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(54) Title: SYSTEM AND METHOD FOR THE COMMUNICATION OF OPERATION AND MAINTENANCE, ADMINISTRATION AND PROVISIONING OVER AN ATM NETWORK (57) Abstract To support communications system repairability, a scalable multi-level data bit stream (38), capable of supporting variable bandwidth ATM network access, includes an embedded operation channel (42) used by a transport network management system (34) to support connection maintenance, performance monitoring, path tracing, service management and testing functionalities. The transport network management system effectuates a service specific convergence sub-layer functionality to convert (256) between Common Management Information Protocol (CMIP) formatted operation and maintenance managed objects and a message format for the embedded operation channel data. The conversion comprises a Remote Operations Service Element (ROSE) encapsulation (258), with the encapsulated data incorporated within the embedded operation channel of the multi-level data bit stream. An interface is provided with the ATM network through an ATM adaptation layer to segment the multi-level data bit stream into a plurality of ATM Cells (26). Operation and maintenance message communication with the transport network management system is provided for both wireless and wireline communications systems accessing the ATM network.		

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SYSTEM AND METHOD FOR THE COMMUNICATION OF OPERATION AND MAINTENANCE, ADMINISTRATION AND PROVISIONING OVER AN ATM NETWORK

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CROSS-REFERENCE TO RELATED APPLICATION

This Application for Patent is related to, and incorporates by reference, and is a continuation-in-part of previously filed, commonly assigned, co-pending Application for Patent Serial Number 08/615,096, entitled "SYSTEM
10 SUPPORTING VARIABLE BANDWIDTH ASYNCHRONOUS TRANSFER MODE NETWORK ACCESS FOR WIRELINE AND WIRELESS COMMUNICATIONS" filed March 14, 1996.

BACKGROUND OF THE INVENTION

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Technical Field of the Invention

The present invention relates to transport network management system (TNMS) communication of operation and maintenance (O&M) information over an asynchronous transfer mode (ATM) network and, in particular, to the encapsulation of common management information protocol (CMIP) formatted operation and
20 maintenance information for asynchronous transfer mode based transport.

Description of Related Art

Broadband transmission and switching have become important topics in the communications industry. A new system has been implemented for transmitting broadband and narrowband packet and circuit signals over a broadband network.
25 This system is commonly referred to as asynchronous transfer mode (ATM). In ATM, data is packed into frames, with each frame segmented into a plurality of fixed length blocks called "cells." Each ATM cell is fifty-three bytes (or octets) long and consists of a five byte header indicating, as one of its functions, the destination of the cell, followed by a forty-eight byte payload containing the data to be
30 transmitted to that destination.

The use of ATM cells permits the information transfer rate over the physical medium of the broadband network to adapt to actual service requirements.

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Depending on the capacity required, the number of cells per unit of time may be increased in a variable bit rate (VBR) ATM network up to the transmission bit rate limit of the physical medium. Alternatively, constant bit rates (CBR) are supported, with the transmission bit rate adjusted by the inclusion of idle or fill in cells when
5 necessary. The cells are transported over the physical medium at a typical constant bit rate of, for example, 155.52 Mbits per second. Faster bit rates are supported for communications occurring solely within the ATM network.

One important characteristic of ATM technology relates to its protocol architecture and is built around the so-called "core-and-edge" principle. The
10 protocol functions specific to the information type being transported, such as retransmissions, flow control, and delay equalization, are performed in user terminals at the "edges" of the ATM network. This leaves an efficient, service-independent "core" network, including only simple cell-transport and switching functions. A user-to-network interface (UNI) implementing an ATM adaptation
15 layer (AAL) is provided at the "edge" of the network to connect the user terminals to the core network thereby allowing for service-independent ATM transport. The ATM adaptation layer performs a mapping operation between the bit stream data format of the user terminals external to the ATM network and the payload field of an ATM cell transmitted through the network.

20 In the field of transport network management (TNM) compliant network management systems, it is required that the interface with the network elements comprise a Q_3 interface. The functionality to be provided under the Q_3 interface is currently described in TMN Standard M.3010. The defined functionalities address the upper levels (4-7) of the International Standards Organization (ISO) Open
25 Systems Interconnection (OSI) model. Some solutions have been proposed with respect to the transmission means (OSI levels 1-3) to be used for supporting the Q_3 interface. This work has primarily focused on the use of the Transmission Control Protocol/Internet Program (TCP/IP) for low speed communications, and the use of Fiber Distributed Data Interface (FDDI) for medium speed communications. What
30 is needed in connection with high speed communications is a mechanism for utilizing an asynchronous transfer mode network as the transmission means for

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supporting the Q₃ interface. Such a transmission means would accommodate real-time and low latency transport of operation and maintenance (O&M) data.

In previously filed, commonly assigned, co-pending Application for Patent Serial Number 08/615,096, entitled "SYSTEM SUPPORTING VARIABLE
5 BANDWIDTH ASYNCHRONOUS TRANSFER MODE NETWORK ACCESS FOR WIRELINE AND WIRELESS COMMUNICATIONS" filed March 14, 1996, the disclosure of which is incorporated by reference, a system is disclosed which utilizes a multi-level data bit stream capable of supporting variable bandwidth ATM network access. The bit stream is dynamic in nature in that it is capable of
10 supporting a number of different sub-rates with respect to its included channel bearers. To support repairability and configurability, the bit stream includes an embedded operation channel for transmitting operation and maintenance messages. Furthermore, to specify the use of the right amount of bandwidth at the proper location within the communications system, the bit stream includes delimiting data
15 for performing add/drop multiplexing and/or digital cross-connection functions.

In particular, the disclosed multi-level data bit stream comprises a basic bit stream block including an appropriate repetition rate for the information being transmitted. The transmission bit rate of the basic bit stream block is a fraction of the transmission bit rate limit of the physical medium used in the ATM network.
20 In instances where higher transmission bit rates are needed, for example in carrying video or data (file transfers), multiple basic bit stream blocks are used to carry the data during the same time period. The basic bit stream block further supports sub-rates useful in carrying voice and data communications in a plurality of channels. With respect to such sub-rate communications, delimiting data is added for
25 performing add/drop multiplexing and/or digital cross-connection functions of the included channels. Furthermore, each basic bit stream block includes an embedded operation channel useful for connection maintenance, performance monitoring, path tracing, supervision and service management functions.

There would be an advantage if the disclosed multi-level data bit stream, and
30 in particular its included embedded operation channel could be used as the

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mechanism for facilitating use of an asynchronous transfer mode network as the transmission means supporting the Q₃ interface.

SUMMARY OF THE INVENTION

5 A multi-level data bit stream capable of supporting variable bandwidth ATM network access and including an embedded operation channel is provided for handling communication external to an ATM network. The embedded operation channel is used to transmit operation and maintenance messages in connection with transport network management system support of network repairability and
10 configurability operations such as connection maintenance, performance monitoring, path tracing, supervision and service management. The transport network management system is implemented through a service specific convergence sub-layer functionality to convert between Common Management Information Protocol (CMIP) formatted operation and maintenance messages and a message format
15 suitable for the embedded operation channel. In particular, the CMIP formatted data is Remote Operations Service Element (ROSE) encapsulated, with the encapsulated data incorporated within an embedded operation channel data format including node addressing and ATM adaptation layer (AAL) information. The resulting message comprises the embedded operation channel which is then incorporated with other
20 user data within the multi-level data bit stream. An interface is provided with the ATM network through the ATM adaptation layer to segment the multi-level data bit stream, including the embedded operation channel, into a plurality of ATM cells.

 The present invention further comprises a wireless communications system wherein a base station concentrator is connected through an access node to an ATM
25 network. The concentrator is further connected to a plurality of base stations which effectuate radio frequency communications with a plurality of mobile stations using a plurality of voice channels. Communications over the link connecting the base station concentrator to the access node utilize the foregoing multi-level data bit stream. By means of the embedded operation channel, a transport network
30 management system may perform connection maintenance, performance monitoring,

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path tracing, service management and testing over the ATM network and with respect to the access node and base station concentrator.

The present invention still further comprises a wireline communications system wherein a wireline concentrator is connected through an access node to an ATM network. The concentrator is further connected to a plurality of wireline telephone terminals through which subscribers engage in telephone communications using a plurality of voice channels. Communications over the link connecting the wireline concentrator to the access node utilize the foregoing multi-level data bit stream. By means of the embedded operation channel, a transport network management system may perform connection maintenance, performance monitoring, path tracing, service management and testing over the ATM network and with respect to the access node and wireline concentrator.

With respect to either or a combination of both wireless and wireline communications systems, a communications exchange is connected through an access node to the ATM network. The transport network management system is also connected through an access node to the ATM network. Communications over the link connecting the exchange to the access node utilize the foregoing multi-level data bit stream. By means of the embedded operation channel, a transport network management system may perform connection maintenance, performance monitoring, path tracing, service management and testing over the ATM network and with respect to the access node and the exchange.

BRIEF DESCRIPTION OF THE DRAWINGS

A more complete understanding of the method and apparatus of the present invention may be acquired by reference to the following Detailed Description when taken in conjunction with the accompanying Drawings wherein:

FIGURE 1 is a block diagram of a communications system utilizing an asynchronous transfer mode (ATM) transport network; and

FIGURE 2 illustrates the configuration of an ATM cell;

FIGURE 3 illustrates a multi-level data bit stream basic block;

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FIGURE 4 illustrates the construction of the basic block of FIGURE 3 to handle sub-rate plural bearer channels for packet voice communications;

FIGURE 5 illustrates the construction of the basic block of FIGURE 3 to handle full rate plural bearer channels for pulse code modulated (PCM) voice communications;

FIGURE 6 illustrates an exemplary format for the embedded operation channel (EOC) within the bit stream basic block;

FIGURE 7 is a communications line diagram illustrating by way of example the connections and associated transmission bit rates for a given communication handled by the communications system of FIGURE 1;

FIGURE 8 is a block diagram of an ATM access node supporting multi-level data bit stream basic block transmissions with an embedded operation channel and an ATM pre-shaping and signaling functionality;

FIGURES 9A and 9B illustrate ATM adaptation layer #1 conversion between ATM cells and $n \times 10$ Mbps bit stream basic blocks at the segmentation and reassembly stages, respectively;

FIGURE 10 is a block diagram of the transport network management system;

FIGURE 11 is a block diagram of an interface portion of a user node supporting multi-level data bit stream basic block transmissions with delimiting bits for add/drop multiplexing and/or digital cross-connection functions;

FIGURE 12 is a block diagram of a portion of a cellular telecommunications system utilizing the communications system of FIGURE 1;

FIGURE 13 is a block diagram of a portion of a wireline telecommunications system utilizing the communications system of FIGURE 1; and

FIGURE 14 is a block diagram of a portion of a combination cellular/wireline telecommunications system utilizing the communications system of FIGURE 1.

DETAILED DESCRIPTION OF THE DRAWINGS

Reference is now made to FIGURE 1 wherein there is shown a block diagram of a communications system 10 utilizing an asynchronous transfer mode

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(ATM) transport network 12. The system 10 includes a plurality of ATM access nodes 14 and user (service) nodes 16 external to the ATM transport network 12. The ATM access nodes 14 perform pre-shaping flow enforcement functions and are located at the "edges" of the ATM transport network 12 between the user nodes 16 and the ATM transport network "core". At such a location, the access nodes 14 implement protocol functions specific to the information being transported over the network (like flow control and delay equalization). The access nodes 14 and the user service nodes 16 are connected by communications links 18 supporting the transmission of an ATM access compatible, multi-level data bit stream as will be described.

