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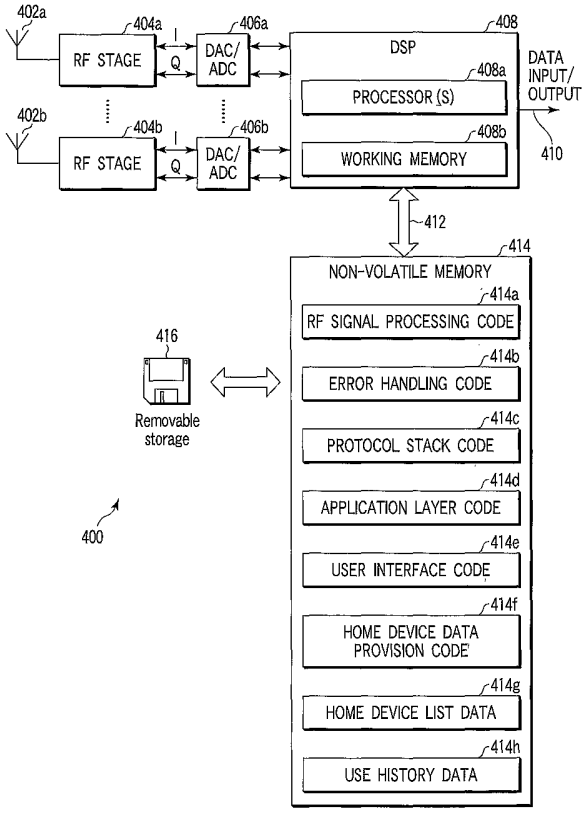
(54) Title: ESTABLISHMENT OF A WIRELESS LINK BY A COMMUNICATIONS DEVICE USING STORED HOME DEVICE DATA PREDICTING A COUNTERPART COMMUNICATIONS DEVICE



(57) Abstract: This invention is generally concerned with wireless communications systems, and more particularly with apparatus, methods and computer program code for establishing wireless communication links. A controller for a mobile wireless communications device, for controlling establishment of a wireless link between the device and a second wireless communications device is described. The controller comprises data memory for storing home device data, the home device data comprising data for establishing a wireless connection with a home second wireless communications device, a data processor coupled to the data memory and configured to control the mobile wireless communications device to attempt to establish the wireless link with the home second wireless communications device, and a data provider for providing the home device data for at least one the home device to the data memory for storage, wherein the home device data comprises data predicting a the home wireless communications device the mobile wireless communications device is likely to connect to as determined from previous use of the mobile wireless communications device.

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D E S C R I P T I O N

ESTABLISHMENT OF A WIRELESS LINK BY A COMMUNICATIONS DEVICE USING STORED HOME DEVICE DATA PREDICTING A COUNTERPART COMMUNICATIONS DEVICE

Technical Field

This invention is generally concerned with wireless communications systems, and more particularly with apparatus, methods and computer program code for establishing wireless communication links.

Background Art

Conventionally, when a cellular or other wireless device is switched on or requires a service, it carries out a search for available infrastructure. In the case of a terminal for a cellular wireless communication system, this may comprise a base station; in the case of a wireless local area network (WLAN) this may comprise a so-called 'Access Point', and in the case of a wireless personal area network (WPAN) it may comprise another device such as a peripheral device with which to communicate. Generally this involves sweeping the RF spectrum to find an appropriate base station (BS) or Access Point or in the case, for example, of a Bluetooth-based WPAN a talk-then-listen inquiry procedure. This can be time-consuming and is a particular problem when the duration of initial synchronisation is significant enough to be observed by a user. For example, in Bluetooth, the default inquiry

procedure has a duration of 10.24 seconds. A further difficulty is encountered with software defined radio (SDR) or multi-mode radio receivers when switching between modes mid-call since in this case there is generally a time constraint.

FIG. 1 shows a flow diagram of a conventional power-up procedure for a terminal of a cellular mobile communication system such as a mobile phone network. Following switch-on at step 10, the terminal checks 12 whether any information was stored when the terminal was last powered down, in particular to determine whether stored information identifying the last serving base station is available.

If no such information is available the procedure performs a conventional initial cell synchronisation (step 14) to attach the terminal to a base station (step 16). Alternatively, where information identifying the last serving base station (or at least its frequency) is available, the terminal attempts to connect to this base station, that is to the cell where the terminal was powered down (step 18) and if successful (step 20) omits the conventional initial cell synchronisation procedure 14. In a similar way, manual pairing of communicating devices may be implemented in a WPAN, for example between a Bluetooth-enabled headset and terminal which will almost exclusively together.

There is room for improvement of these synchronisation techniques, which can still lead to long synchronisation times in certain circumstances. For example, when a terminal is switched on in a different locale to that of the base station which was serving the terminal when it was switched off, say because a user has made a journey, cell synchronisation can show a significant delay. Similarly, in the case of a WPAN, there is often a delay associated with setting up a link, even between devices which have communicated with one another many times in the past.

Disclosure of Invention

Broadly speaking, embodiments of the invention described herein achieve more rapid synchronisation with a base station, access point or WPAN, device based upon the observation that terminal users are relatively predictable in their behaviour. For example users tend to turn on their cellular terminal in one of a relatively few locations or, in the case of a WPAN, using a core device such as a PDA (personal digital assistant) to communicate with a relatively limited set of peripheral devices, such as a digital camera, projector, and/or printer. In reliance on this embodiments of the invention utilise the concept of a home device which may comprise a WPAN device or, for a cellular network, a base station. In the case of a WPAN network, the home device is preferably associated

with a particular service, such as printing, image capture and the like, and thus when a particular service is required this can be mapped onto a home device WPAN address, in a preferred embodiment a Bluetooth address, thus removing the need for an initial device discovery or "inquiry" procedure. In the case of a cellular network, a home base station identifier, for example specifying a frequency and/or code for a home base station, or more preferably a home base station list is employed to direct the terminal towards likely serving base stations, thus in many cases removing the need for a full search of available base stations in the vicinity of a terminal. A similar approach may be employed for a WLAN to allow likely local devices to be paged first.

Thus, according to a first aspect of the present invention, there is provided a controller for a mobile wireless communications device, for controlling establishment of a wireless link between the device and a second wireless communications device, the controller comprising: data memory for storing home device data, the home device data comprising data for establishing a wireless connection with a home second wireless communications device; a data processor coupled to the data memory and configured to control the mobile wireless communications device to attempt to establish the wireless link with the home second wireless

communications device; and a data provider for providing the home device data for at least one the home device to the data memory for storage, wherein the home device data comprises data predicting a the home wireless communications device the mobile wireless communications device is likely to connect to as determined from previous use of the mobile wireless communications device.

The data provider may comprise a manual input interface or means to receive data from an external source or monitoring agent but preferably the data provider is configured to automatically provide the home device data. In an embodiment for use with a cellular network, the home device data may only be employed if the last used base station is not available; alternatively the home device data may comprise data for a plurality of home devices or base stations, one of which comprises the last used base station. Preferably the data memory stores, under processor control, use history data comprising data specific to second wireless communications devices with which the mobile device has previously established a wireless link, optionally including device type data, for use by the data provider in determining the home device data for storage.

When used with a cellular communications network, the home device data may comprise frequency data for

a base station or, in a so-called '3G' system carrier and/or (scrambling) code data for a base station. In a terminal incorporating a multi-mode or software defined radio, a home device may comprise a base station for one or both (or more) or the networks with which the radio operates to allow, for example, more rapid reconfiguration to compensate for gaps in coverage of one or other of the networks.

In a WPAN-based embodiment, the home device data preferably includes data defining a category of a home device, for example, a service category, so that a home device or list of home devices may be selected based upon category determining data such as a service request. This facilitates, for example, rapid connection to one or more home printers, one or more home scanners, one or more home digital cameras and the like. Preferably in a WPAN-based embodiment, the home device data also includes address data for a home device and, optionally estimated clock data for the device, facilitating synchronisation with a home device. Similar techniques may be used for a wireless link to a WLAN.

In WPAN/WLAN-based embodiments, the home device data may include data defining a home device as a fixed location device, such as an access point. Preferably, the controller operates to attempt a connection with a home device before attempting a connection with any

other device.

In another aspect, the invention provides a method for controlling establishment of a wireless link between a mobile wireless communications device and a second wireless communications device, the method comprising: providing the home device data for at least one home second wireless communications device to the data memory for storage, wherein the home device data comprises data predicting a the home second wireless communications device the mobile wireless communication device is likely to connect to determined from previous use of the mobile wireless communications device; and controlling the mobile wireless communications device to attempt to establish a the wireless link with the home second wireless communication device.

