Communication Networks II

BMEVITMA310 in English

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Wednesday 14:15 – 15:45 (I.E.219)

http://opti.tmit.bme.hu/~cinkler/TNS

Backbone / Transport Networks

Outline:

1.: PCM/PDH (http://www.hte.hu/hte2007/data/upload/File/online/THIS/2_en.pdf: 2.1.1.1, 2.1.1.2) (http://www.hte.hu/onlinebook)

2.: SDH/SONET(http://www.hte.hu/hte2007/data/upload/File/online/THIS/2_en.pdf: 2.1.1.3)

3.: ATM

4.: MPLS

5.: ngSDH/SONET (GFP, VCat, LCAS)

6.: OTN

7.: Optical Networks

Introduction

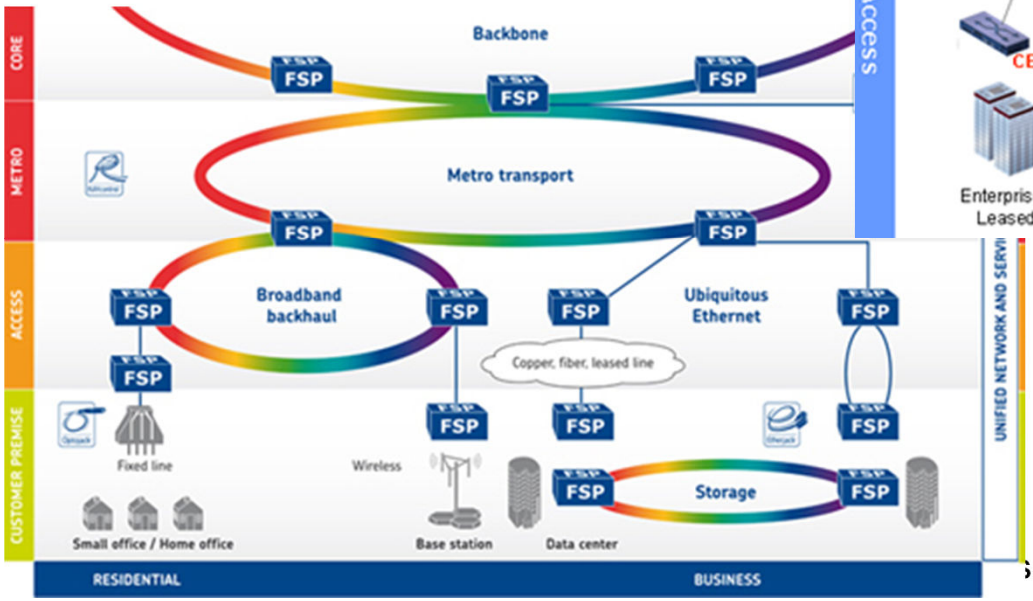
- Evolution of transmission techniques
  - 1915 New York - San Francisco telephony - copper/analog
  - 1936 coaxial cabel PSTN NY - Philadelphia
  - 1947 microwave links
  - 1962 telecom. satelite
  - 1980 fiber
  - 1988 SONET (ANSI) and SDH (CCITT → ITU) standard

