Networking technologies and applications

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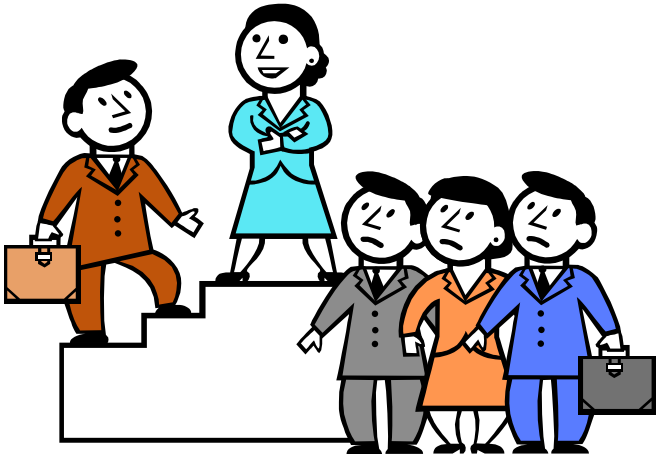
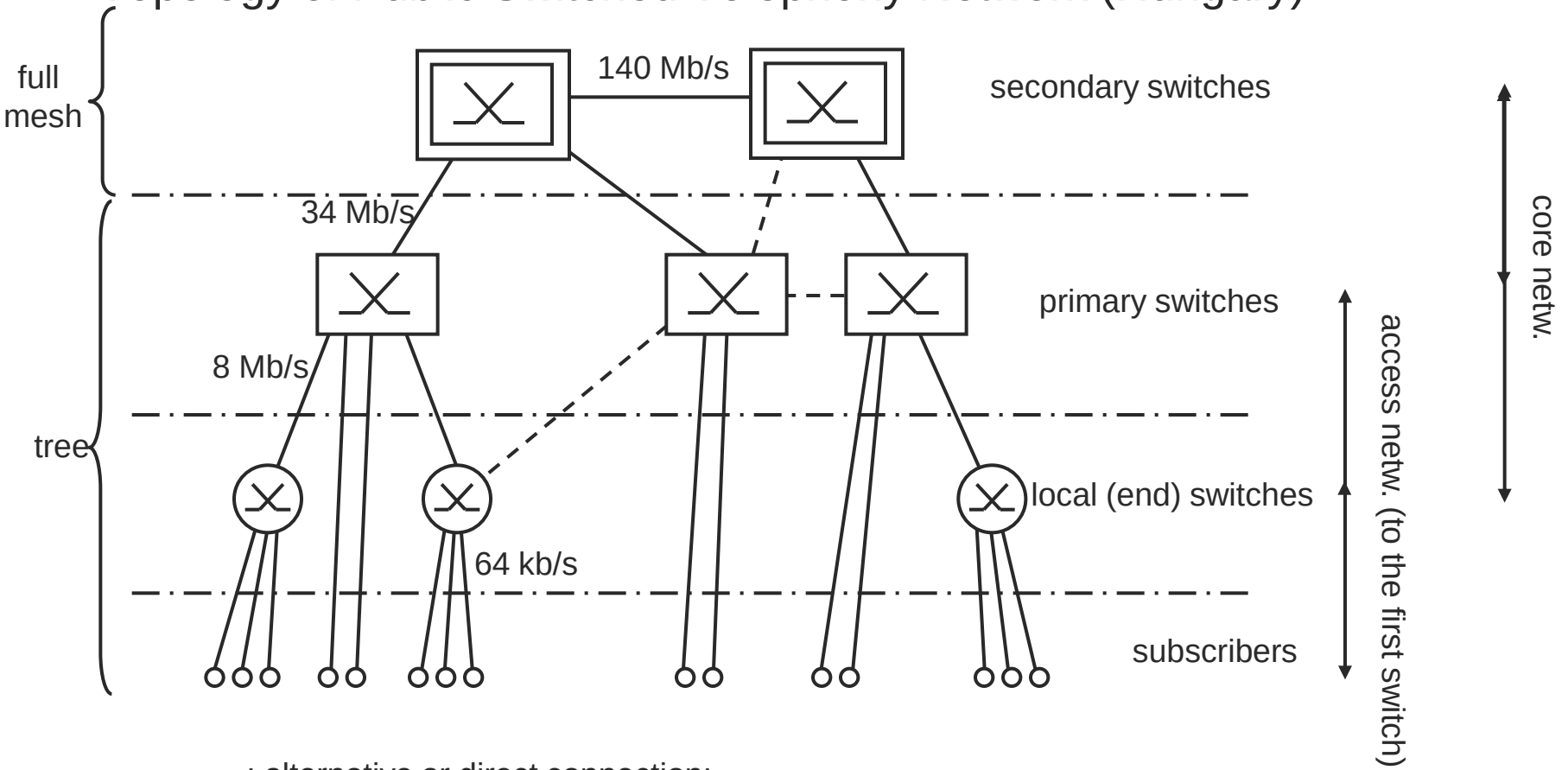
Introduction

