A method of providing group communications between a plurality of terminals over a cellular communications system includes assigning a traffic channel for half-duplex communications between the terminals. This traffic channel includes an inbound portion from the terminals to the communications system and an outbound portion from the communications system to the terminals. More particularly, group communications are received from a first terminal over the inbound portion of the traffic channel, and responsive to receiving the group communications from the first terminal, the group communications received from the first terminal are transmitted over the outbound portion of the traffic channel. Related systems and terminals are also discussed.
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METHODS, SYSTEMS, AND TERMINALS FOR PROVIDING GROUP COMMUNICATIONS OVER A COMMON TRAFFIC CHANNEL

Related Applications
This application is related to: Application Serial No. 09/309,005 (Attorney Docket No. 8194-255) entitled Methods and Systems for Providing Group Calls with Reduced Setup Times; Application Serial No. 09/309,018 (Attorney Docket No. 8194-257) entitled Methods And Systems For Providing Temporary Identification Numbers Form Mobile Terminals; Application Serial No. 09/309,012 (Attorney Docket No. 8194-267) entitled Apparatus And Methods For Conducting Group Calls In Wireless Communications Systems; and Application Serial No. 09/307,996 (Attorney Docket No. 8194-268) entitled Methods, Systems, And Terminals For Assigning Control Channel Time Slots For Group And Individual Pages. Each of these applications is being filed concurrently with the present application, each of these applications has common inventorship, and each of these applications is assigned to Ericsson, Inc., the assignee of the present invention. In addition, the disclosures of each of these applications are hereby incorporated herein by reference.

Field of the Invention
The present invention relates to the field of communications and more particularly to radiotelephone communications methods and systems.

Background of the Invention
Conventional cellular communications systems (such as systems operating according to the IS-136 standard) generally provide one-to-one communications from one mobile terminal to another mobile terminal or to a landline telephone coupled to a public switched telephone network. A conventional cellular communications system is illustrated in Figure 1. This system includes a mobile switching center (MSC) 31 and a home location register 33.
The MSC is coupled to a plurality of radio base stations (RBS) 32 wherein each RBS 32 defines a cell 35. In addition, the MSC can be coupled to a public switched telephone network (PSTN) 36. As will be understood by those having skill in the art, the conventional cellular communications system of Figure 1 can provide cellular radiotelephone communications for one or more cellular mobile terminals (MT) 37. More particularly, the cellular radiotelephone communications can be provided using conventional cellular standards wherein a telephone number is dialed/entered to place a call to another communications device.

Each RBS provides radio frequency transmit and receive functions and supports low level protocol functions. Moreover, a RBS can be considered a dumb peripheral of the MSC 31 wherein the MSC provides central intelligence for the system. Each RBS can be coupled to the MSC 31 via communications links 39. These communications links can be T1 links provided, for example, via landline or microwave. The MSC 31 provides voice path switching between two cells or a cell and the PSTN 36. The MSC 31 provides central system intelligence to control the radio base stations and to process high level protocol messages from mobile terminals 37 relayed by the radio base stations. In other words, the MSC handles call setup, paging, handoff, and call connection.

The home location register 33 keeps track of the current status of the mobile terminals. For each mobile terminal, for example, the home location register can record whether that terminal is on, off, or busy, as well as the location area (including a group of cells) within which the mobile terminal is located. The home location register can also include a database of restrictions and allowed service features for each mobile terminal. The home location register can also be considered a portion of the MSC.

The setup of a call between mobile terminals 37 using the system of Figure 1 is illustrated in Figure 2. As shown, the originating mobile terminal 37a issues an origination message which is received by the radio base station 32a for the cell 35a in which the mobile terminal 37a is located. The radio base station 32a checks the origination message for errors, and if no significant errors are detected, the radio base station 32a forwards the message to the mobile switching center. The mobile switching center
authenticates the originating mobile terminal 37a and analyses the called number. If the originating mobile terminal and the called number are valid, the mobile switching center instructs the radio base station 32a to assign a Digital Traffic Channel (DTC) to the originating mobile terminal. Origination and channel designation messages are discussed, for example, in TR45, TIA/EIA-136-123-A Draft Text, Digital Control Channel Layer 3, August 31, 1998, the disclosure of which is hereby incorporated herein in its entirety by reference.

Because the called party is another mobile terminal, the mobile switching center checks the HLR to determine the current location area (LA) for the called mobile terminal 37b if the called mobile terminal is active. A plurality of cells is assigned to a location area, and a mobile terminal updates its location with the cellular system only when the mobile terminal enters a new location area. Accordingly, location area updates are not needed every time a mobile terminal enters a new cell. While Digital Control Channel (DCCH) traffic may be reduced, pages for a called mobile terminal may need to be transmitted in all cells assigned to the location area.

The mobile switching center then issues a page message to all radio base stations supporting cells in the location area of the called mobile terminal 37b. Each of these radio base stations issues a page message on an appropriate paging subchannel. Because of the DCCH paging structure, however, a period of time as long as 1.28 seconds may pass before the page message can be issued. The page message wakes the called mobile terminal from its battery sleep mode, and the called mobile terminal 37b responds to the appropriate radio base station (now referred to as the called radio base station 32b) with a page response message to indicate the same.

The page response message is relayed from the called radio base station 32b to the mobile switching center, and the mobile switching center instructs the called radio base station 32b to assign a digital traffic channel to the called mobile terminal 37b. The mobile switching center then completes a communications path between the originating mobile terminal 37a and the called mobile terminal 37b using the two digital traffic channels.

The conventional cellular communications system of Figure 1, however, may not support dispatch oriented group calls (also referred to as conference calls). Radio dispatch group communications systems are
commonly used by emergency service providers such as police and/or fire departments to provide communications between a dispatcher and emergency personnel. For example, a police dispatcher can simultaneously call all on-duty police officers using a radio dispatch communications system. Alternately, a police officer can quickly establish communications with other police officers and/or dispatchers simply by pressing a push-to-talk button on his radio. Similar radio dispatch communications systems may also be used by businesses such as trucking and/or taxi businesses.

In general, radio dispatch group communications systems provide one-to-many group communications as opposed to one-to-one communications provided by conventional cellular radiotelephone communications systems. Radio dispatch group communications are also preferably provided without the call setup delays that may be common in a conventional cellular radiotelephone communications system. For example, the time required to setup a call in a conventional IS-136 cellular radiotelephone system may be as long as 6 or 7 seconds including up to 1.28 seconds just to page the receiving cellular radiotelephone. This setup time, however, may be unacceptable for police and other emergency radio dispatch group communications systems.

With the proliferation of cellular communications systems, there has been an effort to provide hybrid communications systems that can support both cellular radiotelephone communications as well as dispatch oriented group communications. Such a system has been developed, for example, by Motorola with service being offered by Nextel. A similar system has been developed by Ericsson (the assignee of the present application) under the name DAMPS-PRO. In particular, the DAMPS-PRO product provides cellular communications according to the IS-136 cellular communications standard, as well as dispatch oriented group communications for predefined user groups.

