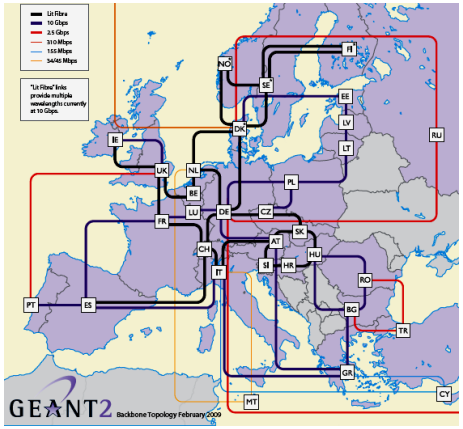
Infokommunikációs rendszerek

8. előadás

Private networks -- Magánhálózatok

Services -- Szolgáltatások

Takács György



Private networks

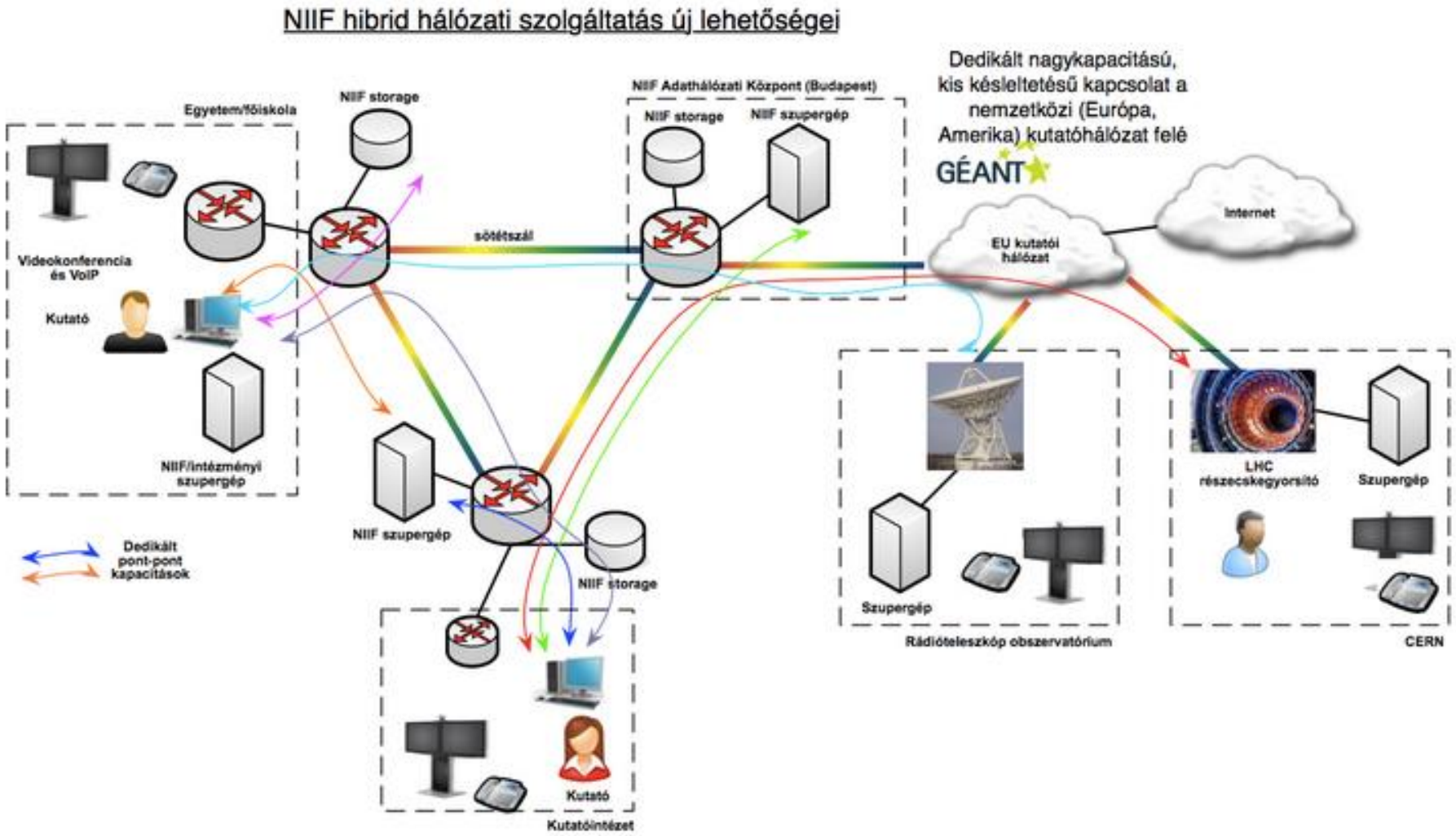
- Closed User Group, Special Purpose network
- Railway, transport, pipeline, fleet
- Water management
- Energy systems
- Emergency services
- Police networks
- Military networks
- Government networks
- Company-wide networks (MOL, OTP)
- Global Company Networks (Coca Cola)
- Seat Reservation Networks (SITA)
- Insurrance companies, Retail Chains (e.g. TESCO)….

Common features of private networks

- 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 …)
- Separated frequency management („governmental” use)

Eexamples of private networks

- Hungarnet -- for research and academic community in Hungary
- Pázmány CU is one of the members
- Governmental support (?)
- Part of EU GEANT project
- The transmission part is set of leased dark fibre connections
- The switching and operation function in the hand of HUNGARNET



Hibrid hálózat

NIIF hibrid hálózati szolgáltatás új lehetőségei

HBONE is the backbone (computer) network of NIIF or Hungarian Academic Community. HBONE delivers services to Hungarian universities and colleges, primary and secondary schools, research and development institutions, libraries, public collections and also to several other non-profit public institutions. HBONE is a separate (telecommunication) network with a closed user-base. HBONE consists of the versatile core, and also the regional center (PoP) routers connected to core routers (directly or indirectly). In the PoPs NIIF operates versatile and robust communication equipments (DWDM, router, switch), servers and other devices required to serve other NIIF services in a climatised and UPS protected environment.

Connections

Professional partners of the Institute.

Desktop conferencing

With the development of collaboration technologies and the increasing performance of handheld devices, it became clear that...

Server Hosting

For those NIIF member institutions who provide data service for their customers, but do not have the necessary bandwidth or...

Streaming

Our institute has the capabilities to offer live video broadcasting of events via the internet. The main profile of the service...

Web Hosting

Web sites of member institutions of NIIF Institute can be hosted on our highly available, distributed, scalable and secure web...

Accomplished projects

The National Information Infrastructure Development (NIIF) Institute coordinates or participates in various national and...

Cloud

In IT, just like in the meteorology, we cannot talk about the one and only meaning of cloud. In general we could say that...

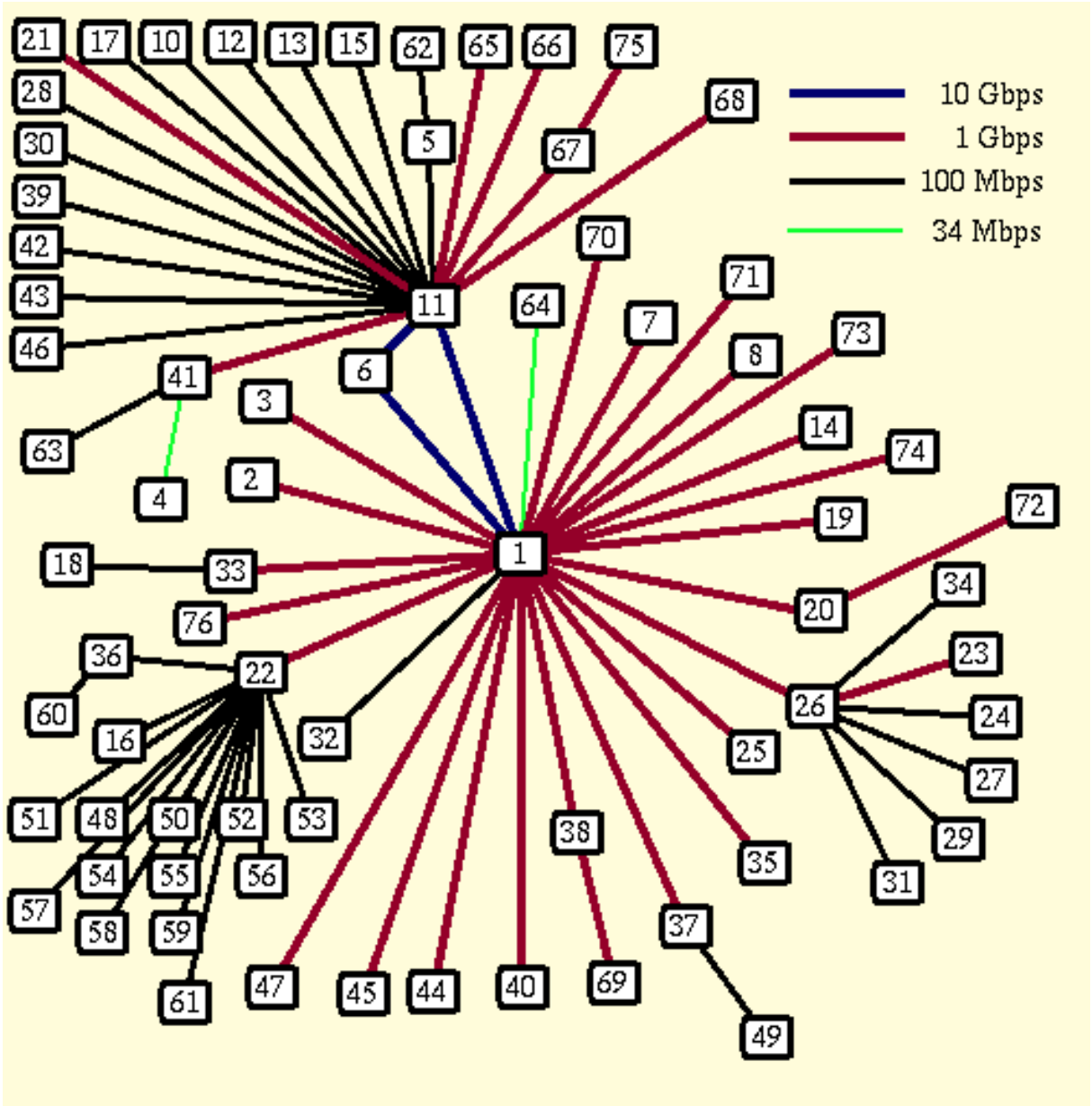
Domain registration

We can register .hu and .eu tld. You can choose other service provider if you need other tld.

EduID

Hungarian Research and Educational Federation (HREF) is a SAML2-based Identity Federation of Hungarian higher education and...


HBONE DF backbone
2018
Sajóivánka
Ózd
Kisvárda
Sárospatak
Salgótarján
Miskolc
Nagybátony
Tiszalök
Piszkéstető
Nyíregyháza
Mosonmagyaróvár
Sajószöged
Esztergom
Vác
Gyöngyös
Eger
Sopron
Győr
Dorog
Lőrinci
Detk
Tatabánya
Zugló
Gödöllő
Debrecen
Piliscsaba
Pannonhalma
Jászberény
Oroszlány
VH
Pápa
Szombathely
Martonvásár
Albertirsa
Karcag
Ajka
Litér
Veszprém
Székesfehérvár
Dunaújváros
Szolnok
Mezőtúr
Kecskemét
Zalaegerszeg
Szabadszállás
Szarvas
Békéscsaba
Keszthely
Paks
Gyula
Hódmezővásárhely
Nagykanizsa
Kalocsa
Toponár
Szekszárd
Kiskunhalas
Sándorfalva
Kaposvár
ELI-ALPS
Bonyhád
Baja
Szeged
Pécs
Szabadka
KIFÜ
HBONE+ PoPs
terminal multiplexer
ROADM
ILA
HEC DF
other DF
managed lambda
34/50/100/200 Mbps

