Networking **T**echnologies and **A**pplications

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BME TMIT

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Lecturers

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Administrative details

Slides on the webpage:
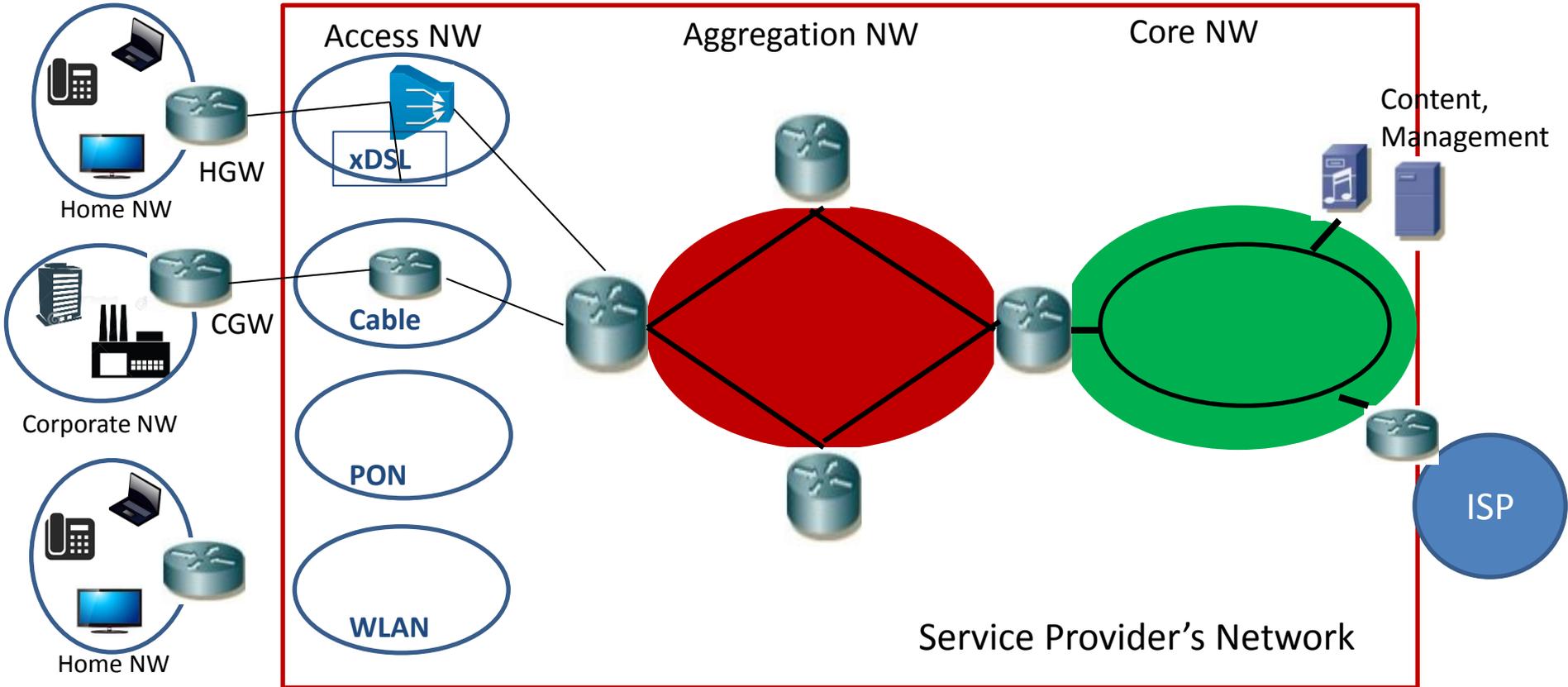
http://www.tmit.bme.hu/vitmac05

No book, but (quite) detailed slides

Presence at the lectures not mandatory **(but advised)**

Exams

- 1 mid-term exam, around the 10th week
- 1 re-take for the mid-term, during the last week
  - The grade of the mid-term exam will not be part of the final grade, you just have to pass it for the signature
  - Material for the mid-term and the re-take are the same

