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Crockett et al.

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(54) **METHOD AND AN APPARATUS FOR ADDING A NEW MEMBER TO AN ACTIVE GROUP CALL IN A GROUP COMMUNICATION NETWORK**

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(52) **U.S. Cl.** **455/518**; 455/519; 370/260; 379/49; 709/204

(58) **Field of Search** 455/518, 519, 455/515, 560; 379/49; 370/260; 709/204

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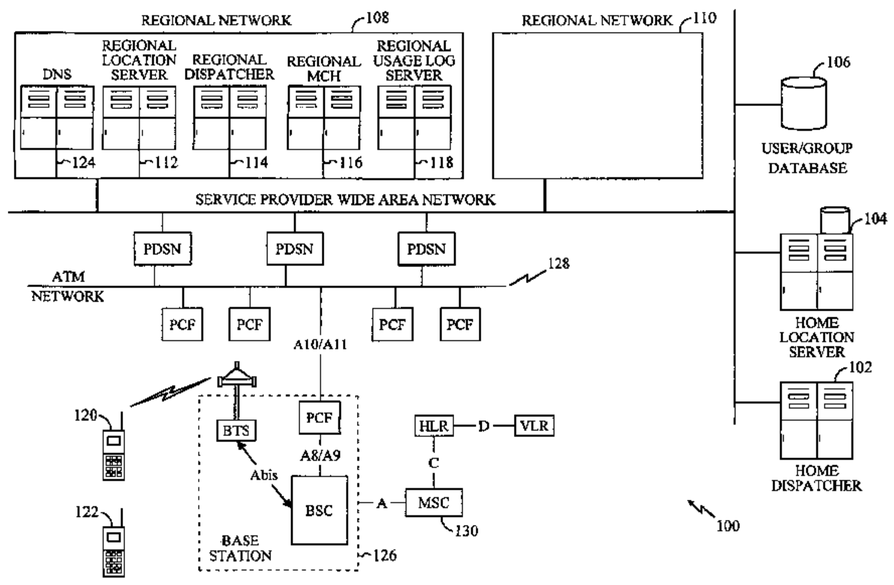
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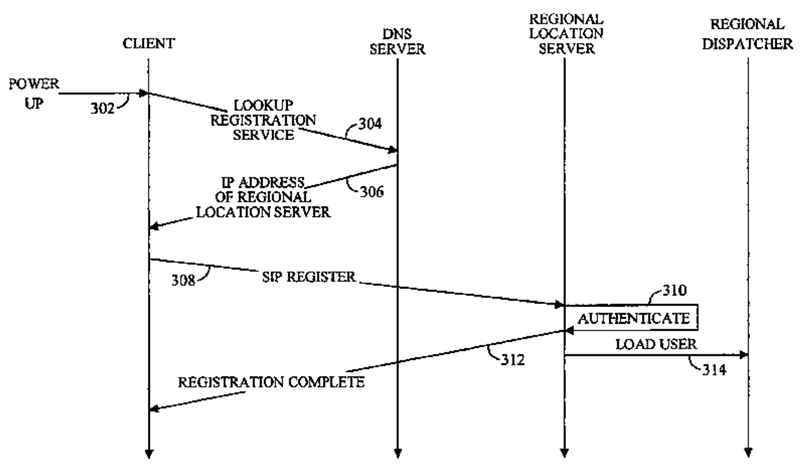
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(57) **ABSTRACT**

A method and apparatus for adding a member to an active call in a group communication network provides for receiving a member list from a user and sending a request to a server to add the member list to the active group call. The method and apparatus further provides for announcing each member in the member list that they are being added to the group call, receiving acknowledgement from a member who wishes to participate in the group call, and forwarding media to the member. The method and apparatus also provides for a significant reduction in the actual total dormancy wakeup time and latency by exchanging group call signaling even when mobiles are dormant and no traffic channel is active.

27 Claims, 18 Drawing Sheets





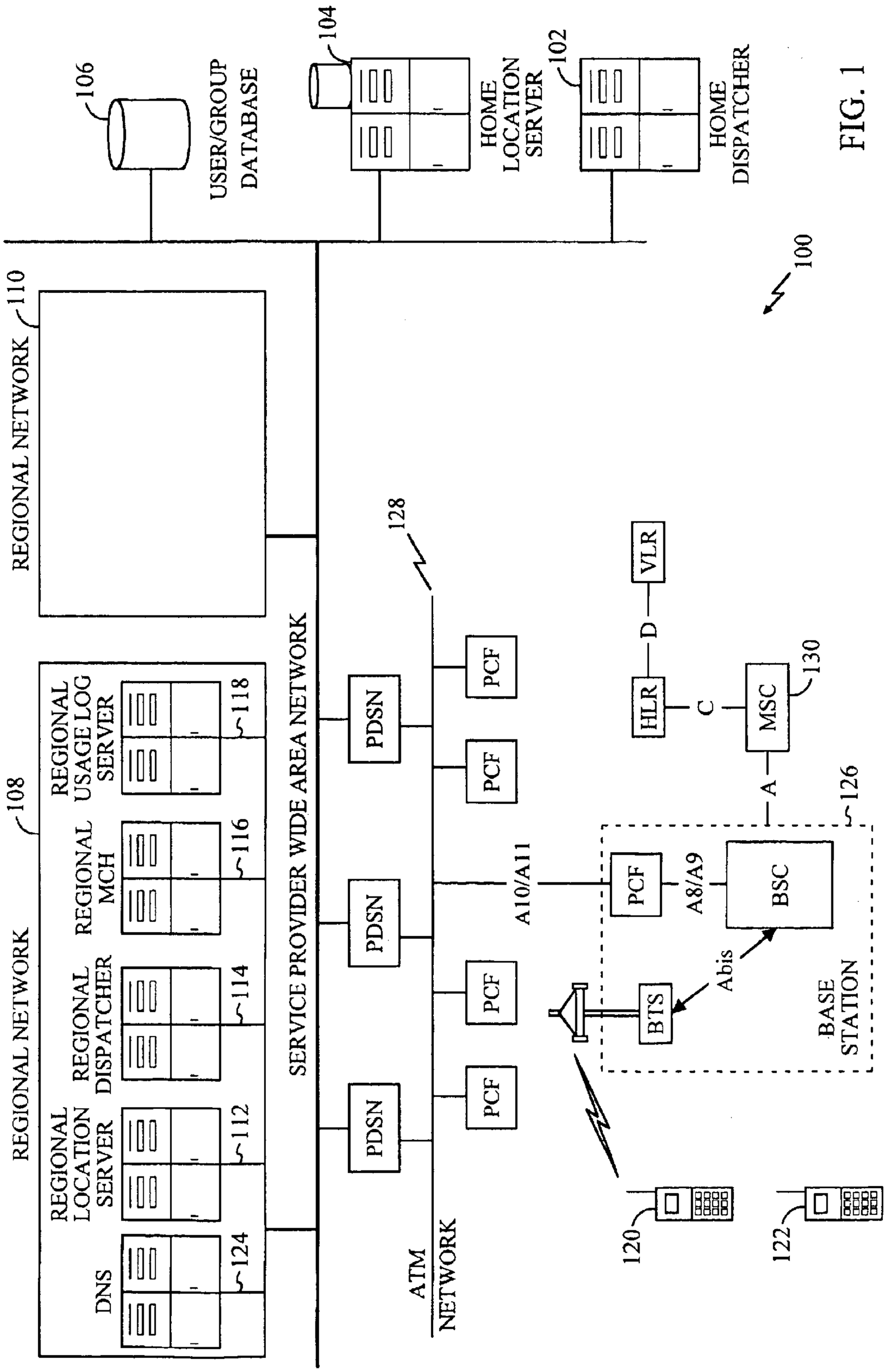

100
HOME DISPATCHER
102
HOME LOCATION SERVER
104
USER/GROUP DATABASE
106
REGIONAL NETWORK
110
SERVICE PROVIDER WIDE AREA NETWORK
REGIONAL NETWORK
108
REGIONAL USAGE LOG SERVER
118
REGIONAL MCH
116
REGIONAL DISPATCHER
114
REGIONAL LOCATION SERVER
112
DNS
124
PDSN
128
PCF
A10/A11
A8/A9
A
Abis
D
C
VLR
HLR
MSC
130
BSC
126
BTS
BASE STATION
120
122
ATM NETWORK

FIG. 1

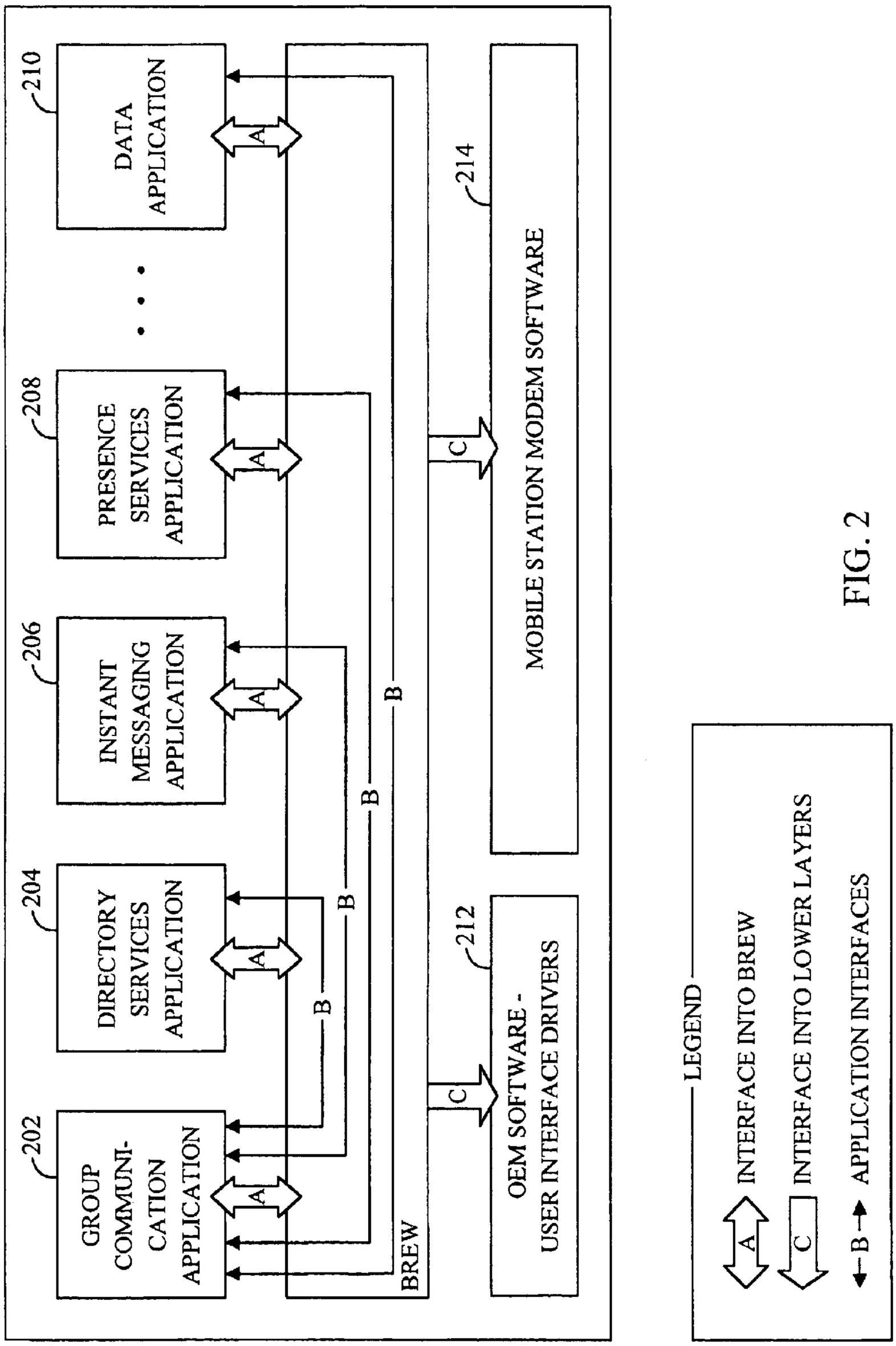

210
DATA APPLICATION
208
PRESENCE SERVICES APPLICATION
206
INSTANT MESSAGING APPLICATION
204
DIRECTORY SERVICES APPLICATION
202
GROUP COMMUNI-CATION APPLICATION
214
MOBILE STATION MODEM SOFTWARE
212
OEM SOFTWARE - USER INTERFACE DRIVERS
BREW
A
B
C
LEGEND
INTERFACE INTO BREW
INTERFACE INTO LOWER LAYERS
APPLICATION INTERFACES

FIG. 2

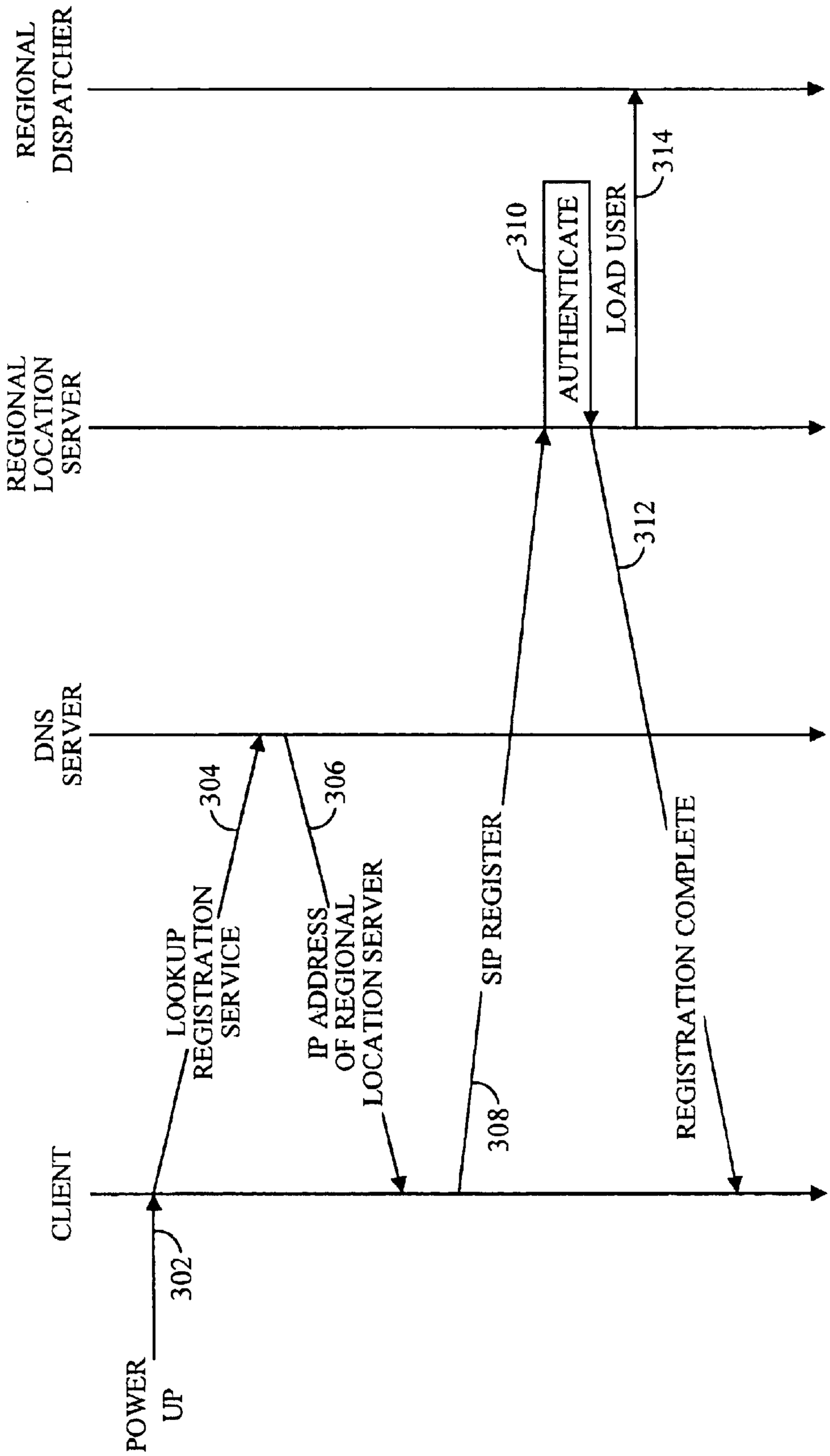

CLIENT
DNS SERVER
REGIONAL LOCATION SERVER
REGIONAL DISPATCHER
POWER UP
302
LOOKUP REGISTRATION SERVICE
304
IP ADDRESS OF REGIONAL LOCATION SERVER
306
SIP REGISTER
308
AUTHENTICATE
310
LOAD USER
312
REGISTRATION COMPLETE
314

FIG. 3

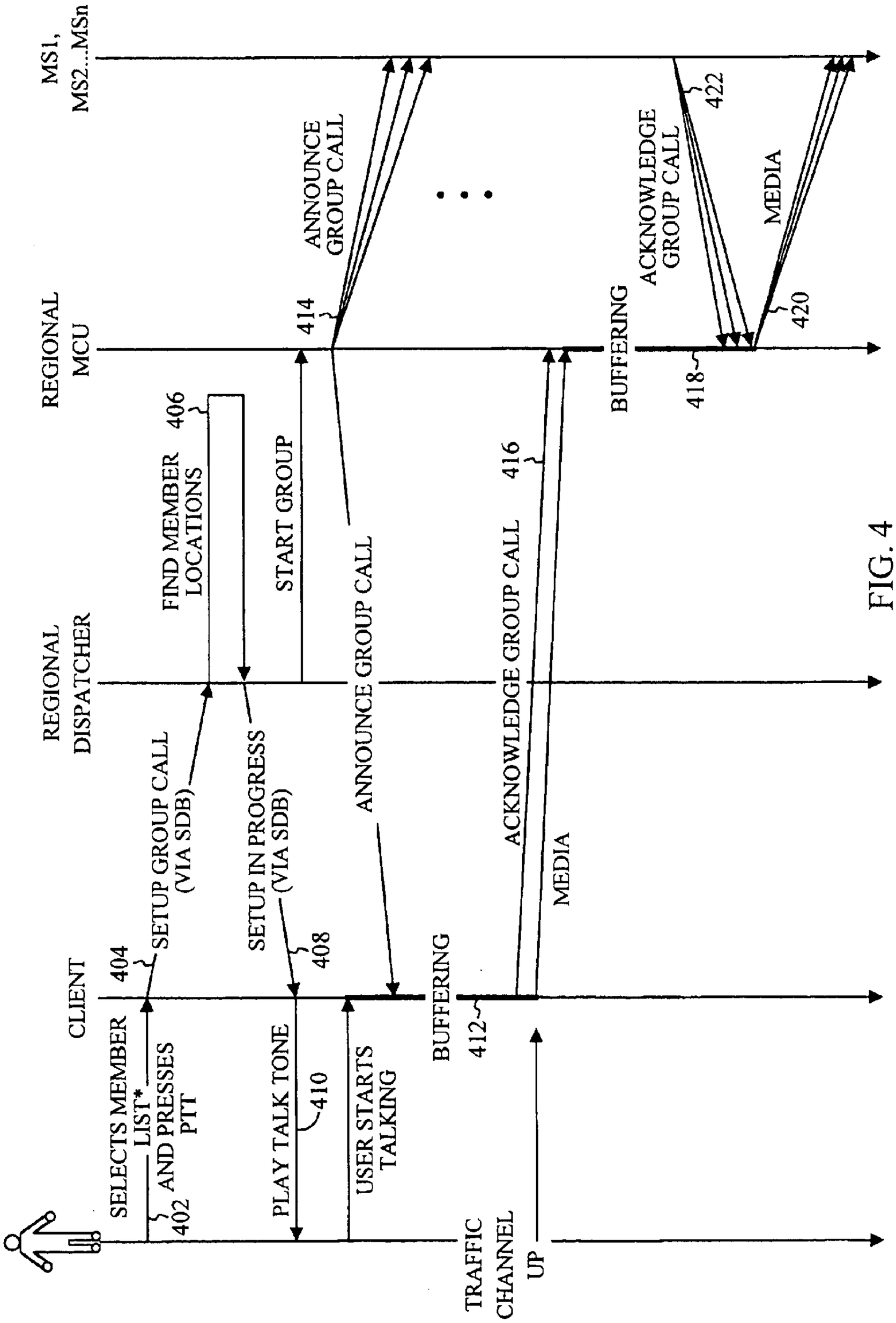

CLIENT
REGIONAL DISPATCHER
REGIONAL MCU
MS1, MS2...MSn
SELECTS MEMBER LIST* AND PRESSES PTT
402
SETUP GROUP CALL (VIA SDB)
404
FIND MEMBER LOCATIONS
406
SETUP GROUP IN PROGRESS (VIA SDB)
408
PLAY TALK TONE
410
USER STARTS TALKING
ANNOUNCE GROUP CALL
414
START GROUP
ACKNOWLEDGE GROUP CALL
416
BUFFERING
412
BUFFERING
418
ACKNOWLEDGE GROUP CALL
422
MEDIA
420
MEDIA
TRAFFIC CHANNEL UP

