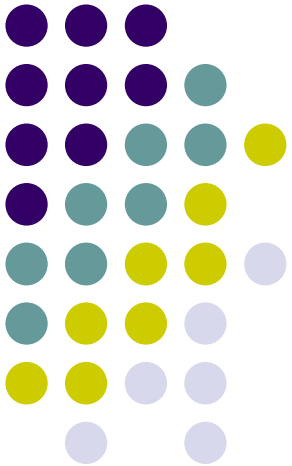
Network Management

Lecture-1

Networking Components

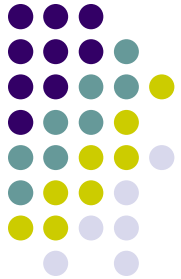
Dr. Md. Nadir Bin Ali



Outline

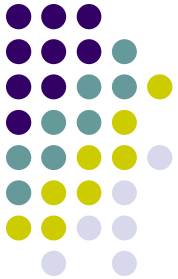
- Data Communications
- Networking
- OSI Reference Model
- TCP/IP Protocol Architecture
- Networking Components

Data Communications



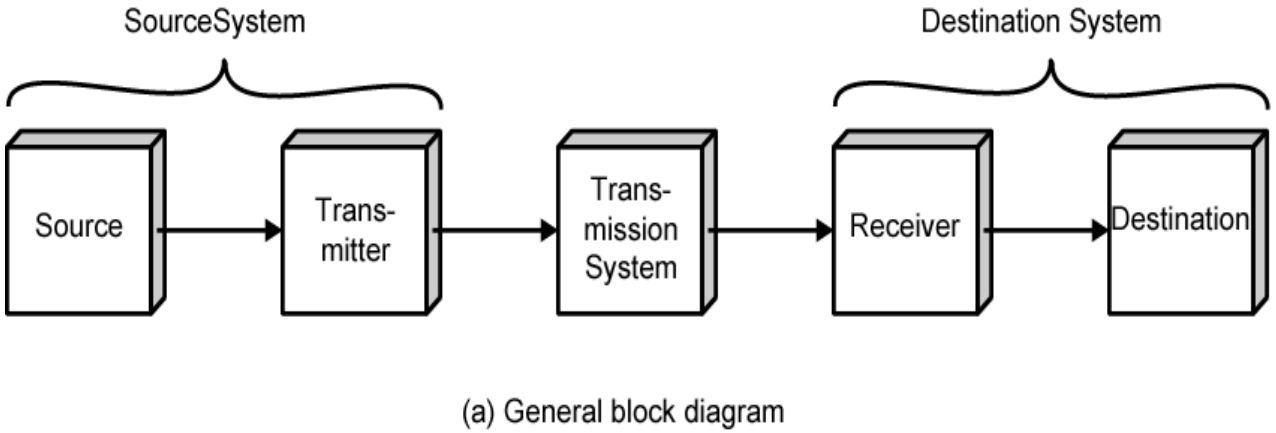
- **Data communications** deals with the transmission of signals in a reliable and efficient manner. Topics covered include *signal transmission*, *transmission media*, *signal encoding*, *interfacing*, *data link control*, and *multiplexing*.

A Communications Model



- Purpose of Communications
  - Exchange of data (information) between entities
- Key elements
  - Source
    - Generates data to be transmitted
  - Transmitter
    - Converts data into transmittable signals
  - Transmission System
    - Carries data
  - Receiver
    - Converts received signal into data
  - Destination
    - Takes incoming data

A Communications Model



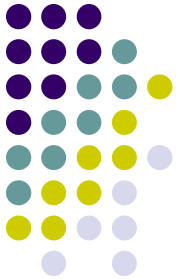
(a) General block diagram

(b) Example

Networking

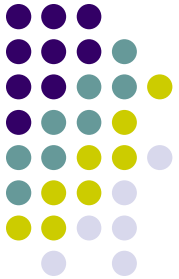
- Solution is a communications network
  - Local Area Network (LAN)
  - Metropolitan Area Network (MAN)
  - Wide Area Network (WAN)

Local Area Networks



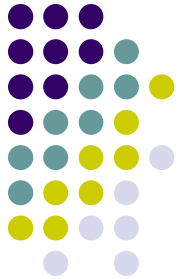
- Smaller scope
  - Office, Building, Campus
- Usually owned by same organization as attached devices
- Data rates are high
- Ethernet dominates the market
  - Ethernet vs. Token Ring
  - Ethernet vs. ATM
- Wireless LAN is now very popular

Metropolitan Area Networks



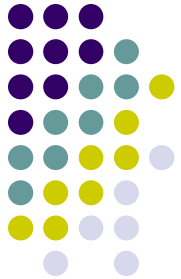
- Large area
- Middle ground between LAN and WAN
- Private or public network
- High speed

