Network Admin

Class 1 - Introduction

By Ian Robert Blair, M.Sc.

Agenda

- Introduction
- Class Rules, Grading, and Assignments
- TCP/IP
- OSI Model

Introduction

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- New York City
- Teaching at Universities in China for 7 years
- Former Senior IT Administrator in Merrill Lynch's Global Technology Department
- Prior to that I worked as a IT consultant

Class Rules

- Please try to come to class on time
- Put your cellphones on vibrate or silent
- Take your calls in the hall
- Please don’t talk during lectures
- Please do all homework, reading, and assignments
- You must come to all classes! Attendance will be taken every day.

Semester Plan

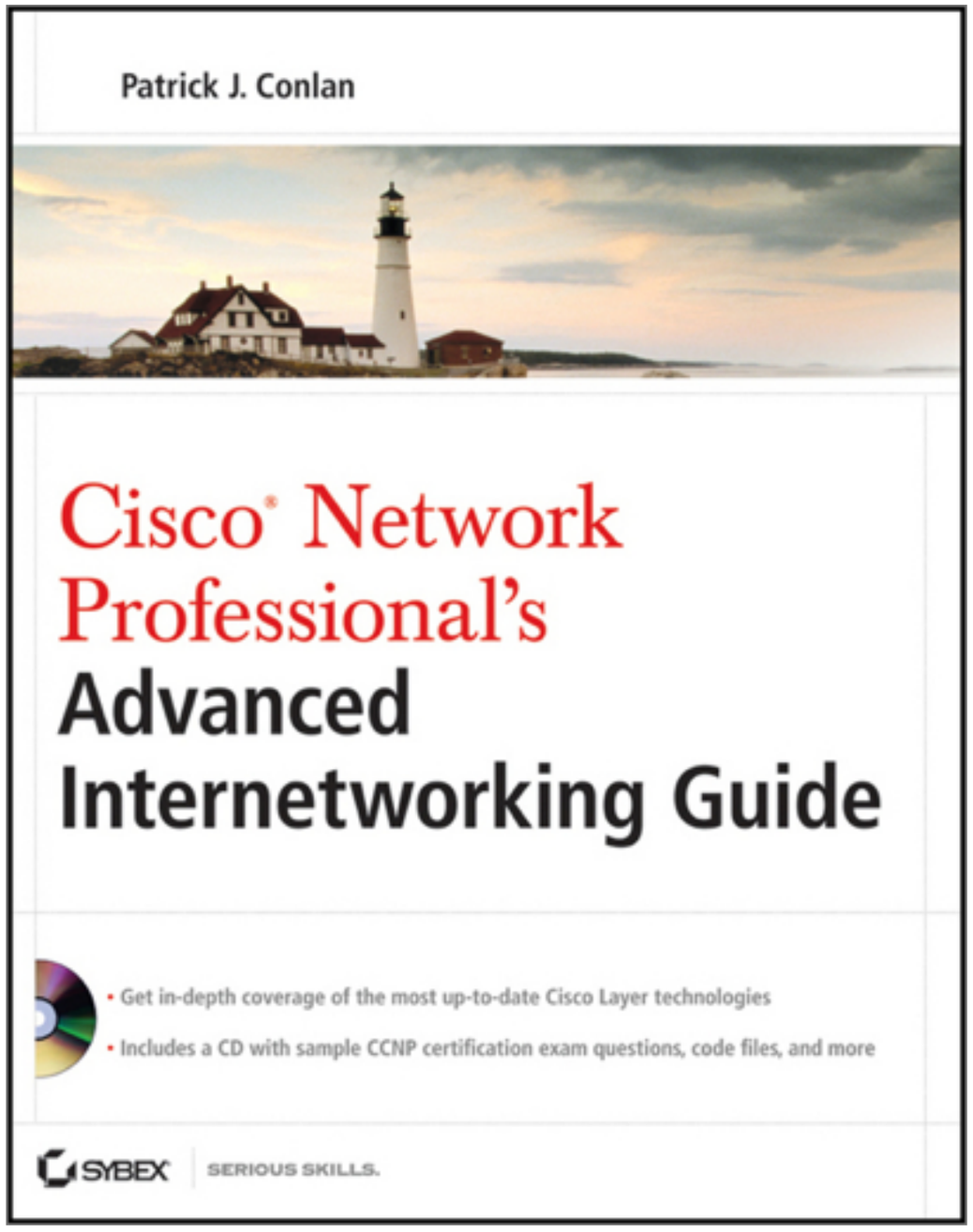
1. Fundamentals
2. Switching
3. Routing (Static, RIPv2, OSPF)
4. Security (Network Firewall, IDS/IPS)
5. Network Services (DNS, DHCP, and EMAIL using Linux)
6. IPv6 and WAN
7. Review

Grading

- Final Exam (60%)
- Network Project (20%)
- Attendance (20%)

Book

Cisco Network Professional's Advanced Networking Guide (ebook) by Patrick J. Conlan



Tools

- **GNS3 Network Emulator**
  (www.gns3.net)

- **CISCO Packet Tracer (simulator)**

Network Administrator or Engineer

Responsibilities of a Network Administrator/Engineer:

- Designing, planning, and setting up the network
- Maintaining and expanding the network
- Network monitoring
- Network security

The Future

- What would you like to do in the future?

Switch

A network **switch** is a computer networking device that connects network devices

Cisco Catalyst 3750

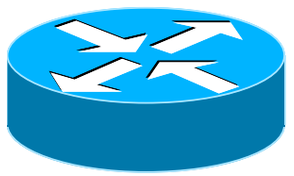
Traditionally a Layer 2 Device

Many of today's switches can operate from layer 2 to 4

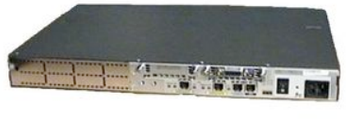
Router

A **router** is a device that forwards data packets between computer networks and/or the internet

When a data packet comes in on one of the lines, the router reads the address information in the packet to determine its ultimate destination



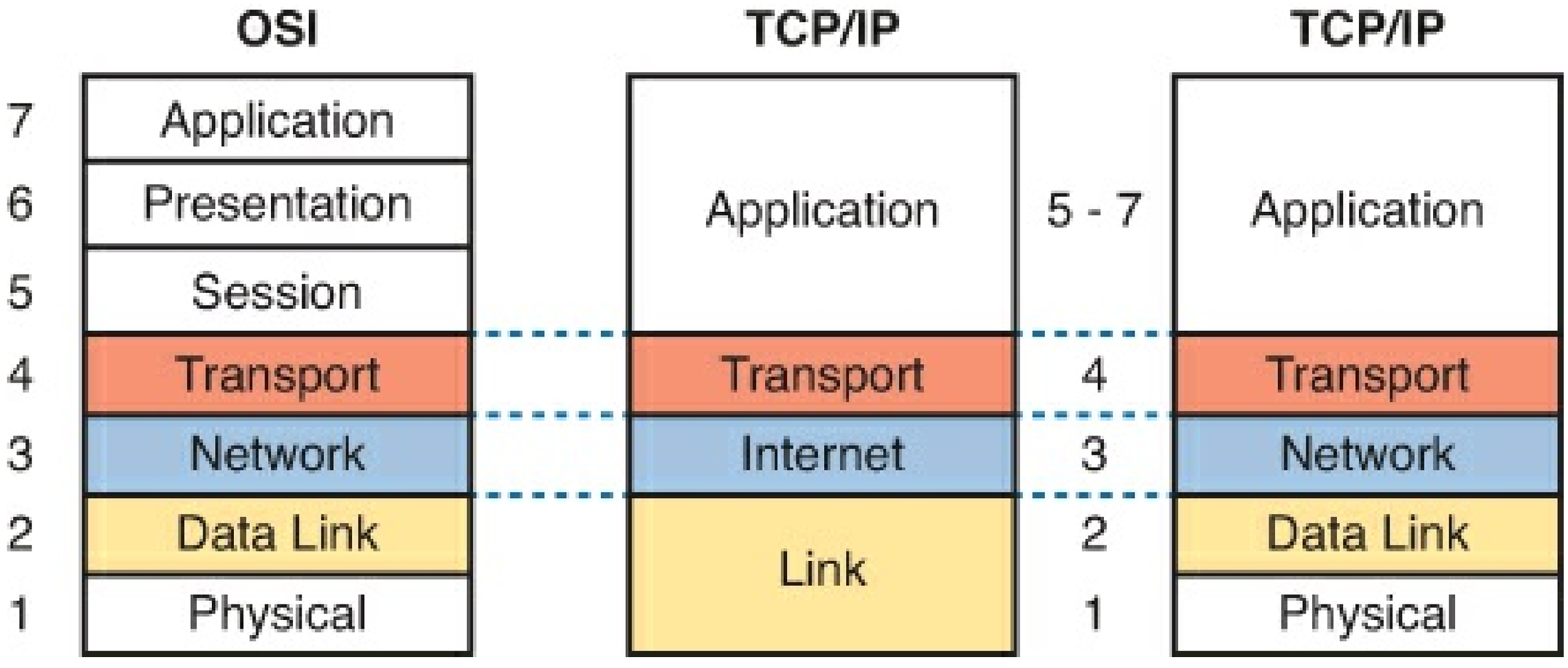
Cisco 2611XM Router



GNS Introduction

- Lets take a look at GNS3...

