Infocommunication systems
Infokommunikációs rendszerek
1. előadás

Takács György

A tantárgy célja

- Mérnök informatikus hallgatók számára az infokommunikációs rendszerek alapjainak elsajátítása és a rendszerszemlélet kialakítása.
- A konvergálódó távközlési, számítástechnikai és műsorközlő rendszerek, szolgáltatások alapelveinek, fejlődési irányainak megismerése.

Mit tartalmaz a tárgy?

- INFOCOM = INFOrmation and COMmunication
- Elsőként (távközlés)technológiai alapokat, alapelemeket (dobozokat),
- A technológiai alapelemekből építhető rendszereket, hálózatokat,
- A rendszereken nyújtható szolgáltatásokat,
- A szolgáltatásokra épülő alkalmazásokat,
- Üzleti környezetet,
- Szabályozási kérdéseket,
- Laboratóriumi méréseket (előírt labor keretében),

Milyen ez a tárgy?

- Nehéz, mert ez nagyon összetett tudomány!
- Nehéz, mert angolul kell tanulni és vizsgázni!
- Nehéz, mert vastag a könyv!
- Hasznos, mert ezen tudomány nélkül félkarú vagy sánta a műszaki informatikus!
- Hasznos, mert sokan ebből fognak megélni!
- Hasznos, mert vannak sok olyan alapelv, amely változatlanul érvényben lesz és használatukban lesz még 2050-ben is!

Miért különösek az infokom rendszerek?

- Ilyeneket nem lehet boltban vásárolni! Meg kell ezeket tervezni, meg kell építeni, működtetni kell, az igények ütemében bővíteni és fejleszteni kell, végül fel kell számolni, ha már nem kell.
- Álmodnak róla, eldöntik, hogy kell és milyen legyen, létrejön, fejlődik, problémák merülnek fel vele kapcsolatban, amiket orvosolni kell, együtt kell élnie és működnie más rendszerekkel, végül elavul, nem kell senkinek, fel kell számolni, átveszik helyét az új generációk.
- Nem az ICT mérnökök játékszere, nem is műszaki kritériumok alapján születik, fejlődik és hal ki.
- Az infokom világot a verseny és az ÜZLET mozgatja. A befektetők ide teszik a pénzt, ha van haszna, ha nincs, befektetik máshol. Valamikor szolgálatként kezelték, mint a mentőket, a tűzoltókat, rendőrséget, hadsereget……
- Ma már nincs normális élet infokom rendszerek nélkül. Képzeljék el mindennapjaikat telefon, rádió, TV, Internet, mobil, bankkártya, CD, számítógép együttműködő rendszerei nélkül. Hogy működne egy patika, egy frankfurti repülőtér vagy egy bank enélkül?
- Ma Magyarországon többet költünk infokom termékekre és szolgáltatásokra, mint élelmiszerre (beleértve a kenyeret, húst, gyümölcsöt, sört…..)
- Már több, mint 7 milliárd mobil előfizetés működik…..

Az oktatás rendje --tantárgykövetelmények

- Előadások angolul
- Rövid magyar bevezető
- Rövid magyar összefoglaló a végén
- Előadás megszakítható angol kérdéssel
- Támogató könyv, ami szinte mindent tartalmaz magyarul, angolul, ingyen, on-line (kérem, hogy ne nyomtassák ki sok példányban, mert nyelvenként kb. 1100 oldal) http://regi.hte.hu/online_konyv
- A vizsgaidőszakban minden héten legalább egy napon lehet vizsgázni
- Zárthelyi a 10. héten (november 12-én) 9:15-10:15 ?????
- Pótzárthelyi egyeztetett időpontban az utolsó tanítási héten,
- Vizsgafeltétel zárthelyi (vagy pótzárthelyi) eredményes megírása
- Szóbeli vizsga angol nyelven kollokvium stílusban
- Minden előadás dia megjelenik a honlapomon az előadás után http://users.itk.ppke.hu/~takacsgy/
- Szószedet csak papíron, csak a jelenlévőknek

	Dátum	Téma
1	2018. 09. 10.	Bevezetés az infokommunikációs rendszerek világába
2	2018. 09. 17.	Vezetékes átviteli rendszerek (sodrott érpárak, koaxiális kábelek, fényvezető kábelek)
3	2018. 09. 24.	Rádiós átviteli rendszerek (földfelszíni, cellás, műholdas)
4	2018. 10. 01.	Kódolás, nyalábolás, kapcsolás rendszerei, megoldásai
5	2018. 10. 08.	Hálózat struktúrák, PSTN hálózatok, gerinchálózatok
6	2018. 10. 15.	Mobil hálózatok és rendszerek
	2018. 10. 22.	Nemzeti ünnep
	2018. 10. 29.	Őszi szünet
7	2018. 11. 05.	Műsorközklő rendszerek, IPTV
8	2018. 11. 12.	Zárthelyi,
9	2018. 11. 19.	Magánhálózatok, épületen belüli hálózatok, infokommunikációs szolgáltatások
10	2018. 11. 26.	ADSL megoldások, hálózati végberendezések, szolgáltatások nyújtásának szabályai
11	2018. 12. 03.	ADSL rendszerek, rádiós adathálózatok (WiFi, WiMAX, bluetooth)
12	2018. 12. 10.	Összefoglaló, az infokommunikációs rendszerek és szolgáltatások következő generációi

The focus area of this course

- In this course the basics of infocommunication systems and the system oriented approach are in the focus for students of information technology.
- The convergence of the three mean area: telecommunications, computer systems and content provision are discussed including the common technical and business development trends.

What are the topics of this course?

- INFOCOM = INFOrmation and COMmunication
- Basics of telecommunications technology and basic components, boxes, building blocks
- Systems and networks constructed from building blocks and boxes
- Services based on systems and networks
- Applications based on the services
- The business aspects of telecommunications
- Telecom regulations issues
- Laboratory exercises, demonstrations, in the frame of laboratoy exercises

On this course

- Telecommunications are very sophisticated kind of technical sciences,
- The English (or Hungrish) language can cause problems during lessons and exam,
- The text book has about 1100 pages – and that is not a simple enjoy to understand it, http://regi.hte.hu/onlinebook
- Useful to understand telecommunications, because this field is an essential part of information technologies. Without this part of knowledge an engineer may be only partial expert of IT!
- Useful because some of you can live well on this knowledge.
- Useful because principles of telecommunications will be valid and usable even in 2050!

1	2018. 09. 10.	Introduction to infocommuncation systems
2	2018. 09. 17.	Wireline transmission systems (twistedd pair, coaxial, fibre)
3	2018. 09. 24.	Radio based transmission systems (terrestrial, cellular, satellite)
4	2018. 10. 01.	Coding, multiplexing, swithing systems
5	2018. 10. 08.	Network structures, PSTN networks, core networks
6	2018. 10. 15.	Mobile networks and systems
	2018. 10. 22.	National holiday
	2018. 10. 29.	Autumn holiday
7	2018. 11. 05.	Media systems, IPTV
8	2018. 11. 12.	Written test
9	2018. 11. 19.	Private systems, indoor networks, infocom services
10	2018. 11. 26.	ADSL systems, terminals, regulation of infocom service provision
11	2018. 12. 03.	Radio based data networks (WIFI, WIMAX, bluetooth)
12	2018. 12. 10.	Summary, next generations os infocom networks and services

Rules of this course

- Lectures will be held in English
- Short (max 10 min.) Hungarian introduction
- Short (max 5 min.) Hungarian summary at the end
- Presentation can be interrupted by English questions
- Textbooks are available both in English and Hungarian electronic form free of charge. Volume is 1100 pages (each). Please protect forests, do not print it!
- http://regi.hte.hu/onlinebook
- Further books can be find in the library (English and Hungarian).
- Verbal exam will be organised one or more per week. I prefer classic low stress version. A group of students will be present. Each of them can agree with (or correct) the actual answer.
- Precondition for exam: successful written test in week No10. Or the second written test in the case of unsuccessful one.
- Slides are shown on my homepage.
- http://users.itk.ppke.hu/~takacsgy/

Why the infocom systems are very particular?

- You could not buy such complete systems. You have to plan, to construct, to operate, to develop according to the actual demands and to eliminate at the end of their life cycle.
- You have to dream on a new infocom system and have to decide its operation parameters. You have to solve the operational problems and the problems of cooperation with other systems.
- The INFOCOM systems are not developed based on pure technical aspects.
- The INFOCOM systems are rather promoted by the business world. The investors put their money in this industry only if it is competitive in general. In other cases the investors put their money rather in other business areas like casinos or real estates…..
- 40 years ago telecom services were considered as public services like the ambulance services or the fire brigades or the POLICE…..
- Recently the normal human life needs the basic infocom systems. Could you imagine your life without mobile phones, without internet, without bank cards? How can a bank or airport can serve the clients without infocom systems?
- Recently in Hungary one citizen spend more money on infocom products and services than foods (including bread meet, fruits, beer….)
- Globally more than 5 billion persons have mobile phones.

Why infocom for computer engineers?

- Internet is TELECOM based
- CONVERGENCE
- Mobile communications, smart phones, tablets have fastest growing penetration
- The infocom systems have **the fastest develeopment speed** compared to any other tehcnical area!

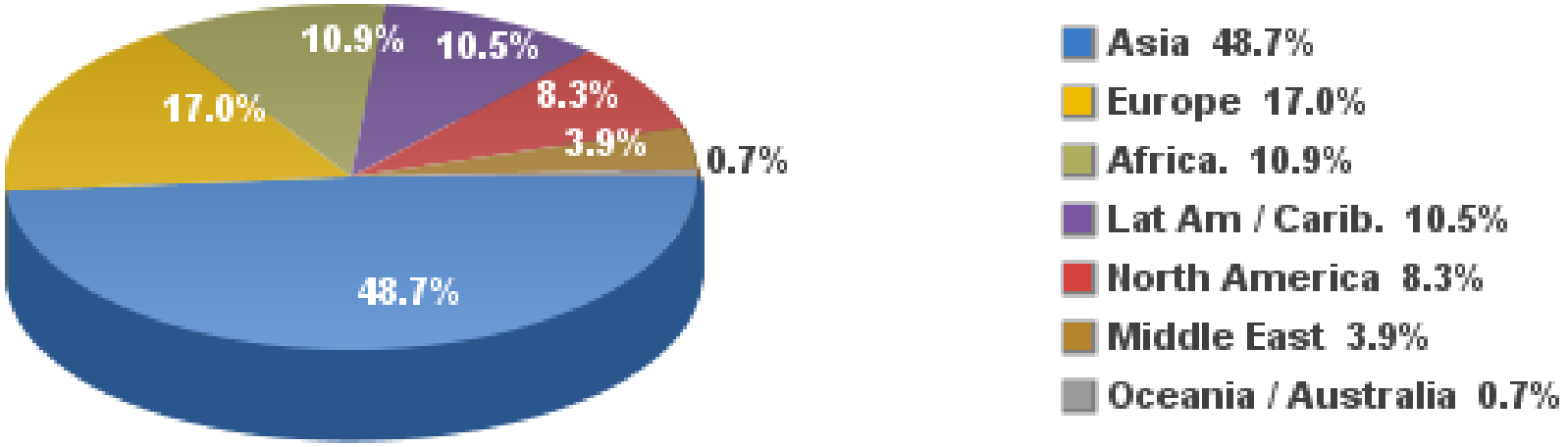
WORLD INTERNET USAGE AND POPULATION STATISTICS
DEC 31, 2017 - Update

World Regions	Population (2018 Est.)	Population % of World	Internet Users 31 Dec 2017	Penetration Rate (% Pop.)	Growth 2000-2018	Internet Users %
Africa	1,287,914,329	16.9 %	453,329,534	35.2 %	9,941 %	10.9 %
Asia	4,207,588,157	55.1 %	2,023,630,194	48.1 %	1,670 %	48.7 %
Europe	827,650,849	10.8 %	704,833,752	85.2 %	570 %	17.0 %
Latin America / Caribbean	652,047,996	8.5 %	437,001,277	67.0 %	2,318 %	10.5 %
Middle East	254,438,981	3.3 %	164,037,259	64.5 %	4,893 %	3.9 %
North America	363,844,662	4.8 %	345,660,847	95.0 %	219 %	8.3 %
Oceania / Australia	41,273,454	0.6 %	28,439,277	68.9 %	273 %	0.7 %
WORLD TOTAL	7,634,758,428	100.0 %	4,156,932,140	54.4 %	1,052 %	100.0 %

NOTES: (1) Internet Usage and World Population Statistics estimates in Dec 31, 2017. (2) CLICK on each world region name for detailed regional usage information. (3) Demographic (Population) numbers are based on data from the United Nations Population Division. (4) Internet usage information comes from data published by Nielsen Online, by the International Telecommunications Union, by GfK, by local ICT Regulators and other reliable sources. (5) For definitions, navigation help and disclaimers, please refer to the Website Surfing Guide. (6) The information from this website may be cited, giving the due credit and placing a link back to www.internetworldstats.com.

