Data Networks
Introduction – Part 2-B

NEN Layer 2 – Technologies

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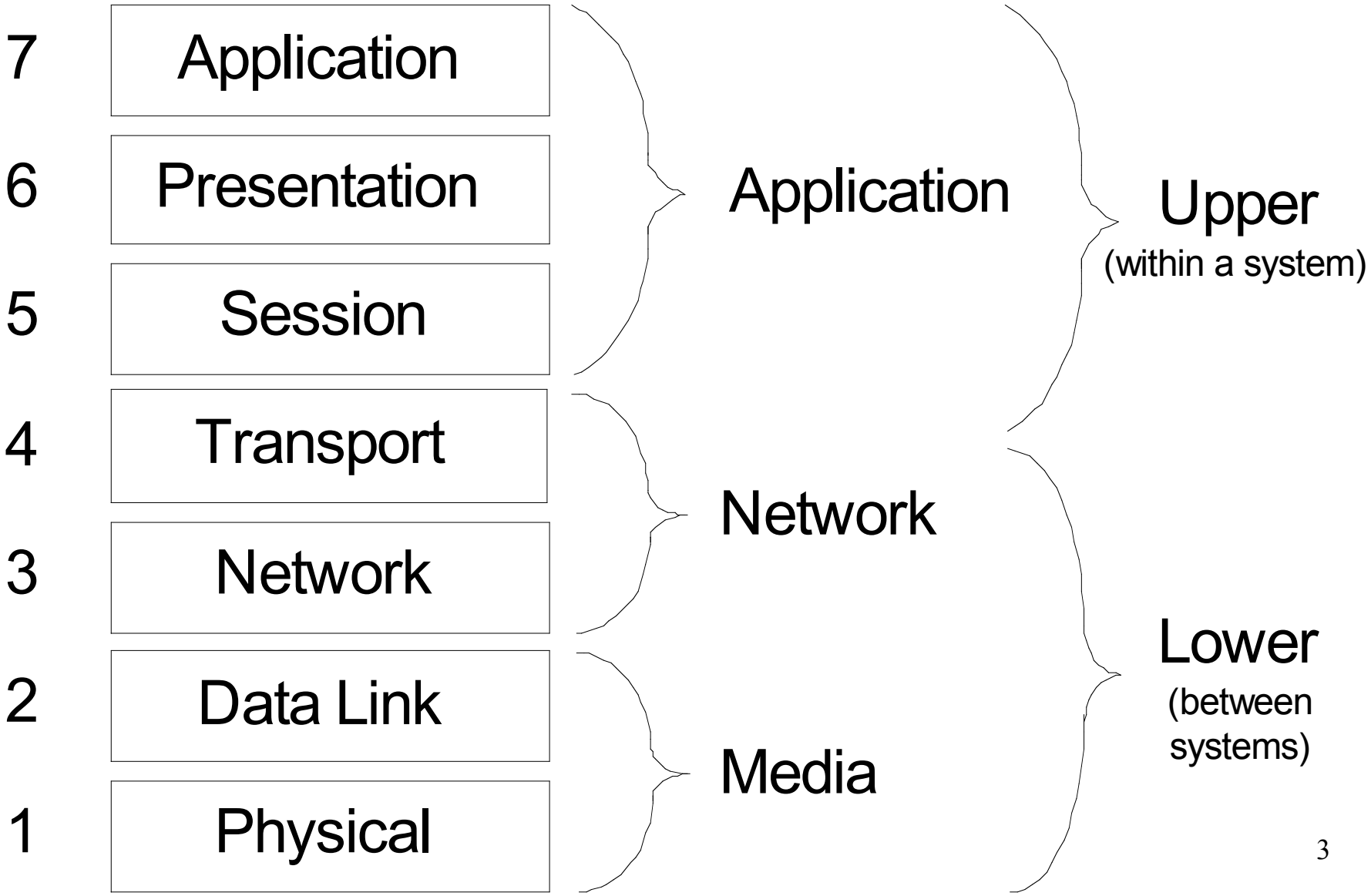
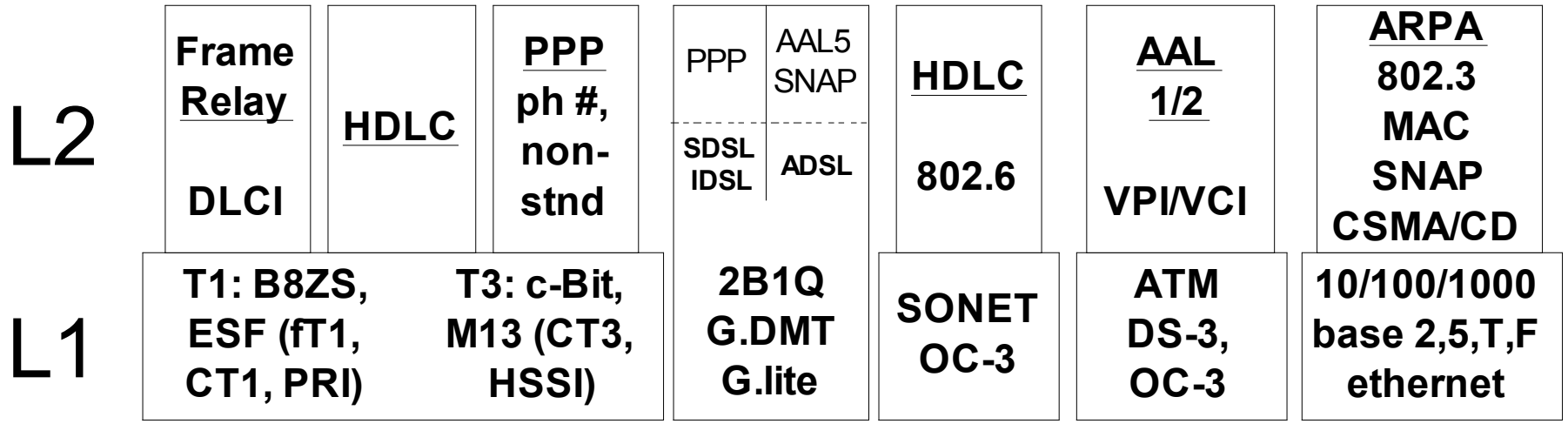
Agenda

