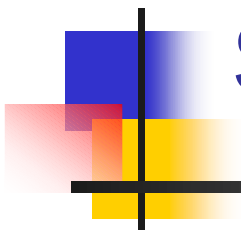


S-72.423 Telecommunication Systems

Overview

Topics Today

- Practicalities & course program
- Networking paradigms
- Network evolution
  - Voice and low rate data (PSTN+ISDN)
  - Mobile (2G, 2.5G, 3G)
  - Next generation (NGN/4G)
- Peek to course contents in selected topics
  - The OSI-model
  - PSTN, ISDN, Mobile networks
- Telecommunication market
- Future trends

Practicalities

- Lectures (Thursdays 14-16 in hall B): Timo Korhonen (09 451 2351), Michael Hall (09 451 2322)
- Tutorials (Wednesdays 14-16 in hall S1): Mika Nupponen (09 451 5416), NaserTarhuni (09 451 2362)
- *Textbooks*:
  - Ericsson, Telia: Understanding Telecommunications, Part II, ISBN 91-44-00214-9 http://www.ericsson.com/support/telecom/index.shtml
  - James F. Kurose, Keith W. Ross: Computer Networking (2nd Ed.,Addison Wesley)
- Grading: (**E**+**T***0.15) consists of
  - Compulsory closed book **E**xam
  - Voluntary **T**utorials
- Homepage: http://www.comlab.hut.fi/opetus/423

Lecture Topics

- Introduction
- Public Switched Telephone Network (PSTN)
- Integrate Services Digital Network (ISDN) and SS7
- Asynchronous Digital Subscriber Line (ADSL)
- Automatic Transfer Mode (ATM) and Broadband-ISDN
- X.25, Frame relay
- Public Land Mobile Networks (PLMN)
  - GSM
  - WCDMA
- The Internet
  - Network topology
  - TCP/IP Suite
  - Services

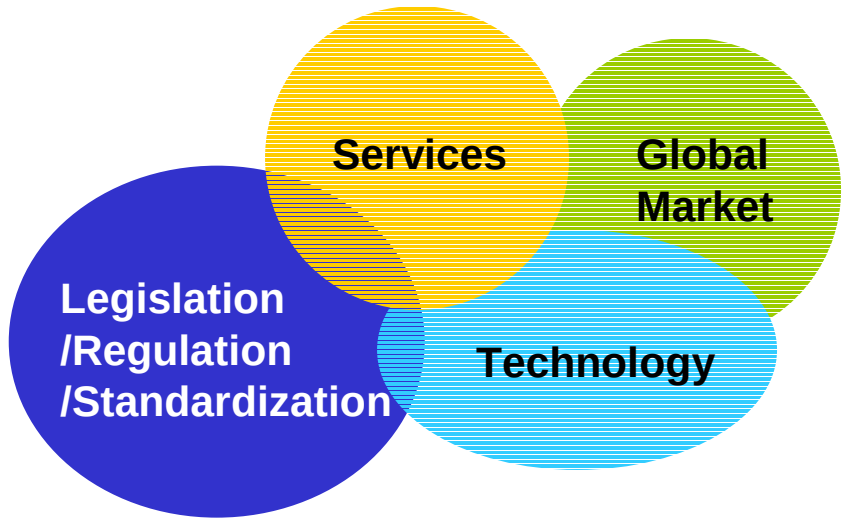
Subtopics in Networks & Examples

- User services as
  - IN services: call last dialed, alternate billing services (as calling card, collect call)
  - Internet: web, mail, ftp ...
- Terminals (modems and PSTN/ISDN phones), user interfaces (DSS1)
- Standards (IETF, IEEE, ITU-T ...)
- Routing and switching (unicast - multicast, devices & protocols RSVP)
- Transmission and links (fibre, coax-cable..)
- Access and transport techniques (flow control, error control)
- Signaling (SS7, X.25, Frame relay ...)
- Network management (as OMAP of SS7...)
- Interworking (gateways, bridges ...)
- Network planning

IN: Intelligent Network
IETF: Internet Engineering Task Force
IEEE: the Institute of Electrical and Electronics Engineers, Inc
RSVP: Resource ReSerVation Protocol
ITU: International Telecommunications Union
SS7: Signaling System 7 (in ISDN)
OMAP: Operation and Maintenance Application Part

Information Society

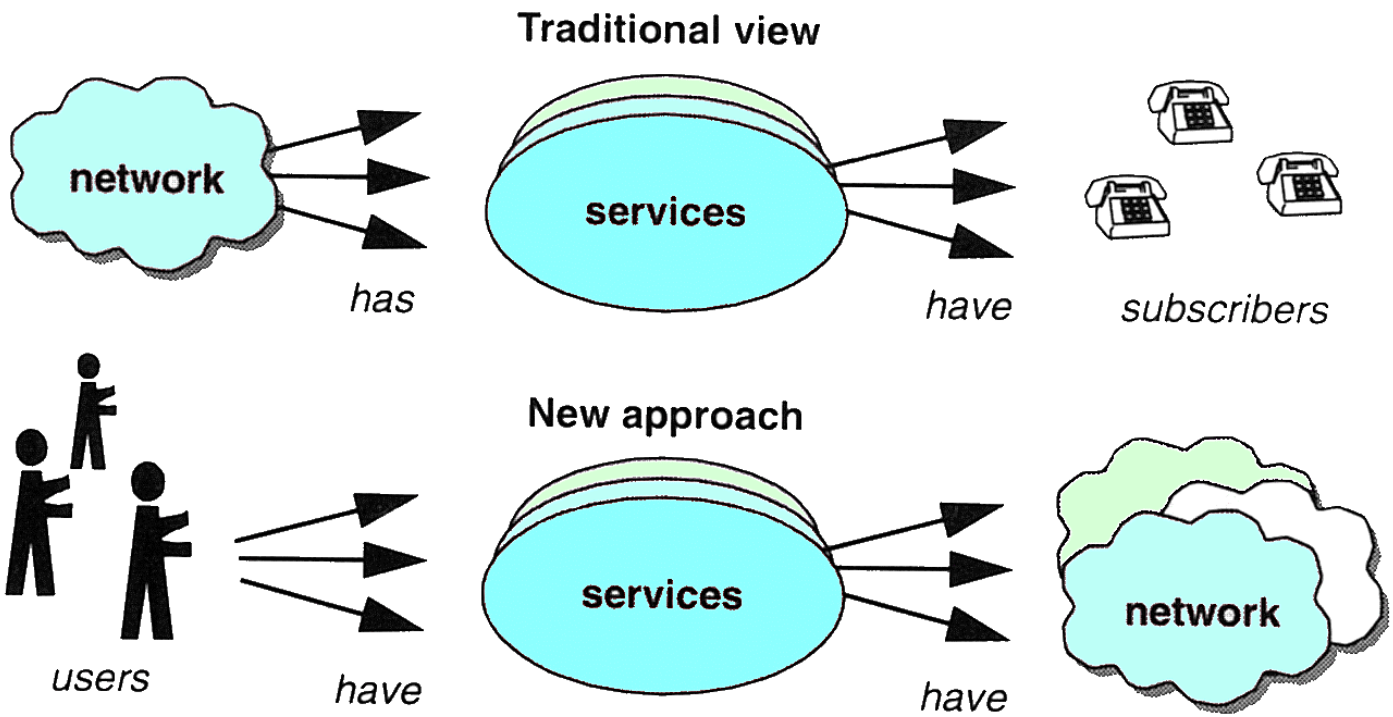
- *"Information and Communication Anytime, Anywhere, and in Any Form"*
- Key development fields:



