an example wireless communication system, in accordance with various embodiments of the present disclosure;

FIG. **2** schematically illustrates user profile-based system level management (SLM), in accordance with various embodiments of the present disclosure;

FIG. **3** schematically illustrates a user profile, and its use as a communication partner profile in further detail, in accordance with various embodiments of the present disclosure;

FIG. **4** schematically illustrates an example life-time optimization using user profile-based SLM, in accordance with various embodiments of the present disclosure;

FIG. **5** schematically illustrates local user profile-based SLM, in accordance with various embodiments of the present disclosure;

FIG. **6** schematically illustrates an alternative implementation of user profile-based SLM, in accordance with various embodiments of the present disclosure;

FIG. **7** schematically illustrates meta profiling to further improve the effectiveness of user profile-based SLM, in accordance with various embodiments of the present disclosure;

FIG. **8** schematically illustrates an example prediction and optimization using multiple maximum likelihood (ML) prediction, in accordance with various embodiments of the present disclosure;

FIG. **9** illustrates an example computer suitable for practicing aspects of user profile-based SLM, in accordance with various embodiments of the present disclosure; and

FIG. **10** illustrates a block diagram of an example article of manufacture having a computer program product for user profile-based SLM, in accordance with various embodiments of the present disclosure.

DETAILED DESCRIPTION OF EMBODIMENTS OF THE DISCLOSURE

The following description sets forth various examples along with specific details to provide a thorough understanding of claimed subject matter. It will be understood by those skilled in the art, however, that claimed subject matter may be practiced without some or more of the specific details disclosed herein. Further, in some circumstances, well-known methods, procedures, systems, components and/or circuits have not been described in detail in order to avoid unnecessarily obscuring claimed subject matter. In the following detailed description, reference is made to the accompanying drawings, which form a part hereof. In the drawings, similar symbols typically identify similar components, unless context dictates otherwise. The illustrative embodiments described in the detailed description, drawings, and claims are not meant to be limiting. Other embodiments may be utilized, and other changes may be made, without departing from the spirit or scope of the subject matter presented here. It will be readily understood that the aspects of the present disclosure, as generally described herein, and illustrated in the Figures, may be arranged, substituted, combined, and designed in a wide variety of different configurations, all of which are explicitly contemplated and make part of this disclosure.

In the following description, algorithms and/or symbolic representations of operations on data bits and/or binary digital signals stored within a computing system, such as within a computer and/or computing system memory may be presented. An algorithm is generally considered to be a self-consistent sequence of operations and/or similar processing leading to a desired result where the operations may involve physical manipulations of physical quantities that may take the form of electrical, magnetic and/or electromagnetic signals capable of being stored, transferred, combined, compared and/or otherwise manipulated. In various contexts such signals may be referred to as bits, data, values, elements, symbols, characters, terms, numbers, numerals, etc. Those skilled in the art will recognize, however, that such terms may be used to connote physical quantities. Hence, when terms such as "storing", "processing", "retrieving", "calculating", "determining" etc. are used in this description they may refer to the actions of a computing platform, such as a computer or a similar electronic computing device such as a cellular telephone, that manipulates and/or transforms data represented as physical quantities including electronic and/or magnetic quantities within the computing platform's processors, memories, registers, etc.

This disclosure is drawn, inter alia, to methods, apparatus, and systems related to user profile-based system level management of a wireless device. The wireless device may be a next generation wireless device, which may be highly complex, providing ultra wide bandwidth, but requiring high power budget wireless radios such as MIMO, cognitive,

and/or ultra wide bandwidth transceivers. Further, the wireless device may communicate with human body embedded devices such pacemakers, portable kidneys and so forth.

Embodiments of the present disclosure combine coordinated development and deployment of models, prediction tools, optimization techniques, and decision procedures that permit relatively efficient use of permanent (e.g. storage), perishable (computing cycles), and/or renewable (e.g. energy) resources so that user specified objective function under a given set of constraints for a wireless device is optimized. In various embodiments, the present disclosure includes long and short terms modeling of the user, his/her communication partners, software and hardware of the devices, operational conditions and environment, energy supply, and other relevant predictors. In various embodiments, predictions from the data of same modality and/or conditional multimodal models may be utilized. In various embodiments, the models may be created in a manner that they facilitate consequent optimization.

In various embodiments, the present disclosure may be practiced with on-line or off-line customization of how and when individual tasks of the wireless device is invoked and executed. In various embodiments, the profiles of the user, the available resources, the quality of links at certain time and place, and likely traffic, and computational and sensing tasks may be used to decide where the task will be executed using which computation resources and which supply voltage.

In various embodiments, the present disclosure may be realized through system-level management (SLM), local or remote, operating on top of the existing operating system of a wireless device. In alternate embodiments, the present disclosure may be realized through employment of parameterized operating systems for a wireless device. Models and predictions for wireless device users behavior and preference, applications (e.g. communication traffic and sensing tasks), the available resources (e.g. energy) and operational environment (e.g. quality of wireless links) may be heuristic, parametric statistical or data-driven. The prediction techniques may be machine learning or Monte Carlo simulations. And, a user interface may be provided for preferences overwriting.

