

Networking Basics

Pre-class work...read/watch all the material at least once before class...I will clarify in class.

Binary Training(Google search for "binary tutorial"):

<http://www.math.grin.edu/~rebelsky/Courses/152/97F/Readings/student-binary>

<http://www.codeconquest.com/tutorials/binary/>

<https://www.youtube.com/watch?v=0qjEkh3P9RE>

<https://www.youtube.com/watch?v=VBDoT8o4q00>

Subnet Addressing and Masks(Google search for "subnet mask tutorial"):

<http://www.techopedia.com/6/28587/internet/8-steps-to-understanding-ip-subnetting>

<http://www.subnetting.net/Tutorial.aspx>

https://www.youtube.com/watch?v=aA-8owNNy_c

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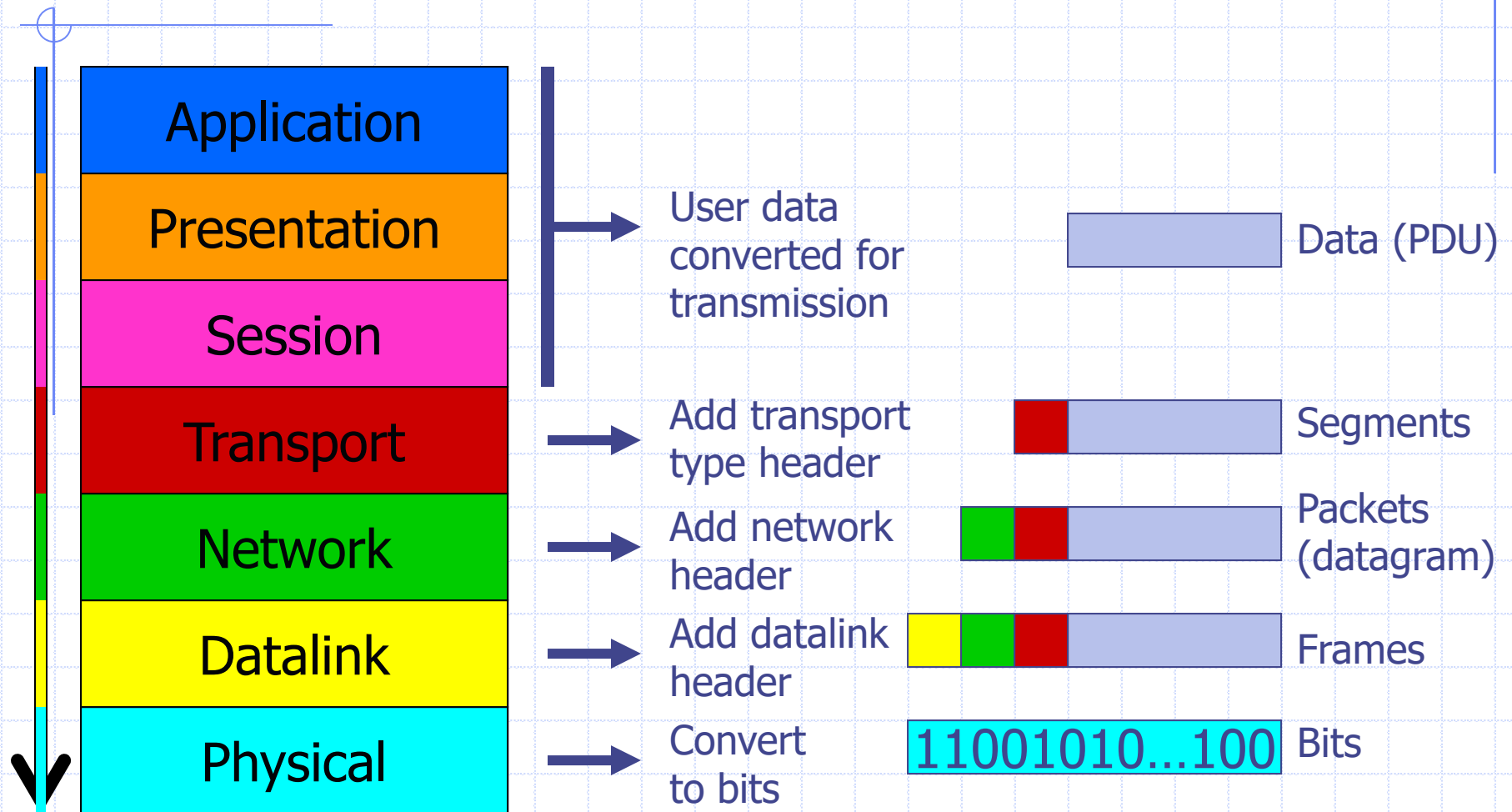
- ◆ (3)What is the OSI Model?
- ◆ (6)What is a Hub, Switch, & Router/Access Server?
- ◆ (10)Mac Addresses and IP Addresses
- ◆ (15)The "3 GOLDEN PARAMETERS"
- ◆ (16)Day in the Life of a Packet
- ◆ (17)Duplex Issues
- ◆ (18)PC Configuration Guidance
- ◆ (21)Basic Discovery & Connectivity Tools
- ◆ (23)IPv4 Layers and Port Numbers

What is the OSI Model?