In the DAMPS-PRO system, intelligent group communications functionality is added to an IS-136 cellular communications system as shown in Figure 3. This intelligent group communications functionality is provided by adding a group server 41, a group bridge 43, a local area network 45, and a group database 47. The cells, mobile switching center, home location
register, public switched telephone network, and radio base stations provide cellular communications as discussed above with regard to Figures 1 and 2.

With regard to group calls, the group bridge provides a bank of telephony equipment which can initiate and receive radiotelephone calls, provide voice prompts, and respond to user inputs. The bridge also provides a group function that sums the audio from all parties within a designated group and distributes the summed audio to all parties. The server communicates with the mobile switching center via standard telephony signaling (such as defined by the SS7 standard) and controls the operation of the bridge equipment via the local area network.

The setup for a group call according to the DAMPS-PRO system is illustrated in Figure 4. In general, a predetermined set of mobile terminals define a group which can communicate in the group call mode. Each of these mobile terminals may have standard cellular radiotelephone functionality whereby one-to-one communications can be provided after entering a telephone number and pressing a send button. Mobile terminals in a conference group may also include a push-to-talk (PTT) button which can automatically establish a group call with other active mobile terminals in the group.

In particular, an originating mobile terminal 37a' may issue an origination message when the PTT button is pushed. The radio base station providing service to the originating mobile terminal 37a' (now referred to as the originating radio base station 32a') receives the origination message, and checks the origination message for errors. If no significant errors are detected, the origination message is forwarded to the mobile switching center. The mobile switching center authenticates the originating mobile terminal 37a' and analyses the called number therein identifying the group. If the originating mobile terminal 37a' and the identified group are valid, the mobile switching center authorizes the originating radio base station 32a' to assign a digital traffic channel to the originating mobile terminal 37a', and a conversation channel is established between the originating mobile terminal 37a' and the group bridge 43 using the assigned digital traffic channel.

Group calls are indicated by a Called party number portion of the origination message that is understood by both the mobile terminals in the
group and the mobile switching center. The mobile switching center detects that the called party number is for a group call and connects the originating mobile terminal to the conference bridge. The conference server accepts the call and then searches the group database to determine the other mobile terminals in the group that should be called. The server then instructs the conference bridge to place calls to each of the other mobile terminals in the group via the mobile switching center. The call from the originating mobile terminal and the calls to each of the other mobile terminals in the group are then grouped together. In particular, the mobile switching center issues

5 pages for each of the other mobile terminals in the group and completes each call normally once each serving radio base station is known. As further shown in the flow diagram of Figure 5, the steps of sending the origination message at block 81, setting up the originating side of the call at block 83, paging to locate the called mobile terminals at block 85, and setting up the terminating side of the call at block 87 proceed sequentially.

Notwithstanding the hybrid methods, systems, and terminals discussed above, there continues to exist a need in the art for hybrid methods, systems, and terminals that can provide improved group communications.

20 Summary of the Invention

It is therefore an object of the present invention to provide improved methods, systems, and terminals for group communications.

It is another object of the present invention to provide methods, systems, and terminals that can allow group communications with reduced setup times.

It is still another object of the present invention to provide methods, systems, and terminals that can allow group communications in a cellular communications network with reduced channel usage.

These and other objects can be provided according to the present invention by assigning a traffic channel for half-duplex communications between a plurality of terminals within a group wherein the traffic channel includes an inbound portion from the terminals to the communications system and an outbound portion from the communications system to the terminals. Group communications are received from a first one of the terminals over the
inbound portion of the traffic channel. Responsive to receiving the group communications from the first terminal, the group communications received from the first terminal are transmitted over the outbound portion of the traffic channel. Half-duplex group communications can thus be provided by a cellular radio base station for a plurality of mobile terminals using a single traffic channel thereby reducing the capacity consumed by a group call.

In addition, group communications can be received from a second one of the terminals over the inbound portion of the traffic channel, and responsive to receiving the group communications from the second terminal, the group communications received from the second terminal can be transmitted over the outbound portion of the traffic channel. In other words, the first and second terminals in the group can both transmit over the inbound portion of an assigned common traffic channel (at different times), and the first and second terminals can both receive over the outbound portion of the assigned common traffic channel. Half-duplex group dispatch communications can thus be provided on a hybrid cellular communications system while reducing the traffic capacity consumed by the group dispatch communications.

Setup times between transmission can be reduced by providing message trunking wherein control messages are transmitted over the traffic channel. Accordingly, a single traffic channel can support transmissions by the different terminals in the group, and there is no need to monitor a separate control channel between transmissions. There is also no need to set up a separate traffic channel for each transmission.

For example, after transmitting the group communication from the first terminal, an unkey message can be transmitted by the first terminal over the inbound portion of the traffic channel to the base station. Responsive to receiving the unkey message, the base station can transmit an idle message over the outbound portion of the traffic channel indicating that the traffic channel is open for transmission. After receiving the idle message, the second terminal can then transmit a key message over the inbound portion of the traffic channel. Responsive to receiving the key message, the base station can transmit a confirm message over the outbound portion of the traffic channel wherein the confirm message includes an identification for the second terminal. Preferably, this sequence of unkey message, idle message,
key message, and confirm message occurs over the traffic channel between transmissions of different terminals during a group call.

The traffic channel can be a digital traffic channel according to the IS-136 standard. Accordingly, group calls according to the present invention can be provided using a hybrid communications system supporting cellular radiotelephone communications according to the IS-136 standard. More particularly, an inbound carrier can be divided into a plurality of inbound time slots grouped into inbound time frames with each inbound time frame including a plurality of successive inbound time slots wherein the inbound portion of the traffic channel includes one inbound time slot in each of a plurality of the inbound time frames. Similarly, an outbound carrier can be divided into a plurality of outbound time slots grouped into outbound time frames with each outbound time frame including a plurality of successive outbound time slots wherein the outbound portion of the traffic channel includes one outbound time slot in each of a plurality of the outbound time frames.

In addition, the assignment of the traffic channel can be preceded by receiving a group call setup message from the first terminal over a control channel, and the traffic channel assignment can be transmitted by the base station as a page over the control channel wherein the page includes a group identification number for the group including the plurality of terminals. Once the mobile terminals receive the traffic channel assignment, the mobile terminals can monitor the assigned traffic channel for the duration of the group call so that only one traffic channel assignment is needed for a group call even though a plurality of terminals can transmit over the duration of the group call. After assigning the traffic channel, the base station transmits a confirm message over the outbound portion of the traffic channel wherein the confirm message includes an identification for the first mobile terminal. The first mobile terminal is thus authorized to transmit while all other terminals in the group are instructed to receive. In other words, no terminal is authorized to transmit over the traffic channel until a confirm message is received authorizing that terminal to transmit.