The invention further provides processor control code to implement the above-described controllers and methods, in particular on a data carrier such as a disk, CD- or DVD-ROM, programmed memory such as read-only memory (firmware) or on a data carrier such as an optical or electrical signal carrier. Embodiments of the above-described apparatus and methods may be implemented on a DSP (digital signal processor), ASIC (application specific integrated circuit) or FPGA (field programmable gate array). Thus, code to implement the invention may comprise conventional program code, or microcode, or, for example, code for

setting up or controlling an ASIC or FPGA. Similarly, the code may comprise code for a hardware description language such as Verilog (trademark), VHDL (very high speed integrated circuit hardware description language) or SystemC. As the skilled person will appreciate, such code may be distributed between a plurality of coupled components in communication with one another.

These and other aspects of the invention will now be further described, by way of example only, with reference to the accompanying figures in which:

Brief Description of Drawings

FIGS. 1 to 5 show respectively, a flow diagram of a conventional power-up procedure for a terminal of a cellular mobile communication system, an example of a Bluetooth network, an example of a personal area network and associated infrastructure, generic structure of a third generation digital mobile phone system, and an example of a software defined radio;

FIG. 6 shows a first cellular terminal power-up procedure according to an embodiment of the present invention;

FIG. 7 shows a second cellular terminal power-up procedure; and

FIG. 8 shows an example of a generic terminal.

Best Mode for Carrying Out the Invention

At this point it is helpful to review some aspects of wireless personal and local area networks and

aspects of cellular networks.

A personal area network (PAN) may include a number of mobile devices which need to exchange information with each other and with their users. Technologies such as cellular radio, Bluetooth (Trade Mark) (Bluetooth Special Interest Group (SIG), http://www.bluetooth.com/), IrDA (Infrared Data Association (IrDA), http://www.irda.org/) and WLAN (for example Wireless Local Area Network IEEE Standard 802.11, "1999 Edition ISO/IEC 8802-5-1998, Standards for Local and Metropolitan Area Networks - Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) specifications," 1999) may be employed.

FIG. 2 shows an example of a Bluetooth network in which a computer 30, printer 32, and camera 34 are all in communication with one another by means of bidirectional Bluetooth radio links 36. Bluetooth can also be used for wireless connection to high speed voice/data access points.

The Bluetooth group of standards is generally concerned with short range (up to around 10 metres) rf transmission as a replacement for cables and for personal area networks (PANs). The basic standard provides a frequency hopping spread spectrum (FHSS) link operating at 0.7 Mbps (V 1.1) or 10 Mbps (V 1.2); High rate Bluetooth operates at speeds of > 10 Mbps. Bluetooth is primarily a European-initiated standard,

and in the USA the IEEE 802.15 series of standards, in particular IEEE 802.15.3, provides a convergent and planned equivalent set of standards. Some embodiments of the invention will be described with reference to Bluetooth (trademark) but the skilled person will understand that the applications of the invention are not limited to this and related standards.

A PAN need not be restricted to a single technology such as Bluetooth. FIG. 3 shows another example of a PAN and associated network infrastructure. A PAN 100 in the illustrated example comprises a mobile terminal 102, a PDA 104 and a camera 106 in wireless (rf) communication with one another. Mobile terminal 102 is also in communication with a base station 108 of a first 3G mobile phone network 110 which has a gateway 112 to Internet 114. A second mobile terminal 116 carried by a second user is in communication with a second base station 118 of a second 3G mobile phone network 120 with a second gateway 122 to Internet 114. PDA 104 is also in communication with a WLAN 124, such as an IEEE 802.11 WLAN, which is also coupled to Internet 114. As will be appreciated many other systems may be coupled to the Internet, as illustrated first and second third party software developer servers 126, 128, home PCs 130, and one or more m-commerce servers 132. Mobile terminals 102 and 116 may also have a direct line of communication with one another,

as illustrated by dashed line 134, for example via a Bluetooth link.

Next recent WLAN technology will be briefly reviewed using the example of Hiperlan/2, a European standard for a 54 Mbps wireless network with security features, operating in the 5 GHz band and the broadly equivalent IEEE802.11a, a US standard. However this is by way of example only and embodiments of the invention are not limited to such WLANs.

The Hiperlan (High Performance Radio Local Area Network) type 2 standard is defined by a Data Link Control (DLC) Layer comprising basic data transport functions and a Radio Link Control (RLC) sublayer, a Packet based Convergence Layer comprising a common part definition and an Ethernet Service Specific Convergence Sublayer, a physical layer definition and a network management definition. For further details of Hiperlan/2 reference may be made to the following documents, which are hereby incorporated by reference: ETSI TS 101 761-1 (V1.3.1): "Broadband Radio Access Networks (BRAN); HIPERLAN Type 2; Data Link Control (DLC) Layer; Part 1: Basic Data Transport Functions"; ETSI TS 101 761-2 (V1.2.1): "Broadband Radio Access Networks (BRAN); HIPERLAN Type 2; Data Link Control (DLC) Layer; Part 2: Radio Link Control (RLC) sublayer"; ETSI TS 101 493-1 (V1.1.1): "Broadband Radio Access Networks (BRAN); HIPERLAN Type 2; Packet based

Convergence Layer; Part 1: Common Part"; ETSI TS 101 493-2 (V1.2.1): "Broadband Radio Access Networks (BRAN); HIPERLAN Type 2; Packet based Convergence Layer; Part 2: Ethernet Service Specific Convergence Sublayer (SSCS)"; ETSI TS 101 475 (V1.2.2): "Broadband Radio Access Networks (BRAN); HIPERLAN Type 2; Physical (PHY) layer"; ETSI TS 101 762 (V1.1.1): "Broadband Radio Access Networks (BRAN); HIPERLAN Type 2; Network Management". These documents are available from the ETSI website at www.etsi.org.

A typical wireless LAN (Local Area Network) based, for example, on the Hiperlan/2 system. comprises a plurality of mobile terminals (MT) each in radio communication with an access point (AP) or base station of the network. The access points are also in communication with a central controller (CC) which in turn may have a link to other networks, for example a fixed Ethernet-type local area network. In some instances, for example in a Hiperlan/2 network where there is no local access point, one of the mobile terminals may take the role of an access point/central controller to allow a direct MT to MT link (in this document, however, references to a "mobile terminal" and to an "access point" should not be taken to imply any limitation to the Hiperlan/2 system).

Data transmission is also important within mobile phone networks such as 2.5G and 3G (Third Generation)

networks.

Third generation mobile phone networks use CDMA (Code Division Multiple Access) spread spectrum signals for communicating across the radio interface between a mobile station and a base station. These 3G networks, (and also so-called 2.5G networks), are encompassed by the International Mobile Telecommunications IMT-2000 standard (www.ituint, hereby incorporated by reference). Third generation technology uses CDMA (Code Division Multiple Access) and the IMT-2000 standard contemplates three main modes of operation, W-CDMA (Wide band CDMA) direct spread FDD (Frequency Division Duplex) in Europe and Japan, CDMA-2000 multicarrier FDD for the USA, and TD-CDMA (Time Division Duplex CDMA) and TD-SCDMA (Time Division Synchronous CDMA) for China.

Collectively the radio access portion of a 3G network is referred to as UTRAN (Universal Terrestrial Radio Access Network) and a network comprising UTRAN access networks is known as a UMTS (Universal Mobile Telecommunications System) network. The UMTS system is the subject of standards produced by the Third Generation Partnership Project (3GPP, 3GPP2), detailed technical specifications for which can be found at www.3gpp.org and which are also hereby incorporated by reference. These standards include Technical Specification 23.101, which describes a general UMTS

architecture, and Technical Specification 25.101 which describes (FDD) radio transmission and reception, versions 4.0.0 and 3.2.2 respectively of which are specifically incorporated by reference.

FIG. 4 shows a generic structure of a third generation digital mobile phone system at 150. In FIG. 4 a radio mast 152 is coupled to a base station 154 which in turn is controlled by a base station controller 156. A mobile communications device 158 is shown in two-way communication with base station 154 across a radio or air interface 160, known as a Um interface in GSM (Global Systems for Mobile Communications) networks and GPRS (General Packet Radio Service) networks and a Uu interface in CDMA2000 and W-CDMA networks. Typically at any one time a plurality of mobile devices 158 are attached to a given base station, which includes a plurality of radio transceivers to serve these devices.

