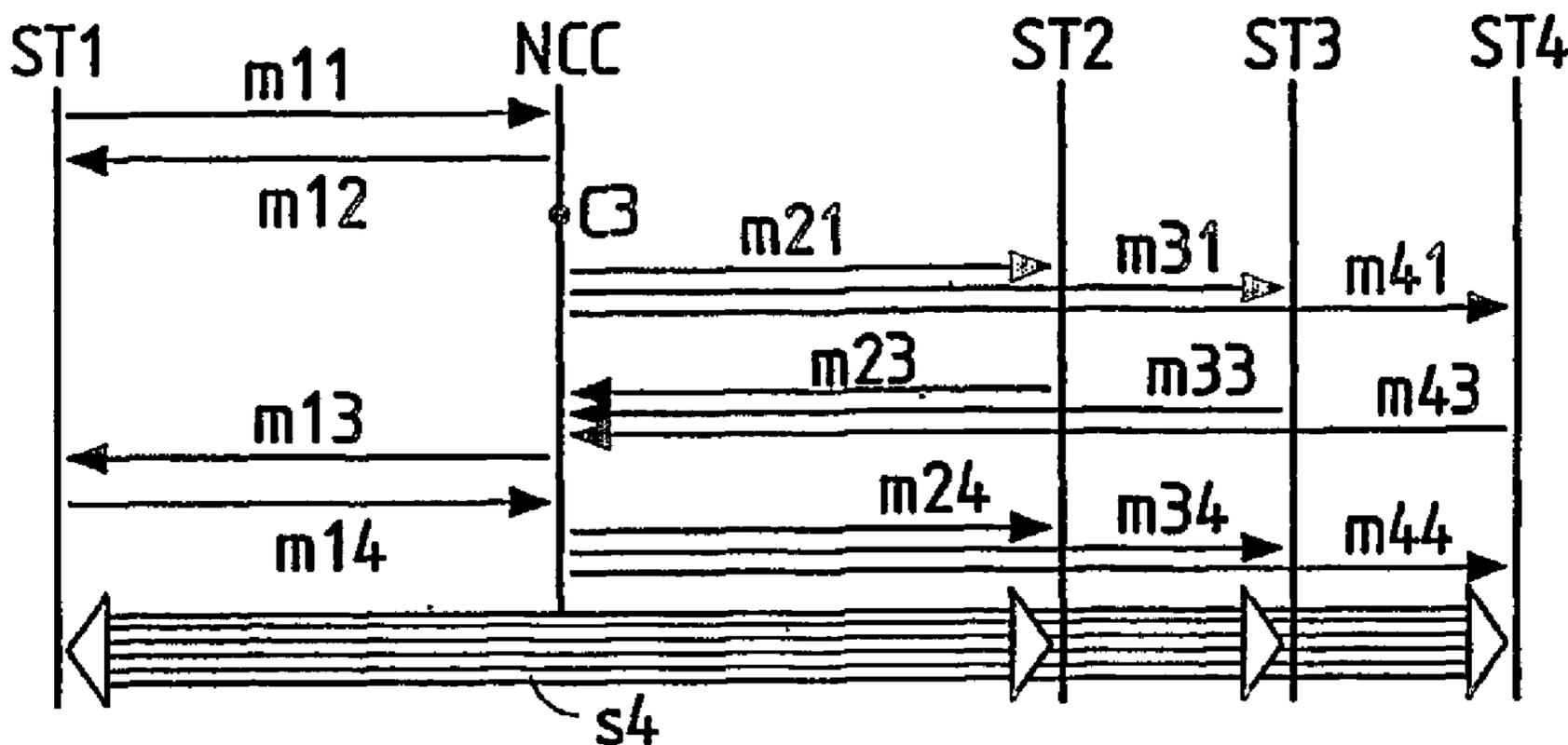




(86) Date de dépôt PCT/PCT Filing Date: 2004/04/21
 (87) Date publication PCT/PCT Publication Date: 2004/11/11
 (45) Date de délivrance/Issue Date: 2012/10/30
 (85) Entrée phase nationale/National Entry: 2005/10/27
 (86) N° demande PCT/PCT Application No.: EP 2004/004213
 (87) N° publication PCT/PCT Publication No.: 2004/098146
 (30) Priorité/Priority: 2003/04/29 (AT A658/2003)

(51) Cl.Int./Int.Cl. *H04L 29/06* (2006.01),
H04M 3/56 (2006.01)
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(54) Titre : COMMANDE DE CONNEXION DANS UN RESEAU DE TELECOMMUNICATION INTERMEDIAIRE
 (54) Title: CONNECTION CONTROL IN A TRANSIT TELECOMMUNICATIONS NETWORK



(57) Abrégé/Abstract:

The invention relates to a transit network, especially a satellite telecommunication system comprising a central control device (NCC), a plurality of terminals (ST1, ST2, ST3, ST4) and optionally one or several internal relay points, especially satellites (SAT), wherein links especially those used to establish a connection and/or release a connection between terminals using (satellite) communication paths extending between two terminals and/or relay points are controlled by means of signalling information which is exchanged between the control device (NCC) and the terminals according to a signalling protocol with at least the following request message types corresponding to the SIP standard: one message type (corresponding to INVITE; m11) in order to initiate the establishment of a connection; one message type (corresponding to BYE; m15) in order to initiate the release of a connection; and one message type (corresponding to ACK; m14) in order to confirm a prior exchange of signalling information, in addition to at least one response message type (m13, m16) corresponding to the SIP standard for confirmation messages and/or error messages.



ABSTRACT

The invention relates to a transit network, especially a satellite telecommunication system comprising a central control device (NCC), a plurality of terminals (ST1, ST2, ST3, ST4) and optionally one or several internal relay points, especially satellites (SAT), wherein links especially those used to establish a connection and/or release a connection between terminals using (satellite) communication paths extending between two terminals and/or relay points are controlled by means of signalling information which is exchanged between the control device (NCC) and the terminals according to a signalling protocol with at least the following request message types corresponding to the SIP standard: one message type (corresponding to INVITE; m11) in order to initiate the establishment of a connection; one message type (corresponding to BYE; m15) in order to initiate the release of a connection; and one message type (corresponding to ACK; m14) in order to confirm a prior exchange of signalling information, in addition to at least one response message type (m13, m16) corresponding to the SIP standard for confirmation messages and/or error messages.

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Connection Control in a Transit
Telecommunications Network

The present invention relates to a method for controlling, in particular for establishing and/or releasing, connections between the transit network terminals of a transit network, with a central control device, a plurality of transit network terminals and, optionally, one or a plurality of internal repeater stations within a transit network, using transit network communication paths that extend in each instance between two of the terminals and repeater stations, control of the communication groups, in particular seizing and releasing these for connections between terminals, being effected by the control device on the basis of signaling information that is exchanged between the station and the terminals.

The present invention also relates to a control device for controlling, in particular for establishing and releasing, transit network communication paths within a transit network, with a plurality of transit network terminals as well as, optionally, one or a plurality of internal repeater stations within the transit network, the communication paths extending in each instance between two of the terminals and/or repeater stations, the controller being setup between the terminals in order to exchange signaling information with the terminals for processing the signaling information for appropriate control of the communication routes, for the purpose of controlling connections, in particular establishing and releasing connections.

The present invention also relates to a terminal device for a transit network, with a central control device, for establishing and releasing connections within the transit network in conjunction with other transit network terminals as well as, optionally, one or a plurality of internal

repeater stations within the transit network, using communications paths which, in each instance, extend between the terminal device and one other terminal or a repeater station, the terminal device being set up to exchange signaling information with the control device, for controlling the communication paths, in particular seizing and releasing these for connections.

Within the context of this disclosure, a transit network is understood to be a communications network that has no end stations that are used by network subscribers; in place of this, access to a transit network is effected exclusively from other communications networks, this being done through the terminals of the transit network, which resemble gateways, for example, on the side of the associated communications networks. Thus, the terminal of the transit network is not an end device (of a network subscriber), but rather an interface device to another communications network. One familiar example of a transit network is a satellite system that makes satellite connections available to other networks and which is accessed from the other networks on its terminals ("satellite terminals"); a transit network can, of course, be in the form of a cable network (e.g., glass-fiber network), a radio network, or a hybrid network that is made up of a number of network types. What is important is that the transit network has a central control center for controlling the communication paths that make up the network.