- OSI Model review
- Layer 1 Connectivity:
  - T1
  - Digital Subscriber Line
- Layer 2 Concepts review
  - PVC and Oversubscription
- Layer 2 Switching Technologies
  - Frame-Relay
  - Asynchronous Transfer Mode

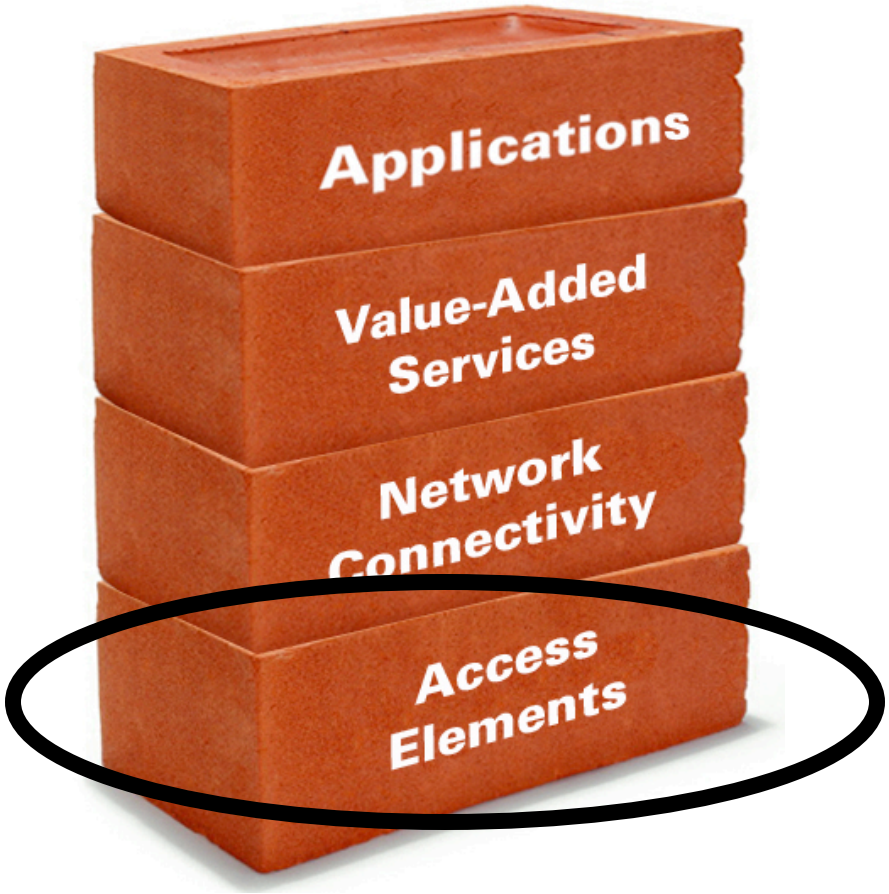
OSI Model – Layers



L1/L2 dependencies



NEN Product Model

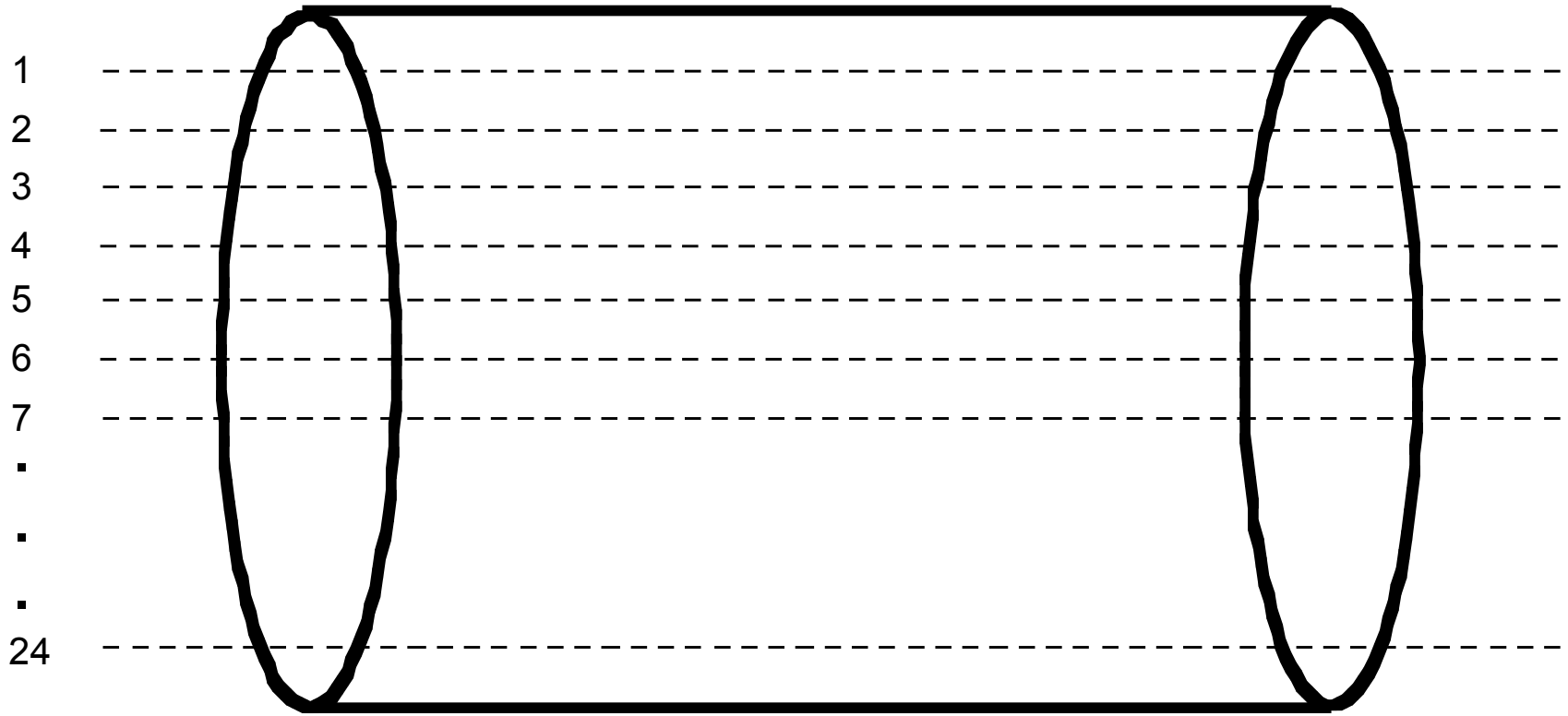


T1 (DS1)

- 24 Channels (DS0's)
  - Each channel – 64Kbps (x 24 = 1.536 Mbps)
  - Time Division Multiplexing (TDM)
  - Types:
    - Channelized or Non-channelized
    - Full or Fractional
- Layer 2 Permanent Virtual Circuit (PVC)
  - 1 or more provisioned on [Non]Channelized
  - Concerns: Oversubscription (a.k.a. "playing the odds")*

