Infocommunication systems

Híradástechnika szigorlat

Kidolgozott tételek

2020

Hunglish

Hasznos linkek:

Tételek 2019: ~ekacs/anyagok/szigorlat/hiradastech/tetelek_infocomm19.pdf
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1. Main characteristics and applications of twisted pair cables (telephone, data, ADSL)

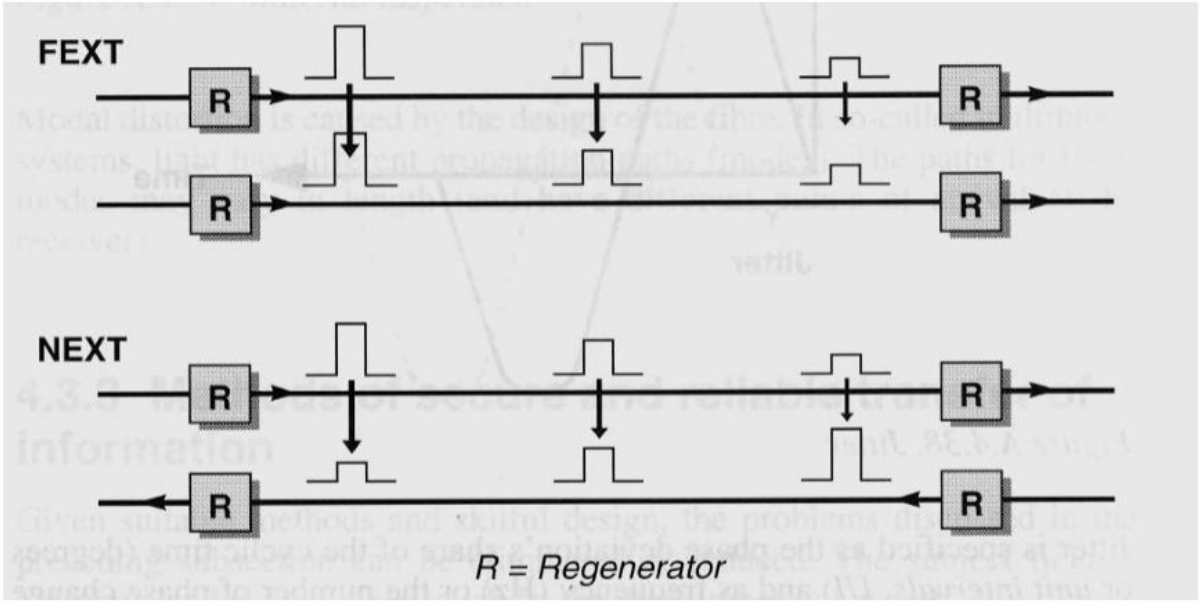
- **Twisted pair cable**: Twisted pair cabling is a type of wiring in which two conductors of a single circuit are twisted together for the purposes of cancelling out electromagnetic interference (EMI) from external sources. *Csökkenti az áthallást igazából.*

Characteristics

- **Attenuation (csillapítás)**: Reduction in the strength of a signal. (reason: material quality) Unit: [dB] *Magasabb frekvenciákat használó kábelek esetén magasabb a csillapítás.*
- **Characteristic impedance (hullámimpedancia)**: Z0. The characteristic impedance of a transmission line is the ratio of the voltage and current of a wave travelling along the line. That is, a wave travelling in one direction in the absence of reflections in the other direction.[1]
  Az átviteli vonal mentén futó hullám feszültségének és áramának aránya. - Itt még valami visszaverődés dologról illik beszélni (nem értem az mi)

$$Z_0 = \sqrt{\frac{R + j\omega L}{G + j\omega C}}$$

- **Delay (késleltetés):** Electromagnetic wave speed ~70% of the speed of light.
- **Crosstalk (áthallás)**: In electronics, crosstalk is any phenomenon by which a signal transmitted on one circuit or channel of a transmission system creates an undesired effect in another circuit or channel. *Két vezeték közötti interferencia. Analóg telefonoknál régen emiatt akár hallottad is más beszélgetését a háttérben.*
- **NeXT**: Near-end Crosstalk. Interference between two pairs in a cable is measured at the same end of the cable as the interfering transmitter. Comes out on the near end when we inject a signal (Nagy jel áthallatszik a kicsire - rossz)
- **FeXT**: Far-end Crosstalk. Interference between two pairs of a cable measured at the other end of the cable with the respect to the interfering transmitter. Comes out on the far end when we inject a signal.

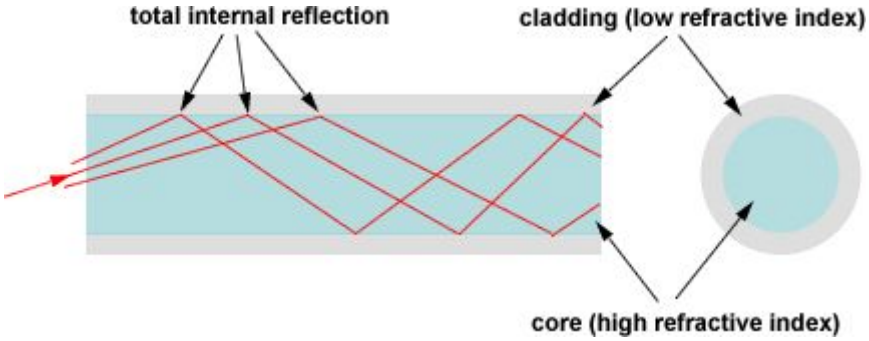


[1] Ajánlott ezen a linken a visszaverődéses jelenséget átolvasni a karakterisztikus impedanciáról, mert külön bele kérdez, hogy mitől karaktersztikus az impedancia (kér rajzot is):
https://www.tankonyvtar.hu/hu/tartalom/tamop412A/2011-0035_digitalis_aramkorok_alkalmazastechnikaja/pdf/15_1.pdfattachment

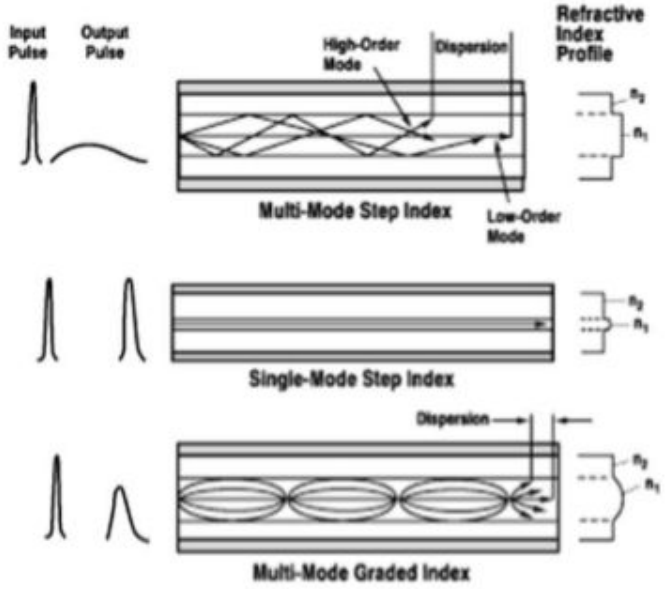
Main applications of twisted pair cable

- Ethernet cabling (UTP), SFTP kábelek, phone networks, ADSL (meglévő telefonvonalon teszi lehetővé a netezést), security cameras etc. (kb. 100 méteres távolságon belül használják, olcsóbb mint az optikai kábel)

2. Main characteristics of optical fibre cables. Main applications of fibre cables.



- An optical fiber or optical fibre is a flexible, transparent fiber made by drawing glass (silica). *Egy kábel, aminek van egy üveg magja, meg egy burkolata.*
- Optical fibers typically include a core surrounded by a transparent cladding material with a lower index of refraction *(Törésmutató - minél nagyobb annál jobban töri a fényt)*.
- Therefore the light is kept in the core by the phenomenon of **total internal reflection (teljes visszaverődés)** which causes the fiber to act as a waveguide.
- The diameter of the glass core is about 100 µm, but it may vary according to the propagation mode used in the cable.
- Transfer data with the speed of light in glass (kb. fénysebesség 70%-a, igen ua. mint a sodrottnál)
- **Three key characteristics** of fiber optic waveguides can be affected by environmental conditions: **strength, attenuation and resistance to losses caused by microbending.**
    - **Attenuation:** very low. We can connect the EU and the USA with a single cable without a single repeater
- **Propagation modes**:[2] multi-mode step index (used on shorter distances), single-mode step index (used on longer distances, itt ilyen szuper vékony a core - de kurva drága), multi-mode graded index (ez a fasza igazából: hullámzik benne a jel és ezért jobban megmarad mint a multi mode step indexnél)