The methods, systems, and terminals of the present invention can thus provide improved half-duplex group communications. In particular, the traffic
channel capacity consumed by group communications can be reduced, and setup times between transmissions of a group call can be reduced. Moreover, the group communications can be provided using traffic channels and messaging formats of cellular communications systems such as cellular systems operating according to the IS-136 standard, so that the group communications according to the present invention can be efficiently provided on a hybrid cellular communications system.

**Brief Description of the Drawings**

Figure 1 is a block diagram of a cellular radiotelephone communications system according to the prior art.

Figure 2 is a message flow diagram illustrating steps of setting up a one-to-one radiotelephone call in the system of Figure 1.

Figure 3 is a block diagram of a cellular radiotelephone communications system with the addition of group calling functionality according to the prior art.

Figure 4 is a message flow diagram illustrating steps of setting up a group radiotelephone call in the system of Figure 3.

Figure 5 is a flow diagram illustrating steps of setting up a group call according to the prior art.

Figure 6 is a block diagram of a cellular radiotelephone communications system including group calling functionality according to the present invention.

Figure 7 is a message flow diagram illustrating steps of cell login according to the system of Figure 5.

Figure 8 is a message flow diagram illustrating steps of setting up a group radiotelephone call in the system of Figure 5.

Figure 9 is a block diagram of a mobile terminal for use with the cellular radiotelephone communications system of Figure 6.

Figure 10 is a block diagram illustrating a radio base station according to the present invention.

Figure 11 illustrates inbound and outbound portions of a digital control channel used to provide group communications according to the present invention.
Figure 12 is a flow chart illustrating operations of a base station according to the present invention.

Figure 13 is a flow chart illustrating operations of a mobile terminal according to the present invention.

**Detailed Description**

The present invention will now be described more fully hereinafter with reference to the accompanying drawings, in which preferred embodiments of the invention are shown. This invention may, however, be embodied in many different forms and should not be construed as limited to the embodiments set forth herein; rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the invention to those skilled in the art. Like numbers refer to like elements throughout.

A hybrid cellular radiotelephone communications system providing group communications according to the present invention will now be described with reference to Figures 6-8. In particular, the system of Figure 6 includes a mobile switching center 131, a plurality of radio base stations defining a respective plurality of cells 132, and a home location register 133. Moreover, the mobile switching center 131 can be coupled to a public switched telephone network 136. The system of Figure 6 can thus provide conventional one-to-one cellular radiotelephone communications according to a cellular communications standard such as the IS-136 standard.

In addition, group call functionality is provided using the group server 141, the group bridge 143, the router 153, the group database 147, the tracking database 149, and the mobile terminal parameter database 151. As shown, the mobile switching center 131 is coupled to the radio base stations 132 through communications links illustrated as solid lines. The communications links between the mobile switching center and the radio base stations (illustrated in solid lines) can be T1 links provided, for example, via landline or microwave.

Communication links are also provided between the router 153 and the radio base stations 132 as indicated by the dotted lines. In particular, the communications links between the router 153 and the radio base stations 132 can also be provided by T1 lines. As shown, the communications links
between the router and the radio base stations can be provided through the mobile switching center using T1 lines, without processing these communications at the mobile switching center. This arrangement has the advantage that existing communications links (such as T1 lines) can be used thereby reducing the need for additional hardware. Alternately, communications links can be provided between the router and the radio base stations without physically passing through the mobile switching center. The communications links between the router and the radio base stations can be provided according to an existing standard such as the TCP/IP standard.

The tracking database 149 and the mobile terminal parameters database 151 are used to keep track of mobile terminal locations and parameters. In particular, each mobile terminal preferably generates a login message (transmitted over a digital control channel) whenever the mobile terminal enters a new cell and is thus serviced by a new base station or whenever the mobile terminal is turned on. The login message is received by the new servicing radio base station which then transmits the login message to the group server. The group server can thus determine which radio base station is currently serving each mobile terminal, and this information can thus be stored in the tracking database. The tracking database can thus be used to identify for each active mobile terminal the particular radio base station providing service to that mobile terminal.

As also shown in Figure 7, a parameter update message can be generated by the mobile terminal when the mobile terminal first enters the communications system or when parameters for the mobile terminal change. In particular, the parameter update message can include parameter information for the mobile terminal that may be different for other mobile terminals operating in the same system. For example, the parameter information can include the particular vocoder used by the terminal, and/or security information such as whether the mobile terminal supports encryption and if so the type of encryption. The parameter update message is received by the radio base station and the corresponding parameter information for the mobile terminal is stored in the mobile terminal database of the conference equipment. This information can then be used when issuing a called origination message as discussed below.
The login message can be a relatively short message transmitted within a single time slot of a single time division multiple access (TDMA) time frame so that traffic on the digital control channels is not significantly increased. The mobile terminal parameter database can be used to store mobile terminal parameters for each mobile terminal, and the mobile terminal parameters can be updated responsive to parameter update messages transmitted by the mobile terminals as discussed in greater detail below. The generation of login messages and parameter update messages is illustrated in Figure 7.

The setup of a group call using the system of Figure 6 according to the present invention is illustrated in Figure 8. In Figure 8, the Conference Equipment includes the group server 141, group bridge 143, router 153, local area network 145, mobile terminal parameter database 151, tracking database 149, and group database 147. In particular, the originating mobile terminal 137a transmits a calling origination message that is received by the radio base station providing service to the originating mobile terminal (now referred to as the originating radio base station 132a). The information transmitted in the calling origination message can be reduced as compared to that of a conventional cellular origination message, because the parameter information for the mobile terminal is stored in mobile terminal parameter database as discussed above. By reducing the information transmitted in the calling origination message, the calling origination message can be transmitted over a single time slot thereby reducing call setup time.

The originating radio base station is able to identify a calling origination message for a group call, and thus transmits a group setup request to the group server 141. The calling origination message and the group setup request include portions thereof identifying the originating mobile terminal 137a (MIN) and the group of mobile terminals (identified by a group number) to be included in the group call. In addition, the mobile identification numbers (MINs) for each mobile terminal in the group are stored in the group database 147. The group server is thus able to identify all mobile terminals to be included in the group call (now referred to as the called mobile terminals 137b).
The server verifies that the requested group is a valid group and that the originating mobile terminal 137a is allowed to initiate calls to the requested group. After successful verification, the server 141 references the group database 147 to determine the other mobile terminals in the called group (now referred to as the called mobile terminals 137b) and their mobile identification numbers (MINs). The server also checks the tracking database to determine the radio base stations currently serving the called mobile terminals (now referred to as the called radio base stations 132b).

As shown in Figure 6, the called mobile terminal 137b is located in the called cell 135b serviced by the called radio base station 132b. The called mobile terminal 137b', however, is in the cell 135a, serviced by the radio base station 132a. Accordingly, the radio base station 132a is both the originating radio base station and one of the called radio base stations. The radio base station 132a can thus provide all the functions discussed with reference to the originating radio base station 132a as well as the functions discussed with reference to the called radio base stations 132b. Furthermore, more than three mobile terminals can be included in the calling group, and one or more of the mobile terminals of the group can be in any of the cells of the system.