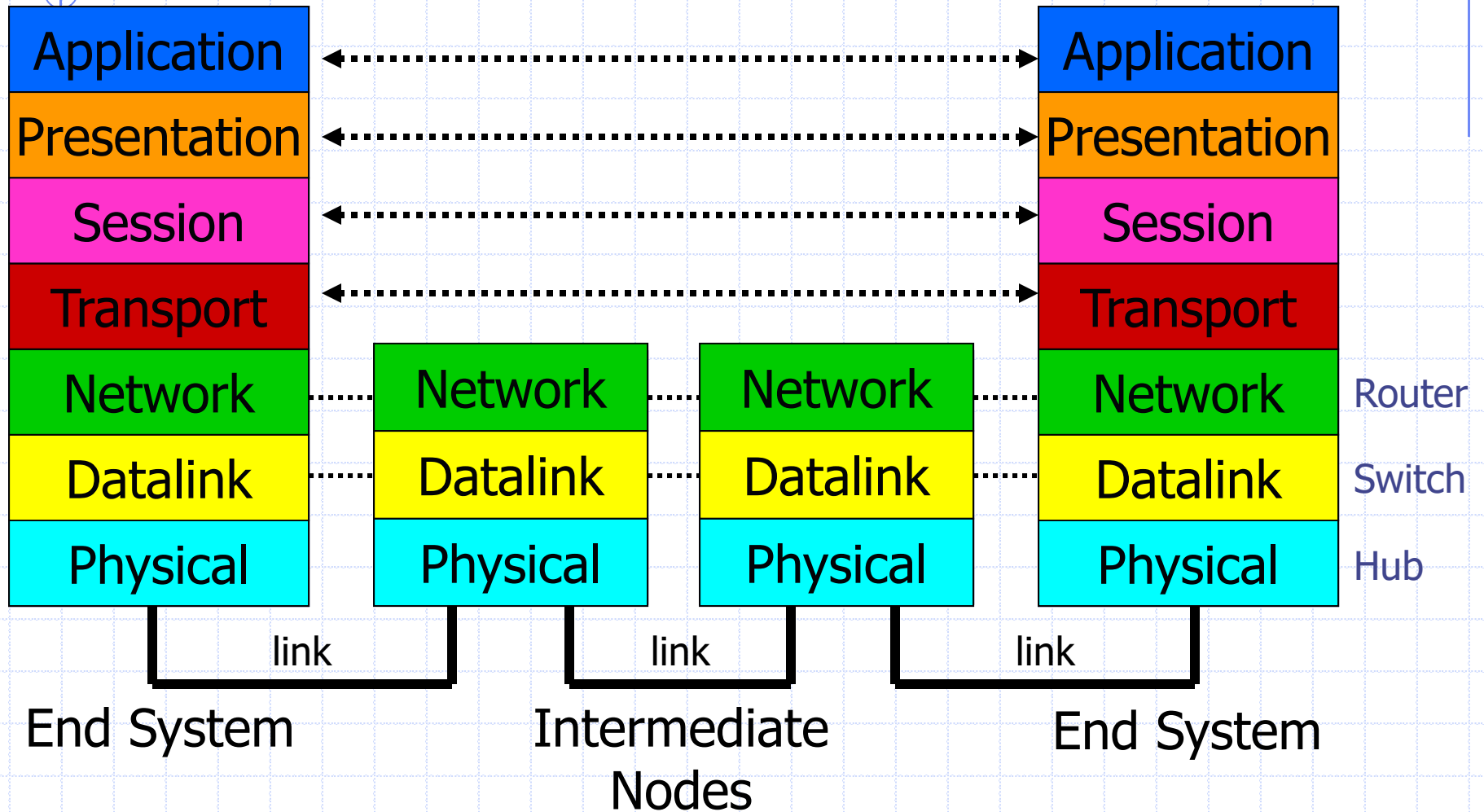
- ◆ OSI – open systems interconnection
- ◆ Main functions
 - Network dependent functions
 - Application-oriented functions
- ◆ Seven layer model
 - Each layer performs a well-defined set of functions



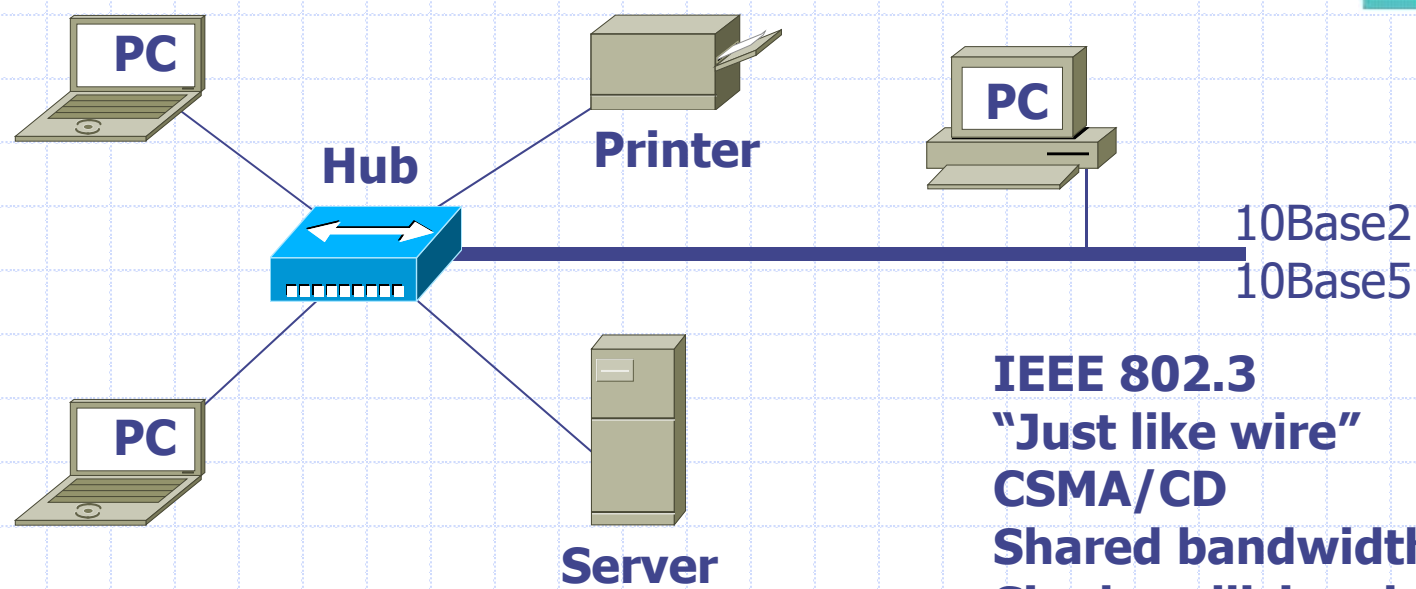
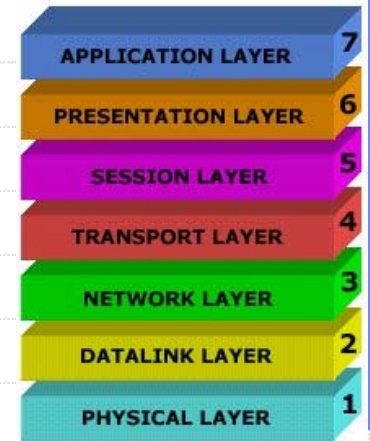
Data Encapsulation