FIG. 4

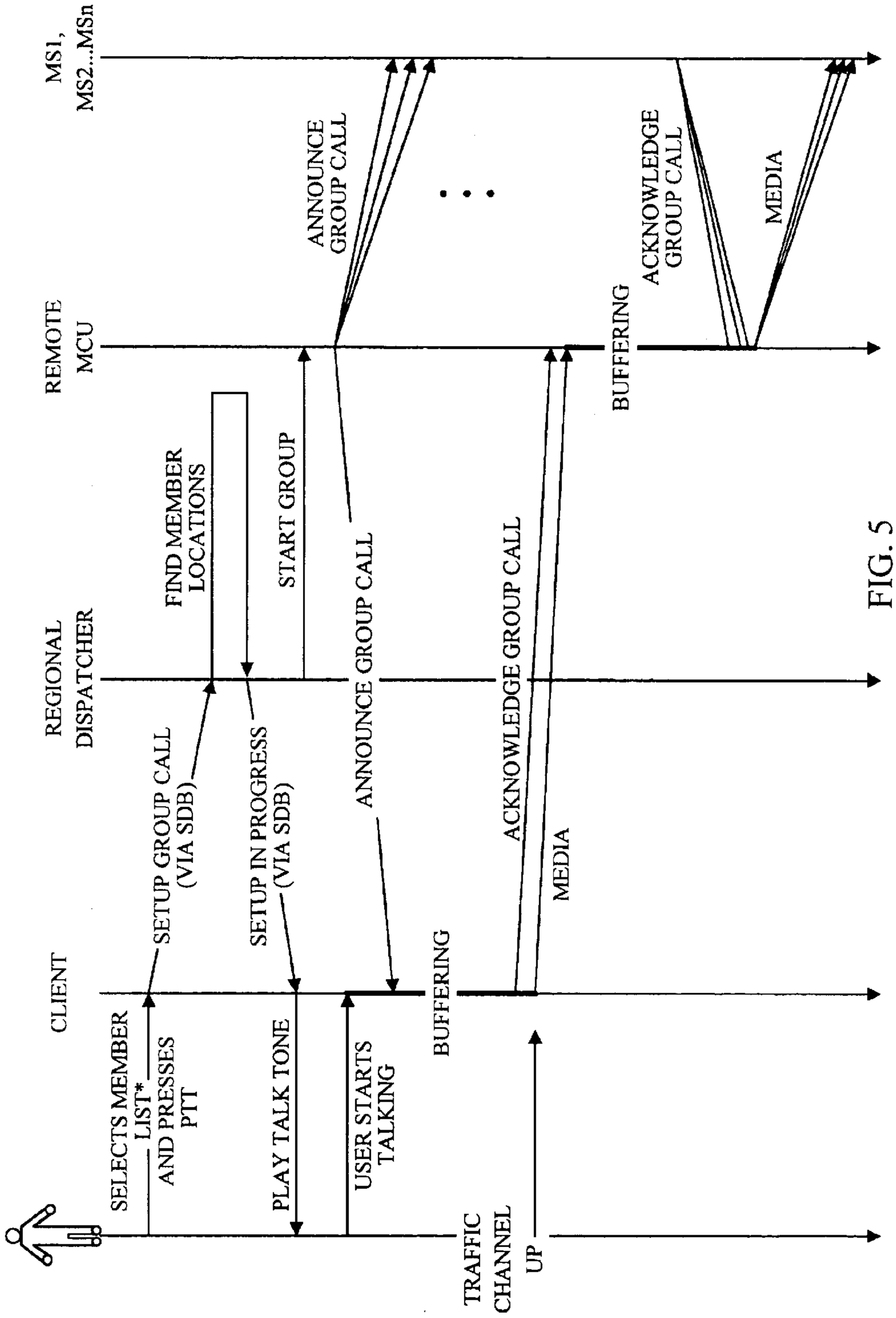

MS1,
MS2...MSn
REMOTE
MCU
REGIONAL
DISPATCHER
CLIENT
ANNOUNCE
GROUP CALL
ACKNOWLEDGE
GROUP CALL
MEDIA
BUFFERING
FIND MEMBER
LOCATIONS
START GROUP
SETUP GROUP CALL
(VIA SDB)
SETUP IN PROGRESS
(VIA SDB)
ANNOUNCE GROUP CALL
ACKNOWLEDGE GROUP CALL
MEDIA
SELECTS MEMBER
LIST*
AND PRESSES
PTT
PLAY TALK TONE
USER STARTS
TALKING
BUFFERING
TRAFFIC
CHANNEL
UP

FIG. 5

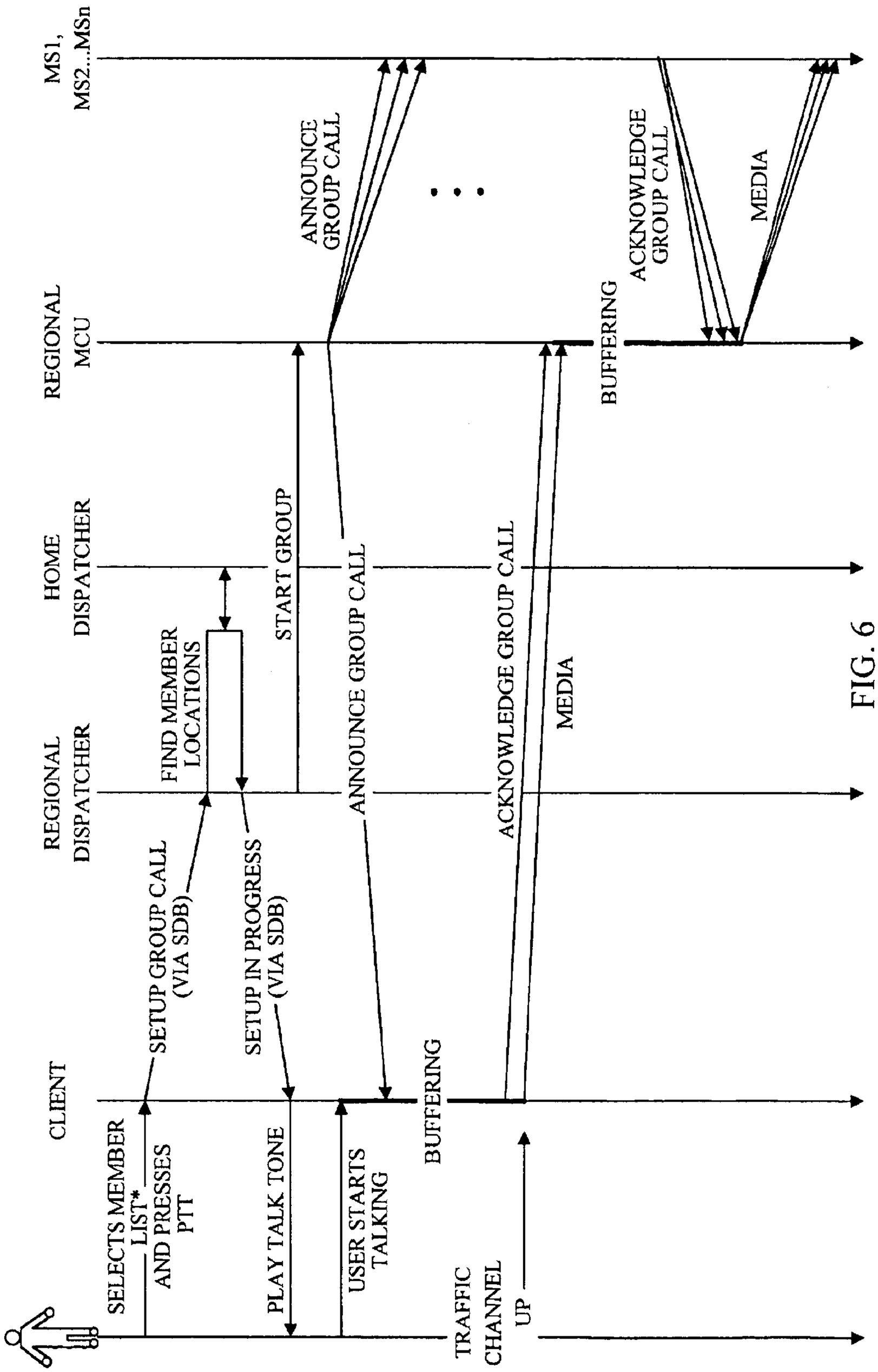

MS1,
MS2...MSn
REGIONAL
MCU
HOME
DISPATCHER
REGIONAL
DISPATCHER
CLIENT
ANNOUNCE
GROUP CALL
ACKNOWLEDGE
GROUP CALL
MEDIA
BUFFERING
FIND MEMBER
LOCATIONS
START GROUP
ANNOUNCE GROUP CALL
ACKNOWLEDGE GROUP CALL
MEDIA
SETUP GROUP CALL
(VIA SDB)
SETUP IN PROGRESS
(VIA SDB)
SELECTS MEMBER
LIST*
AND PRESSES
PTT
PLAY TALK TONE
USER STARTS
TALKING
BUFFERING
TRAFFIC
CHANNEL
UP

FIG. 6

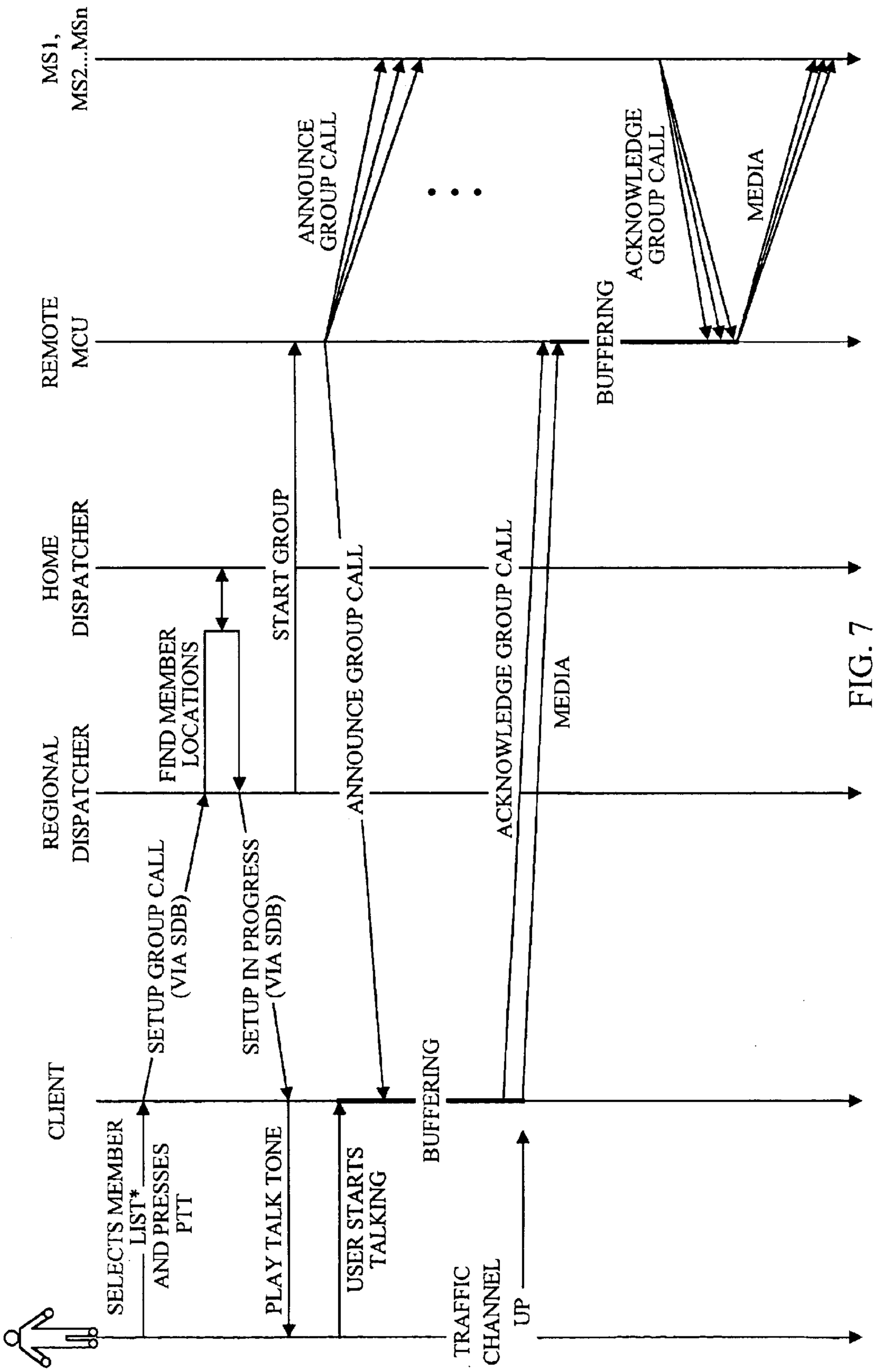

MS1,
MS2...MSn
REMOTE
MCU
HOME
DISPATCHER
REGIONAL
DISPATCHER
CLIENT
ANNOUNCE
GROUP CALL
BUFFERING
ACKNOWLEDGE
GROUP CALL
MEDIA
FIND MEMBER
LOCATIONS
START GROUP
ANNOUNCE GROUP CALL
ACKNOWLEDGE GROUP CALL
MEDIA
SETUP GROUP CALL
(VIA SDB)
SETUP IN PROGRESS
(VIA SDB)
SELECTS MEMBER
LIST*
AND PRESSES
PTT
PLAY TALK TONE
USER STARTS
TALKING
BUFFERING
TRAFFIC
CHANNEL
UP

FIG. 7

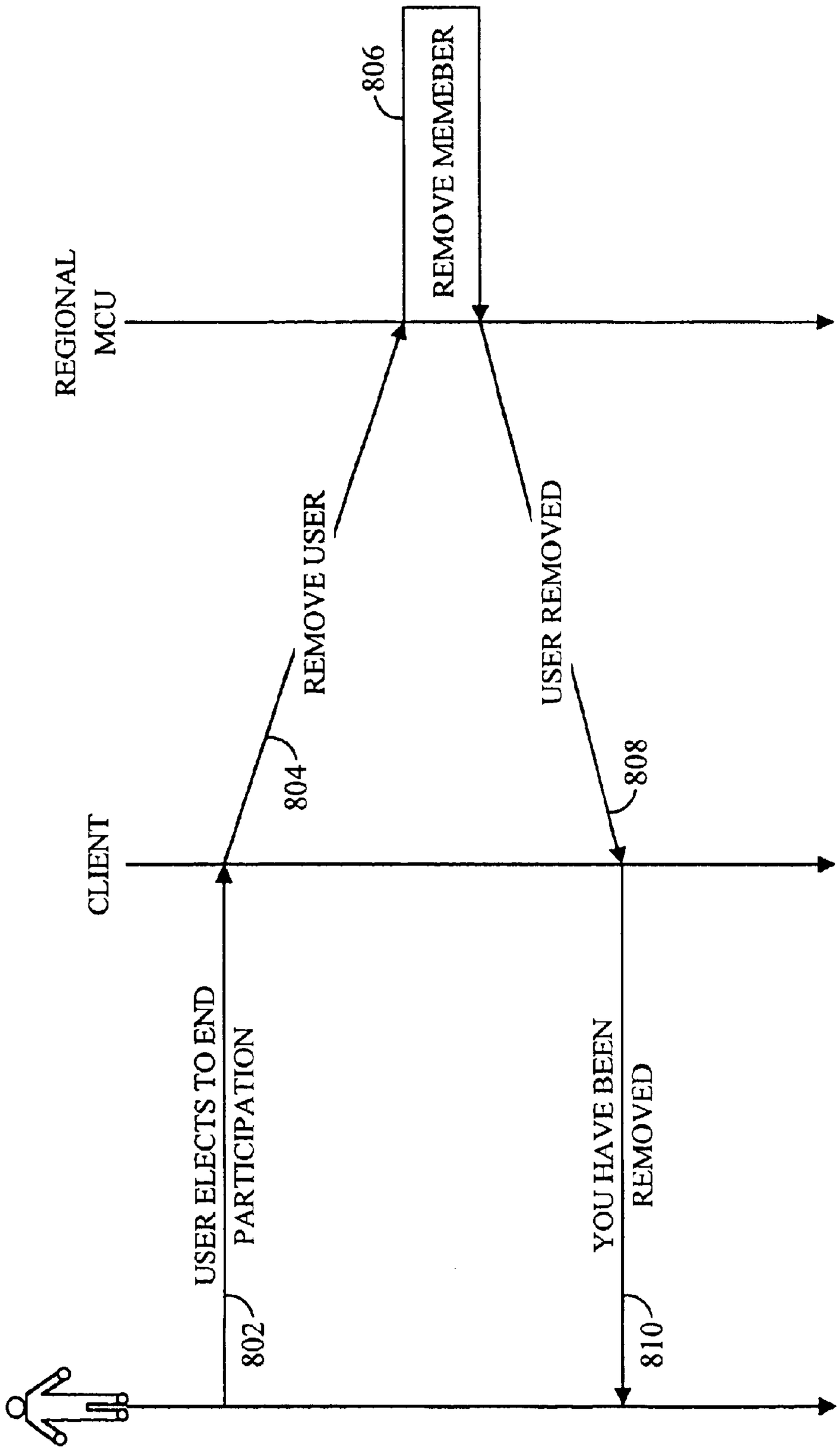

REGIONAL MCU
CLIENT
806
REMOVE MEMEBER
REMOVE USER
804
USER REMOVED
808
USER ELECTS TO END PARTICIPATION
802
YOU HAVE BEEN REMOVED
810

