Infokommunikációs rendszerek
Infocom Systems
5.
Nyilvános távbeszélő (PSTN) hálózatok, gerinchálózatok
Telephone networks(PSTN), backbone networks

Takács György

The 3 lessons in network studies

- **P**ublic **S**witched **T**elephone **N**etworks (PSTN), Integrated Service Digital Networks (ISDN), backbone networks
- Mobile Networks -- **P**ublic **L**and **M**obile **N**etworks (PLMN) GSM, UMTS, DECT, TETRA, Bluetooth, Globalstar, Iridium
- Private networks, Broadcasting networks, Cable TV networks (CaTV)

Flash report on landline services for July 2018

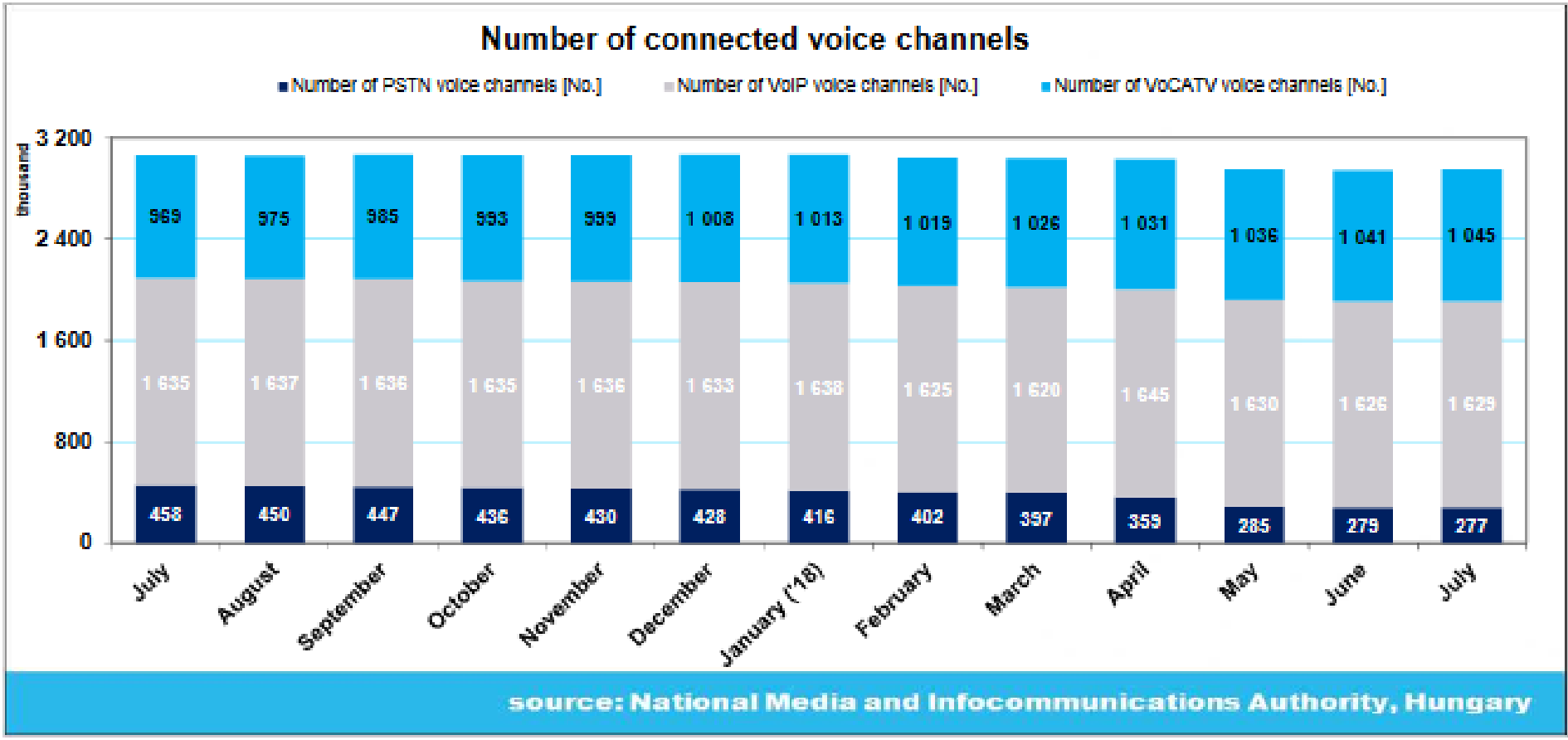
Data suppliers: Magyar Telekom Nyrt., Digi Group: (Invitel Zrt., DIGI Kft.), UPC Magyarország Kft., PR-TELEKOM Zrt., Tarr Kft., ViDaNet Zrt., PARISAT Kft.

Summary data of landline (fixed) voice services		
Number of switched (PSTN) voice channels [No.]	277 110	Number of voice channels within conventional, twisted copper wire networks
Number of VoIP voice channels [No.]	1 628 612	Number of voice channels within IP-based (e.g.: xDSL, leased line, Ethernet, ATM, fibre-optic) networks
Number of VoCATV voice channels [No.]	1 044 840	Number of voice channels within cable television networks
Total number of voice channels (est.) [No.]	3 074 000	Includes estimates of PSTN, VoIP and VoCATV voice channels for the total market.
Number of voice channels per 100 inhabitants [No.]	30,20	As per the latest figures made available by the Central Statistical Office (KSH), Hungary has a population of 9,771,000.
Telephone penetration rate of households [%]	64,55%	Percentage refers to the number of voice channels versus number of households. According to the latest figures made available by the (KSH), the number of households is 4,021,000.
Duration of PSTN calls placed [minute]	19 607 351	The duration of calls with carrier selection is also included.
Duration of IP-based calls placed [minute]	254 906 893	Includes the duration of calls placed within VoIP and VoCATV networks.
Duration of calls placed per voice channel [minute]	93,0	Figure shows the total duration of calls placed in the period under review divided by the number of voice channels connected at the end of the period.
Number geographic numbers ported at the end of the month [No.]	871 640	Based on data obtained from the Central Reference Database since 1 January 2004.

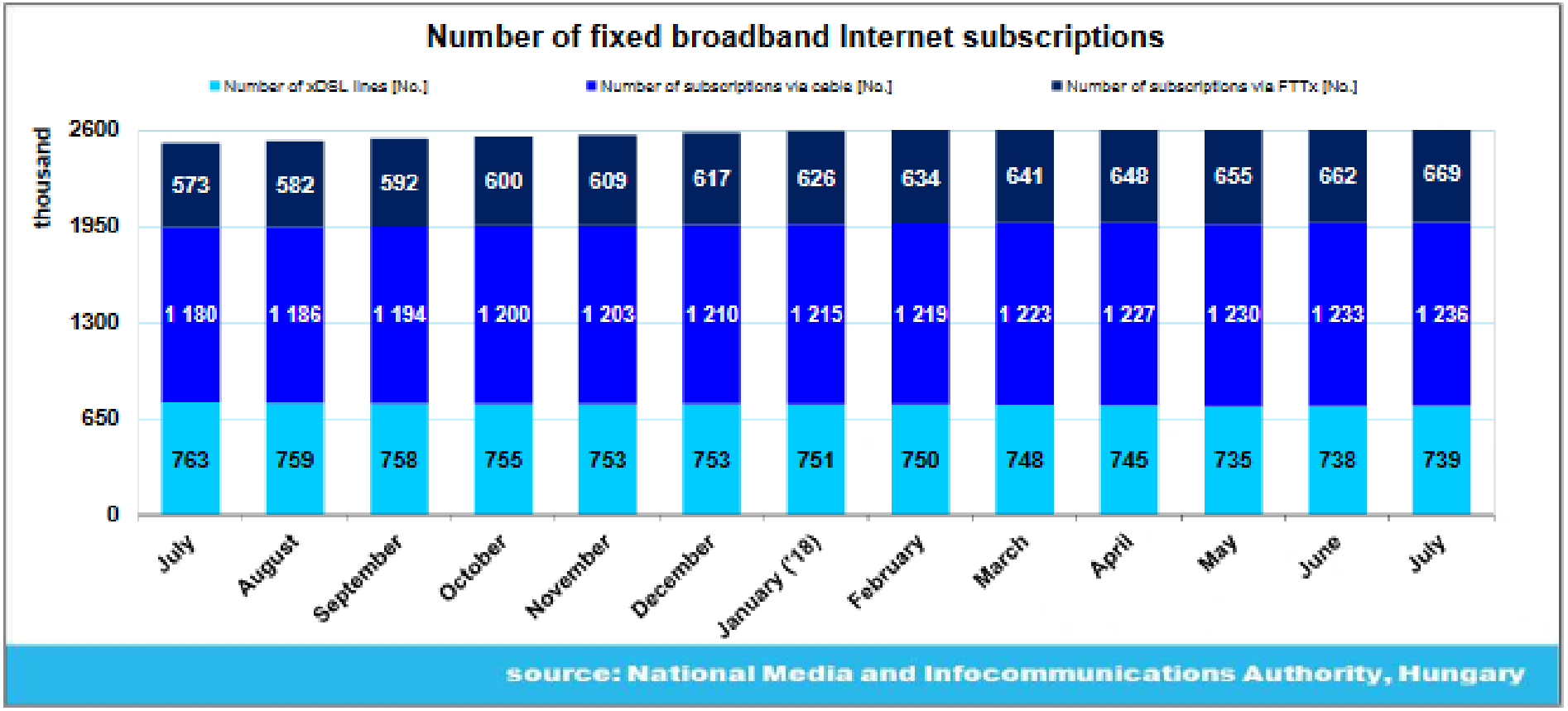
Flash report on landline services for July 1018

Number of broadband Internet subscriptions		
Number of xDSL subscriptions [No.]	739 428	Based on data obtained from the above-mentioned market leader data suppliers, covering almost 98% of all xDSL subscriptions.
Number of subscriptions for broadband via cable [No.]	1 235 904	Based on data obtained from the above-mentioned market leader cable providers, covering 82,8% of all cable modem subscriptions.
Of which: number of broadband subscriptions via Docsis 3.0 [No.]	1 139 800	Number of cable modem subscriptions where the terminal equipment (modem) has been replaced.
Number of broadband subscriptions via FTTx [No.]	668 751	Based on data obtained from the above-mentioned service providers, covering 99% of all FTTx subscriptions.
Total number of fixed-access broadband subscriptions (est.) [No.]	2 925 000	Estimation pertaining to the total market. Includes estimates of xDSL, cable modem and FTTx subscriptions for the total market.

Flash report on landline services for July 2018

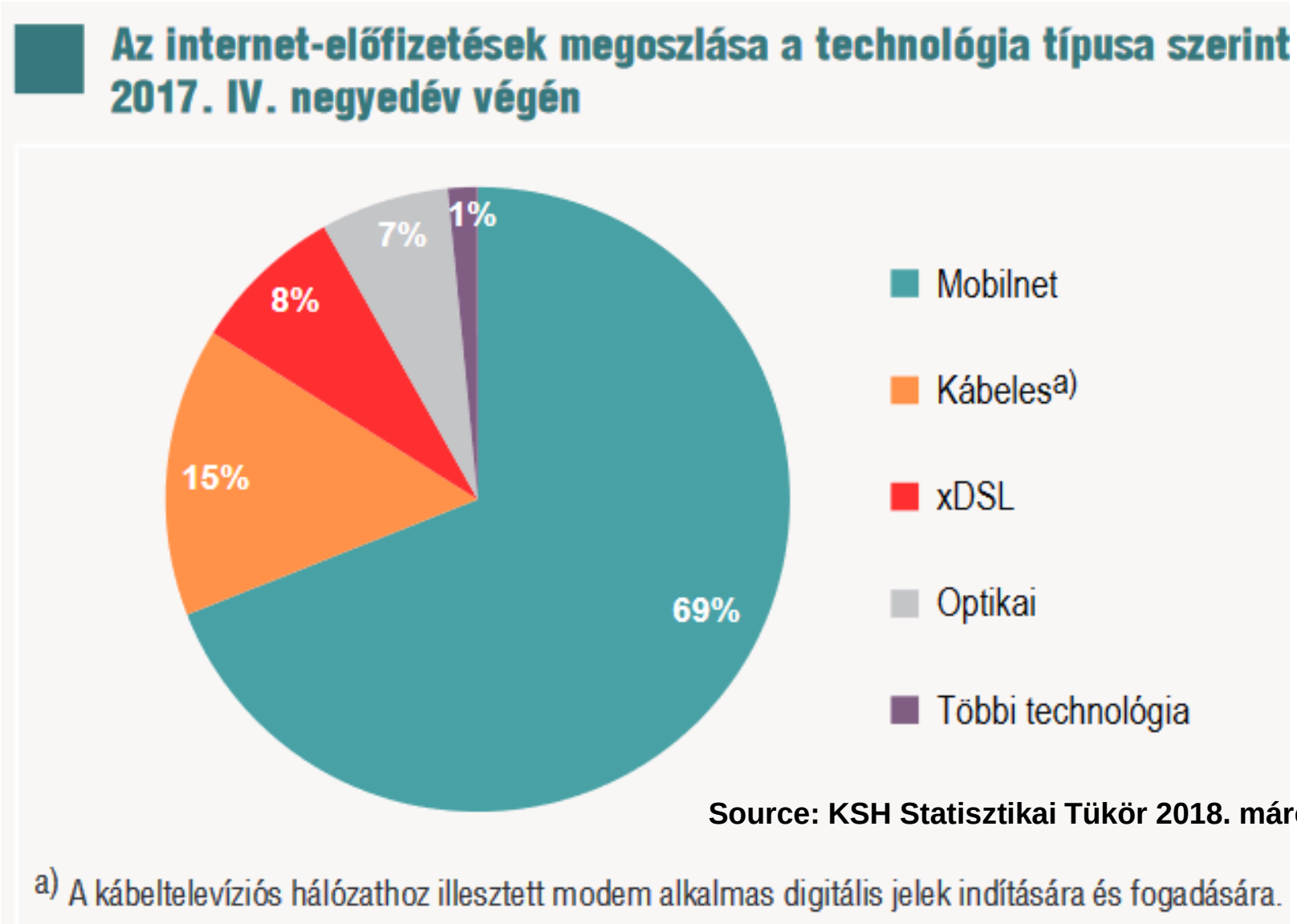


Note: based on data obtained from the above-referenced service providers, covering 96% of the landline voice market.
(number of connected voice channels/number of population)*100



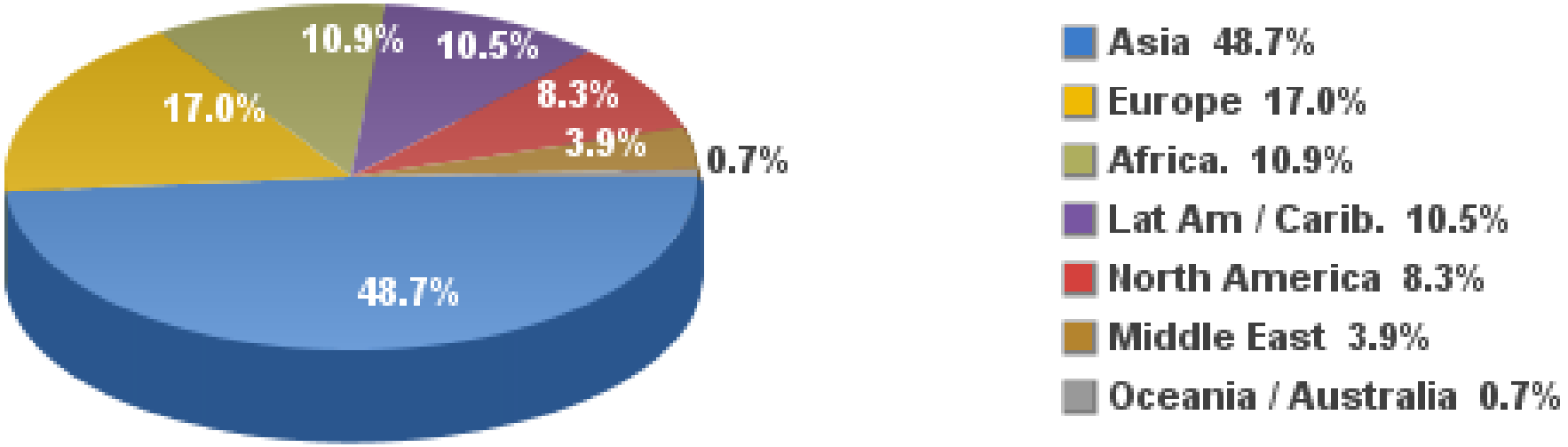
Note: based on data obtained from the above-referenced service providers that cover 90% of the fixed broadband market. Other (i.e. wireless) broadband technologies are excluded.

Technologies of Internet Access in Hungary
The total number of subscriptions was about 9,5 million



Source: KSH Statisztikai Tükör 2018. március 9

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

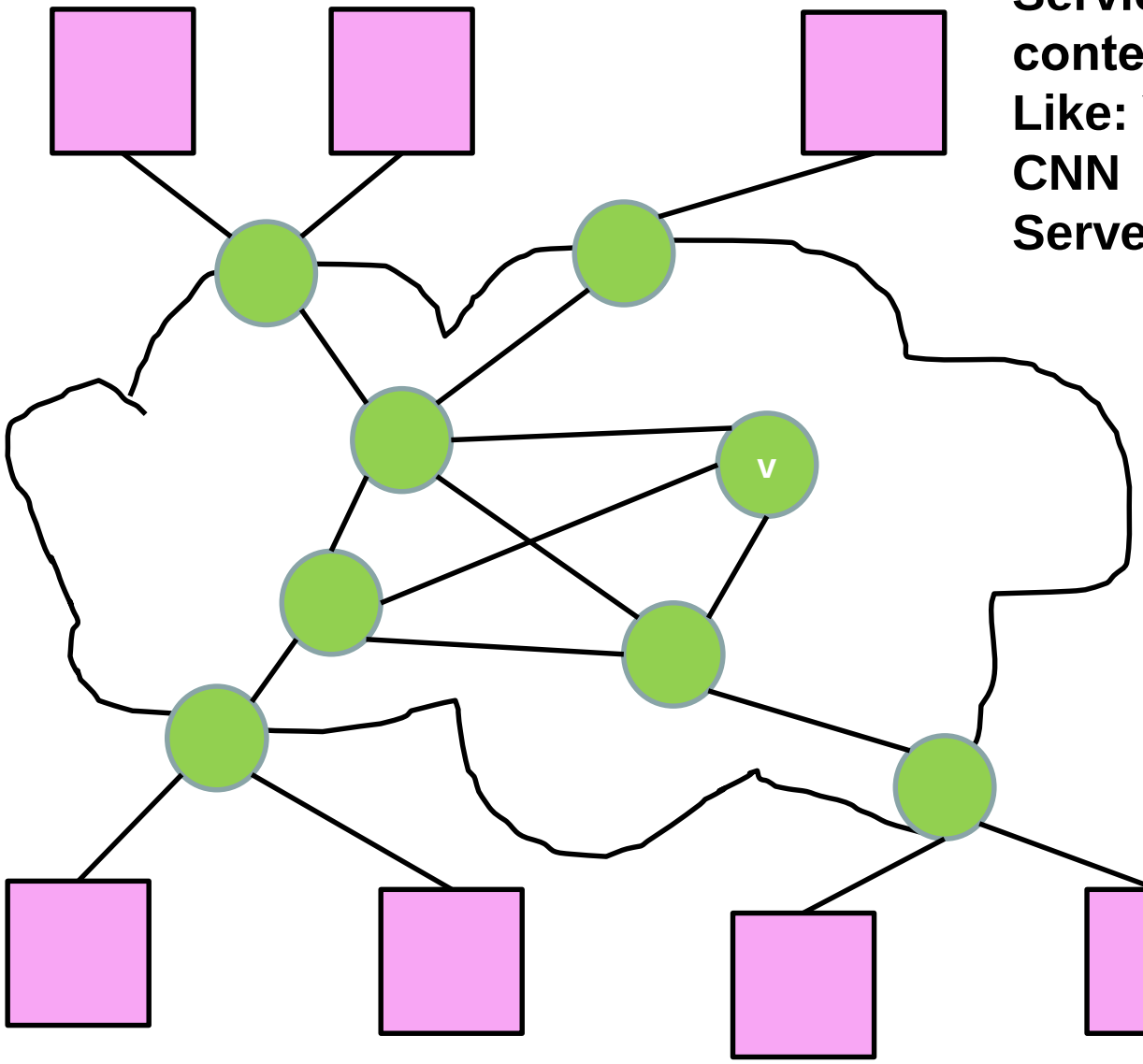
Flash report on television, July 2018

Data provided by Magyar Telekom Nyrt., UPC Magyarország Kft., DIGI Group: (Invitel Zrt., DIGI Kft.), PR-TELEKOM Zrt., Tarr Kft., ViDaNet Zrt., PARISAT Kft., UPC DTH S.à.r.l., Antenna Hungária Zrt.

Summary data of broadcasting subscription service			Base:
Total number of television subscriptions (estimated):	**3 567 000**	Number of television subscriptions (regardless of technology). Estimated value for the entire market. [No.]	Entire market (estimated value)*
Number of television subscriptions:	**3 359 495**	Number of television subscriptions (regardless of technology). Based on data from the above mentioned data suppliers, covering ~94 % of the broadcasting market. [No.]	10 major market players
Number of subscriptions on wired networks (CATV, IPTV):	**2 455 287**	Number of broadcasting subscriptions on cable television networks and IP networks. Based on data from the above mentioned data suppliers, covering ~92 % of the wired broadcasting market. [No.]	8 major market players
total number of analogue television subscriptions of these:	**710 124**	Number of analogue broadcasting subscriptions on cable television networks. [No.]	8 major market players
of these digital subscriptions:	**1 745 163**	Number of subscriptions with set-top-boxes. Number of subscriptions where the subscriber termination point is capable of accessing the service and at least one programme is digitally transmitted. [No.]	8 major market players
Number of wireless subscriptions (DTH)	**804 813**	Satellite broadcasting service subscriptions. Based on data from the above mentioned data suppliers, covering 98% of the wireless broadcasting market. [No.]	3 major market players
Number of MinDig Tv Extra's subscriptions:	**99 395**	Broadcasting subscription service - on DVB-T standard - provided by Antenna Hungária, covering 100% of these subscriptions. [No.]	Entire market: 1 market players
Total number of digital television subscriptions:	**2 649 371**	Number of digital television subscriptions (regardless of technology). Including: (Digital CATV, IPTV, DTH coded DVB-T) [No.]	10 major market players

Special features of networks

- Only services can be sold on the real market!
- There are not infocommunication services without networks.
- You could not buy networks. You have to plan, to construct, to operate, to develope according to the actual demands and to eliminate at the and of service provision.