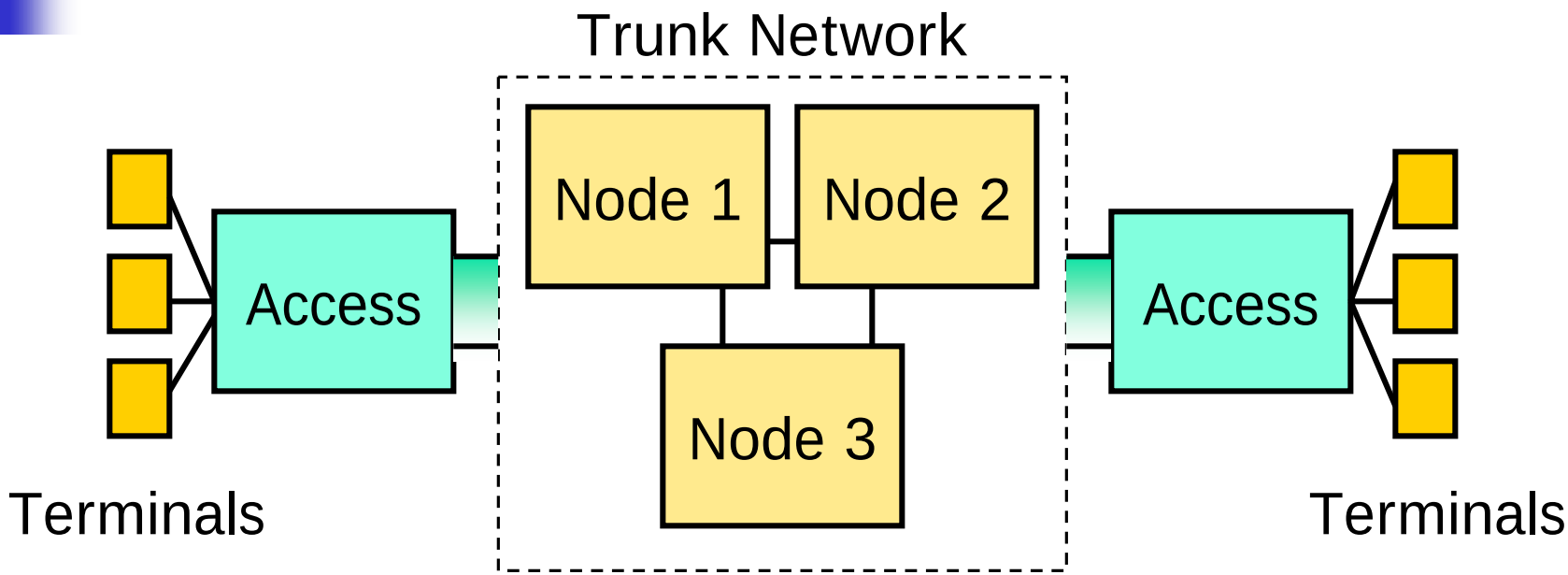
- To understand how networks/terminals/services evolve consider especially services because all network costs are paid by service users:

Services shape telecommunications' evolution and effect greatly on which technology is chosen!

Paradigm Shift



Telecommunication Networks



- Trunk and access parts
- Access part terminated by terminals
- Network nodes and links are optimized for certain *assumed* traffic sources and transmission channels
- Model applies for both data (packet) and voice networks
- All telecommunication networks realized by following layered structure (Open System Interconnections (OSI) or a structure having similar functionalities)

Open System Interconnection (OSI) Layers

7. Application	Access to OSI environment **applications**
6. Presentation	Independence of applications from differences in data presentations(compression & coding)
5. Session	Establishing, managing and termination connections (sessions~dialoques) between cooperating applications
4. Transport	Reliable, transparent data transfer for lower level data segments or blocks(end-to-end flow & error cntr)
3. Network	Routing & switching service for transport layer. Layer of routers.
2. Data Link	Sends data blocks with synchronization, error and flow control for link layer connections. Layer of bridges.
1. Physical	Transmission of electrical signals in medium. Layer or repeaters (multiplexing/bit transmission)