The core of the ATM network 12 comprises a plurality (only two shown) of interconnected ATM cross-connect (switching) nodes 20 that perform only simple ATM transport and switching functions. The cross-connect nodes 20 are connected to the ATM access nodes 14 by communications links 22, and are interconnected with each other by communications links 24. The links 22 and 24 support the transmission of basic information units (cells) through the ATM network 12 at a bit rate in accordance with well known ATM standards and protocols. This "core and edge" principle for building an ATM network 12 makes it relatively simple to introduce new services as the specific service dependent functions are handled external to the ATM network in the ATM access nodes 14, with the ATM network itself solely being responsible for routing and transporting service data.

With reference now to FIGURE 2, the basic information transfer unit within the ATM network 12 is a small, fixed size packet commonly referred to as an ATM cell 26. The fixed length of the ATM cell 26 is fifty-three bytes (or octets) divided into a five octet header field 28 and a forty-eight octet information (payload) field 30. The header field 28 contains, among other things, information identifying the ATM cell 26 and specifying the routing of the cell through the ATM network 12. The routing information comprises a virtual path identifier (VPI) and a virtual channel identifier (VCI). A virtual path comprises a bundle of multiplexed circuits between two termination points at each ATM node and is identified by the virtual path identifier in the ATM cell header field 28. The virtual path concept allows

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multiple virtual channels through the ATM network 12 to be handled as a single unit. The virtual channel is identified by the virtual channel identifier in the ATM cell header field 28.

5 The payload field 30 of the ATM cell 26 typically carries user data. In addition to the ATM cells 26 which carry user data, other cells having the same fixed size are defined for use in the ATM network 12 for signaling and maintenance. The signaling cells are used to set up a service, for example, comprising a connection through or outside of the ATM network 12. The maintenance cells are used to supervise the virtual paths and virtual channels through the ATM network
10 12. Idle cells, also having the same fixed size, may be used to fill the transmission capacity of the ATM network 12 up to the transmission bit rate limit of the physical medium.

Reference is now again made to FIGURE 1. Data received over communications links 18 by the ATM access nodes 14 at the edge of the ATM
15 network 12 must be converted to the ATM cell 26 fixed size format of FIGURE 2 (and vice versa, as appropriate). This is accomplished by a user-to-network interface (UNI) 32. The user-to-network interface 32 implements an ATM adaptation layer (AAL) which performs a mapping between the format of the data carried over the communications links 18 and the information field 30 of the ATM
20 cell 26. Some examples of the functions provided by the ATM adaptation layer are convergence, segmentation and reassembly, variable length packet delineation, sequence numbering, clock recovery and performance monitoring. The ATM adaptation layer is an important part of the user-to-network interface 32 because adaptation between the data on link 18 for the user service external to the ATM
25 network 12 and the ATM cell 26 on link 22 to allow for service independent ATM data transport. Thus, the interface 32 further functions to make the connection to the physical media of the communications link 22. The identifier "UNI/ATM/PHY" for the interface 32 accordingly refers to the UNI operation of converting to and from the ATM cell format (ATM) and inserting and extracting cells with respect to
30 the physical medium (PHY) of the ATM network.

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5 The communications system 10 further includes a transport network management system (TNMS) 34 to process and provide operation and maintenance (O&M) information regarding the communications system 10 in general, as well as the ATM network 12 in particular. It will be noted that the transport network management system 34 is connected to only a single ATM access node 14 via a communications link 36. This is because it is through that single ATM access node 14 and the ATM network 12 that the transport network management system 34 has access for communications to each of the access nodes 14, user service nodes 16 and ATM operation and maintenance of the switching nodes 20.

10 The communications system 10 implements an agent/manager concept with respect to the operation and maintenance functionality. Operation and maintenance managed objects (data or information relating, for example, to performance management, fault management, security management and configuration management) concerning the access nodes 14 themselves and the ATM transport network 12 (and its cross-connect nodes 20) are stored in a local data base memory (dbm) 31 associated with each access node. Similarly, operation and maintenance managed objects concerning the user nodes 16 themselves are stored in an associated local data base memory (dbm) 33. Management of the data stored within the data base memories 31 and 33 for the access nodes 14 and user nodes 16, respectively, is performed by an agent functionality 35. The transport network management system 34 includes a global data base memory (dbm) 37 for storing operation and maintenance managed objects relating to the communications system 10 as a whole. Management of this data is performed by a manager functionality 39. Responsive to requests from the manager functionality 39, the agent functionalities 35 retrieve operation and maintenance data from the data base memories 31 and 33 for forwarding and storage in the global data base memory 37. Alternatively or additionally, and further on a periodic basis or in response to a change in status, the agent functionality 35 retrieves operation and maintenance data from the data base memories 31 or 33, and refreshes the data stored in the global data base memory 37.

30 Reference is now made to FIGURE 3 wherein there is shown a multi-level data bit stream basic block 38 which is transmitted over the communications links

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18 between the access nodes 14 and the user service nodes 16. The bit stream basic block 38 includes a data portion 40 wherein service data relating to the user nodes 16 is carried. The bit stream basic block 38 further includes an embedded operation channel (EOC) 42 which contains the operation and maintenance data associated with transport network management system 34 operation. It is through use of this embedded operation channel 42 that the transport network management system 34 can have access to each of the nodes of the communications system 10 while only being connected to a single access node 14 and offer all of the functionality currently described under TMN Standard M.3010. An operation and maintenance flag (see BOF 200 of FIGURE 6) within the embedded operation and maintenance channel 42 further helps in system 10 determination of the beginning of another bit stream basic block 38.

With reference now again to FIGURE 1, the ATM access node 14 inserts and extracts information to and from the embedded operation channel 42 of the bit stream basic block 38. The extracted information from the embedded operation channel 42 comprises information received from transmissions either over the ATM network 12 or from the connected to user service node(s) 16 or access nodes 14 for processing by the transport network management system 34. The inserted information into the embedded operation channel 42 comprises information received from the transport network management system 34 to be transmitted either over the ATM network 12 or to the connected to user service node(s) 16 or access nodes 14.

In response to bit stream basic blocks 38 received over communications link 18, the ATM access node 14 further functions in accordance with its ATM adaptation layer to segment the data portion 40 and embedded operation channel 42 into segments of an appropriate byte length to fit within the payload portion 30 of one or more ATM cells 26 (see, FIGURE 2). The ATM access node 14 further determines the destination for the received bit stream basic blocks 38 and processes routing table derived addressing information in the header portion 28 of the ATM cells 26 which include the segmented data. The generated ATM cells 26 are then output from the ATM access node 14 over communications link 22 in accordance

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with any specified flow restrictions for transmission over the ATM network 12 to the destination translated by each ATM node according to a given routing algorithm.

An opposite procedure is followed with respect to ATM cells 26 received from the ATM network 12 over communications link 22. The ATM access node 14
5 identifies from the header 28 of the received ATM cell 26 and a destination routing table the particular user service node 16 to which the data in the payload portion of that ATM cell is intended for delivery. From the payloads 30 of the received ATM cells 26, the ATM access node 14 uses the ATM adaptation layer to construct the bit stream basic block(s) 38 needed to convey the information. The bit stream basic
10 block(s) 38 are then transmitted to the appropriate identified destination user service node 16 via communications link 18.

The user service nodes 16 may not be located physically close to the ATM access node 14. To account for this, both the user service node 16 and the ATM access node 14 include a line interface 44 that facilitates bit stream basic block data
15 transmission over certain types of communications links 18 within communications systems better suited for last mile communications. Such communications systems include by way of example asymmetric digital subscriber line (ADSL); hybrid fiber coaxial (HFC); fiber optic transport system (FOTS); fiber in the loop (FITL); category 3 unshielded twisted pair (UTP) cable; or a scalable inversely multiplied
20 (e.g., seven times) T1 connection.

Reference is now again made to FIGURE 3. The bit stream basic block supports transmission at a plurality of rates, and thus may be configured to include a plurality of sub-blocks 46. Each sub-block 46 is at the appropriate repetition rate for the data being transmitted over a plurality of channels. Thus, each sub-block 46
25 includes a data portion 48 for communicating the plural channel communications data. The sub-blocks 46 still further include uniformly spread delimiting bits 50 (indicated by tick marks within the data portions 48) for assisting in the performance of add/drop multiplexing and/or digital cross-connection functions with respect to the plural transmitted channels. The delimiting bits 50 identify particular ones of
30 the plural channels which may be added or dropped from the data stream in order to use these particular channels at the given local user service nodes 16. Because

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the delimiting bits 50 comprise a portion of the bit stream basic block 38, that information may be transmitted from one user service node 16 or ATM access node 14 across the ATM network 12 for implementation at another user service node.

5 The configuration of the bit stream basic block to include both an embedded operation channel 42 and delimiting bits 50 for supporting add/drop multiplexing and/or digital cross-connection functions may be better understood with reference to a specific example. Assume for this example a bit stream basic block transmitted at a rate of 10 Mbps (megabits per second). The rate of 10 Mbps for the bit stream basic block is chosen in this example because it is equivalent to seven T1
10 connections, and thus the selected bit rate for this example is sufficient to be at least an equivalent in cost to one DS3. The bit stream basic block is scalable to handle various types of communications traffic. In the event a transmission rate greater than 10 Mbps is needed to carry the communications, for example, with respect to a high quality video or data (file transfer) communications, additional 10 Mbit basic
15 blocks are added to the bit stream (for the same time period) to increase the overall rate of transmission over the communications links 18 (FIGURE 1) to $n \times 10$ Mbps over the same ATM connection. It will, of course, be understood that the $n \times 10$ Mbps bit stream may not be scaled by n to a rate faster than the transmission bit rate limit of the physical medium (communications links 22 and 24) of the ATM network
20 12.

Each 10 Mbit basic block further supports a number of sub-rates used to transmit voice communications. Voice must be transmitted at a certain repetition rate in order to control call delays and offer the proper level of granularity to provide intelligible voice communications. For packet voice and personal
25 communications systems (PCS) type of communications, the delay between consecutive voice packets is twenty milliseconds which gives a repetition rate of fifty packets per second. For pulse code modulated (PCM) type of voice communications, on the other hand, the repetition rate is 8,000. The bit stream basic block supports both packet voice and pulse code modulated voice
30 communications while also providing the delimiting bits to control the adding or

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dropping of individual voice channels. The foregoing further supports the provision of bit stuffing to control cell delay variations.

Reference is now made to FIGURE 4 wherein there is illustrated the construction of an example bit stream basic block 38 according to FIGURE 3 to handle sub-rate plural bearer channel packet voice communications. The individual packets (P) 52 for a packet voice PCS type communications system comprise one hundred ninety-two bits each. One frame (F) 46 of packet voice communications comprises at least forty packets 52 (bearer channels) of one hundred ninety-two bits each plus three hundred twenty evenly spread add/drop multiplexing delimiting bits (DB) 50 for a total of 8 Kbits. Twenty-four of the frames 46 are then assembled together along with an 8 Kbit embedded operation channel 42 to form a group (G) 54 having a total of 200 Kbits. With the packet voice (PCS) repetition rate of fifty groups 54 per second, this gives the 10 Mbps bit stream basic block 38 (FIGURE 3) having both an embedded operation channel 42 and delimiting bits 50 for performing add/drop multiplexing and/or digital cross-connection functions. Thus, with respect to packet voice, each 10 Mbps bit stream basic block may be used to transmit nine-hundred sixty packet voice channels ($40 \times 24 = 960$).