Base station controller 156 is coupled, together with a plurality of other base station controllers (not shown) to a mobile switching centre (MSC) 162. A plurality of such MSCs are in turn coupled to a gateway MSC (GMSC) 164 which connects the mobile phone network to the public switched telephone network (PSTN) 166. A home location register (HLR) 168 and a visitor location register (VLR) 170 manage call routing and roaming and other systems (not shown) manage

authentication, billing. An operation and maintenance centre (OMC) 169 collects the statistics from network infrastructure elements such as base stations and switches to provide network operators with a high level view of the network's performance. The OMC can be used, for example, to determine how much of the available capacity of the network or parts of the network is being used at different times of day.

The above described network infrastructure essentially manages circuit switched voice connections between a mobile communications device 158 and other mobile devices and/or PSTN 166. So-called 2.5G networks such as GPRS, and 3G networks, add packet data services to the circuit switched voice services. In broad terms a packet control unit (PCU) 172 is added to the base station controller 156 and this is connected to a packet data network such as Internet 178 by means of a hierarchical series of switches. In a GSM-based network these comprise a serving GPRS support node (SGSN) 174 and a gateway GPRS support node (GGSM) 176. It will be appreciated that both in the system of FIG. 4 and in the system described later the functionalities of elements within the network may reside on a single physical node or on separate physical nodes of the system.

Communications between the mobile device 158 and the network infrastructure generally include both data

and control signals. The data may comprise digitally encoded voice data or a data modem may be employed to transparently communicate data to and from the mobile device. In a GSM-type network text and other low-bandwidth data may also be sent using the GSM Short Message Service (SMS).

In a 2.5G or 3G network mobile device 158 may provide more than a simple voice connection to another phone. For example mobile device 158 may additionally or alternatively provide access to video and/or multimedia data services, web browsing, e-mail and other data services. Logically mobile device 158 may be considered to comprise a mobile terminal (incorporating a subscriber identity module (SIM) card) with a serial connection to terminal equipment such as a data processor or personal computer.

Reconfigurable, software defined radio (SDR) concepts have also been the subject of recent, active research (see, for example, "Authorization and use of Software Defined Radio: First Report and Order," U.S. Federal Communication Commission Washington, DC, September 2001). SDR-enabled user devices and network equipment can be dynamically programmed to reconfigure their characteristics to provide improved performance and/or additional features, and hence also offer the opportunity of additional revenue streams for a service provider. Software defined radio has

applications in both civil and commercial and military sectors.

The SDR Forum (Software Defined Radio (SDR) Forum, http://www.sdrforum.org/) has defined an open architecture with a common software API layer with standardised functions. An outline of this arrangement is shown in FIG. 5. In FIG. 5 an SDR comprises a set of seven independent subsystems 182a-g each in turn comprising hardware, firmware, an operating system and software modules which may be common to more than one application. A Control function 184 provides control ('C') over each of the functional blocks, user traffic ('I') comprising data and information being exchanged between the modules. An SDR implementation in a mobile (wireless) terminal is analogous to software running on a generic PC, although for speed some baseband service implementations and control functions interface directly to the hardware layer rather than, say, via an intermediate real-time kernel or drivers. The SDR system of FIG. 5 is suitable for with later described embodiments of methods according to the invention.

Referring now to the implementation of embodiments of the invention, examples will be described for the case of a terminal for a cellular communications network and the case of a WPAN device. Similar concepts can, however, be applied to other wireless systems which search for available resources, such as

wireless LAN systems, satellite services, and the like. We will describe first the use of a home device or base station list and secondly methods for determining data for a home device or base station list.

FIG. 6 shows a cellular terminal power-up procedure using home base station data or a home base station list. Such a home base station list comprises M entries, where M may be one, each entry describing a particular base station, for example in terms of frequency allocation, time slots, code or other parameters. The entries in the home base station list are assumed to relate to locations where the mobile device is likely to be powered up.

Broadly speaking, the mobile terminal searches for the cells named or otherwise identified in the home base station list if the serving base station prior to power-down is not available. Thus, referring to FIG. 6, the terminal is switched on 200 and determines whether information relating to the cell last used when the terminal was previously powered down is available 202. If such information is available, the terminal searches for the base station serving the cell where the terminal was powered-down 204 and attempts to synchronise to this base station. The terminal determines whether synchronisation was successful 206 and, if so, proceeds to operate with this base station 208. If this synchronisation was unsuccessful a

variable n is initialised 210 to zero and then the terminal retrieves entry n from the home base station list and attempts to synchronise to the base station for that entry 212. This procedure is also followed when power-down information for the last-used cell is not available at step 202. The terminal then checks whether synchronisation to the nth base station was successful 214, if not incrementing n 216, checking whether the end of the home base station list has been reached 21 and if not looping back to check the next entry in the list 212. If synchronisation to a base station in the home device list is successful the device proceeds to operate with this base station 218. If the terminal is unable to synchronise with any of the devices in the home base station list the terminal performs a conventional initial cell synchronisation procedure 220.

FIG. 7 shows a simplified cellular terminal power-up procedure in which similar elements to those of FIG. 6 are indicated by like reference numerals. In the procedure of FIG. 7, the base station serving the terminal prior to the last power-down is inserted in the home base station list, in the illustrated example at entry n = 0 in the list. This results in a simplification of the procedure of FIG. 6.

We next describe methods of determining data for the home base station list. One straightforward

approach is for a user to manually programme a terminal with a number of 'favourites' to be inserted into the list. For example, a business user might program in base stations for his or her home, Heathrow and Gatwick Airports, and a common travel destination. Since the user may not know technical parameters such as operating frequency for these base stations such programming may be achieved by the user commanding the terminal to insert a currently serving base station into the list so that, for example, issuing such a command at Heathrow Airport would cause the base station serving the path of Heathrow Airport where the user was located to be inserted into the home base station list. A user may also be provided with an option to set up a 'temporary home' base station to accommodate roaming. More generally, a user may be provided with read/write/edit control of the list.

Although such a manual approach is straightforward to implement, it is preferable that the home base station list is constructed without the need for a user to be involved in the process. There are a number of alternative approaches for achieving this, which may be employed either separately or in combination.

The terminal may keep a record of the cells which are normally chosen on an initial cell search, these base station(s) then forming the basis of a home base station list. Such a list may be dynamic, for example

deleting entries after a pre-determined time, in order to adapt to recent user locales. Another approach is to record the most common base stations that were serving the device when, averaged over a number of occasions, the device was powered down. A further alternative is for home base station data to be received by the terminal over the cellular network. Thus, the network or network operator may program the mobile device or terminal with a number of pre-set base stations such as those corresponding to local airports and, optionally, a base station or an address of the user such as a home address. In a simple embodiment, the home base station list has a single entry for a base station corresponding to a home location of the user (which may be the user's domestic home address or another address such as a business address).

Considering next the example of a WPAN, a home device list may be implemented in a broadly similar manner, again set up either manually or automatically. However, it is preferable for a WPAN or similar network that a WPAN device has a home device or home device list for each of a number of device types, such as a home printer, a home projector and the like. The WPAN device may then determine the service required and map it on to an appropriate home device. It will be appreciated that the WPAN terminal need not exclusively communicate with this peripheral, but rather an attempt

is made to connect to a home peripheral device, for example by paging the device, before a general inquiry scan is implemented.

Consider the implementation of this embodiment in a laptop computer. In many instances, a user will wish to print either from their domestic home or from their business or office, although the home device list need not specify these locations as such. However, by including a printer in the user's domestic home and/or a printer in the user's office in the home device list, the printers in these locations will be paged first, thus potentially significantly reducing the time to set up a wireless communication as a link for printing. However, if the user is in a different location, where there is no response from the 'home printer' or from any device in the 'home printer list', the laptop computer may then perform an inquiry scan in the normal way to find a suitable local device to connect to.

In such an application, the home device list may be determined manually, for example by means of a user interface to allow a user to input data to define a home device, for example address data or by specifying that a currently connected device should be included in the home device list. Alternatively, a home device or device list may be determined automatically by identifying that device or those devices which are used for the longest period of time or most numerously.

As previously described, normally a connection to a home device or devices is attempted prior to attempting a connection to another device of the same type, not in the home device list. In the case of Bluetooth (trademark), this allows the device making the connection to enter the paging procedure without needing a preceding inquiry procedure. Moreover, since the connecting devices have connected in the past, they need not employ the mandatory paging scheme which has to be supported by a Bluetooth device but may employ an optional paging scheme with the aim of more rapidly establishing a connection between the two Bluetooth devices.

In the case of a WLAN, the situation is similar to that described above for a WPAN and, likewise, one or more home devices may be specified for a plurality of different device types, such as a home Access Point, a home printer, and the like.