In many of the transit networks used at present, in particular in the current generation of stationary satellite communications systems (for example, those based on the DVB-RCS standard), no connection-oriented communication between satellite terminals is defined. Guaranteed bandwidths on the satellite link are only provided for services using constant bit rates. Services that use variable bit rates,

such as many Internet applications, for example, can only be operated on the "best-effort" principle. Thus, for many applications, it is not possible to achieve good quality service and efficient utilization of satellite capacity.

At present, a start is being made on developing the next generation of broadband satellite communications systems that are to be based on an efficient system architecture and are intended to provide high quality services. It is intended to use a connection-oriented communications form for this purpose. A typical architecture for such a satellite network SAN is shown diagrammatically in Figure 1; more detailed explanations are contained in the papers titled "Fast Internet Service via on board processing satellites: the EuroSkyWay optimized techniques" by G. Losquardo *et al*, and "The ESW home gateway supporting IP and MPEG Services for residential users," by G. Losquardo *et al*, from the Proceedings of the 19th AIAA International Communications Satellite Systems Conference, Tolosa, April 2001.

The principal components of this type of system are a satellite SAT with onboard processing, a network control center NCC, as well as a number of satellite terminals ST1, ST2. The satellite terminals ST1 and ST2 -- which are in this case ground-based -- (additional terminals ST3, ST4 are indicated) represents the interface between each associated subscriber end device TE1, TE2 and/or terrestrial telecommunications networks TN1, TN2 and the actual satellite system BSS. The end devices TE1, TE2 or the networks TN1, TN2 belong to the known communications network types such as, for example, ISDN, ATM, and the Internet (on the basis of the IP).

It is the task of the satellite terminals ST1 and ST2 to ensure that, when required, connections that are in keeping with subscriber demands are requested or released by way of the satellite system. The signaling required for this -- indicated in Figure 1 by the dashed arrows ssg -- are designated as "internal satellite signaling," or by the abbreviated form "internal signaling." The network control centre NCC receives requests for connection by way of the internal signaling system and decides on the basis of current system load and the characteristics of the connection that is desired (such as, for example, bandwidth and quality) whether or not the new connection can be accepted. In the case of a positive response, on the one hand both the satellite terminals that are involved are informed by way of internal signaling and, on the other hand, a corresponding command to switch the connection through is passed to the satellites SAT. Ultimately, the geostationary satellite SAT makes it possible to switch the channels scl1 and scl2 between the satellite terminals ST1 and ST2 directly "on board" i.e., they are linked directly to a communications path. In this way the traffic data (e.g., speech and/or video, or other data) are exchanged by way of "single-hop" communications. As a rule, the communication paths that are used for this purpose exist between a satellite terminal and a satellite although, if required, communication paths from satellite to satellite can be used (these are the so-called inter-satellite links).

More detailed information on broadband satellite systems can be obtained on the web site http://www.analysis.com/default_acl.asp?mode=article&iLeftArticle=30.

Detailed information about specific satellite systems is also contained in the following web sites:

http://www.euroskyway.it/website/html_eng/index.html with respect to the EuroSkyWay Systems;

<http://www.skybridgesatellite.com> with respect to Sky-

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bridge; <http://www.analysis.com/satellite/profiles/WildBlue.htm> with respect to WildBlue (formally iSky); and <http://www.isr.umd.edu/CSHCN/presentations/conferences/staif99/bravman.pdf> with respect to OrbLink.

For controlling (establishing, maintaining, and releasing) connections in satellite systems, known attempted solutions provide for the use of protocols that are familiar from terrestrial digital telephone networks, typically (broadband)-ISDN based protocols. However, these do not do justice to the special topology of a satellite network and are needlessly complex for this special set of problems.

For this reason, it is the objective of embodiments of the present invention to indicate a way to simplify control of connections in satellite systems and simultaneously improve the performance of such systems.

This objective has been achieved in one aspect by using a method as well as a control device or terminal device of the type referred to in the introduction hereto; in this, in order to exchange signaling information, use is made of a signaling protocol that has at least the following request message types that corresponds to the SIP Standard:

- a message type (corresponding to INVITE) to initiate a connection,
- a message type (corresponding to BYE) to initiate release of the connection, and
- a message type (corresponding to ACK) to confirm a previous exchange of signaling information,

and at least one response message type (corresponding in particular to 200) for confirmation reports and/or error reports.

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In another aspect, there is provided a method for controlling connections between transit network terminals of a transit network, with a central control device and, a plurality of transit network terminals using transit network communication paths that extend in each instance between two of the terminals and repeater stations, control of the communication groups, being effected by the control device using signaling information that is exchanged between the control center and the terminals, wherein a signaling protocol with at least the following request message types that correspond to the Session Initiation Protocol (SIP) standard is used for exchanging signaling information: a message type to initiate a connection setup, a message type to initiate release of a connection, and a message type to confirm a previous exchange of signaling information, as well as at least one response message type for at least one of confirmation messages and error messages.

In another aspect, there is provided a control device for controlling transit network communication paths in a transit network with a plurality of transit network terminals, the communications paths each extending between (i) two of the terminals; or (ii) one or more repeater stations; or (iii) two of the terminals and one or more repeater stations, the control device being equipped for exchanging signaling information with the terminals and for processing the signaling information for appropriate control of the communication paths for the purpose of controlling connections, wherein the control device is equipped for using a signaling protocol for the exchange of the signaling information with at least the following request message types that correspond to the SIP Standard: a message type for initiating a connection setup, a message type for initiating release of the connection, and a message type for confirming a previous exchange of signaling information, as well as at least one response message type for at least one of confirmation messages and error messages.

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In another aspect, there is provided a terminal device for a transit network with a control device for establishing and releasing connections within the transit network in conjunction with other transit network terminals using communications paths which in each instance extend between the terminal device and another terminal or a repeater station, the terminal device being equipped for exchanging signaling information with the control device, for controlling communications paths, wherein the terminal device is equipped for using a signaling protocol for the exchange of signaling information with at least the following request message types that correspond to the SIP Standard: a message type for initiating a connection setup, a message type for initiating release of the connection, and a message type for confirming a previous exchange of signaling information, as well as at least one response message type for confirmation messages and/or error messages.

Thus, the present invention makes provision for modeling the messages that are used on the SIP Standard. It is obvious that the messages must not conform completely to the form defined in the SIP Standard; a configuration that is equivalent to this is sufficient given the identical function of the messages; for example, the name of the message and/or of the fields in the messages can be different, or the syntax format can differ. By optimal matching to a given transit network ~~✘~~- for example, a satellite network -- the fields that are not required in this specific type of transit network can be omitted or instead of being obligatory can be used "only" optionally. Using signaling that conforms to the SIP Protocol makes it possible to achieve surprisingly simple and nevertheless reliable implementation of the signaling within the transit network, in particular in a satellite system.

The protocol that is designated with the name SIP (Session Initiation Protocol) is an IETF standard protocol for initiating interactive sessions such as video conferencing, Internet telephony, and instant messaging in an IP-based network. SIP is based on a standard that has been developed by the Multiparty-Multimedia-Session-Control-Working Group (MMUSIC) of the IETF and defined in RFC 3261 (as of June 2002). For further information regarding the SIP Protocol reference should be made to the SIP website of Henning Schulzrinne at <http://www.es.columbia.edu/~hg/sip/>. In addition to technical background information, this site also contains an extensive collection of different SIP implementations, in particular SIP clients and SIP servers.

To the extent that it is necessary in order to understand the present invention, the following is an overview of SIP protocol that is based on the web site <http://www.reibold.de/knowhow/sip>.

SIP is based on the IP protocol and its essential features are similar to the well-known SMTP and HTTP protocols. Like these two, SIP uses text based messages in order to communicate between an SIP client and an SIP server; requests from the client and responses from the server are effected by means of these text based messages.

SIP also uses HTTP syntax over long paths. As in the case of HTTP, SIP requests elicit defined actions on the server side. There are six methods available for doing this. In addition, SIP also has its own security mechanisms that are responsible for the reliability of the messages. Like HTTP/1.1, SIP can also send a plurality of requests and responses by way of one TCP, UDP, or SCTP connection. SIP uses an e-mail-like address in the form user@ domain, user@ip-address, or telephone number@gateway for addressing correspondents.

The SIP system recognizes two components: the user agent and the network server. The user agent is executed at the user end (e.g., a calling end station). It contains the protocol -- and is also referred to as the user agent and client (UAC) -- and a protocol server that is designated as the user agent server (UAS). The UAC initiates three calls, the UAS answers incoming calls. There are -- amongst others -- two different types provided for on the server side: proxy and redirect server. The SIP proxy server assumes similar tasks as an SMTP server or an HTTP proxy. It receives requests from clients, determines the destination to which these are to be routed, and then passes on the requests. The redirect server is responsible for messages to the recipient. It receives requests and informs the client with which server the agent should make contact. In this regard, SIP always resorts to the DNS (Domain Name Service) when it is appropriate to seek out another server.

