

# Computer networks, data security

## Lecture 1

**Ferenc Peták**

Department of Medical Physics and Informatics  
2018



*„While it took the radio 38 years, and the television a short 13 years, it took the World Wide Web only 4 years to reach 50 million users.”*

### Computer networks: Main topics

1. Definition and advantage
2. Organizational extension
3. Topology
4. Hierarchy
5. Transfer rate
6. Transmission media
7. Scope
8. Communication protocol

## Computer network – 1. definition and advantages

Collection of computers and devices interconnected by **communications channels** that facilitate **communications** among users and allows users to **share resources**

### Advantages:

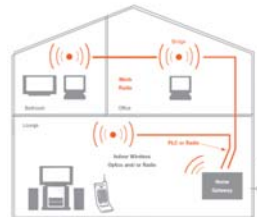
- communication (messages, mails, file sharing)
- sharing hardware and software resources
- uniform distribution of computational power
- more reliable operation
- saving financial resources
- sharing data bases



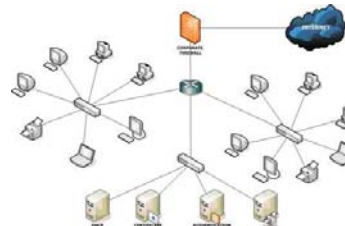
## Computer networks: 2. Organizational extension



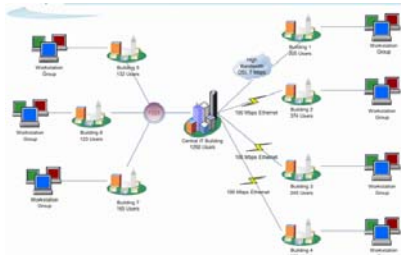
**PAN: personal area network**



**HAN: home area network**



**(W)LAN: (wireless) local area network**



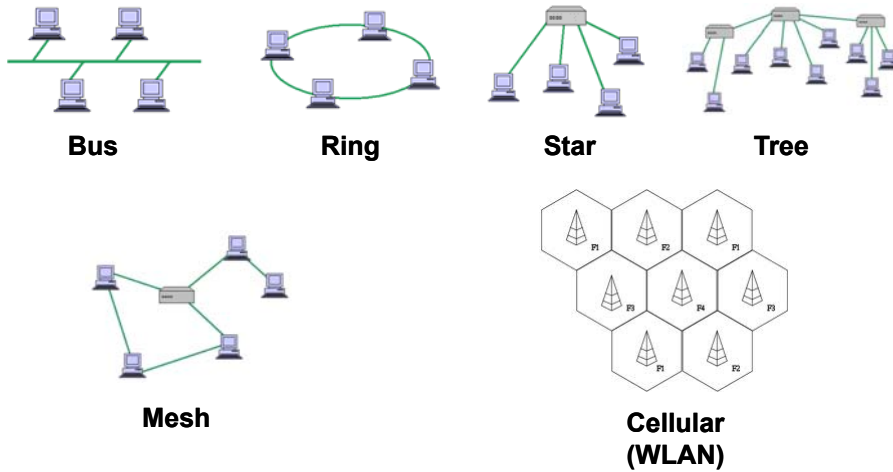
**MAN: metropolitan area network**



**WAN: wide area network**

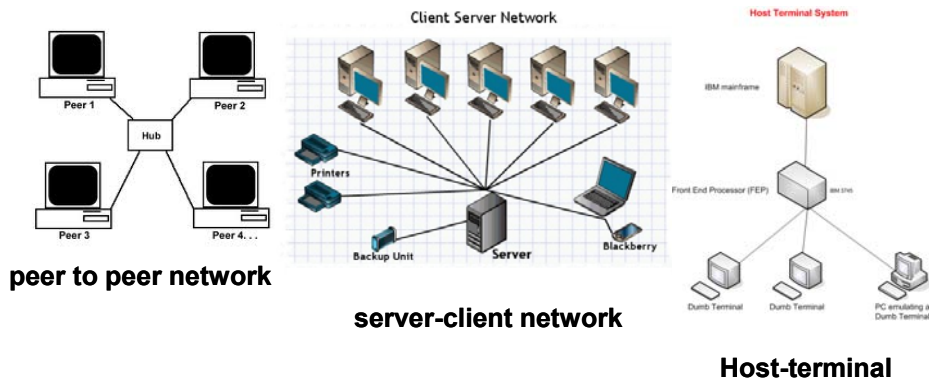
4

### Computer networks: 3. Topology



5

### Computer networks: 4. Hierarchy



- The hierarchy of a computer depends on the application used
- The same computer can be part of a
  - peer-to-peer network (e.g. napster), or
  - server-client network (e.g. web browsing)

6

## Computer networks: 5. transfer rate

### bit/s (not byte/s!)

number of bits transmitted during one second

### baud = signal/sec

number of signal units per second that are required to represent those bits

### baud rate = bit rate / N

where N is no-of-bits represented by each signal shift.



