

Network Management

Lecture 2

Review of Information Network
and Technology

Objectives

- Network components and technologies to be managed
 - Network Topologies: LAN and WAN
 - Wired LAN topology: Bus, Ring, Star, and Hybrid Hub
 - Wireless LAN
 - WAN topology: Mesh and Tree
 - Fixed and mobile wireless networks
 - Fiber networks
- Ethernet LAN:
 - Physical media and MAC protocol
 - 10 and 100 Mbps; 1 and 10 Gbps Ethernet LAN
 - Switched and Duplex Ethernet LANs
 - Virtual LAN
- Token-ring LAN
- FDDI
- Network components
 - Bridges
 - Routers
 - Gateways
- Circuit switching and packet switching
- Transmission technology
 - Transmission media: Wired and Wireless
 - Transmission modes
 - Multiplexing: TDM and WDM
 - SONET and SDH
- Multimedia networks and services

Technology and Management

- What are the technologies that need to be managed?
- Challenges of technological progress on network management

Notes

Information Network Technology

- Network components
 - Links
 - Nodes
- Topology: How they're configured
- LANs
- Wireless LAN
- WANs
- Bridges
- Routers and Gateways
- Switches
- Transmission Media
- Transmission Modes
- ISDN
- Broadband networks and services

Notes

Basic LAN Topologies

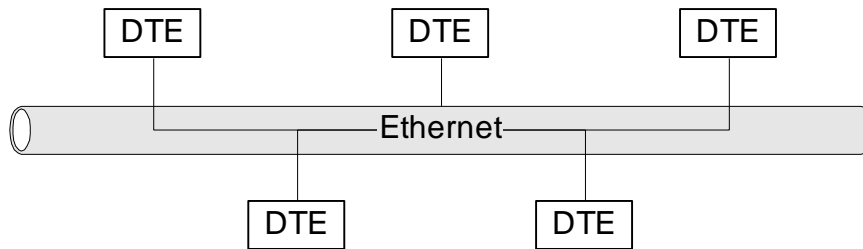


Figure 2.1(a) Bus Topology

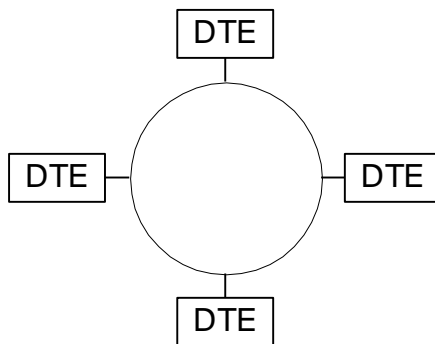


Figure 2.1(b) Ring Topology

Notes

- Bus Topology
 - Used in Ethernet LAN family
 - Common shared medium
 - Randomized access (CSMA/CD)
 - Easy to implement
 - Lower utilization under heavy traffic 30%-40%
 - Single culprit could effect the entire LAN

Basic LAN Topologies (cont.)

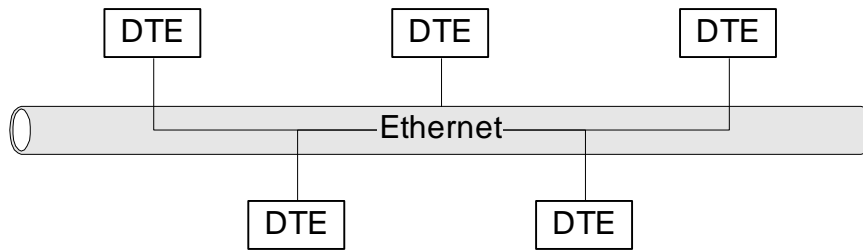


Figure 2.1(a) Bus Topology

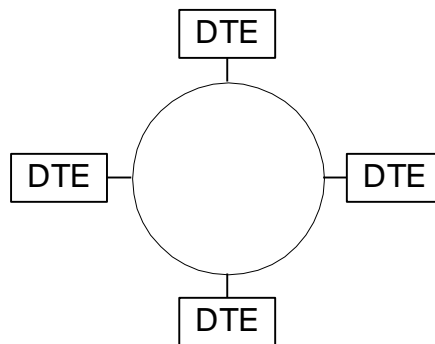


Figure 2.1(b) Ring Topology

Notes

- Ring Topology
 - Used in token ring and FDDI
 - Shared medium
 - Deterministic access
 - Master DTE has control
 - High utilization >90%
 - Also used in MAN

Star & Hybrid LAN Topologies

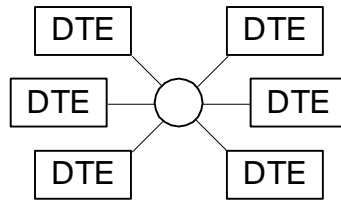


Figure 2.1(c) Star Topology

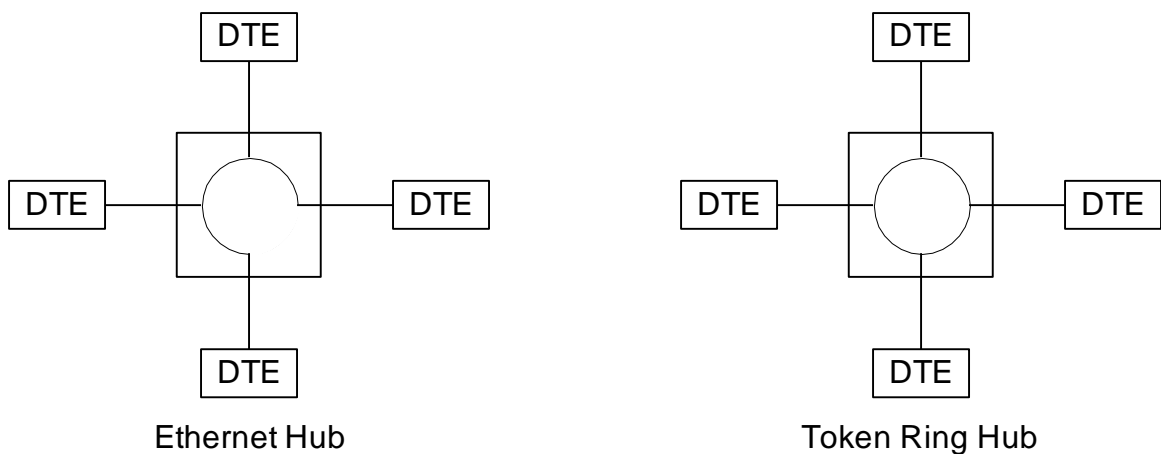


Figure 2.1(d) Hub Configurations

Notes

- Star topology used with bus and ring topology
- Hub is “LAN in a box”
- What does the electronic LAN inside the box look like?
- Why has hub become so popular?

Wireless LAN

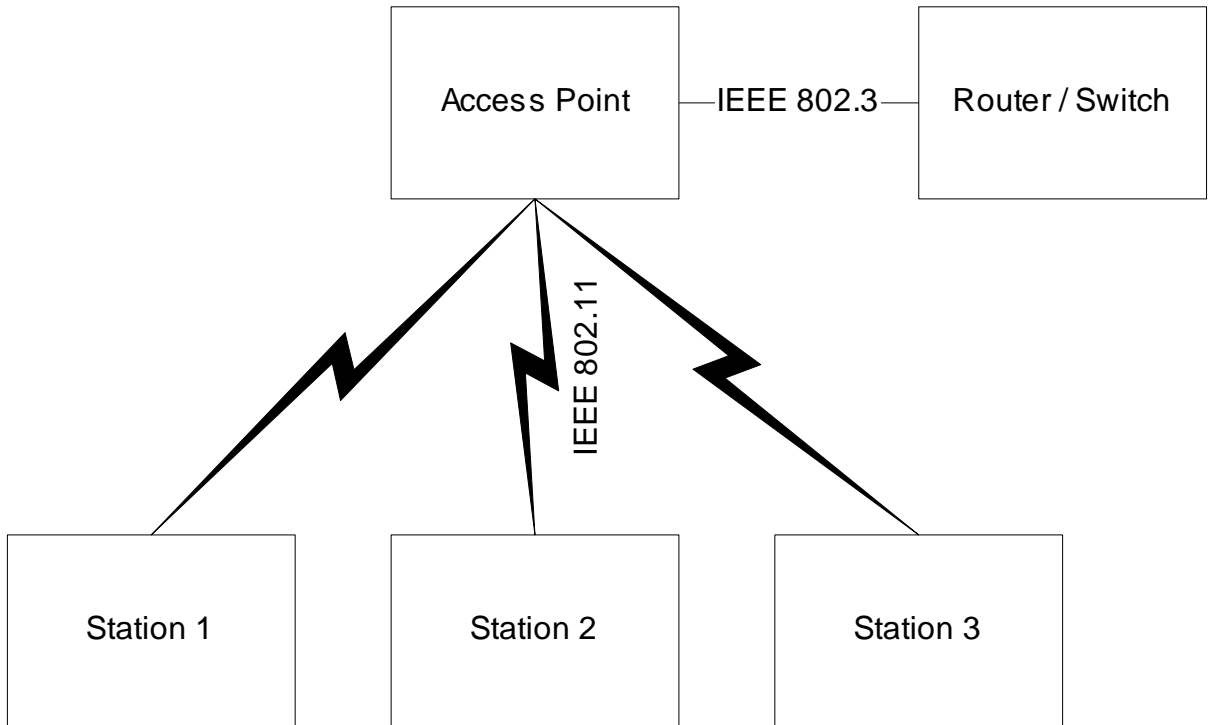


Figure 2.14 Wireless LAN: Hierarchical Topology

Notes

- Hierarchical
- Ad Hoc

IEEE 802.11

Standards and Amendments

802.11a	54 Mbps data rate 5.15 MHz to 5.35 and 5.4 MHz to 5.825 MHz
802.11b	11 Mbps data rate at 2.4 GHz
802.11e	Addresses QoS issues
802.11f	Addresses multivendor AP interoperability
802.11g	Higher data rate extension to 54 Mbps in the 2.4 GHz
802.11h	Dynamic frequency selection and transmit power control for operation of 5 GHz products
802.11i	Addresses security issues
802.11j	Addresses channelization in Japan's 4.9 GHz band
802.11k	Enables medium and network resources more efficiently
802.11n	Addition of multiple-input multiple-output (MIMO); WiFi certification

