

Communication networks and switching systems

Introduction

- The purpose of teaching is to study the principles of construction and functioning of the foundations of telecommunications networks.
- The rapid progress in the field of telecommunications and information technology has led to the ability to integrate disparate networks into a single multi-service network that allows you to provide users with diverse telecommunications services - voice, video and data.

The development of telecommunications networks

- The first global network has been established with the help of the electric telegraph, which reached a global scope in 1899 were the second telephone network, which achieved global status in 1950 of A now - interconnected IP-based network (Internet in 2009) and mobile GSM network communications form the world's largest network of all previously created.
- The rapid progress in the field of telecommunications and information technology has led to the ability to integrate disparate networks into a single multiservice communication network that allows you to represent diverse telecommunications services - voice, video, text, and others.

The multiservice communication network

- The multiservice communication network can be created directly on the basis of both existing digital and virtual networks.
- Intensive development of digital transmission systems (DSP) is due to significant advantages of these systems compared with analogue transmission systems (TSA) high noise immunity, low dependence on the transmission quality of the link length; the stability of the electrical parameters of communication channels, efficient use of bandwidth in the transmission of discrete messages and others.

The main directions of development of integration processes

- Electronization, is the transfer of all telecommunication equipment and technology to the electronic database;
- - Computerization - the saturation of the telecommunication equipment and computer technology;
- - Digitization - the introduction of the existing network of digital components;
- - Intellectualization, which, being a natural manifestation of the integration process, contributes to the emergence and development of new telecommunications services;
- - Unification, which is a factor for the development of telecommunication systems, equipment and components to reduce the cost base, optimizing the interaction of telecommunication networks and services;
- - Personalization, which is manifested primarily in the transition from addressing terminals to a single system user address where each user will have a single address regardless of in which network it's on, what kind of communication uses and where at any given time. Naturally, for the implementation of this area of integration processes require the integration of existing systems addressing in the networks;

The main directions of development of integration processes

- Globalization, resulting from the idea of creating a GII - part of which will be a powerful transport communications network, and distributed access network providing information to users;
- - Standardization, basic documents which are the standards. Since the telecommunications system must be harmoniously united with the world, even in the field of communication Kazakh standards should be as close as possible to the world.
- The requirements for prospective communication networks are:
 - - Multiservice, which means the independence of technology services from transport technologies;
 - - Band width, which means the possibility of flexible and dynamic data rate changes in a wide range depending on the current needs of the user;
 - - Multimedia, which is understood as the ability of a network to transmit a multi-component information (voice, data, video, audio) with the necessary synchronization of these components in real time and using the complex configurations of the compounds;
 - - Intelligence, which is understood as the ability to service management, call and connection from the user or service provider;
 - - Invariance of access, which is understood as the possibility of organizing access to services regardless of the technology used;
 - - Multi-statement, which is understood as the possibility of participation of several operators in the provision of services and the division of their responsibilities in accordance with the area of activity.

The main types of telecommunication systems and networks

- Telephone - kind of telecommunication, providing transmission and reception of voice messages. typical channel voice frequency (VF) is used for communication, the spectrum of which is 300-3400 Hz;
- - Audio broadcasting (AB) - a kind of telecommunications, providing the transmission of programs for direct reception by the public. to a typical pollutant channel requirements depends on the desired sound type. Sound sources in the transmission of broadcasting programs are usually musical instruments and the human voice. The first has a wider bandwidth than the sound of speech. Additionally the dynamic range of a broadcast transmission signal considerably broader than for voice. For example, it has a dynamic speaker range 25-33 dB, Declamation - 40-50 dB Symphony Orchestra - to 65 dB. The range of pollutants takes frequency band 15Hz - 20kHz.
- - Transmits TV programs in black and white and color television. For him, the model provides two channels - for audio accompaniment and image transmission.

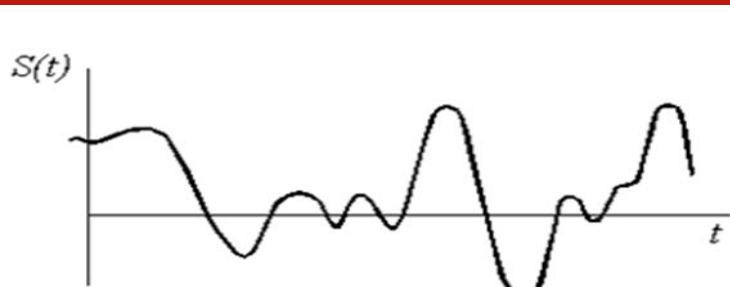
Standardization in the field of telecommunications

- - European Telecommunications Standards Institute (ETSI). Created in 1988 CEPT organization and defines the technical policy in the field of telecommunications for the European Community. The most famous is the standard ETSI standard GSM cellular mobile radio communication system;
- - European Conference of Postal and Telecommunications Administrations (CEPT) was established in 1959. Its activities include commercial cooperation of the participants of the telecommunications market, as well as the standardization of technical and organizational issues;
- - European Association of computer manufacturers (ECMA);
- - American National Standards Institute (ANSI) - is the coordinating body of voluntary standardization groups within the United States. ANSI is a member of ISO. Widely known ANSI standard communications is FDDI;
- - Telecommunications Industry Association (TIA) - one of the groups ANSI, producing standards for telecommunications. The most famous is the TIA standard cellular mobile radio system US IS-54;
- - Electronic Industry Association (EIA) is included in the ANSI group;
- - The Federal Communications Commission (FCC) of the USA. US government organization dedicated to the regulation of the communications industry, including the allocation of the radio spectrum;
- - Regulation on the Internet Works Board (IAB) - defines the basic policies of the global Internet. It includes two subcommittees: Research - IRTF and standardization - IETF. IAB standards are called RFC (Request for Comments).

