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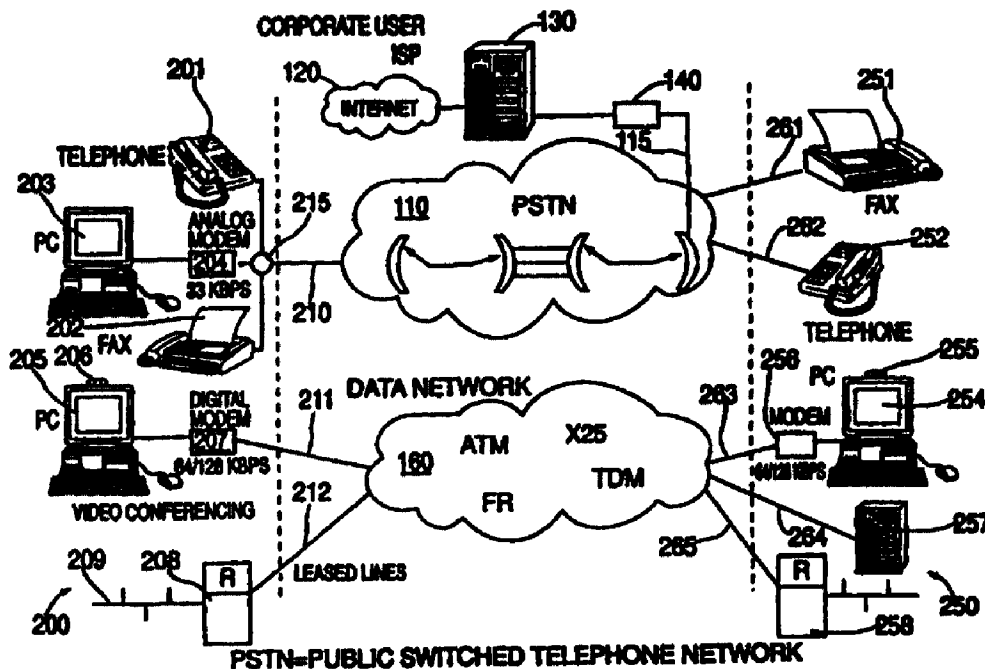
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(54) **SYSTEME MULTI-SERVICES A COMMUTATION D'ACCES**

(54) **MULTI-SERVICE ACCESS SWITCHED SYSTEM**



(57) Ce système multi-services à commutation d'accès permet une utilisation simultanée du téléphone pour des communications vocales ainsi que pour le transfert de données via des systèmes de communications publics et des systèmes de commutation, accélère la vitesse de transmission en matière d'accès aux données et ce, à un niveau autorisant l'existence de vidéoconférences, et décongestionne le réseau téléphonique vocal grâce à la dérivation des données de vidéoconférence et des données informatiques vers le réseau de transmission ultra-rapide de données et à l'accès offert à des réseaux de données utilisant le multiplexage numérique (MRT), le système X.25, le relais de trame et le mode de transfert asynchrone (MRT) et ce, sans qu'il soit nécessaire d'installer une nouvelle paire de câbles téléphoniques ou deux modems numériques tout en dérivant les signaux vocaux sur les systèmes de commutation de compagnies téléphoniques existantes.

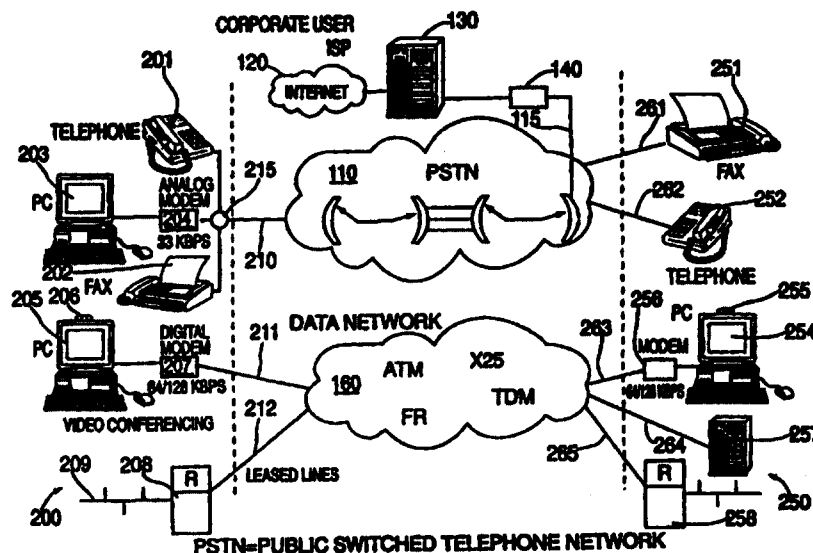
(57) A multi-service access switched system which provides for the simultaneous use of the telephone (201) for voice communications and for transfer of data over public communication and switching system, increases the transmission speed for data access to a level permitting the use of video conferencing, relieves the congestion in a voice telephone network (110) by simultaneously diverting the computer data video conferencing data to a high speed network (160) and accessing data networks employing TDM, X.25, Frame Relay, ATM without the need for an installation of a new pair of telephone wires or a pair of digital modems while diverting voice signals through existing telephone company switch system.



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(54) Title: MULTI-SERVICE ACCESS SWITCHED SYSTEM**(57) Abstract**

A multi-service access switched system which provides for the simultaneous use of the telephone for voice communications and for transfer of data over public communication and switching systems, increases the transmission speed for data access to a level permitting the use of video conferencing, relieves the congestion in the voice telephone network by simultaneously diverting the computer data video conferencing data to the high speed data network and accessing data networks employing TDM, X.25, Frame Relay and ATM without the need for the installation of a new pair of telephone wires or a pair of digital modems while diverting voice signals through existing telephone company switch systems.

MULTI-SERVICE ACCESS SWITCHED SYSTEM**BACKGROUND OF THE INVENTION**

The invention is generally directed to a multi-service access switched system which allows simultaneous use of the telephone lines for voice and data communications, increases transmission speed to provide enhanced services, relieves voice telephone network congestion and provides access to high speed data networks using protocols such as TDM, X.25, Frame Relay and ATM without the need for the installation of a new pair of telephone wires.

In the early 1990's the socio-economic evolution of the industrialized nations has helped these countries to enter the era of information. The foundation of this information era is the knowledge-based industry. The industrial period which is coming to an end was characterized by heavy use of machines which basically replaced and supplemented man's physical efforts. An industrial worker is a typical symbol of this period.

During the last twenty years the increasing use of computers has replaced not only the physical effort of human beings but the mental efforts of human beings through the use of powerful tools to organize people's lives and their personal objectives. These computers, interfacing with various electromechanical and combustion driven machinery have in a brief period revolutionized the quality of life and nature of communications, particularly in the first world.

If we consider the computer as the principal tool of this new era, information is its raw material. However, information by itself has no value if it cannot be adequately accessed by people from a remote source, regardless of the distance between the user and the source. In this process of accessing, analyzing, distributing and acting upon information the telecommunications industry has been and will continue to play a fundamental role.

Until the early 1970's the information carried by the public telecommunication systems was almost exclusively in the form of voice signals known now as telephony. From that time forward, as the exponential growth in the use of computers has proceeded there has been a similar explosive rise in the demand for the transmission of data. As there was a perceived explosive even increasing rise in the demand for data transmission in the early 1970's, today there is an ever increasing interest in the transmission of higher bandwidth signals, such as video conferencing, videophones and multi-media communication. As a result, an important characteristic of current communication networks is the need and the ability to allow voice, music, data and video signals to share the same networks as basic telephony.

The constant pressure to implement more reliable, multimedia-compliant and less expensive networks with every increasing bandwidth capacities has applied substantial pressure to force the data transmission for the communications services

to be completely digital in nature rather than the existing analog and hybrid analog/digital systems. As time progresses the conversion of the last segments of the telecommunications networks to a digital form will be extended even to include the replacement of the copper wires, which physically connect the customer's premises with the local telephone exchange, with optical fiber cabling or other digitally oriented physical mediums. In this way, the entire networks from end to end will be digital. The telephony conversion from the analog speech to the digital signal and vice versa will be performed by the telephony instruments themselves.

With the decreasing costs of computer related equipment and telecommunication services the need for ever increasing high speed access to computer data networks and the Internet have increased beyond the days when only big corporations required telecommunications access beyond conventional telephony. The world wide popularity and success of the Internet is a prime example of this demand for a reliable inexpensive multimedia-compliant digital network. This popularity has included small firms, residential users, educational institutions and created new business opportunities spawned by the Internet and requiring ever increasing digital communication requirements.

The concept of a equal access to a multiplicity of services in a telecommunications network and to date, in particular the Internet, has brought about a need for an enormous

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increase in the bandwidth in the requirements for residential, commercial, industrial or corporate customers of the current telephony based telecommunications networks.

To satisfy all these current and anticipated requirements the characteristics of network which must be implemented within the next several decades can be established. The network must be a multimedia and multi-service network and the switching functions in the network will be an Asynchronous Transfer Mode (ATM) type. Presently, the principal parameters of such a network are in the process of being defined and the network will be known as a Broadband Integrated Services Digital Network (BISDN).

It is possible to distinguish between two principal and distinct phenomena in the evolutionary process towards BISDN services. First, we observe that the linking of trunk lines which, in most cases, are made of fiber optics and that the multiplexing equipment in these trunk lines follow the SDH hierarchy exactly in the same way as it will be used in BISDN networks.

The second phenomenon that is observed is that the links between the digital central offices and the customer premises are still in the form of copper cables exactly as they were in the early days when the public telephone switching networks were implemented. However, if we now consider the total investment in a public telephone network which would include

switching equipment and trunk lines it is clear that the highest percentage of the investment was and continues to be consumed by the physical links between the local exchanges and the customer premises. The cost of replacing the copper cables with optical fiber, within a short or medium time frame, is prohibitively expensive. It is also apparent that the cost of replacing the Stored Program Switches-T (Digital Switches) by Asynchronous Transfer Mode (ATM) switches within a short time frame is also prohibitively expensive except in limited applications.

One solution to this problem would be a gradual migration of all networks toward BISDN. One way to achieve this gradual migration would be to stop using any more copper cables for future connections to customer premises. The capacity of the present copper cable installed base would be increased by utilizing digital carrier and multichannel modems until a new demand for yet wider bandwidth justifies the cost of the replacement of copper cables with optical fiber. This replacement of copper cables with fiber optics at the beginning will be restricted to medium and heavy telecommunication users whose volume of bandwidth justifies economically the conversion to fiber optic connections.

Added to this apparent increasing need for bandwidth and traditional telephony and data transmission requirements is the overwhelmingly expanding bandwidth requirements of the Internet. As more and more people access the Internet, the volume

of bandwidth absorbed likewise expands. This adds more complexity to the plethora of already existing problems affecting the telecommunications networks without adequate time to undertake large scale physical plant changes. The explosive success of the Internet has brought, to the small and light user, the possibility of accessing information sources of all types which could not previously have been imagined. The Internet has cause a complex problem to the telecommunications network. This problem relates to the threat of serious congestion in the switching systems in local exchanges which were not designed to handle this extra demand on the network. In addition to the problem of the Internet affecting the switches at the local exchanges, the small or home user often has a unique problem of his or her own because of use of a single telephone line which does not permit the simultaneous use of the line for both voice and data. Generally, it is one or the other. When a user accesses the Internet it has to establish a connection to the user's Internet service provider (ISP). The user cannot either receive or place telephone calls. This problem of a single line is compounded with the bad quality of lines through which the customer accesses data networks using an analog modem resulting in a low-speed communication full of errors. Other interesting and useful services such as video conferencing, video telephone, e-commerce, video surveillance, telemetry and Frame Relay and the like add to the temptation and pressure on the customer to

implement these services. This further burdens the limited bandwidth available between the customer and the local exchange.

As a result, these problems call for an urgent solution which is based on two basic premises. First of these two premises is that the solution must utilize the existing copper cables connecting the local exchange with the customer's premises. The second premise demands that the solution also relieve congestion at the switches of telephone companies' central offices which were not designed to handle either the length or the bandwidth of the new data and videophone call demand.

Accordingly, there is a need for an improved telecommunications system which can provide increased volume telecommunication service to end users with existing copper cables while relieving congestion at telephone company central switching offices.

SUMMARY OF THE INVENTION

The invention is generally directed to a multi-service access switched system which provides for the simultaneous use of the telephone for voice communications and for transfer of data over public communication and switching systems, increases the transmission speed for data access to a level permitting the use of video conferencing, relieves the congestion in the voice telephone network by simultaneously diverting the computer data video conferencing data to the high speed data network and

accessing data networks employing TDM, X.25, Frame Relay and ATM without the need for the installation of a new pair of telephone wires or a pair of digital modems while diverting voice signals through existing telephone company switch systems.

Another object of the invention is to provide an improved multi-service access switched system which includes a multi-service access terminal installed at the customer premises and a multi-service access switch concentrator installed at the central office of a telephone company.

Still another object of the invention is to provide an improved multi-service access switched system which provides for a customer to transmit both telephony and data over a single telephone connection.

Still a further object of the invention is to provide an improved multi-service access switch system which provides a multi-service access switch concentrator at a central switching office to support multi-channel telephony and data communications on a simultaneous basis over the existing copper wire connection between the customer and the central office.

