Course 1.
General view on the fixed telephone network. Digital networks. General aspects. Definitions.

1. General view on the fixed telephone network

- Communication network dedicated to voice transmission; it is a dedicated network – frequency band, signal processing, allowed delays of the transmission of this particular signal.
- The network must ensure the transmission of the voice signal between two or more subscribers with a given quality of the service: signal to noise/ratio, distortion level, delays, waiting time for connection, connection rejection probability a.s.o.

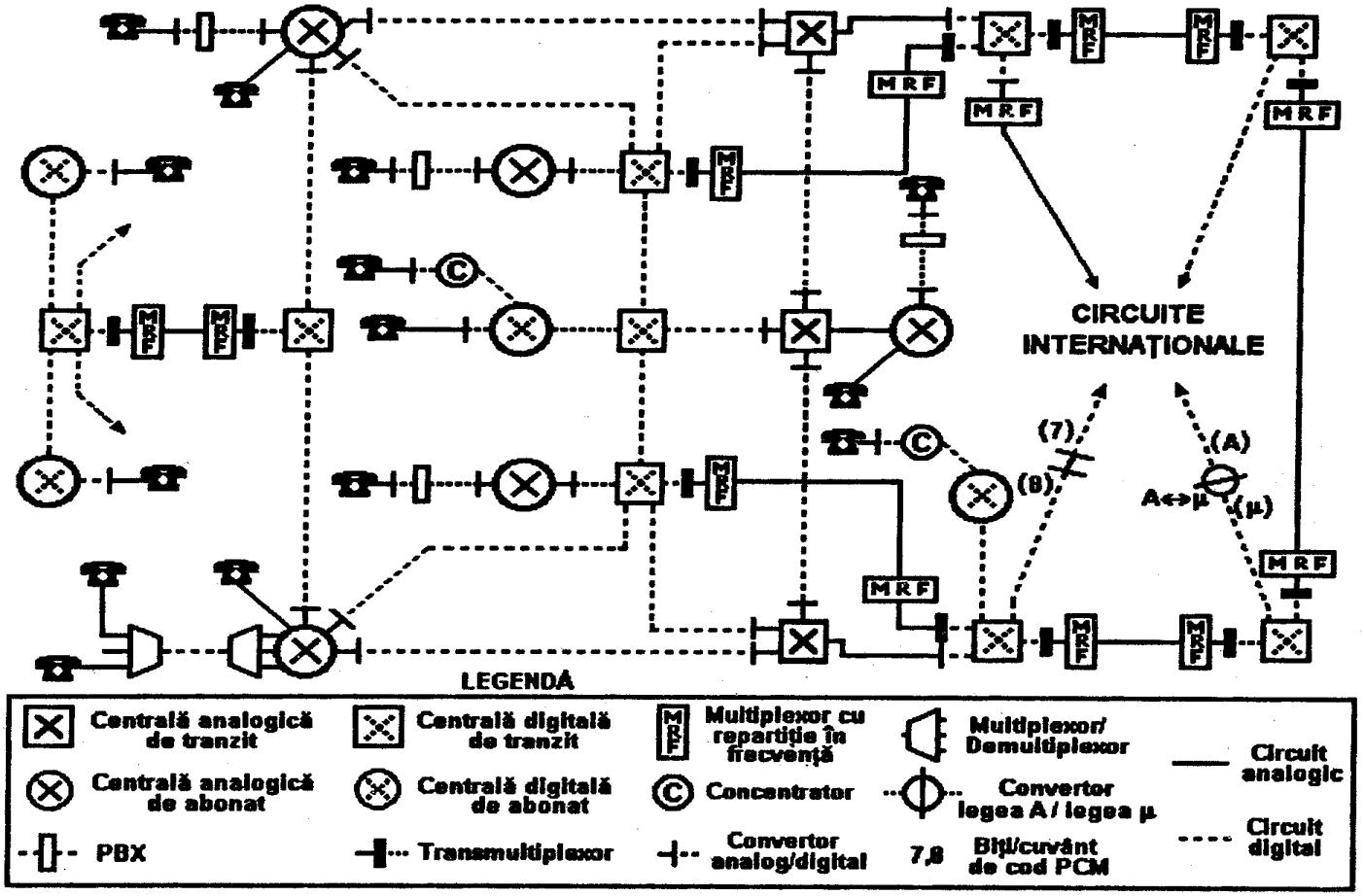


Fig.1 Exemplu de rețea mixtă analog/digitală

- Subscriber terminal – ensures the ensures the analog/digital conversion of the voice signal and the connection to the access network.
- The analogue or digital access network – allows the access in the telephone network, ensures the distant power feeding and the transmission of signaling to and from the subscriber (in some situation ensures the multiplexing or the concentration of several subscribers).
- Local and transit, analogue or digital switching network – ensures connectivity between any two or more subscribers.
- The analogue or digital transport network between the local or transit switching points - ensures the transmission of the data streams between switching points and the multiplexing of these data streams on wide bandwidth channels.