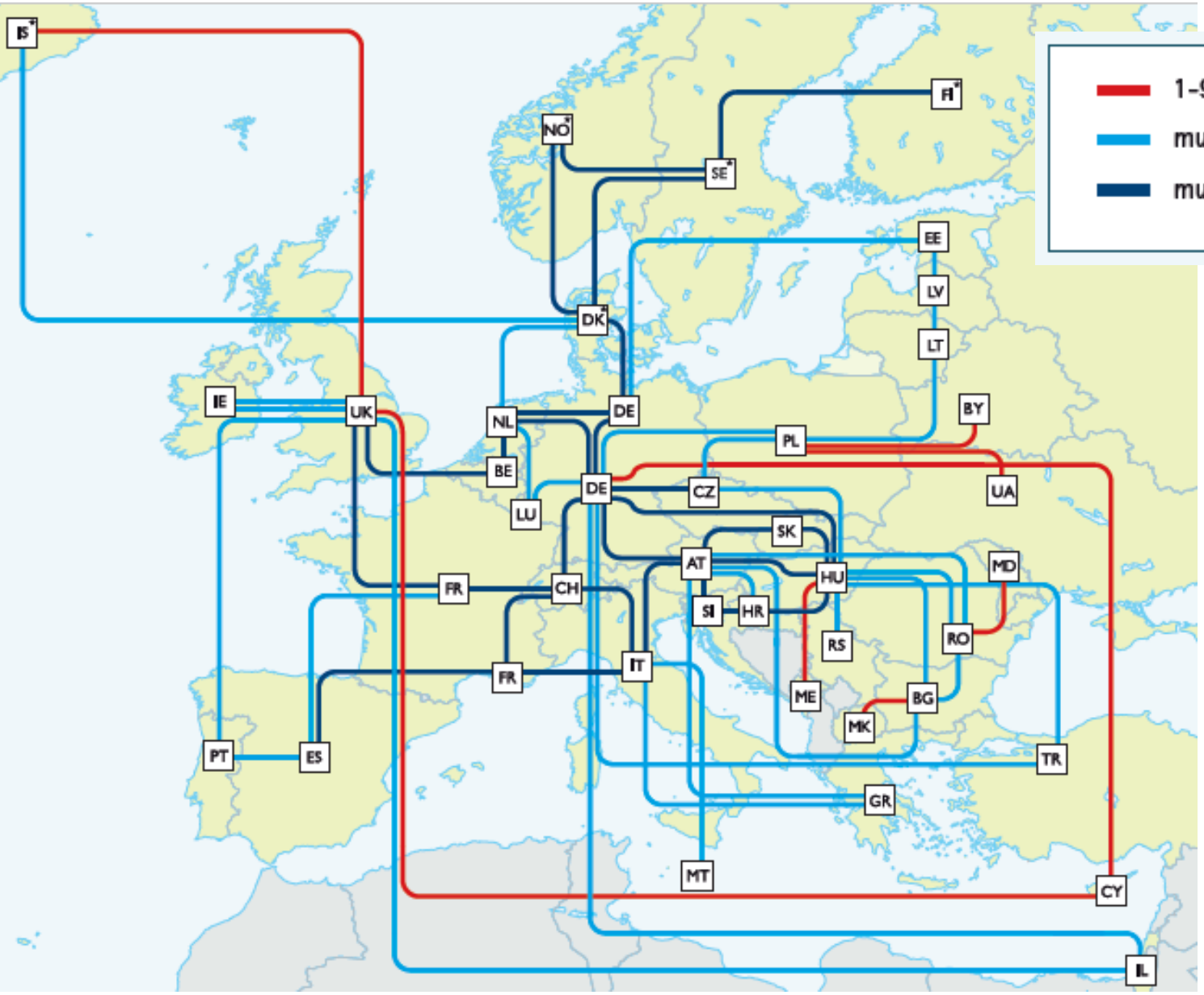


Fővárosi nagysebességű kapcsolatok

1. NIIF központ, Victor Hugo u., XIII

38. Pázmány P. Katolikus Egyetem Jog- és Államtudományi Kar, Szentkirályi u. 28.

69. Pázmány P. Katolikus Egyetem ITK, Práter u.



GÉANT's pan-European research and education network interconnects Europe's National Research and Education Networks (NRENs). Together we connect over 50 million users at 10,000 institutions across Europe.

http://www.geant.org

Connectivity & network management

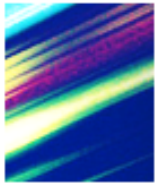
Connectivity services support the NRENs in delivering world-class network facilities to the research and education community.

Trust, identity & security

Securing access to services and providing federated identity systems to enable efficient collaboration.

Cloud services

From large scale computing facilities to personalised storage, the cloud offers research and education immense opportunities.



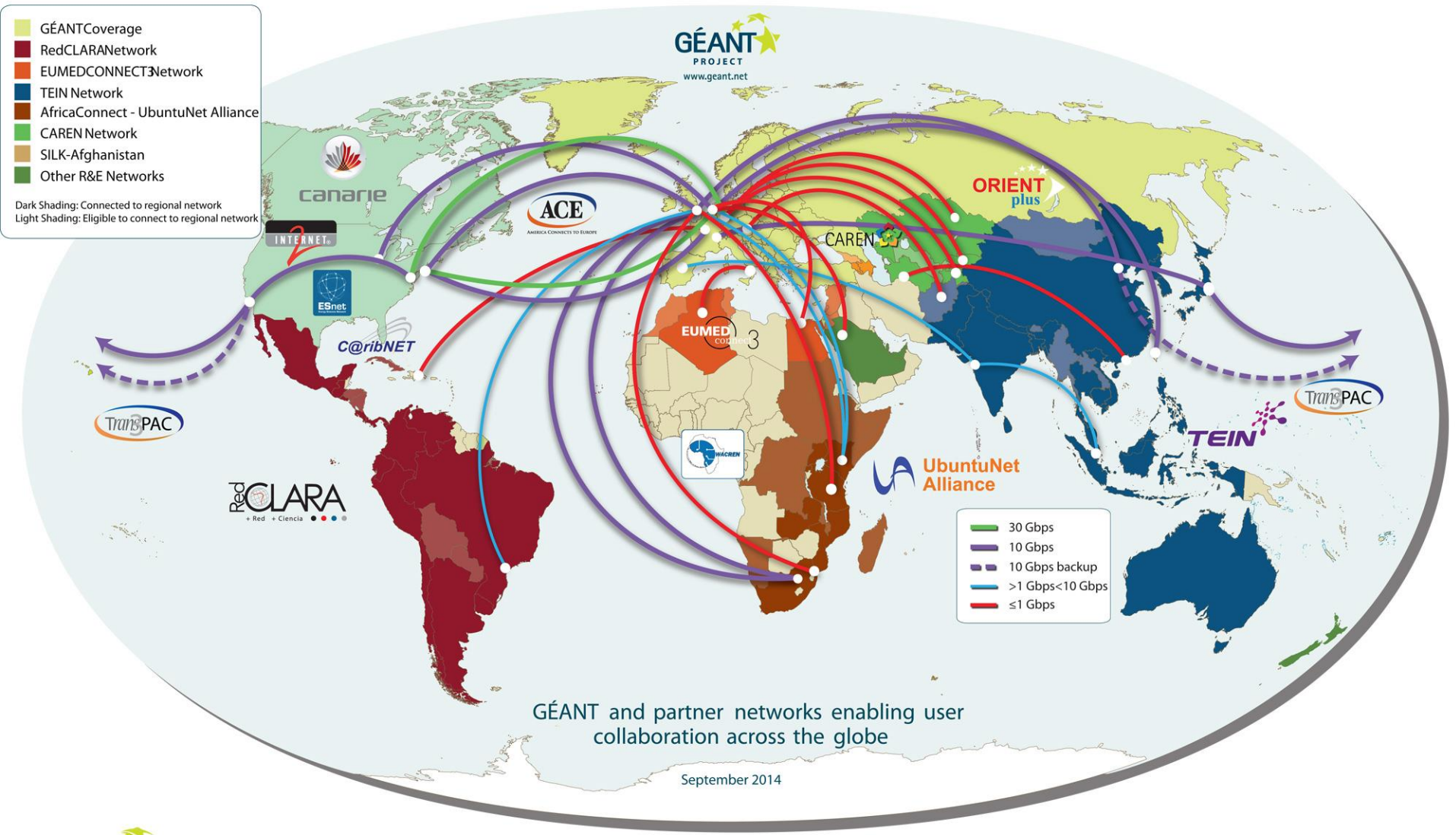
Real-time communications

Enabling communication and collaboration across the community.

Professional services

With more than 40 partners across Europe and a € multi-million budget, GÉANT has met the challenge of complex international project management.

At the Heart of Global Research and Education Networking



GÉANT and partner networks enabling user collaboration across the globe

September 2014

GÉANT PROJECT
www.geant.net

connect • communicate • collaborate

GÉANT is co-funded by the European Union within its 7th R&D Framework Programme.

Co-funded by the European Union

The GÉANT network technology

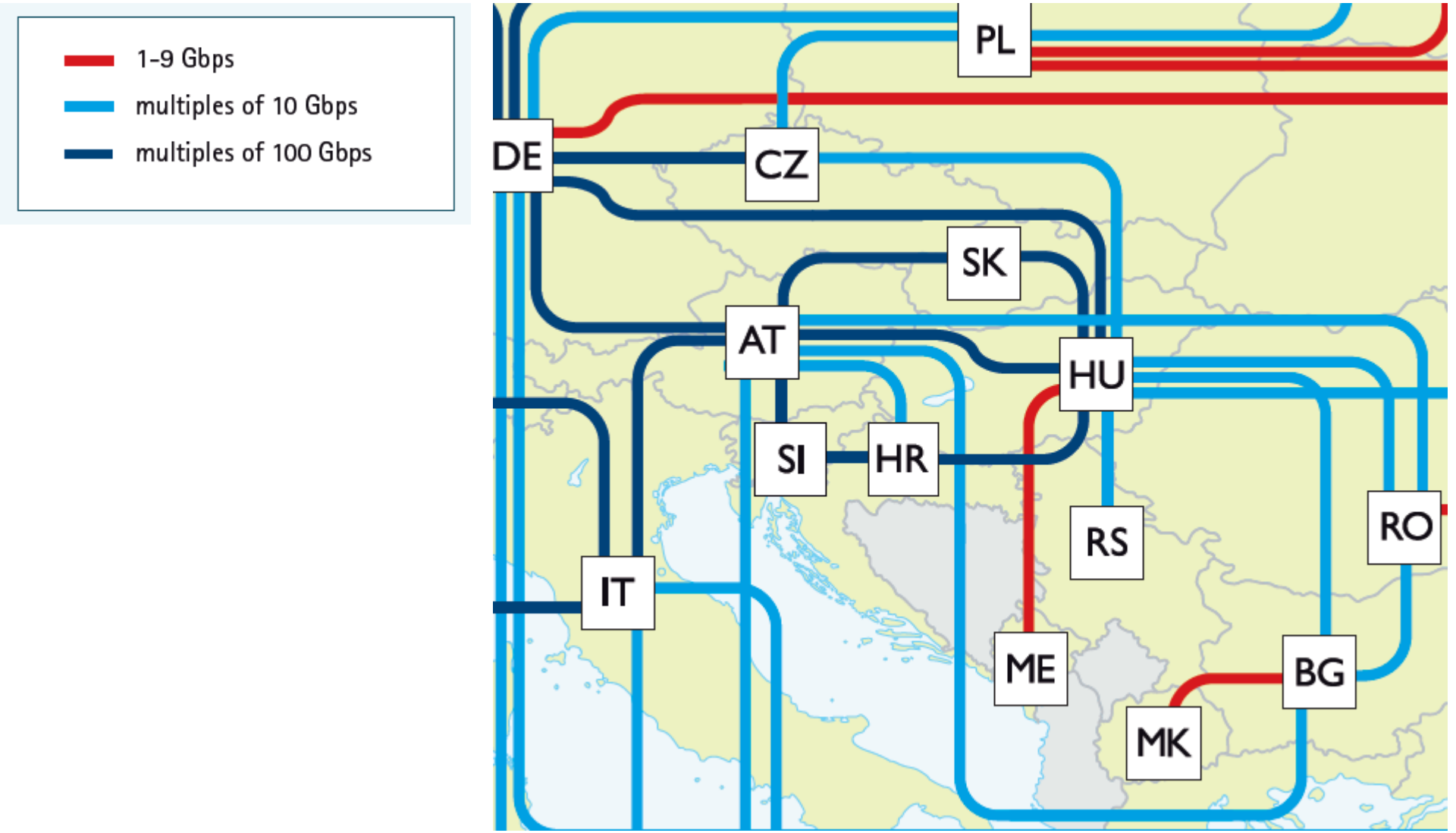
As one of the largest and most complex research and education networks in the world, the GÉANT network needs to support a diverse range of users and services from standard IP transit services to ultra-high capacity data centre interconnects. GÉANT has built a dual layer network able to integrate these service demands across a single core structure. The two layers are: transmission and packet.

Transmission layer

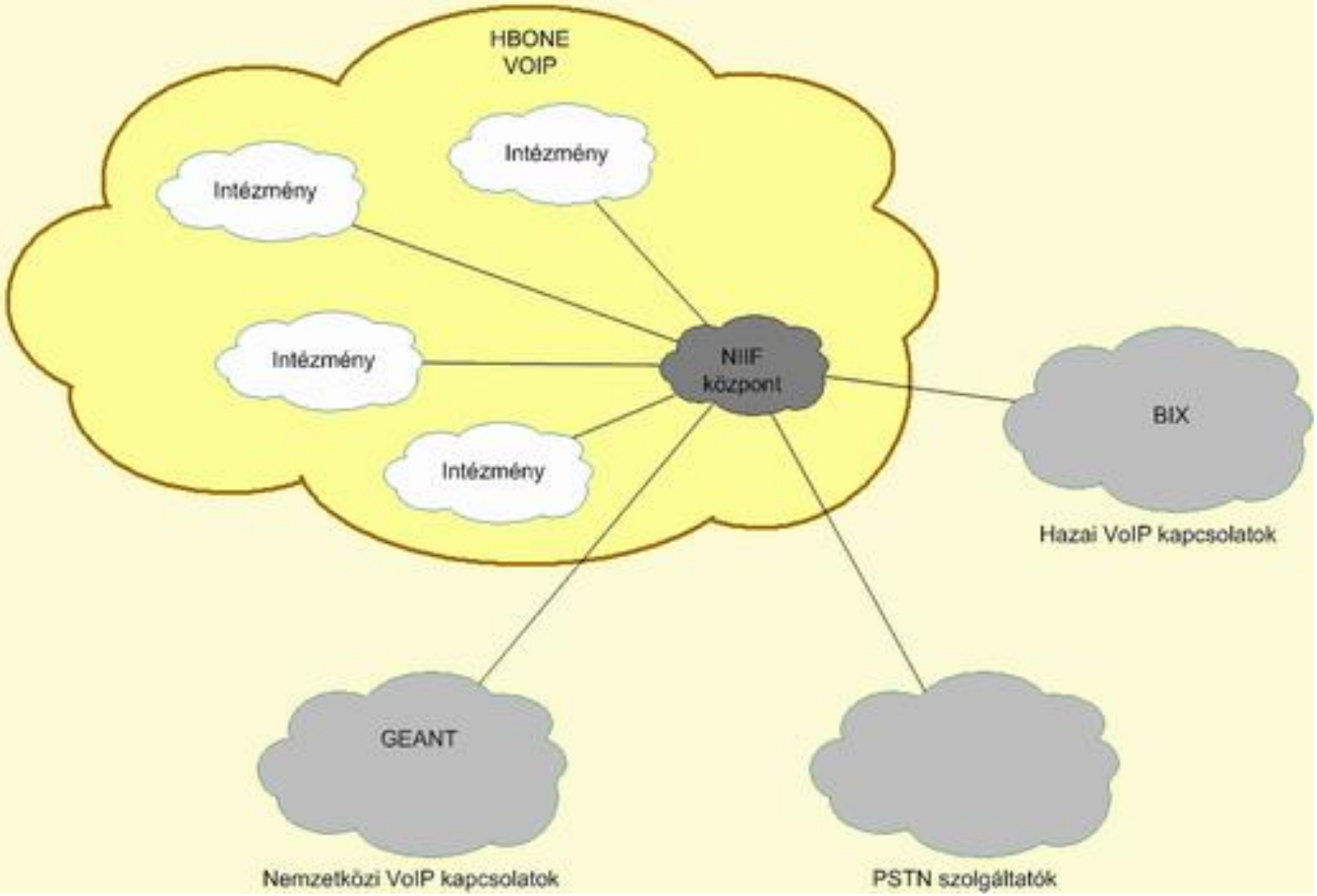
This is built on the dark fibre core of the network, either on GÉANT points of presence (PoPs) or on leased wavelengths from commercial providers or national research and education networking (NREN) organisations. GÉANT uses industry-leading Infinera DTN-X equipment to light this fibre, a cutting-edge optical transmission equipment that integrates hundreds of optical components on a single chip to deliver 500G super-channels. GÉANT employs Infinera DTN-X boxes and optical amplifiers to drive the fibre backbone. The DTN-X also includes an integrated OTN switching layer with a GMPLS control plane which allows rapid provision of bandwidth and fast capacity restoration in the case of fibre cuts. The Infinera equipment is used to deliver GÉANT Lambda services and IP trunks between the GÉANT routers.