Yet another object of the invention is to provide an improved multi-service access switch system which allows a migration from current narrow band ISDN technology to ISDN broad band (i.e. ATM and other new systems) technology with speeds from 2 Mbps up to at least 2.5 Gbps.

Still yet a further object of the invention is to provide an improved multi-service access switched system in which data is efficiently directed by the central office and is piped to the fastest and most efficient network so that data need not clog the analog telephony transmissions.

Yet still another object of the invention is to provide an improved multi-service access terminal installed at the customer's premises which provides both a standard analog telephone line and a digital port without the need for a digital modem.

A further object of the invention is to provide an improved telephone and data system which provides the ability to bundle groups of users' voice and data transmissions for pre-switching processing outside of traditional control of full switching centers so that increased speed and reduced load on telephone company switching equipment is achieved.

Still other objects and advantages of the invention will, in part, be obvious and will, in part, be apparent from the specification.

The invention accordingly comprises the features of construction, combinations of elements, and arrangements of parts which will be exemplified in the constructions hereinafter set forth, and the scope of the invention will be indicated in the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

For a fuller understanding of the invention, reference is had to the following description taken in connection with the accompanying drawings, in which:

Fig. 1 is a flow chart diagram showing the flow of telecommunications transmission by a small office or home office user;

Fig. 2 is a flow chart diagram showing the telecommunications uses by a corporate user;

Fig. 3 is a block diagram of a multi-service access terminal constructed in accordance with a preferred embodiment of the invention;

Fig. 4 is a block diagram of a multi-service access concentrator constructed in accordance with a preferred embodiment of the invention;

Fig. 5A is a block diagram of a line interface module constructed in accordance with a preferred embodiment of the invention;

Fig. 5B is another block diagram of a line interface module constructed in accordance with a preferred embodiment of the invention;

Fig. 6 is a block diagram of a switch and control module constructed in accordance with a preferred embodiment of the invention;

Fig. 7 is a block diagram of a data network interface module constructed in accordance with a preferred embodiment of the invention;

Fig. 8 is a block diagram of the software breakdown of a multi-service access terminal constructed in accordance with a preferred embodiment of the invention;

Fig. 9A is a block diagram showing the implementation of the software in connection with a SCM module for use with an analog R2 protocol constructed in accordance with a preferred embodiment of the invention;

Fig. 9B is a block diagram showing the implementation of the software in connection with a SCM module for use with an analog R2D protocol constructed in accordance with a preferred embodiment of the invention;

Fig. 9C is a block diagram showing the implementation of the software in connection with a SCM module for use with an analog V5.1 protocol constructed in accordance with a preferred embodiment of the invention;

Fig. 10 is a block diagram of an analog interface module constructed in accordance with a preferred embodiment of the invention;

Fig. 11A is a block diagram of a management control module constructed in accordance with a preferred embodiment of the invention;

Fig. 11B is another block diagram of a management control module constructed in accordance with a preferred embodiment of the invention;

Fig. 12 is a block diagram of the multi access service system constructed in accordance with a preferred embodiment of the invention;

Fig. 13 is a block diagram of the multi-service access concentrator, including each of the various components, constructed in accordance with a preferred embodiment of the invention;

Fig. 14 is a block diagram showing the implementation of the software in connection with a DNIM - Frame Relay module constructed in accordance with a preferred embodiment of the invention;

Fig. 15 is a block diagram showing the implementation of the software in connection with a DNIM - ATM module constructed in accordance with a preferred embodiment of the invention;

Fig. 16 is a block diagram showing the implementation of the software in connection with a MCM module constructed in accordance with a preferred embodiment of the invention;

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

The recent commercialization and surprising popularity of the Internet has resulted in extraordinarily high volume of data traffic through public switch telephone networks (PSTN).

The telephone lines, when utilized for the transfer of data or access to the Internet are kept busy for much longer times than for voice telephone connections and time sharing of the telephone lines is not possible as is the case with the standard voice based telephone communication. Traditionally, the central offices were not designed for sustaining connections for extremely long durations. Besides accessing the Internet, small offices in homes and small office environments use the telephone lines of the PSTNs for transfer of large computer files, for holding video conferences and for surfing the Internet.

Reference is made to Fig. 1 in which a block diagram of the small office/home office (SOHO) user configures telecommunications usage in connection with the public switch telephone network in accordance with the prior art. The PSTN 110 is accessed by the small office and home office users 70 and 50, respectively, through standard analog telephone lines 111, 112, 113 and 114. User 50, generally a home office user, has only a single telephone line access 55 with a switch 56 for allocating incoming calls to either telephone 51, fax machine 52 or personal computer 53 through an analog modem 54. Analog modem 54 is shown as a separate box but may conveniently be a component of the personal computer 53. When the home office user has an outgoing connection on the telephone line, the single telephone line prohibits any inward or outward use of the fax machine 52 or the telecommunications capacity of personal computer 53. The

connection is made through the PSTN to the designated location. To the extent that the connection is to the Internet, generally through an Internet Service Provider (ISP), the ISP has a server 130 which is connected to the Internet 120 in accordance with conventional server technology and the server 130 is connected to the PSTN and through the PSTN to the user by a series of analog modems 140 which are connected through a telephone line 115 to the PSTN.

Small office user 70 is shown as having telephone 71, fax machine 72 and personal computer 73 with an analog modem 74. However, this configuration includes a separate, dedicated telephone line, 112, 113 and 114, for each of the three separate forms of telecommunication. Obviously, there may be multiple lines for each of the forms of communications based upon capacity needs.

The traditional volume estimates by the PSTNs have been based upon purely voice based telecommunications. As fax machines developed, telephone calls and data bandwidth requirements increased substantially. However, these loads were manageable by the PSTNs. However, as SOHO users began to use the Internet for e-mail, web surfing and large file data transmission, even the smaller users began to keep Internet access lines open for hours at a time or even continuously around the clock. This use of telephone lines has caused congestion in the central office switching systems and brings them almost to

a point of collapse. Furthermore, the analog telephone lines restrict the transfer of data to about 10,000 bits per second.

The second problem which affects the user of a telephone system is the fact that, having only a single telephone line as in the user 50 shown in Fig. 1, the customer can only use his telephone to call or to be called if at that particular time he does not use his computer modem to access the Internet or to transfer a data file or transmit a fax. It also follows that if the user wishes to use access to the Internet or any online data base he cannot make or receive a telephone call at the same time without adding an additional line of service.

Reference is next made to Fig. 2 wherein a block diagram of the connections of corporate users for telecommunications in accordance with the prior art is depicted, like reference numerals representing like elements. A corporate user 200 is connected to the PSTN 110 by a series of lines 210 through a PBX or similar switch 215 which distributes the available telephone lines among telephones 201, personal computers 203 with analog modems 204 and fax machines 202. In addition, video conferencing can be done through personal computers 205 with cameras 206 through digital modems 207 connected to a data network 160 through an analog line 211. In addition, a router 208 is connected to a digital data network such as one using ATM, X.25, Frame Relay and TDM through leased

lines 212. The internal connections 209 to router 208 can include personal computers, mini computers, mainframes and the like. For the telecommunications needs which go through the PSTN 110, analog lines are general used and connection to Internet 120 is similarly through the PSTN 110. Connections to the data network 160 are digitally oriented to increase the bandwidth availability. Similarly, connections can be made to a corporate user 250 having independent lines 261 and 262 for fax machines 251 and telephones 252. Likewise, the user can have video conferencing capabilities, including a computer 254, camera 255 and modem 256 coupled directly to the data network 160 through line 263. Also, a network server 257 can be connected to the data network or to other locations for the company or customer and vendor servers through data network 160. Finally, leased lines with a router 258 can access data network 160 through leased lines 265. Access to a data communications network 160 demands a dedicated telephone cable and a pair of high speed (64,000 or 128,000 bits per second) modems. This line being dedicated, has a high initial installation expense and a high monthly maintenance charge as well. Furthermore, it should be known that the service offered by such dedicated connection is for a point-to-point configuration. It is generally not possible to "dial" any other physical or virtual address whenever it is needed to do so.

The multi-service access switched system constructed in accordance with a preferred embodiment of the invention satisfies four major challenges for accessing the public telecommunication systems. First, it provides for simultaneous use of the telephone line for voice communication and for transfer of data, including the Internet over public data communications networks and voice switching systems. Second, the transmission speed for data access is increased from the present 10,000 bits per second to at least 64,000 to 128,000 bits per second, permitting the use of video conferencing. Third, the congestion in the voice telephone network is relieved by simultaneously diverting the computer data and video conferencing traffic to a high-speed data network, rather than the PSTN. Fourth, access to data networks employing TDM, X.25, Frame Relay and ATM is achieved without the need for the installation of a new pair of telephone wires or a pair of digital modems.

In contrast to the present access systems which basically offer a point-to-point service over private lines, the multi access service switched system lets the user address (dial) his information to any physical or virtual address as need be or be called from any physical or virtual address.

The system, in accordance with a preferred embodiment of the invention, consists of two components. The first is a multi-service access terminal (MAT) installed at the customer premises and the other is a multi-service access concentrator

switch (MAC) installed at the central office of a telephone company. A block diagram of the MAT, found at the customer's site, is shown in Fig. 3 and a block diagram of the multi-service access terminal concentrator (MAC) is shown in Fig. 4. There is an ST port which can connect any ISDN device.

Reference is made to Fig. 3. The MAT 300 includes a microprocessor 301, line interface 302, signalling component 303, digital to analog converter 304, 2 Mbps bus 305, digital port 306 and analog port 307. The user connects phone line 310 to the central office directly into the MAT 300. The telephone 320 is connected to analog port 307 and computer 330 is connected directly to digital port 306. The MAT 300 is installed at the customer premises, residence or small office. The two ports 306, 307 are digitized, synchronized and multiplexed with the information being transported over the same telephone line but now in the form of two digital channels, each of which is a totally independent, 64,000 per bits per second bi-directional and synchronous channel (B channel). A third 16,000 bit per second channel, designated as a D channel, carries the signalling (dialing) information about the first two channels described above. The D channel can also carry other information such as the number of a credit card using X.25 protocols, for example, which can enter in a signalling port 311.

An important characteristic is that it is possible to combine the two synchronous 64 Kbps channels into one 128 Kbps

channel for transmission of data when the telephone line is not being utilized. However, when a telephone call is made or received, the 128 Kbps channel reverts to the initial two separate 64 Kbps channels.

At the central office the Multiservice Access Concentrator (MAC) connects to wires coming from either 105 or 180 customers in current preferred embodiments of the invention. The telephone number of each individual customer remains unchanged. Physically, the MAC holds, in a current preferred embodiment, 12 cards for interfacing with the customers, three cards for cross-connecting, two cards for interfacing with the data network, one card for management and two for power supplies (one of which acts as a hot standby).

Reference is next made to Figs. 4 and 13, wherein a physical diagram and block diagram of a MAC, generally indicated as 400, is shown. Fig. 4 shows the redundant power supplies 401, 402. As better seen in Fig. 13, MAC includes seven U-interface modules (line interface modules) 403, each of which has 15 ports so that the MAC 400 can deal with 105 customers. The MAC 400 shown in Figs. 4 and 14 is configured for 105 customers but with additional U-interface module capacity can be expanded to 180 incoming lines. The U-interface modules are also known as line interface modules (LIM). Next, there are a series of switching and control modules (SCM) 404. In addition to switching and control module 404 there is a management and control module 406

(shown as a box without attachments, but actually with connections to each of the other modules and buses for control purposes), data network interface module 407 and analog interface modules 408. In one preferred embodiment the MAC 400 physically holds eighteen cards for interfacing with customers, one card for management and two cards for power supply 401, 402 (one as a hot standby). Cross-connection cards 440 are shown in Fig. 4. The double headed arrows in Fig. 13 represent buses.

Reference is next made to Figs. 5A and 5B wherein a circuit diagram and block diagram of a line interface module 403 are shown. As better seen in Fig. 5B, each module is designed to receive input from 15 subscriber lines, each of which includes two B data lines and one D signal channel. The telephone line which carries two digital channels is connected to the concentrator (MAC) 400. The function of the concentrator is the reverse of the MAT 300, which is found at the customer's premises. In other words, the MAC demultiplexes the two digital channels and sends the telephone channel, in an analog form, to the proper terminal of the central office voice switch. This functionality is implemented initially at the line interface module 403 which interfaces with the incoming telephone line. This module with the U-interface receives the two 64 Kbps channels (B channels) and the 16 Kbps signalling channel (D channel). In one single printed circuit board, in a preferred embodiment, up to 15 of these interface components are combined

into a line interface module (LIM) 403. U interface 501 combines two B channels on a 4 Mbps bus and has two outputs, one serial and one for the D channel (also serial). The 15 components on one single card can multiplex information from 15 users forming a block of 15 X 2 B channels or, in other words, thirty channels at one port and another block of 15 D channels at another port. A serial communication port (SCP) bus architecture links U interface components 501 with the management and control module (MCM) 406. Each user on U line 502 is connected to interface 501 where it is demultiplexed and then added to the other U line inputs. Wave controls FOB 503 establish a 4 Mbits/s control signal from the MCM unit. The U interface 501 outputs the demultiplexed D channel signals on the DCH OUT line to the SCM 404. As seen in Fig. 5B, a 20 Mbits/s clock is used to demultiplex the U-channels by the channel interfaces 501. U select and D circuit transmissions block 507, collects each of the D channels, as well as orders the channels by selecting the data signals from the various U lines. The control signals include the SCPEN input (SPIEN) 508 from MCM 406. The U select and D circuit transmission box 507 outputs fifteen D channel signals to an SCM 404. A D channel out signal from a U interface 501 is shown. In fact, each interface 501 has a separate output line which is attached to U select and D circuit transmission box 507. A SCPEN selection box 510 shows the line which enters each U interface 501 to control the interface demultiplexing process.