- Basics of telecommunication networks
  - Topological overview of telecomm. networks
  - Numbering
  - ISDN



Topological overview of telecomm. networks

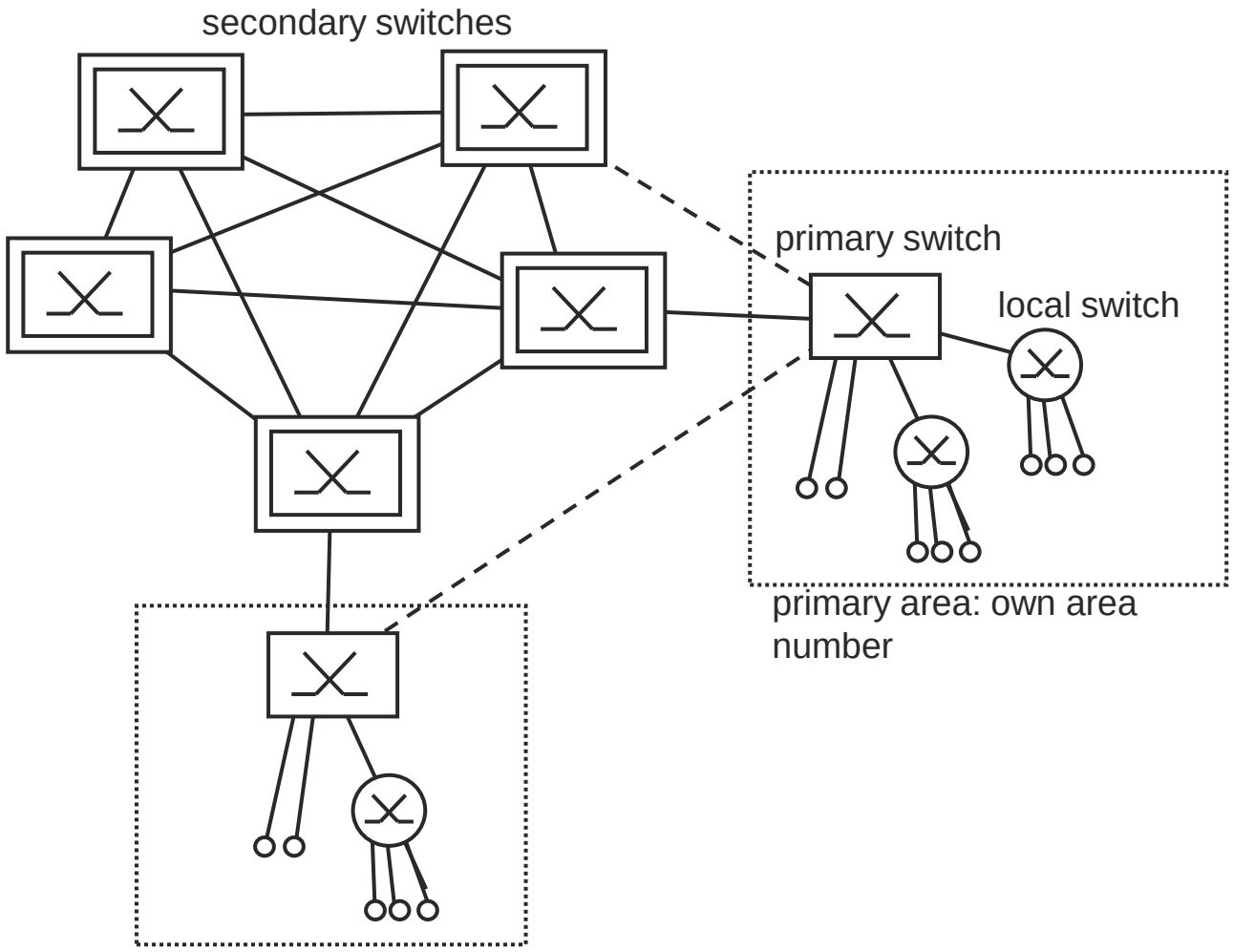
- Topology of Public Switched Telephony Network (Hungary)