In the case of a multi-mode or Software Defined Radio application, the terminal preferably maintains a home base station or home base station list for each mode of the radio. This list may be determined, for example, by determining the most frequently serving base station for the terminal in a mode, or the base station most likely to be serving the terminal after a mode switch. For example, when travelling on a regular route, a gap in 3G coverage may always occur in

substantially the same place, prompting handover to the local GSM base station. In such an instance, this GSM base station may then be inserted into the home base station list for a 3G to GSM handover.

This approach reduces the need for time-consuming searches for serving base stations in a new mode of operation, and reduces the need for additional information on available base stations, which such SDRs might otherwise have to employ.

Further details of implementations of embodiments of the invention for a number of different types of wireless communication network will now be given.

A terminal needs to perform a BCCH Broadcast Control Channel power measurement in order to detect a GSM carrier. In addition, if the GSM carrier is to be used as the serving carrier, the SCH Synchronisation Channel and/or FCCH Frequency Correction Channel need to be acquired so that the BCCH can be decoded. This measurement requires two frequency changes (current mode -> $BCCH_{GSM}$ carrier -> current mode), each taking around 500 μs in a typical implementation, and a power sample. Achieving the accuracy required by the GSM recommendations requires a power sample period of less than 200 μs so the total time required for one measurement is 1.2 ms.

This assumes that the terminal has prior knowledge of which frequencies should be measured - otherwise

this process must be repeated as many times as there are GSM carriers. For example there are 499 carriers in a dual-band GSM-900/DCS-1800 deployment (excluding E-GSM) and at 1.2 ms per measurement (even if several measurements were performed in parallel, the terminal has to retune to each GSM carrier), this requires 500*1.2 ms or approximately 600 ms of elapsed measurement time.

This measurement time may be reduced by employing a home base station (or "Home BS") list. The "HomeBS list" maintains a record of the frequency allocation and carrier of likely serving base stations. The carriers within this list are then scanned prior to the conventional approach described above to significantly reduce the time required to establish a link.

Implementation in a UMTS FDD/TDD network:

The UMTS specifications give 'measurement order parameters' for handover/reselection from GSM to UMTS. These are in general the same as for UMTS inter-frequency handover. If the scrambling code of a given carrier is not known in advance (as would often be the case with initial synchronisation), then the following stages are required: Frame timing; Scrambling code identification; and determination of Ec/Io for P-CCPCH (Primary Communication Control Physical Channel) or Ec/No for CPICH (Communication Pilot Channel).

If the scrambling code is known in advance, then the middle stage can be omitted. This entire process should take of the order of thirty to forty milliseconds.

There are nineteen UMTS 5 MHz-wide carriers, which, due to frequency rasters, can be shifted around in the band in 200 kHz steps, giving a potential one hundred and seventy one centre frequencies. Ignoring the complications caused by this frequency raster (on the basis that once one centre frequency has been located, the options for the others are reduced), this requires (19*35 ms), that is 665 ms elapsed measurement time.

With a "Home BS" the "HomeBS list" keeps a record of the carrier and scrambling code of likely serving base stations. The carriers within this list are then scanned prior to the conventional approach described above.

Implementation in a HiperLAN-2/802.11a network:

A terminal attempting to locate and eventually associate with a HiperLAN-2 system has to estimate the link quality from different access points. This estimation is derived by measuring the received signal strength during reception of the Broadcast Channel (BCH). The BCH is transmitted by the Access Point/Central Controller (AP/CC) at the beginning of every MAC frame - that is once every 2 ms. As the

terminal is not synchronised to the AP/CC, the entire MAC frame potentially has to be received, implying a time of 2 ms for a single instantaneous measurement (with no attempts to mitigate the temporary effects of fading). In addition, the (presumed) constant 500 μs for each synthesiser retune must be considered, resulting in 3 ms per measurement. Again, this assumes that the terminal has been targeted at a specific 20 MHz channel. If the terminal is expected to scan multiple channels, this requires (22*3 ms) 66 ms elapsed measurement time as there are 19 HiperLAN-2 channels defined across the bands within which HiperLAN-2 operates.

With a "HomeBS" the "HomeBS list" keeps a record of the frequency allocation and address of likely serving access points or other devices (such as other PCs when operating with the Distributed Coordination Function). Again this list is scanned prior to the conventional approach described above.

Implementation in a Bluetooth (or IEEE 802.15-based) network:

Setting up connections between two Bluetooth devices is carried out in several phases. The first phase is that of finding another device, which is carried out using the inquiry procedure. The next phase is that of addressing a particular device, which has been filtered from all the devices that have

responded to the inquiry. This particular device is addressed using the page procedure. Traffic can commence after the completion of the page procedure.

Generally, Bluetooth connections take two forms: connecting with a device with an unknown address; and connecting with a device with a known address.

In the first case, a user (more particularly, the Bluetooth device) wishes to discover devices in the area (i.e. within range) and then connect to the wanted device. The first step is really two steps: an inquiry procedure, defined in the standard; and then subsequently making connections to all devices to retrieve their SDP (service Discovery Protocol) record. Once this has been performed the user will select a device (or a device is selected) for paging using a clock offset returned by the Inquiry. At this point the user will be connected with the desired device.

In the second case, the user has connected to the desired device in the past, although it may have been some time since the last connection took place. In the event that the last stored clock offset is accurate, paging will be performed on the correct train and the connection will occur quickly. If, however, the clock offset is old, then the connection will take longer. How much longer is dependent on the paging and page scanning modes.

Breaking these two scenarios down into their

building blocks reveals some common elements: Inquiry, and Paging.

The default Inquiry period is defined as 10.24 seconds. Some devices may not respond in this period due to the Inquiry train changing during the Inquiry Response random backoff period; this results in reduced reliability. Moreover only half of the devices in Inquiry scan mode can hear the Inquiry ID messages at any given time, which effectively slows down the Inquiry process. Paging can also be slow when the estimated clock starts the procedure on the wrong train. Depending on the paging configuration, paging may take 1.28s (R1) or 2.56s (R2) longer than the nominal time.

In an embodiment of the invention a "Home device list" stores a record of the Bluetooth Address, and device capabilities (and optionally also the estimated clock) for other devices that are likely to be used. Depending on where the "Home device list" is being stored, for example on a laptop or PDA, device types in the list may include (but are not limited to) one or more entries for: Access point(s) (e.g. Home AP, Office AP, local coffee shop AP, and the like); Printer(s) (e.g. home, office, local photo shop); Digital cameras; Headset(s); Other PC or PDA; and Cellular terminals;

FIG. 8 shows an example of a generic terminal 400 configured to implement a general embodiment of the

present invention. In the example of FIG. 8 the majority of the signal processing is performed in the digital domain.

In the example of FIG. 8 two transmit/receive antennas 402a,b are coupled to respective RF stages 404a,b, which receive inputs from and provide signals to a digital signal processor (DSP) 408 via respective digital-to-analogue and analogue-to-digital converters 406a, b. A digital data input/output maybe provided on line 410. In other terminals a single antenna may be used.

DSP 408 will generally include one or more processors 408a and working memory 408b, and has a data, address and control bus 412 to couple the DSP to non-volatile memory 414, such as Flash RAM or ROM storing data and processor control code. The processor control code controls DSP 408 to provide terminal functions and comprises, for example, rf signal processing code 414a, error handling code 414b, protocol stack code 414c, application layer code 416d and user interface code 414e. To implement in embodiment of the invention the memory 414 may further store home device (list) data 414g, home device data provision code 414f and optional terminal use history data 414j. This code is loaded and implemented by processor(s) 408a to provide corresponding functions.

As can be appreciated from the above description

embodiments of the invention minimise the time required to perform initial cell sychronization for a cellular terminal in instances where there exist locales which a user commonly visits. Other embodiments of the invention facilitate faster device connections in a WPAN or WLAN system, in particular when connecting to a commonly used device to exploit capabilities specific to that device. In the case of a software defined radio further embodiments of the invention facilitate switching between modes and in particular can help to make such a switch transparent to a user.

Embodiments of the invention have applications in 2G and 3G cellular communication systems of all types, as well as in other wireless systems which have a fixed infrastructure where a terminal connects to an access point, for example wireless LAN systems. There are additional applications for embodiments of the invention in networks without a fixed infrastructure and/or in circumstances where a device pairing is common.

No doubt many other effective alternatives will occur to the skilled person. It will be understood that the invention is not limited to the described embodiments and encompasses modifications apparent to those skilled in the art lying within the spirit and scope of the claims appended hereto.

C L A I M S

1. A controller for a mobile wireless communications device, for controlling establishment of a wireless link between said device and a second wireless communications device, said controller comprising:

data memory for storing home device data, said home device data comprising data for establishing a wireless connection with a home second wireless communications device;

a data processor coupled to said data memory and configured to control said mobile wireless communications device to attempt to establish said wireless link with said home second wireless communications device; and

a data provider for providing said home device data for at least one said home device to said data memory for storage, wherein said home device data comprises data predicting a said home wireless communications device said mobile wireless communications device is likely to connect to as determined from previous use of said mobile wireless communications device.