TCP/IP Model vs. OSI

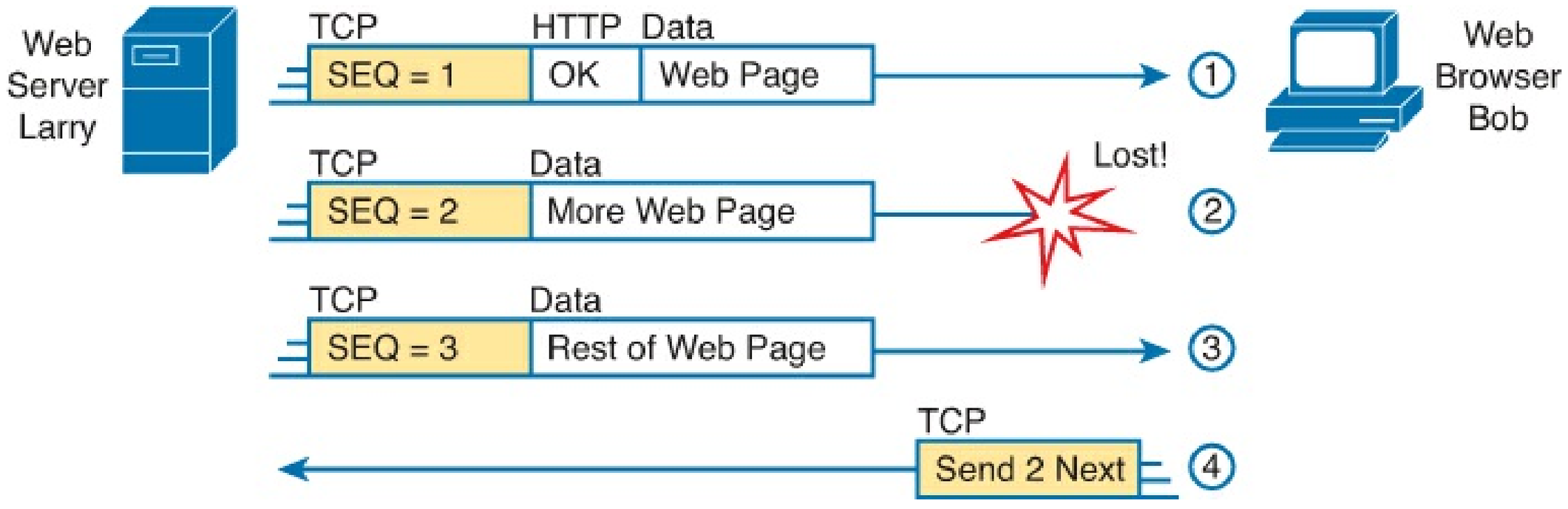


TCP/IP Layers, pt. 1

- Application
    - Application Layer protocols provide services to the application software running on a computer
    - HTTP, POP3, SMTP
- Transport
    - Provides services for application layer protocols like, error recovery
    - The two most commonly used transport layer protocols are Transmission Control Protocol (TCP) and User Datagram Protocol (UDP)

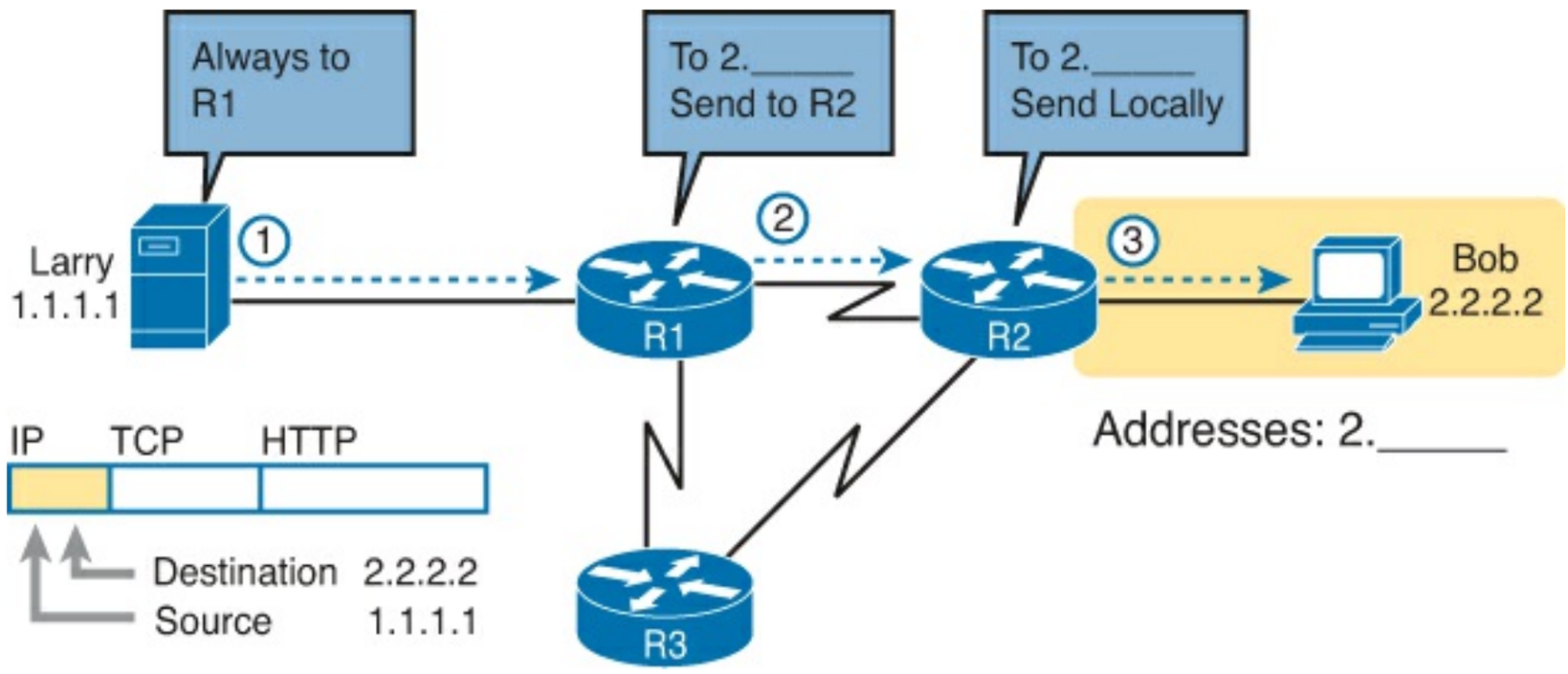
TCP/IP Layers, pt. 2

- Transport, cont. - Error Correction



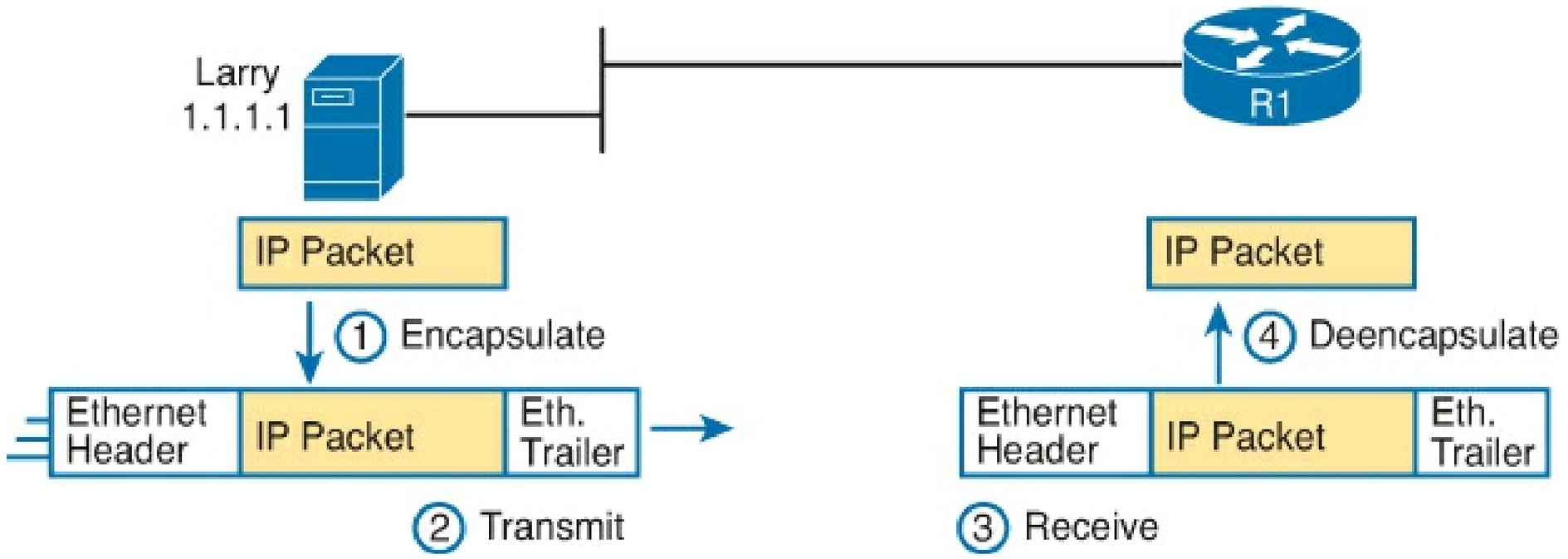
TCP/IP, pt. 3

- Network Layer
    - IP (Internet Protocol) Logical Addressing
    - Routing information

