

Networking Technologies and Applications

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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>

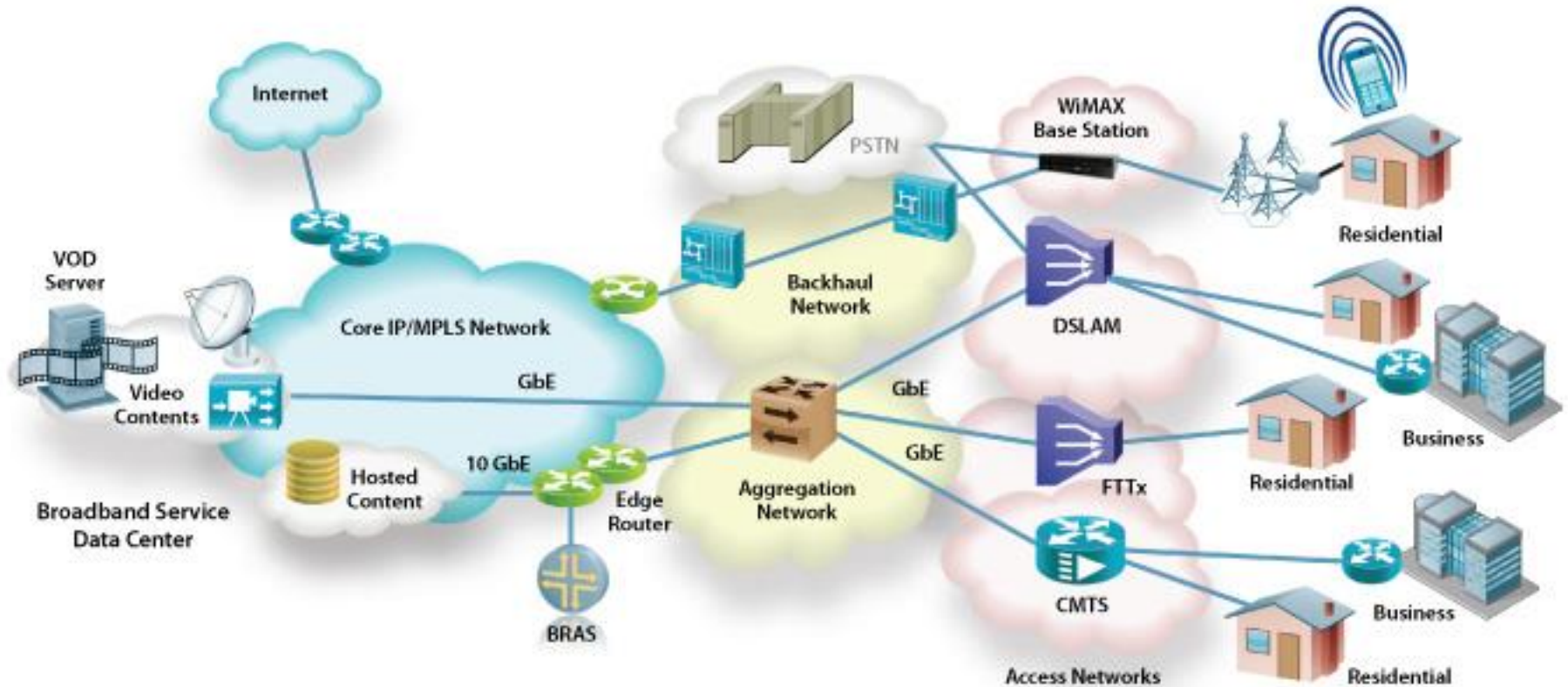
No book, but (quite) detailed slides

Presence at the lectures not mandatory (but advised)

Exams

- 1 mid-term exam, around end of October
- 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

