# Networks & Server Structures

Addressing

DNS

Packet Anatomy

Compression

Network Hardware


# Addressing

Wherever you go, there you are

# Addressing

1234 Chase Rd

Windermere, FL

# Addressing

1234 Chase Rd

Windermere, FL

USA

# IP Address

- An address assigned to each device participating in a computer network that uses the Internet Protocol for communication
- Two functions
  - Host or network interface identification
  - Location addressing

# IP Address

- 32 bits long
- Split into four groups of eight (**4 octets**)
- Written in dotted decimal format
- Network portion & node/host portion

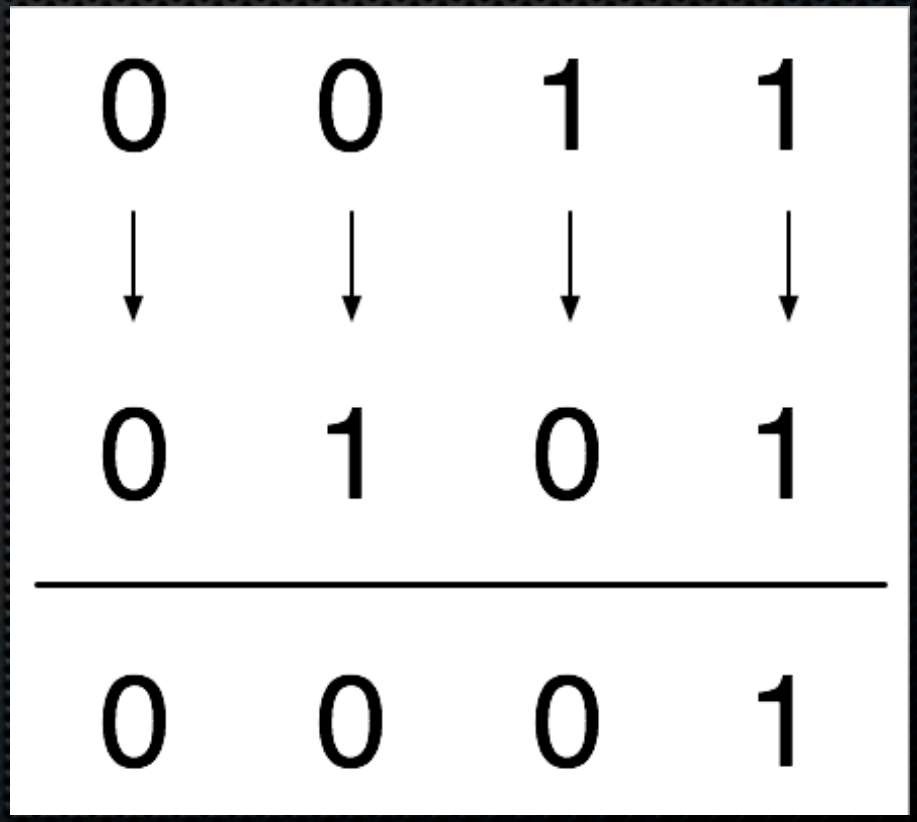
# IP Addressing

- Subnet Mask
- Used to determine how many of the numbers in the IP address are being used to specify a network

| | Dot-decimal Address | Binary |
|---|---|---|
| Full Network Address | 192.168.5.10 | 11000000.10101000.00000101.00001010 |
| Subnet Mask | 255.255.255.0 | 11111111.11111111.11111111.00000000 |
| Network Portion | 192.168.5.0 | 11000000.10101000.00000101.00000000 |
| Host Portion | 0.0.0.10 | 00000000.00000000.00000000.00001010 |

# Binary AND-ing

- 2 rules:
  - Zero AND any value equals zero
  - One AND one equals one



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# Class A

- Includes all addresses between:
  - 1.0.0.0 - 127.255.255.255
- Default subnet mask - 255.0.0.0
- 126 networks
- 16,777,214 nodes per network
- Private space - 10.0.0.0 - 10.255.255.255

# Class B

- Includes all addresses between:
  - 128.0.0.0 - 191.255.255.255
- Default subnet mask - 255.255.0.0
- 16,382 networks
- 65,534 nodes per network
- Private space - 172.16.0.0 - 172.31.255.255
- APIPA - 169.254.x.x

# Class C

- Includes all addresses between:
  - 192.0.0.0 - 223.255.255.255
- Default subnet mask - 255.255.255.0
- 2,097,150 networks
- 254 nodes per network
- Private space - 192.168.0.0 - 192.168.255.255

# Class D

- Includes all addresses between:
  - 224.0.0.0 - 239.255.255.255
- Set aside for multicast transmissions
- Will never be assigned to individual nodes

# Class E

- Includes all addresses between:
  - 240.0.0.0 - 255.255.255.255
- Set aside for research and experimentation
- Will never be assigned to individual nodes

# Network Address

- An address that defines a specific network
- Characterized by all 0's in the host portion of the address when written out in binary
- 64.0.0.0
- 01000000.00000000.00000000.00000000

