

REPLACEMENT SHEETS	SG
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DIGITAL MOBILE TERMINAL AUTOMATICALLY SWITCHING BETWEEN PUBLIC AND PRIVATE MODES

BACKGROUND OF THE INVENTION

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1. Field of the invention

The present invention generally relates to a digital mobile communication system comprising public cell stations and private cell stations, and in particular to a digital mobile terminal and a method for making a connection of the digital mobile terminal to either a public or private cell station.

2. Description of the Related Art

Recently, a digital telephone system known as a personal handy phone system (PHS) has been provided with public cell stations intended for use outdoors in addition to private cell stations intended for home use. A public cell station is connected to an ISDN public line and a private cell station to a subscriber line. A mobile telephone terminal is generally provided with a manual mode switch which manually changes the operation mode of the mobile telephone terminal between a public mode and a private mode. When carrying it outdoors, a user sets the manual mode switch to the position of public mode which allows the mobile telephone terminal to make a connection to the nearest public cell station. When at home, the user sets the manual mode switch to



the position of private mode, allowing it to make a connection to the private cell station.

However, in cases where a public cell station is located in the vicinity of the user's home, the respective radio zones of the private cell station and the public cell station are possibly overlapped, allowing the mobile telephone terminal to make a connection to both the public and the private cell stations. Since a charge is different between public and subscriber connect services, as of now, the subscriber connect service has a smaller charge, the user will set the manual mode switch to the position of the private mode. In this case, when the manual mode switch is carelessly set to the public mode, the public connect service will be charged by the amount of connect time to the user's account without his/her knowing.

SUMMARY OF THE INVENTION

An object of the present invention is to provide a digital mobile terminal and a connection method which can avoid a careless connection of the digital mobile terminal which is located within the overlapped area of radio zones provided by the private cell station installed in the user's home and the public cell station near the home.

Another object of the present invention is to provide a digital mobile terminal and a connection method which can



automatically make a connection of the digital mobile terminal to either the private cell station or the public cell station with reliability.

A digital mobile terminal according to the present invention automatically switches between a public mode and a private mode with giving one a higher priority. More specifically, when in the public mode, the digital mobile terminal is forced into the private mode by off-hook and then starts a predetermined calling sequence to the private cell station. If a connection to the private cell station fails, the digital mobile terminal automatically switches into the public mode and then makes a call to the public cell station.

According to an aspect of the present invention, an operation mode of the digital mobile terminal is detected which is one of a public mode and a private mode. The public mode causes the digital mobile terminal to operate for connection to the public cell station, and the private mode causes the digital mobile terminal to operate for connection to the private cell station. When a calling request occurs due to a user operation is detected in a state that the digital mobile terminal is in the public mode, the digital mobile terminal is forced to switch to the private mode. Therefore, a first connection to the private cell station is requested according to the private mode. If the first connection to the private cell station fails, the digital mobile terminal switches from the private mode to the public mode and then requests a second connection to the public cell station



according to the public mode.

The first connection to the private cell station may be requested according to the private mode when a timer is reset for a predetermined timer value. If the timer reaches the predetermined timer value without receiving a control signal from the private cell station, the digital mobile terminal is forced to switch to the public mode.

Furthermore, the second connection to the public cell station may be requested according to the public mode when the timer is reset for the predetermined timer value. And the digital mobile terminal stops calling if the timer reaches the predetermined timer value without receiving a control signal from the public cell station.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a block diagram showing the functional configuration of a digital cordless telephone terminal according to an embodiment of the present invention;

Fig. 2 is a schematic diagram showing an operation of the digital cordless telephone terminal located in the overlapped areas of the radio zones provided by the public cell station and the private cell station;



Fig. 3 is a flowchart showing a connection procedure of the digital cordless telephone terminal which is in the public mode according to an embodiment of the present invention; and