Wide Area Networks



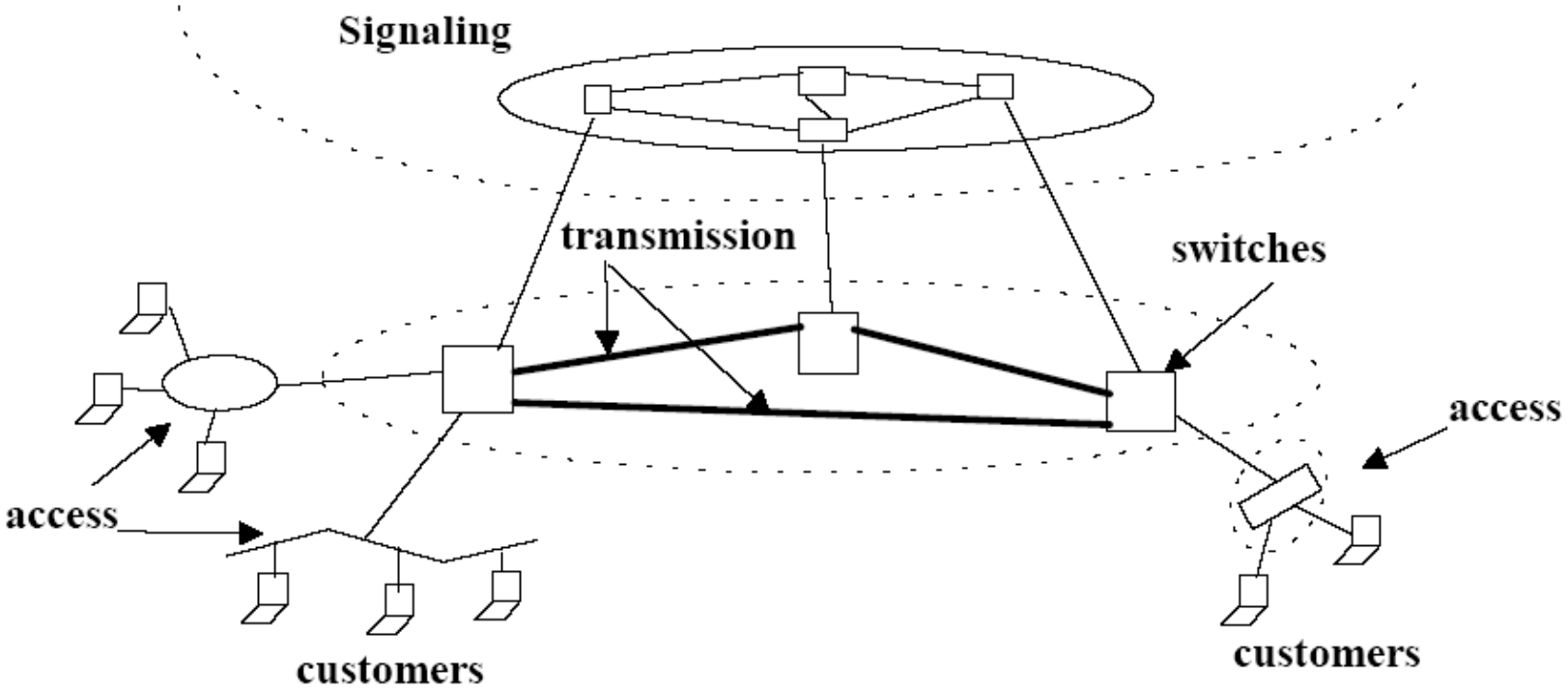
- Cover a large geographical area
  - Consists of a set of interconnected switching nodes
- Alternative technologies
  - Circuit switching
    - Telephone network
  - Packet switching
    - X.25
    - Frame relay
    - Asynchronous Transfer Mode (ATM)
    - Internet

Digital Network

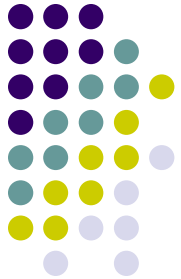


- Five Important Components
  - Transmission (electrical, optical, wireless)
  - Routing and Switching
    - Circuit switching (telephone network)
    - Packet switching
      - Virtual-circuit (X.25, Frame Relay, ATM)
      - Datagram (Internet)
  - Signaling
  - Access
    - xDSL, Cable Modem, WiFi/WiMax, LAN
  - Network Management

Digital Network



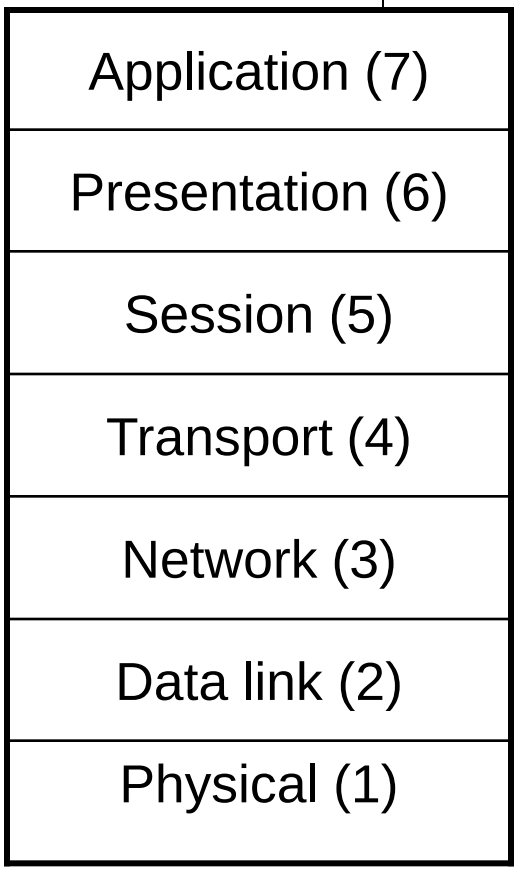
OSI Reference Model



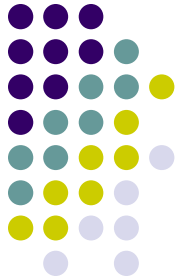
- OSI: Open System Interconnection
- A 7-layer model
- Each layer performs a subset of the required communication functions
- Each layer relies on the next lower layer to perform more primitive functions
- Each layer provides services to the next higher layer
- Changes in one layer should not require changes in other layers

OSI Reference Model

- Application: supporting network applications - FTP, SMTP, HTTP, etc.
- Presentation: handle different data representations (e.g., encryption)
- Session: connections between apps
- Transport: host-host - TCP, UDP
- Network: routing of datagrams from source to dest - IP, routing protocols
- Link: data transfer between adjacent network elements - PPP, Ethernet
- Physical: bits “on the wire”

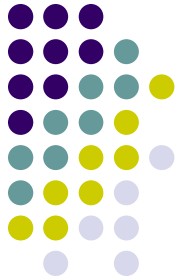


OSI Layers



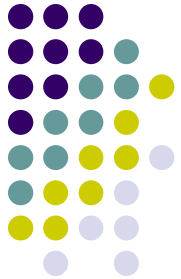
- Physical
  - Physical interface between devices
    - Mechanical
    - Electrical
    - Functional
    - Procedural
- Data Link
  - Means of activating, maintaining and deactivating a reliable link
  - Error detection and control
  - Higher layers may assume error free transmission