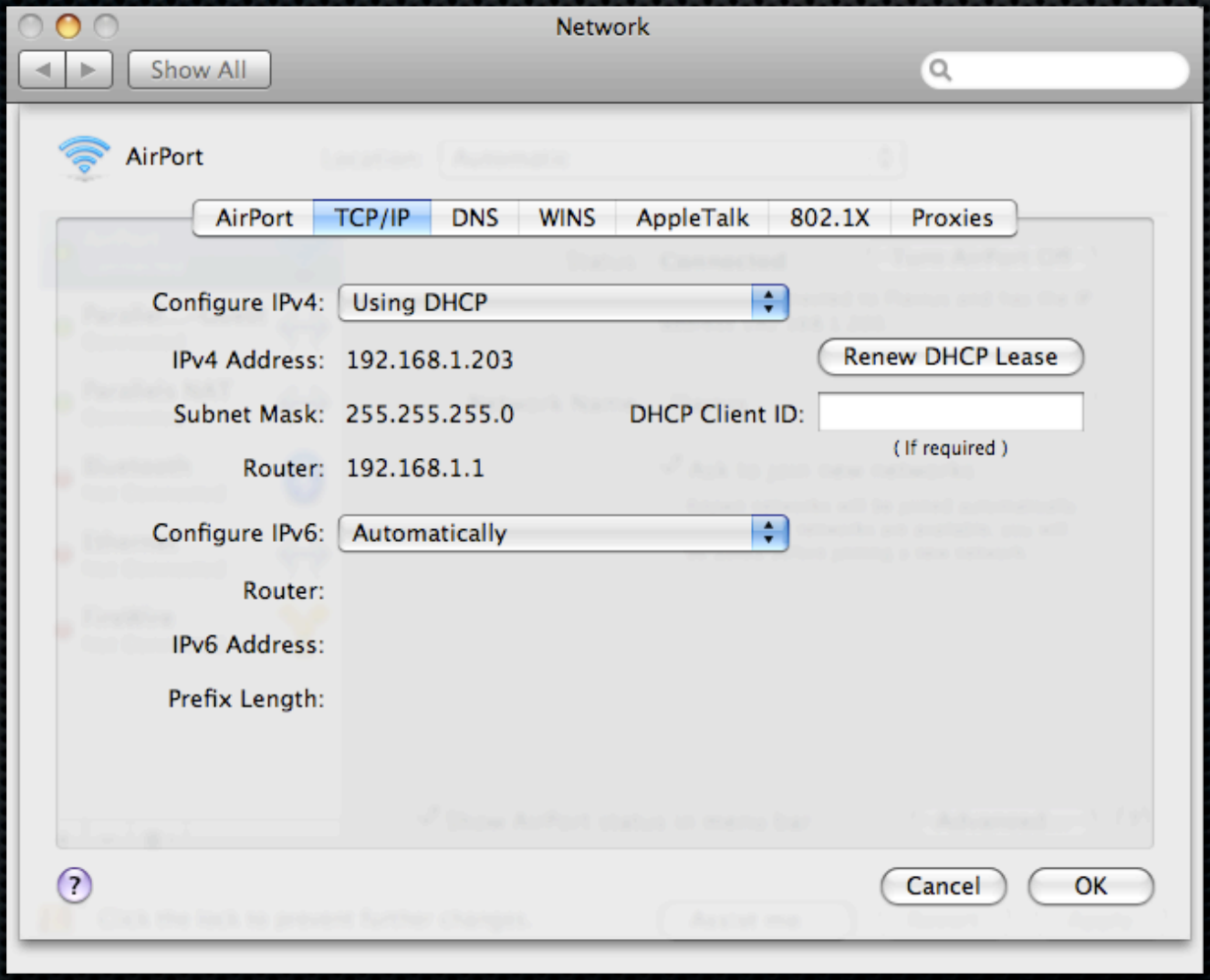
# Broadcast Address

- Directed Broadcast
  - Packets sent to this address will be sent to all the devices on a specific network
  - Characterized by all 1's in the host portion of the address when written out in binary
  - 192.168.0.255
  - 11000000.10101000.00000000.11111111

# Broadcast Address

- Flooded Broadcast
  - Packets sent to this address will be sent to all the devices on the subnet
  - 255.255.255.255
  - Do not confuse with subnet masks!!!

# IP Address


Network
Show All
AirPort
AirPort
TCP/IP
DNS
WINS
AppleTalk
802.1X
Proxies
Configure IPv4:
Using DHCP
IPv4 Address:
192.168.1.203
Renew DHCP Lease
Subnet Mask:
255.255.255.0
DHCP Client ID:
( If required )
Router:
192.168.1.1
Configure IPv6:
Automatically
Router:
IPv6 Address:
Prefix Length:
Cancel
OK

# Private IP Address Space

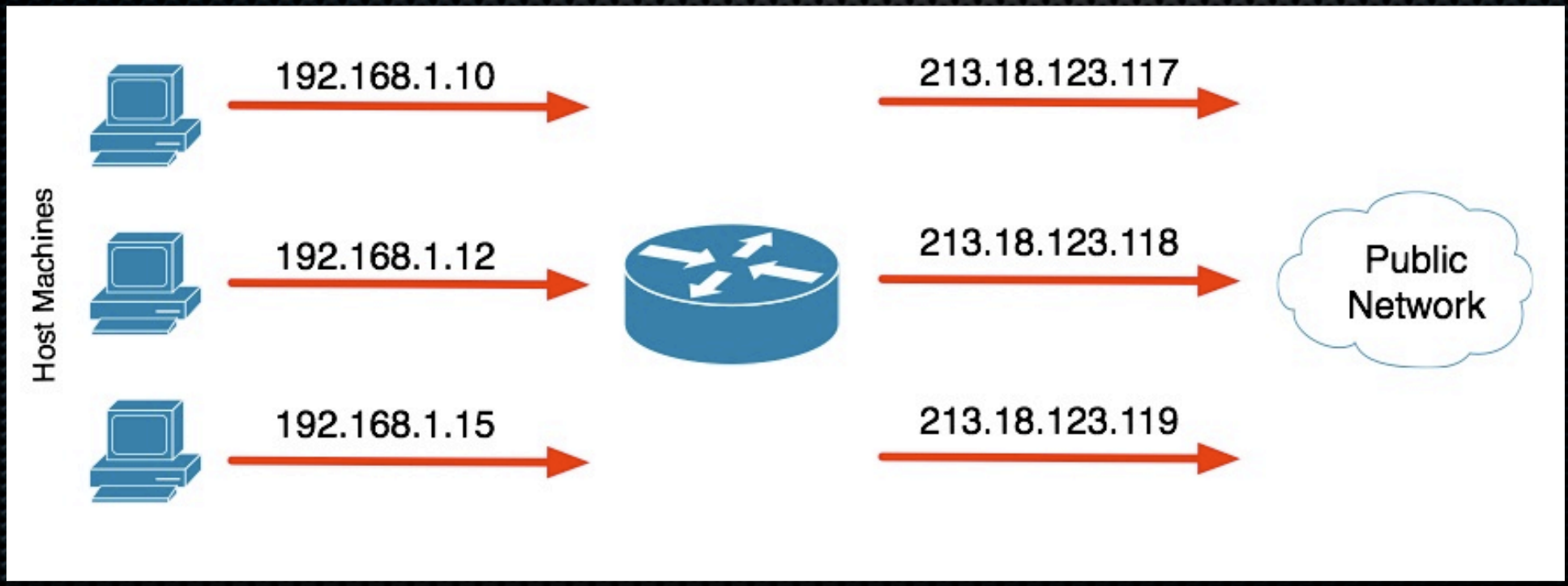
- Addresses that are not globally delegated and cannot be transmitted onto the public Internet.
- Anyone may use these addresses without approval from an Internet registry

