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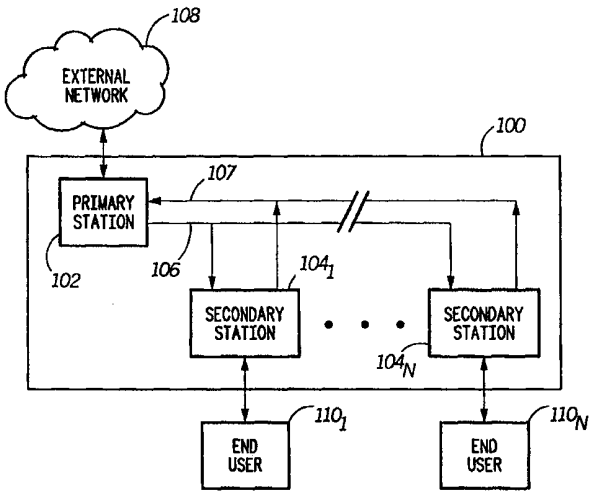


(57) Abstract

A system (100), device, and method for registration in a communication network informs a secondary station (104) of an acceptable alternate channel when a selected channel is unacceptable. Specifically, upon receiving an initial registration request message, a primary station (102) determines an alternate shared channel that is acceptable, and rejects the registration request by sending a registration response message indicating the alternate shared channel. Upon receiving the registration response message indicating the alternate shared channel, the secondary station switches immediately to the alternate shared channel and completes the registration on the alternate shared channel by transmitting another registration request message that is accepted by the primary station in due course.

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# SYSTEM, DEVICE, AND METHOD FOR REGISTRATION IN A COMMUNICATION NETWORK

## *Background*

1. Field of the Invention

The invention relates generally to communication systems, and more particularly to registering communication devices in a communication network.

2. Discussion of Related Art

In today's information age, there is an increasing need for high-speed communication networks that provide Internet access and other on-line services for an ever-increasing number of communications consumers. To that end, communications networks and technologies are evolving to meet current and future demands. Specifically, new networks are being deployed which reach a larger number of end users, and protocols are being developed to utilize the added bandwidth of these networks efficiently.

One technology that has been widely employed and will remain important in the foreseeable future is the shared medium communication network. A shared medium communication network is one in which a single communications channel (the shared channel) is shared by a number of users such that uncoordinated transmissions from different users may interfere with one another. The shared medium communication network typically includes a number of secondary stations that transmit on the shared channel, and a single primary station situated at a common receiving end of the shared channel for receiving the secondary station transmissions. Since communication networks typically have a limited number of communication channels, the shared medium communication network allows many users to gain access to the network over a single communication channel, thereby allowing the remaining communication channels to be used for other purposes.

When a secondary station connects to the shared medium communication network or otherwise attempts to establish a connection in the shared medium communication network, the primary station must identify and register the secondary station. Registration typically involves the secondary station selecting a shared channel from among a plurality of channels and transmitting a

registration request message to the primary station by means of the selected shared channel, and the primary station subsequently accepting the registration request. It is desirable for the registration process to be completed as quickly as possible.

Although the secondary station has no way of knowing *a priori*, the selected shared channel may or may not be acceptable to the primary station. The shared channel may be unacceptable, for example, if the selected shared channel is overloaded or otherwise unable to provide the required bandwidth and other operating requirements for the secondary station. Therefore, upon receiving the registration request message on the selected shared channel, the primary station determines whether the selected shared channel is acceptable or unacceptable. If the selected shared channel is acceptable, then the primary station accepts the registration request by sending an appropriate registration response message to the secondary station. However, if the selected shared channel is unacceptable, then the primary station can either accept or reject the registration request by sending an appropriate registration response message to the secondary station. If the primary station accepts the registration request, then the primary station subsequently determines an alternate shared channel and moves the secondary station to the alternate shared channel by means of an additional exchange of messages. If the primary station rejects the registration request, then the secondary station repeats the process of finding another shared channel and transmitting a registration request message until the primary station accepts a registration request. In either case, the registration process is unnecessarily complicated and overly time consuming.

Thus, an improved registration process that is both simplified and efficient is needed.

## *Brief Description of the Drawing*

In the Drawing,

FIG. 1 is a block diagram showing an exemplary shared medium communication network in accordance with a preferred embodiment of the present invention;

FIG. 2 is a block diagram showing an exemplary primary station in accordance with a preferred embodiment of the present invention;

FIG. 3 is a block diagram showing an exemplary secondary station in accordance with a preferred embodiment of the present invention;

FIG. 4 is a logic flow diagram showing exemplary secondary station logic in accordance with a preferred embodiment of the present invention;

FIG. 5 is a logic flow diagram showing exemplary primary station logic in accordance with a preferred embodiment of the present invention;

FIG. 6 is a block diagram showing the format of a standard registration response message in accordance with the Multimedia Cable Network System (MCNS) protocol;

FIG. 7A is a block diagram showing the format of an exemplary registration response message in accordance with a preferred embodiment of the present invention;

FIG. 7B is a block diagram showing the format of an exemplary Vendor-Specific Data information element in accordance with a preferred embodiment of the present invention;

FIG. 8 is a block diagram showing the format of an exemplary registration response message in accordance with a first alternative embodiment of the present invention;

FIG. 9 is a block diagram showing the format of an exemplary registration response message in accordance with a second alternative embodiment of the present invention; and

FIG. 10 is a logic flow diagram showing exemplary secondary station logic in accordance with a preferred embodiment of the present invention.

## *Detailed Description*

As discussed above, an improved registration process that is both simplified and efficient is needed. The present invention provides such an improved registration process by informing the secondary station of an acceptable alternate shared channel when the selected shared channel is unacceptable. This allows the secondary station to switch directly to the acceptable alternate shared channel without having to repeat the registration process on multiple shared channels.

Specifically, upon receiving the initial registration request message on the unacceptable selected shared channel, the primary station determines an alternate shared channel that is acceptable, and rejects the registration request by sending a registration response message indicating the alternate shared channel. Upon receiving the registration response message indicating the alternate shared

channel, the secondary station switches immediately to the alternate shared channel and completes the registration on the alternate shared channel by transmitting another registration request message that is accepted by the primary station in due course. The registration process in accordance with the present invention is simplified, since the primary station rejects the initial registration request rather than accepting the initial registration request and taking the additional step of subsequently moving the secondary station to the alternate shared channel. Furthermore, the registration process in accordance with the present invention is efficient, since the secondary station moves immediately to the alternate shared channel without having to potentially search through multiple shared channels before finding one that is acceptable. Specific features and advantages of the present invention are described herein with reference to a various exemplary embodiments.

FIG. 1 shows a shared medium communication network 100 in accordance with a preferred embodiment of the present invention. The shared medium communication network 100 allows a number of end users $110_1$ through $110_N$ to access a remote external network 108 such as the Internet. The shared medium communication network 100 acts as a conduit for transporting information between the end users 110 and the external network 108.

The shared medium communication network 100 includes a primary station 102 that is coupled to the external network 108. The primary station 102 is in communication with a plurality of secondary stations $104_1$ through $104_N$ (collectively referred to as "secondary stations 104" and individually as a "secondary station 104") by means of channels 106 and 107. Channel 106 carries information in a "downstream" direction from the primary station 102 to the secondary stations 104, and is hereinafter referred to as "downstream channel 106." Channel 107 carries information in an "upstream" direction from the secondary stations 104 to the primary station 102, and is hereinafter referred to as "upstream channel 107." Each end user 110 interfaces to the shared medium communication network 100 by means of a secondary station 104.

In a preferred embodiment, the shared medium communication network 100 is a data-over-cable (DOC) communication system wherein the downstream channel 106 and the upstream channel 107 are separate channels carried over a shared physical medium. In the preferred embodiment, the shared physical medium is a hybrid fiber-optic and coaxial cable (HFC) network. The downstream channel 106 is one of a plurality of downstream channels carried over the HFC network. The upstream channel 107 is one of a plurality of upstream channels

carried over the HFC network. In other embodiments, the shared physical medium may be coaxial cable, fiber-optic cable, twisted pair wires, and so on, and may also include air, atmosphere, or space for wireless and satellite communication. Also, the various upstream and downstream channels may be the same physical channel, for example, through time-division multiplexing/duplexing, or separate physical channels, for example, through frequency-division multiplexing/duplexing.

In the shared medium communication network 100 of the preferred embodiment, the downstream channels, including the downstream channel 106, are typically situated in a frequency band above approximately 50 MHz, although the particular frequency band may vary from system to system, and is often country-dependent. The downstream channels are classified as broadcast channels, since any information transmitted by the primary station 102 over a particular downstream channel, such as the downstream channel 106, reaches all of the secondary stations 104. Any of the secondary stations 104 that are tuned to receive on the particular downstream channel can receive the information.