This serial control port enable signal orders the selection process among the U channel interface boxes (1-15) 501.

Reference is next made to Fig. 6 wherein a switching and control module 404 constructed in accordance with a preferred embodiment of the invention is depicted. The information from the two blocks linked as described above, is sent, through the back plane (electrical connector), to a switching control module (card) 404. Switching control module 404 consists of two switch matrices 601, 602 and a microprocessor 603. Each of switching matrices 601, 602 is composed of two 4 Mbps ports which combine at each port a block of 60 channels (30 B1 and B2 channels). The 60 channels arriving, each at 4 Mbps, originally grouped from two line interface modules, are forwarded to four 2 Mbps ports. These two Mbps ports carry: 30 voice channels digitized at 64 Kbps from LIM 1 and LIM 2; 15 128 Kbps data channels from LIM 1; and 15 data channels from LIM 2; and 30 signalling channels at 64 Kbps for the voice channels. Another 4 Mbps bus enters the SCM from four LIM 403 and carries 60 D channels to the microprocessor 603. The block containing 30 channels for voice and R2 or V.5.2 signalling may be interfaced directly with the trunk port of the Stored Program Switch (digital switch) at the central office, simplifying the cabling between the multi access switched system and the central office switch. This is the digital interface option to connect the MAC to the voice switch.

The microprocessor has the double function of controlling the two switching matrices 601, 602 and at the same time converting the Q.931 protocol of the D channel signalling information into Q.933 (Frame Relay) or Q.2931 (ATM) signalling protocols. The microprocessor also provides the management information and the information on the configuration of the matrices through a 10 Base-T Ethernet port to the management control module 406. The microprocessor 603 is also responsible for D channel signalling conversion to R2 or V.5 on the digital interface. In addition, each of switching matrices 601, 602 outputs through Frammer DS 2154 transmission blocks 605 and are framed either by E1 Framed G. 703 2 Mbits/s boxes for Voice 606 or for Video Conference 607. Microprocessor 603, which, in a preferred embodiment, is a Motorola 860T, is connected to 60D channels at port TDMA, an SPI bus 612 (to be connected to the AIM), an output port TDMB which is connected to V.35/36 Electrical Drivers 608 with X25 protocol, a 10/100 Base T 609, which is connected in turn to LXT 970 Ethernet Drivers 610 with a TCP/IP for Management input 611.

Figs. 9A, 9B and 9C depict the breakdown of the software operations of the SCM module in connection with analog R2, R2D and V5.1 line protocols.

The 30 128 Kbps channels used for transmission of data or video conference transmission are now combined and sent over 4 Mbps buses to the module which interfaces with the data network

of the network provider. This module is known as the Data Network Interface Module (DNIM), 407 shown in detail in Fig. 7. Data Network Interface Module 407 is composed of two microprocessors 701, 702 which serve the function of receiving at each two 4 Mbps blocks consisting of 60 channels (30 B1 + B2) with the information on data from 30 users' LIM 1 and 30 users' LIM 2.

Data signals, when generated by a video conference, are sent to a deterministic network (TDM) and then on to the video conference service providers. If the data channels are to be fed to a switched packet network of Frame Relay or ATM type, those channels are pre-formatted (packaged) to Frame Relay or ATM protocols at data network interface module (DNIM) 407. DNIM 407 consists of two microprocessors 701, 702. Each serves the function of receiving two 4 Mbps blocks consisting of 60 channels (30 B1 + B2) which would be information or data from 30 users' LIM 1 and 30 users' LIM 2. These blocks of channels arrive at microprocessor 701 or 702 and each processes the corresponding data packets conforming to the Frame Relay or ATM protocols at this level. The interfunctionality between the D channel protocol and the Frame Relay and ATM headers are performed at the main microprocessor here by software. In a preferred embodiment microprocessor 705 which controls the operation of the DNIM is a Motorola 860 SR. The programming and memory for the microprocessor 802 is found in PROM 707 and DRAM 706. The data

is then sent through Framers 711, 712 to an E1 line either with Frame Relay or ATM network protocols. Alternatively, data to be sent to the Internet utilizes the 33 MHZ system I/O bus 714 to SCCI Ethernet Port 713.

The addressing (dialing) function is implemented by correct handling of information contained in a D channel such as the called number, the number of the calling party, busy tone, dial tone and other commonly known signals. All of this information is reformatted from channel D protocols to the respective headers for Frame Relay or ATM for call set up procedures. For each call these data packets are sent to physical or virtual addresses through high-speed networks.

Reference is next made to Figs. 14 and 15 wherein a software breakdown of the DNIM module in connection with Frame Relay and ATM networks in accordance with preferred embodiments of the invention are depicted.

Reference is next made to Fig. 8 which shows the implementation of software and reformatting (routing) on the user side. These virtual addresses include other users of the network or the providers of the Internet access, Intranet, video conferencing and other users or data providers. These networks can be connected to other domestic or international networks as well as described below.

If the voice switch interface of the central office happens to be analog, a different module designated as an analog

interface module (AIM) 408 shown in Fig. 10 is utilized. The AIM 408 basically consists of a demultiplexer of 30 voice channels (B channels) and demultiplexer of the signalling channels (D channels) and fifteen digital/analog converters followed by fifteen analog line interfaces to which the ports of the signalling channel demultiplexer are connected. This signalling is a reproduction of the signalling initiated by a MAT user in the first place.

Reference is next made to Figs. 11A and 11B wherein a management and control module generally indicated as 406 is depicted. The management control module is utilized for the management of other modules contained in the MAC 400 and also receives error and failure signals. The management and control module 406 consists of a clock decision module 1102, wave control generator 1103, which connects to other modules, a microprocessor 1105 and a the serial port (RS-232) SCC2 which is used for local management. The Ethernet port 1107 of this module connects to all other microprocessors of the system. The serial control port (SCC2) controls the U-interfaces of the line interface modules 403. The management and control module 406 is able to do a "loop-back" for identification of the failures, alter configurations if needed and provide data for billing purposes. Clock decision module 1102 improves each of the 2 Mbits/s clocks and selects a master clock for use by all components, splitting the clock speed as required by other components in block 1103.

The host computer line on the Ethernet port 1107 allows control of the overall system by a remote controller, either at the physical site or through the Internet.

Reference is next made to Fig. 12 wherein a diagrammatic view of two setups incorporating the multi-service access switched system constructed in accordance with preferred embodiments of the invention are depicted. On the left side of Fig. 12 a multi-service access terminal 300 is used to connect a large office configuration including telephones 51, card readers 221, faxes 52, video phone personal computers 205 with cameras 206 and a series of personal computers configured in a LAN 222 to the central office and, in particular, to a multi-service access concentrator 400 which directs the signal either to the PSTN 110 or to the data network 160. Similarly, on the right side of Fig. 13 a smaller installation in which telephone 51 and personal computer 53 are connected through a multi-service access terminal 300 to a multi-service access concentrator 400 which acts as a gateway with both the PSTN 110 and data network 160 for access to the Internet and video conferencing through high-speed data networks and to and from data connected to a data network by leased lines.

Reference is next made to Fig. 13 wherein an overall block diagram of the MAC 400, in accordance with a preferred embodiment of the invention, is depicted, like elements being represented by like reference numerals. MAC 400 includes seven

LIM modules 403, two SCM modules 404, a DNIM module 407, a MCM module 406 and seven AIM modules 408 coupled together with various buses. The LIM modules are shown in Figs. 5A and 5B. The SCM modules are shown in Fig. 6. The DNIM module is shown in detail Fig. 7. The AIM modules are shown in Fig. 10 and the MCM module is shown in Fig. 11.

Reference is next made to Fig. 9 wherein the software breakdown for the MAC 400 is shown. Software breakdown includes interfaces, protocol changes and connections for the two B channels and one D channel, as well as a telephone, fax input and a digital ISDN and X25 connectors and a PC connector.

Reference is next made to Fig. 10 wherein a block diagram of the AIM module 408, in accordance with a preferred embodiment of the invention, is depicted. AIM 408 is coupled to the SCM 404 through a 2 Mbps TDM bus for voice 491 and essentially demultiplexes the TDM signal through use of PCM filter codes 1003 and central office interface circuits 1004 in accordance with conventional practice. A wave control selection is performed under wave control generator 1103 found in the MCM 406. A microprocessor 1005 controls the local activity within AIM 408. In practice there are 15 separate parallel circuits for dealing with each of the 15 user inputs under the selection of the wave control generator 1103 controlled by MCM 406.

Reference is next made to Fig. 16 in which a block diagram of the software breakdown of the MCM module constructed

in accordance with a preferred embodiment of the invention is depicted.

There are additional applications for the Multi-Service Access Switched System. As stated before, the MAT is always installed at the user's premises, but the MAC can reside at the Central Office main building or at a POP (point of presence). One possible location for the MAC is inside a cabinet that is installed at the curb. This cabinet is known as an "optical cabinet" as it is linked to the network provider which can be the ILEC (Incumbent Local Exchange Company) or a CLEC (Competitive Local Exchange Company) through a pair of fiber optical cable. The technology employed is FTTL - Fiber To The Loop. In this application the Multi-Service Access Switched System is actually part of the access side of the network and the MAC can be connected to the subscriber over a copper pair in two different ways.

One way is a connection as described in the initial part of the patent application through the "U" interface with the MAT. The other possibility is to connect the same "U" interface with a PCM-4 and provide a voice service to four subscribers with voice compression 2:1 or with a PCM-2 and provide a voice service to two subscribers without the voice compression. The PCM-2 and PCM-4 technologies are a relatively old technique to multiplex respectively two and four subscribers over one single pair of copper wires and is not part of this patent application. In

accordance with the invention each shelf can handle 180 MAT subscribers and the Central Office interface requires 6 E1 for voice and 2 E1 for the data channels. An E1 line is an international standard high bandwidth line similar to the US T1 lines. These E1 are normally transported into the fiber via a PDH or SDH multiplexer. If a PCM-2 or PCM-4 connection is used then the capacity is expanded to 360 or 720 users per shelf. These are low cost solutions to access the voice and data networks.

Another application of Multi-Service Access Switched System is to place the MAC at the Cable Distribution Frame of a condominium or a business offices building. In this case MAC keeps the same analog interface through the AIM board to the Central Office as if it were at the Central Office premises, but the data channels or video-conference signals go directly to the data network of any network provider e.g. an ISP via a high speed local link. This architecture uses the existing cable infrastructure, so the new service can be turned on as soon as the MAC shelf is installed.

A third possible application is to use the Multi-Service Access Switched System as part of the process to digitize the Telephone Plant in countries or regions where the major Central Office switches are still analog. These analog switches cannot provide important new services such as caller party identification, call forwarding, automatic billing, hold and many

others provided by computer-controlled switches. The average capacity of an analog switch is 10,000 subscribers, which can be completely replaced with the MAC with a MAT terminal - in which case ISDN services are provided - or with a PCM-2 or PCM-4 terminal and link the trunk interface with an existing digital switch.

The savings in ground space is greater than 10:1 and the cost per terminal is about half of the current average cost. By using IN (Intelligent Network) signaling the existing subscribers can keep their same phone number although connecting to a new Central Office switch.

As described above, the multi-service access switch system solves the four challenges posed by the current extraordinary increases in demand for capacity of the public telecommunications systems. The multi-service access switched system allows for simultaneous use of telephone for voice communications and for transfer of data. It allows for the increase of transmission speeds for data access from the present limited band width transmission to a much high speed transmission. Congestion in the voice telephone network is relieved by simultaneously diverting computer data and video conferencing traffic to high speed digital data networks rather than the public switched telephone networks. Finally, access to data networks employing new high-speed communication protocols, including TDM, X.25, Frame Relay and ATM without the need for the

installation of a new pair of telephone wires or digital modems is enabled.

The capacity of the system can be easily stepped up on the multi-service access concentrator components either by the use of multiple components based upon subscriber volume or by increased miniaturization and concentration of components.

Accordingly, an improved multi-service access switched system based upon the use of customer based multiple access terminals and central office multiple access concentrators which provide for the more efficient utilization of available bandwidth of existing wiring and simultaneous voice and data transmissions which are allocated by the central office multi-service access concentrator so that data and video conferencing transmissions are dealt with by high-speed data networks thereby freeing the PSTN from excessive data loading is provided.

It will thus be seen that the objects set forth above, among those made apparent in the proceeding description, are efficiently obtained and, since certain changes may be made in the above constructions and processes without departing from the spirit and scope of the invention, it is intended that all matter contained in the above description or shown in the accompanied drawings shall be interpreted as illustrative, and not in the limiting sense.