- Class A private space = 10.0.0.0 - 10.255.255.255
- Class B private space = 172.16.0.0 - 172.31.255.255
- Class C private space = 192.168.0.0 - 192.168.255.255

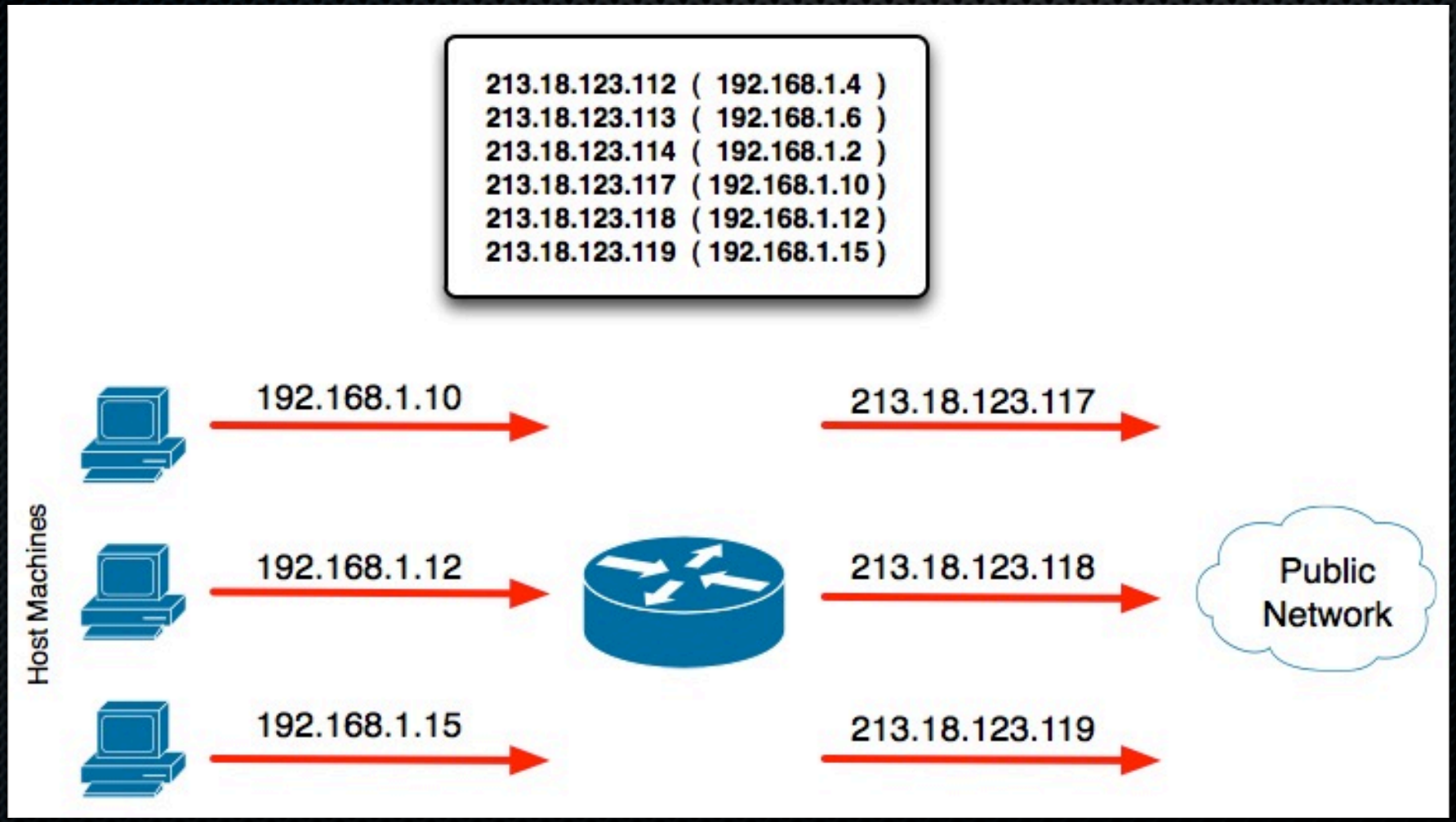
# Network Address Translation

- Network addresses on an internal network are not directly exposed to the external network because they are using private IP address space