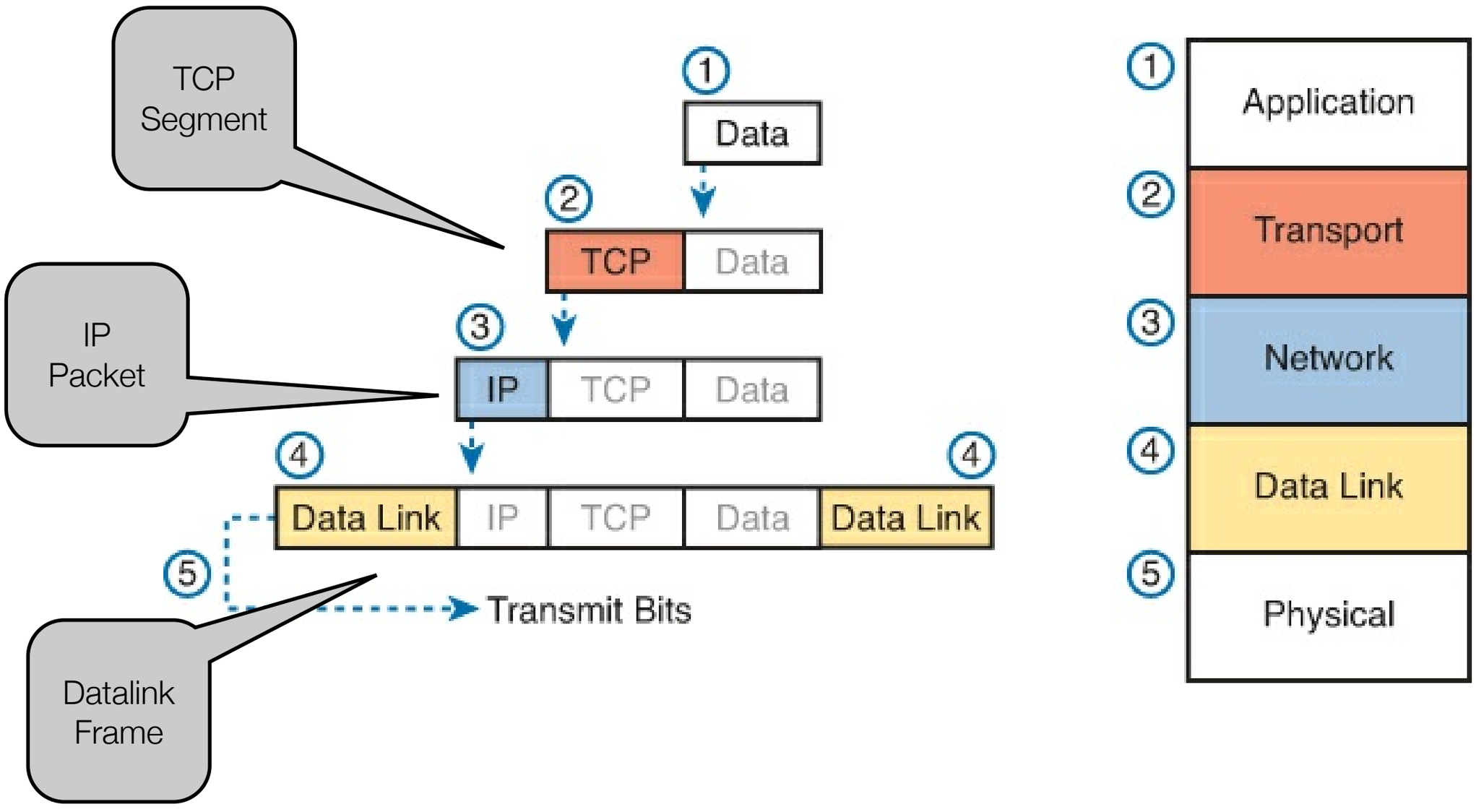


TCP/IP Layers, pt. 4

- Link Layer
    - Refers to physical connections, or links, between two devices and the protocols used to control those links



Encapsulation



OSI Model, pt. 1

Layer	Functional Description
7	**Application layer.** This layer provides an interface between the communications software and any applications that need to communicate outside the computer on which the application resides. It also defines processes for user authentication.
6	**Presentation layer.** This layer's main purpose is to define and negotiate data formats, such as ASCII text, EBCDIC text, binary, BCD, and JPEG. Encryption is also defined by OSI as a presentation layer service.
5	**Session layer.** This layer defines how to start, control, and end conversations (called sessions). This includes the control and management of multiple bidirectional messages so that the application can be notified if only some of a series of messages are completed. This allows the presentation layer to have a seamless view of an incoming stream of data.
4	**Transport layer.** This layer's protocols provide a large number of services, as described in Chapter 5, "Fundamentals of TCP/IP Transport and Applications." Although OSI Layers 5 through 7 focus on issues related to the application, Layer 4 focuses on issues related to data delivery to another computer (for example, error recovery and flow control).

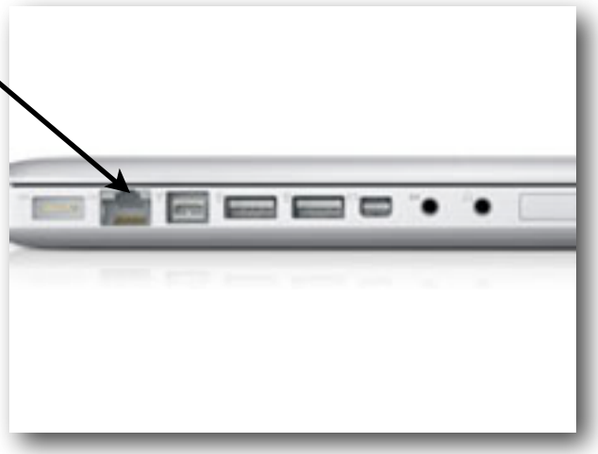
OSI Model, pt. 2

3	**Network layer.** This layer defines three main features: logical addressing, routing (forwarding), and path determination. Routing defines how devices (typically routers) forward packets to their final destination. Logical addressing defines how each device can have an address that can be used by the routing process. Path determination refers to the work done by routing protocols to learn all possible routes and choose the best route.
2	**Data link layer.** This layer defines the rules that determine when a device can send data over a particular medium. Data link protocols also define the format of a header and trailer that allows devices attached to the medium to successfully send and receive data.
1	**Physical layer.** This layer typically refers to standards from other organizations. These standards deal with the physical characteristics of the transmission medium, including connectors, pins, use of pins, electrical currents, encoding, light modulation, and the rules for how to activate and deactivate the use of the physical medium.

Ethernet

- Today, most LANs (Local Area Networks) use IEEE standard Ethernet Protocol
- LANs are either Ethernet Wired (802.3) or Wireless (802.11)
- Ranges from 10Mbps to 100Gbps
- Uses Un-shielded twisted pair (UTP) or fiber cables

