

LOCATION-AWARE MULTIMODAL COMMUNICATION SYSTEM

[0001] This application is a continuation-in-part of US Application Serial No. 11/332,116 filed on January 12, 2006, which is assigned to the assigner hereof and hereby expressly incorporated by reference in its entirety for all purposes.

BACKGROUND

[0002] This disclosure relates in general to communication systems and, more specifically, but not by way of limitation, to identifying communication resources based upon a location of a communication device.

[0003] Mobile devices with more than one communication mode have proliferated in the marketplace. Cellular phones, for example, may contain one transceiver for exchanging voice and data communications with a cellular base station and another transceiver for communicating with a WiFi™ access point. Some phones offer many more communication modes. To determine the access points within communication range of the phone can take time and processing power and impede the ability to move between access points.

[0004] Conventional mobile devices may receive a list of surrounding base stations from a serving base station. This list enables the mobile device to change positions without interrupting service. However, the list is limited to information about base stations owned by a particular service provider or those owned by the service provider's roaming partners. Moreover, information contained in the list may be limited to a specific communication mode of the mobile device.

BRIEF SUMMARY OF THE DISCLOSURE

[0005] In one embodiment, a method of providing a multimodal list of transceiver devices to a remote terminal is disclosed. The method includes retrieving a location of a remote terminal that is able to communicate with a plurality of transceiver devices and that communicates in at least two communication modes. The method further includes identifying a first transceiver device for communicating in a first communication mode

and a second transceiver device for communicating in a second communication mode. The first and second transceiver devices are located within a communication range of the remote terminal and communicate in different communication modes. The method also includes generating the multimodal list of transceiver devices comprising the first and second transceiver devices where the multimodal list contains a transceiver identifier and a communication mode for each of the first and second transceiver devices. The multimodal list of transceiver devices is transmitted to the remote terminal in a communication mode of the remote terminal.

[0006] In another embodiment, a method of identifying transceiver devices for communicating with a remote terminal is disclosed. The method includes communicating information corresponding to a plurality of communication modes of the remote terminal away from the remote terminal. The method also includes receiving a multimodal list of transceiver devices. The multimodal list of transceiver devices includes information about a first transceiver device for communicating in a first communication mode and information about a second transceiver device for communicating in a second communication mode. In addition, the multimodal list of transceiver devices is tailored to a location of the remote terminal. The method further includes storing the multimodal list of transceiver devices in a memory accessible to the remote terminal.

[0007] In yet another embodiment, a system for providing a multimodal list of transceiver devices to a remote terminal is disclosed. The system includes a positioning unit for determining a location of the remote terminal and a database of transceiver device information. The transceiver device information is characterized by, at least, a transceiver identifier, a location of the transceiver device, and a communication mode of the transceiver device. The system also includes a processor configured to retrieve transceiver device information from the database and to create a multimodal list of transceiver devices. The multimodal list of transceiver devices contains information about a first transceiver device having a first communication mode and a second transceiver device having a second communication mode. In addition, the multimodal list of transceiver devices is tailored to the location of the remote terminal. The system also includes a transceiver configured to transmit the multimodal list of transceiver devices to the remote device using a communication mode of the remote device.

[0008] In another embodiment, a system for identifying transceiver devices for communicating with a remote terminal is disclosed. The system includes a first transceiver for communicating in a first communication mode and a second transceiver for communicating in a second communication mode. The system also includes a processor coupled with the first and second transceivers and configured to process communications in the first and second communication modes. A memory coupled with the processor is provided to store a multimodal list of transceiver devices. The multimodal list of transceiver devices includes information about a first transceiver device for communicating in a first communication mode and information about a second transceiver device for communicating in a second communication mode. The multimodal list of transceiver devices is received by the remote terminal in a communication mode of the remote terminal.

[0009] In a further embodiment, a system for providing a multimodal list of transceiver devices to a remote terminal is disclosed. The system includes means for retrieving a location of a remote terminal as well as means for identifying a first transceiver device for communicating in a first communication mode and a second transceiver device for communicating in a second communication mode. The first and second transceiver devices are located within communication range of the remote terminal. The system also includes means for generating the multimodal list of transceiver devices comprising the first and second transceiver devices. The multimodal list of transceiver devices contains, at least, a transceiver device identifier and a communication mode for each of the first and second transceiver devices. Means for transmitting the multimodal list of transceiver devices to the remote terminal are provided.

[0010] In another embodiment, a system for identifying transceiver devices for communicating with a remote terminal is disclosed. The system includes means for communicating information away from the remote terminal. The information communicated away from the terminal represents a plurality of communication modes of the remote terminal. Means for receiving a multimodal list of transceiver devices are included. The multimodal list of transceiver devices contains information about a first transceiver device for communicating in a first communication mode and information about a second transceiver devices for communicating in a second communication

mode. In addition, the multimodal list of transceiver devices is tailored to a location of the remote terminal. Means for storing the multimodal list of transceiver devices in a memory accessible to the remote terminal are included.

[0011] Further areas of applicability of the present invention will become apparent from the detailed description provided hereinafter. It should be understood that the detailed description and specific examples, while indicating various embodiments of the invention, are intended for purposes of illustration only and are not intended to necessarily limit the scope of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] The present disclosure is described in conjunction with the appended figures:

FIG. 1 is a diagram of a multimodal communication system showing interaction between mobile devices and base stations.

FIG. 2 is a diagram of a multimodal communication system showing various transceiver devices within a communication range of a mobile device.

FIGS. 3A and 3B show base stations in communication with a base station controller as part of a multimodal communication system.

FIGS. 4A and 4B are block diagrams depicting base stations configured to operate in a multimodal communication system.

FIGS. 5A and 5B are block diagrams depicting mobile devices configured to operate in a multimodal communication system.

FIGS. 6A and 6B are flow diagrams illustrating a process of providing a multimodal list of transceiver devices to a remote terminal.

FIG. 7 is a flow diagram of a process by which transceiver devices are identified for communicating with a remote terminal.

FIG. 8 is a block diagram of a system for providing a multimodal list of transceiver devices to a remote terminal.