ISO's OSI Reference Model



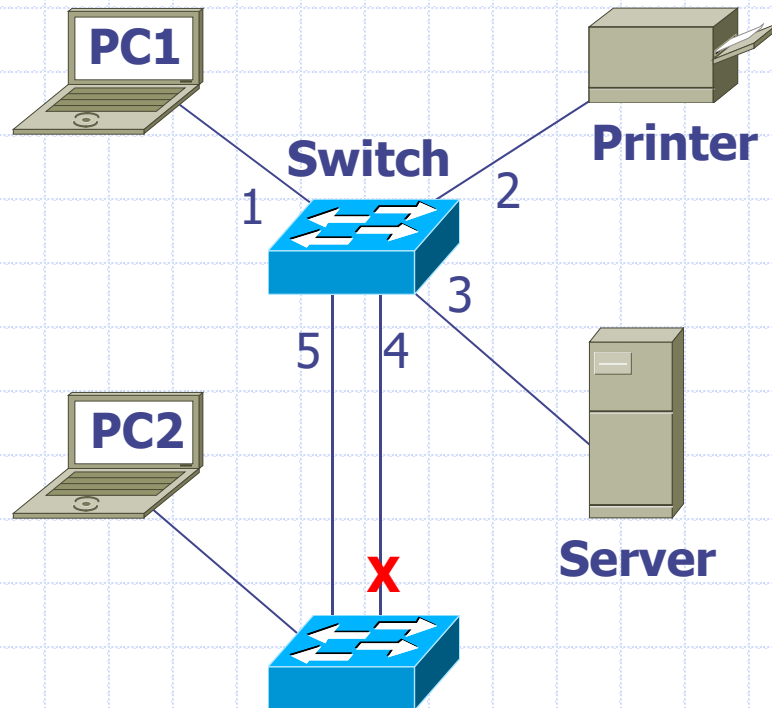
What is a Hub?



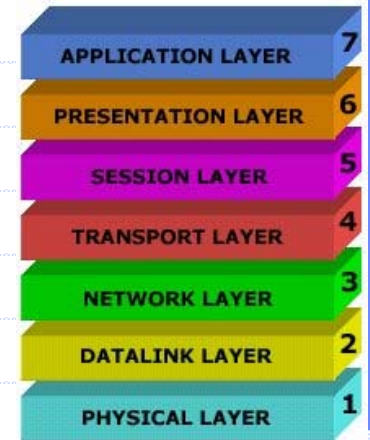
This is a single local area network (LAN)

- IEEE 802.3
- "Just like wire"
- CSMA/CD
- Shared bandwidth
- Single collision domain
- Single broadcast domain
- B=FFFF.FFFF.FFFF
- M=0100.5Exx-xxxx
- No Redundancy

What is a Switch?

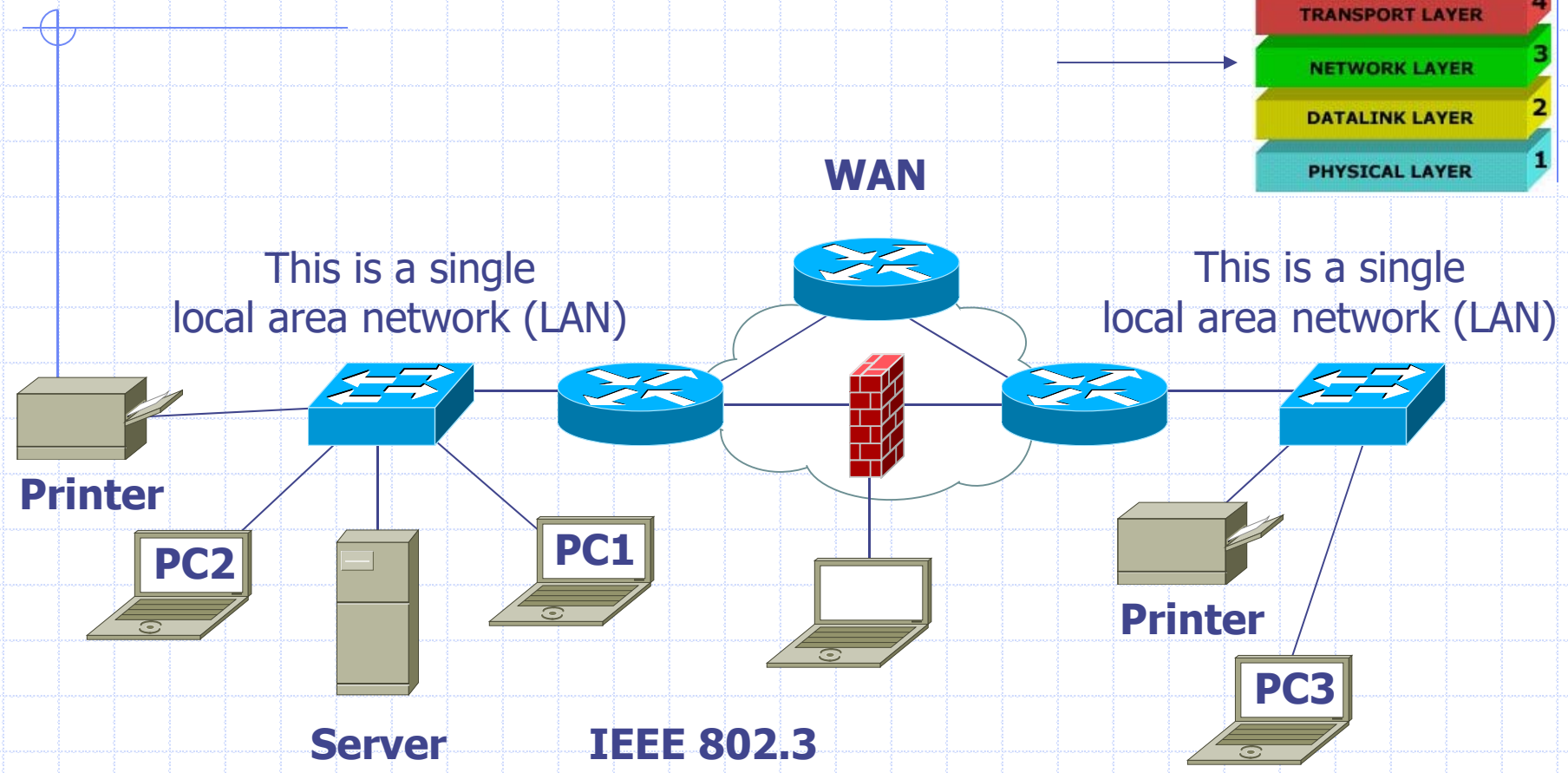
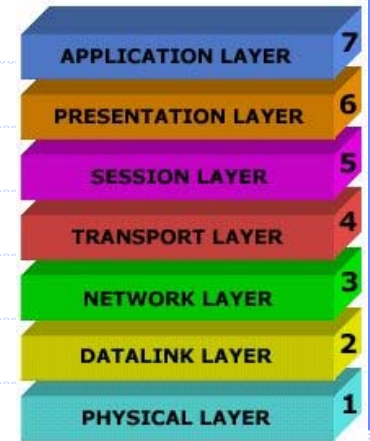