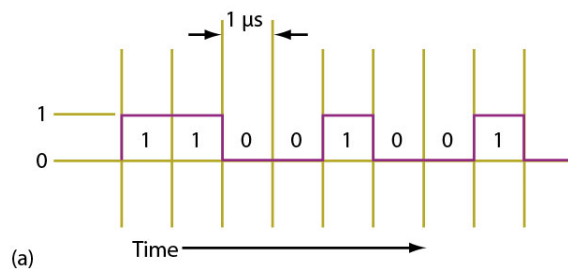
Émile Baudot  
1845-1903  
telegraph engineer

7

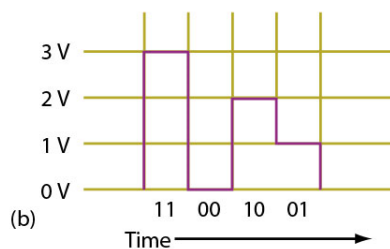
## Computer networks: 5. transfer rate

### bit/s and baud rate: Transfer of 8 bits

**bit rate = Baud rate**  
Each signal shift = 1 bit



**bit rate = 2 x Baud rate**  
Each signal shift = 2 bits



8

## Computer networks: 5. transfer rates

Ethernet LAN	WiFi WLAN	Mobile data
<ul style="list-style-type: none"> <li>• 1975: Experimental 2.94 Mbit/s</li> <li>• 1981: 10 Mbit/s 10BASE5 (coaxial cable)</li> <li>• 1990: 10 Mbit/s 10BASE-T (twisted pair)</li> <li>• 1995: 100 Mbit/s Fast Ethernet</li> <li>• 1999: Gigabit Ethernet</li> <li>• 2003: 10 Gigabit Ethernet</li> <li>• 2010: 100 Gigabit Ethernet</li> </ul>	<ul style="list-style-type: none"> <li>• 1997: 802.11 2 Mbit/s</li> <li>• 1999: 802.11b 11 Mbit/s</li> <li>• 1999: 802.11a 54 Mbit/s</li> <li>• 2003: 802.11g 54 Mbit/s</li> <li>• 2007: 802.11n 600 Mbit/s</li> <li>• 2012: 802.11ac ~1000 Mbit/s</li> </ul>	<ul style="list-style-type: none"> <li>• 1G:                             <ul style="list-style-type: none"> <li>• 1981: NMT 1200 bit/s</li> </ul> </li> <li>• 2G:                             <ul style="list-style-type: none"> <li>• 1991: GSM CSD and D-AMPS 14.4 kbit/s</li> <li>• 2003: GSM EDGE 296 kbit/s down, 118.4 kbit/s up</li> </ul> </li> <li>• 3G:                             <ul style="list-style-type: none"> <li>• 2001: UMTS-FDD (WCDMA) 384 kbit/s</li> <li>• 2007: UMTS HSDPA 14.4 Mbit/s</li> <li>• 2008: UMTS HSPA 14.4 Mbit/s down, 5.76 Mbit/s up</li> <li>• 2009: HSPA+ (Without MIMO) 28 Mbit/s downstreams (56 Mbit/s with 2x2 MIMO), 22 Mbit/s upstreams</li> <li>• 2010: CDMA2000 EV-DO Rev. B 14.7 Mbit/s downstreams</li> <li>• 2011: HSPA+ accelerated (With MIMO) 42 Mbit/s downstreams</li> </ul> </li> <li>• Pre-4G:                             <ul style="list-style-type: none"> <li>• 2007: Mobile WiMAX (IEEE 802.16e) 144 Mbit/s down, 35 Mbit/s up.</li> <li>• 2009: LTE 100 Mbit/s downstreams (360 Mbit/s with MIMO 2x2), 50 Mbit/s upstreams</li> </ul> </li> </ul> <p style="border: 1px solid red; padding: 2px; display: inline-block; color: blue;">2012: 4G: downstream 1Gbit/s, upstream 500 Mbit/s</p>