FIG. 9 is a block diagram of a system for identifying transceiver devices for communicating with a remote terminal.

[0013] In the appended figures, similar components and/or features may have the same reference label. Further, various components of the same type may be distinguished by following the reference label by a dash and a second label that

distinguishes among the similar components. If only the first reference label is used in the specification, the description is applicable to any one of the similar components having the same first reference label irrespective of the second reference label.

DETAILED DESCRIPTION

[0014] The ensuing description provides preferred exemplary embodiment(s) only, and is not intended to limit the scope, applicability or configuration of the invention. Rather, the ensuing description of the preferred exemplary embodiment(s) will provide those skilled in the art with an enabling description for implementing a preferred exemplary embodiment of the invention. It being understood that various changes may be made in the function and arrangement of elements without departing from the spirit and scope of the invention as set forth in the appended claims.

[0015] Specific details are given in the following description to provide a thorough understanding of the embodiments. However, it will be understood by one of ordinary skill in the art that the embodiments may be practiced without these specific details. For example, circuits may be shown in block diagrams in order not to obscure the embodiments in unnecessary detail. In other instances, well-known circuits, processes, algorithms, structures, and techniques may be shown without unnecessary detail in order to avoid obscuring the embodiments.

[0016] Also, it is noted that the embodiments may be described as a process which is depicted as a flowchart, a flow diagram, a data flow diagram, a structure diagram, or a block diagram. Although a flowchart may describe the operations as a sequential process, many of the operations can be performed in parallel or concurrently. In addition, the order of the operations may be re-arranged. A process is terminated when its operations are completed, but could have additional steps not included in the figure. A process may correspond to a method, a function, a procedure, a subroutine, a subprogram, etc. When a process corresponds to a function, its termination corresponds to a return of the function to the calling function or the main function.

[0017] As disclosed herein, the term "storage medium" may represent one or more devices for storing data, including read only memory (ROM), random access memory (RAM), magnetic RAM, core memory, magnetic disk storage mediums, optical storage mediums, flash memory devices and/or other machine readable mediums for storing

information. The term "machine-readable medium" includes, but is not limited to portable or fixed storage devices, optical storage devices, wireless channels and various other mediums capable of storing, containing or carrying instruction(s) and/or data.

[0018] Moreover, embodiments may be implemented by hardware, software, firmware, middleware, microcode, hardware description languages, or any combination thereof. When implemented in software, firmware, middleware or microcode, the program code or code segments to perform the necessary tasks may be stored in a machine readable medium such as storage medium. A processor(s) may perform the necessary tasks. A code segment or machine-executable instructions may represent a procedure, a function, a subprogram, a program, a routine, a subroutine, a module, a software package, a class, or any combination of instructions, data structures, or program statements. A code segment may be coupled to another code segment or a hardware circuit by passing and/or receiving information, data, arguments, parameters, or memory contents. Information, arguments, parameters, data, etc. may be passed, forwarded, or transmitted via any suitable means including memory sharing, message passing, token passing, network transmission, etc.

[0019] FIG. 1 is a diagram of a multimodal communication system. In this system, a mobile device 112-1, 112-2, 112-3, 112-4 exchanges voice and/or data communications with surrounding transceiver devices 108, 110, 112, 116, 120 according to a communication mode and a communication range of the mobile device 112. Transceivers devices 108, 110, 112, 116, 120 support different communication modes or combinations of communication modes. As used herein, transceiver devices include such things as cellular base stations, various radio networks, wireless wide area networks, wireless local area networks, wireless personal area networks, mesh networks, Bluetooth devices, and other communication devices that can exchange voice and/or data communications with a mobile device or fixed-location device. [0020]

Some transceivers 108, 110, 112, 116, 120 can operate in mesh, point-to-point and star network modes. For example, the fourth mobile device 112-4 can communicate in a mesh or peer-to-peer fashion with the second and third mobile devices 112-2, 112-3. In this way, the fourth mobile device 112-4 can communicate with the second or third base stations 108-2, 108-3. Additionally, the fourth mobile device could communicate directly with base stations 108 when within a cellular region 102, 104,

106 in a star mode. With a transceiver 108, 110, 112, 116, 120 that operates in multiple communication modes, some modes may be star and other modes mesh. A multimodal list for a mobile device 112 could include transceivers 108, 110, 112, 116, 120 that operate mesh, point-to-point and star network modes.

[0021] In this embodiment, mobile devices 112 are cellular telephones and each mobile device 112-1, 112-2, 112-3 is capable of communicating in at least two different communication modes. Communication modes may include, for example, various combinations of CDMA (Code Division Multiple Access), WCDMA (Wideband Code Division Multiple Access), GSM (Global System for Mobile communication), TDMA (Time Division Multiple Access), OFDM (Orthogonal Frequency Division Multiplexing), GPRS (General Packet Radio Service), EV-DO (Evolution Data Optimized), WUSB (Wireless Universal Serial Bus), UWB (Ultra-Wideband), WiFi™ (IEEE 802.11), WiMAX (IEEE 802.16), ZigBee™, and/or satellite protocols. In other embodiments, mobile devices may be different and may include such things as child or parolee monitors, navigational equipment, personal navigation devices (PND), tracking devices, wireless pagers, wireless computers, smartphones, voice over IP (VOIP) terminals and terminal adapters, personal computers, laptops, and personal data assistants.

[0022] As illustrated, each mobile device 112-1, 112-2, 112-3 communicates with a base station 108-1, 108-2, 108-3 according to a location of the mobile device 112. In addition, each base station 108 has a footprint that defines a communication range of the base station. For example, base station 108-1 communicates with devices in cellular region 102 whereas base station 108-2 communicates with devices in cellular region 104. In some embodiments, cellular regions 102, 104, 106 are further divided into sectors and base stations 108 are configured to communicate with mobile devices 112 located in a particular sector of a cellular region 102, 104, 106.