The server then issues a group setup message to the called radio base stations 132b (and 132a in this example) as well as a conference acknowledge to the originating radio base station 132a. The server 141 also notifies the group bridge 143 which call-in numbers will be used for the group call so that the bridge 143 can group the calls together. A group setup message is thus sent to respective called radio base stations providing service for each active called mobile terminal in the called group. Moreover, each group setup message can include the following information: (1) the mobile identification number for the called mobile terminal; (2) the call-in number to be called by the called radio base station providing service for the called mobile terminal; (3) the group number called by the originating mobile terminal; and (4) the mobile terminal parameter data for the called mobile terminal.

Each of the called radio base stations then issues a called origination message to the mobile switching center 131 responsive to the group setup message. Each called origination message includes the mobile identification
number (MIN) for the respective called mobile terminal so that the mobile switching center believes the respective called mobile terminal issued the called origination message. The called origination message also includes the call-in number in the called party field, as well as the parameter information previously stored in the mobile terminal parameter database. This allows the call setups for both the originating mobile terminals and the called mobile terminals to proceed in parallel. This procedure also allows the mobile switching center to use its standard authentication and billing functions. In other words, each mobile terminal in the called group is treated as if it originated a call, and each mobile terminal in the called group can be billed for its own air time. In other words, by using the information for the called mobile terminal stored in the tracking database and the mobile terminal parameter database, the called radio base station is able to issue the called origination message without waiting for the called mobile terminal to respond to a page thus reducing call setup time.

After issuing a called origination message, each called radio base station transmits a group page during the next available paging subchannel of the respective digital control channel to the respective called mobile terminal using the mobile identification number specified in the respective group setup message. This group page wakes the mobile terminal to participate in the group call. The group page includes the group number in the calling party number field thus allowing the called mobile terminal to determine that the call is a group call so that the called mobile terminal can behave as if it originated a call once a digital traffic channel is assigned. Accordingly, the group paging can proceed simultaneously with other call setup activities such as the designation of a digital traffic channel by the mobile switching center.

Because the radio base station servicing each called mobile terminal is known as a result of the login message information stored in the tracking database, group setup messages can be transmitted only to radio base stations currently providing service to active mobile terminals in the group. Accordingly, the called radio base stations can transmit the respective called origination messages before receiving a page response from the respective called mobile terminal (or even before sending the page to the called mobile terminal). In other words, a called radio base station can begin setting up
communications between it and the group bridge before the respective called mobile terminal has responded because it is already known that the called mobile terminal is being serviced by that base station, and because the group setup message for called mobile terminals is only sent to the radio base.

5 station(s) providing service therefor. The time required for group call setup can thus be reduced.

In addition, the originating radio base station receives a group setup request acknowledge to confirm that the group setup request was received by the group server. The group setup request acknowledge can include the mobile identification number for the originating mobile terminal, the call-in number (optional for the originating radio base station), the group number called by the originating mobile terminal, and mobile terminal parameter data (optional). The originating mobile terminal modifies the calling origination message received from the originating mobile terminal to include mobile terminal parameters received and replaces the called party number with the group call-in number if provided. The designation of a digital traffic channel and opening of a conversation path for the originating mobile terminal can thus be done in parallel with the designation of digital traffic channels and the opening of conversation paths for the called mobile terminals so that the time required for group call setup can be reduced. Furthermore, the group call functionality according to the present invention can be provided using cellular systems operating according to existing cellular standards such as IS-136.

Figure 9 is a block diagram of a mobile terminal 137 for use in the communications system of Figure 6 providing both one-to-one cellular radiotelephone calls and group calls. As shown, the mobile terminal 137 includes a processor 151, a transceiver 153 (including a transmitter and a receiver), an antenna 155, a keypad 157, a display 159, a push-to-talk (PTT) button 161, a speaker 163, and a microphone 165. The mobile terminal 137 can initiate and receive one-to-one cellular radiotelephone calls according to a conventional cellular standard such as the IS-136 standard. In particular, the mobile terminal can initiate a one-to-one call responsive to the entry of a telephone number through the keypad followed by pushing a send key on the keypad. The mobile terminal can receive a one-to-one call from other terminals upon receipt of a page from the communications system causing the
phone to ring wherein the user can accept the call by pressing the send key on the keypad.

The processor of the mobile terminal 137 can also be programmed to provide the group calling features discussed above with regard to the communications system of Figure 6, 7, and 8. In particular, the mobile terminal processor 151 can be programmed as one of a group of mobile terminals that can be included in group calls. For example, the mobile terminal processor (and the processors of other mobile terminals in the group) can be programmed with a group number identifying the group, and a group call can be initiated responsive to pressing the PTT button. When the PTT button is pushed, the mobile terminal transmits a calling origination message including the group number as discussed above thereby initiating a group call between the active mobile terminals in the group. The mobile terminal can also receive group calls as discussed above with reference to Figures 6-8.

Moreover, the mobile terminal can transmit login messages and parameter messages as discussed above with regard to Figure 7.

A radio base 132 station according to the present invention is illustrated in Figure 10. As shown, the radio base station 132 includes a transmitter 211, a receiver 213, and a controller 215. The transmitter transmits radio communications to mobile terminals in the cell defined by the radio base station, the receiver receives radio communications from mobile terminals in the cell, and the controller controls the operation of the two. The controller also transmits and receives communications to and from the mobile switching center (MSC) 131. In particular, the controller assigns digital traffic channels as discussed in greater detail below.

The methods, systems, and terminals of the present invention can provide a more efficient use of traffic channels as will be discussed with reference to Figure 11. In particular, a single digital traffic channel can be used to provide half-duplex group communications for a plurality of mobile terminals within a common cell serviced by a single radio base station. For example, the mobile terminals 137a and 137b' of Figure 6 are in the common cell 135a serviced by the radio base station 132a. According to the present invention, the digital traffic channel of Figure 11 includes an inbound portion received by the base station and an outbound portion transmitted by the base.
station, and this digital traffic channel is assigned to a group of mobile terminals to provide half-duplex group communications. The radio base station thus receives group communications from one of the mobile terminals over the inbound portion of the digital traffic channel, and then transmits the received group communications over the outbound portion of the digital traffic channel for reception by the other mobile terminal(s) in the group located in the common cell.

The single digital traffic channel can thus provide half-duplex group communications for a plurality of mobile terminals in a common cell thereby reducing the traffic capacity consumed by a group call. In contrast, known hybrid systems assign a complete digital traffic channel (including both inbound and outbound portions) to each mobile terminal in a group. The digital traffic channel of the present invention can thus be used to increase the volume of traffic that can be handled by a communications system.