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

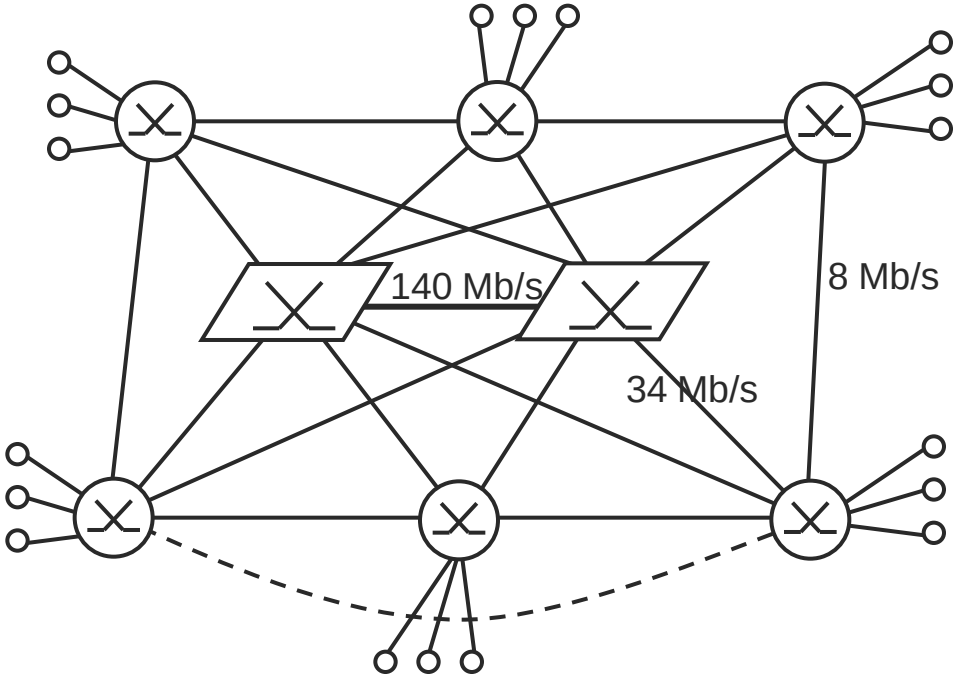
Bit speeds are (typical) examples, other solutions are also possible