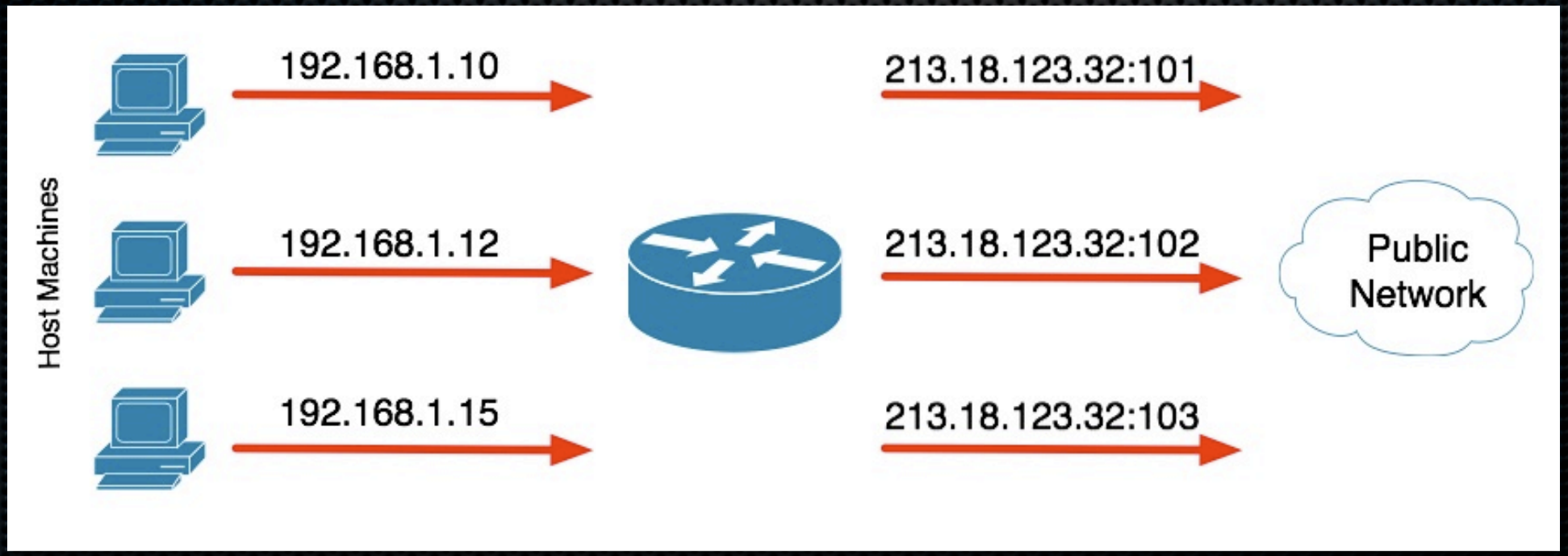
# Static NAT


Host Machines
192.168.1.10
192.168.1.12
192.168.1.15
213.18.123.117
213.18.123.118
213.18.123.119
Public Network

# Dynamic NAT


213.18.123.112 ( 192.168.1.4 )
213.18.123.113 ( 192.168.1.6 )
213.18.123.114 ( 192.168.1.2 )
213.18.123.117 ( 192.168.1.10 )
213.18.123.118 ( 192.168.1.12 )
213.18.123.119 ( 192.168.1.15 )
Host Machines
192.168.1.10
192.168.1.12
192.168.1.15
213.18.123.117
213.18.123.118
213.18.123.119
Public Network

# Port Address Translation



# IPv4 to IPv6

- Feb 3rd, 2011 - final 5 blocks of IP addresses were given out to the five Regional Internet Registries
- Need to switch to a new system

# IPv4 to IPv6

- IPv4
  - 32 bit address gives us 4 billion possible unique IP’s
- IPv6
  - 128 bit address gives us 340 undecillion unique IP’s
  - Broken up into 8 16-bit hex ‘words’

# IPv6

- 2001:0db8:85a3:0000:0000:8a2e:0370:7334

# IPv6

- Network Portion
- **2001:0db8:85a3:0000**:0000:8a2e:0370:7334

# IPv6

- Used for Internet Routing
- **2001:0db8:85a3**:0000:0000:8a2e:0370:7334

# IPv6

- Used for defining subnets
- 2001:0db8:85a3:**0000**:0000:8a2e:0370:7334

# IPv6

- Host Portion
- 2001:0db8:85a3:0000:**0000:8a2e:0370:7334**

# IPv6 Benefits

- Larger address space
- Better end to end communications (no need for NAT)
- Better auto-configuration
- Faster routing via simplified header
- Provides built in security via IPSec protocol
- Better QOS
- Better for mobility

# MAC Address

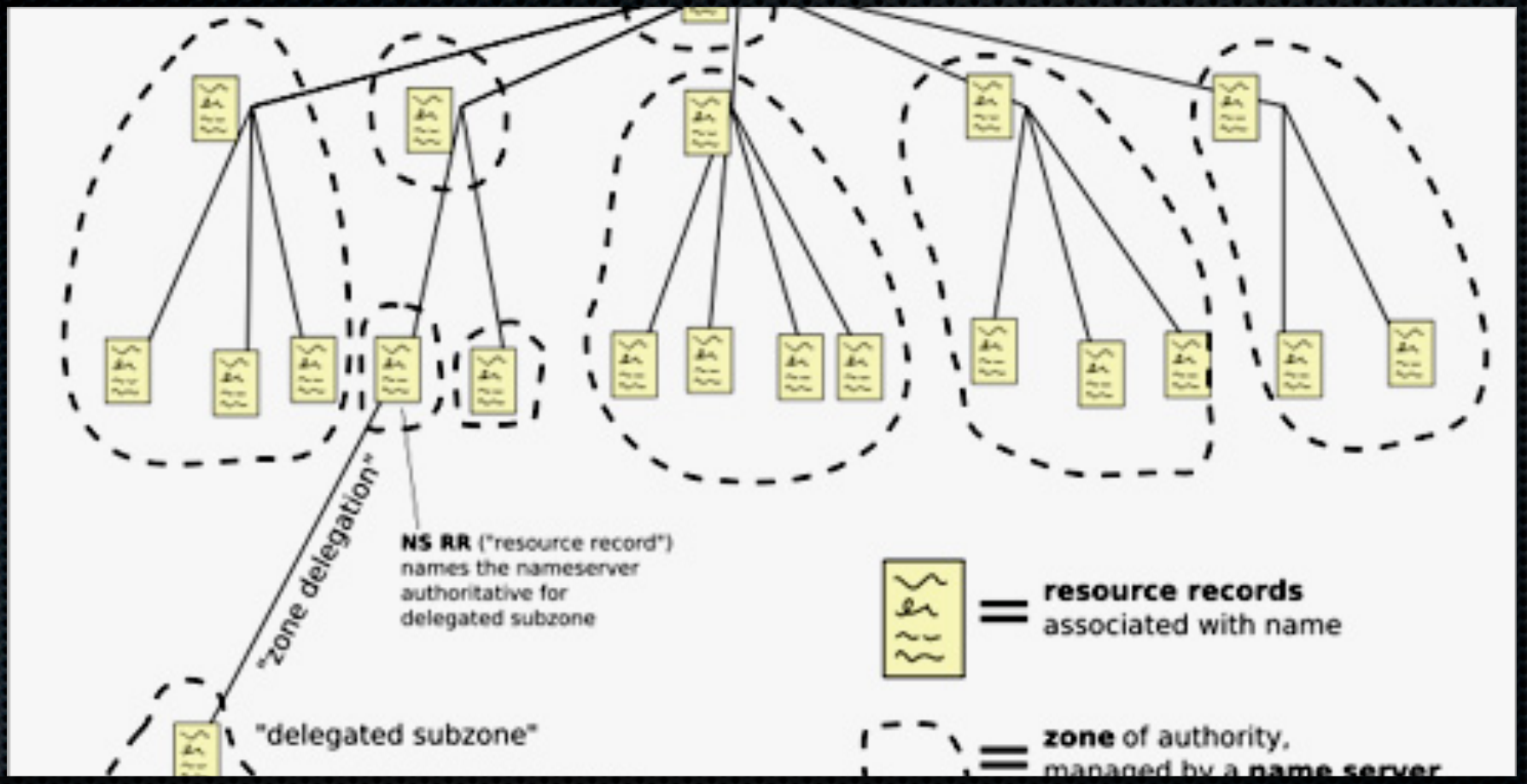
- Media Access Control
- Unique identifier for a machine's network interface
- 6 bytes
- Written in hexadecimal format and each byte separated by hyphens or colons
- 01-23-45-67-89-ab or 01:23:45:67:89:ab
- 1st 3 bytes = Organizationally Unique Identifier (OUI)