Reference is now made to FIGURE 5 wherein there is illustrated the construction of an example bit stream basic block 38 according to FIGURE 3 to handle full rate plural bearer channel pulse code modulated (PCM) voice communications. In accordance with known T1 North American practice, there are twenty-four channels (C) 56 of eight bits each in each PCM sub-frame (SF) 58. Thus, each PCM sub-frame 58 comprises one hundred ninety-two bits. One frame (F) 60 of PCM voice communications comprises forty sub-frames 58 of one hundred ninety-two bits each plus three hundred twenty evenly distributed delimiting bits (DB) 50 for a total of 8 Kbits. In this example, there are six PCM frames 60 (i.e., blocks of 8 Kbits each) in each super frame (SFR) 62, and four super frames 62 plus an 8 Kbit embedded operation channel 42 are included in forming a group (G) 64 having a total of 200 Kbits. It should be noted that within a group 64 the four super frames 62 contain identical (i.e., repeated) PCM channels. Repeated then at a rate of fifty groups 64 per second, this gives the 10 Mbps bit stream basic block 38

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(FIGURE 3) having both an embedded operation channel 42 and delimiting bits 50 for performing add/drop multiplexing and/or digital cross-connection functions. Thus, with respect to PCM voice, each 10 Mbps bit stream basic block may be used to transmit one-hundred forty-four channels ($24 \times 6 = 144$). PCM voice communications have a repetition rate of 8,000 per each eight bit channel 56 to give 64 Kbps channel bearers. This rate is derived with respect to the 10 Mbps bit stream basic block 38 shown in FIGURE 5 from the forty sub-frames 58, the four super frames 62, and the fifty groups 64 per second repetition rate ($40 \times 4 \times 50 = 8,000$).

The bit stream basic block 38 is flexible in application and can simultaneously support both packet voice and PCM voice communications. For example, the bit stream basic block may be configured to support a combination of 160 packet voice channels and 120 PCM voice channels, or 320 packet voice channels and 96 PCM voice channels, or 480 packet voice channels and 72 PCM voice channels. Thus, in a telephone network utilizing the bit stream basic block 38 transmitted over communications links 18 and accessing an ATM transport network 12, either or both packet voice and/or PCM voice is supported. Furthermore, it will be understood that such a communications network may further transmit broadband information (like high quality video or data transfers) using the flexibility of the $n \times 10$ Mbps bit stream basic block 38.

Reference is now made to FIGURE 6 wherein there is illustrated an exemplary format for the embedded operation channel (EOC) 42 message assembled with frames 46 to form a group (G) 54 (see, FIGURE 4), or assembled with super frames 62 to form a group (G) 64 (see, FIGURE 5), in connection with the building of the bit stream basic block 38. The embedded operation channel 42 format includes a one byte beginning of frame (BOF) portion 200 which is used to define a type (for example, direct addressing or translated Internet Program (IP) addressing) for the embedded operation channel 42 message. The beginning of frame portion 200 further identifies the beginning of that message. Next, the embedded operation channel 42 format includes a four byte address field (AF) 202 used for direct addressing and subaddressing of network elements or nodes. The

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embedded operation channel 42 format further includes a Remote Operations Service Element (ROSE) encapsulation 204 of the operation and maintenance data. The encapsulation 204 comprises a twenty-seven byte header field 206 and a nine-hundred sixty-two byte user data field 208. The user data field 208 comprises the operation and maintenance data with respect to transport management network communications. This data follows the Common Management Information Protocol (CMIP) definition for message binding. With respect to the header field 206, Common Management Information Service (CMIS) service primitives are used to form Common Management Information Protocol data units which are mapped onto Remote Operations Service Element services. The embedded operation channel 42 format further includes a three byte ATM adaptation layer (AAL) service definition (AAL-SD) 210 identifying grade of service for the message in terms of latency, as well as priority and configuration parameters to be passed on to the user-to-network interface (UNI) (see, FIGURE 1) for signaling. Finally, the embedded operation channel 42 format includes a three byte Common Management Information Protocol data control (CMIP-DC) 212 which supports definition for binding, manager/agent control messaging, and establishment of a common digital communications network (DCN). The totaled size for the embedded operation channel 42 format is accordingly one thousand bytes, or 8 Kbits. However, within one basic block an EOC can be established as $m \times 8$ Kbps where $m=1$ to 50 (for both PCS and PCM communications). The foregoing accordingly defines a service specific convergence sub-layer (SSCS) encapsulation of the operation and maintenance data, wherein "service specific" refers to the specific service of transport network management communications.

In connection with the foregoing description of the embedded operation channel 42 format, it is noted that while the Common Management Information Service defines the services for management operations, the Common Management Information Protocol defines procedures for the transmission of management information and defines the syntax for the management service of the Common Management Information Service. The Common Management Information Protocol is defined in accordance with CMIP protocol data units that are exchanged between

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peer Common Management Information Service Elements (CMISE) to carry out the CMIS service. The Remote Operations Service Element (ROSE), on the other hand, is intended to support interactive types of applications which are characterized by a request from one application for another application to perform some operation.

5 The basic service provided by the Remote Operations Service Element is the facility for invoking an operation on a remote open system. The application entity (AE) invoking the operation issues a request to the peer application entity specifying a particular operation to be performed. The responding application entity then attempts to perform the operation and may report the outcome of the attempt. The

10 interchange between the two application entities is carried out in the context of an application association.

Reference is now made to FIGURE 7 wherein there is shown a communications line diagram illustrating the connections and an example of associated transmission bit rates for a given communication handled by the

15 communications system of FIGURE 1. Communications between the access nodes 14 and the user nodes 16 are transmitted at a rate of $n \times 10$ Mbps using the 10 Mbps bit stream basic block shown in FIGURE 3. The 10 Mbps bit stream basic block supports data/video transmissions as well as plural sub-rates for multi-channel (e.g., packet or PCM) voice communications, delimiting bits for controlling channel

20 add/drop multiplexing and/or digital cross-connection functions by the user nodes 16, and an embedded operation channel for monitoring and controlling communications system operation and maintenance. Communications between the access nodes 14 and the switching nodes 20 of the ATM network 12 occur at a conventional ATM bit rate of, for example, 155 Mbps using the ATM cells 26

25 (FIGURE 2). The communications links 24 between the switching nodes 20 of the ATM network 12 also utilize the ATM cells 26 for transmitting information, but the rate may be much higher than over the links 22 at, for example, 2.4 Gbps (gigabits per second). A connection is also made between one of the access nodes 14 and the transport network management system 34 communicating operation and

30 maintenance information to be inserted into and extracted from the embedded operation channel at a rate of $m \times 8$ Kbps.

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Reference is now made to FIGURE 8 wherein there is shown a block diagram of the ATM access node 14 (FIGURE 1) supporting multi-level data bit stream basic block transmissions with framing bits for add/drop multiplexing and/or digital cross-connection functions and an embedded operation channel. The access node 14 comprises an ATM traffic pre-shaping and signaling functionality 70 implementing an ATM adaptation layer (AAL), and in particular AAL #1, for converting between the $n \times 10$ Mbps bit stream basic blocks and the ATM cells. As illustrated in FIGURE 9A, this ATM adaptation layer conversion with respect to the $n \times 10$ Mbps bit stream basic blocks 38 involves the segmentation of the basic block into forty-seven or forty-six byte parts 72 for insertion into the payload portions 30 of a plurality of ATM cells 26 for transmission over the communications link 22. Any destination information for the $n \times 10$ Mbps bit stream basic blocks 38 (as well as other accompanying information) is formatted into five byte parts for insertion into the header portion 28 of each of the ATM cells 26. The ATM adaptation layer conversion with respect to the ATM cells 26 received over communications link 22 is illustrated in FIGURE 9B involves extraction of the forty-seven or forty-six byte segments from the ATM payload portion 30 to make parts 72 used in constructing the $n \times 10$ Mbps bit stream basic blocks 38.

As discussed previously, the access node also includes a line interface 44 to handle $n \times 10$ Mbps bit stream basic block 38 transmissions over communications link 18 with, for example, a non-proximately located user service node 16. The line interface 44 facilitates bit stream basic block data transmission over certain types of communications links 18 within communications systems better suited for last mile communications such as asymmetric digital subscriber line (ADSL), hybrid fiber coaxial (HFC); fiber optic transport system (FOTS); fiber in the loop (FITL); category 3 unshielded twisted pair (UTP) cable; or a scalable inversely multiplied (e.g., seven times) T1 connection. The line interface is also used to synchronize the bit stream basic block 38 to the rest of the network either from a derived or an external source. Timing for controlling the operation of the EOC handler 74 and line interface 44 is provided by a phase lock loop 76 derived from the incoming transmission link 18 or from an external clock signal.

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The access node 14 further comprises an EOC insertion and extraction handler 74 connected to the ATM traffic pre-shaping and signaling functionality 70 for receiving and sending EOC information between the access node and the transport network management system 34. The $n \times 10$ Mbps bit stream basic block 38 construction operation further includes the insertion of the information received from the transport network management system (TNMS) 34 over communications link 36 into the embedded operation channel (EOC) 42. The EOC handler 74 and the transport network management 34 communicate synchronization information with each other. The access node 14 further extracts the embedded operation channel 42 information from received $n \times 10$ Mbps bit stream basic blocks 38 and transmits that extracted information to the transport network management system 34 for processing. It should be noted that in those instances where the access node 14 is not connected to a transport network management system 34, the EOC insertion and extraction handler 74 exhibits a disable physical connection to the transport network management system 34 (via an enable/disable input selection). To facilitate the transmission and storage of operation and maintenance data, the EOC insertion and extraction handler 74 is connected to a local data base memory 31 through an agent functionality 35 via a function controller 75. The function controller 75 is further connected to control the operation of the ATM traffic pre-shaping and signaling functionality 70.

