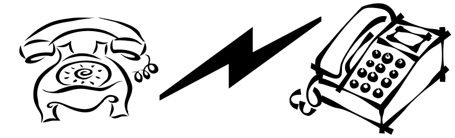
Communication Networks 2

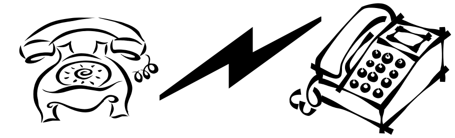
Gusztáv Adamis
BME TMIT

Analogue <-> digital telephony



- Analogue: 4 kHz Digital: approx. 64 kHz
- Then why digital?!
- Because:
  - simpler and more reliable
  - nowadays it is cheaper (10-15 years ago was more expensive)
  - signal/noise ratio independent from the size of the network
  - production of digital equipments does not require individual adjusting
  - smaller equipments
  - lower voltage / smaller power consumption
  - more intelligent services can be implemented
  - more sophisticated signalling
  - integrated data and voice transmission
  - simpler maintenance
  - switching can be implemented without moving parts
  - in mobile systems: new codec types -> smaller bandwidth
- In developed countries the switches, core network pure digital

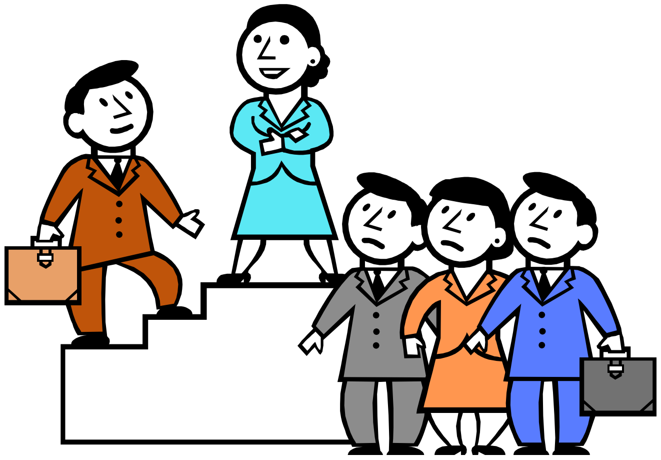
Analogue<->digital telephony



- But: terminals in fixed networks are mainly analogue
  - quality is acceptable
  - lot of users do not want to pay for the new services
  - lot of new services can be accessed by analogue equipments, too:
    - intelligence in the switch not in the equipment!
    - digital extensions in analogue equipments: number presentation (display), SMS
  - See in ISDN chapter!