In the shared medium communication network 100 of a preferred embodiment, the upstream channels, including the upstream channel 107, are typically situated in a frequency band between approximately 5 through 42 MHz, although the particular frequency band may vary from system to system, and is often country-dependent. The upstream channels are classified as shared channels, since only one secondary station 104 can successfully transmit on a particular upstream channel at any given time, and therefore the upstream channels must be shared among the plurality of secondary stations 104. If more than one of the secondary stations 104 simultaneously transmit on a particular upstream channel, such as the upstream channel 107, there is a collision that corrupts the information from all of the simultaneously transmitting secondary stations 104.

In order to allow multiple secondary stations 104 to share a particular upstream channel, such as the upstream channel 107, the primary station 102 and the secondary station 104 participate in a medium access control (MAC) protocol. The MAC protocol provides a set of rules and procedures for coordinating access by the secondary station 104 to the shared upstream channel 107. Each secondary station 104 participates in the MAC protocol on behalf of its end users. For convenience, each participant in the MAC protocol is referred to as a "MAC User."

In a preferred embodiment, the MAC protocol includes a protocol commonly referred to as Multimedia Cable Network System (MCNS), which is defined in the document entitled MCNS Data-Over-Cable Service Interface Specifications Radio Frequency Interface Specification SP-RFI-I02-971008 Interim Specification (hereinafter referred to as the "MCNS Protocol Specification"), incorporated herein by reference in its entirety. In the preferred embodiment, the MAC protocol divides the upstream channel 107 into successive time slots. The MAC protocol supports a plurality of slot types for carrying different types of information. Each time slot is capable of transporting a unit of information (for example, a data packet or a control packet). The primary station 102 assigns each time slot to a particular MAC User or group of MAC Users. A MAC User that has data to transmit is permitted to transmit only in time slots designated by the primary station 102. A MAC User transmission must begin and end within a designated time slot to avoid corrupting transmissions by other MAC Users in other time slots.

FIG. 2 is a block diagram showing an exemplary primary station 102 in accordance with a preferred embodiment of the present invention. In the preferred embodiment, the primary station 102 includes a number of functional modules implemented on individual cards that fit within a common chassis. In order to enable communication within the shared medium communication network 100, the primary station 102 requires at least a minimum set of functional modules. Specifically, the minimum set of functional modules comprises an Adapter Module 210, a MAC Module 220, a Transmitter Module 240, and a Receiver Module 230. In the preferred embodiment, the minimum set of functional modules allows the primary station 102 to support a single downstream channel and up to eight upstream channels. For the sake of convenience and simplicity, the exemplary embodiments described below refer to the single upstream channel 107, although it will be apparent to a skilled artisan that multiple upstream channels are supportable in a similar manner.

The Adapter Module 210 controls the flow of data and control messages between the primary station 102 and the secondary stations 104. The Adapter Module 210 includes Control Logic 218 that is coupled to a Memory 212. The Control Logic 218 includes, among other things, logic for processing data and control (e.g., registration request) messages received from the secondary stations 104, and logic for generating data and control (e.g., registration response) messages for transmission to the secondary stations 104. The Memory 212 is divided into a Dedicated Memory 216 that is used only by the Control Logic 218,

and a Shared Memory 214 that is shared by the Control Logic 218 and MAC Logic 224 (described below) for exchanging data and control messages.

The Control Logic 218 and the MAC Logic 224 exchange data and control messages using three ring structures (not shown) in the Shared Memory 214. Data and control (e.g., registration request) messages received from the secondary station 104 are stored by the MAC Logic 224 in a Receive Queue in the Shared Memory 224. Control (e.g., registration response) messages generated by the Control Logic 218 are stored by the Control Logic 218 in a MAC Transmit Queue in the Shared Memory 214. Data messages for transmission to the secondary station 104 are stored by the Control Logic 218 in a Data Transmit Queue in the Shared Memory 214. The Control Logic 218 monitors the Receive Queue to obtain data and control (e.g., registration request) messages. The MAC Logic 224 monitors the MAC Transmit Queue to obtain control (e.g., registration response) messages, and monitors the Data Transmit Queue to obtain data messages.

The MAC Module 220 implements MAC functions within the primary station 102. The MAC Module 220 includes MAC Logic 224 that is coupled to a Local Memory 222 and to the Shared Memory 214 by means of interface 250. The MAC Logic 224 monitors the MAC Transmit Queue and the Data Transmit Queue in the Shared Memory 214. The MAC Logic 224 transmits any queued data and control (e.g., registration response) messages to Encoder/Modulator 241 of Transmitter Module 240 by means of interface 253. The MAC Logic 224 also processes data and control messages received from the Receiver Module 230 by means of interface 255. The MAC Logic 224 stores the received data and control messages in the Receive Queue in the Shared Memory 214 by means of interface 250.

The Transmitter Module 240 provides an interface to the downstream channel 106 for transmitting data and control (e.g., registration response) messages to the secondary stations 104. The Transmitter Module 240 includes a Transmitter Front End 242 that is operably coupled to the downstream channel 106 and an Encoder/Modulator 241. The Encoder/Modulator 241 includes logic for processing data and control (e.g., registration response) messages received from the MAC Logic 224 by means of interface 253. More specifically, the Encoder/Modulator 241 includes encoding logic for encoding the data and control (e.g., registration response) messages according to a predetermined set of encoding parameters, and modulating logic for modulating the encoded data and control (e.g., registration response) messages according to a predetermined

modulation mode. The Transmitter Front End 242 includes logic for transmitting the modulated signals from the Encoder/Modulator 241 onto the downstream channel 106. More specifically, the Transmitter Front End 242 includes tuning logic for tuning to a downstream channel 106 center frequency, and filtering logic for filtering the transmitted modulated signals. Both the Encoder/Modulator 241 and the Transmitter Front End 242 include adjustable parameters, including downstream channel center frequency for the Transmitter Front End 242, and modulation mode, modulation symbol rate, and encoding parameters for the Encoder/Modulator 241.

The Receiver Module 230 provides an interface to the upstream channel 107 for receiving, among other things, data and control (e.g., registration request) messages from the secondary stations 104. The Receiver Module 230 includes a Receiver Front End 232 that is operably coupled to the upstream channel 107 and to a Demodulator/Decoder 231. The Receiver Front End 232 includes logic for receiving modulated signals from the upstream channel 107. More specifically, the Receiver Front End 232 includes tuning logic for tuning to an upstream channel 107 center frequency, and filtering logic for filtering the received modulated signals. The Demodulator/Decoder 231 includes logic for processing the filtered modulated signals received from the Receiver Front End 232. More specifically, the Demodulator/Decoder 231 includes demodulating logic for demodulating the modulated signals according to a predetermined modulation mode, and decoding logic for decoding the demodulated signals according to a predetermined set of decoding parameters to recover data and control (e.g., registration request) messages from the secondary station 104. Both the Receiver Front End 232 and the Demodulator/Decoder 231 include adjustable parameters, including upstream channel center frequency for the Receiver Front End 232, and modulation mode, modulation symbol rate, modulation preamble sequence, and decoding parameters for the Demodulator/Decoder 231.

In the preferred embodiment, the primary station 102 includes a configuration interface 254 through which the adjustable parameters on both the Receiver Module 230 and the Transmitter Module 240 are configured. The configuration interface 254 operably couples the MAC Logic 224 to the Demodulator/Decoder 231, the Receiver Front End 232, the Encoder/Modulator 241, and the Transmitter Front End 242. The configuration interface 254 is preferably a Serial Peripheral Interface (SPI) bus as is known in the art.

FIG. 3 is a block diagram showing an exemplary secondary station 104 in accordance with a preferred embodiment of the present invention. The secondary

station 104 includes a User Interface 310 for interfacing with the End User 110. Data transmitted by the End User 110 is received by the User Interface 310 and stored in a Memory 308. The secondary station 104 also includes a Control Message Processor 304 that is coupled to the Memory 308. The Control Message Processor 304 participates as a MAC User in the MAC protocol on behalf of the End User 110. Specifically, the Control Message Processor 304 transmits data and control (e.g., registration request) messages to the primary station 102 by means of Transmitter 302, which is operably coupled to transmit data and control (e.g., registration request) messages on the upstream channel 107. The Control Message Processor 304 also processes data and control (e.g., registration response) messages received from the primary station 102 by means of Receiver 306, which is operably coupled to receive data and control (e.g., registration response) messages on the downstream channel 106.