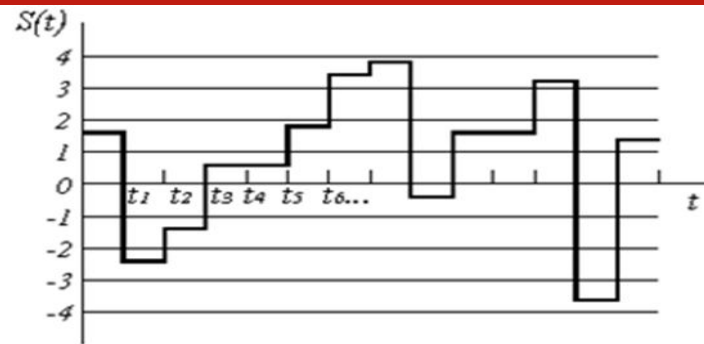
Primary electrical signals and their characteristics

- The signal passes (deploys) a message in time, there is always a function of time. There are four types of signals:
 - - Continuous continuous time signal (see Figure 1a.);
 - - Continuous discrete time (see Figure 1b.);
 - - Discrete continuous time (see Figure 1c.);
 - - Discrete discrete time (see Figure 1d.).

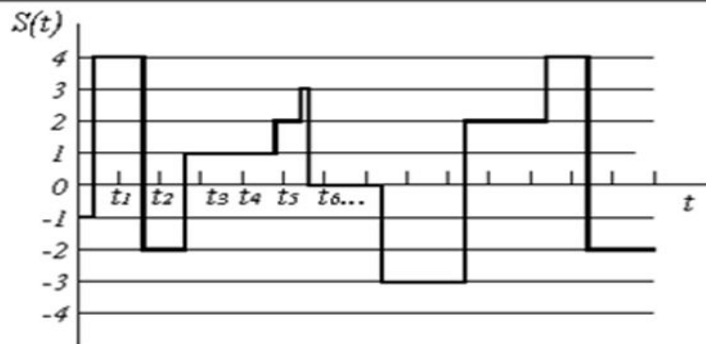
Primary electrical signals and their characteristics



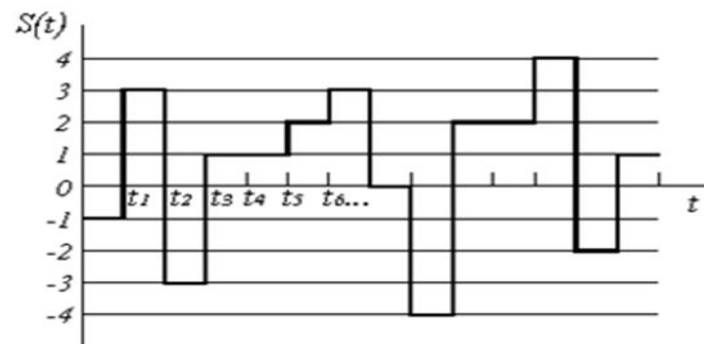
a)



б)



в)



г)

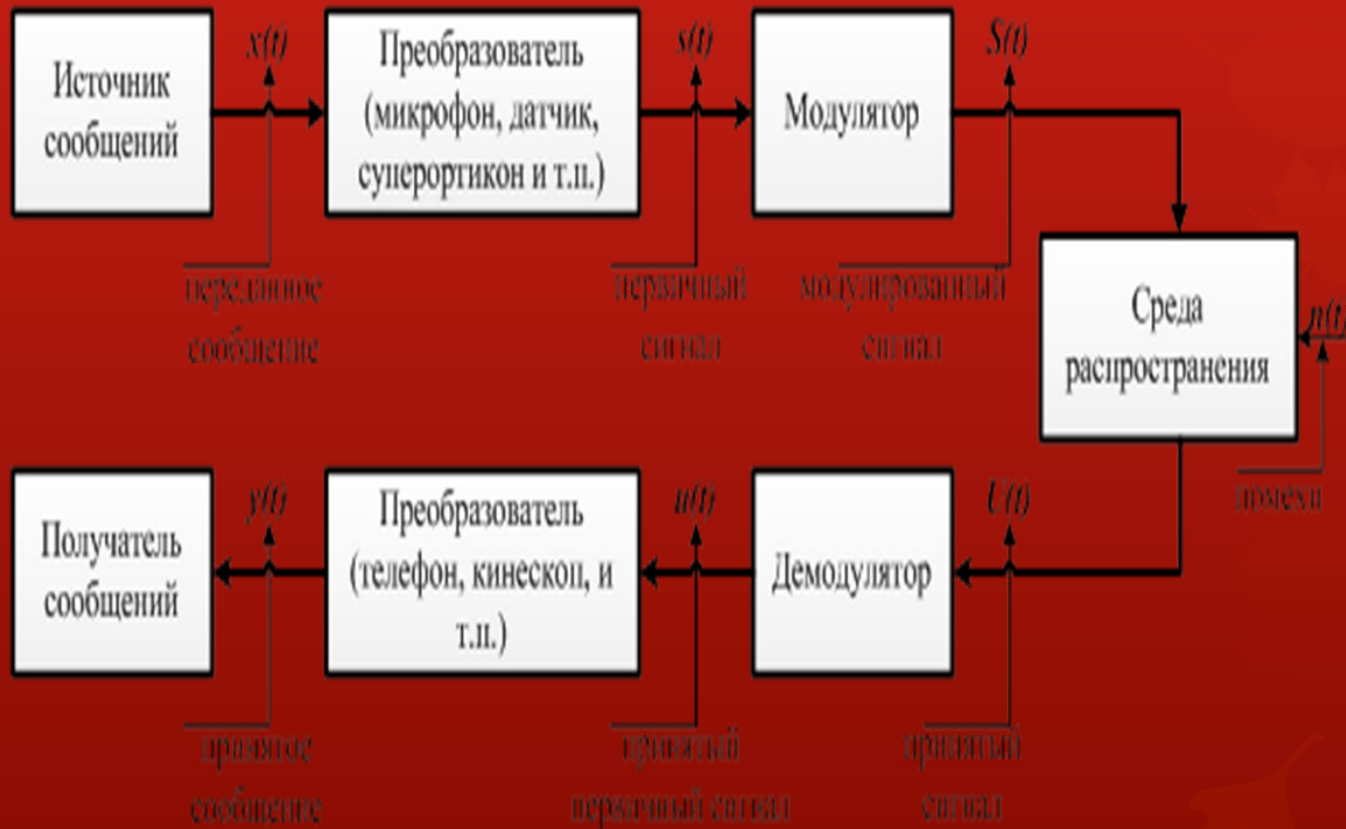
Primary electrical signals and their characteristics

- Continuous signals of continuous call time abbreviated by continuous (analog) signals. They may change at arbitrary times, taking any value from a continuous set of possible values (sine wave).
- Continuous signals are discrete time can take any value, but the change only at certain preassigned (discrete) points $t_1, t_2, t_3, \dots$
- Discrete-time continuous signals differ in that they may change at arbitrary times, but their quantities take only authorized (digital) values.
- Digital signals are discrete time (short for binary) at discrete points in time can take only authorized (digital) values.