This is a single local area network (LAN)



IEEE 802.3
Maps Mac's to Port's
Independent bandwidth
2 port collision domain
Single broadcast domain
B=FFFF.FFFF.FFFF
M=0100.5Exx-xxxx
Redundancy via STP

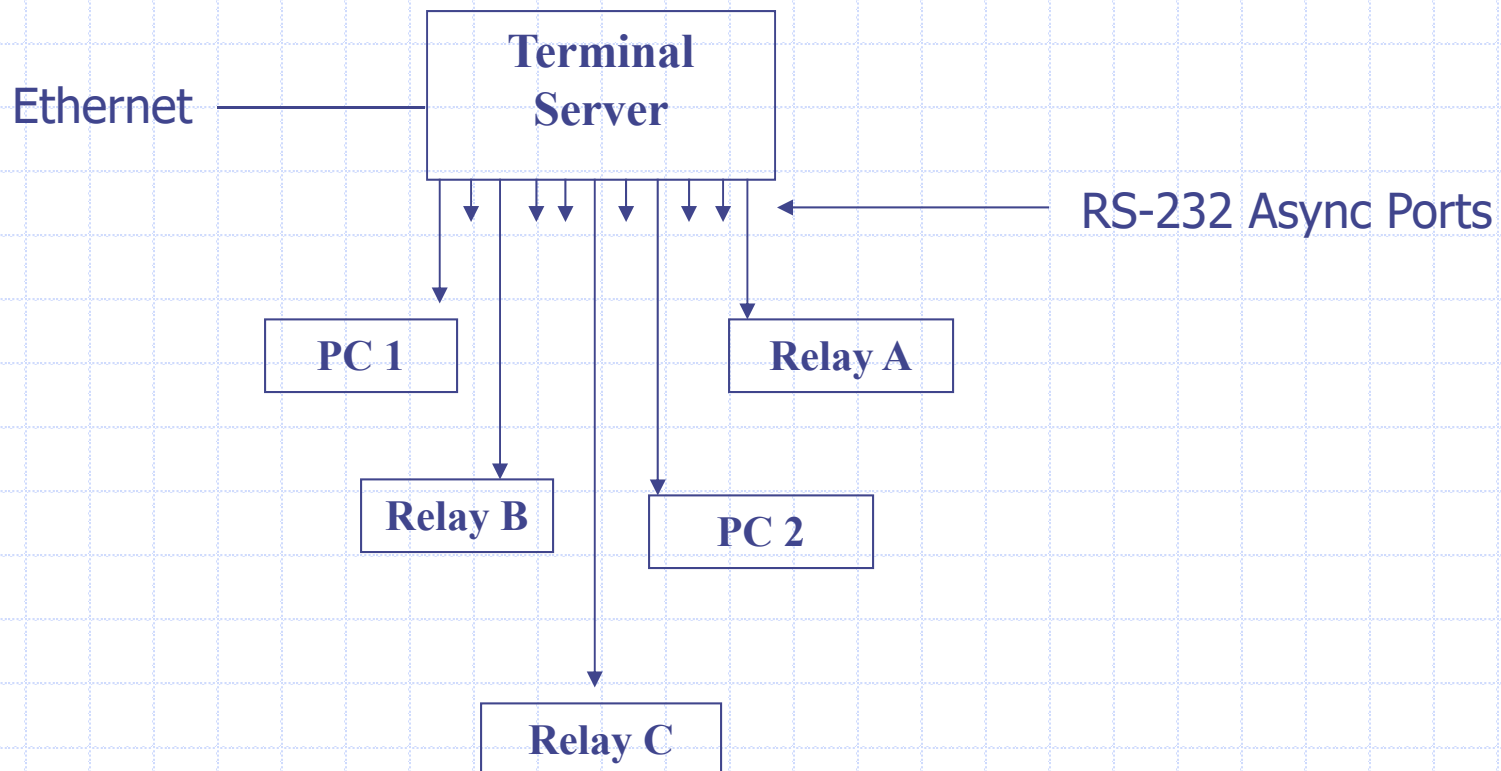
What is a Router?



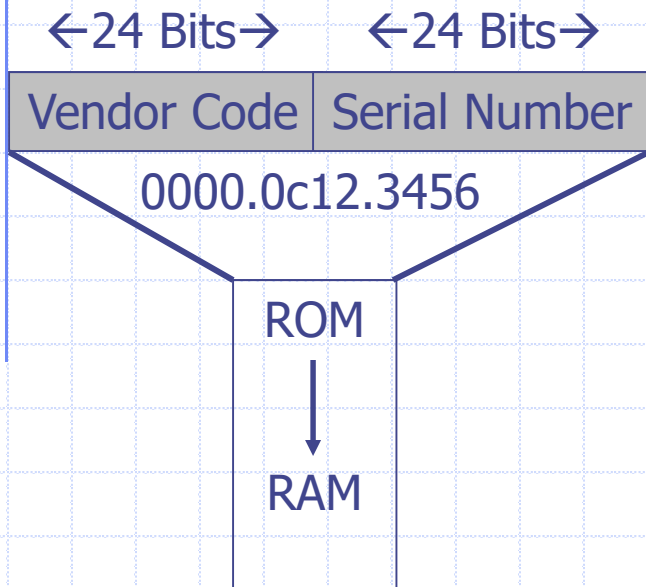
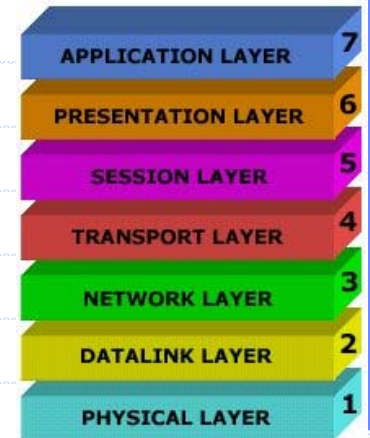
- IEEE 802.3
- Independent bandwidth
- Isolates broadcast domains
- Redundancy via routing

What is an Terminal Server?