Reference is now made to FIGURE 10 wherein there is shown a block diagram of the transport network management system 34 which includes a transport network management system server 250. The server 250 performs all of the standard management functionalities set forth in ITU standard M.3010. The main functions performed by the server 250 are: fault management, performance management, configuration management, security management, and accounting management. The transport network management system 34 further includes a central manager 252 (manager 39 of FIGURE 1) and managed information base (MIB) 254 (global data base 37 of FIGURE 1) connected to the server 250. It is in the MIB 254 where the logical representation of the full network 10 reside and are managed. The managed information base 254 consists of managed objects (MOs)

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and service objects (SOs). The central manager 252 and managed information base 254 further utilize an included look-up table to produce a direct node address for transport network management system 34 communications. The transport network management system 34 further includes a Common Management Information Protocol (CMIP) converter 256 connected to the manager 252 to translate between server processed operation and maintenance data and adequately syntaxed Common Management Information Service (CMIS) messages in accordance with CMIP standard X.711. A Remote Operations Service Element (ROSE) encapsulator 258 is further included in the transport network management system 34. The encapsulator 258 is connected to the CMIP converter 256, and functions to encapsulate 204 the CMIP user data 208 with a ROSE header 206 (see, FIGURE 6). The ROSE header 206 includes ROSE functionality parameters. A corresponding de-encapsulation function is also performed. The transport network management system 34 also includes an embedded operation channel (EOC) controller 260 connected to both the encapsulator 258 and the central manager 252. The embedded operation channel controller 260 forms the embedded operation channel 42 format (see, FIGURE 6) including the ROSE encapsulation 204. Utilizing the central manager 252, the embedded operation channel controller 260 determines the value "m" required for the transmission of m x 8Kbit embedded operation channel 42 needed for a proper time response with respect to the operation and maintenance data and the operation of the transport network management system 34 (in accordance with the n x 10 Mbps bit stream basic block). The embedded operation channel controller 260 further handshakes with the central manager 252 to determine the beginning of frame (BOF) portion 200, address field (AF) 202 (including the foregoing direct address), ATM adaptation layer (AAL) service definition (AAL-SD) 210, and Common Management Information Protocol data control (CMIP-DC) 212. The embedded operation channel controller 260 accordingly effectuates the service specific convergence sub-layer (SSCS) processing of the operation and maintenance data. A corresponding de-forming of the embedded operation channel 42 is also performed.

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Reference is now made to FIGURE 11 wherein there is shown a block diagram of a portion of the user node 16 including a last mile line interface 44 for connecting with the communications link 18 to facilitate bit stream basic block data transmission over last mile communications such as asymmetric digital subscriber line (ADSL), hybrid fiber coaxial (HFC); fiber optic transport system (FOTS); fiber in the loop (FITL); category 3 unshielded twisted pair (UTP) cable; or a scalable inversely multiplied (e.g., seven times) T1 connection. The interface 44 utilizes a digital signal processing technique in handling the bit stream basic blocks. Connected to the interface 44 is a basic block EOC handler 80. Bit stream basic blocks are passed between the interface 44 and handler 80 based on a clock signal output from a phase lock loop 82. The handler 80 further extracts the embedded operation channel from the bit stream basic block, and transmits the extracted information over signal bus 84 to a function controller 86 for the interface 44.

The handler 80 is connected to a buffer scheduler and shaper functionality 88 used to improve cell delay variations relating to accessing of the ATM network. The functionality 88 is connected to timeslot handler 90 capable of making both full rate and sub-rate transmission/reception connections to the user node 16. For voice communications, such connections may be made for example to eight kilohertz MUX cards (8 Kbps) 92 comprising the user nodes 16 and supporting packet voice communications, or to sixty-four kilohertz MUX cards (64 Kbps) 94 comprising the user nodes and supporting PCM voice communications. With respect to user nodes which support plural channels (like the 8 Kbps cards 92), the delimiting bits within the bit stream basic block facilitate add/drop multiplexing and/or digital cross-connection functions and variable bandwidth control. The basic block EOC handler 80 is further connected to a basic block line adapter 96 capable of making both broadband transmission/reception connections to the user node 16 for video 98 or data (file transfer) 100.

In addition to receiving embedded operation channel information from the basic block EOC handler 80 over signal bus 84, the function controller further uses the signal bus, and its connections to the functionality 88, timeslot handler 90 and line adapter 96, to indicate whether sub-rate (8 Kbps), full rate (64 Kbps) or basic

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block rate (10 Mbps) traffic is being carried in accordance with the traffic service requirements specified by the transport network management system 34 (FIGURES 1 and 10). The function controller 86 is further connected to a local processor 102 which is in communication with the user node 16 and issues control commands to the function controller regarding the specified traffic and directing the operation of the function controller in managing operation of the interface 44. To facilitate the transmission and storage of operation and maintenance data, the function controller 86 is connected to a local data base memory 33 through an agent functionality 35.

Referring now to FIGURE 12, there is shown a block diagram of a portion of a cellular telecommunications system 120 utilizing the communications system 10 of FIGURE 1. The user service node 16 on one side of the system 10 comprises the telephone exchange (mobile switching center) 122 for the cellular communications system 120. On the other side of the system 10, the user nodes 16 comprise at least one base station concentrator 124 connected to base stations 130 through which mobile stations 126 engage in radio communications over a plurality of voice channels 128. Communications between the exchange 122 and the access node 14, and between the base station concentrators 124 and the access nodes, occur over links 18 using the previously described bit stream basic blocks in a multi-level bit stream communication. With the use of ATM adaptation layer segmentation and reassembly in the access nodes 14, the multi-level bit stream communication, including its embedded operation channel and add/drop multiplexing delimiting bits, is transmitted across the ATM network 12 using ATM cells. Using the embedded operation channel, the transport network management system 34 performs connection maintenance, performance monitoring, path tracing, service management and testing over the ATM network 12 and with respect to the access nodes 14 and the user nodes 16 comprising the exchange 122, the base station concentrator 124 and base stations 130. Furthermore, using the included delimiting bits and instructions contained within the embedded operation channel, the base station concentrator 124 performs add/drop multiplexing and/or digital cross-connection functions with respect to the voice channels 128 through which mobile station 126 communications are effectuated.

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Referring now to FIGURE 13, there is shown a block diagram of a portion of a wireline telecommunications system 140 utilizing the communications system 10 of FIGURE 1. The user service node 16 on one side of the system 10 comprises the telephone exchange 142 for the wireline communications system 140. On the other side of the system 10, the user nodes 16 comprise at least one wireline concentrator 144 connected to a plurality of wireline telephone terminals 146 through which subscribers engage in telephone communications using a plurality of voice channels. Communications between the exchange 142 and the access node 14, and between the wireline concentrator 144 and the access nodes, occur over links 18 using the previously described bit stream basic blocks in a multi-level bit stream communication. With the use of ATM adaptation layer segmentation and reassembly in the access nodes 14, the multi-level bit stream communication, including its embedded operation channel and add/drop multiplexing delimiting bits, is transmitted across the ATM network 12 using ATM cells. Using the embedded operation channel, the transport network management system 34 performs connection maintenance, performance monitoring, path tracing, service management and testing over the ATM network 12 and with respect to the access nodes 14 and the user nodes 16 comprising the exchange 142 and the wireline concentrator 144. Furthermore, using the included delimiting bits and instructions contained within the embedded operation channel, the wireline concentrator 144 performs add/drop multiplexing and/or digital cross-connection functions with respect to the voice channels through which subscriber wireline telephone terminal 146 communications are effectuated.

Referring now to FIGURE 14, there is shown a block diagram of a portion of a combination wireless/wireline telecommunications system 160 utilizing the communications system 10 of FIGURE 1. The user service node 16 on one side of the system 10 comprises the telephone exchange 162 for the combination communications system 160. On the other side of the system 10, the user nodes 16 comprise at least one wireline concentrator 164 connected to a plurality of wireline telephone terminals 166 through which subscribers engage in telephone communications using a first plurality of voice channels. The user nodes 16 on the

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other side of the system further comprise at least one base station concentrator 168 connected to base stations 170 through which mobile stations 172 engage in radio communications over a second plurality of voice channels. Communications between the exchange 162 and the access node 14, and between the wireline concentrator 164 and its access node, and between the base station concentrator 168 and its access node, occur over communications links 18 using the previously described bit stream basic blocks in a multi-level bit stream communication. With the use of ATM adaptation layer segmentation and reassembly in the access nodes 14, the multi-level bit stream communication, including its embedded operation channel and add/drop multiplexing delimiting bits, is transmitted across the ATM network 12 using ATM cells. Using the embedded operation channel, the transport network management system 34 performs connection maintenance, performance monitoring, path tracing, service management and testing over the ATM network 12 and with respect to the access nodes 14 and the user nodes 16 comprising the exchange 162, the wireline concentrator 164 and the base station concentrator 168. Furthermore, using the included delimiting bits and instructions contained within the embedded operation channel, the wireline concentrator 144 performs add/drop multiplexing and/or digital cross-connection functions with respect to the first plurality of voice channels through which subscriber wireline telephone terminal 146 communications are effectuated, while the base station concentrator 168 performs add/drop multiplexing and/or digital cross-connection functions with respect to the second plurality of voice channels through which mobile station 172 communications are effectuated.

Although a preferred embodiment of the method and apparatus of the present invention has been illustrated in the accompanying Drawings and described in the foregoing Detailed Description, it will be understood that the invention is not limited to the embodiment disclosed, but is capable of numerous rearrangements, modifications and substitutions without departing from the spirit of the invention as set forth and defined by the following claims.

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WHAT IS CLAIMED IS:

1. A cellular telephone communications system accessing an asynchronous transfer mode (ATM) transport network, comprising:

5 a plurality of base stations effectuating radio frequency communications with subscriber mobile stations;

a base station concentrator connected to the plurality of base stations;

a first and second access nodes connected to the ATM transport network;

a first communications link connecting the base station concentrator and the first access node of the ATM transport network;

10 a transport network management system;

a second communications link connecting the transport network management system to the second access node of the ATM transport network;

15 wherein the base station concentrator and each first and second access node include interfaces for communicating voice information over the first communications link using a communications bit stream that includes an embedded operation channel carrying system operation and maintenance information for delivery to and from the transport network management system; and

20 wherein each first and second access node includes means for converting between the communications bit stream carried over the communications link and ATM cells carried over the ATM transport network.

2. The system of claim 1 wherein the second access node includes a handler functionality connected to the transport network management system over the second communications link for inserting and extracting system operation and maintenance information into and from the embedded operation channel of the communications bit stream.

3. The system of claim 1 wherein the means for converting of the first and second access node comprises:

30 means for segmenting the communications bit stream for insertion into a payload portion of transmitted ATM cells; and

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means for assembling payload portions of received ATM cells into the communications bit stream.

4. The system of claim 1 wherein the transport network management
5 system comprises:

a transport network management server including a manager functionality and a managed information base, the transport network management server processing common management information protocol (CMIP) formatted operation and maintenance data;

10 an encapsulator connected to the transport network management server for encapsulating the CMIP formatted operation and maintenance data within a remote operations service element (ROSE) encapsulation; and

an embedded operation channel controller connected to the encapsulator to format the ROSE encapsulated CMIP formatted operation and maintenance data into
15 an embedded operation channel data format for transmission over the second communications link to the second access node, the controller further connected to the transport network management server to determine information therefrom for inclusion in formatting the embedded operation channel.

20 5. The system of claim 4 wherein the transport network management server performs the functions of fault management, performance management, configuration management, security management and accounting management with respect to the system.

25 6. The system of claim 4 wherein the information obtained from the transport network management server comprises node addressing information and ATM adaptation layer service information.

30 7. The system of claim 4 wherein the ROSE encapsulation comprises the CMIP formatted operation and maintenance data and a ROSE header including ROSE functionality parameters.

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8. A telephone communications system accessing an asynchronous transfer mode (ATM) transport network, comprising:

a telephone exchange;

a first and second access node connected to the ATM transport network;

5 a first communications link connecting the telephone exchange and the first access node;

a transport network management system;

a second communications link connecting the transport network management system to the second access node of the ATM transport network;

10 wherein the telephone exchange and each first and second access node include interfaces for communicating voice information over the first communications link using a communications bit stream that includes an embedded operation channel carrying system operation and maintenance information for delivery to and from the transport network management system; and

15 wherein each first and second access node includes means for converting between the communications bit stream carried over the communications link and ATM cells carried over the ATM transport network.