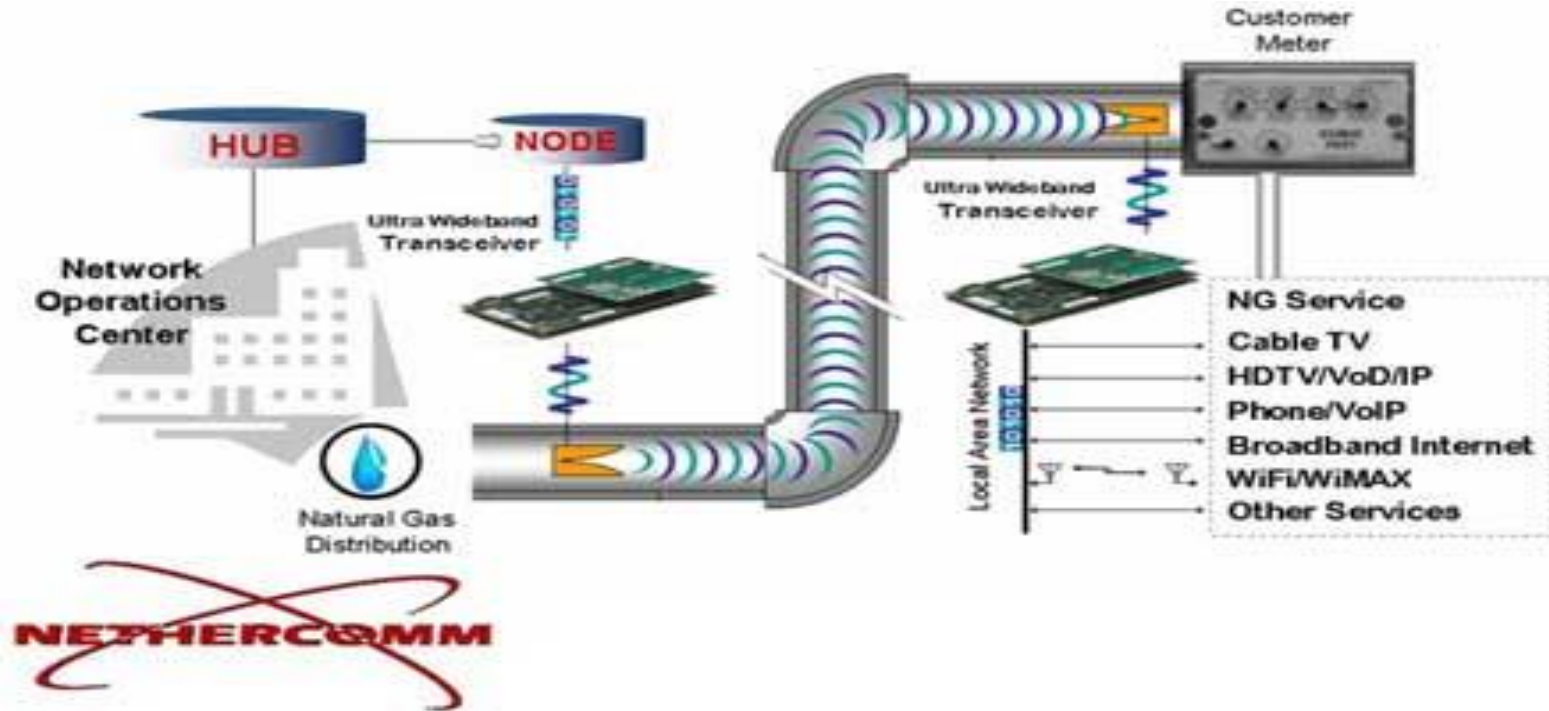
Big picture



Access 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?

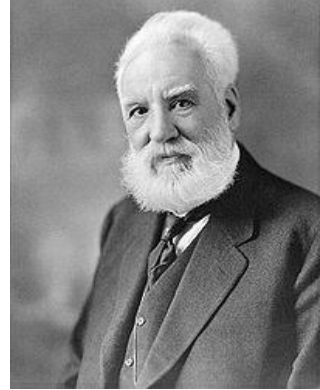


Internet through the gas pipe?

- 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“



PSTN

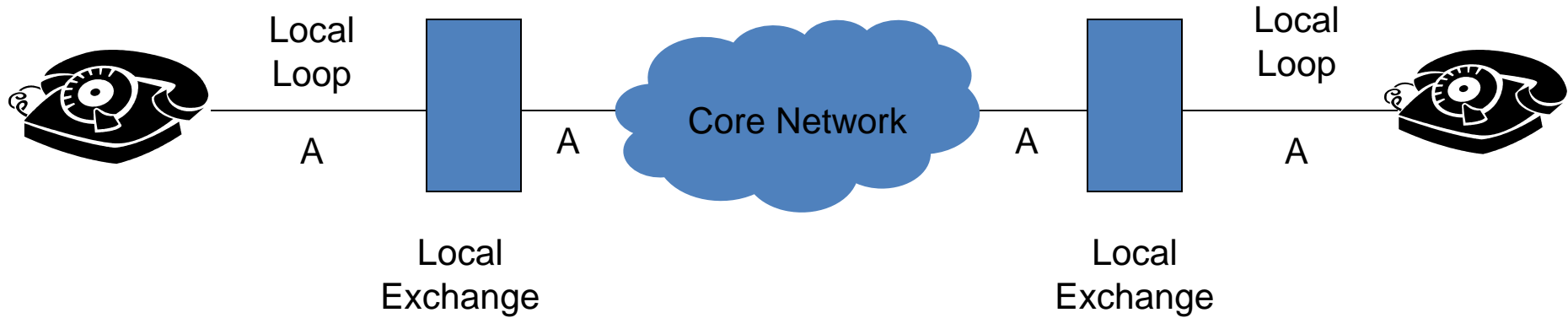
- 1878 – Bell Telephone Company
 - The first switching center – New Haven, Connecticut
 - A human operator switching manually between the users
- Inter-city calls
 - Linking the telephone switching centers
 - Secondary centers, hierarchical architecture
- Only in the US more than 22.000 centers today,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