[0023] Upon activation, a mobile device 112 may listen for a base station 108 or other transceiver device 110, 112, 116, 120 in its surrounding environment. For example, mobile device 112-1 may listen for a signal from base station 108-1 when the mobile device 112-1 is first activated. When the signal is detected, mobile device 112-1 may transmit identifying information to base station 108-1. The identifying information may

specify, for example, capabilities of the mobile device 112, including communication modes supported by the mobile device 112. Alternatively, the identifying information may be a shorthand description of a type of mobile device 112, for example, a serial number or model number. In this case, base station 108-1 (or another remote entity connected to the base station 108-1) may use the shorthand description to access additional information about mobile device 112-1 from a device capabilities database.

[0024] Base station 108-1 also retrieves a geographic position of mobile device 112-1. In some embodiments, the geographic position of mobile device 112-1 is provided to base station 108-1 by the use of a global positioning satellite system. In other embodiments, the geographic position may be determined using a ranging signal and may involve interaction with one or more different transceiver devices 108, 110, 112, 116, 120 within a communication range of mobile device 112-1. In still further embodiments, mobile device 112-1 may assist in the process of determining its location by sending positioning data to the transceiver device 108, 110, 112, 116, 120. In yet another example, the position of the mobile device 112-1 may be derived from the identity (or knowledge) of the transceiver device 108, 110, 112, 116, 120 in communication with the mobile device 112-1. Knowing the location and communication range of the transceiver device 108, 110, 112, 116, 120 allows approximating a location of the mobile device 112-1 since the mobile device 112-1 is in communication range of the transceiver device 108, 110, 112, 116, 120.

[0025] When mobile device 112-1 has been identified and its geographic location has been determined, base station 108-1 or some other transceiver device 108, 110, 112, 116, 120 generates a multimodal list of transceiver devices within a likely communication range of mobile device 112-1. The multimodal list includes information about one or more transceiver devices 108, 110, 112, 116, 120 that communicate in any of the different communication modes supported by the mobile device 112-1. In some embodiments, information contained in the multimodal list includes a transceiver device identifier and a communication mode of the transceiver device. In other embodiments, the multimodal list may include additional, connection-oriented information. For example, information about a WiFi access point may include an SSID, an IP address and an operating frequency. Some embodiments include locations for the other transceiver devices 108, 110, 112, 116, 120 in the multimodal list. In one example,

geographic location determination may involve identification of the base station 108 or transceiver 110, 112, 116, 120 in communication with the mobile device 112-1.

[0026] Base station 108-1 transmits the multimodal list of transceiver devices to mobile device 112-1. In other embodiments, any transceiver device 108, 110, 112, 116, 120 within communication range of the mobile device 112-1 could send the multimodal list. The multimodal list of transceiver devices may include all transceiver devices 108, 110, 112, 116, 120 known to base station 108-1 that are within a likely communication range of mobile device 112-1 or a subset of these transceiver devices. For example, base station 108-1 may have access to information about transceiver devices in cellular region 102 and adjoining cellular regions 104, 106. Based upon the location of mobile device 112-1 and a range of each communication mode of each transceiver device 108, 110, 112, 116, 120, base station 108-1 may determine that transceivers 116-1, 120-1, and 110-1 are within a likely communication range of mobile device 112-1. Alternatively, any of the transceiver devices 108, 110, 112, 116, 120 may have access to the information about other transceiver devices and provide it to the mobile device 112-1 when the mobile device is in the communication range of that transceiver.

[0027] In some embodiments, base station 108-1 includes all transceivers in the multimodal list without regard to communication modes of mobile device 112-1. Thus, for example, mobile device 112-1 may receive information about Bluetooth™ transceivers in a multimodal list regardless of whether the mobile device 112-1 can communicate with Bluetooth™ devices. Other embodiments, however, tailor the multimodal list according to communication modes of mobile device 112-1. In this situation, Bluetooth™ transceivers would not be included in the multimodal list if mobile device 112-1 lacked the ability to communicate with these devices. In general, however, the multimodal list includes information about transceiver devices 108, 110, 112, 116, 120 for communicating in at least two different communication modes.

[0028] In one embodiment, the multimodal list may eliminate the need for mobile device 112-1 to scan communication modes for transceiver devices 108, 110, 112, 116, 120 upon changing location. This may save time and battery power and may help to avoid service interruptions. For example, by referring to the multimodal list, mobile device 112-1 may be able to quickly hop among individual WiFi™ access points as it

moves through a metropolitan area. Similarly, mobile device 112-1 may be able to rapidly transition between communicating with a Bluetooth™ device, cellular base station, and WiFi™ access point without separately scanning for transceiver devices in each of these communication modes. In some embodiments, base station 108-1 prioritizes the multimodal list of transceiver devices according to a communication mode of a transceiver device, a relative location of the transceiver device, favored communication modes, roaming partners in a service agreement, and/or user-specified criteria.

[0029] FIG. 2 is a multimodal communication system showing transceivers disposed in an operating environment of a mobile device 212. Multiple transceiver devices 208, 210, 216, 220, 228 for exchanging voice and data communications in different communication modes are shown at various distances from mobile device 212. Initially, mobile device 212 may be unaware of the surrounding transceiver devices 208, 210, 216, 220, 228 or may lack the information needed to communicate with these transceiver devices 208, 210, 216, 220, 228. This embodiment is able to communicate between the mobile device 212 and a satellite 228 in one communication mode as explained more fully below.

[0030] As shown, mobile device 212 is capable of communicating in three different communication modes in this embodiment. The communication range of these different communication modes is represented by concentric circles 224-1, 224-2, 224-3 extending from a location of the mobile device 212 that generally indicate the theoretical range of the communication modes. A first concentric circle 224-1 corresponds to a short-range communication mode of mobile device 212 and may include, for example, communications from Bluetooth™ devices. Thus, the radius of concentric circle 224-1 may be approximately ten meters to signify a range over which Bluetooth™ and other personal area devices normally communicate. Bluetooth™ devices 216 located within concentric circle 224-1 are potentially within a communication range of mobile device 212, whereas Bluetooth™ devices 216 located outside concentric circle 224-1 may be beyond the communication range of mobile device 212. As illustrated, Bluetooth™ device 216-1 is within a likely communication

range of mobile device 212 whereas Bluetooth™ devices 216-2 and 216-3 are outside of this communication range.