It will also be understood that the following Claims are intended to cover all of the generic and specific features

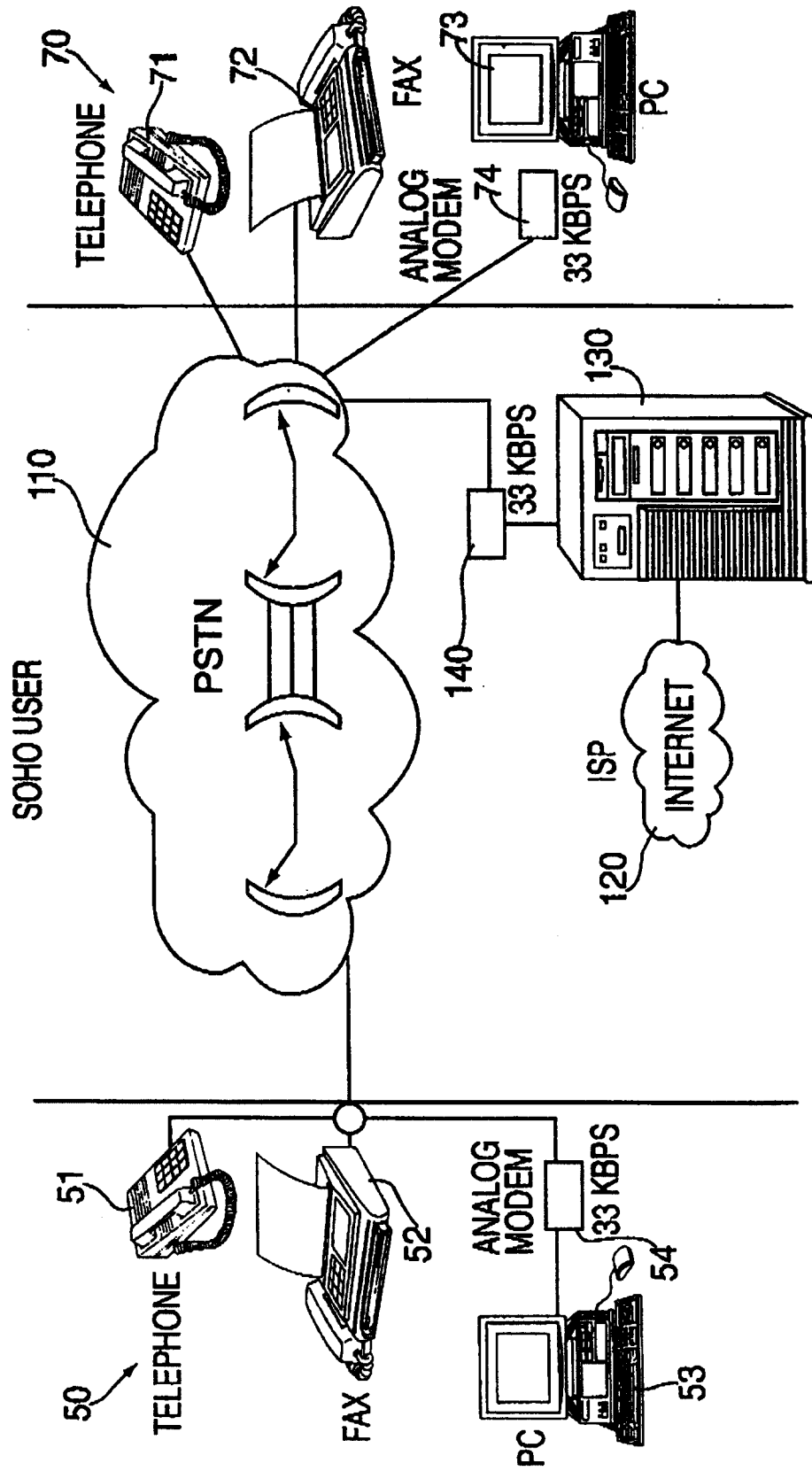
of the invention, herein described and all statements of the scope of the invention which, as a matter of language, might be said to fall therebetween.

C L A I M S

1. A multi-service access switched system for providing simultaneous voice and data, comprising:

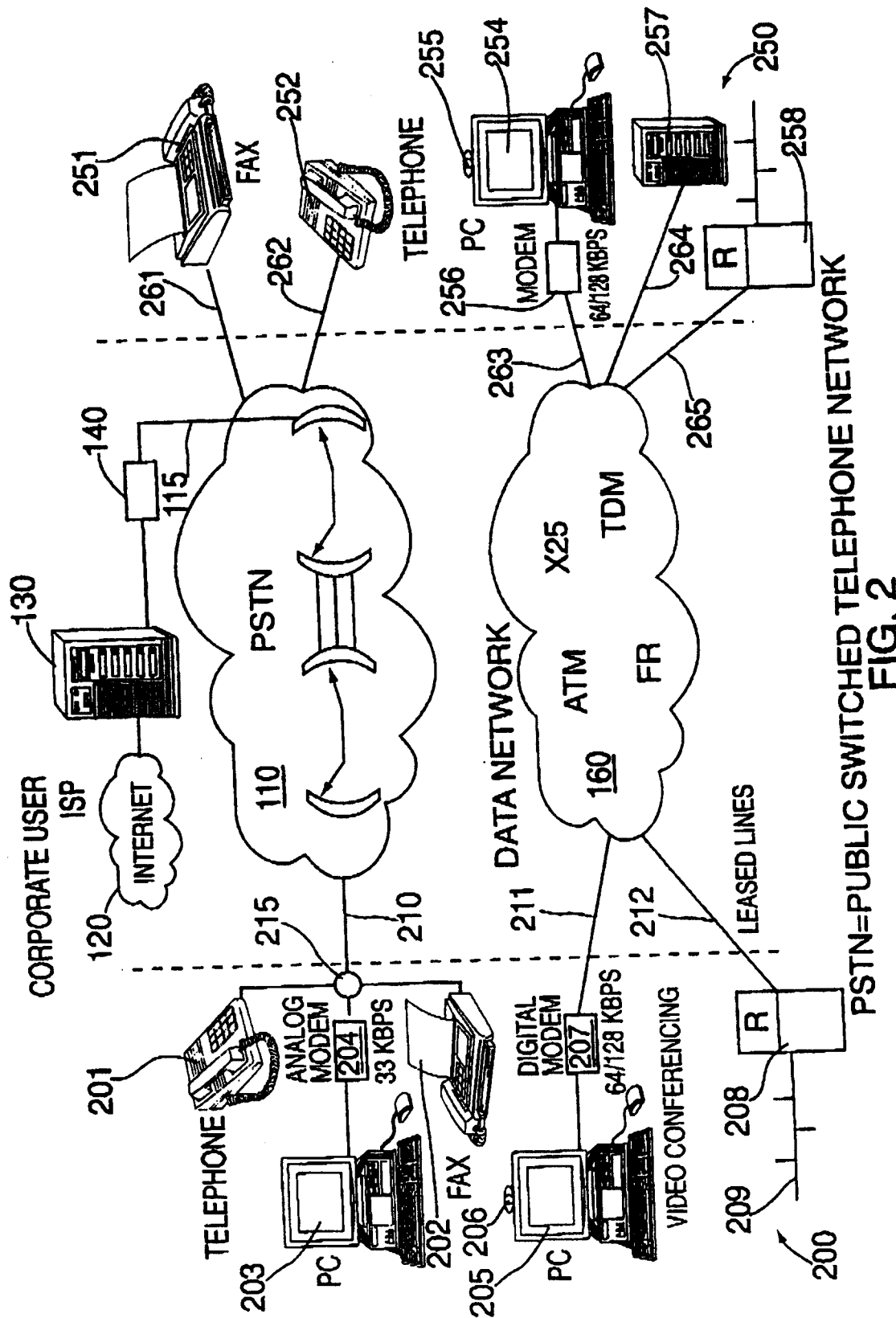
a multi-service access terminal unit coupled to a user's telephone and data processing equipment; and

multi-service access concentrator means for receiving the output of a plurality of multi access terminal units and directing the voice components of the transmission to a public switch telephone network and the data components of the transmission to a separate data network.



PSTN=PUBLIC SWITCHED TELEPHONE NETWORK

FIG. 1



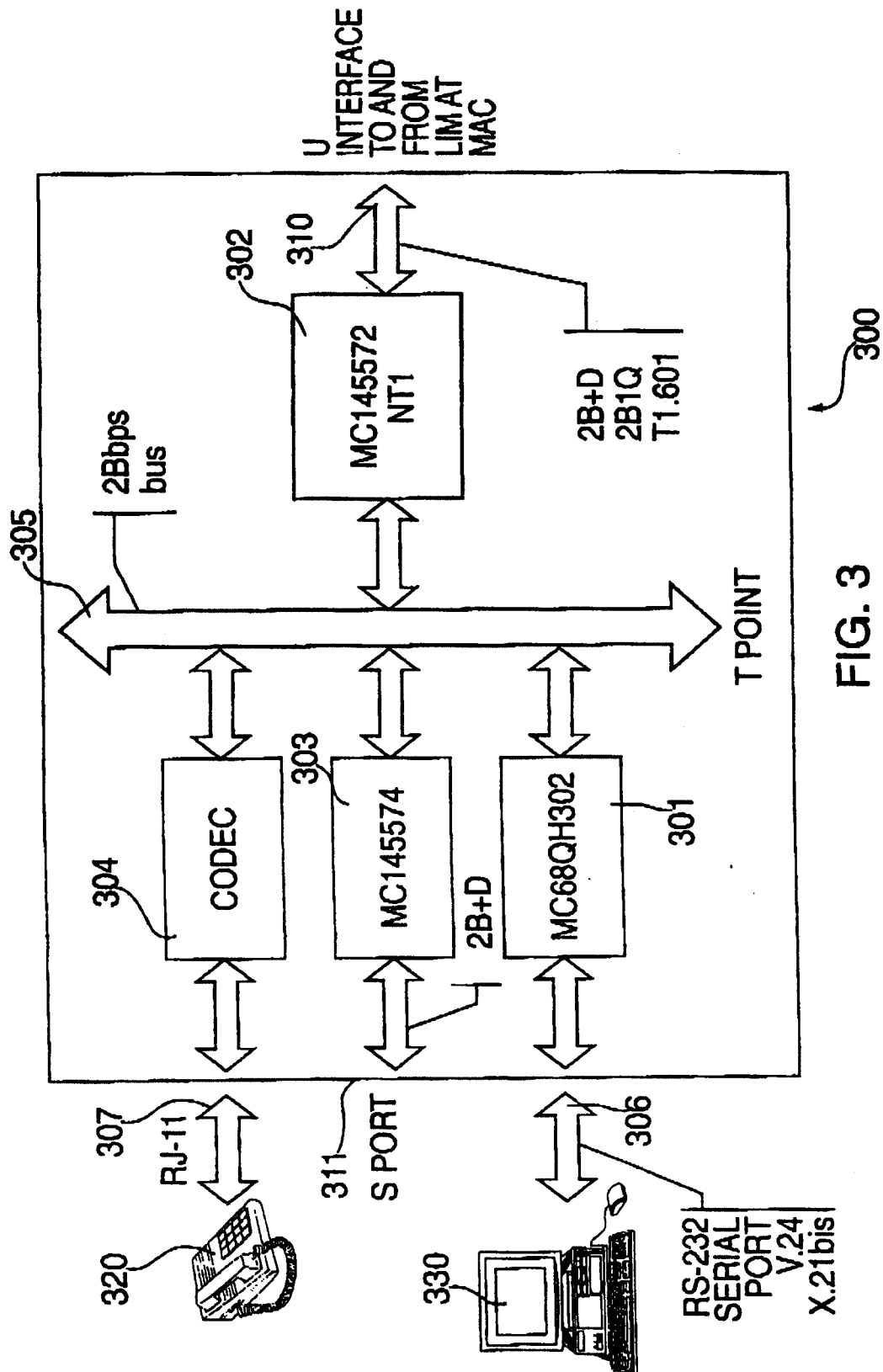
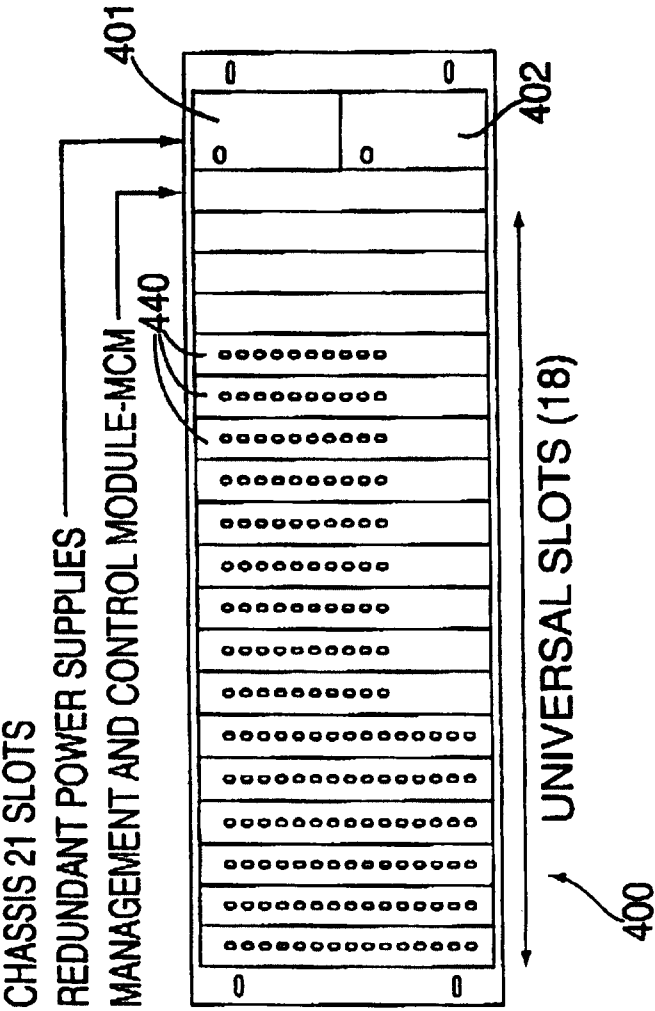