2. Basic aspects concerning the switching techniques

- basic structure of a telephone exchange

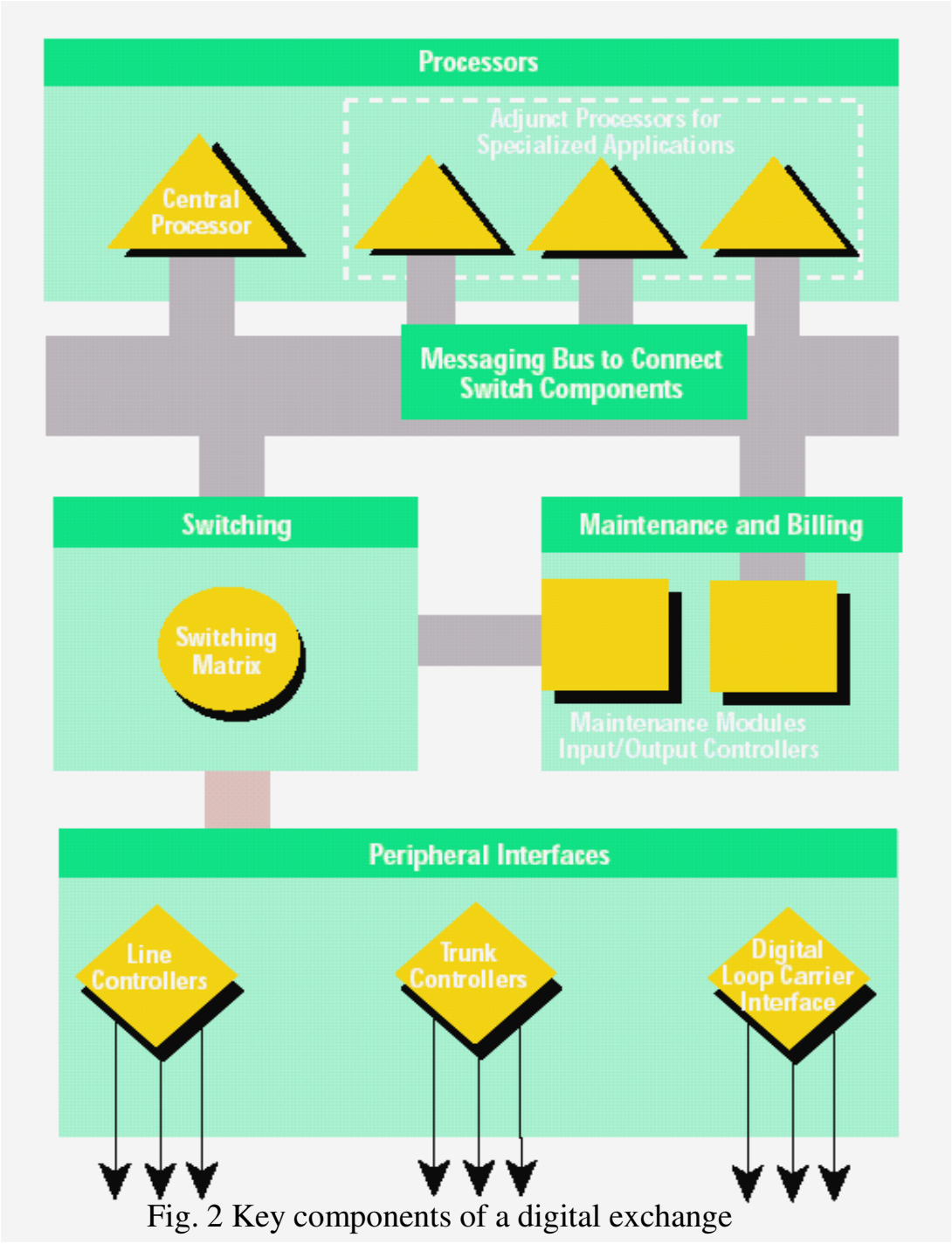


Fig. 2 Key components of a digital exchange

- special structure of local central office (end office)

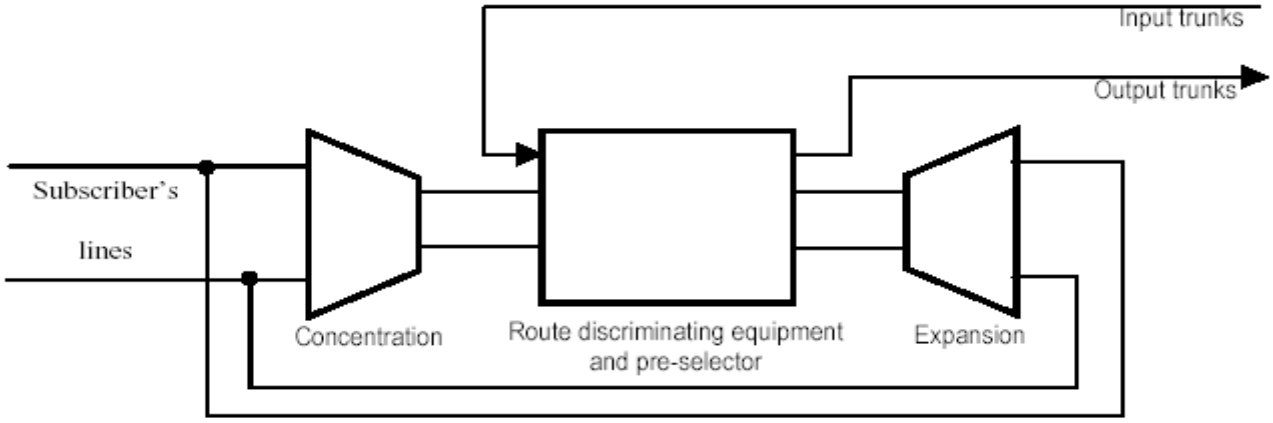


Fig. 3 Switching module (block schematic) of a local central office

- Typical call structure:
    - Detection of service request
    - Dialing connection
    - Routing through the network
    - Ringing connection and answer detection
    - Talking connection
    - Billing procedure (if necessary)
    - Call disconnect
- Local and transit switching base schematic