Fig. 4 is a flowchart showing a connection procedure of the digital cordless telephone terminal which is in the private mode according to the embodiment.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to Fig. 1, a cordless telephone terminal according to the present invention is mainly comprised of a RF (radio frequency) system 10, a baseband system 11 and a control system 12. The RF system 10 is comprised of an antenna 101, an antenna switch 102, a RF receiver 103, a RF transmitter 104 and a frequency synthesizer 105. The antenna 101 is connected to the antenna switch 102 which is in turn connected to the RF receiver 103 and the RF transmitter 104. The RF receiver 103 converts a RF received signal into a baseband received signal and outputs it to the baseband system 11. The RF transmitter 104 converts a baseband transmitting signal received from the baseband system 11 into a RF transmitting signal and outputs it to the antenna 101 through the antenna switch 102. The frequency synthesizer 105 supplies variable reference frequencies to the RF receiver 103 and the RF transmitter 104, respectively, and changes the receiving frequency and the transmitting frequency in accordance



with a frequency control signal.

The baseband system 11 is comprised of a demodulator 106, a channel encoder and decoder (CODEC) 107 including a TDMA/TDD control circuit, a modulator 108 and a speech CODEC 109. The baseband received signal is demodulated by the demodulator 106 and then is decoded by the channel CODEC 107 and the speech CODEC 109 into a received speech signal which is reproduced by the speaker 110. On the other hand, the microphone 111 generates a transmitting speech signal which is encoded by the speech CODEC 109 and the channel CODEC 107. The channel-coded transmitting signal is modulated by the modulator 108 into the baseband transmitting signal which is output to the RF transmitter 104 of the RF system 10. The channel CODEC 107 outputs the frequency control signal to the frequency synthesizer 105 and outputs a timing control signal to the RF system 10 for transmission and reception timing control.

The operations of the RF system 10 and the baseband system 11 are controlled by the control system 12. The control system 12 is comprised of a processor 112, a memory 113, a mode-switch timer 114, and a controller 115 for a display 116 and a keypad 117.

The memory 113 previously stores private setting data, public setting data, an identification number (ID), an identification number of the private cell station (private CS-ID) and an identification number of the public cell station (public CS-ID). The private setting data is comprised of transmitting



and receiving frequency data and other necessary data for a private-mode operation including a connection establishment to the private cell station. The public setting data is comprised of transmitting and receiving frequency data and other necessary data for a public-mode operation including a connection establishment to the public cell station. The processor 112 selects one of the private setting data and the public setting data according to the position of the mode setting key of the keypad 117 and a connection procedure as mentioned later. The private CS-ID is used to check whether a received acknowledgment includes the same ID number at the time of connection to the private cell station. Similarly, the public CS-ID is used to check whether a received acknowledgment includes the same ID number at the time of connection to the public cell station.

The mode-switch timer 114 is reset and started by the processor 112 and outputs a time-out signal to the processor 112 when a predetermined maximum time interval has elapsed. Receiving the time-out signal from the mode-switch timer 114, the processor 112 switches an operation mode of the telephone terminal from the private mode to the public mode or from the public mode to a stop mode, which will be described in detail later. Furthermore, the processor 112 performs calling/called and connection procedures by controlling the RF system 10 and the baseband system 11.

Referring to Fig. 2, the mobile telephone terminal 201 as shown in Fig. 1 is taken with the user, the public cell station



202 is installed outdoors, and the private cell station 203 is placed in the user's house. The public cell station 202 is connected to the ISDN public line 204 and the private cell station 203 to the subscriber line 205. In Fig. 2, it is assumed that the public cell station 202 is in the vicinity of the user's house and there is an overlapped area E3 of the radio zone E1 of a public cell station 202 and the radio zone E2 of a private cell station 203.

In such a situation, when located in the overlapped area E3, the mobile telephone terminal 201 can make a connection to both the public cell station 202 and the private cell station 203. According to the embodiment of the present invention, a higher priority is given to a connection to the private cell station 203 because the charge of a private connection service through the subscriber line 205 is generally smaller than that of a public connection service through the public line 204 at the present time. More specifically, when calling, the processor 112 performs a private connection procedure according to the private setting data stored in the memory 113 even if the mode setting key of the keypad 117 is set to the public-mode position. Needless to say, the higher priority will be given to a smaller-charge service of the private and public connection services. The calling operations of the mobile telephone terminal will be described in detail hereinafter.