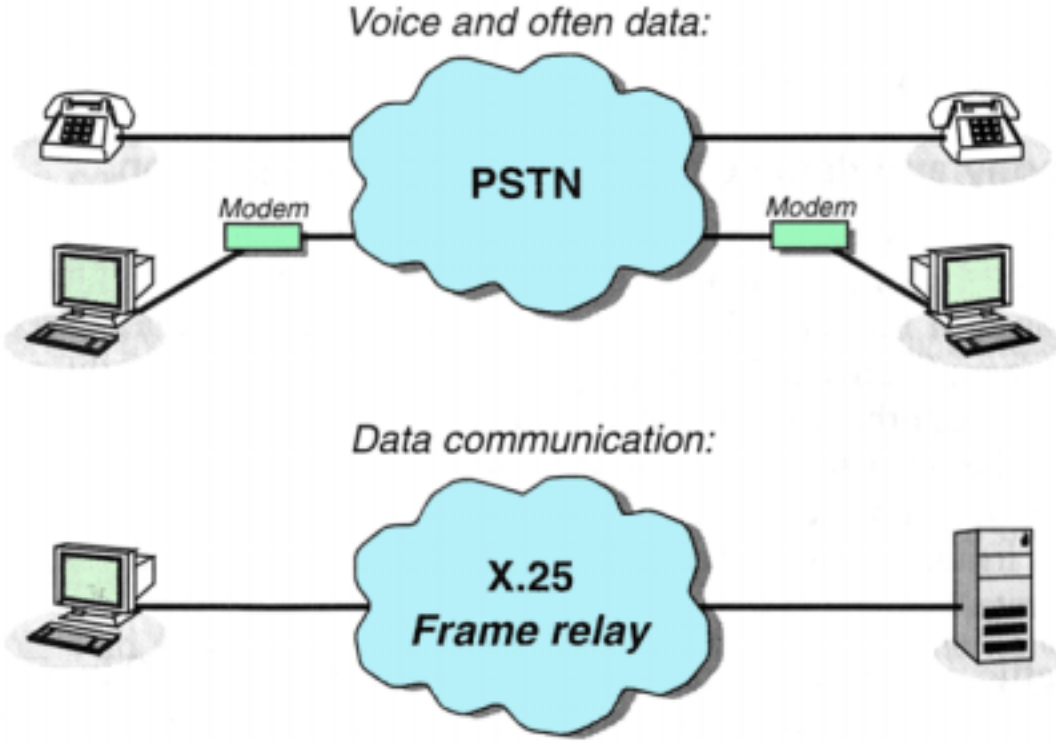
Gateway Layers

LAN Layers

Each OSI-layer has its Standardized Services

7. Application	NCP, FTP, Telnet, **SMTP**, SNMP, LAT, AFP, SMB…
6. Presentation	SNA Presentation services
5. Session	NetBIOS, NetBEUI, **DNS**, …
4. Transport	SPX, PEP, **TCP**, **UDP**, NSP…
3. Network	IPX, RIP, SAP, IDP, **IP**, ARP, **RSVP**, ICMP, X.25, RIP…
2. Data Link	**IEEE 802.X**, ANSI X3T9.5, SMT,…
1. Physical	V.24, V.35, **V.90**, 10Base5, 10Base2, 10BaseT, FDDI, SDH, G.703…

Data and Voice Networks

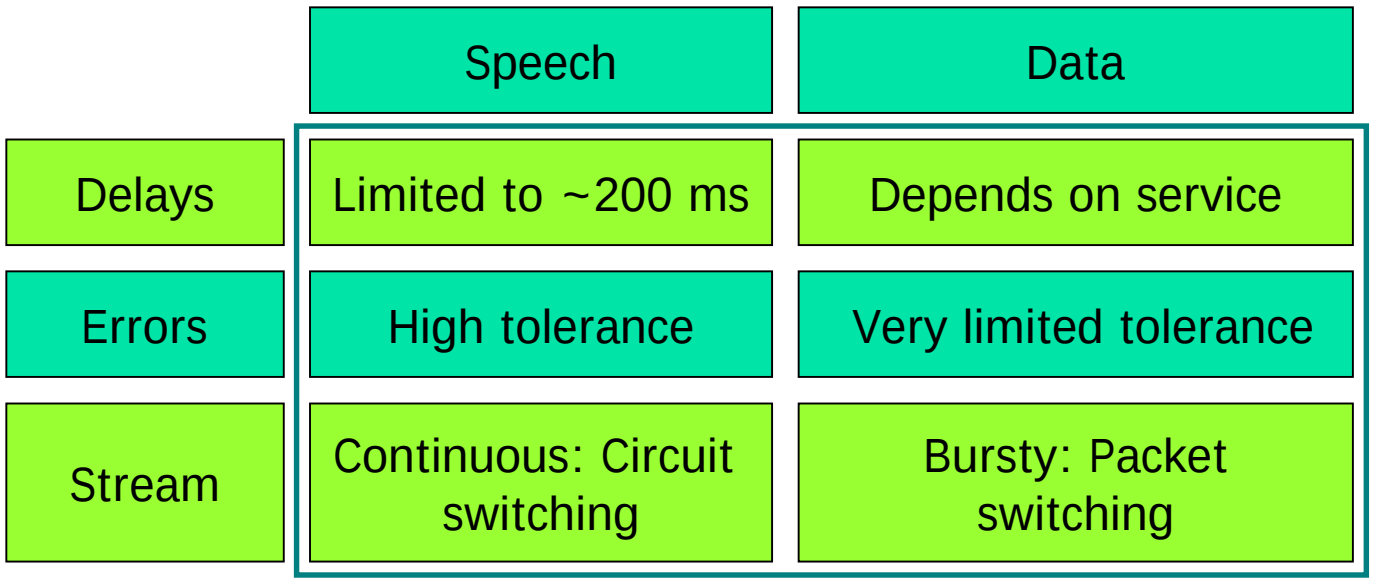


Frame relay:
- applies virtual circuits
- example to connect LANs
- for high quality (links have modest error correction & flow control)
- rates: 2-50 Mb/s

Frame Flow Control:
- service for a pair of communicating entities
- reassures non-overwhelming comms. (not too many packets)