As is the case with HTTP, a distinction is made between SIP requests and SIP responses. An SIP request consists of three parts: a start line (request lines or status lines), header fields of a fixed format and content, as well as (after a blank line) a message body (or body for short) that consists of one or more body fields. The various header fields contain information about call services, addresses, and protocol features. SIP defines six request types: INVITE, BYE, OPTIONS, ACK, REGISTER, and CANCEL.

The most important request type is INVITE, which is responsible for initiating a call between client and server. Using this method, a caller can "invite" a called party to a telephone call. The information that is contained in the associated header fields is very similar to that used when sending an electronic message. Amongst other things, it passes on the address of the calling party and the address of the called party, subject, priority, and routing information. The body of the message can optionally contain MIME-coded contents, for example, SMIL or XML contents.

Location information as to where an SIP client can be reached is passed to an SIP server by the REGISTER method. This is done so that incoming messages from one or more communications partners can be passed on to the appropriate client.

BYE ends a session between two terminals. ACK confirms a reliable exchange of messages and CANCEL attempts to erase a previously sent request. OPTIONS can contain optional information about the user.

In addition, SIP lays down six groups of status messages for responses; each of these is designated with a three-place number (1xx, 2xx, 3xx, 4xx, 5xx, 6xx).

However, not all of the message types defined in the SIP Standard are absolutely necessary for the present invention; rather, the above-coded message types (INVITE, BYE, ACK, and 200) guarantee the fundamental functions of the present invention. Naturally, the solution according to the present invention permits the signaling protocol to make provision for even more request- and/or response-message types that corresponds to the SIP Standard, in particular the following:

- a message type (corresponding to CANCEL) to interrupt establishment of a connection;
- a message type (corresponding to REGISTER) to log on a satellite terminal in the satellite telecommunications system;
- one or more message types (corresponding, in particular, to 100-and/or 4xx and/or 5xx responses) for answers of a non-conclusive type, as well as error reports that refer to a satellite terminal or the server.

Such message types can be advantageous, depending on the actual implementation.

If the present invention is used for satellite systems (for which it was developed in the first place), its advantages become relevant to a particular extent. In this case, what is involved is the control of connections between the satellite terminals of a satellite telecommunications system, with at least one satellite, using satellite communication paths which extend in each instance between a satellite terminal and a satellite, or between two satellites. Control of the satellite communications paths is managed from the control device during the exchange of signaling information with the satellite terminals, and for processing signaling information for appropriate control of satellite communication paths.

One preferred development of the present invention permits the establishment of point-to-multipoint sessions, to which the particular properties of a transit network and in particular a satellite system, especially the broadcast functionality of the satellite, as well as the architecture underlying the satellite system, all comply. To this end it is expedient if the naming of a plurality of called terminals is permissible in the messages exchanged according to the signaling protocol, in particular messages according to the message type for initiating the establishment of communications (INVITE), such messages being used for controlling point-to-multipoint connections.

More advantageously, in order to provide for the economic processing of error messages, an additional response message type can be used, with which an error message is signaled to all the called (satellite) terminals of a point-to-multipoint connection. In addition, body fields based on an additional body-field type can be used in the confirmation reports for point-to-multipoint connections, or at least in some of these, with an error report relating to a called (satellite) terminal of the point-to-multipoint connection being signaled by means of each such body field.

In one particularly simple version, the signaling protocol can be realized as a signaling protocol that is superimposed on the IP Protocol, and/or on a protocol such as TCP or UDP that is of a higher order.

In order to satisfy the special requirements of a connection within a transit network, it is useful if, within the body of a request message that is sent from one terminal to the control station, it is permissible to quote the details of the desired or required connection parameter. The connection parameter transmitted in this way can apply in

particular the one or a plurality of the following variables: connection type, service category, maximal data rate, utilization factor, maximal burst size, desired priority of the connection, cell delay variation, maximal cell transfer delay.

In a preferred embodiment of the present invention -- in particular in a satellite system -- the assignment of bandwidths for data transmission is controlled on the part of the satellite or satellites by dynamic resource management as a function of the connection quality that is required, so as to arrive at an optimal loading and thereby improve the quality of connection. When this is done, the resource management associated with a satellite can be conducted as part of an on-board system on this satellite.

The present invention together with additional advantages will be described below on the basis of a non-restrictive embodiment shown in the drawings appended hereto. These drawings show the following in diagrammatic form:

Figure 1: a satellite communications network with on-board processing;

Figure 2: the establishment of a point-to-point connection within the network shown in Figure 1;

Figure 3: the release of a connection as in Figure 2;

Figure 4: the establishment of a point-to-multipoint connection;

Figure 5: the partially successful establishment of a point-to-multipoint connection;

Figure 6: the expansion of a point-to-multipoint connection;

Figure 7: release of the connection shown in Figure 4;

Figure 8: ISDN interworking based on the signal exchange shown in Figure 2.

The present invention can be used for different types and architectures of a transit network. A satellite network SAN with a broadband satellite system BSS of the type shown in the introduction to this description on the basis of Figure 1 underlies the exemplary embodiment. As has already been discussed, such a BSS incorporates a geostationary satellite SAT with onboard processing, a central network control centre NCC that is a control device in the sense of the present invention, and a number (typically several thousand) of satellite terminals ST1, ST2, ST3, ST4, which in the present example are ground-based and can operate using various transmitting and receiving capacities.

As part of its on-board processing system, the satellite SAT incorporates dedicated, dynamic resource management. This is responsible for the actual assignment of bandwidths for transmitting data. If a connection has been successfully made, resource management provides information to the effect that a connection with specific connection qualities exists between the participating satellite terminals. Resource management is thereby instructed to allocate bandwidths (as defined in the connection quality for the transmission of data to these terminals whenever such terminals wish to transmit data. The allocation of resources is thus effected to the satellite link dynamically, which is to say exactly when the satellite terminal needs these resources. When the satellite is sending no data, these resources can be used for other connections.

The present invention uses the SIP standard in accordance with IETF Standard RFC 3261 (Standard SIP) as a departure point. Proceeding from this standard, within the framework of the present invention described herein, the Protocol is optimized for use in the described satellite architecture. When this is done, the similarity of the satellite architecture to an SIP network with proxy service is

exploited. An SIP proxy server can establish connections between different SIP end devices (e.g., SIP telephones). The tasks of the control center NCC are very similar to those of an SIP proxy server. The satellite terminals ST1, ST2 correspond to the SIP end devices within the SIP network. The modified SIP Protocol that results from this can thus be designated as Sat-SIP.

Because of the special architecture of the satellite network used here as a basis, the following simplifications to Sat-SIP are proposed:

1. Sat-SIP functions with significantly fewer header fields in the messages than Standard-SIP. Concretely, only the following head fields are necessary in Sat-SIP: accept, allow, error-info, from, to, cseq, call-id, expires and retry-after, as well as the three header fields for authentication: WWW-authenticate, authorization, and authentication-info.

2. Sat-SIP functions with significantly fewer messages than Standard SIP. Concretely, only the following messages are provided for in Sat-SIP: ACK, BYE, CANCEL, INVITE, REGISTER, 100, I0, as well as 4xx and 5xx messages. In Sat-SIP, the same names for the individual message types are used as in Standard-SIP, although other designators could be used without impairing the functionality of the protocol.

In contrast to this, Sat-SIP is meant to permit the following extension of functionality as compared to Standard-SIP:

- support of point-to-multipoint (ptmp) sessions. In the case of a ptmp connection, one calling and a plurality of called terminals are involved. The methods for establishing and releasing such connections, as well as for adding or

removing subscribers, are defined in Sat-SIP. These methods are described in greater detail below. Naturally, the Sat-SIP protocol (like the Standard-SIP) supports the establishment and release of point-to-point (ptp) sessions, which is to say those between one calling and one called terminal.

- use of an access control method for connections, namely the CAC that is discussed below, which in this instance monitors authorization of connections within the satellite system SAN. Corresponding locations are provided in the connection establishment and connection release processes in which such a method is to be incorporated. However, it can remain open as to which specific method is used.