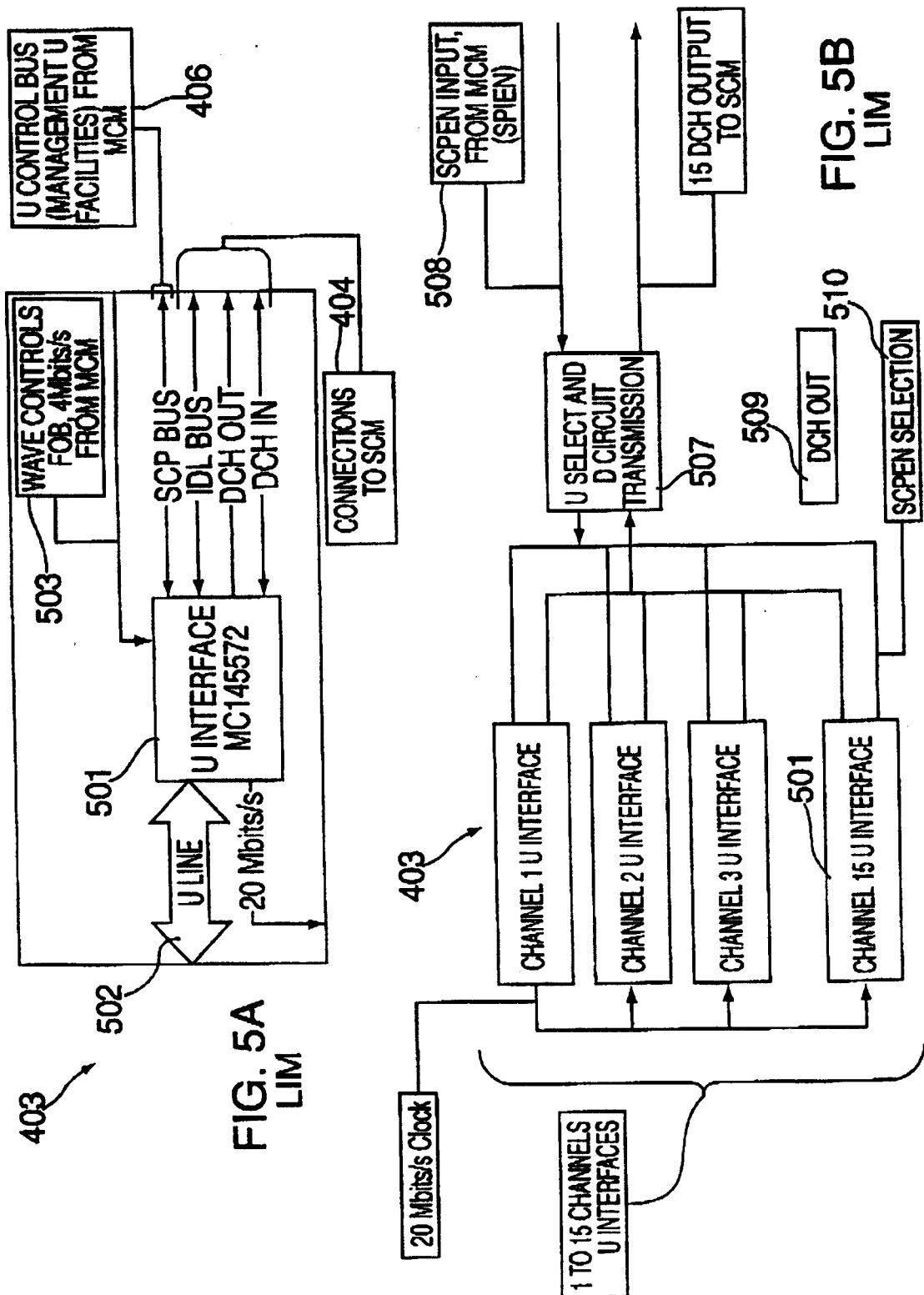
FIG. 3

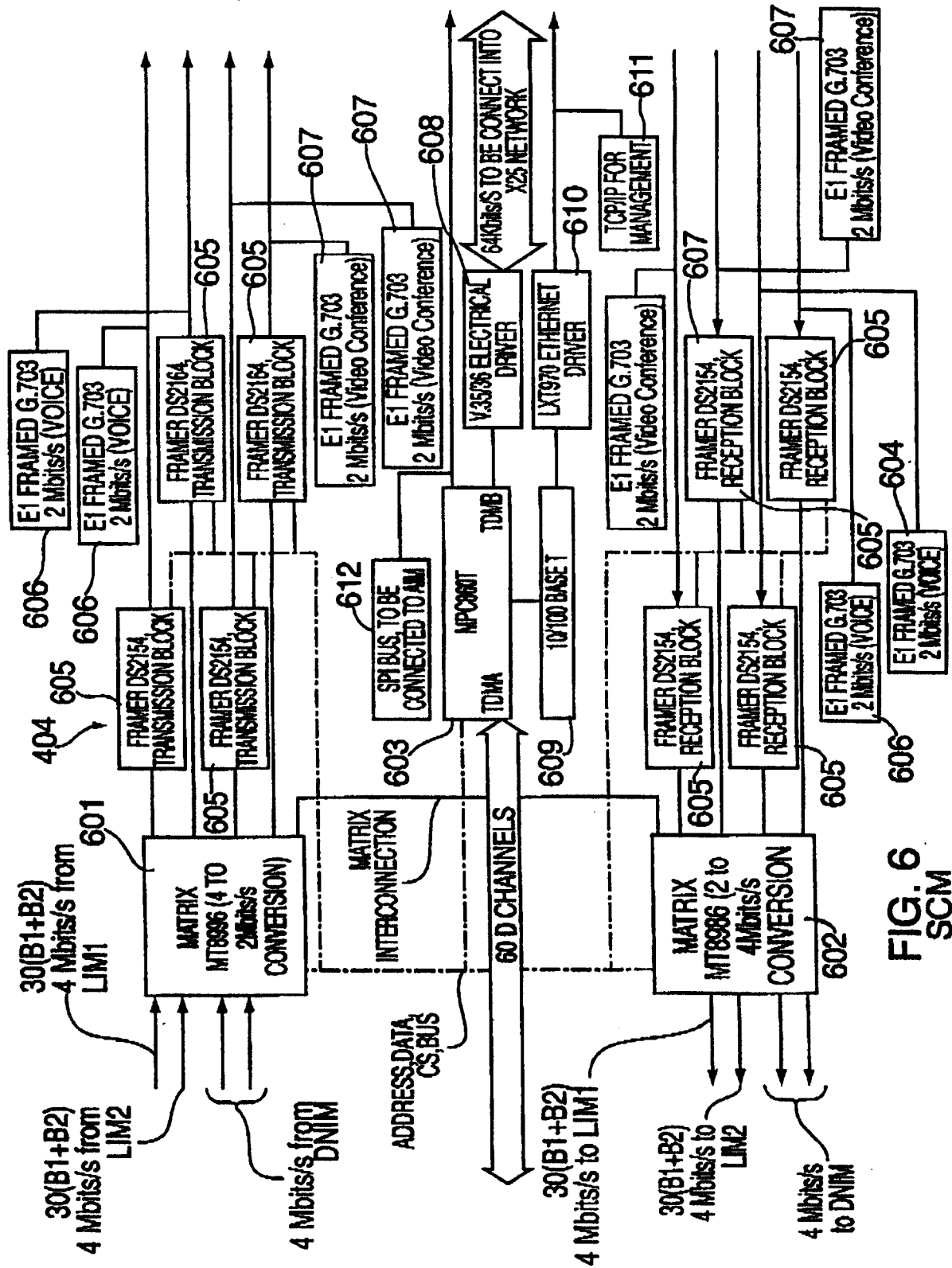
M@SS
MAC-MULTISERVICE ACCESS CONCENTRATOR



UNIVERSAL SLOTS	
TYPE	NO. PORTS
LINE INTERFACE MODULE-LIM	15
ANALOG INTERFACE MODULE-AIM	15
SWITCHING AND CONTROL MODULE-SCM	60 SUBSCRIBERS
DATA NETWORK INTERFACE MODULE-DNIM (FR OR ATM)	1 ATM E1 / 1 FR E1
ATM E3 MODULE	FUTURE
FR E3 MODULE	FUTURE