FIG. 4 is a logic flow diagram showing exemplary secondary station logic in accordance with a preferred embodiment of the present invention. The logic begins in step 402, and proceeds to select an upstream channel, in step 404. After completing a ranging process on the selected upstream channel in accordance with the MAC protocol, the logic transmits an initial registration request message to the primary station 102 on the selected upstream channel, in step 406. Assuming the selected upstream channel is unacceptable to the primary station 102, the logic receives a registration response message from the primary station 102 rejecting the initial registration request and identifying an alternate upstream channel, in step 408. Upon receiving such a registration response message, the logic switches to the alternate upstream channel in step 410, and after completing the ranging process on the alternate upstream channel, transmits a second registration request message to the primary station 102 on the alternate upstream channel in step 412. The logic receives a registration response message from the primary station 102 accepting the second registration request, in step 414. The logic terminates in step 499.

FIG. 5 is a logic flow diagram showing exemplary primary station logic in accordance with a preferred embodiment of the present invention. The logic begins in step 502, and upon receiving an initial registration request message from the secondary station 104 on a selected upstream channel in step 504, proceeds to determine whether the selected upstream channel is acceptable or unacceptable, in step 506. If the selected upstream channel is acceptable (ACCEPTABLE in step 508), then the logic transmits a registration response message to the secondary station 104 accepting the initial registration request on

the selected upstream channel, in step 510. However, if the selected upstream channel is unacceptable (UNACCEPTABLE in step 508), then the logic determines an alternate upstream channel, in step 512, and transmits a registration response message to the secondary station 104 rejecting the initial registration request and identifying the alternate upstream channel, in step 514. The logic subsequently receives a second registration request message from the secondary station 104 on the alternate upstream channel, in step 516, and transmits a registration response message to the secondary station 104 accepting the second registration request on the alternate upstream channel. The logic terminates in step 599.

In the MCNS protocol as specified in MCNS Protocol Specification, the registration response message does not include a field or other means for identifying the alternate upstream channel. The format of a standard registration response message 600 in accordance with the MCNS protocol is shown in FIG. 6. The standard registration response message 600 includes a MAC Management Message Header 602, a Service Identifier (SID) 604, a Response 606, and a number of Information Elements (IEs) 608. The Response 606 indicates whether the registration request was accepted or rejected, and if rejected, whether the rejection was due to an authentication failure or a class-of-service failure. The IEs 608 carry additional information from the primary station 102 to the secondary station 104. Each IE includes a single-octet Type field uniquely identifying the type of information carried in the IE, a single-octet Length field indicating the number of octets in the IE (excluding the Type and Length fields), and a Value field for carrying up to 254 octets of data. In the MCNS Protocol Specification, the IEs are referred to as "TLV Encoded Information."

The MCNS Protocol Specification defines a number of IEs that can be included in the registration response message. Specifically, the registration response message can include a Modem Capabilities IE, a Service Class Data IE, a Service Not Available IE, and a Vendor-Specific Data IE. The information carried by the Modem Capabilities, Service Class Data, and Service Not Available IEs is specified in the MCNS Protocol Specification. Information carried by the Vendor-Specific Data IE is not specified in the MCNS Protocol Specification, and is available for each vendor to define independently.

In a preferred embodiment, the alternate upstream channel identifier is carried in a Vendor-Specific Data IE included in the registration response message. As shown in FIG. 7A, an exemplary registration response message 700 in accordance with the preferred embodiment of the present invention

includes standard MAC Management Message Header 602, SID 604, Response 606 indicating a class of service failure, Modem Capabilities IE 702, and Service Not Available IE 704. The registration response message 700 also includes a Vendor-Specific Data IE 706, such as the exemplary Vendor-Specific Data IE shown in FIG. 7B, which includes the alternate upstream channel identifier. The preferred embodiment is practicable within the existing MCNS protocol framework without requiring any changes to the MCNS Protocol Specification. Furthermore, the preferred embodiment is practicable by a single vendor to the exclusion of other vendors, so the improved registration process in accordance with the preferred embodiment differentiates the vendor's products from those of the other vendors.

In a first alternative embodiment, the alternate upstream channel identifier is carried in one of the IEs presently included in the registration response message. Specifically, one of the IEs, such as the Service Not Available IE, is redefined to include the alternate upstream channel identifier. As shown in FIG. 8, an exemplary registration response message 800 in accordance with the first alternative embodiment of the present invention includes standard MAC Management Message Header 602, SID 604, Response 606 indicating a class of service failure, and Modem Capabilities IE 702. The registration response message 800 also includes a modified Service Not Available IE 802 that includes the alternate upstream channel identifier. For this first alternative embodiment to be practicable within the MCNS protocol framework, the MCNS Protocol Specification must be modified to redefine the Service Not Available IE (or another IE) for carrying the alternate upstream channel identifier.

In a second alternative embodiment, the alternate upstream channel identifier is carried in an IE other than one of the IEs presently included in the registration response message. Specifically, the registration response message is redefined to include another IE, such as an Upstream Channel ID IE as defined in the MCNS Protocol Specification or a new IE defined specifically for carrying the alternate upstream channel identifier. As shown in FIG. 9, an exemplary registration response message 900 in accordance with the second alternative embodiment of the present invention includes standard MAC Management Message Header 602, SID 604, Response 606 indicating a class of service failure, Modem Capabilities IE 702, and Service Not Available IE 704. The registration response message 900 also includes an IE 902, such as an Upstream Channel ID IE as defined in the MCNS Protocol Specification or a new IE defined specifically for carrying the alternate upstream channel identifier, that includes the

alternate upstream channel identifier. For this second alternative embodiment to be practicable within the MCNS protocol framework, the MCNS Protocol Specification must be modified to redefine the registration response message format and, if necessary, define a new IE for carrying the alternate upstream channel identifier.

In order to maintain backward compatibility with existing primary stations, the secondary station 104 must be able to distinguish a standard registration response message that does not include an alternate upstream channel identifier from a registration response message that includes an alternate upstream channel identifier, and react accordingly. FIG. 10 is a logic flow diagram 1000 showing exemplary secondary station 102 logic in accordance with a preferred embodiment of the present invention. The logic begins in step 1002, and proceeds to select an upstream channel, in step 1004. After completing the ranging process on the selected upstream channel, the logic transmits an initial registration request message to the primary station 102 on the selected upstream channel, in step 1006. Assuming the selected upstream channel is unacceptable to the primary station 102, the logic may receive a registration response message from the primary station 102 rejecting the initial registration request, in step 1008. Upon receiving such a registration response message, the logic determines whether the registration response message includes an alternate upstream channel identifier, in step 1010. If the registration response message includes an alternate upstream channel identifier (YES in step 1012), then the logic switches to the alternate upstream channel in step 1014, and after completing the ranging process on the alternate upstream channel, transmits a second registration request message to the primary station 102 on the alternate upstream channel in step 1018. If the registration response message does not include an alternate upstream channel identifier (NO in step 1012), then the logic selects an alternate upstream channel in step 1016, and after completing the ranging process on the selected alternate upstream channel, transmits a second registration request message to the primary station 102 on the selected alternate upstream channel in step 1018. The logic terminates in step 1099.

All logic described herein can be embodied using discrete components, integrated circuitry, programmable logic used in conjunction with a programmable logic device such as a Field Programmable Gate Array (FPGA) or microprocessor, or any other means including any combination thereof. Programmable logic can be fixed temporarily or permanently in a tangible medium such as a read-only memory chip, a computer memory, a disk, or other storage medium.

Programmable logic can also be fixed in a computer data signal embodied in a carrier wave, allowing the programmable logic to be transmitted over an interface such as a computer bus or communication network. All such embodiments are intended to fall within the scope of the present invention.

Thus, the present invention comprises various embodiments including, but not limited to, the secondary station 104 including secondary station logic 400 and 1000, the primary station 102 including primary station logic 500, the shared medium communication network 100 including a primary station 102 and at least one secondary station 104 in accordance with the present invention, and registration response messages 700, 800, and 900 including the alternate upstream channel identifier.

In accordance with the present invention, the secondary station 104 can be embodied as a method, device, computer readable medium, or data signal enabling the secondary station 104 to select an upstream channel, transmit a first registration request message on the selected upstream channel, receive a first registration response message rejecting the first registration request and identifying an alternate upstream channel, switch to the alternate upstream channel, and transmit a second registration request message on the alternate upstream channel.

In accordance with the present invention, the primary station 102 can be embodied as a method, device, computer readable medium, or data signal enabling the primary station 102 to receive a first registration request message on a selected upstream channel, determine that the selected upstream channel is unacceptable according to predetermined criteria, determine an alternate upstream channel, transmit a first registration response message rejecting the first registration request and identifying the alternate upstream channel, receive a second registration request message on the alternate upstream channel, and transmit a second registration response message accepting the second registration request on the alternate upstream channel.