As shown in Figure 11, the outbound portion of the digital traffic channel for group communications is transmitted by the radio base station 132a, and the inbound portion of the digital traffic channel for group communications can be received from either mobile terminal 137a or mobile terminal 137b'. The radio base station 132a and the mobile terminals 137a and 137b' respectively correspond to the radio base station 132a and the mobile terminals 137a and 137b' of Figure 6. Furthermore, control messages during a group call can be handled over the digital traffic channel to provide message trunking so that the mobile terminals of a group call do not have to switch back and forth between the digital traffic channel and a control channel during a group call.

By providing both voice communications and control messages over the traffic channel, there is no need to set up a new traffic channel each time a terminal transmits during a single group call. In addition, delays between transmissions of different terminals can be reduced. More particularly, the control messages transmitted over the traffic channel can be transmitted as base station manufacturer code (BSMC) fast access control channel (FACCH) messages according to the IS-136 standard. As will be understood, BSMC messages are designated within the IS-136 standard as being unique to a
particular equipment manufacturer thus allowing proprietary messaging protocols.

According to a particular example of operations according to the present invention illustrated in Figures 11-13, the mobile terminal 137a can initiate a group call by transmitting a calling origination message on a digital control channel (DCCH) as discussed above. This calling origination message can be transmitted responsive to pressing the push to talk (PTT) button. The calling origination message is received by the radio base station 132a over the digital control channel (block 601), and in response, the radio base station assigns a digital traffic channel (DTC) for the group call (block 603). The radio base station transmits a digital traffic channel assignment page including the digital traffic channel assignment over the digital control channel addressed to the mobile terminals in the group (block 605). For example, the digital traffic channel assignment page can include a group call number used by the mobile terminals in the group to identify pages addressed thereto. The mobile terminals 137a and 137b in the group can thus receive the digital traffic channel assignment (block 705) and go to the assigned digital traffic channel (DTC) (block 707) using the information in the assignment page.

The inbound and outbound portions of the digital traffic channel can be provided on respective inbound and outbound carriers. For example, an inbound carrier can be divided into a plurality of inbound time slots grouped into inbound time frames with each inbound time frame including a plurality of successive inbound time slots wherein the inbound portion of the traffic channel includes one inbound time slot in each of a plurality of the inbound time frames. Similarly, an outbound carrier can be divided into a plurality of outbound time slots grouped into outbound time frames with each outbound time frame including a plurality of successive outbound time slots wherein the outbound portion of the traffic channel includes one outbound time slot in each of a plurality of the outbound time frames.

An exemplary division of the inbound and outbound portions of a digital traffic channel into time slots $S_0$-$S_N$ according to the present invention is illustrated in Figure 11. As will be understood, each of the time slots $S_0$-$S_N$ can be provided in a respective time frame with other time slots in the frames.
supporting other channels. Moreover, a message transmitted over either the inbound or outbound portions of the digital traffic channel can be spread over one half of each of two time slots of adjacent time frames. For example, the Confirm1 message is transmitted over the outbound portion of the traffic channel using one half each of time slots $S_0$ and $S_1$, and the Confirm2 message is transmitted over the outbound portion of the traffic channel using one half each of time slots $S_1$ and $S_2$. In combination with error detection/correction algorithms, this arrangement allows improved data transmission and reception. As shown in Figure 11, each of the confirm, unkey, idle, and drop control messages can be provided as FAACH messages spread over one half of each of two time slots. In addition, voice messages can also be spread over one half of each of two time slots.

Once the digital traffic channel has been assigned, the radio base station transmits a confirm message (block 607) identifying the mobile terminal that successfully requested the group call (radio base station 137a in this example). The confirm message can be transmitted multiple times to increase the probability that all mobile terminals of the group receive it. Control messages transmitted over the traffic channel are preferably transmitted at least three times. In the example of Figure 11, the first confirm message is transmitted three times as messages Confirm1, Confirm2, and Confirm3. In the event that more than one mobile terminal of the requests the group call at about the same time, the confirm message can be used to communicate which mobile terminal is allowed to transmit so that only one mobile terminal in the group transmits at a time.

In this example, the mobile terminal 137a requested the group call over the digital control channel, and the confirm messages Confirm1, Confirm2, and Confirm3 thus identify the mobile 137a as the mobile terminal allowed to transmit. In response to receipt of the message Confirm1 (block 709) identifying the mobile terminal 137a (block 711), the mobile terminal 137a transmits group communications such as voice messages Voice1 and Voice2 over the inbound portion of the digital traffic channel (block 713). While two voice messages are illustrated, any number of voice messages can be sent by the mobile terminal 137a. The radio base station receives the group communications over the inbound portion of the traffic channel and transmits
the group communications (Voice1 and Voice2) over the outbound portion of the digital traffic channel as messages Voice1’ and Voice2’ (block 609). The other mobile terminal(s) in the group (mobile terminal 137b’ in this example) can thus receive the group communications over the outbound portion of the digital traffic channel (block 727).

When the user of mobile terminal 137a is finished talking, the user can release the PTT button, initiating the transmission of the sequence of unkey messages Unkey1, Unkey2, and Unkey3 from the mobile terminal 137a over the inbound portion of the digital traffic channel (block 715). As with the confirm messages, the unkey messages can be repeated a plurality of times to increase the probability of correct reception at the base station. Moreover, each of the unkey messages of a sequence can include a counter so that the radio base station can determine when the sequence of unkey messages will end even if one of the unkey messages is missed.

In response to successfully receiving the unkey message Unkey1 (block 611), the radio base station transmits the idle messages Idle1, Idle2, Idle3, and Idle4 (block 613) to signal the mobile terminals in the group that the digital traffic channel is open for transmission. While four idle messages are shown in Figure 11 for the purpose of illustration, the number of idle messages transmitted can be dependent on the period of time that passes before a key message is received (block 615) from one of the mobile terminals in the group. In addition, a predetermined period of time can be set (block 617) so that if a key message is not received within the predetermined period of time, the radio base station can terminate the call (block 621) thus freeing the digital traffic channel for other traffic. A release message can then be transmitted by the base station over the traffic channel signaling the mobile terminals to resume monitoring the control channel. An assigned traffic channel that is not being used can thus be reassigned. Upon receipt of a release message, the mobile terminals can resume monitoring the control channel.

In the example of Figure 11, the mobile terminal 137b’ receives the first idle message Idle1 over the outbound portion of the traffic channel (block 719), and transmits the key message Key (block 721) responsive to pressing the PTT button. While the user of the mobile terminal 137b’ may press the
PTT button at any time, the mobile terminal preferably prevents transmission of a key message until after receipt of an idle message indicating that the traffic channel is free. Furthermore, the key message can be transmitted any time after receipt of first idle message but before receipt of a subsequent confirm message. In addition, the key message Key is preferably transmitted as a single slot message to reduce the likelihood of collisions and increase the speed of access to the traffic channel. For example, the key message can be transmitted over a single time slot of the inbound portion of the digital traffic channel using a digital control channel format such as the digital control channel (DCCH) format of the IS-136 standard. By transmitting the key message over a single time slot, the time needed to transmit the key message can be reduced, and the probability that two key messages are received from two terminals at the same time can be reduced.