Campus Network

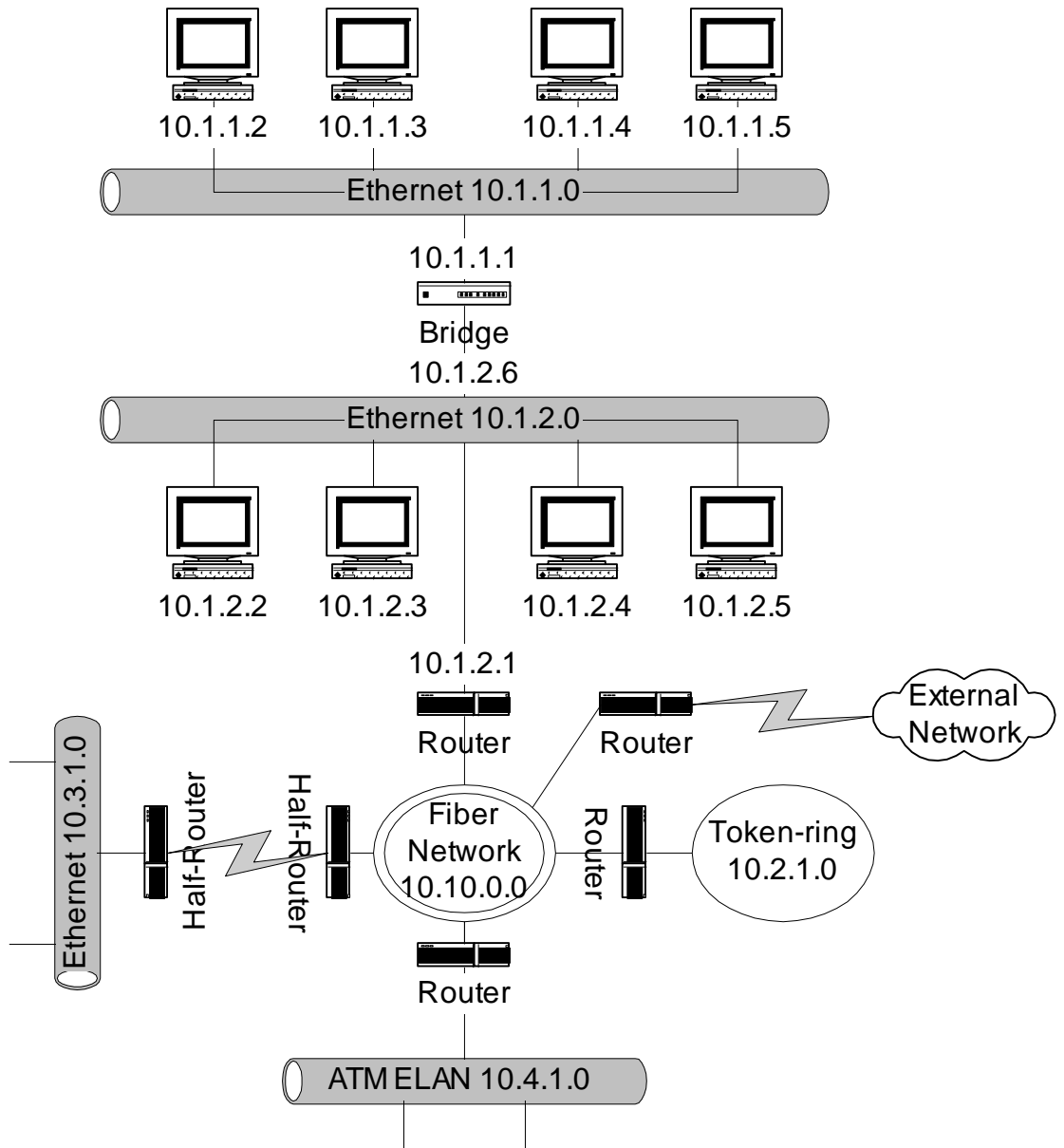


Figure 2.3 Campus Network of LANs

Notes

- Fiber Network could be Gigabit LAN or MAN

WAN Topologies

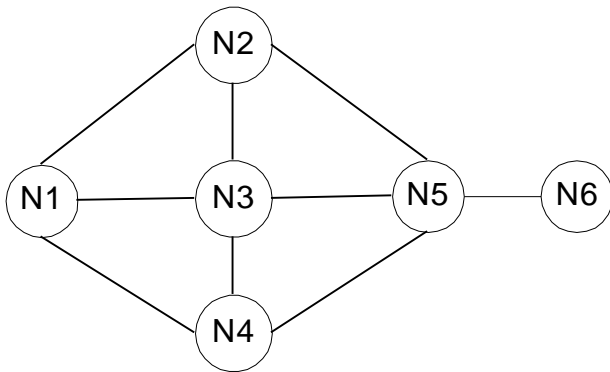


Figure 2.2(a) Mesh Topology

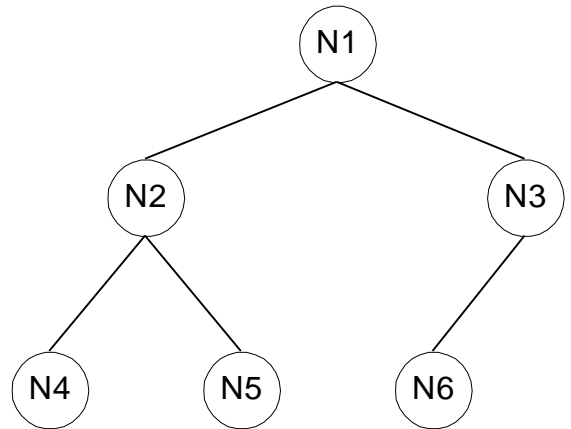


Figure 2.2(b) Tree Topology

Notes

- Mesh topology
 - Implemented in network layer level
 - Multiple paths between nodes
 - Flat topology
 - Redundancy
 - Load balancing
 - Shortest path
- Tree topology
 - Used with Ethernet bridges
 - Hierarchical
 - Efficient for small networks and special purpose networks
- Ring Topology
 - SONET / SDH
 - MAN
 - Broadband feeder network

Ethernet

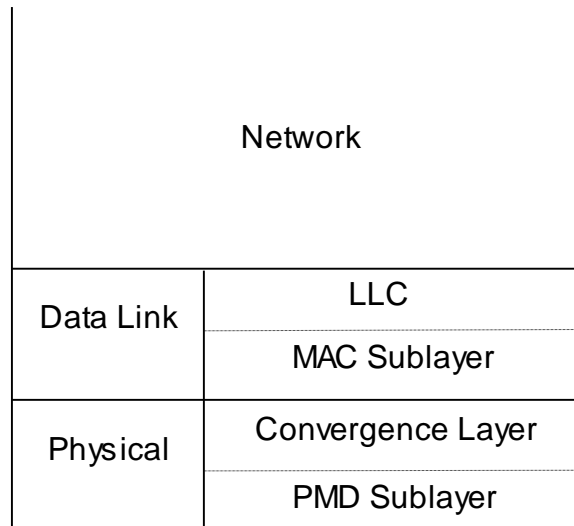
Table 2.1 Ethernet LAN Topology Limits

TYPE	DESCRIPTION	SEGMENT LENGTH	DROP CABLE
10Base2	Thin coax (0.25")	200 meters	Not allowed
10Base5	Thick Coax (0.5")	500 meters	Twisted pair: 50 meters
10Base-T	Hub topology	N/A	Twisted pair: 100 meters
10Base-F	Hub topology	N/A	2 km

Notes

- IEEE 802.3 standard
- 10 Mbps data rate
- Collision - analogy of hollow pipe
- Principle of operation; CSMA/CD
- Segment length and drop cable length
- Minimum size of packet 64 bytes
- Maximum size of packet 1500 bytes
- Hub configuration

Fast Ethernet



LLC Logical Link control

MAC Medium Access Control

PMD Physical Medium Dependent

Figure 2.4 100Base-T Fast Ethernet Protocol Architecture

Notes

- Rationale
 - Max drop length 100m => Max round-trip time 1/10 of Ethernet; hence 10 times data rate
- Standard 100Base-T4
- Compatibility with 10BaseT
- Cat 5e (Max 100 m, 100 MHz)
- Cat 6 (Max 100 m, 250 MHz)
- 100Base FX optical fiber (Max 10 km single and 400 m multimode)