FIG. 4



FIG. 6
SCM

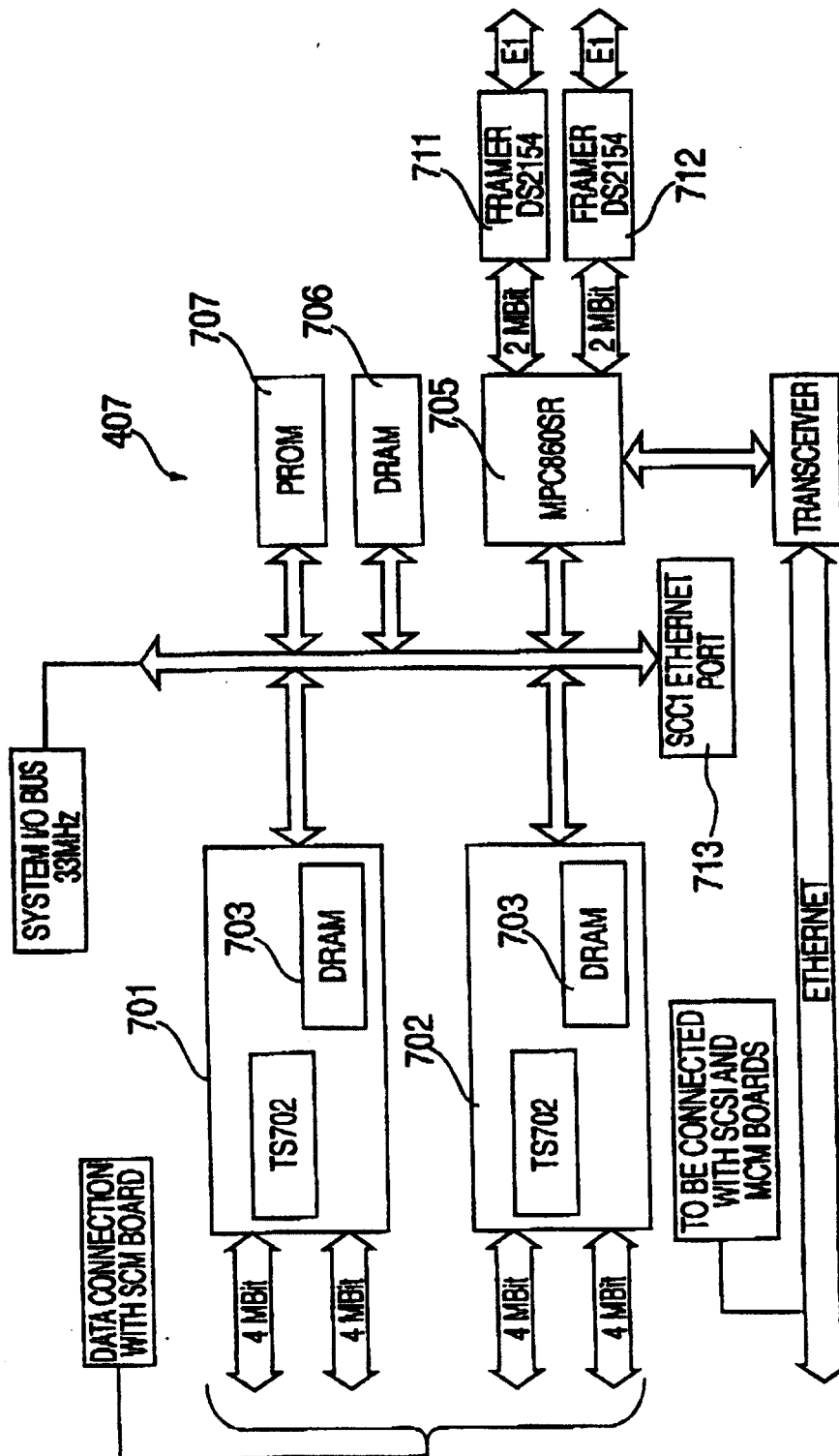


FIG. 7
DNIM

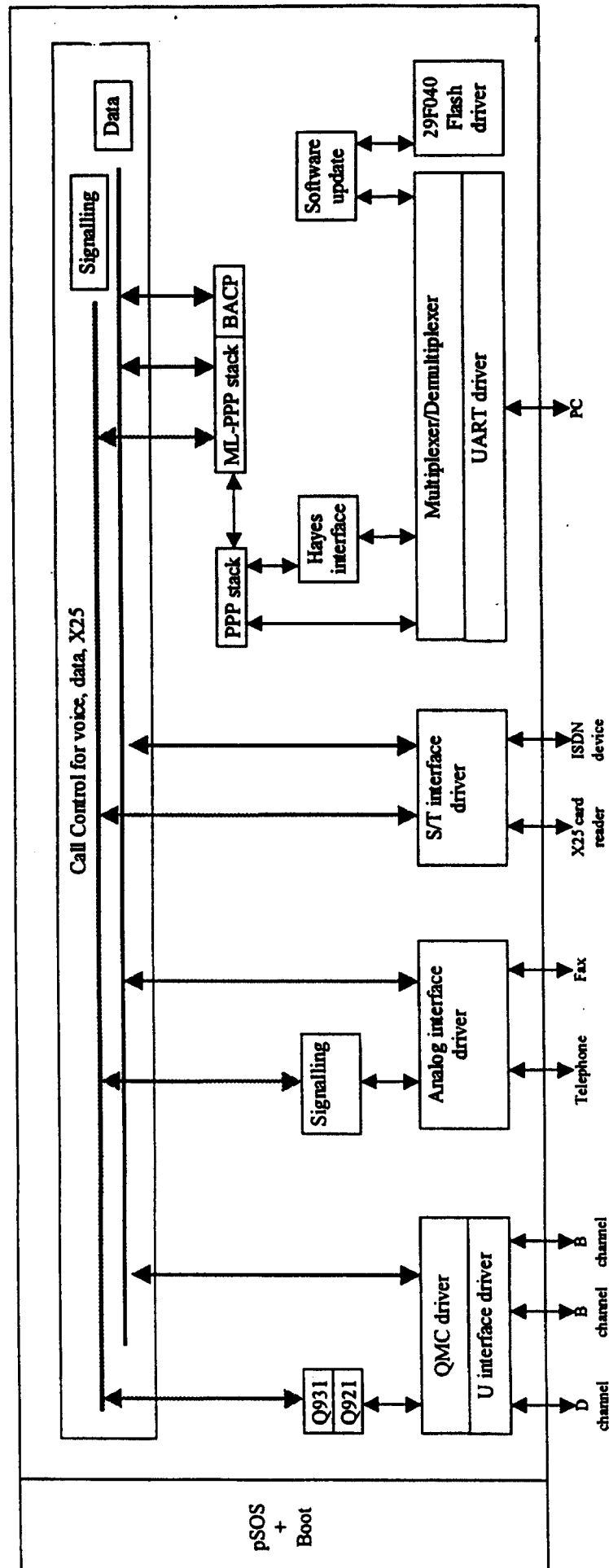


FIG.8

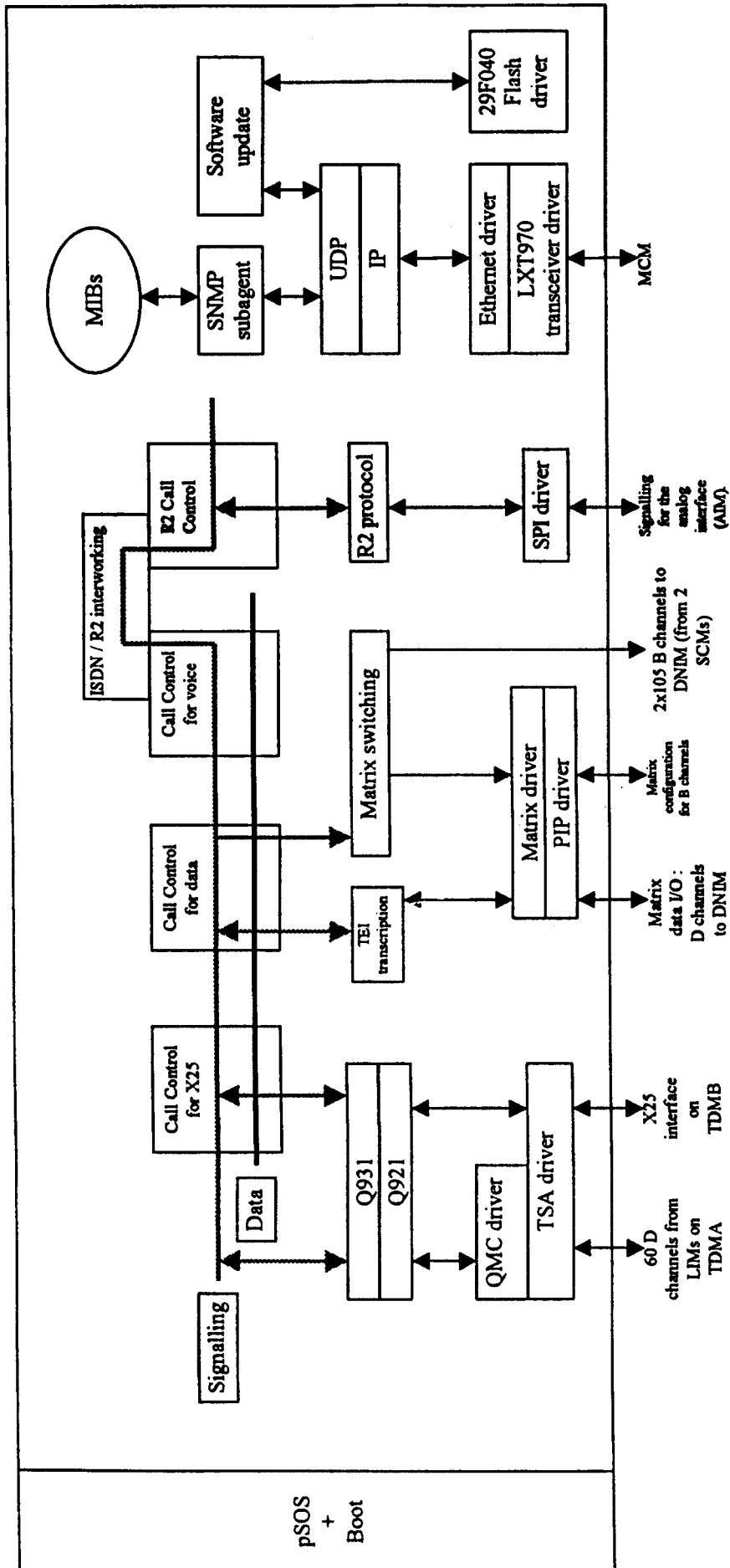


FIG. 9a