9. The system of claim 8 wherein the second access node includes a handler functionality connected to the transport network management system over
20 the second communications link for inserting and extracting system operation and maintenance information into and from the embedded operation channel of the communications bit stream.

25 10. The system of claim 8 wherein the means for converting of the first and second access node comprises:

means for segmenting the communications bit stream for insertion into a payload portion of transmitted ATM cells; and

30 means for assembling payload portions of received ATM cells into the communications bit stream.

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11. The system of claim 8 wherein the transport network management system comprises:

a transport network management server including a manager functionality and a managed information base, the transport network management server processing common management information protocol (CMIP) formatted operation and maintenance data;

an encapsulator connected to the transport network management server for encapsulating the CMIP formatted operation and maintenance data within a remote operations service element (ROSE) encapsulation; and

an embedded operation channel controller connected to the encapsulator to format the ROSE encapsulated CMIP formatted operation and maintenance data into an embedded operation channel data format for transmission over the second communications link to the second access node, the controller further connected to the transport network management server to determine information therefrom for inclusion in formatting the embedded operation channel.

12. The system of claim 11 wherein the transport network management server performs the functions of fault management, performance management, configuration management, security management and accounting management with respect to the system.

13. The system of claim 11 wherein the information obtained from the transport network management server comprises node addressing information and ATM adaptation layer service information.

14. The system of claim 11 wherein the ROSE encapsulation comprises the CMIP formatted operation and maintenance data and a ROSE header including ROSE functionality parameters.

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15. A telephone communications system accessing an asynchronous transfer mode (ATM) transport network, comprising:

a plurality of wireline telephone terminals;

a concentrator connected to the plurality of wireline telephone terminals;

5 a first and second access node connected to the ATM transport network;

a first communications link connecting the concentrator and the first access node;

a transport network management system;

10 a second communications link connecting the transport network management system to the second access node of the ATM transport network;

wherein the concentrator and each first and second access node include interfaces for communicating voice information over the first communications link using a communications bit stream that includes an embedded operation channel carrying system operation and maintenance information for delivery to and from the transport network management system; and

15 wherein each first and second access node includes means for converting between the communications bit stream carried over the communications link and ATM cells carried over the ATM transport network.

20 16. The system of claim 15 wherein the second access node includes a handler functionality connected to the transport network management system over the second communications link for inserting and extracting system operation and maintenance information into and from the embedded operation channel of the communications bit stream.

25

17. The system of claim 15 wherein the means for converting of the first and second access node comprises:

means for segmenting the communications bit stream for insertion into a payload portion of transmitted ATM cells; and

30 means for assembling payload portions of received ATM cells into the communications bit stream.

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18. The system of claim 15 wherein the transport network management system comprises:

a transport network management server including a manager functionality and a managed information base, the transport network management server processing common management information protocol (CMIP) formatted operation and maintenance data;

an encapsulator connected to the transport network management server for encapsulating the CMIP formatted operation and maintenance data within a remote operations service element (ROSE) encapsulation; and

an embedded operation channel controller connected to the encapsulator to format the ROSE encapsulated CMIP formatted operation and maintenance data into an embedded operation channel data format for transmission over the second communications link to the second access node, the controller further connected to the transport network management server to determine information therefrom for inclusion in formatting the embedded operation channel.

19. The system of claim 18 wherein the transport network management server performs the functions of fault management, performance management, configuration management, security management and accounting management with respect to the system.

20. The system of claim 18 wherein the information obtained from the transport network management server comprises node addressing information and ATM adaptation layer service information.

21. The system of claim 18 wherein the ROSE encapsulation comprises the CMIP formatted operation and maintenance data and a ROSE header including ROSE functionality parameters.

22. A communications system, comprising:
a first node;

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a second node;
a communications link connecting the first and second nodes; and
a transport network management system connected to the first node;
wherein the first and second nodes include interfaces for communicating
5 voice information over the communications link using a bit stream basic block
comprising a plurality of communications channels and an embedded operation
channel carrying system operation and maintenance information for delivery to and
from the transport network management system.

10 23. The system of claim 22 wherein the bit stream basic block supports
an appropriate repetition rate for the plurality of communications channels.

24. The system of claim 22 wherein the first node includes a handler
functionality for inserting and extracting system operation and maintenance
15 information into and from the embedded operation channel of the bit stream basic
block.

25. The system of claim 21 further including:
an asynchronous transport mode (ATM) transport network;
20 wherein the first node comprises an ATM access node connected to the ATM
transport network and further includes means for converting between the bit stream
basic block carried over the communications link and ATM cells carried over the
ATM transport network.

25 26. The system of claim 25 wherein the means for converting of the ATM
access node comprises:
means for segmenting the bit stream basic block for insertion into a payload
portion of transmitted ATM cells; and
means for assembling payload portions of received ATM cells into the bit
30 stream basic block.

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27. The system of claim 22 wherein the transport network management system comprises:

a transport network management server including a manager functionality and a managed information base, the transport network management server processing common management information protocol (CMIP) formatted operation and maintenance data;

an encapsulator connected to the transport network management server for encapsulating the CMIP formatted operation and maintenance data within a remote operations service element (ROSE) encapsulation; and

an embedded operation channel controller connected to the encapsulator to format the ROSE encapsulated CMIP formatted operation and maintenance data into an embedded operation channel data format for transmission to the first node, the controller further connected to the transport network management server to determine information therefrom for inclusion in formatting the embedded operation channel.

28. The system of claim 27 wherein the transport network management server performs the functions of fault management, performance management, configuration management, security management and accounting management with respect to the system.

29. The system of claim 27 wherein the information obtained from the transport network management server comprises node addressing information and ATM adaptation layer service information.

30. The system of claim 27 wherein the ROSE encapsulation comprises the CMIP formatted operation and maintenance data and a ROSE header including ROSE functionality parameters.

31. The system of claim 22 wherein the communications system comprises a packet voice communications system.

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32. The system of claim 22 wherein the communications system comprises a pulse code modulated (PCM) voice communications system.

33. A transport network management system connected over a communications link to a communications network, the system comprising:

a transport network management server including a manager functionality and a managed information base, the transport network management server processing common management information protocol (CMIP) formatted operation and maintenance data;

an encapsulator connected to the transport network management server for encapsulating the CMIP formatted operation and maintenance data within a remote operations service element (ROSE) encapsulation;

an embedded operation channel controller connected to the encapsulator to format the ROSE encapsulated CMIP formatted operation and maintenance data into an embedded operation channel data format for transmission over the communication link, the controller further connected to the transport network management server to determine information therefrom for inclusion in formatting the embedded operation channel format; and

a node of the network connected to the communications link and including a handler functionality for inserting and extracting the embedded operation channel formatted operation and maintenance information into and from an embedded operation channel of a bit stream basic block also including a plurality of communications channels.

34. The system of claim 33 wherein the transport network management server performs the functions of fault management, performance management, configuration management, security management and accounting management with respect to the system.

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35. The system of claim 33 wherein the information obtained from the transport network management server comprises node addressing information and ATM adaptation layer service information.

- 5 36. The system of claim 33 wherein the ROSE encapsulation comprises the CMIP formatted operation and maintenance data and a ROSE header including ROSE functionality parameters.

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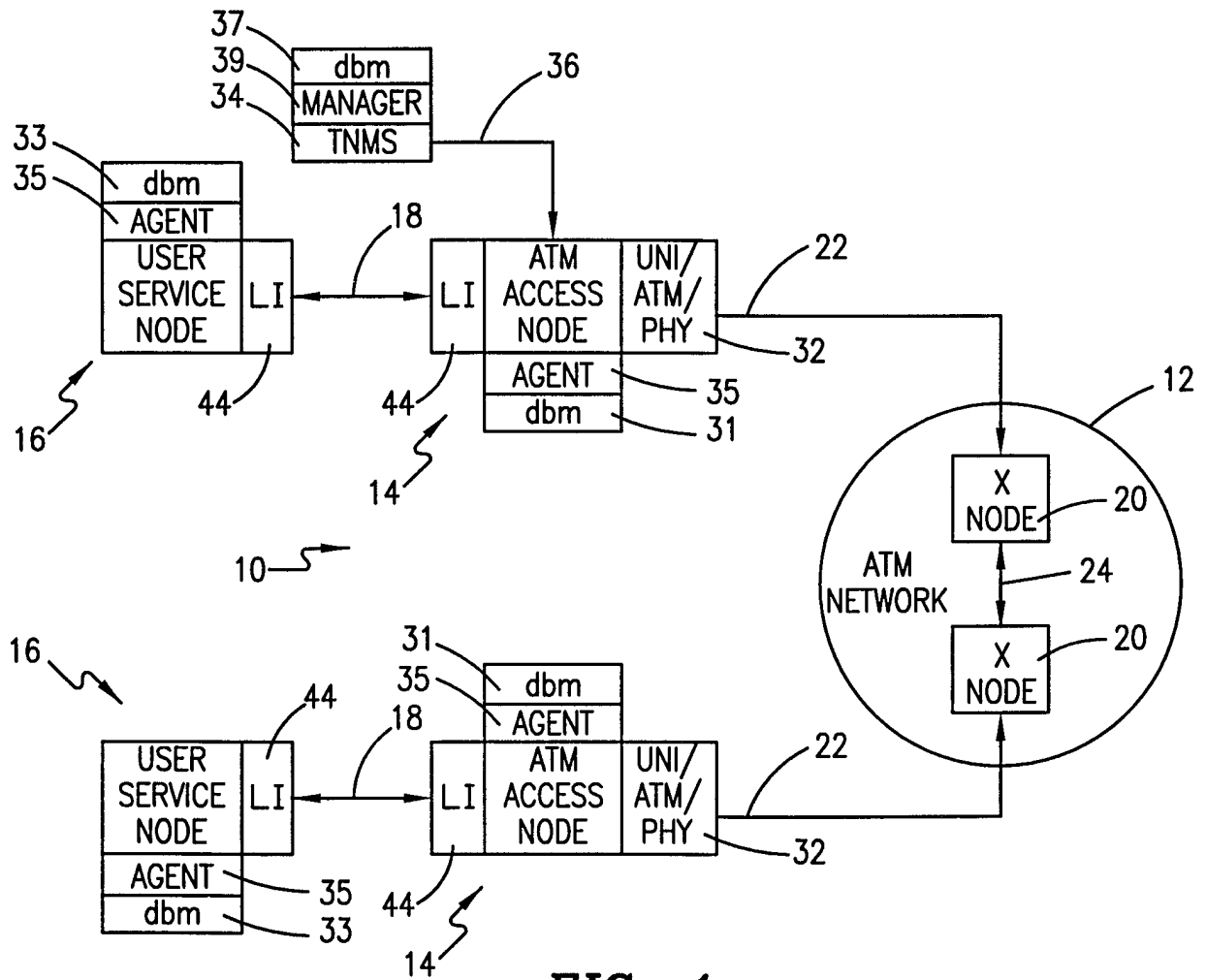