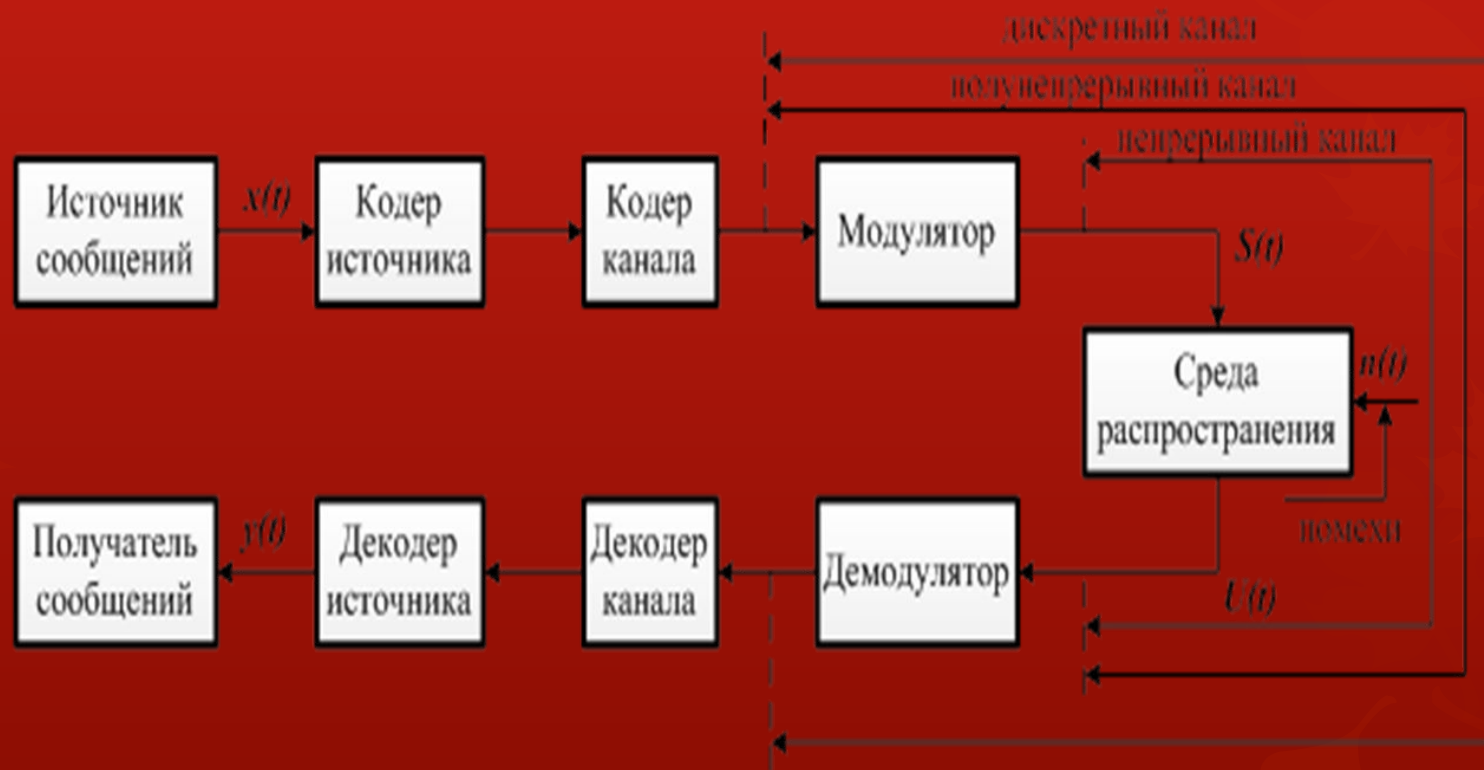
Structural diagram of telecommunication systems (TS)

- Source of the message - a physical object that forms the message $x(t)$ (people, computers, sensors);
- - Probes in electrical communication signal (microphone sensor) that is converted to $x(t)$ message to the primary signal $s(t)$;
- - Modulator - performs the primary signal conversion $s(t)$ to the secondary signal $S(t)$, for convenience of transmission in the propagation medium in conditions of interference;
- - Propagation medium serves for transmitting electrical signals from the transmitter to the receiver. This can be a cable or waveguide, radio systems in an area of space in which electromagnetic wave propagates from the transmitting antenna to the receiver;
- - Demodulator - a device in which the electrical signal from the primary $u(t)$, which is due to the interference action may significantly differ from the transmitted $s(t)$ received $U(t)$ signal is allocated.
- - Converter is required to generate $y(t)$ from the received messages the primary signal $u(t)$. TS quality is determined by the degree of conformity of the received message $y(t)$ transmits the message $x(t)$.

Structural diagram of telecommunication systems (TS)



Structural electrical connection diagram of a system for transmitting digital messages



Structural electrical connection diagram of a system for transmitting digital messages

- source encoder serves to convert messages in code symbols in order to reduce redundancy of the communication source, that is, providing a minimum average number of characters per message, and presenting in a convenient form (for example in the form of binary numbers).
- An encoder channel for introducing redundancy to detect and correct errors in the channel decoder, in order to increase the reliability of transmission.
- channel decoder provides redundancy check (error-correcting) code and converting it into a series of primary electrical breakeven code signal.
- the source decoder (SD) - a device for converting the primary sequence of electrical signals (SES) breakeven code in the message.

The principle of operation of the TV

- The primary television signal is formed by electronic scanning using the scanning beam television transmitting tube, which converts an optical image into a video signal or the luminance signal. The moving image is transmitted in the form of instant photo - frames, replacing each other. And to create smooth motion effects transmitted 25 frames / sec. Each frame is decomposed into a string, which is determined by the number of established standards. In a widely distributed standard, each frame is expanded to 625 lines. To change the frame on the CRT screen was invisible, the number of images should be at least 50 frames / sec.