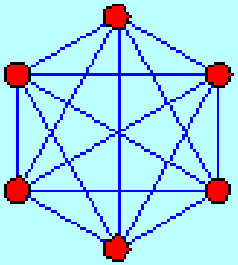
Service, application and content providers….
Like: Vodafone, CIB Bank, CNN
Servers

Network operators
Transmission lines,
Multiplexers,
Routers,
Switches

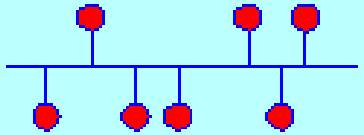
End users
Like: subscribers, Companies
Mobile sets, TV sets computers

Basics of network components

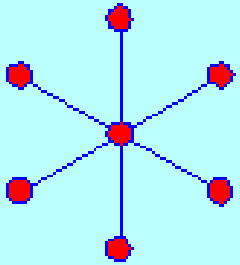
- Backbone networks: long distances, high traffic, interconnection of nodes, transport bits of any services, high reliability, high availability.
- Access networks: local distances, interconnection of terminals and local nodes
- Network planning: selecting topology, optimal selection of positions of nodes, dimensioning of node traffic handling capacities, dimensioning of link capacities, selecting technologies.



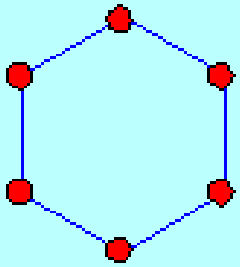
a) Fully Connected Topology



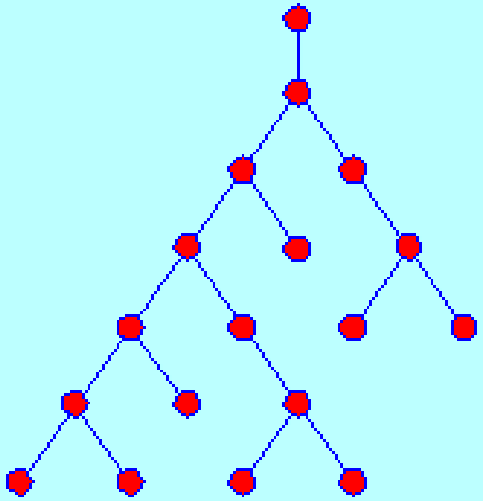
b) Bus Topology



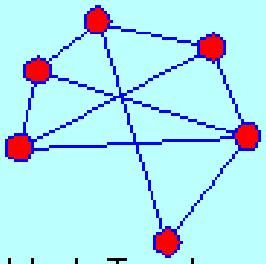
c) Star Topology



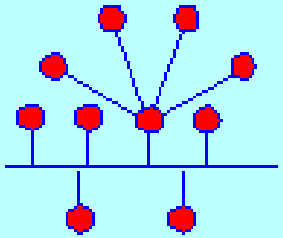
d) Ring Topology



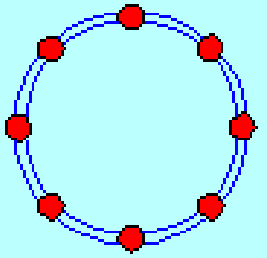
e) Tree Topology



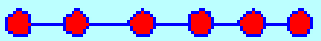
f) Mesh Topology



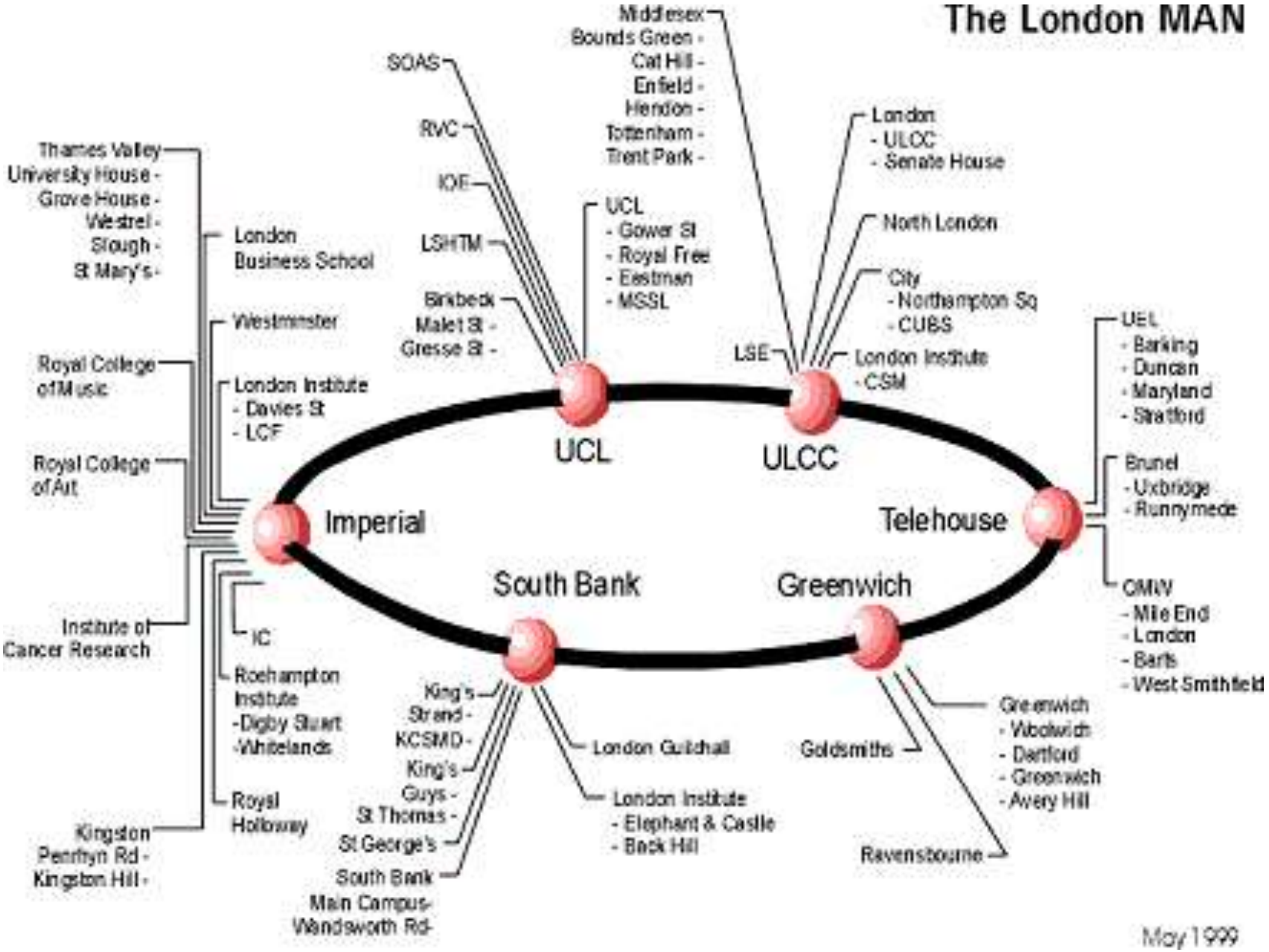
g) Hybrid Topology
(example: combination of
Star topology and Bus topology)

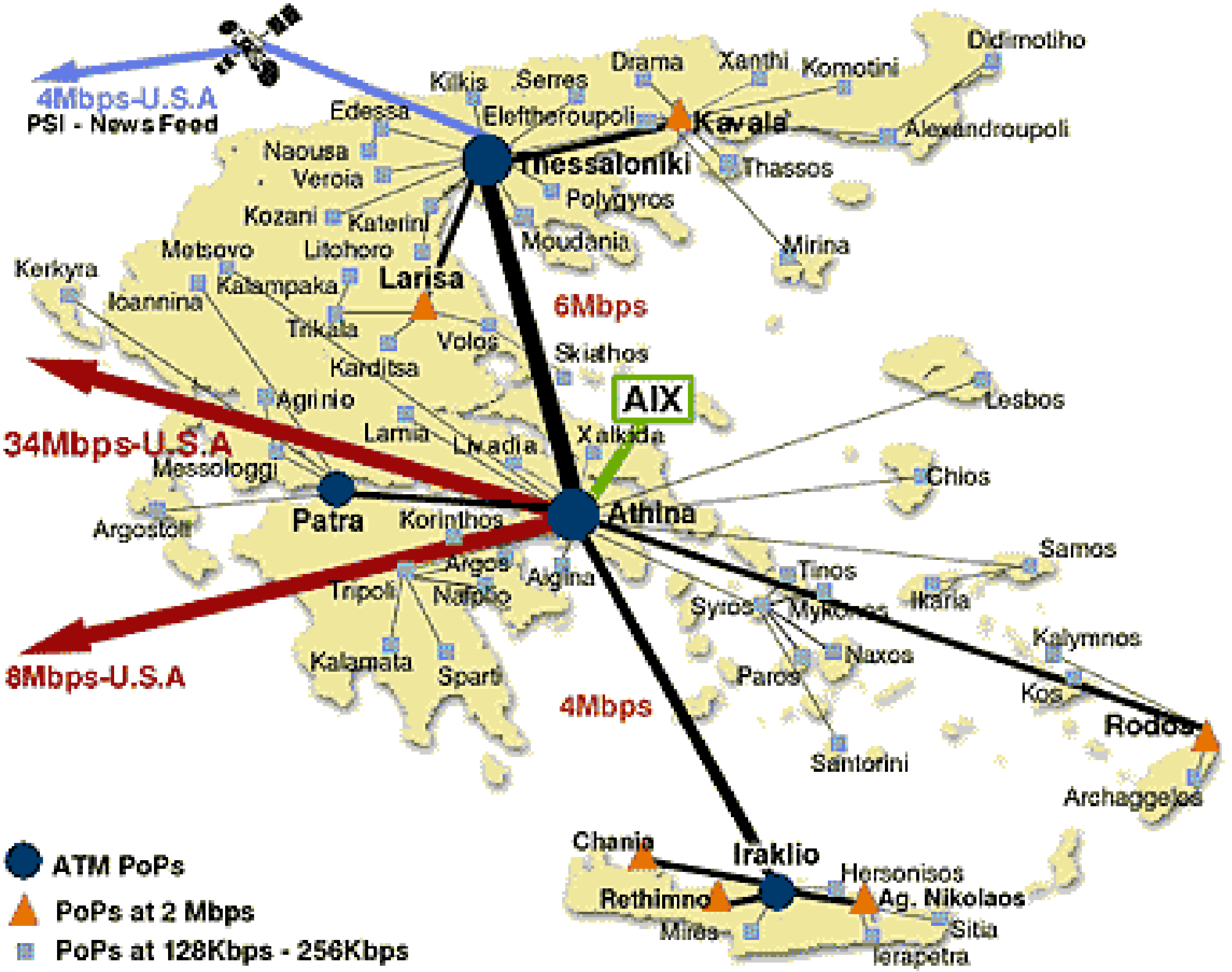


h) Dual Ring Topology

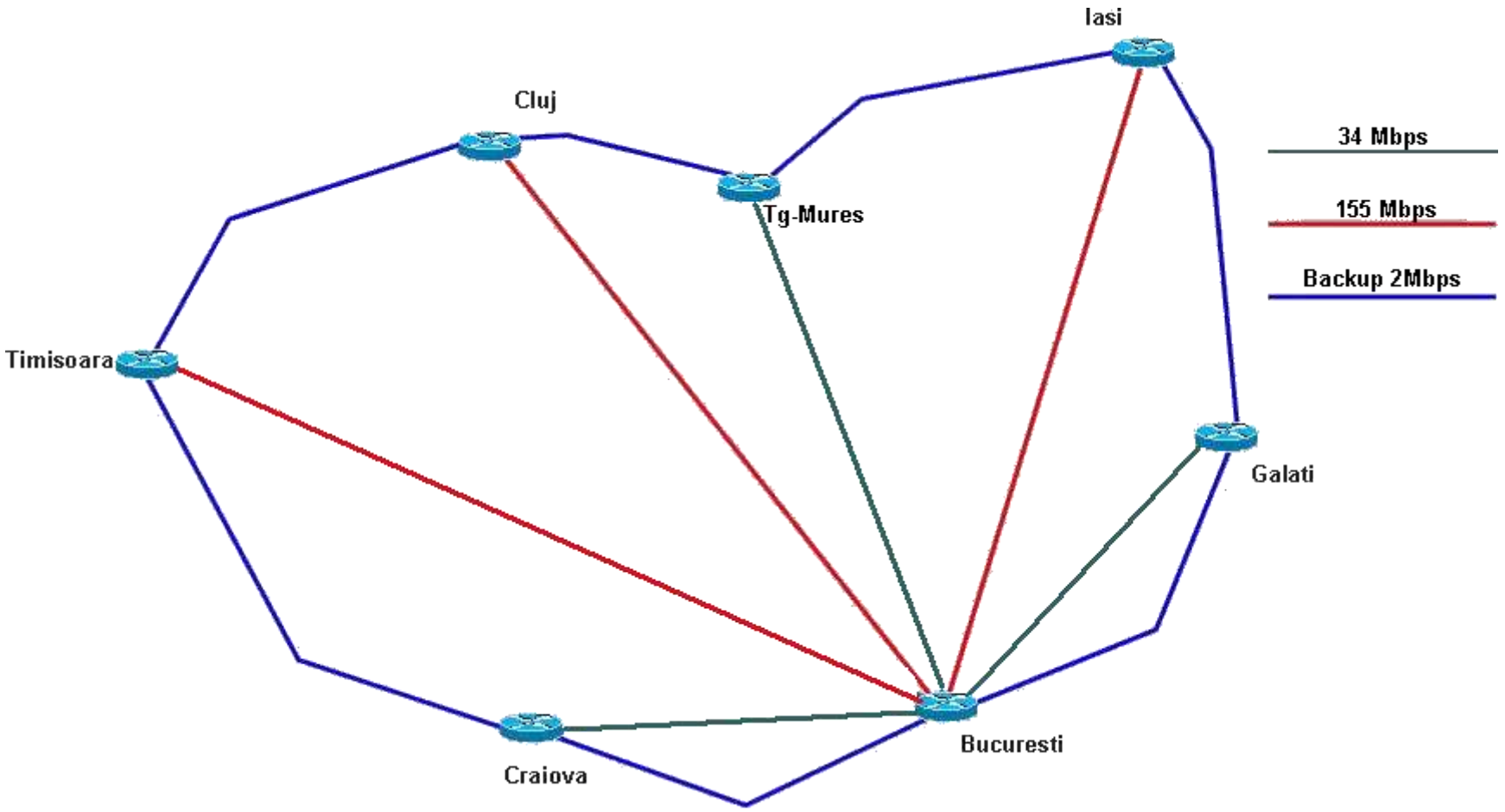


i) Linear Topology

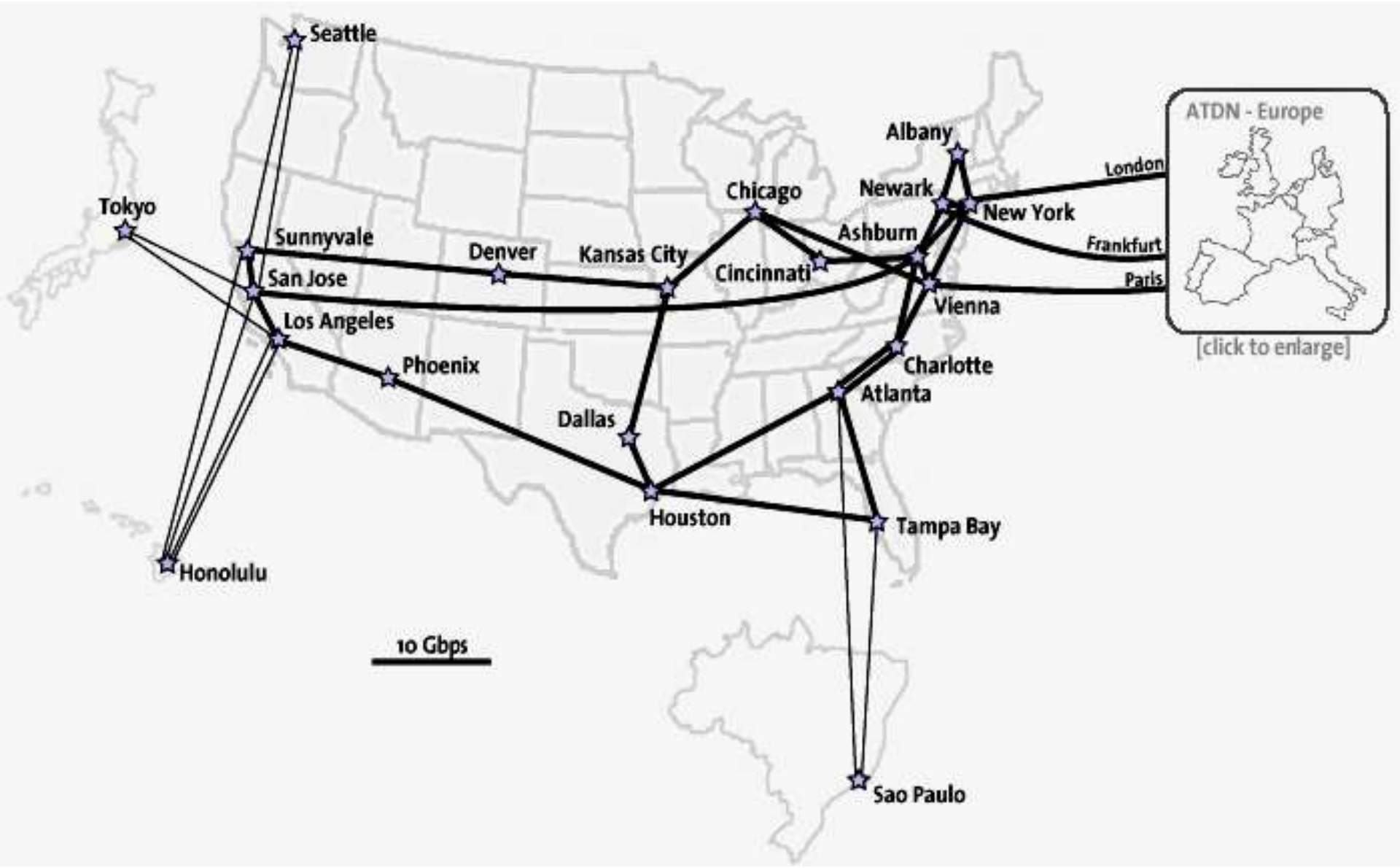

The London MAN
Middlesex
Bounds Green -
Cat Hill -
Enfield -
Hendon -
Tottenham -
Trent Park -
SOAS
RVC
IOE
LSHTM
Birkbeck
Malet St -
Gresse St -
UCL
- Gower St
- Royal Free
- Eastman
- MSSL
London
- ULCC
- Senate House
North London
City
- Northampton Sq
- CUBS
LSE
London Institute
- CSM
UEL
- Barking
- Duncan
- Maryland
- Stratford
Brunel
- Uxbridge
- Runnymede
QMW
- Mile End
- London
- Barts
- West Smithfield
Thames Valley
University House -
Grove House -
Westrel -
Slough -
St Mary's -
London
Business School
Westminster
London Institute
- Davies St
- LCF
Royal College
of Music
Royal College
of Art
Institute of
Cancer Research
UCL
ULCC
Imperial
Telehouse
South Bank
Greenwich
IC
Roehampton
Institute
-Digby Stuart
-Whitelands
Royal
Holloway
Kingston
Penrhyn Rd -
Kingston Hill -
King's
Strand -
KCSMD -
King's
Guys -
St Thomas -
St George's
South Bank
Main Campus
Wandsworth Rd
London Guildhall
London Institute
- Elephant & Castle
- Back Hill
Goldsmiths
Greenwich
- Woolwich
- Dartford
- Greenwich
- Avery Hill
Ravensbourne
May 1999