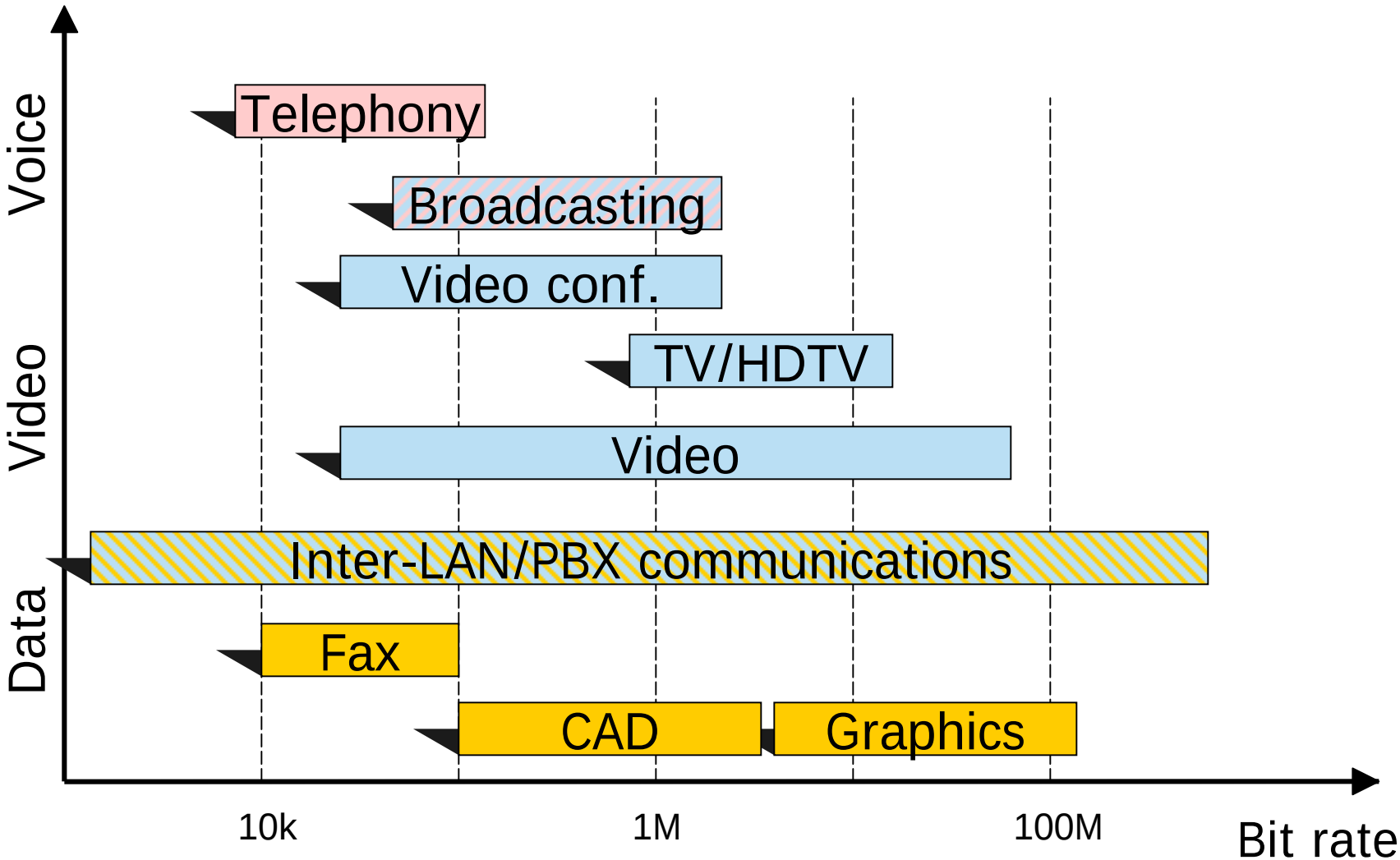
- Nodes, links & layers with well-defined (standardized) interfaces
- Network is optimized for certain, assumed traffic
- Traditional assumption: Voice and data services in different networks. Problem: Internet/PSTN carries nowadays both!

Speech and Data Communications



- Teletraffic can be forced to fixed rate or bandwidth as speech in PSTN or in ATM traffic (->waste of network resources)

Services Require Different Rates



Symmetry

- Categories:
  - **Asymmetrical channel**
    - based on idea that downlink traffic is much larger that uplink traffic
    - Traditionally in access networks (ADSL, Cable modems)
    - Data over DVB
  - **Symmetrical channel** as in fixed line telephony
    - Some **services (as P2P)** require symmetrical traffic channel!
  - **Point-to-multipoint** channel (broadcasting)
    - TV and Fax are point-to-multipoint distributive services
    - Webcasting (PointCast news service.)
- Rapidly developing Internet services set stringent requirements for network infrastructure & planning
  - adaptivity
  - service/system upgradability

Network/Service Adaptivity

- Services manifest themselves via various service profiles (that may differ within a short time period), and thus efficient adaptivity should be supported by networks and terminals
- Advanced networks have a tendency to carry intelligence in terminals (and not in network nodes, exchanges, routers…)
  - Reduces signaling traffic
  - Moves costs to end-users
- IN (Intelligent Network) solutions developed first for PSTN but typically an important part of most networks as in PLMNs
  - Enable service flexibility (software radio does this in terminals)
  - IN services designed in cooperation with terminal intelligence

Differentiated Services

- UMTS supports wide range of applications that posses different quality of service (QoS) requirements.
- Transportation system differentiated into constant rate, real-time and higher-latency services by Multi-Protocol Label Switching (**MPLS**) or Differentiated Services (**DiffServ**)
- User services can be divided to different groups, depending on QoS requirements. Four traffic classes can been identified:
  - **Conversational class** (very delay-sensitive traffic)
  - **Streaming class**
  - **Interactive class**
  - **Background class** (the most delay insensitive)
- Hence **TCP** (Connection-oriented transport-layer) is not a good choice if errors can be tolerated
- **UDP** (Connectionless transport-layer protocol) appropriate for many streaming applications