The terms "predictor," "optimizer," "analyzer," "system level manager," "organizer," "filter," and "profiler" refer to respective hardware and/or software implementing entities, and does not include a human being. The operations performed by the "predictor" et al are operations performed by the respective hardware and/or software implementations, e.g. operations that transform data representative of real things from one state to another state, and these operations do not include mental operations performed by a human being.

FIG. **1** schematically illustrates an example wireless communication system, in accordance with various embodiments of the present disclosure. Wireless communication system **100** may include one or more wireless communication networks, generally shown as **110**, **120** and **130**. In particular, the wireless communication system **100** may include a wireless local area network (WLAN) **110**, a wireless metropolitan area network (WMAN) **120** and a wireless wide area network (WWAN) **130**. Although FIG. **1** depicts three wireless communication networks, the wireless communication system **100** may include additional or fewer wireless communication networks. For example, the wireless communication system **100** may include more or less WLANs, WMANs and/or WWANs. The methods and apparatus described herein are not limited in this regard.

The wireless communication system **100** may also include one or more mobile stations, also referred to as subscriber stations, generally shown as **140**, **142** and **144**. For example, the subscriber stations **140**, **142** and **144** may include wireless electronic devices such as a desktop computer, a laptop computer, a handheld computer, a tablet computer (e.g., personal digital assistant (PDA)), a cellular telephone, a pager, an audio and/or video player (e.g., an MP3 player or a DVD player), a gaming device, a video camera, a digital camera, a navigation device (e.g., a global positioning satellite (GPS) device), a wireless peripheral (e.g., a printer, a scanner, a headset, a keyboard, a mouse, etc.), a medical device (e.g., a heart rate monitor, a blood pressure monitor, etc.), and/or other suitable fixed, portable, or mobile electronic devices. Although FIG. **1** depicts three subscriber stations **140**, **142** and **144**, the wireless communication system **100** may include more or less subscriber stations.

Typically, each of the subscriber stations **140**, **142** and **144** may include a number of hardware and software resources, such as processor cycles, memory space, storage, networking bandwidth, applications and so forth, and an operating system configured to manage the resources, including allocating the resources for various tasks performed on the wireless device. For various resources, the operating system may manage their use and allocation via various policies and/or parameters, e.g. processor cycle time, memory space sizes, cache sizes, networking protocols and so forth.

The subscriber stations **140**, **142** and **144** may use a variety of access schemes such as, for example, orthogonal frequency-division multiple access (OFDMA), spread spectrum schemes (e.g., direct sequence code division multiple access (DS-CDMA) and/or frequency hopping code division multiple access (FH-CDMA)), time-division multiple access (TDMA), frequency-division multiplexing access (FDMA) and/or other suitable access schemes to communicate via wireless links.

In one example, the subscriber stations **140**, **142** and **144** may use a direct sequence spread spectrum (DSSS) scheme and/or frequency hopping spread spectrum (FHSS) scheme to implement the WLAN **110** (e.g., modulations in accordance with any one of a number of industry standards developed by various standard and/or industry organizations, such as, the Institute of Electrical and Electronic Engineers (IEEE)). For example, the laptop computer **140** may communicate with devices associated with the WLAN **110** such as the handheld computer **142** and/or the cellular phone **144** via wireless links. The laptop computer **140** may also communicate with an access point (AP) **150** via a wireless link. Generally, WLANs and WMANs include multiple APs **150**. The AP **150** may be operatively coupled to a router **152** as described in further detail below. Alternatively, the AP **150** and the router **152** may be integrated into a single device (e.g., a wireless router).

The subscriber stations **140**, **142** and **144** may use OFDMA to transmit large amounts of digital data by splitting a radio frequency signal into multiple small sub-signals, which in turn, may be transmitted simultaneously at different frequencies. In particular, the subscriber stations **140**, **142** and **144** may use OFDMA to implement the WMAN **120**. For example, the subscriber stations **140**, **142** and **144** may operate in accordance with the 802.16 family of standards developed by IEEE to provide for fixed, portable, and/or mobile broadband wireless access (BWA) networks (e.g., the IEEE std. 802.16, published by IEEE 2004) to communicate with base stations, generally shown as **160**, **162**, and **164**, via wireless link(s).

Although some of the above examples are described with respect to standards developed by IEEE, the methods and apparatus disclosed herein are readily applicable to many specifications and/or standards developed by other special interest groups and/or standard development organizations (e.g., Wireless Fidelity (Wi-Fi) Alliance, Worldwide Interoperability for Microwave Access (WiMAX) Forum, Infrared Data Association (IrDA), Third Generation Partnership Project (3GPP, 3GPP2), etc.). For example, long term evolution (LTE, a 3GPP standard), air interface evolution (a 3GPP2 standard) are suitable standards for applicability with regard to various embodiments of the present disclosure in addition to IEEE 802.16 and WiMAX standards. The methods and apparatus described herein are not limited in this regard. Additionally, the subscriber stations **140**, **142** and **144** may operate in accordance with other wireless communication protocols to support the WWAN **130**. In particular, these wireless communication protocols may be based on analog, digital, and/or dual-mode communication system technologies such as, for example, Global System for Mobile Communications (GSM) technology, Wideband Code Division Multiple Access (WCDMA) technology, General Packet Radio Services (GPRS) technology, Enhanced Data GSM Environment (EDGE) technology, Universal Mobile Telecommunications System (UMTS) technology, standards based on these technologies, variations and evolutions of these standards, and/or other suitable wireless communication standards.