- configuration of a resource control system. In the connection establishment and connection release processes there are corresponding locations at which such a configuration is to be incorporated. Since various resource control systems can be used in different satellite systems, Sat-SIP leaves it open as to the specific manner in which the control functions. Resource control can be provided in the control center NCC and/or on board, which is to say on this satellite, as is known, for example, from the EuroSky-Way System. The advantage of the latter variant lies in the fact that the signal run times are shorter and resource request can be handled quicker, which can make up for the disadvantage of the greater complexity of onboard systems.

The following changes and developments with respect to messages and header fields are proposed for the implementation of these extended features:

1. New body fields can be incorporated in the INVITE message; these make it possible to transport parameters for

describing connection quality. These body fields replace the SDP body that is provided in the Standard-SIP.

2. One or more terminals can be cited in the header field "to," which is used to designate the end device that is called. In the event that the more than one terminal is cited, a ptmp connection is established. (In the Standard-SIP, only one end device can be specified within the header field.)

3. One additional body field ("4xx Final Response," short form "4FIN") has been introduced; to the extent that it is required, this is used especially in the case of ptmp connections.

4. A new message (499 "All Terminals Failed") has been introduced especially for ptmp connections. This message must contain 4FIN body fields.

The body fields referred to in Paragraph 1 above are used especially so that a satellite terminal can inform the control center NCC about the characteristics of the required connection. Parameters other than those contained in the SDP body in the case of connections of the Standard-SIP are required in order to describe these characteristics. In the exemplary embodiment, the following parameters are used to describe the connection characteristics that are requested: connection type (unidirectional or bidirectional; ptp or ptmp), service category, maximal data rate, utilization factor (the ratio between average and maximal data rate), maximal burst size (the maximal quantity of data to be sent at one time), desired priority of the connection, cell delay variation, maximal cell transfer delay. In the case of bidirectional connections, all the features -- with the exception of the connection type -- can be quoted for each connection direction.

The extended features referred to in Paragraphs 2 to 4 above relate to ptmp connections and will be discussed in greater detail below.

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For this reason, using Sat-SIP:

- "connection awareness" is established in the satellite terminals ST1 and ST2, as well as in this central control center NCC;
- this connection awareness, in conjunction with a suitable method such as the CAC, is used for authorizing new calls into the system; and
- resource control of the satellite system is configured in keeping with the newly established connection. With this configuration, a new user-data connection is established between the satellite terminals, so that these can begin to transmit useful data via the satellite.

As has been discussed, a method for authorizing connections within the satellite network has been set up in the control center NCC; in this disclosure, this is referred to as CAC ("Connection Admission Control"). The CAC is typically in the form of a computer program, although in principle it can also be a hardware unit. Based on a statistical example, the CAC decides whether or not a requested connection can be authorized on the basis of current load, without prejudicing the service quality of existing connections or endangering them. If the decision that is reached is positive, the connection is established. If not, establishment of the connection is abandoned. A method of this kind is described, for example, in EP 1 146 763 A2.

CAC is extremely advantageous, above all in the high-load area, although it requires connection awareness. It should be mentioned that CAC is not an essential element of the present invention. Rather, in a simplified embodiment of

the present invention, it is possible to dispense with CAC if the advantage of guaranteed service quality for accepted connections is not required.

In principle, the SAT-SIP Protocol can control ptp sessions in the same way as the Standard-SIP Protocol. As has been described above, to this end it is essential that the messages and finite-state machines that are defined in the SIP standard be used. The essential additional features are consideration of the procedures for quality assurance (QoS, Quality of Service) and resource management insofar as the prerequisites have been created by the SAT-SIP Protocol in order to support these proceedings efficiently in a satellite system. From the standpoint of the protocol defined in a SIP-Standard, QoS and resource management are to be covered by other protocols, since only the application view is decisive for the Standard SIP.

As has been discussed already, however, an essential additional feature compared to the standard SIP are the ptmp sessions. Whereas the standard SIP Protocol always sets up multipoint sessions ("multicast sessions") as a plurality of ptp sessions (for example, by way of a conference bridge), the present invention can more favorably use another solution that is also realized in the Sat-SIP. The possibility of the ptmp is very well suited for this because of the broadcast functionality of the satellite and the underlying architecture.

The signaling messages are transported from the satellite terminals ST1 or ST2 through a dedicated signaling channel (not shown in the drawing), to the so-called RASC ("Random Access Channel") by way of the satellite SAT (omitted from Figure 2 and Figure 3 for the sake of clarity) to the control centre NCC, or from there by way of the satellites to the relevant satellite terminal ST1 or ST2. The RASC is

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a channel that is not collision free and can be realized, for example, using the known ALOHA or slotted-ALOHA method.

Within the control center NCC, based on the QoS and traffic parameters that have been transmitted, a decision is made as to whether or not the new connection can be authorized within the communications network. Authorization follows if the QoS of all the connections already existing within a network will not be prejudiced. Procedures of this kind are already familiar from the prior art.

Figure 2 shows the message flow for a successful ptp call setup in a signal-sequence diagram. Within the signal sequence diagrams, the time axis extends vertically downward, and the messages that are exchanged between the different points, which are symbolized as vertical lines, are shown as arrows. In this disclosure, three-place reference numbers are used for the messages exchanged in the signal sequence diagrams, the second figure indicating the satellite terminal ST ($n=1, . . . , 4$), with which the message is exchanged, and the third indicates the type of message (e.g., a final figure 1 indicates an INVITE message).

The messages P11-P24 are exchanged in the process shown in Figure 2. The following assumptions are made for the messages.

- The identification of the NCC that is used internally within the satellite system is NCCID;
- The identification of the satellite terminals ST1, ST2, ST3, and ST4 are ST1ID, ST2ID, ST3ID, and ST4ID;
- within the body of the INVITE message there are some, but not all, of the QoS parameters defined in Sat-SIP are contained within the body of the INVITE message.

In one implementation, regardless of the concrete satellite system, the CAC that is used, and the type of connection, only the required QoS parameters (all or, as in this case, only some), are transported within the body field of the INVITE messages. In addition, in the case of bidirectional parameters, the QoS parameters for the forward and return directions are given separately; in the case of unidirectional connections, only the parameters for the forward direction are given. In every case, however, two parameters that specify the type of connection must be given: ptp (point-to-point: "True" or "False"). and UNI (unidirectional: "True" or "False").

- In the interest of better readability, in each instance the full field designators were used in the messages. However, like Standard-SIP, Sat-SIP provides for abbreviating the designators of frequently occurring fields so as to make the messages shorter. For example, in place of "From:" a message could contain simply "f" or "I" in place of "Call-ID."

The setup of a ptp session is initiated by a request p11 "INVITE" from the (calling) satellite terminal ST1. The successful arrival of the INVITE message is confirmed by a return message p12 "100." A CAC check is carried out in the CNC. This is symbolized by the reference C1. If the CAC is successful, the connection is authorized and resource management procedures to allocate resources to the transmission paths are started, and the called satellite terminal ST2 is informed by an INVITE message p21. If the call terminal ST2 can accept the connection, it responds with a 200-message p23 that is returned to the NCC. After successful conclusion of the resource allocation, the 200-message p13 is passed on to the calling terminal ST1 that in its turn acknowledges receipt by an ACK message p14 that,

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as the message p24, is accordingly passed on to the called terminal ST2. This concludes the call set up and the satellite terminals can begin with the transmission of useful information s21. Depending on the implementation, e.g., after a successful CAC, the allocation of connection paths is effected in parallel to the transmission of the INVITE message p21; however, the confirmation p23 could also be awaited for this. In contrast to the Standard-SIP, there is no RINGING message in this sequence.

The timer that is defined in the Standard-SIP is adapted to take into account the longer signal run times within satellite networks.

The unsuccessful cases as well as the possibility of canceling a call setup request proceed taking into account what has been said above, analogously to those in the SIP-Standard; for this reason, any discussion of these in this disclosure is unnecessary.

Figure 3 shows the flow of messages of a successful ptp call release, e.g., the release of a connection established as in

Figure 2. The release is initiated by means of a BYE message p15, p16, which is also acknowledged by a 200-message p26, p16. The procedure corresponds to the procedures of the Standard-SIP. The resources that were allocated in the control center NCC are then released, or the QoS parameters are reset by a CAC.

Figure 4 shows a successful call setup for a ptmp call. Other than in the Standard SIP, single ptp sessions are not connected together for a ptmp session, but the ptmp call is processed as a whole within the control center NCC. The INVITE message m11 that is sent from the calling satellite terminal ST1 to the control center NCC, which initiates the call set up, contains the identifications and the parameters of all the called satellite terminals ST2, ST3, ST4, that are to be connected together for the desired ptmp session.