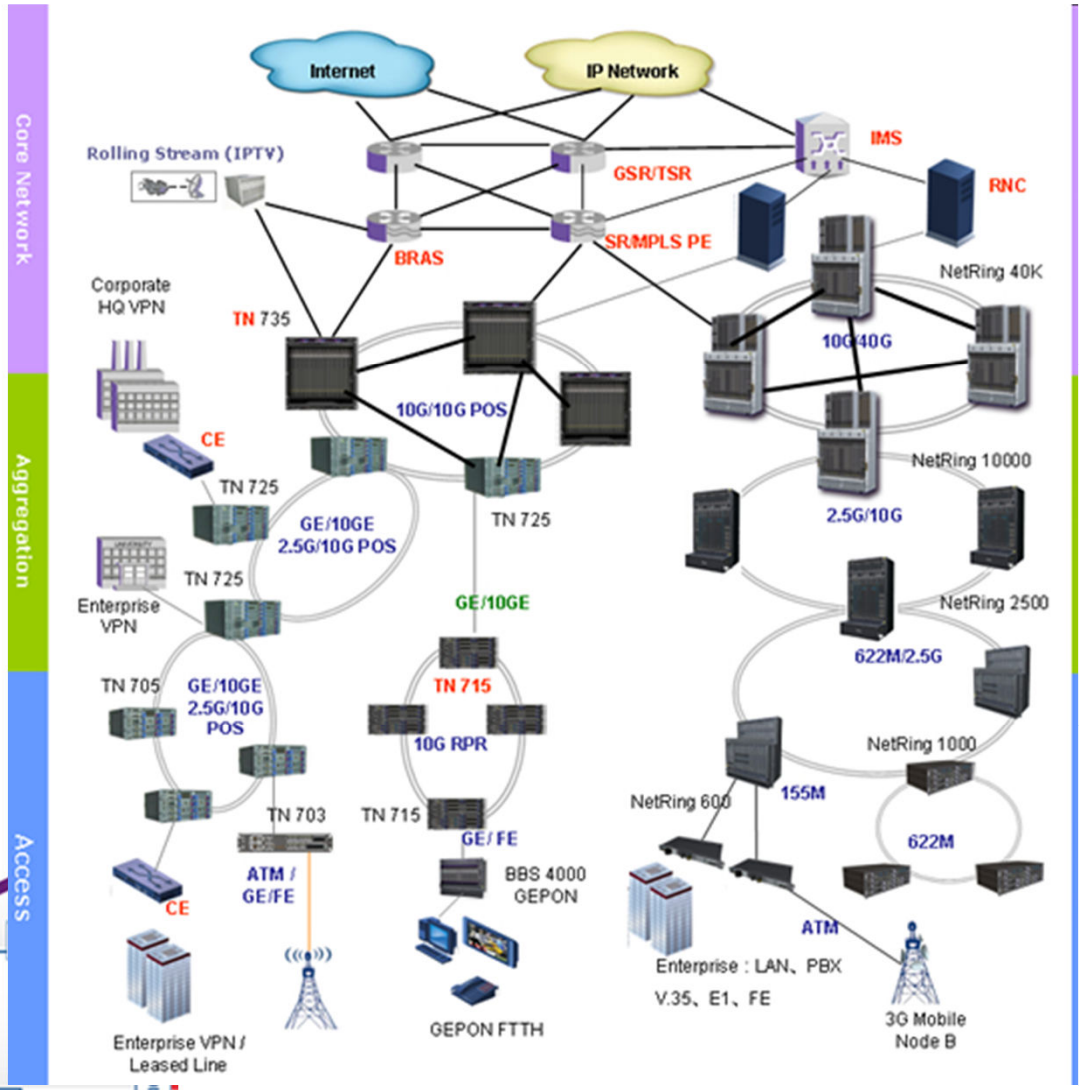
Analog -> Digital

PDH -> SDH

- Today
  - PCM/PDH, ISDN
  - SDH/ngSDH
  - ATM/MPLS
  - IP/Ethernet
  - DWDM
  - GMPLS
  - MPLS-TP