FIG. 1

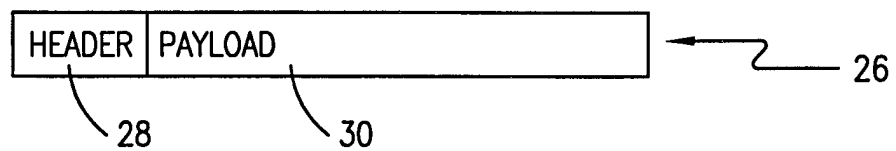


FIG. 2

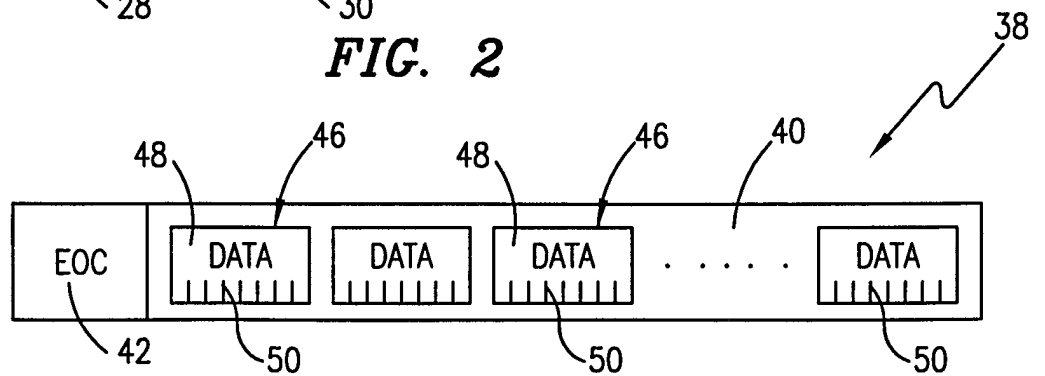


FIG. 3

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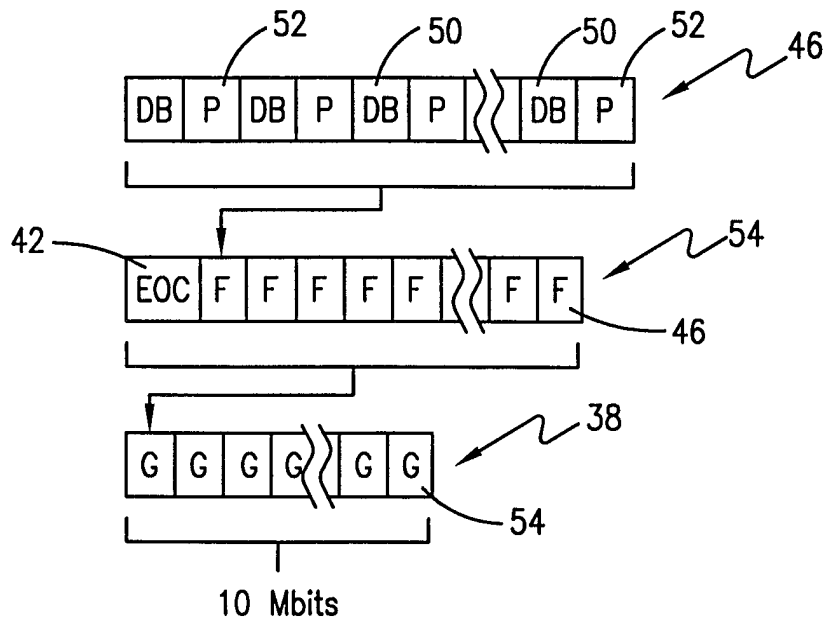


FIG. 4

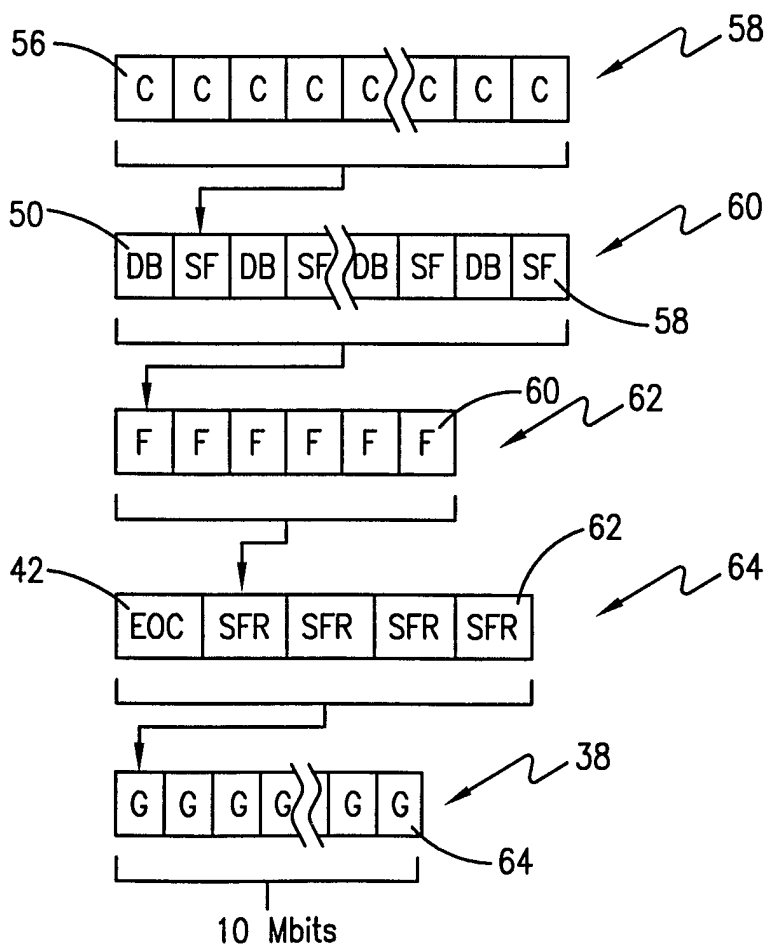
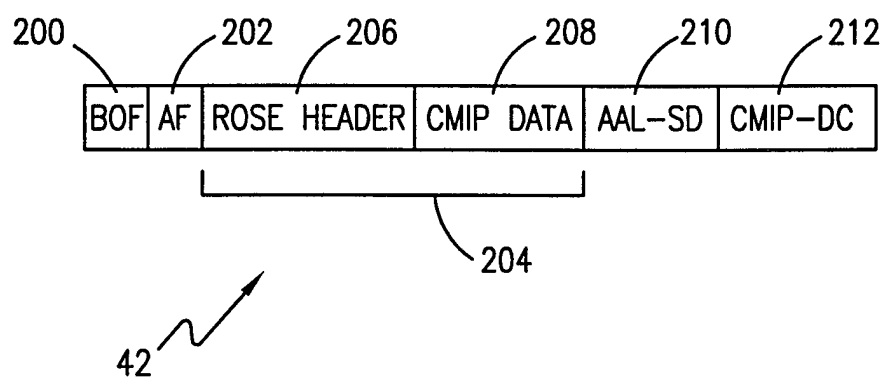