Terminal Server – provides RS-232 connectivity



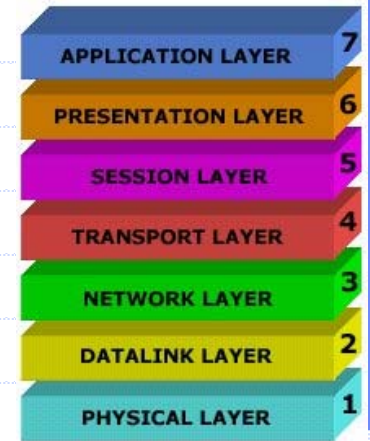
MAC Address at Datalink Layer



Could also be displayed as follows:
00-00-0c-12-34-56
00.00.0c.12.34.56

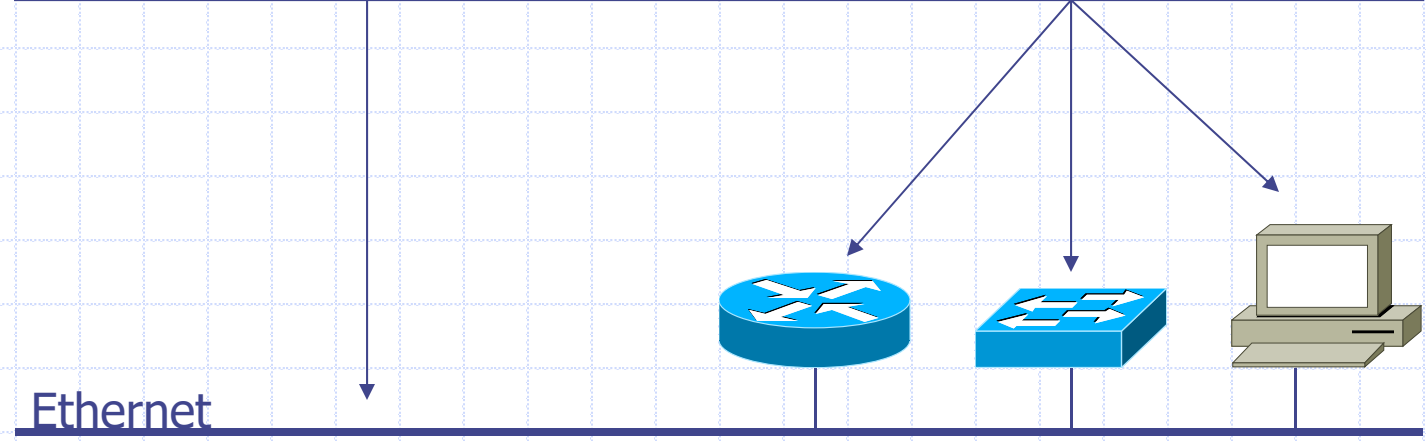
- The MAC address is burned into ROM on a network interface card
- DOS prompt> ipconfig /all
- IEEE assigned Vendor Code portion

IP Address at Network Layer



8, 16, or 24 bits from ARIN
Varies with subnet mask.

32 Bits



•ARIN: American Registry for Internet Numbers

IPv4 Addressing

Network part of address in **BLUE** cannot be modified by owner.

Host part of address in **RED** and can be used for more networks.

		Classful Mask
0nnnnnnn.hhhhhhhh.hhhhhhhh.hhhhhhhh	Class A	255.0.0.0
10nnnnnnn.nnnnnnnn.hhhhhhhh.hhhhhhhh	Class B	255.255.0.0
110nnnnn.nnnnnnnn.nnnnnnnn.hhhhhhhh	Class C	255.255.255.0
1110hhhh.hhhhhhhh.hhhhhhhh.hhhhhhhh	Class D	Multicast Addresses

2 ⁷	2 ⁶	2 ⁵	2 ⁴	2 ³	2 ²	2 ¹	2 ⁰
128	64	32	16	8	4	2	1

Binary counting is necessary!

Basics

Powers of 2

$2^0 = 1$
 $2^1 = 2$
 $2^2 = 2 \times 2 = 4$
 $2^3 = 2 \times 2 \times 2 = 8$
 $2^4 = 2 \times 2 \times 2 \times 2 = 16$
 $2^5 = 32$
 $2^6 = 64$
 $2^7 = 128$
 $2^8 = 256$

The Subnet Mask represents how large an IP subnetwork is. The first IP address within the subnet is called Network ID IP address. The last IP address within the subnet is called Broadcast IP address. We don't use the first and last IP address within the subnet by convention.

10.12.16.0/30 10.12.16.1→3	4 Hosts and used for point to point links between routers
10.12.16.4/30 10.12.16.5→7	4 Hosts
10.12.16.8/30 10.12.16.9→11	4 Hosts
10.12.16.12/30 10.12.16.13→15	4 Hosts
10.12.16.16/28 10.12.16.17→31	16 Hosts and used for PMU subnets (/28 must start on a 16 host boundary)
10.12.16.32/30 10.12.16.33→35	4 Hosts (/30 must start on a 4 host boundary)
etc...	

Hosts	Mask	Mask	Binary	
1	/32	255.255.255.255	11111111.11111111.11111111.11111111	Known as a host mask
2	/31	255.255.255.254	11111111.11111111.11111111.11111110	
4	/30	255.255.255.252	11111111.11111111.11111111.11111100	
8	/29	255.255.255.248	11111111.11111111.11111111.11111000	
16	/28	255.255.255.240	11111111.11111111.11111111.11110000	
32	/27	255.255.255.224	11111111.11111111.11111111.11100000	
64	/26	255.255.255.192	11111111.11111111.11111111.11000000	
128	/25	255.255.255.128	11111111.11111111.11111111.10000000	
256	/24	255.255.255.0	11111111.11111111.11111111.00000000	
512	/23	255.255.254.0	11111111.11111111.11111110.00000000	
1024	/22	255.255.252.0	11111111.11111111.11111100.00000000	etc...

IP Masks

How to determine the Network part of an address versus the Host part.

128	192	224	240	248	252	254	255
128	64	32	16	8	4	2	1

Do the IP Addressing and Subnetting Lab!

How many networks and hosts for any given mask and the IP 10.20.31.0?