# The Dilemma

- People like names, computers like numbers
- We don’t type IP addresses into web browser address bars
- Need a way to convert a name into an address

# Hosts File

- Database for matching host names with their corresponding IP address
- Like a phone book for the Internet
- Location
  - /etc/hosts - for Mac and Linux
  - C:\system32\drivers\etc - for Windows

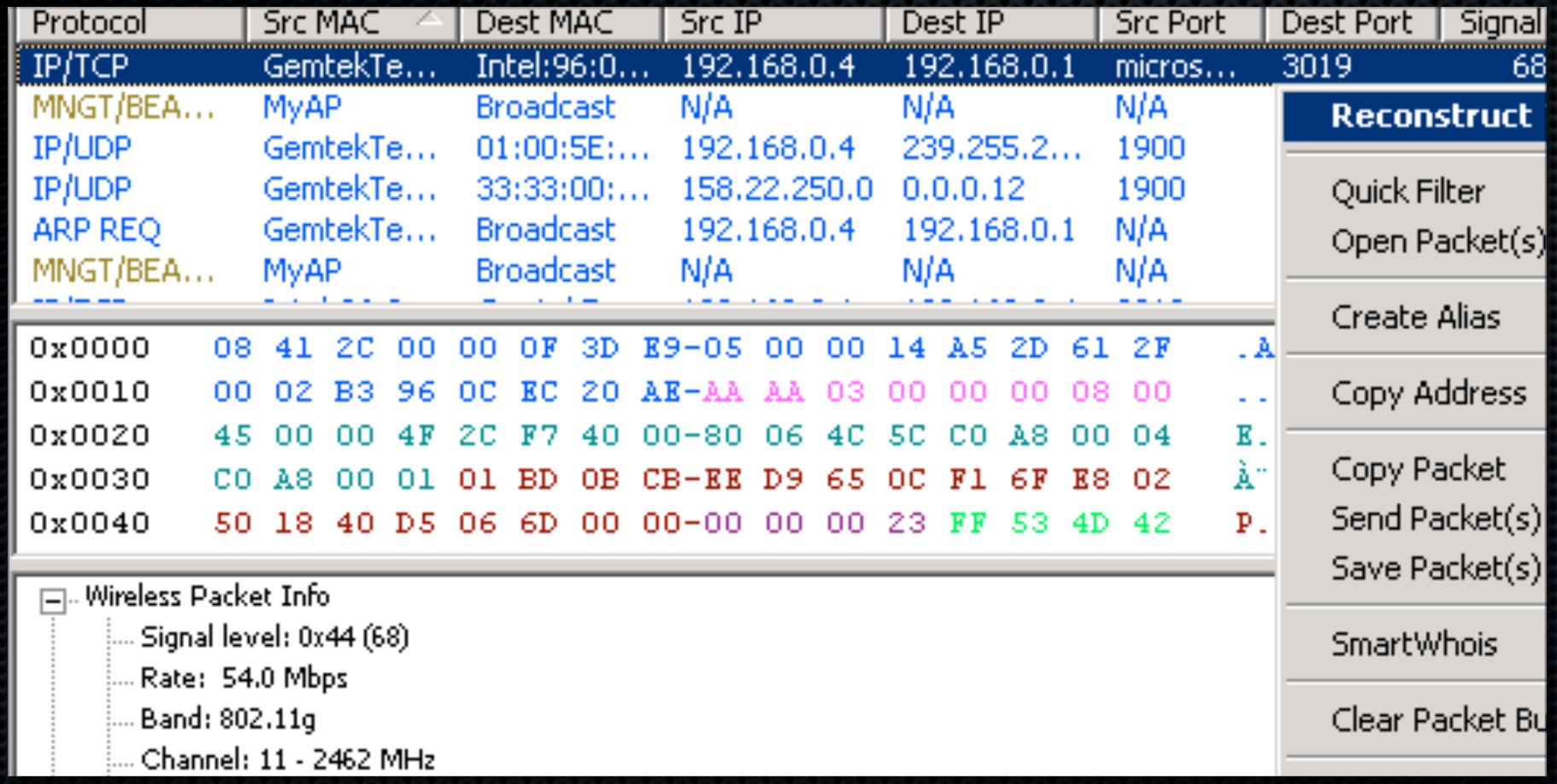



# Domain Name System

## The reason it all still works

# Domain Name System

- A distributed database that contains mappings of DNS host names to IP addresses
- Like 411 for the Internet
- Fully Qualified Domain Name - specifies the exact location or a resource in the DNS's tree hierarchy
- PROTOCOL://HOSTNAME.DOMAIN NAME.TOP LEVEL.ROOT
- http://www.example.com.




# Packet Anatomy

## The structure of your data

# Packet Anatomy

- A file that we wish to send might be billions of bits long so we break it up into more manageable chunks that we generally call packets.