OSI Layers



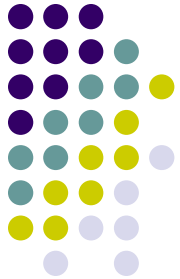
- Network
  - Transport of information
  - Higher layers do not need to know about underlying technology
  - Not needed on direct links
- Transport
  - Exchange of data between end systems
  - Error free
  - In sequence
  - No losses
  - No duplicates
  - Quality of service

OSI Layers



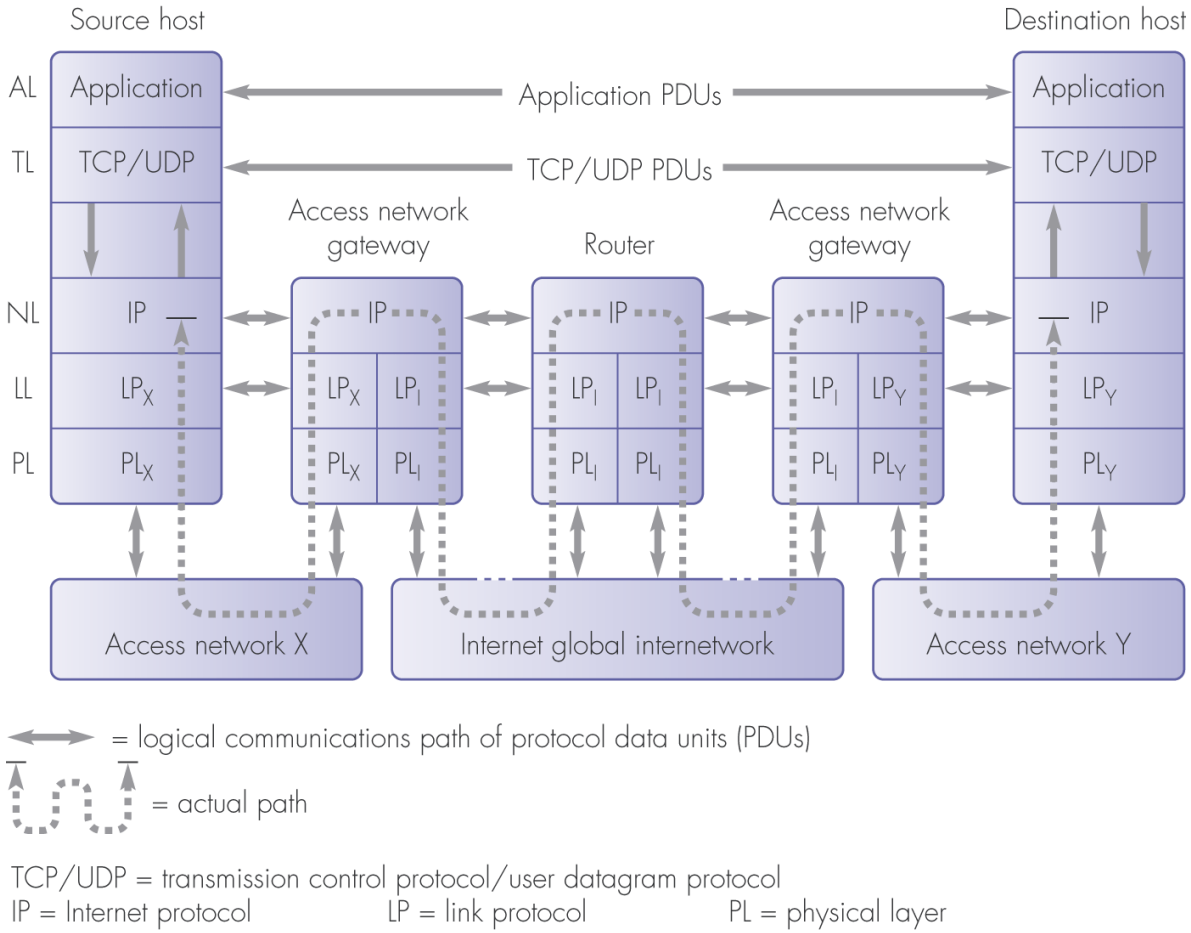
- Session
  - Control of dialogues between applications
  - Dialogue discipline
  - Grouping
  - Recovery
- Presentation
  - Data formats and coding
  - Data compression
  - Encryption
- Application
  - Means for applications to access OSI environment

TCP/IP Protocol Architecture

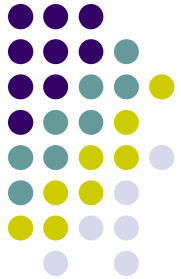


- Developed by the US Defense Advanced Research Project Agency (DARPA) for its packet switched network (ARPANET)
- Used by the global Internet
- No official model but a working one.
  - Application layer
  - Transport layer
  - Internet layer (or Network Layer)
  - Network access layer (or Link Layer)
  - Physical layer

TCP/IP Protocol Architecture

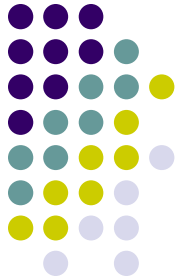


Physical Layer



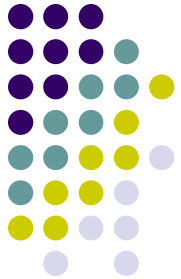
- Physical interface between data transmission device (e.g. computer) and transmission medium or network
- Characteristics of transmission medium
- Signal levels
- Data rates
- etc.