Responsive to receipt of a valid key message Key over the inbound portion of the traffic channel (block 615), the radio base station transmits a second series of confirm messages Confirm11, Confirm12, Confirm13, and Confirm14 over the outbound portion of the traffic channel (block 607). Each of these confirm messages preferably identify the mobile terminal (mobile terminal 137b' in this example) from which the key message was received, and each of these confirm messages can be the same. Once a valid key message is received by the radio base station, the base station can stop accepting DCCH format messages (including key messages) over the traffic channel. As before, multiple confirm messages can be transmitted to increase the probability that at least one of the confirm messages is received by each of the mobile terminals (block 709) in the group serviced by the radio base station. In addition, by identifying the mobile terminal allowed to transmit, other mobile terminals in the group that may have sent key messages at about the same time can be prevented from transmitting. In other words, each mobile terminal preferably transmits only after receipt of a confirm message identifying that terminal as being designated to transmit (block 711).

If the confirm message includes an identification for another mobile terminal, the mobile terminal can assume that it lost its bid for access and can thus continue to receive (block 727). If no confirm message is received by the
mobile terminal within a predetermined period of time after transmitting the key message, the mobile terminal can assume that the key message was not received and then retransmit the key message after a random delay. The use of a random delay can reduce the probability that two terminals transmit successive interfering key messages.

As shown in Figure 11, upon successful receipt of the first confirm message Confirm11 (block 709) identifying the mobile terminal 137b' as designated to transmit (block 711), the mobile terminal 137b' transmits group communications messages (Voice11 and Voice12) over the inbound portion of the traffic channel (block 713). Upon receipt of these group communications messages, the radio base station retransmits these group communications messages over the outbound portion of the traffic channel as messages Voice11' and Voice12' for receipt by the other mobile terminal(s) 137a in the group (block 609). As discussed above with regard to messages Voice1 and Voice2, any number of group communications messages can be transmitted by the mobile terminal 137b'. When the user of the mobile terminal 137b' is through talking, the user can release the PTT button thereby generating a second series of unkey messages (block 715) as discussed above with regard to the mobile terminal 137a. This course of action can open the traffic channel for transmissions from another of the mobile terminal(s) in the group.

As shown in the example of Figure 11, however, upon completion of transmitting voice messages, the user terminal can transmit a series of drop messages Drop1, Drop2, and Drop3 (block 715) over the inbound portion of the traffic channel to terminate the group call. Instead of simply releasing the PTT key, for example, the user of the mobile terminal can press a drop key. Multiple drop messages can be transmitted to increase the probability that one of the drop messages is received by the radio base station. In response to receipt of the first drop message Drop1 (block 619), the radio base station transmits a corresponding series of drop messages Drop1' and Drop2' to inform the other mobile terminal(s) 137a in the group that the group call is being terminated. After transmission of the drop messages by the radio base station, the digital traffic channel is freed for other use, and the mobile terminals in the group can switch to the digital control channel to monitor for
subsequent pages. The use of the drop messages can free the traffic channel without waiting for a time out interval to pass. Upon receipt of a drop message (block 725 or 728), the mobile terminal can return to monitoring the digital control channel (DCCH) (block 730) for digital traffic channel assignments.

According to methods, systems, and terminals of the present invention, group communications can be provided on a hybrid cellular communications system using protocols of the IS-136 standard. In particular, a single digital traffic channel according to the IS-136 standard can be assigned to provide half-duplex group communications for a plurality of mobile terminals in a common cell. The same digital traffic channel can also be assigned (at another time) to provide full-duplex radiotelephone communications for a single mobile terminal. For example, the mobile terminal 137a may be a hybrid terminal supporting both half-duplex group communications and full-duplex one-to-one cellular radiotelephone communications so that the mobile terminal 137a can provide full-duplex radiotelephone communications using the same traffic channel used (at another time) to provide half-duplex group communications for a plurality of mobile terminals.

The flowcharts of Figures 12 and 13 illustrates exemplary operations of base stations and mobile terminals according to aspects of the present invention. It will be understood that blocks of the flowcharts of Figures 12 and 13, and combinations of blocks in the flowcharts, can be implemented by computer program instructions which may be loaded onto a computer or other programmable data processing apparatus, such as the controller 215 of the radio base station 132 of Figure 10 or the processor 151 of the mobile terminal 137 of Figure 9 to produce a machine(s) such that the instructions which execute on the computer or other programmable data processing apparatus create means for implementing the functions specified in the flowchart block or blocks. The computer program instructions may also be loaded onto a computer or other programmable data processing apparatus to cause a series of operational steps to be performed on the computer or other programmable apparatus to produce a computer implemented process such that the instructions which execute on the computer or other programmable
apparatus provide steps for implementing the functions specified in the
flowchart block or blocks.

Accordingly, blocks of the flowcharts of Figures 12 and 13 support
combinations of means for performing the specified functions and
combinations of steps for performing the specified functions. It will also be
understood that each block of the flowcharts of Figure 12 and 13, and
combinations of blocks therein, can be implemented by special purpose
hardware-based computer systems which perform the specified functions or
steps, or combinations of special purpose hardware and computer
instructions.

In the drawings and specification, there have been disclosed typical
preferred embodiments of the invention and, although specific terms are
employed, they are used in a generic and descriptive sense only and not for
purposes of limitation, the scope of the invention being set forth in the
following claims.
THAT WHICH IS CLAIMED IS:

1. A method of providing group communications between a plurality of terminals over a cellular communications system, the method comprising the steps of:
   assigning a traffic channel for half-duplex communications between the terminals wherein the traffic channel comprises an inbound portion from the terminals to the communications system and an outbound portion from the communications system to the terminals;
   receiving group communications from a first one of the terminals over the inbound portion of the traffic channel; and
   responsive to receiving the group communications from the first terminal, transmitting the group communications received from the first terminal over the outbound portion of the traffic channel.

2. A method according to Claim 1 wherein the steps of receiving and transmitting the group communications from the first terminal are followed by the steps of:
   receiving group communications from a second one of the terminals over the inbound portion of the traffic channel; and
   responsive to receiving the group communications from the second terminal, transmitting the group communications received from the second terminal over the outbound portion of the traffic channel.

3. A method according to Claim 2 wherein the step of receiving the group communications from the second terminal is preceded by the steps of:
   after receiving the group communication from the first terminal, receiving an unkey message over the inbound portion of the traffic channel from the first terminal; and
   responsive to receiving the unkey message, transmitting an idle message over the outbound portion of the traffic channel.