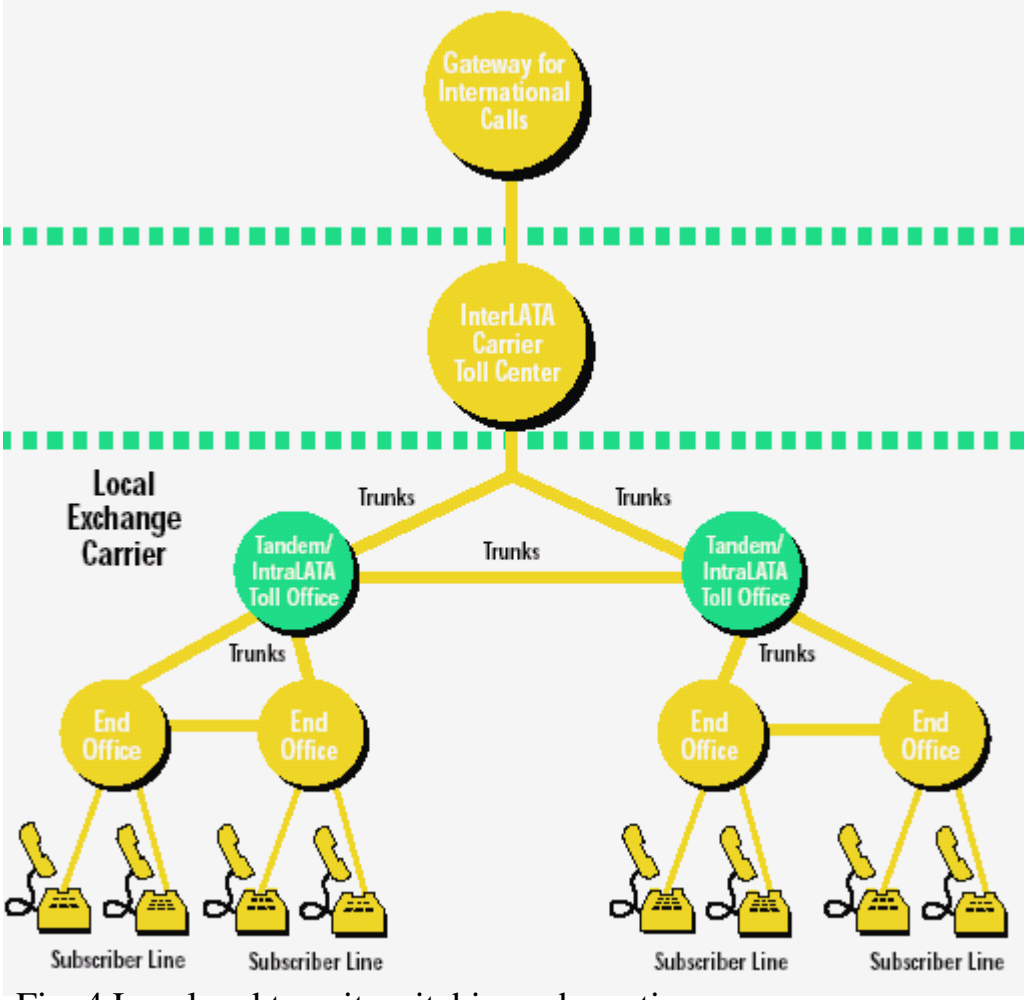


Fig. 4 Local and transit switching schematic

LATA (Local Access and Transport Area) – the geographic area that is the domain of the local exchange carrier

- End Office functions:
    - Connects customers to the network.
    - Provide dial tone, talk battery and ringing.
    - Telephone number associated with the end office.
    - Connects lines to lines or lines to trunks.
    - Has billing capability.
- Transit Office functions:
    - Connects local and transit exchanges.
    - Connects trunks to trunks.
    - Ensures the signaling necessary for trunk connections.
    - Has billing capability.

- **Trunk definition in telephony**
  - A single transmission channel between two points that are switching centers or nodes, or both.
  - A circuit between switchboards or other switching equipment, as distinguished from circuits which extend between telephone exchange switching equipment and information origination/termination equipment.

Note: Trunks may be used to interconnect switches, (public and private switches), to form networks.

2. IDN networks and the evolution toward ISDN

- IDN (Integrated Digital Network) – transmission network dedicated to the transmission of a given type of signal; the term "integrated" refers to the common character of digital techniques used in transmission, switching, multiplexing – processing requested by a telecommunication network.
- Telephonic IDN: uses pulse coded modulation (PCM) of the vocal signal at a 64kbps rate; this coding technique is used both in the transmission and the multiplexing system.
- There are differences between the PCM multiplexing and digital multiplexing – in both situation time division multiplexing is used (TDM) ; PCM multiplexing – interleaving of 64kpbs rate channels, which means that are interleaved groups of 8 bits (8 bits/sample) generating the primary PCM multiplex with rate 2,048Mbps (32 channels - Europe) or rate 1,544Mbps (24 channels-SUA) ; digital multiplexing use a bit level interleaving of the tributary digital signals to form a signal with much bigger bit rate.

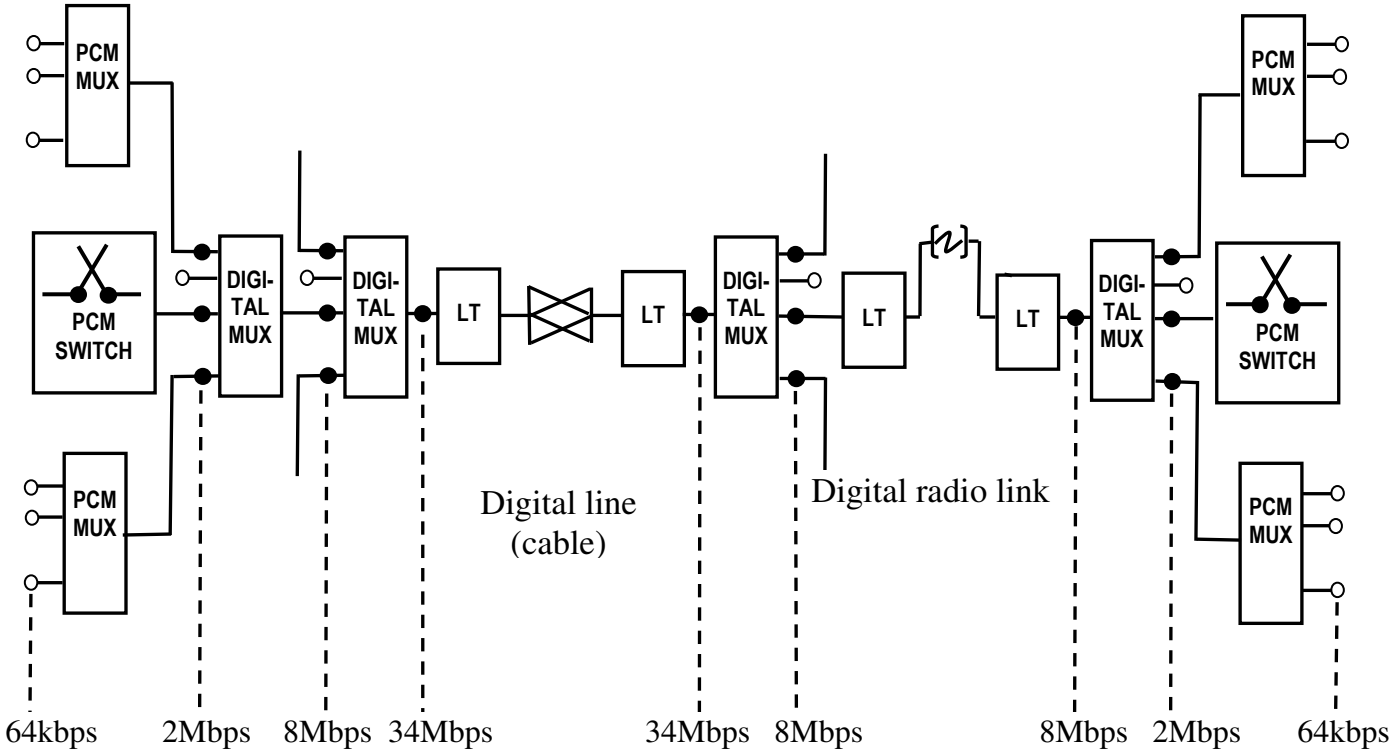


Fig. 5 Typical multiplexing and transmission system used in a digital telephone network