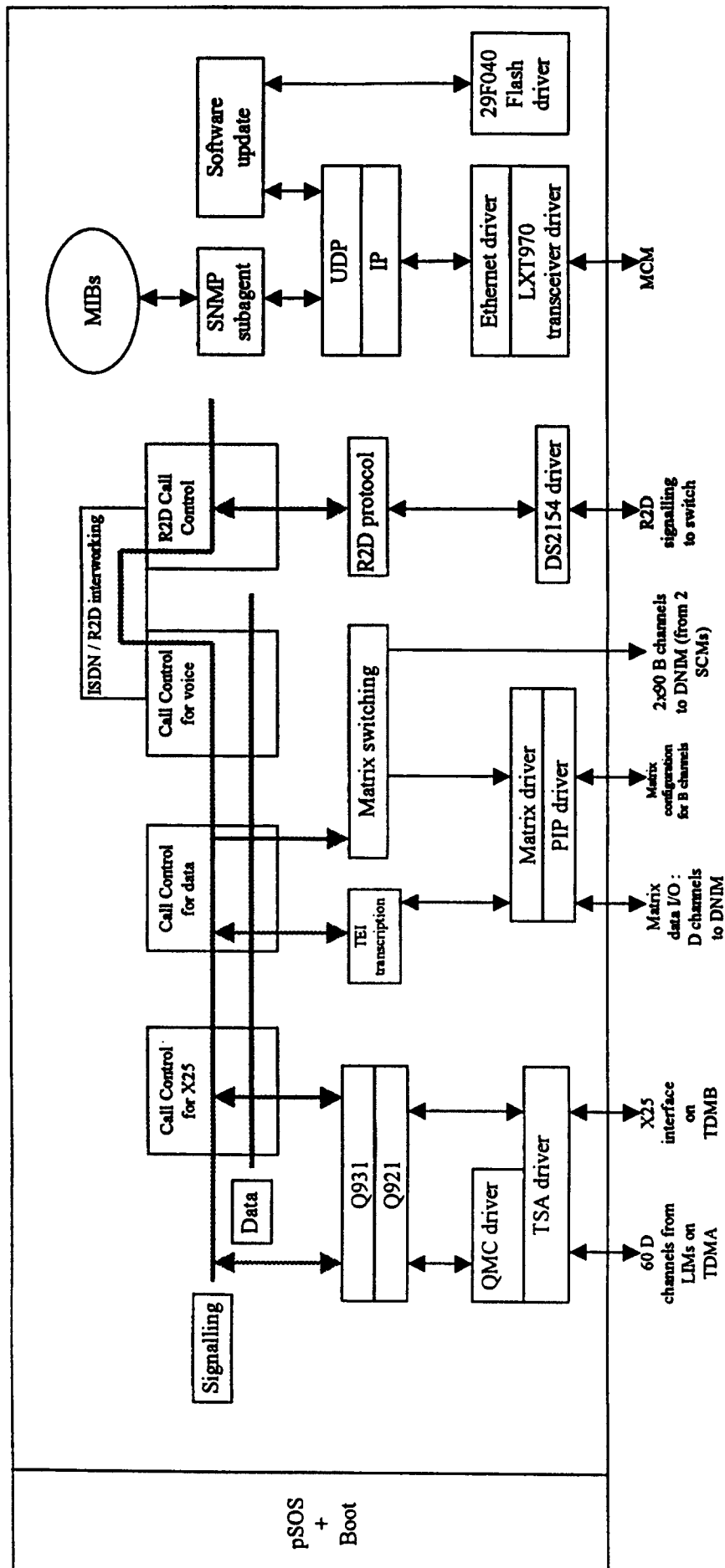


FIG. 9b

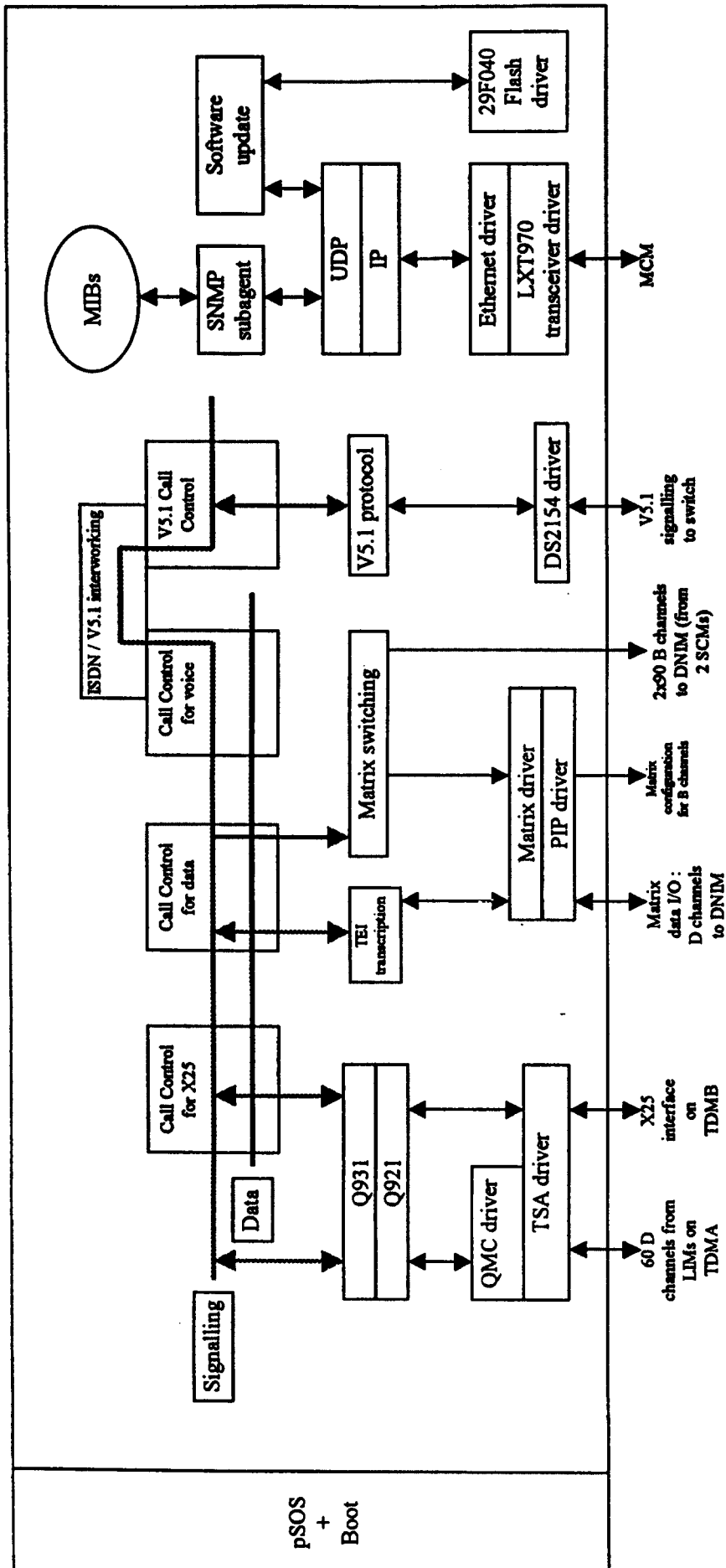


FIG. 9c

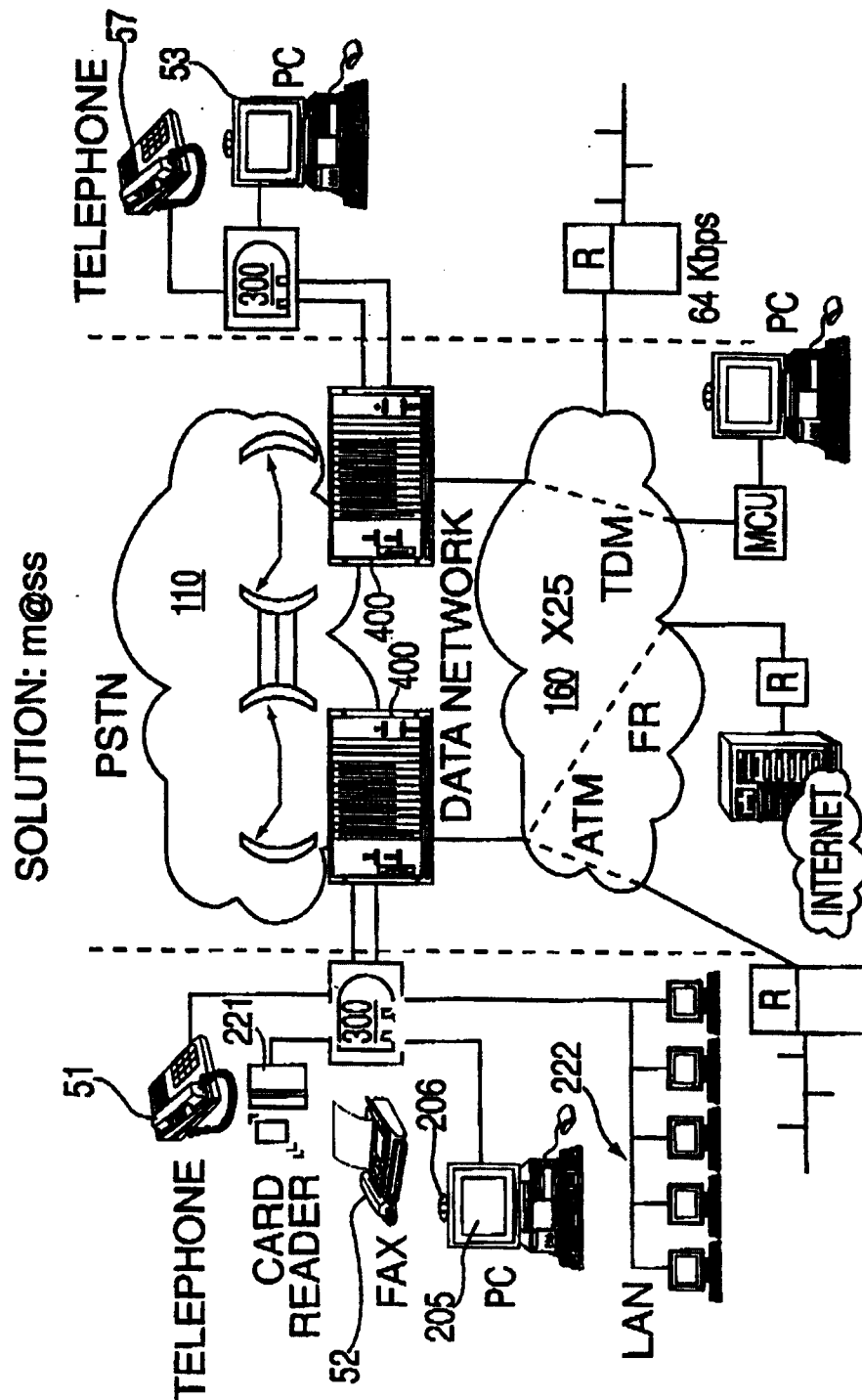
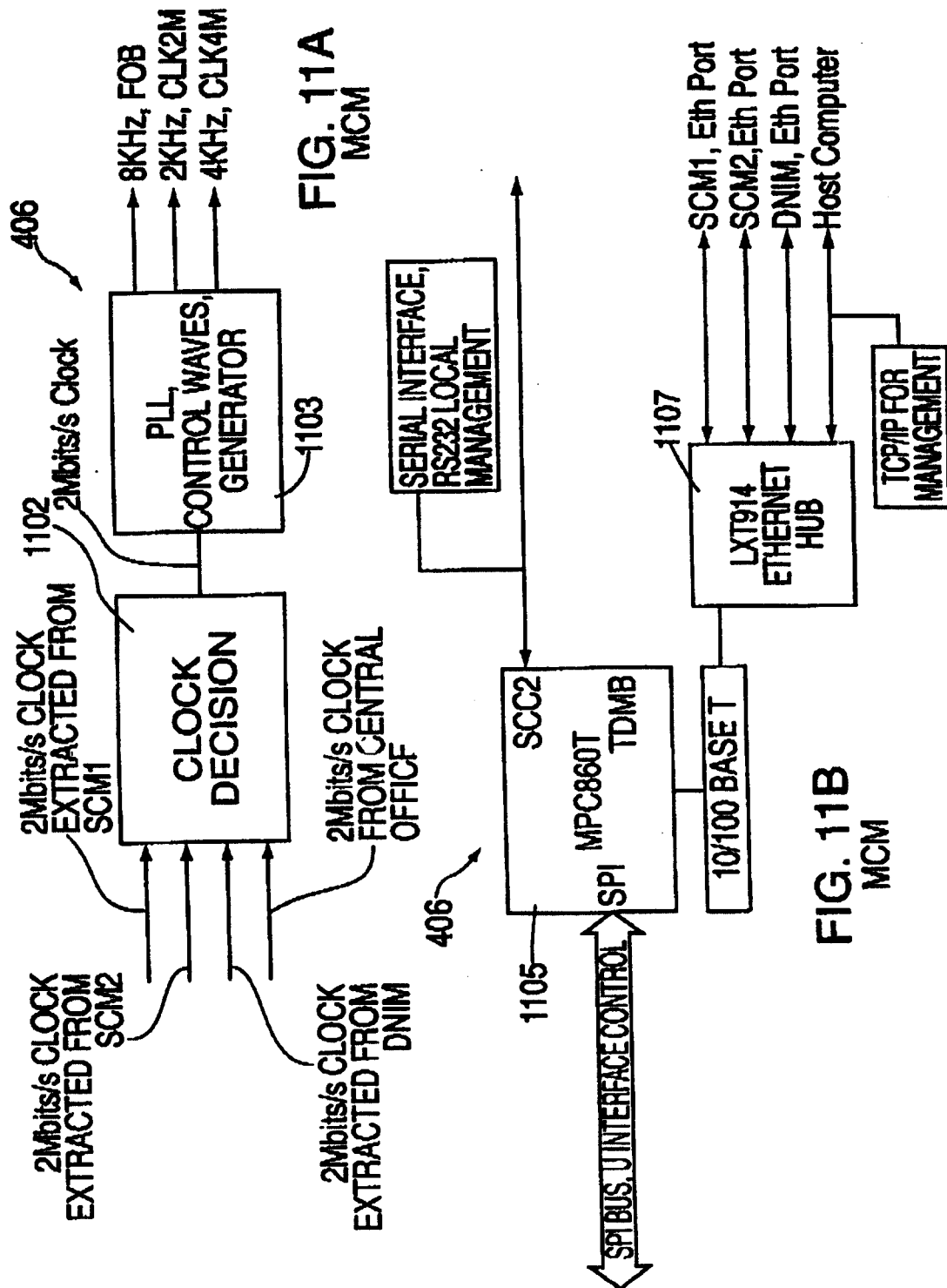