Packet layer

The packet layer is a converged layer that supports both Layer2 and Layer3 services. This means that we offer both Ethernet connections (GÉANT Plus) and IP services on this layer. GÉANT implements the packet layer with Juniper MX equipment. MX is a carrier grade router which supports labels switching (MPLS), router virtualisation and more. The GÉANT Plus service is delivered using MPLS technology in the MXs. IP services include: GÉANT IP, Layer 3 VPN, GÉANT World Service, peering service.


1-9 Gbps
multiples of 10 Gbps
multiples of 100 Gbps
PL
DE
CZ
SK
AT
HU
SI
HR
RS
RO
IT
ME
BG
MK

NIIF VoIP hálózat



PPKE ITK INFOCOM SYSTEM

- The ICT is not the part of the building, but topic of the education program.
- We need a building, that capable to implement any kind of new technologies.

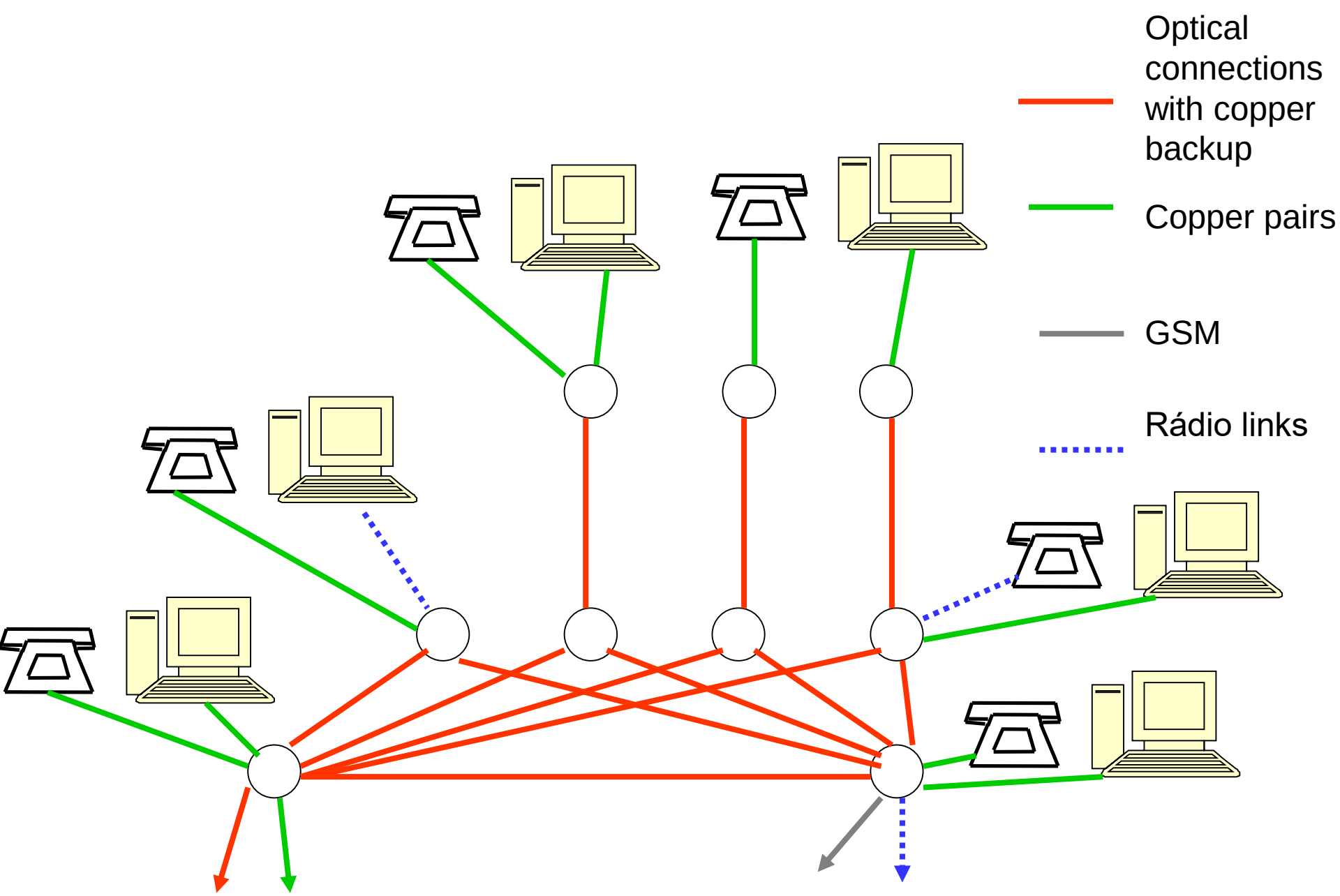
Nice configuration of light items in the corridor…..
New optical fibres can be implemented in the duct system without disturbing the outlook.

Planning principles

- 1000 computers and 100 telephone in the networks,
- Fast, error free and reliable operation,
- Ready system for any new technologies,
- Popular test bed for system suppliers,
- No disturbing in outlook!

Consequences

- Robust, multi-path external connections, meshed topology, load sharing operation
- Copper, optical, radio technologies in internal and external links
- Over dimensioned and accessible duct system


Optical connections with copper backup
Copper pairs
GSM
Rádio links

Basic issues in prvate network planning

- Existing or new building
- Single site or separated sites
- Integrated or dedicated networks
- Selecting of the transport technologies (optical, copper or radio)
- Design of the network topology (star, meshed……)
- Optimal placing and dimensioning of nodes
- Duct system planning

Existing or new building

- The lifetime of the building is minimum 100 years.
- The lifetime of a network technology is about 10 years.
- The capacity demand is permanently increasing.
- The physical place of the duct system is defined by the building construction.
- Critical places are: vertical ducts, backbone parts, distribution frames.
- Further critical issues: powering, climatic system capacities, uninterrupted powering

Multiple site networks

- Multi site systems need standardised interfaces (physical, protocol and signalling)
- Interconnection links are usually leased lines. Managed leased links and spare capacities can provide the required reliability. Spared links might be switched connections.
- Independent path or technology (radio or wired) can improve availability.

Integrated or dedicated networks

- The terminals might be computers, TV-sets, mobile phones radio sets or universal devices like the smartphones.
- Popular solution is a unified access like a structured network.
- The structured network has vertical and horisontal links. The interconnection points are in distribution frames.
- Radio based access fits well to the structured systems.

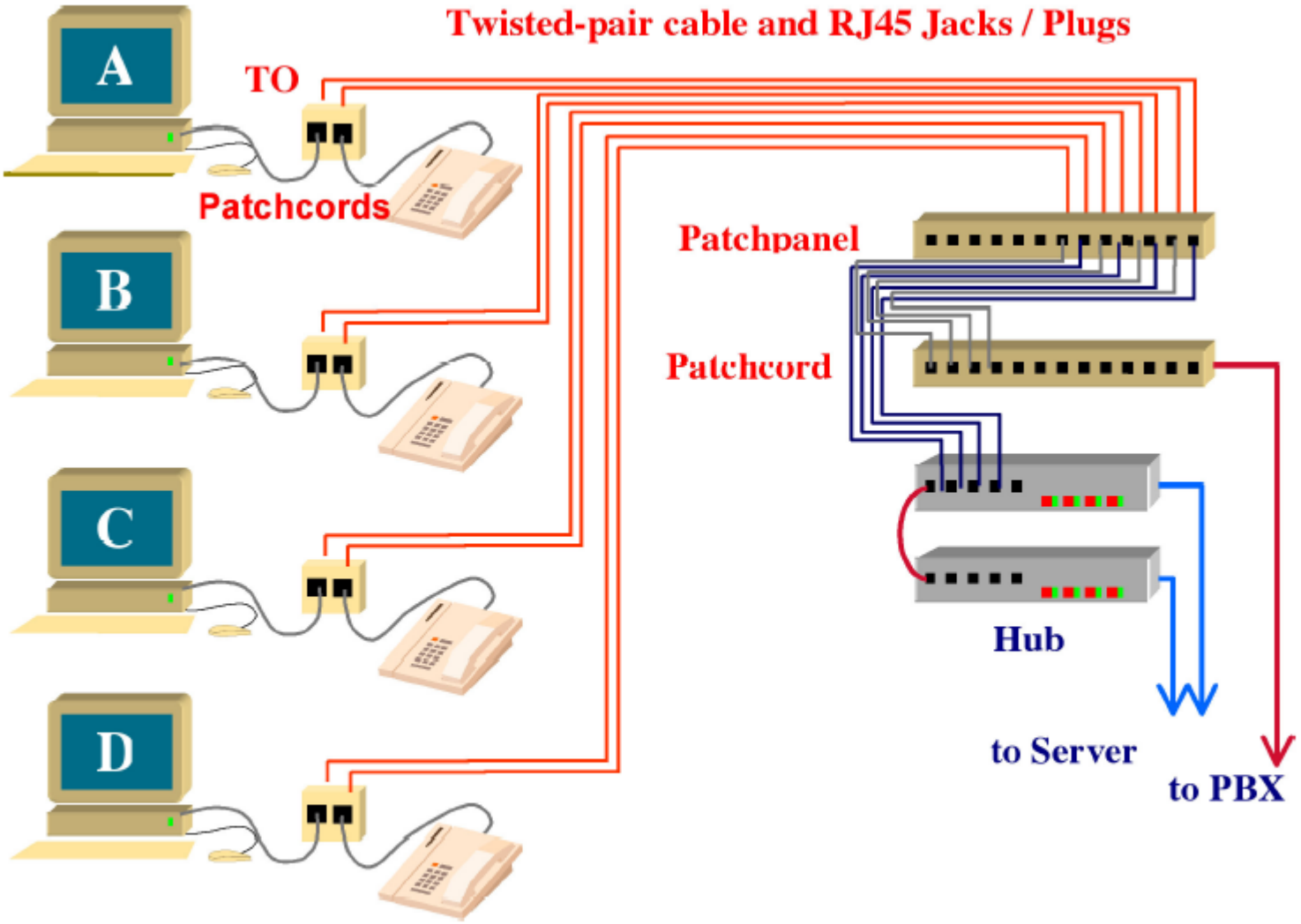
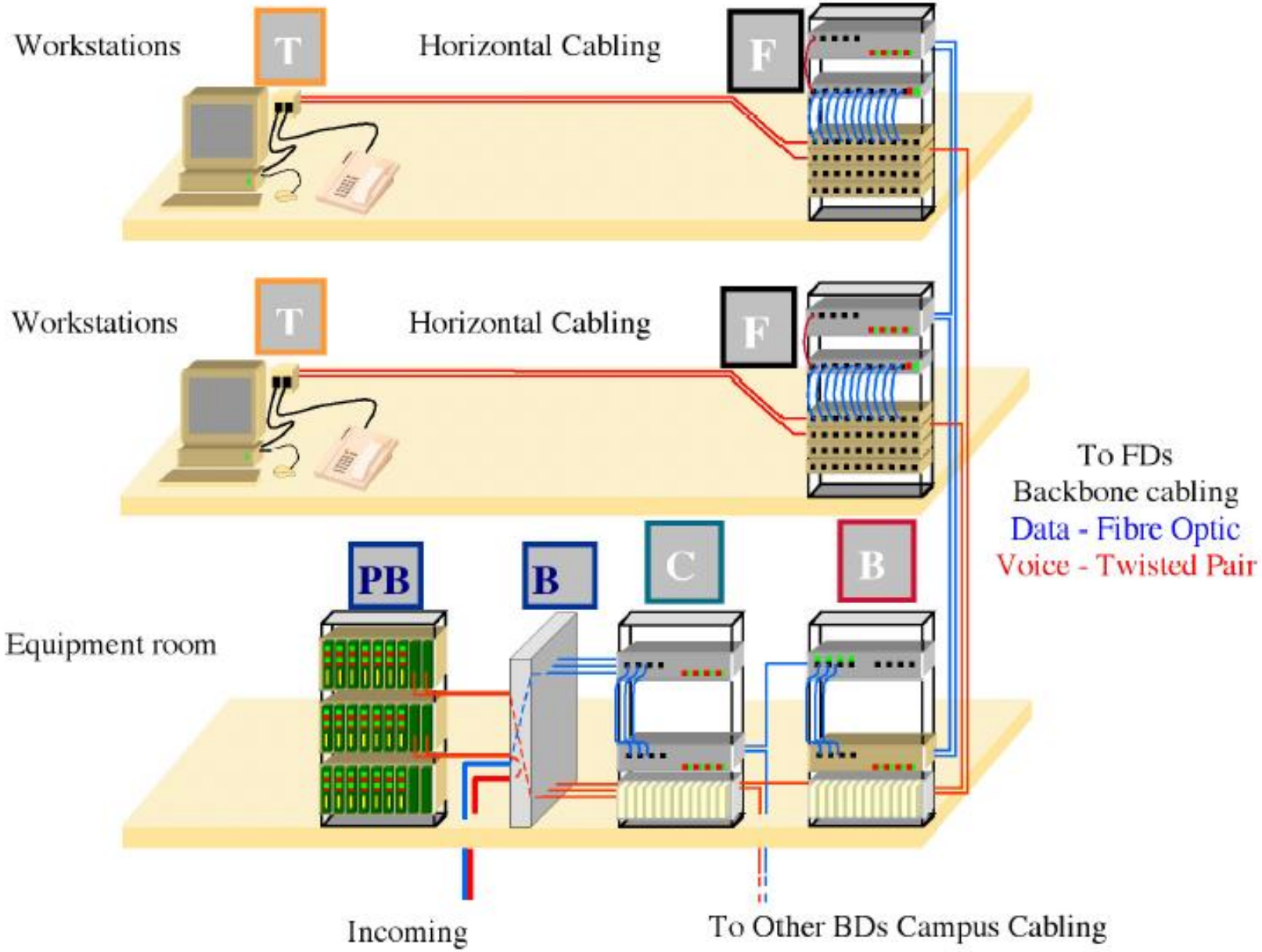