Referring to Fig. 3, it is assumed that the mode setting key of the keypad 117 is set to the public-mode position and the



processor 112 are performing an intermittent receiving operation in the public mode (S10). When the user presses an off-hook function key for calling (S11), an operation mode of the mobile telephone terminal is forced into the private mode by the processor 112 (S12). More specifically, when the off-hook key is pressed, the processor 112 reads the private CS-ID and the private setting data from the memory 113 and sets the RF system 10 and the baseband system 11 according to those data. In other words, the operation mode of the telephone terminal switches from the public mode to the private mode and thereby the frequency of a control channel also switches to a predetermined frequency for connection to the private cell station.

After switching to the private mode, the processor 112 controls the channel CODEC 107 of the baseband system 11 to transmit a call request to the private cell station when starting the mode-switch timer 114 set for the predetermined maximum time interval (S13). At the same time, the destination number input by the dialing keys of the keypad 117 is displayed on the LCD 116. After that, the processor 112 waits for an acknowledgment from the private cell station (S14-S18). More specifically, when receiving a control signal (S14), the processor 112 checks whether a source identification number included in the received control signal is identical to the private CS-ID (S15). If not identical, the waiting steps (S14-S18) are repeatedly executed until the private CS-ID is received (YES of S15) or the mode-switch timer 114 exceeds the predetermined maximum time interval (YES of S18).



When receiving the private CS-ID (YES of S15), the processor 112 controls the baseband system 11 so as to take well-known steps for connection establishment (S16) and a telephone communication is started through the private cell station (S17). In other words, in this embodiment, a higher priority is given to the private mode because, as of now, the private connection service has a smaller charge than the public connection service. Therefore, even if the mobile telephone terminal is performing the public-mode receiving operation with the mode setting key setting to the public-mode position, the calling steps are started with the private mode.

On the other hand, if the mode-switch timer 114 exceeds the predetermined maximum time interval (YES of S18), the operation mode of the telephone terminal switches from the private mode to the public mode (S19) and thereby the frequency of a control channel also switches to a predetermined frequency for connection to the public cell station.

After switching to the public mode, the processor 112 controls the channel CODEC 107 of the baseband system 11 to transmit a call request to the public cell station when starting the mode-switch timer 114 set for the predetermined maximum time interval (S20). After that, the processor 112 waits for an acknowledgment from the public cell station (S21-S25). More specifically, when receiving a control signal (S21), the processor 112 checks whether a source identification number included in the received control signal is identical to the public CS-ID (S22).



If not identical, the waiting steps (S21-S25) are repeatedly executed until the public CS-ID is received (YES of S22) or the mode-switch timer 114 exceeds the predetermined maximum time interval (YES of S25).

When receiving the public CS-ID (YES of S22), the processor 112 controls the baseband system 11 so as to take well-known steps for connection establishment (S23) and a telephone communication is started through the public cell station (S24).

If the mode-switch timer 114 exceeds the predetermined maximum time interval (YES of S25), the processor 112 stops calling (S26) and returns to the intermittent receiving operation in the public mode.

Referring to Fig. 4, it is assumed that the mode setting key of the keypad 117 is set to the private-mode position and the processor 112 are performing an intermittent receiving operation in the private mode (S30). When the user presses an off-hook function key for calling (S31), the processor 112 controls the channel CODEC 107 of the baseband system 11 to transmit a call request to the private cell station when starting the mode-switch timer 114 set for the predetermined maximum time interval (S32). At the same time, the destination number input by the dialing keys of the keypad 117 is displayed on the LCD 116. After that, the processor 112 waits for an acknowledgment from the private cell station (S33-S37). More specifically, when receiving a control signal (S33), the processor 112 checks whether a source identification number included in the received control signal is



identical to the private CS-ID (S34). If not identical, the waiting steps (S33-S34) are repeatedly executed until the private CS-ID is received (YES of S34) or the mode-switch timer 114 exceeds the predetermined maximum time interval (YES of S37).

When receiving the private CS-ID (YES of S34), the processor 112 controls the baseband system 11 so as to take well-known steps for connection establishment (S35) and a telephone communication is started through the private cell station (S36).

On the other hand, if the mode-switch timer 114 exceeds the predetermined maximum time interval (YES of S37), the processor 112 stops calling (S38) and returns to the intermittent receiving operation in the private mode.