- Written exam

Big picture

Access NW

Aggregation NW

Core NW

Content, Management

xDSL

Cable

PON

WLAN

HGW

CGW

Home NW

Corporate NW

Home NW

ISP

Service Provider's Network

Networks

- Internet
  - „Network of networks"
  - Free world
  - Distributed operation
  - Low network intelligence
  - No general management solution
  - No service quality guarantees (Best Effort)
- Service Providers' Networks
  - Centralized
  - General management solutions
  - Service quality guarantees

Access Networks

- Easiest way for two computers to communicate – direct connection
- If long distances and many computers – too expensive
  - It's not the cost of the wires…
    - But the digging, and the work inside the buildings
- Solution: use some existing infrastructures/networks
  - Public Switched Telephone Network (PSTN)
  - Cable TV network
  - Electric network
  - Gas pipes (?)
    - Ultra Wideband radio communication
  - Drainpipes (?)
    - Optical fiber cables
- But sometimes you can build new ones as well…

Internet through the gas pipe?


Networking technologies and applications
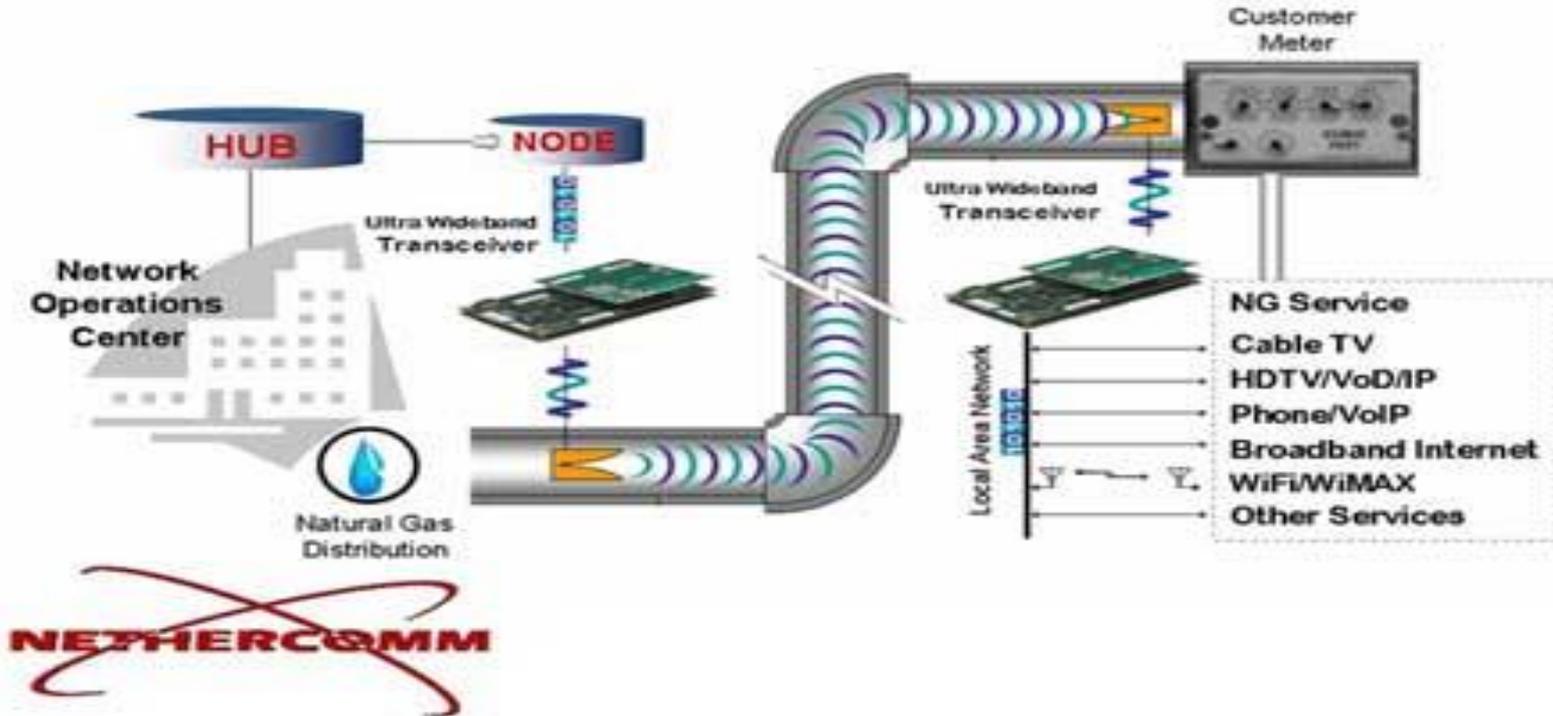
Internet through the gas pipe?