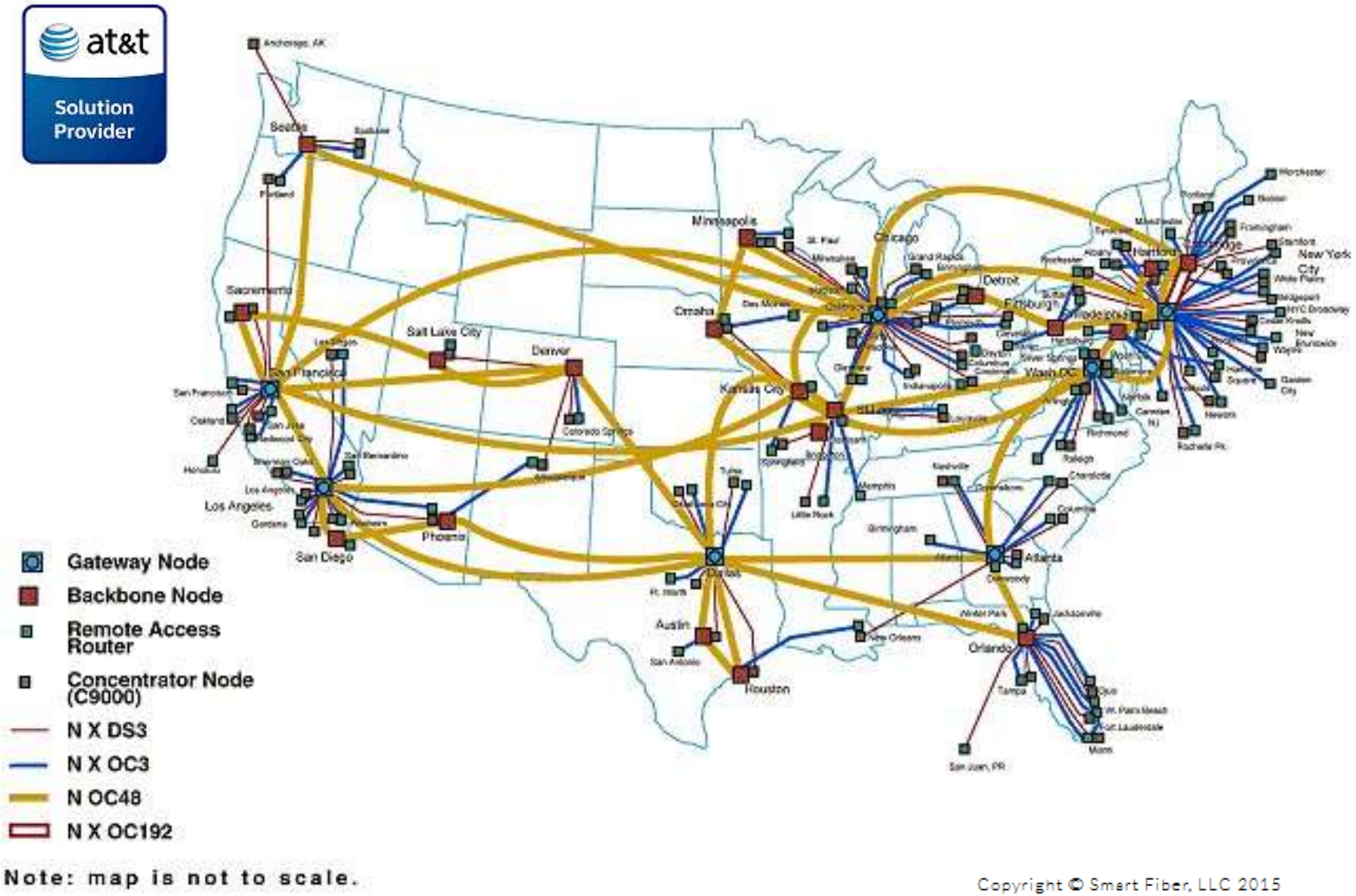

4Mbps-U.S.A
PSI - News Feed
34Mbps-U.S.A
6Mbps-U.S.A
6Mbps
4Mbps
AIX
Didimotiho
Drama
Xanthi
Komotini
Kilkis
Serres
Edessa
Eleftheroupoli
Kavala
Alexandroupoli
Naousa
Veroia
Thessaloniki
Thassos
Polygyros
Kozani
Katerini
Moudania
Mirina
Metsovo
Litohoro
Kerkyra
Kalampaka
Larisa
Ioannina
Trikala
Volos
Skiathos
Karditsa
Agrinio
Lesbos
Lamia
Livadia
Xalkida
Messologgi
Chios
Argostoli
Patra
Korinthos
Athina
Samos
Argos
Aigina
Tinos
Tripoli
Nafplio
Ikaria
Syros
Mykonos
Kalymnos
Kalamata
Sparti
Naxos
Paros
Kos
Rodos
Santorini
Archaggelos
Chania
Iraklio
Hersonisos
Rethimno
Ag. Nikolaos
Sitia
Ierapetra
ATM PoPs
PoPs at 2 Mbps
PoPs at 128Kbps - 256Kbps

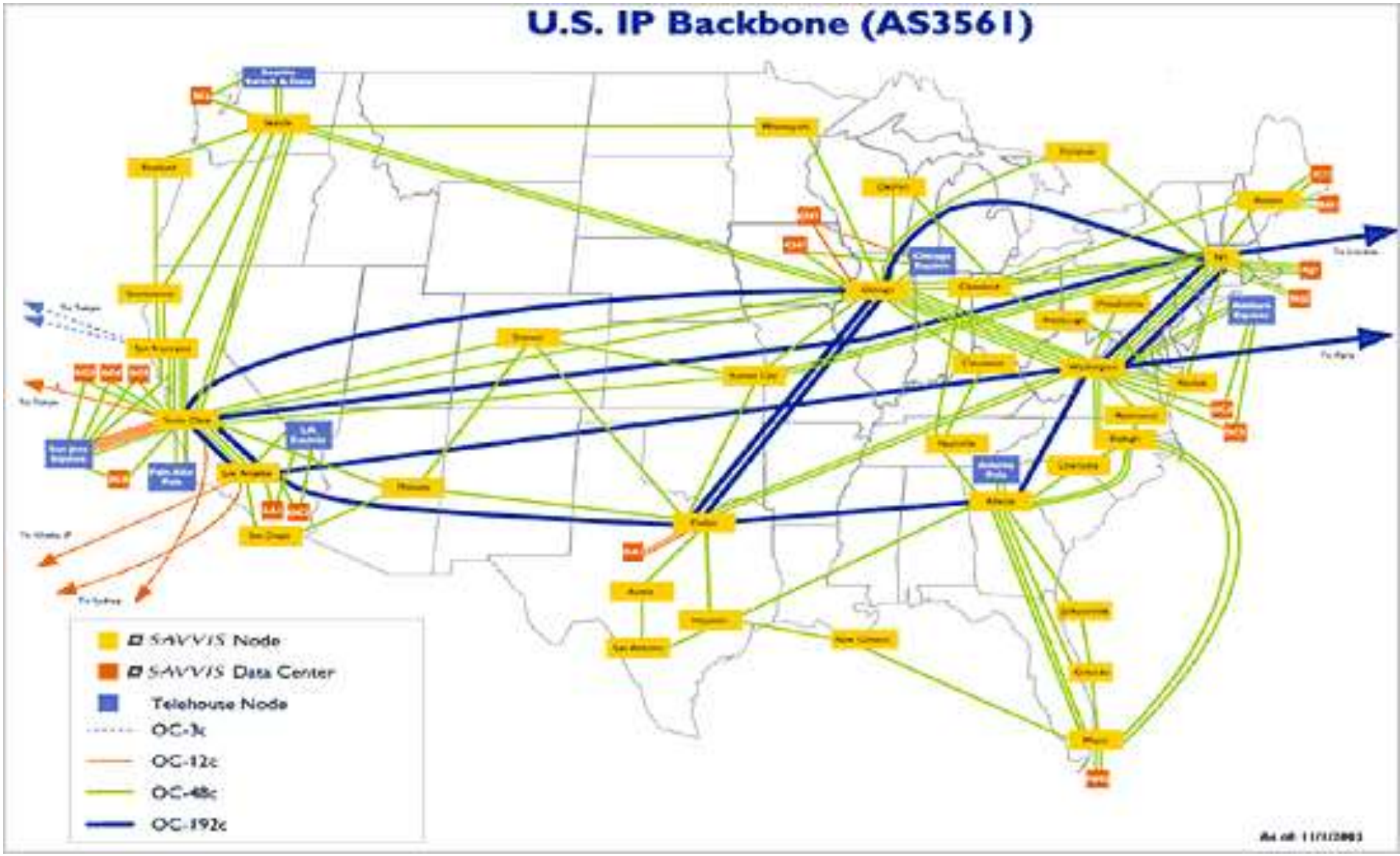
The pan European KPNQwest network, when complete, will connect major cities together by six high-capacity backbone rings.

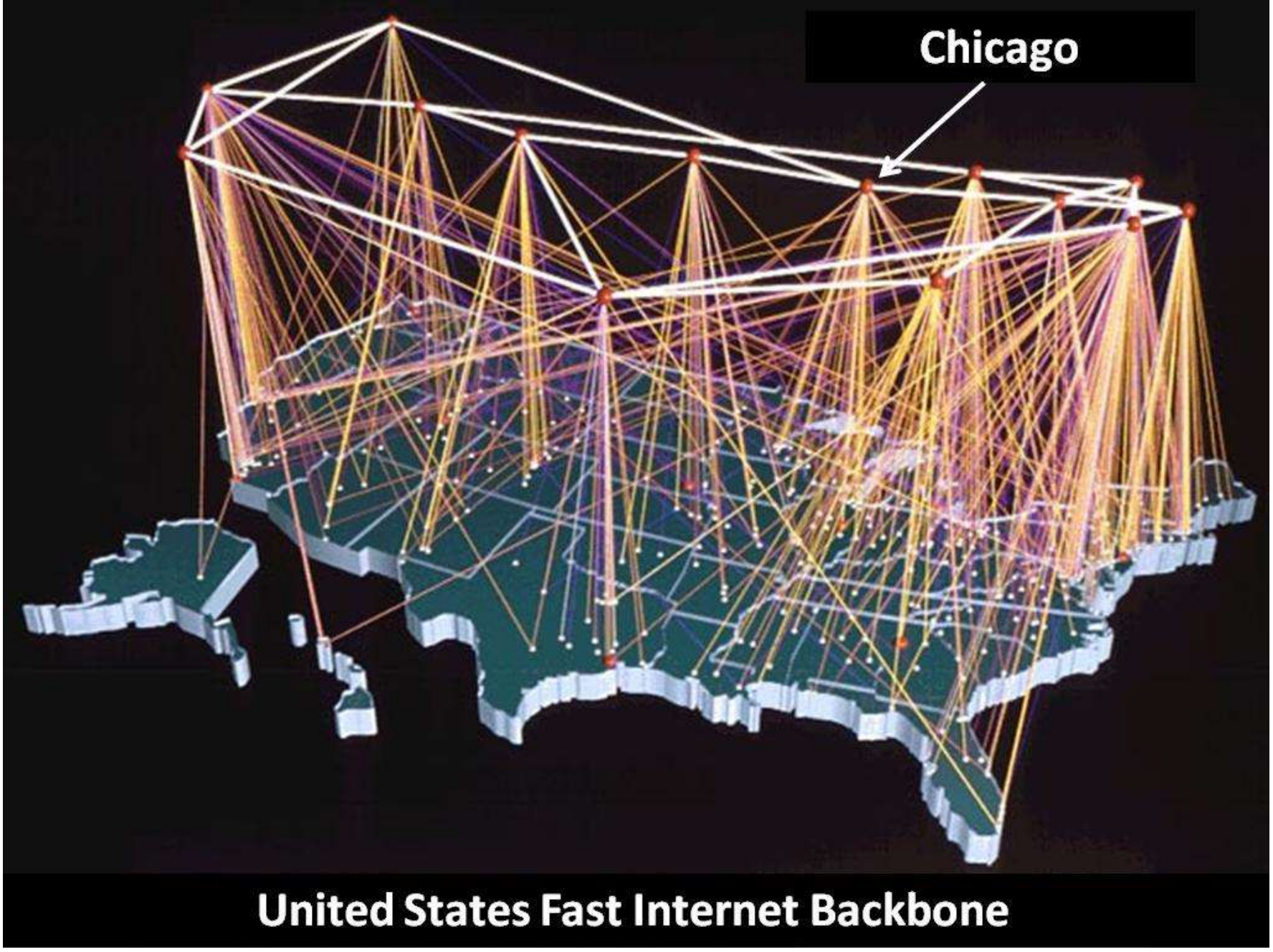

Iasi
Cluj
Tg-Mures
34 Mbps
155 Mbps
Backup 2Mbps
Timisoara
Galati
Bucuresti
Craiova

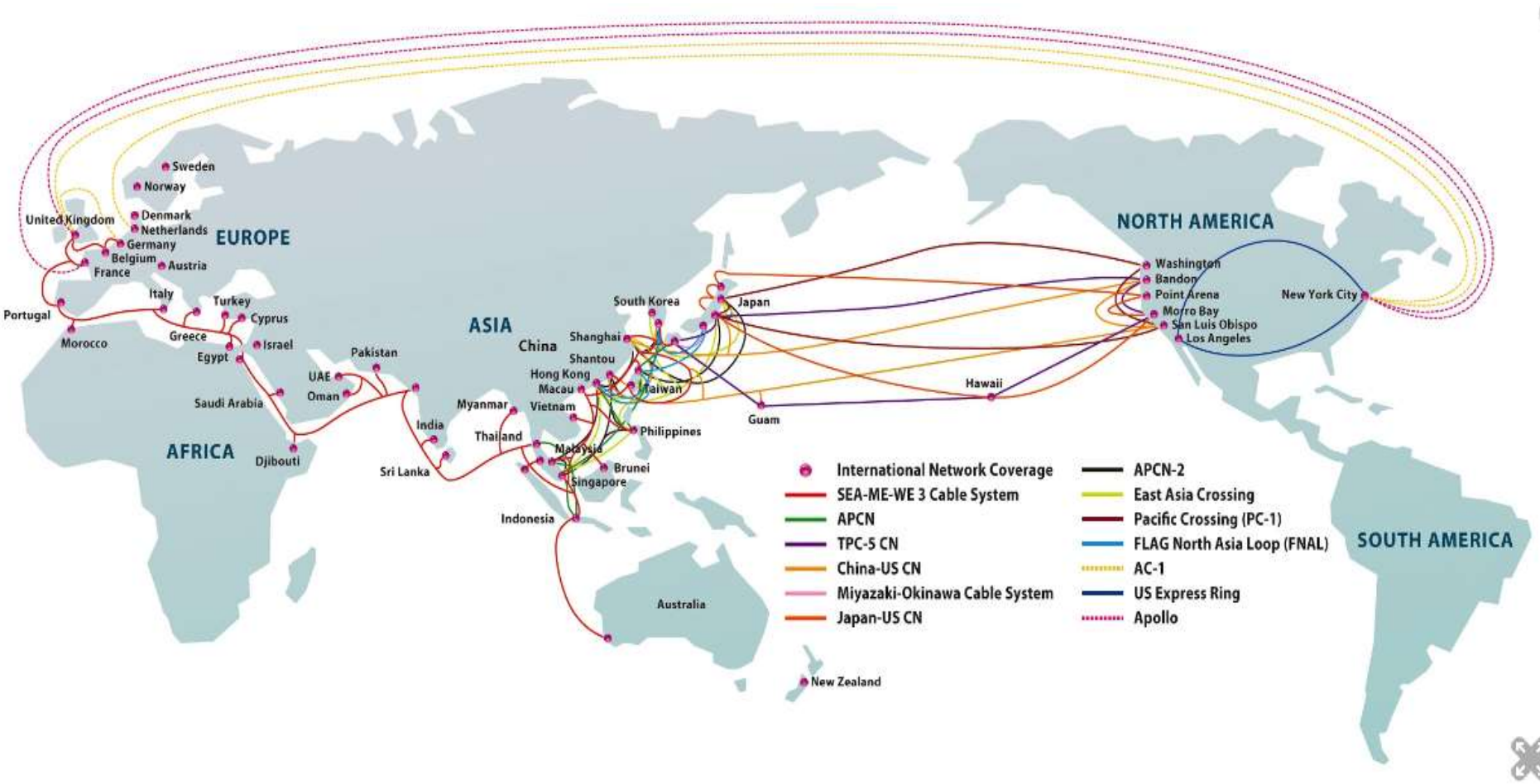
AOL USA BACKBONE




at&t
Solution Provider
Seattle
Sacramento
San Francisco
Salt Lake City
Denver
Los Angeles
San Diego
Phoenix
Minneapolis
Chicago
Detroit
Omaha
Kansas City
Dallas
Austin
Houston
Atlanta
Orlando
Wash DC
Hartford
New York City
Gateway Node
Backbone Node
Remote Access Router
Concentrator Node (C9000)
N X DS3
N X OC3
N OC48
N X OC192
Note: map is not to scale.
Copyright © Smart Fiber, LLC 2015


U.S. IP Backbone (AS3561)
SAVVIS Node
SAVVIS Data Center
Telehouse Node
OC-3c
OC-12c
OC-48c
OC-192c


Chicago
United States Fast Internet Backbone


Sweden
Norway
Denmark
Netherlands
Germany
Belgium
France
Austria
United Kingdom
EUROPE
Portugal
Morocco
Italy
Turkey
Cyprus
Greece
Egypt
Israel
Saudi Arabia
UAE
Oman
Pakistan
AFRICA
Djibouti
Sri Lanka
India
Myanmar
Thailand
Vietnam
China
Shanghai
Shantou
Hong Kong
Macau
Taiwan
South Korea
Japan
Philippines
Malaysia
Brunei
Singapore
Indonesia
Australia
New Zealand
Guam
Hawaii
NORTH AMERICA
Washington
Bandon
Point Arena
Morro Bay
San Luis Obispo
Los Angeles
New York City
SOUTH AMERICA
International Network Coverage
SEA-ME-WE 3 Cable System
APCN
TPC-5 CN
China-US CN
Miyazaki-Okinawa Cable System
Japan-US CN
APCN-2
East Asia Crossing
Pacific Crossing (PC-1)
FLAG North Asia Loop (FNAL)
AC-1
US Express Ring
Apollo

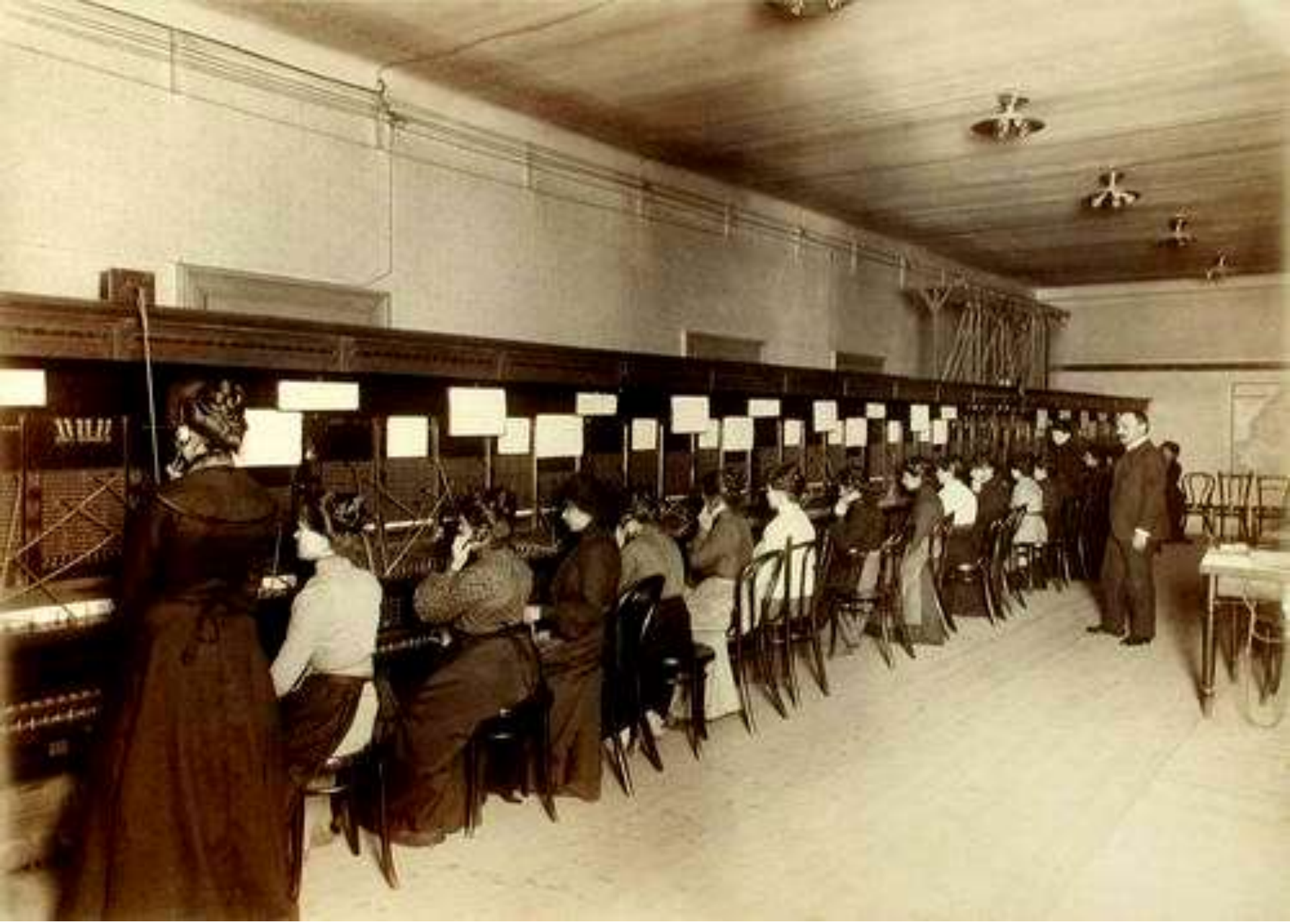

Judge Harry Pregerson Interchange, LA, USA

Public Switched Telephone Networks (PSTN)

- Brief history
- Basics
- Network structures
- Network implementation
- Network development trends
- Missing topics

Brief history I.

- 1876 A. G. Bell Patent of telephone (50.000 phone within 3 years)
- 1877 T. A. Edison patent of carbon microphone (covering long distances)
- 1878 Puskás Tivadar the first telephone exchange in Connecticut
- 1881 Puskás Ferenc the first telephone exchange in Budapest
- 1890 The first Wien-Budapest international telephone connection
- 1892 The first automatic telephone exchange in Indiana
- 1928 The first automatic telephone exchange in Budapest
- 1997 The last manual exchange moved to museum in Hungary



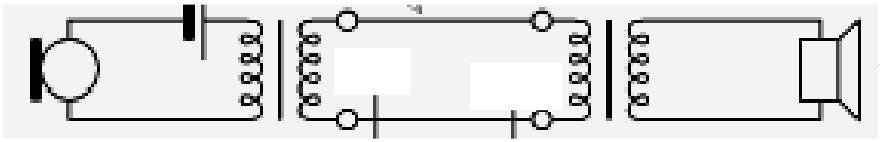
Brief history II.