Gigabit Ethernet

Table 2.2 Gigabit Ethernet Topology Limits

	9 micron Single- Mode	50 micron Single Mode	50 micron Multimode	62.5 micron Multimode	Balance Shielded Cable	UTP
1000BASE-LX	10 km	3 km	550 m	440 m	-	-
1000BASE-SX	-		550 m	260 m	-	-
1000BASE-CX	-		-	-	25 m	-
1000BASE-T	-		-	-	-	100 m

Notes

- Packet size 512 bytes, slot size 4.096 microseconds
- Minimum frame size 64 bytes for backward compatibility; Slot filled with carrier extension
- Packet bursts with no idle time between frames increases efficiency

Switched Ethernet

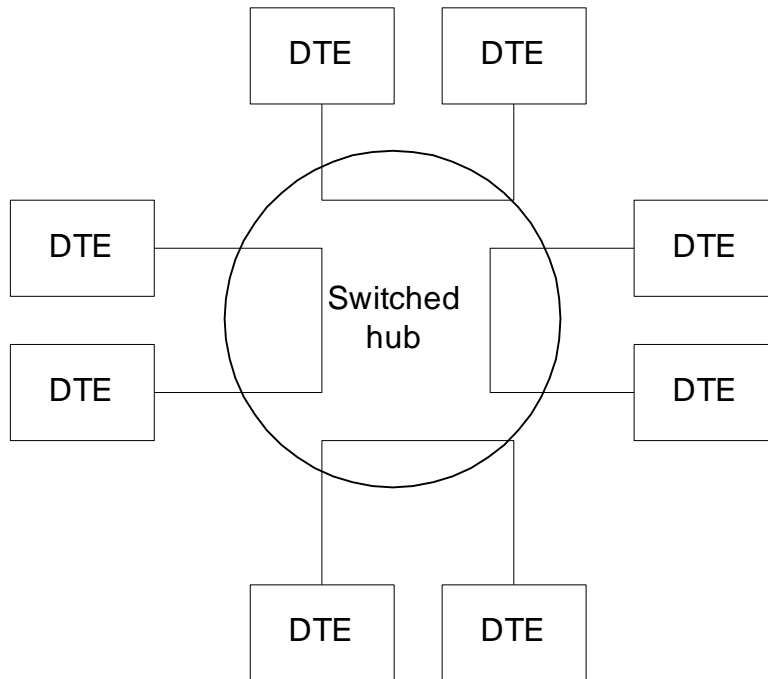


Figure 2.8 Switched Ethernet Hub

Notes

- Maximum throughput increased $\sim N/2$ in N-port hub
- Snooping capability lost for management

Client-Server Configuration using Switched Hub

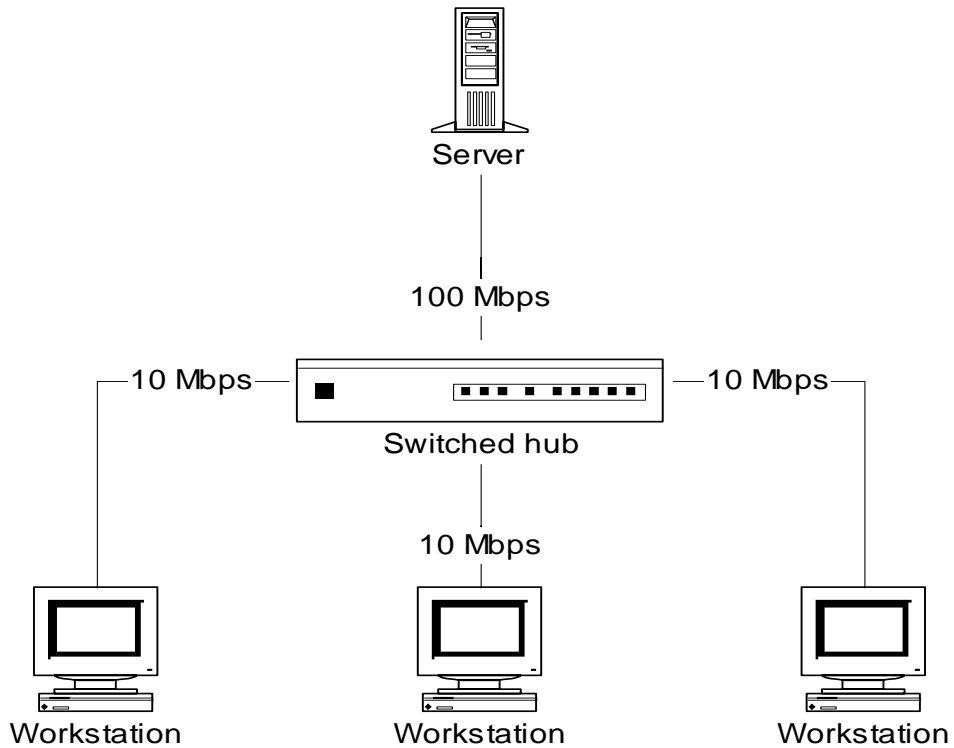


Figure 2.9 Switched Hub in Client-Server Configuration

Notes

Virtual LAN

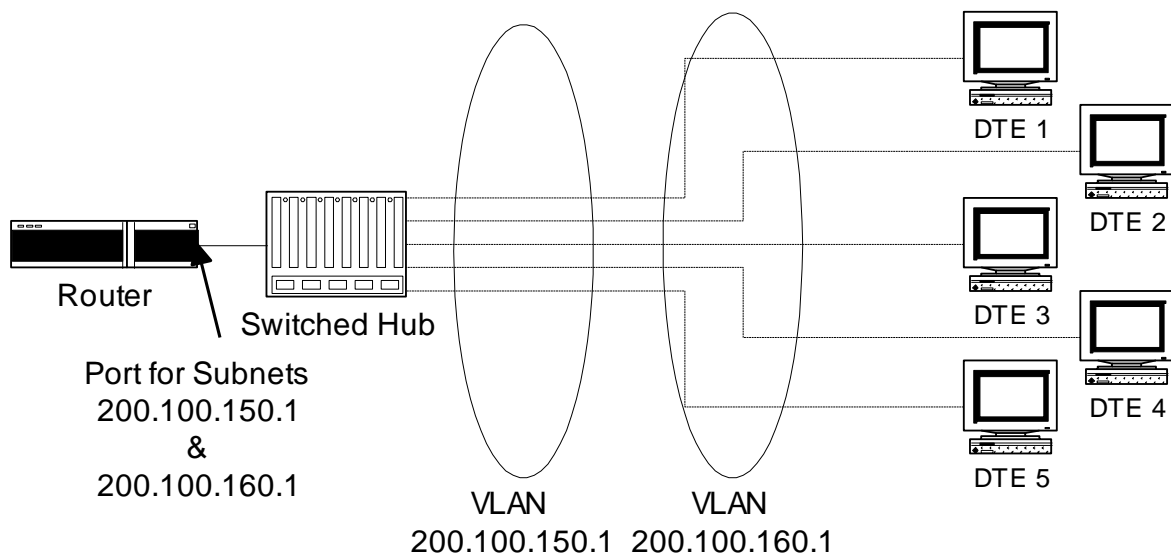


Figure 2.10 Virtual LANs

Notes

- Switched hub enables establishing virtual LANs
- Permits switching stations between LANs without physical moving of equipment
- Remote VLAN via switch offered by service providers

Token Ring

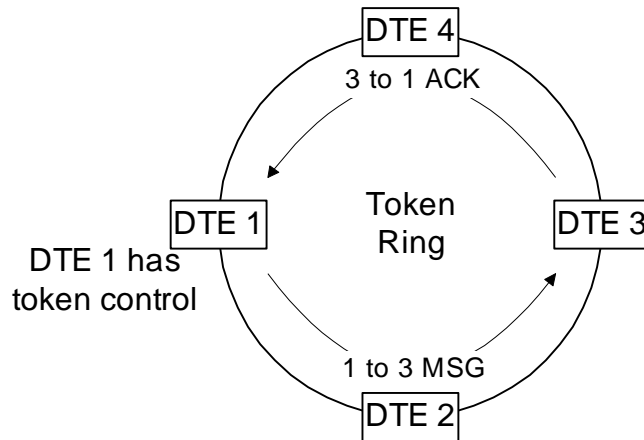


Figure 2.11 Token Ring LAN

Notes

- Adopted by IBM
- IEEE 802.5 standard
- Data rates of 4 Mbps and 16 Mbps
- Single- and dual-ring LANs