FIG. 8

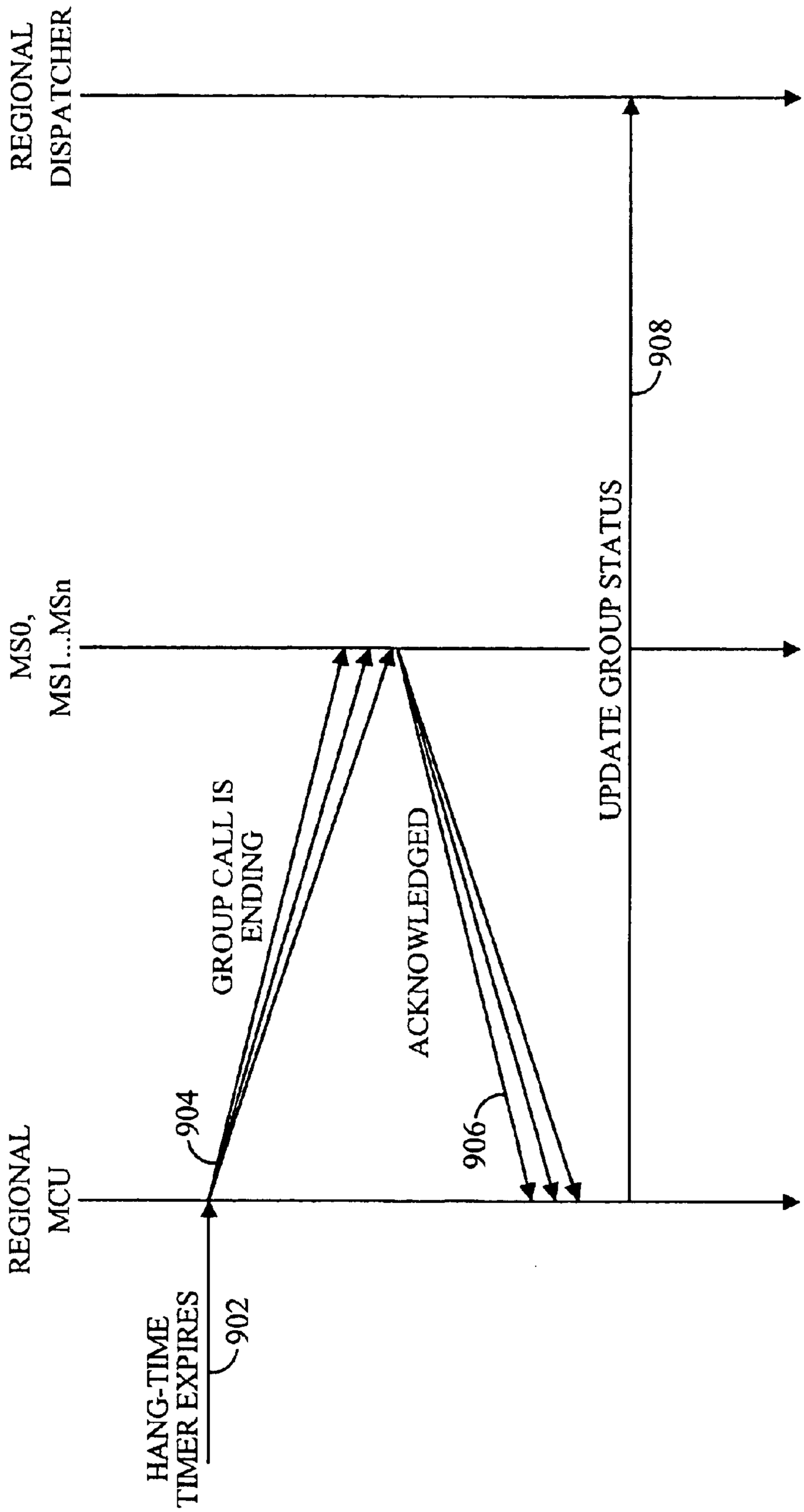

REGIONAL DISPATCHER
908
MS0, MS1...MSn
GROUP CALL IS ENDING
ACKNOWLEDGED
UPDATE GROUP STATUS
904
906
REGIONAL MCU
HANG-TIME TIMER EXPIRES
902

FIG. 9

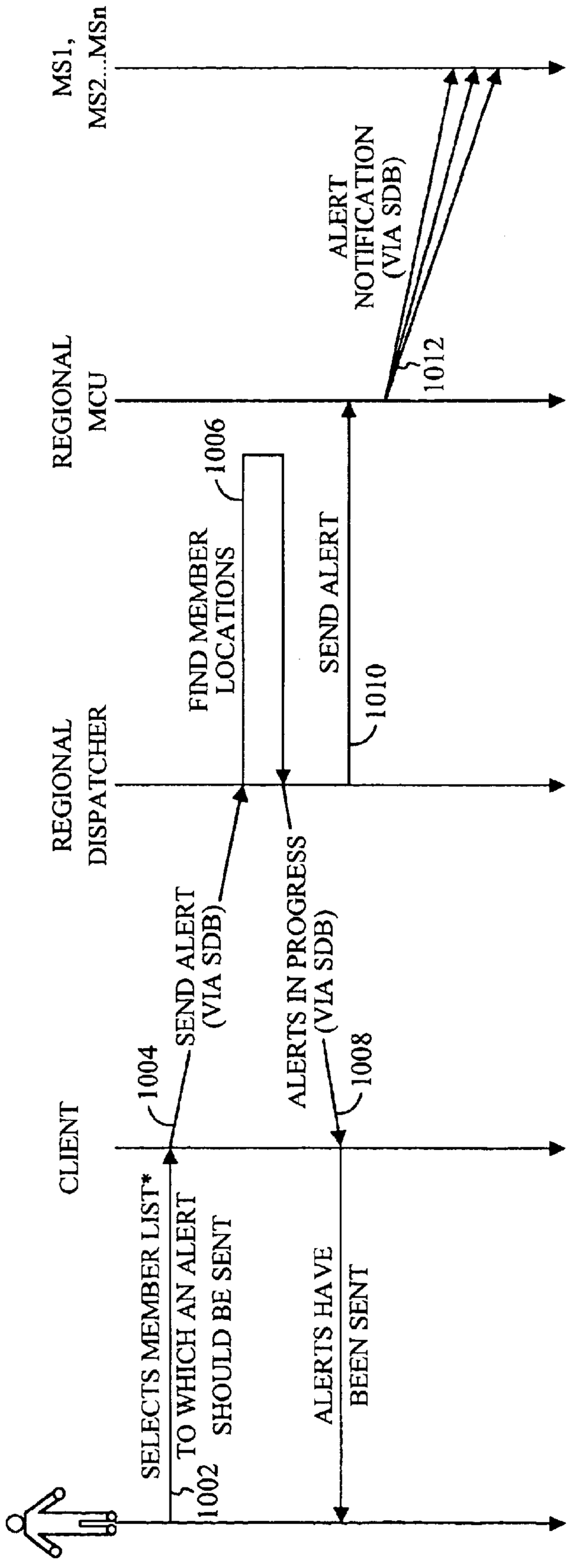

CLIENT
REGIONAL DISPATCHER
REGIONAL MCU
MS1, MS2...MSn
SELECTS MEMBER LIST* TO WHICH AN ALERT SHOULD BE SENT
1002
SEND ALERT (VIA SDB)
1004
FIND MEMBER LOCATIONS
1006
ALERTS IN PROGRESS (VIA SDB)
1008
SEND ALERT
1010
ALERTS HAVE BEEN SENT
ALERT NOTIFICATION (VIA SDB)
1012

FIG. 10

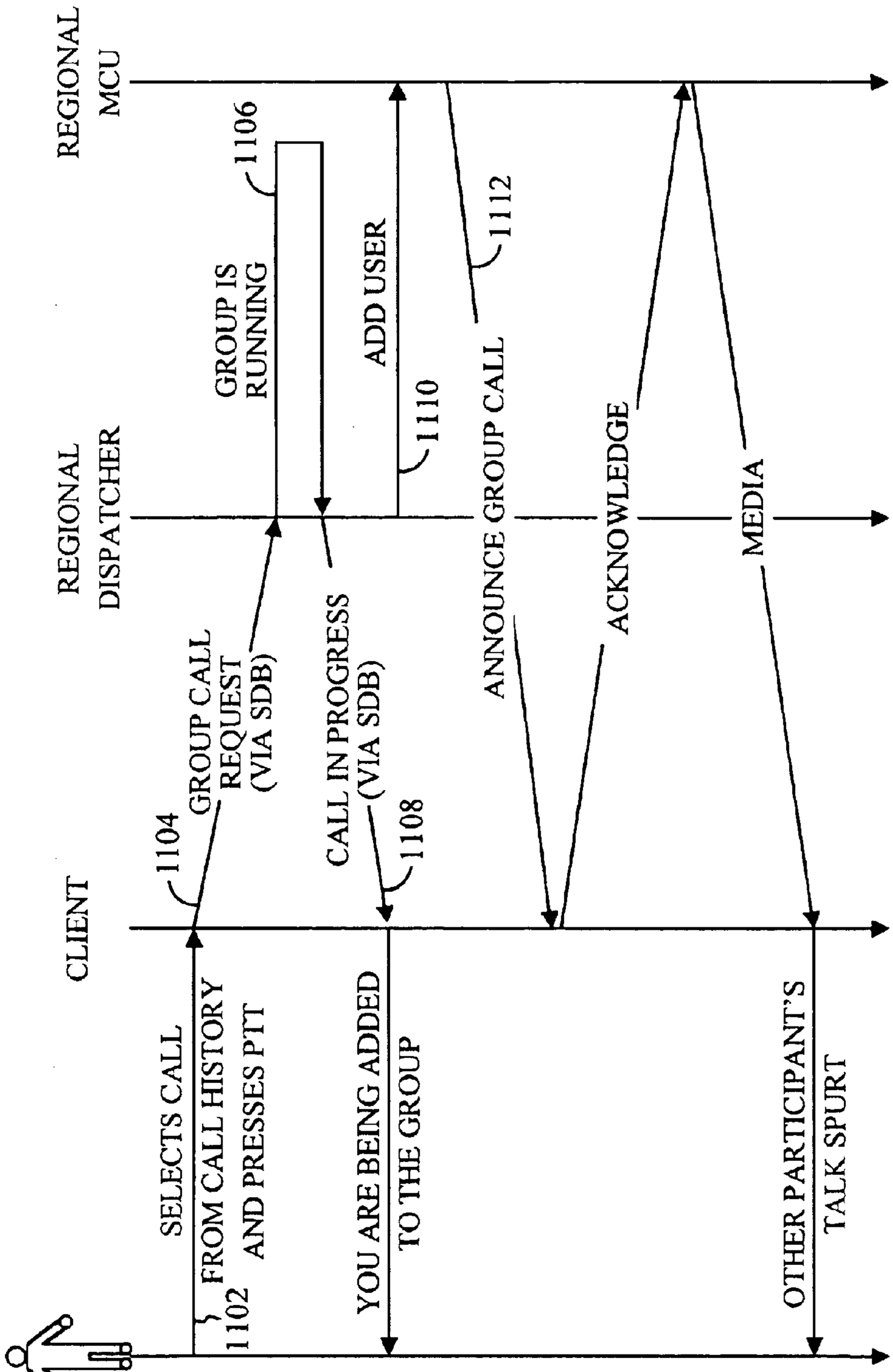

REGIONAL MCU
REGIONAL DISPATCHER
CLIENT
1102
SELECTS CALL FROM CALL HISTORY AND PRESSES PTT
1104
GROUP CALL REQUEST (VIA SDB)
1106
GROUP IS RUNNING
CALL IN PROGRESS (VIA SDB)
1108
ADD USER
1110
1112
YOU ARE BEING ADDED TO THE GROUP
ANNOUNCE GROUP CALL
ACKNOWLEDGE
MEDIA
OTHER PARTICIPANT'S TALK SPURT

FIG. 11

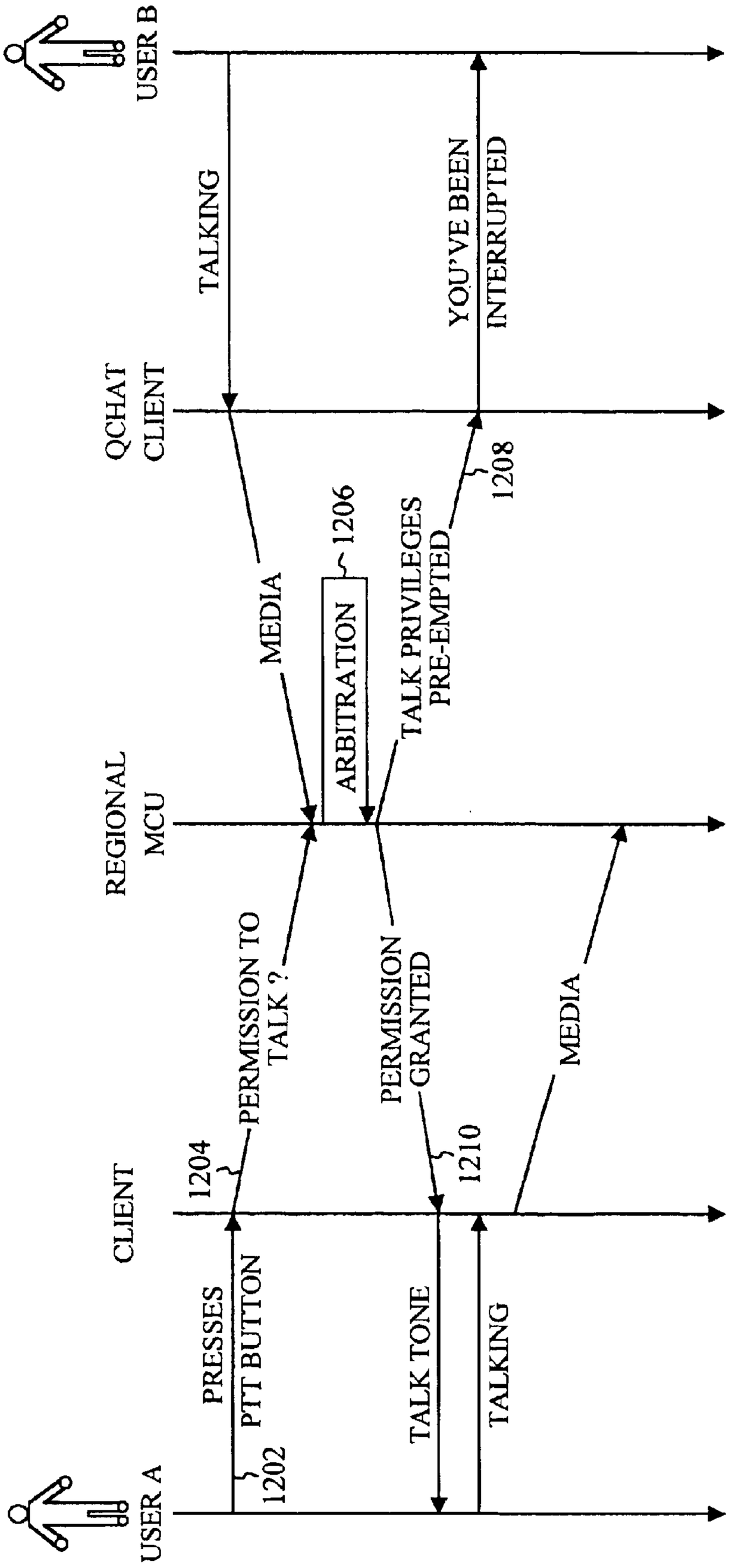

USER A
USER B
CLIENT
QCHAT CLIENT
REGIONAL MCU
PRESSES PTT BUTTON
1202
1204
PERMISSION TO TALK ?
PERMISSION GRANTED
TALK TONE
TALKING
MEDIA
ARBITRATION
1206
TALK PRIVILEGES PRE-EMPTED
1208
YOU'VE BEEN INTERRUPTED
MEDIA
1210

FIG. 12

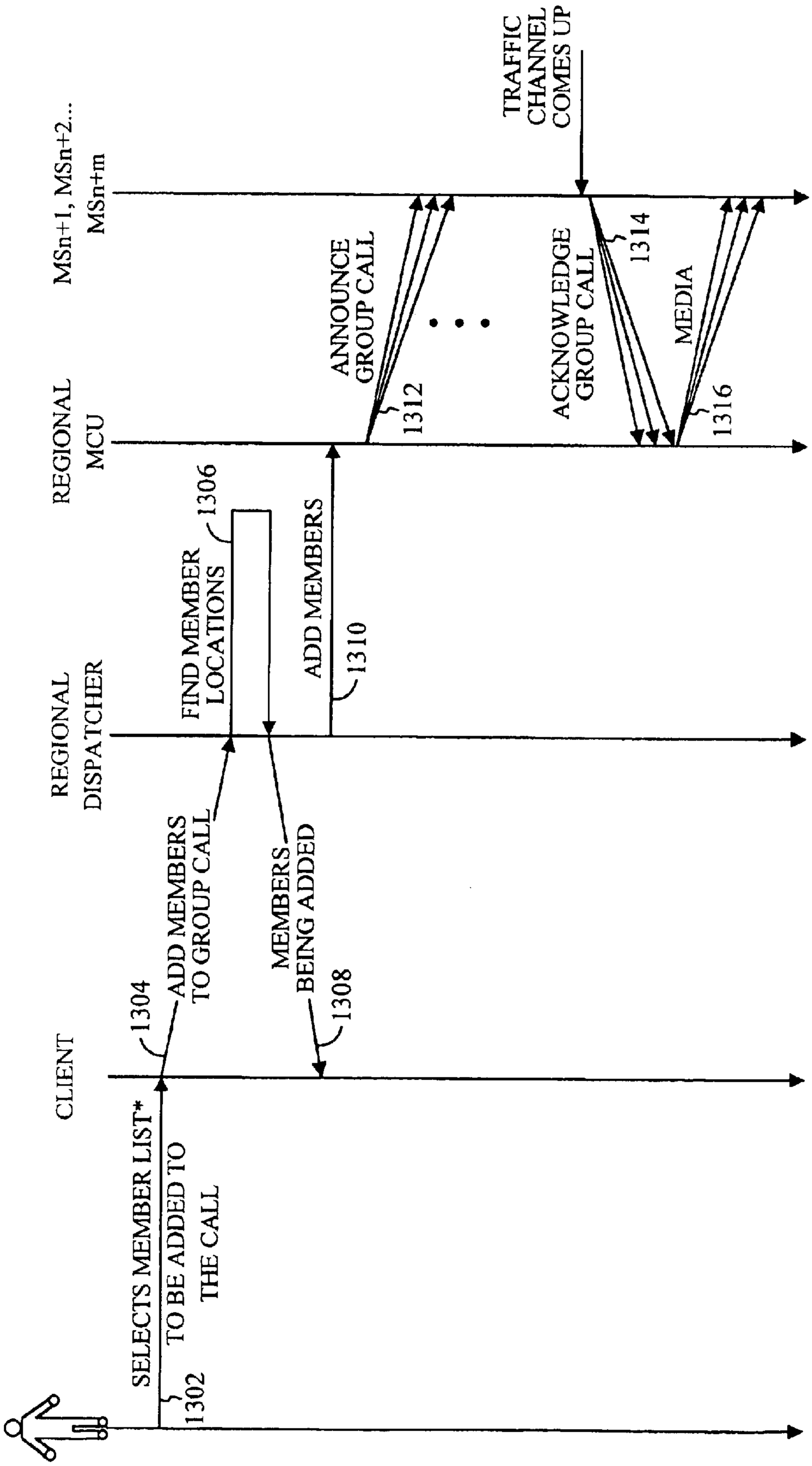

CLIENT
REGIONAL DISPATCHER
REGIONAL MCU
MSn+1, MSn+2...
MSn+m
SELECTS MEMBER LIST* TO BE ADDED TO THE CALL
1302
ADD MEMBERS TO GROUP CALL
1304
FIND MEMBER LOCATIONS
1306
MEMBERS BEING ADDED
1308
ADD MEMBERS
1310
ANNOUNCE GROUP CALL
1312
ACKNOWLEDGE GROUP CALL
1314
MEDIA
1316
TRAFFIC CHANNEL COMES UP