Source: Wikipedia

## Computer networks: 5. transfer rates

### Typical transfer rates



**10 – 1000 Mbps**



**802.11ac:**  
Theoretical: ~1000 Mbps

**Real:**  
**~ 1 – 150 Mbps**  
(variable)



**4G:**  
Theoretical:  
150-300 Mbps

**Real:**  
**~20 – 100 Mbps**

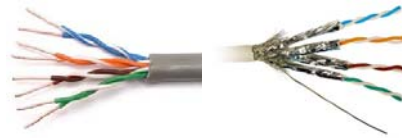
10

## Computer networks: 6. Transmission media

### Wired media



**Coaxial cable**  
(10 Mbit/s)



Unshielded (UTP) (up to 100 Mbit/s)    Shielded (STP) (up to 10 Gbit/s)  
**Twisted pair cable**



Connector



**Fiber optic cable**  
Up to 400 Gbit/s

## Computer networks: 6. Transmission media

### Wireless media

**Laser**



**Infra red waves**



**Radio waves**



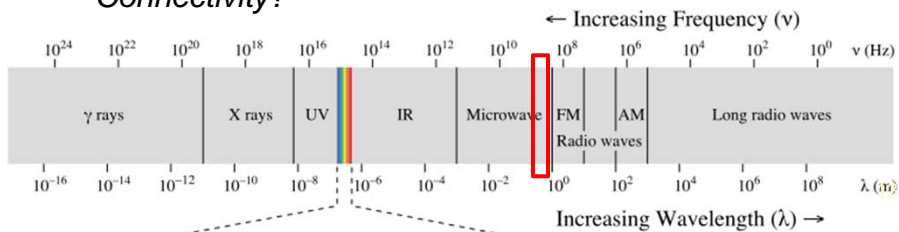
## Wireless media: Wi-Fi



- Connect to the internet wirelessly using microwaves in the 2.4 GHz and 5 GHz bands
- The name is a trademark name (after Hi-Fi)

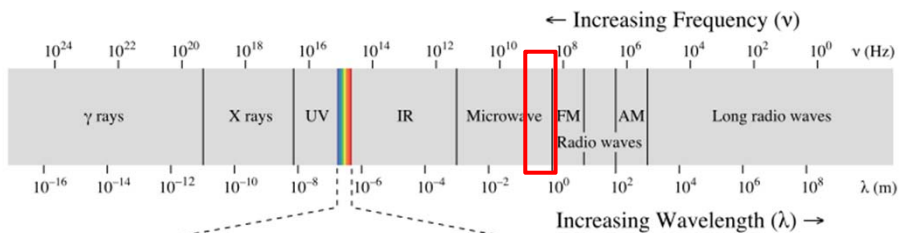


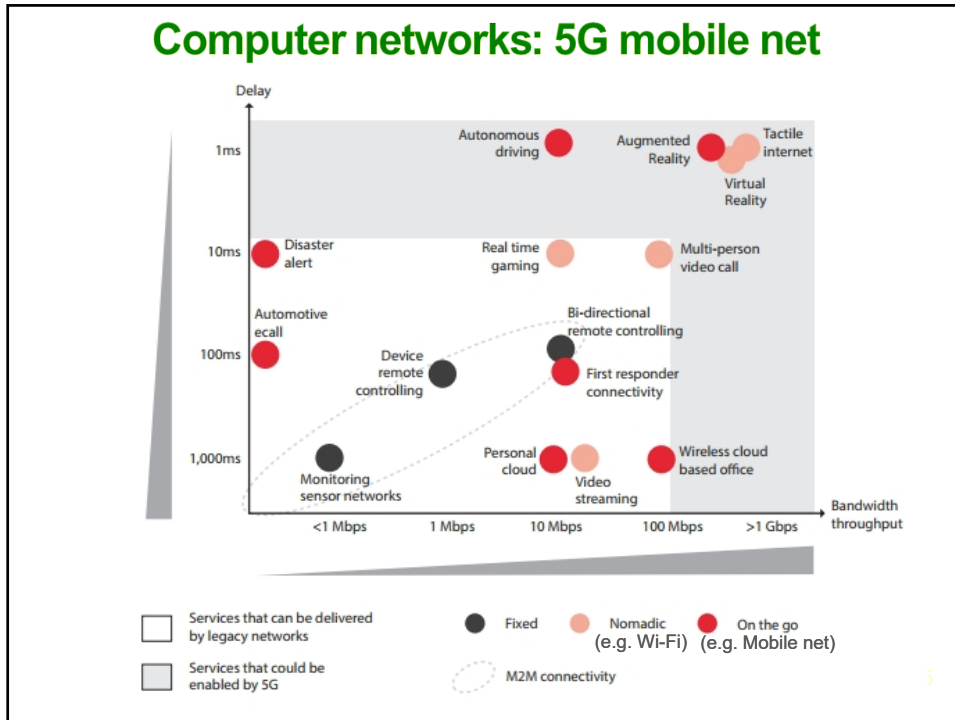
- Security: Wi-Fi Protected Access encryption (WPA2)
- Interference: microwave ovens, security cameras, Bluetooth devices, cordless phones, baby monitors
  - „Why Does Running My Microwave Kill My Wi-Fi Connectivity?“