[0031] A second concentric circle 224-2 corresponds to an intermediate-range communication mode of mobile device 212 and may include, for example, WiFi™ communications. Thus, the diameter of second concentric circle 224-2 may be approximately 100 meters to signify the range over which these and other local area devices normally communicate. WiFi™ access points 220 located within second concentric circle 224-2 are potentially within a communication range of mobile device 212, whereas WiFi™ access points 220 located outside first concentric circle 224-1 may be beyond the communication range of mobile device 212. As illustrated, two WiFi™ access points 220-1, 220-2 are within a likely communication range of mobile device 212 whereas another WiFi™ access point 220-3 is outside of this communication range.

[0032] A third concentric circle 224-3 corresponds to a longer-range communication mode of mobile device 212. The third concentric circle 224-3 includes base station 208. In this embodiment, the base station 208 is a fully functioning cellular base station or another wide area transceiver able to exchange voice and/or data communications in a communication mode of mobile device 212.

[0033] In some embodiments, even longer-range communication modes may be also supported by the mobile device 212, for example, satellite 228 communication. In this case, other measurement techniques, such as a signal strength, may be used to determine whether satellite 224 is within communication range of mobile device 212. An even larger concentric circle would be configured for the satellite 228.

[0034] Mobile device 212 sends identifying information to base station 208 (or some other transceiver) upon detecting that it is within a communication range of the base station 208. After receiving identifying information, base station 208 retrieves a location of mobile device 212 and identifies transceiver devices for inclusion in the multimodal list. Although, in some embodiments, base station 208 has access to transceiver device information for a large number of transceivers, it may select only those transceivers within a likely communication range of mobile device 212 for inclusion in the multimodal list. As illustrated, these transceivers may include Bluetooth™ device 216-1, WiFi™ access points 220-1, 220-2 and base station 208.

Generally, the multimodal list includes transceiver devices for communicating in at least two different communication modes.

[0035] In the preceding embodiment, base station 208 generated the multimodal list and transmitted it to mobile device 212. It is understood, however, that these activities may be performed by any of the various transceiver devices or by any combination of transceiver devices. Thus, for example, the multimodal list of transceiver devices might be generated by a computer connected to a wireless wide-area network and transmitted to a mobile device located within a communication range of the wireless wide-area network. Similarly, a WiFi™ access point may be configured to provide a multimodal list of transceivers to mobile devices located within its communication range. A mobile device located in overlapping communication ranges may potentially receive multimodal lists in each of its communication modes.

[0036] Not every mobile device 212 supports every communication mode for the transceiver devices 208, 210, 216, 220, 228. In this embodiment, a WiFi™ base station 210 is not supported by the mobile device 212. WiFi™ base stations 210 might be excluded from the multimodal list for the mobile device 212. Alternatively, the multimodal list may include the WiFi™ base station 210 and just be ignored by the mobile device 212.

[0037] FIG. 3A shows a multimodal communication system including an arrangement of base stations 308 communicating with a base station controller 316. Mobile devices 212 communicate with base stations 308 according to their respective locations. Base stations 308, in turn, communicate with base station controller 316, which is responsible for generating the multimodal list of transceiver devices. The base station controller 316 includes a processor 320, positioning data 328 and transceiver device data 324.

[0038] In this embodiment, individual base stations 308 provide identifying data from mobile devices 212 to base station controller 316. Processor 320 located within base station controller 316 is configured to generate a multimodal list of transceiver devices using information contained in one more databases or otherwise recorded on a storage medium. Thus, for example, processor 320 may query positioning data database 328 and indicate a location of a mobile device. This query may return transceiver device

identifiers for all transceiver devices within a likely communication range of the mobile device location regardless of whether the mobile device can communicate in all those transceiver devices.

[0039] Processor 320 may then query a database of transceiver device information 324 with the transceiver identifiers to retrieve a list of the communication modes the mobile device 212 is capable of using. Base station controller 316 may cull the transceiver devices returned from the positioning data database 328 according to the communication modes of the mobile device to determine a multimodal list. The tailored multimodal list is returned to the base station 308 for transmission to the mobile device 212. The multimodal list of transceiver devices transmitted to the mobile device 212 generally includes transceiver devices for communicating in at least two different communication modes. In an alternative embodiment, a mobile switch center or some other core network entity may be responsible for generating the multimodal list of transceiver devices.

[0040] **FIG. 3B** shows a further embodiment of a multimodal communication system in which base stations 308 communicate with a base station controller 316. In this embodiment, base station controller 316 is networked to data source 340. Network interface 332 receives commands and data from processor 320 and transmits them via network 336. These commands may represent requests for multimodal lists of transceivers. The data may include information identifying the requesting base station 308 and the mobile device 212 for which the multimodal list is to be generated.

[0041] Data source 340 may be adapted to receive commands and data from multiple base station controllers 316 at its network interface 344. This feature may enable implementation of a hierarchical coverage scheme. For example, an individual base station 308 may be responsible for receiving identifying information from mobile devices 212 in a particular cellular region. Base stations 308 serving one or more cellular regions may communicate with a designated base station controller 316. Groups of base station controllers 316 may serve a particular geographic area, and data source 340 may contain transceiver device information for all known transceivers located in the geographic area.

[0042] Data source 340 includes network interface 344, processor 348 and transceiver device database 352. Transceiver device database 352 may include one or more databases accessible to processor 348. These databases may be recorded on various storage media. In general, transceiver device database 352 will include an identifier and a geographic location. However, data source 340 may also store additional information, including communication mode(s), availability and usage statistics, for each transceiver device entry. Network 336 may be a circuit switch network, a packet switch network and/or an IP network.

[0043] FIG. 4A is a block diagram of a base station 208 configured to operate in a multimodal communication system. Base station 208 includes antenna 404 and transceiver 408 for exchanging communications with mobile devices 212. As illustrated, transceiver 408 operates in a single communication mode. This embodiment may, for example, represent a cellular base station that has been configured to generate a multimodal list of transceiver devices. Base station 208 receives identifying information from a mobile device 212. This identifying information is transmitted within a communication range of the base station 208 and using the communication mode of the base station 208.