The WLAN **110**, WMAN **120** and WWAN **130** may be operatively coupled to a common public or private network **170** such as the Internet, a telephone network (e.g., public switched telephone network (PSTN)), a local area network (LAN), a cable network, and/or another wireless network via connection to an Ethernet, a digital subscriber line (DSL), a telephone line, a coaxial cable, and/or any wireless connection, etc. In one example, the WLAN **110** may be operatively coupled to the common public or private network **170** via an AP **150** and/or the router **152**. In another example, the WMAN **120** may be operatively coupled to the common public or private network **170** via the base station(s) **160**, **162**, and/or **164**. In another example, the WWAN **130** may be operatively coupled to the common public or private network **170** via base station(s) **180**, **182** and/or **184**.

The wireless communication system **100** may include other WLAN, WMAN, and/or WWAN devices (not shown) such as network interface devices and peripherals (e.g., network interface cards (NICs)), access points (APs), redistribution points, end points, gateways, bridges, hubs, etc. to implement a cellular telephone system, a satellite system, a personal communication system (PCS), a two-way radio system, a one-way pager system, a two-way pager system, a personal computer (PC) system, a personal data assistant (PDA) system, a personal computing accessory (PCA) system, and/or any other suitable communication system. Although certain examples have been described above, the scope of coverage of this disclosure is not limited thereto.

The efficient operation of wireless electronic devices within a system such as wireless communication system **100** may become increasingly difficult due to complex interaction of hardware, software, applications, operational and environmental conditions. Almost all of these entities have numerous options that greatly impact the effective use of a wireless device. For example, high temperature may double or triple energy consumption, and high energy consumption may rapidly additionally increase the temperature of a wireless device. However, the energy consumption may be impacted by many other issues, including the allocated time for the task, cache line policy, used scheduled algorithm, the quality of communication links, and/or used bandwidth.

Therefore, in accordance with various embodiments of the present disclosure, a system level manager (SLM) **190** may be provided to individual portable electronic wireless devices, such as may be illustrated by subscriber stations **140**, **142**, and **144** (hereinafter, simply wireless devices). In various embodiments, individual SLMs **190** may comprise a predictor and an optimizer/analyzer operatively coupled to each other. In various embodiments, the predictor may be configured to predict a future task to be performed by a wireless device, including resource requirement for performing the future task by the wireless device, based at least in part on a profile of a user of the wireless device and at least one of a profile of a communication partner of the user, an operational recommendation for the wireless device, a performance model of the wireless device and/or a current state of the wireless device. The optimizer/analyzer may be configured to generate a plurality of instructions to configure the wireless device, based at least in part on the predicted future task and resource requirement for performing the future task and a quality of service requirement of the wireless device, in anticipation of the wireless device having to perform the predicted task.

In various embodiments, on determination of the instructions, individual SLMs **190** may convey to the operating system the management action to be taken. The process may be repeated periodically, or performed continuously by SLM **190**, to allow the performance of the wireless device to be managed periodically or continuously to achieve the quality of service requirements, as required.

In accordance with various embodiments, an SLM **190** may be generic for one type of wireless device (e.g. a particular type of cell phone or a particular type and/or configuration of a laptop computer), or may target a specific device that may be unique due to software customization or due to hardware factors such as manufacturing variability and aging of device components. It may target both devices that allocate their resources using standard or real-time operating systems.

In alternate embodiments, some or all aspects of SLM **190** may be integrated with the operating system of that wireless device. In still other embodiments, SLM **190** may be disposed on a remote computing device (not shown) instead. The remotely disposed SLM **190** may remotely manage one or more wireless devices in the network.

In various embodiments, the operating system of subscriber stations **140**, **142**, and **144** may be configured to provide measurements for various task, hardware and/or software related metrics, e.g. processor cycle time, cache hit, packet error rate and so forth. In various embodiments, subscriber stations **140**, **142**, and **144** may be configured with sensors to measure and to provide measurements for various user and/or device related metrics, e.g. temperature sensors, user bio-metric sensors and so forth. In various embodiments, wireless communication system **100** may be configured with sensors to measure and/or repositories to store, and to provide measurements for various environment related metrics, e.g. ambient temperature and/or humidity, network traffic bandwidth and/or error rates. In various embodiments, these sensors or data collection units may be configured to take real time measurements, and/or take measurements continuously or periodically. SLM **190** may utilize these device and/or system capabilities in obtaining the measurements.