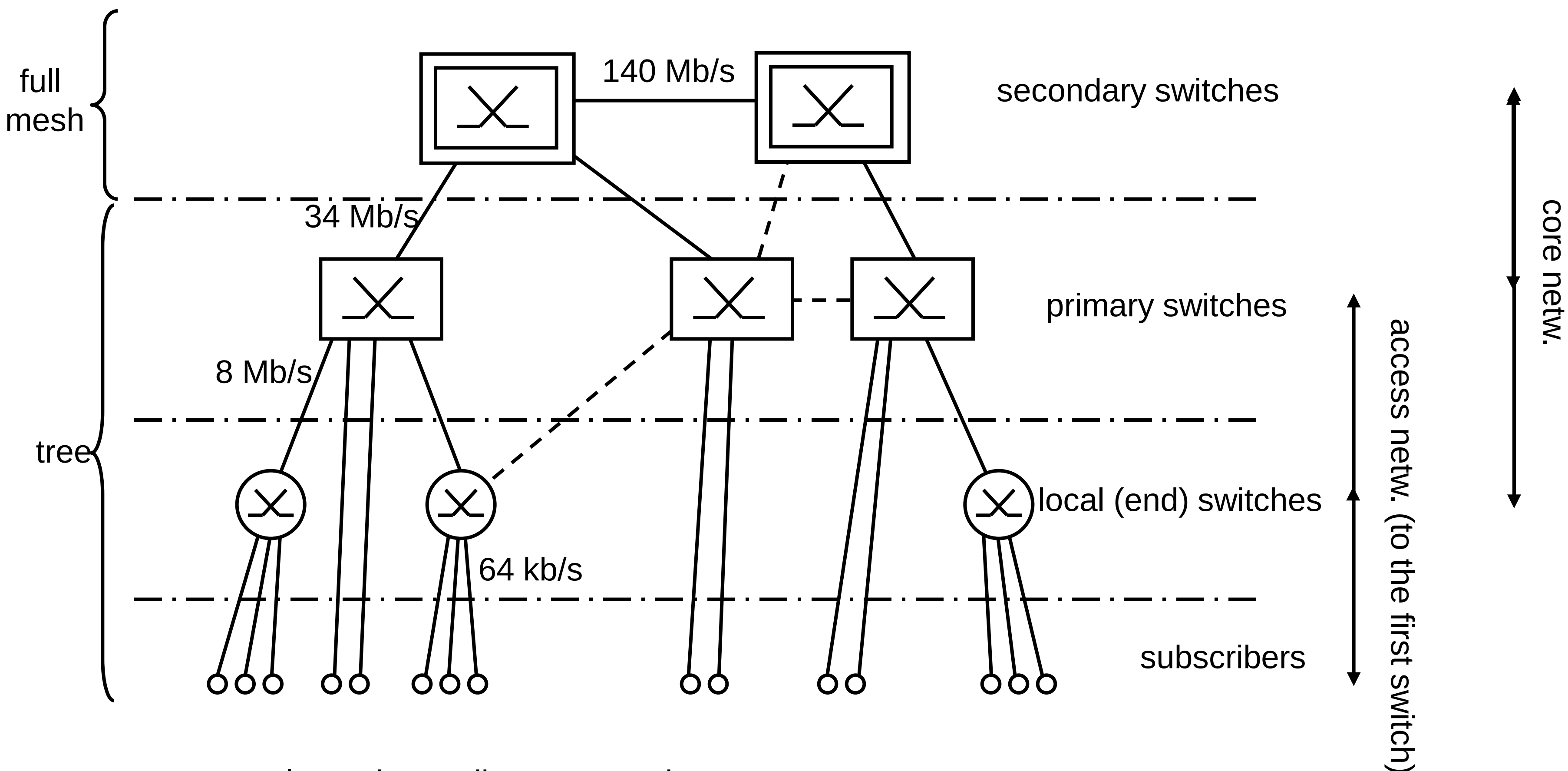
Introduction

- Basics of telecommunication networks
  - Analogue and digital transmission
  - Topological overview of telecomm. networks
  - Numbering
  - ISDN



Topological overview of telecomm. networks

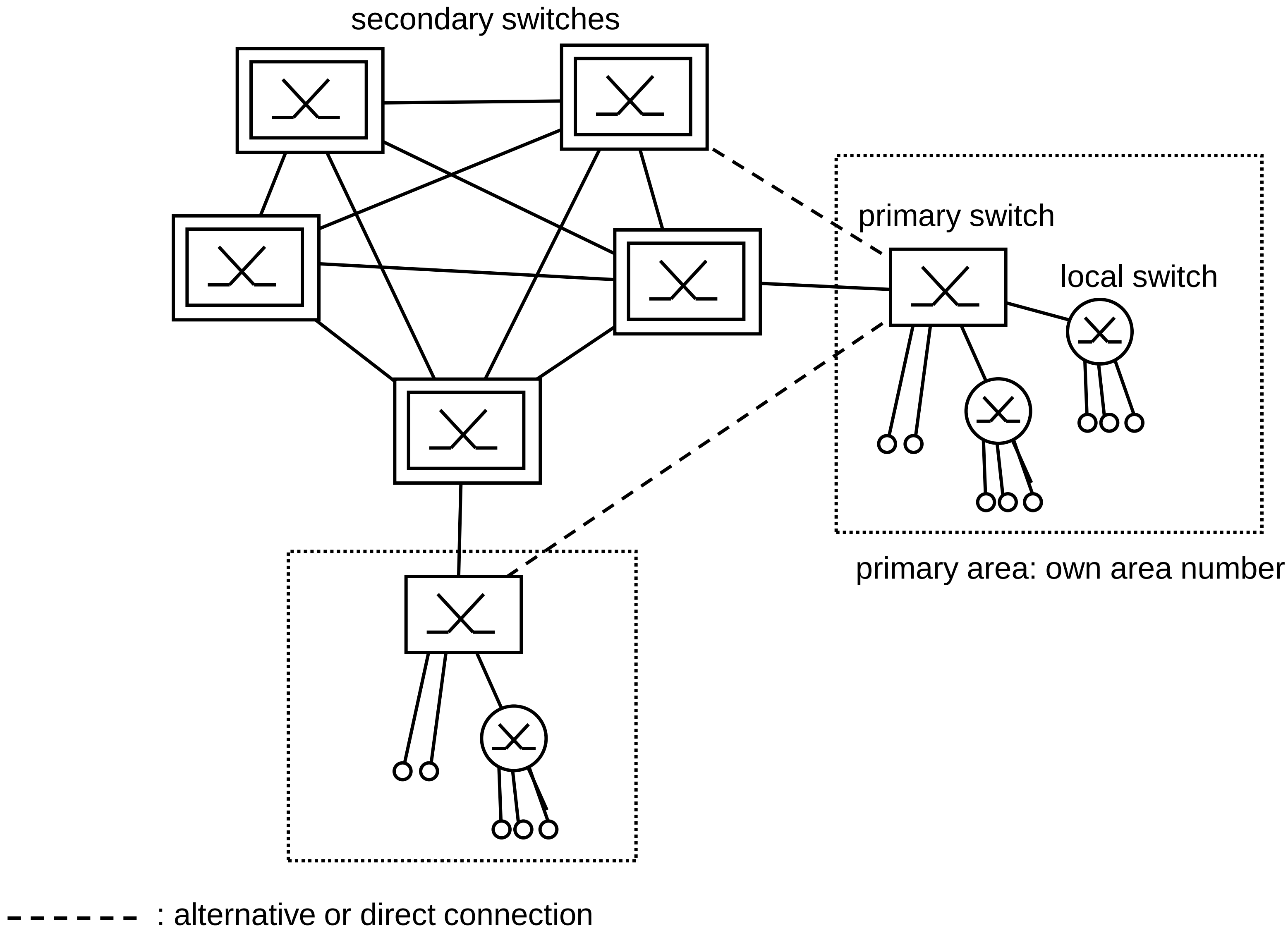
- Topology of Public Switched Telephony Network (Hungary)