## Mobile telecommunications technology

- Wireless internet using microwaves in the 800 MHz - 5 GHz bands
- Generations
  - 1981: 1G, analogue
  - 1992: 2G, digital technology
  - 2001: 3G, multi-media support
  - 2012: 4G, ultra broadband access (mobile web, HD mobile 3D TV, cloud computing)
  - 2020: 5G, real time communication (>1 Gbit/s)





5

### Computer networks: 5G mobile net

#### POTENTIAL USES OF 5G

Cloud-based systems will be able to stream software updates, music, navigation data and traffic conditions to driverless cars

Download time for a high-definition full-length movie will be seconds, not minutes

5G speeds offer the potential for simultaneous language translation between people attending a teleconference

Source: [www.raconteur.net](http://www.raconteur.net)

16



## Access to Wi-Fi: Eduroam



- **Education roaming:** secure, world-wide roaming access service developed for the international research and education community



17

## Access to Wi-Fi: Eduroam

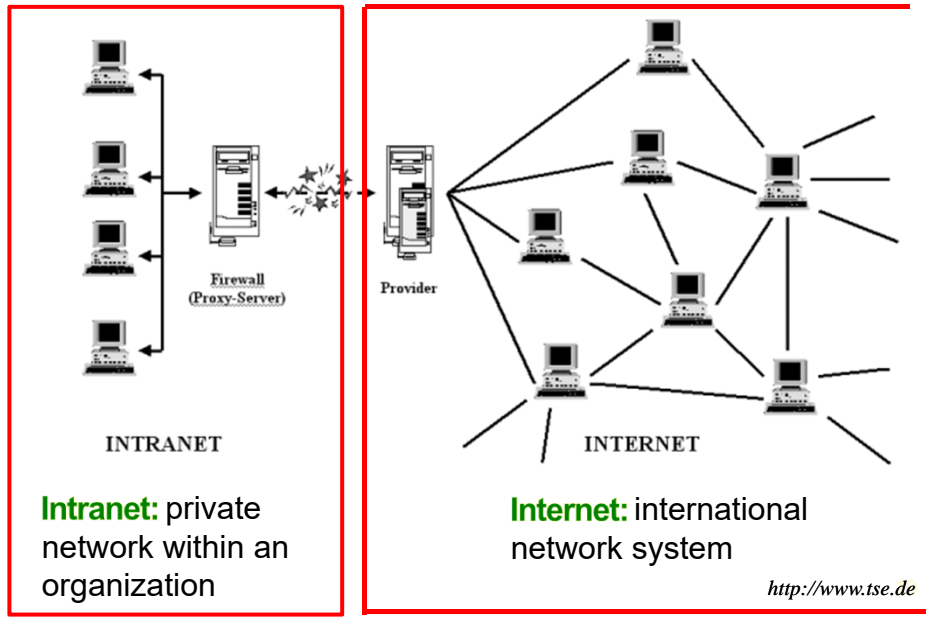


- **Username:** Student ID on the card (10 digits)
  - xxxxxxxxxxx@bibl.u-szeged.hu
- **Password:** birth date (e.g. 01-JAN-70)
- **In Szeged:**
  - Main educational building (Dóm square)
  - Small educational building (Dept. of Medical Physics and Informatics)
  - Ophthalmology Clinics
  - Central library
  - ... more and more locations
- **More information:**

<http://eduroam.bibl.u-szeged.hu/index.en.html>

18

## Computer networks: 7. scope



## Computer networks: 8. Communication protocols

**Description of digital message formats and rules for exchanging data**

**Formats and rules:**

<b>Internet</b>	<b>TCP/IP</b>
<b>Novell</b>	<b>IPX/SPX</b>
<b>Microsoft</b>	<b>NetBEUI</b>

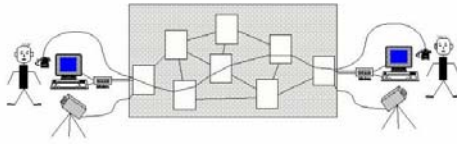
**Main routes:**  
 backbone: principal data routes  
 Hbone: Hungarian backbone