FIG. **2** schematically illustrates user profile-based system level management (SLM), in accordance with various

embodiments of the present disclosure. Optimization under uncertainty may be much more difficult and less effective than one where the future actions may be at least partially known. For example, majority of on-line algorithms for majority of combinatorial and continuous optimization problems may be significantly inferior to the algorithms that assume complete knowledge about the pertinent problem instance. Some operating systems exactly operate in one such scenario. For example, such operating systems may modify the operating voltage without knowing either the status of the battery or pending tasks in near future. The present disclosure addresses these disadvantages through a user profile-based system level management (SLM) approach that may profile a user of a wireless device, the user's communicating partners, and environment (e.g. reception rate of links) in such a way that they facilitate prediction and management of the pending resource requirements and supply of resources, such as energy.

As illustrated, for one or more embodiments, predictor **212** may be provided and configured to predict **232** a future task **214** to be performed by a wireless device, including resource requirement for performing the future task by the wireless device. For one or more embodiments, predictor **212** may make a prediction based at least in part on a profile **202** of a user of the wireless device, and at least one of a profile **204** of a communication partner of the user, an operational recommendation **206** for the wireless device, a performance model **208** of the wireless device and/or a current task and system status **210** of the wireless device. Note that some of the communication partners may be service providers, e.g. email service providers, telephony service providers, instant messaging service providers, movie or music distributors. Further, optimizer/analyzer **216** may be provided and configured to generate **234** a plurality of instructions **218** to configure the wireless device, based at least in part on the predicted future task **214** and resource requirement for performing the future task and a quality of service requirement of the wireless device, in anticipation of the wireless device having to perform the predicted task.

Profiles **202** and **204** may contain information about the habits and preferences of the user and his/her communication partners, in terms of the invoked tasks and their properties. For example, profiles **202** and **204** may have information about the send and received emails, voice calls, instant messages, invoked games, accessed web sites, downloaded movies/music, as well as the accepted and favored quality of service in terms of latency, throughput, resolution, security, and privacy. Profiles **202** and **204** may also contain the information about battery recharging patterns. The information may be abstracted to statistical models and typical patterns that may be either frequency-based or formulated in terms conditional probabilities. Thus, profiles **202** and **204** may contain statistical, probabilistic, and heuristic information about the probability that a particular task will be initiated or terminated at a particular moment or a particular scenario. For example, profiles **202** and **204** may contain the information about the expected number of send and received emails, voice calls, and/or instant messages in the next hour, and/or the expected number of files, movies and/or music downloads in the next 24 hours (given the current and/or recent context of activities and/or conditions). Furthermore, profiles **202** and **204** may contain information about the properties of emails, calls, instant messages, games, web sites/pages, files, movies and/or songs, such as their size/duration, their rate of arrival/invocation, and so forth.

Profiles **202** and **204** may be established by observing and extrapolating the previous behavior of the user. The profiles may be unconditional or conditional on time, location, mobility pattern, or local or global events. For example, the user may be interested to receive an email alert any time when a subset of stocks or managed funds changed their value by more than a specified amount.

Recommendations **206** may comprise one or more operational recommendations for the wireless devices. Recommendations **206** may be mainly related to the resource required to execute a particular task and how they may be optimized for various objectives. Recommendations **206** may be provided by other users who have already conducted the same or similar tasks executions. For example, recommendations **206** may comprise one or more display resolution recommendations (depending on the items or media type of the items to be displayed) for the wireless device, one or more modulation recommendations (depending on the items, media type of the items to be transmitted and/or network condition) for the wireless device, one or more error correction code recommendations (depending on integrity needs) for the wireless device, and one or more packet size recommendations for communication for the wireless device (depending on the items, media type of the items to be transmitted and/or network condition).

Performance models (or simply model) **208** may comprise performance information about the wireless device, its software, operational conditions and the environment. For example, models **208** may contain information about the quality of the links at a particular location in terms of the signal-to-noise ratio, reception rate, interference, and current and expected traffic congestion. Models **208** may also comprise temperature and/or energy consumption of the wireless device under certain operating conditions. In various embodiments, models **208** may be constructed, based at least in part on measurements obtained for the device under the various operating and/or environmental conditions.

Current task and system status **210** may comprise information about the current tasks, their resource consumption, in terms of e.g. permanent (e.g. storage), perishable (computing cycles), or renewable (e.g. energy) resources. Current task and system status **210** may comprise current latency of each task, the available energy, the temperature of a subset of the components, ambient light and so forth.

The resource requirement of the predicted future task **214** may comprise e.g. its processor cycle requirements, its caching resource requirements, its transmit/receive requirements, and/or other execution requirements.

Continuing to refer to FIG. **2**, in various embodiments, predictor **212** may be configured to provide short term higher accuracy as well as longer terms low accuracy predictions **214**. Predictor **212** may employ simulation and/or Monte Carlo method. Predictions **214** may be in turn may be used by optimizer/analyzer **216** to optimize and manage resource allocation and protocol and policy selections. In various embodiments, as described earlier, optimizer/analyzer **216** based at least in part on the predictions and their resource requirements, may generate a set of instructions for the operating system of the wireless device to guide the operating system in allocating and managing resource.