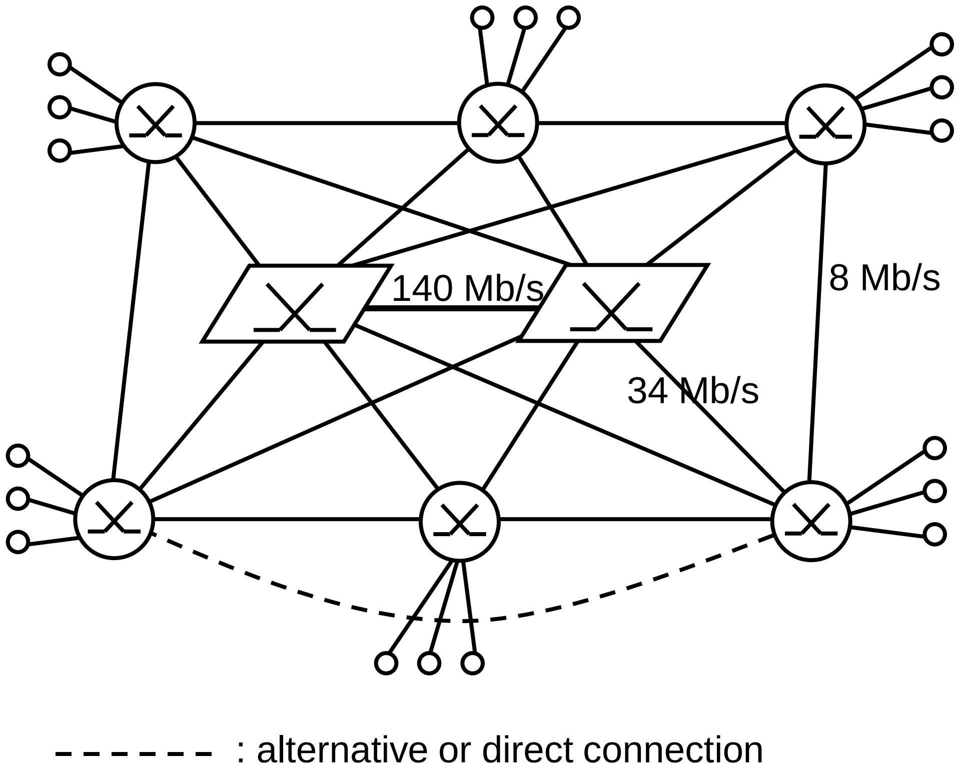
- - - - - - : alternative or direct connection:
goal: to optimize routing, make the network more reliable (redundancy!)