Security and secrecy*

- Services require security & secrecy, e. g. reliable, shielded transfer. Important for
  - NGNs - services that are 'near to users'
  - vulnerable services:
    - medical/health as telesurgery
    - rescue, police, defense
- Networks can provide this in several network levels (problem: overheads);
  - fixed lines (PSTN, frame relay)
  - flexible routing (SS7)
  - scrambling or encryption (PLMNs)
  - coding or ciphering (in all modern telecom links & nets)
- Often used concept: AAA: Authentication, Authorization, Accounting

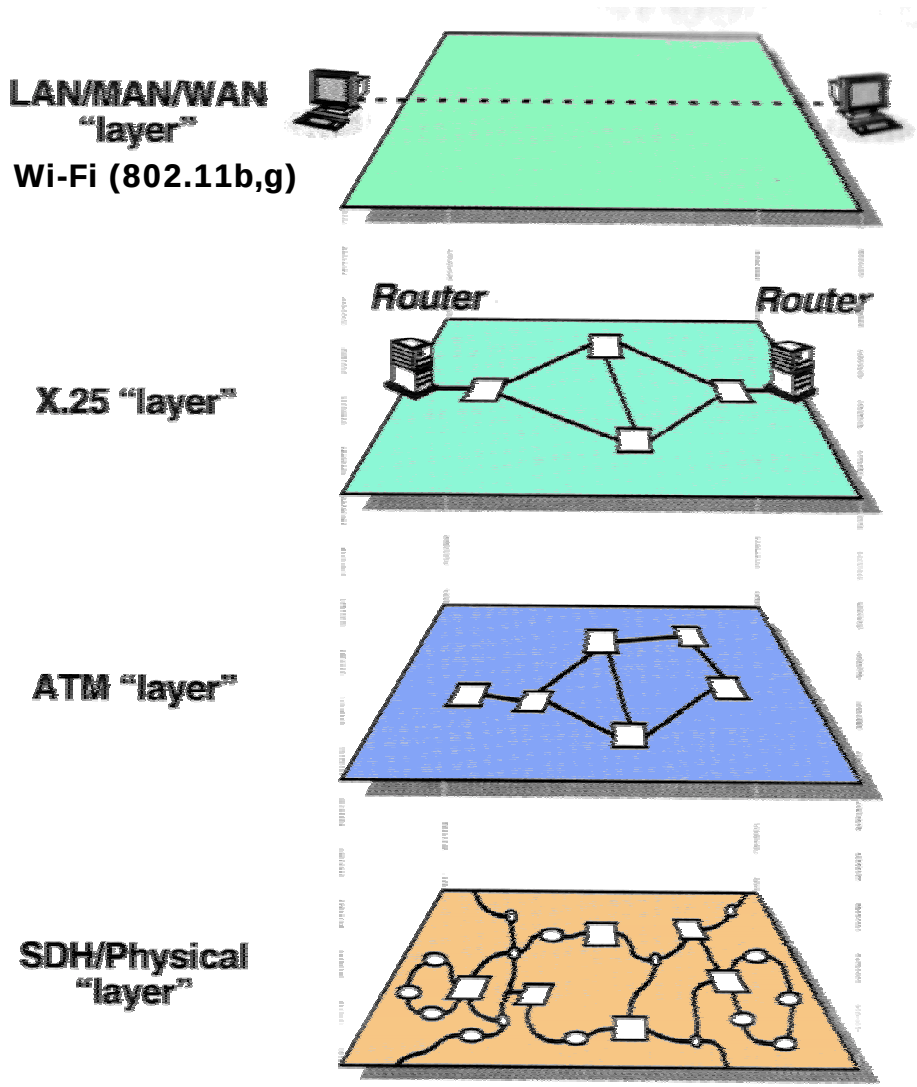
* • Message goes to the right receiver
• Others can not do eavesdropping

Public Switched Telephone Network (PSTN)