Figure 1
Elements of a Structured Cabling System


Workstations
T
Horizontal Cabling
F
Workstations
T
Horizontal Cabling
F
To FDs
Backbone cabling
Data - Fibre Optic
Voice - Twisted Pair
PB
B
C
B
Equipment room
Incoming
To Other BDs Campus Cabling

Technology selection

- In one optical fibre in one wavelength window can be transported 10 Gbit/s
- In a UTP cable up to 100m can be transported 10 Gbit/s
- A WIFI access point can transport 300Mbit/s using 802.11.n standards and 6 Gbit/s 802.11.ac in the 5GHz band
- Transport technology standards are in IEEE 802.3 series

Selection based on price figures

- 1 m UTP CAT6 takes about 0,5$, easy to install, one port takes about 5$
- 1 m optical cable takes about 1 $, installation require special tools and skills, one port takes about 200 $.
- UTP cables can be install easily in new ducts.
- Optical cables can be installed (e. g. by compressed air into existing holes, ducts)
- a 802.11.n WIFI access points takes about 40$
- The prices are decreasing!

Topology selection

- The basic form is the star topology in the horizontal part.
- The physical place of star nodes is price sensitive.
- The meshed horizontal is advised in the case of high reliability.
- The multiple connection to outside (public) networks can improve the availability.

Dimensioning of nodes

- A small (16-20 port switch) takes about 100$. – and this is equal to the price of 200m UTP cable!
- A new node in a room is economical in the case of 20 terminals, if the nearest existing node distance is more then 10 m.
- The usual port number of active devices are 5-8-16-20-40. Their price is decreasing.

Placing and dimensioning of ducts

- Careful laying and installation is required. The radius of turning is defined. The fixing of cables must be soft.
- The ducts of structured cables must be well separated from the powering cabling. Careful grounding is required for safety reasons and to reduce interferences.
- Spare capacity in the ducts must be minimum 50%!

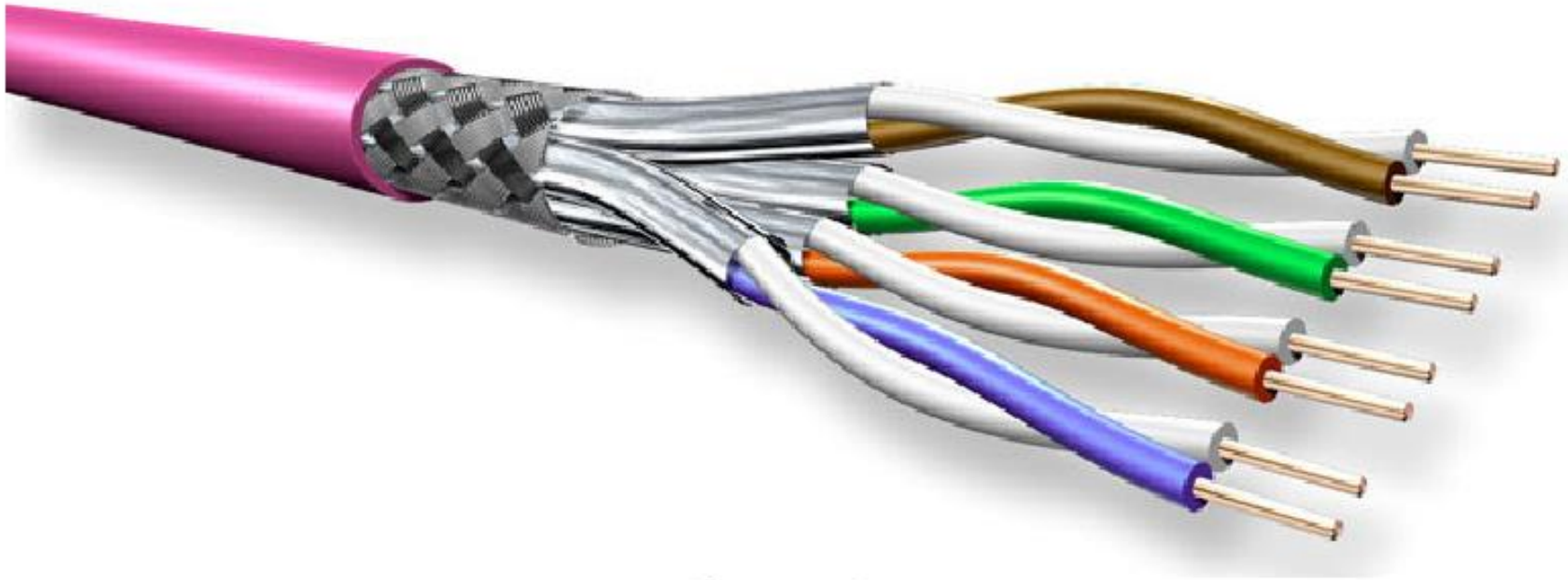


Figure 8
STP/ScTP – Shielded Twisted Pair

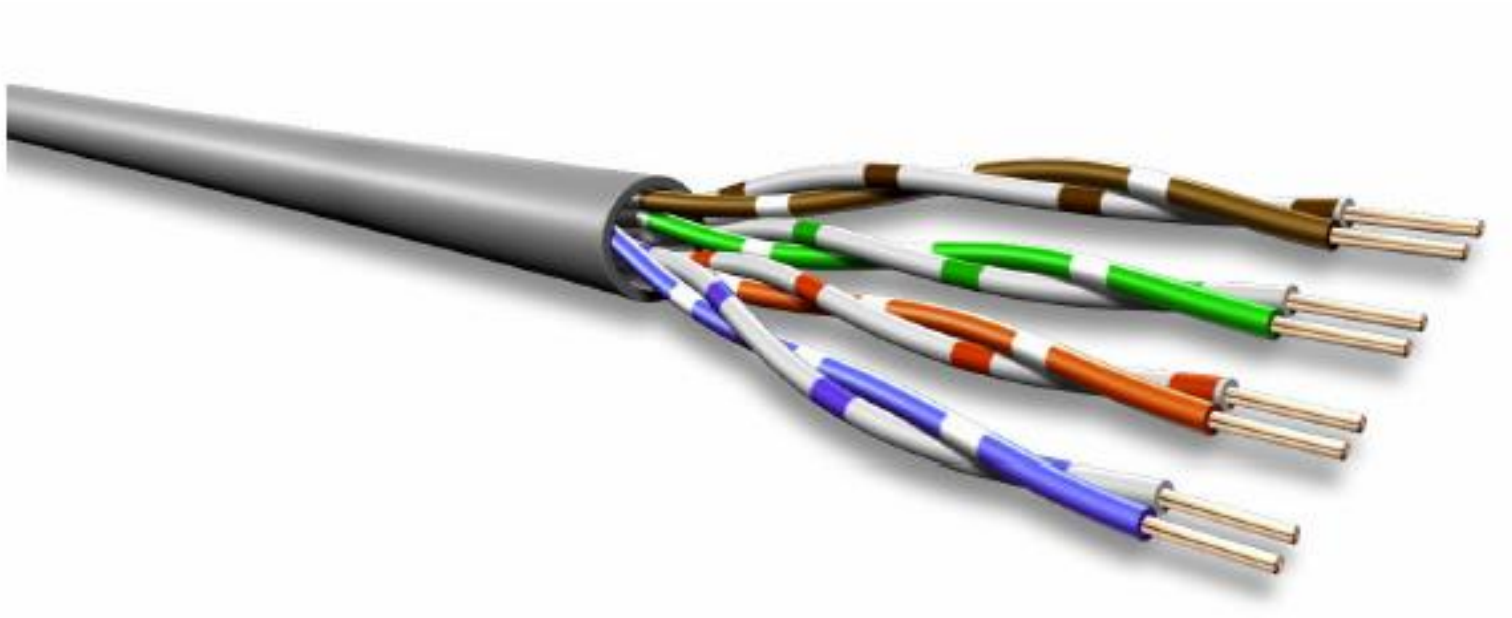
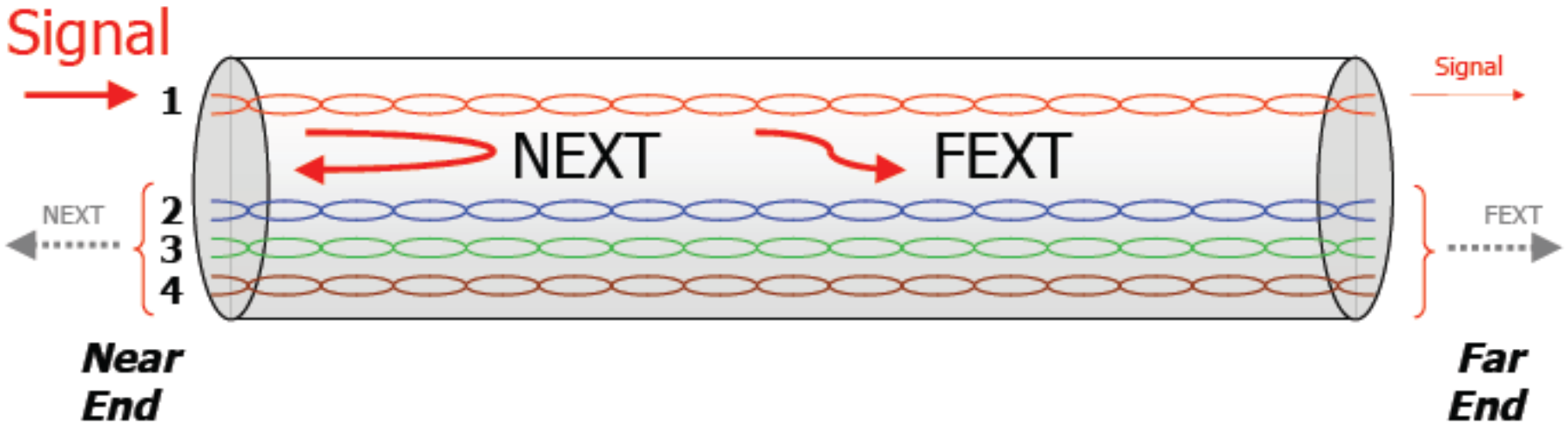


Figure 6
UTP – Unshielded Twisted Pair
(4 Pair Cable)

Impairments Inside The Cable



- Insertion Loss (IL) is the loss the signal experiences traveling down a pair in the cable
- Near End Cross Talk (NEXT) is what comes out on the near end of the other pairs, when you inject a signal on #1
- Far End Cross Talk (FEXT) is what comes out on the far end of the other pairs, when you inject a signal on #1

Impairments Outside The Cable

- Alien NEXT (ANEXT) is what comes out on the near end of the other pairs, when you inject a signal on a pair in the center cable
- Alien FEXT (AFEXT) is what comes out on the far end of the other lines, when you inject a signal on a pair in the center cable

CAT-6a

- To create a UTP channel capable of providing greater than 10 Gb/s of information BW, cable manufacturers did the following for CAT-6a:
  - Increased the twist
  - Varied the twist rates between the four pairs, so that coupling is controlled
  - Increased the diameter of the cable (0.31" vs. .22")
  - Installed a separator for controlling the pair positions within the cable
  - Specs up to 625 MHz for all impairments