In accordance with the present invention, the shared medium communication network 100 can be embodied as a method or system including a primary station in communication with at least one secondary station for selecting, by the secondary station, an upstream channel; transmitting, by the secondary station to the primary station, a first registration request message on the selected upstream channel; receiving, by the primary station, the first registration request message on the selected upstream channel; determining, by the primary station, that the selected upstream channel is unacceptable according to predetermined

criteria; determining, by the primary station, an alternate upstream channel; transmitting, by the primary station to the secondary station, a first registration response message rejecting the first registration request and identifying the alternate upstream channel; receiving, by the secondary station, the first registration response message rejecting the first registration request and identifying the alternate upstream channel; switching, by the secondary station, to the alternate upstream channel; transmitting, by the secondary station to the primary station, a second registration request message on the alternate upstream channel; receiving, by the primary station, the second registration request message on the alternate upstream channel; and transmitting, by the primary station to the secondary station, a second registration response message accepting the second registration request on the alternate upstream channel.

In accordance with the present invention, the registration response message (700, 800, 900) for use in a Multimedia Cable Network System (MCNS) protocol includes an alternate upstream channel identifier identifying an alternate upstream channel for registration, wherein the alternate upstream channel identifier is included in a vendor-specific data information element, a Modem Capabilities information element, a Service Class Data information element, a Service Not Available information element, an Upstream Channel ID information element, or any other existing or new information element included in the registration response message.

The present invention may be embodied in other specific forms without departing from the essence or essential characteristics. The described embodiments are to be considered in all respects only as illustrative and not restrictive.

I claim:

1. A method for registering a secondary station in a communication network, the method comprising the steps of:

selecting an upstream channel;

transmitting a first registration request message on the selected upstream channel;

receiving a first registration response message rejecting the first registration request and identifying an alternate upstream channel;

switching to the alternate upstream channel; and

transmitting a second registration request message on the alternate upstream channel.

2. A device comprising:

selecting logic operably coupled to select an upstream channel from among a plurality of upstream channels;

first transmitting logic operably coupled to transmit a first registration request message on the selected upstream channel;

receiving logic operably coupled to receive a first registration response message rejecting the first registration request and identifying an alternate upstream channel;

switching logic operably coupled to switch to the alternate upstream channel; and

second transmitting logic operably coupled to transmit a second registration request message on the alternate upstream channel.

3. The device of claim 2 comprising:

means for selecting an upstream channel;

means for transmitting a first registration request message on the selected upstream channel;

means for receiving a first registration response message rejecting the first registration request and identifying an alternate upstream channel;

means for switching to the alternate upstream channel; and

means for transmitting a second registration request message on the alternate upstream channel.

4. An apparatus comprising a computer usable medium having embodied therein a computer readable program for registering a secondary station in a communication network, the computer readable program comprising computer readable program instructions enabling a computer to perform the steps of:

selecting an upstream channel;

transmitting a first registration request message on the selected upstream channel;

receiving a first registration response message rejecting the first registration request and identifying an alternate upstream channel;

switching to the alternate upstream channel; and

transmitting a second registration request message on the alternate upstream channel.

5. The apparatus of claim 4 wherein the computer readable program comprises:

computer readable program code means for selecting an upstream channel;

computer readable program code means for transmitting a first registration request message on the selected upstream channel;

computer readable program code means for receiving a first registration response message rejecting the first registration request and identifying an alternate upstream channel;

computer readable program code means for switching to the alternate upstream channel; and

computer readable program code means for transmitting a second registration request message on the alternate upstream channel.

6. A data signal embodied in a carrier wave, wherein embodied in the data signal is a computer readable program for registering a secondary station in a communication network, the computer readable program comprising computer readable program instructions enabling a computer to perform the steps of:

selecting an upstream channel;

transmitting a first registration request message on the selected upstream channel;

receiving a first registration response message rejecting the first registration request and identifying an alternate upstream channel;

switching to the alternate upstream channel; and

transmitting a second registration request message on the alternate upstream channel.

7. The data signal of claim 6 wherein the computer readable program comprises:

computer readable program code means for selecting an upstream channel;

computer readable program code means for transmitting a first registration request message on the selected upstream channel;

computer readable program code means for receiving a first registration response message rejecting the first registration request and identifying an alternate upstream channel;

computer readable program code means for switching to the alternate upstream channel; and

computer readable program code means for transmitting a second registration request message on the alternate upstream channel.

8. A method for registering a secondary station in a communication network, the method comprising the steps of:

receiving a first registration request message on a selected upstream channel;

determining that the selected upstream channel is unacceptable according to predetermined criteria;

determining an alternate upstream channel;

transmitting a first registration response message rejecting the first registration request and identifying the alternate upstream channel;

receiving a second registration request message on the alternate upstream channel; and

transmitting a second registration response message accepting the second registration request on the alternate upstream channel.

9. A device comprising:

first receiving logic operably coupled to receive a first registration request message on a selected upstream channel;

first determining logic operably coupled to determine that the selected upstream channel is unacceptable according to predetermined criteria;

second determining logic operably coupled to determine an alternate upstream channel from among a plurality of upstream channels;

first transmitting logic operably coupled to transmit a first registration response message rejecting the first registration request and identifying the alternate upstream channel;

second receiving logic operably coupled to receive a second registration request message on the alternate upstream channel; and

second transmitting logic operably coupled to transmit a second registration response message accepting the second registration request on the alternate upstream channel.

10. The device of claim 9 comprising:

means for receiving a first registration request message on a selected upstream channel;

means for determining that the selected upstream channel is unacceptable according to predetermined criteria;

means for determining an alternate upstream channel;

means for transmitting a first registration response message rejecting the first registration request and identifying the alternate upstream channel;

means for receiving a second registration request message on the alternate upstream channel; and

means for transmitting a second registration response message accepting the second registration request on the alternate upstream channel.

11. An apparatus comprising a computer usable medium having embodied therein a computer readable program for registering a secondary station in a communication network, the computer readable program comprising computer readable program instructions enabling a computer to perform the steps of:

receiving a first registration request message on a selected upstream channel;

determining that the selected upstream channel is unacceptable according to predetermined criteria;

determining an alternate upstream channel;

transmitting a first registration response message rejecting the first registration request and identifying the alternate upstream channel;

receiving a second registration request message on the alternate upstream channel; and

transmitting a second registration response message accepting the second registration request on the alternate upstream channel.

12. The apparatus of claim 11 wherein the computer readable program comprises:

computer readable program code means for receiving a first registration request message on a selected upstream channel;

computer readable program code means for determining that the selected upstream channel is unacceptable according to predetermined criteria;

computer readable program code means for determining an alternate upstream channel;

computer readable program code means for transmitting a first registration response message rejecting the first registration request and identifying the alternate upstream channel;

computer readable program code means for receiving a second registration request message on the alternate upstream channel; and

computer readable program code means for transmitting a second registration response message accepting the second registration request on the alternate upstream channel.

13. A data signal embodied in a carrier wave, wherein embodied in the data signal is a computer readable program for registering a secondary station in a communication network, the computer readable program comprising computer readable program instructions enabling a computer to perform the steps of:

receiving a first registration request message on a selected upstream channel;

determining that the selected upstream channel is unacceptable according to predetermined criteria;

determining an alternate upstream channel;

transmitting a first registration response message rejecting the first registration request and identifying the alternate upstream channel;

receiving a second registration request message on the alternate upstream channel; and

transmitting a second registration response message accepting the second registration request on the alternate upstream channel.

14. The data signal of claim 13 wherein the computer readable program comprises:

computer readable program code means for receiving a first registration request message on a selected upstream channel;

computer readable program code means for determining that the selected upstream channel is unacceptable according to predetermined criteria;

computer readable program code means for determining an alternate upstream channel;

computer readable program code means for transmitting a first registration response message rejecting the first registration request and identifying the alternate upstream channel;

computer readable program code means for receiving a second registration request message on the alternate upstream channel; and

computer readable program code means for transmitting a second registration response message accepting the second registration request on the alternate upstream channel.

15. A method for registering communication devices in a communication network, the communication network including a primary station in communication with at least one secondary station, the method comprising the steps of:

selecting, by the secondary station, an upstream channel;

transmitting, by the secondary station to the primary station, a first registration request message on the selected upstream channel;

receiving, by the primary station, the first registration request message on the selected upstream channel;

determining, by the primary station, that the selected upstream channel is unacceptable according to predetermined criteria;

determining, by the primary station, an alternate upstream channel;

transmitting, by the primary station to the secondary station, a first registration response message rejecting the first registration request and identifying the alternate upstream channel;

receiving, by the secondary station, the first registration response message rejecting the first registration request and identifying the alternate upstream channel;

switching, by the secondary station, to the alternate upstream channel;

transmitting, by the secondary station to the primary station, a second registration request message on the alternate upstream channel;

receiving, by the primary station, the second registration request message on the alternate upstream channel; and

transmitting, by the primary station to the secondary station, a second registration response message accepting the second registration request on the alternate upstream channel.