[2] Tudd mindegyikre, hogy mi az alkalmazási terület külön-külön, hogy miért és az ábrát is.
https://community.fs.com/blog/single-mode-cabling-cost-vs-multimode-cabling-cost.html
https://community.fs.com/blog/step-index-multimode-fiber-vs-graded-index-multimode-fiber.html

- **Dispersion: (Szórás)** The group delay difference between the slowest and the fastest mode divided by the length of the cable. Multi-Mode Step Index > Multi-Mode Graded Index > Single-Mode Step Index = 0

https://www.fiberoptics4sale.com/blogs/archive-posts/95052678-what-is-optical-fiber-dispersion

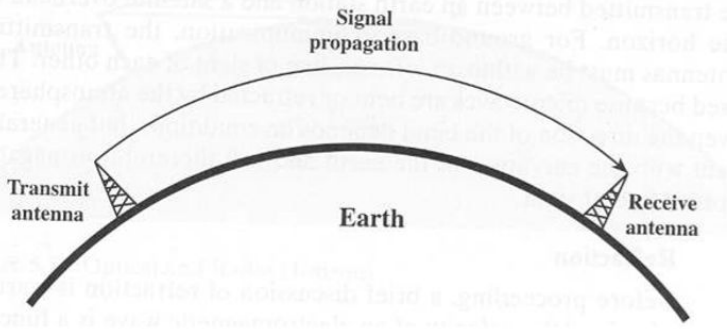
$$D_{lm} = \frac{\Delta\tau}{L}[ns/km]$$

- **Intermodal dispersion**: the phenomenon that the group velocity of light propagating in a waveguide structure depends on the waveguide mode.
- Optical fibers are used most often as a means to transmit light between the two ends of the fiber and find wide usage in fiber-optic communications, where they permit transmission over longer distances and at higher bandwidths (data rates) than electrical cables.
- Concrete applications: https://www.doityourself.com/stry/9-uses-of-fiber-optic-cables

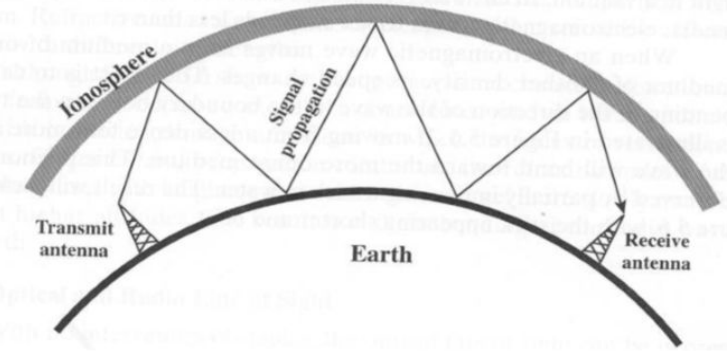
3. Main radio wave propagation modes, transmission characteristics of radio connections

Propagation modes

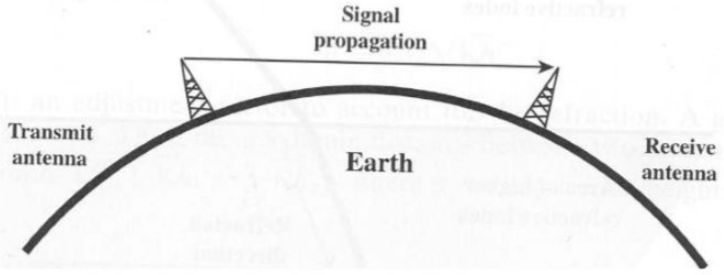
- **Ground wave propagation (below 2 MHz)**: Used to provide relatively local radio communications coverage.



- **Sky wave propagation (2 to 30 MHz)**: Reflected by the ionosphere.



- **Line-of-Sight propagation (above 30 MHz)**: Any obstruction between the transmitter and the receiver will block the signal, just like the light the eye may sense. Can be used for 30-50 km due to the spherical nature of the earth.



Transmission characteristics of radio connections

- **Path loss**: path loss or path attenuation is the reduction in power density of an electromagnetic wave as it propagates through space.
- **Delay**: A hullám ideje, hogy elérje a vevőt.
- **Fading**[3]: In wireless communications fading is the deviation of the attenuation affecting a signal over certain propagation media. Fading may vary with time, geographical position and radio frequency, and is often modeled as a random process. A fading channel is a communication channel comparising

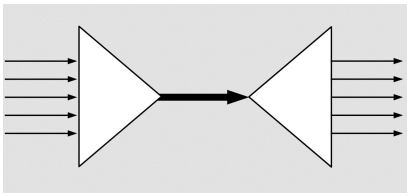
[3] http://users.itk.ppke.hu/~tihanyia/eloirt1/Fading_meres2.pdf

fading. In wireless systems, fading may either be due to multipath propagation, referred to as multipath induced fading or due to shadowing from obstacles affecting the wave propagation, sometimes referred as shadow fading.

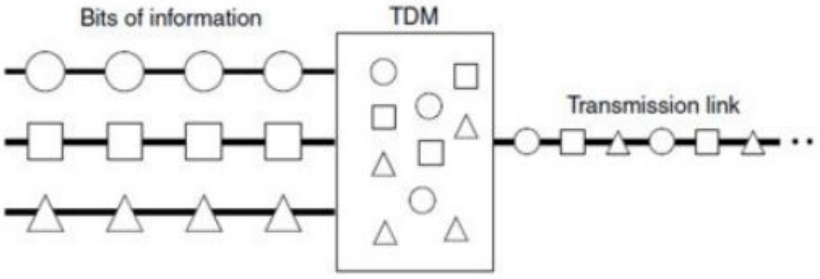
A vezeték nélküli hírközlésben a többutas hullámterjedés által okozott jelenség, amelynek során a vételi térerősség véletlenszerűen erősödhet/gyengülhet, amelyet a vevőantennára különböző amplitúdókkal és fáziskülönbséggel érkező felületi és térhullámú jelek interferenciája okoz.

- **Reflection**: When a radio wave hits an obstacle, some or all of the wave is reflected, with loss of intensity. Reflection is such that the angle of incidence is equal to the angle of reflection.
- **Polarization**: *The ability of waves to oscillate in more than one direction.* Property of a radiated electromagnetic wave describing the time varying direction and relative magnitude of the electric-field vector. In general, the field is elliptically polarized.
- **Reliability and availability** - equipment and propagation parameters (lightning, snow, rain, fog smoke)

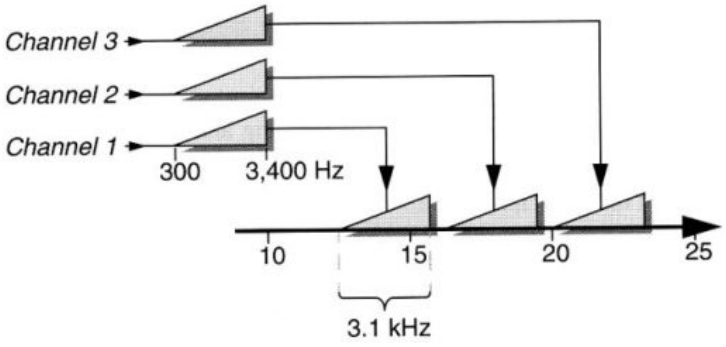
4. Main functions of multiplexing and switching nodes in the networks, the main features of circuit switching, packet switching and cell switching



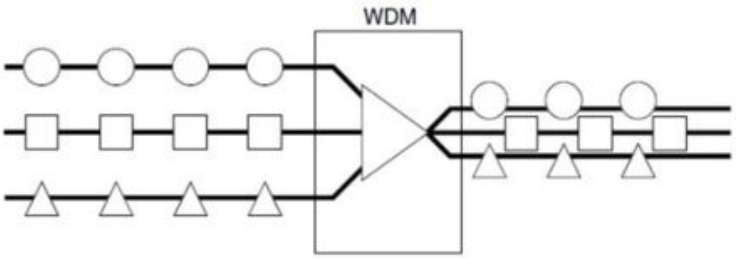
- **Multiplexing:** In telecommunication and computer networks, multiplexing (sometimes contracted to muxing) is a method by which multiple analog or digital signals are combined into one signal over a shared medium.
  - Eg: Several telephone calls may be carried using one wire.
  - **Time-division Multiplexing (TDM)**: The channel is split into dedicated time frames. TDM is a method of transmitting and receiving independent signals over a common signal path by means of synchronized switches at each end of the transmission line so that each signal appears on the line only a fraction of time in an alternating pattern. Used in ISDN telephone lines, public switched telephone network, some telephone systems, wire line telephone lines -> szóval mindenféle TELÓHOZ. Disadvantages: synchronization is required, complex to implement.