* Every service provider does it

24 Channels



Digital Subscriber Line

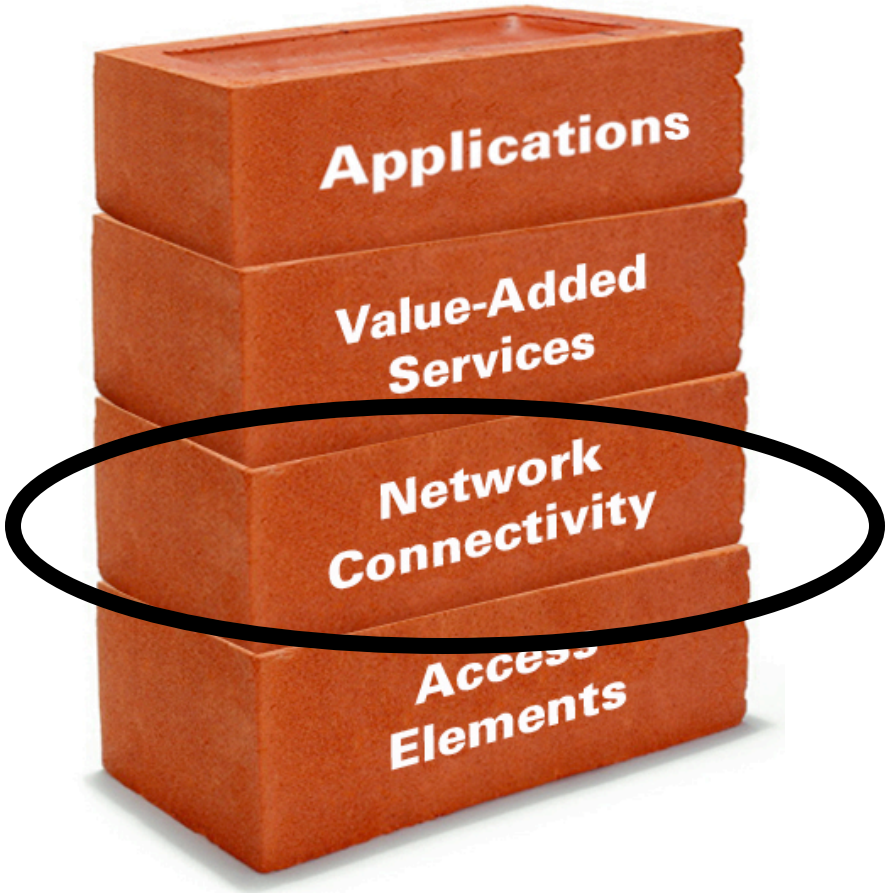
- Capabilities
  - "Last Mile" ONLY!
  - Frame-Relay or ATM out the back end
  - *NO* PVC provisioning – CURRENTLY
- Many flavors
  - Based on
    - Bandwidth needs
    - "last mile" distance: environmental factors, cross-talk
    - Installed equipment (DSL Access Multiplexer)
  - Types
    - ADSL: Asymmetric
    - SDSL: Symmetric
    - HDSL: High-bit-rate
    - IDSL: ISDN

DSL Flavors

- ADSL: Asymmetric (based on ATM technology)
  - Up to 8Mbps "download" / Up to 1Mbps "upload"
    - 7Mbps @ 8000 ft. – 1Mbps @ 16000 ft.
  - Supports data and analog phone line in same circuit
- SDSL: Symmetric
  - Up to 2.3Mbps "up" and "down"
    - 1.5Mbps @ 9500 ft. – 160Kbps @ 22770 ft.
- HDSL: High-bit-rate*
  - Alternative to HDLC-T1 (@ 1.536Mbps)
- IDSL: ISDN-DSL
  - Up to 144Kbps @ 36000 ft.

* Uses 4-wire (2 pair) instead of other flavors of DSL that use just 1 pair.