- The technical level of Hungarian PSTN networks are very high due to the fast development from 1992-2002
- From 1 million subscriber to 10 million one
- From 1000 manual exchange to almost fully digital network
- COCOM list restriction not from our side!!!

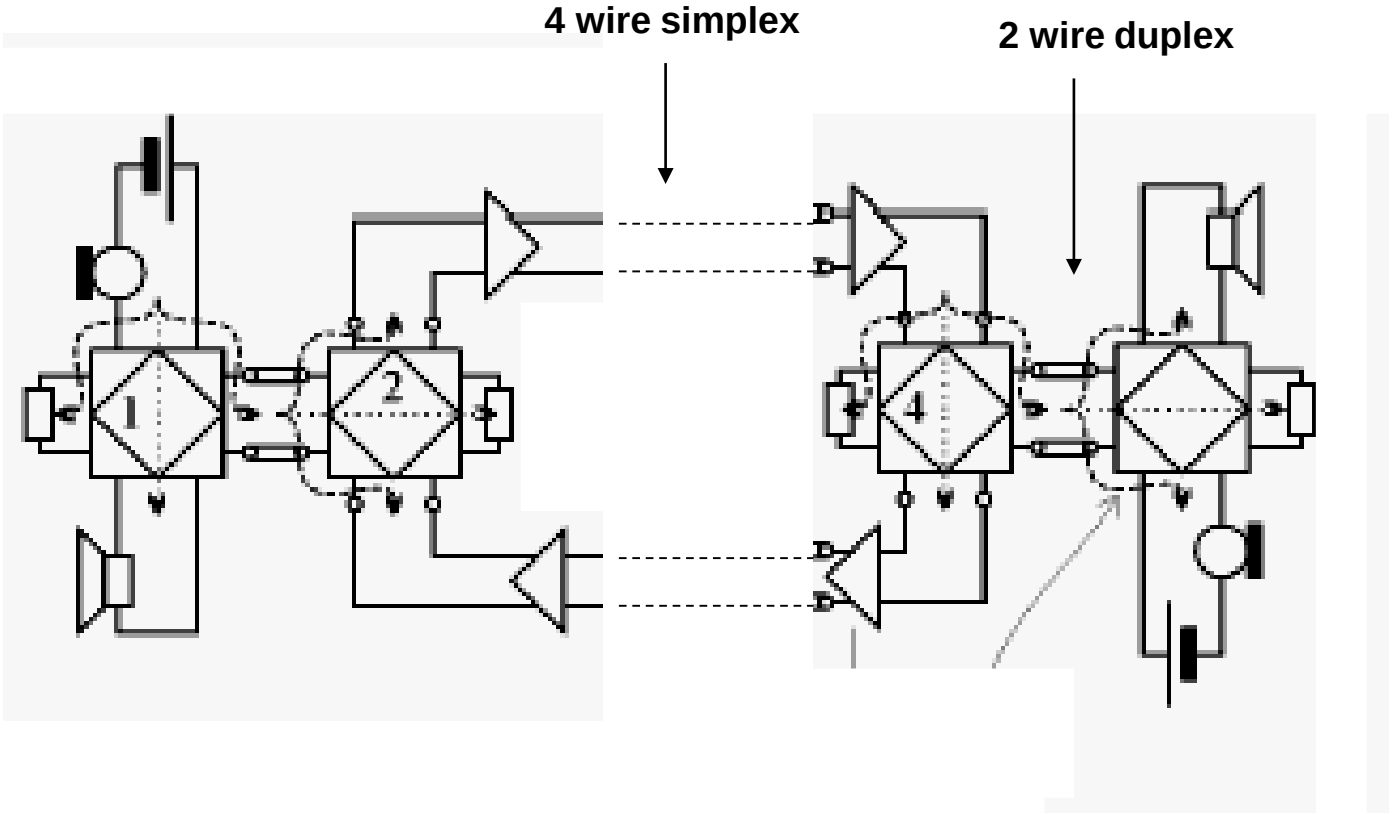
Basics of telephony

- 2/4 wire for voice
- Feeding of circuit
- Access solutions
- Backbone
- Signalling basics for a telephone call
- Source of revenues
- ADSL principles