In various embodiments, optimizer/analyzer **216** may be configured to optimize a complex objective subject to a complex set of constraints in fast and effective way (to generate a set of instructions for a predicted task, or generate a consolidated/optimized set of instructions for a number of predicted tasks). In various embodiments, the optimization may alter the operational parameters, algorithms and/or protocols of the wireless device, in order to improve quality of service objective of the wireless device, such as life time

maximization or improvement, or the optimization or improvement of the quality of service in terms of operational parameters such as used resolution and latency. In various embodiments, optimizer/analyzer **216** may assume the predictions **214** for the future tasks and their resource requirements to be correct. Therefore, in such a way, for these embodiments, the uncertainty may be reduced or eliminated. In various embodiments, in order to maximize or improve the effectiveness and the accuracy, optimizer/analyzer **216** may be configured to consider during optimization several likely future scenarios, and select the solution that performs best over many or all of the considered scenarios.

In various embodiments, optimizer/analyzer **216** may be configured to use engineering change paradigm to incrementally keep improving the available solution and adapting to changed requirements and available resources. In various embodiments, optimizer/analyzer **216** may be configured to use several variants of maximum likelihood, where optimizer/analyzer **216** may be configured to find the most likely parameter set-up that may be most likely to optimize the objective function for the most likely scenarios. In various embodiments, for multiple predicted tasks, optimizer/analyzer **216** may first respectively generate configuration instructions for the tasks, and then generate an optimize set of configuration instructions based on the respectively generated set of instructions for the tasks.

In various embodiments, the profile building and/or optimization may be performed either locally (on the wireless device) or at the remote computer. In various embodiments, the decision with respect to where each operation may be performed, may itself be handled using existing user profile for SLM to allocate the tasks in such a way that the energy consumption, latency, the accuracy, or other user specified objective function may be optimized. The actual interaction of the user profile-based SLM may be effectuated in several ways. For example, the SLM may exchange the information with modified operating system or operating system that is designed in such a way that they may interact with a SLM.

In various embodiments, user interface **220** may be provided to inform the user about some or all SLM aspects. In various embodiments, user interface **220** may be further configured to allow the user to overwrite either directly or using more generic specification any subset of the decision or the process.

FIG. **3** schematically illustrates a user profile and its use as a communication partner profile in further details, in accordance with various embodiments of the present disclosure. As illustrated, user profile **300**, in addition to profile information **302** related to the user's behavior with respect to email, voice calls, instant messages, games, files, web sites, movies and/or songs, user profile **300** may also comprise general communication attributes **304** with other parties in general, user preferences **306**, specific communication attributes **308** with selected parties (e.g., dominant parties), and privacy and security attributes **310**.

Communication attributes **304** and **308** may comprise information about reception rate, latency, throughput, backlog etc. for other communication parties in general or special parties in particular, respectively. User preferences **306** may comprise information about the user's communication preferences, e.g. display resolution (for email, instant messaging and so forth), modulation, packet size and/or error correction code. Privacy and security attributes **310** may comprise information about e.g. the user's location, mobility mode and communication activity.

For one or more embodiments, information organizer **312** may be provided and configured to organize the various information into both recent and long term information to permit the more relevant information be shared (subject to the user's privacy and security preferences) for communication and cooperation. For one or more embodiments, information filter **314** may be provided and configured to filter the organized information for release to a particular communication partner.

In various embodiment, information communicator and negotiator **316** may also be provided and configured, to decide when and how to communicate the releasable information to a communication partner or a group of communication partners. In various embodiments, information communicator and negotiator **316** may also be configured to negotiate with another party for the what, when and how to communicate the releasable information.

FIG. **4** schematically illustrates an example life-time optimization using user profile-based SLM, in accordance with various embodiments of the present disclosure. The example illustrates how energy usage may be optimized for a wireless device, using user profile-based SLM. As illustrated, the user **402** and his/her communicating partners **404** provide information about the predicted future tasks **406**. As described earlier, the predicted future tasks may include information about the required resources associated with the predicted future task. For the example, this information may be used to create a set of likely expect workloads for the wireless device.

For the example, the optimizer/analyzer consequently may conduct optimization at one or more of two levels: (i) at the individual task level; and (ii) at the interaction level. As illustrated and earlier described, the optimizer/analyzer first may generate instructions **408** for the wireless device to configure itself for each of the predicted future task. As illustrated and described earlier, the instructions **408** may comprise properties such as which processor to use, which software to employ, and so forth. Thereafter, the optimizer/analyzer may further analyze the various sets of instructions **408**, and may search for improved or the best overall parameters and policies **410**, for rapid and accurate evaluation; and stopping criteria. For one or more embodiments, on determination, the optimizer/analyzer may communicates the decision **410** to the operating system and communication hardware and system about the selected most or more beneficial parameter setting and selected algorithms, protocols, and policies, including e.g. the device voltage Vdd, buffer allocation, player selection, and so forth, where applicable.

As with the earlier described embodiments, user interface **420** may be provided to inform the user about some or all SLM aspects. In various embodiments, user interface **420** may be further configured to allow the user to overwrite either directly or using more generic specification any subset of the decision or the process.