Network Access Layer



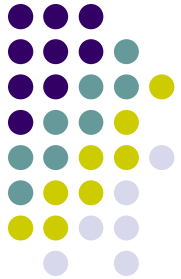
- Exchange of data between end system and network
- Destination address provision
- Invoking services like priority

Internet Layer



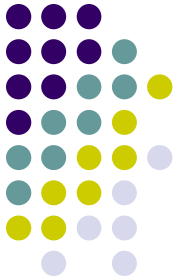
- Systems may be attached to different networks
- Routing functions across multiple networks
- Implemented in end systems and routers

Transport Layer



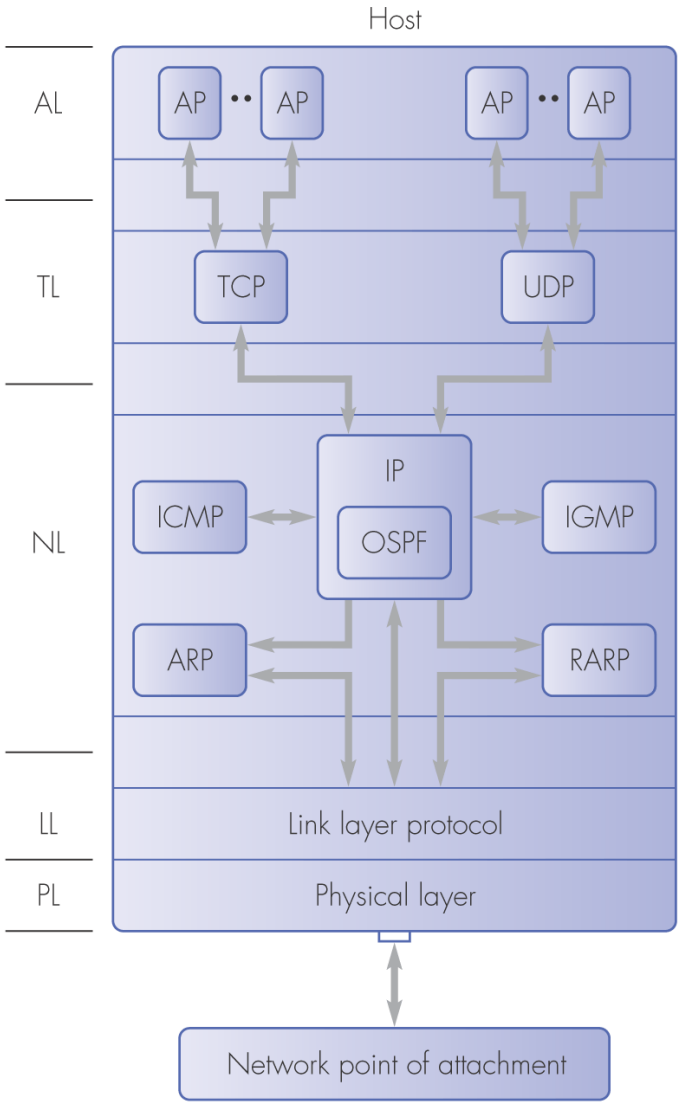
- Usually there is a requirement of reliable delivery of data:
  - Error-free (Packets could be lost in the network!)
  - Ordering of delivery
- TCP is mainly designed for this purpose.
- Another transport layer protocol in TCP/IP protocol architecture is UDP.