- The digital multiplexing hierarchy establishes the hierarchical bit rates corresponding to different multiplexing levels:

Europa	2,048	8,448	34,368	139,264 Mbit/s
America de Nord	1,544	6,312	44,736	Mbit/s

Table 1. Bit rates characteristic to different multiplexing hierarchies

2.1. Telephonic IDN

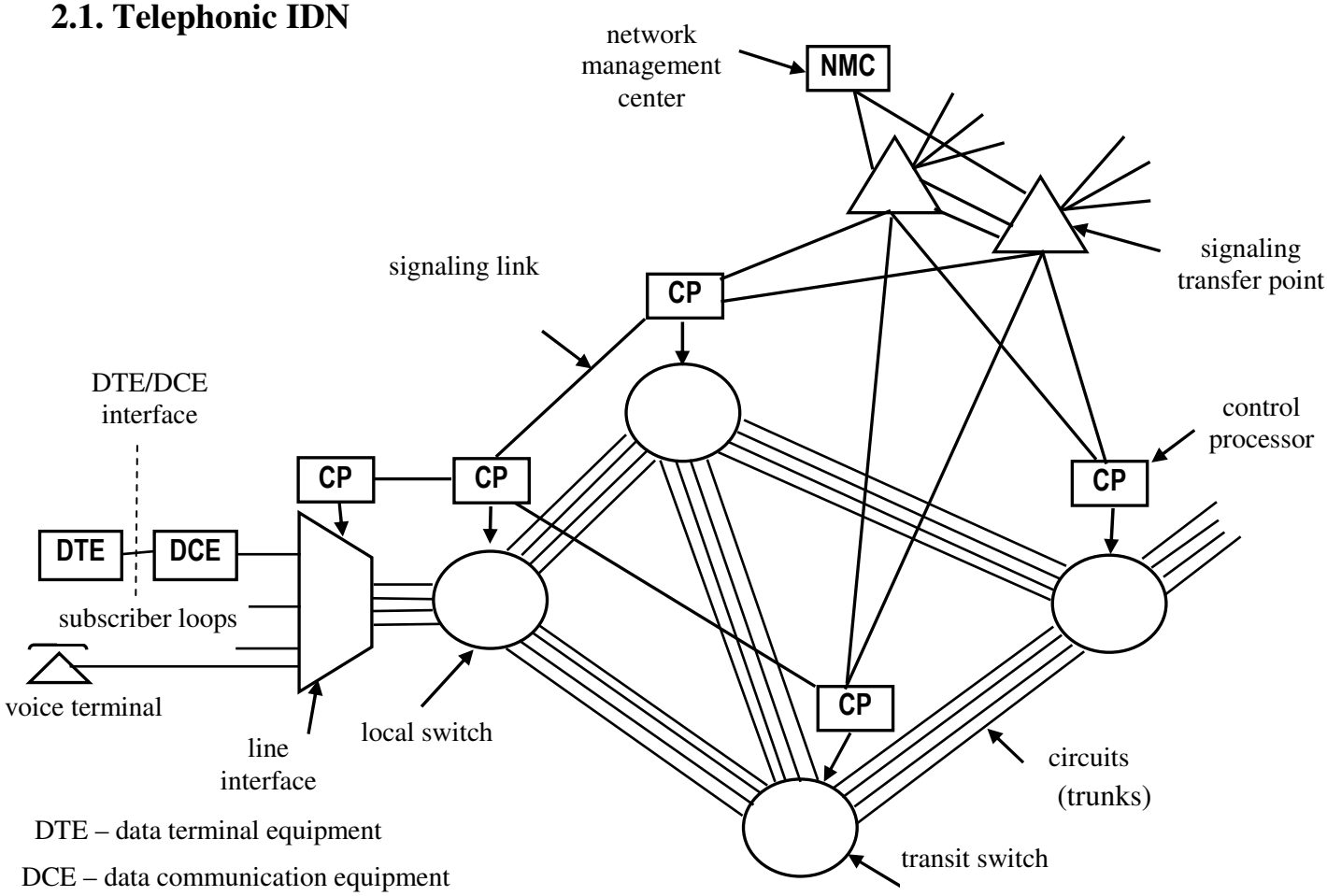


Fig. 6 Basic schematic of a telephonic IDN

- Circuit switching – it ensures fixed physical input-output connection at a 64kbps bit rate and it operates with multiplexed signals having bit rates bigger or equal with primary rate.
- The subscriber blocks – with interface and concentration functions - and the group blocks – with distribution and switching functions, compose local exchanges; the group blocks compose transit exchanges.
- Interconnection circuits ensure 64kbps channels implemented on transmission systems.
- PCM multiplex and switching equipments work synchronously with a common reference frequency of the network; it is necessary to implement o proper distribution of the clock according to synchronization strategy of the network.
- The exchange are controlled by software programs stored in reliable processing units
- The call control information of the (signaling) is exchanged between the switching centers through a dedicated signaling network with common channel (CCS – Common Channel Signaling) ; the CCS network is a communication network between computers and uses packet switching technique to transfer the signaling messages between the exchange control computers ; the CCS switch are referred as signaling transfer points (STP-Signaling Transfer Points); the packet switching used in the CCS network is based on data grams (DG) – (DG) is a message that contains in his header the addresses of the transmitter and receiver exchange and can be routed through the network as an independent message ; the data grams corresponding to a given signaling transaction are routed through the same path in the CCS network.