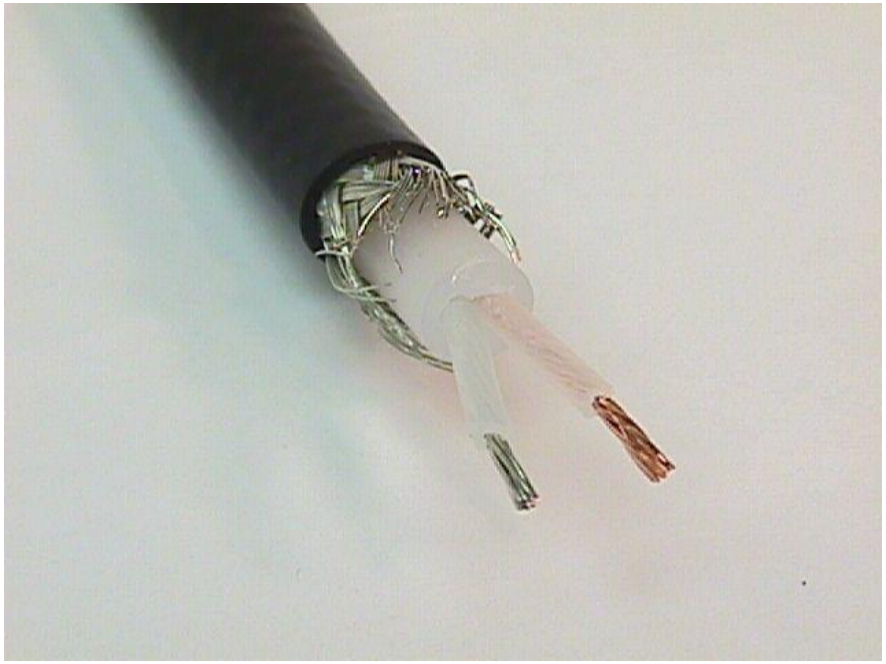
* Systimax Cable Cross-section

100 Gbit/s Ethernet

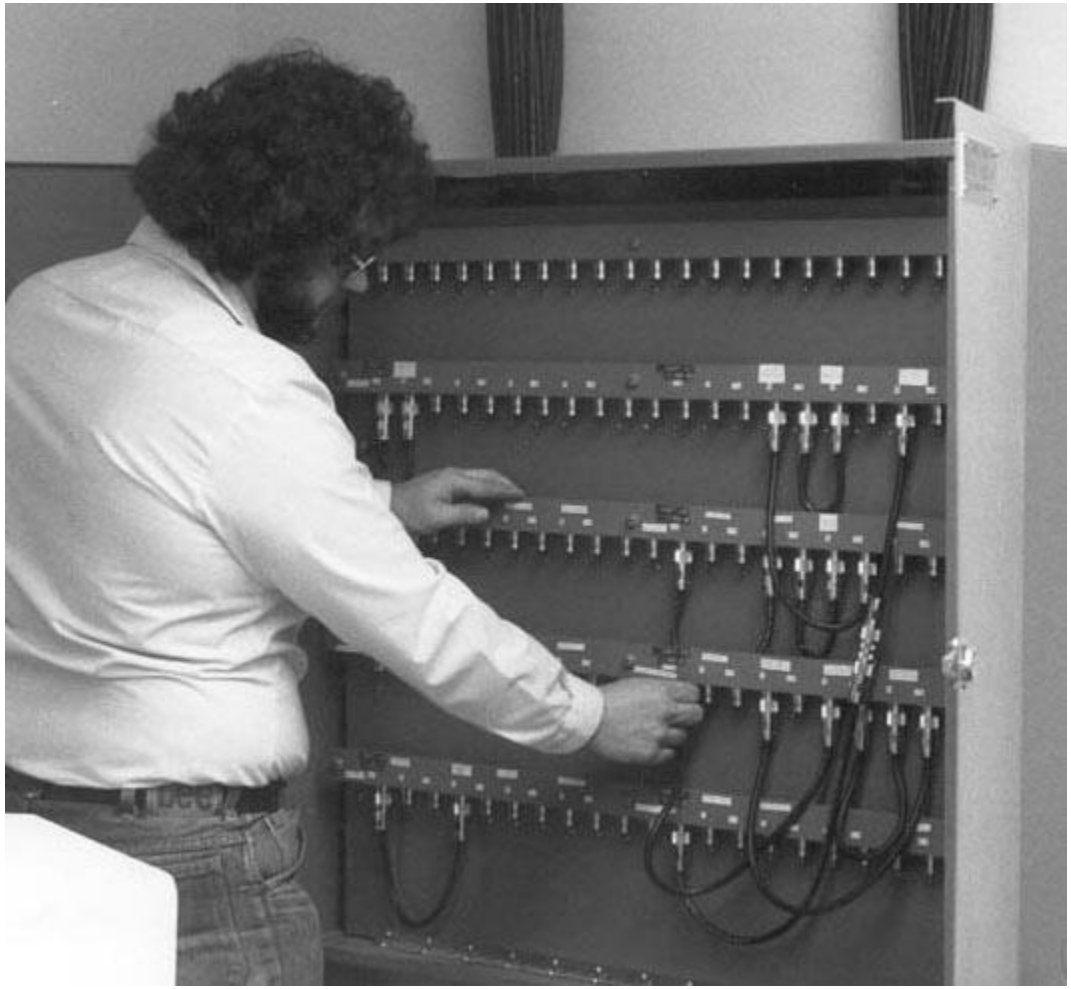
- 802.3ba is the designation given to the higher speed Ethernet task force which completed its work to modify the 802.3 standard to support speeds higher than 10 Gbit/s
- The speeds chosen by 802.3ba were 40 and 100 Gbit/s to support both end-point and link aggregation needs.
- The decision to include both speeds came from pressure to support the 40 Gbit/s rate for local server applications and the 100 Gbit/s rate for internet backbones.

Physical layer	40 Gigabit Ethernet	100 Gigabit Ethernet
Backplane	40GBASE-KR4	100GBASE-KP4
Improved Backplane		100GBASE-KR4
7 m over twinax copper cable	40GBASE-CR4	100GBASE-CR10
30 m over "Cat.8" twisted pair	40GBASE-T	
100 m over OM3 MMF	40GBASE-SR4	100GBASE-SR10
125 m over OM4 MMF[16]		
10 km over SMF	40GBASE-LR4	100GBASE-LR4
40 km over SMF		100GBASE-ER4
2 km over SMF, serial	40GBASE-FR	

Twinax cabeling



Twinax distribution frame



Services -- Szolgáltatások

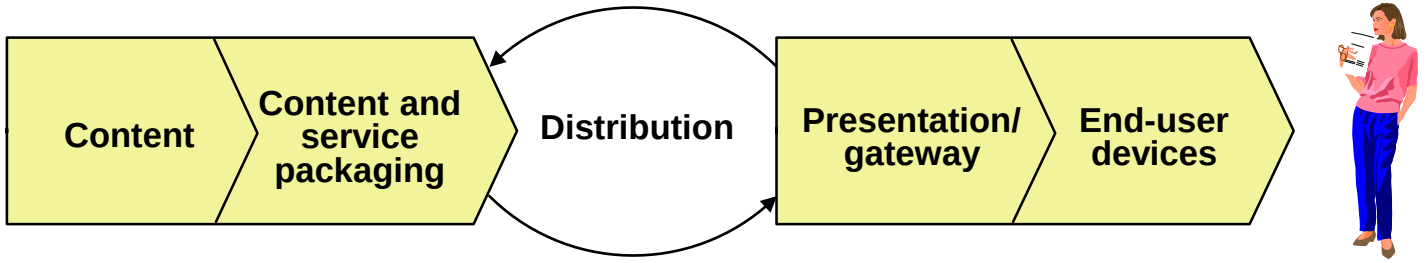
Alapigazságok az infokommunikációban

- Eddig hálózatokról tanultunk
- Csak szolgáltatást lehet eladni (hálózatot nem)!
- Hálózat nélkül nincs elektronikus kommunikációs szolgáltatás!
- A hálózatépítés és üzemeltetés minden költségét a fogyasztók fizetik meg a szolgáltatás árában!
- Nagyon sokat költünk – önként – elektronikus kommunikációs szolgáltatásokra (többet, mint élelmiszerre és italra)!
- A mérnök-informatikus olyan az elektronikus kommunikációs szolgáltatásokban, mint a nyomdász a könyvszakmában (nem ő írja a regényt, a verset, nem ő rajzolja a képeket…..). A mérnök-informatikus felel a hatékony, pontos, hiteles információ átvitelért, szolgáltatásért!

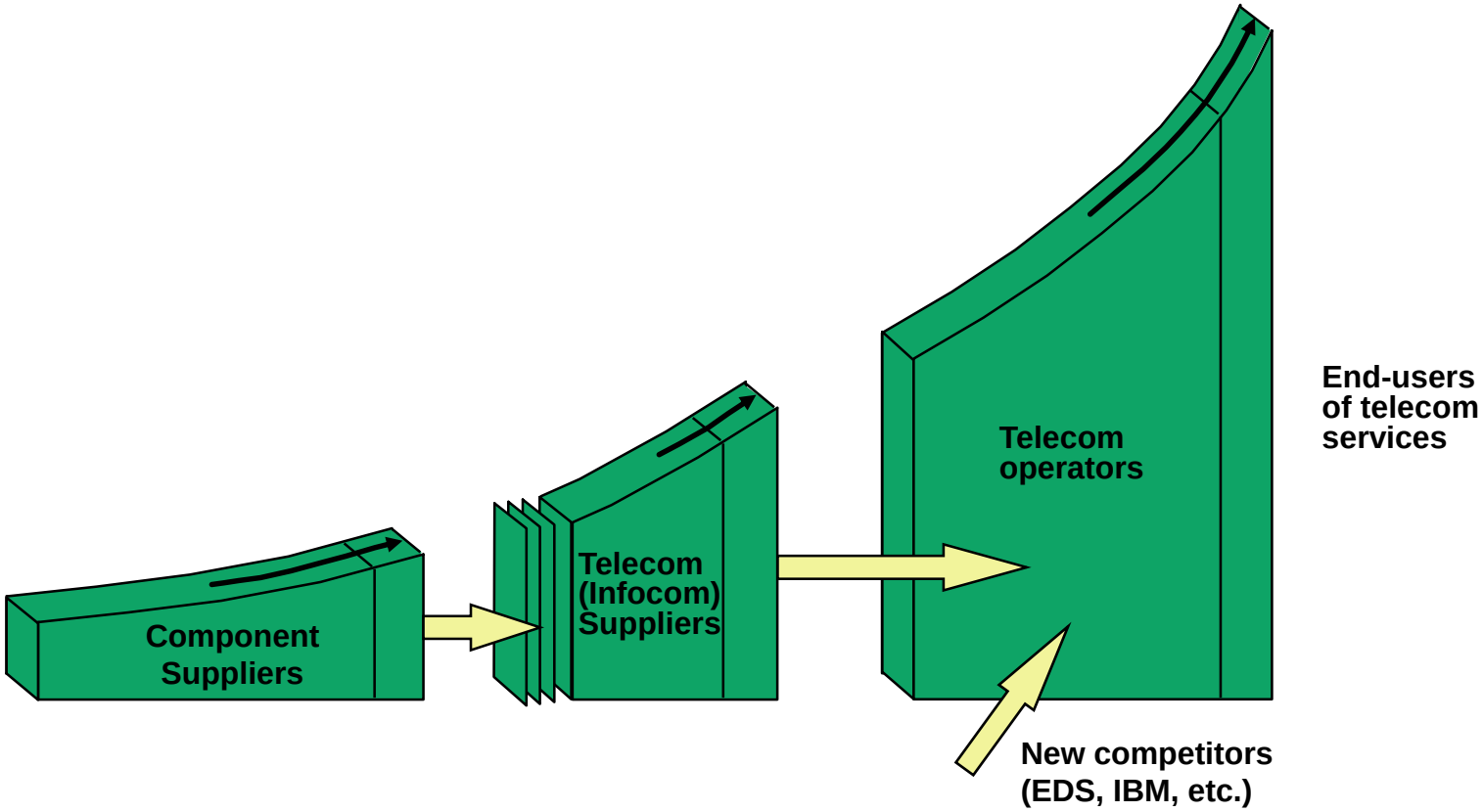
Basic statements in infocommunication systems

- We have discussed networks
- Only services can be sold (networks are not on the market)
- No networks = no services
- All of the costs of network construction and operation are covered by the users of services.
- Modern people pay big money for electronic communication services (more than for food and drinks!)
- The infocommunication engineers play similar roles in electronic communication like typographers in book publishing. (The text is not written by typographers, the pictures are not painted by typographers…..) The infocommunication engineers are responsible for exact and efficient information transmission and presentation and for such services!

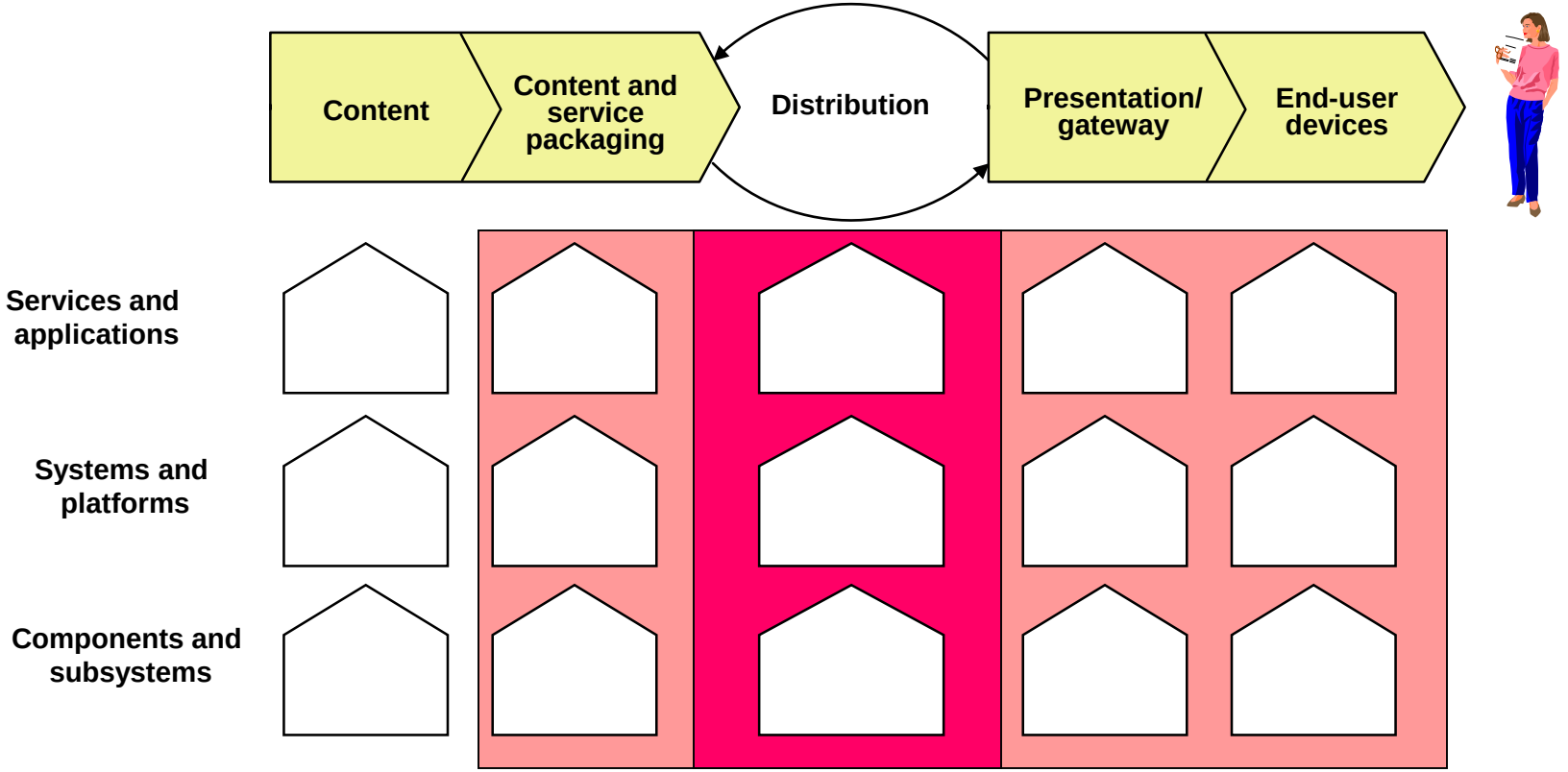
Value chain in infocommunications



Shift in the value chain



The detailed electronic communication value chain



Roles in service provision I.