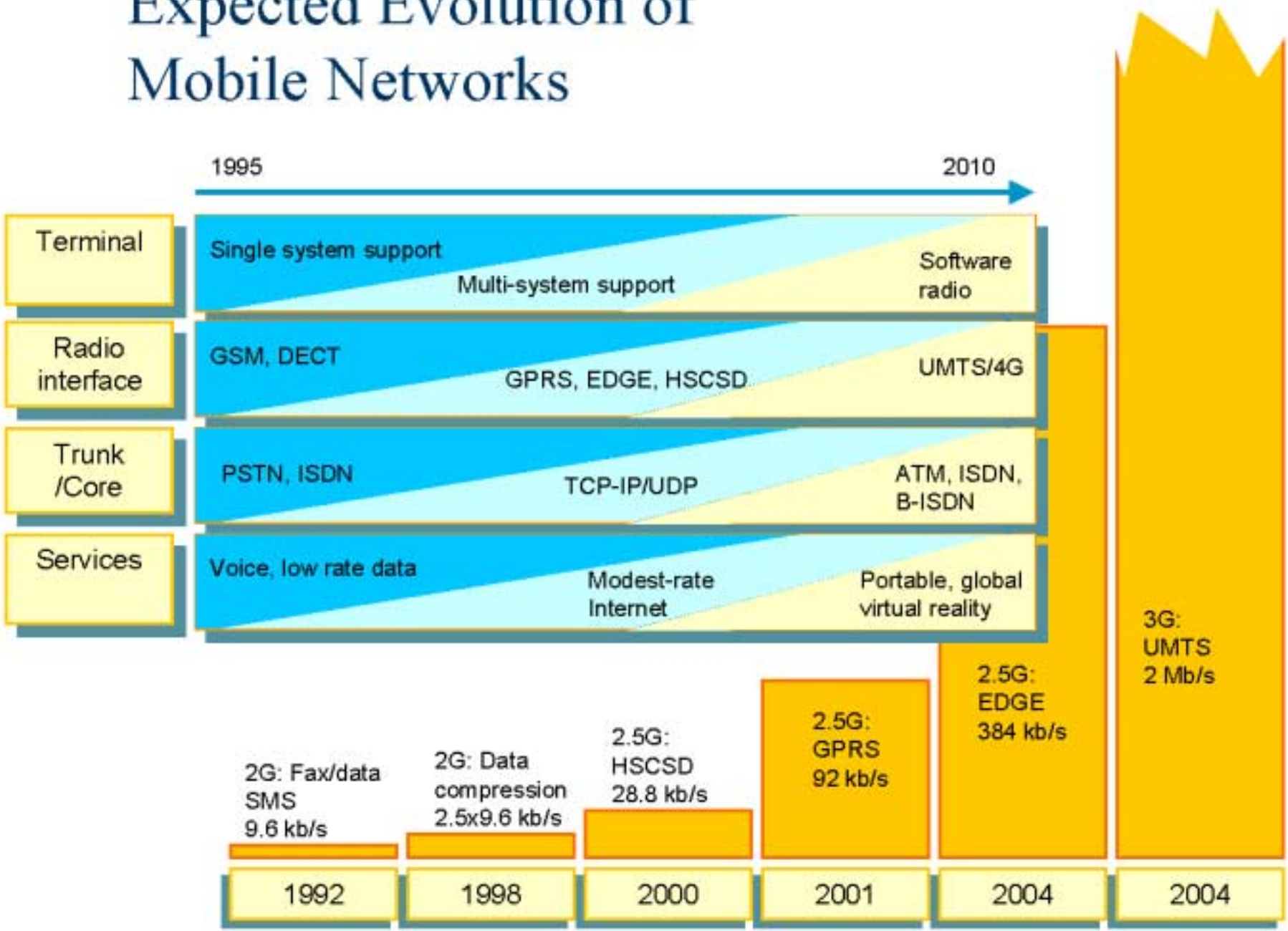
- The oldest (1876) bearer network (other: ISDN, ATM, frame relay, The Internet)
- After 1960 has got many renovations: data, fax, processor exchanges, PCM, satellite communications, network intelligence (IN)
- Primary characteristics
  - Analog access: bandwidth 300-3400 Hz
  - Circuit switched connection
  - 2x64 kbit/s + 16 kbits/s (ISDN)
  - Limited mobility (DECT=PABX RF-interface)
  - Exhanges (& often terminals) apply ISDN

Network Stratums of PSTN

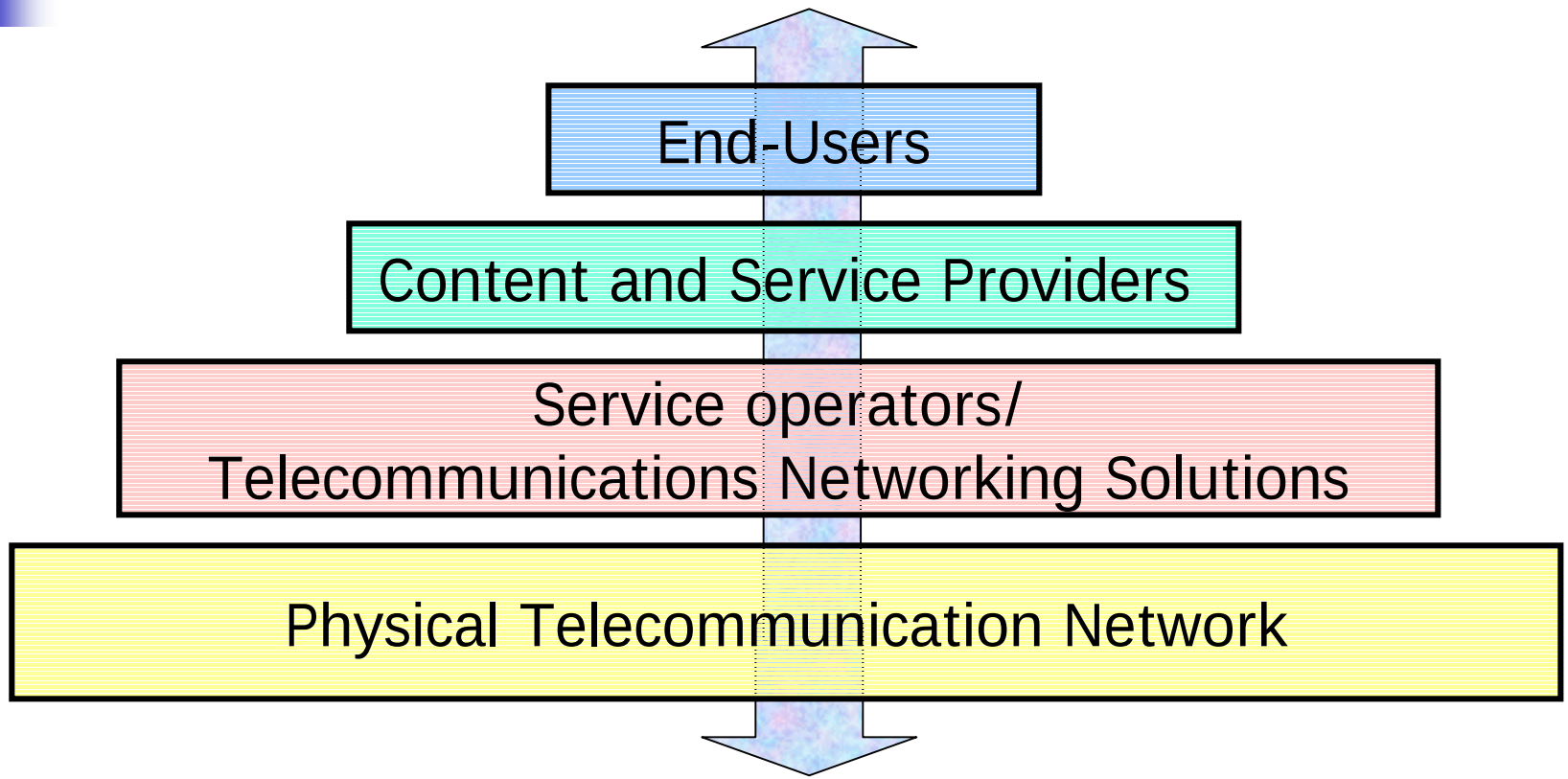
- In practical PSTN different networks form ‘stratums’
- In this example X.25 packet network operates on ATM based SDH access stratums.
- ATM forms an efficient info pipe (virtual circuits) where no address checking or error correction is done but it is left for lower layers