2.2. Data IDN

- Data applications can be classified according to the terminal activity during a call - time interval in which the data terminal is active during the data transfer phase; there are two type of data: volume data and burst data; volume data (ex. facsimile, teletex, file transfer) are characterized by a intense activity of the terminal; burst data (ex. start-stop transmissions between the data terminal and the computer, telemetry) present a low activity of the terminal during the call.
- IDN for data transfer uses circuit switching or packet switching.
- IDN with circuit switching are designed according the same rules as the ones used for telephonic applications; they are used especially in the case of synchronous transmissions; basic bit rates between the data terminal equipment (DTE) and the data circuit equipment (DCE) are 2.4, 4.8, 9.6, 19.2, 48, 56 and 64kbps; TDM multiplexing techniques are used to insert several low rate channel in a bigger bit rate channel; the basic structure of the network is identical with the one presented in fig.2.3. (ex. : the telex network).
- IDN with packet switching – variant of the message switching techniques; the information is assembled in short messages (packets) transmitted by the users at the same bit rates as the ones specified for the networks with circuit switching; a statistical multiplexing (SM) of the packets is used in general on digital links – a 64kbps rate in the most cases.
- packet switching is based on the memorize and send principle; the switch are processing units with memorized programs; the users can communicate using unique data packets (DG) – every packet is transmitted on a separate path - or by establishing a bi-directional transmission implying multiple data packets (virtual call) – several packet on the same path.
- routing on virtual circuits – established by special control packets (have the same format as the data packets and use the same resources) allow o smaller overload of the network (the packets headers contains short number identifying the logical channels instead of the DTE addresses in the case of DG) and minimize the probability of delivering in wrong order of packets associated to a given call.

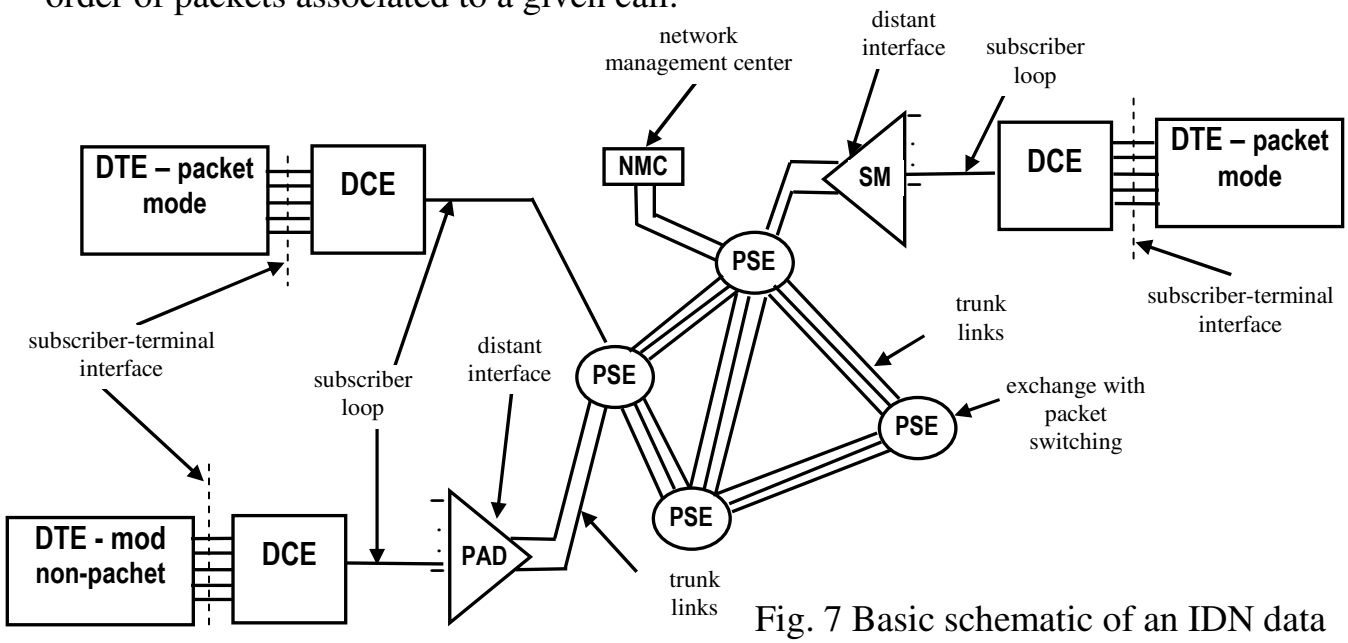


Fig. 7 Basic schematic of an IDN data network based on packet switching

PAD – packet assembling/disassembling
SM – statistical multiplexer

2.3. Evolution toward ISDN (Integrated Services Digital Network) – digital network with integrated services requested by the apparition of new communication services - table 2 presents briefly different communication services and the requested bit rates

Binary rate (bps)	Services	Binary rate (bps)	Services	Binary rate (bps)	Services
1 - 10	-	$10^3 – 10^4$	- Teletex - Low bit rate file transfer - Videotex - Fax	$10^6 – 10^7$	- Video conference - Interactive video
$10 - 10^2$	- Telemetry - Alarms - Distant control	$10^4 – 10^5$	- PCM telephony - High quality telephony - High speed file transfer - Video with low rate sweep - Facsimil	$10^7 – 10^8$	- Standard TV
$10^2 – 10^3$	-	$10^5 – 10^6$	- High quality music - Video-telephone - High speed fax	$10^8 – 10^9$	- High definition TV

Table 2 ISDN sevices and required bit rates

- Three main aspects characterize an ISDN network: 1. End-to-end digital connectivity; 2. multi-service capacity (voice, data, video); 3. standard interface; it is ensured a multitude of digital communication modalities, unique administration and a limited set of standard user interface.
- Usually an ISDN network is based on the telephonic IDN with 64kbps bit rate, including the digital the digital subscriber line equipments; the telephonic IDN ensures the connection with the equipment assigned to services that demand data packet switching or wide band switching.
- The evolution toward ISDN presents three stage:
  - an early ISDN architecture voice and data transmissions – basic ISDN access permits a maximum number of 8 terminals and uses two B type channel (64kbps) – data channels, typical PCM voice channels and a D type channel for signaling information (transmission control of B channels), telemetry, low bit rate burst data