FIG. **5** schematically illustrates local user profile-based SLM, in accordance with various embodiments of the present disclosure. For these embodiments, the pertinent wireless device **504** does some or all profiling and modeling associated with user profile **502**, as well as predictions, and optimization itself. Some benefits may include self-sufficiency and reduction of communication cost. Note that the communication with other communication partners **506** and **508** may still be utilized at least for coordination about the communication set-up. For example, information about the communicating times, used modulation, synchronization code, used frequencies, and the error correction code may be coordinated between the communication partners **506** and **508**. The main disadvantage may be that often more sim-

plistic profiling, modeling, and optimization may be conducted in order to avoid the overloading of the local resources of the wireless device **504**.

FIG. **6** schematically illustrates an alternative implementation of user profile-based SLM, in accordance with various embodiments of the present disclosure. For these embodiments, at least part of the profiling, modeling, predictions, and optimization for communication with communication partners **606** and **608** may be done at a remote computing device **610** (in lieu of the target wireless device **604**), using user profile **602**. One advantage for these embodiments may be that now each of profiling, modeling, predictions, and optimization may be done in more elaborated way and that coordination may be better achieved. However, some of the privacy may be reduced, the communication cost may be non-trivial and that the latency of decision may be increased.

In various embodiments, both local and remote user profile-based SLM may be used in such a way that the advantages may be combined and the limitations of each individual scheme may be reduced.

FIG. **7** schematically illustrates meta profiling to further improve the effectiveness of user profile-based SLM, in accordance with various embodiments of the present disclosure. As illustrated, for these embodiments, the instructions sets **708** generated by optimizer/analyzer **706** for the predicted future tasks **704**, include meta data describing the information used in generating the instructions. For these embodiments, a meta profiler **710** may be further provided and configured to analyze the meta data included with the instruction sets **708** to determine which information was used by the various optimizer/analyzers **706** in generating the various instructions for various predicted future tasks, and their relevance. As earlier described, the various optimizer/analyzers **706** generate the instructions based at least in part on the predicted future tasks **704**, which may be predicted based at least in part on the user and their communication partners' profiles **702**.

For these embodiments, meta profiler **710** analyzes these instructions sets **708** and generates conclusions **712** for the various optimizers/analyzers **706** with respect what operational parameters should be optimized, what device performance characteristics should be modeled, what kind of user behavior attributes should be profiled, and so forth. Conclusions **712** may also include information identifying those particular operations that may be actually most practically important for a specific wireless device and/or a specific user.

As illustrated, the conclusions **712** may be feedback to the optimizers/analyzers **706** for optimizers/analyzers **706** to improve their optimization and analysis. This process of analyzing what information used in generating instructions, their relevance, and feeding back to the optimizer/analyzer **706** may be repeated periodically or continuously. Accordingly, the effectiveness of the user profile-based SLM approach may be further improved.

FIG. **8** schematically illustrates an example prediction and optimization using multiple maximum likelihood (ML) predictions, in accordance with various embodiments of the present disclosure. In various embodiments, the optimizer/analyzer performs the ML SLM optimization in the following way. The predictor first may use the information from the profiles **802** and the system current status **804** to generate a number of highly likely sets **806** of tasks, e.g. a set having tasks {T**1**, T**2**, T**3**}, another set having tasks {T**2**, T**3**, T**4**} and so forth. For each set **806** of predicted tasks, the optimizer/analyzer may find the best selection of parameters **808-814**. These selections of parameters **808-814** may provide information about likelihood that each of the decision may be most beneficial and to what extent. Next, the optimizer/analyzer may combine the information about likelihood using ML prediction to generate the combined optimization solution **816** that may be most likely optimize the pertinent quality of service objective function under the specified constraints. For various embodiments, if some task is actually not executed, the instructions associated with such tasks may be skipped in the determination of the combined optimization solution **816**. On the other hand, if an unexpected task is invoked initially, the task may be performed using the set-up that is most beneficial without considering other tasks and the SLM process is invoked. In alternate embodiments, variations of these basic schemes may be executed.

FIG. **9** illustrates an example computer suitable for practicing aspects of user profile-based SLM, in accordance with various embodiments of the present disclosure. FIG. **9** includes a computer **900**, including a processor **902**, memory **904** and one or more drives **906**. The drives **906** and their associated computer storage media, provide storage of computer readable instructions, data structures, program modules and other data for the computer **900**. The drives **906** may include an operating system **908**, application programs **910** and program modules **912**. For one or more embodiments drives **906** further include programming instructions **907** implementing various earlier described aspects of user profile-based SLM.

The computer **900** may further include user input devices **916** through which a user may enter commands and data. Input devices may include an electronic digitizer, a microphone, a keyboard and pointing device, commonly referred to as a mouse, trackball or touch pad. Other input devices may include a joystick, game pad, satellite dish, scanner, or the like.

These and other input devices may be coupled to processor **902** through a user input interface that is coupled to a system bus **918**, but may be coupled by other interface and bus structures, such as a parallel port, game port or a universal serial bus (USB). Computers such as the computer **900** may also include other peripheral output devices such as speakers, which may be coupled through an output peripheral interface **920** or the like.