RJ-45
Connectors

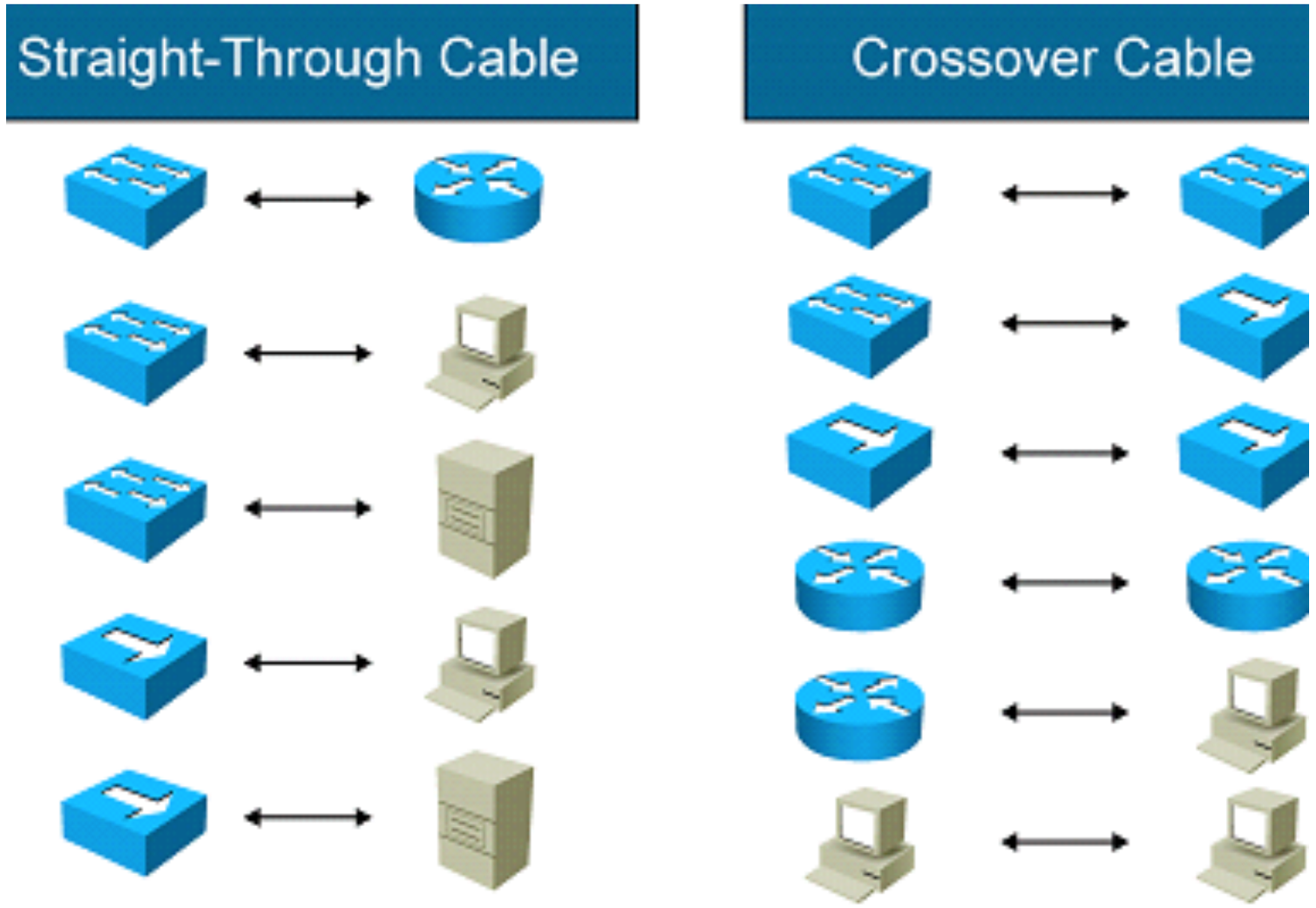


Types of Ethernet

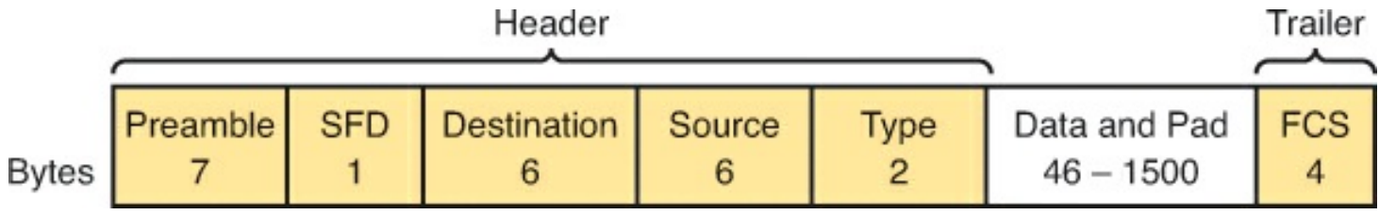
Speed	Common Name	Informal IEEE Standard Name	Formal IEEE Standard Name	Cable Type, Maximum Length
10 Mbps	Ethernet	10BASE-T	802.3	Copper, 100 m
100 Mbps	Fast Ethernet	100BASE-T	802.3u	Copper, 100 m
1000 Mbps	Gigabit Ethernet	1000BASE-LX	802.3z	Fiber, 5000 m
1000 Mbps	Gigabit Ethernet	1000BASE-T	802.3ab	Copper, 100 m
10 Gbps	10 Gig Ethernet	10GBASE-T	802.3an	Copper, 100 m

1000BASE-LX
Fiber Cables

ST vs. CO Cables



Ethernet Frame Anatomy



Field	Field Length in Bytes	Description
Preamble	7	Synchronization
Start Frame Delimiter (SFD)	1	Signifies that the next byte begins the Destination MAC Address field
Destination MAC Address	6	Identifies the intended recipient of this frame
Source MAC Address	6	Identifies the sender of this frame
Type	2	Defines the type of protocol listed inside the frame; today, most likely identifies IP version 4 (IPv4) or IP version 6 (IPv6)
Data and Pad*	46–1500	Holds data from a higher layer, typically an L3PDU (usually an IPv4 or IPv6 packet). The sender adds padding to meet the minimum length requirement for this field (46 bytes).
Frame Check Sequence (FCS)	4	Provides a method for the receiving NIC to determine whether the frame experienced transmission errors

MAC Address

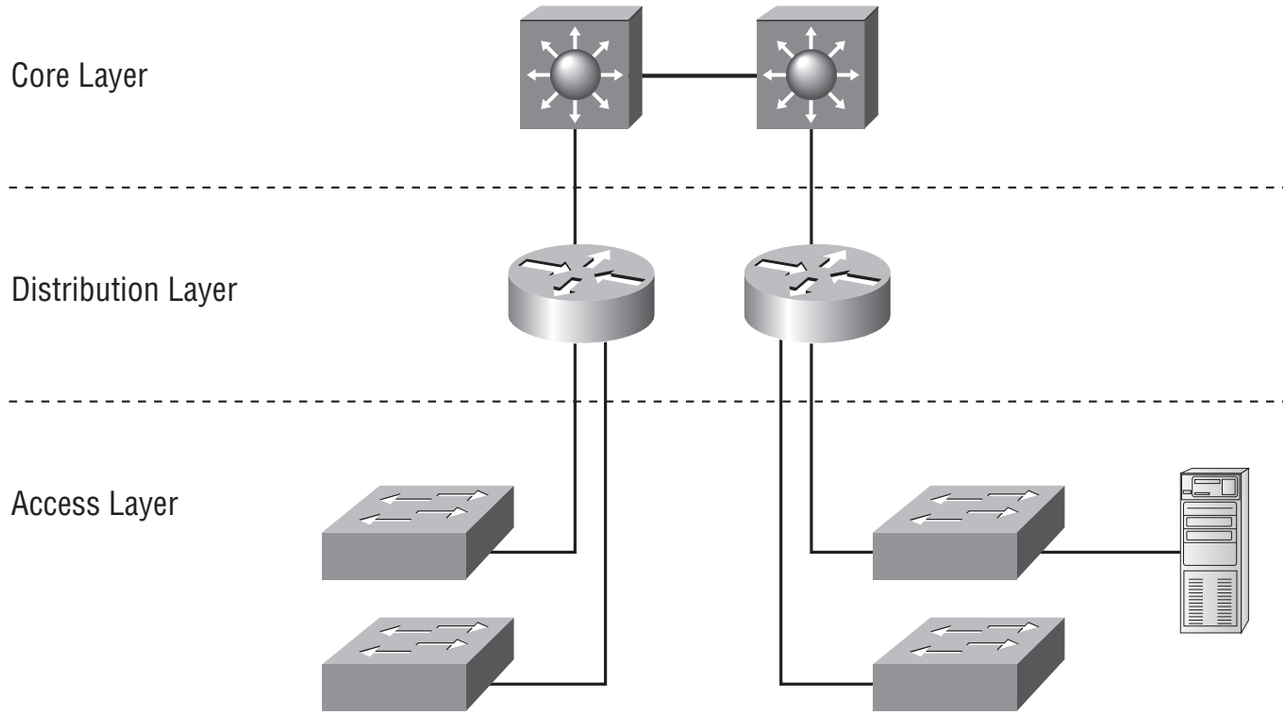
- Globally unique 48 bit address
- First 24 bits are the organizationally unique identifier (OUI) assigned by IEEE
- Next 24 bits are assigned by the vendor
- Broadcast address FFFF.FFFF.FFFF

Duplex

- Half-duplex: Data can be sent only when not receiving data
- Full-duplex: Data can be sent and received simultaneously