Geographical topology - example



– – – – – – : alternative or direct connection

Metropolitan network architecture

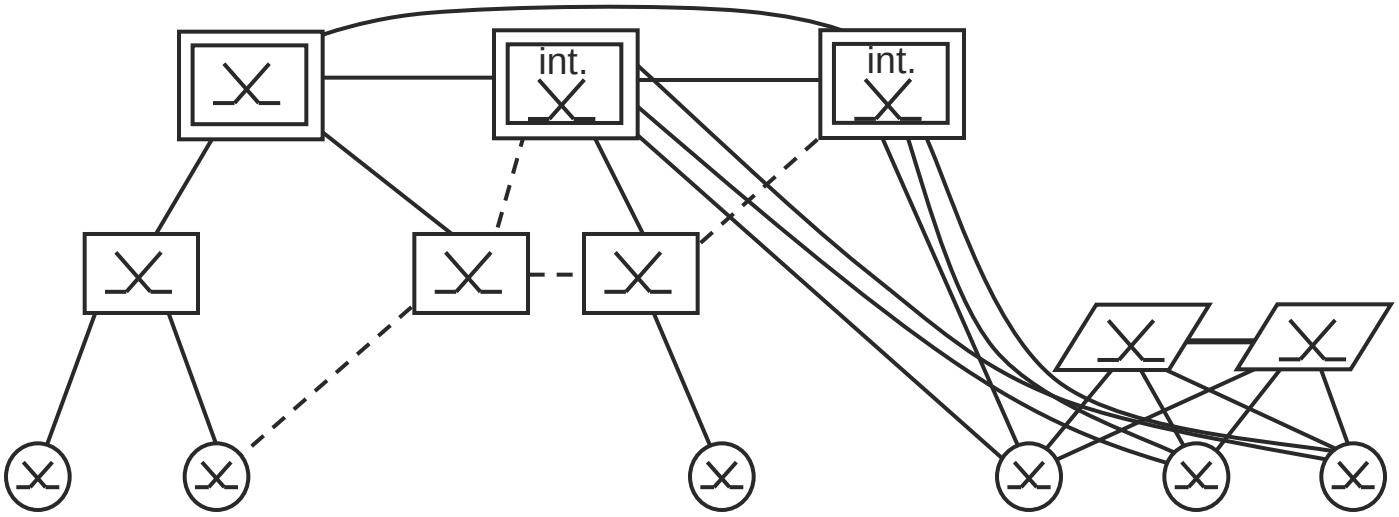


- - - - - - : alternative or direct connection

- 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

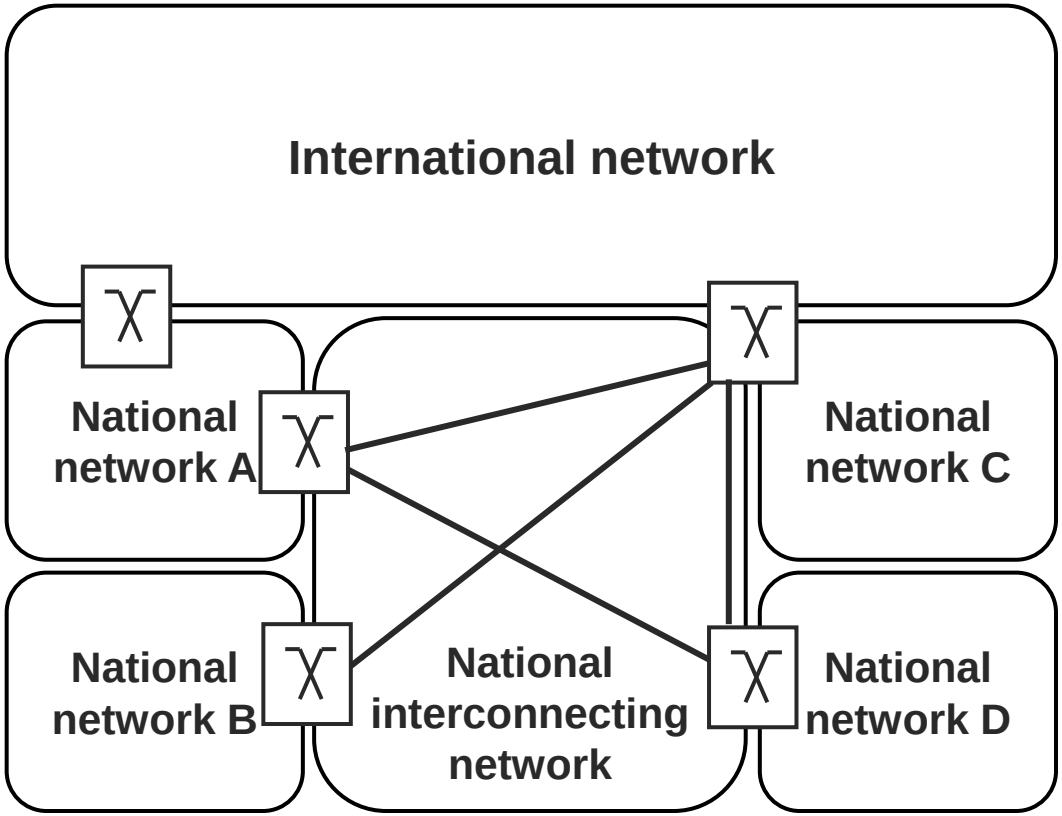
Nationwide & metropolitan network (integrtd)