- Idea from NetherComm in 2005
- Ultra Wideband
  - Large frequency band (>500 MHz), large transfer speeds (100 Mbps)
  - In case of high power transmitters too much interference with other wireless technologies. Therefore, its operation only allowed for short ranges
  - In underground gas pipes this is not a problem, we can use higher transmit powers
- The UWB technology seemed promising, but …
  - Strict regulations, slow standardization, lower speeds than promised
  - In 2008-2009 the industry support melts away
  - NetherComm disappears

PSTN

- The telephony network was designed only for speech transmission
- 1876 – Graham Bell patents the first telephone
  - A few hours before Elisha Gray
- You could buy the phone, but the wire was installed by the users
  - A separate wire for each pair of users
  - In a year the cities became completely „wired"


Networking technologies and applications
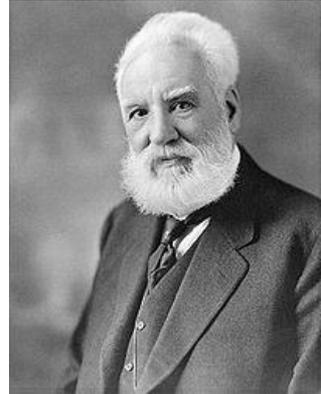
PSTN

- 1878 – Bell Telephone Company
  - The first switching center – New Haven, Connecticut
  - A human operator switching manually between the users
- Inter-city calls
  - Linking the telephone switching centers
  - Secondary centers, hierarchical architecture
- Only in the US more than 22.000 centers today, 5-level hierarchy

PSTN

- Elements of the PSTN network:
  - Local loop
    - From the user's home to the local exchange point
      - „last mile"
      - Optical local loop, wireless local loop
    - Twisted pair of copper wires
  - Switching centers / telephone exchanges
  - Optical trunks
    - Linking the a switching centers
    - Core network

- The first network was completely analog
  - Step by step transition to digital transmission, mainly in the core