FIG. 13

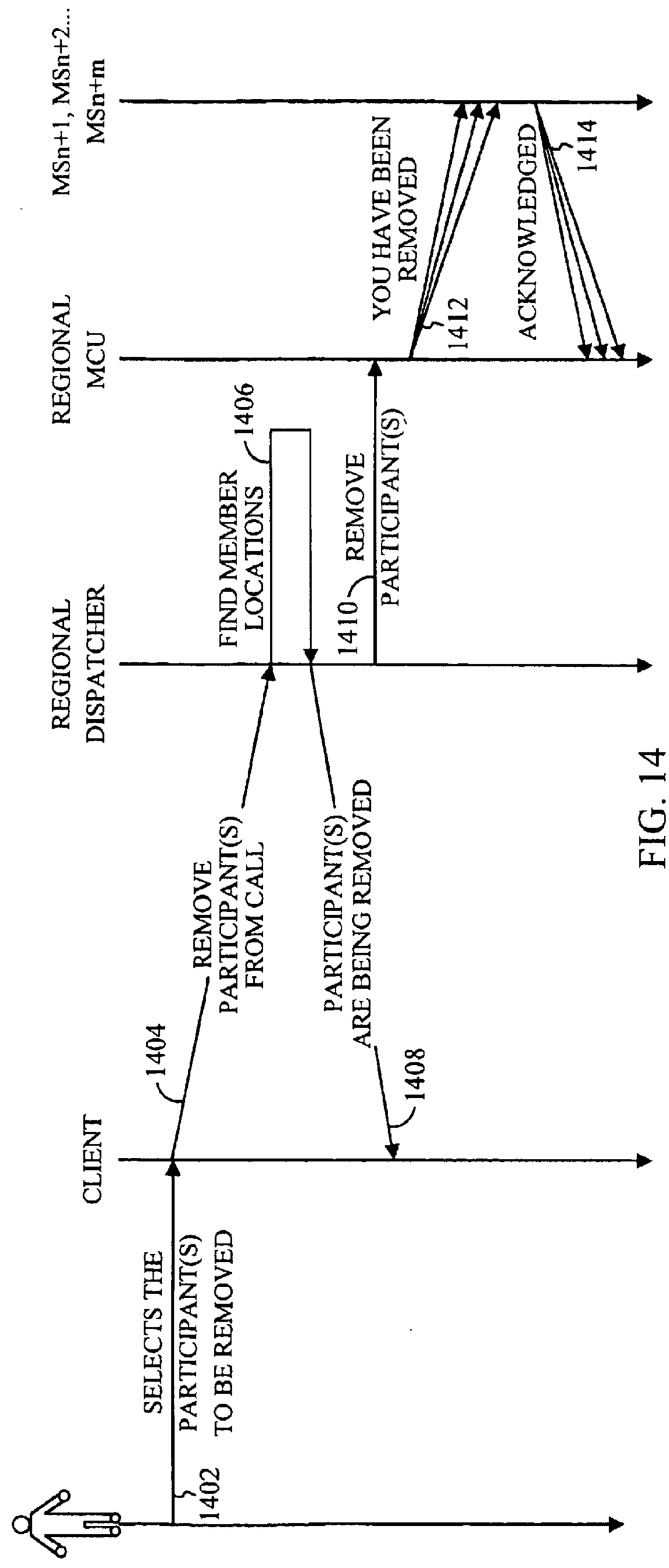

CLIENT
REGIONAL DISPATCHER
REGIONAL MCU
MSn+1, MSn+2... MSn+m
SELECTS THE PARTICIPANT(S) TO BE REMOVED
1402
REMOVE PARTICIPANT(S) FROM CALL
1404
FIND MEMBER LOCATIONS
1406
PARTICIPANT(S) ARE BEING REMOVED
1408
REMOVE PARTICIPANT(S)
1410
YOU HAVE BEEN REMOVED
1412
ACKNOWLEDGED
1414

FIG. 14

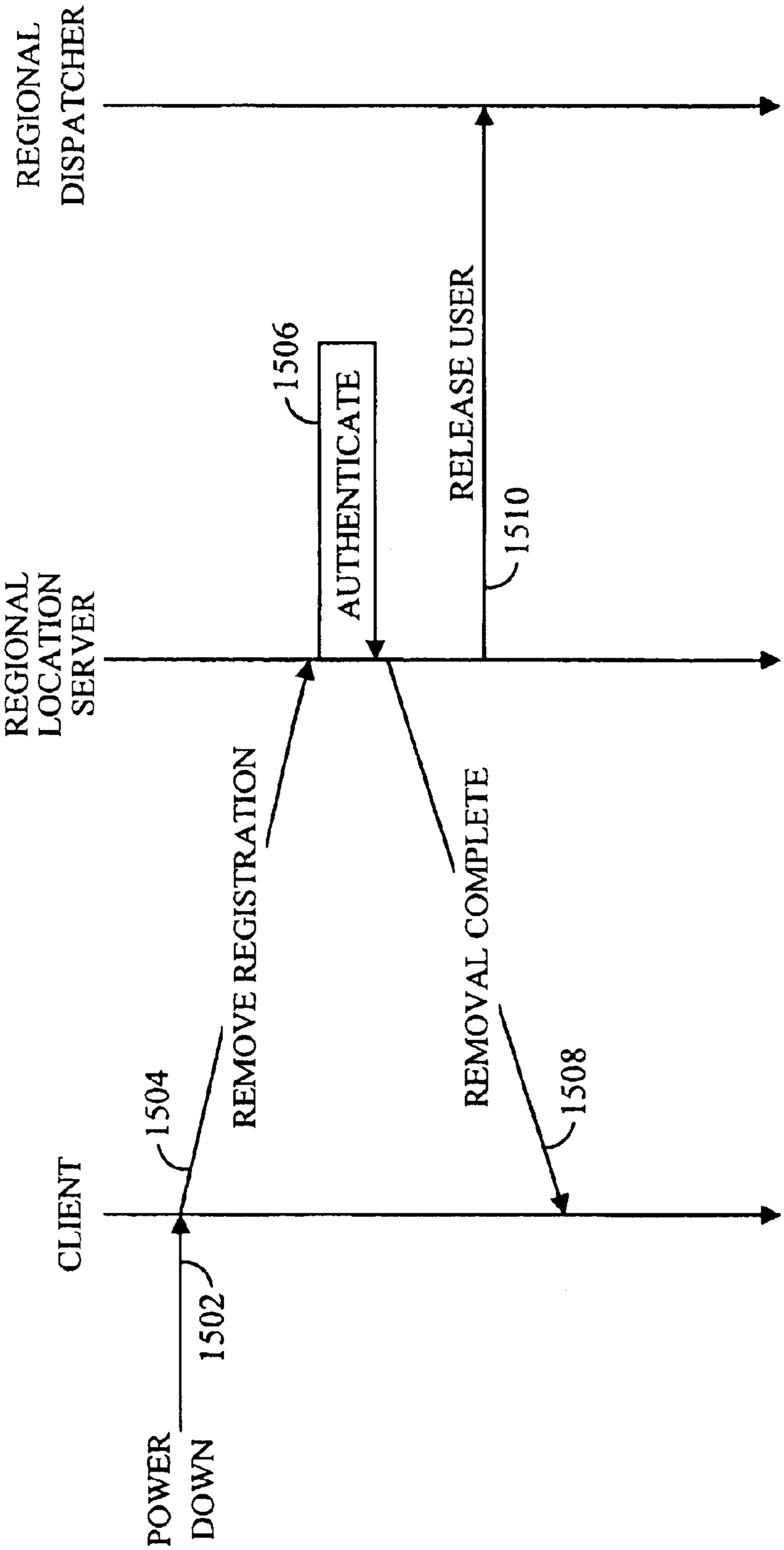

CLIENT
REGIONAL LOCATION SERVER
REGIONAL DISPATCHER
POWER DOWN
1502
1504
REMOVE
REGISTRATION
1506
AUTHENTICATE
AL COMPLETE
RELEASE USER
1510
REMOV
1508

FIG. 15

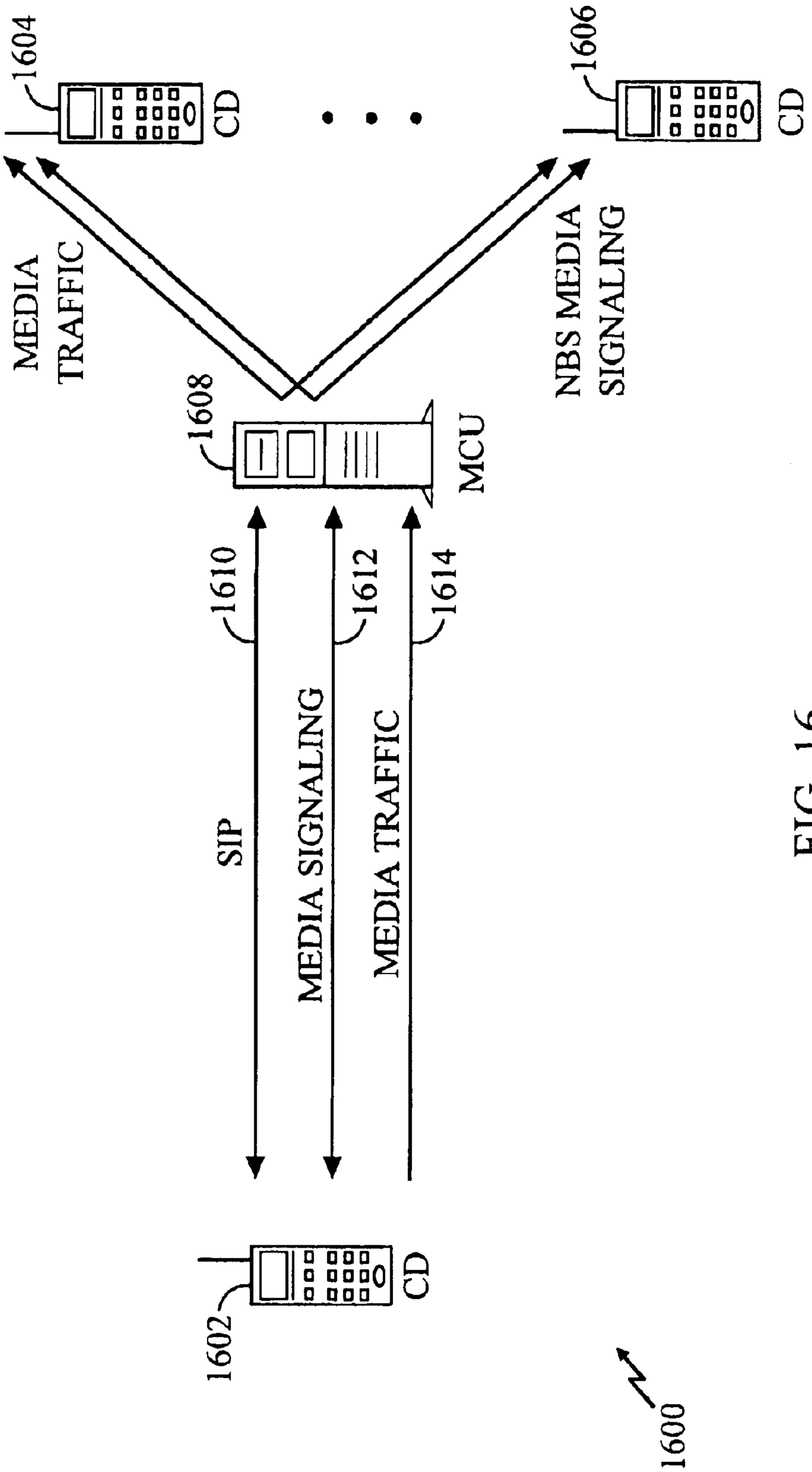

1604
CD
1606
CD
MEDIA TRAFFIC
NBS MEDIA SIGNALING
1608
MCU
1610
1612
1614
SIP
MEDIA SIGNALING
MEDIA TRAFFIC
1602
CD
1600

FIG. 16

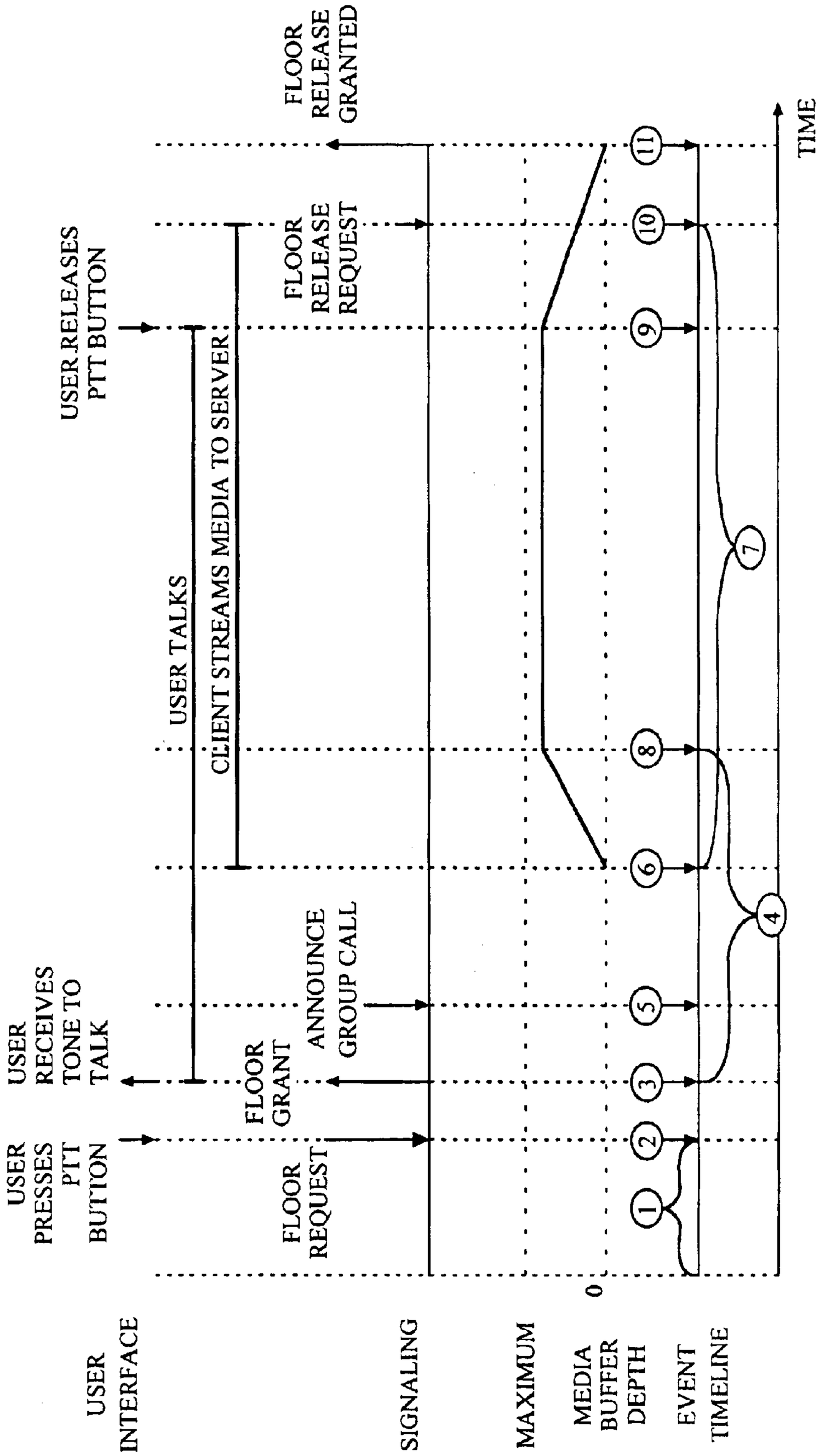

USER RELEASES PTT BUTTON
FLOOR RELEASE REQUEST
FLOOR RELEASE GRANTED
TIME
USER PRESSES PTT BUTTON
USER RECEIVES TONE TO TALK
FLOOR REQUEST
FLOOR GRANT
ANNOUNCE GROUP CALL
CLIENT STREAMS MEDIA TO SERVER
USER TALKS
USER INTERFACE
SIGNALING
MAXIMUM
MEDIA BUFFER DEPTH
0
EVENT TIMELINE
1
2
3
4
5
6
7
8
9
10
11

FIG. 17

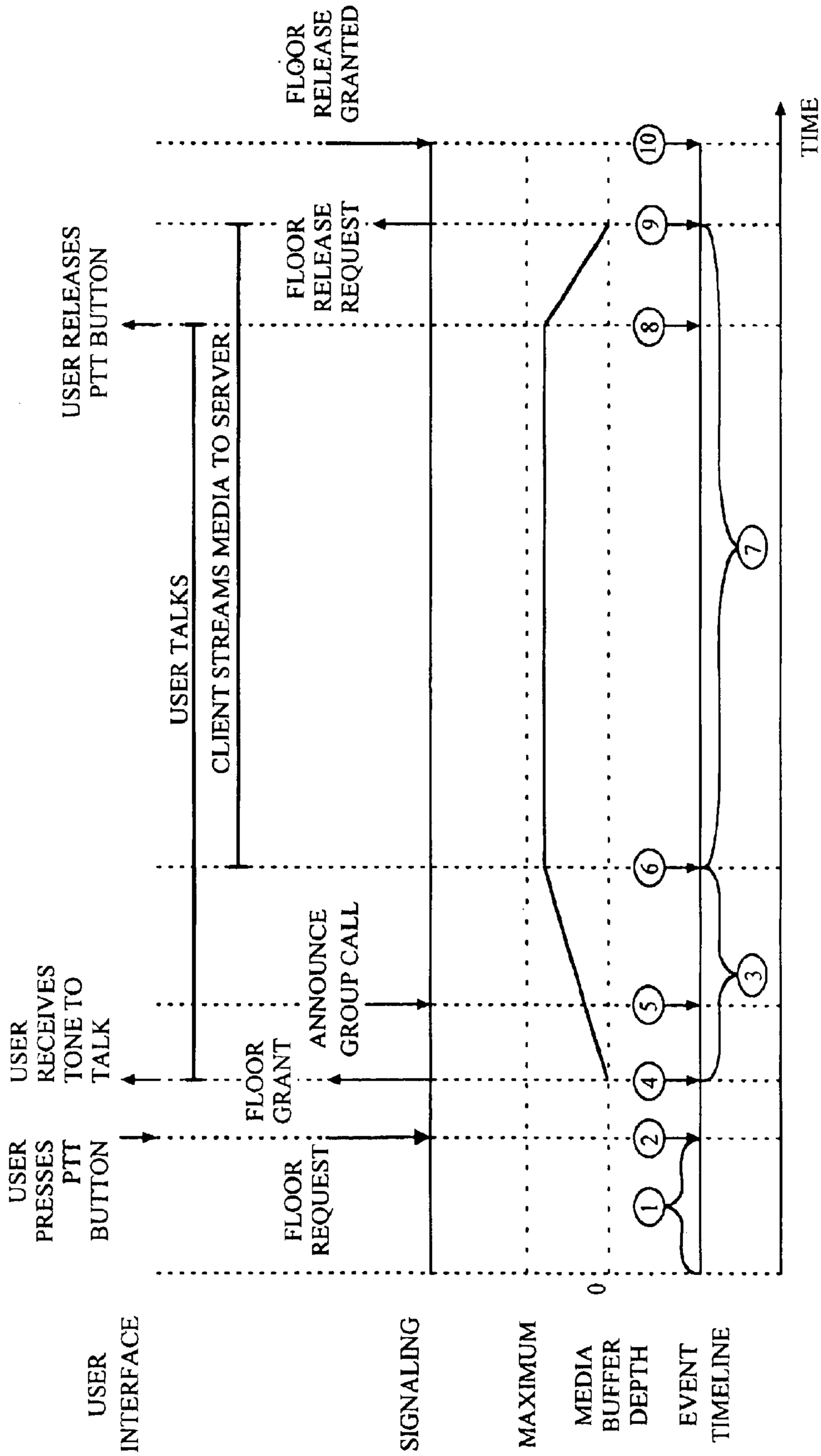

USER PRESSES PTT BUTTON
USER RECEIVES TONE TO TALK
USER RELEASES PTT BUTTON
FLOOR REQUEST
FLOOR GRANT
USER TALKS
CLIENT STREAMS MEDIA TO SERVER
ANNOUNCE GROUP CALL
FLOOR RELEASE REQUEST
FLOOR RELEASE GRANTED
TIME
USER INTERFACE
SIGNALING
MAXIMUM
MEDIA BUFFER DEPTH
0
EVENT TIMELINE
1
2
3
4
5
6
7
8
9
10

FIG. 18

METHOD AND AN APPARATUS FOR ADDING A NEW MEMBER TO AN ACTIVE GROUP CALL IN A GROUP COMMUNICATION NETWORK

FIELD

The present invention relates to point to multi-point communications systems. More specifically, the present invention relates to a method and apparatus for adding new members to an active group call in a group communication network.