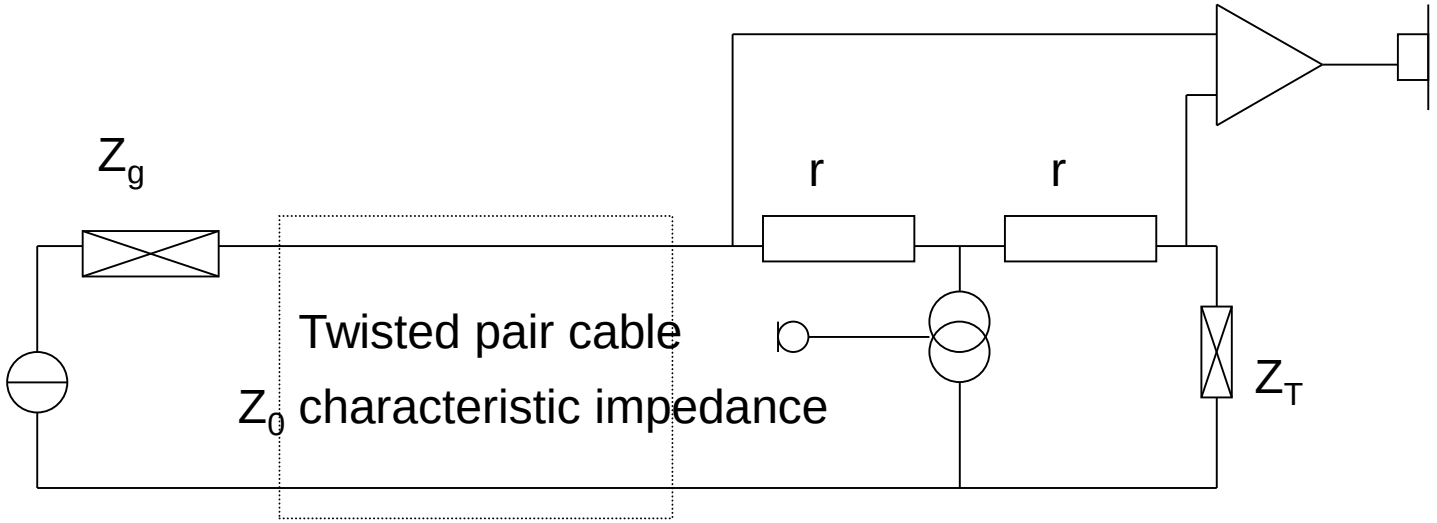
2/4 wire for voice



2 wire simplex

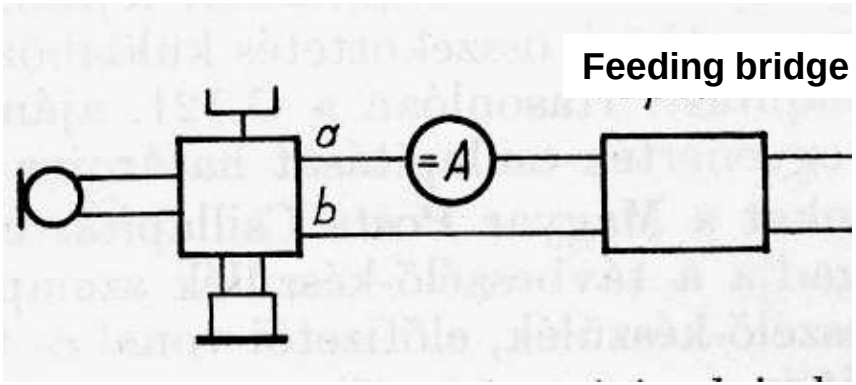


Electronic hybrid circuit

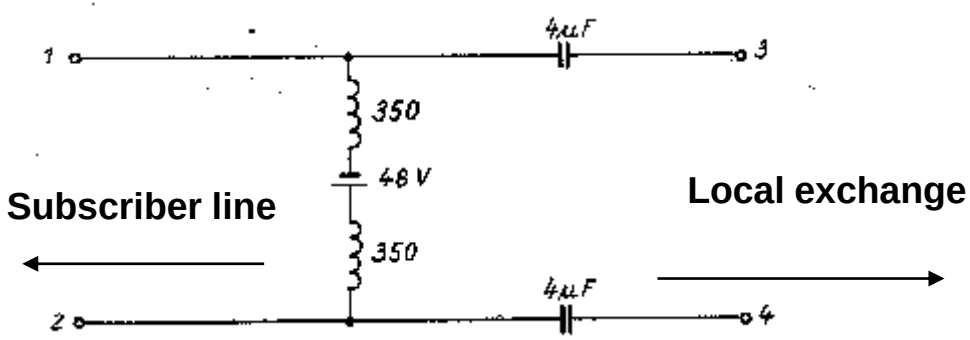


$Z_T \sim Z_0$

Powering of telephone sets

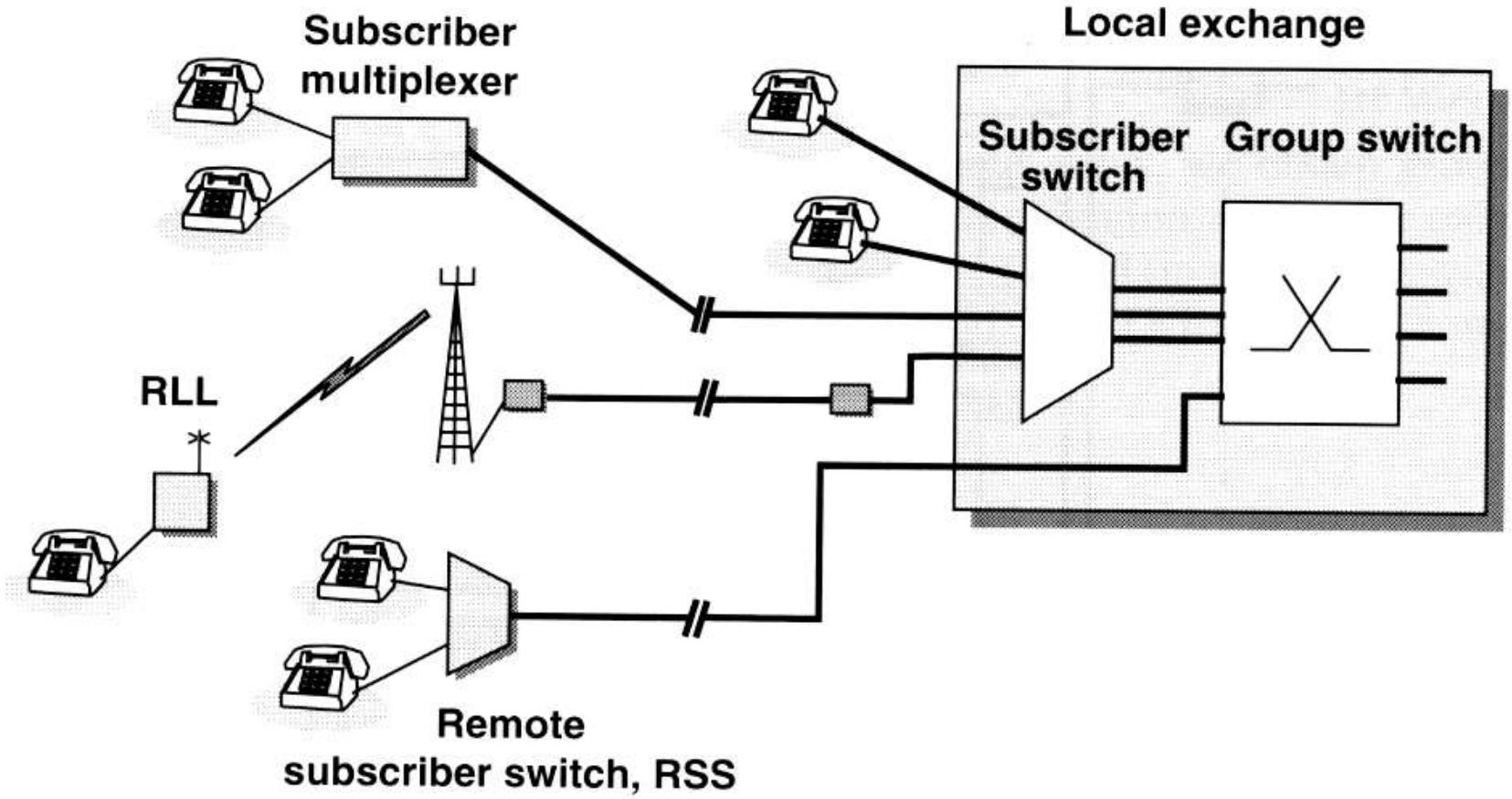


Traditional feeding bridge circuit

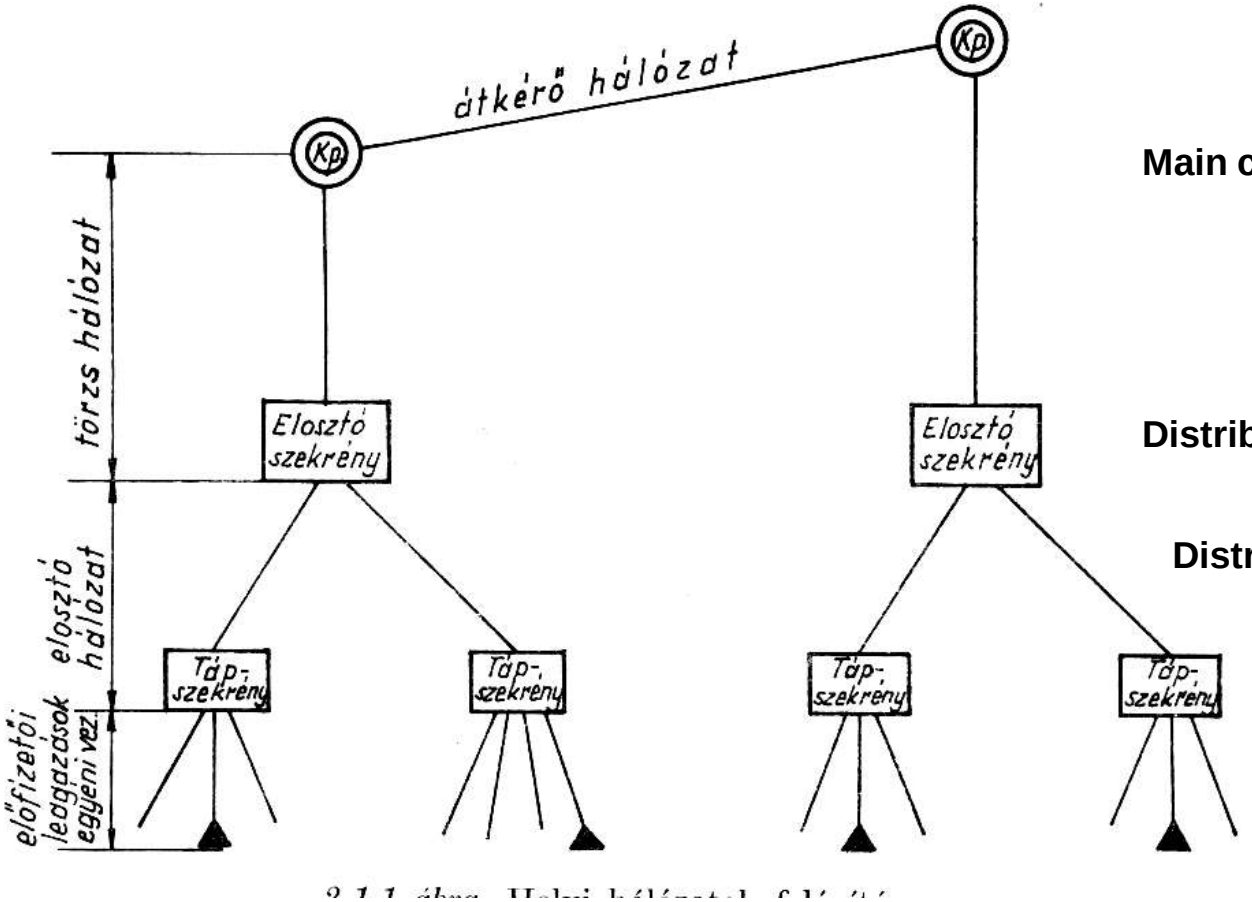


DC line current:
20….60 mA

Access solutions



Connections to the local exchange



Main cables

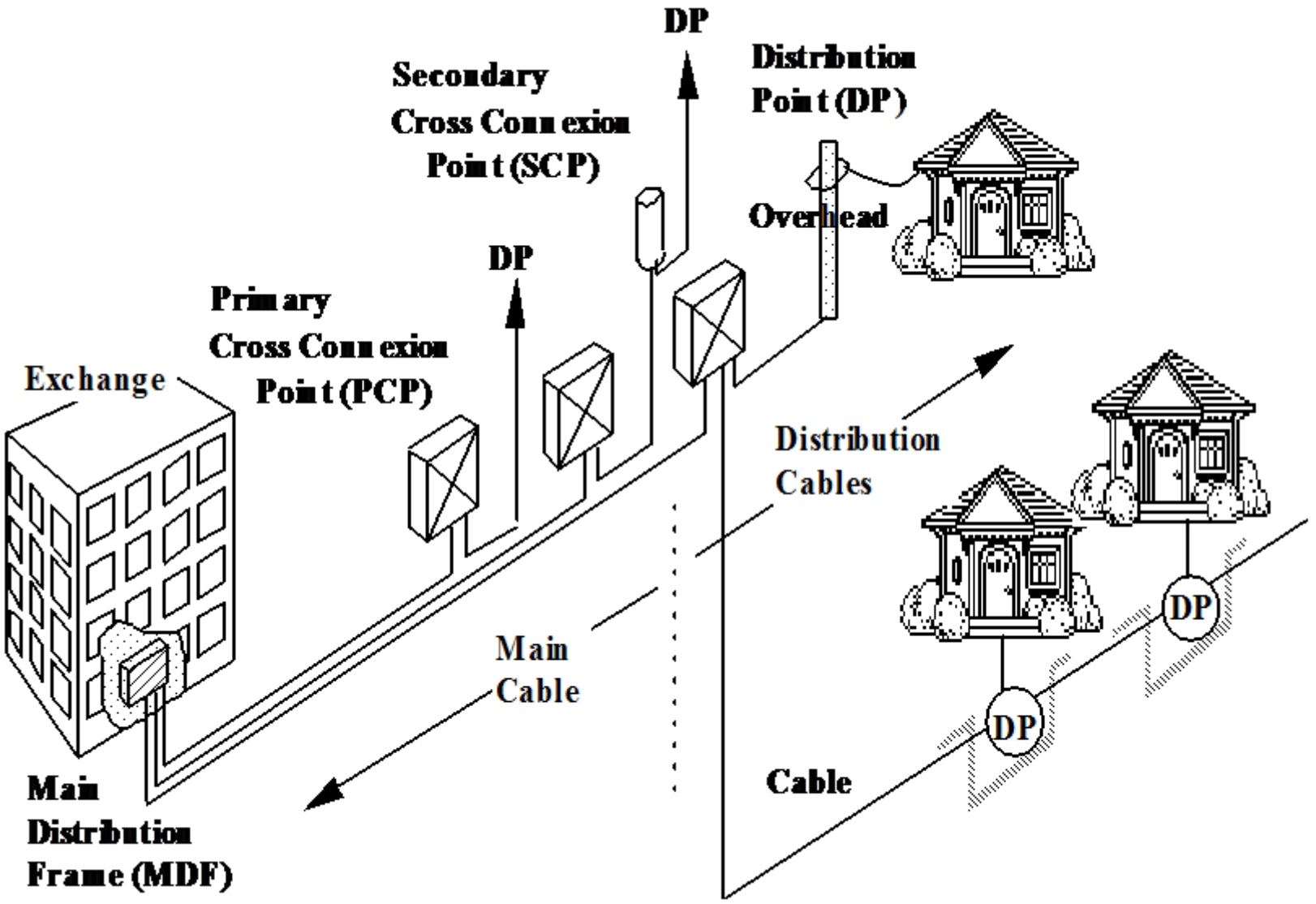
Distribution cabinets

Distribution cables

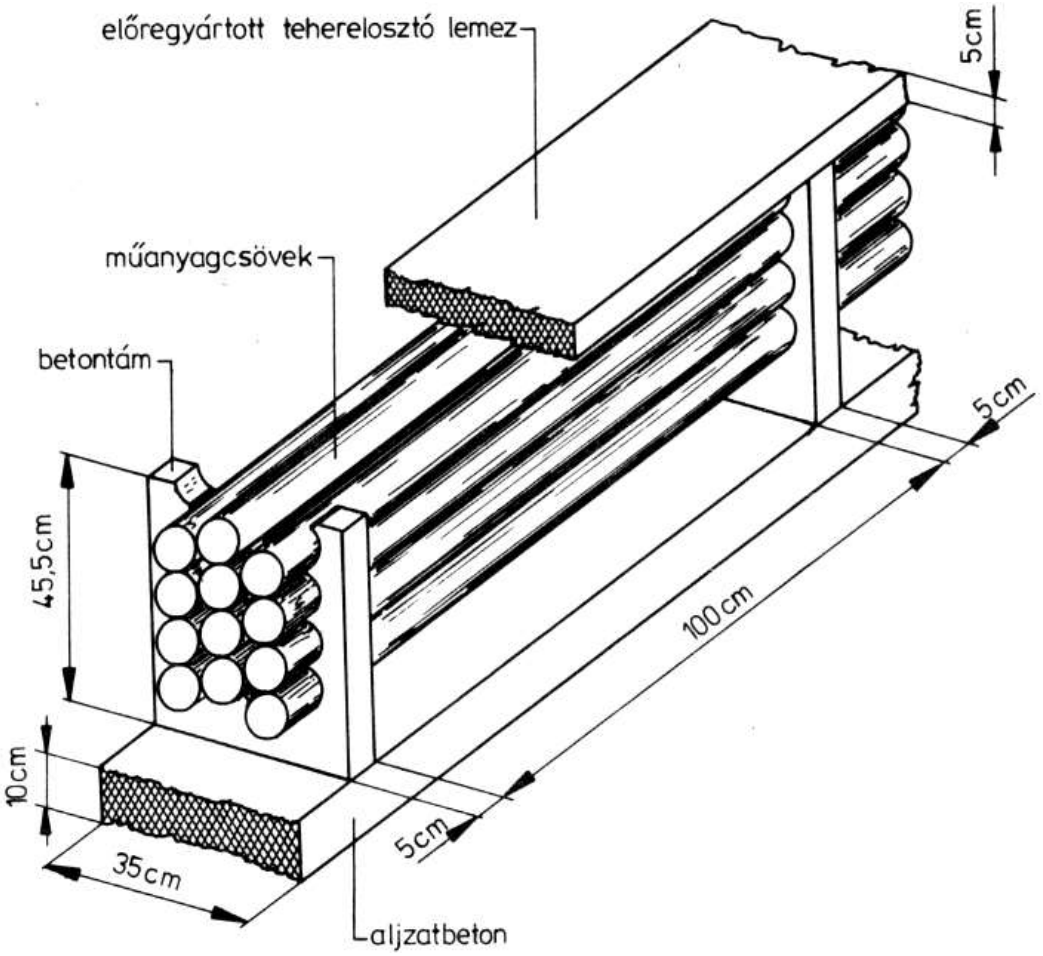
Distribution boxes

Drop cables, Indoor cables

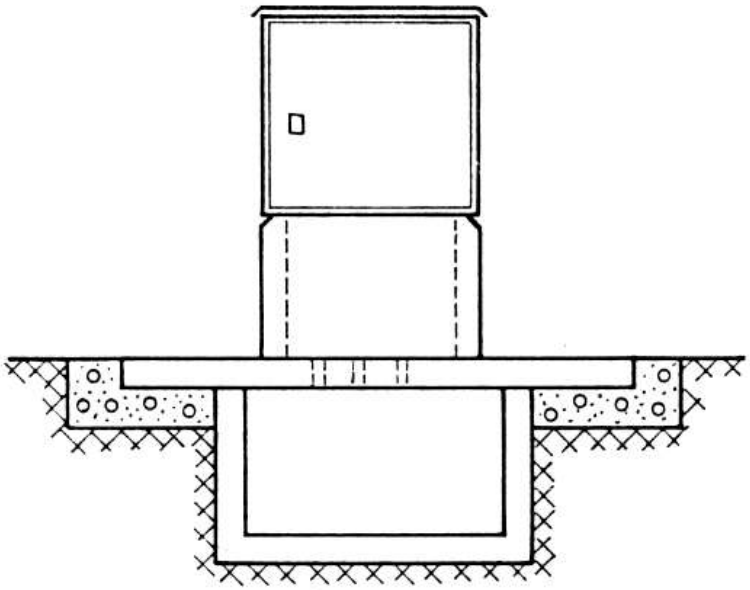
Access network implementation

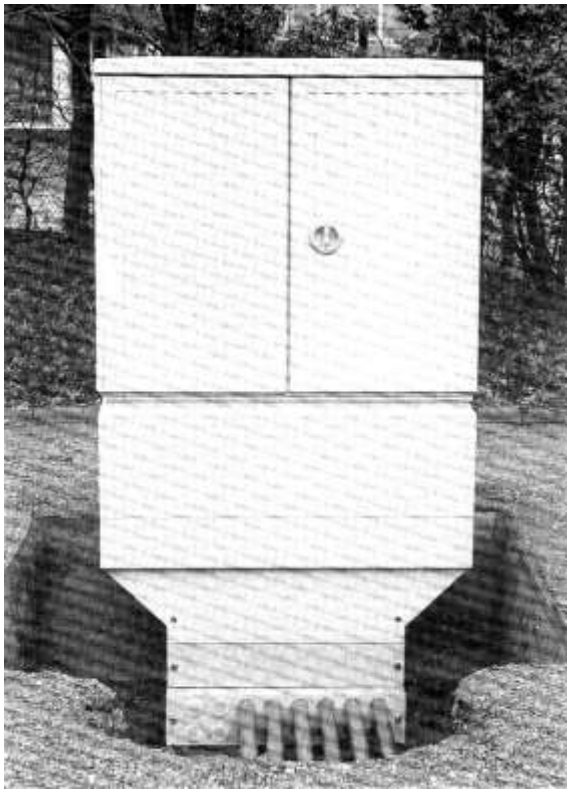


Cable duct system implementation

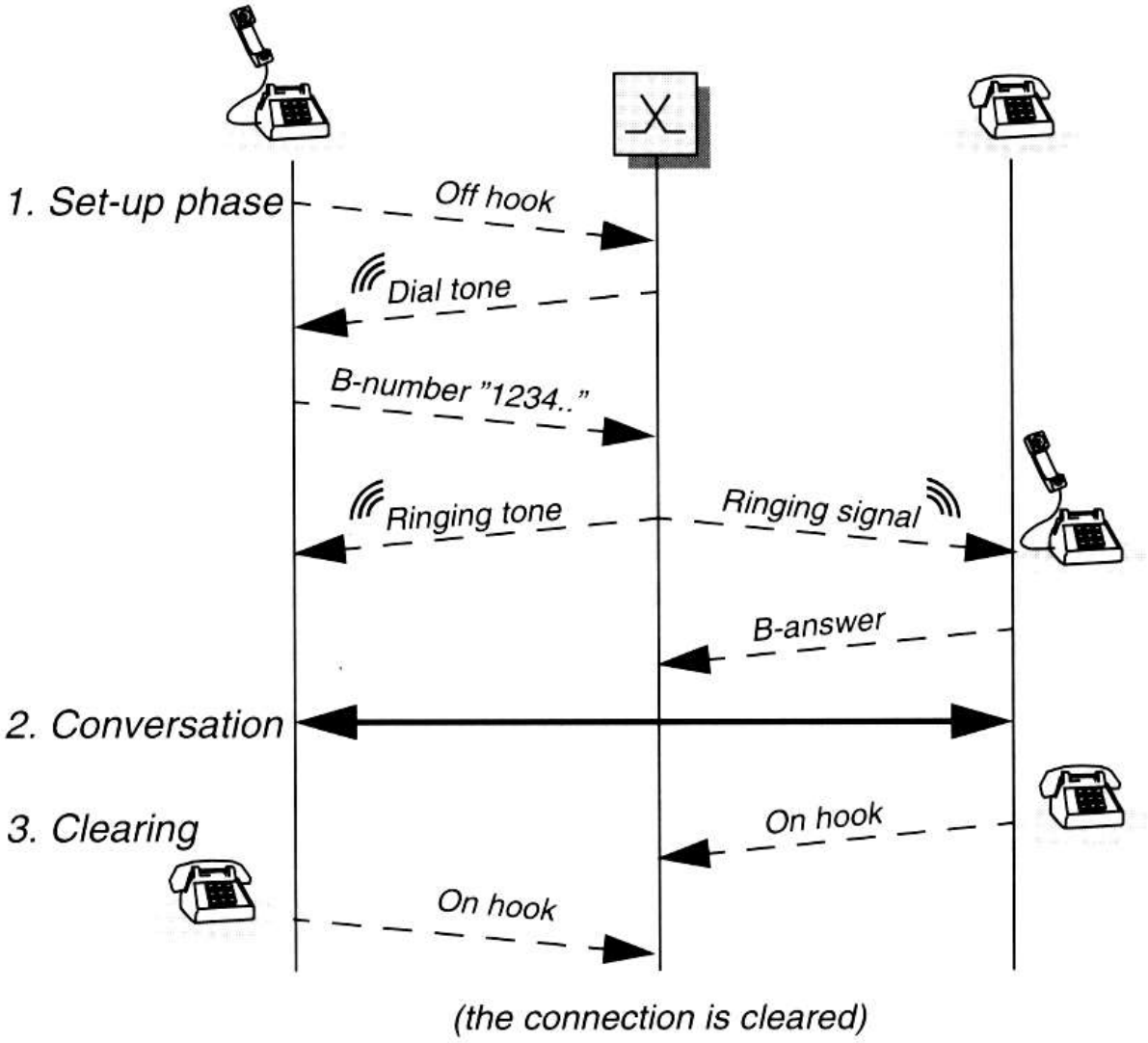


Cable distribution cabinet (street version) implementation

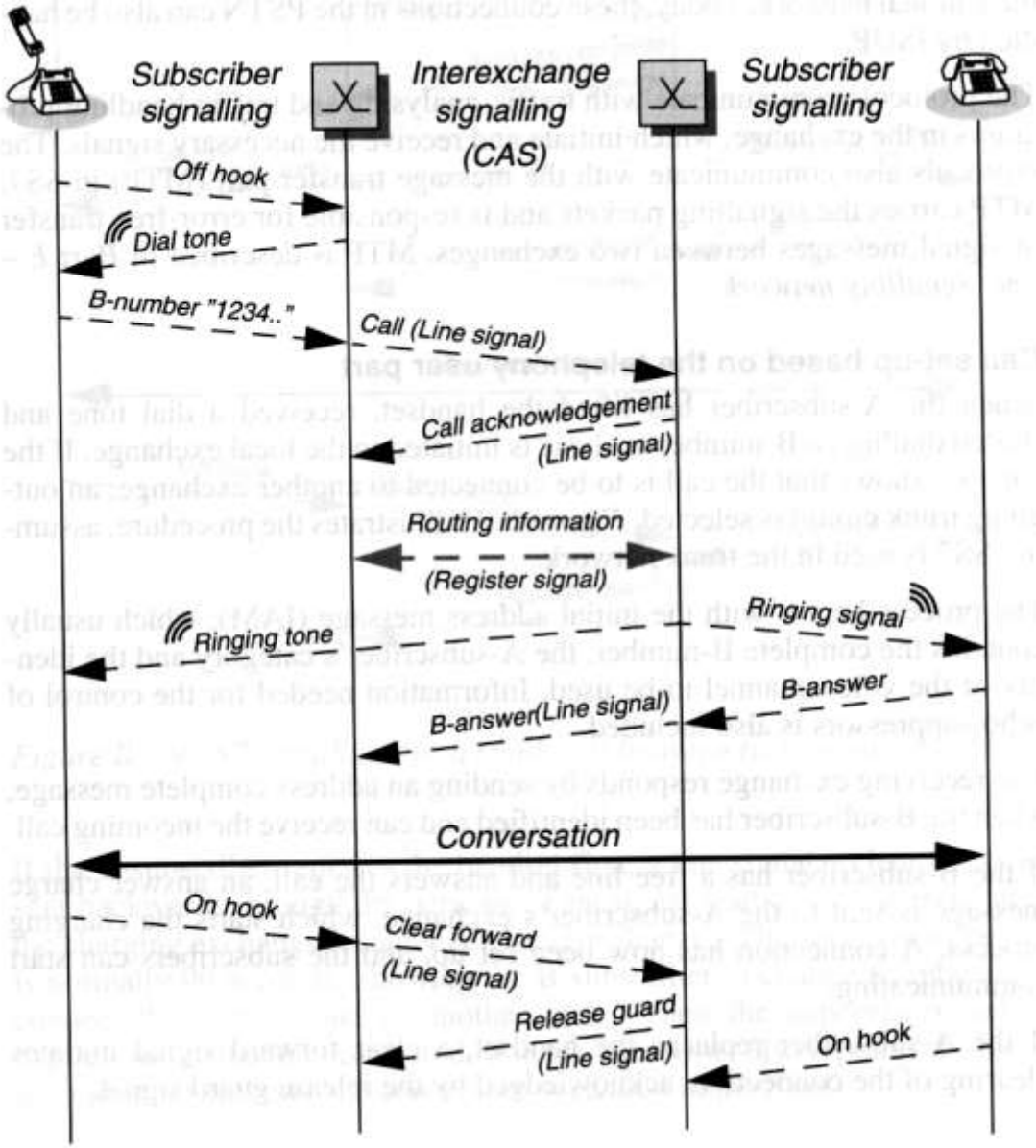




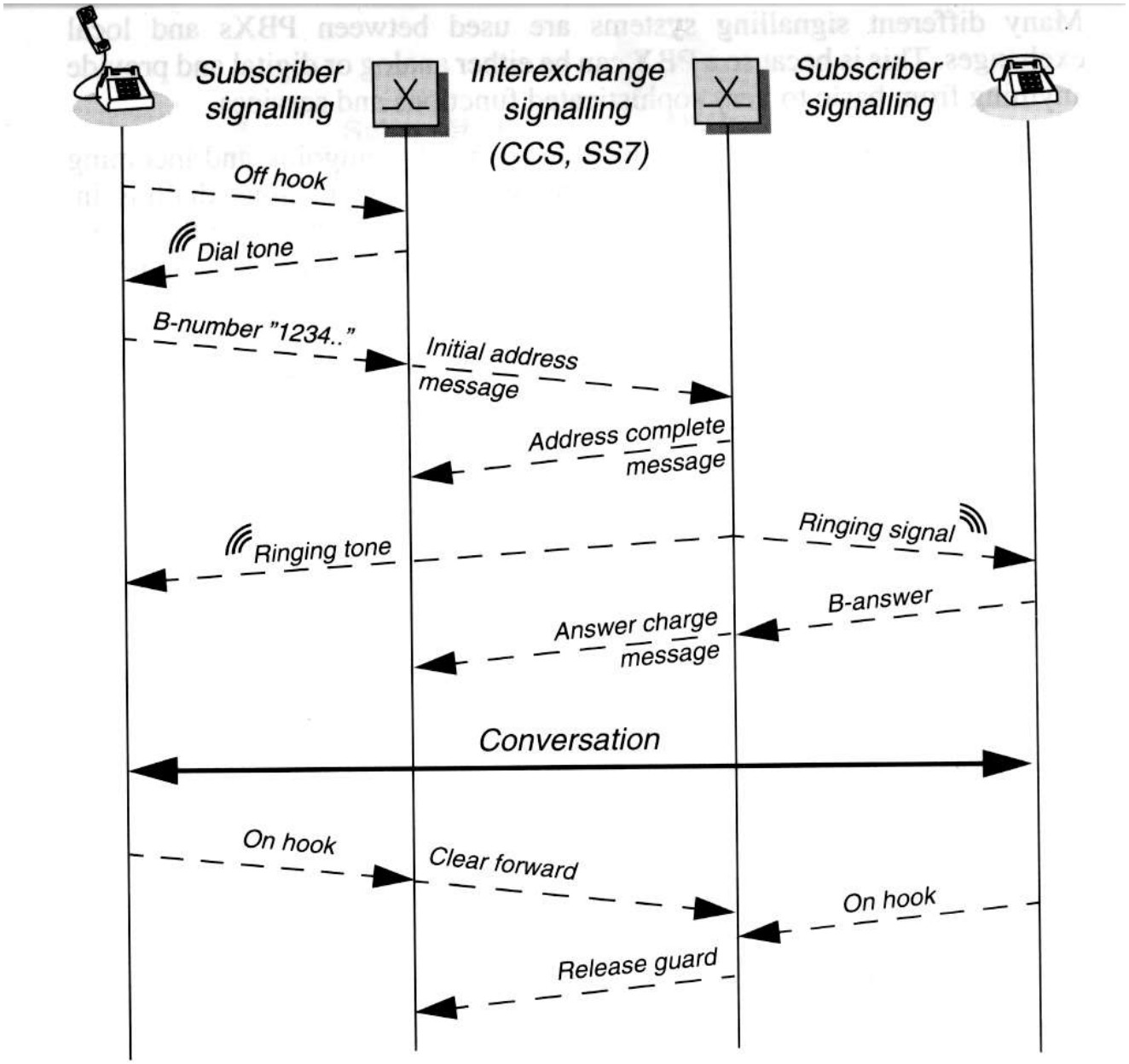
Signalling basics for a telephone call



Channel-associated signalling for a trunk call



Common-channel signalling for a trunk call



Backbone issues in a small country with dense population

- Fully optical – only spare radio connections
- Covered distance between nodes max 100 km
- In Hungary the source of telecom traffic (including telephone, TV programs, Internet) concentrated in Budapest (like the road traffic)
- Concentration of switching capacities in higher level nodes
- Fault tolerant topology is required for reliable services

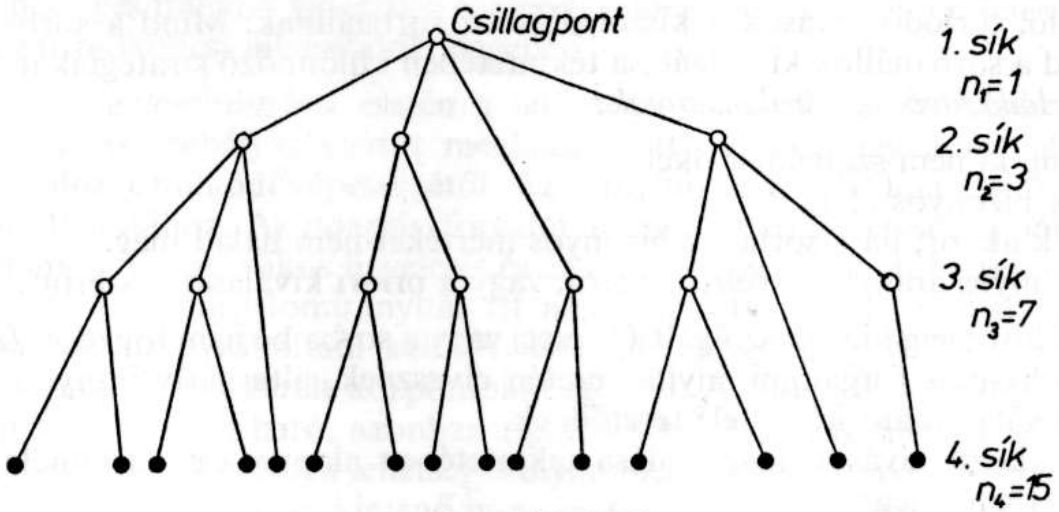
Network structures

- Basics
- MATÁV structures
- PANTEL structures
- Interconnection issues
- Structure and numbering
- Intelligent Network Concept

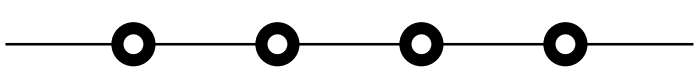
Basic structures in PSTN/ISDN networks

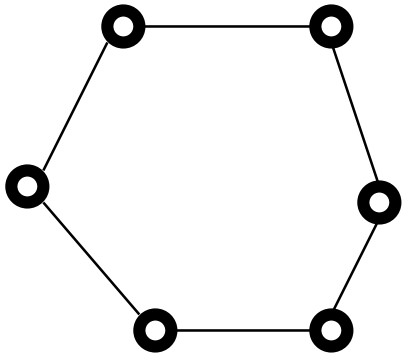
- Star topology
- Multipolar topology
- Meshed topology
- Ring topology
- Bus topology