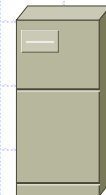
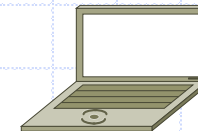
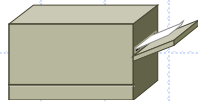
Mask	Networks	Hosts
255.255.0.0		
255.255.240.0		
255.255.255.0		
255.255.255.252		

IP Rules, ALL devices adhere to!

The 3 Golden Parameters:

**IP Address
IP Mask
Default Gateway (Router)**

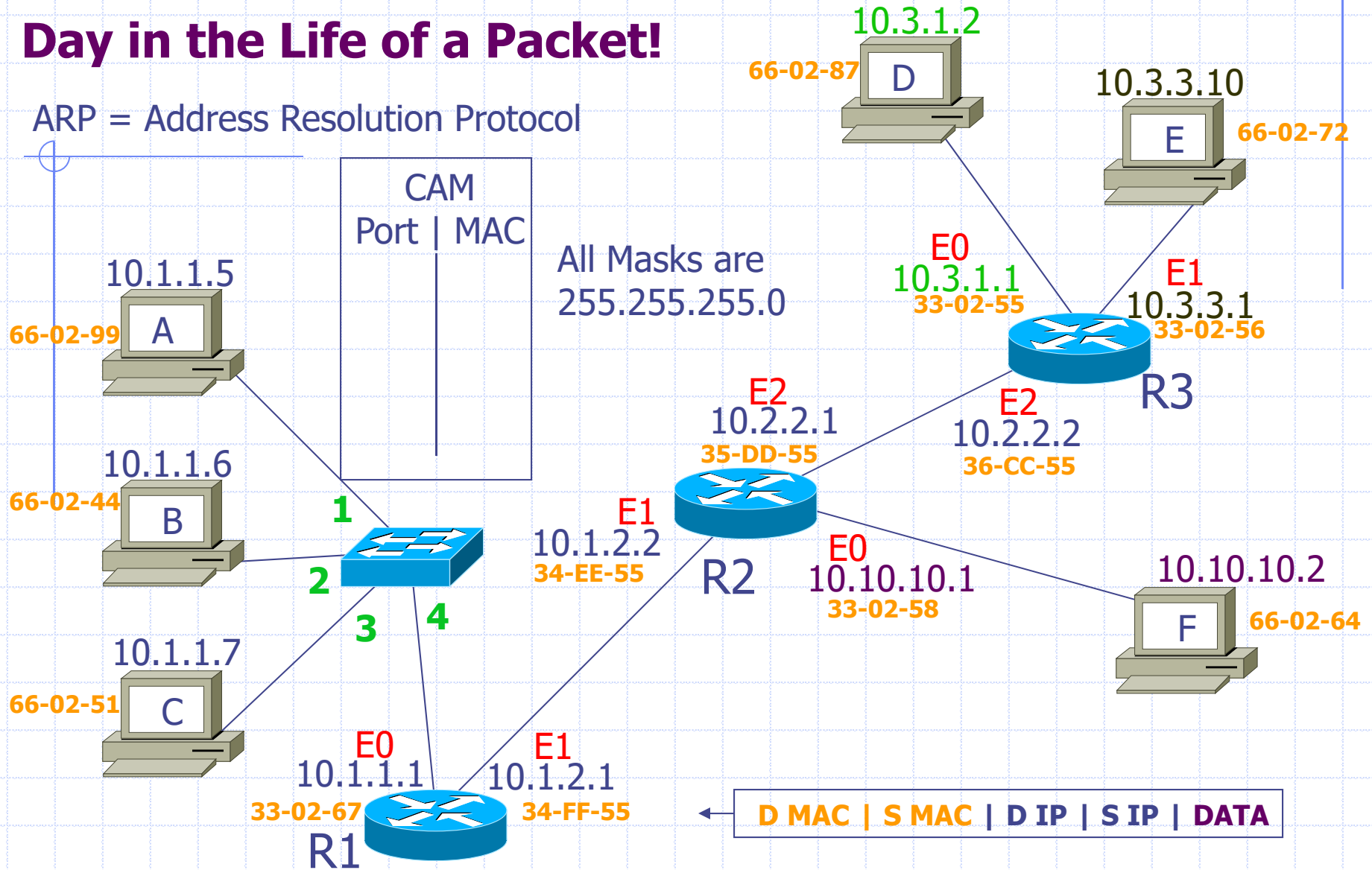
**[Done by DHCP for laptops...
Dynamic Host Config Protocol]**



1. A device is told to communicate to an IP Address via user input.
2. The device compares the local IP Address with the destination IP Address using the IP Mask.
3. The device then chooses from the following options:
 - a. If the two network portions of the IP Address are the same, deliver the packet without assistance from the Default Gateway.
 - b. If the two network portions of the IP Address are different, send the packet to the Default Gateway, and let the router worry about delivery.

Day in the Life of a Packet!

ARP = Address Resolution Protocol

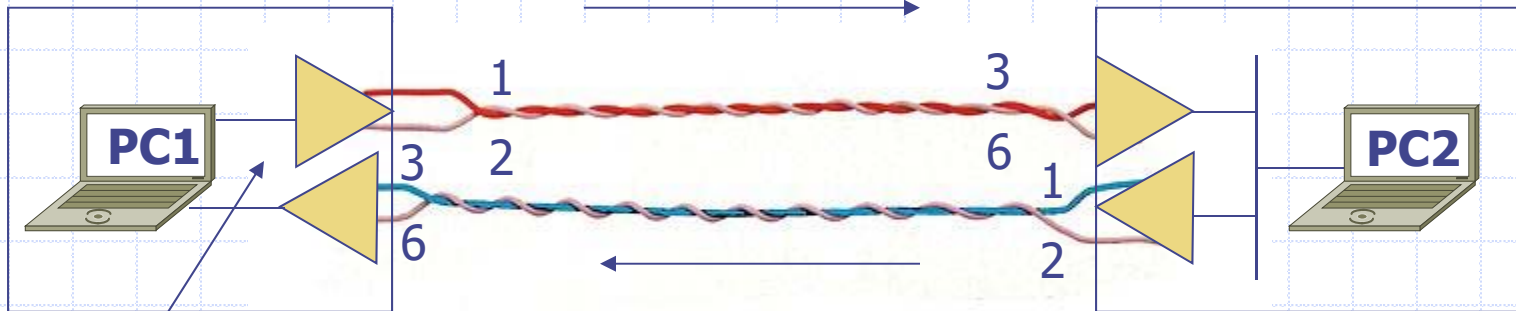


The default gateway is always a router's interface on the same subnet as the device.