Dual Ring Token Ring LAN

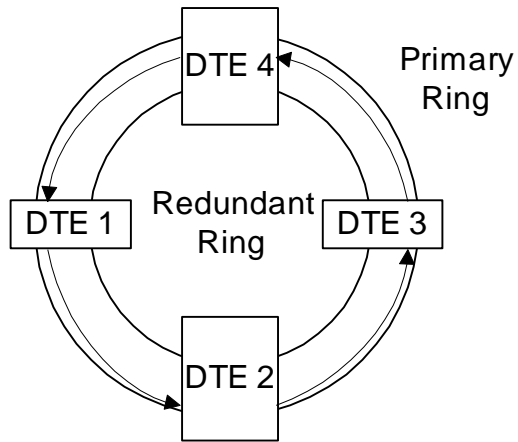


Figure 2.12(a) Token Ring Dual Ring Management

Notes

Failure Recovery in TR LAN

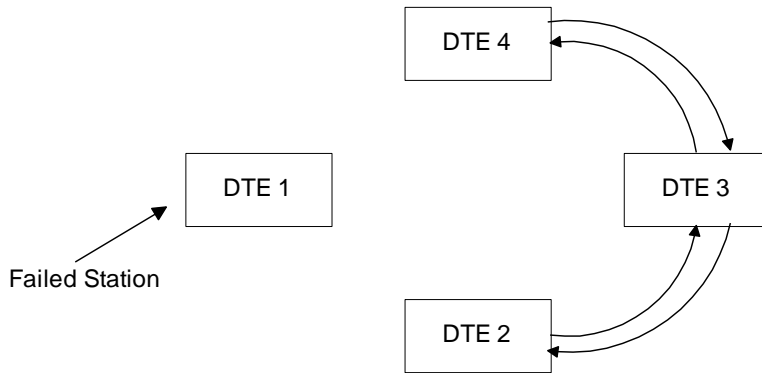


Figure 2.12(b) Token Ring DTE Isolation

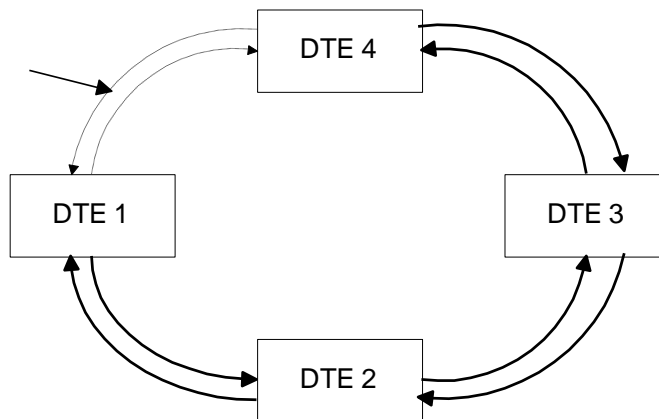
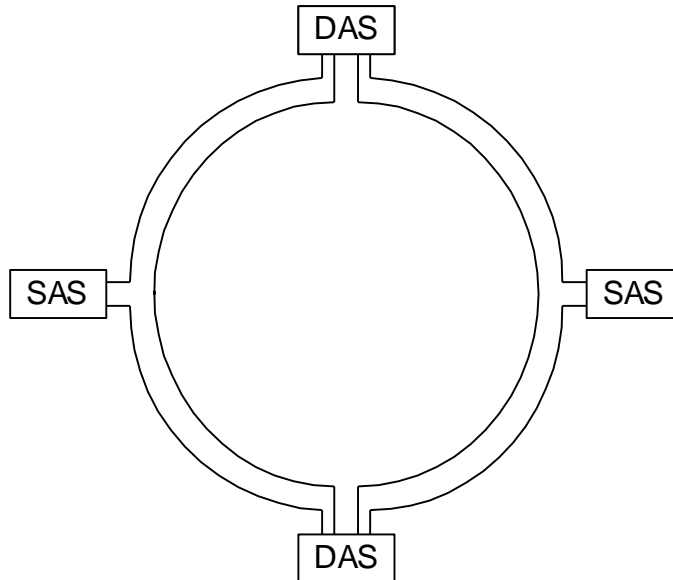


Figure 2.12(c) Token Ring Segment Isolation

Notes

- Station failure recovery
- Link failure recovery

FDDI



SAS Single Attached Station
DAS Dual Attached Station

Figure 2.13(a) Dual Ring FDDI Network Configuration

Notes

- Uses fiber optics medium
- Modified token-ring protocol
- Data rate 100 Mbps
- Segment length 100 km
- 500 stations in the ring with max separation of 2 km
- Single- and dual-attached stations
- Dual-attached stations load share the two rings

Basic Network Nodes

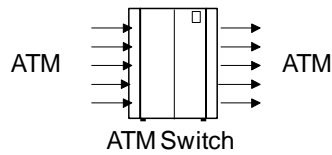


Figure 2.14(a) Switch

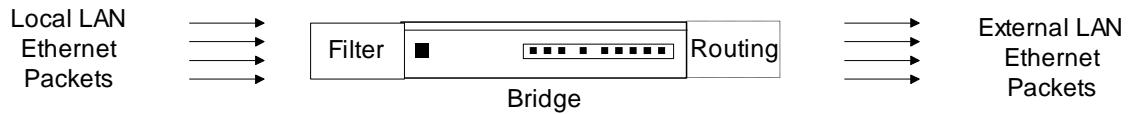


Figure 2.14(b) Bridge

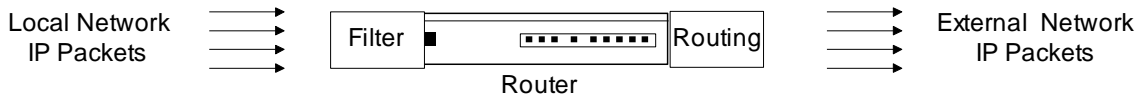


Figure 2.14(c) Router

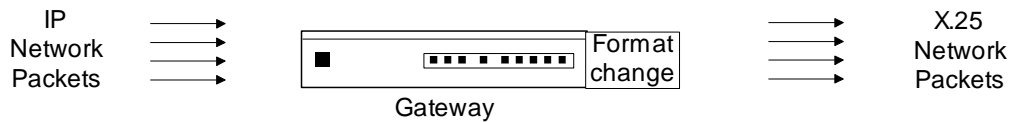


Figure 2.14(d) Router

Figure 2.14 Basic Network Node Components

Notes

Network Node Components

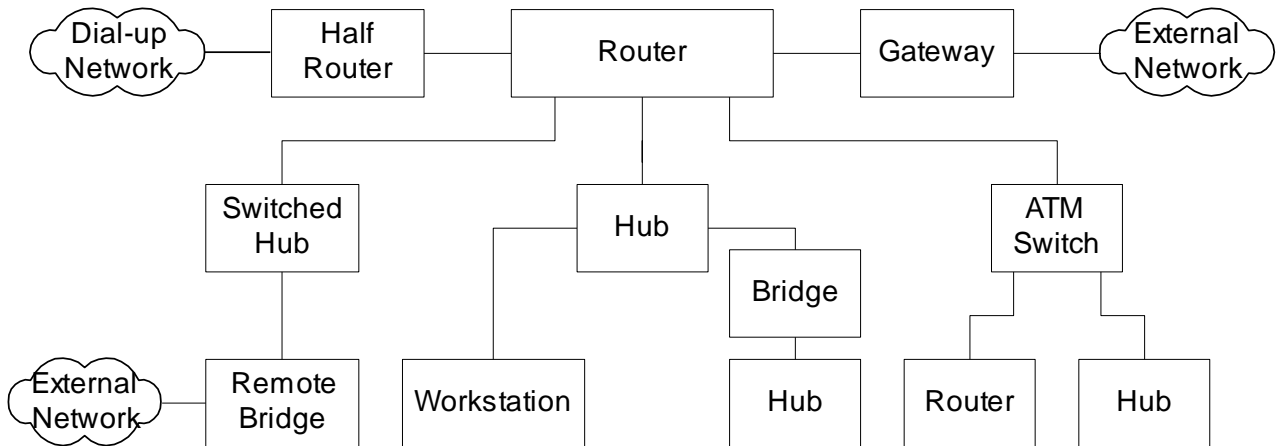


Figure 2.15 Networked Components

Notes

- Hubs
- Bridges
- Remote bridges
- Routers
- Gateways
- Half bridge / half router
- Switches
- Transport devices (ADM, SDH)
- Broadband access components
- Residential distribution devices

Hubs

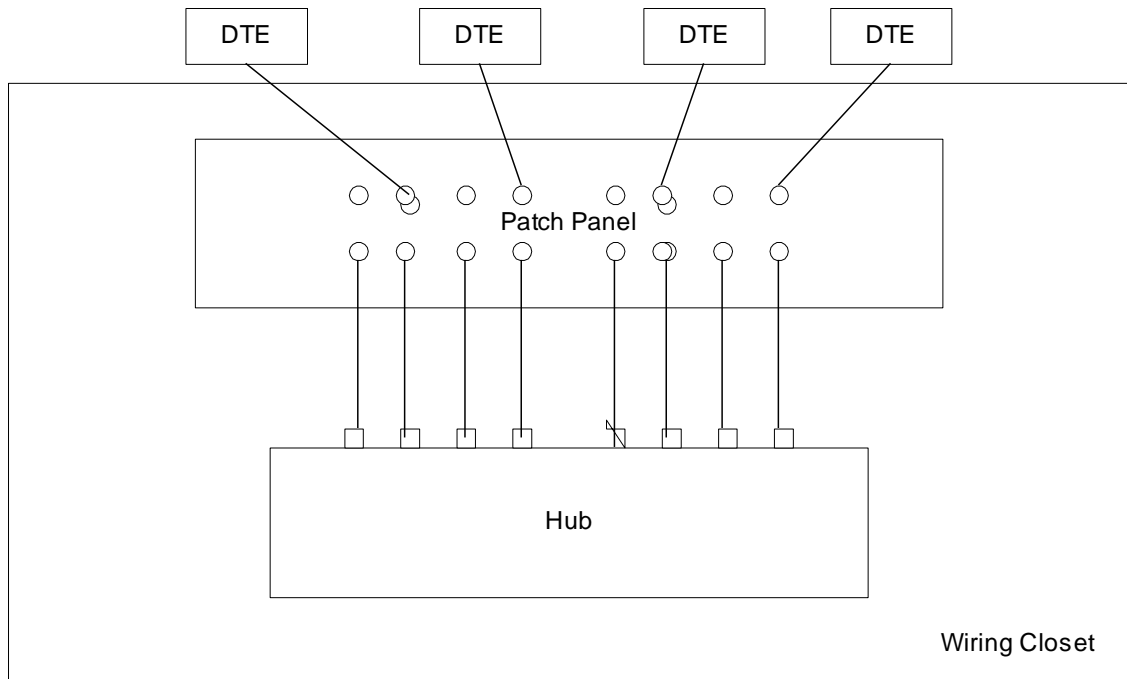


Figure 2.16(a) Hub Configuration

Notes

- Hub is a platform
- Function dependent on what is housed
 - LAN
 - Switched LAN
 - Bridge