  - **Frequency-division Multiplexing (FDM):** The channel is split up to dedicated non-overlapping frequency sub-bands, each of which is used to carry a separate signal. GSM (first gen), CaTV, radio.



  - **Code Division Multiple Access (CDMA):** Spread Spectrum concept, several transmitters can send information simultaneously over a single communication channel using a hopping technique. (FHSS, DSSS) **TODO**
  - **Wavelength Division Multiplexing (WDM):** As light has different colors on different frequencies, we can separate in fibres by wavelength using a simple prism.



- **Switching**: in the telecommunications industry, switching is used to connect two nodes that are not in direct proximity to each other.
    - Nodes are endpoints or redistribution points that receive and send data across distributed networks.
    - Switches connect these nodes to ensure seamless communication across devices which are not physically close or connected. This ability to quickly and accurately distribute the right information to the proper node so that it reaches the end user in a digestible way is why switching is so important.
    - There are two main types of switching in use in telecom today:
        - **Circuit switching**: in this method, the nodes determine a dedicated path over which they will communicate. This ensures optimal bandwidth use.
        - **Packet switching**: In packet switching the transmitted message is broken into parcels, or packets each of which are informed by a destination address. This method allows for many transmissions to use the same path.
        - **A rule of thumb**: Band is cheap: circuit switching. Processing is cheap: packet switching.
- **Main functions:**
    - To reduce transmission costs
    - To utilize higher bandwidth
    - Framing and packing information
- **Circuit switching** is a method of implementing a telecommunications network in which two network nodes establish a dedicated communications channel (circuit) through the network before the nodes may communicate.
    - The circuit guarantees the full bandwidth of the channel and remains connected for the duration of the communication session.
    - The circuit functions as if the nodes were physically connected as with an electrical circuit.
    - The defining example of a circuit-switched network is the early analog telephone network. When a call is made from one telephone to another, switches within the telephone exchanges create a continuous wire circuit between the two telephones, for as long as the call lasts.
    - **Advantage**: it provides for **continuous transfer** without the overhead associated with packets, making **maximal use of available bandwidth** for that communication.
    - **Disadvantage**: it can be **relatively inefficient**, because unused capacity guaranteed to a connection cannot be used by other connections on the same network.
    - Két csomópont között előre lefoglal egy csatornát mielőtt elkezdene két csomópont kommunikálni, ezáltal a teljes csatorna sávszélessége használható adatátvitelre, viszont ha nem is használja éppen adatküldésre akkor is a teljes kommunikációra lefoglalja a csatornát. Ezt tekinthetjük úgy mintha a csomópontok fizikailag is össze lennének kötve egy elektromos hálózatban, mint a régi analog telefonnál. Fix késleltetés van a kommunikációban szemben a packet switching-gel ahol változó késleltetés.
- **Packet switching** is a method that groups all transmitted data into suitably sized blocks (packets), which are transmitted via a medium that may be shared by multiple simultaneous communication sessions.

    - In packet switching, instead of being dedicated to one communication session at a time, network links are shared by packets from multiple competing communication sessions, resulting in the loss of the quality of service guarantees that are provided by circuit switching.
    - Packet switching is the primary basis for data communications in computer networks worldwide.
    - Packet switching increases network efficiency, robustness and enables technological convergence of many applications operating on the same network.
    - Connection-oriented
    - Connectionless
    - Az adatokat csomagokba rakjuk melyet elküldünk, a packet egy header (cél) és egy payload (változó méretű adat) részből áll, hatékonyabban használja ki a hálózatot, viszont változó idejű késleltetéssel bír. FIFO alapú módon továbbítják általában a csomagokat a csomópontok. Connection oriented(guarantee is possible) vs connectionless(best effort).
    - https://www.geeksforgeeks.org/difference-between-connection-oriented-and-connection-less-services/
- **Cell switching** is associated with **Asynchronous Transmission Mode (ATM)**
    - Asynchronous Transfer Mode (ATM) is, according to the ATM Forum, "a telecommunications concept defined by ANSI and ITU (formerly CCITT) standards for carriage of a complete range of user traffic, including voice, data, and video signals".
    - ATM uses asynchronous time-division multiplexing, and encodes data into small, fixed-sized packets (ISO-OSI frames) called cells.
    - This differs from approaches such as the Internet Protocol or Ethernet that use variable sized packets and frames.
    - Fixed cell length
    - Kisméretű, fix csomagokra vagyis cellákra osztjuk az adatot, melyeket elküldünk. Cell relay-nek is nevezik. Nem megbízható, manapság lassúnak számít. Videó és hang továbbításra használták elsődlegesen. Nincs benne hiba kezelés, flow control és adatvisszaállítás. Nagyon fontos adatok továbbítására megbízható elvileg. It is an unreliable, connection-oriented packet switched data communications protocol.
    - https://www.quora.com/What-is-the-difference-between-packet-switching-frame-switching-and-cell-switching

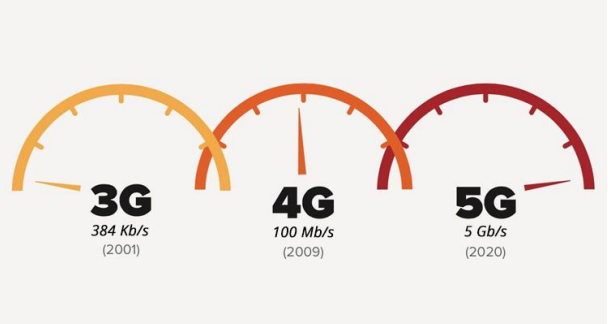
5. Next generation infocommunication systems

Ezt az internetből

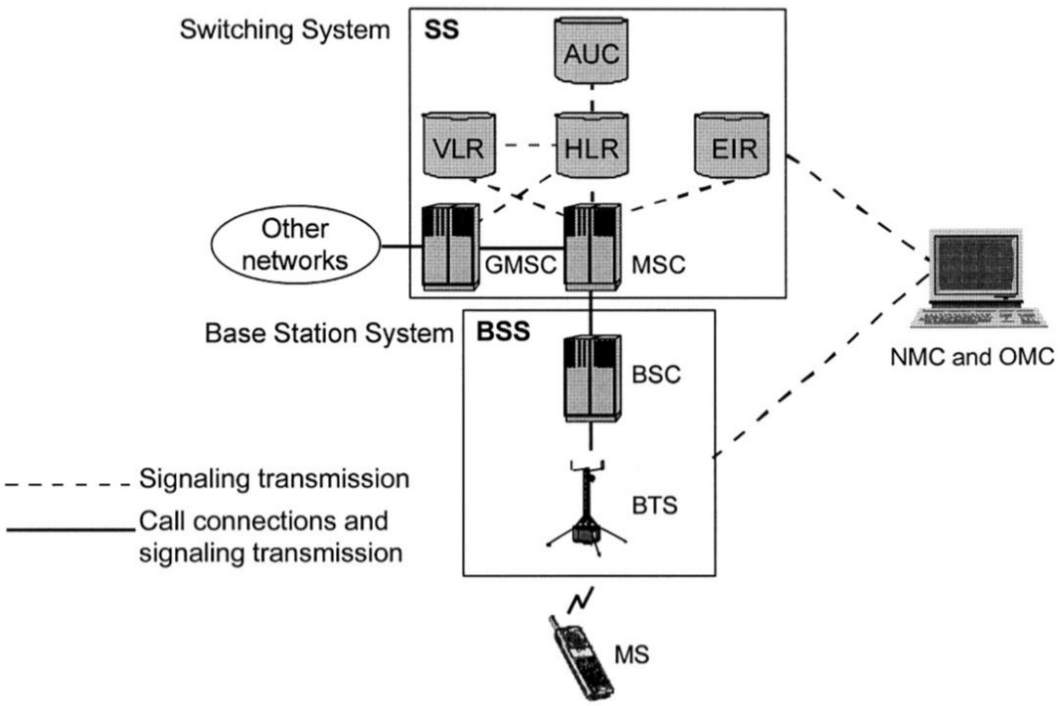
- **The next-generation network (NGN)** is a body of key architectural changes in telecommunication core and access networks.
- The general idea behind the NGN is that **one network transports all information and services** (voice, data, and all sorts of media such as video) by encapsulating these into **IP packets**, similar to those used on the Internet.
- NGNs are commonly built around the Internet Protocol, and therefore the term all IP is also sometimes used to describe **the transformation of formerly telephone-centric networks toward NGN.**
- Next-generation networks are purely based on Internet technologies including **Internet Protocol (IP)** and **multiprotocol label switching (MPLS)**.