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



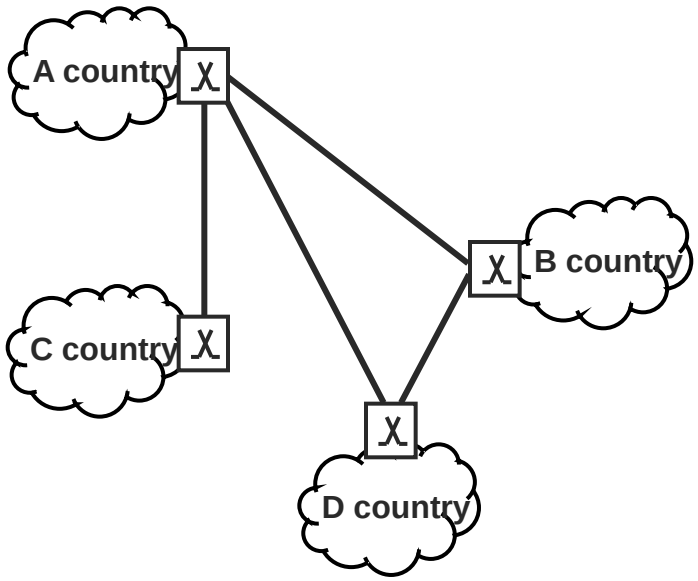
int. = international

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)



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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 national prefix (
    - 06 – in Hungary,
    - 0 – in other European countries)

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

Short codes

- Short numbers:

104, 105, 107, 112	emergency numbers
116c(d)	
118de	
12cd	
140d-144d, 145de-149de	
17c(d(e))	
18c(d)	
190-194, 197-199	operator services

- Prefixes:

00	internat. prefix
06	nat. prefix
130	number presentation allowance prefix
131	number presentation disabling prefix
15cd	carrier selection prefix

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	.	.	. . . . .

National Destination Codes in Hungary

- Service and Network Codes:

A\B	0	1
2	GSM (Telenor)	Nomadic service
3	GSM (T-Mobile)	GSM (Other operators)
4	Shared cost service („blue” number)	-
5	Reserved for new GSM operator	Internet access
6	-	-
7	GSM (Vodafone)	Machine to machine communication (M2M)
8	Freephone („green” number)	-
9	Premium rate service	Premium rate service (restricted content and price)

Introduction

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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 25 years old!
- **IS**-: integrated service: several services on one network, e.g.:
  - voice (POTS), videoconference, data transfer
- -**DN**: full digital: voice codec in terminal
- switches, transmission paths 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