2. A controller as claimed in claim 1, wherein said data memory is further configured to store use history data for said mobile wireless communications device comprising data specific to second wireless communications devices with which said mobile wireless

communications device has previously established a wireless link, and wherein said data provider is configured to determine said home device data for storage from said history data.

3. A controller as claimed in claim 1 or 2, wherein said wireless link comprises a link of a local or personal area network, wherein said home device data comprises data for a plurality of said home devices including for each data defining a category of said device, and wherein said data processor is configured to receive data determining a said category for said second device with which said link is to be established and, responsive to said received data, to select one of said home wireless communications devices with which to attempt to establish said wireless link.

4. A controller as claimed in claim 3, wherein said home device data further comprises address data for a said home device.

5. A controller as claimed in claim 4, wherein said home device data further comprises estimated clock data for a said home device.

6. A controller as claimed in claim 3, 4 or 5, wherein said category data includes data defining a said home device as a fixed location device.

7. A controller as claimed in any one of claims 3 to 6, wherein said data processor is configured to control said mobile device to attempt to establish said

wireless link with a said home second device before attempting to establish a link with any other said second device.

8. A controller as claimed in any one of claims 3 to 7, wherein said wireless link comprises a Bluetooth standard or IEEE802.15 standard compatible link in which establishment of said link according to said standard comprises an inquiry phase and a paging phase; and wherein said data processor is configured to control said mobile wireless communication device to omit said inquiry phase when attempting to establish a said link with a said home device.

9. A controller as claimed in claim 1 or 2, wherein said wireless link comprises a link of a wireless local area network, and wherein said home device data comprises address and/or frequency data for a said home device.

10. A controller as claimed in claim 1 or 2, wherein said wireless link comprises a link of a cellular mobile communications network, wherein a said home device comprises a base station of the network, and wherein said home device data comprises data for a plurality of said home wireless communication devices.

11. A controller as claimed in claim 10, wherein said home device data includes data for a last used base station of said network.

12. A controller as claimed in claim 10 or 11,

wherein said home device data comprises frequency data for a said base station.

13. A controller as claimed in claim 10 or 11, wherein said home device data comprises carrier and/or code data for a said base station.

14. A controller as claimed in claim 2, wherein said wireless link comprises a link of a cellular mobile communications network, wherein a said home device comprises a base station of the network, and wherein said use data comprises data determining cells of said network selected for use after an initial cell search.

15. A controller as claimed in claim 2, wherein said wireless link comprises a link of a cellular mobile communications network, wherein a said home device comprises a base station of the network, and wherein said use data comprises data determining cells of said network in use when said mobile device is powered down.

16. A controller as claimed in claim 1 or 2, wherein said mobile wireless communications device comprises a device including a radio frequency portion with two selectable modes of operation for use in establishing wireless links with second devices on two different networks, and wherein a said home device comprises a base station for one of said networks.

17. A mobile wireless communications device

incorporating the controller of any preceding claim.

18. A carrier medium carrying computer program code to, when running, implement the controller of any one of claims 1 to 16.

19. A method for controlling establishment of a wireless link between a mobile wireless communications device and a second wireless communications device, the method comprising:

providing said home device data for at least one home second wireless communications device to said data memory for storage, wherein said home device data comprises data predicting a said home second wireless communications device said mobile wireless communication device is likely to connect to determined from previous use of said mobile wireless communications device; and

controlling said mobile wireless communications device to attempt to establish a said wireless link with said home second wireless communication device.

20. A method as claimed in claim 19, further comprising storing use history data for said mobile wireless communication device comprising data specific to second wireless communications devices with which said mobile wireless communications device has previously established a wireless link; and determining home device data for storage from said use history data.

21. A method as claimed in claim 19 or 20, wherein said wireless link comprises a link of a local or personal area network, wherein said home device data comprises data for a plurality of said home devices including for each data defining a category of said device, and wherein said method further comprises receiving data determining a said category for said second device with which said link is to be established and, responsive to said received data, selecting one of said home wireless communications devices with which to attempt to establish said wireless link.