FIG. 5

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**FIG. 6**

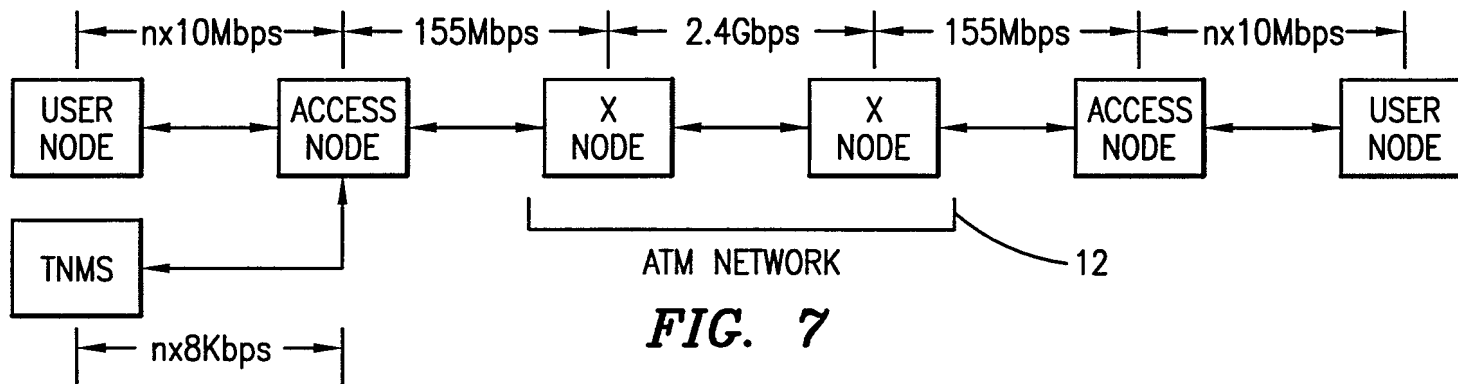


FIG. 7

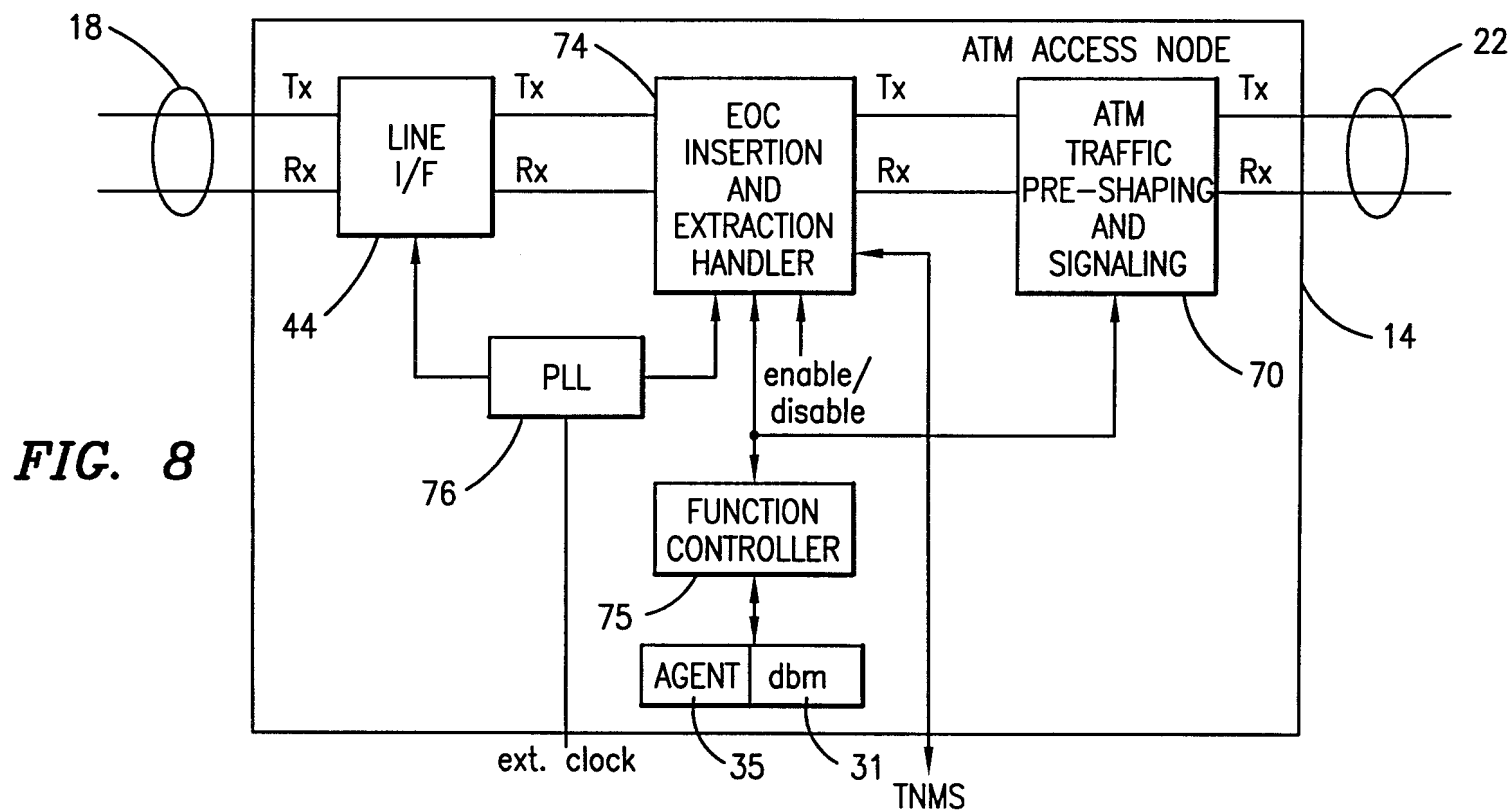


FIG. 8

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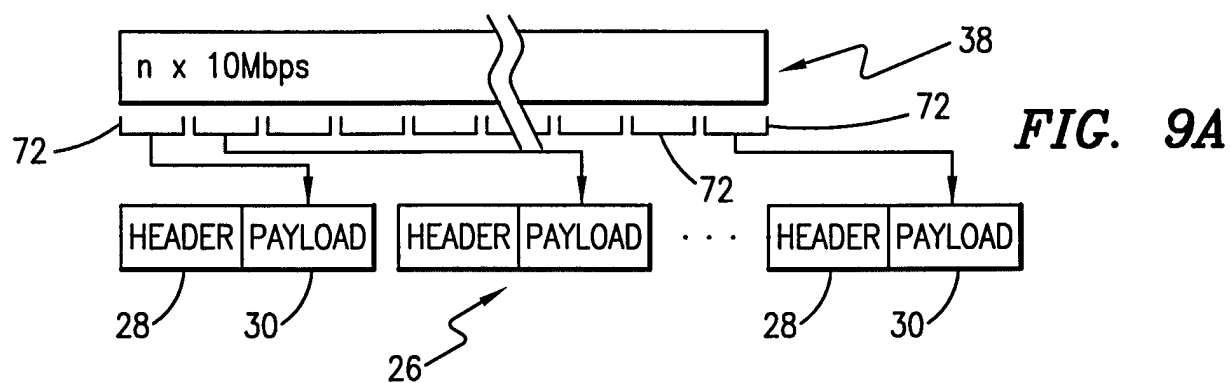