[0044] Processor 412 receives the identifying information from transceiver 408 and activates positioning unit 416. Positioning unit 416 determines an approximate geographic location of the mobile device 212 and returns positioning data to processor 412. Positioning unit 416 may determine the location of the mobile device by using global positioning satellite system and/or relying on terrestrial range finding signals. In some embodiments, positioning data is included with the identifying information received from the mobile device 212. Thus, for example, a mobile device 212 may assist base station 208 to locate its position by providing base station 208 with information about other transceiver devices in its operating environment.

[0045] Processor 412 identifies transceiver units within a likely communication range of the mobile device 212 by querying transceiver information database 428. Transceiver information database 428 stores transceiver device information for a plurality of transceivers communicating in various communication modes. For example, among other things, transceiver information database 428 may include transceiver information for cellular base stations, radio access networks, wireless wide-

area networks, WiFi™ access points, Bluetooth™ devices, and personal area networks. Each entry in transceiver information database 428 may include a transceiver device identifier, a location of the transceiver device, and a communication mode(s) of the transceiver device.

[0046] In some embodiments, transceiver information database 428 stores positioning data corresponding to a likely communication region for each transceiver device. The communication region may be centered at the physical location of the transceiver device and sized according to a communication mode of the transceiver device. In some embodiments, the communication region is expressed as a set of positioning coordinates that define a region inclosing all points within a likely communication range of the transceiver device. Thus, for example, transceiver information database 428 may contain an entry for a WiFi™ access point including a set of positioning coordinates that define a communication region represented by a circle comprising all points within 100 meters of where the access point is located. Using positioning data from positioning unit 416, processor 412 may determine whether a mobile device is located within this communication region. If the mobile device is within the communication region, information about the transceiver may be included in a multimodal list of transceiver devices. Otherwise, processor 412 may determine that the transceiver device is not within a likely communication range of the mobile device. In this case, information about the transceiver device would not be included in the multimodal list. In another embodiment, the positioning unit 416 and/or transceiver information database 428 may be remotely connected to the base station 208 using a network, for example.

[0047] After transceivers within a likely communication range of the mobile device have been identified, processor 412 generates a multimodal list containing transceiver device information. The multimodal list includes information about transceiver devices for communicating in at least two different communication modes and may include a transceiver identifier and a communication mode for each transceiver device. In some embodiments, processor 412 filters the transceiver devices determined to be within a communication range of a mobile device according to communication modes of the mobile device. For example, a mobile device may supply a list of its communication modes with the identifying information provided to base station 208. Processor 412 may exclude transceiver devices that do not communicate in a communication mode of

the mobile from the multimodal list. This tailored multimodal list is then transmitted from base station 208 to the mobile device.

[0048] FIG. 4B is a further embodiment of a base station configured to operate in a multimodal communication system. Base station 308 includes two transceivers 408-1, 408-2 corresponding to different communication modes and also includes device capabilities database 424 for determining communication modes of a mobile device. In this embodiment, base station 308 receives identifying information containing a shorthand description of a mobile device. The identifying information may further include positioning data for the mobile device. Processor 416 queries device capabilities database 424 with the shorthand description to determine communication modes of the mobile device. Positioning information and a list of communication modes for the mobile device is sent over a network via network interface 420. In some embodiments, network interface 420 connects base station 308 to a base station controller which is responsible for identifying transceiver devices within a likely communication range of the mobile device. Processor 416 receives transceiver device information from network interface 420, generates a multimodal list including transceivers for communicating in at least two different communication modes, and transmits the multimodal list to the mobile device.

[0049] FIG. 5A is a block diagram of a mobile device configured to operate in a multimodal communication system. Mobile device 212 includes antenna 504 and separate transceivers 508-1, 508-2 for communicating in two different communication modes. Processor 516 coordinates the exchange of voice and/or data communications through transceivers 508-1, 508-2 and is configured to receive a multimodal list of transceiver devices in either or both of the communication modes. Receiving the multimodal list may involve a sequence of steps that are performed by processor 516 upon activation of the mobile device and at various intervals as the mobile device changes location. Upon activation, for example, processor 516 may listen for base stations in each communication mode. The order in which mobile device 212 listens for base stations may be controlled by device settings or user preferences. For example, a user may specify a preferred communication mode or may express a preference for communicating with a nearest transceiver device in any supported communication mode. When a base station is detected, processor 420 causes identifying information

about mobile device 212 to be transmitted by the transceiver 508 associated with the communication mode in which the base station was detected. In some embodiments, the identifying information may be stored in memory 520 and may include a list of communication modes supported by the mobile device 212. In another example, each transceiver may come with its own antenna optimized for a communication mode supported by the transceiver.

[0050] Mobile device 212 tracks its location with positioning unit 524 and may include positioning data as part of the identifying information it transmits to a detected base station. In some embodiments, positioning unit 524 receives positioning data from a global positioning satellite and may periodically update the positioning data as its location changes. In other embodiments, positioning unit 524 includes a ranging signal for determining the location of mobile device 212 relative to other transceivers in its operating environment. In yet another embodiment, positioning unit 524 determines the identification of the transceiver (or identifications of multiple transceivers) whereby this identification information is used to determine the approximate location of the mobile device 212.

[0051] Processor 516 is also configured to process a multimodal list of transceiver devices. The multimodal list of transceiver devices includes information about transceiver devices for communicating in at least two different communication modes. Transceiver device information generally includes a transceiver identifier and a communication mode for each transceiver device. In some embodiments, the multimodal list may contain information about transceiver devices that do not communicate in a communication mode of the mobile device. In this case, processor 516 filters the multimodal list of transceiver devices according to communication modes of the mobile device. Processor 516 stores the processed multimodal list in memory 520.

[0052] FIG. 5B is a further embodiment a mobile device configured to operate in a multimodal communication system. Mobile device 212 includes separate transceivers 508-1, 508-2, 508-3 for communicating in three different communication modes. In this embodiment, mobile device 212 does not include a positioning unit and must therefore rely upon other transceivers to determine its position.