Stacked Hubs

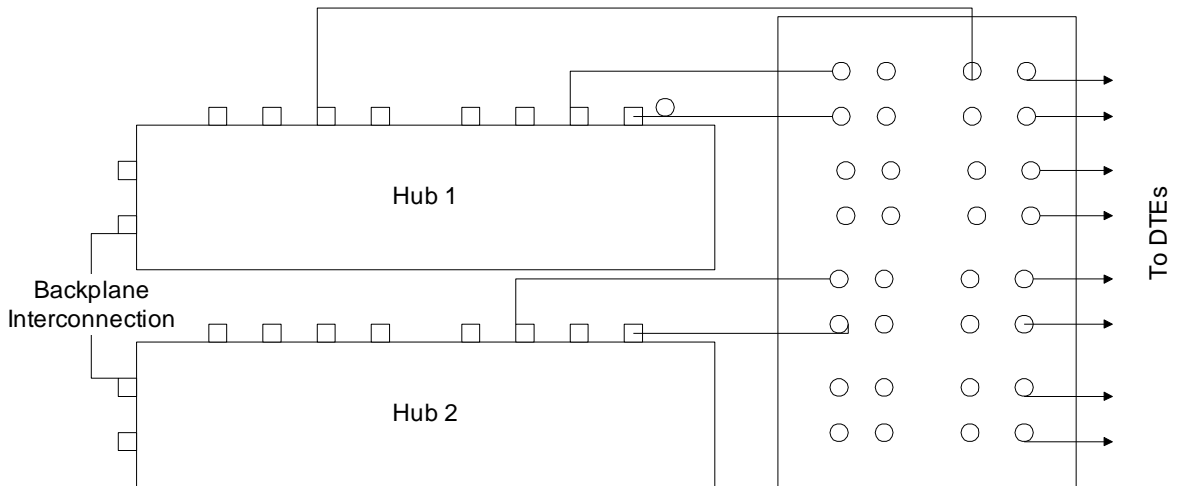
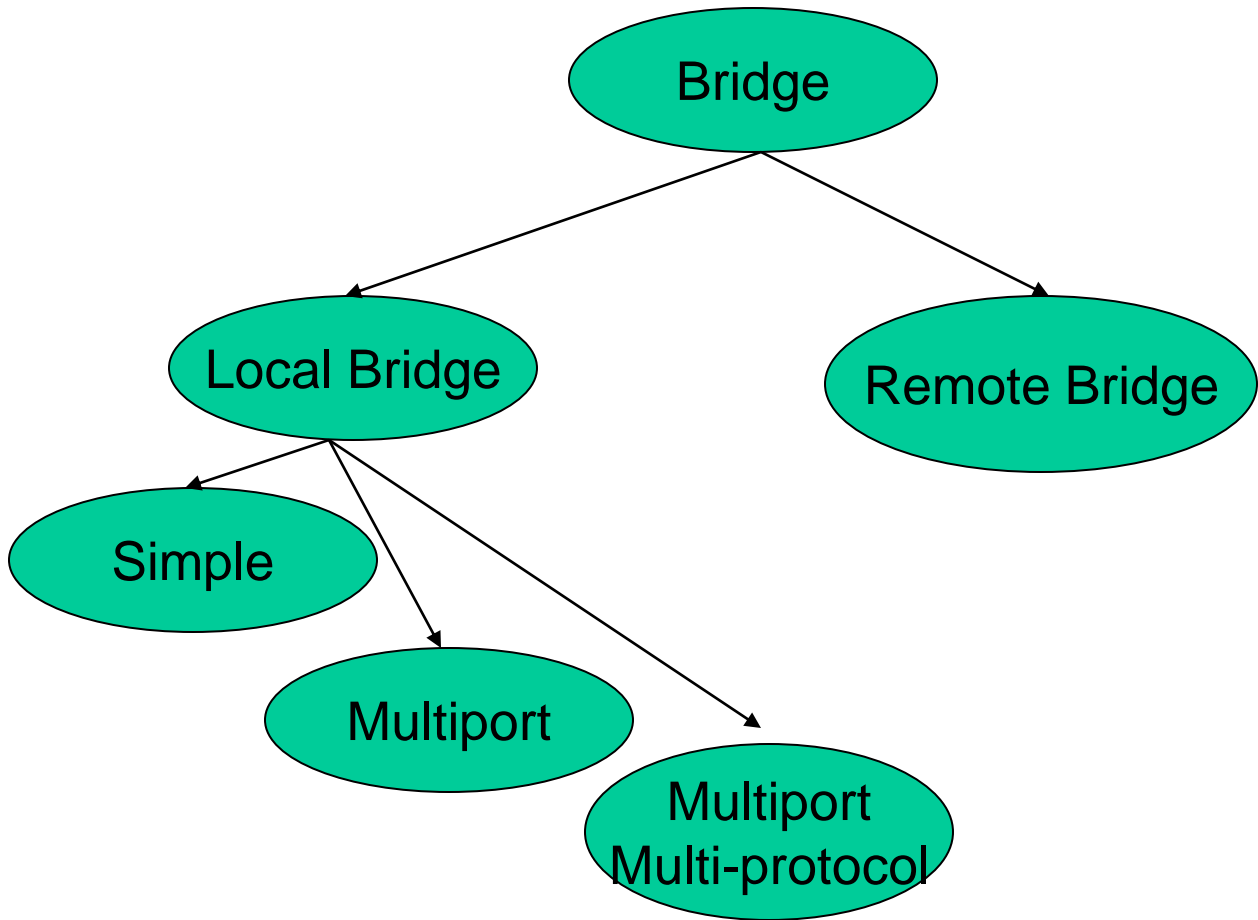


Figure 2.16(b) Stacked Hub

Notes

- Hub ports can be scaled up using stacked hubs
- Stacked hub
 - Extend back plane
 - Connected as daisy chain

Bridges



Notes

- Bridges two nodes at data link control layer
 - Ethernet: tree topology, transparent bridge
 - Token ring: mesh topology, source routing bridge
- Remote bridge uses WAN interface cards; same protocol used at both ends
- Ethernet bridge is a learning bridge

Routers

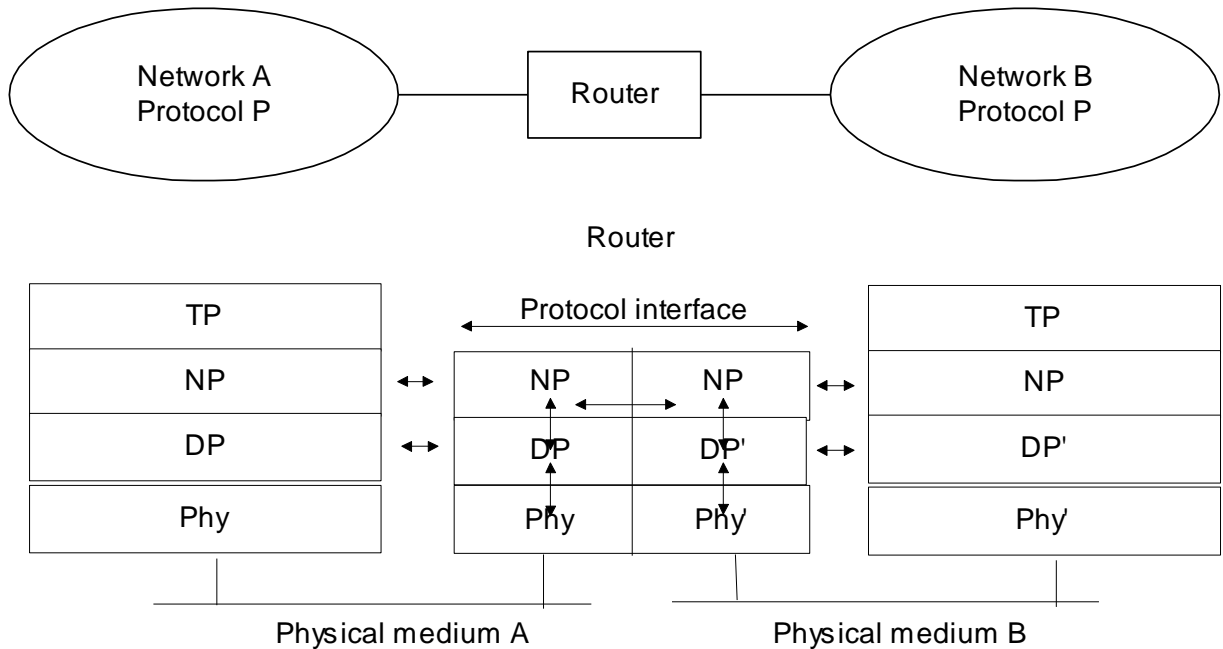


Figure 2.21 Router Configuration

Notes

- Routers operate at network layer
- Routes packets between nodes of similar network protocols
- Routing table used to route packets
- DLC and Physical layers could be different under the same common network layer protocol