STAR

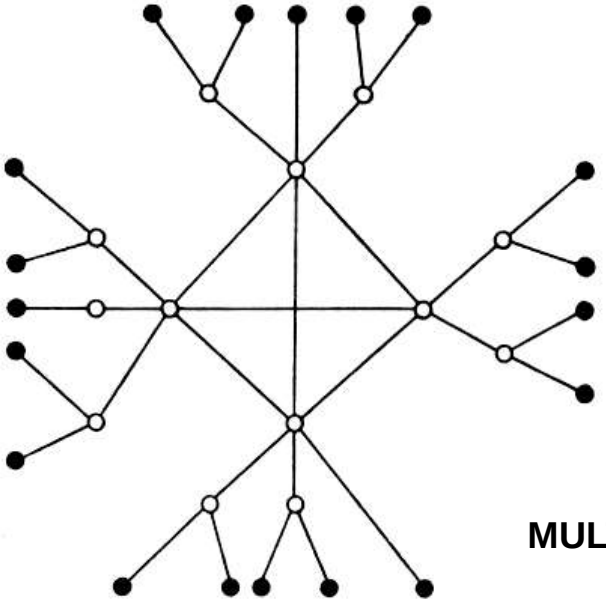


BUS



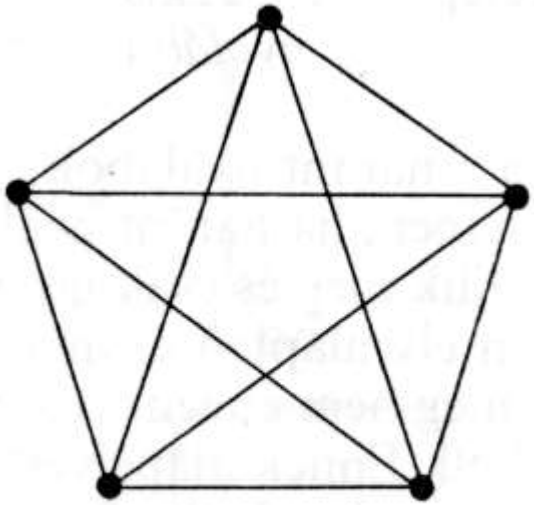


RING



MULTIPOLAR

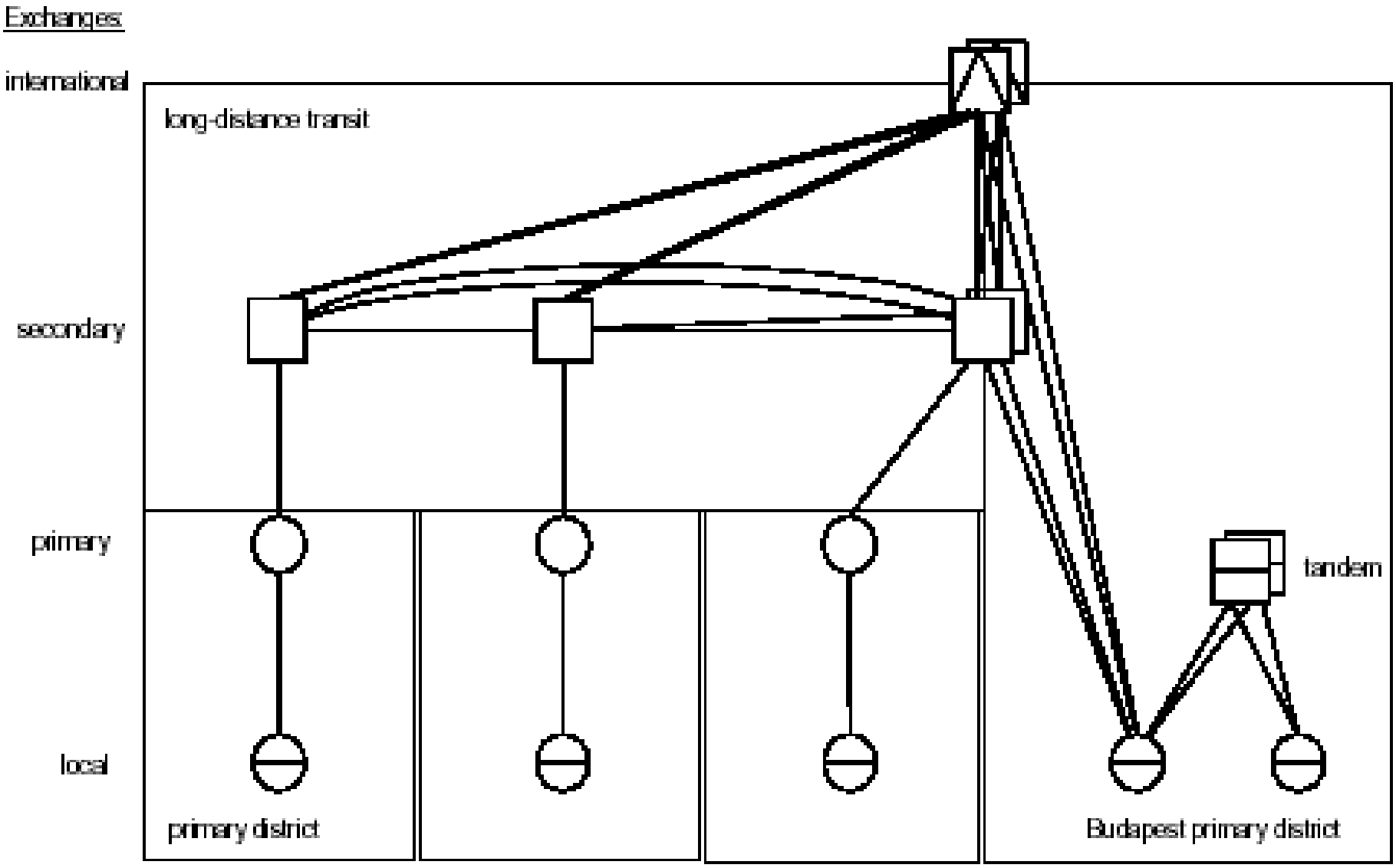
$L=3;\ n_1=4;\ n=32$



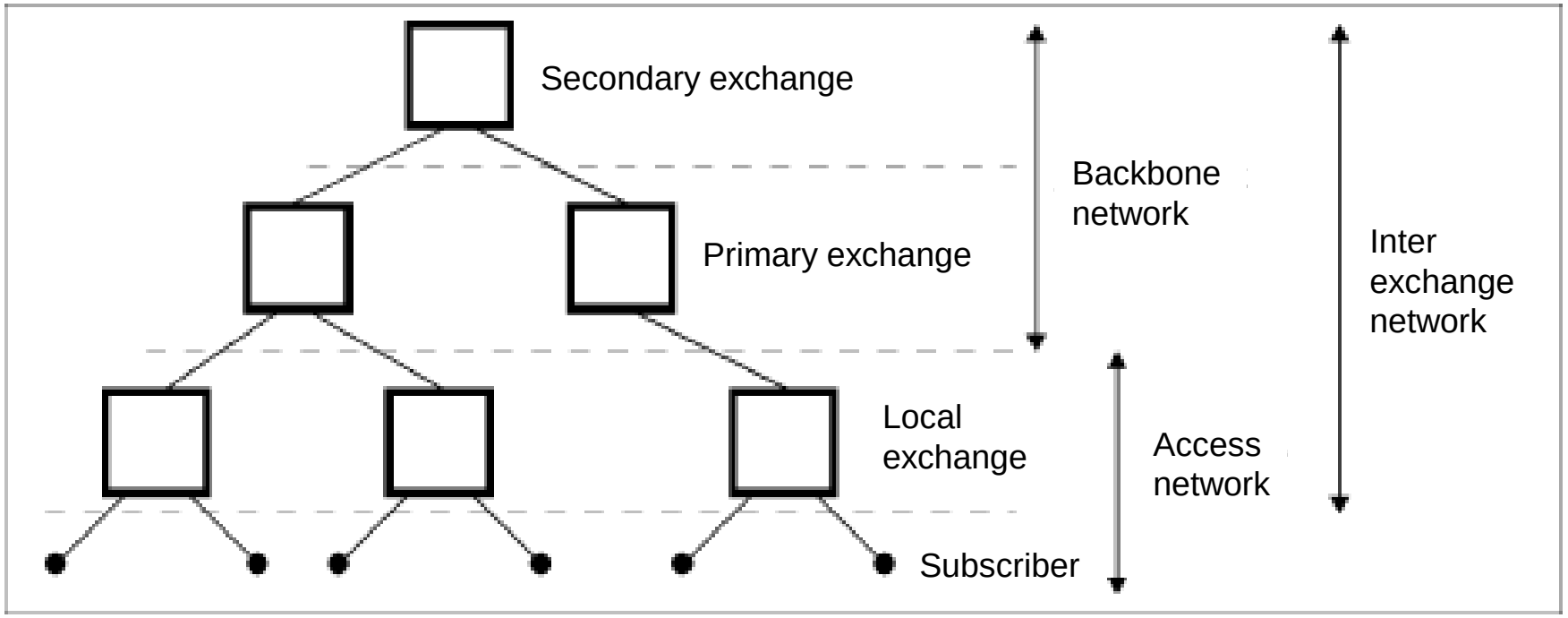
MESHED

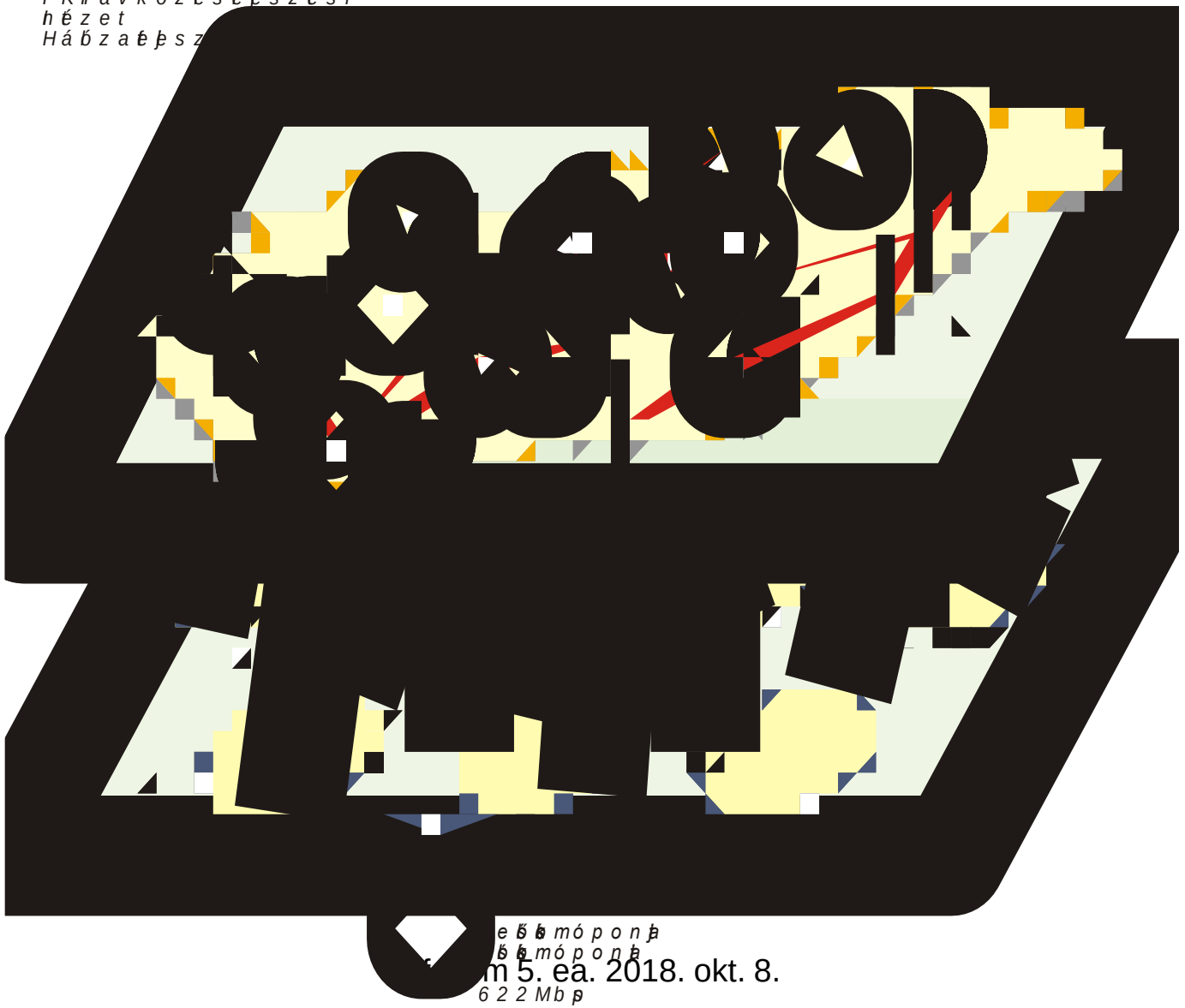
$L=1;\ n=5$

MATÁV NETWORK STRUCTURE

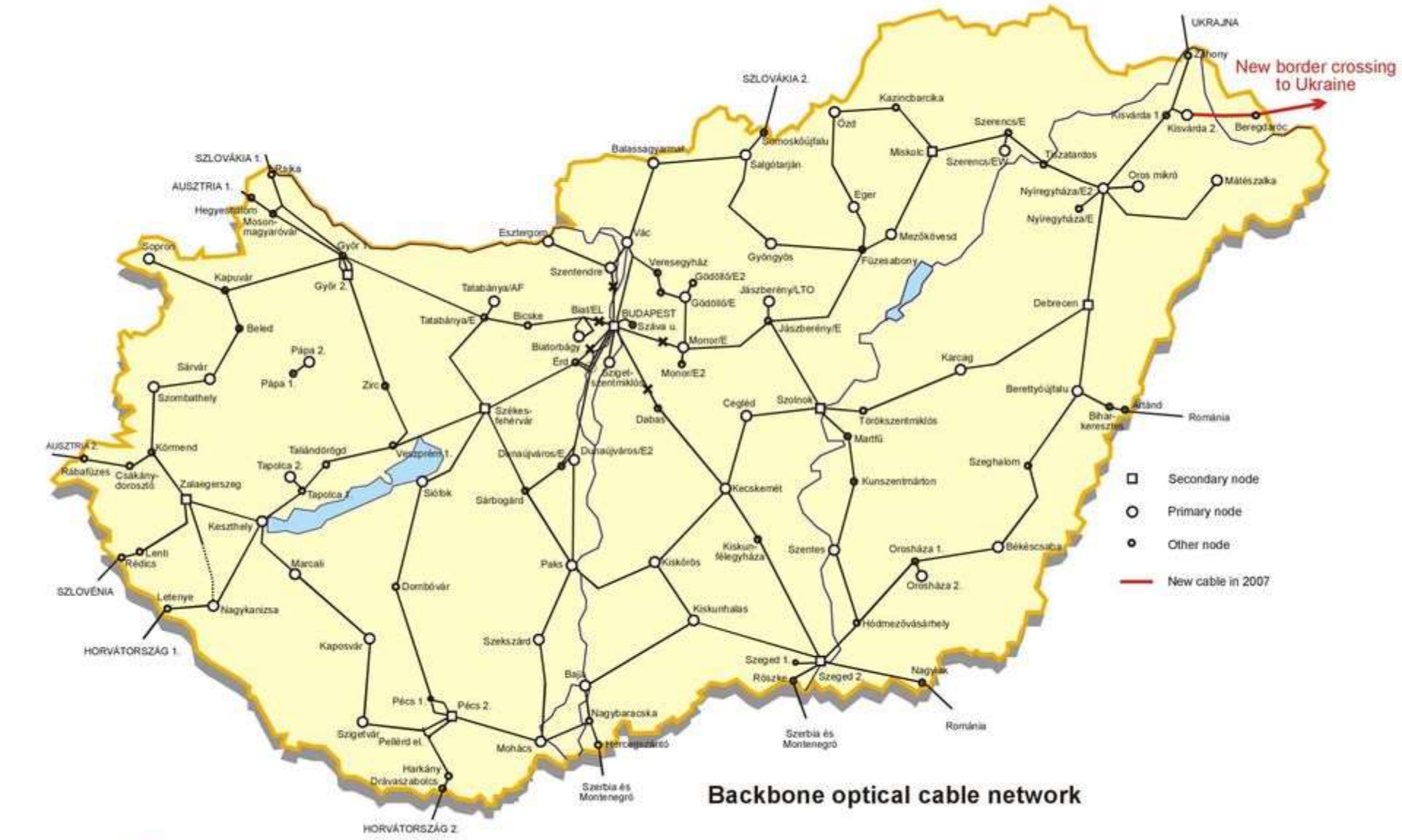


Telephone network structure of MATAV





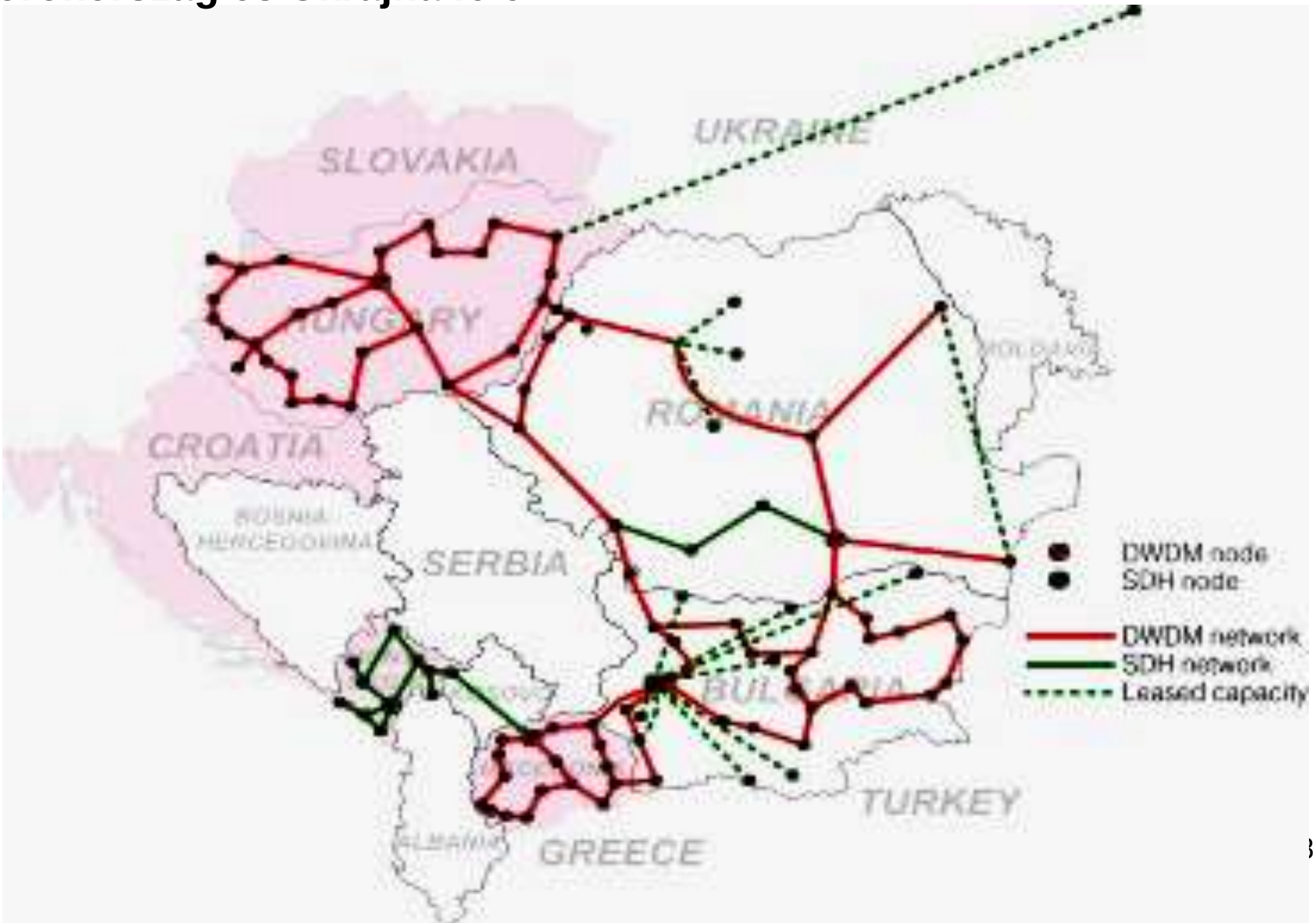
A T-Com optikai gerinchálózata

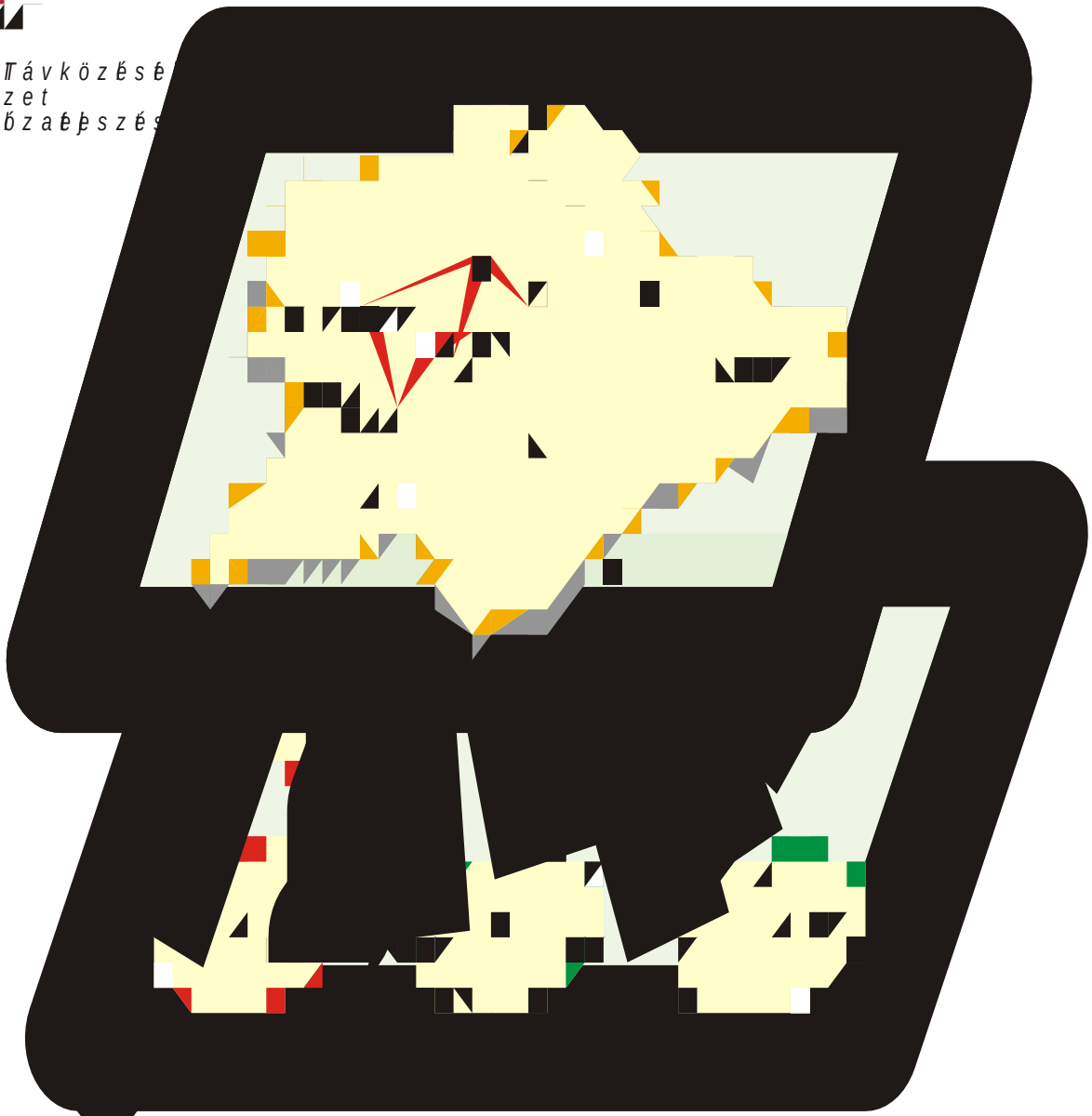


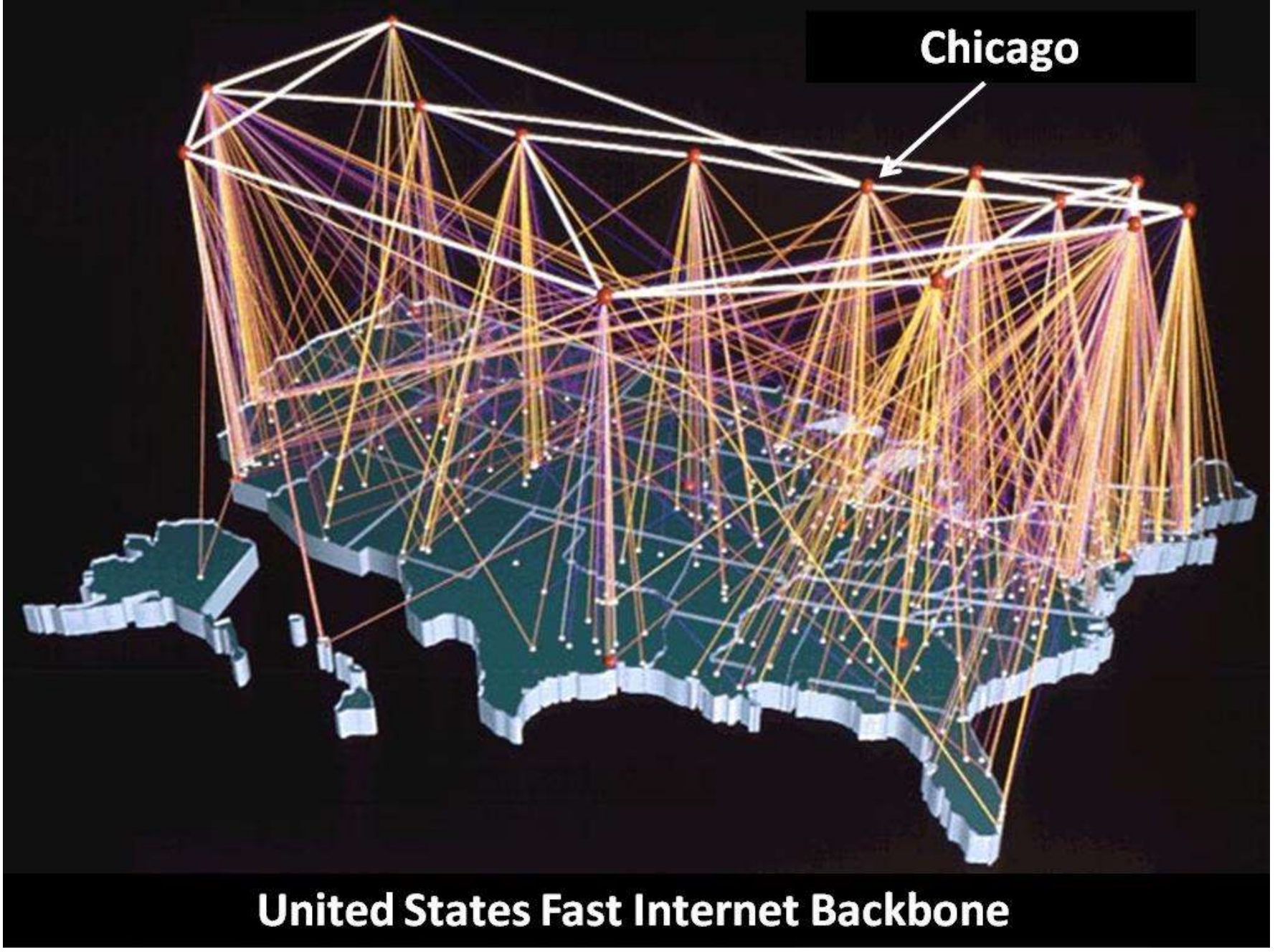
Backbone optical cable network

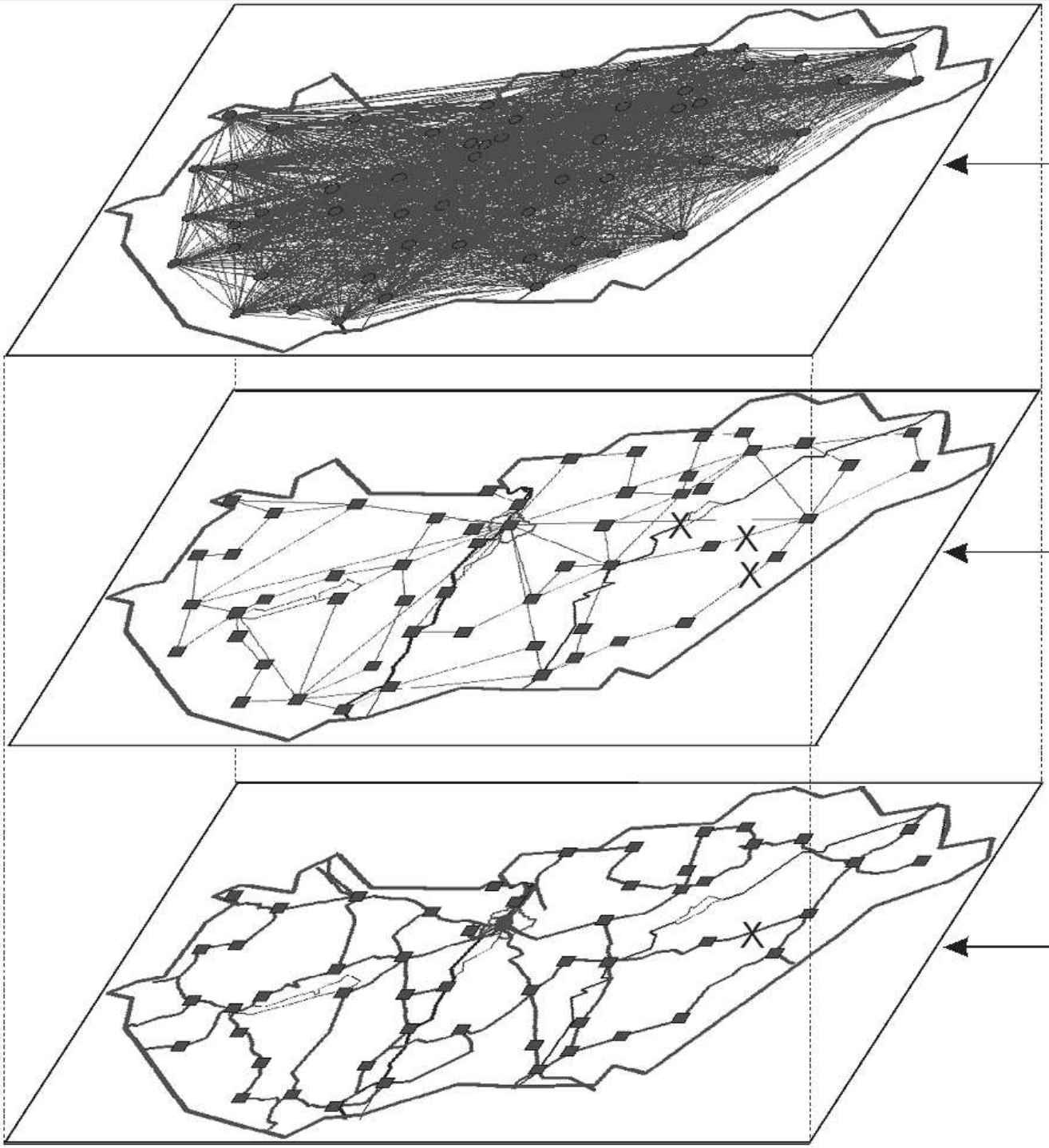
T-Com

A Magyar Telekom terjeszkedési tervei:
A magyarországi hálózati kapacitás továbbfejlesztése, bővítése, valamint további határátlépő pontok létesítése Románia, Bulgária Törökország és Ukrajna felé.






Chicago
United States Fast Internet Backbone



3. Layer

Network layer

2. Layer

Data link layer

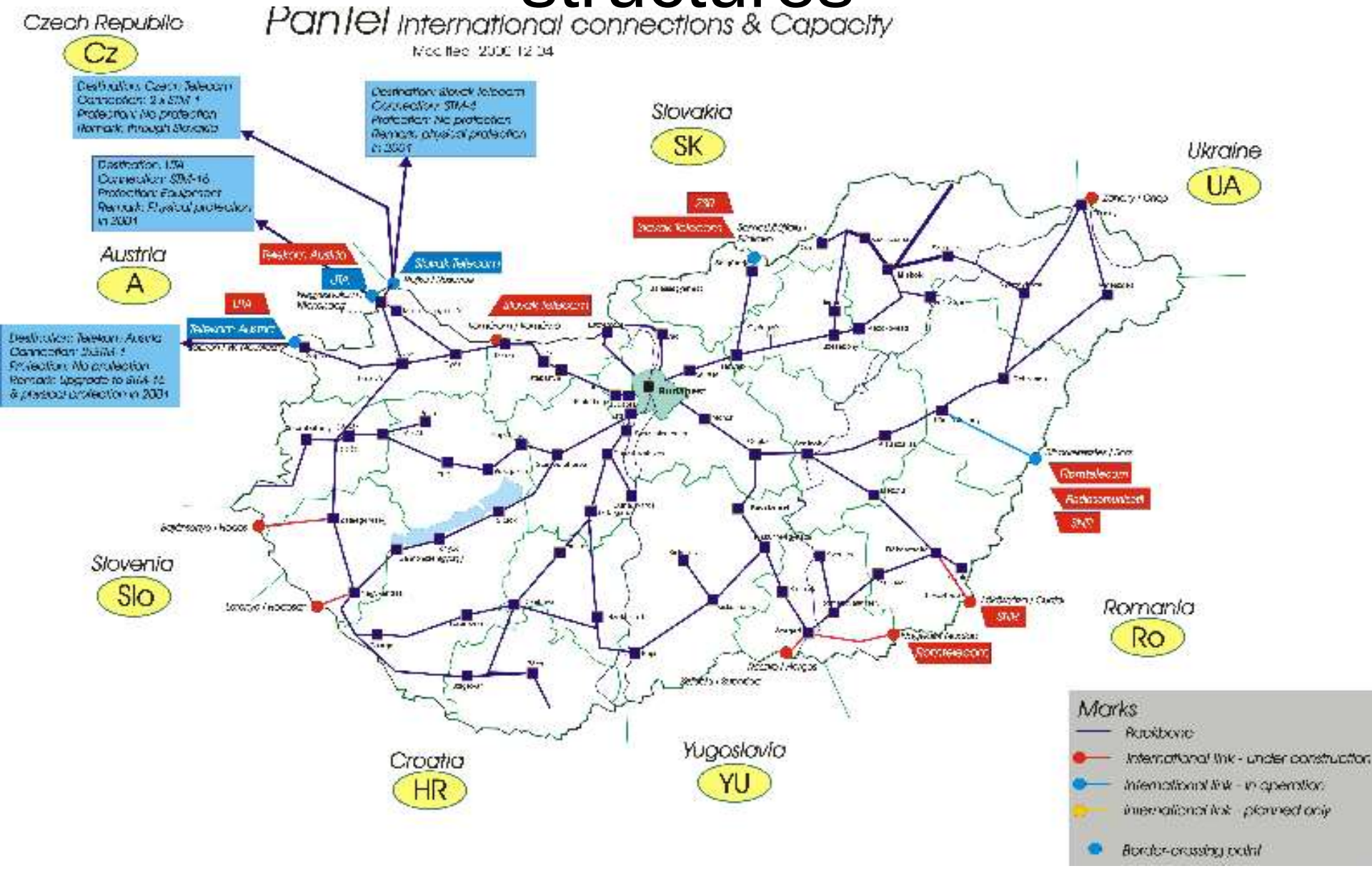
IP link

1. Layer

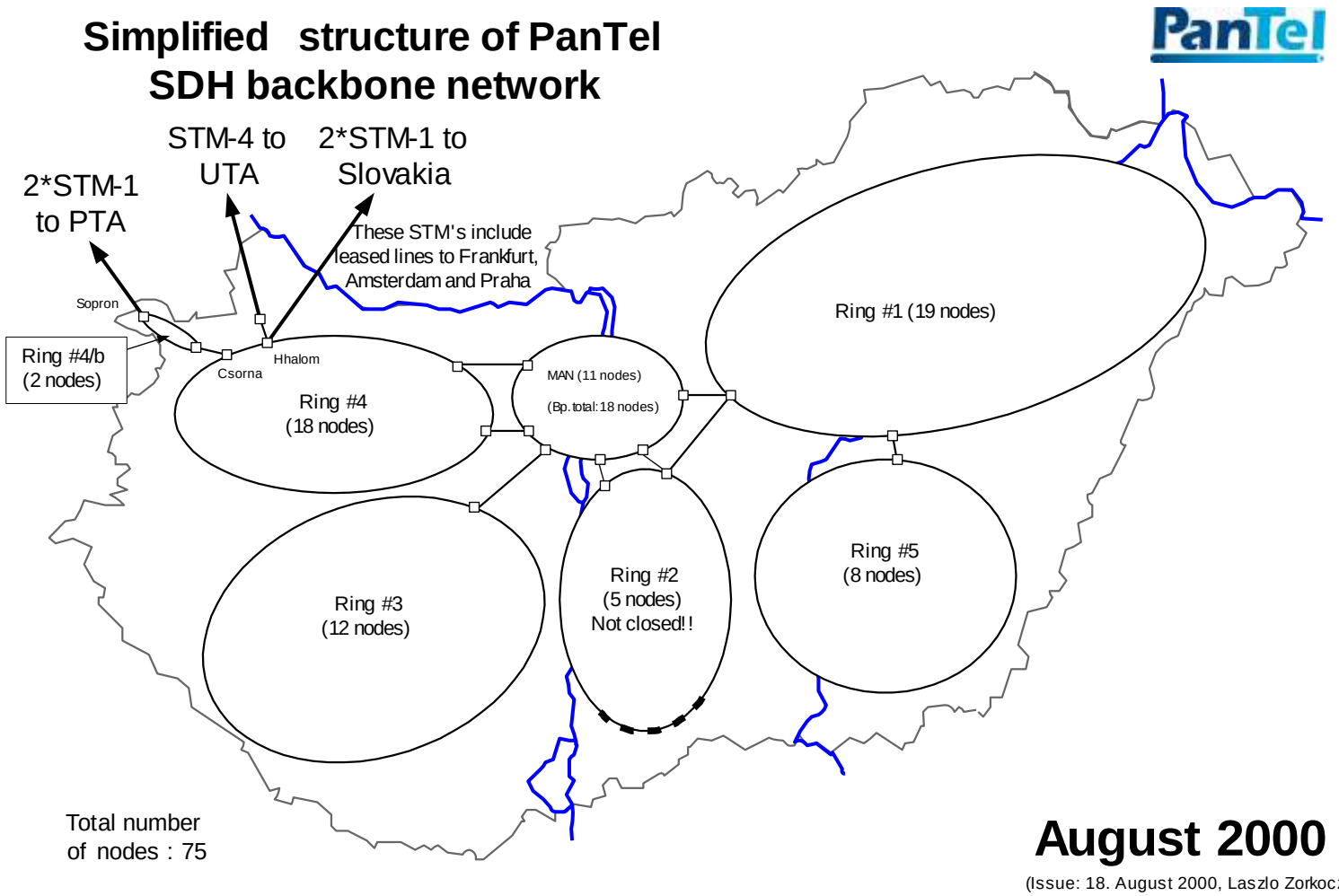
Physical layer

Optical cable

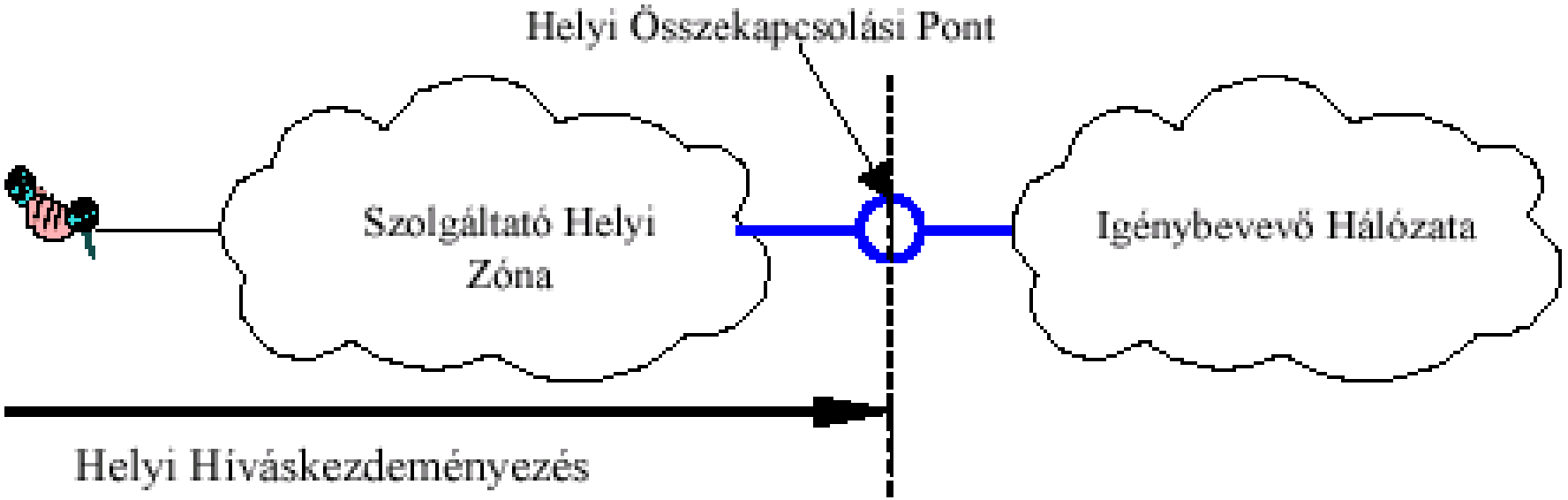
PANTEL optical backbone structures



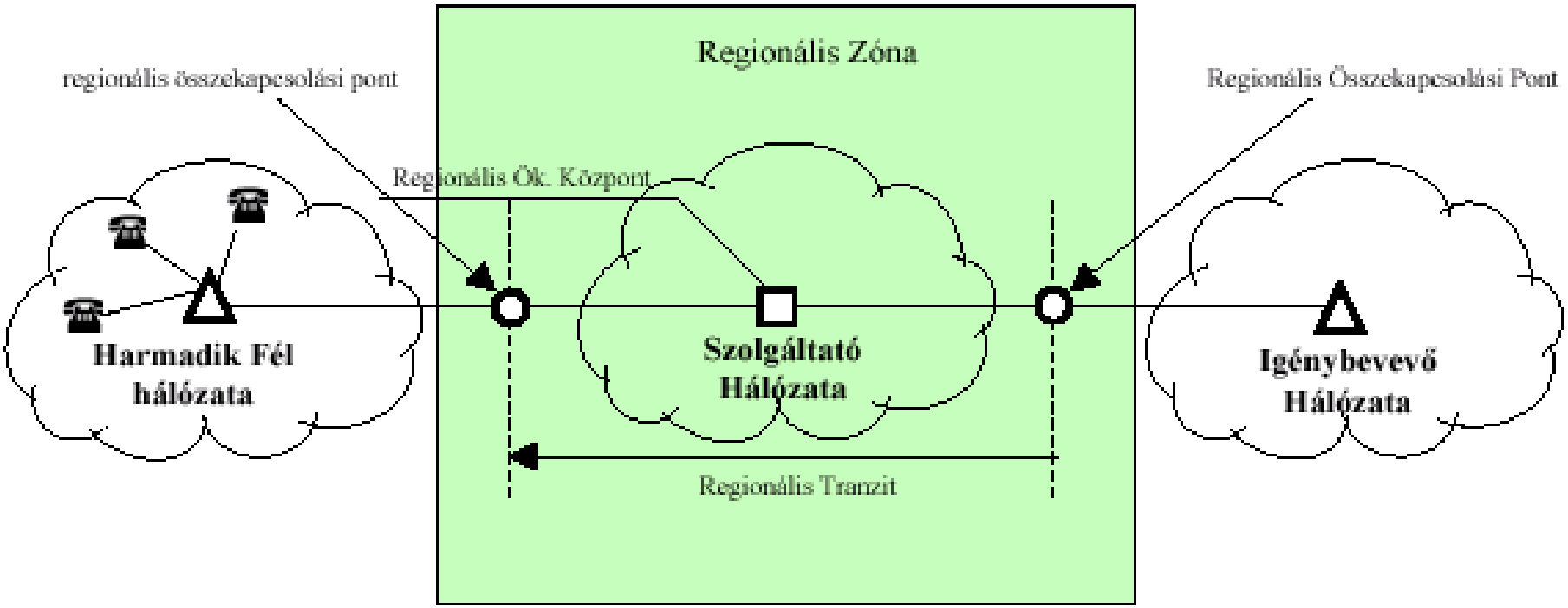
PANTEL logical SDH rings



Interconnection principles



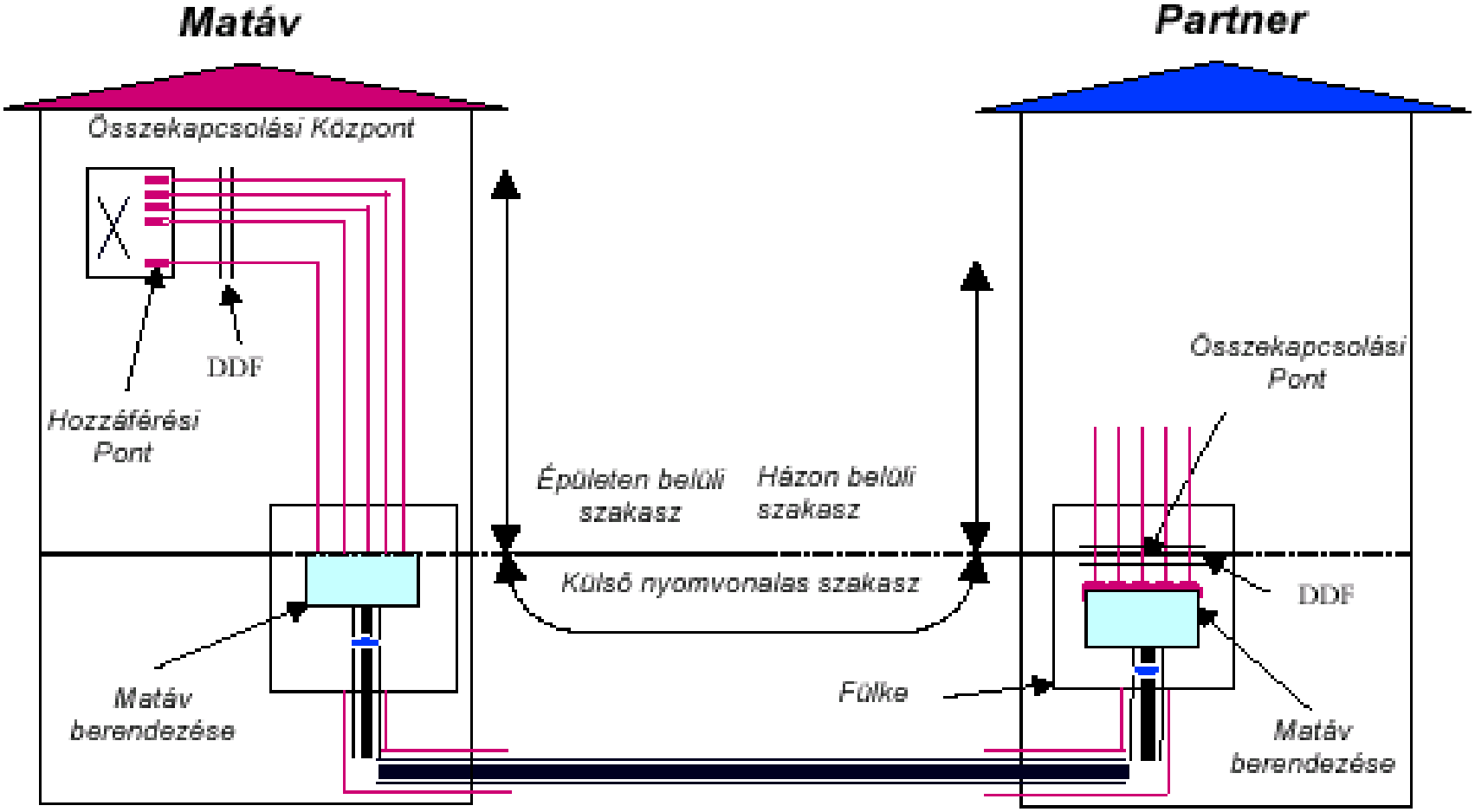
Interconnection principles



1. ábra: Híváskezdeményezés és Regionális Tranzit Szolgáltatás

280x0,009=2,5Ft/perc !!!!