The principle of operation of the TV

- At the core of color television based on the following physical processes:
- - Expansion of the optical multi-color image with the help of special color filters in the three-color image in primary colors - red (R - red), green (G - green) and blue (B-blue);
- - Conversion of three monochrome images of a television tube to a corresponding three signals ER, EG, EB;
- - Transfer of the three electrical signals over the communications channel;
- - Inverse image converting electrical signals in a special three-color picture tube of the optical images of red, green and blue colors. Each color is characterized by two parameters, brightness and chroma;
- - Optical addition in certain proportions of three-color images in a single multi-color.

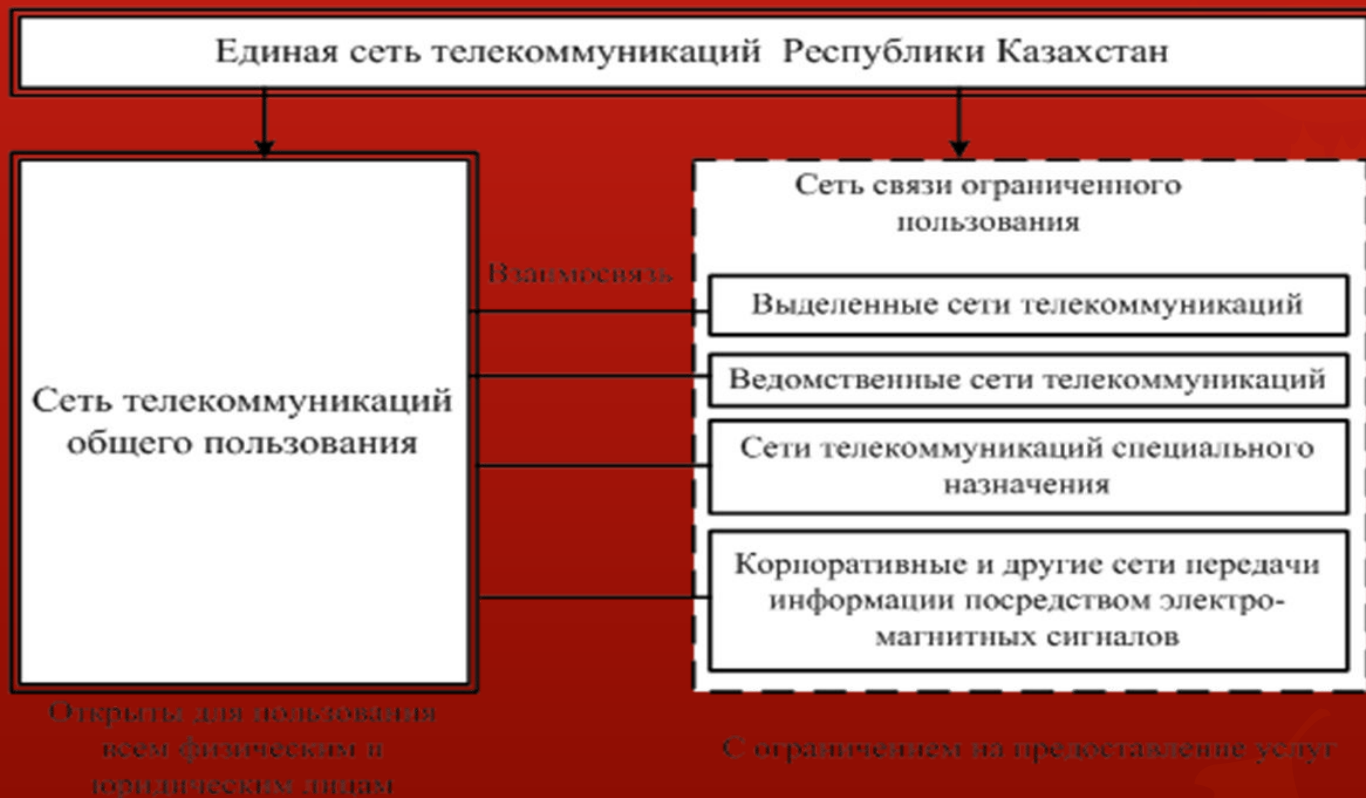
United telecommunications network of Republic Kazakhstan

- In 1960, a promising direction of building telecommunication network was EASC, which was based on the union of disparate and numerous smaller networks in the national network of telecommunications of each type, and then into a single network with a view to sharing certain technical means, and, above all, communication systems and switching systems. When creating EASC it was taken into account that certain technical means of transmission involved in the process, regardless of message type, are common. In this regard, the whole network of the country became divided into two interrelated components:
- - The primary network (set of network stations, network nodes and interconnecting transmission lines, which allows you to organize a network of transmission paths and group channels);
- - Secondary network (set of technical means providing transmission of messages a certain kind).

United telecommunications network of Republic Kazakhstan

- In 2004, a new law "On Telecommunications", according to which the new stage - informatization of society. The network has become the foundation of the Republic of Kazakhstan, the UNT . The aim of the UNT is to bring together all of Kazakhstan telecommunication network located on the territory of the Republic of Kazakhstan. The structure of the Republic of Kazakhstan UNT enters TNJU and limited use of the network connection, which include: departmental and dedicated networks, telecommunication networks for special purposes, and other corporate data transmission network by means of electromagnetic signals.. TNJU - an integral part of the Republic of Kazakhstan UNT differs widely ramified, covers the entire territory of the country, serves the bulk of the population, economic management bodies, defense, as well as any other users without any restrictions. TNJU is based on the territorial principle and includes trunk, intrazonal and local areas. Departmental communication network established and operated to ensure the implementation of management and organizational purposes the relevant public authorities and local governments in accordance with their powers, as well as to ensure the implementation of production and management objectives of public enterprises, are in their jurisdiction and operated by them.