Expected Evolution of Mobile Networks



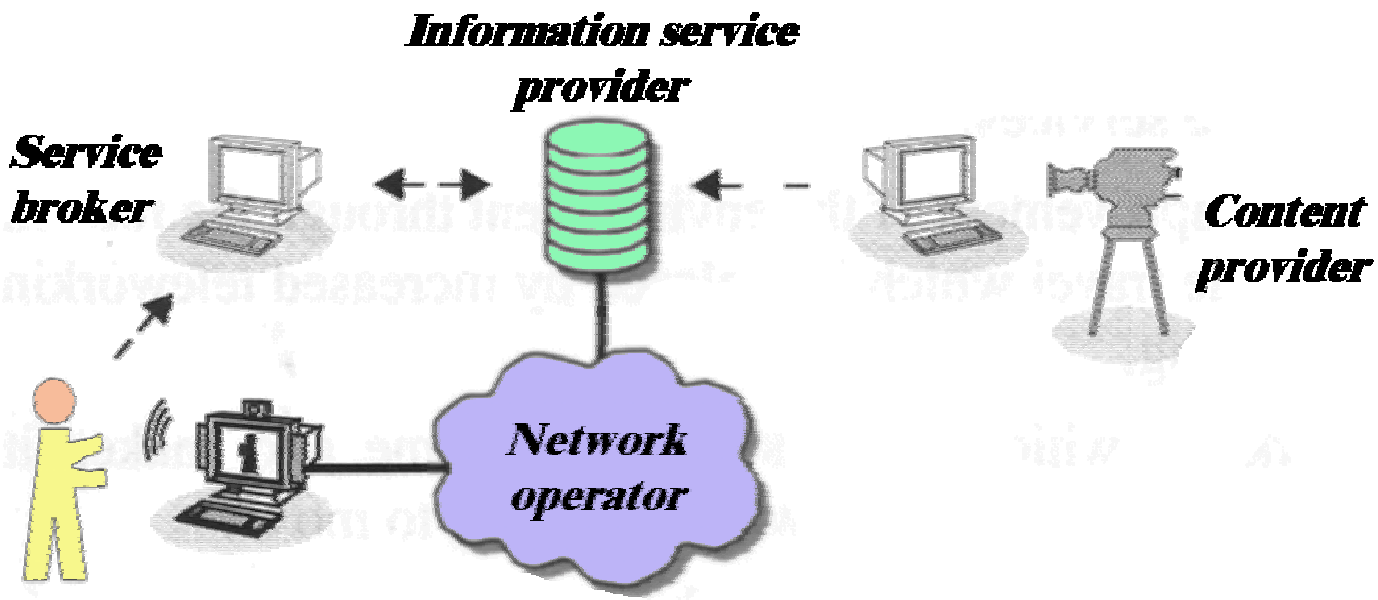
Telecommunications Market



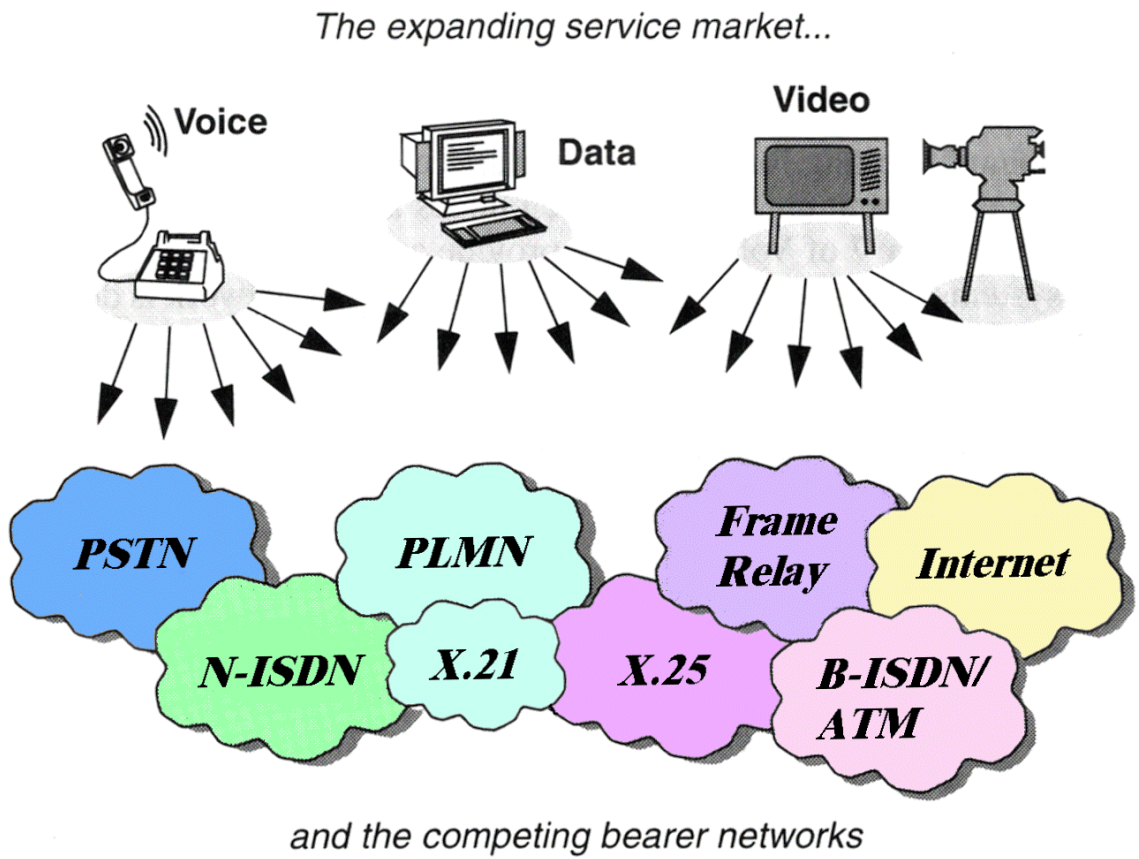
- Telecommunication network content and technology producers, operators and consumers form an interoperable hierarchy