[0053] **FIG. 6A** is a flow diagram illustrating a process of providing a multimodal list of transceiver devices to a remote terminal or mobile device. In a first block 604, a remote terminal identifier is received. The remote terminal identifier is received in a communication mode of a remote terminal and may represent a plurality of communication modes of the remote terminal. Using the remote terminal identifier, a location of the remote terminal is determined and retrieved in block 608. Various methods of locating the remote terminal are possible, including the use of satellite and/or terrestrial positioning signals.

[0054] In a next block 612, transceiver devices within a communication range of the remote terminal are identified. A database of transceiver device information may be accessed to determine transceiver devices within a likely communication range of the remote terminal. The communication range of each transceiver device is determined according to a communication mode of the transceiver device and may extend radially from the physical location of the transceiver device. If the remote terminal is located within this communication range, the transceiver device may be identified for inclusion in the multimodal list. Otherwise, the transceiver device may not be identified for inclusion in the multimodal list.

[0055] In a next block 616, the multimodal list of transceiver devices is generated. The multimodal list includes transceiver devices for communicating in at least two different communication modes and may include all or a subset of the transceiver devices identified in the preceding block. The multimodal list of communication devices is then transmitted in block 620 to the mobile device using a communication mode of the remote terminal.

[0056] **FIG. 6B** is a flow diagram illustrating another process of providing a multimodal list of transceiver devices to a remote terminal. This process includes a block 610 that retrieves capabilities of the remote terminal. In this block, communication modes of the remote terminal are determined. Communication modes of the remote terminal are used to refine the block of identifying transceiver devices 612 so that only transceiver devices within a communication range of a supported communication mode are selected for inclusion in the multimodal transceiver devices. In this way, the multimodal list of transceiver devices can be tailored to the capabilities of the remote terminal.

[0057] When multimodal lists are generated in some embodiment, the communication range is used. The communication range corresponds to the signal coverage for communication purposes. We note that a transceiver signal coverage for positioning purposes (i.e., positioning range) can be significantly different from the signal coverage for communication purposes (i.e., communication range). Some embodiments may use positioning range when determining multimodal lists. Although we use the "communication range" in parts of the description, the communication range terminology can be alternatively defined as the positioning range in various embodiments.

[0058] FIG. 7 is a flow diagram of a process by which transceiver devices are identified for communicating with a remote terminal. In a first block 704, an identifier is transmitted in a first communication mode. The identifier may represent a request for a multimodal list of transceiver devices and may contain information about the remote terminal. For example, information about the remote terminal may include an address of the remote terminal and device capabilities of the remote terminal. Following transmission of the identifier, the process waits for acknowledgement. This may include listening on a particular operating frequency for an acknowledgement message addressed to the remote terminal. If the transmission is acknowledged in block 708, a multimodal list of transceiver devices is received in the first communication mode in block 712. The multimodal list is then stored in a memory in block 728 and the acquisition process terminates in block 732.

[0059] If the first transmission is not acknowledged, the identifier is retransmitted in a second communication mode in block 716. This may occur, for example, if a preset amount of time passes without acknowledgement in the first communication mode. After the identifier is transmitted in the second communication mode, the process waits for an acknowledgement in the second communication mode in block 720. If the acknowledgement is received, a multimodal list of transceiver devices is received in the second communication mode in block 724. The multimodal list is stored in a memory in block 728 and the acquisition process terminates in block 732. If, however, the transmission in the second communication mode is not acknowledged, the acquisition process terminates unsuccessfully in block 732. This process can continue for a preset

number of retries either until acknowledgement is received in one of the communication modes or the total predetermined acquisition process is exceeded.

[0060] **FIG. 8** is a block diagram of a system for providing a multimodal list of transceiver devices to a remote terminal. The system includes means for retrieving a location of a remote terminal 804 (e.g., a datalink, a wireless link, a database interface, a network) as well as means for identifying (e.g., a processor or state machine) a first transceiver device for communicating in a first communication mode and a second transceiver device for communicating in a second communication mode 808. The first and second transceiver devices are located within communication range of the remote terminal. The system also includes means for generating the multimodal list of transceiver devices (e.g., a processor or state machine) comprising the first and second transceiver devices 812. The multimodal list of transceiver devices contains, at least, a transceiver device identifier and a communication mode for each of the first and second transceiver devices. Means for transmitting (e.g., a wired or wireless communication link) the multimodal list of transceiver devices to the remote terminal are also provided 816.

[0061] **FIG. 9** is a block diagram of a system for identifying transceiver devices for communicating with a remote terminal. The system includes means for communicating information away from the remote terminal 904, for example, a wireless transmitter of some configuration. The information communicated away from the terminal represents a plurality of communication modes of the remote terminal. Means for receiving a multimodal list of transceiver devices (e.g., a receiver of some sort) are included 908. The multimodal list of transceiver devices includes information about a first transceiver device for communicating in a first communication mode and information about a second transceiver device for communicating in a second communication mode. The multimodal list of transceiver devices is tailored to a location of the remote terminal or a geographic region associated with the location of a remote terminal. The system also includes means for storing (e.g., a storage medium) the multimodal list of transceiver devices 912 in a memory accessible to the remote terminal.

[0062] While the principles of the disclosure have been described above in connection with specific apparatuses and methods, it is to be clearly understood that this description is made only by way of example and not as limitation on the scope of the disclosure.

CLAIMS

WHAT IS CLAIMED IS:

1. A method of providing a multimodal list of transceiver devices to a remote terminal, the method comprising:

retrieving a location of a remote terminal, wherein:

the remote terminal is able to communicate with a plurality of transceiver devices, and

the remote terminal communicates in at least two communication modes;

identifying a first transceiver device for communicating in a first communication mode and a second transceiver device for communicating in a second communication mode, wherein:

the first and second transceiver devices are located within communication range of the remote terminal, and

the first and second communication modes are different;

generating the multimodal list of transceiver devices comprising the first and second transceiver devices, the multimodal list of transceiver devices containing a transceiver identifier and a communication mode for each of the first and second transceiver devices; and

transmitting the multimodal list of transceiver devices to the remote terminal.