The sequence of the call set up between the calling satellite terminal ST1 and the control center NCC is completed in accordance with the procedures of the Standard-SIP Protocol, which means that the finite-state machines do not have to be adapted. A further advantage of this is that the signaling load at the RASC is minimized so that the probability of collision is reduced. This is an important requirement for translation paths in satellite networks, where resources are costly and therefore valuable. In each instance, individual sub-sessions are set up between the control center NCC and the called satellite terminals ST2, ST3, and ST4. These are part of a common ptmp and are identified by a common call id number.

The called satellite terminals respond with different backward messages depending on whether the satellite terminal in question can or cannot participate in the ptmp session. In the event of a successful called setup, the

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control station NCC concentrates all the backward messages (200 or 4xx messages) coming from the called terminals.

Thus, the setup of the ptmp session (Figure 4) is effected similarly to that of a ptp session; for clarification, reference numbers in the form 3nm are used for the messages exchanged in Figure 4, Figure 5, and Figure 7, and these correspond to those in Figure 2 and Figure 3 (in the form 1nm). The successful arrival of the INVITE message is confirmed by means of a backward message m12 "100." A CAC check C3 is made in the NCC; if this is successful, the connection is authorized and resource management procedures are initiated to allocate resources to the transmission paths; in addition, the called terminals ST2, ST3, ST4 are informed by INVITE messages m21, m31, and m41. The called satellite terminals respond with 200-messages m23, m33, and m43. These are bundled in a 200 message m13 and passed on to the calling satellite terminal ST1. The acknowledging ACK message m14 is transmitted by messages m24, m34, and m44 to the called satellite terminals, whereupon the satellite terminals can begin with the transmission of useful information s4 in the ptmp session.

Figure 5 considers the case in which one of the called satellite terminals -- for example the terminal ST3 -- does not participate in the ptmp session. This terminal then responds with a 486 message (reference symbol m37), whereas the other terminals, which accept the call, respond with 200 (reference symbols m23, m24). In this case, a 200 message m13' is transmitted which, in addition, contains in the body the identification of those terminals that have acknowledged negatively. For each 4xx; response of an invited satellite terminal ST3, a 4FIN body field (4FIN for "4xx Final Response) is appended; this contains the identification of

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the declining satellite terminal and the associated 4xx response type; thus, the 200 message m13' discloses a 4FIN body field that contains the information that the satellite terminal ST3 has responded with 486. Thus, in this case, too, only a 200 message m13' is transmitted at the interface between the control center NCC and the calling satellite terminal ST1; this simplifies the finite state machine of the calling satellite terminal and permits the retention of the standard machine. In this case, the ptmp session s3 that is set up in this way does not involve the satellite terminal ST3. For the remainder, the setup of the session s3 as in Figure 5 corresponds to the procedure for the successful set up as described in Figure 4.

If -- referring to Figure 5 -- all of the invited terminals ST2, ST3, and ST4, respond with a 4xx message m27, m37, a 499 message m17 is drawn up in place of a 200 message m13'. In the same way as with the m13' message for each 4xx response to the 499 message m17, a 4FIN body field will be appended.

In addition, proceedings for involving additional subscribers a ("Add Party") or the exclusion of individual subscribers ("Drop Party") can also be supported by the Sat-SIP Protocol according to the present invention, with reference to a ptmp session. Figure 6 shows one example of an add-party procedure, for example, the subsequent involvement of the satellite terminal ST3 following the procedure shown in Figure 5 so that, proceeding from session s3, a session s4' is achieved in which the terminal ST3 is similarly involved according to the results shown in Figure 4. This case proceeds like the setup of a characteristic session (Figure 2) and the separate messages are designated with the reference symbol *bnm* which corresponds to the messages *pnm* in Figure 2. The

difference from the procedure shown in Figure 2 is that during establishment of the ptmp connection as in Figure 5 in the header fields, the value of the parameter cseq is increased in order to distinguish the sequence as a characteristic transaction, whereas the parameter callid is the same. If a number of INVITE messages are used within the session, for example in order to invite a number of satellite terminals to a ptmp session or, in this case, to INVITE a satellite terminal subsequently, each INVITE message contains the identical callid; in order to be able to distinguish between the individual INVITE messages, they contain different cseq values. This corresponds to the Standard SIP. The same occurs in the case of BYE messages, whereas in an ACK or CANCEL message the identical cseq as in the particular associated INVITE message is used. The INVITE message b11 differs from the corresponding p11 message in particular in that it has an empty message body.

Figure 7 shows the successful call setup in the ptmp case. Once again, all of the information concerning the satellite terminal that is to be informed is sent to the calling satellite terminal ST1 in a common BYE message m15; this is done in order, on the one hand, to use the RASC channel effectively and, on the other hand, to remain in conformity with standards. A common acknowledgment m16 is used for the acknowledgment message. In an unsuccessful case, the body of the 200 messages is used in order to inform the calling satellite ST1 of the subscribers who have sent a negative acknowledgement. As far as the satellite terminals ST2, ST3, and ST4 are concerned, the procedure is analogous to that shown in Figure 3; in particular, the messages m25, m35, and m45 (BYE) and m26, m36, and m46 (200) correspond to the messages p25 or p26, respectively, shown in Figure 3. Here, too, the resources allocated in the control center NCC, are ultimately released by means of a CAC call C4, or the QoS parameter is reset.

QoS and/or traffic parameters can be newly negotiated for an existing Sat-SIP session, as this information is communicated from the calling terminal ST1 to the control center NCC in a new INVITE message. In the event that the new parameters are accepted by the CAC, the control center NCC sends appropriate INVITE messages to the called terminals. As soon as all the called terminals have responded with a 200 message, the control center NCC sends a 200 message to the calling satellite terminal. This responds with an ACK message to the control center, which once again sends an ACK message to each of the called satellites. Only the calling terminal can initiate modification of QoS and/or traffic parameters.

The Sat-SIP Call Control Prototype is described at length in SDL ("Specification and Description Language"). The architecture of the Sat-SIP Call Control prototype that the Sat-SIP Protocol implements is oriented essentially on the functional units required by the SIP Standard. Consequently, the terminal Sat-SIP software and the control center Sat-SIP software in the processes are subdivided according to transaction user, client transaction, and server transaction. Client and server transactions are described in the Standard-SIP and with the exception of the adapted timer, have been incorporated, complete and unmodified, in Sat-SIP.

In addition, if required for purposes of coordination (for control of the different process stages), processes that go beyond the standard must also be introduced. For example, the SIP Standard describes only the fact that specific tasks have to be assumed by a certain logical entities, but not, however, how this is to be done in a specific case. The same applies to the software architecture of the satellite terminals.

Another important point is the matter of the interworking of SAT-SIP with existing terrestrial protocols, namely, connection oriented protocols (ISDN, ATM) as well as non-connection protocols (IP). To this end, a dedicated interworking unit is required in the satellite terminal; this generates an action request either from a message (ISDN, ATM) arriving in the satellite terminal from the terrestrial network, or from an incoming packet (IP), or derives the appropriate parameters from the incoming message and composes a suitable Sat-SIP INVITE message. If necessary, mapping the parameters onto the SAT-SIP parameters must take place within the interworking unit (termination of the incoming connection), or the incoming messages are transmitted by way of the speech/data channel that has been set up. Then, consideration must be given individually to the special features of the particular terrestrial protocol (timer behaviour in the case of TCP/IP TCP splitting).

Figure 8 shows one example of a signal sequence with interworking between the ISDN Protocol and the Sat-SIP protocol. A Q931.SETUP message has been received by an ISDN interworking function IF1 associated with the calling satellite terminal ST1. The incoming SETUP message is then "held back" by the IWF in order to check whether or not a connection request for the anticipated (ISDN) traffic can be accepted. Only then can the SETUP message be sent on to the called terminal ST2 or its interworking function IF2. The interworking function IF1 thus generates a setup request ip1 (setup_req) from the SETUP message that is the trigger to generate an INVITE message p11. The setup request ip1 contains all the information from the incoming SETUP message that is required for generating an INVITE message p11 (which is to say essentially the traffic and QoS parameters). Within the satellite system, the messages p11, p21 and so on follow in the same way as has been discussed above on the

basis of Figure 2. On the called side ST2, a setup indication pi1 (setup_ind) is generated when the INVITE message p21 arrives, and this goes to the interworking function IF2 of the called satellite terminal ST2. Receipt is acknowledged by a setup response pi3 (setup_resp). This contains all the parameters that are required to generate the 200 message p23, which is then sent back through the satellites to the calling satellite terminal ST1 as message p13. Within the calling satellite terminal ST1, a setup confirmation ip3 (setup_cnf, "setup confirmation") is generated from this, and this is in its turn acknowledged by a message ip4 (setup_cmp_req, "setup completion request"). This leads to the transmission of an ACK message p14, p24 which concludes the transaction within the satellite system (Figure 2. On the called side, the ACK is once again converted to a confirmation pi4 (setup_cmp_ind "setup complete indication"). The Sat-SIP session S12 and the associated voice/data channel are set up through the satellites.