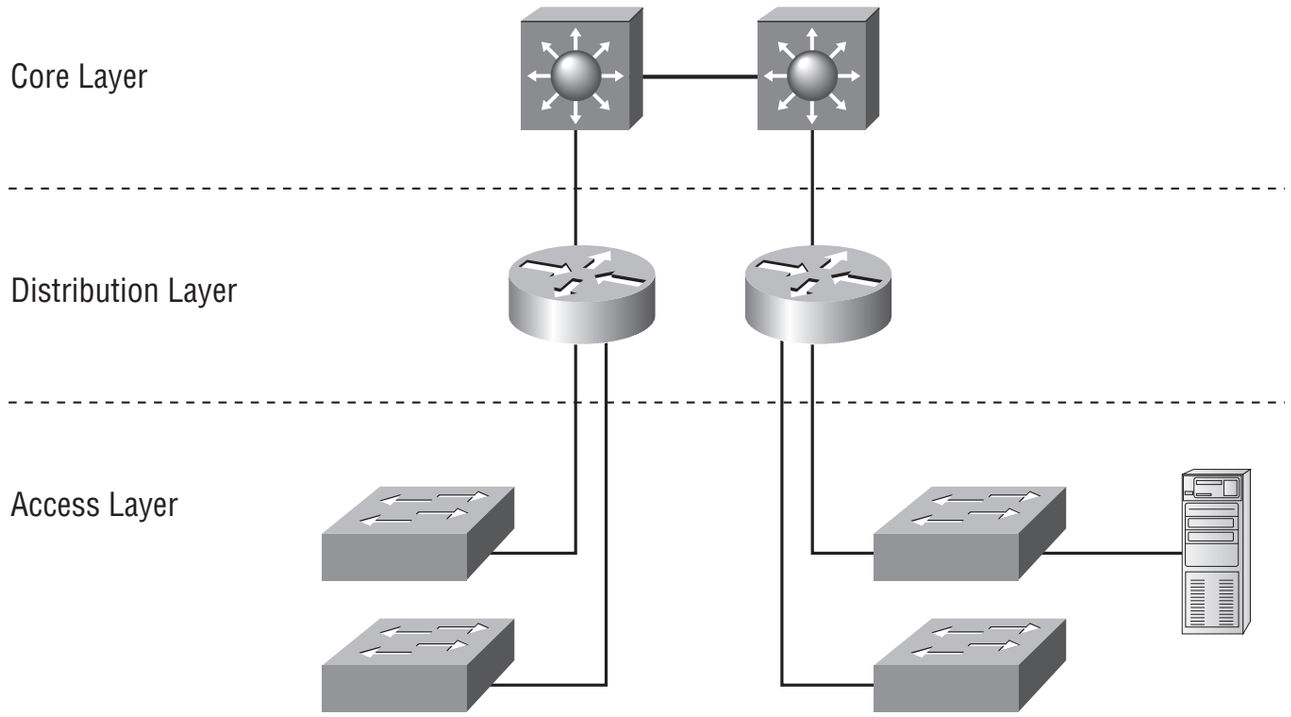
Cisco 3 Layer Model

- Access Layer
  - connects all of the hosts and user workstations
  - switches with high port density or the lowest port cost
  - high speed uplinks to the other layers
- Distribution Layer
  - aggregation point for access layer networks and devices
  - Routing
  - Quality of service (QoS) policies, access control lists (ACLs), and route filtering
  - Redundancy (to core, access)



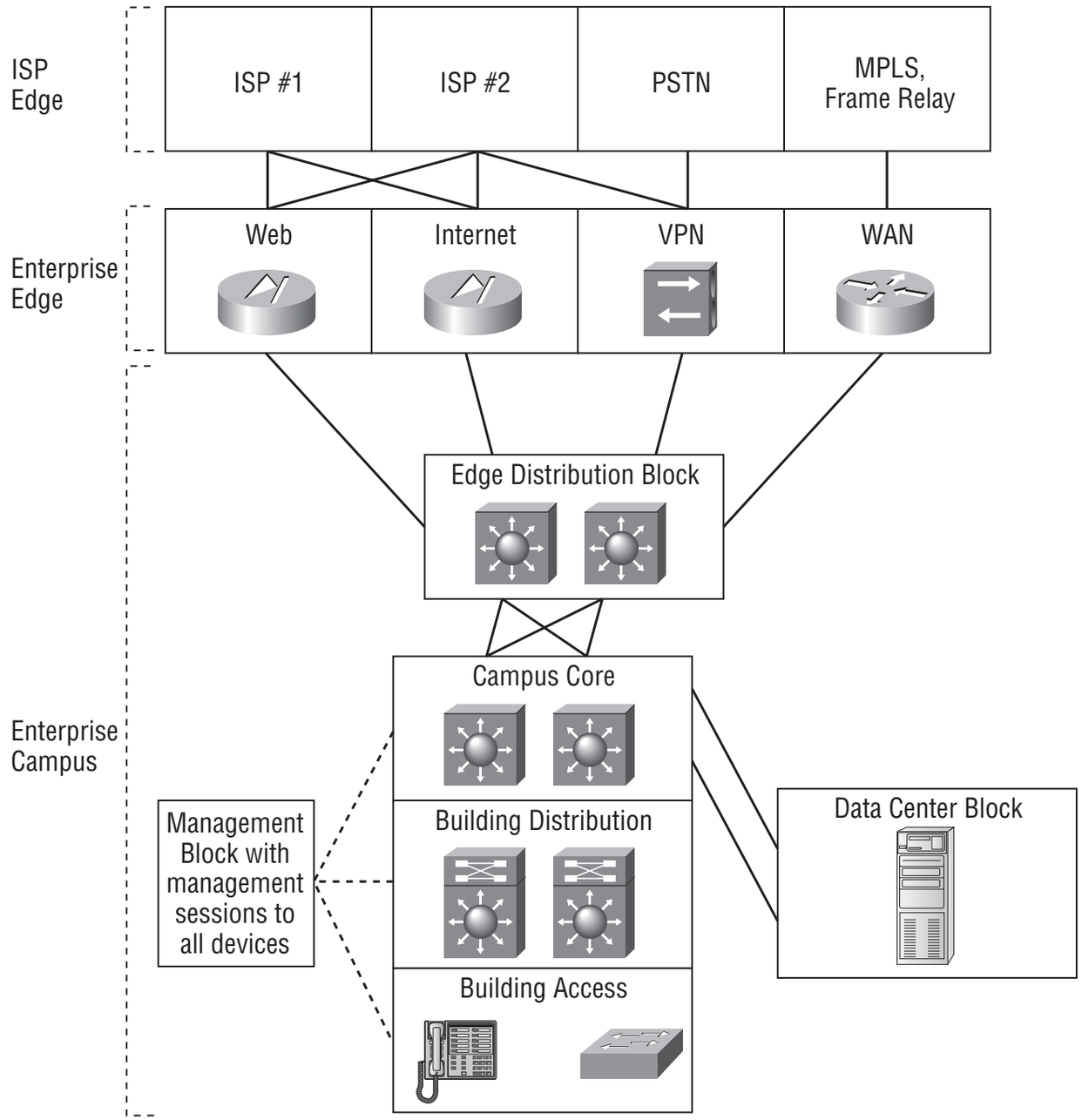
Cisco 3 Layer Model

- Core Layer
  - provides high-speed transport for data
  - No filtering or access lists
  - All of the connections in and out of the core layer should be redundant for high availability



Enterprise Composite Model

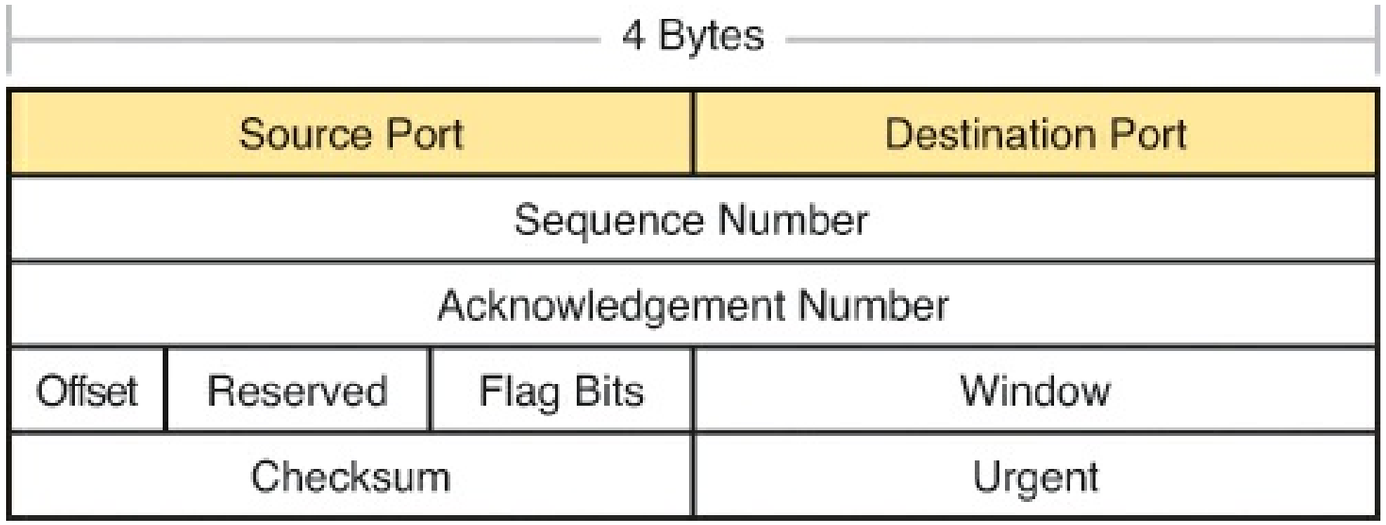
- ISP Edge
- Enterprise Edge
- Enterprise Campus
- Campus Core
- Building Distribution
- Data Center Block
- Management Block



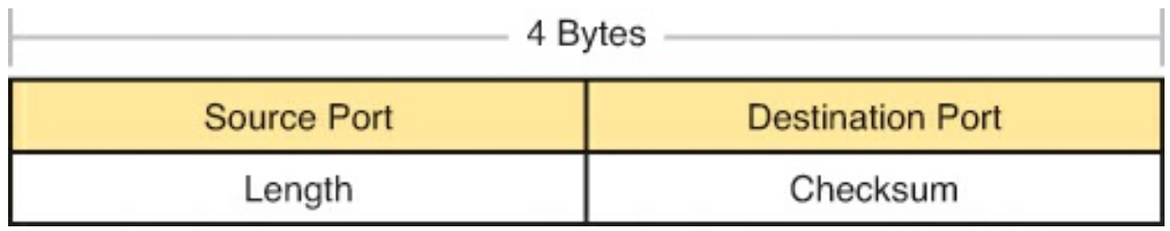
TCP/UDP, pt. 1

- Each TCP/IP application chooses to use either TCP or UDP (or both)
- TCP provides error recovery, but consumes more bandwidth (File Transfers)
- UDP doesn’t provide error recovery, but consumes less bandwidth (VOIP, Media Streaming)
- Applications can use both TCP and UDP can send and receive data on different ports
- TCP is a connection-oriented protocol, UDP is a connection-less protocol