Source: https://www.internetworldstats.com/stats.htm

Internet Users in the World by Regions - December 31, 2017



Source: Internet World Stats - www.internetworldstats.com/stats.htm
Basis: 4,156,932,140 Internet users in December 31, 2017

Source: https://www.internetworldstats.com/stats.htm

	2017	2023	CAGR
Worldwide mobile subscriptions	7.8bn	8.9bn	2%
Worldwide smartphone subscriptions	4.3bn	7.2bn	9%
Worldwide mobile broadband subscriptions	5.3bn	8.3bn	8%
Worldwide LTE subscriptions	2.7bn	5.5bn	12%
Worldwide monthly data traffic per active smartphone	3.4GB	17GB	31%
Worldwide total monthly mobile data traffic	15EB	107EB	39%

2 billions of people have no healthy tap water

the majority of them has mobile phone

Global Internet traffic

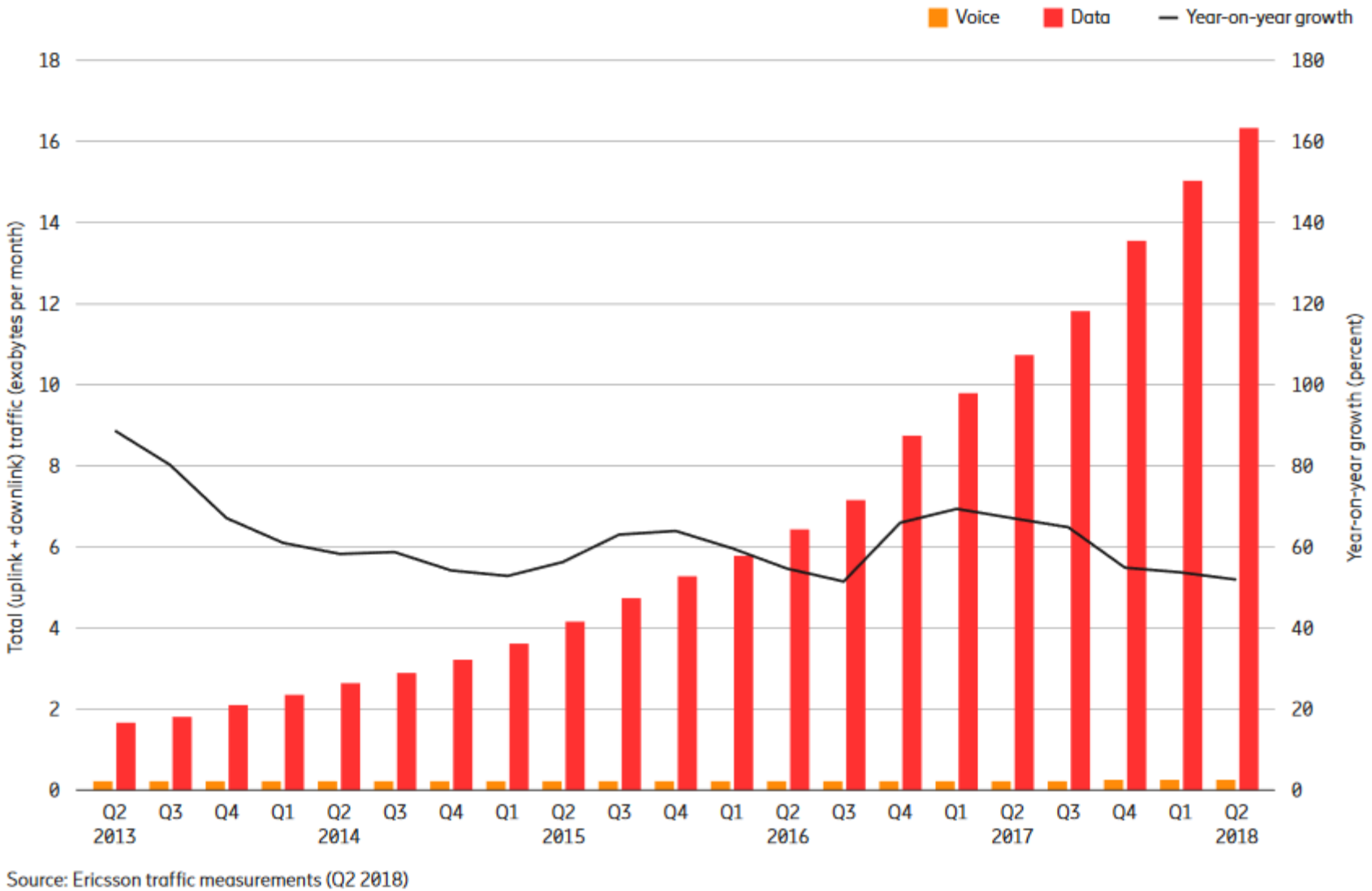
Table 1. Global IP Traffic, 2015–2020

IP Traffic, 2015–2020							
	2015	2016	2017	2018	2019	2020	CAGR 2015–2020
By Type (Petabytes [PB] per Month)							
Fixed Internet	49,494	60,160	73,300	89,012	108,102	130,758	21%
Managed IP	19,342	22,378	25,303	28,155	30,750	33,052	11%
Mobile data	3,685	6,180	9,931	14,934	21,708	30,564	53%
By Segment (PB per Month)							
Consumer	58,539	72,320	89,306	109,371	133,521	162,209	23%
Business	13,982	16,399	19,227	22,729	27,040	32,165	18%

The petabyte (symbol PB) is 10^{15} bytes of digital information

Source: White paper: Cisco VNI Forecast and Methodology, 2015-2020

Mobile traffic, Mobile data traffic



Source: Ericsson traffic measurements (Q2 2018)

exabyte 1 EB = 10^{18}bytes = 1000 petabytes = 1million terabytes = 1billion gigabytes.

The number of potential subscribers will be saturated soon! What about on Internet traffic?

- In 2018 the total transit traffic estimated by user access points 4400 petabytes/day and doubling within one year
- How much is the amount of 4400 petabytes?
- The Library of Congress (No1 on the globe) has about 5 petabytes (including books, papers, videos)
- Nowadays users download 880 times equal content of the Library of Congress per day! The 80% of this traffic is generated by private users (consumers). The traffic growth is increasing!!!

2. Samsung Galaxy Note 8

One of the highest-spec phones on the market

Release date: August 2018 | **Weight:** 205g | **Dimensions:** 162 x 76.4 x 9mm | **OS:** Android 8.1 | **Screen size:** 6.4-inch | **Resolution:** 2960×1440 | **CPU:** Exynos 9810 | **RAM:** 6/8GB | **Storage:** 128/512GB (up to 1TB with card) | **Battery:** 4,000mAh | **Rear camera:** 12MP + 12MP | **Front camera:** 8MP

The alpha generation (born after 2010) started the school in in 2017. Usining infocom systems seems to be absolute natural activity for them.

The **INTEL Corporation** has announced the production of a **new processor system**!

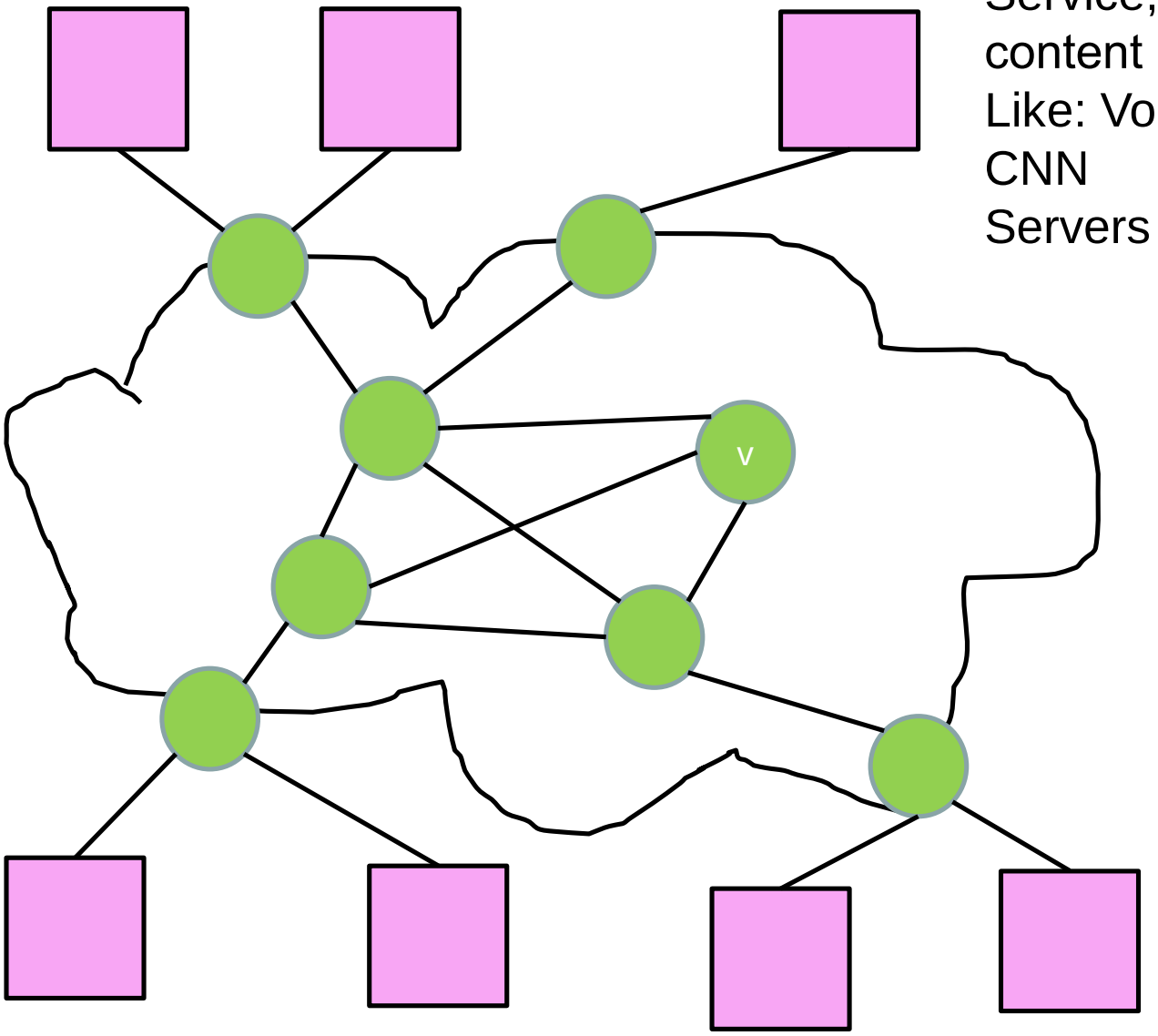
- This processor system can couse revolution in computer systems, capable to reduce the size an costs of computers, might be the basis of more intelligent devices.
- **Have hou heard it?**

The mass produciton of Intel 8080 microprocessor was started **in April 1974.**

This compact, 24-bit general-purpose computer was designed for aviation and navigation……
Weighing only a few kilograms, the computer was used for guidance on the Poseidon submarine-launched ballistic missile and for fuel management on the B-1 bomber. It was even considered for the space shuttle.

Source: IEEE Spectrum
The Surprising Story of the First Microprocessors,
By Ken Sheriffc 30 Aug 2016

Typical networks

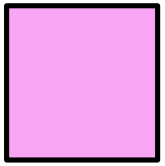


Service, application and content providers….
Like: Vodafone, CIB Bank, CNN
Servers

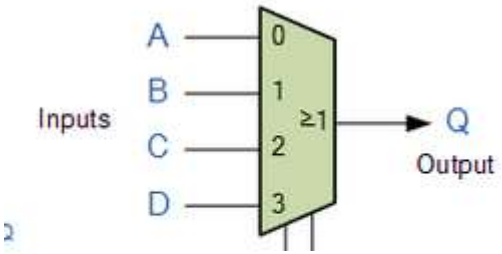
Network operators
Transmission lines,
Multiplexers,
Routers,
Switches

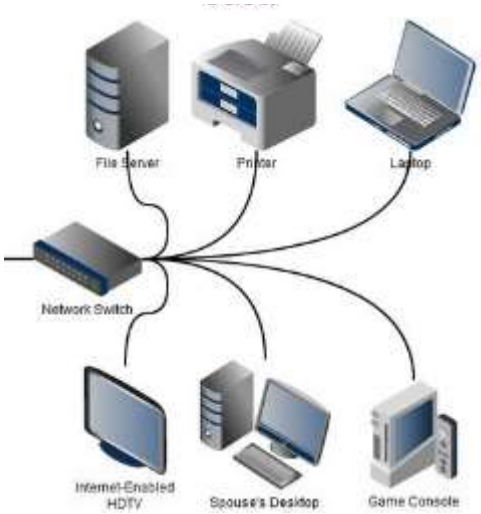
End user devices (owned by subscribers, companies)
Mobile sets, TV sets, computers

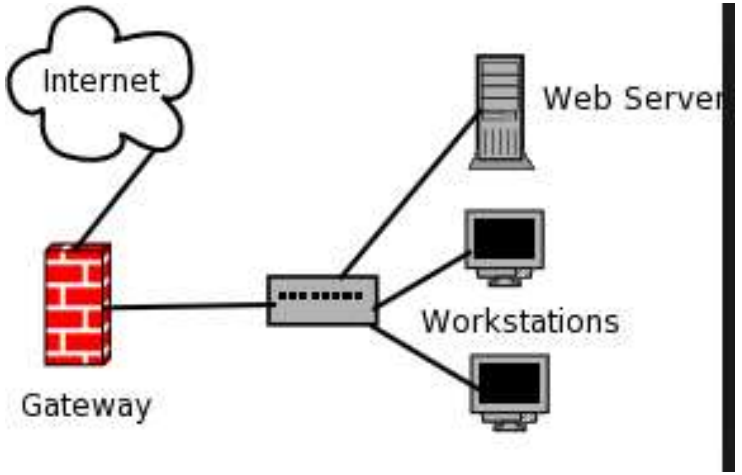
End systems in infocommunication: stations, hosts, terminals