The Q.931 SETUP message q1 that is waiting in the called interworking function IF1 is now transmitted by way of a dedicated signaling channel to the called satellite terminal ST2/IF2 (complete separation of signaling and useful information), and from there passed to a subordinate ISDN exchange that processes the Q.931 Protocol in the known manner. When this is done, the signaling channel can be allocated permanently, for example, by configuration of one or more satellite terminals, or it is set up as required, for example, in a manner similar to the method described. The signaling information for a specific satellite terminal thus passes through a "single hop." There is now ISDN signaling that conforms to standard between the two interworking functions IF1, IF2, the exchange of information being effected transparently by way of the Sat-SIP session S12.

Signalling for call release is effected in a manner that corresponds to that discussed above.

The present invention is not restricted to the example of the Sat-SIP discussed above; rather, it can be used in general systems. Thus, the present invention can also be used, for example, with a narrow-band satellite system. Resource management of the satellite SAT can be either on-board or localized in the control center NCC. In addition, the control center NCC does not have to be realized as a ground location that is separated from the satellite, but can be on-board either wholly or in part. It is also possible to use a communications satellite system without onboard processing." In this case, the data connection is made in a "double-hop" from the calling satellite terminal through a central ground station to the called satellite station.

The connections can also be set up by involving terrestrial network connections (without satellite) which are signaled in the same way as in the present invention, e.g., via Sat-SIP.

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CLAIMS:

1. A method for controlling connections between transit network terminals of a transit network, with a central control device and, a plurality of transit network terminals using transit network communication paths that extend in each instance
5 between two of the terminals and repeater stations, control of the communication groups, being effected by the control device using signaling information that is exchanged between the control center and the terminals, wherein a signaling protocol with at least the following request message types that correspond to the Session Initiation Protocol (SIP) standard is used for exchanging signaling
10 information:
- a message type to initiate a connection setup,
 - a message type to initiate release of a connection, and
 - a message type to confirm a previous exchange of signaling information,
- as well as at least one response message type for at least one of confirmation
15 messages and error messages.
2. The method as defined in claim 1, wherein controlling connections comprises at least one of establishing and releasing connections.
3. The method as defined in claim 1 or 2, further comprising controlling connections with one or a plurality of repeater stations within the transit network.
- 20 4. The method as defined in any one of claims 1 to 3, wherein control of the communication groups comprises seizing and releasing the communication groups for connections between terminals.

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5. The method as defined in any one of claims 1 to 4, wherein in at least some of the messages exchanged in accordance with the signaling protocol, a plurality of called transit network terminals are designated, such messages being used for controlling point-to-multipoint connections.
- 5 6. The method as defined in claim 5, wherein the at least some of the messages comprises messages according to the message type for initiating a connection setup.
7. The method as defined in claim 5 or 6, wherein an additional response message type is used with which an error message is signaled in reference to all the
10 called transit network terminals of a point-to-multipoint connection.
8. The method as defined in any one of claims 5 to 7, wherein in the confirmation reports for point-to-multipoint connections, body fields according to an additional body field type are used, an error message relative to one called transit network terminal of the particular point-to-multipoint connection being signaled by
15 means of such a body field.
9. The method as defined in any one of claims 1 to 8, wherein the signaling protocol is realized as a signaling protocol that is superimposed on at least one of the Internet Protocol (IP) and a protocol that is of a higher order than the IP.
10. The method as defined in claim 9, wherein the protocol that is of a
20 higher order than the IP comprises Transmission Control Protocol (TCP) or User Datagram Protocol (UDP).
11. The method as defined in any one of claims 1 to 10, wherein desired or required connection parameters are detailed in the body of a request message sent from a transit network terminals to the control device.

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12. The method as defined in claim 11, wherein at least some of the connection parameters apply to one or more of the following: connection type, service category, maximal data rate, utilization factor, maximal burst size, desired priority of the connection, cell delay variation, maximal cell transfer delay.

5 13. The method as defined in any one of claims 1 to 12, used to control connections between satellite terminals of a satellite telecommunications system, with the central control device, a number of satellite terminals, and at least one satellite, using communication paths which extend in each instance between
10 (i) two of the satellite terminals; (ii) the at least one satellite; or (iii) two of the satellite terminals and the at least one satellite, wherein control of the communications paths being effected from the central control device on the basis of signaling information which is exchanged between the control center and the satellite terminals.

14. The method as defined in claim 13, wherein control of the communications paths comprises seizing and releasing the communications paths
15 for connections between satellite terminals.

15. The method as defined in claim 13 or 14, wherein the allocation of bandwidths for data transmission is controlled by at least one of the satellite and satellites by dynamic resource administration, as a function of the connection quality that is required.

20 16. The method as defined in claim 15, wherein for each satellite, the resource administration that is associated with the respective satellite proceeds within the framework of an on-board system on the respective satellite.

17. A control device for controlling transit network communication paths in a transit network with a plurality of transit network terminals, the communications paths
25 each extending between (i) two of the terminals; or (ii) one or more repeater stations;

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or (iii) two of the terminals and one or more repeater stations, the control device being equipped for exchanging signaling information with the terminals and for processing the signaling information for appropriate control of the communication paths for the purpose of controlling connections, wherein the control device is
5 equipped for using a signaling protocol for the exchange of the signaling information with at least the following request message types that correspond to the SIP Standard:

- a message type for initiating a connection setup,
- a message type for initiating release of the connection, and
- 10 - and a message type for confirming a previous exchange of signaling information, as well as at least one response message type for at least one of confirmation messages and error messages.

18. The control device as defined in claim 17, wherein controlling the transit communication paths comprises establishing and releasing the transit communication
15 paths.

19. The control device as defined in claim 17 or 18, wherein the control device is also for controlling the one or more repeater stations that are internal to the transit network.

20. The control device as defined in any one of claims 17 to 19, wherein
20 controlling connections comprises setting up the connections and releasing the connections between the terminals.

21. The control device as defined in any one of claims 17 to 20, wherein the device is equipped as a control device for a satellite telecommunications system with a plurality of satellite terminals and the at least one satellite, for controlling, satellite

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communication paths in each instance extend between (i) two of the satellite terminals; (ii) the at least one satellite; or (iii) two of the satellite terminals and the at least one satellite.

22. The control device as defined in claim 21, wherein controlling the satellite communication paths comprises establishing and releasing the satellite communication paths.

23. A terminal device for a transit network with a control device for establishing and releasing connections within the transit network in conjunction with other transit network terminals using communications paths which in each instance extend between the terminal device and another terminal or a repeater station, the terminal device being equipped for exchanging signaling information with the control device, for controlling communications paths, wherein the terminal device is equipped for using a signaling protocol for the exchange of signaling information with at least the following request message types that correspond to the SIP Standard:

- a message type for initiating a connection setup,
 - a message type for initiating release of the connection, and
 - a message type for confirming a previous exchange of signaling information,
- as well as at least one response message type for at least one of confirmation messages and error messages.

24. The terminal device as defined in claim 23, wherein the terminal device is also for establishing and releasing connections in conjunction with one or a plurality of repeater stations that are internal within the transit network.

25. The terminal device as defined in claim 23 or 24, wherein controlling the communications paths comprises establishing and releasing the communication paths.

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26. The terminal device as defined in any one of claims 23 to 25, configured as a satellite terminal device for a satellite telecommunications system equipped with a plurality of satellite terminals and at least one satellite, the satellite terminal device being for setting up and releasing connections in the satellite telecommunications
5 system in conjunction with the at least one satellite using satellite telecommunications paths which in each instance extend between at least one satellite terminal and at least one satellite.

27. The terminal device as defined in any one of the claims 23 to 26, wherein in the messages exchanged in accordance with the signaling protocol,
10 designation of a plurality of called terminals is permissible, such messages being used for controlling point-to-multipoint connections.