Bit speeds are (typical) examples, other solutions are also possible

Geographical topology - example



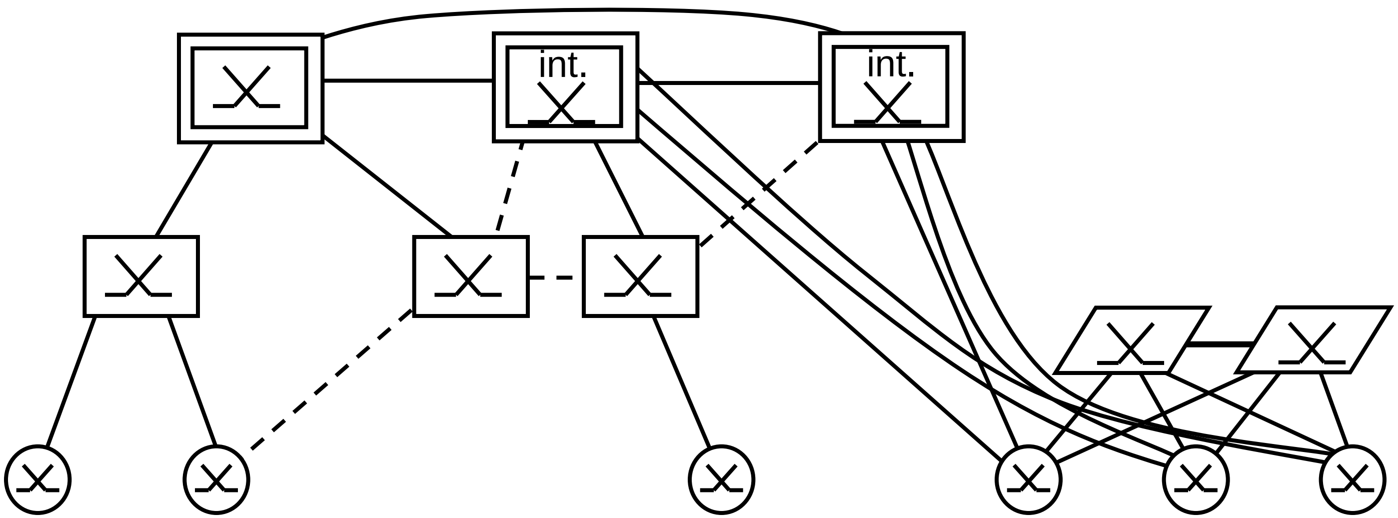
Metropolitan network architecture



- E.g.. Topology in Budapest:
  - approx. 30 local switches
  - 2 *tandem switches*
- Tandem switches:
  - at the hierarchial level of the local switches
  - Bp.: Városmajor, Angyalföld (local + tandem switch)
- Special primary area:
  - Metropolitan network (local switches + tandem switches) = primary area, without a primary switch