Telecomm Market Players

- **End-users** (individuals , companies, machine-to-machine communications)
- Information **service providers** (Telephone catalog services designed by a company, giving telephone numbers when you give a name or an address... Eniro)
- **Service brokers** sell dedicated service packages (...MySAP)
- Network **operators** (...Elisa, Telia, or Radiolinja)
- **Content providers** (...Paramount Pictures)

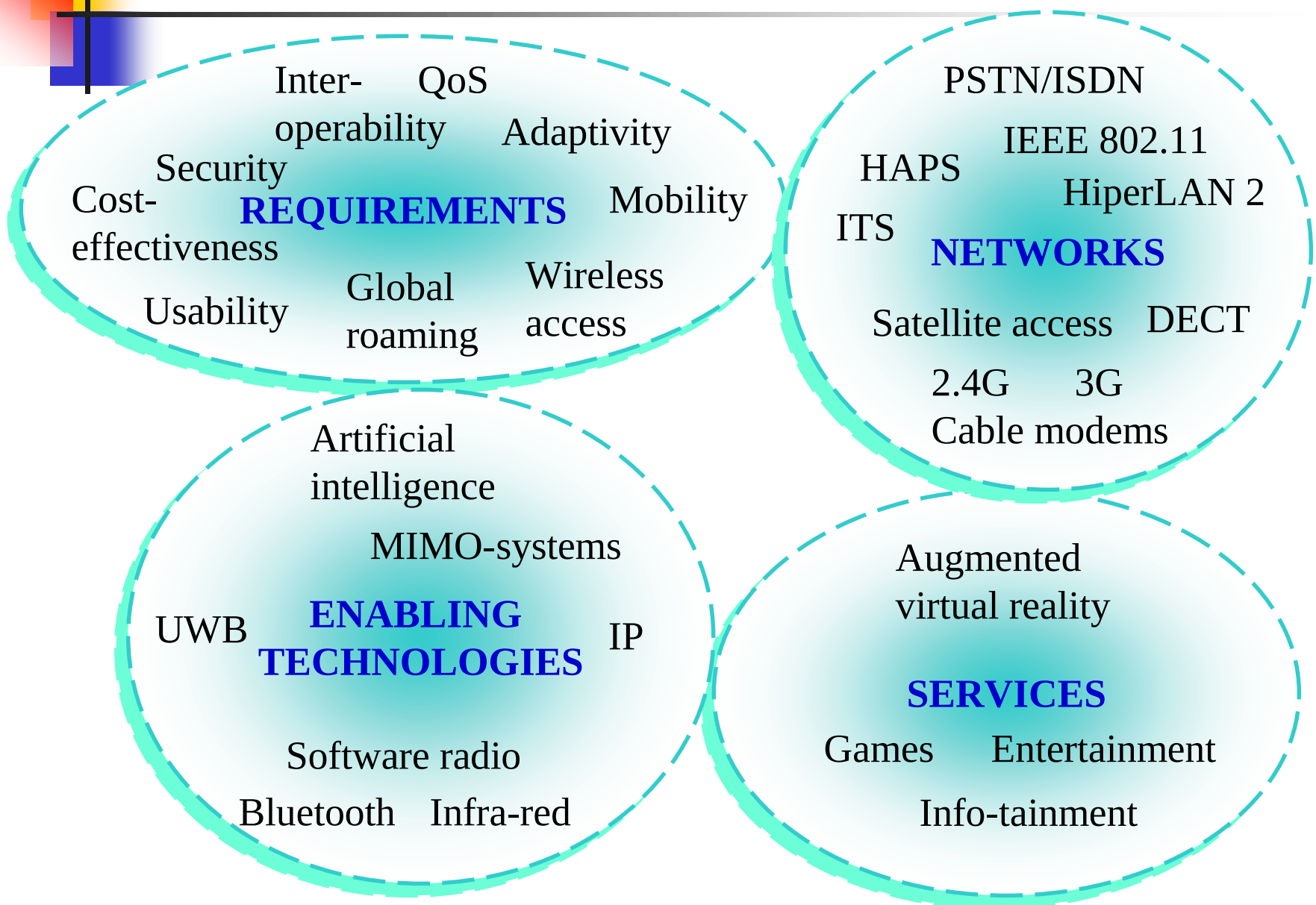


Competition of Service Platforms



- The expanding service markets and the competing bearer networks form an interesting playground!

4G - Framework



Future Trends Summarized

- Inter(net)working between networks increases
- PLMNs and especially wireless LANs develop very fast in home & office networks
- Increasing data rates
- QoS very important
- Traffic gets more symmetrical (P2P)
- PSTN:
  - Is used to transfer more and more data traffic
  - Voice services of PSTN use IP (VoIP) and move to Internet
- Need of seamless communication of NGN means that different networks must link efficiently

PLMN: Public Land Mobile Network, IP:Internet Protocol
SLIP: Serial line IP

Web resources

- xDSL: www.adsl.com
- 3:rd generation PLMN: www.w3.org, www.3gpp.org
- Telehallintokeskus: www.thk.fi
- IEEE standards: www.ieee.org
- Finnish standards: www.thk.fi/tele/suomi/standard.htm
- Network & terminal realization: www.nokia.com
- Have a look on link list at Kurose-Ross's homepage: open resources/references (!)
- ... and so many more!

Important auxiliary use for abundant abbreviations is their applicability for Internet search!