The computer **900** may operate in a networked environment using logical connections to one or more computers, such as a remote computer coupled to network interface **922**. The remote computer may be a personal computer, a server, a router, a network PC, a peer device or other common network node, and may include many or all of the elements described above relative to the computer **900**. Networking environments are commonplace in offices, enterprise-wide area networks (WAN), local area networks (LAN), intranets and the Internet. For example, in the subject matter of the present application, the computer **900** may comprise the source machine from which data is being migrated, and the remote computer may comprise the destination machine or vice versa. Note, however, that source and destination machines need not be coupled by a network **924** or any other means, but instead, data may be migrated via any media capable of being written by the source platform and read by the destination platform or platforms. When used in a LAN or WLAN networking environment, the computer **900** is coupled to the LAN through a network interface **922** or an adapter. When used in a WAN networking environment, the computer **900** typically includes a modem or other means for establishing communications over the WAN, such as the

Internet or network **924**. It will be appreciated that other means of establishing a communications link between the computers may be used.

Articles of manufacture and/or systems may be employed to perform one or more methods as disclosed herein. FIG. **10** illustrates a block diagram of an example article of manufacture having a computer program product **1000** for user profile-based system level management (SLM), in accordance with various embodiments of the present disclosure. The computer program product **1000** may comprise computer readable storage medium **1032** and plurality of programming instructions **1034** stored in the computer readable storage medium **1032**. In various ones of these embodiments, programming instructions **1034** may be adapted to program a processor of an apparatus, such that when the programming instructions are executed by the processor, the programming instructions enable the apparatus to perform one or more of receiving a user profile, a communication partner profile, a recommendation, a performance model and/or a current system status of a wireless device; predicting a future task including resource requirement for the wireless device based at least in part on the user profile and at least one of the received communication partner profile, recommendation, performance model and/or current system status; generating one or more instructions to configure the wireless device to perform the predicted future task based at least in part on the resource requirement and a quality of service requirement; and/or conveying or performing the generated instructions.

Computer readable storage medium **1032** may take a variety of forms including, but not limited to, non-volatile and persistent memory, such as, but not limited to, compact disc read-only memory (CDROM) and flash memory.

Claimed subject matter is not limited in scope to the particular implementations described herein. For example, some implementations may be in hardware, such as employed to operate on a device or combination of devices, for example, whereas other implementations may be in software and/or firmware. Likewise, although claimed subject matter is not limited in scope in this respect, some implementations may include one or more articles, such as a storage medium or storage media. This storage media, such as CD-ROMs, computer disks, flash memory, or the like, for example, may have instructions stored thereon, that, when executed by a system, such as a computer system, computing platform, or other system, for example, may result in execution of a processor in accordance with claimed subject matter, such as one of the implementations previously described, for example. As one possibility, a computing platform may include one or more processing units or processors, one or more input/output devices, such as a display, a keyboard and/or a mouse, and one or more memories, such as static random access memory, dynamic random access memory, flash memory, and/or a hard drive.

There is little distinction left between hardware and software implementations of aspects of systems; the use of hardware or software is generally (but not always, in that in certain contexts the choice between hardware and software may become significant) a design choice representing cost vs. efficiency tradeoffs. There are various vehicles by which processes and/or systems and/or other technologies described herein may be effected (e.g., hardware, software, and/or firmware), and that the favored vehicle may vary with the context in which the processes and/or systems and/or other technologies are deployed. For example, if an implementer determines that speed and accuracy are paramount, the implementer may opt for a mainly hardware and/or firmware vehicle; if flexibility is paramount, the implementer may opt for a mainly software implementation; or, yet again alternatively, the implementer may opt for some combination of hardware, software, and/or firmware.

In some embodiments, several portions of the subject matter described herein may be implemented via Application Specific Integrated Circuits (ASICs), Field Programmable Gate Arrays (FPGAs), digital signal processors (DSPs), or other integrated formats. However, those skilled in the art will recognize that some aspects of the embodiments disclosed herein, in whole or in part, may be equivalently implemented in integrated circuits, as one or more computer programs running on one or more computers (e.g., as one or more programs running on one or more computer systems), as one or more programs running on one or more processors (e.g., as one or more programs running on one or more microprocessors), as firmware, or as virtually any combination thereof, and that designing the circuitry and/or writing the code for the software and/or firmware would be well within the skill of one of skill in the art in light of this disclosure. In addition, those skilled in the art will appreciate that the mechanisms of the subject matter described herein are capable of being distributed as a program product in a variety of forms, and that an illustrative embodiment of the subject matter described herein applies regardless of the particular type of signal bearing medium used to actually carry out the distribution. Examples of a signal bearing medium include, but are not limited to, the following: a recordable type medium such as a floppy disk, a hard disk drive (HDD), a Compact Disc (CD), a Digital Video Disk (DVD), a digital tape, a computer memory, etc.; and a transmission type medium such as a digital and/or an analog communication medium (e.g., a fiber optic cable, a waveguide, a wired communication link, a wireless communication link, etc.).