PSTN

Local Loop

Core Network

Local Exchange

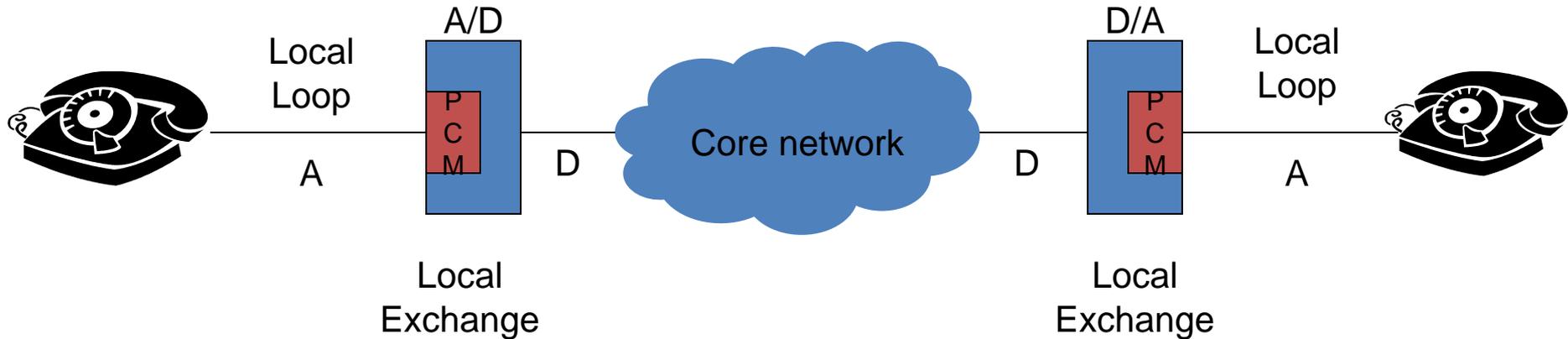Local Loop

Local Exchange

A

A

A

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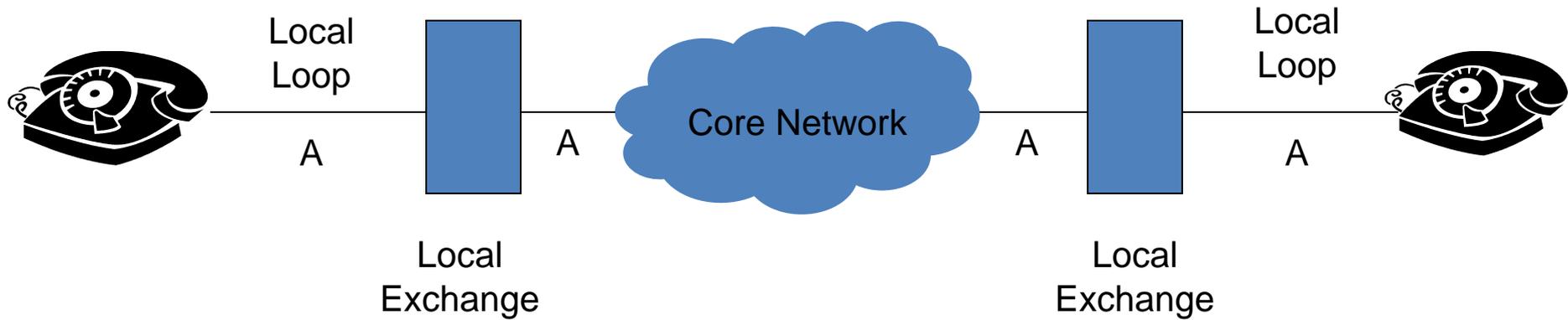
Voice channel

- 4kHz bandwidth for the voice channel
  - The transmission domain of the voice signal between 0.3 and 3.4 kHz
  - Some added guard bands
- The frequency range sensed by the human ear: 20Hz – 15-20 kHz
  - The goal was to transmit the voice signals
  - Not all the sounds should be transmitted
    - Economic aspects

PCM

- Pulse Code Modulation
  - Transforming analog signals to digital
- Based on the Nyquist rule, for a 4kHz signal we need an 8kHz sampling
  - Quantized to 256 signal levels
    - Represented on 8 bits
  - Transmission speed: 8bit x 8kHz = 64 kbit/s

Networking technologies and applications
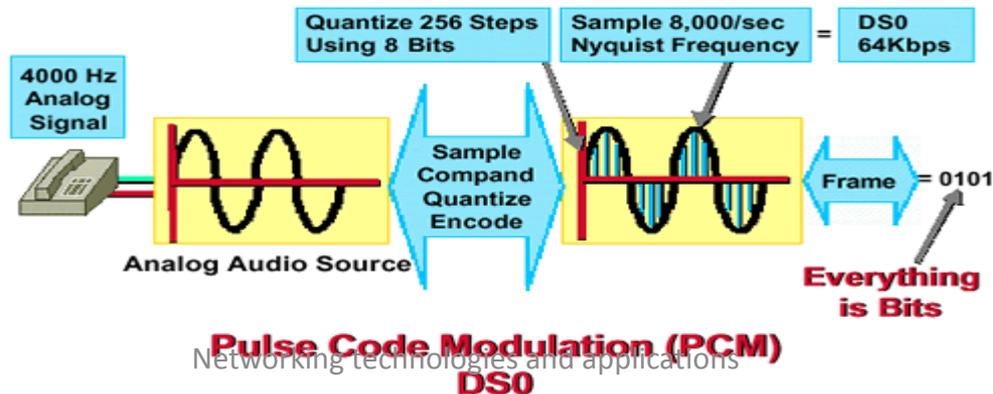
Digital speech transmission

Networking technologies and applications

Dial-up Access

- The digital information of a computer transformed into analog signals, and transmitted over a PSTN network
  - „Modem" – modulator-demodulator
    - Amplitude modulation
    - Frequency modulation
    - Phase modulation

Networking technologies and applications