16. A system comprising a primary station in communication with a secondary station, wherein:

the secondary station selects an upstream channel and transmits a first registration request message to the primary station on the selected upstream channel;

the primary station receives the first registration request message on the selected upstream channel, determines that the selected upstream channel is unacceptable according to predetermined criteria, determines an alternate upstream channel, and transmits a first registration response message to the secondary station rejecting the first registration request and identifying the alternate upstream channel;

the secondary station receives the first registration response message rejecting the first registration request and identifying the alternate upstream channel, switches to the alternate upstream channel, and transmits a second registration request message to the primary station on the alternate upstream channel; and

the primary station receives the second registration request message on the alternate upstream channel and transmits a second registration response message to the secondary station accepting the second registration request on the alternate upstream channel.

17. A registration response message for use in a Multimedia Cable Network System (MCNS) protocol, the registration response message comprising an alternate upstream channel identifier identifying an alternate upstream channel for registration.

18. The registration response message of claim 17, wherein the alternate upstream channel identifier is included in a vendor-specific data information element in the registration response message.

19. The registration response message of claim 17, wherein the alternate upstream channel identifier is included in one of:

a Modem Capabilities information element;

a Service Class Data information element; and

a Service Not Available information element.

20. The registration response message of claim 17, wherein the alternate upstream channel identifier is included in an Upstream Channel ID information element in the registration response message.

21. The registration response message of claim 17, wherein the alternate upstream channel identifier is included in a unique information element in the registration response message.

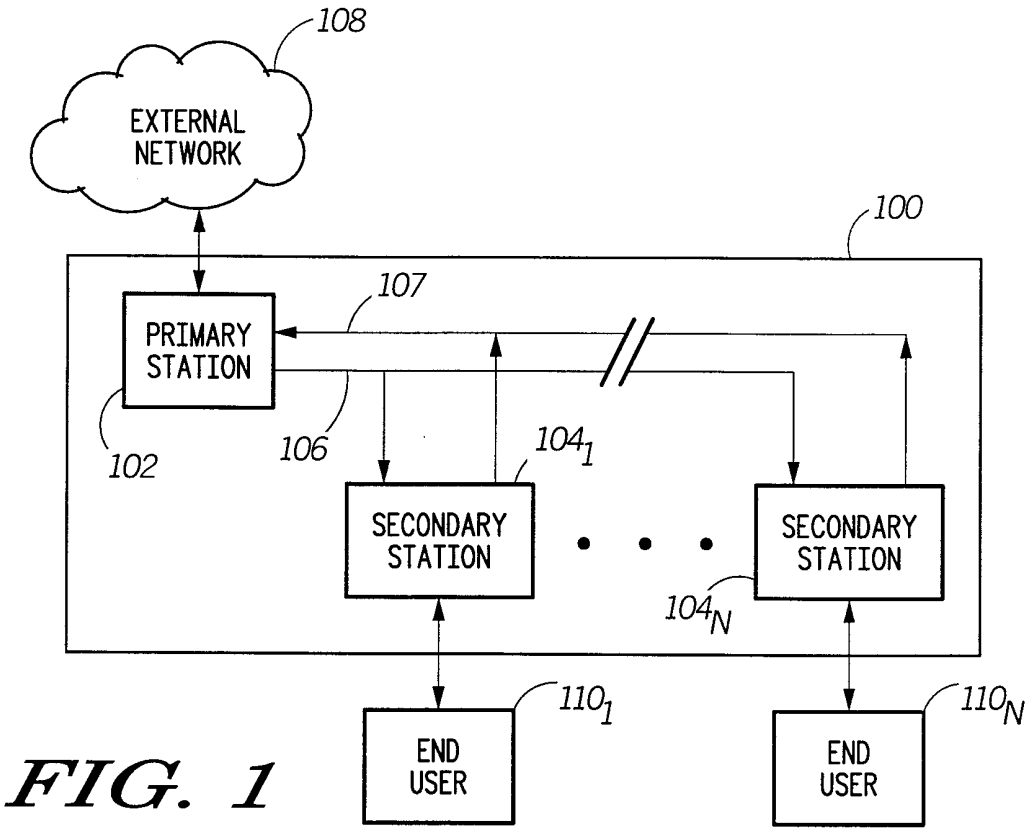

108
EXTERNAL NETWORK
100
107
PRIMARY STATION
102
106
$104_1$
SECONDARY STATION
SECONDARY STATION
$104_N$
$110_1$
END USER
$110_N$
END USER