BACKGROUND

A class of wireless service intended for quick, efficient, one-to-one or one-to-many (group) communication has existed in various forms for many years. In general, these services have been half-duplex, where a user presses a "push-to-talk" (PTT) button on his phone/radio to initiate speech. Pushing the button either keys his radio, in some implementations, or in a moderated system, where communications occurs via a server of some type, indicates the user's request for the "floor." If granted the floor, or talker permission, the user then generally speaks for a few seconds, after which he releases his PTT button, and other speakers can request the floor. Communication is generally from one speaker to a group of listeners, but may be one-to-one. This service has traditionally been used in applications where one person, a "dispatcher," needs to communicate to a group of people, such as field service personnel or taxi drivers, which is where the "dispatch" name for the service comes from.

Similar services have been offered on the Internet and are generally known as "voice chat." These services are usually implemented as personal computer applications that send vocoder frames in Internet protocol (IP) packets, i.e., voice-over-IP (VoIP) service, to a central group chat server, or possibly from client to client in a peer-to-peer service.

A key feature of these services is that communication is quick and spontaneous, usually initiated by simply pressing a PTT button, without going through a typical dialing and ringing sequence. Communication in this type of service is generally very short, with individual talk "spurts" being generally on the order of several seconds, and "conversations" lasting possibly a minute or less.

The time delay between when the user requests the floor and when he receives a positive or negative confirmation from the server that he has the floor and may begin speaking, which is known as the PTT latency, is a critical parameter for half-duplex group communications systems. As mentioned previously, dispatch systems place a priority on short, quick conversations, which makes the service less effective if the PTT latency becomes large.

Existing group communication infrastructures provide limited opportunities for significantly reducing the PTT latency, i.e., actual PTT latency may not be possibly reduced below the time required to re-establish traffic channels within dormant packet-data sessions. Further, talker and listeners traffic channels are brought up in series, because the only mechanism available to begin waking up a dormant group is to wait for the talker's traffic channel to be re-established to signal the server. Currently, no mechanism exists to send mobile-originated user signaling data on anything other than a traffic channel—a limitation that requires traffic channels to be re-established before any communication between clients and the server can take place.

There is a need, therefore, for mechanisms to reduce both apparent PTT latency experienced by the talker and total time required to re-establish traffic channels for participating mobiles without negatively impacting system capacity, client battery life, or other resources.

In a dispatch model, communication between endpoints takes place within virtual groups wherein the voice of one "talker" is broadcast to one or more "listeners". A single instance of this type of communication is commonly referred to as a dispatch call or simply a call. A call is an instantiation of a group, which defines the characteristics of the call and is, in essence, a member list with some associated information, such as a group name or group id. A member list is a list of one or more users that are invited to participate in the call.

There is a need for a dispatch model that supports both the chat-room model and the ad-hoc model of group call services. In the chat-room model, the groups are pre-defined, which may be stored on the dispatch server. In the ad-hoc model, however, the groups may be defined and/or modified in real-time.

SUMMARY OF THE INVENTION

The disclosed embodiments provide a novel and improved method in a communication device for adding a member to an active group call in a group communication network, which includes receiving a member list from a user and sending a request to a server to add the member list to the active group call.

In another aspect of the invention, a computer-readable medium in a communication device embodies a method for adding a member to an active group call in a group communication network, the method including the above-mentioned steps.

In another aspect of the invention, a communication device for adding a member to an active group call in a group communication network includes means for receiving a member list from a user and means for sending a request to a server to add the member list to the active group call.

In another aspect of the invention, a communication device for adding a member to an active group call in a group communication network includes a receiver, a transmitter, and a processor communicatively coupled to the receiver and the transmitter. The processor is capable of receiving a member list from a user and sending a request to a server to add the member list to the active group call. In one aspect, the communication device is a push-to-talk (PTT) device.

The disclosed embodiments also provide a novel and improved method in a server for adding a member to an active group call in a group communication network, which includes the steps of receiving a request for adding a member list from an active group call and adding the member list from the active group call. In one aspect, the method further includes announcing each member in the member list that they are being added from the group call.

In another aspect of the invention, a computer-readable medium in a server embodies a method for adding a member to an active group call in a group communication network, the method including the above-mentioned steps.

In another aspect of the invention, a server for adding a member to an active group call in a group communication network includes means for receiving a request for adding a member list to an active group call and means for adding the member list to the active group call. In one aspect, the server

further includes means for announcing each member in the member list that they are being added to the group call.

In another aspect of the invention, a server for adding a member to an active group call in a group communication network includes a receiver, a transmitter, and a processor communicatively coupled to the receiver and the transmitter. The processor is capable of receiving a request for adding a member list to an active group call and adding the member list to the active group call. In one aspect, the processor is further capable of announcing each member in the member list that they are being added to the group call.

BRIEF DESCRIPTION OF THE DRAWINGS

The features and advantages of the present invention will become more apparent from the detailed description set forth below when taken in conjunction with the drawings in which like reference characters identify correspondingly throughout and wherein:

FIG. **1** illustrates a group communications system;

FIG. **2** illustrates how several applications interact with each other;

FIG. **3** illustrates an exemplary user-registration process according to one embodiment;

FIG. **4** illustrates an exemplary local, intra-regional call-setup process according to one embodiment;

FIG. **5** illustrates an exemplary remote, intra-regional call-setup process according to one embodiment;

FIG. **6** illustrates an exemplary local, inter-regional call-setup process according to one embodiment;

FIG. **7** illustrates an exemplary remote, inter-regional call-setup process according to one embodiment;

FIG. **8** illustrates an exemplary process for leaving a group call according to one embodiment;

FIG. **9** illustrates an exemplary process for terminating a group call according to one embodiment;

FIG. **10** illustrates an exemplary process for sending an alert for a group call according to one embodiment;

FIG. **11** illustrates an exemplary process for late-joining a group call according to one embodiment;

FIG. **12** illustrates an exemplary process for pre-empting a talker according to one embodiment;

FIG. **13** illustrates an exemplary process for adding new members to an active group call according to one embodiment;

FIG. **14** illustrates an exemplary process for removing participants from a group call according to one embodiment;

FIG. **15** illustrates an exemplary process for removing a user's registration according to one embodiment;

FIG. **16** illustrates how several communication devices interact with a communications manager according to one embodiment;

FIG. **17** illustrates buffering media at a communications manager side according to one embodiment; and

FIG. **18** illustrates buffering media at a client side according to one embodiment.

DETAILED DESCRIPTION

Before one embodiment of the invention is explained in detail, it is to be understood that the invention is not limited in its application to the details of the construction and the arrangement of the components set forth in the following description or illustrated in the drawings. The invention is capable of being implemented in other embodiments and are carried out in various ways. Also, it is understood that the phraseology and terminology used herein is for purpose of description and should not be regarded as limiting.

FIG. **1** illustrates an exemplary functional block diagram of a group communication system **100**. The group communication system **100** is also known as a push-to-talk (PTT) system, a net broadcast service (NBS), a dispatch system, or a point-to-multi-point communication system. In one embodiment, the group communication system **100** includes application server components, such as dispatchers, location servers, media control unit (MCU) complexes, usage log servers and Internet protocol (IP) clients (wireless and/or wireline devices with IP connectivity). The application server components may be deployed in either a centralized deployment or a regionalized deployment, based on the component's functionality. The centralized deployment may include a home dispatcher (HD) **102**, a home location server (HLS) **104**, and a user/group database **106**. These components may be centrally located in the service provider's network and may be accessible by the regional deployments. The centralized components may be used in locating the roaming users and in initiating inter-regional group calls. A regionalized deployment **108**, **110** may include a regional location server (RLS) **112**, a regional dispatcher (RD) **114**, a regional media control unit (MCU) complex **116**, and a regional usage log server (ULS) **118**.

The regional deployments may be distributed across the service provider's network to ensure the network delays associated with call setup are kept at a minimum, for the purpose of satisfying instant-response requirement. Distributing the call load across several regionalized systems also ensures that adequate scalability schemes can be developed to support large number of users. The regionalized application server components provide user registration, intra-regional call setup and management, and alert initiation and delivery for the users, which are registered in the region.

The group communication devices (clients) **120**, **122**, which may be deployed on a cdma2000 handset, for example, requests a packet data session using a standard data service option and uses this session to register its IP address with the application server and to perform group call initiations. In one embodiment, the application server components **108**, **110** are connected to the service provider's packet data service nodes (PDSNs). Clients **120** and **122**, upon requesting a packet data session from the wireless infrastructure, have IP connectivity to the application server components **108**, **110** through the PDSNs.

Upon power-up, clients **120**, **122** may request a packet data session using the data service option. As part of the establishment of the packet data session, the client is assigned an IP address. At this time, the client also receives the address of a domain name service (DNS) server **124**. The client **120**, **122** queries the DNS server **124**, e.g., by using a service record (SRV) lookup, to find the address of RLS **112**. After locating RLS **112**, the client **120**, **122** may perform a registration, notifying the application server of its location information, e.g., IP address. The registration may be performed using an IP protocol, such as session initiation protocol (SIP) over user datagram protocol (UDP). The IP address of the client **120**, **122** may be used to contact the client when the user is invited into a group call.

In one embodiment, after the registration is complete, the client may perform another DNS SRV record lookup to find the address of regional dispatcher **114**. The client contacts regional dispatcher whenever the user requests to start a call or sends an alert. The interface between regional dispatcher **114** and client **120**, **124** may be signaling protocol over UDP.

Once a group call is established, client **120**, **114** and MCU complex **116** exchange media and signaling messages. In one embodiment, the media may be sent between the call participants and MCU complex **116** using real-time protocol (RTP) over UDP. The signaling messages may be also signaling protocol over UDP. These protocols and the functionality they provide are described later.

Components

The group communication system **100** may include the IP endpoints that contain the client software and regionalized and centralized server components that are required to offer the group communication service. The group communication clients and the application server components are described in more detail in the following sections.

Clients

The group communication client **120**, **122** may run on any IP endpoint that have access to the appropriate vocoder(s). The IP endpoints may include applications running on a wireless system, e.g., cdma2000, an application development platform, e.g., binary runtime environment for wireless (BREW), and personal computers.

The client may include a software application, which may be developed using BREW, and interfaces to the mobile station modem software (MSM), which may be downloaded to the client that contains the BREW environment. BREW is a platform that allows developers to create applications that may operate on client communication devices. BREW provides an isolation layer to the application developer, enabling the development of applications without having direct contact into the MSM software and the original equipment manufacturer (OEM) software. This allows the applications to be developed rapidly and to evolve independent of the MSM and/or OEM software. It also enables applications to be downloaded on any device containing the BREW environment. As shown in FIG. **2**, the client group communication application software **202** may execute in parallel with other applications **204**, **206**, **208**, **210**. While these services may be directly offered through the OEM **212** and MSM **214** interfaces, BREW provides isolation from modifications made by the application in these layers. This allows the OEM **212** and MSM **214** to evolve separately from the data applications **202**, **204**, **206**, **208**, **210**.

In order for the client to operate effectively on a personal computer, the personal computer may include access to a compatible vocoder, access to sound drivers, and IP connectivity to application servers.

Location Server

In one embodiment, the location server (LS) may accept and/or maintain user location information, e.g., the network-level IP address, the physical location of the user, such as longitude and latitude, and/or packet zone id, i.e. a system identifier broadcast over-the-air on forward common channels which identifies the scope of the PDSN which is providing packet-data service for that sector. In one embodiment, the LS may include a component that processes registrations from the clients and supplies user location information to other applications, such as instant messaging, using an SIP-interface.

The LS may include two functional elements, the regional location server (RLS) **112** and the home location server (HLS) **104**. RLS **112** may be deployed on a region-by-region basis and the HLS **104** may be centralized. The details of these elements and their functions are described below.

Regional Location Server

The RLS **112** may process and maintain registrations from clients located within its region. In one embodiment, RLS **112** is a standard SIP-based LS, with associated storage for the user location information. As part of the maintenance of the registration entries, RLS **112** may check the expiration date, "expiry" fields, for each registration. The RLS ensures the expired entries are removed, and both the regional dispatcher (RD) and the HLS are notified of the removed entries.

As discussed previously, the clients may perform an IP registration in order to notify the application server of their location. The clients may maintain their registrations for the duration of their availability to the group communication service. The clients may perform re-registrations when the client's IP address changes and when the registration is about to expire.

When the client registers or re-registers, the RLS **112** may notify its associated RD **114**. This allows RD **114** to pre-load user data in preparation for call setup requests, thus reducing call setup time. The RD **114** may cache the user's location information, eliminating the need for RD **114** to contact the RLS to retrieve user location information during call setup.

The RLS **112** may notify RD **114** in the event the user's location information is updated or removed from RLS **112**. This ensures RLS **112** and RD **114** remain in sync with the latest information on users registered within the region.

The RLS **112** may also periodically update HLS **104** with registered users' location information. In the event the RLS **112** submits a registration to HLS **104** for a user that already has a valid registration in another region, the HLS may resolve the conflict.

Home Location Server

The HLS **104** may process queries for user location information. In one embodiment, HLS **104** provides a SIP-based interface to allow other applications, such as instant messaging application, to query the location information for a particular user.

If HLS **104** is a centralized component and the RLSs communicate with it, the HLS may resolve multiple registrations in different regions for roaming users. The HLS **104** may receive registration information from each of the RLSs. If HLS **104** receives multiple registrations for the same user, the HLS **104** may keep the most recent registration and request removal of the stale registration(s) for the user from the RLSs. This in turn may trigger the removal of cached information for that user from RD **114** associated with the RLS that contains the stale registration.

Dispatcher

The dispatcher may facilitate call setup by locating users and assigning group calls to media control units (MCU) complex **116**. The dispatcher is the server component that is key to meeting the "instant access" requirement. To ensure the lowest call setup times, the dispatcher may include two functional elements with similar structure and functionality, but have different deployment strategies. These two elements, regional dispatcher (RD) **114** and home dispatcher (HD) **102**, are described in detail in the following sections.

Regional Dispatcher

The RD **114** may be the initial point of contact for the call setup requests and alert requests. RD **114** may pre-load user information when it receives an indication from RLS **112** that a user has registered. Along with the user information, RD **114** may cache information about group calls, which are running in the system. RD **114** may use the cached information for users and groups during call setup to keep the setup time at a minimum, i.e., no database lookups may be required.

In one embodiment, the group information the RD stores in the cache includes the group member list and the address of the MCU complex **116** on which the group is running. The

RD **114** may maintain the member list and MCU address for the life of the call. This helps RD **114** quickly determine if an incoming call request contains a group definition, which is identical to one that has an associated call already running in the system, which allows the RD to quickly respond to call setup requests and confidently grant or deny the "floor" request in the response.

The RD **114** may grant or deny the floor-control request. The RD **114** may decide whether it will request MCU complex **116** to add the user to the call as a "late-join" participant or to start a new call with the associated member list.

During call-setup request processing, RD **114** may use the cached user information to retrieve location information for the users specified in the call setup request. If a user cannot be located, RD **114** may request HD **102** to locate the user. In one embodiment, if at least one or more target users are located, RD **114** continues with the call setup. After the targets have been located, RD **114** may decide to which MCU the call should be assigned. This determination may be based on the IP addresses of the users in the group, including the originator.

The RD **114** may handle alert requests similar to call requests. In one embodiment, the alert request is assigned to local MCU complex **116** for processing, regardless of the location of the targets.

In one embodiment, the information in the RD's cache may be periodically written to a reliable storage mechanism so that it may be recovered in the event of a failure. Upon recovery of the RD failure, the user and group information that was written to the reliable storage mechanism may be re-loaded into cache and the RD proceeds to validate the cached information in conjunction with processing incoming call setup requests.

In one embodiment, RD **114** loads the user data into local cache upon each user registration notification from RLS **112**. By eliminating the need to do several database lookups at call setup time, RD **114** significantly reduces the amount of time it takes to validate and respond to call setup requests or alert requests.

The RD **114** may access the user/group database **106** during call setup to expand pre-defined group addresses, if present in the request, to lists of individual users and, if necessary, to translate alternate identifiers of users or groups, e.g., telephone numbers, conference IDs, to canonical address(es).

Home Dispatcher

Home dispatcher (HD) **102** may track the registered users' location information. The HD may contain location information for the users that have performed registrations with RLS **112**.

As discussed previously, each RLS **112** may notify its associated RD **114** every time a user registration, re-registration, un-registration, or registration expiration occurs. RD **114** may use this information to load or release user information in its local cache. Each RD **114** may update the HD **102** with the user location information. Since the HD **102** receives updates from RD **114**, HD **114** may assist in finding users that are spread out geographically across different regions. RD **114** may request assistance from HD **102** when it receives a request for a user that is not currently registered within the region, i.e., not in the RD's cache of user information.

DNS Server

In one embodiment, the group communication system **100** may use the service provider's DNS server **124** to provide location information for RLS **112** and RD **114** to the clients. This information may be configured upon each regional deployment and updated periodically to ensure its accuracy.

In one embodiment, each client learns the DNS server's address through Internet protocol control protocol (IPCP) negotiation during point-to-point protocol (PPP) session establishment, when it asks for a packet data session. DNS server **124** may be advertised in this fashion on a region-by-region basis. This allows the client to roam from region to region and communicate with DNS server **124** in the same region in which the client is located. DNS server **124** is deployed on a region-by-region basis, in conjunction with each PDSN. In one embodiment, the DNS server **124** may be updated with each RD **124** and RLS that is servicing the PDSN with which the DNS server **124** is associated.

In one embodiment, the mechanism used to locate the appropriate RD **114** and RLS **112** is based on a combination of DNS and SIP addressing. DNS service (SRV) record lookup may be performed based on the "<domain>" portion of the SIP URI under which the client registers. The SRV record request may include the protocol or service, which the requestor is attempting to find. For example, in the case of attempting to locate the RLS **112**, the client may request a "registration service" in the DNS SRV record lookup. The DNS response may include one or more valid network and port addresses for the server, which offers the requested service. DNS server **124** may be used in load balancing between servers that offer the same service, by allowing DNS server **124** to round-robin between the multiple server when returning answers to client requests.