Half/Full Duplex & Cable Issues!

Full Duplex

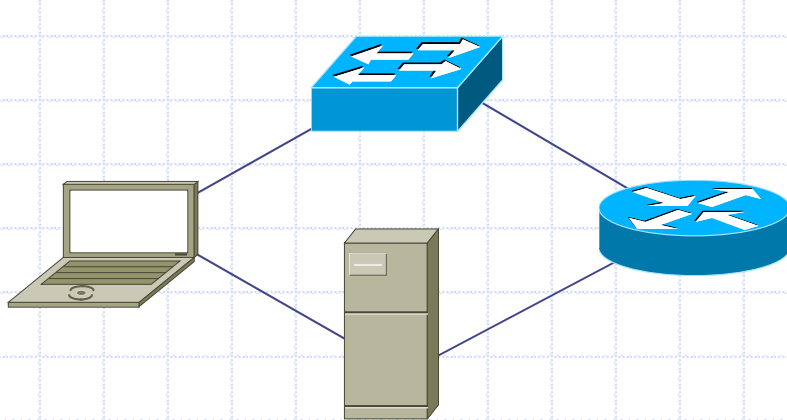
Half Duplex



Balanced Line Receiver

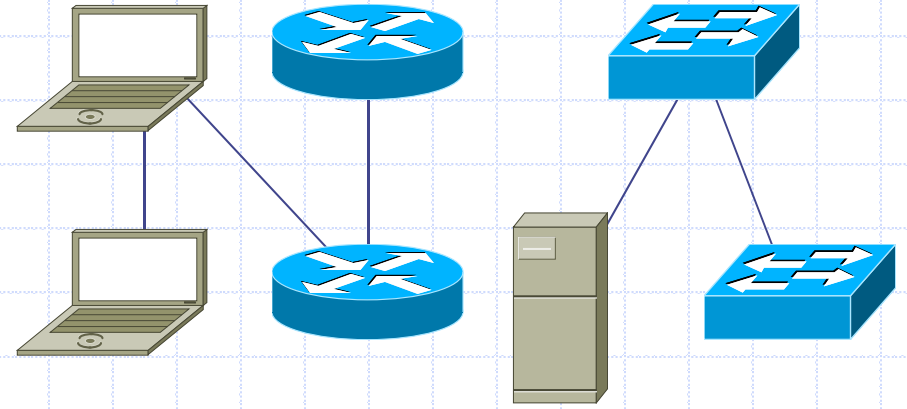
Use a straight through cable

Use a **cross-over** cable



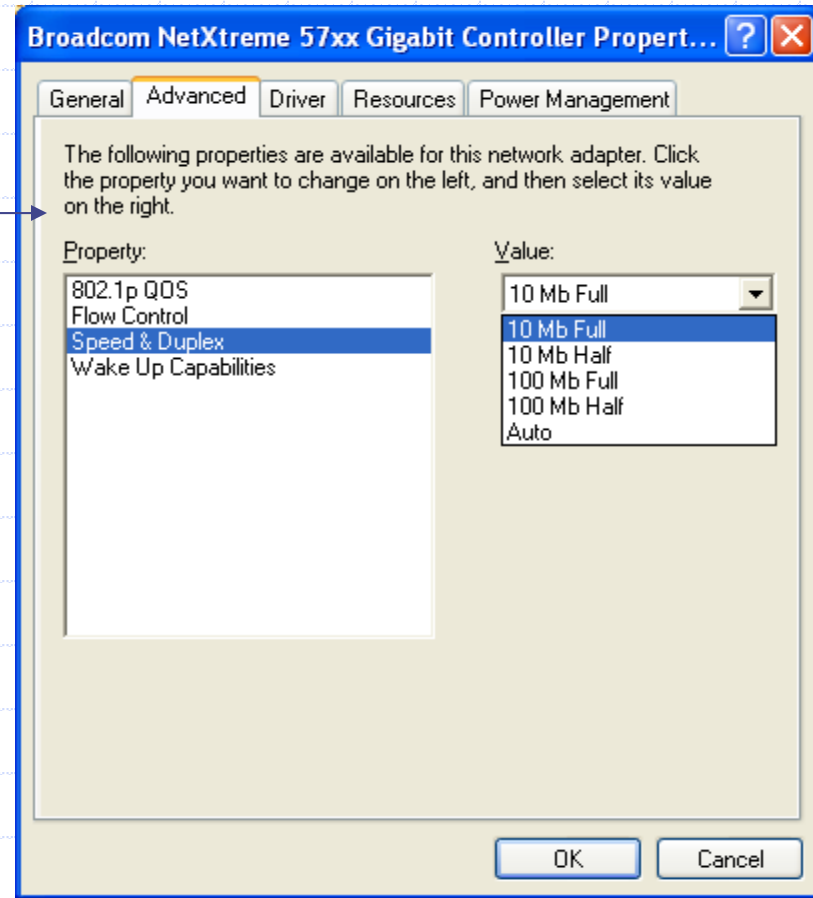
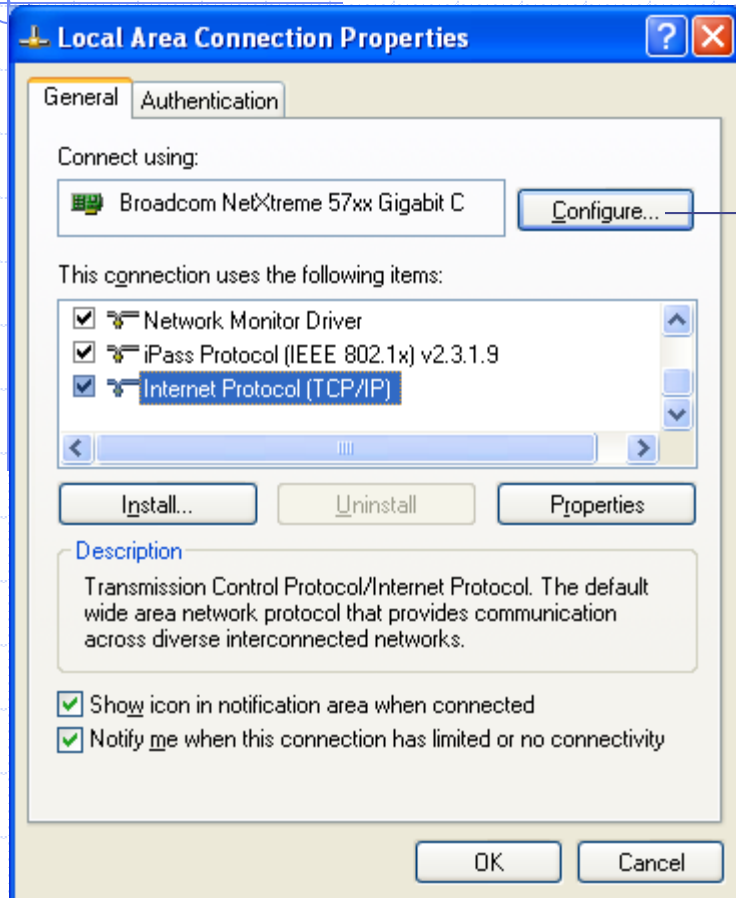
2/10/2017