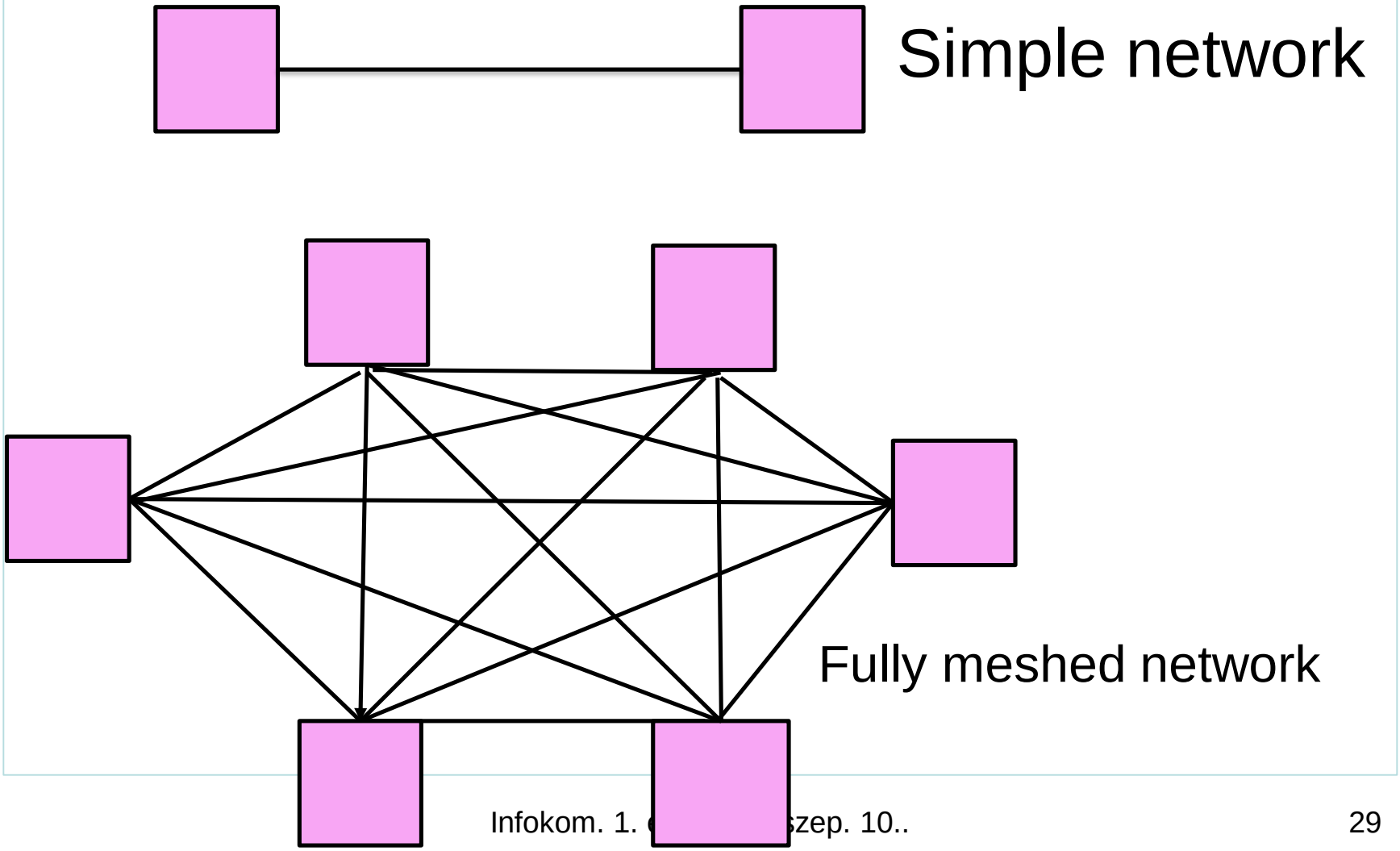
Node elements in infocommunication: multiplexers, switches, routers, gateways







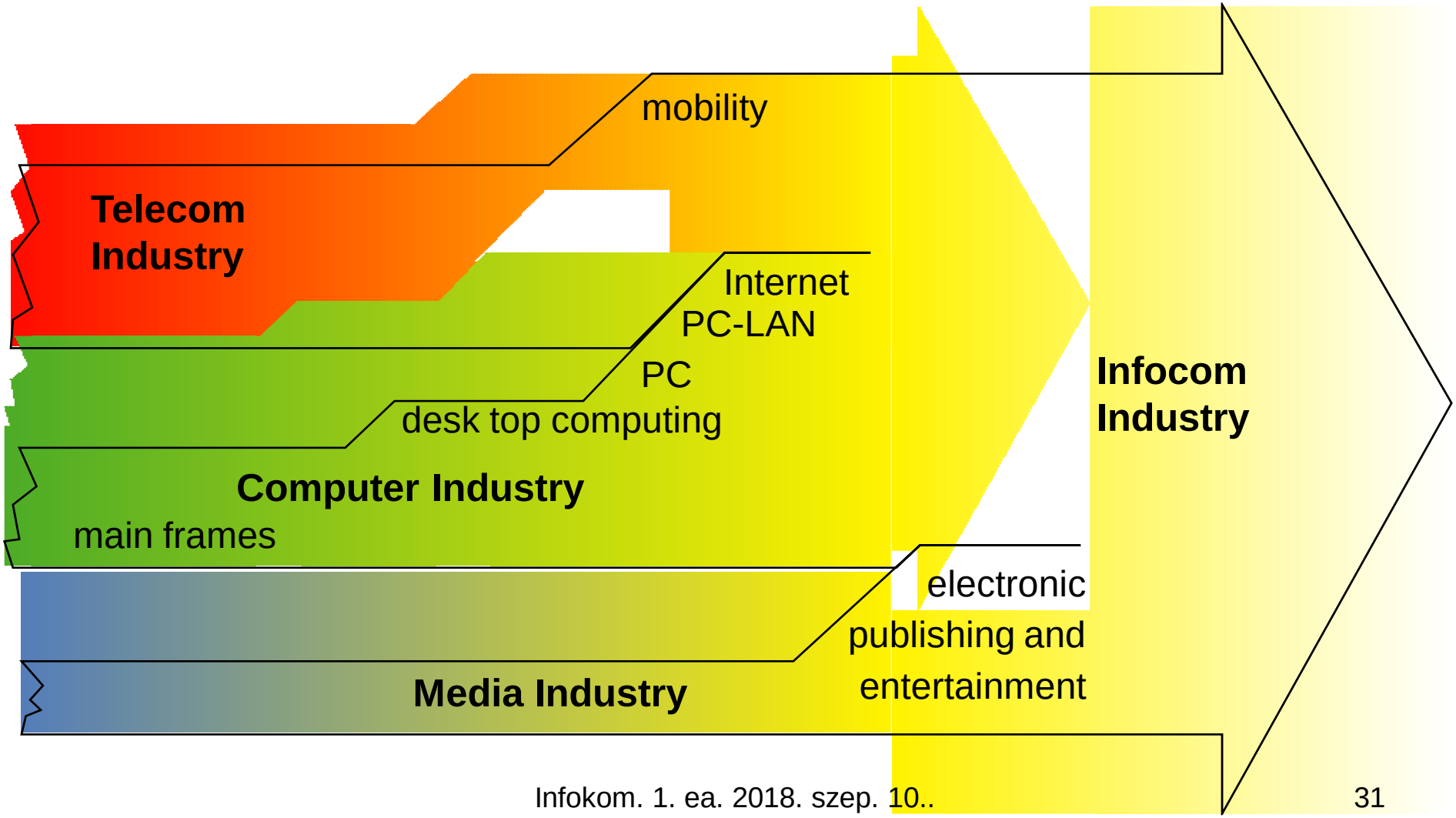
Basics of networks



Links, connections in the network

- Wireline (twisted pairs, coaxial, optical cables)
- Radio connections (indoor, terrestrial, satellite)

Convergence



What is the source of convergence?

Development of technology???

Market demand???

Several reasons:

- Common technology platform – digital technology – common development rate,

  •Unlimited telecom possibilities – no practical limit in bandwidth and no limit in geographic distance

  •Store, copy and searching of information content

  •Mobile communications

Convergence in networks

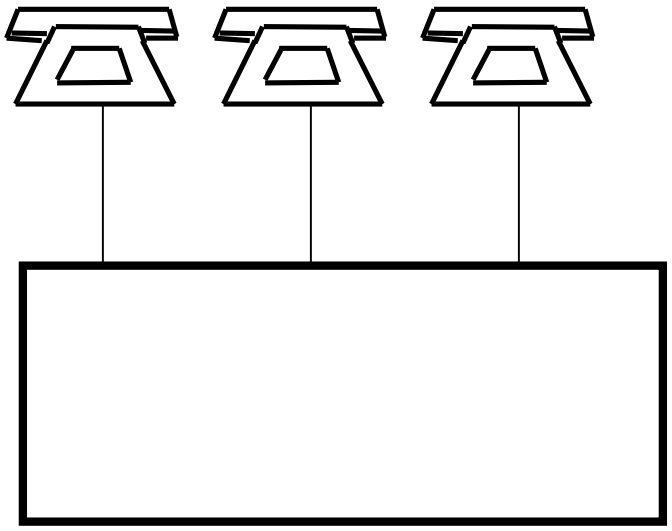
- Traditionally separate networks and different technologies for telephone, for cable TV, for radio program broadcasting, for data communications
- Today: we make telephone calls on CaTV networks, on Internet, we access to Internet via telephone lines (ADSL) or using Mobil telephone networks
- Today we download films on Internet and can receive TV news on mobile networks
- ……..

Convergence in terminals

- Traditionally it was telephone, TV set, computer, CD player……
- Today: we play MP3 files on mobile telephone, watch TV programs on Computer, edit excel files on mobile phone, read e-mails on TV screen….
- Today the refrigerator can order beer by internet, we can control the heating of our room by mobile , the copy machine sends the scanned documents as e-mail attachment, the *surveillance* system send messages if the dog went out from the garden, IOT in self driving cars .....
- Which intelligent equipment is not a real terminal?

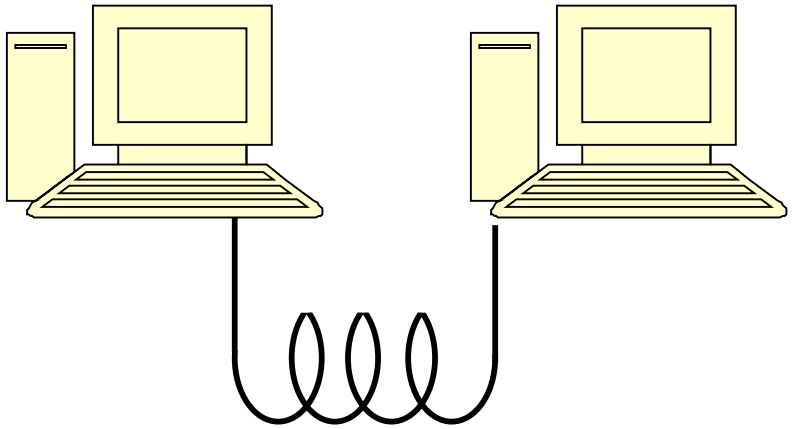
Telecom people -- computer people
Cultural differences I.

Stupid terminals



intelligent network

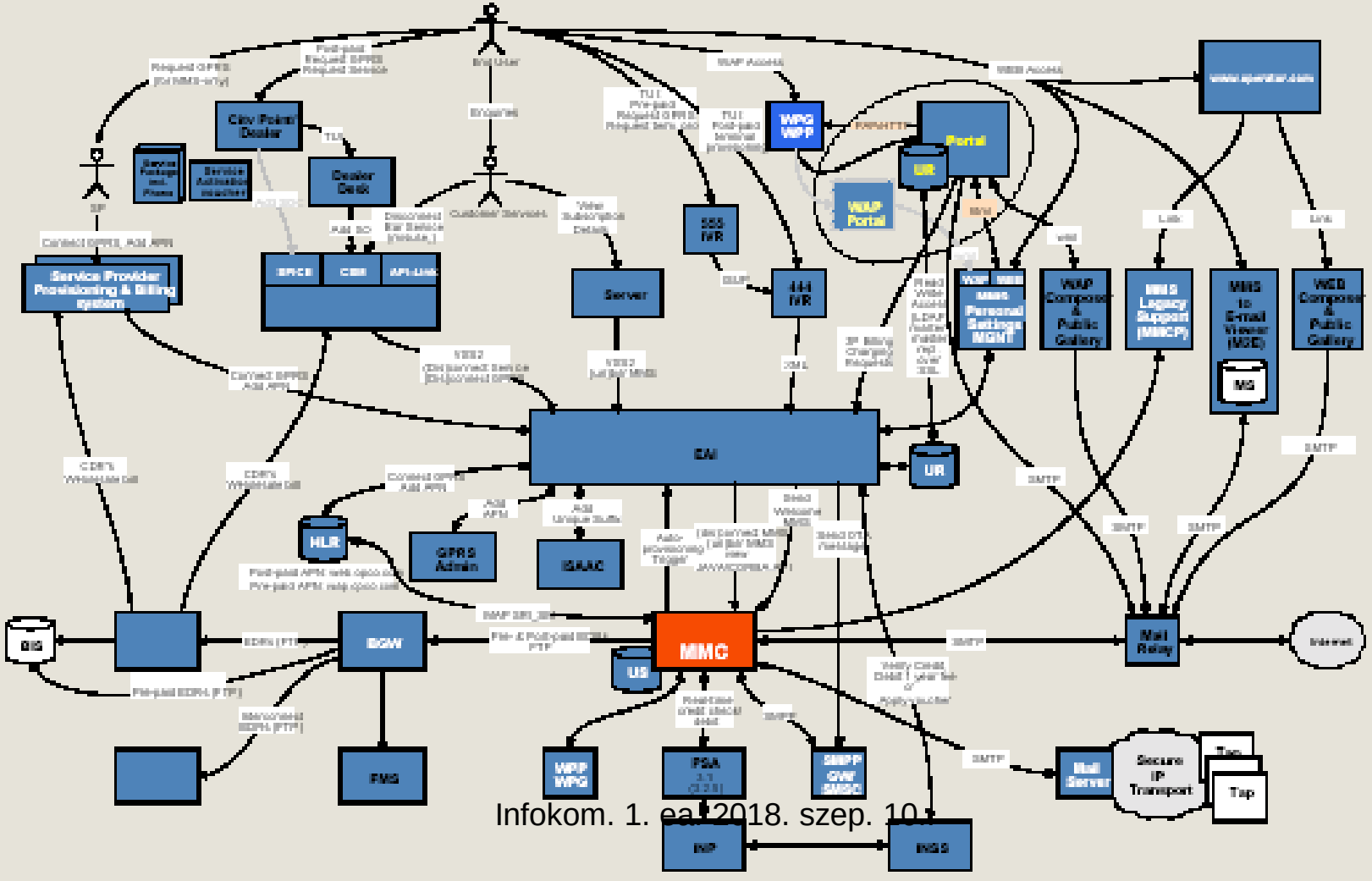
Intelligent terminals



Stupid networks

ERICSSON

És a valóság...



Telecom world -- computer world
Cultural differences II.

Telecom world	Computer world
Sate monopoly/income	totally market oriented
International standards	Proprietary solutions
Detailed legal regulation	Self regulation (if any: such as Facebook)
Statistical figures available	Estimations only

The big competition in the INFOCOM game (source: Carelli, EURESCOM)

- Processing power
- Transmission capacity
- Storage capacity
- *Is it cheaper a stored bit, a processed bit or a travelling bit?*
- *How will its cost vary with time?*

Three “decreasing costs” for a bit

Processing **Transmitting** **Storing**

Who is running faster?