United telecommunications network of Republic Kazakhstan



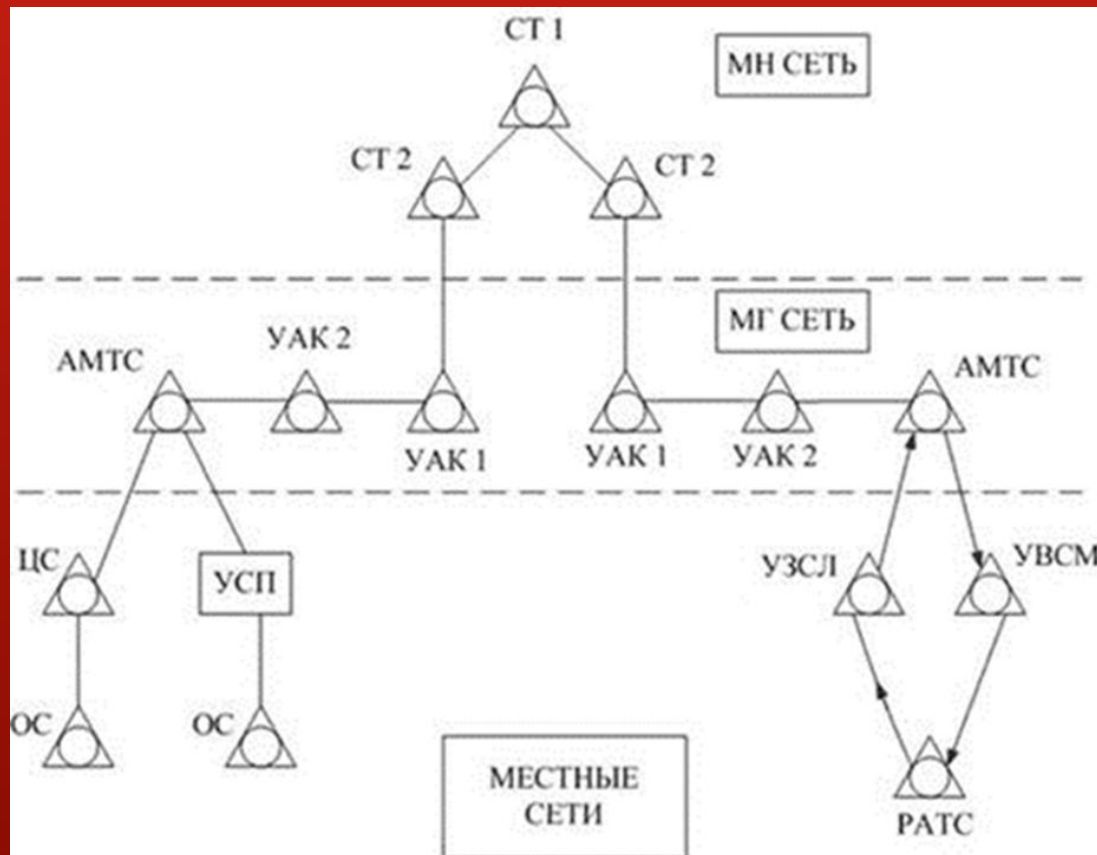
Telephone networks, types and principles of their construction

- Basic principles define the general principles of the construction of communication networks:
- - Interconnectivity interoperability of different types and purposes;
- - The principle of hierarchical networking;
- - The principle of the separation of networks on public and restricted networks;
- - The principle of sustainable and reliable network operation;
- - The principle of compliance with international and national standards and guidelines.

International communication network

- International communication networks - telecommunication network technology associated with communication networks of other states (. See Figure 4.1). In accordance with the recommendation E.171 ITU-T network is based on the automatic switching of the 3 classes of devices: ST-1, NT-2 and ST-3, which are the international terminal stations. ST-1 and ST-2, in addition, perform function of automatic transit centers. The whole area of the globe is divided into 8 switching zones ("Telephone continents"), each of which are mounted switching centers first class ST-1: North and Center-I American (code 1), Africa (Code 2), Europe (codes 3 and 4), South America (code 5), Asia Minor, Australia and Oceania (code 6), Russia (code 7), Central Asia and the Far East (code 8), India and the Middle East (code 9). The range of the CT-1, CT-2 construct and NT-3. NT-2 incorporates several countries. Area NT-3, as a rule, limited to the country. In the CIS centers NT-3 is not created.

International communication network



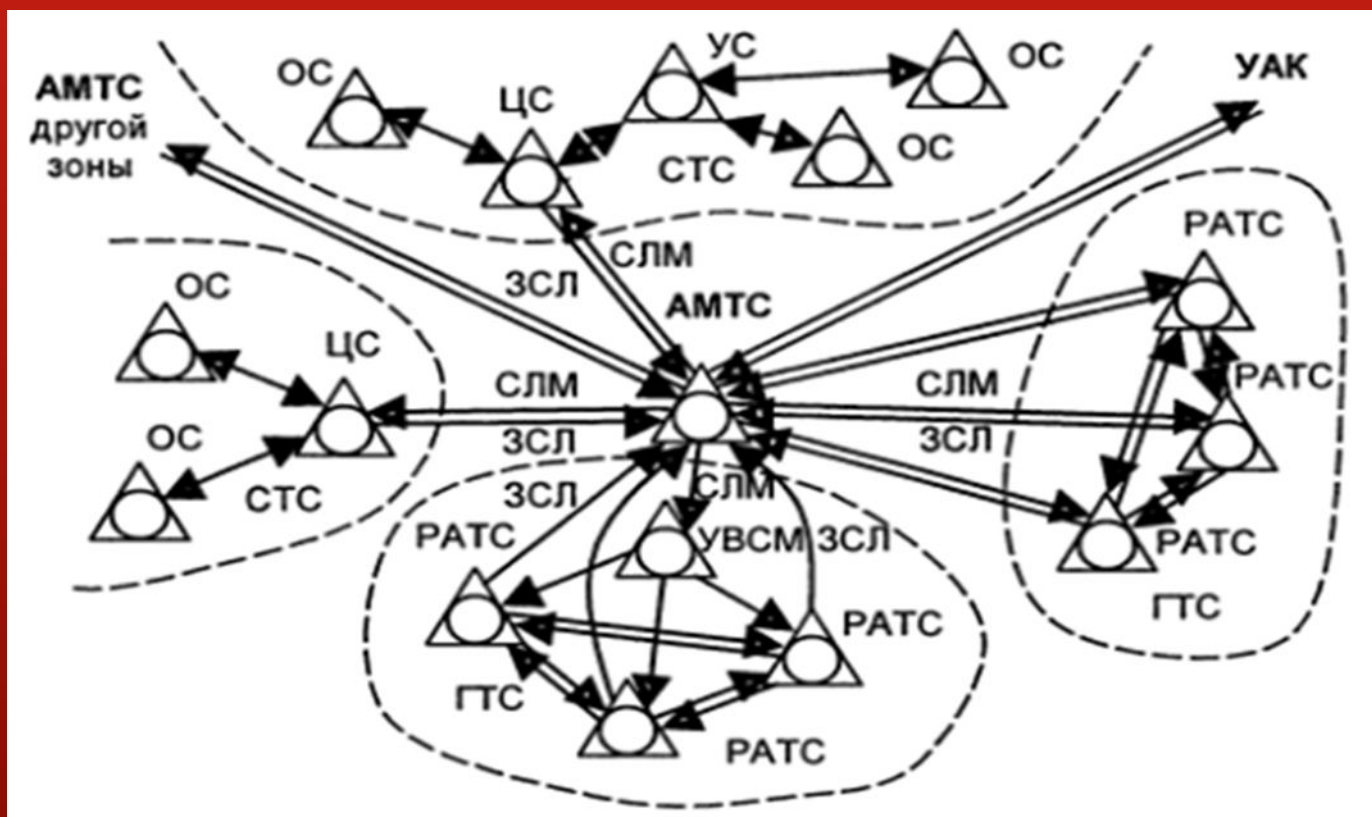
Telephone networks, types and principles of their construction