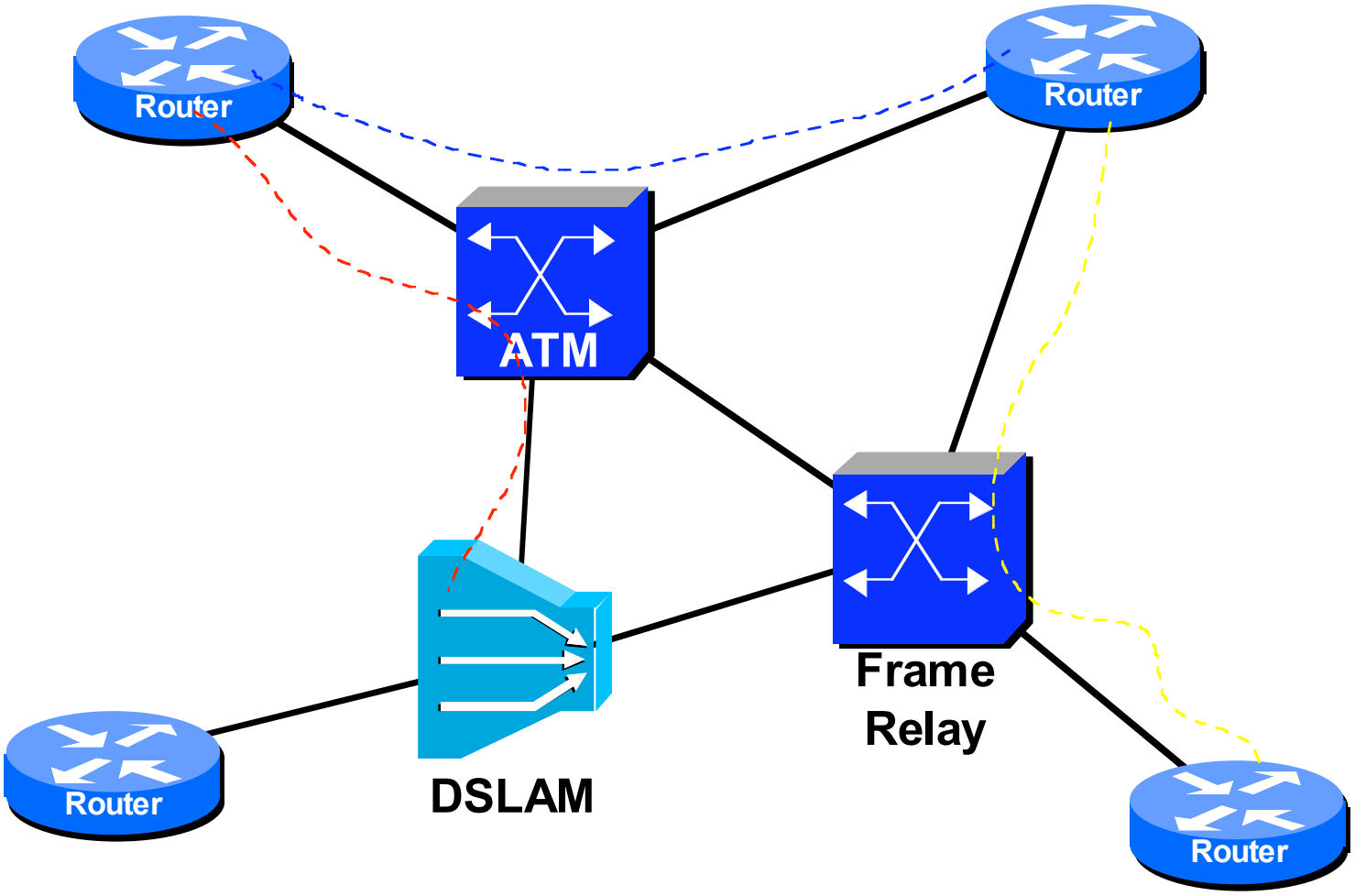
NEN Product Model



Layer 2 - Switching

- Defines Layer 2 Virtual Circuits (P or S - VC)
  - Addressing:
    - MAC (Ethernet)
    - DLCI (Frame Relay)
    - VPI/VCI (ATM)
  - End-points: Layer 3 devices (routers)
- Interworking (bridging):
  - Translation between different Layer 2 devices (i.e. FDDI and Ethernet, ATM and Frame Relay, ADSL and Ethernet)
- Security:
  - Virtual Private Network (VPN)

Virtual Circuits



Physical

Virtual
(Logical)

Frame-Relay

- Addressing:
  - DLCI (Data Link Connection Identifier)
  - Local to [CPE's physical] interface
  - No global numbering capabilities
- Capabilities:
  - Permanent Virtual Circuits (PVC)
  - Reroute of PVC's on physical links
  - Congestion control: FECN & BECN
  - QoS: prioritize PVC
- Terms:
  - User-Network-Interface, Network-to-Network-Interface
  - Committed Information Rate (CIR) & Burst