Application Layer



- Support for user applications
- e.g. FTP, TELNET, SMTP, HTTP, SNMP

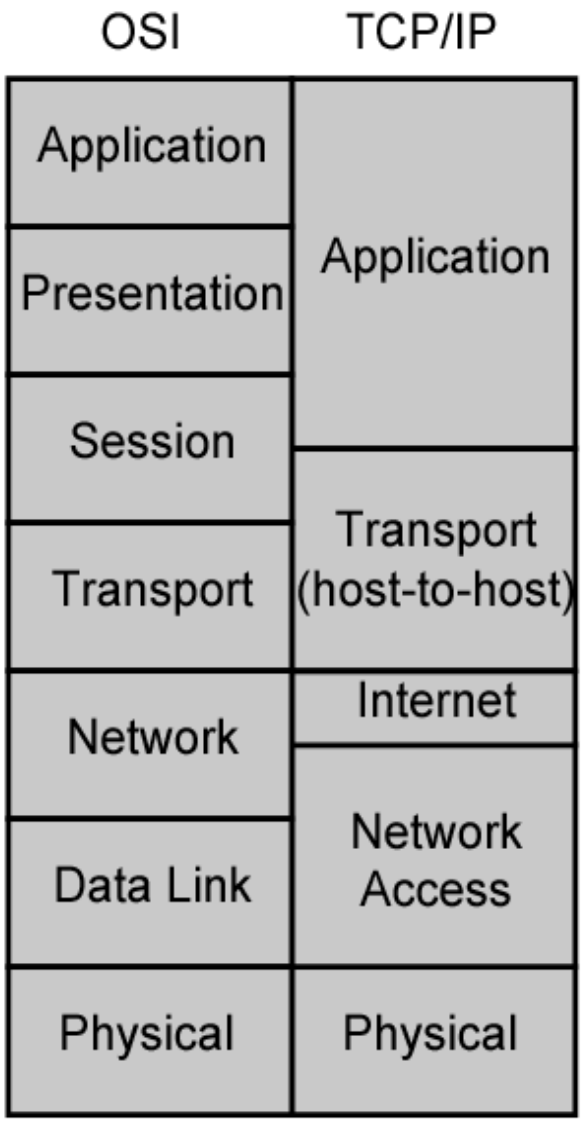
TCP/IP Protocols



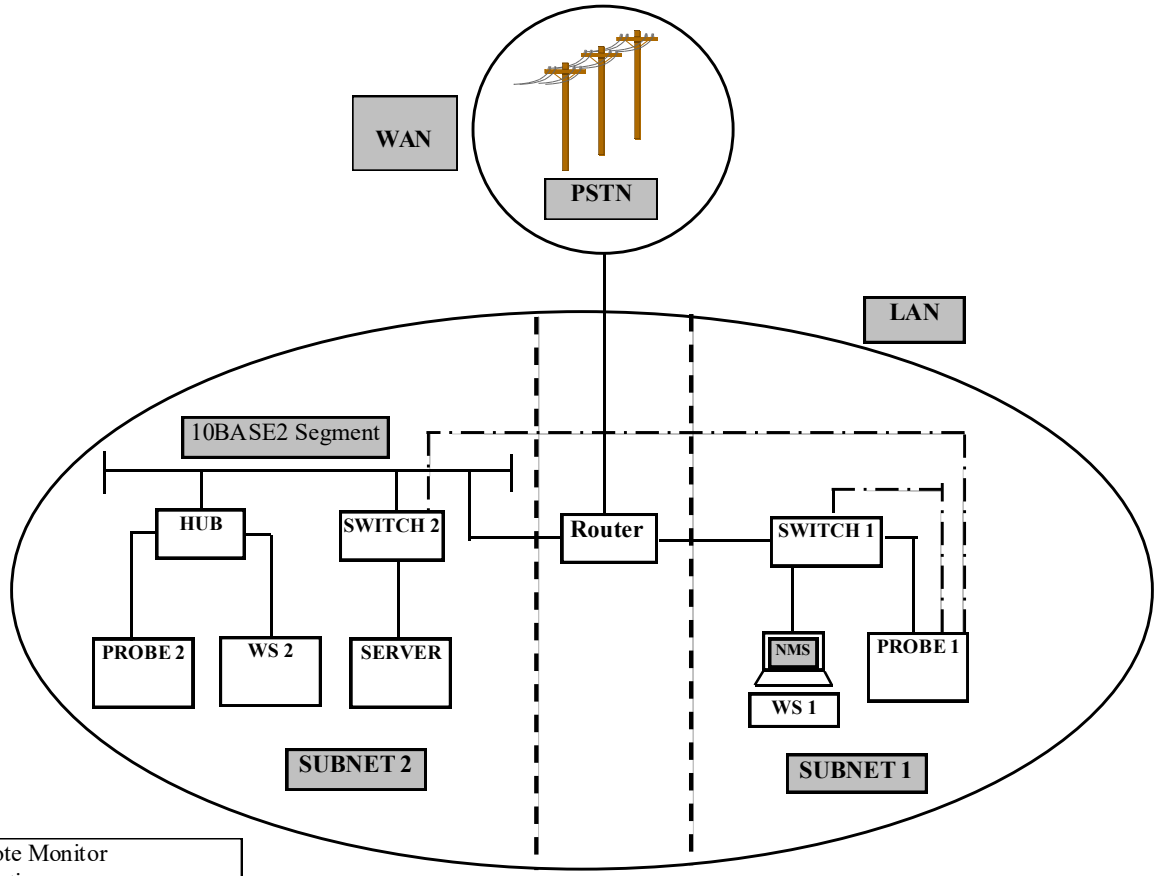
AP = application protocol/process
IP = Internet protocol
ARP = address resolution protocol
RARP = reverse ARP

ICMP = Internet control message protocol
IGMP = Internet group message protocol
OSPF = open shortest path first

OSI vs. TCP/IP

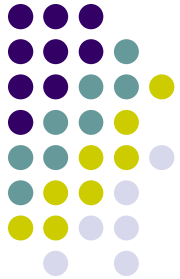

OSI
TCP/IP
Application
Presentation
Session
Transport
Network
Data Link
Physical
Application
Transport (host-to-host)
Internet
Network Access
Physical

Network Components



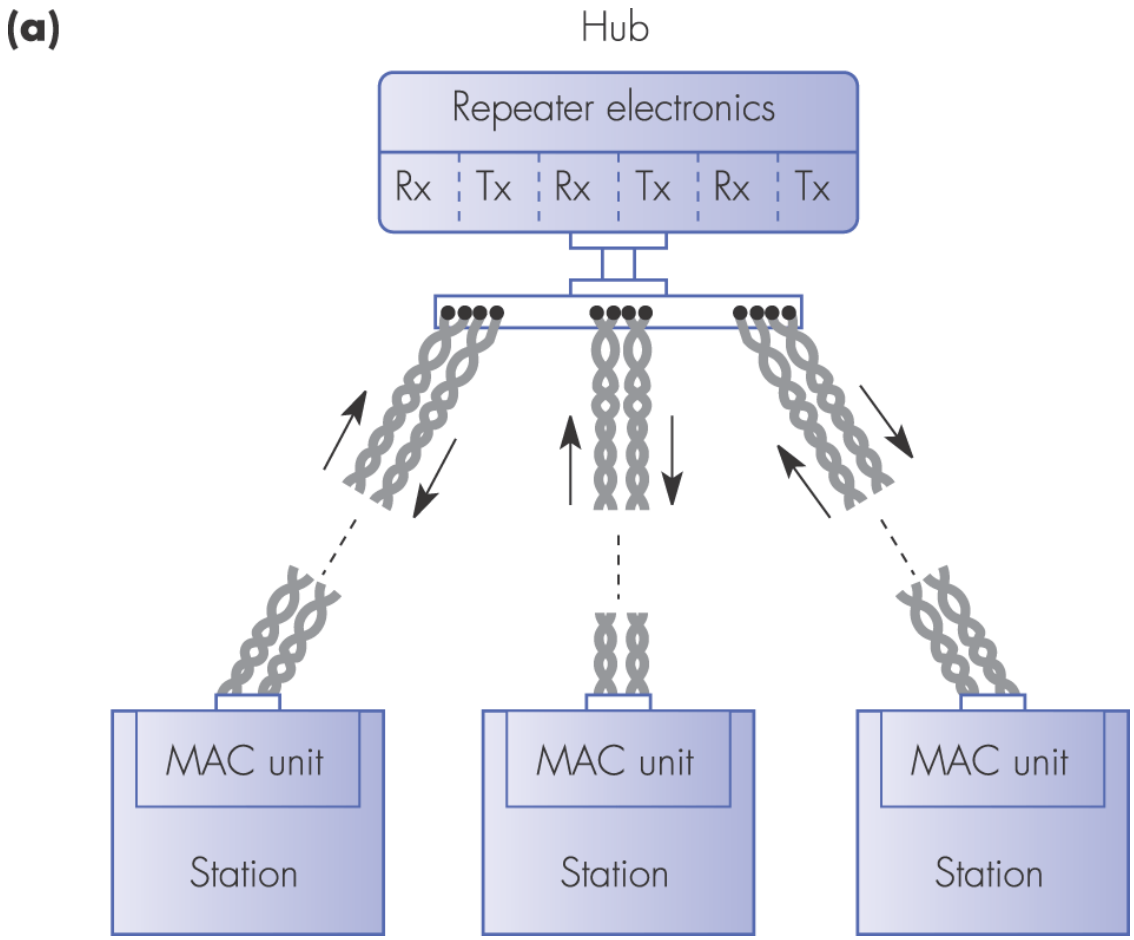
Probe = Remote Monitor
WS = Workstation
PSTN = Public Switched Telephone Network
NMS = Network Management System
= network links
= management links