- CT-1 are connected to the principle of "everyone with everyone" beams the last choice (BLC). Bunches of PPV channels form the basic structure. For BLC are used whenever possible terrestrial channels. ITU-T is not recommended to include two or more jumps satellite communications in one international connection path. Between the center CT of any class can be arranged direct beams of high quality channels (HQC) with blocking probability less than 1%, or use high beams channels (HBC) with lock-order probability (15-20)%. In accordance with the recommendation E.171 number of dial-up areas involved in the establishment of an international connection should not exceed 12. In exceptional cases and for a small number of compounds the number of dial-up areas can reach 14.

Backbone network

- Backbone communication - technology associated telecommunications network formed between the zones. Backbone network connects Astana centers zones (areas), as well as between a zone

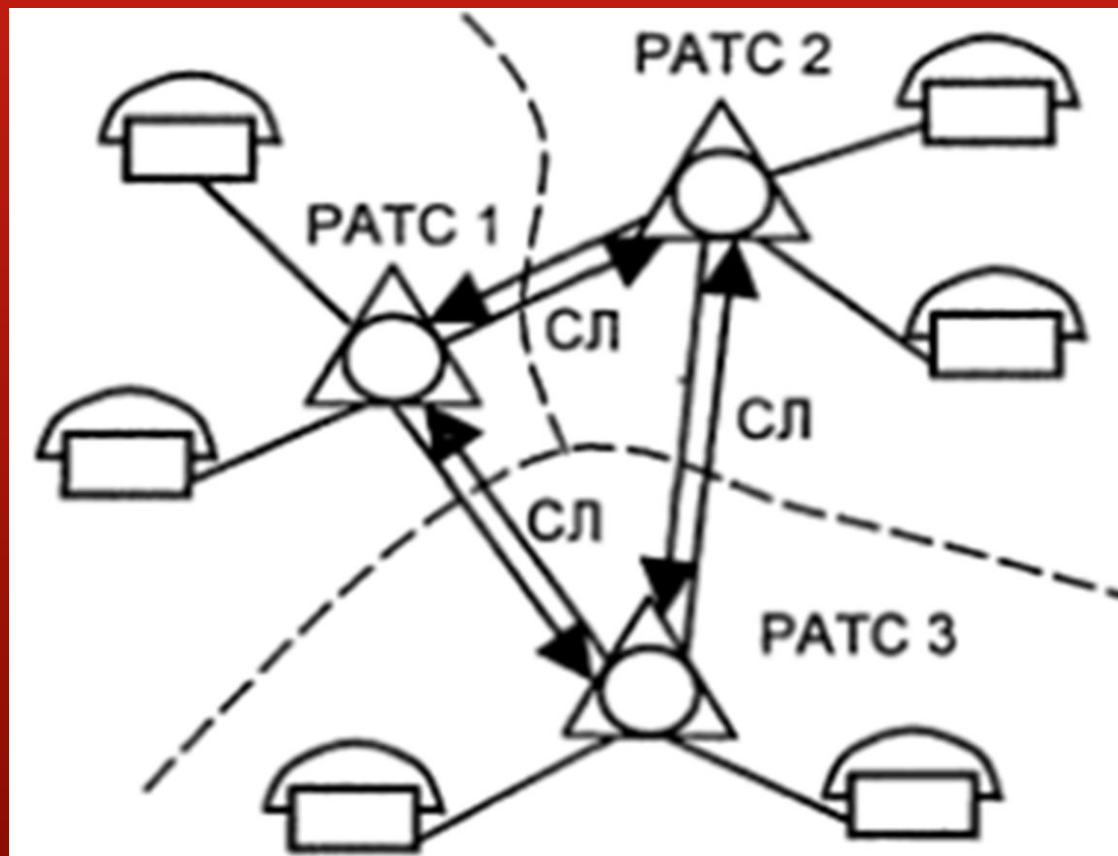
Intra (intra) network



City Telephone Network

- Given the existing technical means then switch provides the following variants of GTS structure [7]:
- - Not zoned CTN. In such a network is installed a PBX, where the AL included. Subscribers can connect to the PBX, either directly or through the PBX. Pridelnyh capacity PBX 7000. Numbering five-valued. Interoffice trunk in such a network is not available;
- - Zoned CTN. In this case, the area of the city is divided into areas. Each district is located RATS, in which subscribers of the area included. Limit capacity of the district ATS 70,000 subscribers. Numbering five-valued, where the first number is the code of the district ATS. RATS interconnected beams SL on the principle of "each"