Access
Metro
Core





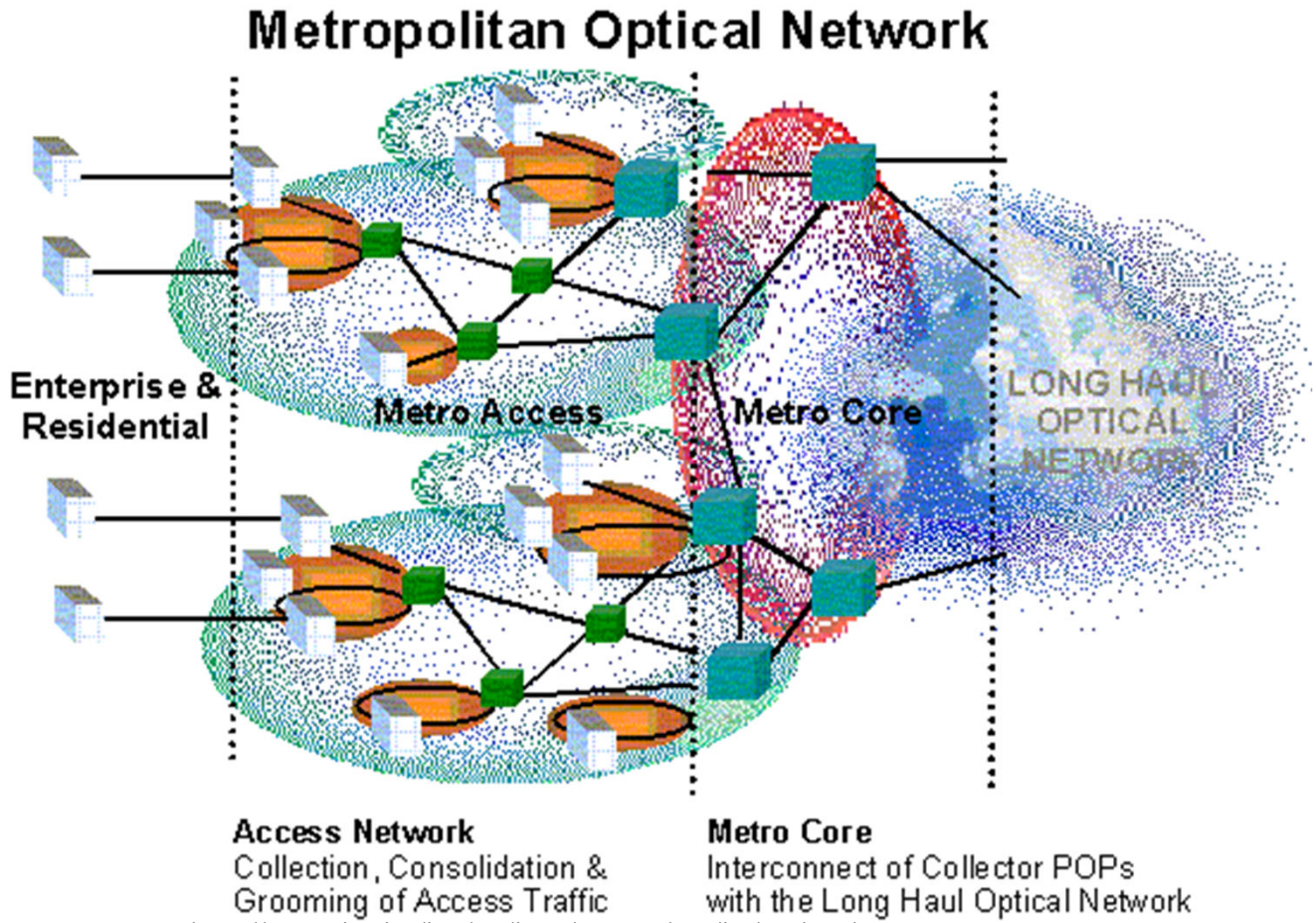
MON-LHON — Positioning

OR:

- Access
- Metro
  - Metro-Aggregation
  - Metro-Core
- Core or Backbone

OR:

- Metro Access
  - First mile access
  - Metro aggregation
- Core



Source: ITU-T: http://www.itu.int/itudoc/itu-t/com15/otn/index.html

Network Architectures

- Access/Aggregation:
  - LAN (Eth, GbE, 10GbE, 100GbE), xDSL, FTTx, PLC,...
  - DECT, GSM, HSCSD, GPRS, EDGE, 3G (UMTS), HSPA, LTE, 5G...
  - WLAN: WiFi (IEEE 802.11a,b,g,n,ac) (http://www.ieee802.org/11/)
  - Wireless MAN: WiMAX (IEEE 802.16) (http://www.ieee802.org/16/)
  - p2p microvawe, terrestrial, satelite (InMarSat, Iridium, Thuraya), free space optics, etc.
  - PON (EPON, GPON,10xPON, WDM PON…)
- METRO:
  - SDH, ngSDH, METRO Ethernet, (ATM), MPLS, optics …
  - METRO Access/Aggregation:
    - aggregate the traffic from access networks
    - classical approaches (SONET/SDH aggregation rings, RPR, Full Ethernet, Pt2Pt Optical Ethernet)
  - METRO Core: ROADM with CWDM or DWDM
- Transport (Backbone, Core)
  - DWDM, flexgrid, DW / OTN
  - (ng)SDH/SONET, ASON, GMPLS, ASTN
  - MPLS-TP

"Last Mile"/ "First Mile"

- Question of the point of view
  - "First Mile„ for the customer
  - "Last Mile„ for the operator
  - in practice it is the same…
- Becomes shorter and shorter:
  - Last mile, km, 100m, meters, etc
  - Wi-Fi a, b, g, n, ac… or mobile data
- Mostly wireless and mobile
  - Rarely wireline solution

Communication Satelite Systems

- GEO 36 000 km from Earth surface
- MEO (2 000-36 000 km)
- LEO (160-2 000 km)

- Inmarsat www.inmarsat.com
  - Voice, data, M2M
- Iridium www.iridium.com
  - Voice, data, IoT
- Thuraya www.thuraya.com
  - Voice, data, IoT/M2M
- Etc., etc., etc…

FTTx systems

- Fiber to the
  - Curb
  - Cabinet
  - Building
  - Home
  - Office
  - Desktop
- The closer the better
- Point-to-point or point-to-multi-point systems
  - P2MP: PON (EPON, GPON,10xPON, WDM PON, CDMA PON, TWDM PON…)

Mobil data and voice

- 2G: **GSM**, HSCSD, GPRS, EDGE,
- 3G: **UMTS**, HSUPA, HSDPA, HSPA, HSPA+
- 4G: LTE, **VoLTE,** LTE Adavnced, LTE Advanced Pro
  - 4G to 3G FallBack for Voice
    - No voice service for4G was availablein the start
    - VoLTE solves this problem now
- 5G

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4. MPLS (http://opalsoft.net/qos/MPLS.htm)

- http://www.cisco.com/c/en/us/about/press/internet-protocol-journal/back-issues/table-contents-10/mpls.html

MultiProtocol Label Switching:

- Unified IP/MPLS control
- Simpler than ATM
- Reduced label space rquirement via FEC (Forwarding Equivalence Class)
- Label Swapping and Stacking
- Not much new compared to ATM ☺
- Topology or Traffic driven
- Some QoS issues still open
- TE and VPN support (Traffic Engineering and Virtual Private Networks)
- IPoMPLS: Peer Model !
  - RSVP-TE
  - CR-LDP