Moore law on processing power	**The processing power doubling within 18 months**
Gilder law on bandwidth	**The total bandwidth tripling within 12 months**
Metcalf law on the values of networks	**The potential value of networks are proportional with the quadrate of users**
Shugart law on the price of memory capacity	**The price per bit in magnetic storage devices halving within 18 months**
Ruettgers law on the storing capacity	**The memory capacity doubling within 12 months**
Wacker law on meta-data	**The information related to a transaction can have more value than the transaction itself**

Statements:

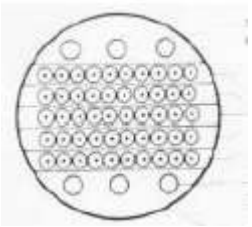
1. The winner is the bit transport
2. We are in the age of practically infinite bandwidth
3. We are in the age of the practically free bandwidth („too cheap to meter”)
4. No distance limits within the globe
5. These facts together can lead to revolution in the field of infocommunications

Verification No 1. (The bit transport is the winner)

- Highest exponent
- The physical limits are close in memories and processors

Verification No 2. (infinite bandwidth in fibre optic cables)

- 10Gbit/s per carrier
- 1000 carrier per fibre
- 1000 fibre per cable



- Totally 10^{16} bit/s/cable
- Can be considered 10^{16} bit/s as practically infinite bandwidth?

Verification No 2. (infinite bandwidth)

- 1 human life ~80 years
- 1 human life ~ $2{,}5*10^9$ s
- Video downloads with normal quality ~ 1Mb/s

- 1 optical cable is suitable to download within 1 s videos for 4 persons full life!! (80 years, 365 days per year, 24 hours per day)

Verification No 3. (free bandwidth)

- PPKE has connection to the NIIF network by 2 Gb/s link
- The leasing fee for the dark fibre takes about 200.000 Ft/month
- Can be considered this value free????

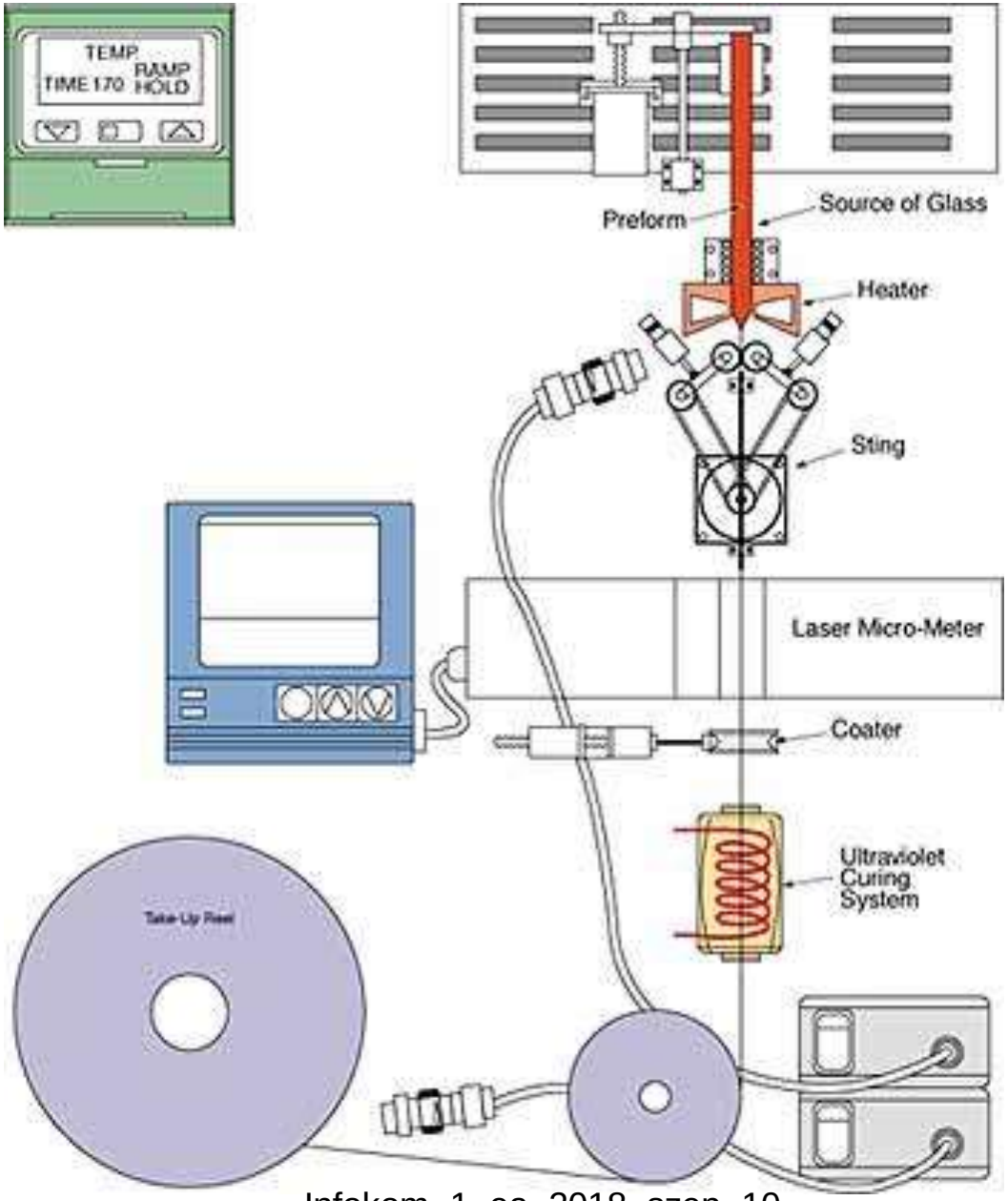
Verification No 3. (free bandwidth)

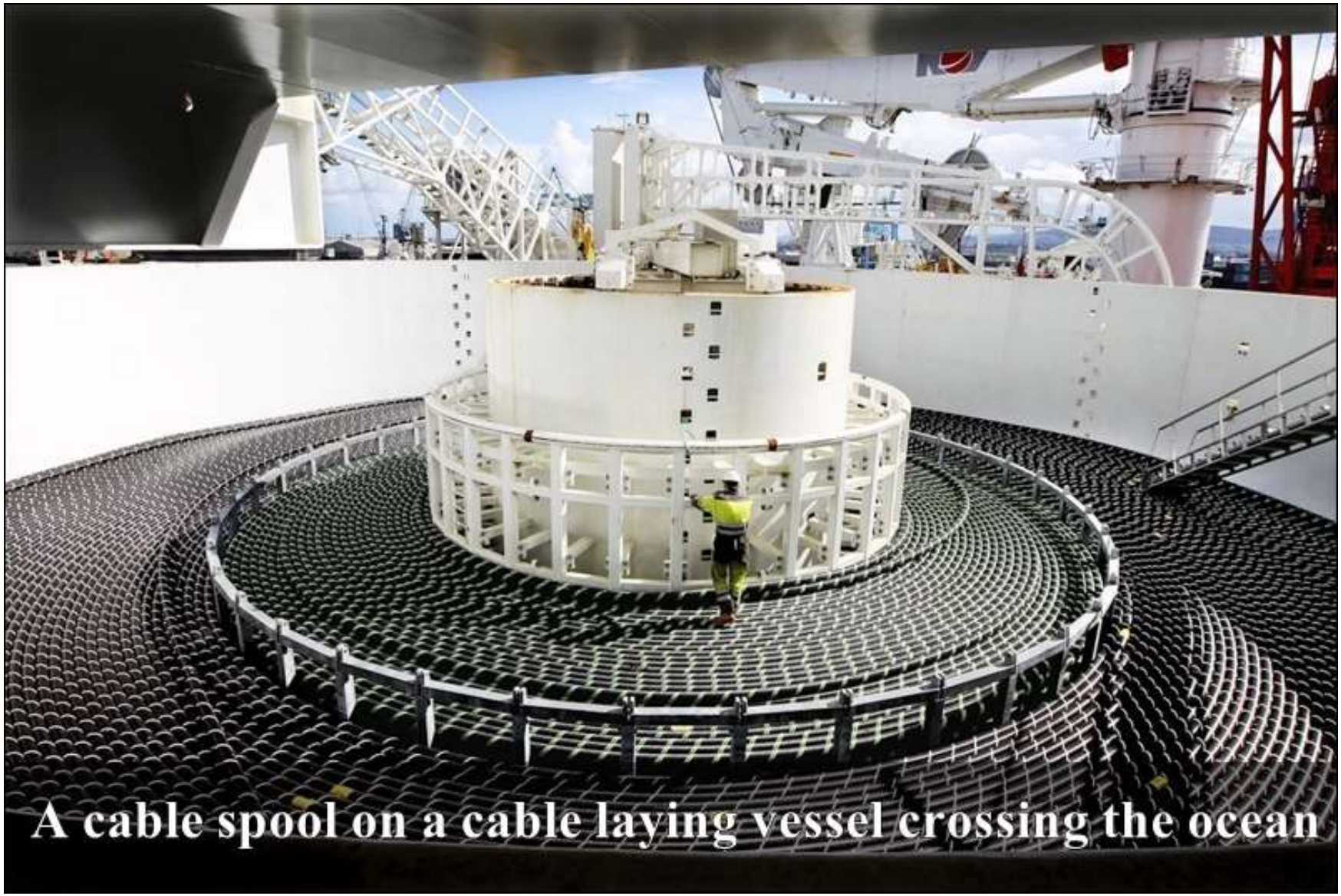
- downloading1Gb takes in the ITK = 0,079 Ft!!!

Verification No 4. (no distance limits)

- The smallest attenuation in fibre cables nowadays 0,001 dB/km
- Using such cable Práter u. - **Berkeley** can be connected without repeaters !

4 life/s/cable


TEMP
TIME 170
RAMP
HOLD
Preform
Source of Glass
Heater
Sting
Laser Micro-Meter
Coater
Ultraviolet
Curing
System
Take-Up Reel


A cable spool on a cable laying vessel crossing the ocean

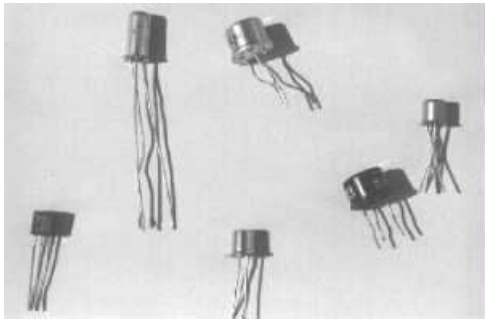
Consequence No1 (infinite and free bandwidth)

- Free(??) products are nod good basis of business ! Only way to have profit to force wasteful usage or to pay for other products

Example for wasteful usage

1970

1$/transistor



2002

0,000 000 040 $/transistor

Consequence No 2 (infinite and free bandwidth)

- New network philosophy, structure, new functions in the nodes.

Consequence No 3 (infinite and free bandwidth)

- Completely different user behaviour
- New ratio of computing – downloading – storing!

What network architecture?

- Circuit vs. packet switching
- A rule of thumb:
  - Band is cheap: circuit switching
  - Processing is cheap: packet switching
- Distributed vs. centralized intelligence
- Packet processing by 10^{16} b/s ????

packet switch like node solution

Point-to point like network node solution in a modern highway system

As it was at the very beginning of telephony by Bell….
One line to the grocery, one line to the bank, other line to the hair dresser…

Now we can use fibre cables as Bell…..
Or as in radio broadcasting…..

$\Rightarrow$ No switching!
Broadcasting in the fibresphere!
(fényhéj).

peer world (Egyenrangúak világa)


© AP

1. This is Facebook's massive Arctic Sever Farm:

A vízhütés csövezetékei az atlantai szerverközpontban. A különféle szinek a víz hőmérsékletét és folyási irányát jelzik, a méretekhez jó összehasonlítási alapot nyújt a folyosón hagyott bicikli - ilyenekkel közlekednek a mérnökök az óriási szervertermekben.

Routerek és switchek az iowai adatközpontban, ezek a gépek teszik lehetővé a kommunikációt a Google adatcenterei között. A kapcsolatok sebessége itt átlagosan 200 ezerszer nagyobb, mint a leggyorsabb otthoni internetkapcsolatoké.


Judge Harry Pregerson Interchange, LA, USA

Higher and higher limits in memories?

This 100TB drive is the largest capacity SSD ever made

at the price of $455.99

Source:
https://thenextweb.com/plugged/2018/03/20/this-100tb-drive-is-the-largest-capacity-ssd-ever-made/

Hard dick storage prices

- Price decreasing from about US$15,000 per megabyte to less than $0.0001 per megabyte ($100/1 terabyte), a greater than 150-million-to-1 decrease.

Consequences on university level education (Jacques Vaisey, Simon Frases University)

- The efficiency of telelearning will be comparable of contact courses.
- Canned free courses in several subjects (MIT OpenCourseWare Initiative)
- Peer-to-peer communities of students (no profs)
- Consultation of experts/profs „for a fee”
- The certifiers of knowledge are issued not only by universities!

The main tasks of infocom engineers:

- Efficient, fast, valid, error free, transport, process, store of information (data, voice, speech, pictures, moving pictures)!