TCP/UDP, pt. 2



TCP header

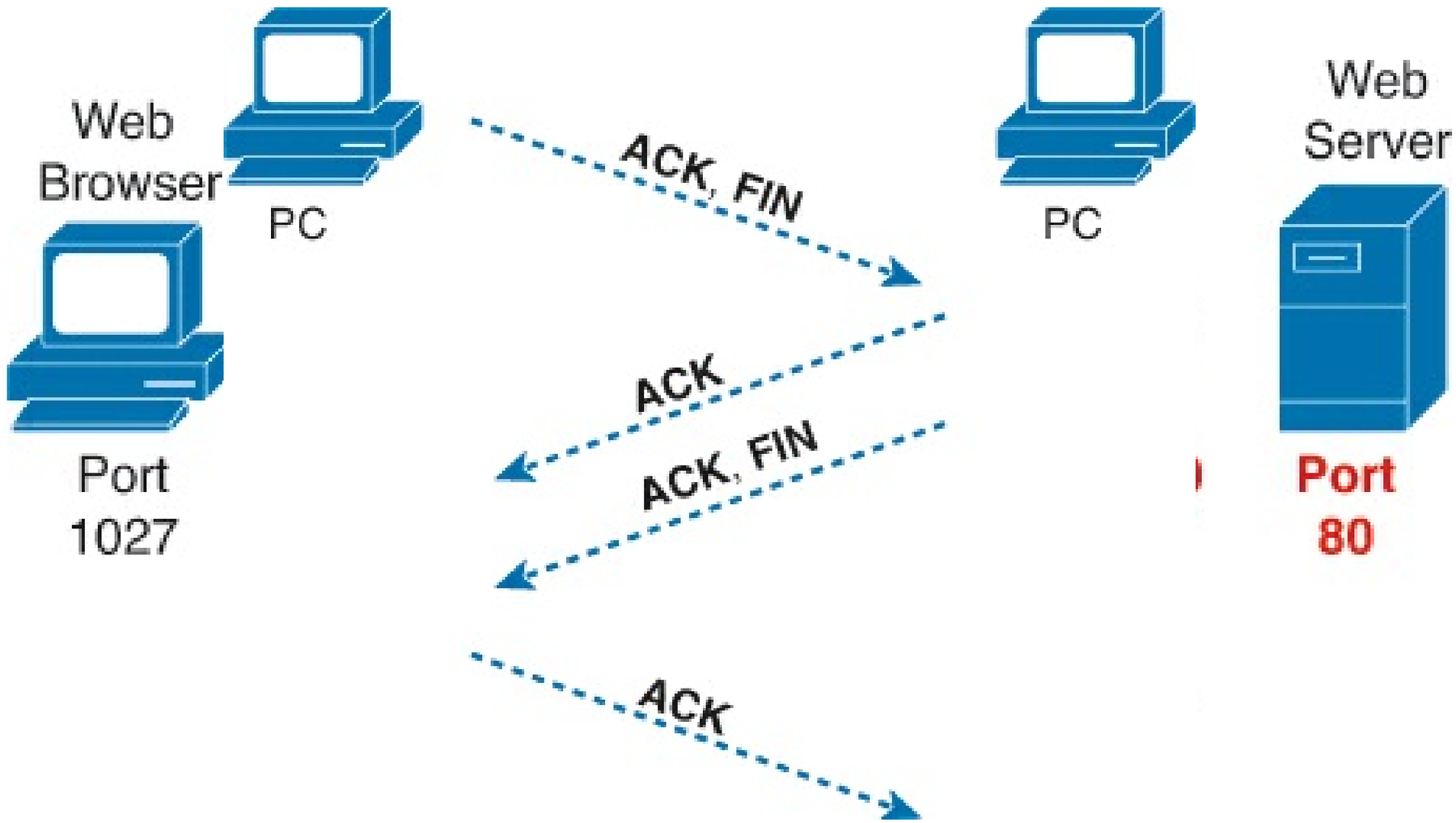


UDP header

Well Known Port Numbers

Port Number	Protocol	Application
20	TCP	FTP data
21	TCP	FTP control
22	TCP	SSH
23	TCP	Telnet
25	TCP	SMTP
53	UDP, TCP	DNS
67, 68	UDP	DHCP
69	UDP	TFTP
80	TCP	HTTP (WWW)
110	TCP	POP3
161	UDP	SNMP
443	TCP	SSL

TCP 3-Way Handshake and Termination



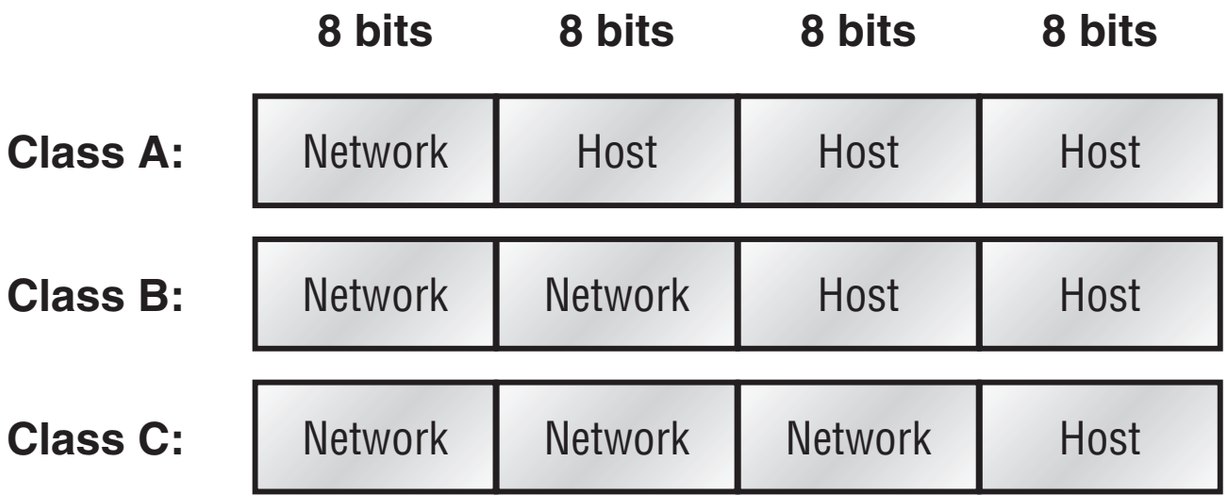
Additional Services and Utilities

- **Domain Name System (DNS)** converts hostnames to IP addresses
- An **ARP Request** is a broadcast to all the computers on the subnet, “If this is your IP address, please reply with your MAC address”
- **Ping** is a utility that uses Internet Control Message Protocol (ICMP) to send a ICMP Echo request to an IP address and waits for a Reply

IPv4 Address

- 32-bit number written in dotted-decimal notation (DDN)
- The number is divided into 4, 8 bit “octets”
- Each network interface has 1 or more IP addresses
- For Example: 192.168.100.2

Address Classes



Class D: Multicast

Class E: Research

Class	Range	Networks	Hosts
A	0-127	126	16,777,216
B	128-191	16,384	65,534
C	192-223	2,097,152	254
D	224-239	n/a	n/a
E	240-255	n/a	n/a

Special Purpose IP Addresses

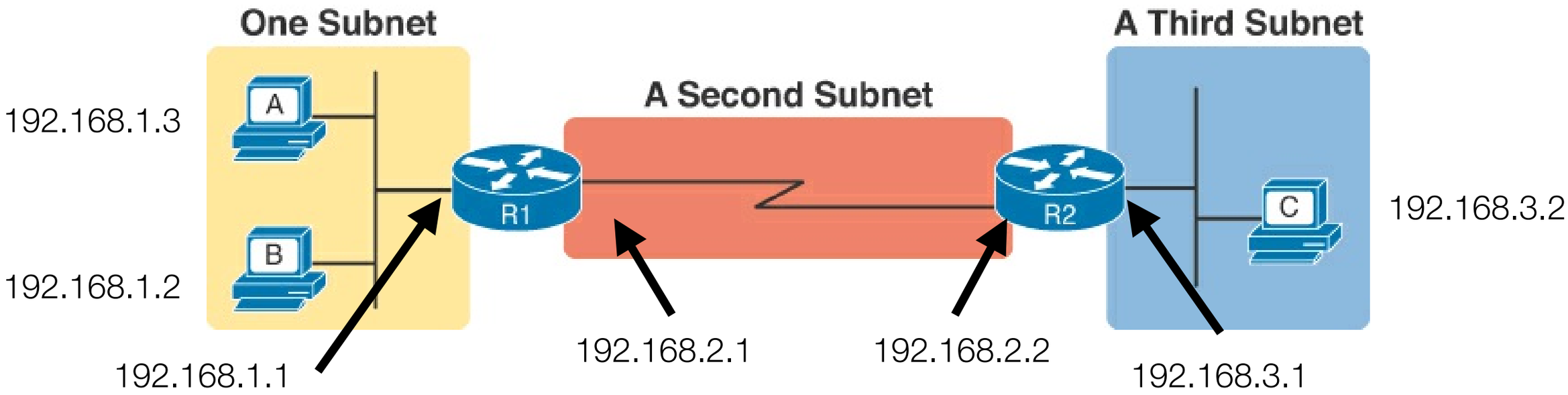
- Network address of all 0's represents segment
- Network address of all 1s means "all networks"
- Network address 127.0.0.1 is reserved for loopbacks
- Host address of all 0s means "network address" or all hosts on a a network
- Host address of all 1s is the broadcast to all hosts
- Entire IP address set to all 0s designates the default route
- Entire IP address set to all 1s is also a broadcast to all hosts on the current network