# Segment

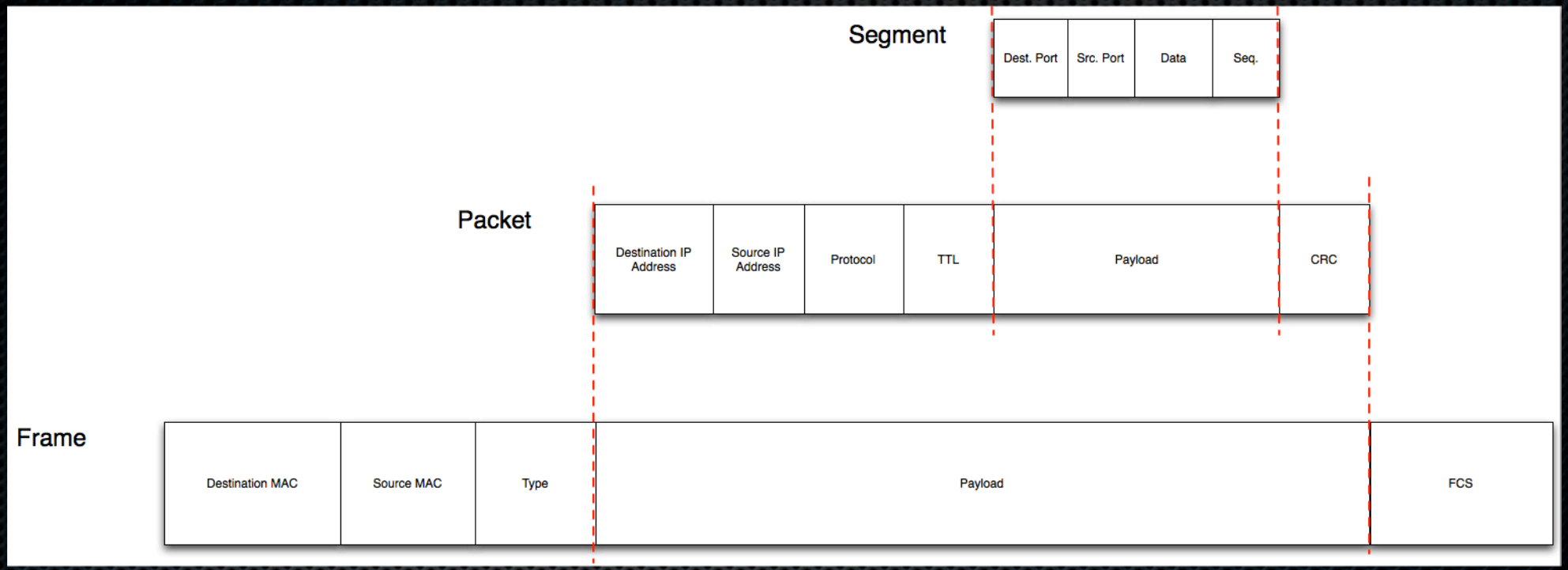
- Data broken into chunks
- Each chunk is given a source and destination port address and a sequence number

# Packet (Datagram)

- Header
- Source & Destination IP address
- Protocol number
- TTL
- User Data (Payload)
- Footer
- Cyclic Redundancy Check

# Frame

- Packet is encapsulated by a Frame
- Header
- Source & Destination MAC address
- Ethernet type / Frame type
- Data / Payload
- Footer
- CRC


Segment
Dest. Port
Src. Port
Data
Seq.
Packet
Destination IP Address
Source IP Address
Protocol
TTL
Payload
CRC
Frame
Destination MAC
Source MAC
Type
Payload
FCS

# Compression

# Compression Techniques

- The process of encoding information into fewer bits
- Reduces file size by reducing redundant data
- Various types of algorithms available

# Algorithm

- An affective method in which a well-defined set of instructions are used to complete a given task.
- Most popular is the LZ algorithm

# Three Main Formats

- Archive
- Compressed
- Combined

# Archive

- Compress every file separately into one file
- Can use different algorithms for different files
- Can be very large if contains large number of files

# Compressed

- Compress one file
- Commonly used to compress Archive formats further

# Combined

- Combines both types together into one file format

# Archive File Types

- Tar
- Tape Archive
- Initially developed as a raw format, used for tape backup
- Commonly used in Unix-like server environments
- Preserves file system information
- .tar file extension

# Compressed File Types

- Gzip
- GNU Zip
- Free
- Commonly used to compress TAR files
- .gz file extension
- .tar.gz file extension for Gzip compressed TAR files

# Compressed File Types

- Bzip2
- Free
- Open Source
- Generally more effective than gzip but slower
- .bz2 file extension

# Combined File Types

- Zip
- RAR
- Sit(x)
- DMG

# Zip

- Originally evolved by Phil Katz from the previous ARC archiving format
- .zip file extension

# RAR

- Roshal Archive
- Developed by Eugene Roshal
- Patented
- Handles split volumes
- Allows for recovery from corruption through redundancy
- .rar file extension
- .rar, .r00, .r01, .r02, etc. used for split volumes

# Sit(x)

- Stuffit
- Developed by Smith Micro Software, Inc.
- Proprietary format
- Used to be default format for Mac OS X
- No longer used by Mac OS X
- Not widely supported because of proprietary nature

# DMG

- Disk Image
- Commonly used with Mac OS X
- Offers number of compression options
- Can contain file system references such as HFS+ or UDF
- .dmg file extension

# Network Hardware

## Tools of the trade

# Ethernet

- a family of frame-based computer networking technologies for LAN's.  Defines a number of wiring and signaling standards  and a common addressing format.
- In use since the early 80’s.
- Developed at Xerox PARC by Bob Metcalfe
- Most popular and widely deployed network technology in the world

# Hub

- Allows multiple computers to share a connection
- Floods all traffic through all ports
- Becoming more rare in corporate environments

# Switch

- Provide the same cabling advantage as hubs
- Provide significant performance improvements
- Examines the contents of Ethernet frames

# Switch

- Switch receives a frame on incoming port
- Switch enters source MAC address and the port that received the frame into the MAC table
- If the destination address is unknown, the switch floods the frame to all ports
- The destination device replies to the broadcast
- Switch enters the MAC address and the switch port that received the frame into the MAC table
- Switch can now switch frames between source and destination devices onto the network without broadcasting

# Switching Methods

- Store & Forward - copies entire frame into buffer, checks CRC, then sends on
- Cut Through - Looks at destination address and sends
- Modified Cut-Through / Fragment Free - Checks the first 64 bytes and forwards if there is no error

# Bridge

- Similar to a switch
- Uses software to perform frame switching
- Much slower
- Connects two dissimilar types of networks

# Router

- Smartest of the networking devices
- Discovers possible routes to the intended destination and can select the best route

# Router

- Three Functions
  - Maintain its routing tables and notify other routers of changes
  - Use its routing tables to determine where to forward packets
  - Avoid and prevent loops

# Router

- Routers separate networks
- Each interface of the router gets its own unique IP address

# Wireless Access Point (WAP)

- Allows devices to connect to a wireless network
- Consists of a radio transmitter and receiver as well as an interface to a wired network (Ethernet)
- Serves as a bridge between the wireless network and larger Ethernet network or Internet