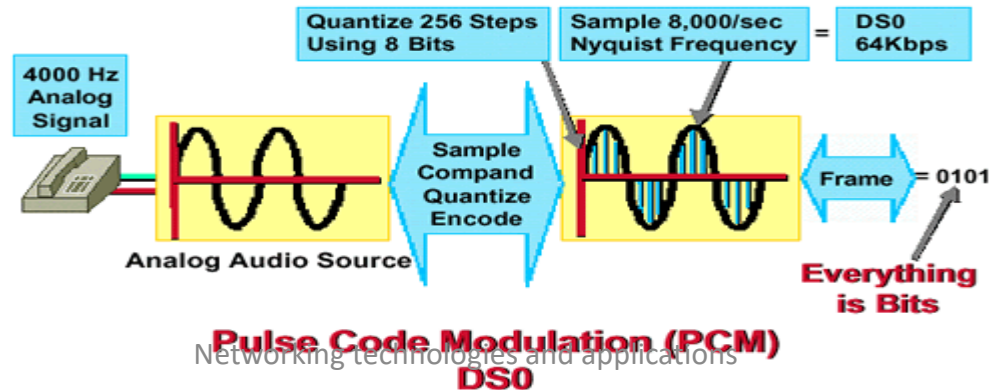


Voice channel

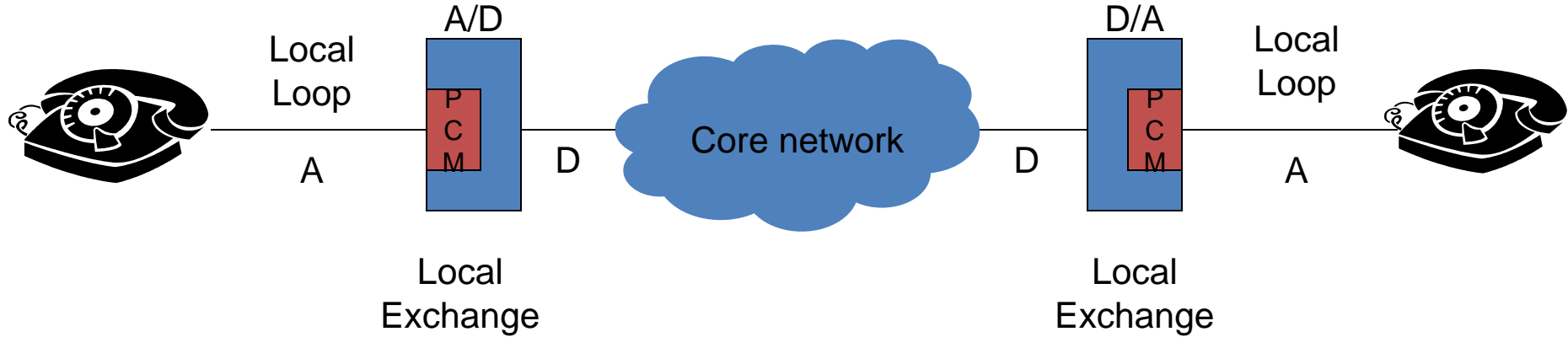
- 4kHz bandwidth for the voice channel
 - The transmission domain of the voice signal between 0.3 and 3.4 kHz
 - Some added guard bands
- The frequency range sensed by the human ear: 20Hz – 15-20 kHz
 - The goal was to transmit the voice signals
 - Not all the sounds should be transmitted
 - Economic 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: $8\text{bit} \times 8\text{kHz} = 64\text{ kbit/s}$