Repeater Hub

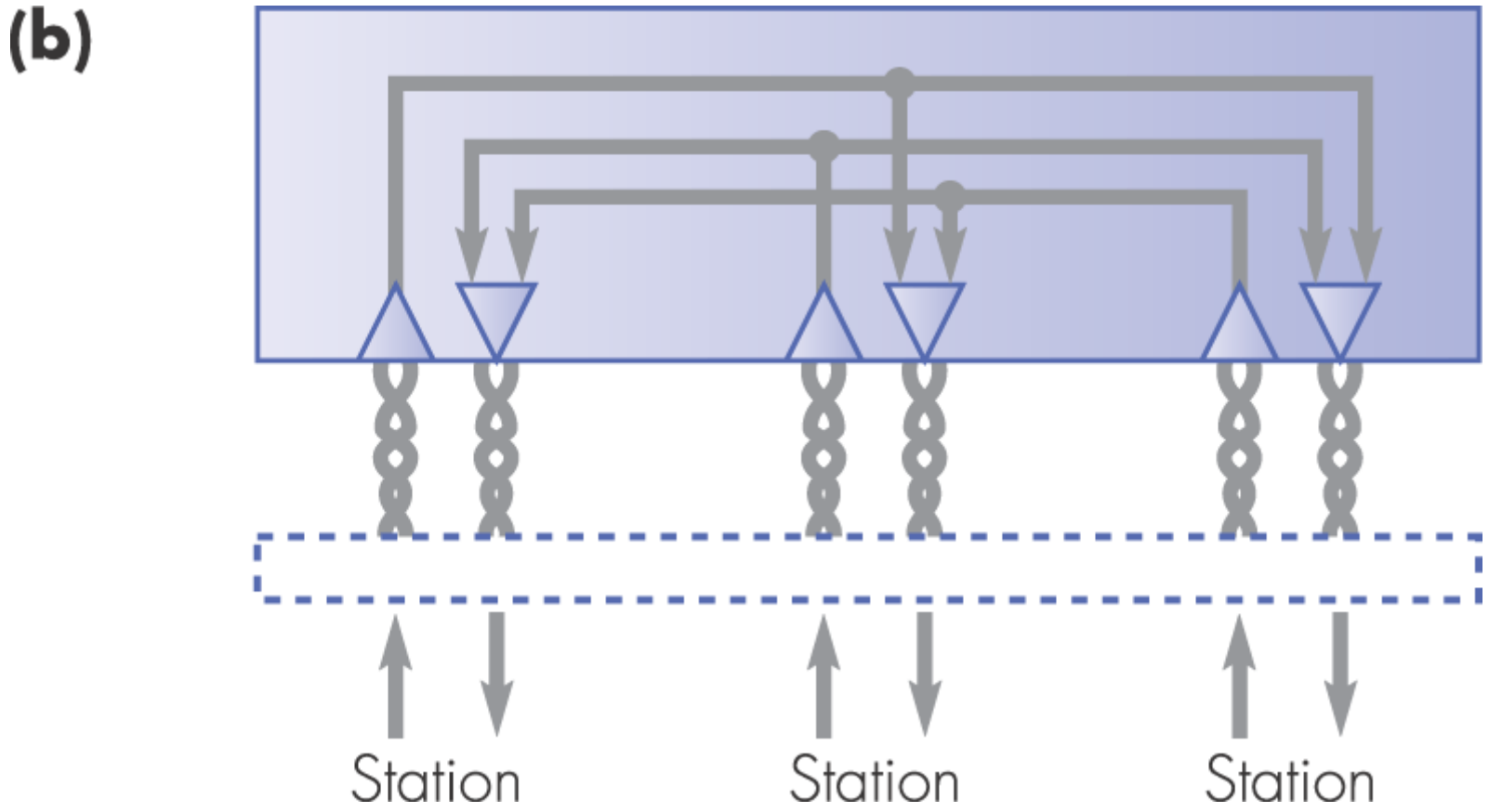


- Repeater is a physical layer device
  - Amplifies the signal
  - Can extend the length of the LAN
- Hub is a repeater with multiple I/O ports
  - A physical layer device
  - Demo network has a hub in subnet 2
  - Sometimes called “repeater hub”
- Repeaters and Hubs work at Physical layer.
- The bandwidth is shared by all attached devices.