Ezt a diákból

- Gyorsul az új technológiák elterjedésének üteme
- Ugye volt az EDGE, meg a 3G, meg a 4G és most jövögetnek az 5G-s cuccok, de ez mi meg miért kell
- 3 limits:
    - we are reaching the limit of smartphone value creation
    - we are reaching the physical limit of current networks
    - we are reaching the limit of operational complexity
- URLLC (Ultra Reliable Low Latency Communication): ennek az a lényege, hogy annyira icipici lesz a látencia meg stabilan is, hogy az érzékelésünk sebességével egyezni fog. tehát a sense of touch can be transported to the other side of the world in real time.
- Digital lollipop is an electronic device that synthesizes virtual tastes by stimulating the human tongue with electric currents.
- Digital smell technology is the main application of e-nose. With digital scent technology, it is possible to sense, transmit & receive smell through the internet.
- Remote surgery
- Bandwidth requirements for Holographic-Type Communications
- beszél aztán még a spacex starlinkről, erről mindenki tudja mi sztem. röviden 30000 műhold repked majd és ad internetet. csillagászoknak egyébként nem tetszik
- amazon is akar ilyet
- 5G-ről meg IOT-ről beszélt
    - https://prohardver.hu/teszt/iot-internet_of_things/iot_okosodo_vilag.html
    - https://hu.ign.com/5g-halozat-1/25309/feature/mi-az-az-5g-miert-van-ra-szukseg

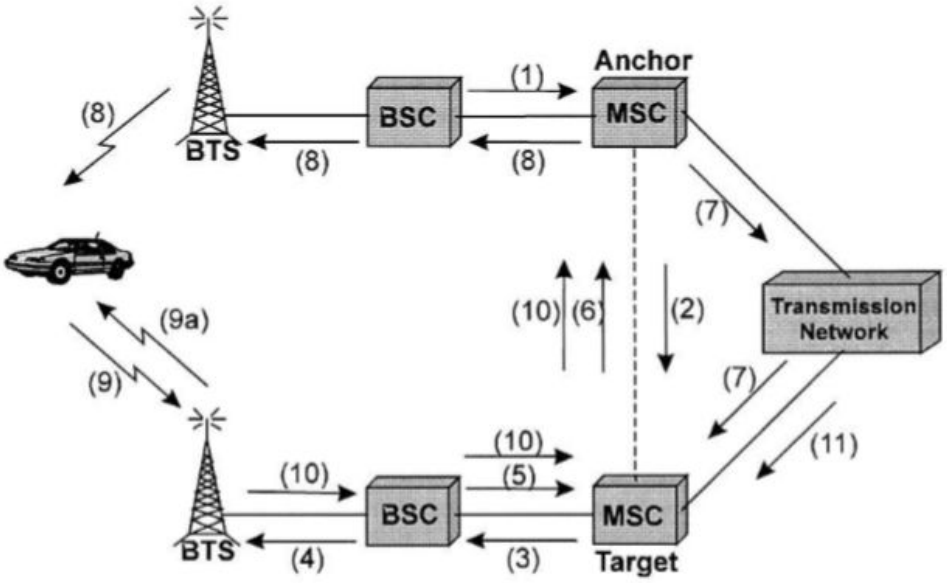


6. Main elements and their functions in a GSM network (MSC, BSC, BTS, HLR, VLR LA, MS...)



- **Global System for Mobile Communications (GSM)**
- **Switching system**
  - **HLR**: Home Location Register
    - Centralized network database to store:
      - Subscriber identification
      - Subscriber supplementary services
      - Subscriber location information
      - Subscriber authentication information
  - **AUC**: Authentication Center
    - The AUC is to authenticate subscribers attempting to use a network
  - **VLR**: Visitor Location Register
    - Information about subscriber located in an MSC service area (a copy of HLR information)
  - **EIR**: Equipment Identity Register
    - Database to block calls from stolen, unauthorized or defective MSs.
  - **Mobile Switching Center (MSC):** MSC is the primary service delivery node for GSM/CDMA responsible for routing voice calls and SMS (Short Message System) and other services (Conference calls, FAX, etc.)
    - It's a function to manage billing, delivering SMSs.
    - Arranges handovers and supőplementary services.
    - Controls BSCs. GMSC is the Gateway MSC for other MSCs
  - **GMSC**: Gateway Mobile Switching Center
- **Base Station System**
  - **BSC:** Base Station Controller
    - Manages all the radio related functions of the network
    - MS handover
    - Radio channel assignment

        - Collection of cell configuration data
        - Controlled by MSC
    - **BTS**: Base Transceiver Station
        - Controlled by Bsc
        - Controls the radio interface to MS
        - Comprises transceivers and antennas
    - **MS:** Mobile Station
        - Mobile subscriber to communicate network
        - Consist of mobile terminal and Subscriber Identity Module (SIM)
        - Subscription is separated from the mobile terminal
        - Subscription information is stored in SIM.
        - States:
            - Idle: MS is on but a call is not in progress
            - Active: The MS is ON and a call is in progress
            - Detached: The MS is OFF
- **Steps of Basic Handover:**
    1. BSC send handover-required message to the MSC
    2. The MSC ask the target MSC to assist. The target MSC allocates a handover number that reroutes the call
    3. A handover request is sent down to the new BSC
    4. The BSC tells the new BTS to activate TCH
    5. The MSC receives the information about the new Traffic Channel
    6. The MSC passes info on new TCH from new BSC
    7. A speech path to the new MSC is set up
    8. A handover command goes to the MS with frequency and time slot data in the new cell
    9. The MS sens handover burst on the new TCH
    10. The target MSC is informed that the handover successful
    11. A new path in the Group Switch is set up

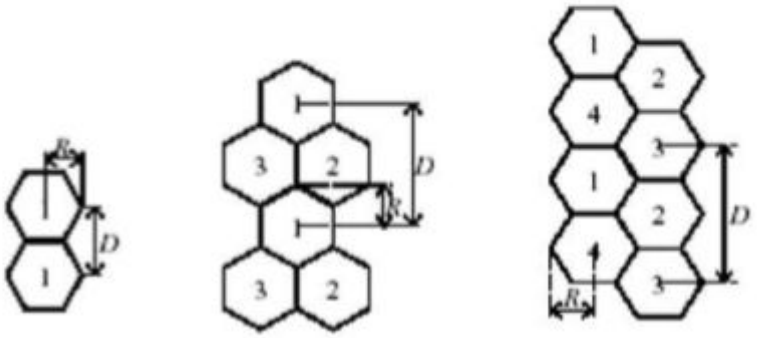


Principles of cellular systems

- A **cellular network** or mobile network is a communication network where **the last link is wireless**. The network is distributed over land areas called cells, each served by at least one fixed-location transceiver, but more normally three cell sites or base transceiver stations. These base stations provide the cell with the network coverage which can be used for transmission of voice, data, and other types of content.