22. A carrier medium carrying processor control code to, when running, implement the method of claim 19, 20 or 21.

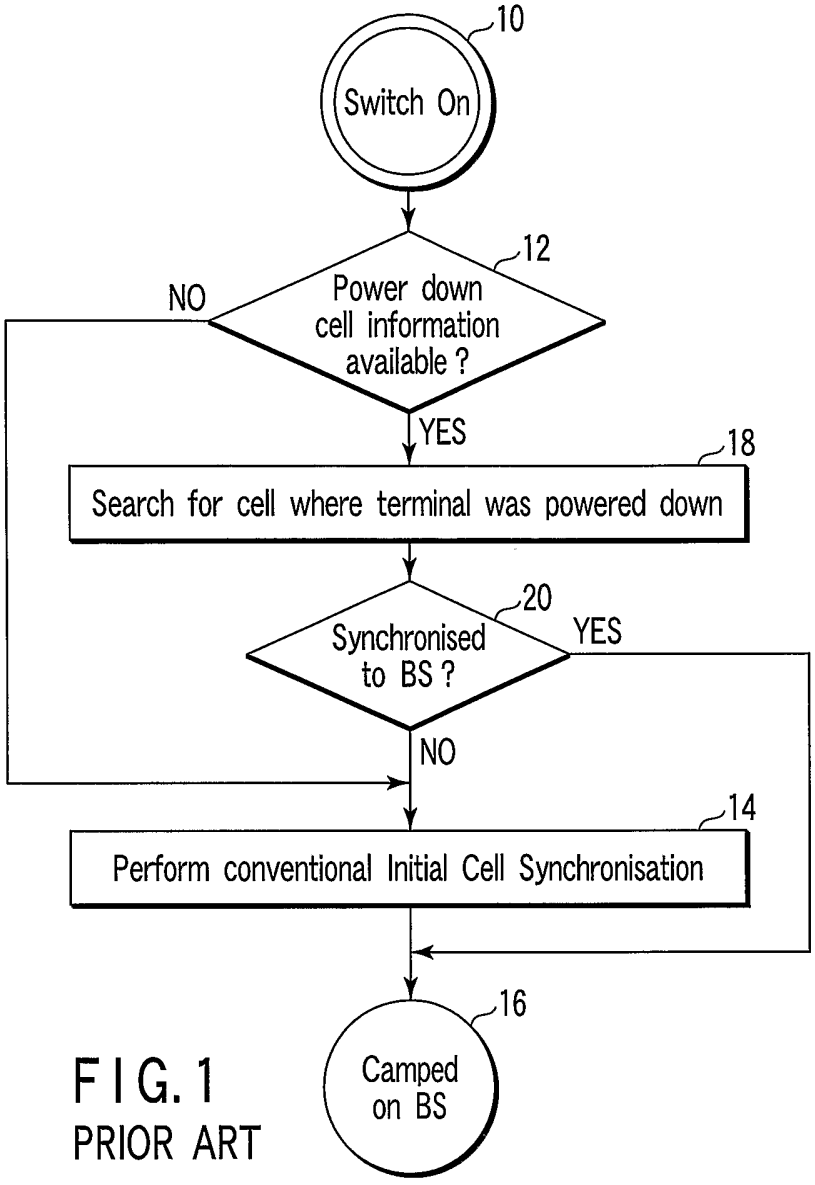


FIG. 1
PRIOR ART

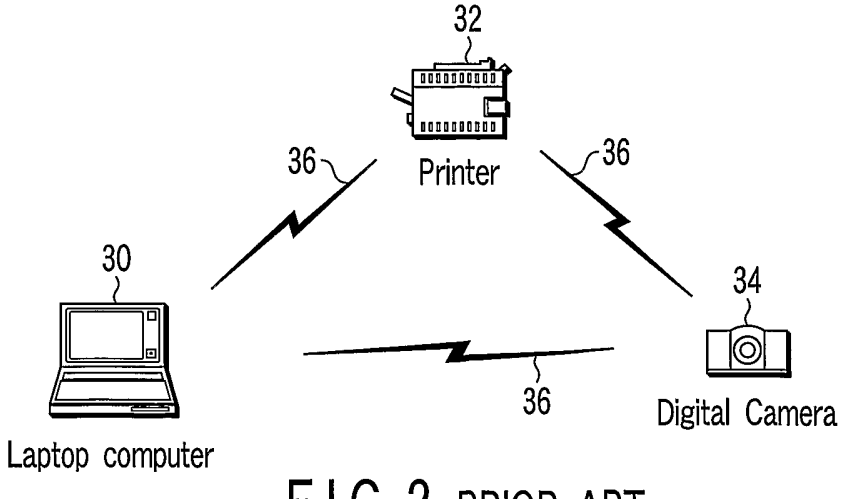


FIG. 2 PRIOR ART

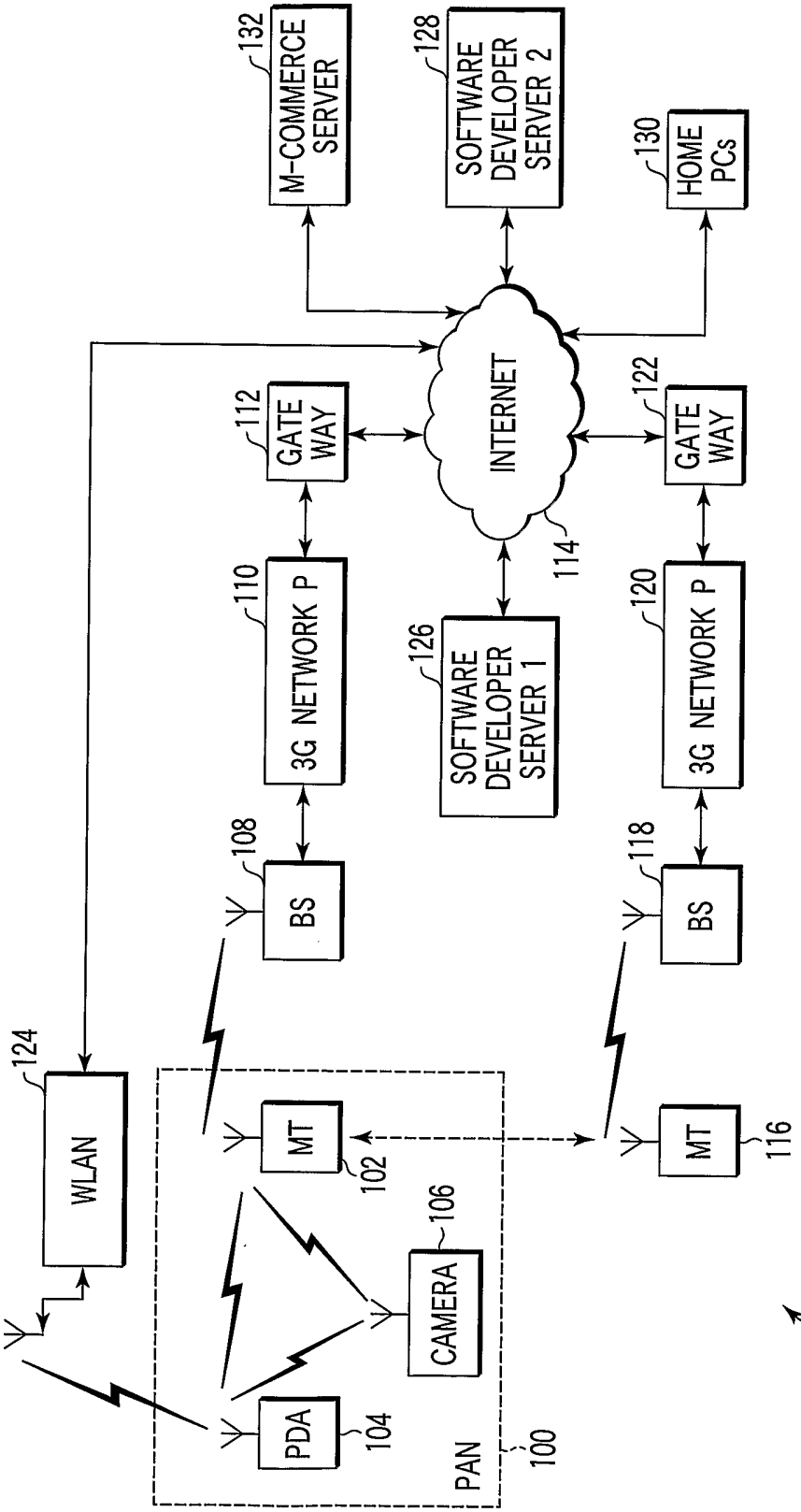
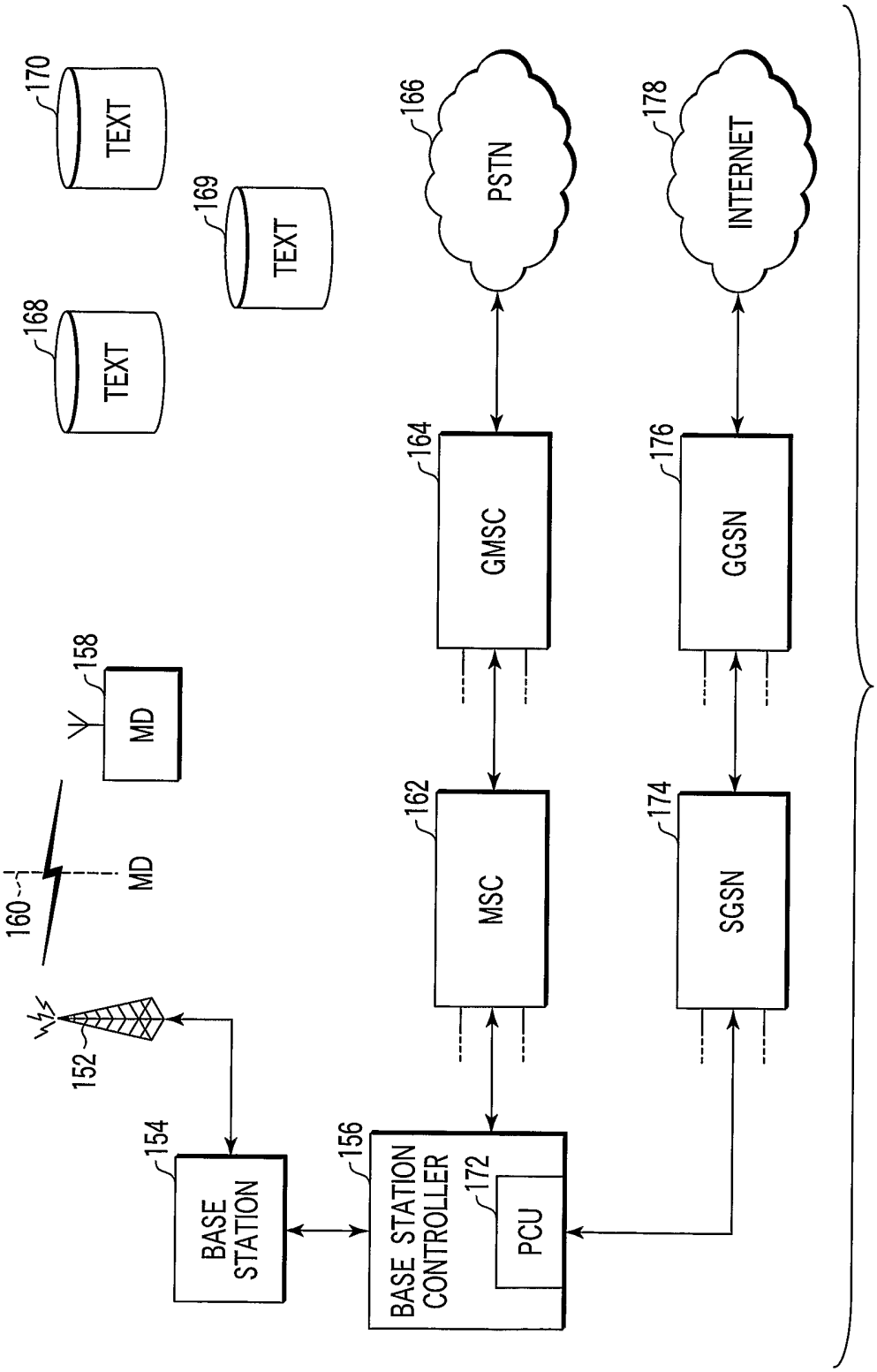

M-COMMERCE SERVER
132
SOFTWARE DEVELOPER SERVER 2
128
HOME PCs
130
INTERNET
114
GATE WAY
112
GATE WAY
122
3G NETWORK P
110
3G NETWORK P
120
SOFTWARE DEVELOPER SERVER 1
126
BS
108
BS
118
WLAN
124
MT
102
MT
116
CAMERA
106
PDA
104
PAN
100
100