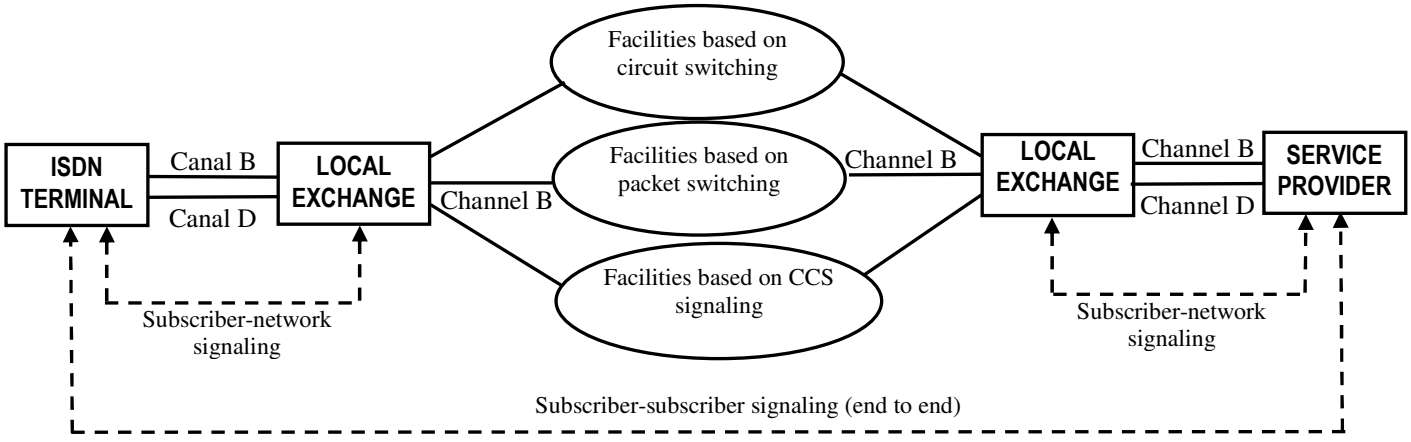


Fig. 8 Early ISDN architecture with voice and data services

- an advanced ISDN architecture for voice and data services

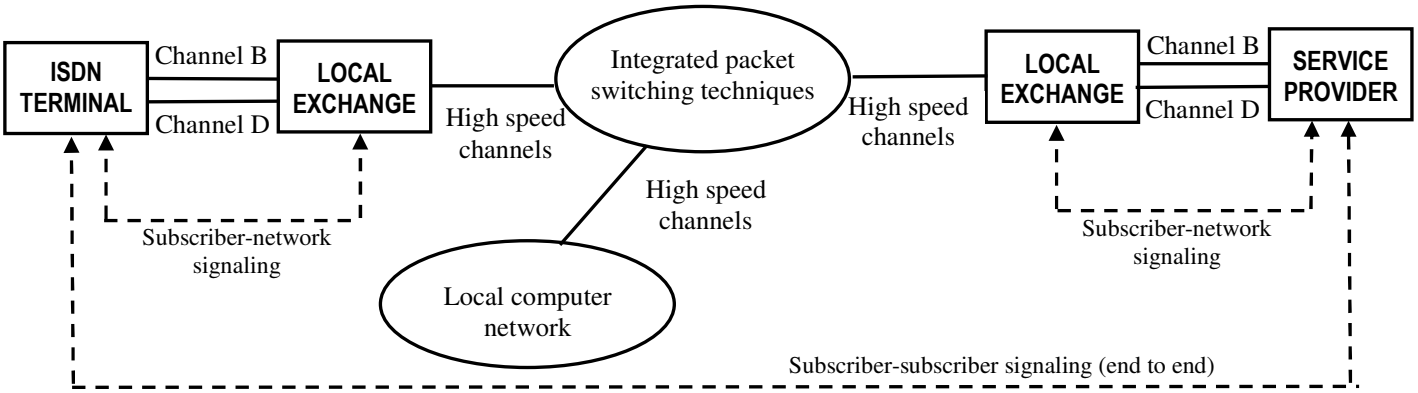
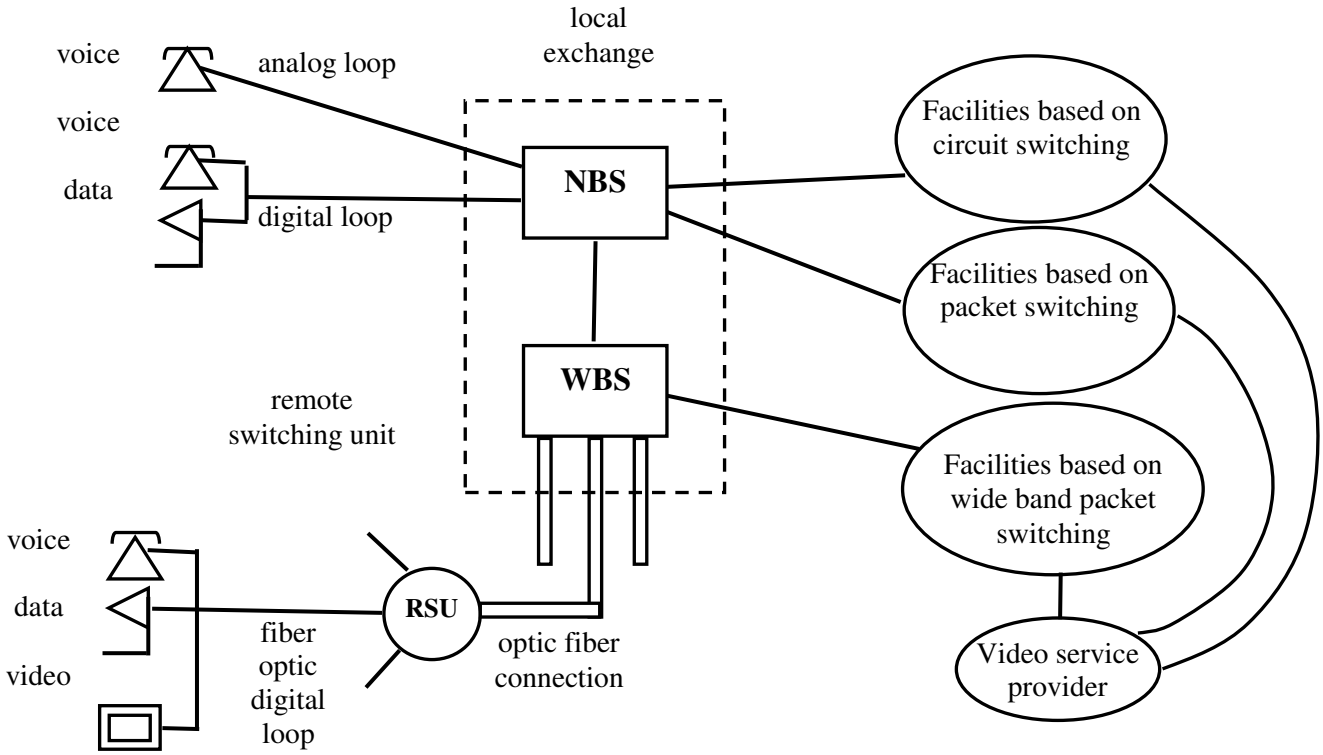