Private Address Ranges

Class of Networks	Private IP Networks	Number of Networks
A	10.0.0.0	1
B	172.16.0.0 through 172.31.0.0	16
C	192.168.0.0 through 192.168.255.0	256

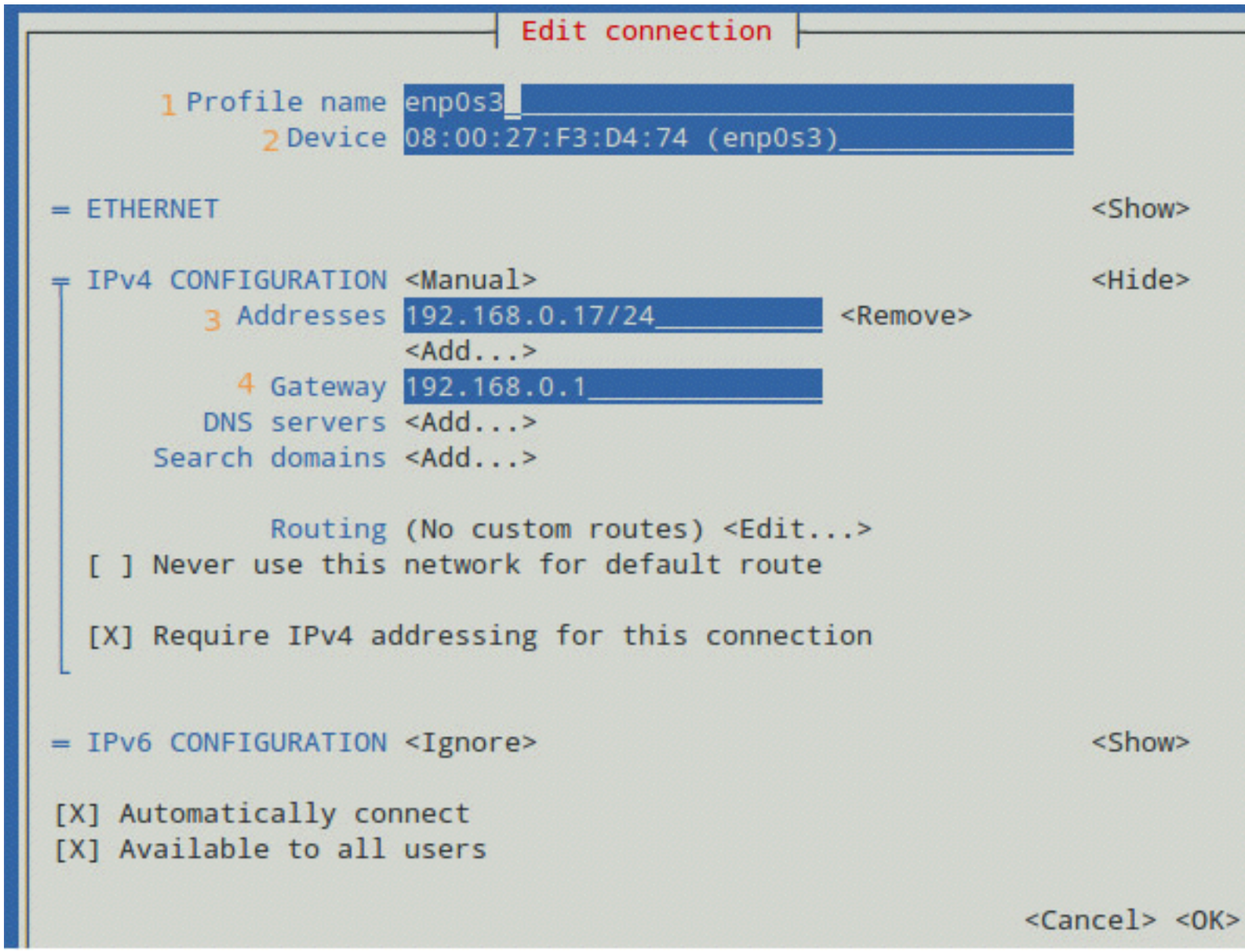
Network Addressing, pt. 1

- Every device that connects to an IP internetwork needs to have an IP address
- This includes:
    - Servers, mobile phones, laptops, desktops, IP phones, tables, routers, switches, firewalls, and network printers
- The network will be divided into different subnets