Electronic communication **activity**: transmission of messages in the form of electronic signals.

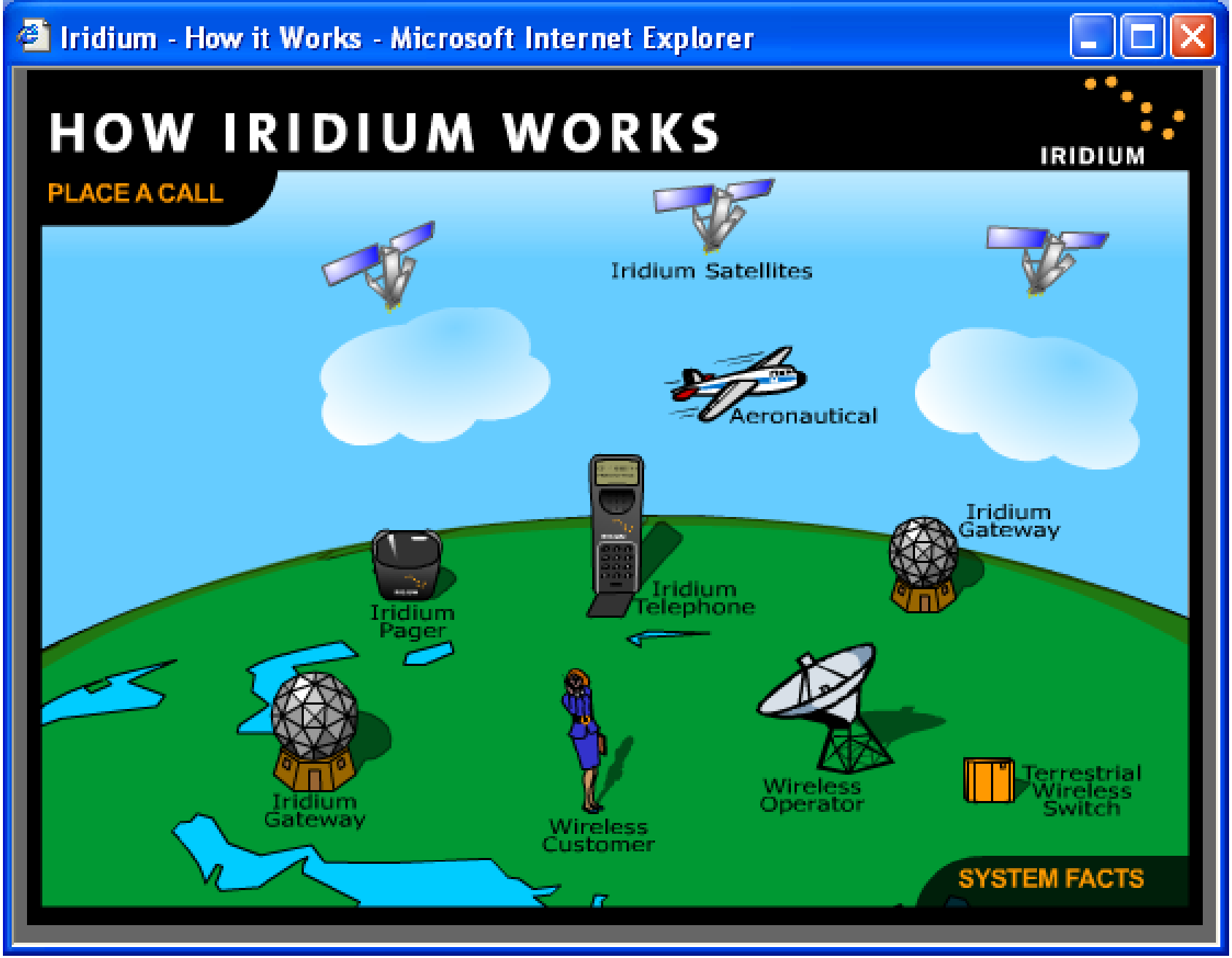
- Messages: speech, voice, music, text, picture, video, data file, multimedia file etc.

- Distance issues????
- Is a simple telephone call within a building an electronic communication activity?
- Is the receiving of the radio signals from a far-far star an electronic communication activity?
- Is the opening the garage door by a radio controller an electronic communication activity?
- Is the leasing of a dark fibre an electronic communication activity?

Electronic communication **service**: activity for other entity for fees (service, facility, feature).

Roles in service provision II.

- Requirements concerning electronic communication **activity**:
  - content fidelity (depending on message type , speech <> data, bandwidth <> bit error rate)
  - acceptable delay (depending on message type, isochronous services are sensitive on delay and jitter)
- Requirements concerning electronic communication **services**:
  - services for real demand of users,
  - affordable price (Iridium, 8KTV!!),
  - high penetration (be attractive for many users),
  - user friendly services (easy to use, react quickly),
  - continuous availability.


Iridium - How it Works - Microsoft Internet Explorer
HOW IRIDIUM WORKS
IRIDIUM
PLACE A CALL
Iridium Satellites
Aeronautical
Iridium Pager
Iridium Telephone
Iridium Gateway
Iridium Gateway
Wireless Customer
Wireless Operator
Terrestrial Wireless Switch
SYSTEM FACTS

Hívásindítás

	Havi díjas
Emsat Satellite Részletek a szolgáltatásról	**708 Ft**
Inmarsat Részletek a szolgáltatásról	**1260 Ft**
Iridium alapszolgáltatás Részletek a szolgáltatásról	**1140 Ft**
Iridium értéknövelt szolgáltatás Részletek a szolgáltatásról	**2220 Ft**
Norway Maritime Communications Részletek a szolgáltatásról	**346,8 Ft**
Thuraya Részletek a szolgáltatásról	**708 Ft**

A forgalmi díjakat 60 másodperces egységekben mérjük. A számládon az egyenleget szabá forintban vezetjük. Az árak tartalmazzák az áfát.

Roles in service provision III.

- Traditional players in the electronic communication services:
  - network operators,
  - service providers,
  - Operator partners (e.g.. Access providers, collocation providers),
  - Wholesale and retail partners,
  - End users, subscribers, who pay all the bills for the value chain
- Other players in electronic communication services :
  - Content providers,
  - Content and service packagers,
  - Service and application brokers

Roles in service provision IV.

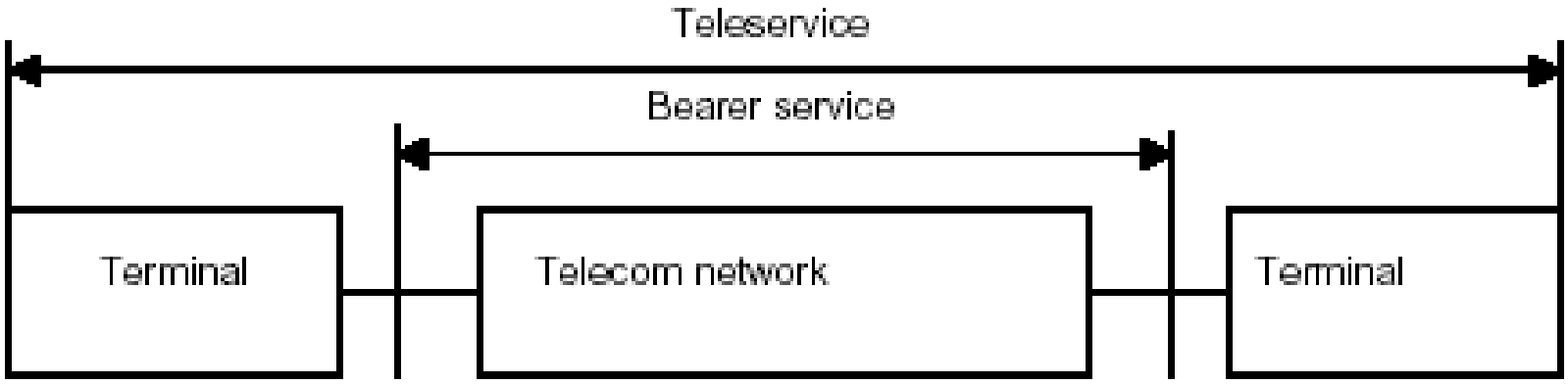
Electronic communication service categories based on user group:

- public services (available for anyone, based on uniform service conditions, subscriber contracts),
- closed users group services (CUG), CENTREX, virtual private network (VPN)
- Interconnection services and access services (services for other service providers).

ATTENTION!!! The network issues are different!!! The public network can support CUG and a private network can be part of public cervices....

Service structures I.

- Teleservices
- Bearer services



Service structures II.

- Teleservices
  - Defined at user interface
  - Providing full communication between users,
  - E.g. telephone service, telefax service, emergency calls, SMS services…..
- Bearer services
  - Defined at network interface
  - Providing signal transmission capabilities between network access points
  - E.g. 64 kbit/s unrestricted, structured circuit mode bearer service, packet mode bearer service

Service structures III.

- **Teleservices from provider point of view:**
  - **Basic services** (mandatory service elements with minimal quality requirements e.g. real time, understandable…..)
  - **Supplementary services** (to make basic services even more usable, e.g. call transfer, conference call, automatic call beck on busy, wake up services, least cost routing services, credit card based call……
  - **Value added services** (e.g. bank transaction by phone, televoting, telephone based donation, position based services …..)

Service structures IV.

- **Teleservices from user point of view:**
  - **Interactive services** (telephone, videoconference ...)
  - **Messaging services** (voice mail, e-mail ...)
  - **Retrieval services** (account balance retrieval, time table …)
  - **Distribution services** (cable TV, personalized news by fax …)

Service structures V.

- **Teleservices/voice:**
  - **Interactive services** (telephone, teleconference (voice) **...**)
  - **Message handling services** (voice mail…..)
  - **Retrieval services (** account balance retrieval, time tables…)
  - **Distribution services** (telephone news…..)

Cisco TelePresence

Cisco TelePresence

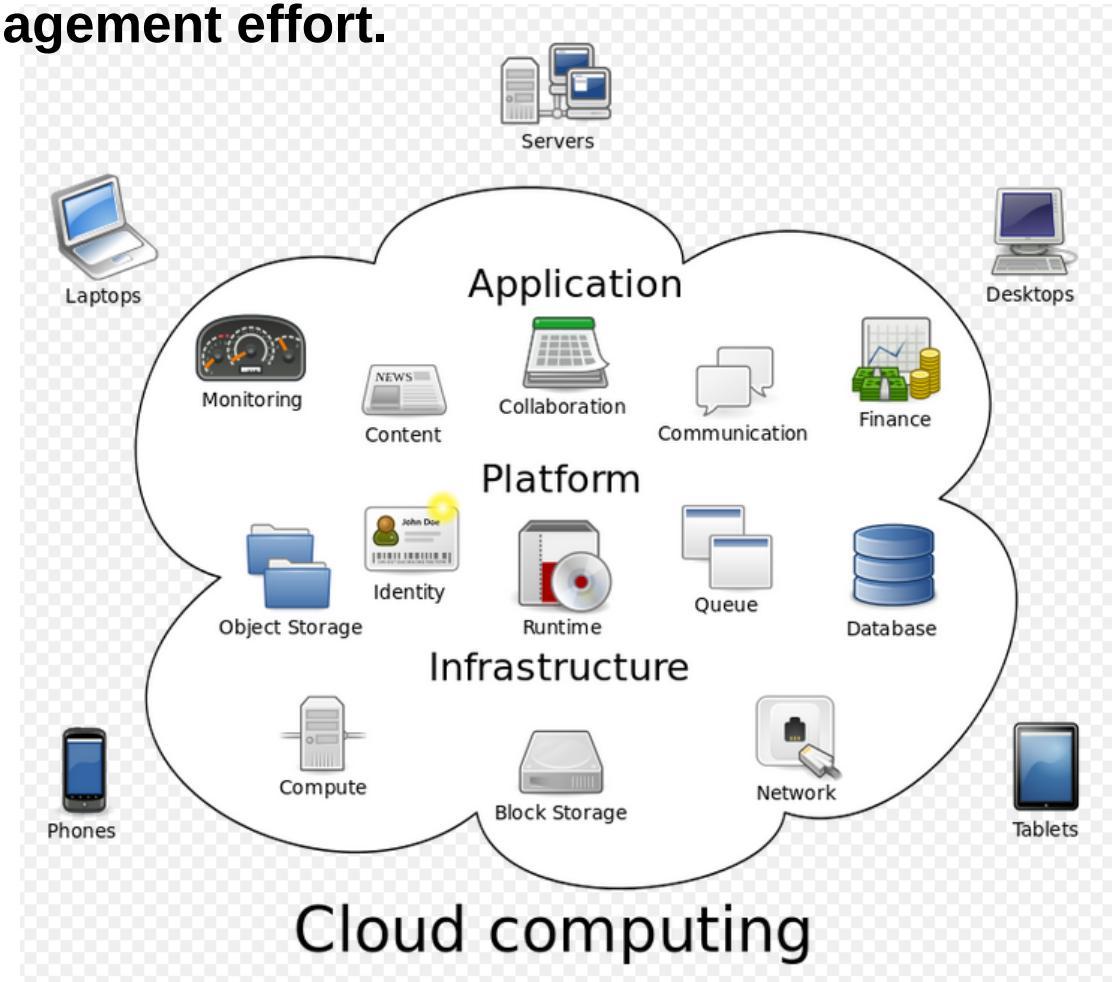
Service structures VIII.