Alternatively, in cases where the mode setting key of the keypad 117 is set to the private-mode position and the processor 112 are performing an intermittent receiving operation in the private mode, the processor 112 may allow the mode-switch timer 114 to stop working. In other words, the calling procedure may continue to be performed until the user stops the calling procedure by pressing an on-hook key.

While there has been described what is at present considered to be preferred embodiment of the invention, it will be understood that various modifications may be made therein. For instance, the present invention may be applied to the data transmission of facsimile machines, computers and the likes. It is intended to cover in the appended claims all such modifications as fall within the spirit and scope of the invention.



What is claimed is:

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1. A method for providing a connection between a digital mobile terminal and one of a public cell station and a private cell station, said public cell station being located outdoors which is connected to a public communication line, and said private cell station being located indoors which is connected to a subscriber line, said method comprising the steps of:

a) detecting an operation mode of said digital mobile terminal, said operation mode being one of a public mode and a private mode, said public mode causing said digital mobile terminal to operate for connection to said public cell station, and said private mode causing said digital mobile terminal to operate for connection to said private cell station;

b) detecting a calling request in said operation mode, said calling request occurring due to a user operation;

c) switching said digital mobile terminal to said private mode when said calling request is detected in said public mode;

d) requesting a first connection to said private cell station according to said private mode;

e) switching said digital mobile terminal to said public mode when said first connection to said private cell station fails; and

f) requesting a second connection to said public cell





station according to said public mode.

2. The method according to claim 1, wherein:

said step (d) comprises a step of requesting said first connection to said private cell station according to said private mode when resetting a timer for a predetermined timer value; and

said step (e) comprises the steps of:

waiting for a control signal from said private cell station; and

switching said digital mobile terminal to said public mode when said timer reaches said predetermined timer value without receiving said control signal from said private cell station.

3. The method according to claim 1, further comprising a step of:

g) stopping calling when said second connection to said public cell station fails.

4. The method according to claim 3, wherein:

said step (f) comprises a step of requesting said second connection to said public cell station according to said public mode when resetting a timer for a predetermined timer value; and

said step (g) comprises a step of:





waiting for a control signal from said public cell station; and

stopping calling when said timer reaches said predetermined timer value without receiving said control signal from said public cell station.

5. A method for providing a connection between a digital mobile terminal and one of a first cell station and a second cell station, said first cell station being connected to a first communication line, said second cell station being connected to a second communication line which has a smaller connection service charge than said first communication line, said method comprising the steps of:

a) detecting an operation mode of said digital mobile terminal, said operation mode being one of a first operation mode and a second operation mode, said first operation mode causing said digital mobile terminal to operate for connection to said first cell station, and said second operation mode causing said digital mobile terminal to operate for connection to said second cell station;

b) detecting a calling request in said operation mode, said calling request occurring due to a user operation;

c) switching said digital mobile terminal to said second operation mode when said calling request is detected in said first operation mode;

d) requesting a first connection to said second cell





station according to said second operation mode;

e) switching said digital mobile terminal to said first operation mode when said first connection to said second cell station fails; and

f) requesting a second connection to said first cell station according to said first operation mode.

6. A method for providing a connection between a digital mobile terminal and one of a first cell station and a second cell station, said first cell station being connected to a first communication line, said second cell station being connected to a second communication line, said method comprising the steps of:

a) detecting an operation mode of said digital mobile terminal, said operation mode being one of a first operation mode and a second operation mode, said first operation mode causing said digital mobile terminal to operate for connection to said first cell station, said second operation mode causing said digital mobile terminal to operate for connection to said second cell station, and said first operation mode having a higher priority than said second operation mode;

b) detecting a calling request in said operation mode, said calling request occurring due to a user operation;

c) switching said digital mobile terminal to said first operation mode when said calling request is detected in a state that said digital mobile terminal is in said second operation mode;





d) requesting a first connection to said first cell station according to said first operation mode so as to establish said first connection between said digital mobile terminal and said first cell station;

e) switching said digital mobile terminal to said second operation mode when said first connection to said first cell station fails; and

f) requesting a second connection to said second cell station according to said second operation mode so as to establish said second connection between said digital mobile terminal and said second cell station.