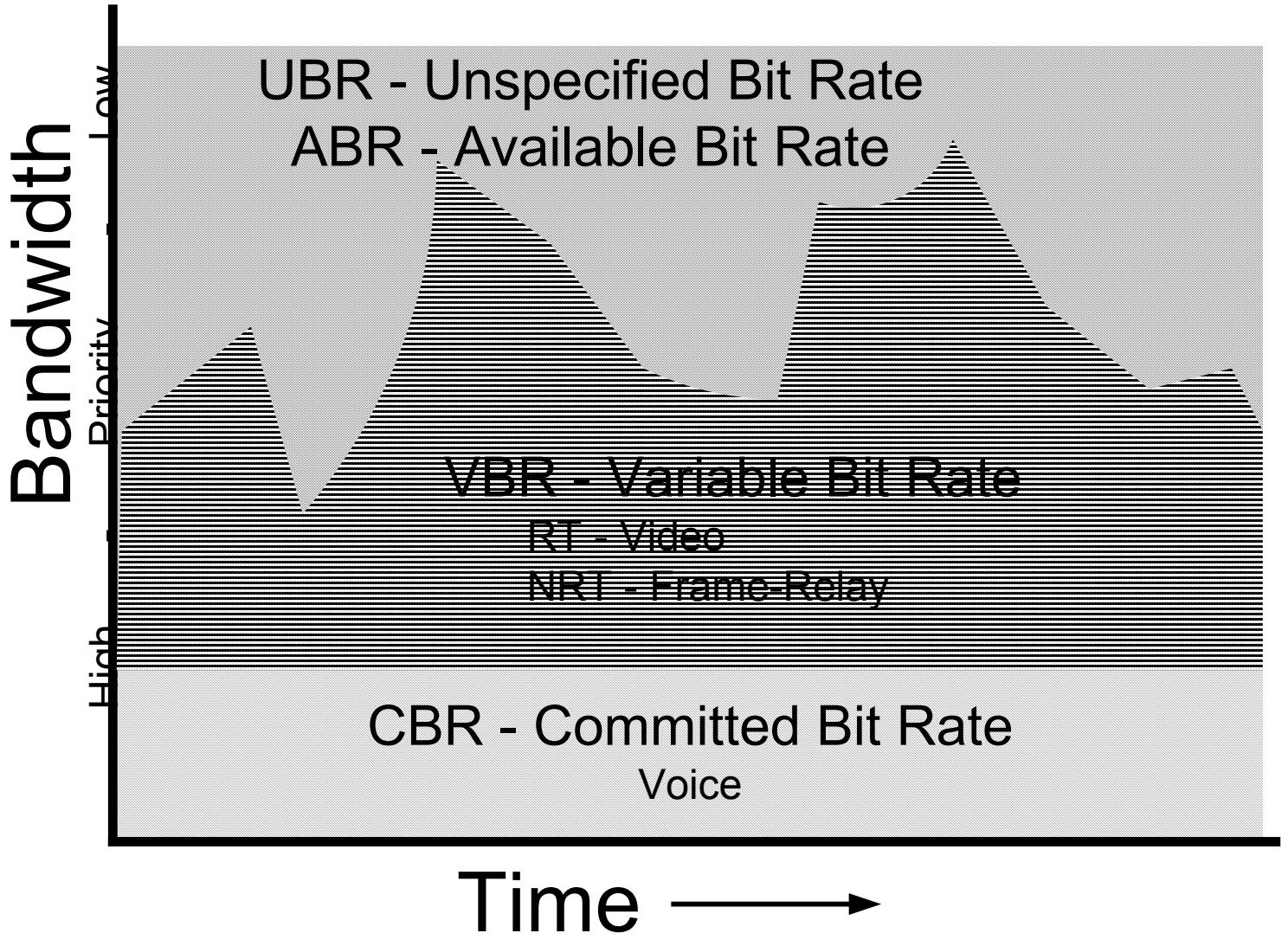
Asynchronous Transfer Mode

- Addressing
  - Globally capable – never used
  - Virtual Path Id & Virtual Circuit Id (VPI/VCI)
  - Network-to-Network Interface (NNI)
- Capabilities
  - Virtual Circuits: Permanent and Switched
  - Bit Rate: CBR, VBR (RT & NRT), ABR, UBR
  - QoS
  - Reroute of PVC's on physical links
- Terms:
  - User-Network-Interface, Network-to-Network-Interface
  - Committed Information Rate (CIR) & Burst