Gateway

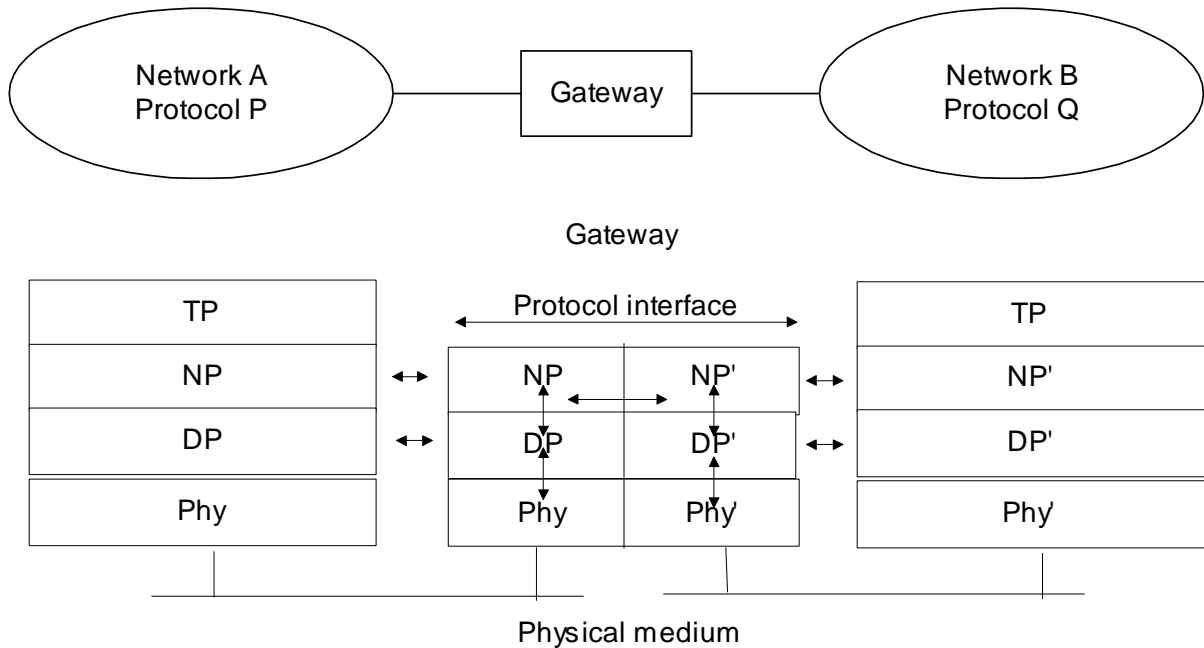


Figure 2.22 Gateway Configuration

Notes

- Gateway is router connecting two networks with dissimilar network protocols.
- Gateway does the protocol conversion at the network layer.
- Protocol converter does the conversion at the application layer.

Tunneling

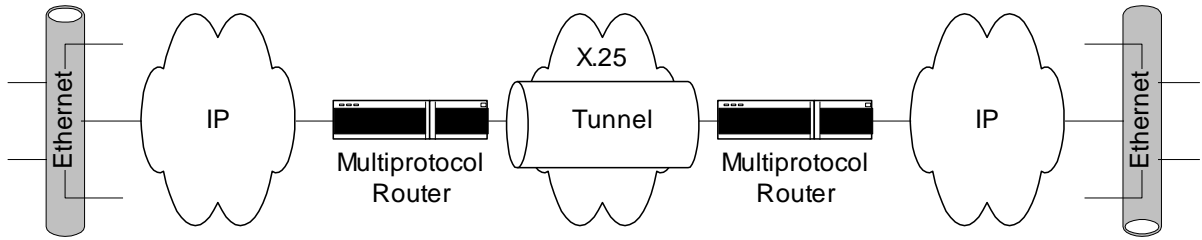
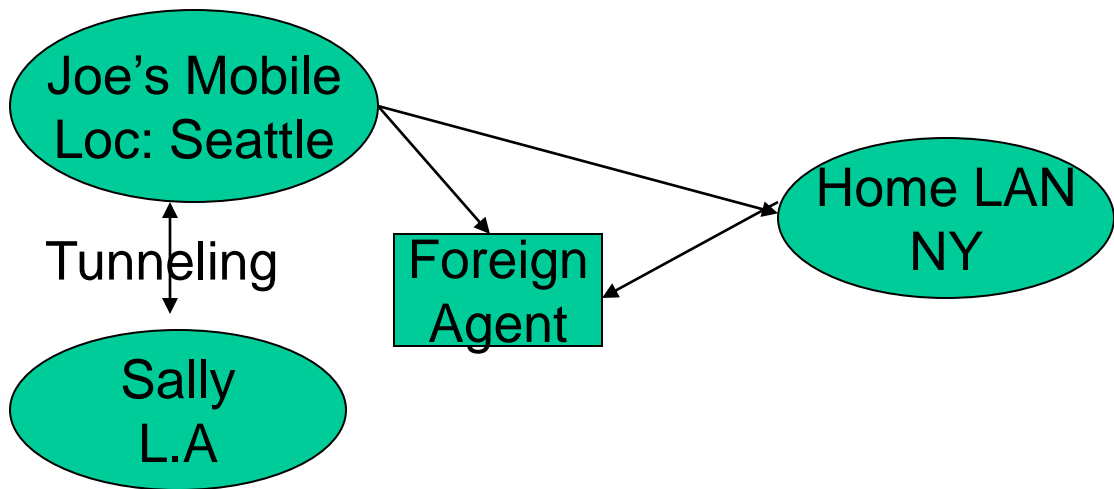


Figure 2.24 Tunneling Using Multiprotocol Routers



Notes

- Tunneling is transmission of packets (via multiprotocol routers) by encapsulation.
- In Figure 2.24, packets are encapsulated and transmitted through X.25 network in a serial mode.
- In the mobile environment, Joe and his home agent in NY communicate Joe's Seattle location to the foreign agent. His communication with Sally in LA is tunneled.

Half-Bridge

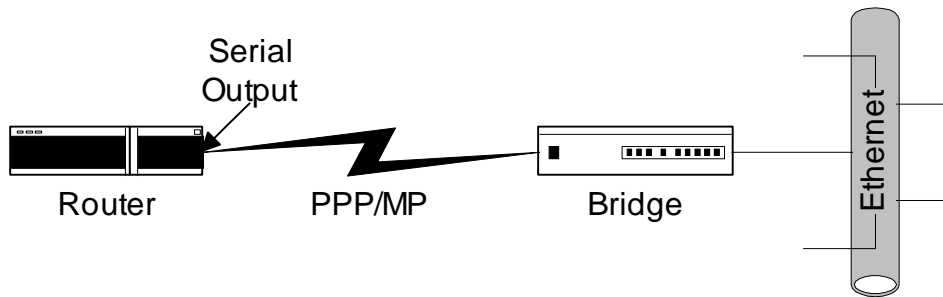


Figure 2.25 Half-Bridge Configuration

Notes

- Half-bridge (also referred to as half-router) is point-to-point communication
- Uses PPP protocol
- Helps low-end users to communicate with ISP on dial-up link saving the expense of dedicated link
- Router encapsulates packets in PPP frames and puts serial outputs to the bridge, and vice-versa