Responsibility of infocommunication engineers

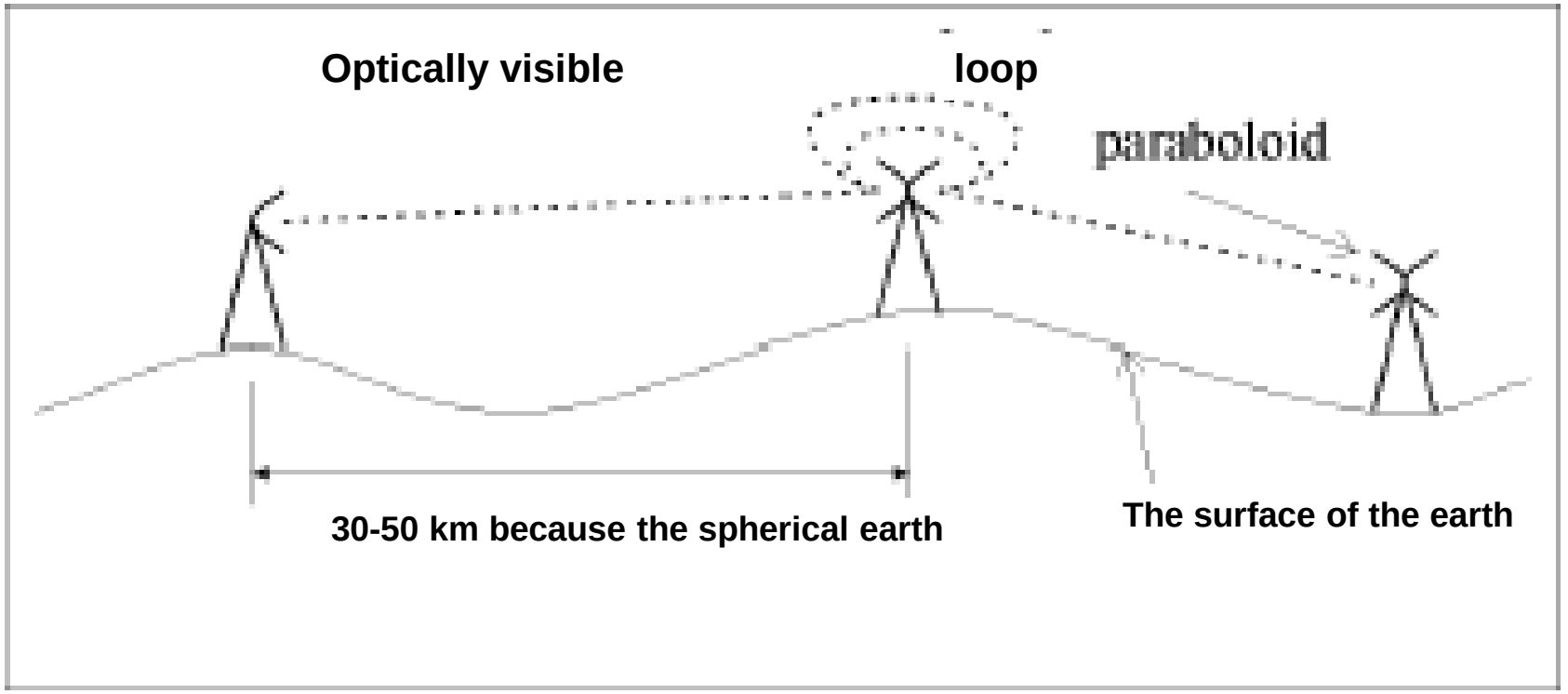
- The free flow of information and access to information are fundamental rights of human. The European Convention of Human Right authorize national bodies to limit the harmful and dangerous content.
- Illegal contents: child pornography, violent pornography, extreme violence, incitement to racial…..
- As the several hundred years practice in Europe clearly the editor in chief is responsible for the content**.**
- The infocommunication engineers are able to construct and operate systems which can be more dangerous then bombs.

New infocommunication systems -- Consequences on migration

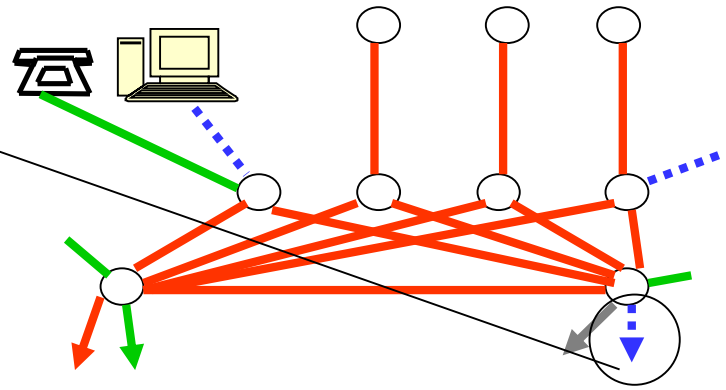
http://www.thedrum.com/news/2016/01/13/how-refugee-phones-initiative-using-tech-bring-connectivity-calais-jungle-camp

Interesting topics in this course

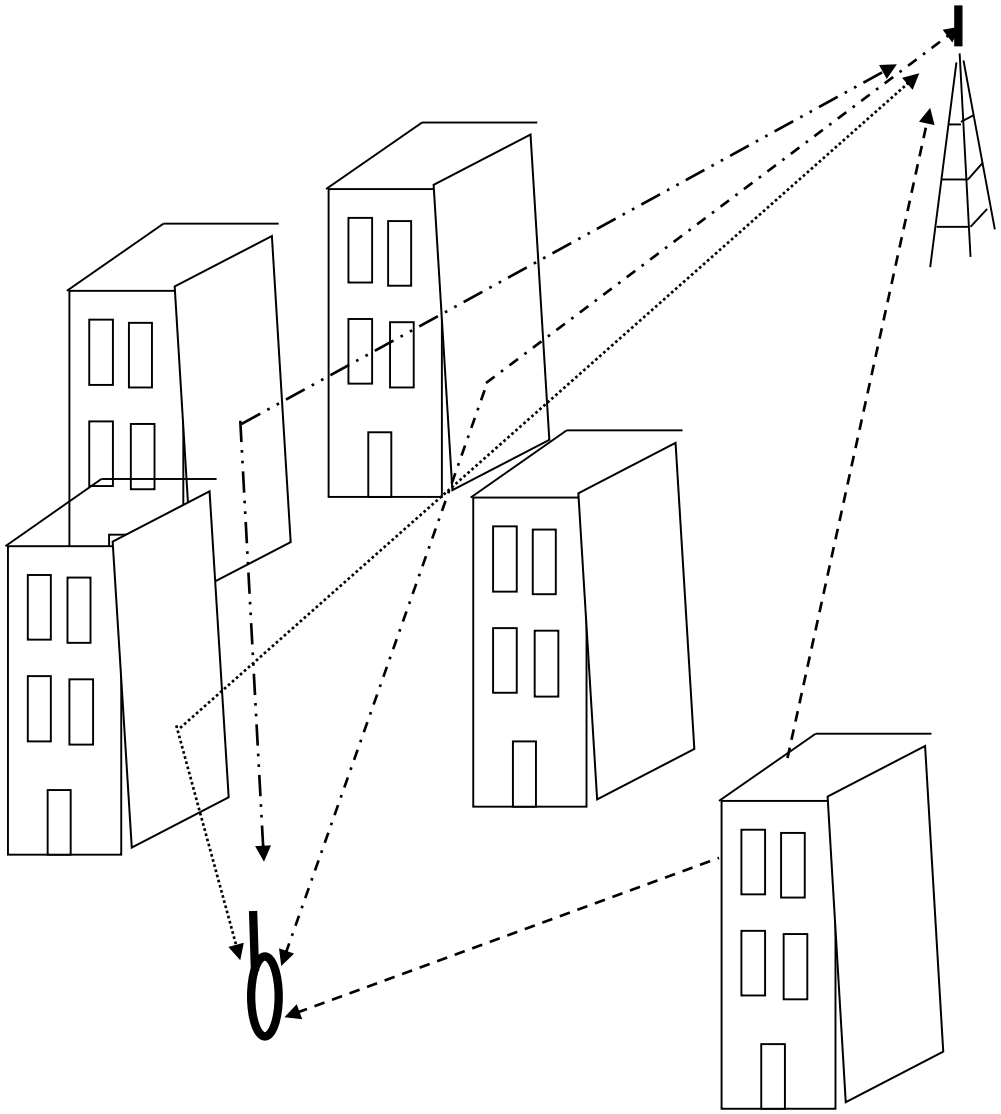
Technology / Transmission	**copper**	**optical**	**radio**			
Technology / Switching	**circuit**	**pocket**	**cell**	**signalling**		
Networks	**telephone**	**mobile**	**broadcast**	**CATV**	**data**	**special**
Services	**dialogue**	**content**	**network**			
Applications	**Commerce**	**learning**	**working**	**medicine**		
Terminals	**telephone**	**mobile**	**special**			
Regulation	**EU**	**Hungary**	**limited resources**			