- **Teleservices / multimedia:**
  - **Interactive services** (videoconference for medical consultation including EKG, EEG, X-ray transmission, multimedia games...)
  - **Message handling services** (MMS….)
  - **Retrieval services** (… downloading multimedia shows …)
  - **Distribution services** (video on demand, pay per view …)

Hosting services

- **web hosting service:** a type of Internet hosting service that allows individuals and organizations to make their website accessible via the World Wide Web
- Colocation web hosting service
- **file hosting service**: hosts files, not web pages
- **image hosting service**
- **video hosting service**
- **e-mail hosting service**
- **cloud hosting** powerful, scalable and reliable hosting based on clustered load-balanced servers and utility billing
- **Cloud computing!**

Cloud computing is a type of Internet-based computing that provides shared computer processing resources and data to computers and other devices on demand. It is a model for enabling ubiquitous, on-demand access to a shared pool of configurable computing resources (e.g., computer networks, servers, storage, applications and services), which can be rapidly provisioned and released with minimal management effort.



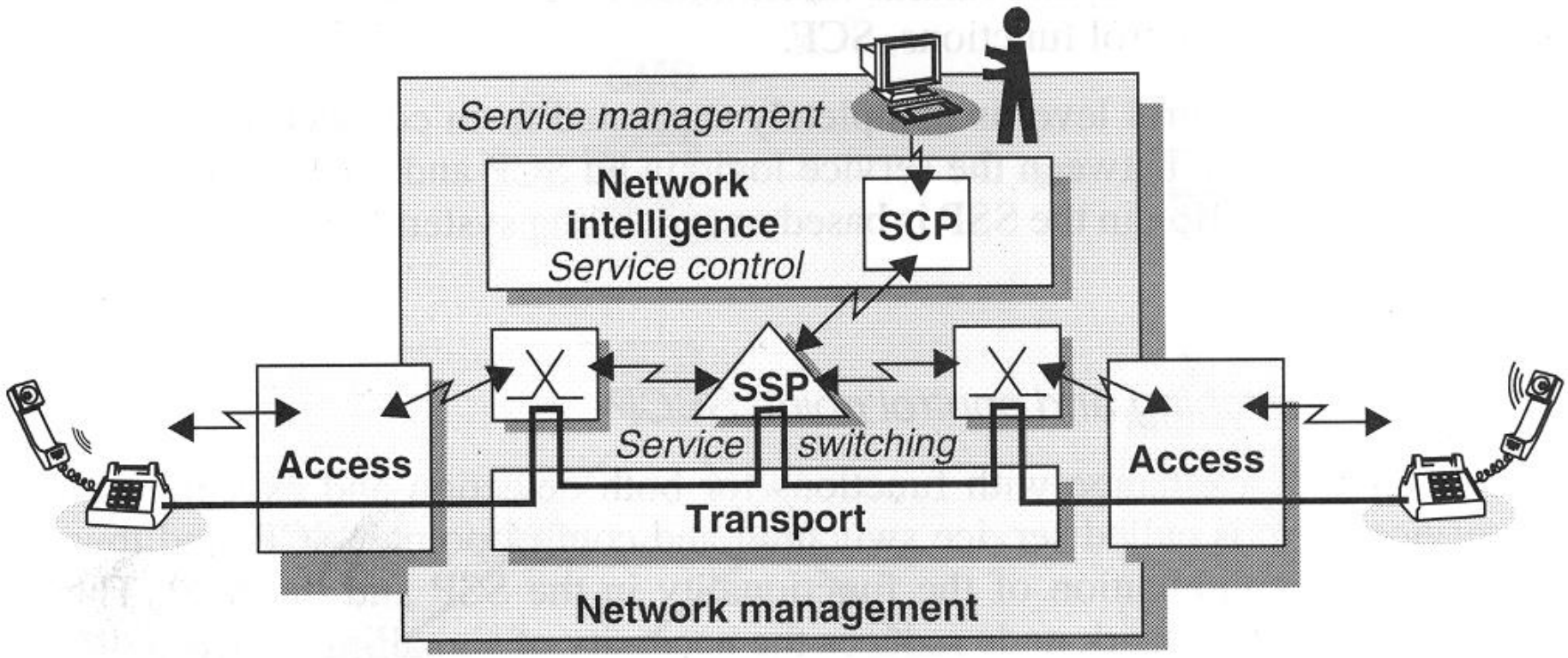
Interactive services / PSTN-ISDN

- **Publicly available telephone service, mandatory features:**
  - Available for public,
  - Originating and receiving national and international calls,
  - Access to emergency services,
  - Provision of operator assistance,
  - Directory enquiry services,
  - Directories,
  - Public payphones,
  - Legal interception,
  - Carrier selection,
  - Number portability,
  - Itemised billing,
  - Calling-line identification.

Features are implemented in switches

Interactive services / IN

- **Intelligent Network (IN concept) for easy service creation and provision**



Interactive services / IN

- **Standardised IN elements (CS1):**
  - Freephone services (zöldszám),
  - Shared cost services (kékszám),
  - Premium rate services (emelt díjas),
  - Virtual card (hívókártya),
  - Prepaid card (előre fizetett hívókártya),
  - Virtual private network (virtuális magánhálózat),
  - Universal Personal Number (személyi hívószám)

Interactive services / GSM supplementary services I.

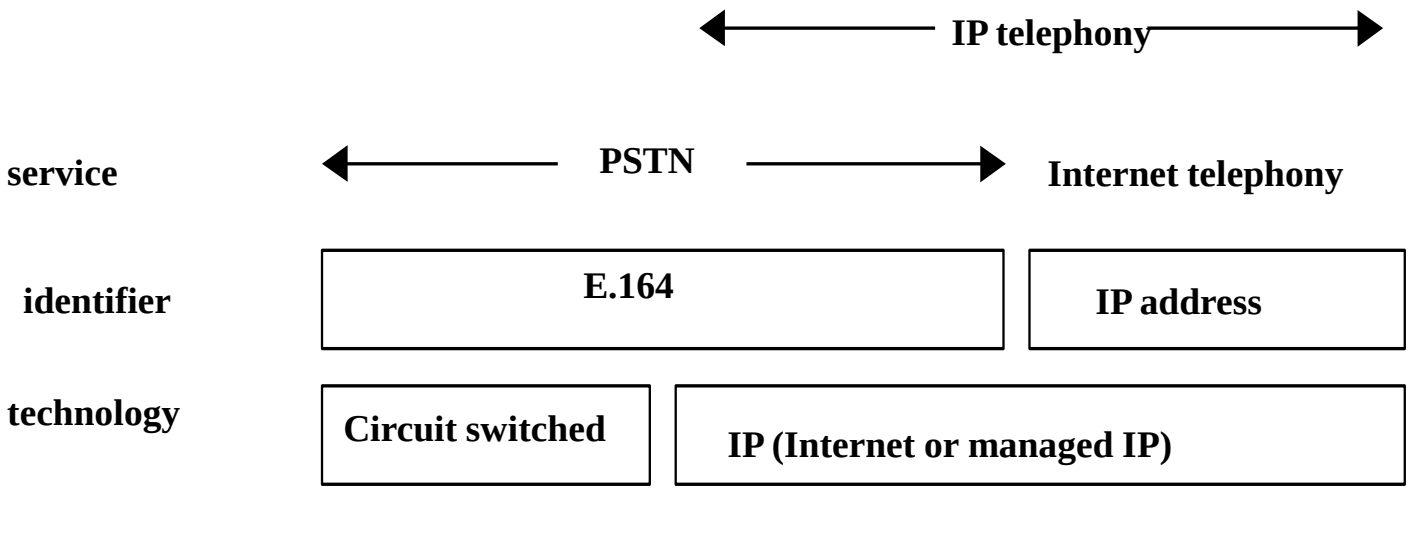
- **Calling Line Identification Presentation (CLIP)**
- **Calling Line Identification Restriction (CLIR)**
- **Connected Line Identification Presentation (COLP)**
- **Connected Line Identification Restriction (COLR)**
- **Call Forwarding Unconditional (CFU)**
- **Call Forwarding on Mobile Subscriber Busy (CFB)**
- **Call Forwarding on No Reply (CFNRy)**
- **Call Forwarding on Mobile Subscriber Not Reachable (CFNRc)**

Interactive services / GSM supplementary services II.

- **Call Deflection (CD)**
- **Call Hold (HOLD)**
- **Call Waiting (CW)**
- **Barring of All Outgoing Calls (BAOC)**
- **Barring of Outgoing International Calls (BOIC)**
- **Barring of All Incoming Calls (BAIC)**
- **Barring of Incoming Calls when Roaming Outside the Home PLMN Country (BIC-Roam)**
- **Closed User Group (CUG)**
- **Advice of Charge (AOC)**
- **User-to-user signalling (UUS)**
- **Multi Party Service (MPTY)**

Interactive services / IP telephony

- **IP telephony: services or technology?**



Defining VoIP

ITU Internet Report 2001

- ***IP Telephony*** – carriage of voice over IP-based networks *irrespective of ownership*
- ***Voice over Internet Protocol (VoIP)*** – voice traffic carried wholly or partly using IP over broadband networks *competing with incumbent operators*

QoS

QoS (Quality of Service) is a major issue in VOIP implementations. The issue is how to guarantee that packet traffic for a voice or other media connection will not be delayed or dropped due interference from other lower priority traffic.

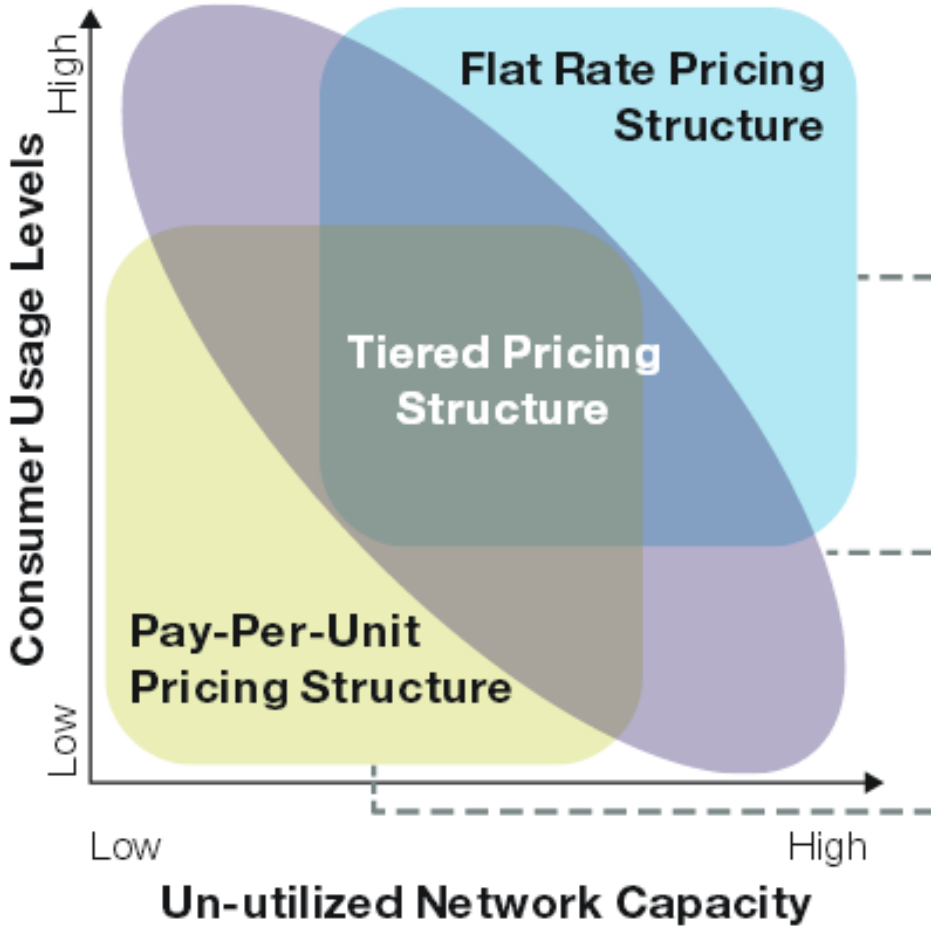
Things to consider are
Latency: Delay for packet delivery
Jitter: Variations in delay of packet delivery
Packet loss: Too much traffic in the network causes the network to drop packets
Burstiness of Loss and Jitter: Loss and Discards (due to jitter) tend to occur in bursts

Roaming in the EU

The EU "roam like at home" rules mean that when you use your mobile phone while travelling outside your home country in any EU country you don't have to pay any additional roaming charges. You benefit from these rules when calling (to mobile and fixed phones), sending text messages (SMS) and using data services while abroad. These rules also apply when receiving calls or texts while roaming even if the person you are calling is using a different service provider.