User/Group Database

In one embodiment, the user/group database **106** is the central repository for the users and group information. For each user, the database may include information such as user address, pre-emption rank, authentication information, user contact information, and lawful intercept flag, which indicates if the user is under surveillance. The database may also include definitions of pre-defined groups, which are lists of users and an associated group name, for chat-room model of dispatch services. Each group may be uniquely identified by the group address, for example. The client may use the group address to identify the group in the group call setup request. The RD **14** may use the group address to retrieve the associated member list from user/group database **106** when it receives a group call setup request with a pre-defined group in it.

Media Control Unit Complex

The media control unit (MCU) complex may include media control hosts (MCH) and media control unit (MCU). The MCH may host and manage multiple MCU processes. Each MCU may handle the real-time signaling and media processing for a single call. The functions the MCU performs for a call may include:

- Handling call assignments from RD **114**
- Sending loading and status information to the MCH
- Sending call initiation information to clients
- Processing in-call signaling from the clients, such as PTT requests
- Ensuring signaling messages are delivered to the clients reliably
- Replicating and distributing media for "one-to-many" calls
- Providing media translation using the appropriate transcoder for "mixed" vocoder "one-to-many" calls
- Monitoring call activity and initiating call termination based on media flow inactivity
- Producing usage information for usage log server (ULS) **118**

Forwarding media and signaling information to the appropriate lawful intercept point when requested.

The MCU may process alert requests from RD **114**, send out alert notifications to the client, and wait for acknowledgements from the clients. Upon receipt of acknowledgements from the targets, the MCU releases any resources assigned to the alert transaction. At this time, the MCU may handle other call assignments or alert requests.

Usage Log Server

The ULS **118** may exist in every region and may be co-located with the MCU complex **116**. ULS **118** may collect usage events from MCU complex **116** for each call or alert processing, format them into a usage data record (UDR), and then store these UDRs in a sequence of UDR files. The UDRs for calls may contain information regarding individual calls including the list of participants and participant usage totals. The UDR for alerts may contain information that indicates the originator of the alert and the target users to whom the alert was sent. The UDR files may be collected by the service provider for billing analysis, and may be deleted after a fixed amount of time.

ULS **118** may write a single UDR per call instance at the end of each call. The ULS **118** may also write a single UDR for each time an alert request is processed. UDRs written by the ULS **118** may contain the following information:

Call instance identifier or alert instance identifier

MCU identifier, which also implies call location. At the start of a call, an appropriate MCU may be chosen based on the registered location of all the proposed participants. The location of the MCU may or may not be in the same region as the originator.

Start time of the call or alert

End time of the call or alert

Originating user name and/or identifier

Originating user IP address

For each participant, username, user address, user IP address, cumulative participation time, which may be zero for alerts, and total number of seconds the participant held the floor, which may be zero for alerts.

In one embodiment, for each call a single UDR is issued, which may represent the total collection of talk segments during the call. If UDR event logging is required on a per talk segment basis, it may be implemented at the expense of additional processing load, file I/O, and disk space requirements.

The group communication system **100** performs several different functions in order to operate the group services. The functions relating to user experiences include registration, call initiation, call termination, sending alerts, late join, talker arbitration, adding users, removing members, un-registering, addressing, and authentication. The functions relating to system preparation and operation include administration and provisioning, scalability, and reliability. These functions are described in detail in the following sections.

Registration

In a wireless communication system, e.g., CDMA system, registration is the process by which a mobile station makes its location known to the wireless system infrastructure. This location information may include the geographical area the mobile station is in and the identification of the base station that is serving the mobile station, which may be used to aid in the efficient use of the paging and access channels.

In one embodiment, the user location information is the IP address of the client, regardless of whether the client is connected via wireless or wireline services. An exemplary IP protocol that enables IP applications to locate clients based on their IP address is the session initiation protocol (SIP). Among other functions, SIP provides methods for clients to register their IP address and other location information with a SIP server component. In addition, SIP provides methods for IP applications interested in "finding" clients to query the same SIP server component for location information, such as the client's IP address.

Registration may include the process of an IP client communicating with a SIP server component to notify and maintain its location information, e.g., IP address. The SIP server component that provides this functionality is the location server. The method by which a client notifies the location server of its location or changes to its location is the SIP REGISTER method.

In one embodiment, the clients register their location information with a regional location server. Other IP based applications, such as instant messaging, may benefit from having knowledge of each client's IP address available in a location server. An external service or the client may perform the registration. FIG. **3** illustrates an exemplary call flow for performing the registration function.

Upon power-up **302**, the client may request a packet data session and start the process of registering its IP address with RLS **112**. In order to perform the registration, the client may perform a DNS SRV record lookup **304** to determine the address of the RLS. Once the RLS address has been retrieved **306**, the client may register its location information, e.g., by using a SIP registration message **308**. The RLS may authenticate **310** the user and issue a response **312** to the client. The RLS may notify **314** the regional dispatcher that the user has registered, and the regional dispatcher may use this information to pre-load the user's associated data record in order to facilitate a faster response time during call setup. At this point, the client may be contacted with an invitation to participate in a group call. In one embodiment, clients may need to perform registration in order to receive a group call, regardless of the type of data connectivity they have, i.e. wireless or wireline.

Registrations may have an "expiry" field associated with them, which indicates how long the client's registration information may be considered valid. In order to guarantee the client is always reachable via IP, the client may be aware of the expiration of its registration and perform a re-registration prior to the time of expiration. Registrations may also become invalid or stale due to other circumstances, such as when the client's IP address is changed or the data connection between the client and the location server is severed. The clients may be aware of the state of their data connectivity and whether their IP address has changed.

After the initial registration has been completed, a client may allow its packet data session to go dormant, which may release the dedicated traffic channel. The client may monitor its packet data session to ensure that it remains valid during periods of extended dormancy. conditions that may affect the validity of the session include moving to an area with a different packet zone ID, experiencing a fade or loss of service, and accepting and/or placing a PSTN call. The client's IP address may change and the client may be required to re-establish data connectivity to the infrastructure. When the client re-establishes its packet data session, it receives a new IP address. The new IP address needs to be communicated to the location server to ensure the client's location information remains accurate. This may be accomplished by performing a re-registration.

A wireline client that is communicating to the location server through a firewall, may need to maintain the opening

through the firewall by periodically "pinging" the location server. This is accomplished by performing re-registrations.

Group Call Initiation

After registration is complete, the user may make or receive calls. Before the initiation of the first call after power-up, the client may perform a DNS SRV record lookup to find the location of the regional dispatcher. This may be performed as part of the start-up process.

A "group" is associated with an originator, the user who initiated the group setup, and a member list, which contains the target user or users. The member list may contain one or more users, one or more pre-defined groups, or a combination of the two. If the member list contains only one user, the call initiated using that member list is commonly referred to as a private call. If the member list contains any pre-defined groups, the regional dispatcher may expand the predefined groups into a list of one or more target users, e.g., by replacing the pre-defined group identifier in the original member list, with the pre-defined group's associated member list. After the pre-defined groups have been expanded, the resulting member list may contain only target user names. At this point, the regional dispatcher attempts to locate the target users in the member list, e.g., by scanning the regional dispatcher's cache of user information. If the targets are located within the regional dispatcher's cache, the members of the group may be registered within the same region as the regional dispatcher. This type of group call is labeled an "intra-regional" call. If there are users which the regional dispatcher was unable to locate, the regional dispatcher may request assistance from the home dispatcher to locate the users. The call associated with a group that contains members from two or more regions is referred to as an "inter-regional" call.

After the regional dispatcher has determined whether the call is intra-regional or inter-regional, it may start the process of determining which media control unit (MCU) may host the call. For intra-regional calls, the regional dispatcher may assign the call to an MCU located in the same region as the regional dispatcher, if there are MCU resources available in that region. The resulting call using this type of call setup is referred to as a "locally-hosted" call, or local call. For inter-regional calls, the regional dispatcher may have a choice to assign the call to an MCU within the same region or in a remote or foreign region. The regional dispatcher may make this decision based on the users' location information to find the optimal path of travel for the IP packets containing media and signaling. If a majority of the users are located in a particular region, the call may be assigned to that region. If the users are evenly dispersed across regions, the call may be assigned to one of the regions containing the target users. If the inter-regional call is assigned to an MCU in different region then the region in which the regional dispatcher resides, the call is referred to as a "remotely-hosted" or remote call. The regional dispatcher may have knowledge of the network topology and/or connectivity between the MCUs and the PDSNs they are serving and may use this knowledge to make a better decision on the assignment of calls.

Intra-Regional Calls

The group communications system **100** may be deployed to ensure the majority of the calls are intra-regional. Intra-regional calls may eliminate the need for communication between regional dispatcher **114** and home dispatcher **102** at call setup time. The need for communication between the regions may also be eliminated when the targets are in the same region and the call is being hosted locally, as is the case for the majority of intra-regional calls. The following sections describe call flows, timing estimates, and messaging schemes for intra-regional calls.

Initiating a Local Call

FIG. **4** illustrates an exemplary message flow for starting a local group call. The user may select **402** one or more target users, one or more pre-defined groups, or a combination of the two and may depress the push-to-talk (PTT) button. The client may send a request **404** to the regional dispatcher to setup the group call, regardless of whether the mobile station has a dedicated traffic channel or not, as will be discussed in more detail later. After the request is sent, if the mobile station's packet data session is dormant, the client may initiate the process of re-establishing dedicated traffic channels and preparing the packet data session for media activity. The client may buffer speech input received from the originator for some period of time.

When the regional dispatcher receives the request, it may expand the pre-defined groups, which may be specified in the request, into target user member lists. Then, the regional dispatcher may retrieve **406** the target users' location information. At this point, the regional dispatcher may also determine if the group is already running in the system. FIG. **4** shows a scenario in which the group is not already running. The late-join call scenario, which is described later herein, illustrates the case in which the group is already running.

After the regional dispatcher locates at least one of the target users, the regional dispatcher may send a response **408** back to the client indicating the group call is being set up. At this point, the client may optimistically grant **410** the originator's request to talk and start buffering **412** his media.

The regional dispatcher may use the locations of the target users to determine the region in which the call may be assigned. If it is determined that the target users are in the same region as the regional dispatcher, as in FIG. **4**, the regional dispatcher may assign the call to a regional MCU. The MCU may send out announcements **414** to the entire group indicating the call is starting. For the target users, the sending of the announcement may trigger their packet data sessions to come out of dormancy and re-establish their traffic channels.

After the client has received the call announcement from the MCU and the mobile station's traffic channel has been re-established, the client may forward **416** the buffered media to the MCU. The MCU may buffer **418** the media received from the originator. In one embodiment, the MCU may buffer the media until the "target response threshold" is met or exceeded. The target response threshold is an indication of the amount of target responses required in order to proceed with the sending of media. The threshold may be a configurable parameter. Once the threshold is met, the MCU replicates and forwards **420** the media to the target users that have responded **422** to the announcement for the call.

Messaging Via Short Data Burst

The "instant response" relates to the response time it takes for the application server to respond to a PTT or call setup request. The goal for responding to any PTT request, including group call setup requests, is to consistently respond to the request in a predetermined time period, e.g., one second or less. In many cases, when a user requests to setup a group call, the user's packet data session is dormant and no dedicated traffic channel exists. Re-establishing dedicated traffic channels may take considerable time. Therefore, communication to the application server may be accomplished through some other means.

To ensure that the group communication system meets the "instant response," small IP datagrams may be sent at any time in either direction, i.e., mobile-originated or mobile-

terminated, regardless of the state of the packet data session. In one embodiment, IP datagrams may be sent in short data burst message (SDB) form. In situations when the packet data session is dormant, the SDB message will be sent over the overhead channels. When dedicated traffic channel connectivity is present, the SDB message is sent over the traffic channel.

Referring to FIG. **4**, the group call-setup request **404** may be sent via an SDB message. The group call-setup response **408** from the application server may also be sent in an SDB message. The call setup request and response messages sent via SDB messages may enable the group communications system **100** to meet the "instant response" goal.

To complete the process of setting up the group call, the MCU may send out call announcements to the users in the member list, including the originator. These call announcements may be sent via the dedicated traffic channels. In most cases, the group member's packet data sessions are dormant, i.e. no dedicated traffic channels are established. This means the MCU may have to resend the call announcement message on an aggressive reliability schedule until all of the members' traffic channels have been re-established and the members have acknowledged the message or the reliability timer expires. Sending the call announcement aggressively ensures that the media buffers on the client and the MCU are kept at a minimum. The client may send buffered media as soon as it's traffic channel is up and it receives a call announcement containing MCU contact information. The MCU may replicate and forward buffered media as soon as the target response threshold is met or exceeded. This means the quicker the targets receive the call announcement and respond to it, the faster this threshold may be met, then the faster the MCU may stop buffering and start sending media.

The call announcement to the originator may also be sent via SDB. This provides two benefits. First, since the call announcement contains MCU contact information, the group call client may start sending buffered media to the MCU as soon as the mobile station's traffic channel is re-established, which may reduce the RAM requirements on the mobile station for holding the buffered media. Second, if the originator decides to abort the call or release the floor, which may occur prior to the traffic channel being re-established, when the call announcement comes in via SDB, the client may notify the MCU with that information. The impacts of sending the call announcement to the originator via SDB is an increase in the load on the common channels and a requirement for the MCU to give special treatment to the originator's call announcement message.

Initiating a Remote Call

Intra-regional calls may be hosted locally if all members are located within the same region. The regional dispatcher may assign an intra-regional call to a remote region due to local resources being overloaded or unavailable. In such cases, the media and signaling may experience additional latency and errors due to extended communication paths between the user's PDSN and the remote MCU. FIG. **5** illustrates an exemplary call setup for a remote, intra-regional call.

Initiating an intra-regional call on a remote host is similar to the call-setup scenario discussed in connection with FIG. **4**, with the exception of the regional dispatcher's call assignment to a MCU. After the regional dispatcher has retrieved the location of the group members, it may determine the MCU to which the call may be assigned. The regional dispatcher may make this decision based on the users' location information, loading, and availability of the MCUs. In an intra-regional call the users may be located in the same region, therefore the regional dispatcher may check the loading and availability of the MCU complex in the local region. If the regional dispatcher receives an indication that the local MCU complex is overloaded or temporarily experiencing operational failures, then it may assign the call to a remote MCU. In one embodiment, MCUs may be replications of identical functionality with the exception of the call configuration; therefore, the remote MCU may handle the call similar to the local MCU.

Inter-Regional Calls

The group call system **100** may be designed to allow a user to communicate with any other user regardless of their physical location or proximity to the each other. The group communication system **100** may be deployed to limit the number of calls that are inter-regional, because the inter-regional calls require communication between the regional dispatcher and the home dispatcher at call setup time. The call assignment may be to an MCU that is in a remote region from one or more of the call participants. The following sections describe exemplary call flows, timing estimates and messaging schemes for inter-regional calls.

Initiating a Local Call

FIG. **6** illustrates an exemplary message flow for starting a locally-hosted group call. Call setup for a local, inter-regional call is similar to the call setup for a local, intra-regional call, as described in connection with FIG. **4**, with the exception of the process in which the regional dispatcher retrieves the location information for the target users. In one embodiment, the regional dispatcher attempts to locate the target users within its cache. If some users are not found in the cache, the regional dispatcher may request assistance from the home dispatcher to locate the users. The home dispatcher may contain user location information for the users that have performed IP registrations using the regional location server. As discussed previously, the regional location server may notify its associated regional dispatcher every time a user registration occurs. Each regional dispatcher may notify the home dispatcher of the user registrations. This allows the home dispatcher to assist the regional dispatchers in finding users that are spread out geographically across different regions.

Initiating a Remote Call

FIG. **7** illustrates an exemplary setup for a remote, inter-regional call. Initiating an inter-regional call on a remote host is similar to the call setup scenario, as described in connection with FIG. **4**, with the exception of the regional dispatcher's call assignment to a MCU. After regional dispatcher (RD) **114** retrieves the location of the group members, it may determine the MCU to which the call may be assigned. RD **114** may make this decision based on the users' location information, loading, and availability of the MCUs. Using group members' locations, the RD attempts to find the optimal path of travel for the IP packets containing media and signaling, over the service provider's network, for a majority of the members. If a majority of the users are located in a particular region, the call may be assigned to that region. If the users are evenly dispersed across regions, the call may be assigned to one of the regions containing the target users.

Group Call Termination

A group call may end for two reasons: either all participants have requested to leave the call or all participants have stopped talking for a pre-defined period of time, called "hang-time." Each participant may elect to end participation in the call prior to the planned end of the call. If all participants leave the call, the MCU may terminate the call and release all resources assigned to it. If all but one

participant leaves the call, the MCU may notify the participant, referred to as the "lonely user." The lonely user has the option of leaving the call immediately or waiting for the hang-time timer to expire, which may trigger the MCU to disband the call.

The MCU may terminate the call upon the expiration of the hang-time timer. The MCU may track each talk spurt and set a timer after the completion of a talk spurt. This timer is referred to as the hang-time timer and may track the duration of silence, i.e., no talking or media flow activity, in the call. If the call remains silent for duration of the hang-time, which may be configured by the service provider, the MCU may assume the participants are no longer interested in the call, and therefore, terminates the call.

User Initiated Call Termination

FIG. **8** illustrates an exemplary scenario in which a user has elected to end participation in a group call. The scenario depicts the message flow to terminate the user's participation. When the user elects **802** to end participation in the group call, the client may send **804** a request to the MCU to remove the user from the call. The MCU may remove **806** the user from the call and notify **808** the client that the user has been removed **810**.

Server Initiated Call Termination

FIG. **9** illustrates an exemplary message flow that occurs when the hang-time timer expires and the MCU terminates the group call. Upon the expiration of the hang-time timer **902**, the MCU may send **904** the participants a notification that the call is ending. Each client that receives a call end notification may reply **906** with an acknowledgement. Upon receipt of the acknowledgements, the MCU may notify **908** the RD that the call has ended and may release the resources that were assigned to the call.

Sending an Alert

The alert mechanism may be used to notify target users that another user, the alert originator, has expressed a desire to have them participate in a group call. The alert mechanism may contain a text message that allows the originator to specify the subject of the call, the desired time of the call, or any other user customizable text messages. FIG. **10** illustrates an exemplary message flow that occurs when a user sends an alert.

The originator may select **1002** one or more target users, one or more pre-defined groups, or a combination of the two, and may indicate an alert may be sent. The client may send **1004** a request to the RD to send out alerts to the target users specified in the request. When the RD receives **1006** the request, it may expand the pre-defined groups specified in the request into target user member lists, and the RD may retrieve the target users' location information. After the RD has located at least one of the target users, the RD may send a response **1008** back to the client. The RD may assign **1010** the alert request to a MCU to broadcast alert messages **1012** to the target users.

As noted on FIG. **10**, the alerts request may be sent via short data burst (SDB). Sending alerts via SDB messages allows the involved parties' packet data sessions to remain dormant. Alert notification contains the necessary information to allow the target users to setup group calls with the originator and the rest of the target users, e.g., by selecting the alert notification and pressing PTT. When this occurs, the group call setup proceeds similar to the call set-up scenario discussed in connection with FIG. **4**.

Late Join

A group call setup request is considered a late join, if it is determined that the member list, which may be specified in the call setup request, is identical to one which is associated with a call already in progress in the system. This situation may occur in one of two ways. First, the user may create a member list identical to one that already has a call associated with it, e.g., by selecting the exact same user(s) and/or group(s) and depressing the PTT button. Second, the user may select a call, which is still running in the system, from the call history list and depress PTT. In either case, the RD may detect that the call the user has requested to start is already in progress, and treat the user as a late join.