Interconnection implementation



Fülke: A Matáv berendezés elhelyezésére kialakított helyiség

3. ábra: Összekapcsolás megvalósítása Partner telephelyen

Network structure and numbering

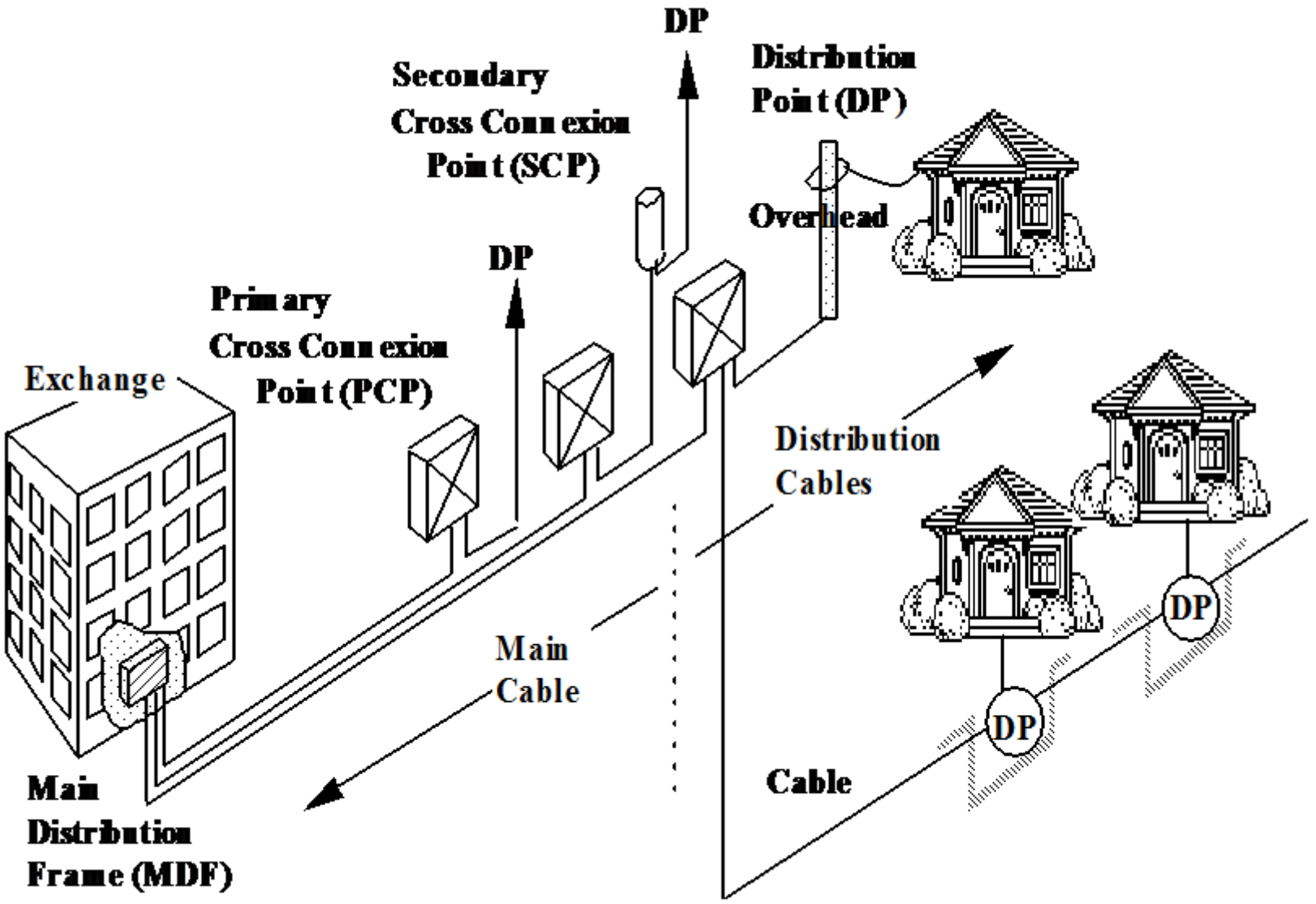
A / B	2	3	4	5	6	7	8	9
2	Székesfehérvár	Biatorbágy	Szigetsztmiklós	Dunaújváros	Szentendre	Vác	Gödöllő	Monor
3	Salgótarján	Esztergom	Tatabánya	Balassagyarmat	Eger	Gyöngyös	-	-
4	Nyíregyháza	-	Mátészalka	Kisvárda	Miskolc	Szerencs	Ózd	Mezőkövesd
5	Debrecen	Cegléd	Berettyóújfalu	Teszt*	Szolnok	Jászberény	-	Karcag
6	Szeged	Szentes	-	-	Békéscsaba	-	Orosháza	Mohács
7	Pécs	Szigetvár	Szekszárd	Paks	Kecskemét	Kiskunhalas	Kiskörös	Baja
8	Kaposvár	Keszthely	Siófok	Marcali	-	Tapolca	Veszprém	Pápa
9	Zalaegerszeg	Nagykanizsa	Szombathely	Sárvár	Győr	-	-	Sopron

A/B	0	1
2	Közcélú mobil rádiótelefon hálózat (GSM/DCS)	-
3	Közcélú mobil rádiótelefon hálózat (GSM/DCS)	B-ISDN hozzáférési szolgáltatás (tervezett)
4	Osztott díjas hívás szolgáltatás*	Informatikai szolgáltatás*
5	Országos közcélú személyhívó hálózat	Internet hozzáférési szolgáltatás*
6	Közcélú mobil rádiótelefon hálózat (NMT)	-
7	Közcélú mobil rádiótelefon hálózat (GSM/DCS)	Üzleti hálózat hozzáférési szolgáltatás*
8	Díjmentes hívás szolgáltatás*	Intelligens hálózati szolgáltatás*
9	Emeltdíjas hívás szolgáltatás*	IP VPN hozzáférési szolgáltatás

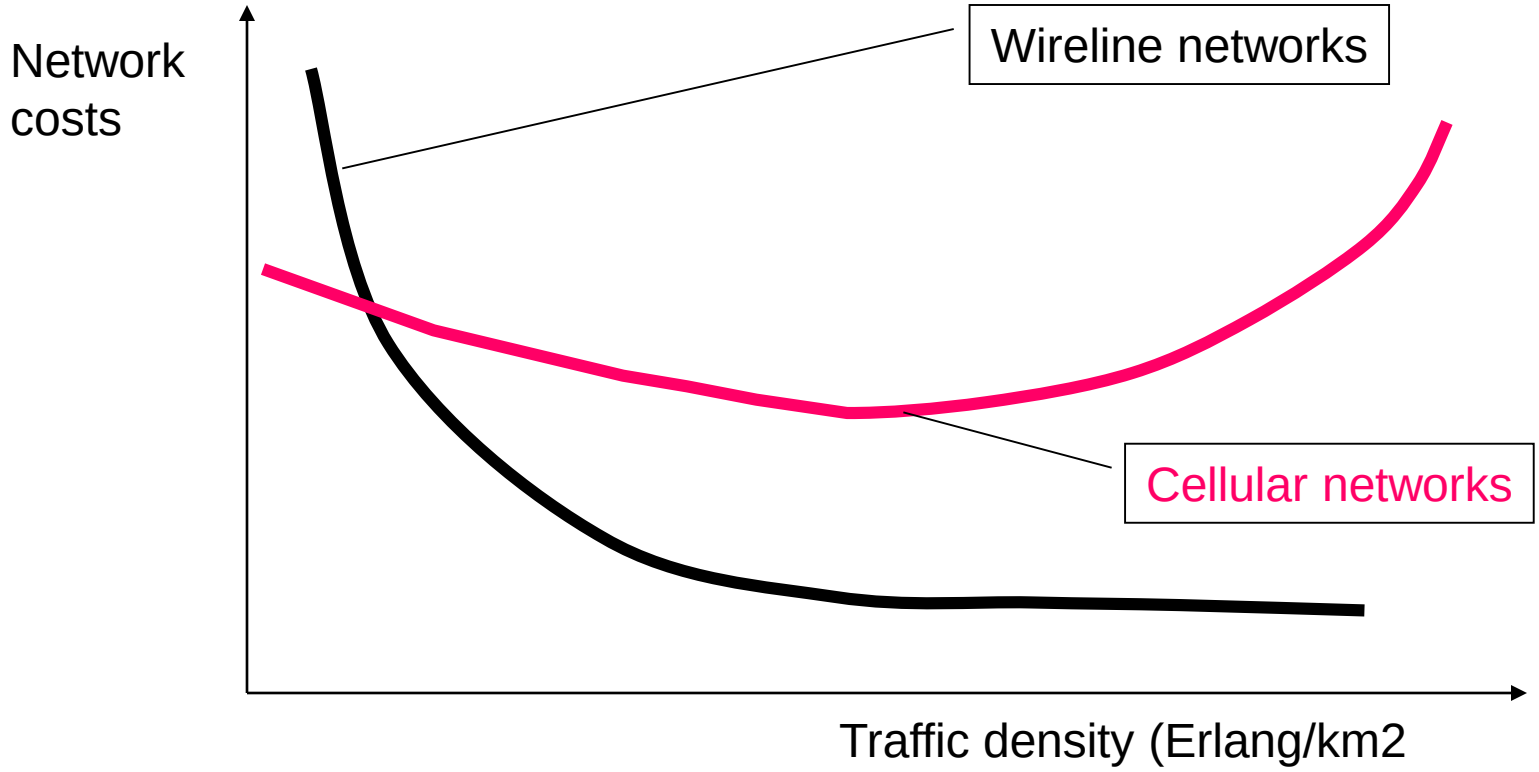
Network implementation

- Access issues: Rural, City, Down-town, areas, In-door cabling, Underground copper cables, Overhead cables, ADSL, Fibre To the Curb (FTC), distribution frames
- Core issues: Underground fibres, overhead fibres,
- Switching and multiplexing position of nodes
- Traffic issues: dimensioning of switches and links

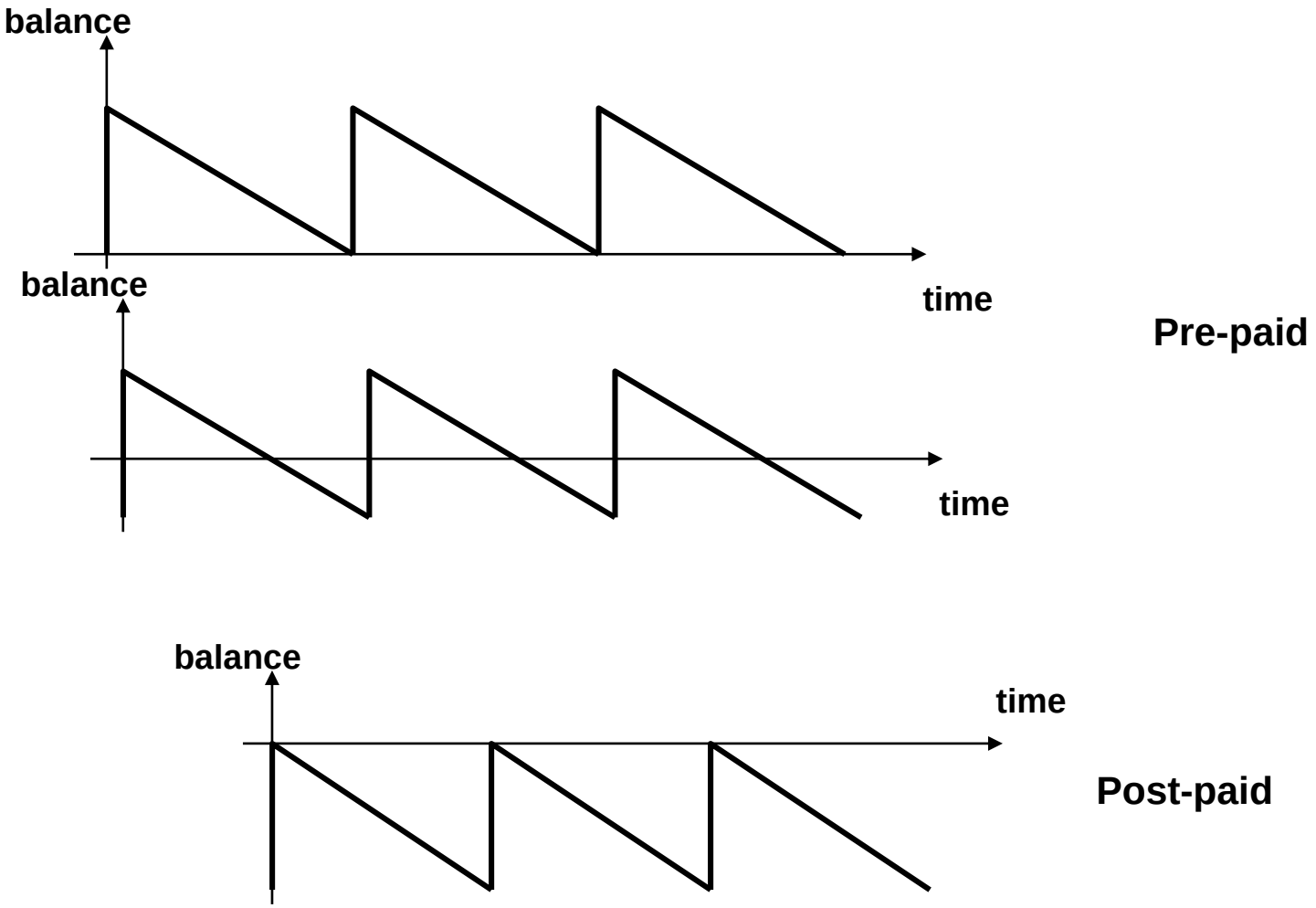
Access network implementation



Costs and revenues –> market failure
The revenues are monthly fees and traffic based fees
Network costs are implementation and operation



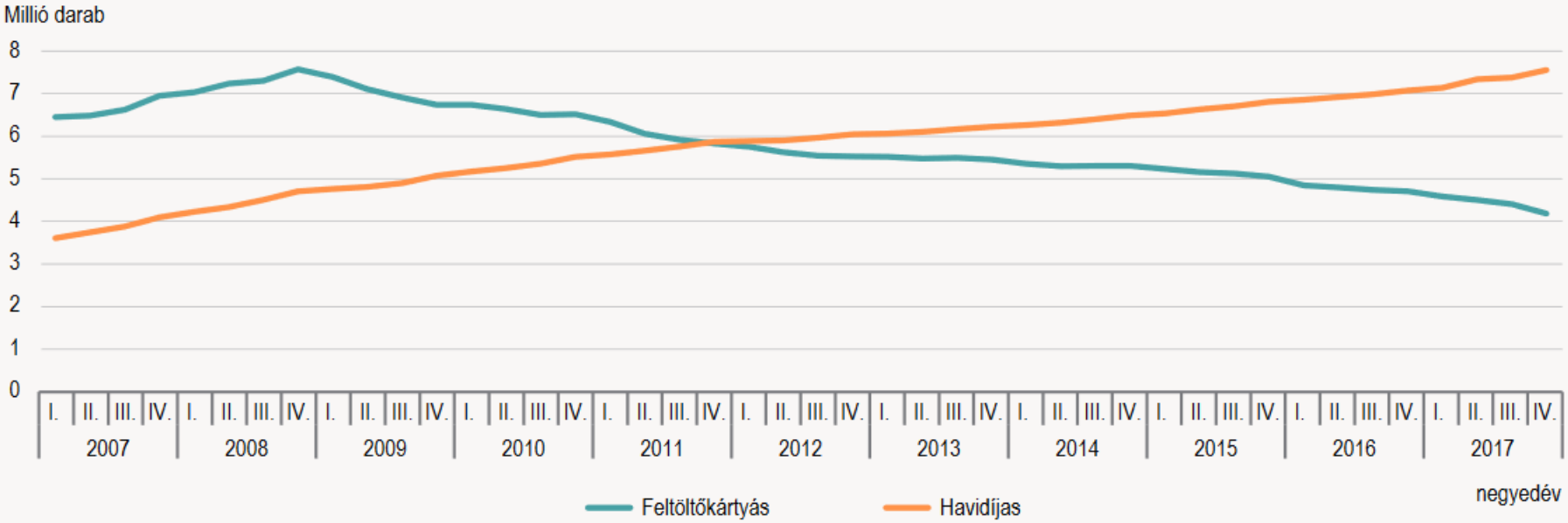
Telephone bill balance



Prepaid and billed mobile subscriptions in Hungary

2. ábra

A mobiltelefon-előfizetések száma az előfizetés típusa szerint



Prepaid subscription

Monthly billed subscription

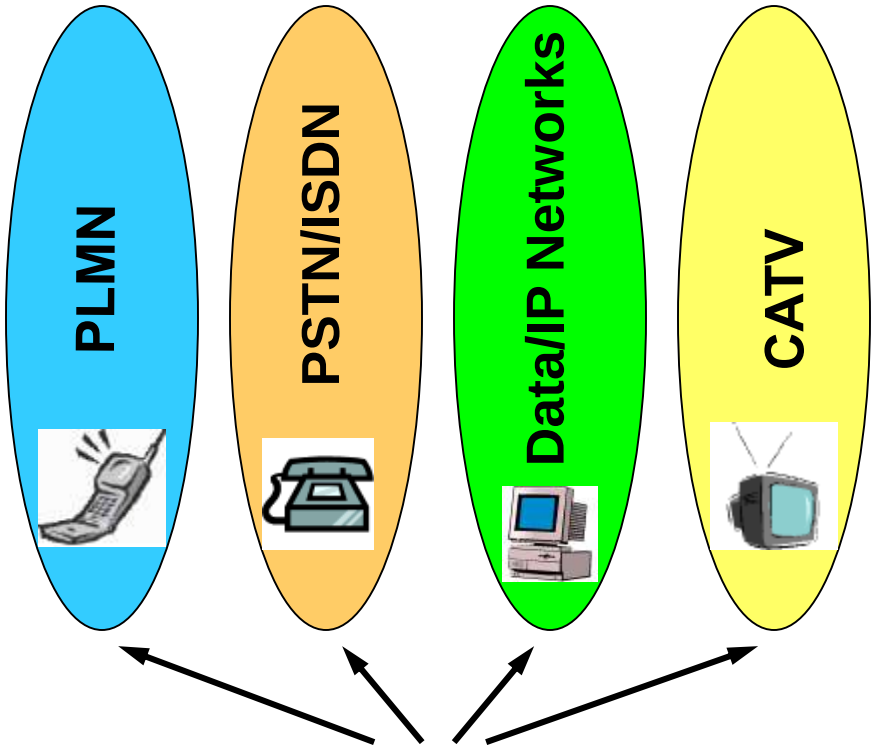
Missing topics

- Telephone sets, terminal equipment (Lecture in Nov)
- Services (Lecture in Nov)
- Regulation issues (Lecture in November)
- Details of ADSL
- NGN (Next Generation Networks in December)
- Network planning (optional subject in semester 7.)

Network development trends

Traditional Solutions in

Services



Access Transport & Switching Networks

Future Solutions