28. The terminal device as defined in claim 27, wherein the messages exchanged are according to the message type for initiating setup of a connection.

29. The terminal device as defined in claim 27 or 28, wherein an additional
15 response message type is provided for signaling an error message relative to all the called terminals of a point-to-point at the connection.

30. The terminal device as defined in any one of claims 27 to 29, wherein body fields according to an additional body field type are permissible in the confirmation reports for point-to-multipoint connections, an error message relative to
20 a called terminal of the particular point-to-multipoint connection being signaled by means of each such body field.

31. The terminal device as defined in any one of claims 27 to 30, wherein the signaling protocol is realized as a signaling protocol that is superimposed on at least one of IP and a protocol such as TCP or UDP that is of a higher order.

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32. The control device as defined in any one of claims 17 to 22, wherein the signaling protocol is realized as a signaling protocol that is superimposed on at least one of the IP and a protocol such as TCP or UDP that is of a higher order.

33. The terminal device as defined in any one of claims 27 to 31, wherein
5 an indication of desired or required connection parameters is permissible within the body of a request message that is sent from a terminal to the control device.

34. The control device as defined in any one of claims 17 to 22 and 32,
wherein an indication of desired or required connection parameters are permissible
within the body of a request message that is sent from a terminal to the control
10 device.

35. The terminal device as defined in claim 33, wherein at least some of the
connection parameters sent in this way concern two or more of the following
variables: connection type, service category, maximal data rate, utilization hardware
where factor, maximal burst size, desired priority of the connection, cell delay
15 variation, maximal cell transfer delay.

36. The control device as defined in claim 34, wherein at least some of the
connection parameters sent in this way concern two or more of the following
variables: connection type, service category, maximal data rate, utilization hardware
where factor, maximal burst size, desired priority of the connection, cell delay
20 variation, maximal cell transfer delay.

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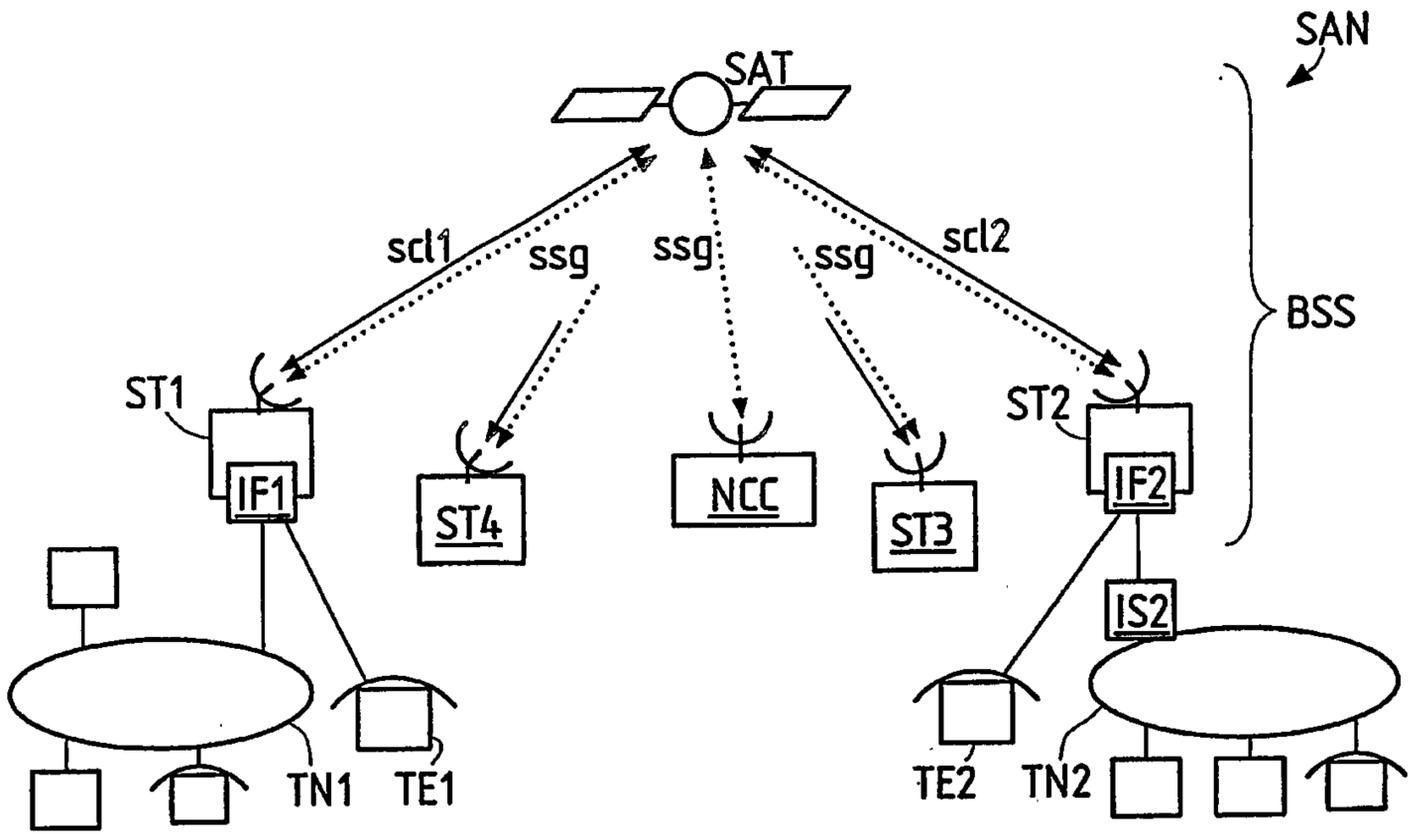