Switch blade



Switch blade₁₇

Checking the PC's Speed & Duplex Settings Is Your PC Firewall ON?



How is my PC set up? DOS> ipconfig /all

```
C:\Users\xxxxxxx>ipconfig/all
```

Windows IP Configuration

```
Host Name . . . . . : xxxxxxxxxxxxxx  
Primary Dns Suffix . . . . . : xxx.bpa.gov  
Node Type . . . . . : Hybrid  
IP Routing Enabled. . . . . : No  
WINS Proxy Enabled. . . . . : No  
DNS Suffix Search List. . . . . : xxx.bpa.gov
```

Ethernet adapter Local Area Connection:

```
Connection-specific DNS Suffix . : xxx.bpa.gov  
Description . . . . . : Intel(R) 82579LM Gigabit Network Connection  
Physical Address. . . . . : F0-1F-AF-4D-54-69  
DHCP Enabled. . . . . : Yes  
Autoconfiguration Enabled . . . . : Yes  
IPv4 Address. . . . . : 10.10.10.10(Preferred)  
Subnet Mask . . . . . : 255.255.255.0  
Lease Obtained. . . . . : Tuesday, January 17, 2017 9:56:23 AM  
Lease Expires . . . . . : Tuesday, January 24, 2017 9:58:28 AM  
Default Gateway . . . . . : 10.10.10.1  
DHCP Server . . . . . : 10.10.10.100  
DNS Servers . . . . . : 10.10.10.200  
                        10.10.10.201  
NetBIOS over Tcpi. . . . . : Disabled
```

```
C:\Users\xxxxxxx>
```

Automatic Private IP Addressing (APIPA)

A Windows-based computer that is configured to use DHCP can automatically assign itself an Internet Protocol (IP) address if a DHCP server is not available. For example, this could occur on a network without a DHCP server, or on a network if a DHCP server is temporarily down for maintenance.

The Internet Assigned Numbers Authority (IANA) has reserved 169.254.0.0-169.254.255.255 for Automatic Private IP Addressing. As a result, APIPA provides an address that is guaranteed not to conflict with routable addresses.

Disable APIPA on the Entire Computer:

1. Use Registry Editor to create the following registry key:
HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Services\Tcpip\Parameters
2. Add the following value to this key:
Value name: IPAutoconfigurationEnabled
Value type: REG_DWORD
Value in hexadecimal: 0 (A value of 0 disables APIPA support on this computer)

NOTE: If the IPAutoconfigurationEnabled entry is not present, a default value of 1 is assumed, which indicates that APIPA is enabled.

3. After you make this change, restart your computer.

Testing Connectivity with Ping

```
C:\Users\xxxxxxx>ping www.google.com
```

```
Pinging www.google.com [172.217.2.196] with 32 bytes of data:
```

```
Reply from 172.217.2.196: bytes=32 time=68ms TTL=49  
Reply from 172.217.2.196: bytes=32 time=68ms TTL=49  
Reply from 172.217.2.196: bytes=32 time=68ms TTL=49  
Reply from 172.217.2.196: bytes=32 time=68ms TTL=49
```

```
Ping statistics for 172.217.2.196:
```

```
Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),  
Approximate round trip times in milli-seconds:  
Minimum = 68ms, Maximum = 68ms, Average = 68ms
```

```
C:\Users\JNA2267>
```

```
C:\Users\JNA2267>
```

```
C:\Users\JNA2267>
```

```
C:\Users\JNA2267>ping 172.217.2.196
```

```
Pinging 172.217.2.196 with 32 bytes of data:
```

```
Reply from 172.217.2.196: bytes=32 time=68ms TTL=49  
Reply from 172.217.2.196: bytes=32 time=68ms TTL=49  
Reply from 172.217.2.196: bytes=32 time=68ms TTL=49  
Reply from 172.217.2.196: bytes=32 time=68ms TTL=49
```

```
Ping statistics for 172.217.2.196:
```

```
Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),  
Approximate round trip times in milli-seconds:  
Minimum = 68ms, Maximum = 68ms, Average = 68ms
```

Testing Connectivity with Tracert

```
C:\Users\xxxxxxx>tracert www.google.com
```

```
Tracing route to www.google.com [172.217.7.164]  
over a maximum of 30 hops:
```

```
 1  4 ms   1 ms   1 ms 10.10.10.1  
 2 21 ms  40 ms  25 ms 10.20.20.1  
 3 <1 ms <1 ms <1 ms 170.160.65.1  
 4 <1 ms <1 ms <1 ms 170.160.64.2  
 5  2 ms   2 ms   2 ms 174.127.154.237  
 6 *    2 ms   2 ms br1-spk-te-0-0-12.bb.spectrumnet.us [174.127.139.31]  
 7 13 ms  13 ms  13 ms 174.127.136.122  
 8 13 ms  13 ms  14 ms cr2-sea-a-te-0-0-0-16.bb.spectrumnet.us [174.127.140.185]  
 9 13 ms  13 ms  13 ms 216.243.15.243  
10 13 ms  14 ms  13 ms 108.170.245.99  
11 13 ms  14 ms  13 ms 74.125.37.211  
12 53 ms  53 ms  53 ms 72.14.233.110  
13 68 ms  68 ms  68 ms 209.85.143.171  
14 68 ms  73 ms  68 ms 216.239.48.100  
15 68 ms  68 ms  68 ms 108.170.240.97  
16 68 ms  68 ms  68 ms 216.239.54.15  
17 68 ms  68 ms  68 ms 172.217.7.164
```

```
Trace complete.
```

Layer De-capsulation A TCP/IP Example