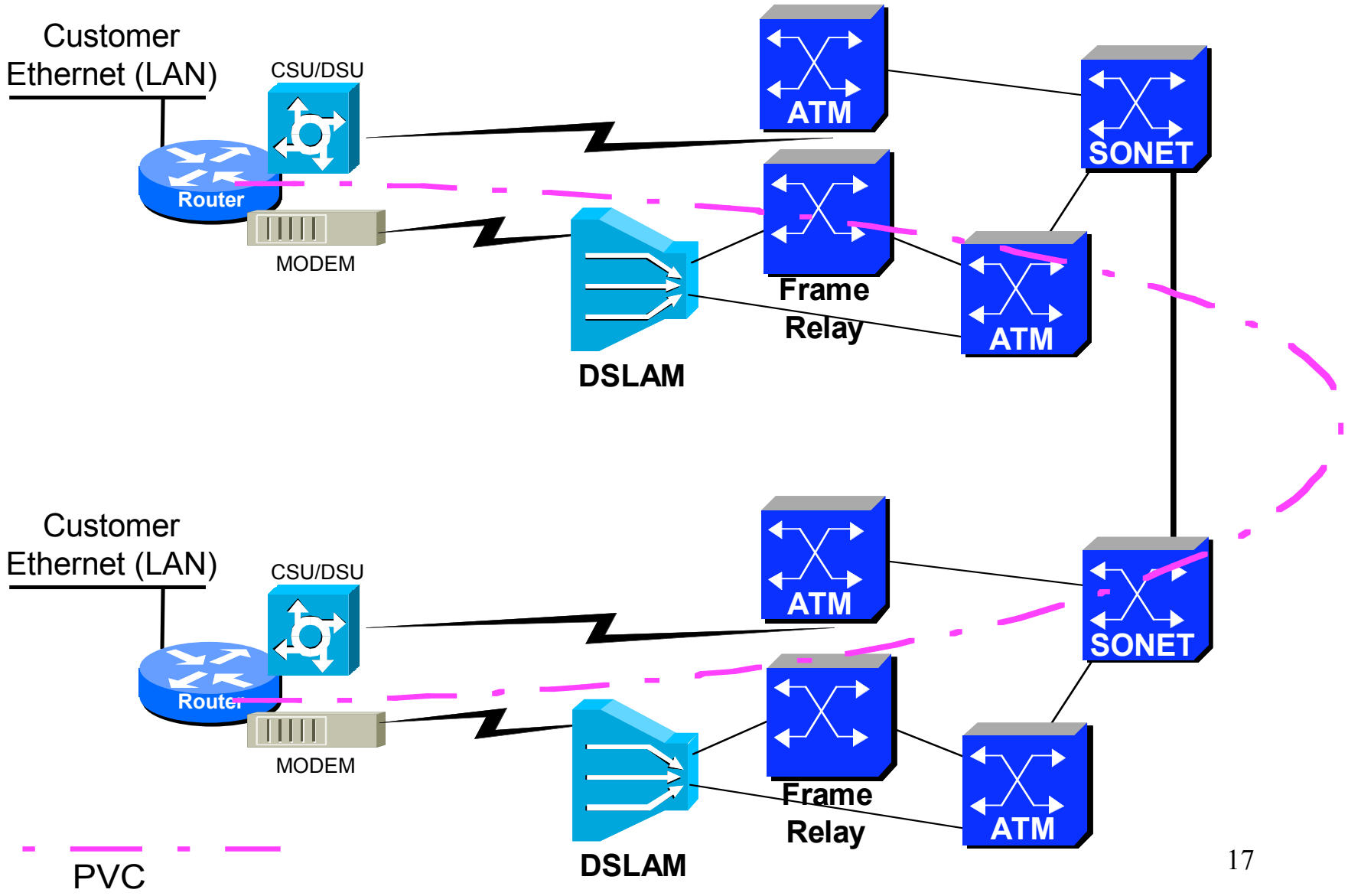
ATM QoS Comparison

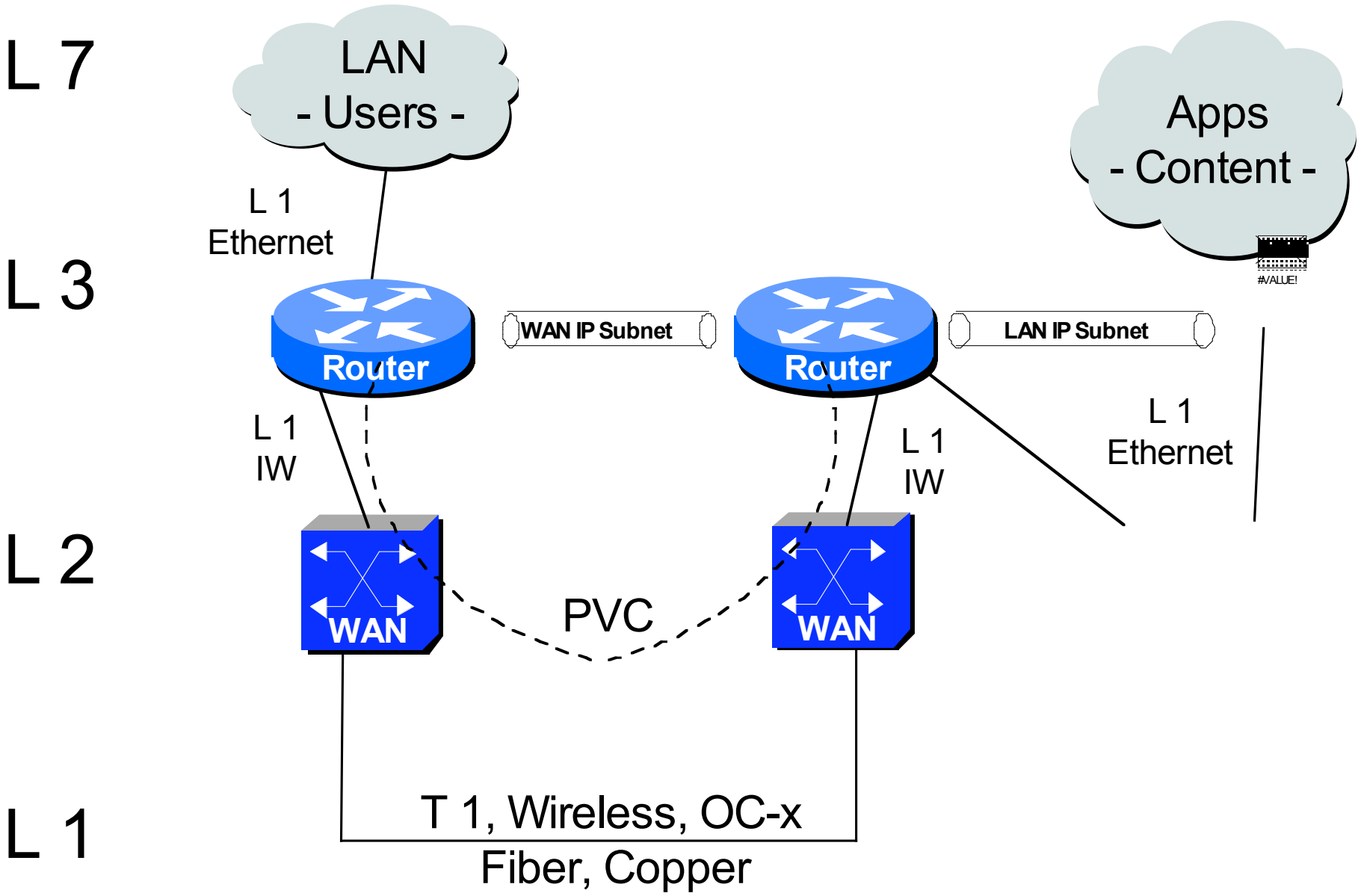
- Committed Bit Rate (CBR)
  - Voice
- Variable Bit Rate (VBR)
  - Real-Time (RT) for Video
  - Non-Real-Time (NRT) for Frame-Relay
- Unspecified Bit Rate (UBR)
  - Best Effort
- Available Bit Rate (ABR)
  - Better Best Effort