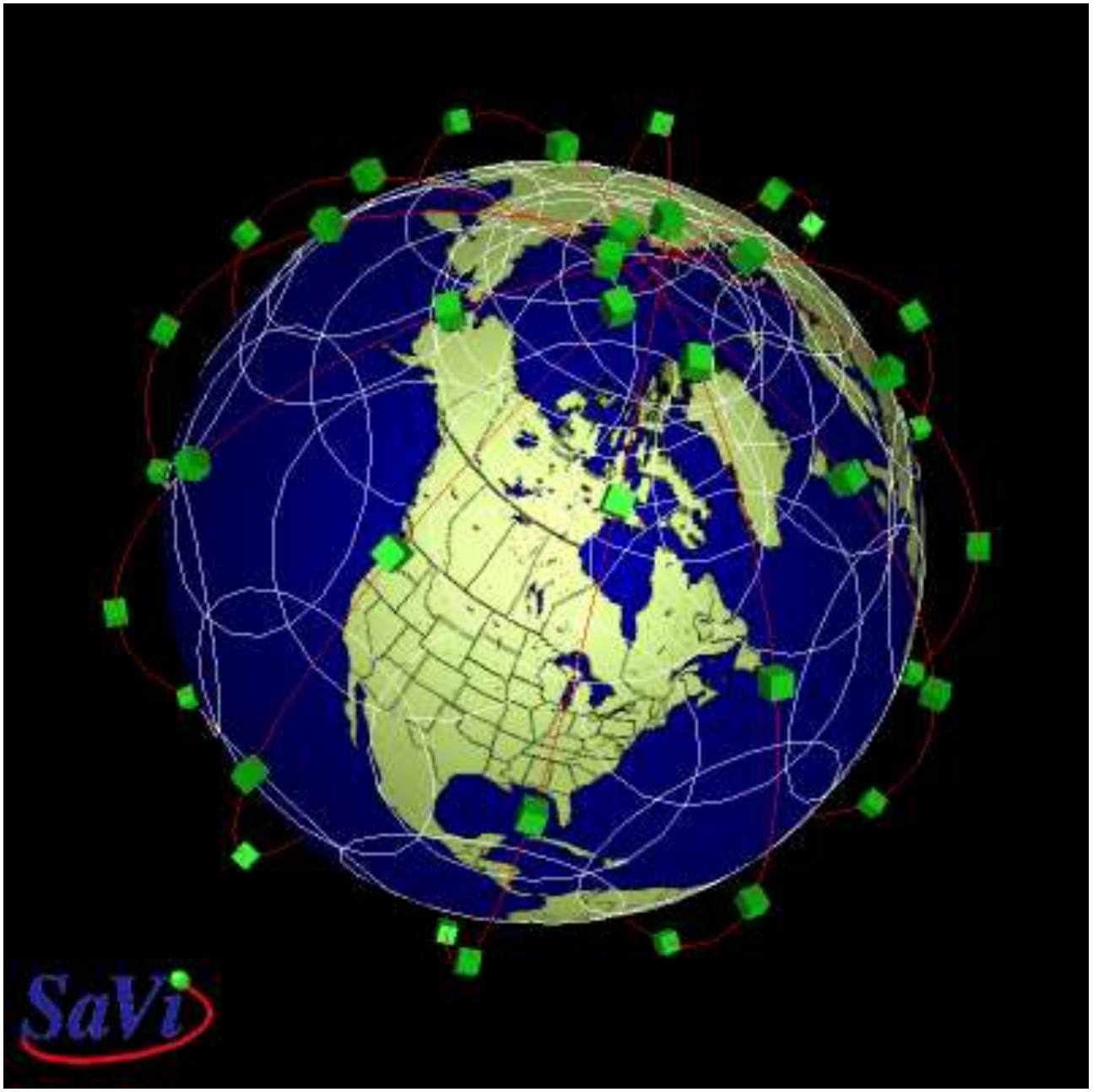


Terrestrial microwave connections



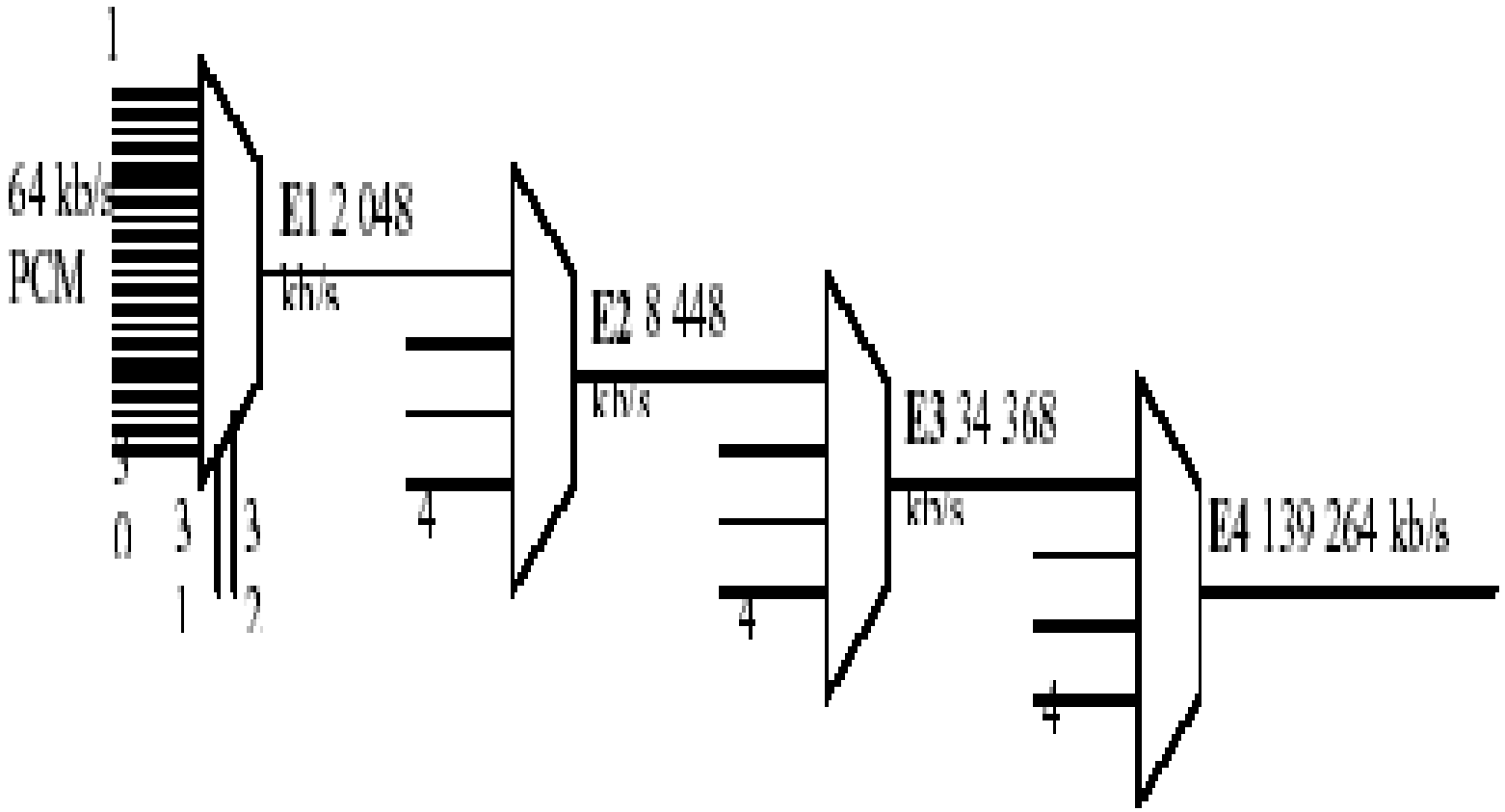
Multipath radio wave propagation



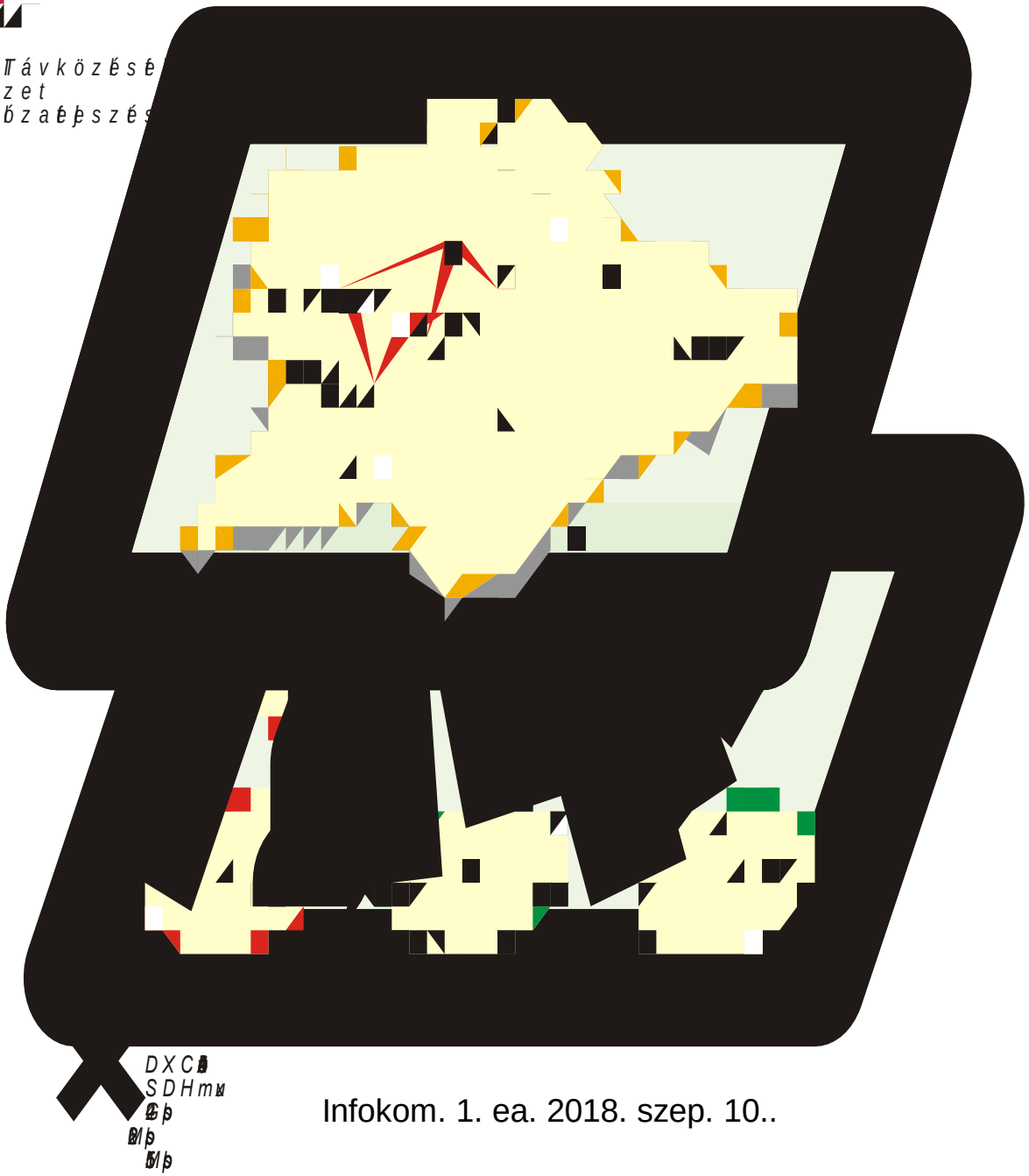

SaVi

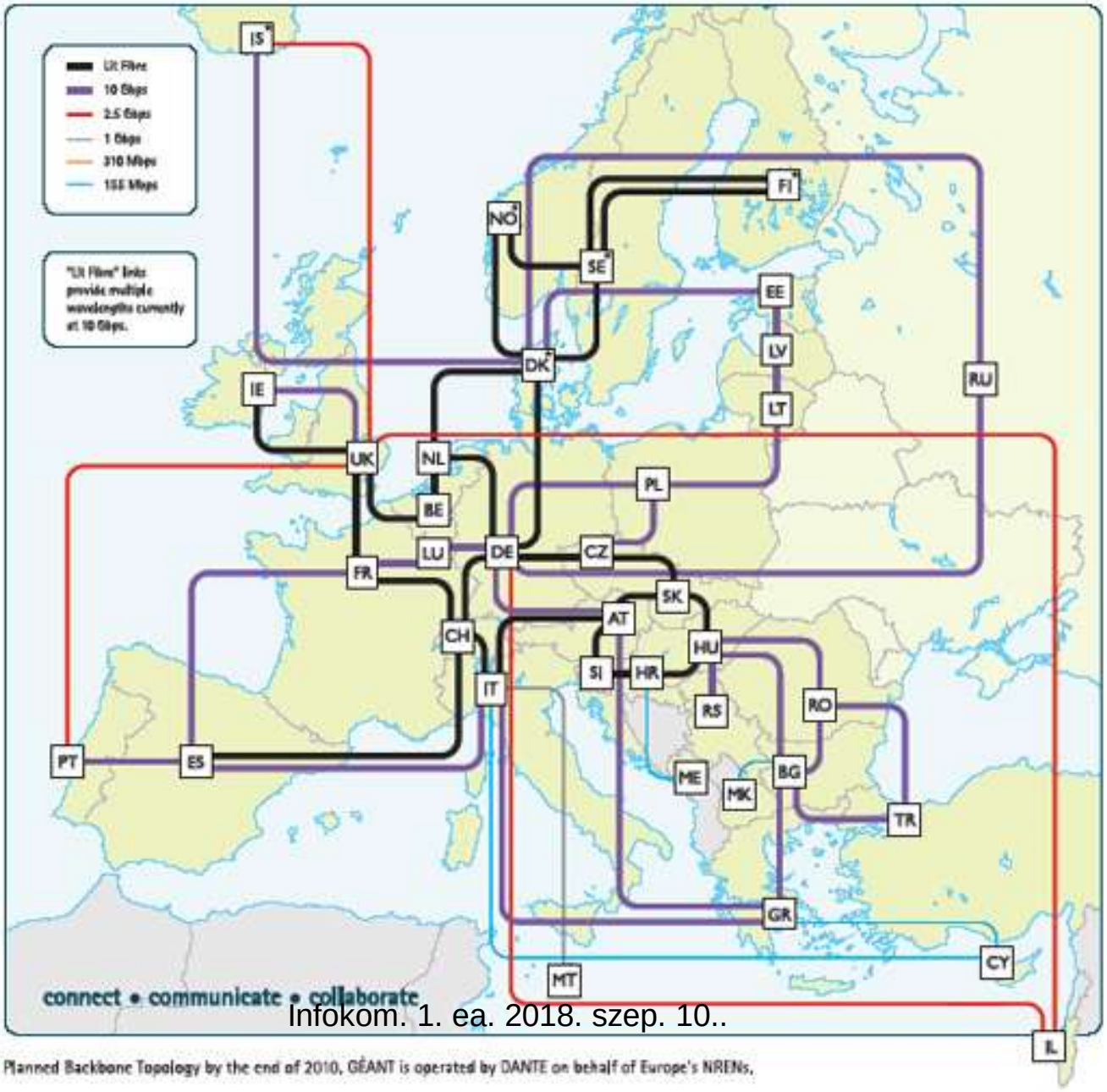
Cisco Aironet 3700 Series

Multiplexing in PDH

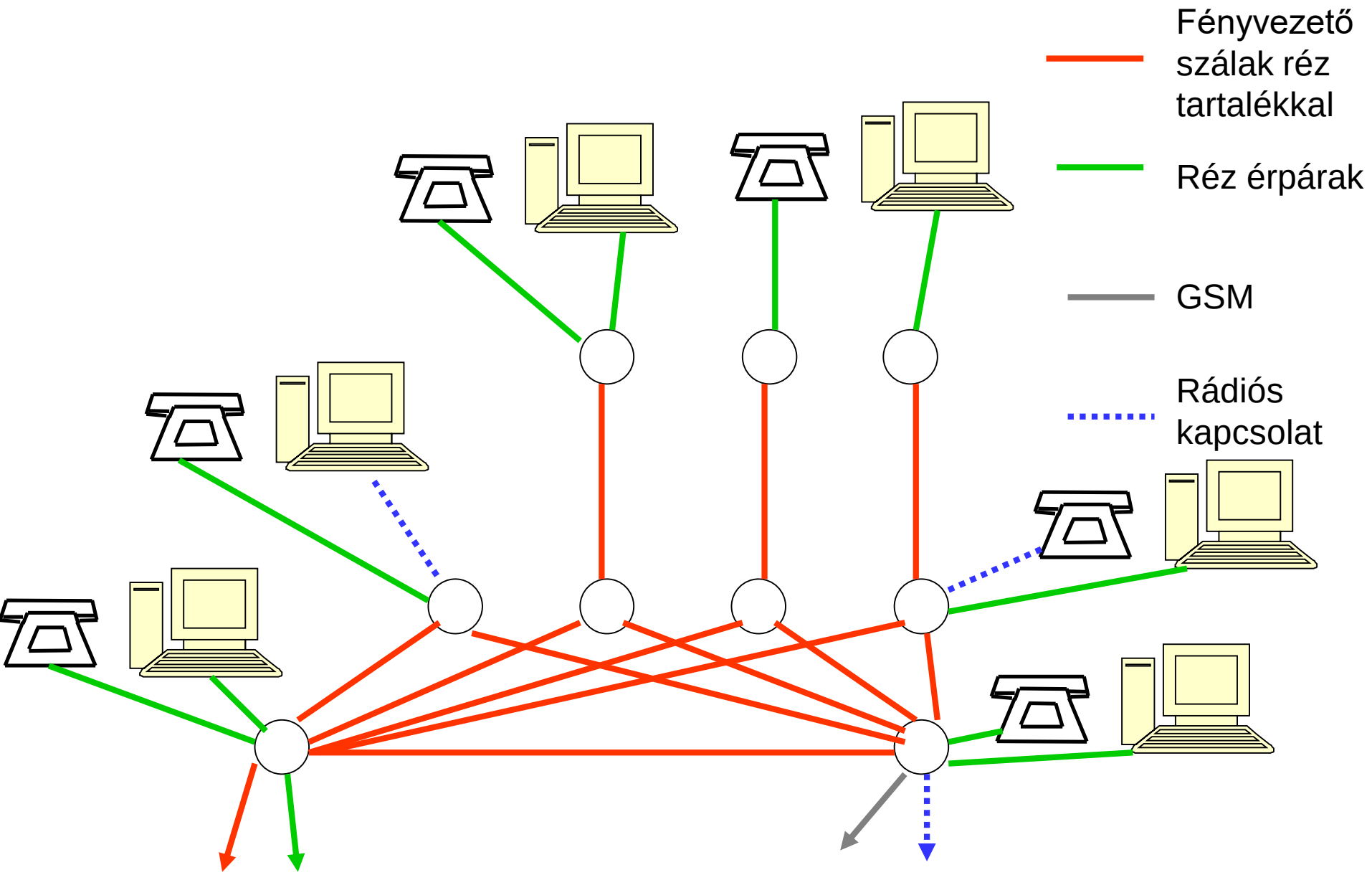


PKI Távközlésfejlesztési hálózat
Hálózatfejlesz

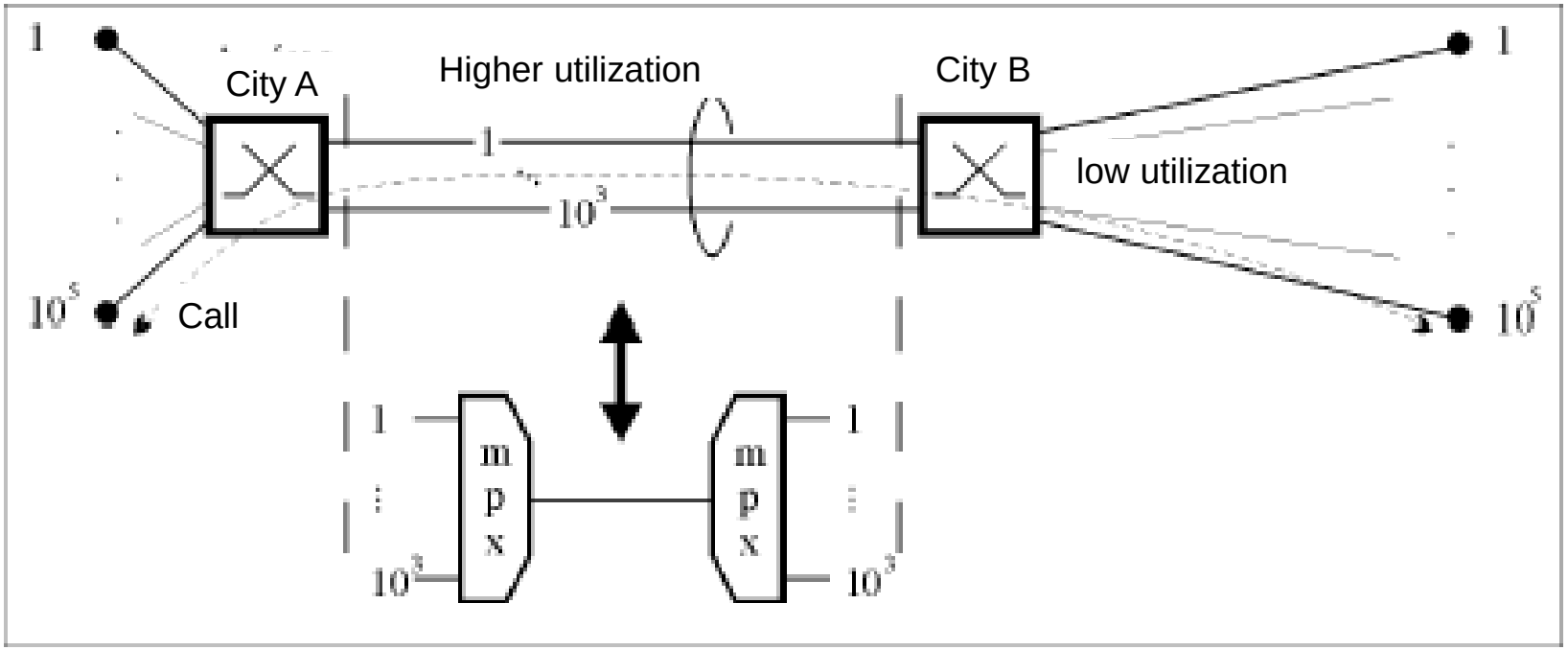




Planned Backbone Topology by the end of 2010. GÉANT is operated by DANTE on behalf of Europe's NRENs.