FIG. 1

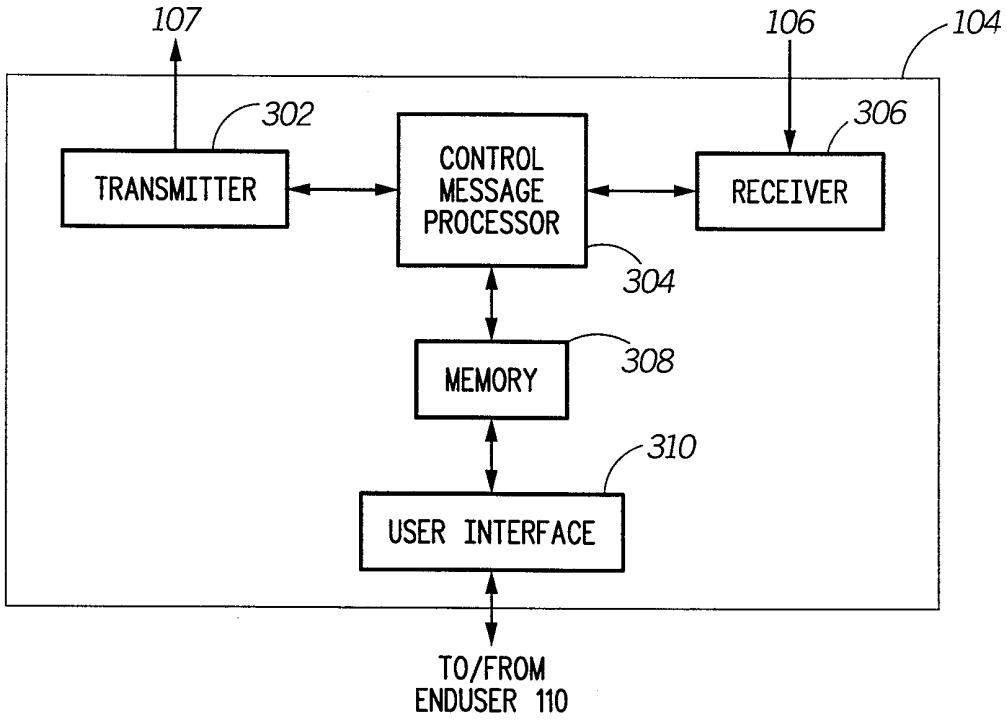

107
106
104
302
306
TRANSMITTER
CONTROL MESSAGE PROCESSOR
RECEIVER
304
MEMORY
308
310
USER INTERFACE
TO/FROM ENDUSER 110

FIG. 3

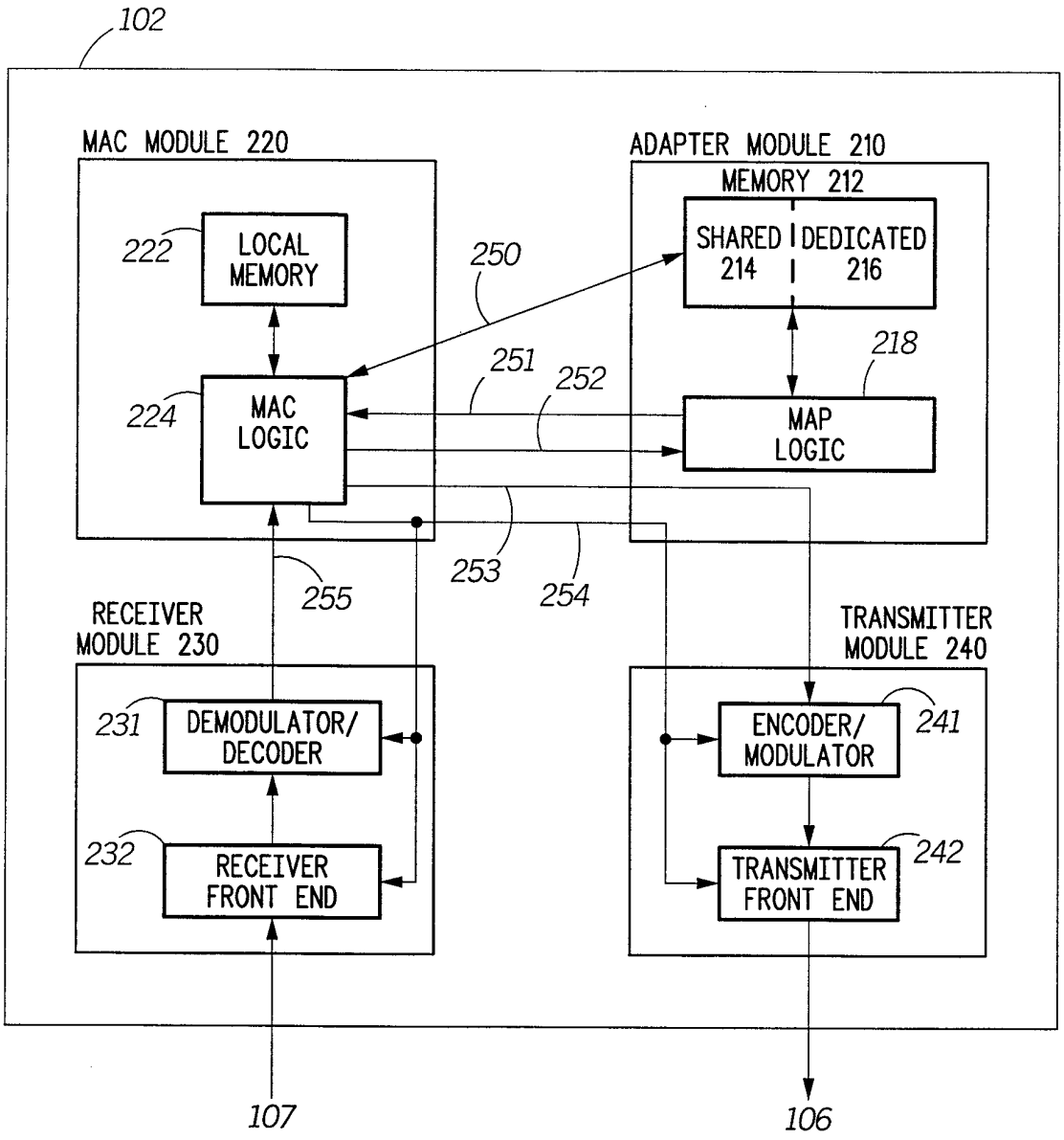
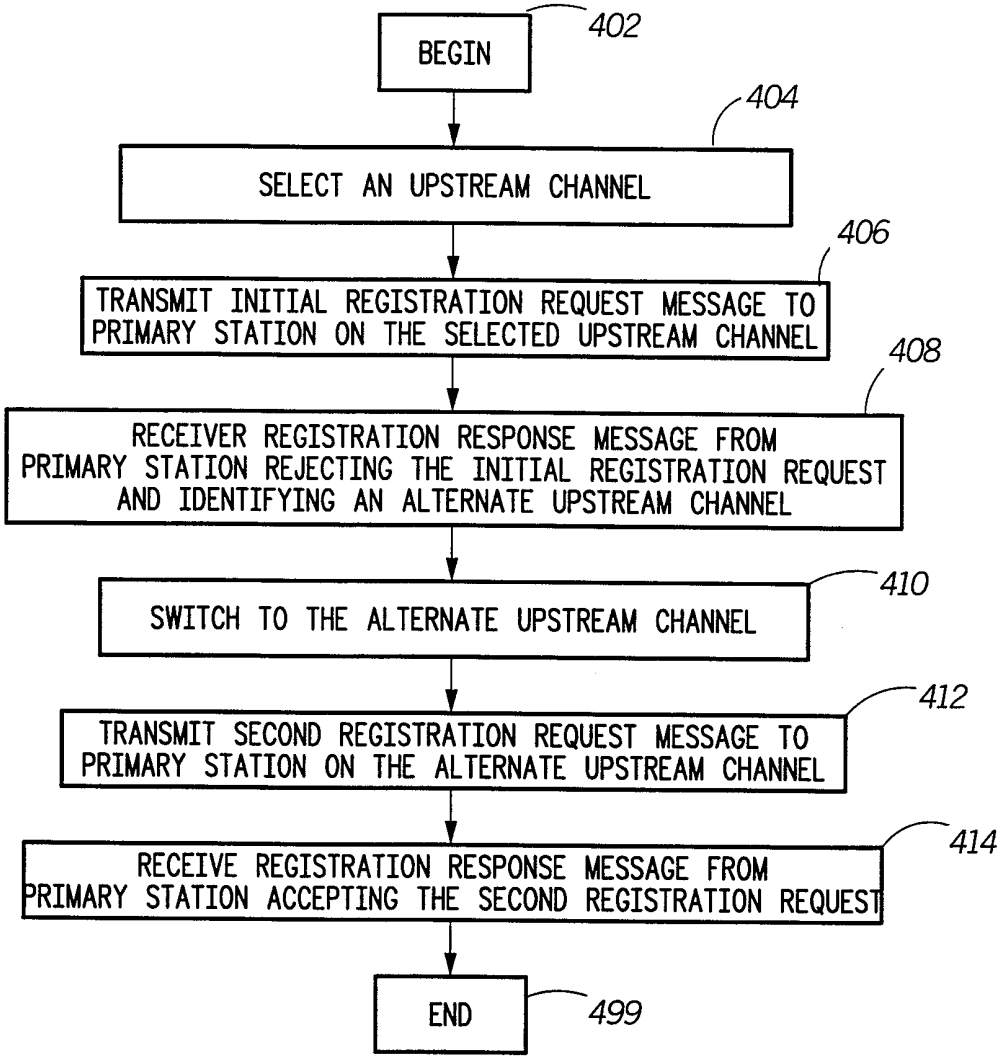

102
MAC MODULE 220
ADAPTER MODULE 210
MEMORY 212
222
LOCAL MEMORY
SHARED 214
DEDICATED 216
250
218
251
252
224
MAC LOGIC
MAP LOGIC
253
254
255
RECEIVER MODULE 230
TRANSMITTER MODULE 240
231
DEMODULATOR/ DECODER
ENCODER/ MODULATOR
241
232
RECEIVER FRONT END
TRANSMITTER FRONT END
242
107
106

FIG. 2


BEGIN
402
SELECT AN UPSTREAM CHANNEL
404
TRANSMIT INITIAL REGISTRATION REQUEST MESSAGE TO PRIMARY STATION ON THE SELECTED UPSTREAM CHANNEL
406
RECEIVER REGISTRATION RESPONSE MESSAGE FROM PRIMARY STATION REJECTING THE INITIAL REGISTRATION REQUEST AND IDENTIFYING AN ALTERNATE UPSTREAM CHANNEL
408
SWITCH TO THE ALTERNATE UPSTREAM CHANNEL
410
TRANSMIT SECOND REGISTRATION REQUEST MESSAGE TO PRIMARY STATION ON THE ALTERNATE UPSTREAM CHANNEL
412
RECEIVE REGISTRATION RESPONSE MESSAGE FROM PRIMARY STATION ACCEPTING THE SECOND REGISTRATION REQUEST
414
END
499