Fig. 9 Advanced ISDN architecture with voice and data

- an ISDN architecture with band wide capacity – includes optic fiber distribution networks and wide band switching units; ensures wide band services (5 – 35MHz)



RSU – remote switching unit
NBS – narrow band switching system
WBS – wide band switching system

Fig. 10 Wide band ISDN architecture

- basic structure of a narrow band ISDN network and local exchange

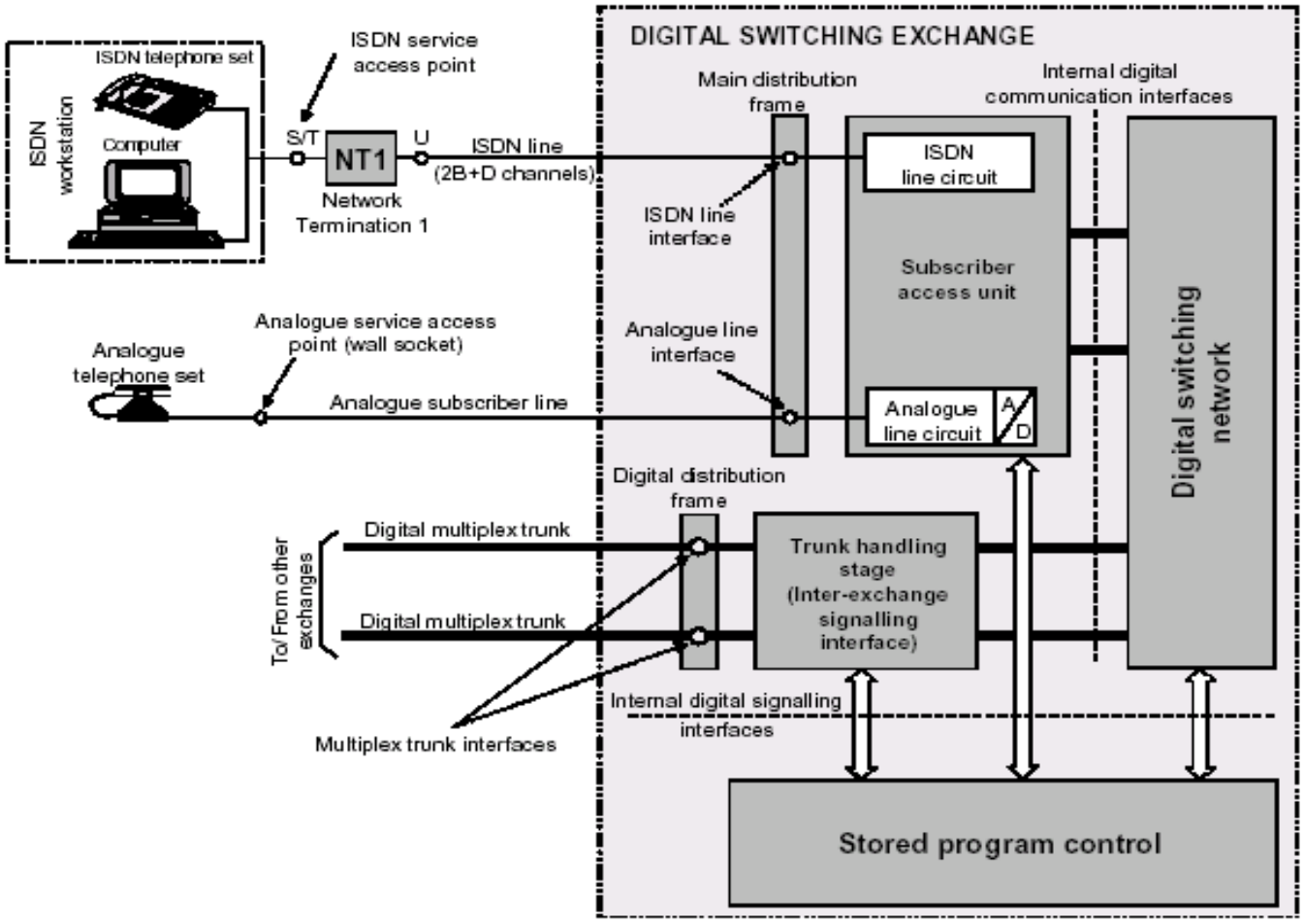


Fig. 11 Subscriber loops and basic structure of an exchange in a narrow band ISDN network