- A cell typically uses a different set of frequencies from neighboring cells, to avoid interference and provide guaranteed service quality within each cell.
- In the cellular concept frequencies allocated to the service are re-used in a regular pattern of areas, called “cells”, each covered by one base station. In mobile telephone networks these cell are usually hexagonal.
- **Notations**:
    - In a cluster each cell has a separate frequency
    - a: the area of one cell
    - A: the cluster area
    - R: the cell diameter
    - D: the distance between clusters (cells with identical frequencies)
    - K: number of cluster cells.

$$K = \frac{A}{a} = \left(\frac{D}{\sqrt{3}R}\right)^2$$



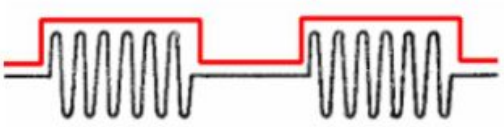
- **Increasing capacity in cellular systems**
    - Adding new channels
    - Frequency borrowing
    - Cell splitting
    - Cell sectoring
    - Microcells

7. Basic services, supplementary services, service quality requirements of different services in the infocommunication systems

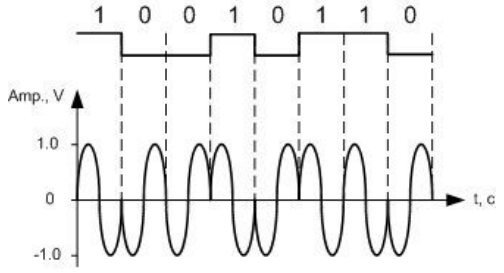
- **Services**
  - **Basic services**
    - Mandatory service elements with minimal quality requirements such as real-time and understandable voice.
  - **Supplementary services**
    - To make basic services even more usable, eg. call transfer, conference call, automatic call back on busy, wake up services, least cost routing services, credit card based call, etc.
  - **Value added services**
    - Bank transactions by phones, televoting, telephone based donation, etc.
- **Services quality requirements**
  - **Voice, music, video**
    - Sensitive on **delay** (max 300ms)
    - Sensitive on **jitter** (max 30ms)
    - Sensitive on **video-voice synchrony**
    - **Error tolerant** (bit error rate 10^{-3} is acceptable)
  - **Games**
    - Sensitive on **delay** (max 30ms)
    - Sensitive on **error**
  - **Data, still picture**
    - Sensitive on **error**
    - **Delay** and **jitter tolerant**
- **Itt kell még valami? Nagyon úgy tűnik, hogy nem.. :(**

8. Digital modulation systems and their applications (BPSK, QPSK, QAM)

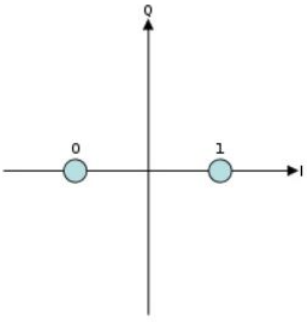
- **Amplitude Shift Keying (ASK):** a form of amplitude modulation that represents digital data as variants in the amplitude of a carrier wave. In an ASK system, the binary symbol 1 is represented by transmitting a fixed amplitude carrier wave and fixed frequency for a bit duration of T seconds. If the signal value is 1 then the carrier signal will be transmitted, otherwise a signal value 0 will be transmitted.



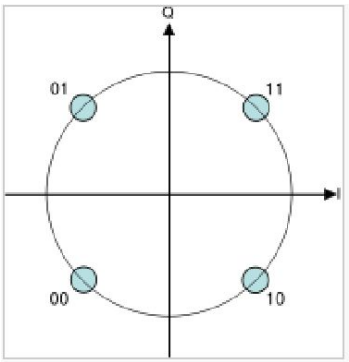
- **Phase-Shift Keying (PSK):** digital modulation scheme that conveys data by changing, or modulating, the phase of a reference signal (the carrier wave).



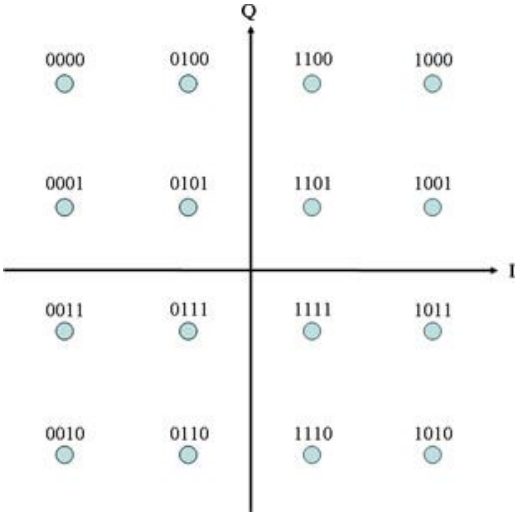
- **Binary Phase-Shift Keying (BPSK):** the simplest form of phase shift keying. It uses two phases which are separated by 180°.
  - It does not particularly matter exactly where the constellation points are positioned.
  - This modulation is the most robust of all the PSKs, since it takes the highest level of noise or distortion to make the demodulator reach an incorrect decision.
  - It is, however, only able to modulate at 1 bit/symbol and so is unsuitable for high data-rate application.
  - It is widely used for wireless LANs, RFID and Bluetooth communication.



- **Quadrature Phase-Shift Keying (QPSK):** uses four points of the constellation diagram, equispaced around a circle.
  - With four phases QPSK can encode two bits per symbol to minimize the bit error rate.
  - The mathematical analysis shows that QPSK can be used either to double the data rate compared with a BPSK system while maintaining the same bandwidth or to maintain the data rate but halving the bandwidth needed.
  - The engineering penalty is that QPSK transmitters and receivers are more complicated. This cost is very moderate though.
  - Two carriers: sine wave (Q - quadrature), cosine wave (I - in-phase). Modulated signal is the sum of the two components.
  - Application: Mobile networks, GSM (because of higher data-rate, but still pretty hard to reach an incorrect decision)



- **Quadratic Amplitude Modulation (QAM):** both an analog and a digital modulation scheme. It conveys two analoge message signals or two digital bit streams, by changing the amplitudes of two carrier waves, using Amplitude-Shift Keying (ASK) digital modulation scheme or amplitude modulation (AM) analog modulation scheme.
    - Two carriers: sine wave (Q), cosine wave (I)
    - The two carrier waves of the same frequency are out of phase with each other by 90 fok, and are thus called quadrature carriers or quadrature components.
    - The modulated signal is the sum of the two components.
    - Different amplitude and different phase values for one symbol.
    - 16QAM means: one symbol is four bits.
    - Demodulating
        - Because of the orthogonality property of the carrier signals it is possible to detect the modulating signals independently.
        - The demodulator needs to be exactly in phase with the recieved signals. This can be achieved by transmitting a pilot signal.
    - Application: Internet connections (where high data-rate is important): WiFi, ethernet, ADSL stb.
    - ellab: Érzékeny volt a többutas terjedés okozta zajra.

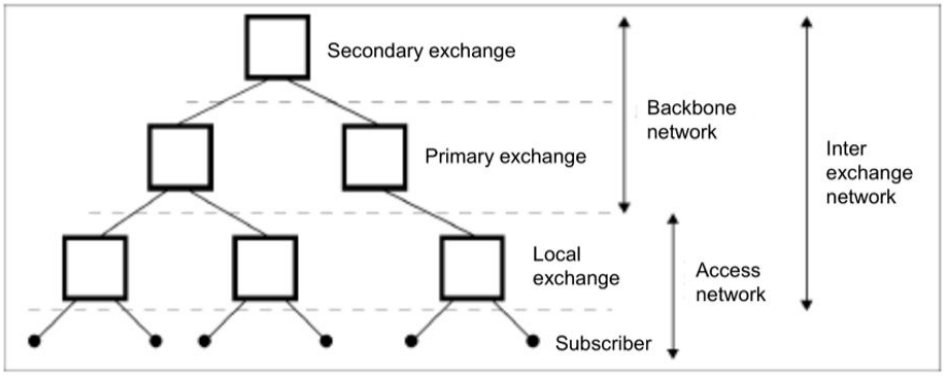


- A konstellációs ábrán található értékek a Grey kód sémát követik: https://en.wikipedia.org/wiki/Gray_code