# Cable / DSL Modems

- Cable Modem
  - Not really a modem
  - Actually a bridge
- DSL Modem
  - Performs similar to voiceband modems
  - Uses phone lines (POTS)
  - DSL modems on each end of the line

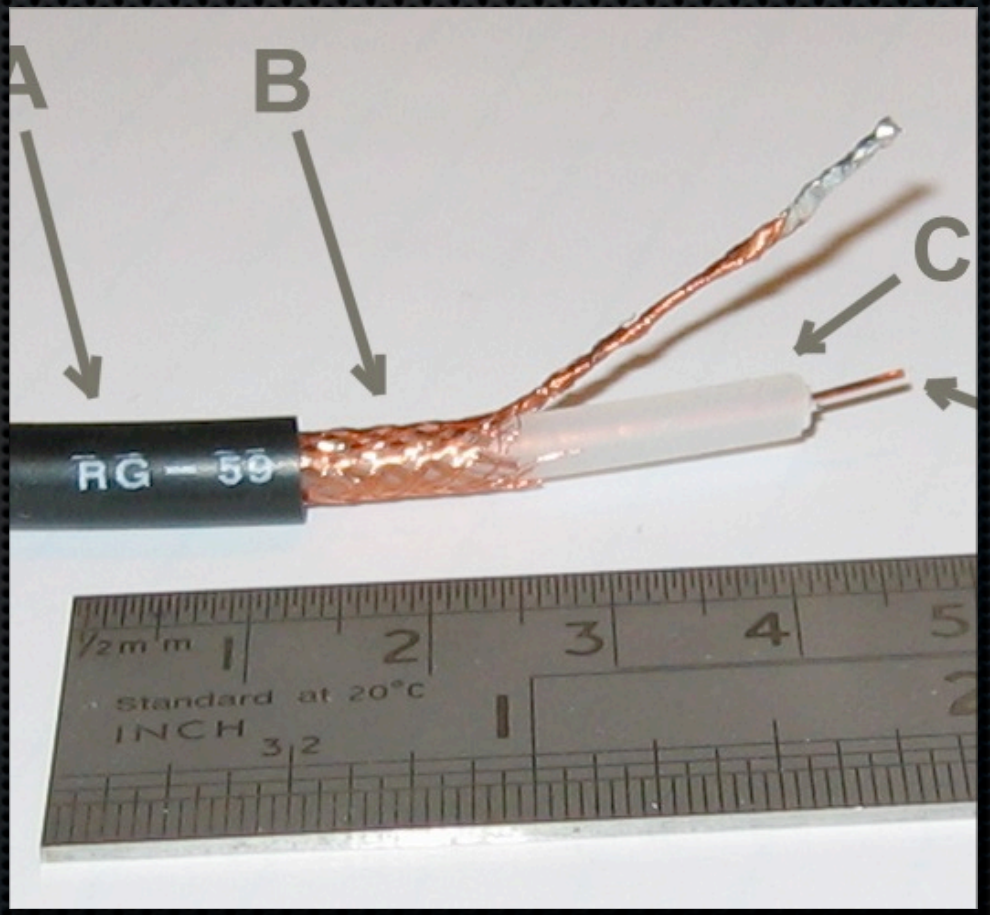
# Network Media

Media = cabling

The medium upon which your data travels

# Copper Media

- Coaxial Cable
  - Center wire surrounded by plastic insulation and then a grounded shield of braided wire which lessens interference

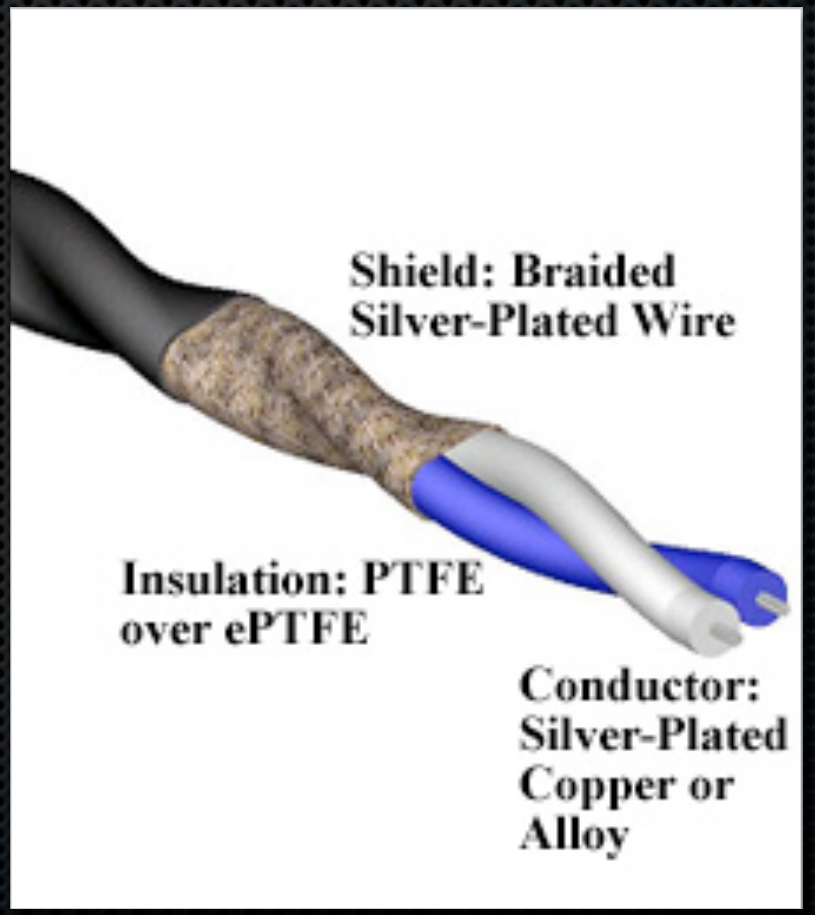


# Copper Media

- Unshielded Twisted Pair
  - Two unshielded wires that twist around each other
  - Twisting the wires helps minimize EMI