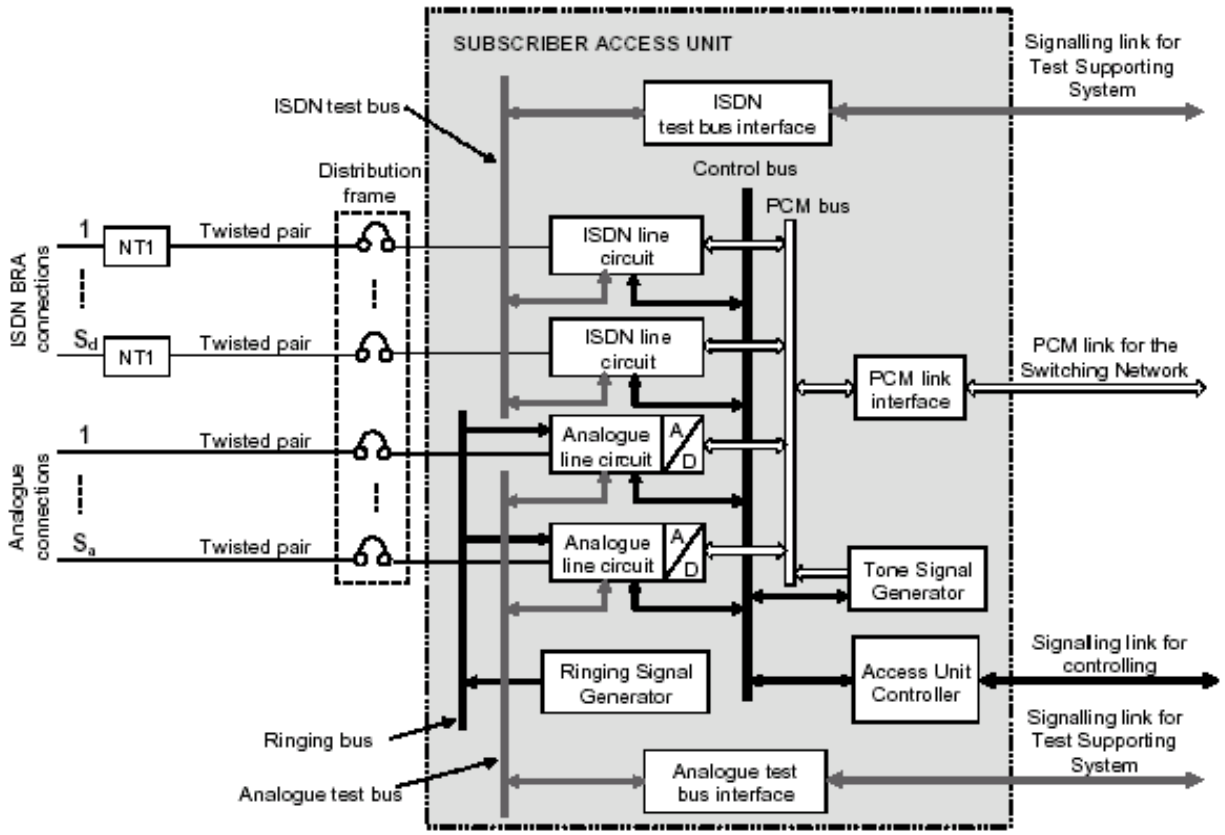


Fig. 12 Subscriber access unit of a digital exchange with narrow band ISDN facilities

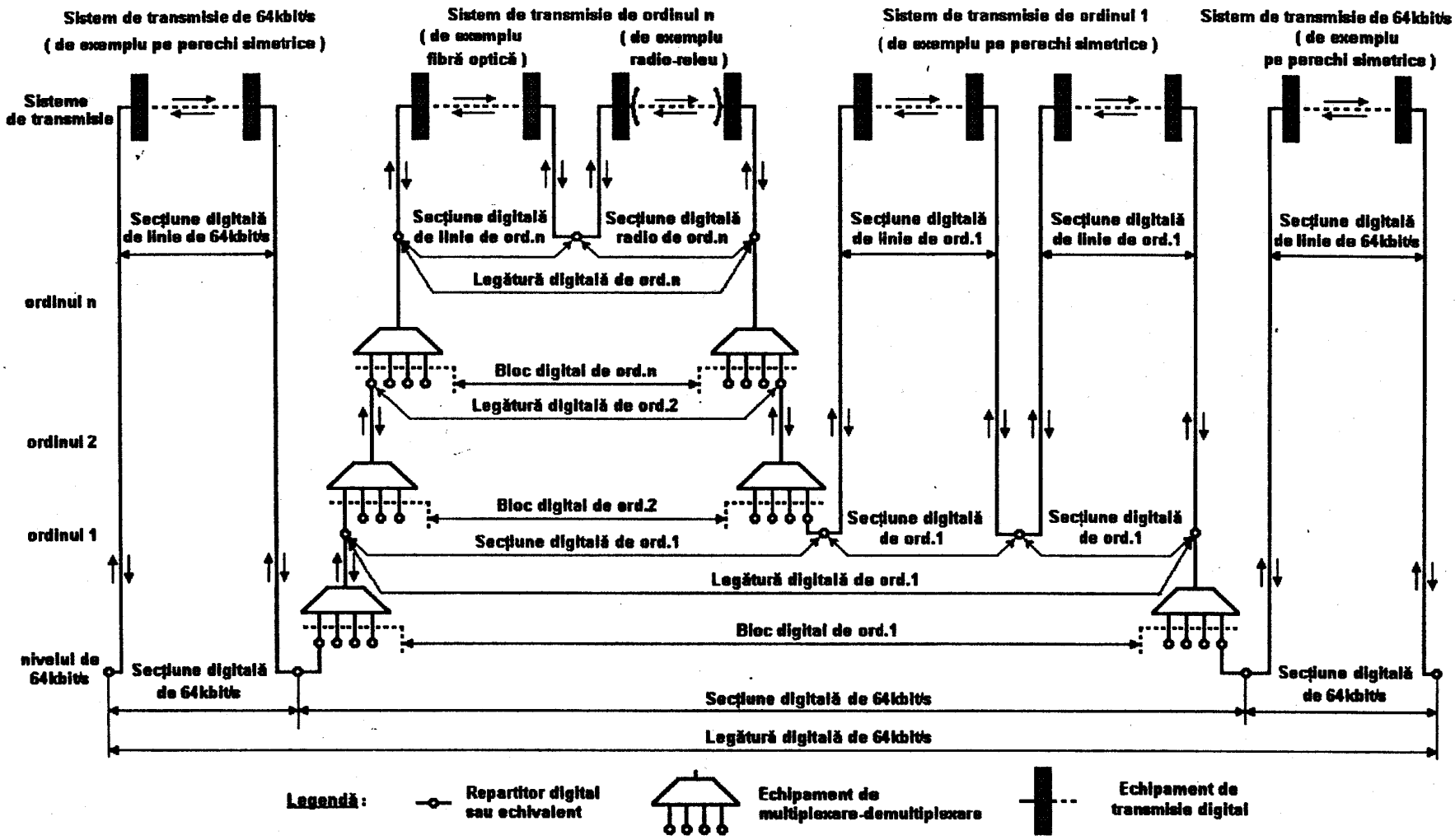


Fig.5. Ilustrarea elementelor specifice reţelelor digitale (secţiune digitală, bloc digital etc)