9. Typical structures and technologies in PSTN networks

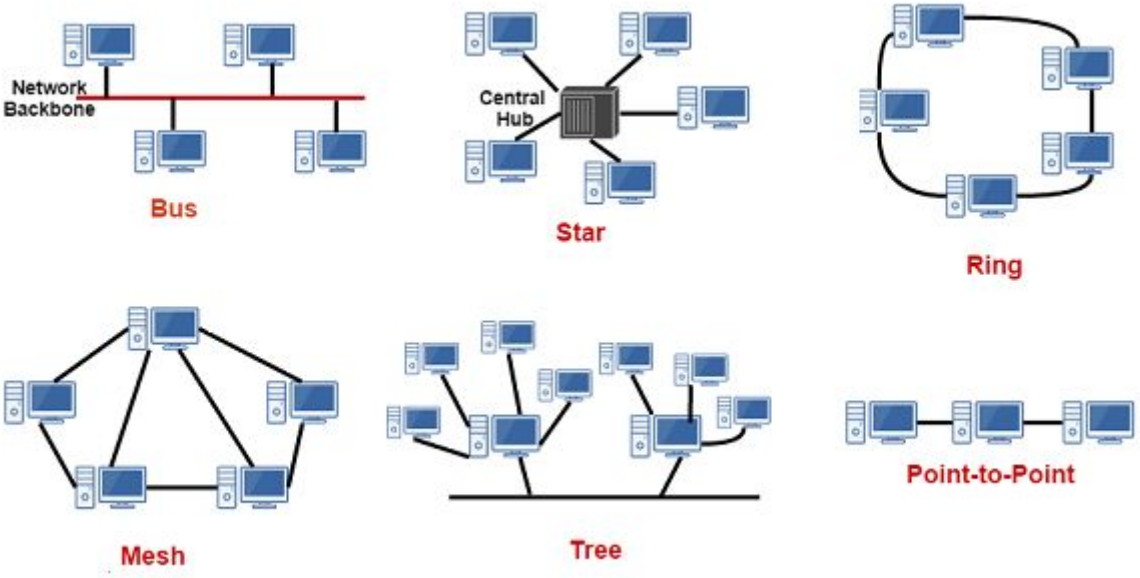
PSTN (Public Switched Telephone Networks)

The public switched telephone network (PSTN) is the aggregate of the world's circuit-switched telephone networks that are operated by national, regional or local telephony operators, providing infrastructure and services for public telecommunication.
The PSTN consists of telephone lines, fiber optic cables, microwave transmission links, cellular networks, communications satellites and undersea telephone cables, all interconnected by switching centers, thus allowing most phones to communicate with each other.



Components

- **Backbone networks**
  - A backbone is a part of a computer network that interconnects various pieces of network, providing a path for the exchange of information between different LANs or sub-network. A backbone can tie together diverse networks in the same building, in different buildings in a campus environment or over wide areas. Normally the backbones capacity is greater than the networks connected to it.
  - Long distances, high traffic, interconnection of nodes, transport bits of any services, high reliability, high availability.
- **Access networks**
  - Local distances, interconnection of terminals and local nodes
- **Network planning**
  - Selecting topology optimal selection of positions of nodes, dimensioning of node traffic handling capacities, dimensioning of link capabilities, selecting technologies with enough space in the cable duct system for future expansion.
- **Topologies**
  - **Star topology**
  - Multipolar topology
  - Meshed topology
  - Ring topology
  - Bus topology
  - Tree topology (Matáv)
  - (Pantel uses railway lines)

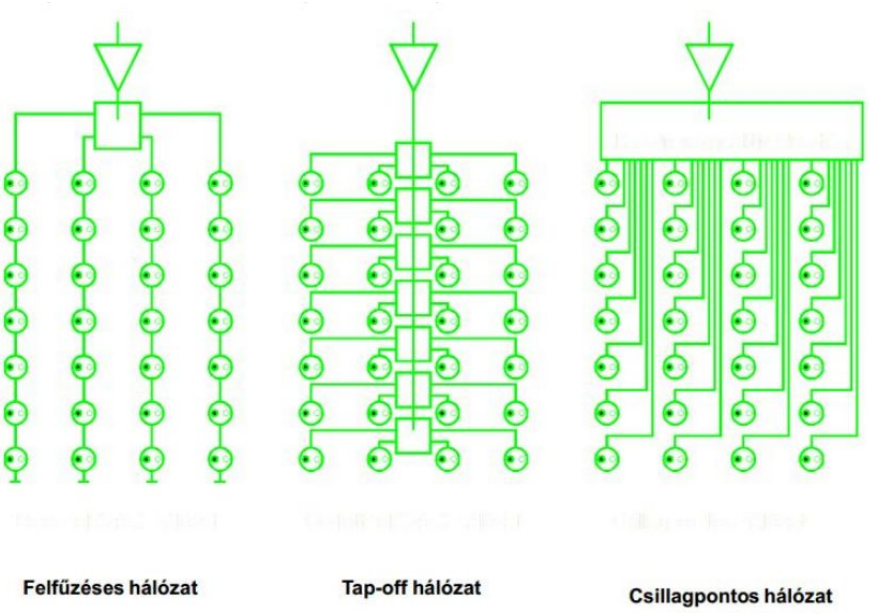


TODO: kell még valami?

10. CaTV, private (academic and university) networks

CaTV

- **Cable television (CATV)** is a system of delivering television programming to consumers via radio frequency signals transmitted through coaxial cables, or in more recent systems, light pulses through fiber-optic cables.
- This contrasts with broadcast television (also known as terrestrial television), in which the television signal is transmitted over the air by radio waves and received by a television antenna attached to the television; or satellite television, in which the television signal is transmitted by a communications satellite orbiting the Earth and received by a satellite dish on the roof.
- FM radio programming, high-speed Internet, telephone services, and similar non-television services may also be provided through these cables.
- **Topologies:** string (can't turn off service for single user), tap-off, star (more cabling)



- **Main characteristics of CATV systems**
  - Traditional AM VSB TV sets
  - Set top boxes for receiving DVB[4] programs (including demodulator, MPEG decoder and some sort of descramblers)
  - Internal frequency plan with 8 MHz raster (free assignment of programs to 8 MHz channels)
  - Low split system: from 5 MHz up to 55 (50, 68) MHz for the uplink path from 70 (87) MHz up to 630 MHz for the analogue downlink path and 630 - 862 MHz for digital downling path
  - 8 TV and 8 radio channel is one 8 MHz channel (in the digital channels)
  - The nominal impedance at all connection points of CATV system is 75 ohms

Private networks

- **Why?**
  - **Closed user group, special purpose network**
    - Railway, transport, pipeline, fleet
    - Water management, energy systems, emergency services, police networks
    - Company-wide networks (MOL, OTP)
    - Global company networks (Coca-Cola)

[4] Digital Video Broadcasting

    - **Common features:**
        - Internal numbering schemes, addressing system
        - Strictly regulated gateway function for interconnection to other (public) networks
        - The transmission part of networks might be leased line or own connection (radio)
        - The multiplexing, switching, management, authentication processes are private functions
        - Task oriented service quality parameters (reliability, usability, error rate, response time, redundancy, backup time etc.)
        - Separated frequency management (“governmental” use)
- **Examples of private networks**
    - Hungarnet (research and academic community in Hungary)
        - Part of EU GÉANT project (Transmission and packet layer)
        - **Services:** HBONE (Backbone network of NIIF), ADSL, registration service, email, web hosting, web page, ftp etc.
        - Operated by NIIF (Nemzeti Információs Infrastruktúra Fejlesztési Program)
        - Cutting edge technologies: IPv6
        - 40 GB/s speed
        - Hybrid network structure
- **Network planning problems**
    - Existing or new building
    - Single site or separated sites
    - Integrated or dedicated networks
    - Selecting the transport technology
    - Design of network topology
    - Optimal placing and dimensioning of nodes
    - Enough space in the cable duct system for future expansion etc.