FIG. **11** illustrates an exemplary late-join case in which a user may select a call from the call history list. The user may select **1102** a call from the call history list and press the PTT button. The client may send **1104** a request to the RD to start the group call. The RD may determine the call is already running **1106** and send a response **1108** to the client that the user is being added to a call in progress. If the call is already running, the floor may not be granted to the user because a current call participant may already be holding floor by the time the late join user is prepared to receive media, i.e., packet data session is brought out of dormancy. The RD may request **1110** the MCU that is hosting the call to add the late-join user to the group. The MCU adds the user and sends **1112** an announcement to the user containing the MCU's contact information. After the late join user's traffic channel is re-established, media flow within the call may be transmitted to the user. At this time, the late join user may attempt to request the privilege to talk.

The late join scenario is similar to the scenario for initiating a new group call as discussed in connection with FIG. **4**. The differentiating factor is the late join user is denied the floor in response to the initial group call setup request.

Talker Arbitration

In one embodiment, each group call user is assigned a talker pre-emption rank, which determines what level of rights the user has when requesting privileges to seize the "floor" and begin talking. After the group call is setup, the MCU may be responsible for floor control and determining if a participant requesting the floor may be allowed to speak. The MCU may perform talker arbitration when two or more call participants are competing for control of the floor for a particular group.

FIG. **12** illustrates the exemplary events that may occur during an arbitration process. The arbitration scheme used in this scenario allows the pre-emption of user B when user A requests the floor. User B has control of the floor, i.e. user B is speaking, when user A requests permission to talk by pressing **1202** the PTT button. The client may send **1204** a message to the MCU requesting permission to talk. The MCU may perform talker arbitration **1206** and determine that user B may be pre-empted and user A granted the floor. In order to ensure a break in media flow, i.e. user B may stop talking before user A's media is transmitted, the MCU first sends **1208** a message to the client for user B, indicating the floor has been preempted by another user, and then send **1210** a response granting the floor to user A.

Adding Users to an Active Group Call

The group communications system **100** allows a group-call participant to add new users to a group call in progress. This is accomplished by the call participant selecting one or more target users, one or more pre-defined groups, or a combination of the two, and indicating that the participant would like the targets to be added to the group call the participant is currently in. FIG. **13** illustrates the events that occur when new targets are added to a group call that is in progress. The call participant may select **1302** one or more target users, one or more groups, or a combination of the two

that should be added to the call. The client may send **1304** a message to the RD requesting that the specified target users be added to the group call in progress, which may be specified in the request. When the RD receives the request, it may expand the predefined groups, specified in the request, into target user member lists. Then, the RD may retrieve **1306** the target users' location information. After the RD has located at least one of the target users, the RD may send **1308** a response back to the client indicating that the targets are being added to the call. The RD may send **1310** a request to the MCU to add the specified users to the call. The MCU may send **1312** call announcements out to the new targets, which may start the process of bringing their packet data sessions out of dormancy. The announcements may be sent on a reliability schedule to ensure the targets receive the message. After the targets' traffic channels are re-established, the targets may send **1314** acknowledgements to the MCU. The additional targets may be included **1316** in the media and signaling communication that is occurring in the call.

Removing Members from an Active Group Call

The group communications system **100** allows a group-call participant to remove members from an active group. In one embodiment, this may be accomplished by a call participant selecting one or more target participants and indicating that they should be removed from the group call. FIG. **14** illustrates the exemplary events that may occur when participants are removed from a group call in progress. The group-call participant may select **1402** one or more target participants that are to be removed from the call. The client may send **1404** a message to the RD, requesting that the targets, which may be specified in the message, be removed from the group call. When the RD receives the request, it may retrieve **1406** the target's location information and may send **1408** a response back to the client indicating the targets are being removed. The RD may send **1410** a request to the MCU to remove the targets from the call. The MCU may send **1412** messages to the targets, which may be specified in the remove request, indicating that they are being removed from the call. The targets may send **1414** acknowledgments to the MCU.

Un-Registering

When a user no longer wishes to be contacted by the application server or any other IP application that uses the user's IP address to contact the user, the un-register function may be performed. The un-register function removes the user's IP address and other contact information from the RLS and frees any resources allocated on behalf of the user. FIG. **15** illustrates how the user's registration is removed from the RLS as a result of the mobile station being powered down, according to one embodiment. The client may receive **1502** an indication that the mobile station, which the client resides on, is being powered down. As a part of the shut down process, the client may send **1504** a message to the RLS, indicating the user's location information should be removed. The RLS may authenticate **1506** the request to ensure it is from a valid source. Upon successful authentication, the RLS may notify **1508** to the client with a success indication, and may notify **1510** the RD about the removal of the user. The RD may remove the user's data records from its cache and may free the resources that may have been allocated to the user. In the event of a failure to un-register, the user's location information may eventually be removed from the RLS when the time associated with the expiry field has elapsed.

In one embodiment, the group communication system **100** supports both the chat-room model and the ad-hoc model. In the chat-room model, the groups are pre-defined, which may be stored on the dispatch server. The pre-defined groups may be public, implying that the group has an open member list, i.e. any dispatch user is a potential participant. In the chat-room model, the call is started when the first person opts to join the chat-room, and the call remains running, with server resources assigned to the call, regardless of talk activity, for a pre-determined amount of time, which may be configured by the service provider. Users specifically request to join and leave these types of calls. During periods of talk inactivity, each call is brought into a group dormant state, as will be discussed later, until a user requests permission to talk.

In the ad-hoc model, groups may be defined in real-time and have a closed member list associated with them. A closed member list may specify which users are allowed to participate in the group, may not be available to users outside of the closed member list, and may only exist for the life of the call. Ad-hoc group definitions may not be stored anywhere; they may be used to establish the call and released after the call has ended.

An ad-hoc group may be formed when an originating user selects one or more target users and generates a request, which is sent to a server to start the call. The target users may be sent a notification that they have been included in a group and may automatically be joined into the associated call, i.e., no user action may be required. When an ad-hoc call becomes inactive, the application servers may "tear down" the call and free the resources assigned to it, including the group definition used to start the call.

When operating in the chat-room model, in the group communications system **100**, a group of communication device users, individually known as net members, communicate with one another using a communication device assigned to each net member. The term "net" denotes a group of communication device users authorized to communicate with each other.

In one embodiment, a central database may contain information identifying the members of each particular net. More than one net may operate in the same communication system. For instance, a first net may be defined having ten members and a second net may be defined, having twenty members. The ten members of the first net may communicate with each other, but may not communicate with members of the second net. In another embodiment, members of different nets are able to monitor communications between members of more than one net, but may be only able to transmit information to members within their own net.

A net may operate over an existing communications system, without requiring substantial changes to the existing infrastructure. Thus, a controller and users on a net may operate in any system capable of transmitting and receiving packet information using Internet protocol (IP), such as a Code Division Multiple Access (CDMA) system, a Time Division Multiple Access (TDMA) system, a Global System for Mobile Communications (GSM) system, satellite communication systems such as Globalstar™ or Iridium™, or a variety of other systems.

Net members may communicate with each other using an assigned communication device, shown as communication devices (CDs) **120** and **122**. CDs **120** and **122** may be wireline or wireless communication devices such as terrestrial wireless telephones, wireline telephones having with push-to-talk capability, satellite telephones equipped with push-to-talk functionality, wireless video cameras, still cameras, audio devices such as music recorders or players, laptop or desktop computers, paging devices, or any com-

bination thereof. For example, the CD **120** may comprise a wireless terrestrial telephone having a video camera and display. Furthermore, each CD may be able to send and receive information in either a secure mode, or a non-secure (clear) mode. Throughout the following discussion, reference to an individual CD infers a wireless push-to-talk phone. However, it should be understood that reference to a CD is not intended to be limited as such, and may encompass other communication devices that have the capability to transmit and receive packet information in accordance with the Internet Protocol (IP).

In the group communications system **100**, a transmission privilege generally allows a single user to transmit information to other net members at a given time. The transmission privilege is granted or denied to a requesting net member, depending on whether or not the transmission privilege is currently assigned to another net member when the request is received. The process of granting and denying transmission requests is known as arbitration. Arbitration schemes may evaluate factors such as priority levels assigned to each CD, the number of unsuccessful attempts to gain transmission privilege, the length of time a net member has held transmission privilege, or other factors, in determining whether a requesting net member is granted the transmission privilege.

In order to participate in the system **100**, CDs **120** and **122** each may have the ability to request transmission privilege from a controller or MCU **116**. MCU **116** may manage the real-time and administrative operation of the groups. The MCU is any type of computer type device having at least one processor and memory. MCU **116** may operate remotely through either a communication system service provider, members, or both, assuming that authorization is provided by the service provider. MCU **116** may receive group definitions through an external administration interface. Group members may request administrative actions through their service provider or administrate net functions through defined systems, such as a member-operated security manager (SM) that conforms to a MCU administration interface. MCU **116** may authenticate the party who attempts to establish or modify a net.

The SM may perform key management, user authentication, and related tasks to support secure nets. A single group communication system may interact with one or more SMs. The SM may not be involved in the real-time control of a net, including net activation or PTT arbitration. The SM may have administration capabilities compatible with MCU interface to automate administration functions. The SM may also be capable of acting as a data endpoint for the purpose of participating in a net, broadcast net keys, or simply monitor net traffic.

In one embodiment, the means for requesting the transmission privilege from a MCU comprises a push-to-talk (PTT) key or switch. When a user in the system **100** desires to transmit information to other members, the user may depress the push-to-talk switch located on his or her CD, sending a floor-control request to obtain the transmission privilege from MCU **116**. If no other net member is currently assigned the transmission privilege, the requesting user may be granted the transmission privilege and the user may be notified by an audible, visual, or tactile alert through the CD. After the requesting user has been granted the transmission privilege, information may then be transmitted from that user to the other member.

In one embodiment of the present invention, each wireless net member establishes a forward link and a reverse link with one or more base stations **126**, or alternatively with a satellite gateway, as the case may be. Voice and/or data may be converted into data packets, using a CD, for example, which are suitable for a particular distributed network **128** through which communications to other users may take place. In one embodiment, distributed network **128** is the Internet.

In one embodiment, a dedicated forward channel is established in each communication system, i.e., a terrestrial communication system and a satellite communication system, for broadcasting information from each net member to the other net members. Each net member may receive communications from other net members over the dedicated channel. In another embodiment, a dedicated reverse link is established in each communication system for transmitting information to MCU **116**. In one embodiment, a combination of the above schemes may be used. For example, a scheme may involve establishing a dedicated forward broadcast channel but requiring wireless CDs to transmit information to MCU **116** over a dedicated reverse link assigned to each CD.

When a first net member wishes to transmit information to other members of the net, the first net member may request the transmission privilege by pressing a push-to-talk key on his or her CD, which generates a request formatted for transmission over the distributed network **128**. In the case of CDs **120** and **122**, the request may be transmitted over the air to one or more base stations **126**. A mobile switching center (MSC) **130**, which may include a well-known inter-working function (IWF), packet data serving node (PDSN), or packet control function (PCF), for processing data packets may exist between BS **126** and the distributed network **128**. The request may be transmitted through the public switched telephone network (PSTN) to a modem bank, which may receive the request and provide it to distributed network **128**. A terminal may monitor traffic of the system **100** through its connection to distributed network **128**.

If no other member currently holds the transmission privilege, when the MCU **116** receives a transmission privilege request, MCU **116** may transmit a message to the requesting net member, notifying it that the transmission privilege has been granted. Audio, visual, or other information from the first net member may then be transmitted to the other net members by sending the information to MCU **116**, using one of the just-described transmission paths. In one embodiment, MCU **116** then provides the information to the other net members by duplicating the information and sending each duplicate to the other net members. If a single broadcast channel is used, the information need only be duplicated once for each broadcast channel in use.

In an alternative embodiment, MCU **116** is incorporated into MSC **130** so that data packets from supporting base stations are routed directly to MCU **116** without being routed onto distributed network **128**. In this embodiment, MCU **116** is still connected to distributed network **128** so that other communication systems and devices may participate in a group communication. In yet another embodiment, the MCU **116** may be incorporated into the PDSN or the PCF modules of the MSC **130**.

In one embodiment, MCU **116** maintains one or more databases for managing information pertaining to individual net members as well as to each defined net. For example, for each net member, a database may comprise information such as the user name, account number, a telephone number, or dial number, associated with the member's CD, a mobile identification number assigned to the CD, the current member's status in the net, such as whether the member is

actively participating in the net, a priority code for determining how the transmission privilege is assigned, a data telephone number associated with the CD, an IP address associated with the CD, and an indication of which nets the member is authorized to communicate with. Other related types of information may also be stored by the database with respect to each net member.

In one embodiment, the CD may form connections with individual communication terminals to form one talk group, or net. The MCU may comprise a variety of functional capabilities in hardware and software that are configurable in different ways to accommodate different applications. The MCU may provide capability to manage real-time, administrative, and authenticity operations of the nets, push-to-talk (PTT) request arbitration, maintenance and distribution of net membership and registration lists, call set-up and tear-down of necessary communication, e.g., CDMA, systems and network resources, as well as overall control of net status.

The nets may be within a stand-alone deployable cellular system, or a large multiple site configuration. In the case of a large configuration, multiple MCUs may be deployed geographically to form a single, integrated system, each operating as a plug-in module into existing cellular infrastructure. As such, new features introduced by the nets are available to cellular users without requiring modification to existing cellular infrastructure.

The MCU may maintain a list of defined nets. In one embodiment, each net definition includes a net identifier, a list of members, including phone numbers or other identifying information, user priority information, and other generic administration information. Nets may be statically defined as either clear or secure, and transitions between clear and secure may not be permitted. A secure net typically uses media encryption to provide authentication and guard against eavesdropping. Media encryption for secure nets is implemented on an end-to-end basis, meaning encryption and decryption may take place within the communication device. The MCU may operate without knowledge of security algorithms, keys, or policies.

FIG. **16** illustrates an exemplary group **1600** for showing how communication devices **1602**, **1604**, and **1606** interact with a MCU **1608**. Multiple MCUs may be deployed as desired for large-scale groups. In FIG. **16**, CD **1602** has permission to transmit media to other members of the group. In this case, CD **1602** is known as the talker and transmits media over a channel. When CD **1602** is designated as the talker, the remaining participants, CD **1604** and CD **1606**, may not have permission to transmit media to the group. Accordingly, CD **1604** and CD **1606** are designated as listeners.

As described above, CDs **1602**, **1604**, and **1606** are connected to MCU **1608**, using at least one channel. In one embodiment, the channel is divided into separate channels comprising a session initiation protocol (SIP) channel **1610**, a media signaling channel **1612**, and a media traffic channel **1614**. SIP channel **1610** and media signaling channel **1612** may be used at any time as bandwidth allows by any of the CDs **1602**, **1604**, and **1606**, regardless of being designated a talker or a listener. The SIP is an Internet engineering task force (IETF) defined application-layer protocol that describes control mechanisms to establish, modify, and terminate multimedia sessions operating over Internet protocol (IP). The SIP provides a general solution to call-signaling problems for Internet telephony applications by supporting mechanisms to register and locate users, mechanism which define user capabilities and describe media parameters, and mechanisms to determine user availability, call setup, and call-handling.

In one embodiment, SIP channel **1610** is used to start and end participation of a CD within the group **1600**. A session description protocol (SDP) signal may also be used within SIP channel **1610**. When the CD's participation within the group is setup, e.g., by using SIP channel **1610**, real-time call control and signaling between the CD and the MCU takes place, e.g., by using NBS media signaling channel **1612**. In one embodiment, media signaling channel **1612** is used to handle push-to-talk requests and releases, arbitrate between conflicting requests, or floor control, announce the beginning and end of information transmission, manage net dormancy, track endpoint connectivity, request and exchange net status, and notify any error messages. The protocol of media signaling channel **1612** minimizes the length of most common messages, and simplifies the task of interpreting replies and responding to requests while retaining flexibility for future enhancements. The protocol of media signaling channel **1612** also allows requests to be resent without adversely affecting protocol state.

In one embodiment, signaling traffic on media signaling channel **1612** includes call setup and control signaling, which may consist of session invitation requests and acknowledgements, and media signaling, which may comprise of real-time floor control requests and related asynchronous messages. Media traffic on the media traffic channel **1614** may comprise of real-time point-to-multi-point voice and/or data broadcasts. Both messaging categories have unique functional attributes. In addition, each CD may issue domain name service (DNS) client requests to facilitate mapping fully qualified DNS hostnames to Internet network addresses.

In one embodiment, the call-setup and call-control signaling is performed according to SIP semantics. Although SIP may be transported using either the well-known user datagram protocol (UDP) or transmission control protocol (TCP), in one embodiment, each CD performs SIP based signaling functions using UDP. Also, each CM may expect to receive SIP signaling requests via UDP. Real-time signaling may occur via dynamic UDP/IP interface on the CM and each CD. Other signaling may take place via a fixed TCP/IP interface between the CM and the CD using the SIP, for example.

PTT Latency

In one embodiment, when the packet data service is active, resources in the infrastructure, e.g., base station transceiver subsystem (BTS), base station controller (BSC), interworking (IWF), and the radio link are actively assigned to the mobile station (MS). In an IP-based VoIP dispatch service, while there is an active conversation going on between group participants, the packet data connection for each user remains active. However, after a period of inactivity, i.e., "hang time," in the group communications the user traffic channels may transition to the dormant state.

The transition to the dormant state conserves system capacity, reduces service cost and battery drain, and makes the user available to receive incoming conventional voice calls. For example, when the user is in an active packet data call, he will generally be considered to be "busy" to incoming voice calls. If the user's packet data call is in the dormant state, the user may be able to receive incoming voice calls. For these reasons, it is desirable to transition the packet data call to the dormant state after periods of packet data inactivity.

While packet data calls are active, even if no data packets are being exchanged, radio frequency (RF) energy may still

be transmitted by the mobile phones, albeit at a low level, to maintain synchronization and power control with the base station. These transmissions may cause a significant power drain on the phone. In the dormant state, however, the phone may not perform any RF transmission. To conserve phone power and extend battery life, the hang time may be set to transition the phone to dormant mode after extended periods of no data transmission.

While the packet data service is active for all users, PTT requests, which may be IP datagrams sent between the MS and the dispatch server, have very low latency. However, if the user channels have previously transitioned to the dormant state, the PTT latency may be much longer. During packet data dormancy, state information associated with the packet data session, including the mobile IP address, may be maintained. However, state information associated with layers below PPP, such as the physical traffic layers, may be released and/or de-allocated.

In some infrastructures, to wake up a dormant data connection, the traffic channel must be reallocated, the resources must be reassigned, and the radio link protocol (RLP) layer must be reinitialized. The effect of this is that after a talk group has not talked for a while, when a user presses his PTT button to request the floor, the PTT latency for the first talk spurt is generally much longer than for subsequent talk spurts. While this is relatively infrequent, it can affect the utility of the service, and should be minimized.

To reduce the PTT latency, in one embodiment, the group call signaling, such as the floor-control requests, floor-control responses, and dormancy wakeup messages, may be transmitted on some available common channels, without waiting for dedicated traffic channels to be re-established. Such common channels may be always available, regardless of the state of the mobiles, and may not require being requested and reassigned each time a user wishes to initiate a group call. Therefore, the group call signaling may be exchanged even when mobiles are dormant, which may provide a means to re-establish dedicated traffic channels for the talker and listener mobiles in parallel.

In one embodiment, the calling mobile may send a floor-control request to the wireless infrastructure over some available reverse common channels, such as reverse access channel and reverse enhanced access channel. The calling mobile may also receive a response to the floor-control request on some available forward common channels, such as forward paging channel and forward common control channel. In one embodiment, the dormant listener mobiles may receive dormancy wakeup messages on some available forward common channels, such as forward paging channel and forward common control channel.