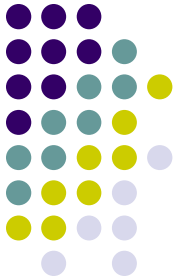
Repeater Hub: topology



Repeater Hub: schematic

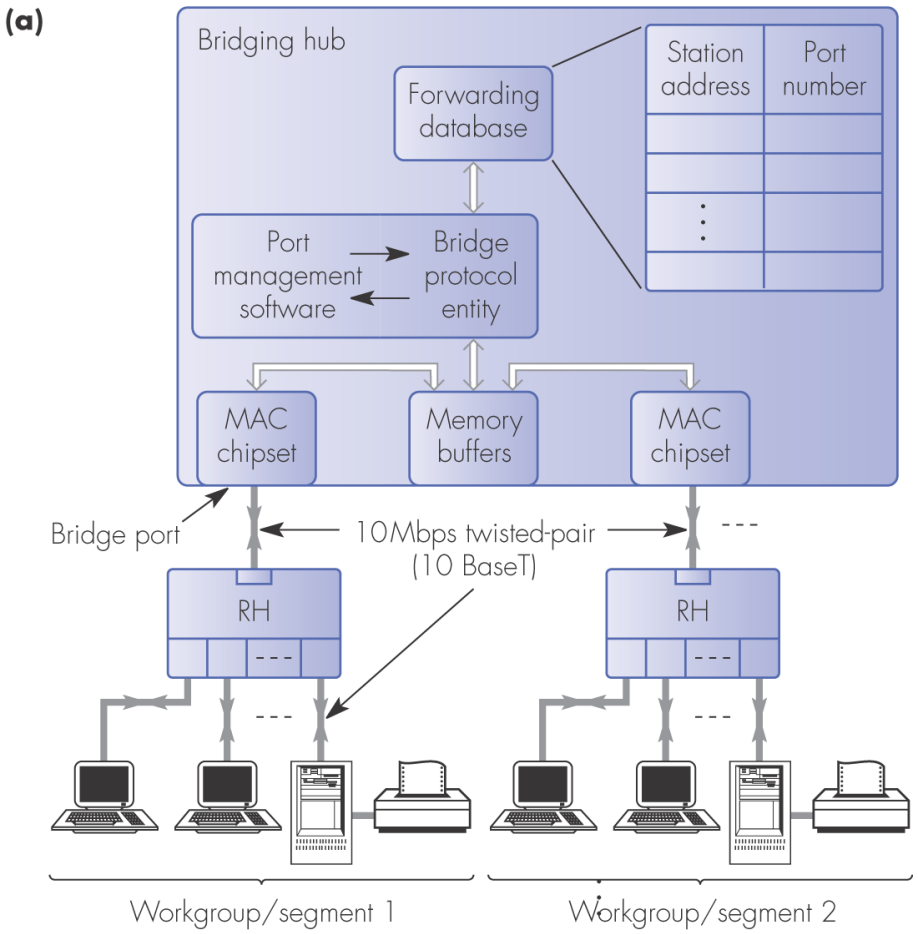


Bridge and Switch

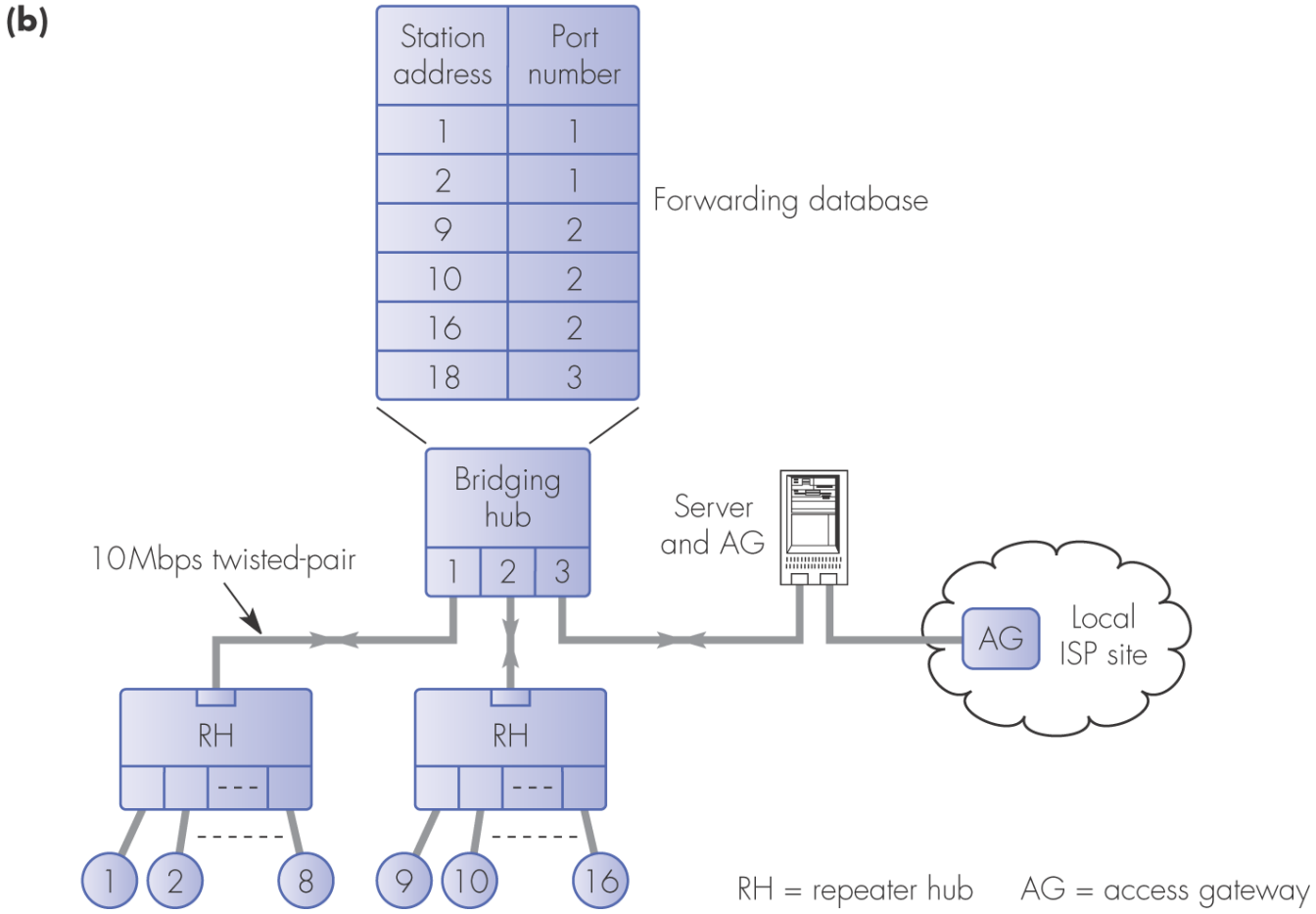


- Bridge is a Link layer device
  - Only forwards frame onto appropriate link(s)
  - “Transparent” since self-learning
  - Sometimes called “bridge hub”
- A switch is a multiport bridge
  - So a switch is a layer 2 device
  - In “switched Ethernet”, can have simultaneous comm. between hosts on LAN without collisions
  - Sometimes called “switch hub”

Bridge Hub

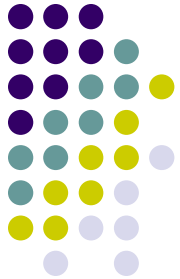

(a)
Bridging hub
Forwarding database
Station address
Port number
Port management software
Bridge protocol entity
MAC chipset
Memory buffers
MAC chipset
Bridge port
10Mbps twisted-pair (10 BaseT)
RH
RH
Workgroup/segment 1
Workgroup/segment 2