4. A method according to Claim 3 wherein the step of receiving the group communications from the second terminal is preceded by the step of:
after transmitting the idle message, receiving a key message from the
second terminal over the inbound portion of the traffic channel; and

responsive to receiving the key message, transmitting a confirm
message over the outbound portion of the traffic channel wherein the confirm
message includes an identification for the second terminal.

5. A method according to Claim 1 wherein an inbound carrier is
divided into a plurality of inbound time slots grouped into inbound time frames
with each inbound time frame including a plurality of successive inbound time
slots with the inbound portion of the traffic channel comprising one inbound
time slot in each of a plurality of the inbound time frames, and wherein an
outbound carrier is divided into a plurality of outbound time slots grouped into
outbound time frames with each outbound time frame including a plurality of
successive outbound time slots with the outbound portion of the traffic
channel comprising one outbound time slot in each of a plurality of the
outbound time frames.

6. A method according to Claim 5 wherein the traffic channel
comprises a digital traffic channel according to the IS-136 standard.

7. A method according to Claim 1 wherein the step of assigning the
traffic channel is preceded by the step of:

receiving a group call setup message from the first terminal over a
control channel.

8. A method according to Claim 7 wherein the steps of receiving
and transmitting the group communications are preceded by:

responsive to receiving the group call origination message from the first
terminal, transmitting a confirm message over the outbound portion of the
traffic channel wherein the confirm message includes an identification for the
first mobile terminal.
9. A method according to Claim 7 wherein the step of assigning the traffic channel comprises transmitting the traffic channel assignment as a page over the control channel.

10. A method according to Claim 9 wherein the page includes a group identification number for the group including the plurality of terminals.

11. A method according to Claim 1 wherein the steps of receiving and transmitting the group communications from the first terminal are followed by the steps of:

   receiving an inbound drop message from one of the terminals over the inbound portion of the traffic channel;

   responsive to receiving the drop message, transmitting an outbound drop message over the outbound portion of the traffic channel; and

   after transmitting the outbound drop message, ending group communication between the terminals.

12. A method according to Claim 1 wherein the steps of receiving and transmitting the group communications from the first terminal are followed by the steps of:

   receiving an unkey message from one of the terminals over the inbound portion of the traffic channel;

   after receiving the unkey message, waiting a predetermined period of time for a key message to be received from one of the terminals; and

   responsive to waiting the predetermined period of time without receiving further group communications from the terminals, ending communications between the terminals.

13. A method according to Claim 1 further comprising the step of:

   assigning the traffic channel including the inbound and outbound portions to a single terminal for full-duplex radiotelephone communications.

14. A method of providing group communications over a cellular communications system, the method comprising the steps of:
receiving a traffic channel assignment for half-duplex communications
at a first terminal wherein the traffic channel comprises an inbound portion
from the first terminal to the communications system and an outbound portion
from the communications system to the first terminal; and
transmitting group communications over the inbound portion of the
traffic channel for retransmission by the cellular communications system over
the outbound portion of the traffic channel to a second terminal.

15. A method according to Claim 14 further comprising the step of:
receiving group communications at the first terminal from the second
terminal over the outbound portion of the traffic channel from the
communications system.

16. A method according to Claim 15 wherein the step of receiving
the group communications from the second terminal is preceded by the steps
of:

after transmitting group communication over the inbound portion of the
traffic channel, transmitting an unkey message over the inbound portion of the
traffic channel.

17. A method according to Claim 14 wherein the step of transmitting
group communications over the inbound portion of the traffic channel is
preceded by the steps of:

after receiving the traffic channel assignment, receiving an idle
message from the communications system over the outbound portion of the
traffic channel;

after receiving the idle message, transmitting a key message over the
inbound portion of the traffic channel; and

after transmitting the key message, receiving a confirm message over
the outbound portion of the traffic channel wherein the confirm message
includes an identification for the first terminal.

18. A method according to Claim 14 wherein an inbound carrier is
divided into a plurality of inbound time slots grouped into inbound time frames
with each inbound time frame including a plurality of successive inbound time slots with the inbound portion of the traffic channel comprising one inbound time slot in each of a plurality of the inbound time frames, and wherein an outbound carrier is divided into a plurality of outbound time slots grouped into outbound time frames with each outbound time frame including a plurality of successive outbound time slots with the outbound portion of the traffic channel comprising one outbound time slot in each of a plurality of the outbound time frames.

19. A method according to Claim 18 wherein the traffic channel comprises a digital traffic channel according to the IS-136 standard.

20. A method according to Claim 14 wherein the step of receiving the traffic channel assignment is preceded by the step of:
transmitting a group call setup message from the first terminal over a control channel.

21. A method according to Claim 20 wherein the step of transmitting group communications is preceded by:
transmitting the group call setup message over the control channel,
receiving a confirm message over the traffic channel wherein the confirm message includes an identification for the first mobile terminal.

22. A method according to Claim 20 wherein the step of assigning the traffic channel comprises receiving the traffic channel assignment as a page over the control channel.

23. A method according to Claim 22 wherein the page includes a group identification number for the group including the first and second terminals.

24. A method according to Claim 14 wherein the step of transmitting group communications from the first terminal followed by the steps of:
transmitting an inbound drop message over the inbound portion of the traffic channel; and

5 after transmitting the inbound drop message, ending group communication.

25. A method according to Claim 14 further comprising the step of:
receiving a traffic channel assignment for the traffic channel including
the inbound and outbound portions at the terminal for full-duplex
radiotelephone communications.

26. A cellular communications system providing group communications between a plurality of terminals, the system comprising:
a controller that assigns a traffic channel for half-duplex communications between the terminals wherein the traffic channel comprises
5 an inbound portion from the terminals to the communications system and an outbound portion from the communications system to the terminals;
a transmitter coupled to the controller wherein the transmitter transmits the traffic channel assignment to the terminals;
a receiver coupled to the controller wherein the receiver receives group communications from a first one of the terminals over the inbound portion of the traffic channel, and wherein responsive to receiving the group communications from the first terminal, the transmitter transmits the group communications received from the first terminal over the outbound portion of the traffic channel.

27. A system according to Claim 26 wherein the receiver further receives group communications from a second one of the terminals over the inbound portion of the traffic channel, and wherein responsive to receiving the group communications from the second terminal, the transmitter transmits the group communications received from the second terminal over the outbound portion of the traffic channel.

28. A system according to Claim 27 wherein the group communications from the first terminal are received and transmitted before
receiving and transmitting the group communications from the second terminal, and wherein before receiving and transmitting group communications from the second terminal the receiver receives an unkey message over the inbound portion of the traffic channel from the first terminal, and responsive to receiving the unkey message, the transmitter transmits an idle message over the outbound portion of the traffic channel.

29. A system according to Claim 28 wherein before receiving the group communications from the second terminal and after transmitting the idle message, the receiver receives a key message from the second terminal over the inbound portion of the traffic channel, and responsive to receiving the key message, the transmitter transmits a confirm message over the outbound portion of the traffic channel wherein the confirm message includes an identification for the second terminal.