Fényvezető szálak réz tartalékkal
Réz érpárak
GSM
Rádiós kapcsolat

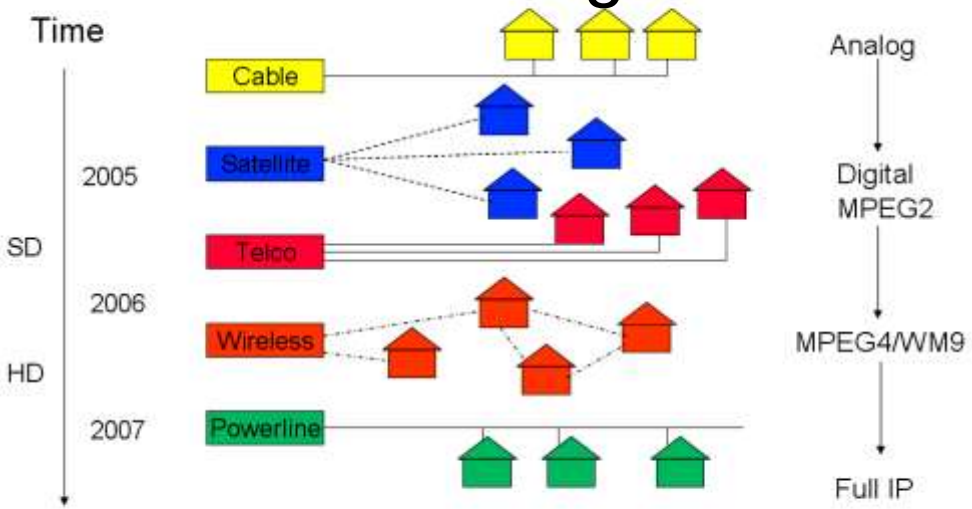
Switching and multiplexing



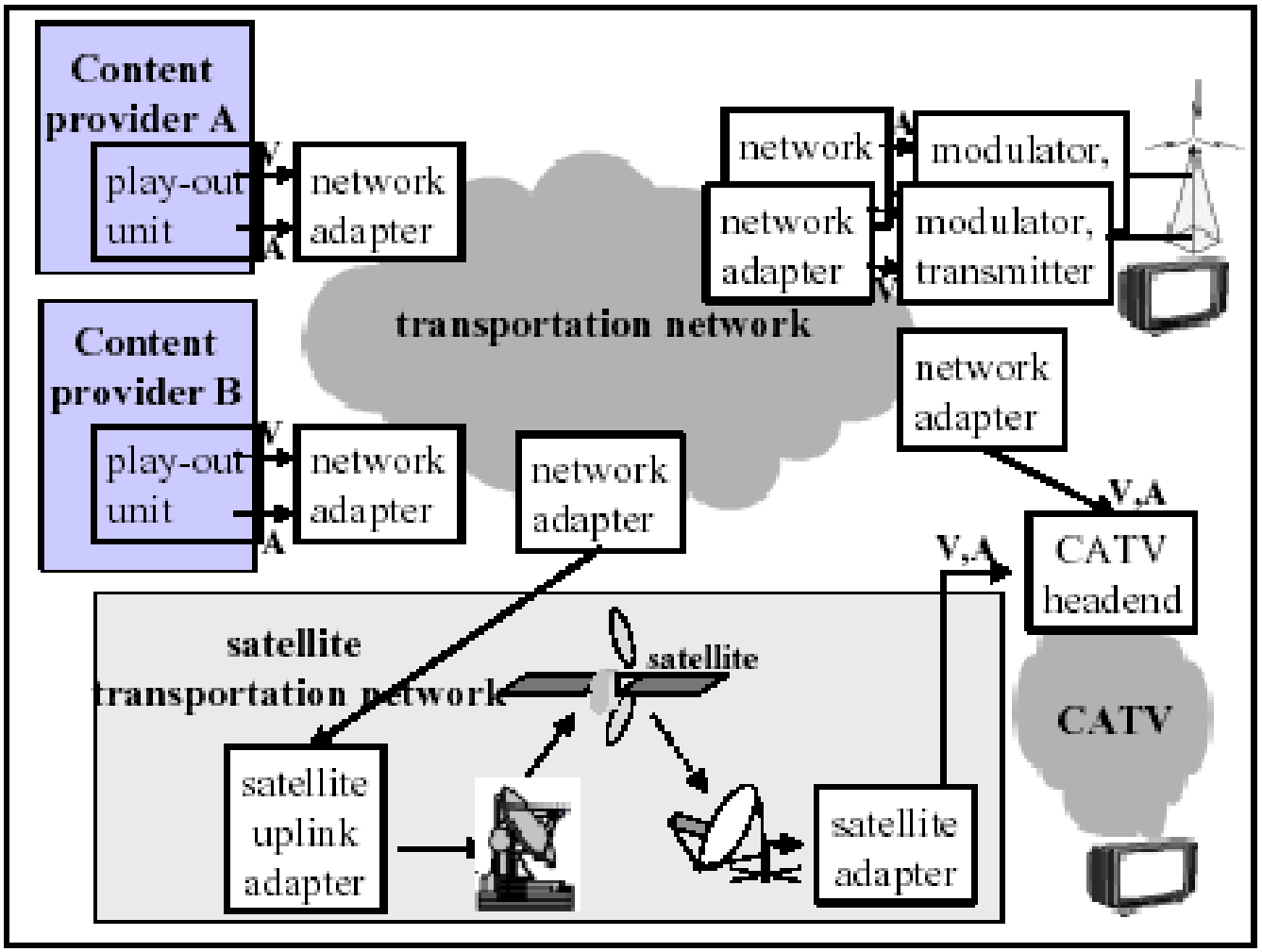
Changing on the TV market

Few providers (cable, broadcast)	→	Many (cable, satellite, telco, digital terrestrial, UMTS, 3G (DVB-H), WiMAX,,)
Analog	→	Digital (satellite is already all-digital)
Broadcast	→	Personal (stream based)
MPEG2	→	MPEG4
SD	→	HD

Changing in the technologies

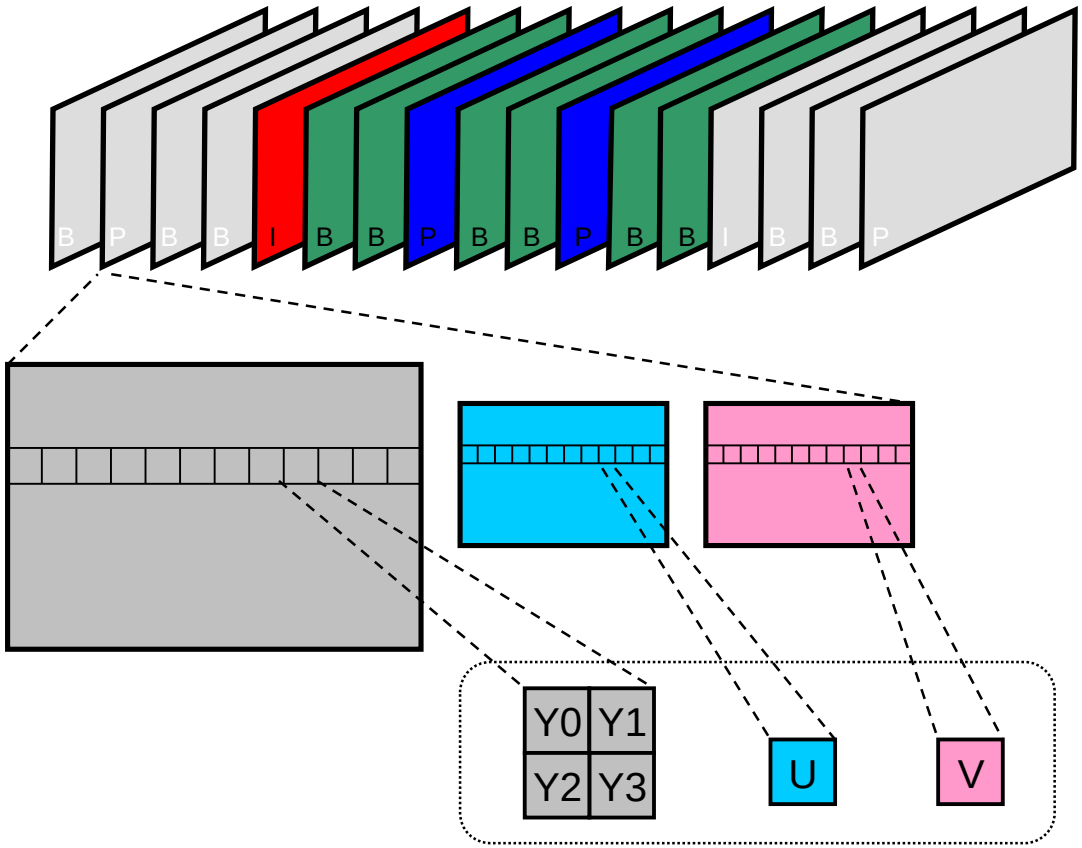


Broadcasting networks

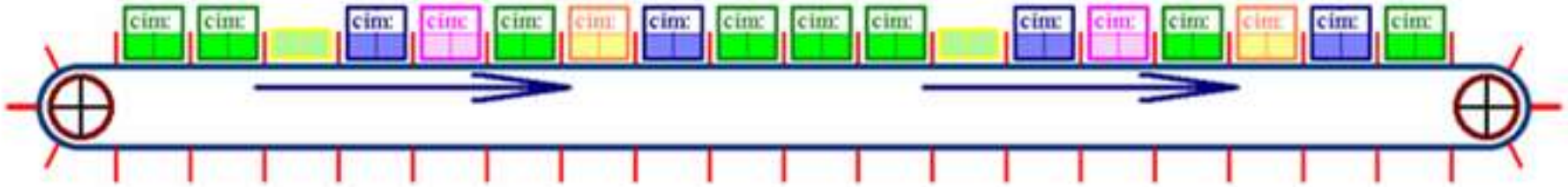


MPEG-2 structure

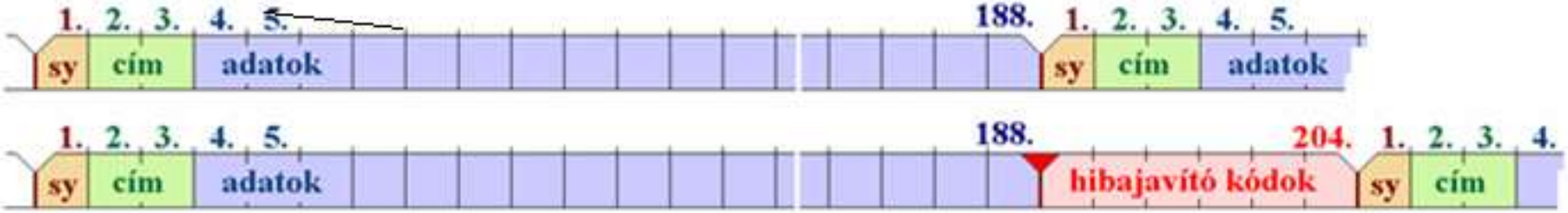
- Hierarchic
  - Picture sequence
  - Group of pictures
  - picture
  - slice
  - macroblock
  - block



Transport Stream structure



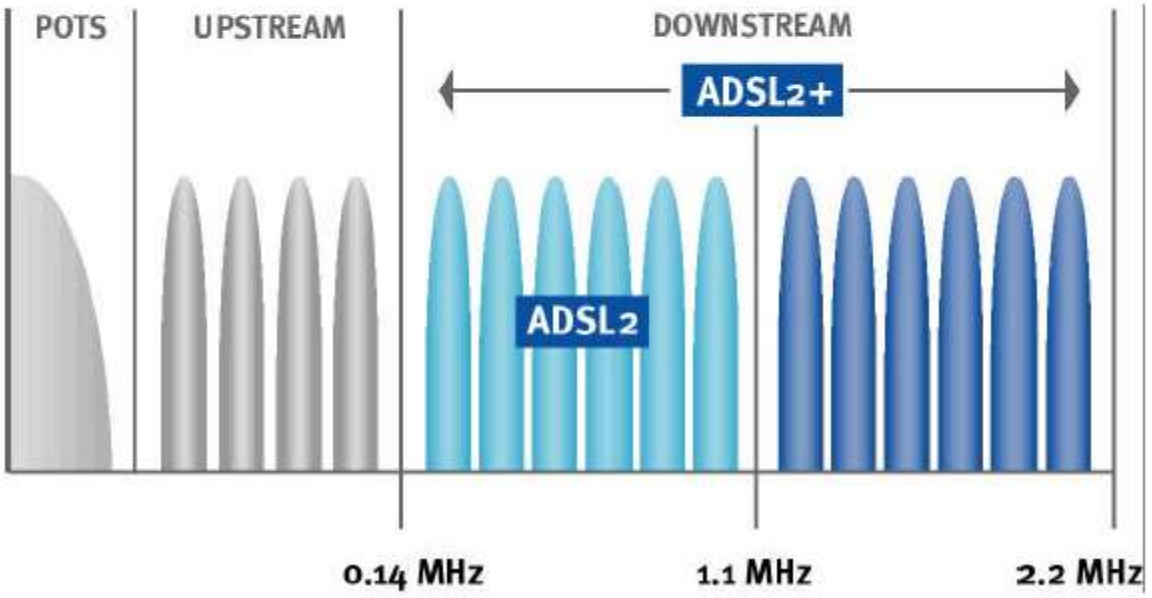
Az adatok szempontjából aszinkron adattovábbítás