2. The method of providing a multimodal list of transceiver devices to a remote terminal recited in claim 1, further comprising retrieving information about communication modes of the remote terminal and tailoring the multimodal list of transceiver devices according to the communication modes of the remote terminal.

3. The method of providing a multimodal list of transceiver devices to a remote terminal recited in claim 1, wherein the identifying step includes sub-steps of:

determining that the first transceiver device is likely within a communication range of the remote terminal operating in the first communication mode, and

determining that the second transceiver device is likely within a communication range of the remote terminal operating in the second communication mode.

4. The method of providing a multimodal list of transceiver devices to a remote terminal recited in claim 1, wherein the first and second transceiver devices include at least one of a cellular base station, radio access network, WiFi access point, Bluetooth device, router, wide-area network, local-area network, and personal-area network.

5. A method of identifying transceiver devices for communicating with a remote terminal, the method comprising:

communicating information away from the remote terminal, the information corresponding to a plurality of communication modes of the remote terminal;

receiving a multimodal list of transceiver devices, wherein:

the a multimodal list of transceiver devices includes information about a first transceiver device for communicating in a first communication mode and information about a second transceiver device for communicating in a second communication mode, and

the multimodal list of transceiver devices is tailored to a location of the remote terminal; and

storing the multimodal list of transceiver devices in a memory accessible to the remote terminal.

6. The method of identifying transceiver devices for communicating with a remote terminal recited in claim 5, further comprising communicating a location of the remote terminal away from the remote terminal.

7. The method of identifying transceiver devices for communicating with a remote terminal recited in claim 5, wherein the multimodal list of transceiver devices includes a transceiver identifier and a communication mode for each transceiver device.

8. The method of identifying transceiver devices for communicating with a remote terminal recited in claim 5, wherein the multimodal list of transceiver devices is tailored according to communication modes of the remote terminal.

9. The method of identifying transceiver devices for communicating with a remote terminal recited in claim 5, wherein the communication modes of the remote terminal include at least two of CDMA (Code Division Multiple Access), WCDMA (Wideband Code Division Multiple Access), GSM (Global System for Mobile communication), TDMA (Time Division Multiple Access), OFDM (Orthogonal Frequency Division Multiplexing), GPRS (General Packet Radio Service), EV-DO (Evolution Data Optimized), WiFi (IEEE 802.11), WiMAX (IEEE 802.16), WUSB (Wireless Universal Serial Bus), Bluetooth, ZigBee, UWB (Ultra-Wideband), and satellite protocols.

10. The method of identifying transceiver devices for communicating with a remote terminal recited in claim 5, further comprising a step of filtering the multimodal list of transceiver devices based, at least in part, upon communication modes of the remote terminal.

11. A system for providing a multimodal list of transceiver devices to a remote terminal, the system comprising:

a positioning unit for determining a location of the remote terminal;

a database of transceiver device information, the transceiver device information including at least a transceiver identifier, a location of the transceiver device, and a communication mode of the transceiver device;

a processor configured to retrieve transceiver device information from the database and to create a multimodal list of transceiver devices, wherein:

the multimodal list of transceiver devices includes information about a first transceiver device having a first communication mode and a second transceiver device having a second communication mode, and

the multimodal list of transceiver devices is tailored to the location of the remote terminal; and

a transceiver configured to transmit the multimodal list of transceiver devices to the remote device using a communication mode of the remote device.

12. The system for providing a multimodal list of transceiver devices to a remote terminal recited in claim 11, wherein the processor is further configured to retrieve information about communication modes of the remote terminal and to tailor the multimodal list of transceiver devices according to the communication modes of the remote terminal.

13. The system for providing a multimodal list of transceiver devices to a remote terminal recited in claim 11, wherein the processor determines that the first transceiver device is likely within a communication range of the remote terminal operating in the first communication mode, and that the second transceiver device is likely within a communication range of the remote terminal operating in the second communication mode.

14. The system for providing a multimodal list of transceiver devices to a remote terminal recited in claim 11, wherein the database of transceiver device information comprises a plurality of single-modal databases, each single-modal database containing information about transceiver devices for communicating in a same communication mode.

15. A system for identifying transceiver devices for communicating with a remote terminal, the system comprising:

a first transceiver for communicating in a first communication mode;

a second transceiver for communicating in a second communication mode;

a processor coupled with the first and second transceivers and configured to process communications in the first and second communication modes; and

a memory coupled with the processor for storing a multimodal list of transceiver devices, wherein:

the multimodal list of transceiver devices includes
information about a first transceiver device for communicating in a first

communication mode and information about a second transceiver device for communicating in a second communication mode, and

the multimodal list of transceiver devices is received by the remote terminal in a communication mode of the remote terminal.

16. The system for identifying transceiver devices for communicating with a remote terminal recited in claim 15, wherein the multimodal list of transceiver devices is tailored according to a communication range of the remote terminal.

17. The system for identifying transceiver devices for communicating with a remote terminal recited in claim 15, wherein the multimodal list of transceiver devices is tailored according to communication modes of the remote terminal.

18. The system for identifying transceiver devices for communicating with a remote terminal recited in claim 17, wherein the communication modes of the remote terminal include at least two of CDMA, WCDMA, GSM, TDMA, OFDM, GPRS, EV-DO, WiFi, WiMAX, WUSB, Bluetooth, ZigBee, UWB, and satellite communication protocols.

19. The system for identifying transceiver devices for communicating with a remote terminal recited in claim 15, wherein the multimodal list of transceiver devices is received in a message addressed to the remote terminal.

20. A data signal embodied in a carrier wave, the data signal representing a multimodal list of transceiver devices, the multimodal list of transceiver devices comprising:

first transceiver data including a first transceiver identifier and a first communication mode identifier; and

second transceiver data including a second transceiver identifier and a second communication mode identifier, wherein:

the first transceiver data and the second transceiver data form part of a same message,

the first communication mode identifier and the second communication mode identifier correspond to different communication modes, and

the multimodal list of transceiver devices is tailored for a location of a remote terminal.