11. Main functions and characteristics of terminals interfaces, regulation of terminals

Main functions and characteristics of terminals interfaces

- **Terminals:** In the context of telecommunications, a terminal is a device which ends a telecommunications link and is the point a signal enters and/or leaves a network. Examples of equipment containing network terminations are telephones, fax machines, computer terminals and network devices, printers and workstations.
    - Terminals are part of the networks but individual elements
    - No terminals = No electronic communications
    - Terminals are commerced in normal shops and supermarkets and they are owned by users.
- **Main function**
    - **B** (battery supply)
    - **O** (overload protection)
    - **R** (ringing)
    - **S** (supervision, signalling)
    - **C** (coding)
    - **H** (hybrid)
    - **T** (testing)
- **Characteristics**
    - eg. Telephone
        - Basic technical functions and requirements
        - Handset requirements
        - Hand free terminal requirements
        - Keyboard requirements
        - Display requirements
        - Intelligence in the terminal
        - Special requirements of elderly or handicapped people
    - Interfaces
        - Speech circuit
        - Dialer circuit
        - Handset
        - Ringing circuit
        - Display

Regulation of terminals

- **Az elektronikus hírközlés szabályozásának korszakai**[5]
    - Természetes (állami) monopólium (hatósági ár, ellátási kötelezettség, végberendezések, egységes rendszer - kevés szabályozni való)
    - Posta, távközlés, műsorszórás, hatósági területek szétválasztása
    - Magánkézbe adás, koncessziós működés a kizárólagosság - ellátási kötelezettség megtartásával és fejlesztési kötelezettséggel
    - Korlátozott verseny, új piacra lépők segítése a “kimazsolázás” lehetőségével, jelentős piaci erővel rendelkezők kötelezettségeivel (RIO-RUO), eszköz piac liberalizálása (rengeteg szabályozni való)
    - Kiegyenlített piaci viszonyok által áthatott működés

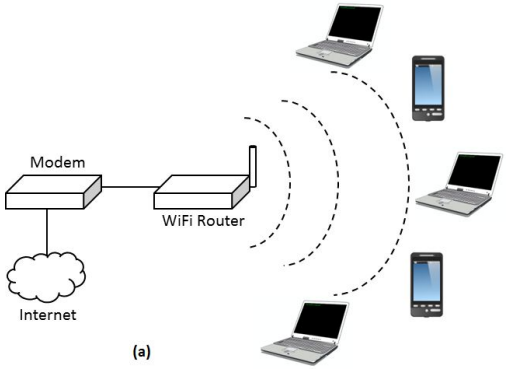
[5] *Sajnos ezt angolul nem tette be a diájába, online forrást angolul nem találtam hozzá.*

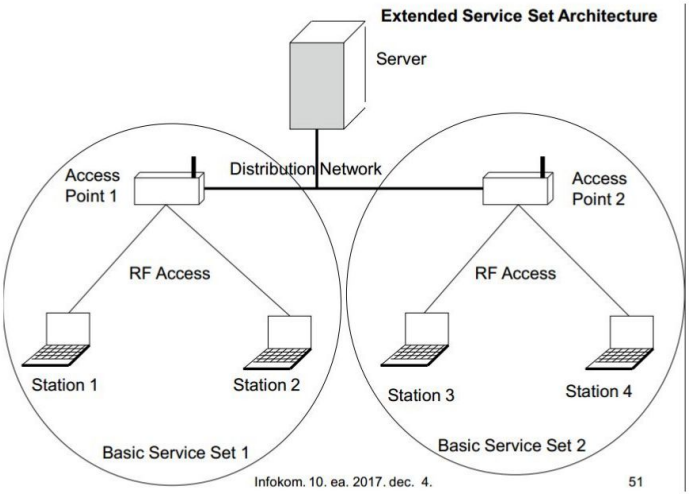
- **Competition instead of monopoly**
    - Monopolies are bad because the monopolists have no incentive to innovate or invest in R&D[6] of new technologies
    - Monopolies strangle budding companies and stop competition
    - Monopolies can control prices and quality

[6] Research and development

12. Wireless LAN principles, IEEE802.11 standard

- **Local Area Network (LAN):** A local area network (LAN) is a computer network that interconnects computers within a limited area.
- **Radio Local Area Network (RLAN, WLAN)**: using wireless communication to form a local area network (LAN)
    - In-door communication
    - Distance: 150 meters or less
- **Wireless Fidelity (WiFi):** Commercial name of RLAN operating fit to IEEE 802.11 in frequency band 2.4 GHz or in band 5.6 GHz or 60 GHz
- Wifi using fast changing FHSS to avoid interference and fading.
- **Components of a WiFi network:**
    - User stations (laptop PCs, phones etc.)
    - Access points
    - Backbone network (Distribution system)
    - The user statins competing for access over a shared medium is termed the Basic Service Set (BSS)
    - Two or more of these BSSs are interconnected by a DS network.
    - The complete set of BSSs and the interconnecting network are termed an extended service set (ESS)
    - A service set is the set of all the devices associated with a particular wifi network. The service set can be local, independent, extended or mesh.
    - Each service set has an associated identifier, the 32-byte Service Set Identifier (SSID), which identifies the particular network .The SSID is configured within the devices that are considered part of the network and it is transmitted in the packets. Receivers ignore wireless packets from networks with a different SSID.
    - https://www.youtube.com/watch?v=3lvlXXAdLR4





- **Media Access Control (MAC)** sublayer and the logical link control (LLC) sublayer together make up the **data link layer**.
    - MAC is mandatory for all stations
    - MAC is to assemble data into a **frame including local address and error detection field**
    - MAC checks the frame address perform error correction on the frame, disassemble the frame and passes it to the Logical Link Control
    - The LLC identifies higher layer programs to handle the data and provides an interface to these higher layer programs while perform flow and error control
- **Collision detection**

    - We can’t use the wired Ethernet’s CSMA/CD (Carrier Sensing Media Access and Collision Detection) operation, because the devices can’t communicate with each other.
    - **TODO: Leírni ez mi volt**
    - Collisions avoided rather than detected.
    - End device requests the WiFi Router to send a message containing a source address, destination address, duration of the transaction.
    - The transmission will only happen if the router sends a verification to the device.
    - WIFI controls all transmission, and avoids collisions.
- **Other devices using 2.4 Ghz**
    - microwave ovens, ISM band devices, security cameras, ZigBee devices, Bluetooth devices, video senders, cordless phones, baby monitors, amateur radio (yes interference could happen) etc.

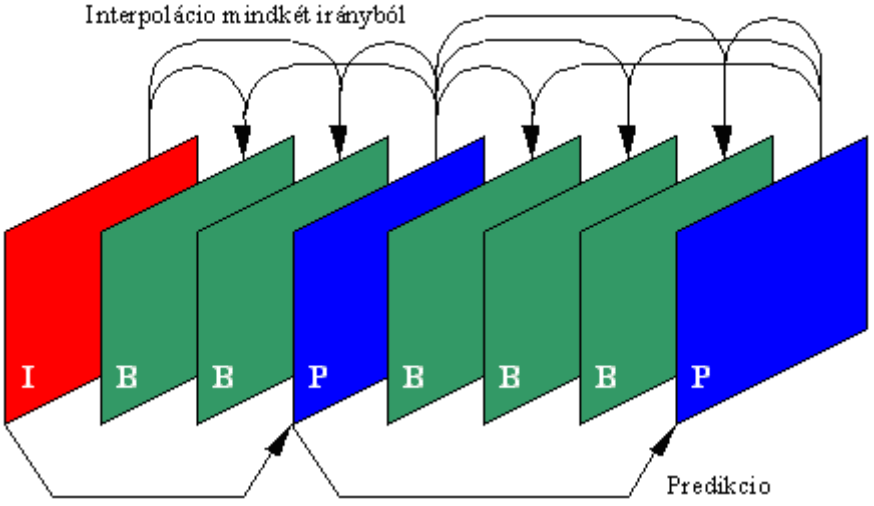
13. IPTV, MPEG, TS (Transport Stream), multimedia program distribution

IPTV

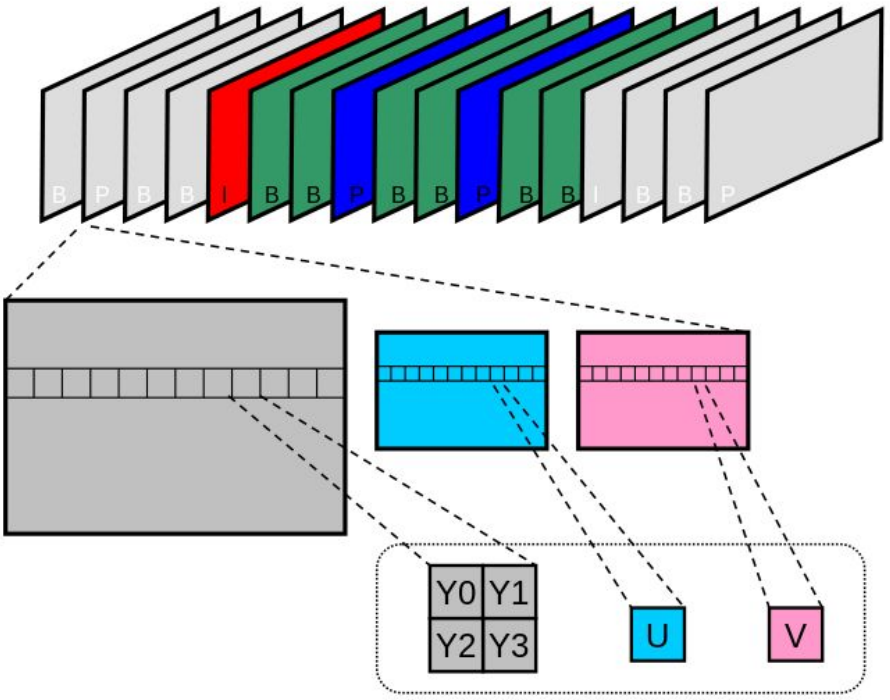
- **Internet Protocol Television (IPTV)** is the delivery of television content over Internet Protocol (IP) networks.
- This is in contrast to delivery through traditional terrestrial, satellite, and cable television formats. Unlike downloaded media, IPTV offers the ability to stream the source media continuously.
- As a result, a client media player can begin playing the content (such as a TV channel) almost immediately. This is known as **streaming media.**
- IPTV is also used for media delivery around corporate and private networks.