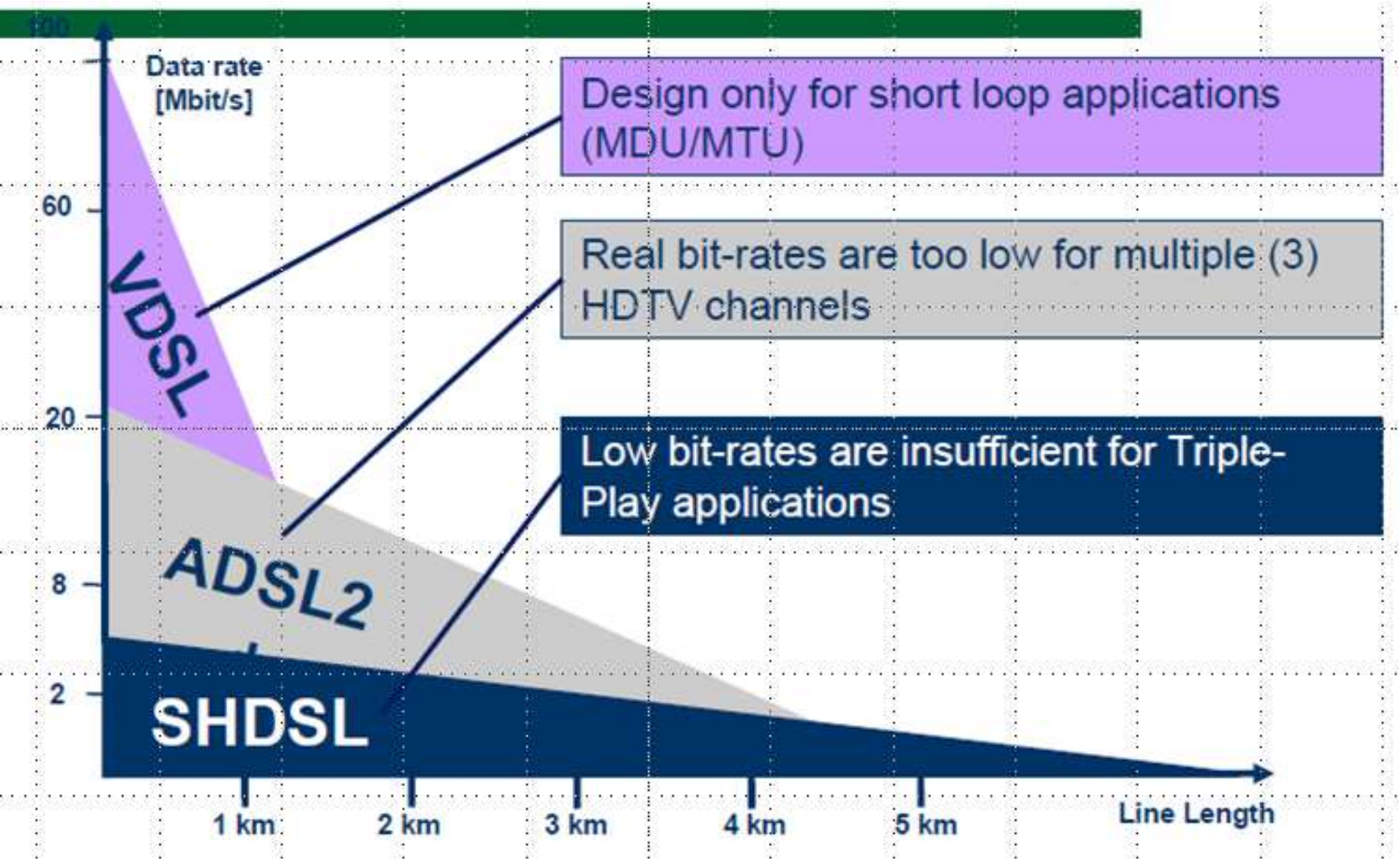


A packetek felépítése 188 és 204 bájtos formátum esetén

ADSL2+

- Increases downstream data rate by extending bandwidth to 2.2 MHz
  - Maximum data rate of 24 Mbps on short loops
- CPE silicon and firmware will support ADSL2, RE-ADSL2 and ADSL2+

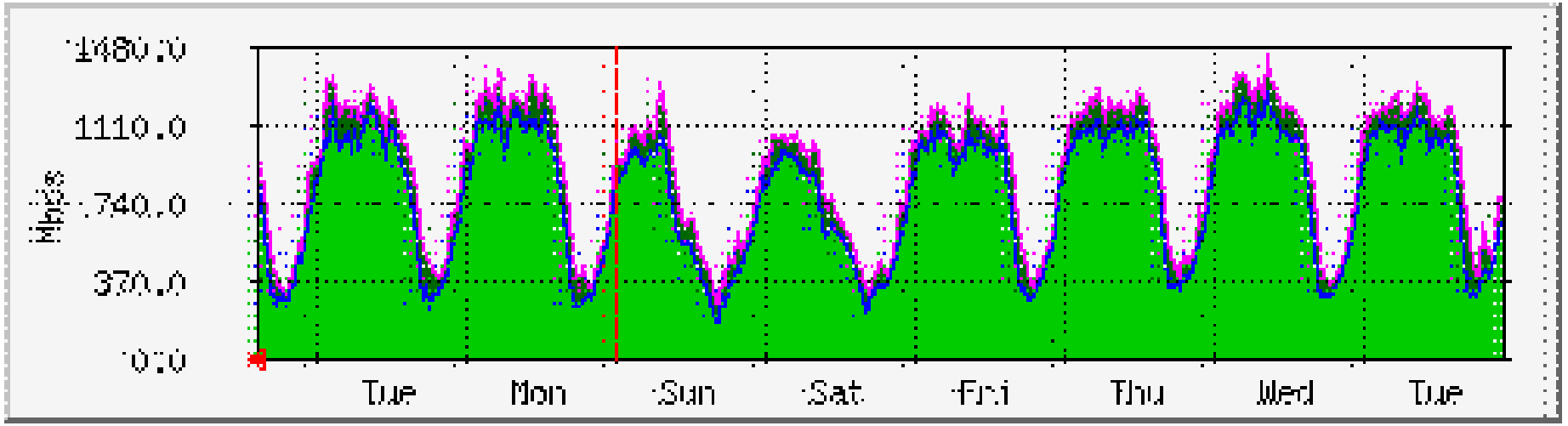



Data rate
[Mbit/s]
60
20
8
2
VDSL
ADSL2
SHDSL
Design only for short loop applications (MDU/MTU)
Real bit-rates are too low for multiple (3) HDTV channels
Low bit-rates are insufficient for Triple-Play applications
1 km
2 km
3 km
4 km
5 km
Line Length

The September 11 attacks (also referred to as 9/11) were a series of four coordinated terrorist attacks by the Islamic terrorist group al-Qaeda against the United States crashed into the North and South towers, respectively, of the World Trade Center on the morning of Tuesday, September 11, 2001. The attacks killed 2,996 people, injured over 6,000 others, and caused at least $10 billion in infrastructure and property damage.

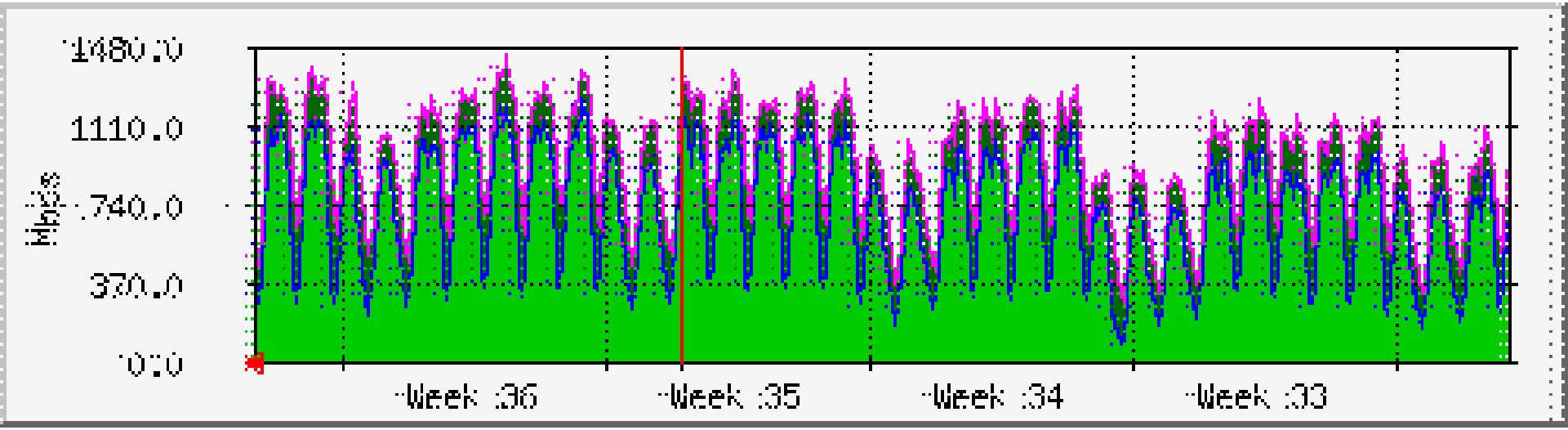
11th September 2001.

BIX traffic

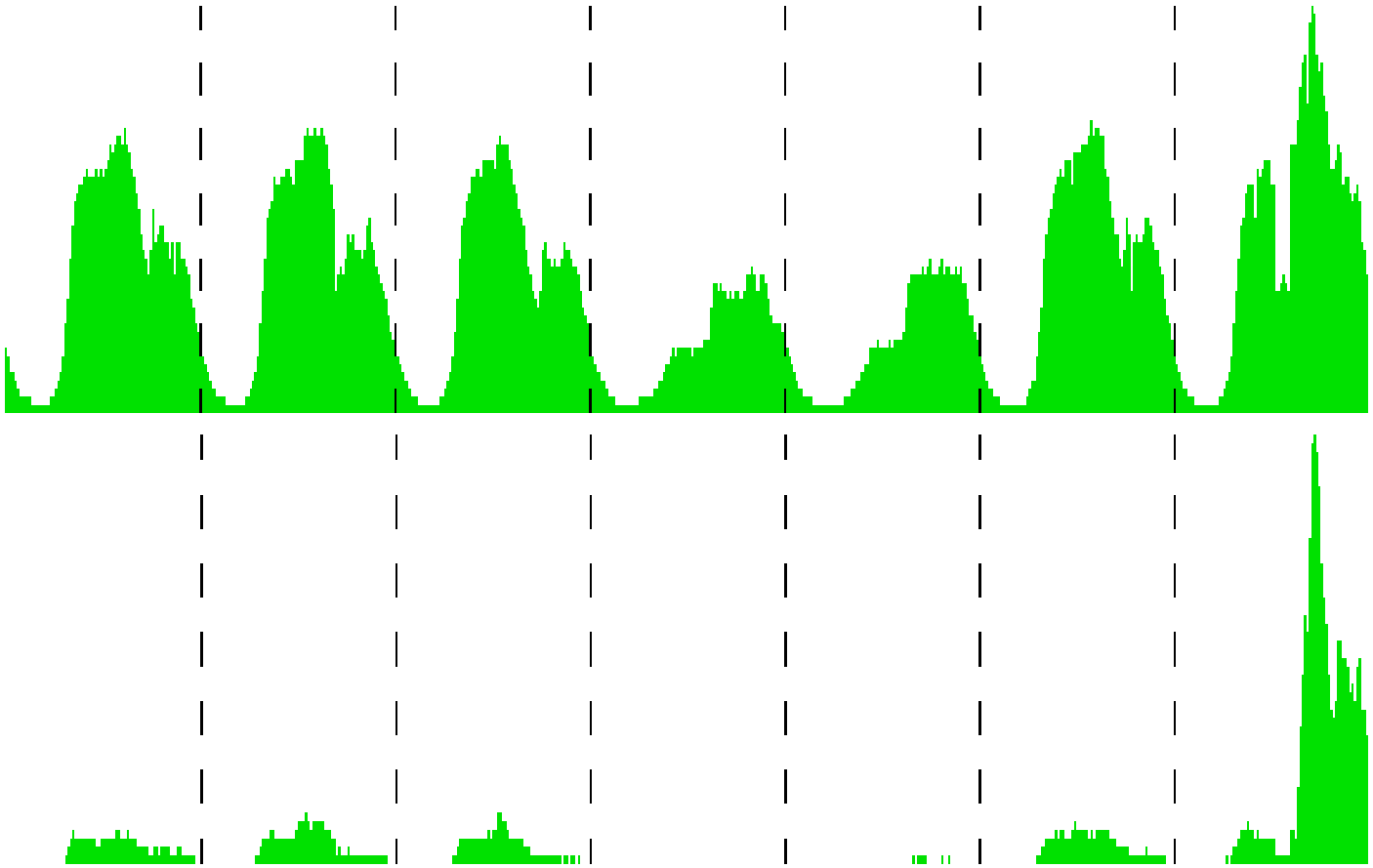


11th September 2001.

BIX traffic



11th September 2001.



Origo

Origo - news

Arany János
TOLDI ESTÉJE
HATODIK ÉNEK.

Hajt az idő gyorsan - rendes útján eljár -
Ha felülünk, felvesz, ha maradunk, nem vár;
Változik a világ: *gyengül*, ami erős,
És *erős* lesz, ami gyenge volt azelőtt.