FIG. 3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TEXT
169
TEXT
168
TEXT
166
PSTN
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INTERNET
164
GMSC
176
GGSN
158
MD
160
MD
162
MSC
174
SGSN
152
154
BASE STATION
156
BASE STATION CONTROLLER
172
PCU

FIG. 4

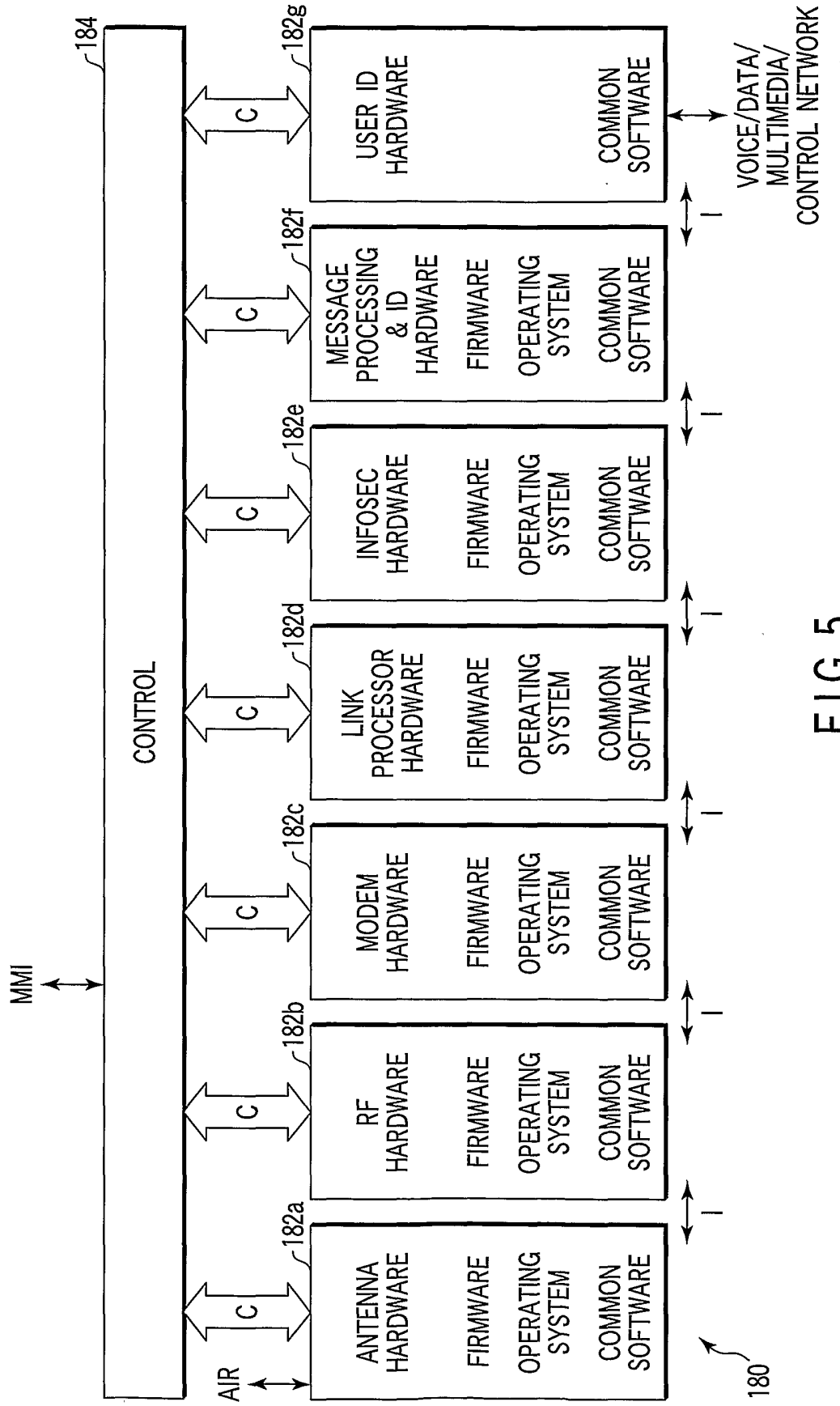
MMI
AIR
CONTROL
184
180
182a
182b
182c
182d
182e
182f
182g
C
I
ANTENNA HARDWARE
RF HARDWARE
MODEM HARDWARE
LINK PROCESSOR HARDWARE
INFOSEC HARDWARE
MESSAGE PROCESSING & ID HARDWARE
USER ID HARDWARE
FIRMWARE
OPERATING SYSTEM
COMMON SOFTWARE
VOICE/DATA/ MULTIMEDIA/ CONTROL NETWORK

FIG. 5

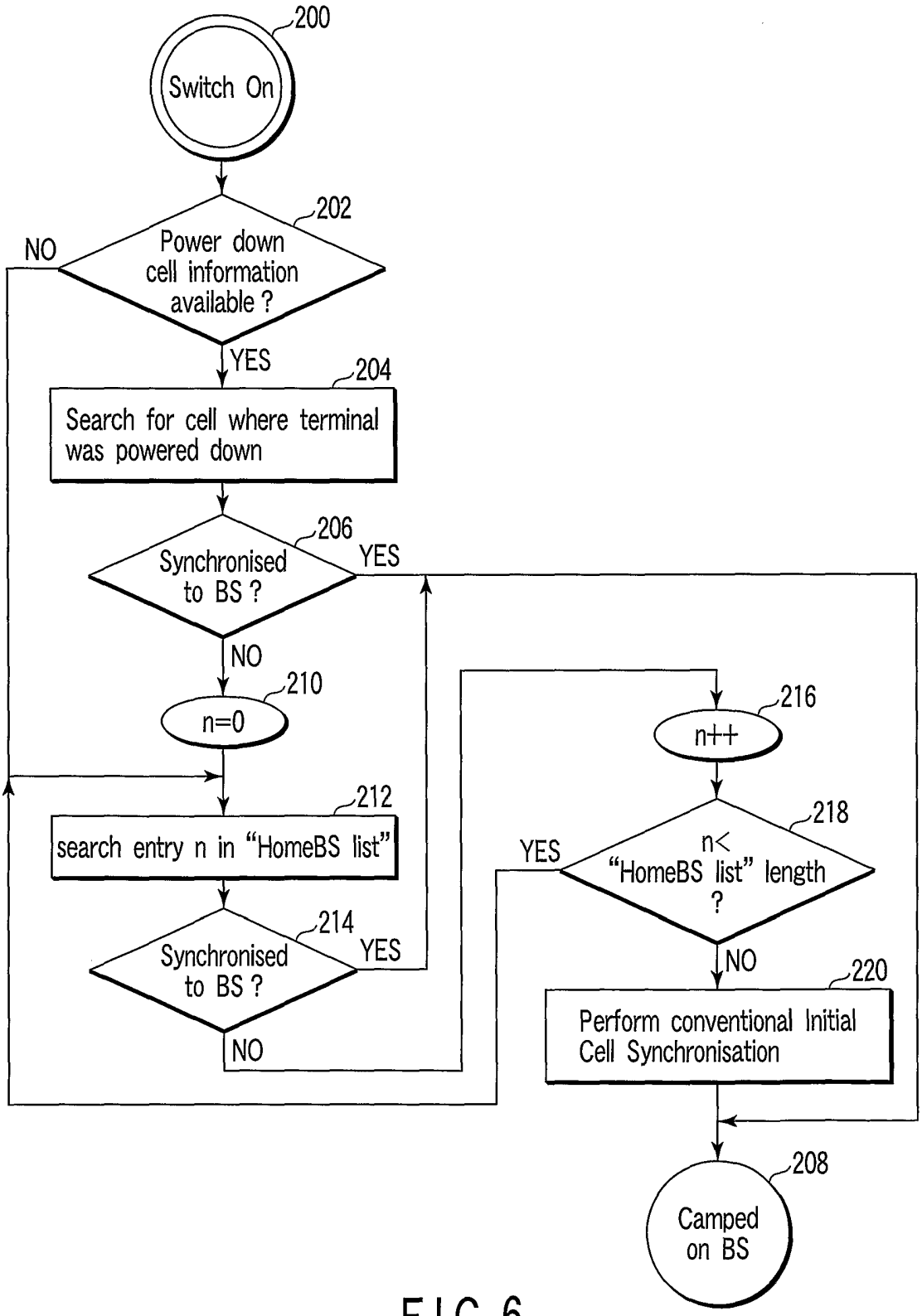
200
Switch On
202
Power down cell information available ?
NO
YES
204
Search for cell where terminal was powered down
206
Synchronised to BS ?
YES
NO
210
n=0
212
search entry n in "HomeBS list"
214
Synchronised to BS ?
YES
NO
216
n++
218
n< "HomeBS list" length ?
YES
NO
220
Perform conventional Initial Cell Synchronisation
208
Camped on BS