Short Data Burst Call-Signaling Messages

In one embodiment, a significant reduction in the actual total dormancy wakeup time and the PTT latency perceived by the talker, may be achieved through the use of the short data burst (SDB) messages, as provided in "TIA/EIA/IS-2000 Standards for cdma2000 Spread Spectrum Systems," hereinafter referred to as "the cdma2000 standard," for example. In one embodiment, SDB messages may be sent over both dedicated physical channels, such as the forward fundamental channel (FCH) or forward dedicated common control channel (F-DCCH), or common physical channels, such as the reverse access channel (R-ACH), reverse enhanced access channel (R-EACH), forward common control channel (F-CCCH), or paging channel (PCH). SDB messages may be transported by radio burst protocol (RBP), which maps the messages onto an appropriate and available physical layer channel. Because SDB messages may carry arbitrary IP traffic and may be sent over common physical channels, SDB messages provide a mechanism to exchange group call signaling when a calling client's mobile has no dedicated traffic channels.

Mobile-Originated Call-Signaling Messages

In one embodiment, media-signaling messages may carry IP datagrams over the reverse link or mobile-originated link. A client mobile station may signal the MCU quickly whenever the user requests the floor and a dedicated reverse traffic channel is not immediately available. Assuming the client mobile station has released all dedicated traffic channels, the client mobile station may immediately forward the floor-control request over a reverse common channel of a wireless infrastructure, which may relay the request to the MCU. For example, either the reverse access channel or the reverse enhanced access channel may be used to send such messages when a dedicated reverse channel is not available. In one embodiment, the client mobile station may transmit a floor-request message to the MCU as an SDB Message.

Referring to FIG. **4**, in one embodiment, the client MS may send the PTT floor request **404** over a reverse common channel, such as the access channel or enhanced access channel, before attempting to re-establish its dedicated traffic channel. In one embodiment, the client MS may send the PTT floor request **404** in a SDB message regardless of what channel is used.

The client MS may then start re-establishing its dedicated traffic channel, e.g., by performing the "service option **33** re-origination," for example. The client MS may also start radio link protocol (RLP) synchronization. In one embodiment, the client MS may re-establish its dedicated traffic channel and synchronize RLP advantageously in parallel with sending the PTT floor request **404**.

Therefore, use of the available reverse common channels and/or SDB feature to signal floor-control requests to the CM, when a mobile station does not have active dedicated traffic channels, reduces the total time required to wake up the participating mobiles. Although the talker client may not receive confirmation that its floor-request has been granted until the talker's forward traffic channel is re-established, the ability to quickly signal the CM to begin waking up participating listeners reduces the overall latency.

Referring to FIG. **4**, the wireless infrastructure may send the PTT floor-control request **404** to packet data service node (PDSN) and then to the MCU. In one embodiment, after receiving the floor-control request, the MCU may arbitrate the request, burst media signaling wakeup messages (triggers) to a group of target participants (listeners), and/or trigger the re-establishment of participants' (listeners') traffic channels **414**. If the MCU grants the PTT floor request, the MCU may send PTT floor grant **408** to the client MS. In one embodiment, the RD may send PTT floor grant **408** to the client MS on an available forward common channel, such as forward paging channel and forward common control channel, if the client's dedicated traffic channel is not re-established yet. In one embodiment, the infrastructure may send PTT floor grant **408** to the client MS in SDB form regardless of what channel is used.

In one embodiment, the MCU may wait for dormancy response timer to expire before responding to the PTT floor-control request. If the group's dormancy response timer is set to zero, the CM may respond to the floor-control request immediately. In one embodiment, if the client MS has completed re-establishing its traffic channel and RLP synchronization, the client MS may stream media **416**, which may have been buffered **412** in the client MS, to the MCU.

Network-Originated Call-Signaling Messages

In one embodiment, after receiving the floor-control request, the MCU may burst media signaling wakeup messages to a group of target participants (listeners) and trigger the re-establishment of participants' (listeners') traffic channels. If the group's dormancy response timer is set to zero, the MCU may respond to the floor control request immediately. In one embodiment, if the talker has began re-establishing its traffic channel immediately upon sending the PTT request, the caller's and listeners' traffic channels may be advantageously re-established in parallel.

Referring to FIG. **4**, after the MCU receives PTT floor-control request, the MCU may send wakeup triggers **414** directed to target listeners. The MCU may determine whether a packet-data session exists for the target mobile, and forwards the trigger packet to the appropriate infrastructure element, e.g., a base station. The infrastructure may page each individual target MS to start re-establishing its dedicated traffic channel. The target MS may then start re-establishing its dedicated traffic channel, e.g., by performing the "service option **33** re-origination," for example. The target MS may also start radio link protocol (RLP) synchronization. In one embodiment, the target MSs may re-establish their dedicated traffic channels and synchronize their RLPs advantageously in parallel with same functions being performed by the client MS.

In one embodiment, after a target MS has completed re-establishing its dedicated traffic channel and synchronizing its RLP, the target MS may send the wakeup reply **422** to the MCU, indicating that the target MS is ready to receive media. The MCU may send a talker announcement to the client MS before streaming media **420**, which may have been buffered **418** in the MCU, to the target MS.

In one embodiment, the MCU may send the wakeup trigger **414** to a target listener over some available common forward channels, such as forward paging channel and forward common control channel, while the target listeners' traffic channels are not re-established yet. In one embodiment, the MCU may send the wakeup trigger **414** to the target listener in SDB form, regardless of what channel is used. If the PTT floor-control request is sent on the talker's reverse common channel as a SDB message and the target group's dormancy response timer is set to zero at the MCU, actual PTT latency at the talker client may be reduced to the time required to send an SDB request message on the reverse link followed by a SDB response message on the forward link.

Network Interfaces for Call-Signaling Messages

To determine what network-originated specific traffic, e.g., SDB payload, is sent for an idle mobile station with no dedicated traffic channels, some infrastructure policy or interface for distinguishing such specific traffic from other traffic may be implemented.

In a first embodiment, IP datagrams may be filtered based on their sizes, as the SDB messages may carry a limited user payload. IP datagrams smaller than a predetermined size limit may be sent as SDB message, if destined for a mobile with no dedicated traffic channels. The group communication system may use such filters, as the application floor-request response message is quite small, e.g., 34 bytes including the IP headers.

In a second embodiment, an infrastructure vendor may define an IP-based service for encapsulating IP traffic destined for delivery to a mobile station. An IP server with knowledge of this service may transmit small IP, e.g., UDP, datagrams, appropriately encapsulated with IP headers, to this service for delivery to a mobile suspected of not having a dedicated traffic channel. The group communication systems may use this service to indicate to the infrastructure that the floor-request response message be delivered to the requesting client MS in SDB form, for example. Coordination of SDB traffic with pending pages or service origination requests is also important to insure quick and reliable delivery of user traffic.

In a third embodiment, an IP server may transmit special IP, e.g., UDP, datagrams with IP headers for delivery to a mobile suspected of not having a dedicated traffic channel. The IP server may tag the IP datagrams, e.g., by designating a special value in the IP header, for instructing the infrastructure to deliver the IP datagrams to the client MS. The group communication systems may use this service to indicate to the infrastructure that the floor-request response message be delivered to the requesting client MS in SDB form, for example. In a third embodiment, a UDP or TCP port range may be reserved for delivering specific IP datagrams, e.g., SDB messages.

Mobile-Initiated Service Origination and Paging

In one embodiment, a client may send the floor-control request **404**, which may be in SDB form, followed immediately with a service origination request to the wireless, e.g., CDMA, infrastructure for quickly re-establishing its traffic channels. However, if the dormancy response timer is set to a small value, the RD may respond to the floor-control request quickly and transmit a response **408** back to the client. If this response arrives at the infrastructure during the early phases of the service origination transaction, the infrastructure notes that the talker MS does not have any active traffic channel and may attempt to page the response to the talker MS. However, this paging action may abort the service origination transaction already in progress. In one embodiment, the talker MS may respond to the page, insuring that the floor-control response message is delivered to the talker, and request service origination again, but an unnecessary delay is experienced in re-establishing the talker's traffic channel as a result of the aborted original service origination attempt.

In a first embodiment, to avoid the race condition between the service origination process and paging, the RD may be configured to not respond immediately to the floor-control request **404**. Accordingly, the dormancy response timer may be adjusted so that the MCU transmits the response **408** to the talker MS after the service origination process is complete.

In a second embodiment, the PDSN, which receives the response **408**, and the mobile switching center (MSC), which responds to the talker's service origination request, are coordinated. That is, if the PDSN determines that a packet-data service origination process for the talker MS is already in progress when response **408** arrives at the infrastructure, the MSC may defer paging the talker MS. The PDSN may cache the response and send it over the talker mobile's forward traffic channel once the service origination process is complete. Alternatively, the MSC may send the response to the talker MS as an SDB message if the service origination process is still in progress.

In a third embodiment, the talker MS may avoid the race condition by not issuing a service origination request until after the talker MS has received a response to the floor-control request. In one embodiment, since the talker MS has no active dedicated traffic channel, the MCU may send the response to the talker MS on some available forward common channels, such as forward paging channel and forward common control channel. In one embodiment, the MCU may send the response to the talker MS in SDB form. The

talker MS may rely on the RD-generated floor-control response to trigger its traffic channel re-activation, in the same fashion that the wakeup requests sent by the MCU trigger traffic channel re-activation for the listener mobiles. The race condition is avoided as the potential for simultaneous mobile-initiated service origination and network-initiated paging of the mobile is avoided.

Caching Network-Initiated Packet Data Triggers

The IP datagram, including the wakeup trigger **414**, that arrives at the wireless, e.g., CDMA, infrastructure and is destined for a listener mobile that has no dedicated traffic channels may be lost, either by the network in general or by the wireless infrastructure specifically. In one embodiment, the wakeup trigger **414** sent to the listener mobile is retransmitted aggressively according to a defined schedule until the listeners respond or the group's wakeup timer expires. For example, the wakeup trigger **414** may be resent every 500 ms. However, re-transmitting the wakeup triggers **414** at this rate may cause a maximum delay of up to 500 ms, or an average delay of 250 ms, from the time a listener's traffic channel is re-established to the time next wakeup trigger destined for that listener arrives at the infrastructure.

In one embodiment, the infrastructure or another entity in the network may cache the wakeup trigger **414** sent by the MCU, and deliver it to a target MS as soon as the target MS has re-established its traffic channel. This eliminates the need for retransmission of wakeup request by the MCU, and reduces total dormancy wakeup time. Cashing the wakeup trigger **414**, as opposed to re-transmitting it at the rate of 500 ms, for example, may eliminate a delay of up to 500 ms. from the total dormancy wakeup time.

Media Buffering

In one embodiment, the user may be allowed to start talking after the user has requested floor control, by buffering the media before dedicated channels are re-established between the client and the listeners. By buffering the talker's speech, the system allows the talker to start talking before the listeners' traffic channels have been fully re-established. This allows the talker to start talking earlier, reducing his apparent PTT latency. Since listeners don't experience PTT latency, their experience is unaffected, i.e., the PTT latency is shifted from the talker to other parts of the system. The talker may wait just as long to receive a response from a listener to his first talk spurt, but as mentioned previously, he already expects the response to his first talk spurt to take longer than the response to subsequent talk spurts that occur while he is engaged in an active conversation. Buffering of the talker's first talk spurt can be done on the MCU side or on the client MS side.

MCU-Side Buffering

In one embodiment, the MCU may buffer the talker's first talk spurt. After a user has pressed his PTT button and the user's traffic channels are re-established, he may be allowed to communicate with the MCU. At this time, since the listener traffic channels are not yet up, the MCU buffers **418** the talker's speech for future transmission to the target listeners. MCU buffering may reduce the apparent PTT latency that the talker sees to the approximate time it takes to bring up the talker's traffic channel. FIG. **17** shows MCU-Side buffering according to one embodiment, as described below:

(1) No call in progress, originator and target's traffic channels are dormant.

(2) Users presses the PTT button. Server receives a "setup group call" request from the client.

(3) Floor is granted to the user after the client receives "setup in progress" response from the server or after a configurable delay (1 second) and begins buffering user media.

(4) Server begins process of re-establishing packet data traffic channels of the targets.

(5) Server sends "group call announcement" message to the client via SDB.

(6) Client successfully re-establishes traffic channel, starts sending buffered media to the server.

(7) Client streams media to the server.

(8) Targets' traffic channels have been re-established ("target response threshold" is met).

(9) User releases the PTT button. Client stops buffering media.

(10) Client finishes streaming buffered media to server, requests release of the floor by the server.

(11) Server sends floor release acknowledgement to the client.

Client-Side Buffering

In one embodiment, where a shorter apparent latency is desired, the talker may be allowed to begin speaking before even his traffic channel is re-established. Because the client MS is not yet in communication with the MCU, the signal to the talker to begin talking is made by the client MS. If the talker is allowed to speak before the talker's traffic channel is re-established, the client MS may buffer **412** the speech. Because communication with the CM has not yet been established, permission to talk is being given "optimistically." FIG. **18** shows client-side buffering according to one embodiment, as described below:

(1) No call in progress, originator's traffic channel is dormant.

(2) User presses the PTT button. Client sends a "setup group call" request to server via SDB.

(3) Client begins process of re-establishing a packet data traffic channel.

(4) Floor is granted to the user after the client receives "setup in progress" response from the server or after a configurable delay (1 second) and begins buffering user media.

(5) Client receives "group call announcement" message from the server via SDB.

(6) Client successfully re-establishes traffic channel.

(7) Client streams buffered media to server.

(8) User releases the PTT button. Client stops buffering media.

(9) Client finishes streaming buffered media to server, requests release of the floor by the server.

(10) Client receives acknowledgement of floor release from the server.

In one embodiment, both MCU buffering **418** and client-side buffering **412** may operate concurrently. Client-side buffering may allow the apparent PTT latency to be small. In one embodiment, the client MS may buffer media to control the apparent PTT latency experienced by the user. The combination of mobile-originated SDB and client-side media buffering may reduce the delays associated with re-establishing active traffic channels.

Therefore, the disclosed embodiments provide for a dispatch model that supports at least two types of dispatch calls: the chat-room model and the ad-hoc model. In the chat-room model, the groups are pre-defined, which may be stored on the dispatch server. In the ad-hoc model, however, the groups may be defined and/or modified in real-time.

The disclosed embodiments also provides for a significant reduction in the actual total dormancy wakeup time and the PTT latency by exchanging group call signaling even when

mobiles are dormant and no traffic channel is active. The method and apparatus provides for exchanging the group call signaling through the use of the short data burst (SDB) message signaling. The method and apparatus provides for re-establishing dedicated traffic channels for the talker mobile and the dormant listener mobiles advantageously in parallel.

In another embodiment, the dormant-wakeup latency in a group communication network may be reduced through caching the network-initiated wakeup triggers destined for target listeners, and delivering a wakeup trigger to a target mobile station as soon as the target mobile station has re-established its traffic channel.

In another embodiment, simultaneous service origination and paging in a mobile operating in a group communication network is avoided by transmitting a response to a floor-control request after the service origination process is complete. In one embodiment, the response to the floor-control request may be in SDB form if the service origination process is not complete. In another embodiment, the service origination process for the source communication device is initiated after transmitting the response to the source communication device.

What is claimed is:

1. A method for adding a new member to an active group call in a group communication network, the method comprising:

receiving a request for adding a member list to an active group call; and

adding the member list to the active group call;

announcing the group call to each member in the member list and wherein the announcing includes transmitting a message on a forward common channel of a wireless network;

receiving acknowledgment from a member in the member list who wishes to participate in the group call; and

forwarding media to the member.

2. The method of claim **1**, further including triggering the member to re-establish its traffic channel before said forwarding the media.

3. The method of claim **2**, further including buffering media for transmission to the member after its traffic channel is re-established.

4. The method of claim **1**, wherein the transmitting includes transmitting the message on a forward paging channel (F-PCH) of the wireless network.

5. The method of claim **1**, wherein the transmitting includes transmitting the message on a forward common control channel (F-CCCH) of the wireless network.

6. The method of claim **1**, wherein the transmitting includes transmitting the message in short data burst (SDB) form.

7. A computer-readable medium embodying a method for adding a new member to an active group call in a group communication network, the method comprising:

receiving a request for adding a member list to an active group call; and

adding the member list to the active group call;

announcing the group call to each member in the member list and wherein the announcing includes transmitting a message on a forward common channel of a wireless network;

receiving acknowledgement from a member in the member list who wishes to participate in the group call; and

forwarding media to the member.

8. The computer-readable medium of claim **7**, further including triggering the member to re-establish its traffic channel.

9. The computer-readable medium of claim **8**, wherein the method further includes buffering media for transmission to the member after its traffic channel is re-established.

10. The computer-readable medium of claim **7**, wherein the transmitting includes transmitting the message on a forward paging channel (F-PCH) of the wireless network.

11. The computer-readable medium of claim **7**, wherein the transmitting includes transmitting the message on a forward common control channel (F-CCCH) of the wireless network.

12. The computer-readable medium of claim **7**, wherein the transmitting includes transmitting the message in short data burst (SDB) form.

13. An apparatus for adding a new member to an active group call in a group communication network, comprising:

means for receiving a request for adding a member list to an active group call; and

means for adding the member list to the active group call; announcing the group call to each member in the member list and wherein the announcing includes transmitting a message on a forward common channel of a wireless network;

receiving acknowledgment from a member in the member list who wishes to participate in the group call; and

forwarding media to the member.

14. The apparatus of claim **13**, further including means for triggering the member to re-establish its traffic channel.

15. The apparatus of claim **14**, further including means for buffering media for transmission to the member after its traffic channel is re-established.

16. The apparatus of claim **13**, wherein the means for transmitting includes means for transmitting the message on a forward paging channel (F-PCH) of the wireless network.

17. The apparatus of claim **13**, wherein the means for transmitting includes means for transmitting the message on a forward common control channel (F-CCCH) of the wireless network.

18. The apparatus of claim **13**, wherein the means for transmitting includes means for transmitting the message in short data burst (SDB) form.

19. An apparatus for adding a new member to an active group call in a group communication network, comprising:

a receiver;

a transmitter; and

a processor communicatively coupled to the receiver and the transmitter, the processor being capable of:

receiving a request for adding a member list to an active group call; and

adding the member list to the active group call wherein the processor is further capable of announcing the group call to each member in the member list and wherein the announcing includes transmitting a message on a forward common channel of a wireless network;

receiving acknowledgment from a member who wishes to participate in the group call; and

forwarding media to the member.

20. The apparatus of claim **19**, further including triggering the member to re-establish its traffic channel.

21. The apparatus of claim **20**, wherein the processor is further capable of buffering media for transmission to the member after its traffic channel is re-established.

22. The apparatus of claim 21, wherein the announcing includes transmitting a message on a forward common channel of a wireless network.

23. The apparatus of claim 22, wherein the transmitting includes transmitting the message on a forward paging channel (F-PCH) of the wireless network.

24. The apparatus of claim 22 wherein the transmitting includes transmitting the message on a forward common control channel (F-CCCH) of the wireless network.

25. The apparatus of claim 22, wherein the transmitting includes transmitting the message in short data burst (SDB) form.

26. An apparatus for adding a new member to an active group call in a group communication network, the server comprising:

a dispatcher that receives a request for adding a new member to an active group call based on a member list; wherein the dispatcher determines location information for each member in the member list; and

a controller that announces the group call based on the member list, wherein the controller includes a local controller for a member that is located within a local region.

27. The apparatus of claim 26, wherein the controller includes a remote controller for a member that is located outside a local region.

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