Switched Networks

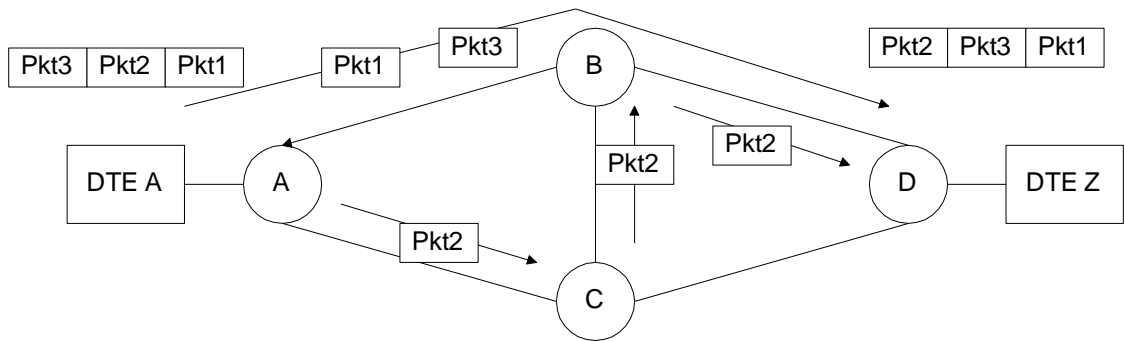


Figure 2.26(a) Datagram Configuration

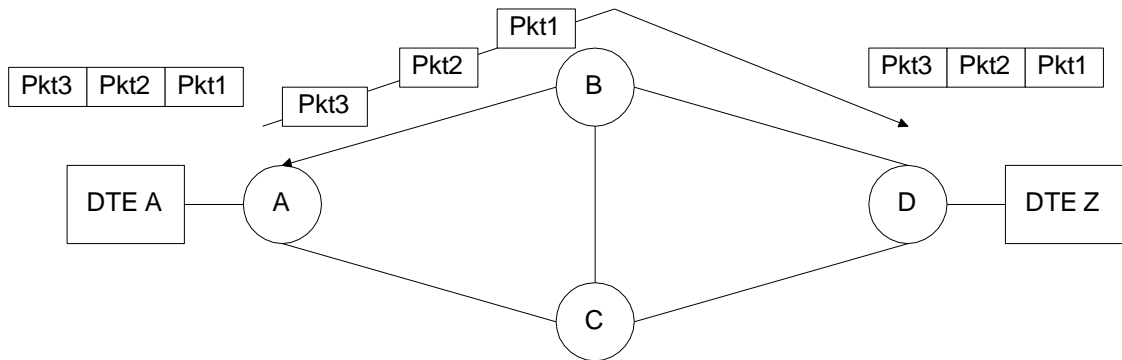
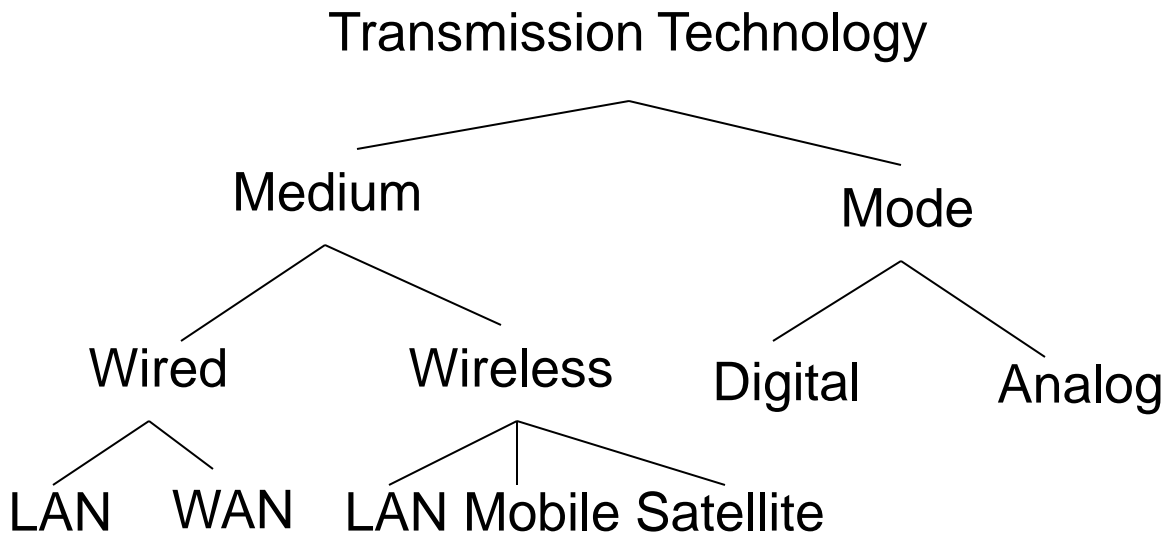


Figure 2.26(b) Virtual Circuit Configuration

Notes

- Switches are embedded in bridges and routers
- Switched network used in WAN
- Two types of switched networks
 - Circuit-switched
 - Packet-switched
 - Datagram service
 - Virtual circuit

Transmission Technology



Notes

- Physical transport media
 - UTP
 - Coax
 - Fiber
- Terrestrial wireless
- Satellite transmission

Transmission Modes

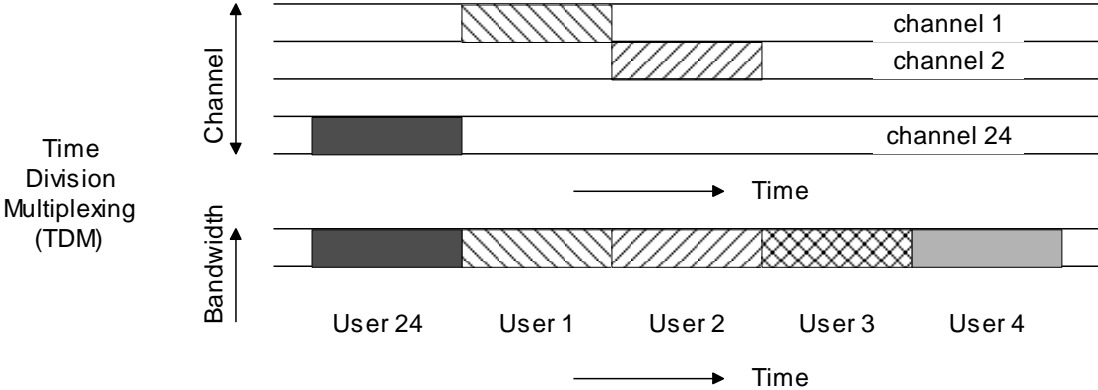


Figure 2.27(a) T1 Time Division Multiplexing (TDM) Transmissic

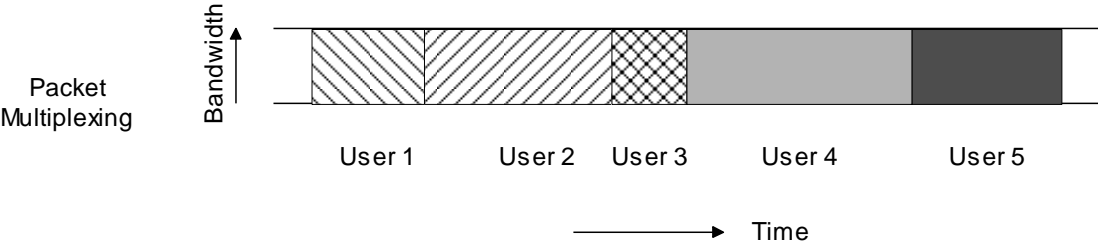


Figure 2.27(b) Packet Transmission (X.25)

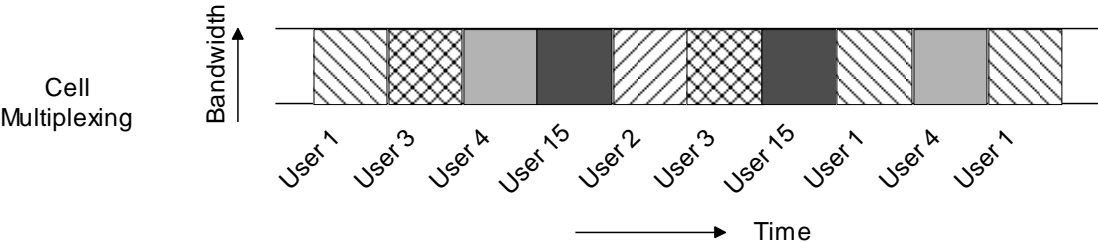
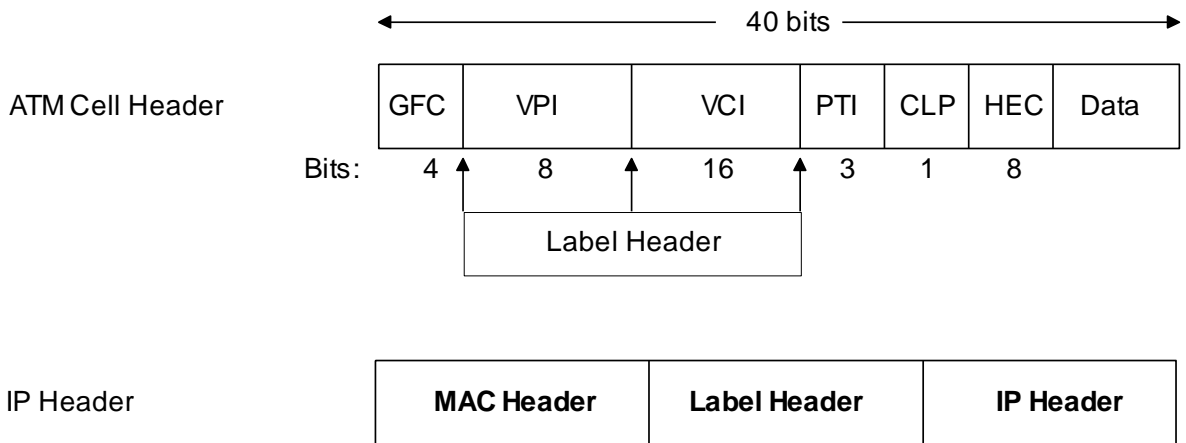


Figure 2.27(c) Cell Transmission (ATM)

Notes

MPLS Transmission Mode



GFC = 4-bit Generic Flow Header
VCI = Virtual Circuit Identifier
CLP = Congestion Priority

VPI = Virtual Path Identifier
PTI = 3-bit Payload Type
HEC = Header Error Control

Figure 2.29 MPLS Transmission Mode

Notes

- Multiprotocol Label Switching
- Combines
 - Richness of IP
 - Performance of ATM
- Label inserted between 2nd and 3rd layers
- Compatible with IP and ATM