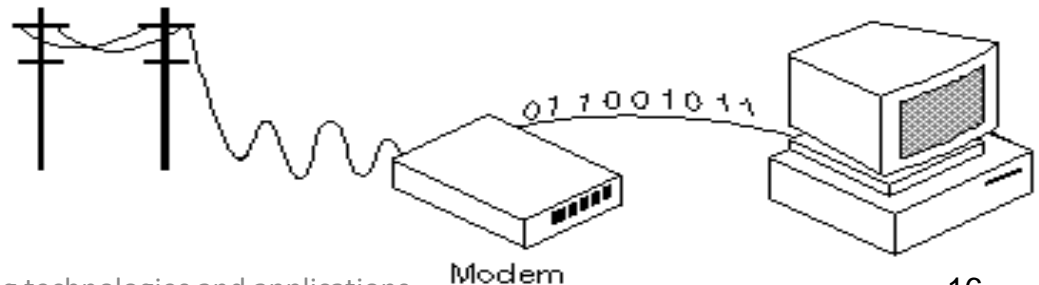


Digital speech transmission

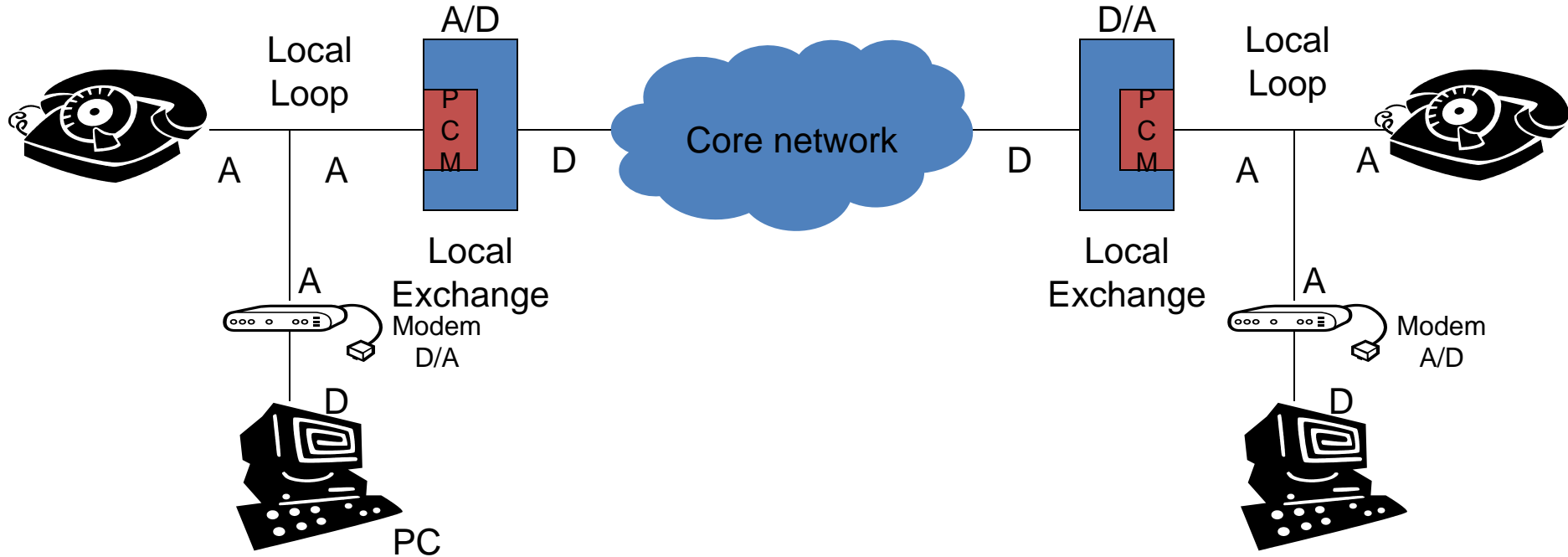


Dial-up Access

- The digital information of a computer transformed into analog signals, and transmitted over a PSTN network
 - „Modem” – **m**odulator-**d**emodulator
 - Amplitude modulation
 - Frequency modulation
 - Phase modulation



Dial-up access



What's the limit?

- The core network is digital
 - After the PCM coding, the signal is restricted to a 64 Kbps channel, this is the upper limit
 - In most of the systems 1 bit/byte for signaling
 - Max. 56Kbps
 - Quantization noise due to the A/D and D/A conversions
 - The actual limit is 33.6 Kbps

Dial-up is dying out...?