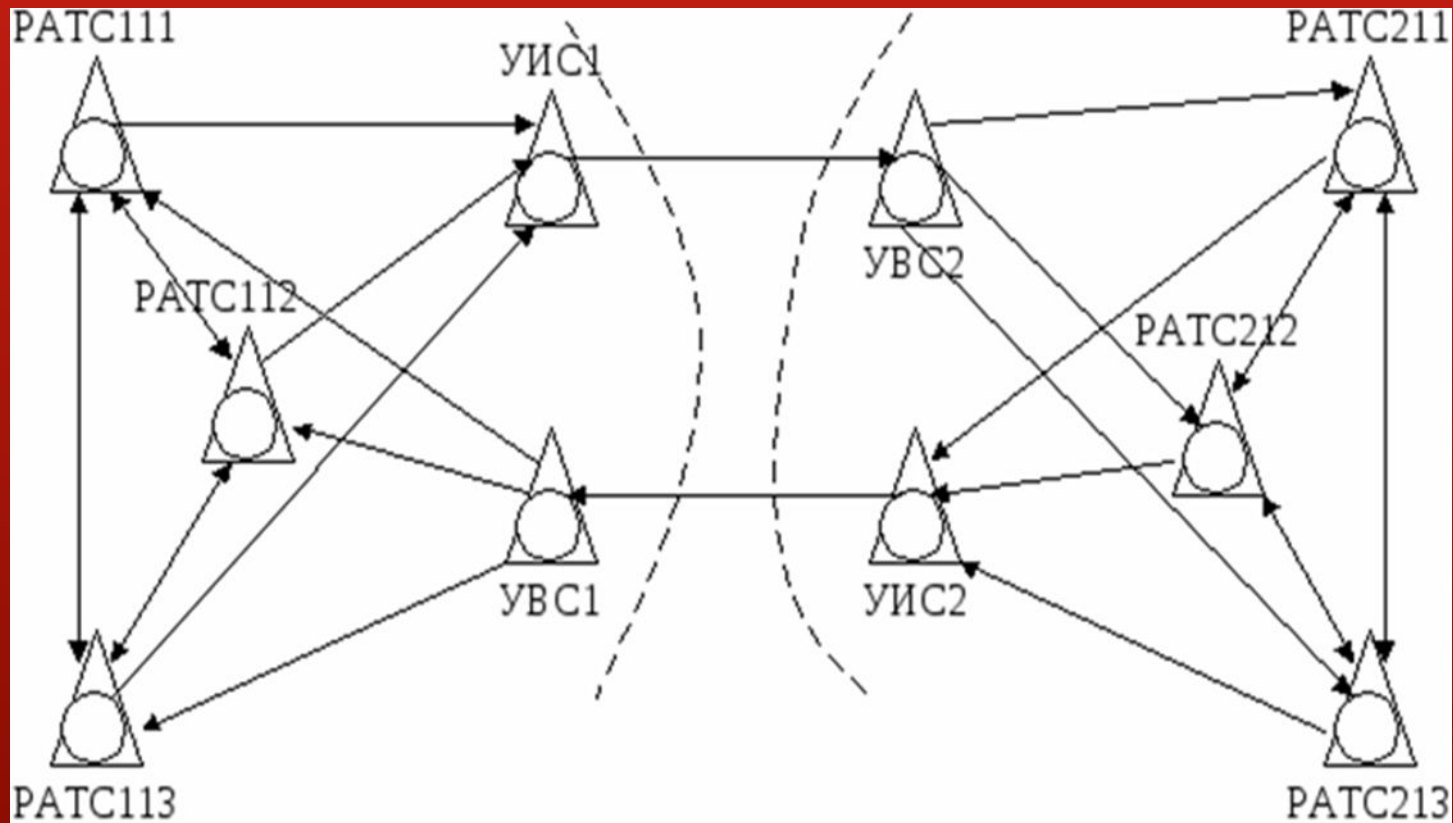
Intra-network



City Telephone Network

- zoned GTS with incoming message assembly. RATS one nodal region may be connected to each other on the principle of "each other" (1 nodal area) or through contact incoming message assembly its nodal region (nodal region 2). Six-digit numbering;
- - Zoned GTS with incoming message assembly and outbound node.

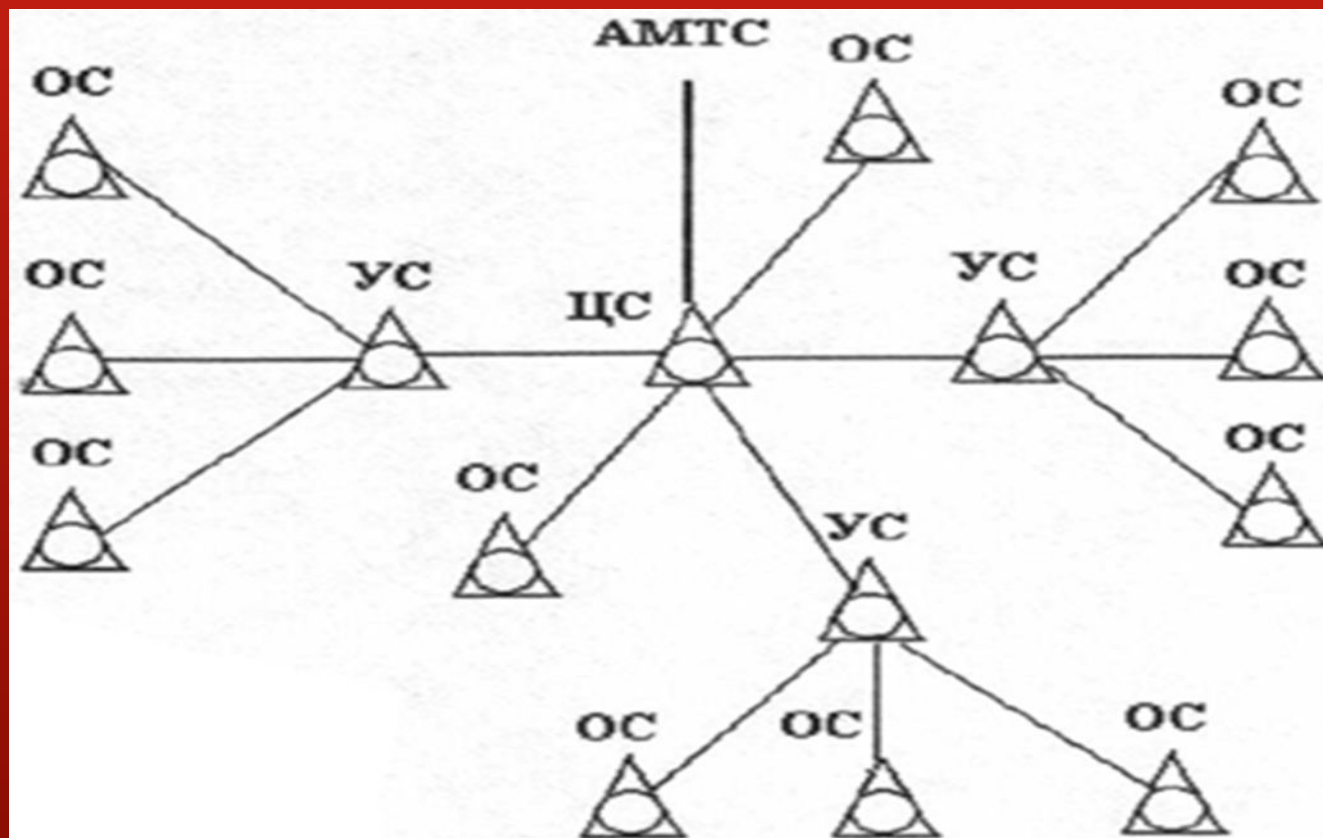
Zoned GTS with incoming message assembly and outbound node.