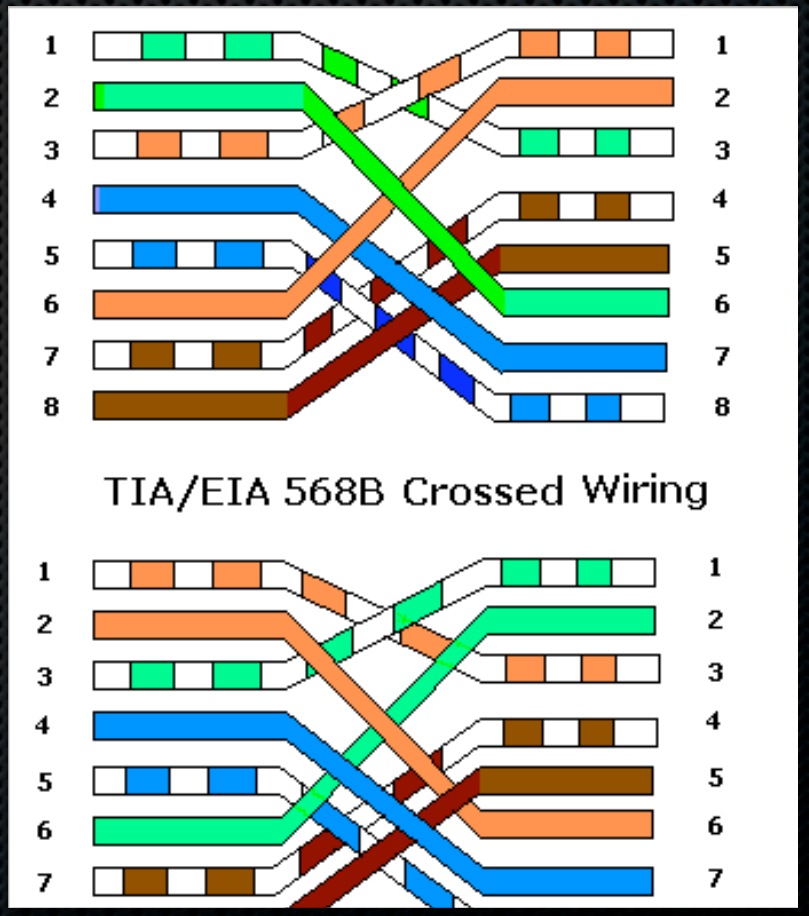
# Copper Media

- Shielded Twisted Pair
  - Insulating metal coating that functions as a ground is added to a twisted pair
  - Much less affected by interference



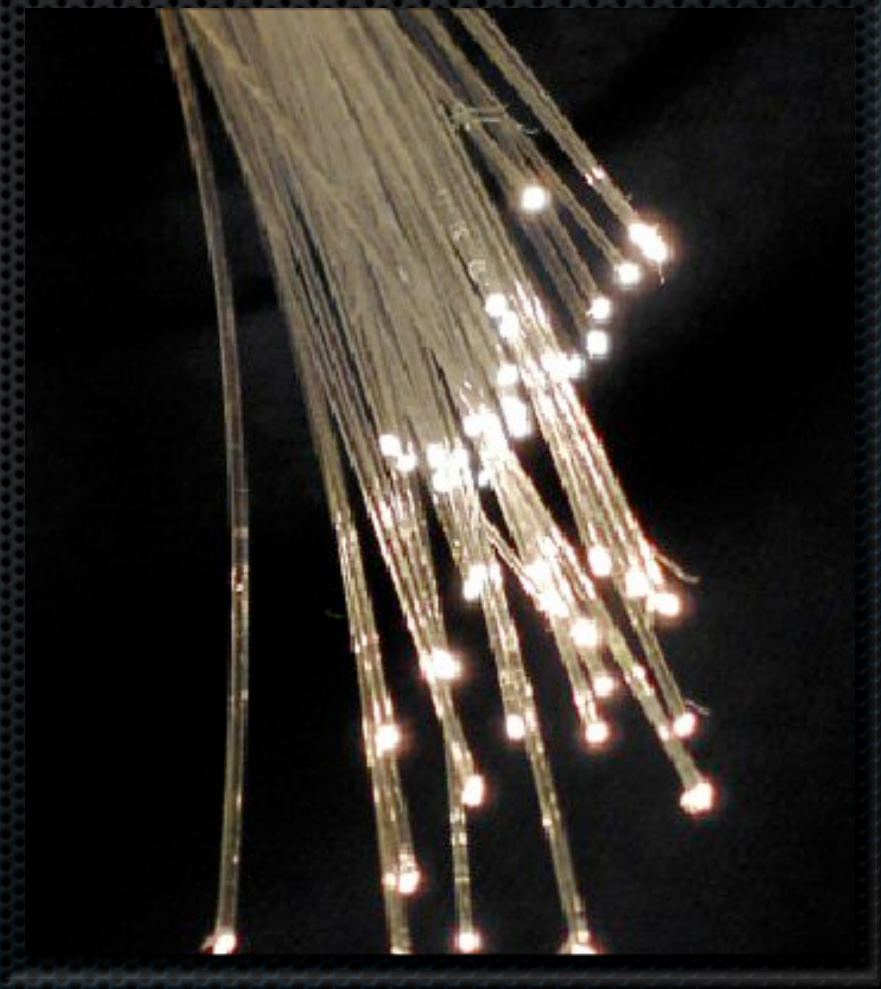
# Crossover Cable

- Maps all output signals on one electrical connector to the input signals on the other connector
- Allows devices to communicate without a hub, router, or switch



# Optical Media

- Uses glass threads to transmit data
- Greater bandwidth
- Less susceptible to interference and can therefore carry data farther
- Thinner and lighter
- Expensive



# Baseband

- Digital signaling is used to send data over a single transmission medium using the entire bandwidth of that medium
- Single channels of transmission

# Broadband

- Analog signaling is used to send data over a transmission medium using a portion of the bandwidth of that medium.  Signals are sent as waves of electromagnetic or optical energy
- Multiple channels of transmission

# 10Base-2

- Variant of Ethernet that uses coaxial cable
- 10Mbps maximum transmission speed
- Maximum distance of 200 meters

# 10Base-5

- Used a thicker coaxial cable
- 10Mbps maximum transmission speed
- Max distance of 500 meters

# 10Base-T

- Ethernet over twisted pair
- 100Base-TX = 100Mbps
- 1000Base-T = 1000Mbps = 1Gbps
- 10GBase-T = 10Gbps
- Max distance of 100 meters

# RJ45

- A type of registered jack (a standardized physical network interface)

# Cat5

- Category 5 Cable
- Twisted pair cabling, typically unshielded
- Used for Ethernet or ATM
- Cat6 used for Gigabit Ethernet