PAN EUROPEAN FIBEROPTIC NETWORK ROUTES PLANNED OR IN PLACE



## Circuit switching vs. Packet switching protocol

### Circuit Switched Network

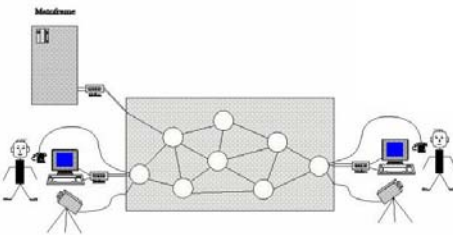


Dedicated route

Receiver

Caller

### Packet Switched Network



Alternative routes

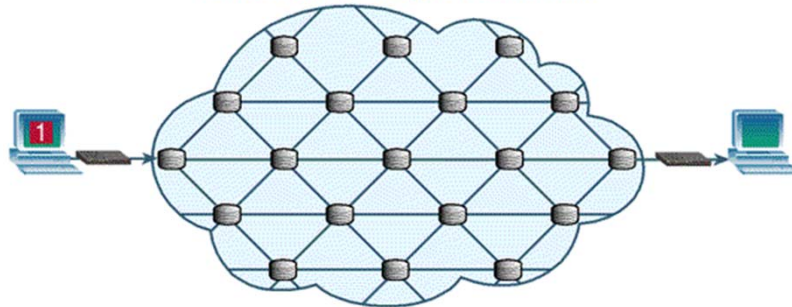
Receiver

Caller

21

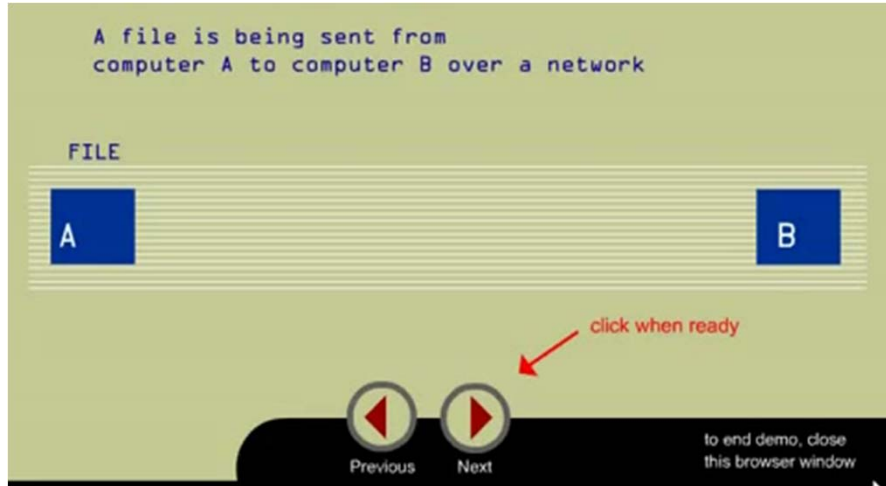
## Data exchange on the Internet: Packet switching protocol

Packet routing through WAN/Internet



[www.boerner.net](http://www.boerner.net)

## Packet switching protocol



23

## Intranet: Computer network of the University of Szeged, Faculty of Medicine

### Medical faculty (ÁOK) LAN:

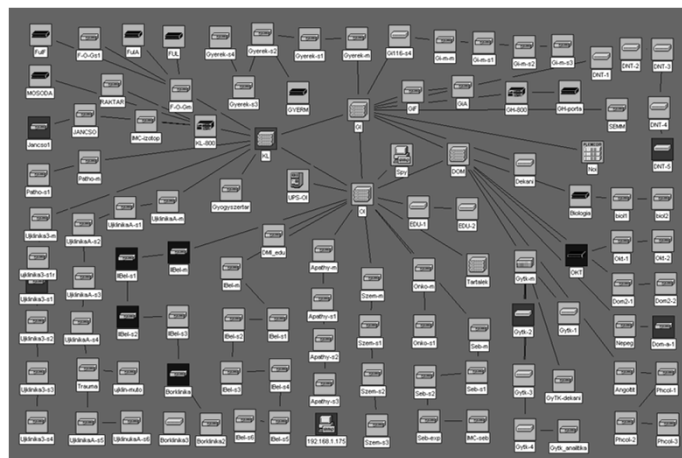
Local backbone with speed of Gbit, 40 Gbit/s outside connection

Number of workstations: ~2000

Servers: ~100

Users: ~2500

Extended star topology



24

## Intranet: Computer network of the University of Szeged, Faculty of Medicine

**Novell Network servers for institutes**

**Server for local administration:**  
 IBM RS6000:  
 Hospital Information System (MedSol)

Laboratory, SAP

Linux: mail, webserver, nameserver



25

## NIIF/Hungarnet

The HBONE, Hungarian backbone main routes