30. A system according to Claim 26 wherein an inbound carrier is divided into a plurality of inbound time slots grouped into inbound time frames with each inbound time frame including a plurality of successive inbound time slots with the inbound portion of the traffic channel comprising one inbound time slot in each of a plurality of the inbound time frames, and wherein an outbound carrier is divided into a plurality of outbound time slots grouped into outbound time frames with each outbound time frame including a plurality of successive outbound time slots with the outbound portion of the traffic channel comprising one outbound time slot in each of a plurality of the outbound time frames.

31. A system according to Claim 30 wherein the traffic channel comprises a digital traffic channel according to the IS-136 standard.

32. A system according to Claim 26 wherein before assigning the traffic channel, the receiver receives a group call setup message from the first terminal over a control channel.
33. A system according to Claim 32 wherein before receiving and transmitting the group communications and responsive to receiving the group call origination message from the first terminal, the transmitter transmits a confirm message over the outbound portion of the traffic channel wherein the confirm message includes an identification for the first mobile terminal.

34. A system according to Claim 32 wherein the traffic channel assignment is transmitted as a page over the control channel.

35. A system according to Claim 34 wherein the page includes a group identification number for the group including the plurality of terminals.

36. A system according to Claim 26 wherein after receiving and transmitting the group communications from the first terminal, the receiver receives an inbound drop message from one of the terminals over the inbound portion of the traffic channel, wherein responsive to receiving the drop message, the transmitter transmits an outbound drop message over the outbound portion of the traffic channel, and wherein after transmitting the outbound drop message, the controller ends communication between the terminals.

37. A system according to Claim 26 wherein after receiving and transmitting the group communications from the first terminal, the receiver receives an unkey message from one of the terminals over the inbound portion of the traffic channel, wherein after receiving the unkey message, the controller waits a predetermined period of time for a key message to be received from one of the terminals, and wherein responsive to waiting the predetermined period of time without receiving further group communications from the terminals, the controller ends communications between the terminals.

38. A system according to Claim 26 wherein the controller assigns the traffic channel including the inbound and outbound portions to a single terminal for full-duplex radiotelephone communications.
39. A terminal providing group communications through a cellular communications system, the terminal comprising:
   a receiver that receives a traffic channel assignment for half-duplex communications at a first terminal wherein the traffic channel comprises an inbound portion from the first terminal to the communications system and an outbound portion from the communications system to the first terminal;
   a processor coupled to the receiver wherein the processor generates group communications to be transmitted to a second terminal through the cellular communications system over the traffic channel; and
   a transmitter coupled to the processor wherein the transmitter transmits group communications generated by the processor over the inbound portion of the traffic channel for retransmission by the cellular communications system over the outbound portion of the traffic channel to the second terminal.

40. A terminal according to Claim 39 wherein the receiver receives group communications from the second terminal over the outbound portion of the traffic channel from the communications system.

41. A terminal according to Claim 40 wherein before receiving the group communications from the second terminal and after transmitting group communication over the inbound portion of the traffic channel, the processor generates an unkey message, and the transmitter transmits the unkey message over the inbound portion of the traffic channel.

42. A terminal according to Claim 39 wherein before transmitting group communications over the inbound portion of the traffic channel and after receiving the traffic channel assignment, the receiver receives an idle message from the communications system over the outbound portion of the traffic channel, wherein after receiving the idle message, the transmitter transmits a key message over the inbound portion of the traffic channel, and wherein after transmitting the key message, the receiver receives a confirm message over the outbound portion of the traffic channel wherein the confirm message includes an identification for the first terminal.
43. A terminal according to Claim 39 wherein an inbound carrier is divided into a plurality of inbound time slots grouped into inbound time frames with each inbound time frame including a plurality of successive inbound time slots with the inbound portion of the traffic channel comprising one inbound time slot in each of a plurality of the inbound time frames, and wherein an outbound carrier is divided into a plurality of outbound time slots grouped into outbound time frames with each outbound time frame including a plurality of successive outbound time slots with the outbound portion of the traffic channel comprising one outbound time slot in each of a plurality of the outbound time frames.

44. A terminal according to Claim 43 wherein the traffic channel comprises a digital traffic channel according to the IS-136 standard.

45. A terminal according to Claim 39 wherein before receiving the traffic channel assignment, the transmitter transmits a group call setup message over a control channel.

46. A terminal according to Claim 45 wherein before transmitting group communications, the transmitter transmits the group call setup message over the control channel, the receiver receives a confirm message over the traffic channel wherein the confirm message includes an identification for the terminal.

47. A terminal according to Claim 45 wherein the receiver receives the traffic channel assignment as a page over the control channel.

48. A terminal according to Claim 47 wherein the page includes a group identification number for the group including the terminal.

49. A terminal according to Claim 39 wherein after transmitting group communications, the transmitter transmits an inbound drop message
over the inbound portion of the traffic channel, and wherein after transmitting the inbound drop message, the controller ends group communication.

50. A terminal according to Claim 39 wherein the receiver receives a traffic channel assignment for the traffic channel including the inbound and outbound portions for full-duplex radiotelephone communications.
FIG. 1.
(PRIOR ART)
FIG. 3.
(PRIOR ART)
FIG. 4.
(PRIOR ART)
FIG. 5.

(PRIOR ART)

FIG. 6.
FIG. 8.

RBS DETECTS CONF. CALL

CONF. SETUP REQUEST

CONF. SETUP REQUEST ACK

ORIGINATION

DTC DESIGNATION

CONVERSATION

NOTE THE CONNECTION IS BETWEEN MT AND CONF. BRIDGE VIA THE MSC

NEW RBS TO SERVER LINK

SERVER DETERMINES CELLS WITH CONF. MEMBERS

SEND TO EACH RBS IN CALL

THIS SEPARATION IS FOR DRAWING CLARITY. THE ORIGINATION MAY BEGIN ASAP AFTER CONF. SETUP

PAGE

PAGE RESP

REPEAT FOR EACH MEMBER IN THE GROUP

ORIGINATION

SETUP

DTC DESIGNATION

CONNECT

CONVERSATION
FIG. 9.

FIG. 10.
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H04Q7/28 H04Q7/38

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 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, WPI Data, PAJ, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
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<td>WO 94 26867 A (YARWOOD ANTHONY CHARLES; BRITISH TELECOMM (GB)) 8 December 1994 (1994-12-08) column 3, line 15 - line 28 column 11, line 5 - line 10 column 14, line 24 - line 32</td>
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Further documents are listed in the continuation of box C. Patent family members are listed in annex.

* Special categories of cited documents:
+ "A" document defining the general state of the art which is not considered to be of particular relevance
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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

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"Z" document member of the same patent family

Date of the actual completion of the international search: 19 September 2000
Date of mailing of the international search report: 28/09/2000

Name and mailing address of the ISA:
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

Authorized officer: Janyszek, J-M
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