MPEG

- Moving Picture Experts Group
- MPEG-2 is a standard for "the generic coding of moving pictures and associated audio information".
- MPEG-2 is widely used as the format of digital television signals that are broadcast by terrestrial (over-the-air), cable, and direct broadcast satellite TV systems.
- **Principles:**
    - **Intra-coding** relies on two characteristics of typical images:
        - Not all spatial frequencies are simultaneously present
        - The higher is the spatial frequency the lower the amplitude is likely to be.
        - Requires analysis of the spatial frequencies.
        - Divide the picture into **tiles**[7], and if neighboring colors are similar enough we take the average color and compress the image.
    - **Inter-coding** relies on finding similarities between successive pictures.
        - The next picture can be created by sending only the picture differences.
        - We can check even further images and scan the differences.
        - The shifting process is controlled by a pair of horizontal and vertical displacement values (collectively known as the motion vector) that is transmitted to the decoder.
        - The motion vector transmission requires less data than sending the picture-difference data.
- **Structure:**
    - Hierarchy: Sequence, Group of Pictures, Picture, Slice, Macroblock, Block

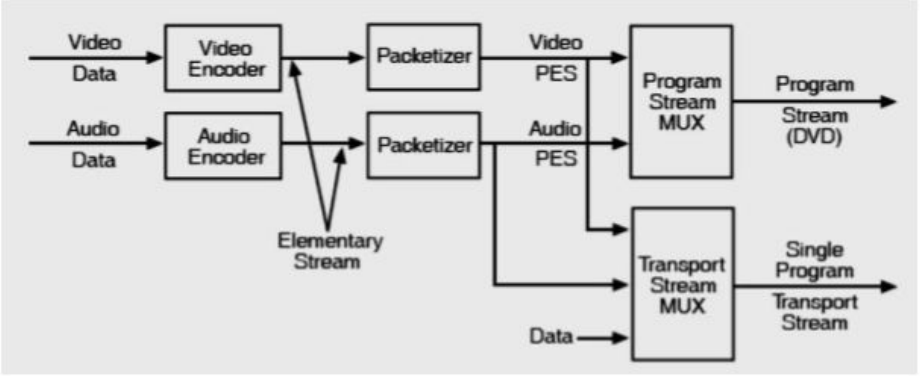


[7] Ezt a szót akarja hallani.



TS (Transport Stream)

- **MPEG streams**:
  - **Elementary stream** is an endless near real-time signal.
  - **Program streams** have variable-length packets with headers.
  - **Transport stream**: PES packets are subdivided into short fixed-size packets and multiple programs can be carried in the same stream.



Multimedia program distribution

3 kind of basic transport networks

- Traditional broadcasting network (analogue or digital)
- Dedicated data network for multimedia transport (IPTV, t-home)
- Multimedia content on general networks like
  - Internet based multimedia
  - Multimedia over GPRS/UMTS

14. VoIP, SIP, ADSL

VoIP

- **Voice over Internet Protocol (VoIP):** Voice over Internet Protocol (also voice over IP, VoIP or IP telephony) is a methodology and group of technologies for the delivery of voice communications and multimedia sessions over Internet Protocol (IP) networks, such as the Internet.
  Az internet protokoll feletti hangátvitel – elterjedt nevén VoIP, Voice over IP vagy IP-telefónia – a távközlés egy olyan formája, ahol a beszélgetés nem a hagyományos telefonhálózaton, hanem az interneten vagy más, szintén IP-alapú adathálózaton folyik. Ez tehát azt is jelenti, hogy privát VoIP kiépítése minden további nélkül lehetséges egy helyi hálózaton.
    - Phone service over the Internet
    - If you have a reasonable quality Internet connection you can get phone service delivered through your Internet connection instead of from your local phone company.
    - Not Skype (!)
- **Versions:**
    - **Cordless Hard Phones**
    - **Dial Up Hard Phones**: A dialup hard phone is a hard phone with a built-in modem instead of Ethernet port
    - **WLAN or WiFi phones**: hard phone with built-in WiFi transceiver unit instead of an Ethernet port to connect to a WiFi base station and from there to remote VoIP server
    - **Hard Phones (voice and video)**
    - **Soft Phones (voice only)**
    - **Soft Phones (voice and video)**
- **VoIP codecs** are used to convert an analog voice signal to digitally encoded version. Codecs vary in sound quality, required bandwidth and computational requirements. Each service /program /phone etc. typically supports several different codecs, and when talking to each other, negotiate which codec they will use.

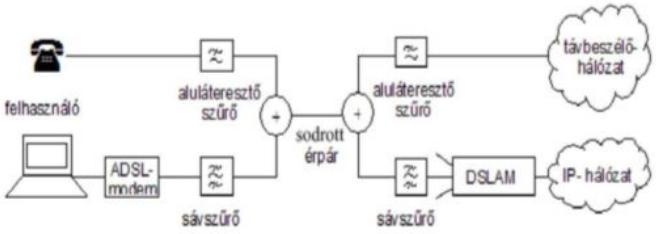
SIP

- **Session Initiation Protocol (SIP**) is an application-layer control protocol that can **establish, modify, and terminate multimedia sessions (conferences)** such as Internet telephony calls. SIP can also **invite participants** to already existing sessions, such as multicast conferences. Media can be added to (and removed from) an existing session. SIP transparently supports name mapping and redirection services, which supports personal mobility (users can maintain a single externally visible identifier regardless of their network location).
    - **Creation and management of session**, where a session is considered an exchange of data between association of participants.
    - **User may:**
        - **move** between endpoints
        - addressable by **multiple names**
        - **communicate in several different media** - sometimes simultaneously.
- SIP supports **five facets of establishing and terminating multimedia communications**:
    - **User location**: determination of the end system to be used for communications:
    - **User availability**: determination of the willingness of the called party to engage in communications
    - **User capabilities**: determination of the media and parameters to be used
    - **Session setup**: “ringing”, establishment of session parameters at both called and calling party

- **Session management**: including transfer and termination of sessions modifying session parameters, and invoking services

ADSL

- **Asymmetric Digital Subscriber Line (ADSL) principles**
  - A modem technology
  - Convert existing twisted-pair telephone lines into access for multimedia and high speed data communication
  - Can transmit to 30 Mb/s downstream (VDSL 100 Mb/s)
  - Transform the existing PSTN[8] network to a powerful system capable of bringing multimedia, full motion video to the subscriber's home
- **Technology of ADSL**
  - No ultimate technology!
  - Frequency division multiplexing, time division multiplexing, modulation, error control, flow control, scrambling, adaptation, handshaking, etc.
  - More room for further development



- **Very-High-Bit-Rate Digital Subscriber Line (VDSL)** is a digital subscriber line (DSL) technology providing data transmission faster than ADSL over a single flat untwisted or twisted pair of copper wires, and on coaxial cable.
  - Frequency band from 25 kHz - 12 MHz
  - Capable of supporting applications over a single connection (high-definition television, telephone services, internet access)
  - VDSL is deployed over existing wiring used for analog telephone service, and lower-speed DSL connections

[8] Public Switched Telephone Network (https://en.wikipedia.org/wiki/Public_switched_telephone_network)