400

FIG. 4

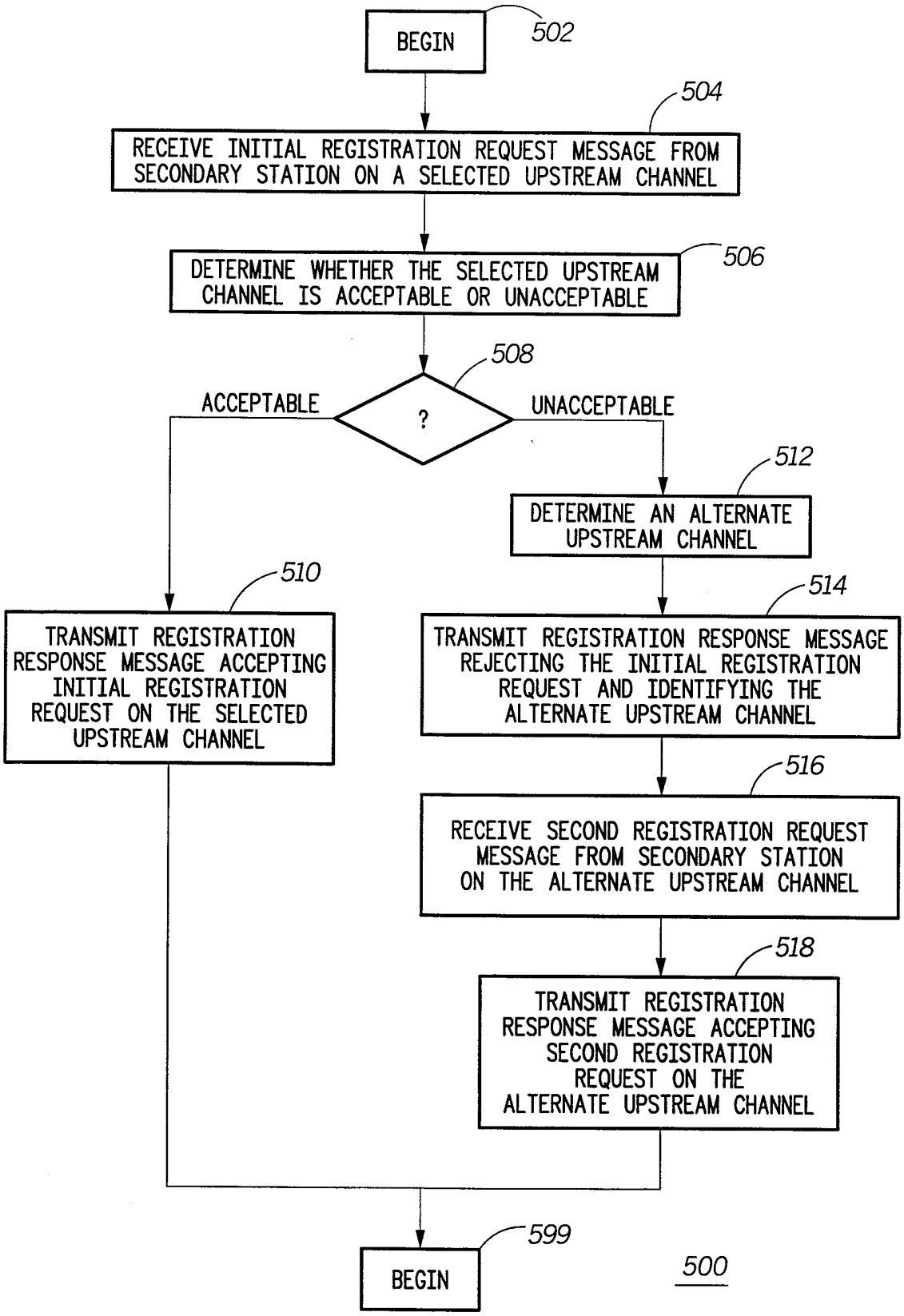

BEGIN
502
RECEIVE INITIAL REGISTRATION REQUEST MESSAGE FROM SECONDARY STATION ON A SELECTED UPSTREAM CHANNEL
504
DETERMINE WHETHER THE SELECTED UPSTREAM CHANNEL IS ACCEPTABLE OR UNACCEPTABLE
506
508
ACCEPTABLE
?
UNACCEPTABLE
512
DETERMINE AN ALTERNATE UPSTREAM CHANNEL
510
TRANSMIT REGISTRATION RESPONSE MESSAGE ACCEPTING INITIAL REGISTRATION REQUEST ON THE SELECTED UPSTREAM CHANNEL
514
TRANSMIT REGISTRATION RESPONSE MESSAGE REJECTING THE INITIAL REGISTRATION REQUEST AND IDENTIFYING THE ALTERNATE UPSTREAM CHANNEL
516
RECEIVE SECOND REGISTRATION REQUEST MESSAGE FROM SECONDARY STATION ON THE ALTERNATE UPSTREAM CHANNEL
518
TRANSMIT REGISTRATION RESPONSE MESSAGE ACCEPTING SECOND REGISTRATION REQUEST ON THE ALTERNATE UPSTREAM CHANNEL
599
BEGIN
500

FIG. 5

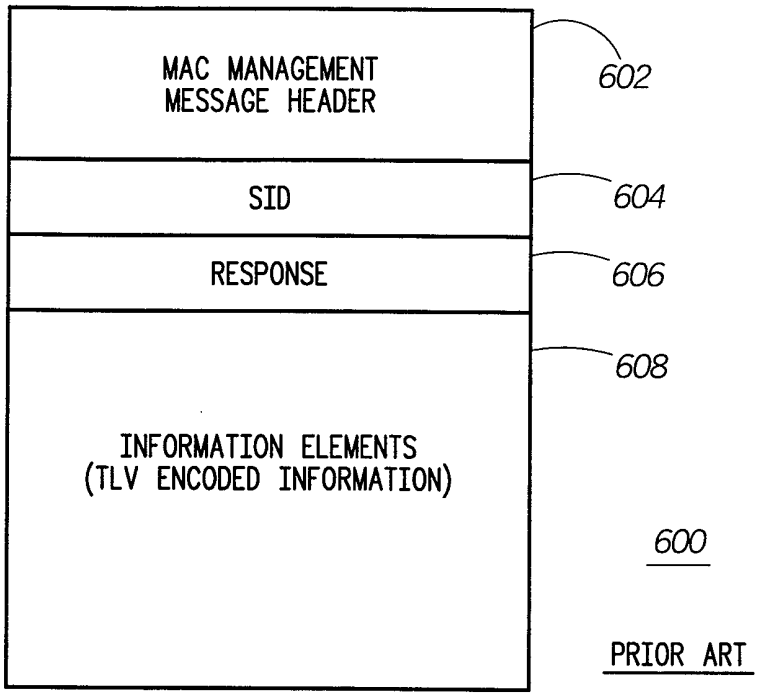

MAC MANAGEMENT MESSAGE HEADER
602
SID
604
RESPONSE
606
608
INFORMATION ELEMENTS (TLV ENCODED INFORMATION)
600
PRIOR ART

FIG. 6

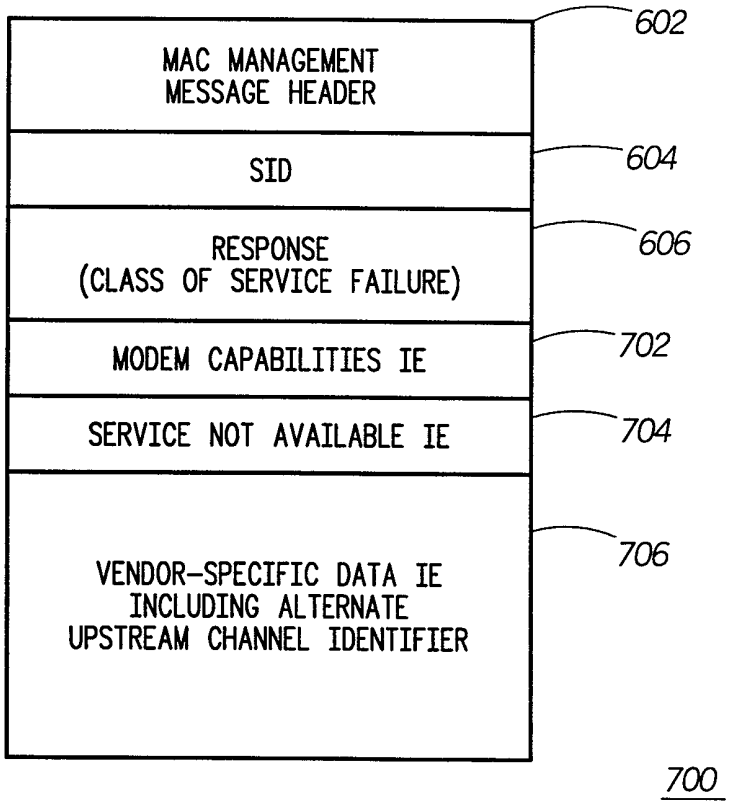

602
MAC MANAGEMENT MESSAGE HEADER
SID
604
RESPONSE (CLASS OF SERVICE FAILURE)
606
MODEM CAPABILITIES IE
702
SERVICE NOT AVAILABLE IE
704
VENDOR-SPECIFIC DATA IE INCLUDING ALTERNATE UPSTREAM CHANNEL IDENTIFIER
706
700