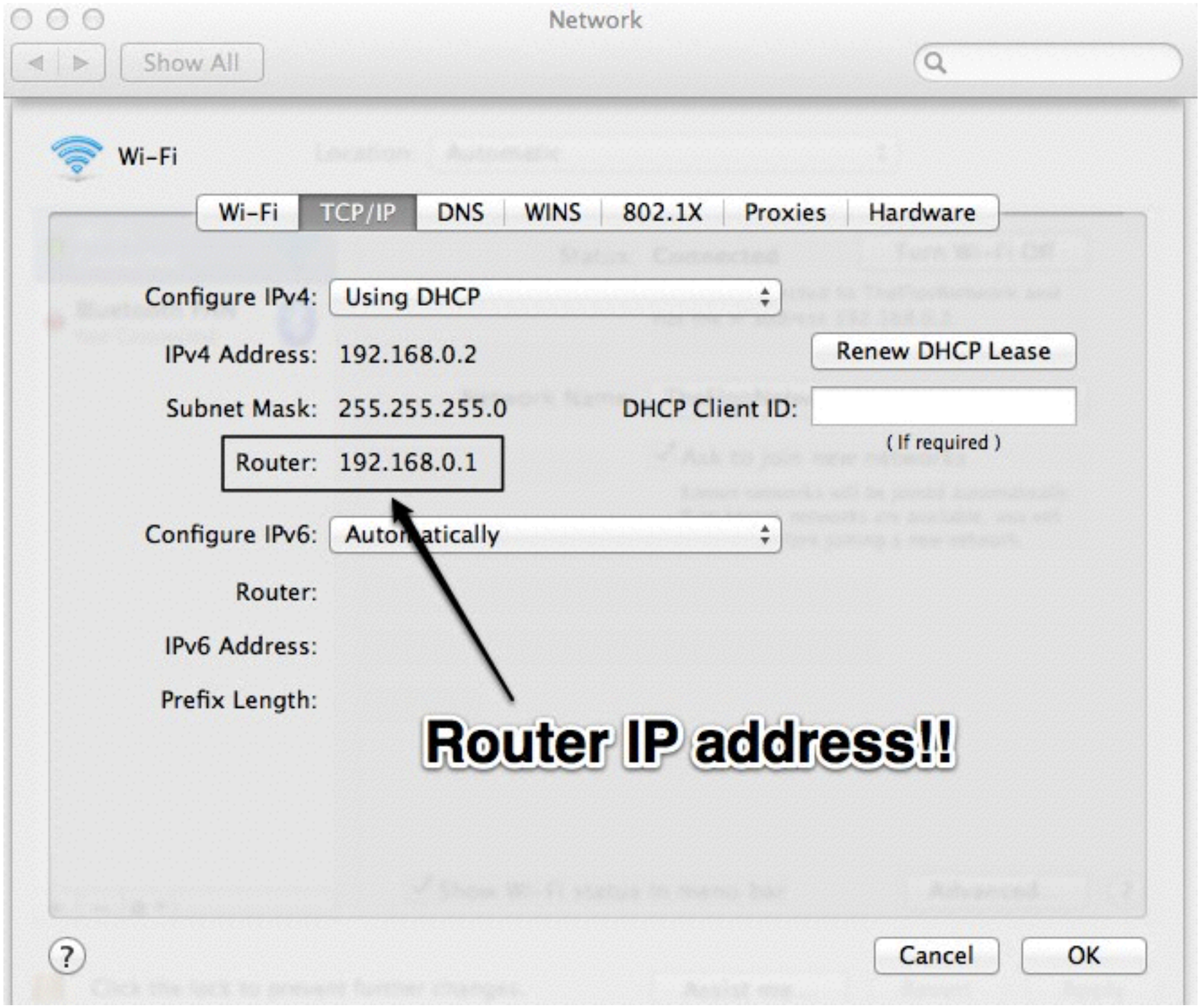


IP Address Config Linux

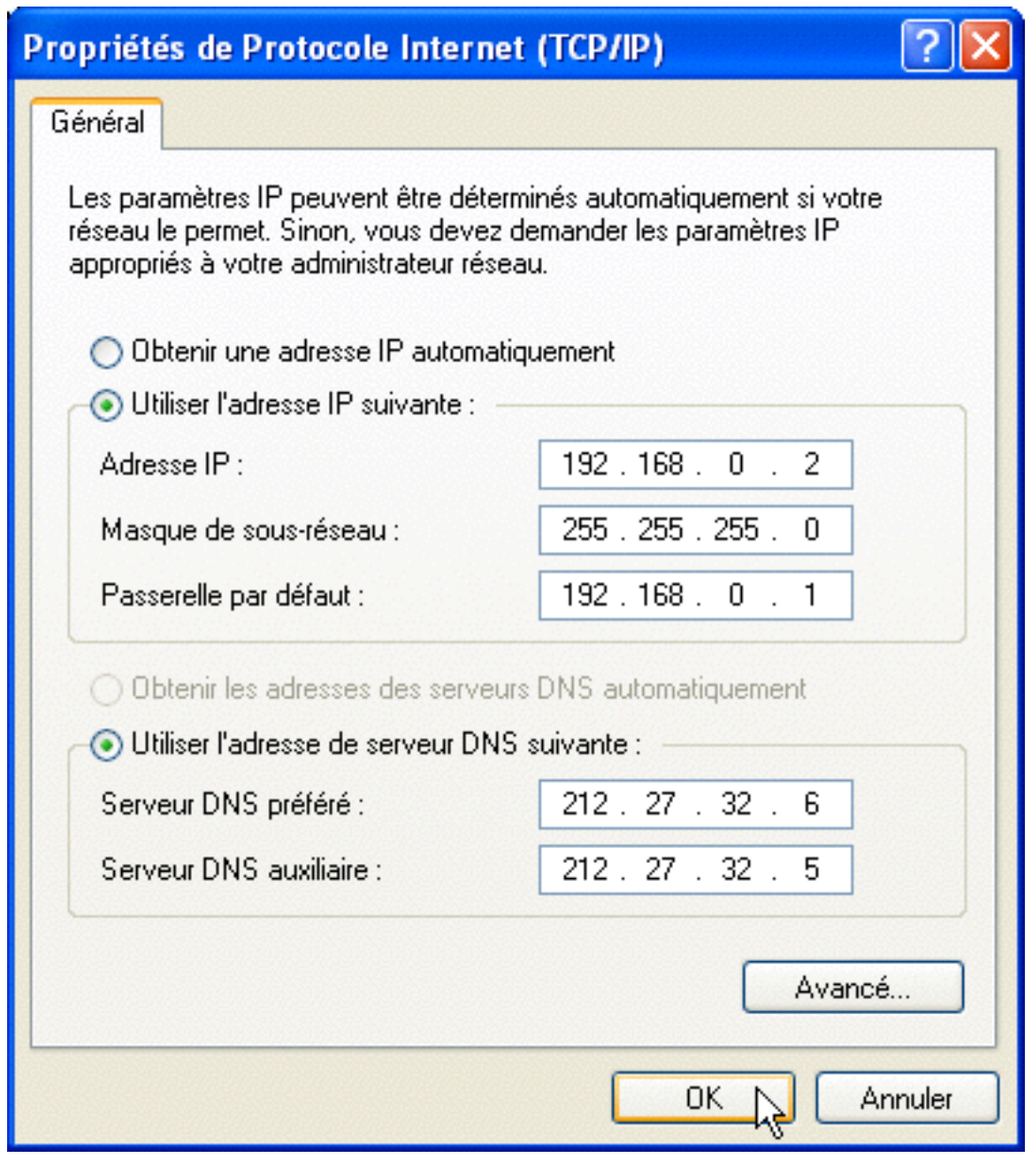
- Right-click the **NetworkManager** applet (Graphical)
- Run nutmeg
- Edit the appropriate configuration file in /etc/sysconfig/network-scripts (Redhat, Fedora)
  - vi /etc/sysconfig/network-scripts/ifcfg-Auto_eth0
- /etc/network/interfaces (Ubuntu)



IP Address Config Mac

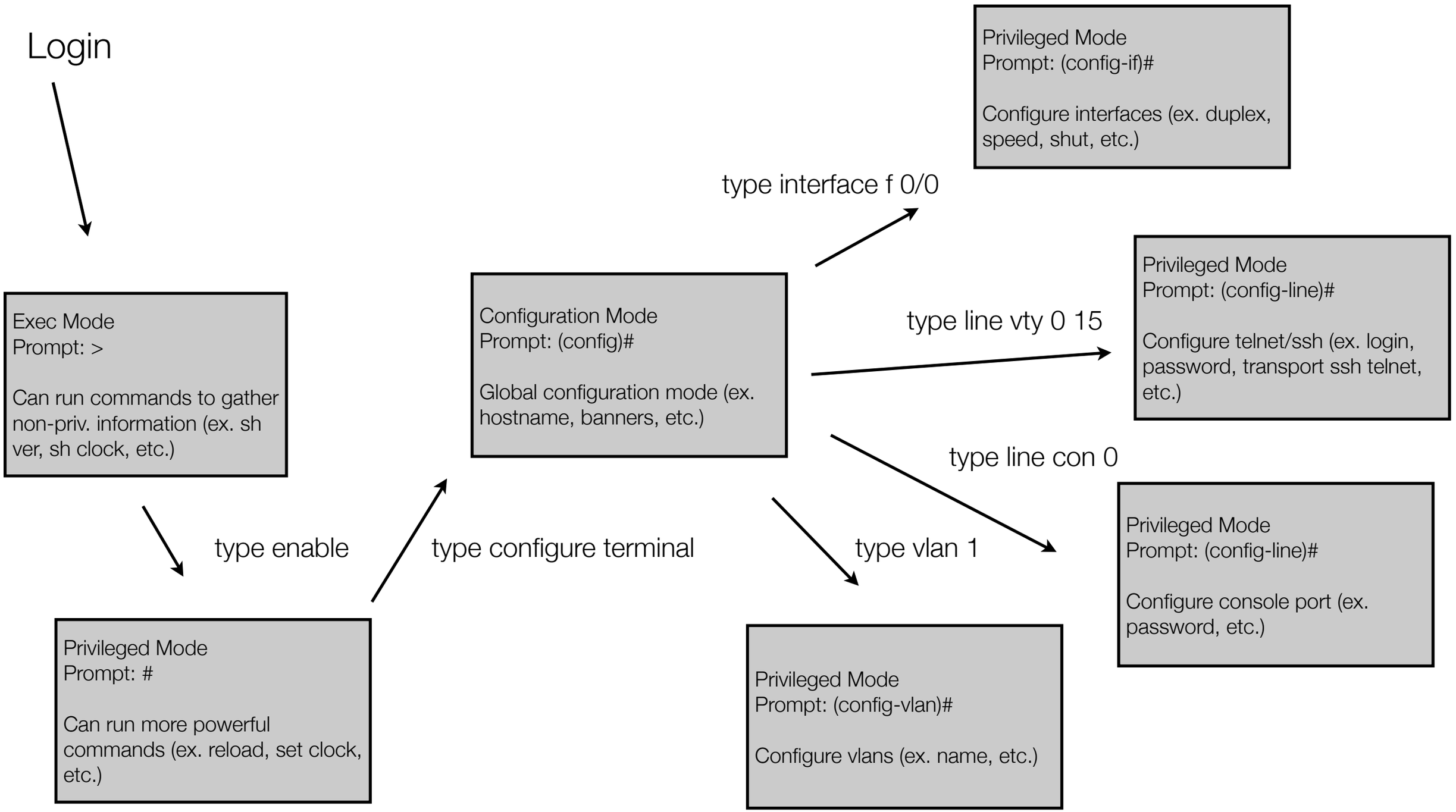


IP Address Config Windows



CISCO IOS

Cisco IOS modes



Basic Commands, pt. 1

- Show version - view router hardware, memory, IOS version, and uptime
  - type **show version**
- Show current configuration
  - type **show run**
- Show and set clock
  - type **enable**
  - type **clock set 10:30:00 14 September 2014**
  - type **show clock**
  - type **ntp master**
- Other router
  - **ntp logging**
  - **ntp server 192.168.2.1**

Basic Commands, pt. 2

- set host name type:
  - enable
  - config t
  - hostname ROUTER1
- set password type:
  - enable secret c1sc0!
- save configuration type:
  - copy run start (wr)

Basic Commands, pt. 3

- Configure interface type:
  - enable
  - config t
  - inf fa 0/0
  - ip address 192.168.1.1 255.255.255.0
  - description VLAN1GW
  - speed 100
  - duplex full
  - no shut
- Ping interface type:
  - enable
  - ping 192.168.1.2

Basic Commands, pt. 4

- Show a summary of the current interfaces
    - Show ip int br
- Show details on one interface
    - show int f 0/0

Network Project

- Must Contain
  - 2 Sites (connected by a serial link)
  - 6 Devices (routers and router w/ switch cards)
  - Use OSPF, DHCP, host files on routers, banners, network time configuration, ACLs, and configure SSH on at least 1 router
- Include a brief description of your design (150+ words)
- Include diagram (use GNS3 or Visio)
- Include the configurations (i.e. show run), remove blank lines, and no screen shots!

Lab

- Install GNS3 on your computer
- Add a router image and login
- Practice basic commands

HW Questions

- Read Chapter 1-3
- Answer the following Questions:

1. Name two types of network devices and give their functions?
2. Define and give a detailed explanation of each layer of the TCP/IP Model.
3. What is a straight-through cable? cross-over cable?
4. What is a MAC address? What is it for?
5. Explain the functions of each of the 3 layers of Cisco's 3 layer design model (ie. Core, Access, and Distribution)