FIG. 6

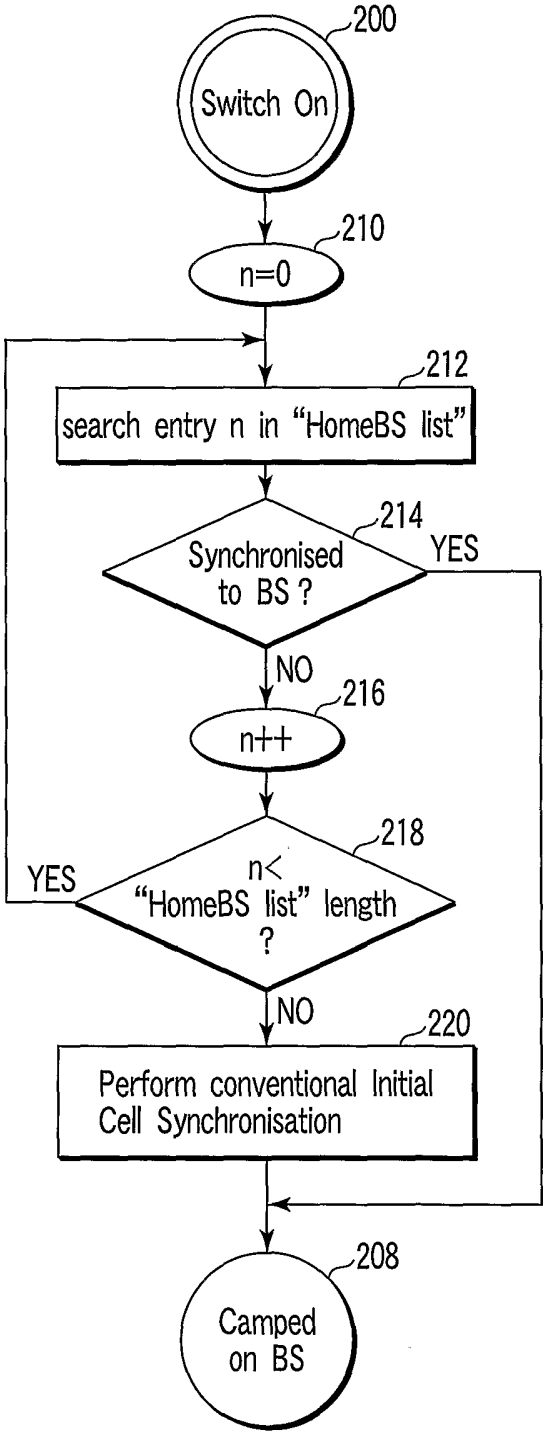
200
Switch On
210
n=0
212
search entry n in "HomeBS list"
214
Synchronised to BS ?
YES
NO
216
n++
218
n< "HomeBS list" length ?
YES
NO
220
Perform conventional Initial Cell Synchronisation
208
Camped on BS

FIG. 7

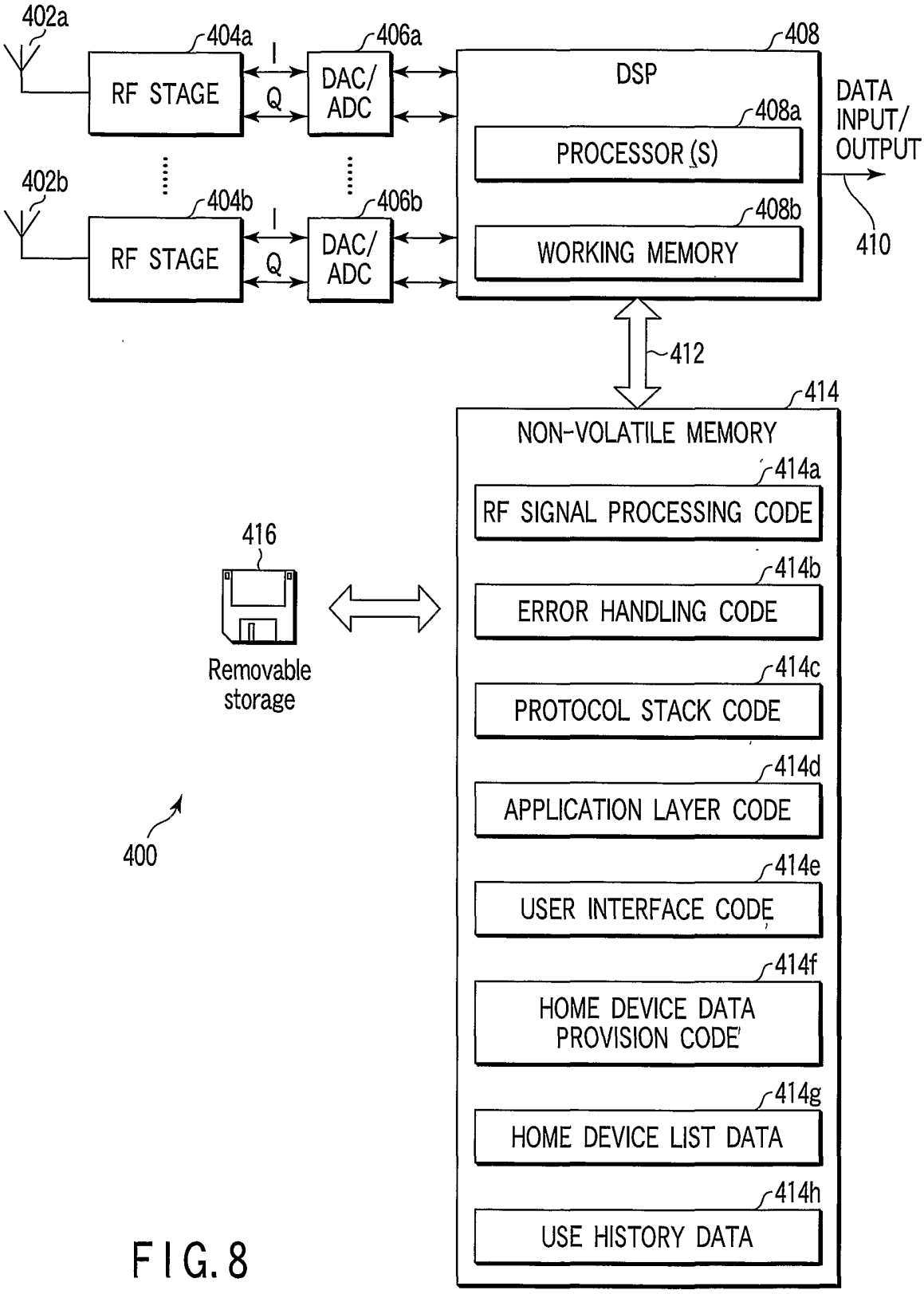
402a
404a
406a
408
RF STAGE
I
Q
DAC/
ADC
DSP
408a
PROCESSOR (S)
DATA
INPUT/
OUTPUT
402b
404b
406b
408b
RF STAGE
I
Q
DAC/
ADC
WORKING MEMORY
410
412
414
NON-VOLATILE MEMORY
414a
RF SIGNAL PROCESSING CODE
416
414b
ERROR HANDLING CODE
Removable
storage
414c
PROTOCOL STACK CODE
414d
APPLICATION LAYER CODE
400
414e
USER INTERFACE CODE
414f
HOME DEVICE DATA
PROVISION CODE
414g
HOME DEVICE LIST DATA
414h
USE HISTORY DATA

FIG. 8

INTERNATIONAL SEARCH REPORT

Inter nal Application No
PCT/JP2004/014778

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H04L12/56

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H04L H04Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2003/002678 A1 (KIM SU-HWAN) 2 January 2003 (2003-01-02) paragraphs '0009!, '0010!, '0023! - '0032!	1-9, 17-22
X	US 5 946 620 A (SCHULTZ ET AL) 31 August 1999 (1999-08-31) column 1, line 60 - column 4, line 51 figures 1,3	1,2, 10-20,22
A	US 2003/063655 A1 (YOUNG SONG-LIN) 3 April 2003 (2003-04-03) paragraphs '0001!, '0008!, '0045!	1-9, 17-22
A	US 2001/034232 A1 (KUWAHARA SOICHI) 25 October 2001 (2001-10-25) paragraphs '0020! - '0027!, '0054! - '0056! figures 6-8	1,2, 10-20,22

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

° Special categories of cited documents :

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
27 January 2005	04/02/2005

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	Goedhart, A

INTERNATIONAL SEARCH REPORT

....ormation on patent family members

Inter nal Application No
PC1/JP2004/014778

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