FIG. 7A

| TYPE =43 | LENGTH =1 | ALTERNATE UPSTREAM CHANNEL ID |
|---|---|---|

FIG. 7B

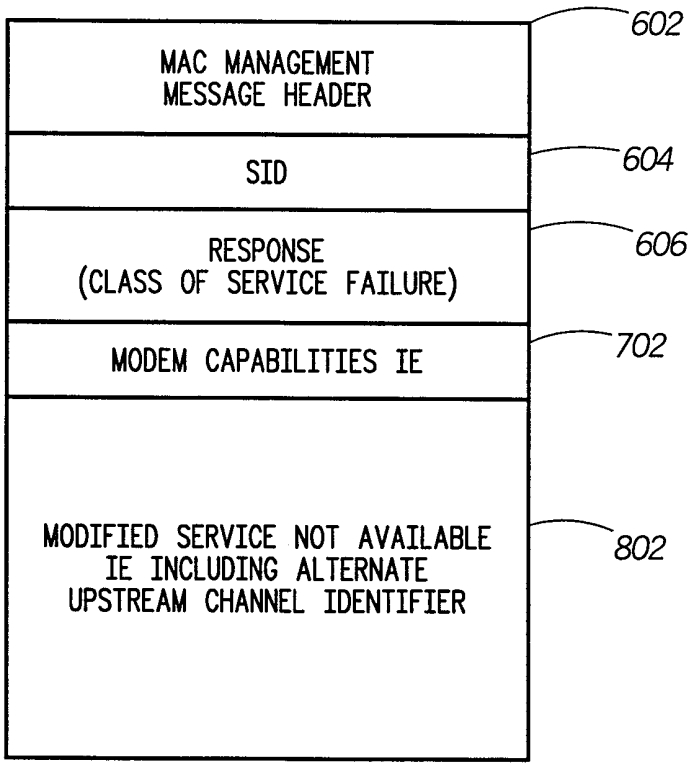



FIG. 8

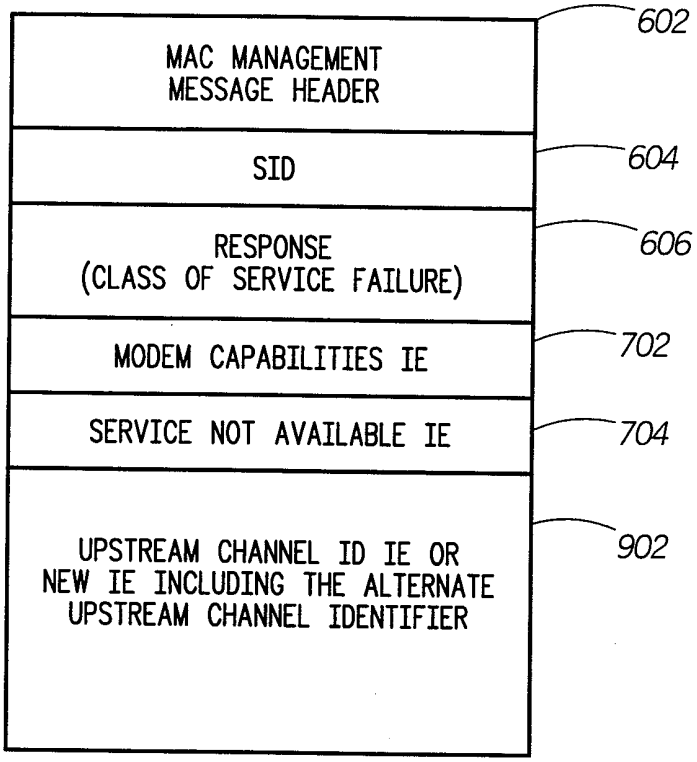
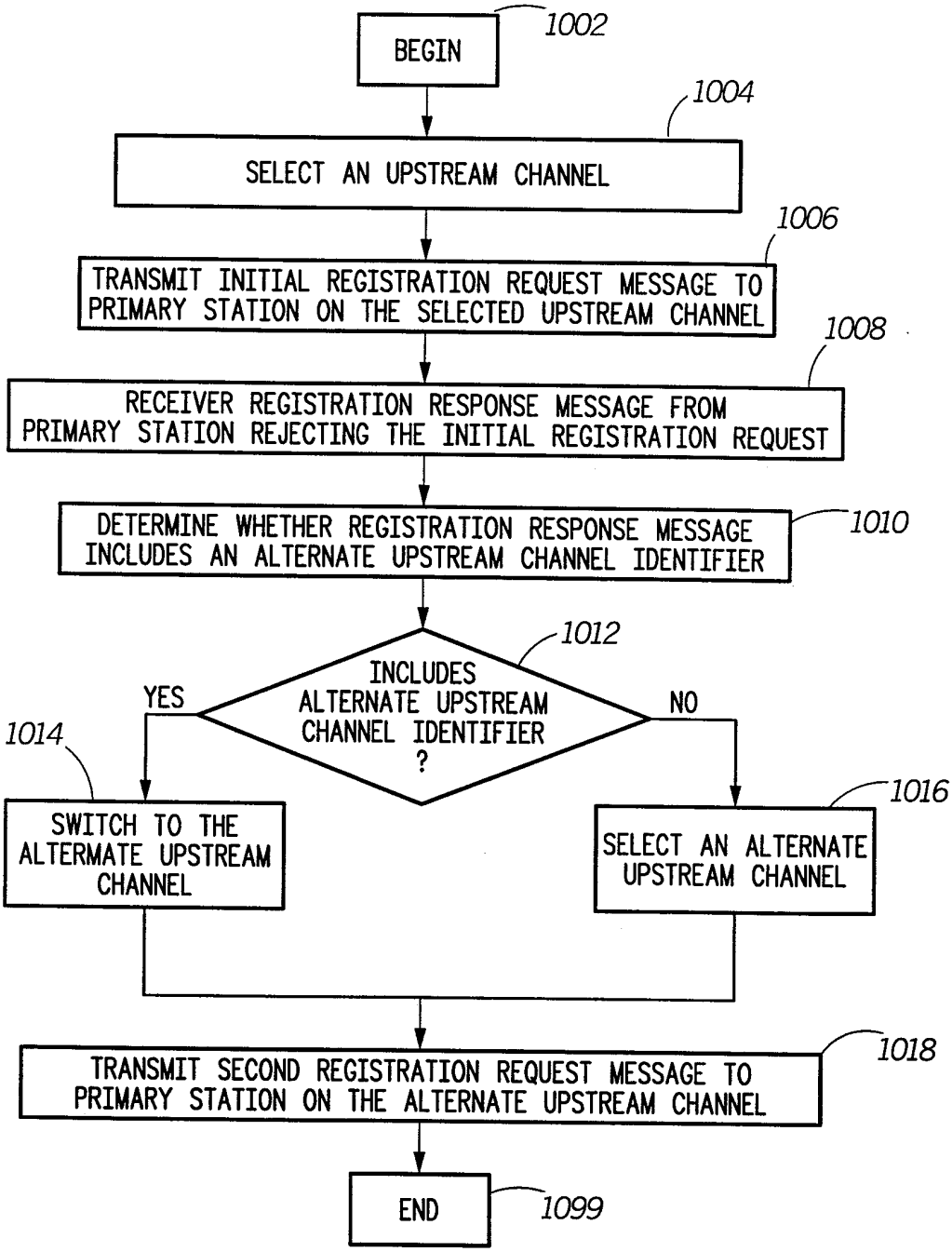

MAC MANAGEMENT MESSAGE HEADER
602
SID
604
RESPONSE (CLASS OF SERVICE FAILURE)
606
MODEM CAPABILITIES IE
702
SERVICE NOT AVAILABLE IE
704
UPSTREAM CHANNEL ID IE OR NEW IE INCLUDING THE ALTERNATE UPSTREAM CHANNEL IDENTIFIER
902
900

FIG. 9


BEGIN
1002
SELECT AN UPSTREAM CHANNEL
1004
TRANSMIT INITIAL REGISTRATION REQUEST MESSAGE TO PRIMARY STATION ON THE SELECTED UPSTREAM CHANNEL
1006
RECEIVER REGISTRATION RESPONSE MESSAGE FROM PRIMARY STATION REJECTING THE INITIAL REGISTRATION REQUEST
1008
DETERMINE WHETHER REGISTRATION RESPONSE MESSAGE INCLUDES AN ALTERNATE UPSTREAM CHANNEL IDENTIFIER
1010
INCLUDES ALTERNATE UPSTREAM CHANNEL IDENTIFIER ?
1012
YES
NO
SWITCH TO THE ALTERMATE UPSTREAM CHANNEL
1014
SELECT AN ALTERNATE UPSTREAM CHANNEL
1016
TRANSMIT SECOND REGISTRATION REQUEST MESSAGE TO PRIMARY STATION ON THE ALTERNATE UPSTREAM CHANNEL
1018
END
1099

1000

FIG. 10

# INTERNATIONAL SEARCH REPORT

International application No.
PCT/US99/06169

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :HO4J/ 1/16; HO4L 12/28; HO4Q 11/02

US CL : 370/230, 236, 351, 431, 437; 340/825.03; 375/346; 455/6.1

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 370/230, 236, 351, 431, 437; 340/825.03; 375/346; 455/6.1

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

NONE

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

APS

search terms: cable, registrations, allocating, interference, upstream, alternate channel, request, rejecting, MCNS protocol

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| Y,P | US 5,847,660 A (WILLIAMS et al) 08 December 1998, see col. 8, lines 51 + & Fig 16. | 1-21 |
| Y | US 5,583,863 A (DARR, JR et al) 10 December 1996, see col. 17, lines 8-14. | 1-16 |
| Y,P | US 5,835,723 A (ANDREWS et al) 10 November 1998, see col. 17, lines 17 + & Fig 5. | 17-21 |
| A | US 5,903,558 A (JONES et al) 11 May 1999, see Fig 5. | 1-21 |

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

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

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

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

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

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

"&" document member of the same patent family

Date of the actual completion of the international search

04 JUNE 1999

Date of mailing of the international search report

28 JUN 1999

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Form PCT/ISA/210 (second sheet)(July 1992) ★