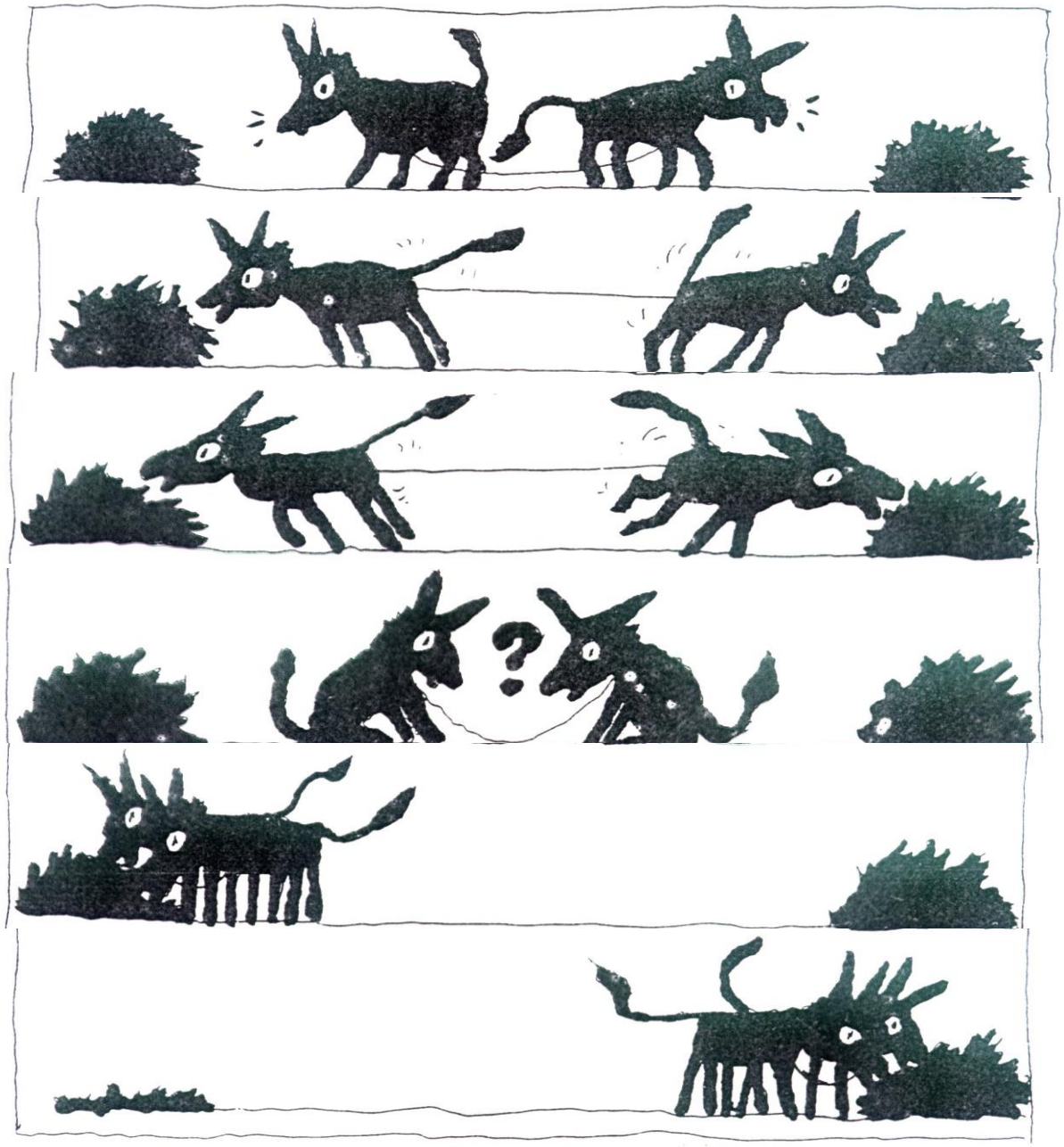
You pay exactly the same price for using these services when travelling in the EU as you would if you were at home. In practice, your operator simply charges or takes your roaming consumption from the volumes in your domestic mobile tariff plan / bundle.

Pay-Per-Unit or Flat Rate Pricing?



What is the future?

- Traditional Telco's, traditional services and traditional business model with precise billing?
- New operators, new business model and free-like services (like Skype)?



Network services

- Leased line services
- Interconnection services
- VPN - Virtual Privet Network Services
- Network Access Services
- Billing services
- Centrex services

Leased line services

- Transparent transmission capacity without switching function
- For operator partners to extend their networks,
- For interconnection of network nodes
- For end users to access networks or services
- Interconnection of private network nodes
- Main characteristics: service features, transmission parameters, interface types,
- Main classes: analogue/digital, two wire/four wire, simple / observed / managed

Standardised leased line services

- Ordinary Quality Voice bandwidth (2 wire) ETS 300448
- Ordinary Quality Voice bandwidth (4 wire) ETS 300448
- 64 kbit/s ETS 300 288, ETS 300 289
- 2048 kbit/s E1 ETS 300 418, ETS 300 247
- Nx155520 kbit/s STM-1 ETS 300 299

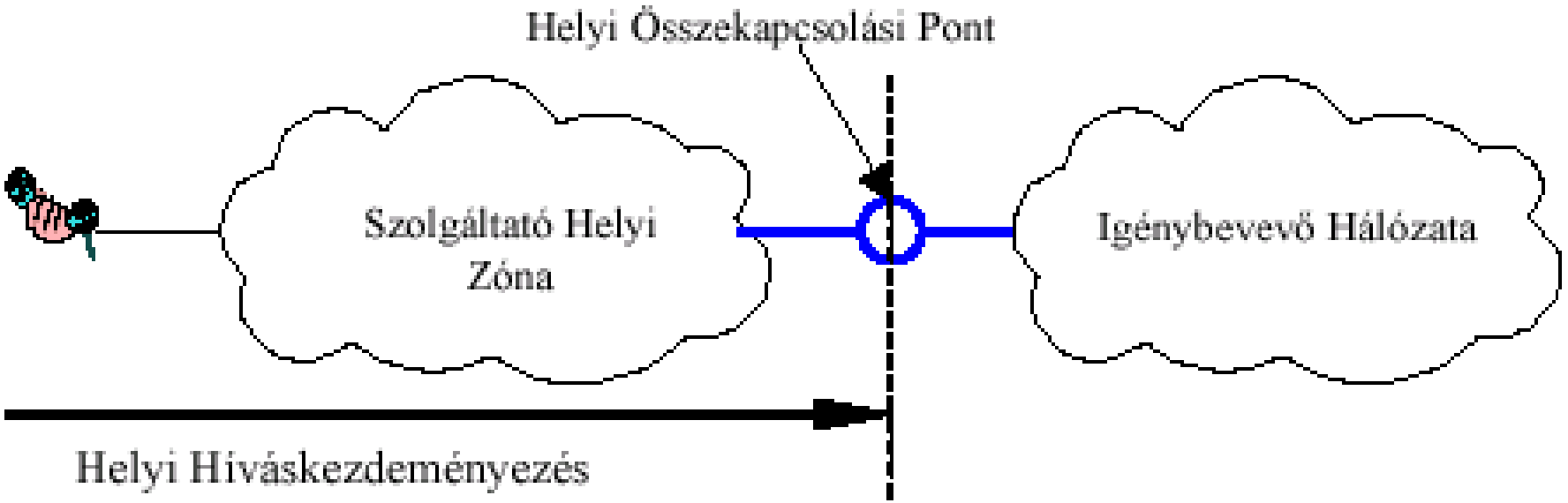
Interconnection services

- Call origination, call termination, call transit as the tipical traffic situation
- Support services (e.g. billing)
- Carrier selection services
- Standard solutions for interconnection PSTN, ISDN and GSM ETS 300 356
- Peer-to-peer interconnection without detailed traffic accounting

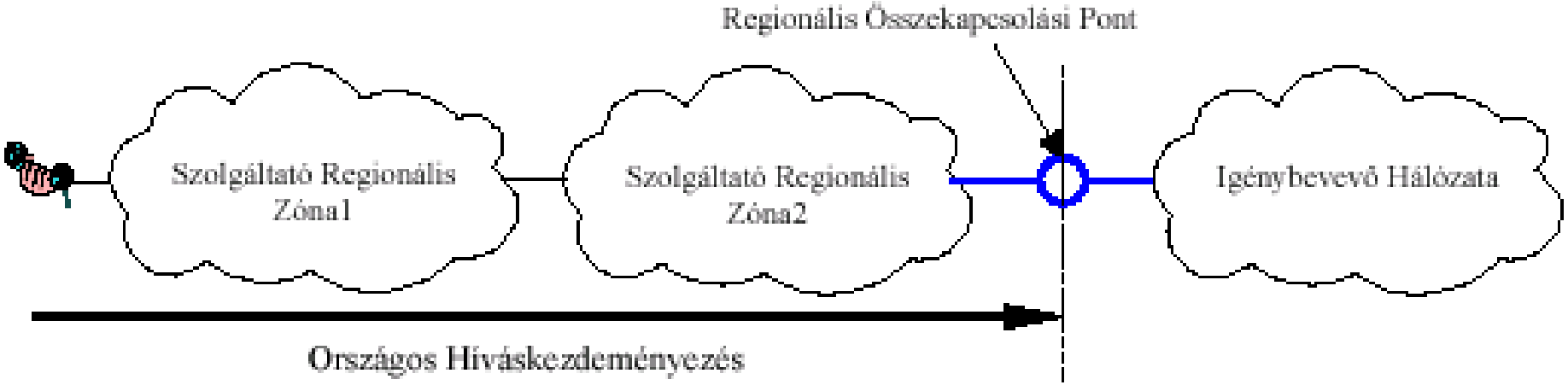
Interconnection services

- Mandatory for public networks!
- Technical, commercial and legal aspects!
- Critical issues: which services are supported, where is the interconnection point?
- Network operators with significant market power have special obligations!
- Reference interconnection offers are accepted by Authority.
- All the accepted interconnection reference offers in Hungary are bringing to justice.

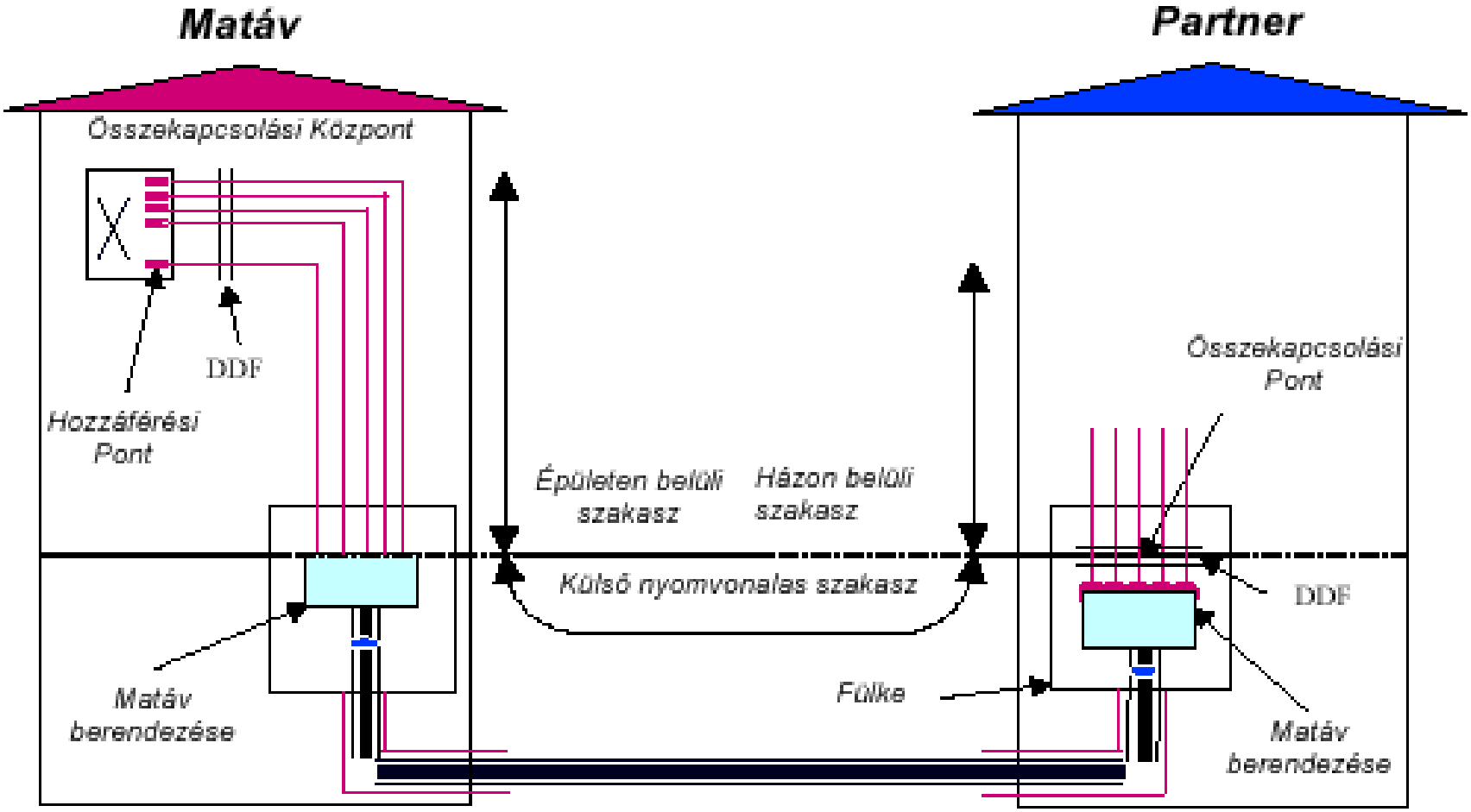
Functions of interconnection



Functions of interconnection



Functions of interconnection



Fülke: A Matáv berendezés elhelyezésére kialakított helyiség

3. ábra: Összekapcsolás megvalósítása Partner telephelyen