21. The data signal embodied in a carrier wave recited in claim 20, wherein:

the first transceiver data corresponds to a first transceiver device and the second transceiver data corresponds to a second transceiver device, and

the first and second transceiver devices are located within a communication range of the remote terminal.

22. The data signal embodied in a carrier wave recited in claim 21, wherein the first and second transceiver devices are stationary during normal operation.

23. A system for providing a multimodal list of transceiver devices to a remote terminal, the system comprising:

means for retrieving a location of a remote terminal;

means for identifying a first transceiver device for communicating in a first communication mode and a second transceiver device for communicating in a second communication mode, wherein the first and second transceiver devices are located within communication range of the remote terminal;

means for generating the multimodal list of transceiver devices comprising the first and second transceiver devices, the multimodal list of transceiver devices containing a transceiver device identifier and a communication mode for each of the first and second transceiver devices; and

means for transmitting the multimodal list of transceiver devices to the remote terminal.

24. The system for providing a multimodal list of transceiver devices to a remote terminal recited in claim 23, further comprising:

means for retrieving information about communication modes of the remote terminal, and

means for tailoring the multimodal list of transceiver devices according to the communication modes of the remote terminal.

25. The system for providing a multimodal list of transceiver devices to a remote terminal recited in claim 23, further comprising:

means for determining that the first transceiver device is likely within a communication range of the remote terminal operating in the first communication mode, and

means for determining that the second transceiver device is likely within a communication range of the remote terminal operating in the second communication mode.

26. The system for providing a multimodal list of transceiver devices to a remote terminal recited in claim 23, further comprising means for transmitting the multimodal list of transceiver devices to the remote terminal in a message addressed to the remote terminal.

27. The system for providing a multimodal list of transceiver devices to a remote terminal recited in claim 23, wherein the first and second transceiver devices include at least one of a cellular base station, radio access network, WiFi access point, Bluetooth device, router, wide-area network, local-area network, and personal-area network.

28. A system for identifying transceiver devices for communicating with a remote terminal, the system comprising:

means for communicating information away from the remote terminal, the information representing a plurality of communication modes of the remote terminal;

means for receiving a multimodal list of transceiver devices, wherein:

the multimodal list of transceiver devices includes information about a first transceiver device for communicating in a first communication mode and information about a second transceiver device for communicating in a second communication mode, and

the multimodal list of transceiver devices is tailored to a location of the remote terminal; and

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means for storing the multimodal list of transceiver devices in a memory accessible to the remote terminal.

29. The system for identifying transceiver devices for communicating with a remote terminal recited in claim 28, further comprising means for communicating a location of the remote terminal away from the remote terminal.

30. The system for identifying transceiver devices for communicating with a remote terminal recited in claim 28, wherein the multimodal list of transceiver devices includes a transceiver identifier and a communication mode for each transceiver device.

31. The system for identifying transceiver devices for communicating with a remote terminal recited in claim 28, further comprising means for tailoring the multimodal list of transceiver devices according to communication modes of the remote terminal.

32. The system for identifying transceiver devices for communicating with a remote terminal recited in claim 28, further comprising means for tailoring the multimodal list of transceiver devices according to a communication range of the remote terminal.

33. A communication device for providing a multimodal list of transceiver devices to a remote terminal, the communication device comprising:

a processor configured to:

retrieve a location of the remote terminal;

identify a first transceiver device for communicating in a first communication mode and a second transceiver device for communicating in a second communication mode, wherein the first and second transceiver devices are located within communication range of the remote terminal;

generate the multimodal list of transceiver devices comprising the first and second transceiver device, the multimodal list containing information about each transceiver device including a

transceiver device identifier and a communication mode of the transceiver device; and

cause the multimodal list of transceiver devices to be transmitted to the remote terminal; and

a memory coupled with the processor and configured to store information about the first and second transceiver devices.

34. The communication device for providing a multimodal list of transceiver devices to a remote terminal recited in claim 33, wherein the processor is further configured to:

retrieve information about communication modes of the remote terminal; and

tailor the multimodal list of transceiver devices according to the communication modes the remote device.

35. The communication device for providing a multimodal list of transceiver devices to a remote terminal recited in claim 33, wherein the processor is further configured to:

determine that the first transceiver device is likely within a communication range of the remote terminal operating in the first communication mode; and

determine that the second transceiver device is likely within a communication range of the remote terminal operating in the second communication mode.

36. The communication device for providing a multimodal list of transceiver devices to a remote terminal recited in claim 33, further comprising a database of transceiver device information and wherein the processor retrieves information about the first and second transceiver devices from the database for inclusion in the multimodal list of transceiver devices.

37. A communication device for receiving a multimodal list of transceiver devices, the communication device comprising:

a processor configured to:

cause information to be transmitted away from the communication device, the information corresponding to a plurality of communication modes of the communication device;

process a multimodal list of transceiver devices received by the communication device, wherein:

the multimodal list of transceiver devices includes information about a first transceiver device for communicating in a first communication mode and information about a second transceiver device for communicating in a second communication mode, and

the multimodal list of transceiver devices is tailored to a location of the communication device; and

store the multimodal list of transceiver devices in a memory accessible to the communication device; and

a memory coupled with the processor and configured to store the multimodal list of transceiver devices.

38. The communication device for-receiving a multimodal list of transceiver devices recited in claim 37, wherein the processor is further configured to cause information about the location of the communication device to be transmitted away from the communication device.

39. The communication device for receiving a multimodal list of transceiver devices recited in claim 37, wherein the multimodal list of transceiver devices includes a transceiver identifier and a communication mode for each transceiver device.

40. The communication device for receiving a multimodal list of transceiver devices recited in claim 37, wherein the multimodal list of transceiver devices is tailored according to communication modes of the communication device.

41. The communication device for receiving a multimodal list of transceiver devices recited in claim 37, wherein communication modes of the communication device include at least two of CDMA, WCDMA, GSM, TDMA,

OFDM, GPRS, EV-DO, WiFi, WiMAX, WUSB, Bluetooth, ZigBee, UWB, and satellite protocols.