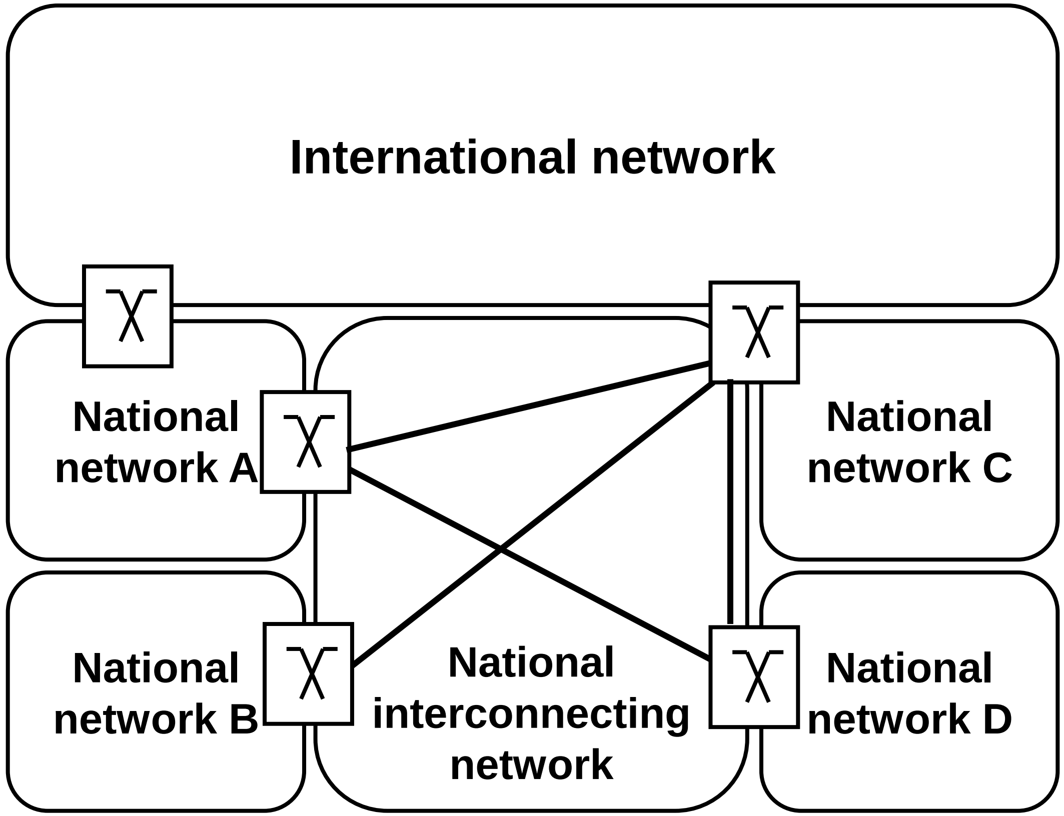
Nationwide & metropolitan network (integrtd)

- There are 2 international gateway switches in 2 secondary switches in Budapest
  - Kelenföld, Józsefváros (local, secondary, international switch)
- Integrated topology (simplified):



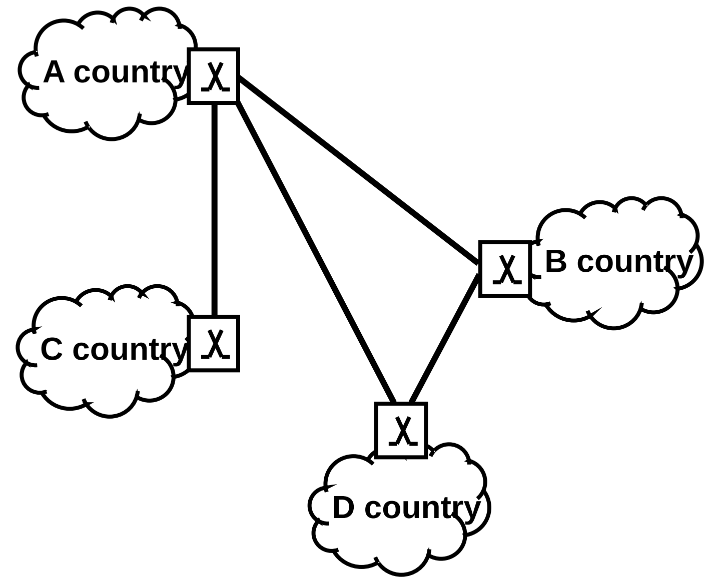
int. = international

Structure of the telephony network of a country – competitive service providers



International telephony network

- Larger service providers have international gateways
- Several competiting international service providers
- No need for direct connections between any two countries
- ... but 1 international connection may contain maximal 6 trunks (7 switches)
  - (including national parts)



Introduction

- Basics of telecommunication networks
  - Analogue and digital transmission
  - Topological overview of telecomm. networks
  - Numbering
  - ISDN

Numbering (addressing)

- Called party's number: identified originally the location (address)
- Now tendency: identifies the subscriber itself (name)
  - mobile networks - obviously
  - examples in fixed networks:
    - number portability
    - premium rate, freephone (green), shared cost (blue) numbers
- E.164 Recommendation (ITU-T, http://www.itu.int/rec/T-REC-E.164/en)
- An international number: max. 15 digits
  - country code (1-3 digits) + national destination code (area code, service or network identifier) + subscriber number

1	North America
2	Africa (+Greenland)
3,4	Europe
5	Middle and south America
6	Australia Oceania
7	Russia, Kazakhstan
8	Far East (+Inmarsat, Internat. green number: 800)
9	Middle and Near East