FIG. 12



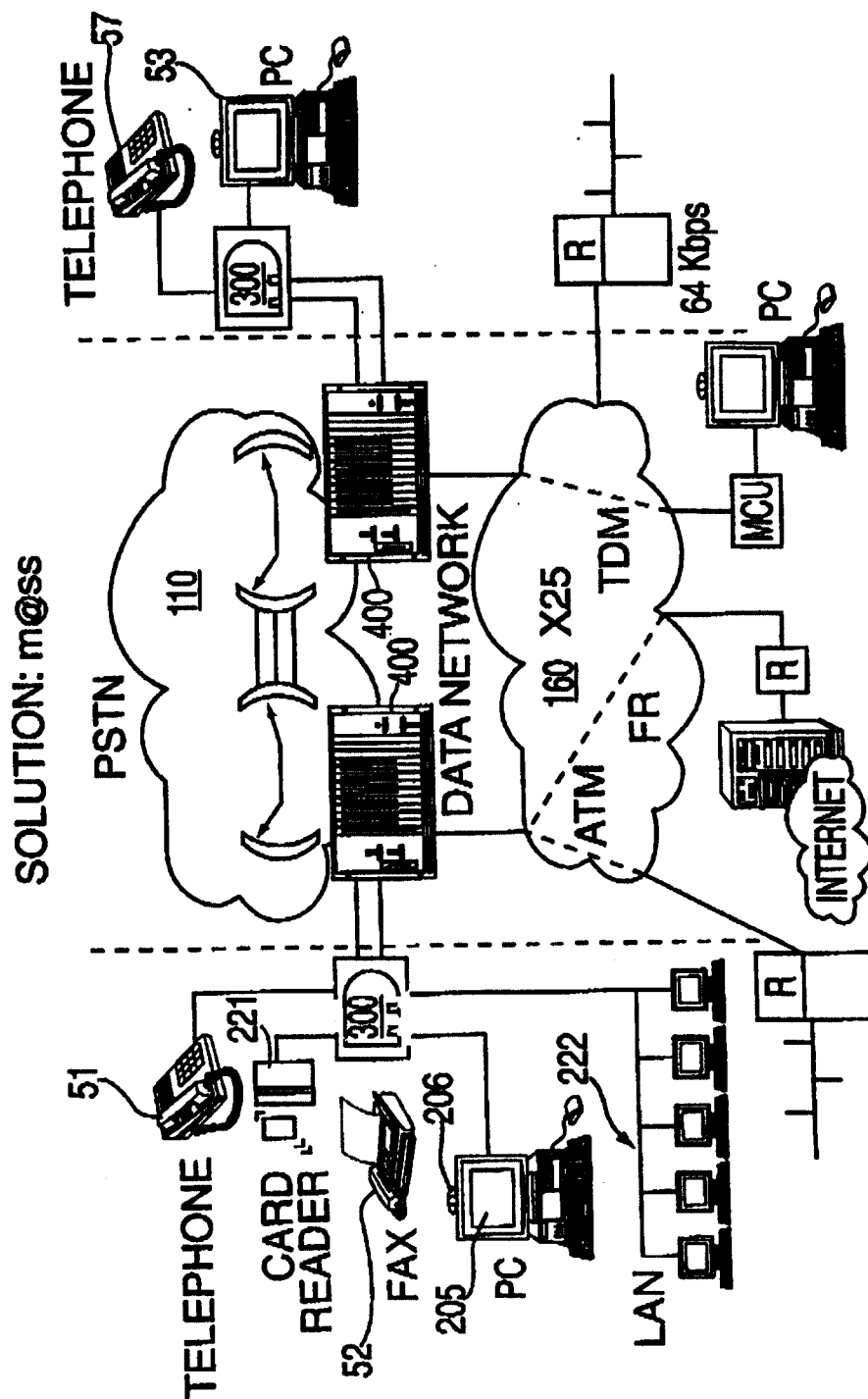


FIG. 12

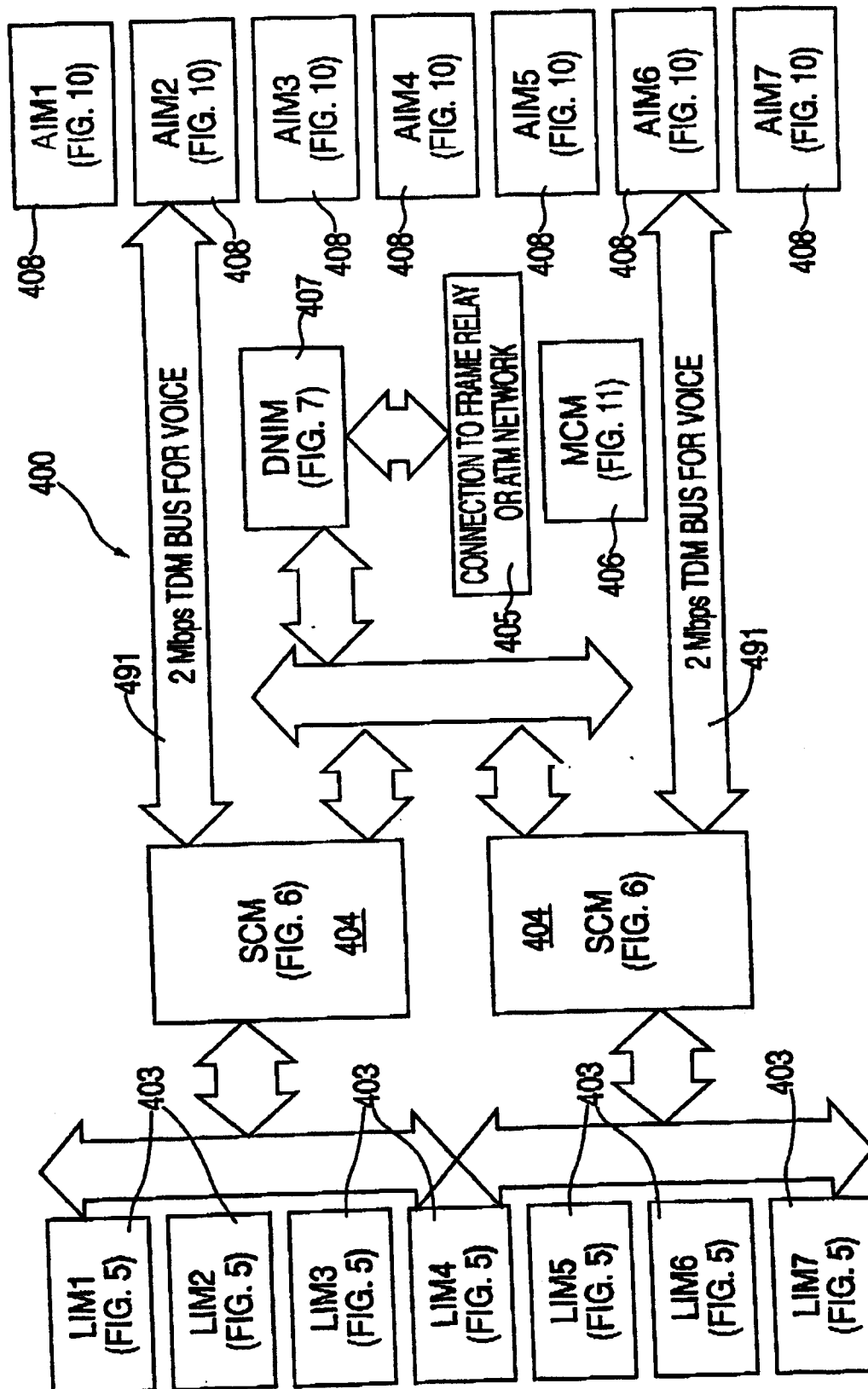


FIG. 13

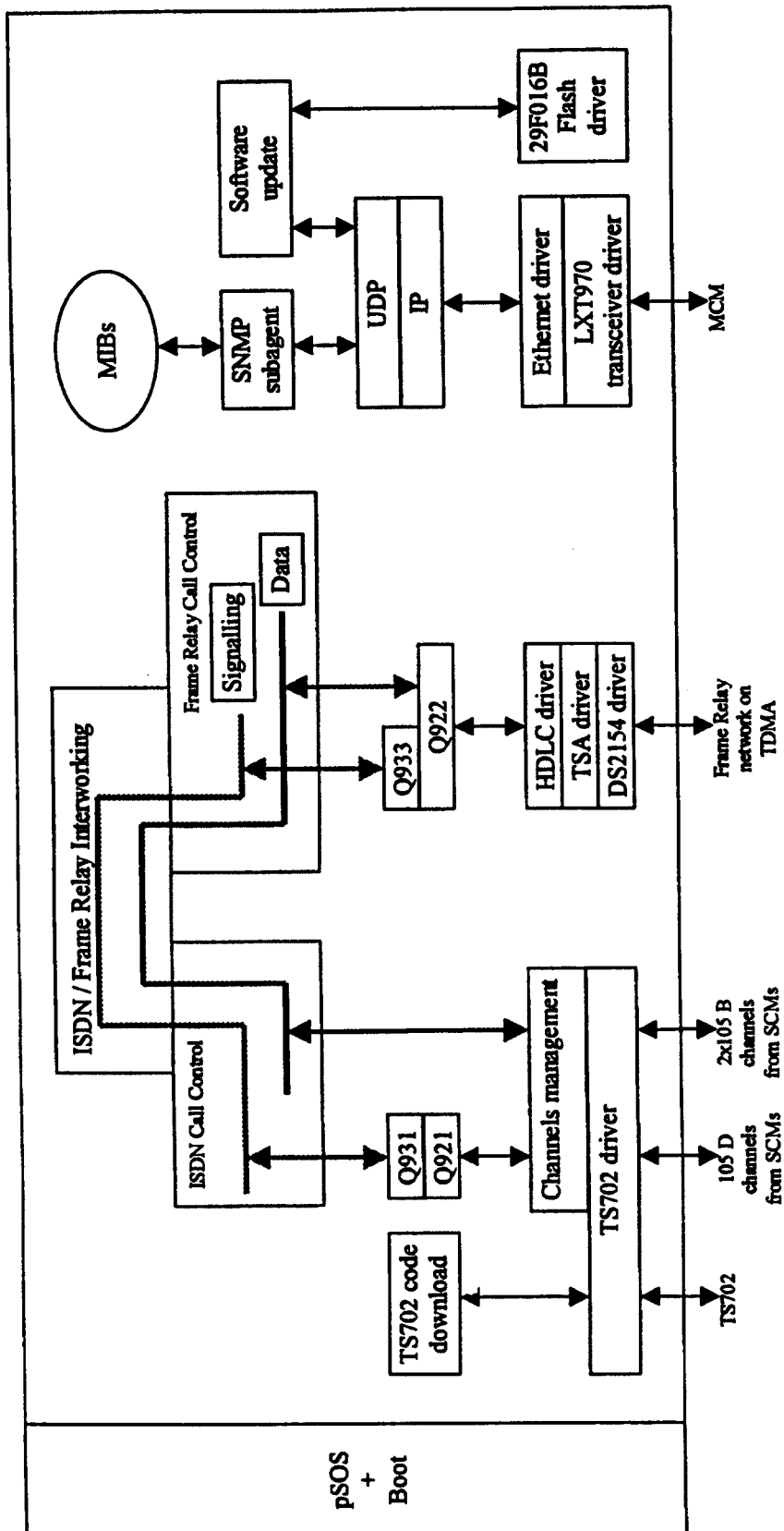


FIG. 14

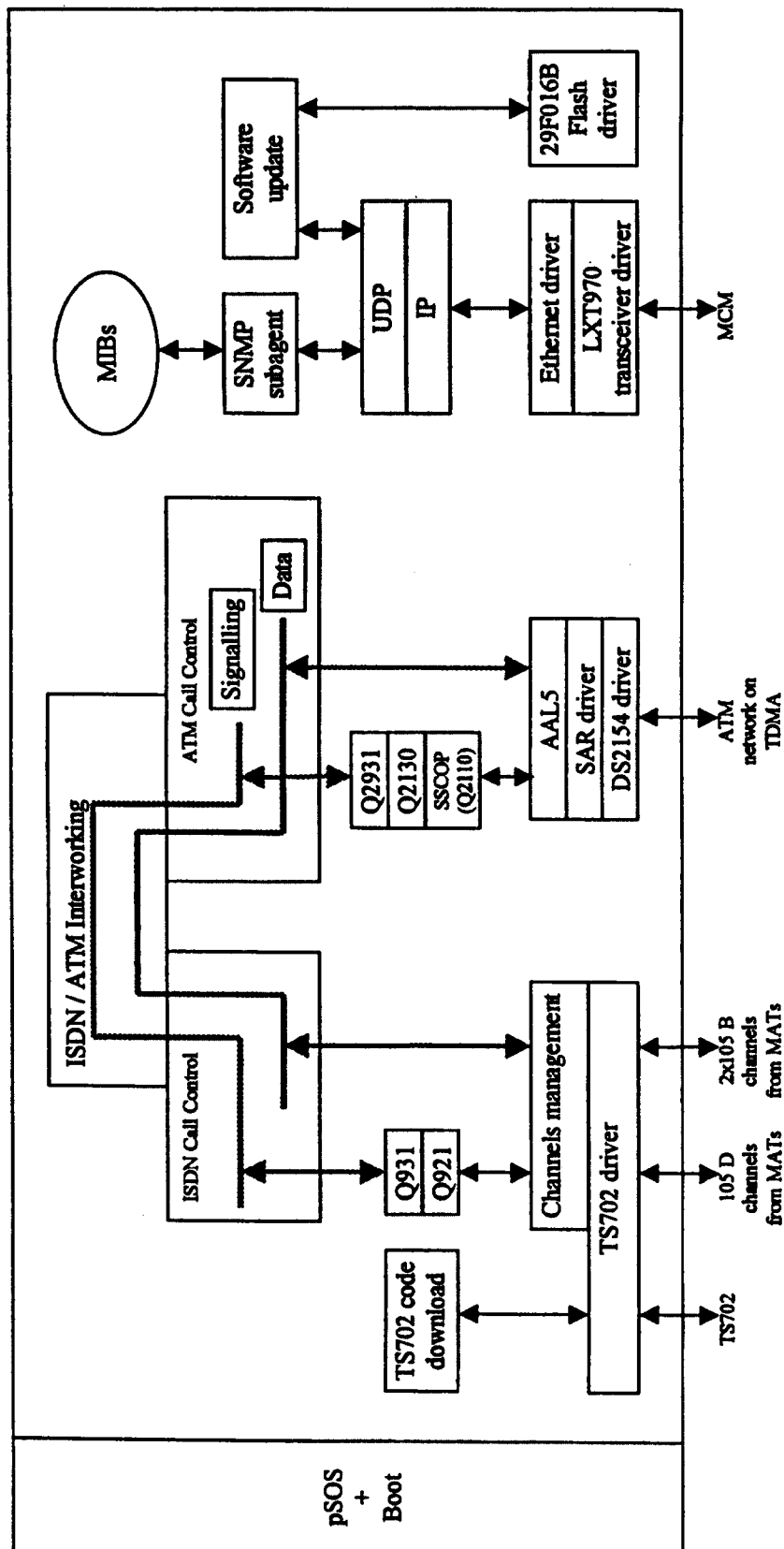


FIG. 15

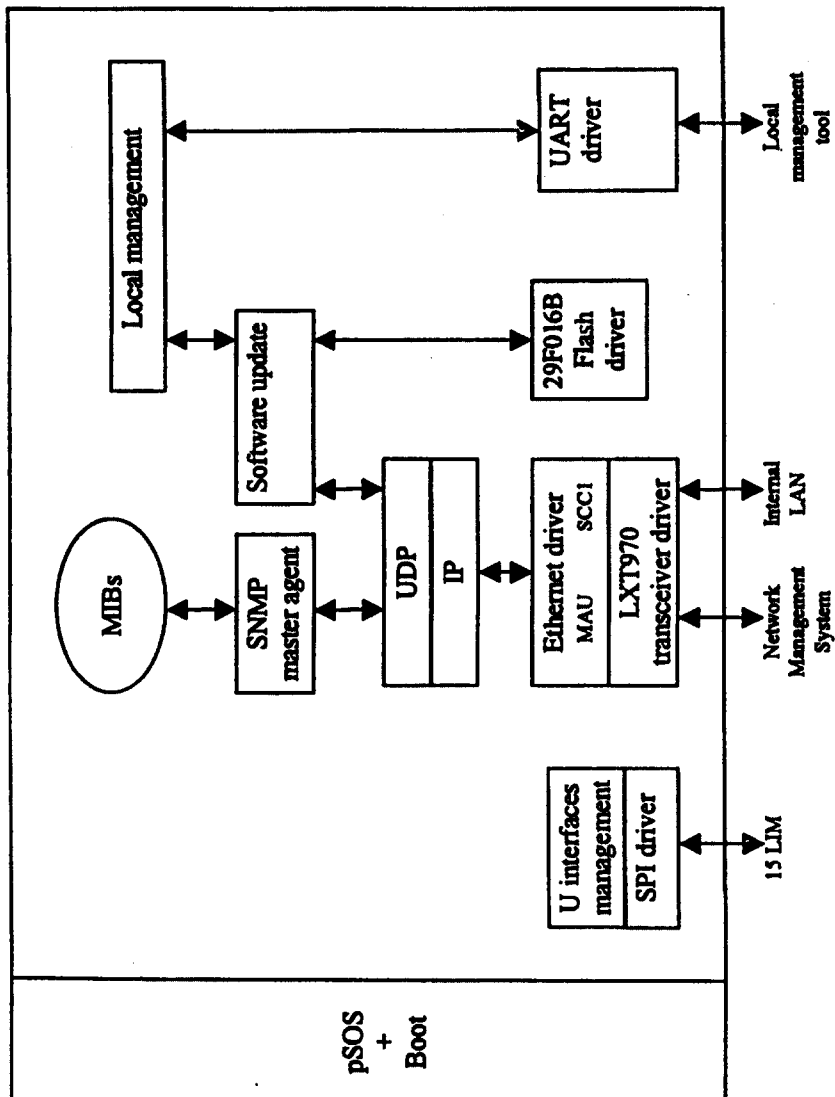


FIG. 16