Fig. 1

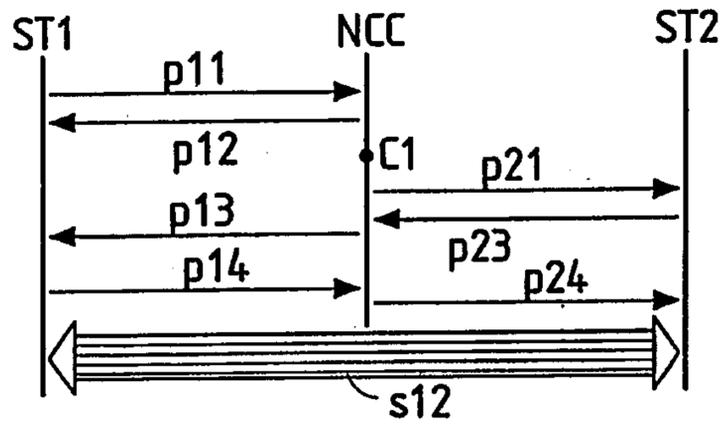


Fig. 2

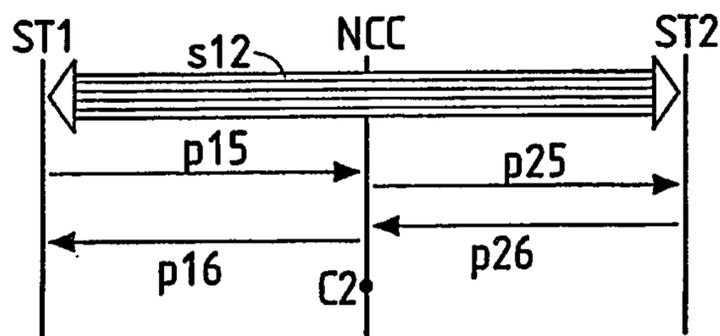
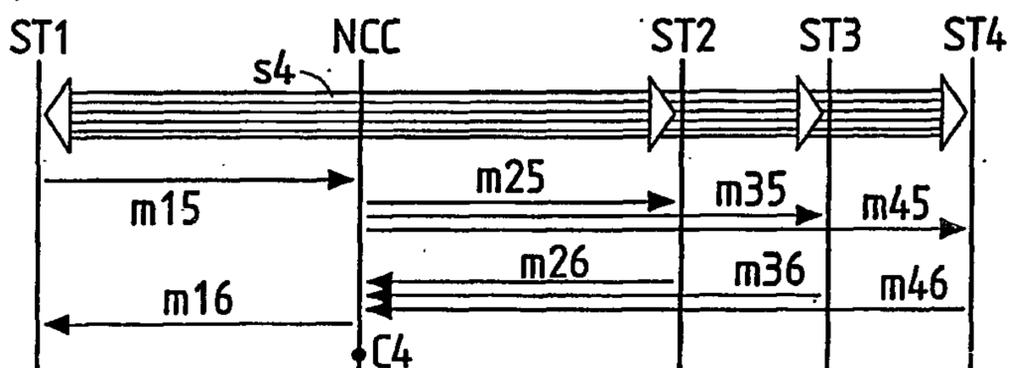
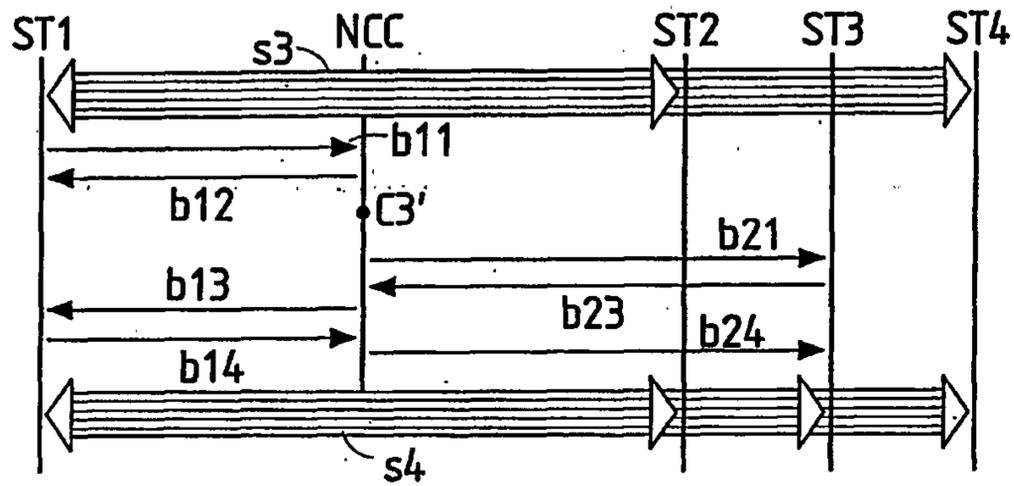
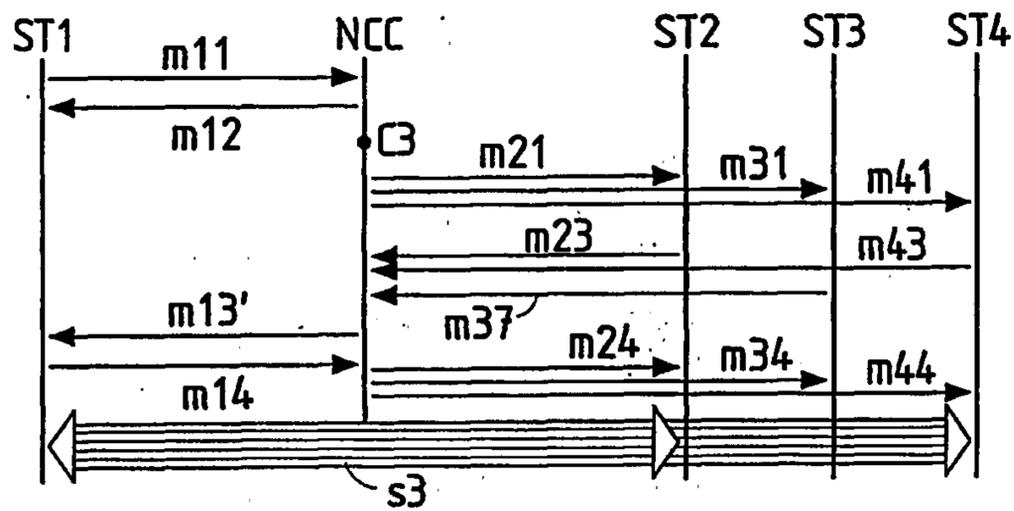
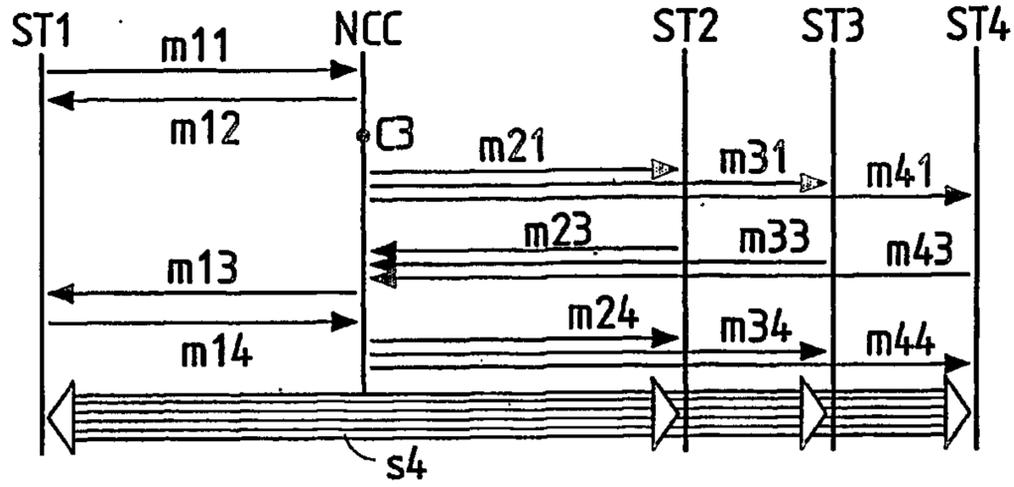


Fig. 3

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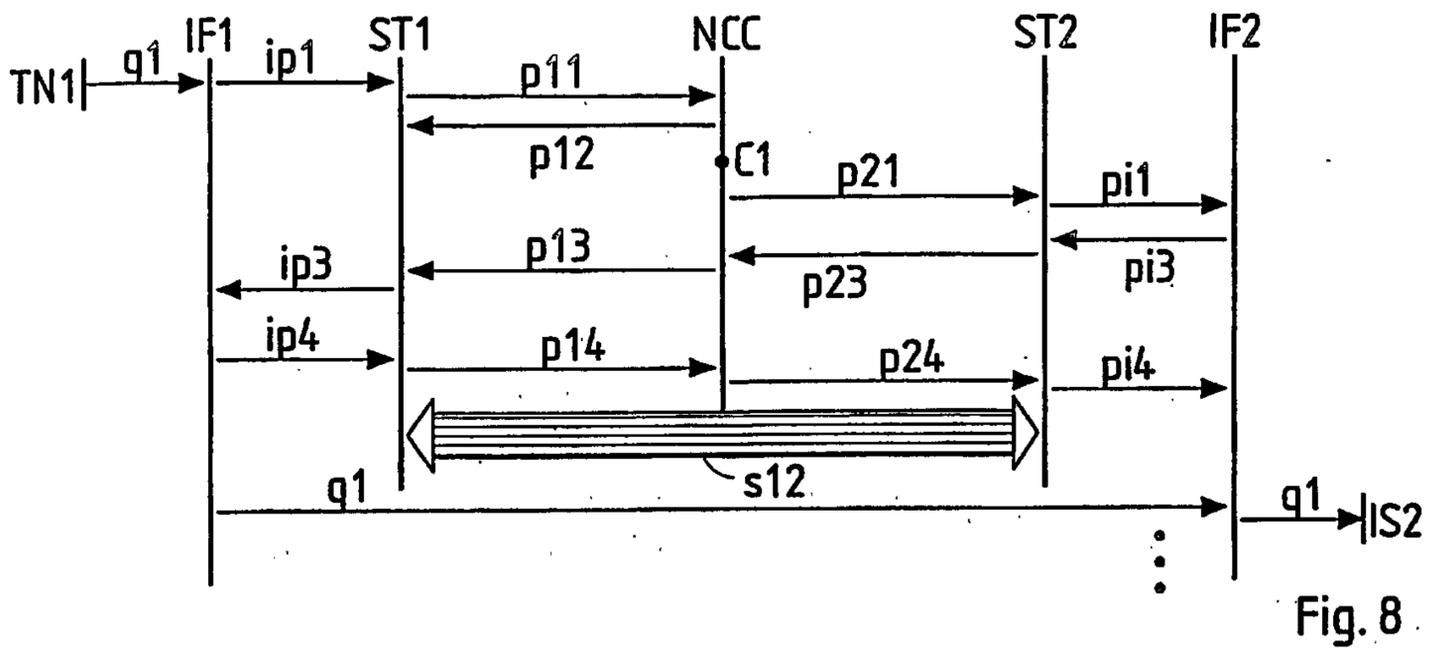


Fig. 8