Numbering (addressing)

- National Destination Code:
  - Area code, e.g.: 33: Esztergom
  - Network Code, e.g.: 30: t-mobile
  - Service Code, e.g.: 80: green number
- Subscriber Number
- National Destination Number = NDC + SN
- Connection between the network and numbering hierarchies

Numbering (addressing)

- Open numbering scheme:
  - Two forms: national/local number
  - Local numbers shorter, but needs a national prefix (06 – in Hungary, 0 – in other European countries)

- Closed numbering scheme:
  - Always national destination number
  - Simple, unambigous
  - One form, independently where to start the call from
  - Tendency in Europe (Norway, France, Italy, UK....)

National Destination Codes in Hungary

- Area codes

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

Introduction

- Basics of telecommunication networks
  - Analogue and digital transmission
  - Topological overview of telecomm. networks
  - Numbering
  - ISDN

ISDN

- ISDN = Integrated Services Digital Network
- Improvement of PSTN
  - Public Switched Telephone Network,
    - or POTS: Post Office Telephone Service -> Plain Old Telephone Service
- Since 1987, more than 20 years old!
- **IS**-: integrated service: more services on one network, e.g.:
  - voice (POTS), videoconference, data transfer
- -**DN**: full digital: voice codec in terminal
- Switches, transmission paths: all are digital
    - (UNI: user-network interface,
      NNI: netwrok-network interface)

ISDN – motivation

- A bit of history: C64 is the computer of the year in 1982!

- In those days the high-tech in telephony was still something like this ☹

ISDN – motivation

- Need for improved services
  - Better voice quality than in PSTN
  - Value added supplementary services, e.g.:
    - number presentation
    - conference call
    - call forwarding
    - call waiting
    - etc.
  - Videotelephony (!)
  - Faster data transmission

- Solution: digitalisation

ISDN – motivation

- Service provider side: digital trunks (PCM), digital switches
  - easier to sell if there are new services... → ISDN
- Not sure that the new *services* would have been enough:
  - 2 „telepone lines” on one wire pair (2B channels)
  - that is the real benefit!

ISDN implementation

- (Re)usage of the existing copper wire pairs in digital subscriber loops
  - Though only several km, but expensive (copper, lay down,...)
  - Half (!!) of the total cost of a telephony network lays in the copper wires of the subscriber loops!

- Digital transmission instead of analogue
- Speed depends on the number of channels
- Two channel types:
  - **B channel**: 64 kb/s, bidirectional (full duplex), voice OR digital data OR video
  - **D channel**: 16 (in subsc. loops) or 64 kb/s (between switches): signalling (e.g. call establishment, release, etc.) 1 D channel is enough for controlling SEVERAL (2 or 30) B channels

ISDN implementation

- Allowed combinations:
- 2B+D16: BRA/BRI: Basic Rate Access/Interface,
  - 144 kb/s useful speed
  - on one wire pair – bandwidth of the copper pair is more than enough
  - tipically for individuals / small companies
  - possible combinations:
    - 2 independent voice connections
    - 1 voice + 1 fax
    - 1 voice + 64 kb/s data transfer (e.g. Internet access)
    - 128 kb/s data transfer
    - can be changed dynamically
- 30B+D64 (Eu, 23B+D US): PRA/PRI Primary Rate Access/Interface
  - 1984 kb/s ~2 Mb/s
  - typically on 1, 2 or 3 wire pairs: depending on the quality of wire, length, encoding
  - for large companies, 30 independent channels
  - typically controlled by a P(A)BX (private switch)

S_0 bus (User side of a DSL)

- Speed: 2B + D16 + synchronisation (48 kb/s) = 192 kb/s
- 4 wires
- If closed by a proper impedancy
  - Max. 8 TE can be connected to it
- But terminals can also be connected directly to DSL
  - 1 TE: point-point topology

Telephone numbers

- Max. 10 tel. number may be assigned to 1 BRA subscription (in Hungary, but this is typical)
- Max. 8 terminals can be connected to a DSL
- We may use max. 2 B channels in parallel
- ...?!
- Simple!
  - TEs are programmed which number they recognize („ring”)
  - Any (of max. 10) number is called, the Setup message is transmitted to ALL the TEs
  - That TE will answer the call, which is programmed for that number
  - Without PBX (switch)!
  - (This is the Multiple Subscriber Number (MSN) ISDN service)