Multiport Bridge Hub



Cisco Catalyst 2950 Series Switches

Performance



- Some main performance metrics:
  - Backplane bandwidth: measured in bps (bits per second)
  - Forwarding capability: measured in pps (packets per second)
  - Number of MAC address

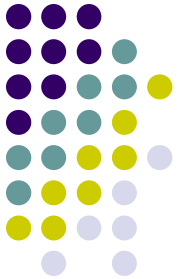
- 13.6 Gbps switching fabric
- Cisco Catalyst 2955T-12: 6.4 Gbps maximum forwarding bandwidth
- Cisco Catalyst 2955C-12: 2.8 Gbps maximum forwarding bandwidth

(Forwarding rates based on 64-byte packets)
- Cisco Catalyst 2955T-12: 4.8 Mpps wire speed forwarding rate
- Cisco Catalyst 2955C-12: 2.0 Mpps wire speed forwarding rate

- Configurable up to 8000 MAC addresses

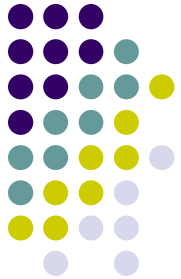
Cisco Catalyst 6500 Series Switches

Performance



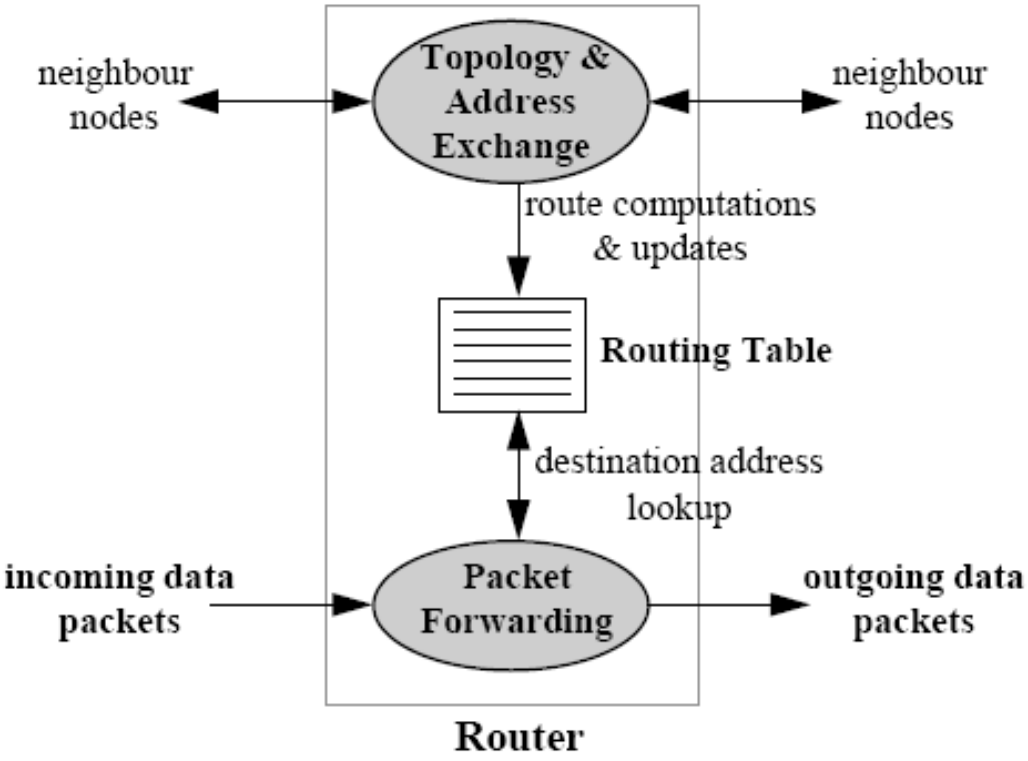
- **Backplane Bandwidth**
  - 32-Gbps shared bus
  - 256-Gbps switch fabric
  - 720-Gbps switch fabric
- **Layer 3 Forwarding Performance**
  - Cisco Catalyst 6500 Supervisor Engine 1A Multilayer Switch Feature Card (MSFC2): 15 Mpps
  - Catalyst 6500 Supervisor Engine 2 MSFC2: up to 210 Mpps
  - Catalyst 6500 Supervisor Engine 32 MSFC2a: 15 Mpps
  - Catalyst 6500 Supervisor Engine 720: up to 400 Mpps

IP Router



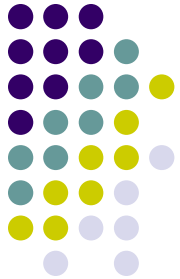
- Routers
  - Layer 3 devices
  - Like bridges/switches, routers isolate collision domains
  - Routers also isolate broadcast domains
  - *Routing tables* use IP address
  - For small network, static table is OK
  - For larger network, use RIP, OSPF, etc.

Router: Framework



Cisco 7600 Series Routers

Performance



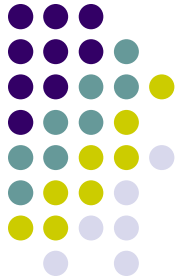
Model	7603	7606	7609	7613
Slots	3	6	9	13
Forwarding Performance	15 Mpps	30 Mpps	30 Mpps	30 Mpps
Backplane Capacity	240 Gbps	480 Gbps	720 Gbps	720 Gbps

Cisco 12000 Series Routers

Performance

Modle	Switching Capacity
12816	1.28 Tbps
12810	800 Gbps
12416	320 Gbps
12410	200 Gbps
12406	120 Gbps
12404	80 Gbps
12016	80 Gbps
12010	50 Gbps
12006	30 Gbps

Juniper's Router



Platform	Throughput	Max Forwarding Rate
T320	320 Gbps	385 Mpps
T640	640 Gbps	770 Mpps

References

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- William Stallings, *Data and Computer Communications*, 7th Edition, Prentice Hall, 2004.
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