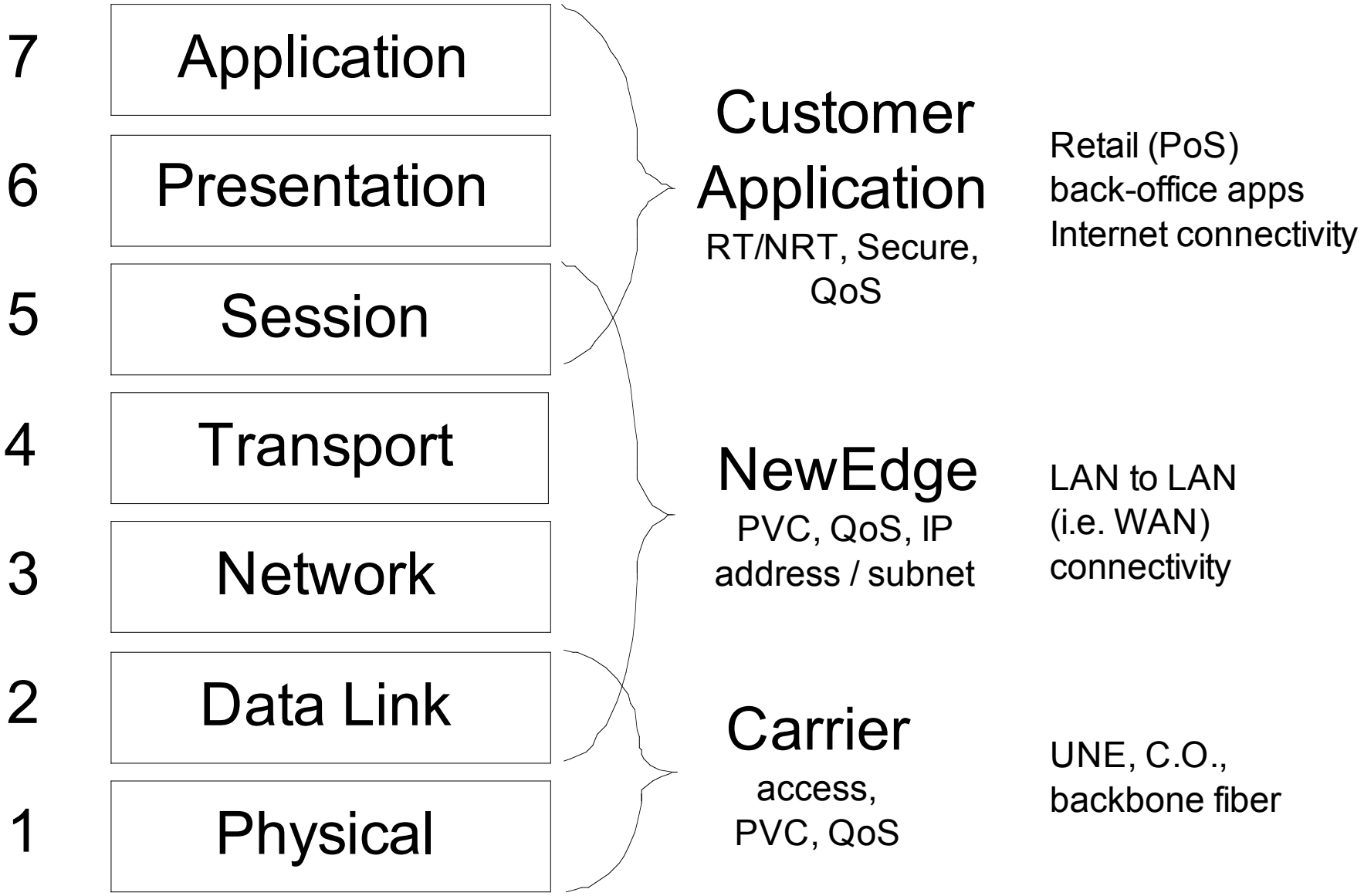
ATM QoS Comparison



End-to-End Connectivity Example




L 7
L 3
L 2
L 1
LAN
- Users -
Apps
- Content -
#VALUE!
L 1
Ethernet
Router
WAN IP Subnet
Router
LAN IP Subnet
L 1
IW
L 1
IW
L 1
Ethernet
WAN
PVC
WAN
T 1, Wireless, OC-x
Fiber, Copper


7
Application
6
Presentation
5
Session
4
Transport
3
Network
2
Data Link
1
Physical
Customer Application
RT/NRT, Secure, QoS
NewEdge
PVC, QoS, IP address / subnet
Carrier
access, PVC, QoS
Retail (PoS)
back-office apps
Internet connectivity
LAN to LAN (i.e. WAN) connectivity
UNE, C.O., backbone fiber