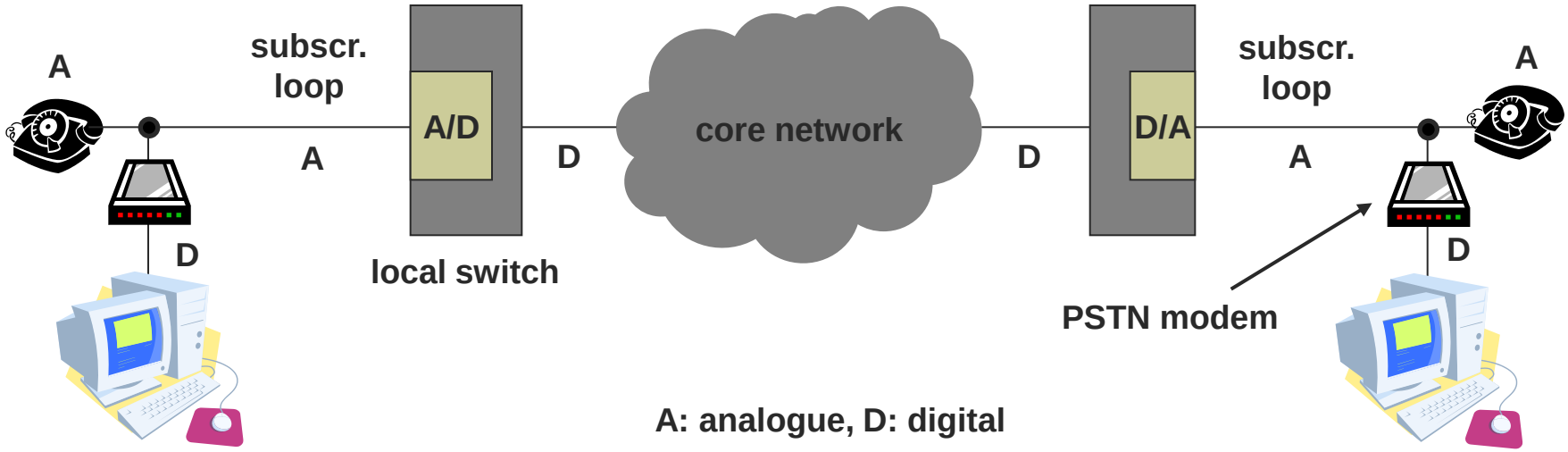
- Need for improved services
  - Better voice quality than in PSTN
  - Value added supplementary servi
    - number presentation
    - conference call
    - call forwarding
    - call waiting
  - videotelephony (!)
  - faster data transmission
- Solution: digitalisation – that is ISDN

ISDN – motivation

- Producer 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
  - that is the real benefit!

PSTN – analogue/digital transmission

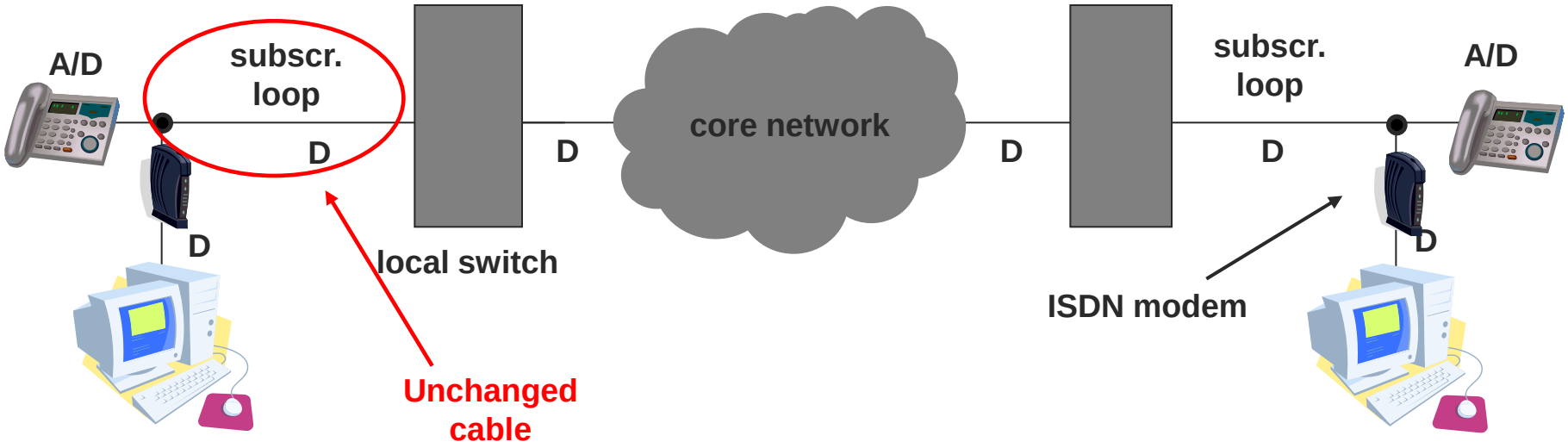
- PSTN data transmission with modems:



- When the core network is digital, the D/A/D/A/D transmission sounds not too good ☹
  - Not effective: 33 kb/s instead of 64 kb/s
- Solution: ISDN – Digital Subscriber Loop

ISDN – digital transmission

- ISDN transmission with modems :



- Data path is digital all along the way!
- Voice codecs in terminals
- **Then, why do we need a modem?**

  ISDN signalling: connection establishment, release

  Data transmission interface
  - PC: e.g.. RS-232
  - ISDN: D channels

ISDN implementation

- (Re)usage of the existing copper wire pairs in digital subscr. 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 or 64 kb/s: signalling (e.g. call establishment, release, etc.) 1 D channel is enough for SEVERAL B channels
  - more details later

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

ISDN BRA

- BRA Basic Rate Access
- In practice it often provides other features:
  - S_0 bus, but often provides direct connetions for ISDN terminals
  - may contain 1-2 Terminal Adaptor (TA) to connect analogue equipments (telephone, fax)
  - may contain PC plug-in (RS-232, or USB), so it serves as a modem, too

S_0 bus

- Speed: 2B + D16 + synchronisation (48 kb/s) =
  192 kb/s
- 4 wire cable, closed by a proper impedancy
- Max. 8 terminals (TE) can be connected to it
- But terminals can also be connected directly to switch (NT)
  - 1 TE: point-point topology
  - more TEs: star topology

Telephone numbers

- Max. 10 tel. number may be assigned to 1 BRA subscription (in Hungary, but this is typical)
- Max. 8 terminals
- We may use max. 2 B channels in parallel
- ...?!
- Simple!
  - TEs are programmed which number they recognize („ring”)
    - In case of an analogue equipment - TA
  - Any (of max. 10) number is called, the message is transmitted to ALL TE
  - That will answer the call, which is programmed for that number
  - Without PBX (Private Branch Exchange – ‘company owned switch’)!
  - (This is the Multiple Subscriber Number (MSN) ISDN service)

ISDN past, present, future

- Enormous technological progress
- in 1990s-2000 that was the „high speed” Internet access for homes/small companies
- But only 10% of the PSTN subscriber lines
  - in Western Europe 25%
- Reasons:
  - most popular supplementary services can be reached nowadays by analogue equipments
    - plus functionalities in switches
    - digital elements in analogue equipments (display, SMS, memory)
  - In 1990s: much more expensive equipments
  - For Internet-access ADSL/cable TV etc. better
  - Because of mobiles - no need for two telephone lines

ISDN past, present, future

- ISDN = dead end?
  - No!
    - > 100 million B channels worldwide
    - network services can be used by analogue equipments
    - ISDN interswitch signalling system is still the universal telecommunications signalling system (chapter 6)
    - provided the basics for GSM networks
  - But: it is the technology of the present and near past, but not of the future