FIG. 9A

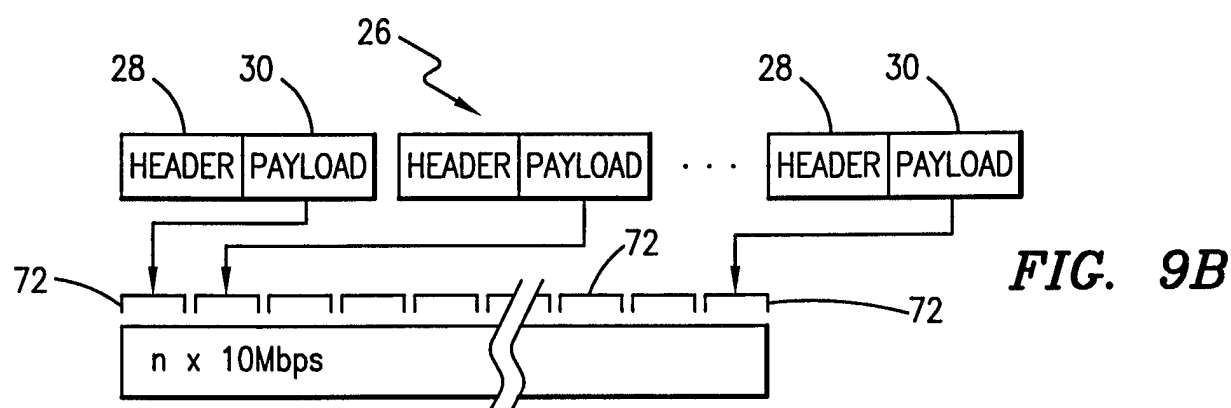


FIG. 9B

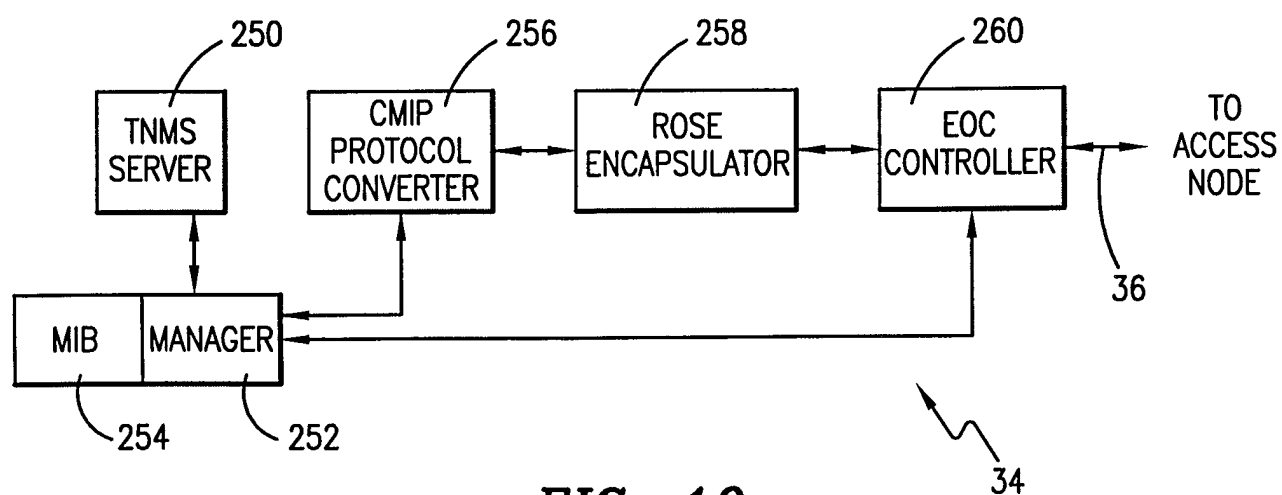


FIG. 10

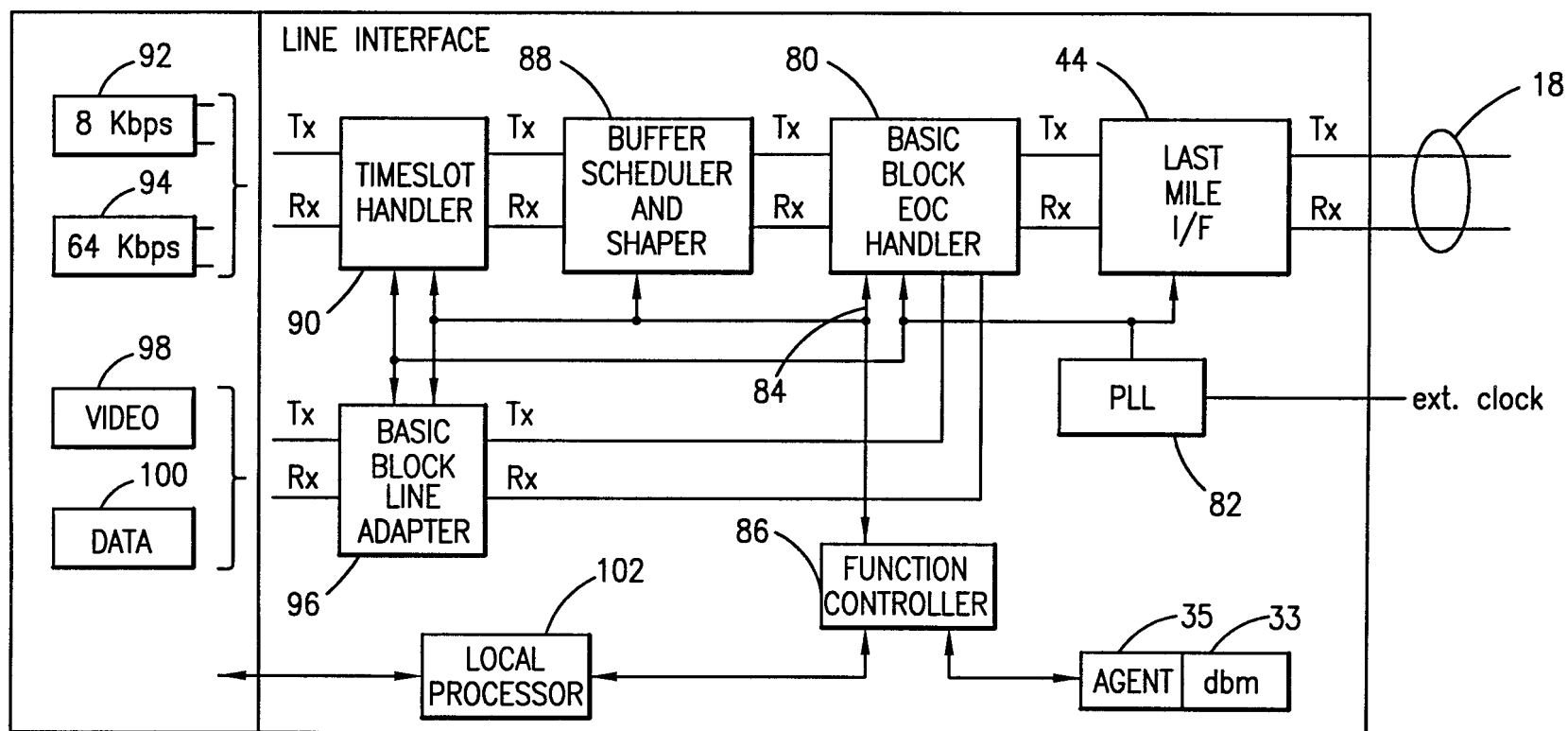
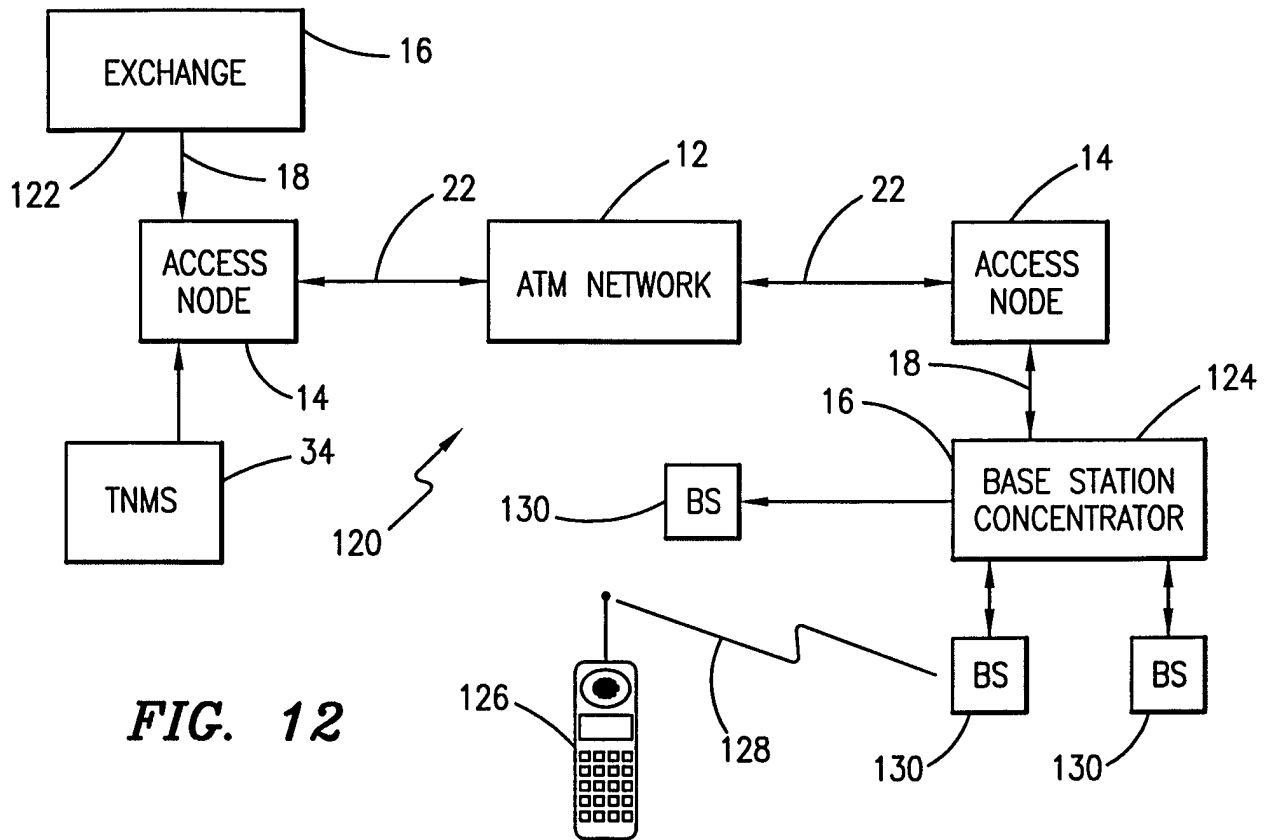
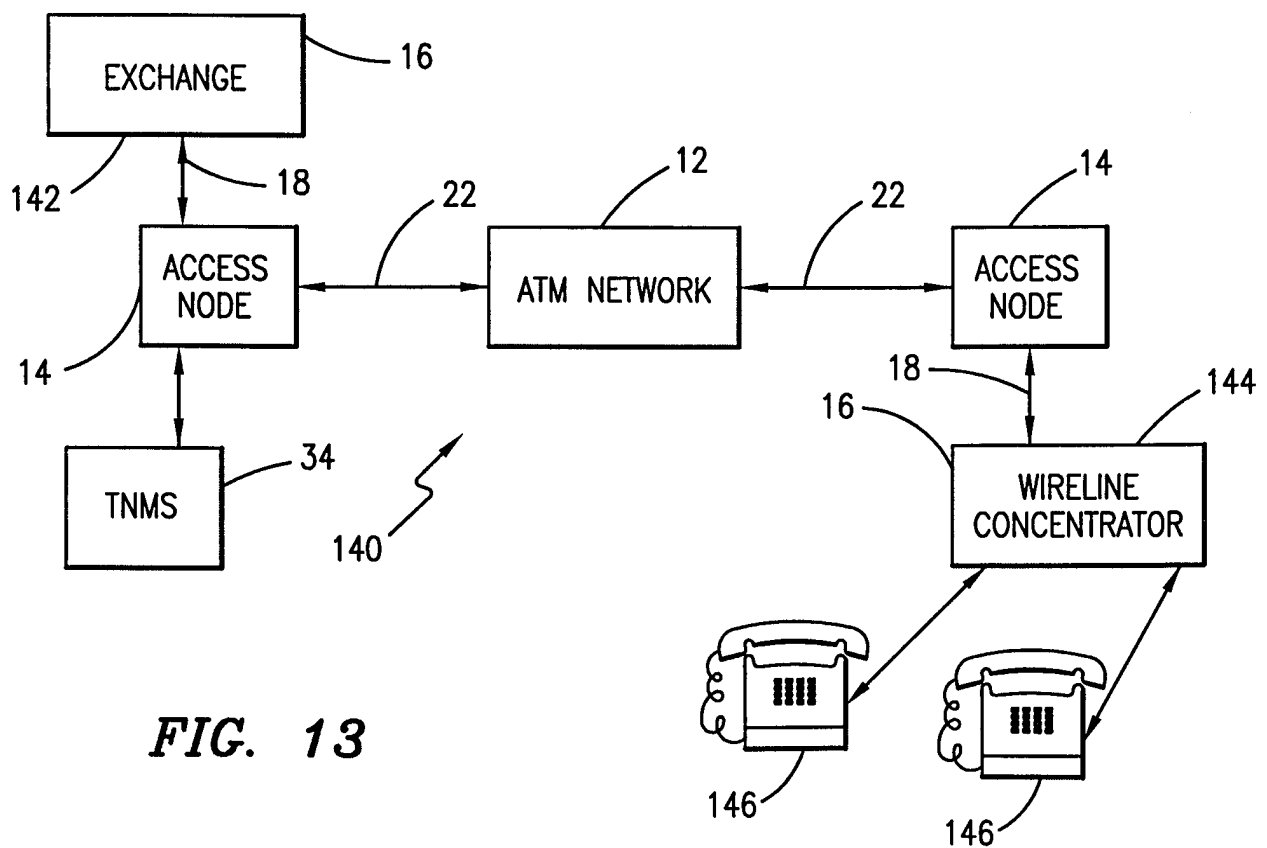
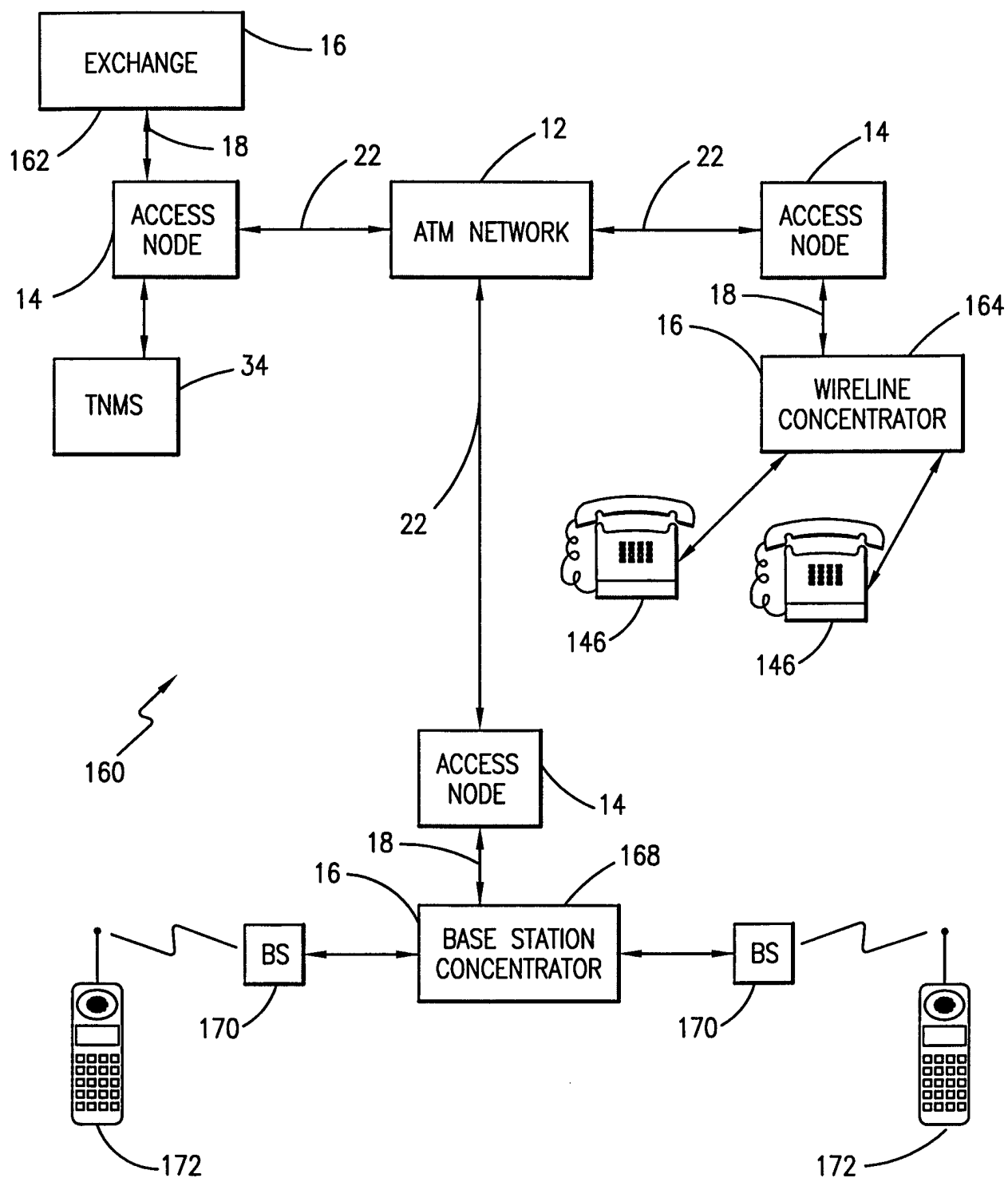


FIG. 11

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**FIG. 12****FIG. 13**

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**FIG. 14**

INTERNATIONAL SEARCH REPORT

International Application No
PCT/SE 97/01891

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 H04Q11/04

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 H04Q H04L

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

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category ^o	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5 495 484 A (SELF L DAVID ET AL) 27 February 1996 see column 4, line 9 - line 13; figure 6 see column 5, line 55 - line 67 see column 7, line 10 - line 28 see column 7, line 62 - line 67 ----	1,8,15, 22,33
A	US 5 343 468 A (RAU PETER) 30 August 1994 paragraph "Summary of the invention" ----- -/--	1,8,15, 22,33

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

^o Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance
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Date of the actual completion of the international search

26 February 1998

Date of mailing of the international search report

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INTERNATIONAL SEARCH REPORT

International Application No
PCT/SE 97/01891

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JABLECKI H M ET AL: "SONET-BASED TR-303 RDTS: TRANSITIONAL INTEROPERABILITY CONCERNS AND SOLUTIONS" COMMUNICATION FOR GLOBAL USERS, INCLUDING A COMMUNICATIONS THEORY MINI CONFERENCE ORLANDO, DEC. 6 - 9, 1992, vol. 1 - 2 - 03, 6 December 1992, INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS, pages 143-147, XP000357776 see paragraph 2.1.1 a. and paragraph 3 see abstract -----	1,8,15, 22,33

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

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