SONET Transmission

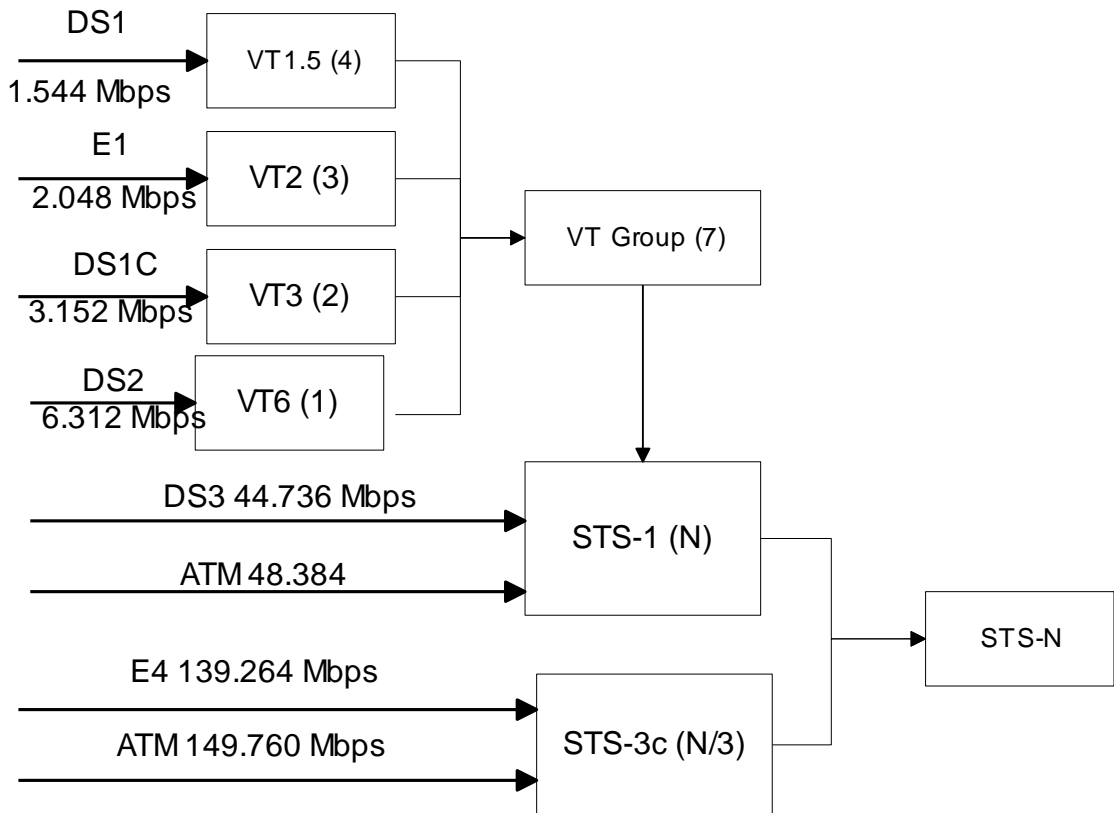


Figure 2.30 SONET Transmission

Notes

- Synchronous Optical Network (SONET) based on Synchronous Digital Hierarchy (SDH)
- Incompatible T1 and E1 made into universally compatible digital network
- Uses fiber optics carrying large bandwidth
- Basic digital bandwidth STS-1 of 51.84 Mbps
- Hierarchy based on STM-N (Synchronous Transmission Mode): STM-1, STM-4, etc.

Synchronous Digital Hierarchy

SONET Signal	SDH Signal	Bit Rate (Mbps)
STS-1		51.84
STS-3	STM-1	155.52
STS-12	STM-4	622.08
STS-24		1244.16
STS-48	STM-16	2488.32
STS-192	STM-64	9953.28
STS-768	STM-256	39,814.32

Notes

DWDM

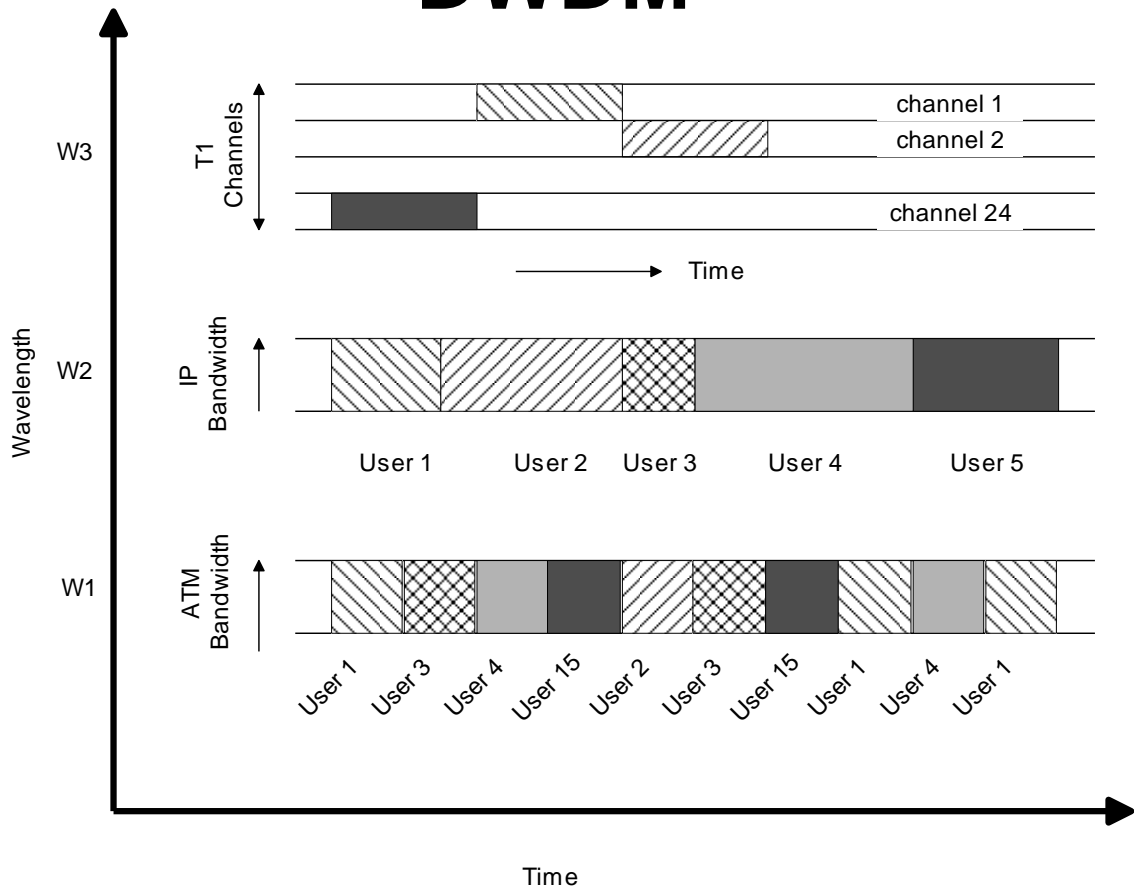


Figure 2.31 Multi-Wavelength Fiber: WDM

Notes

- (Dense) Wavelength Division Multiplexing
- Similar to FDM at lower frequencies
- Multiple wavelength carrier can be configured for multiple protocol transmission.

Broadband Services

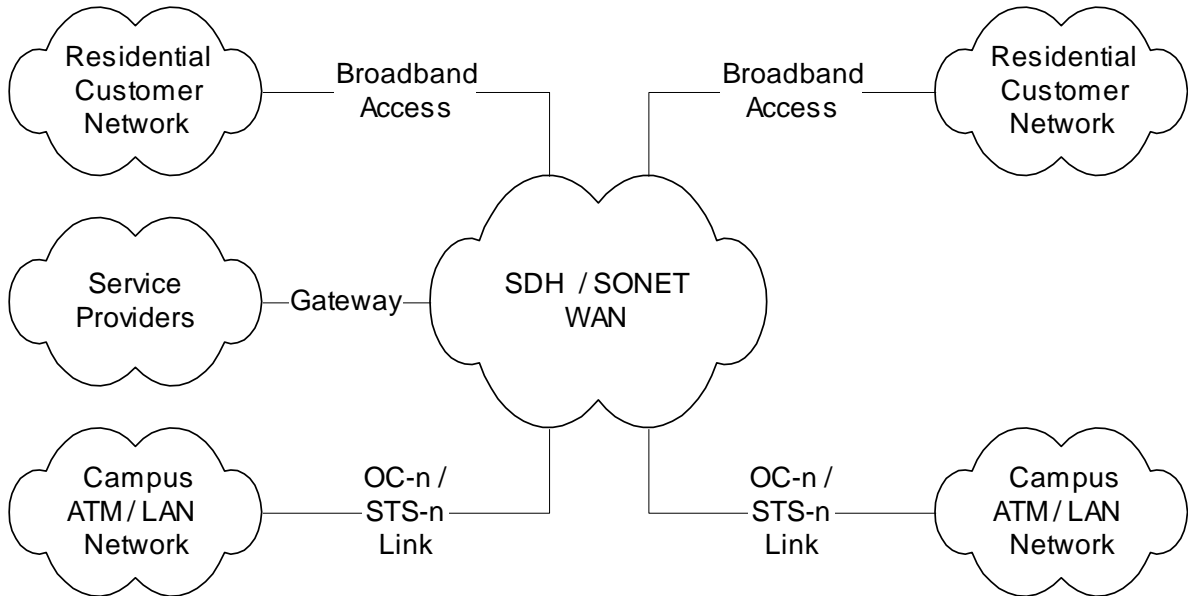


Figure 2.28 Broadband Services Network

Notes

- Integrated services: Voice, video, and data
- Narrow band ISDN (Integrated Services Digital Net.)
 - Basic rate: 2B + D (B channel 64 kbps and D channel 16 kbps)
 - Primary rate: 23B + D channels
- Broadband (ISDN) Services uses ATM technology
 - SONET (Synchronous Optical Network) or SDH (Synchronous Digital Hierarchy)
 - Data rate OC-n
 - OC-1 51.84 Mbps
 - OC-3 155.52 Mbps
 - Access technologies:
 - Cable
 - ADSL (Asymmetric Digital Subscriber Line)
 - Fixed Wireless
 - Mobile cellular wireless