With respect to the use of substantially any plural and/or singular terms herein, those having skill in the art may translate from the plural to the singular and/or from the singular to the plural as is appropriate to the context and/or application. The various singular/plural permutations may be expressly set forth herein for sake of clarity.

Although certain example methods, apparatus, and articles of manufacture have been described herein, the scope of coverage of this disclosure is not limited thereto. On the contrary, this disclosure covers all methods, apparatus, and articles of manufacture fairly falling within the scope of the appended claims either literally or under the doctrine of equivalents. For example, although the above discloses example systems including, among other components, software or firmware executed on hardware, it should be noted that such systems are merely illustrative and should not be considered as limiting. In particular, it is contemplated that any or all of the disclosed hardware, software, and/or firmware components could be embodied exclusively in hardware, exclusively in software, exclusively in firmware or in some combination of hardware, software, and/or firmware.

I claim:

1. A method for managing a wireless device in a wireless environment, the method comprising:

predicting, based at least in part on a first profile associated with the wireless device and one or more second profiles associated respectively with one or more communication partners of the wireless device, a future task by the wireless device and a resource requirement associated with the future task; and

generating a set of instructions to configure the wireless device, based at least in part on the predicted future task, the predicted resource requirement associated with the predicted future task, and a quality of service requirement of the wireless device to perform in the wireless environment.

2. The method of claim **1**,

wherein the first profile comprises information about voice communications via the wireless device,

wherein the one or more communication partners are network service providers, and

wherein the one or more second profiles comprise information about the voice communications via the wireless device over one or more networks serviced by the one or more communication partners.

3. The method of claim **2**, further comprising:

accessing, by the wireless device based on network conditions, a wireless network serviced by one of the network service providers,

wherein the wireless network serviced by the one of the network service providers includes cellular and Wi-Fi networks, and

wherein the network conditions include one or more of latency, throughput, or resolution.

4. The method of claim **1**, wherein the first profile comprises information about movie watching via the wireless device.

5. The method of claim **1**, wherein the first profile comprises information about song listening via the wireless device.

6. The method of claim **1**, wherein the resource requirement comprises a transmit/receive resource requirement.

7. A wireless device, comprising:

a processor;

a predictor configured to be operated by the processor to predict, based at least in part on a first profile associated with the wireless device and one or more second profiles associated respectively with one or more communication partners of the wireless device, a future task by the wireless device and a resource requirement associated with the future task; and

an optimizer/analyzer operatively coupled to the predictor and configured to be operated by the processor to generate a set of instructions to configure the wireless device, based at least in part on the predicted future task, the predicted resource requirement associated with the predicted future task, and a quality of service requirement of the wireless device to perform in a wireless environment.

8. The wireless device of claim **7**,

wherein the first profile comprises information about voice communications via the wireless device,

wherein the one or more communication partners are network service providers, and

wherein the one or more second profiles comprise information about the voice communications via the wireless device over one or more networks serviced by the one or more communication partners.

9. The wireless device of claim **8**, further comprising:

a network interface to access, by the wireless device based on network conditions, a wireless network serviced by one of the network service providers,

wherein the wireless network serviced by the one of the network service providers includes cellular and Wi-Fi networks, and

wherein the network conditions include one or more of latency, throughput, or resolution.

10. The wireless device of claim **7**, wherein the first profile comprises information about movie watching via the wireless device.

11. The wireless device of claim **7**, wherein the first profile comprises information about song listening via the wireless device.

12. The wireless device of claim **7**, wherein at least one of the predictor and the optimizer/analyzer is integrated with an operating system of the wireless device.

13. The wireless device of claim **7**, wherein the predictor and the optimizer/analyzer form a system level manager configured to manage a plurality of wireless devices that includes the wireless device.

14. The wireless device of claim **7**,

wherein the prediction of the future task by the wireless device is based at least in part on a performance model of the wireless device in terms of one or more of a signal-to-noise ratio, a communication reception rate, or a communication interference.

15. A method for managing a wireless device in a wireless environment, the method comprising:

predicting, based at least in part on a first profile associated with the wireless device and one or more second profiles associated respectively with one or more communication partners of the wireless device, a future resource requirement of the wireless device; and

generating a set of instructions to configure the wireless device, based at least in part on the predicted future resource requirement and a quality of service requirement of the wireless device to perform in the wireless environment.

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

wherein the first profile comprises information about voice communications via the wireless device,

wherein the one or more communication partners are network service providers, and

wherein the one or more second profiles comprise information about the voice communications via the wireless device over one or more networks serviced by the one or more communication partners.

17. The method of claim **16**, further comprising:

accessing, by the wireless device based on network conditions, a wireless network serviced by one of the network service providers,

wherein the wireless network serviced by the one of the network service providers includes cellular and Wi-Fi networks, and

wherein the network conditions include one or more of latency, throughput, or resolution.

18. The method of claim **15**, wherein the first profile comprises information about movie watching via the wireless device.

19. The method of claim **15**, wherein the first profile comprises information about song listening via the wireless device.

20. The method of claim **15**, wherein the resource requirement comprises a transmit/receive resource requirement.

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