Rural Telephone Network

- Species structure of construction RTN:
- - Radial;
- - Radial-junction;
- - Combined.

Angular junction RTN



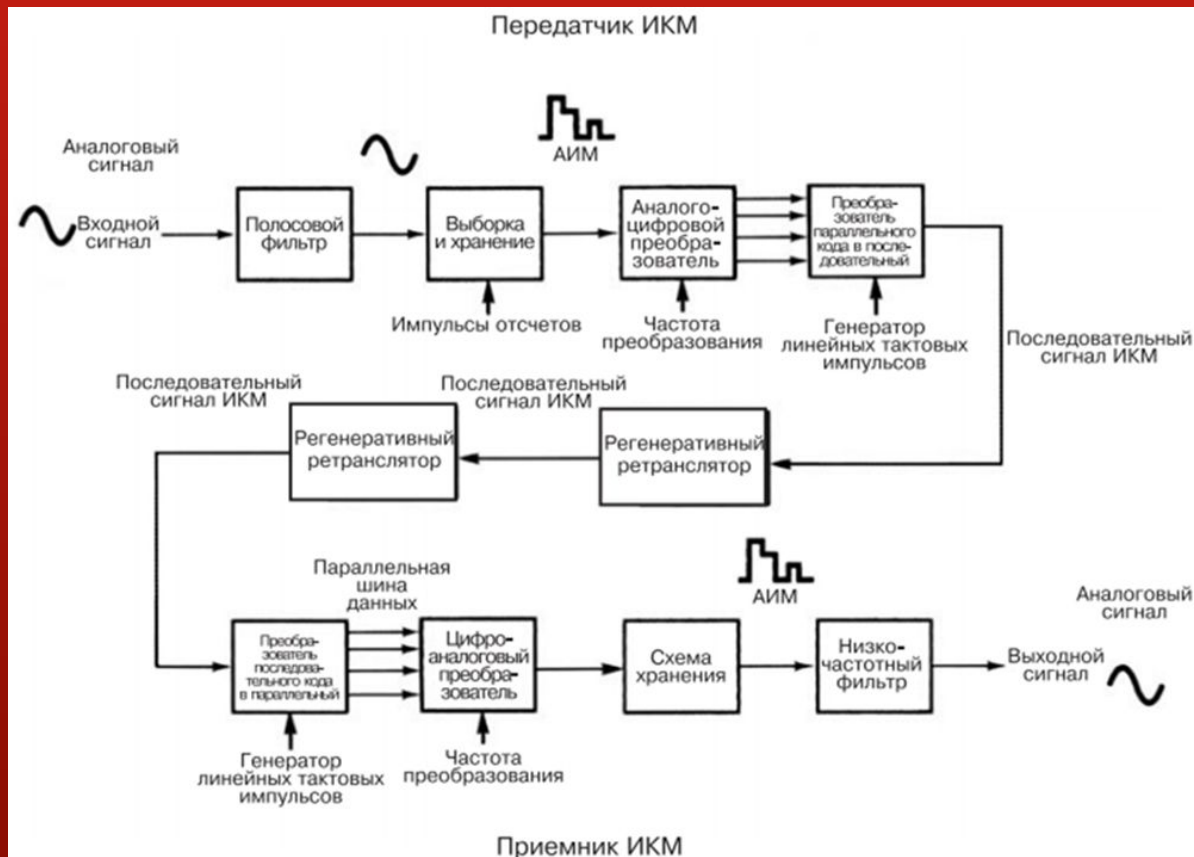
Basics of digital telephony

- Compared to analog transmission techniques, digital transmission methods have several advantages including:
 - - High noise immunity;
 - - A weak dependence of the transmission quality of the link length;
 - - The stability of the parameters of the DSP channels;
 - - Efficient use of channel capacity for the transmission of digital signals;
 - - The possibility of a digital communications network.
 - - Ease of classification of information.

Basics of digital telephony

- The disadvantages of digital systems include:
- - Transmission of the analog signal into digital form requires significantly more bandwidth than analog transmission signal in its original form;
- - The analog signal must be converted to digital form prior to transmission and inverse conversion on reception - this leads to the need for additional coding and decoding devices;
- - The need to synchronize the generator equipment transmitters and receivers.

A simplified diagram of the transmission system of the PCM.



Building a digital network strategy

- There are several strategies for building a digital network, the main ones are:
- - Islands of the strategy (replacement strategy);
- - Overlay strategy;
- - Pragmatic strategy (combined).

Islander Strategy

- For island strategy is characterized by the fact that all of the existing analog system gradually replaced by digital within limited geographical areas called digital islands. Then, the digital network of the island is gradually combined to form a single digital network. Digital Island is recommended to implement in areas with a large number of obsolete telephone exchanges, the life of which is coming to an end, just as in areas with extensive use of DSP. Islands can be an attractive strategy in the case where the telephones regions separated by great distances, and the initial costs for the modernization of the top-level networks are high.

Overlay strategy

- Overlay strategy is aimed at creating a digital network, which covers the same territory as the existing analogue network. Digital stations are connected to each other only digital signal SL and exchange information using common channel signaling system (ACS №7). Pairing the digital network to the existing analog network provides the ability to the number of nodes (gateways) that perform the functions matching alarm systems

Pragmatic strategy

- In pragmatic strategies have in common that during the development of its various network sites can be upgraded using a blending strategy or by introducing digital islands. Pragmatic strategies involve more detailed technical and economic analysis of the numerous combinations of islands and overlay strategies, applicable to all segments of the network to achieve optimal solutions.