The Closure Lecture

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Agenda

- Network classes
- Subnetting
- VLANs
- Static routing

Network classes

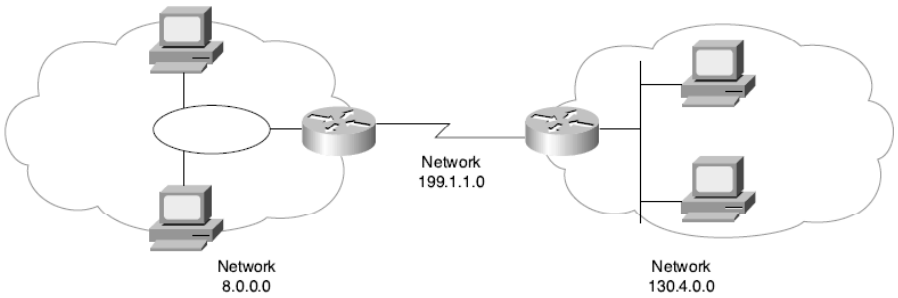
Classes of Networks

- IP defines three different network classes, called A, B, and C, from which individual hosts are assigned IP addresses.
- TCP/IP defines Class D (multicast) addresses and Class E (experimental) addresses as well.
- By definition, all addresses in the same Class A, B, or C network have the same numeric value *network portion of the addresses.*
- *The rest of the address is called the host portion of the* address.

- Class A networks have a 1-byte-long network part. That leaves 3 bytes for the rest of the address, called the host part.
- Class B networks have a 2-byte-long network part, leaving 2 bytes for the host portion of the address.
- Class C networks have a 3-byte-long network part, leaving only 1 byte for the host part.

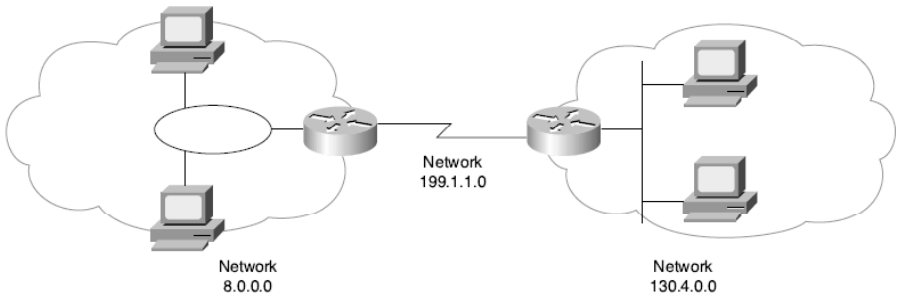
- network 8.0.0.0 next to the Token Ring. Network 8.0.0.0 is a Class A network, which means that only 1 byte is used for the network part of the address.

Sample Network Using Class A, B, and C Network Numbers



- Class B network 130.4.0.0 is listed next to the Ethernet; because it is Class B, 2 bytes define the network part, and all addresses begin with those same two bytes.
- So, Class A network "8" is written 8.0.0.0, Class B network 130.4 is written 130.4.0.0, and so on.

Sample Network Using Class A, B, and C Network Numbers



Sizes of Network and Host Parts of IP Addresses with No Subnetting

Any Network of This Class	Number of Network Bytes (Bits)	Number of Host Bytes (Bits)	Number of Addresses per Network*
A	1 (8)	3 (24)	$2^{24} - 2$
B	2 (16)	2 (16)	$2^{16} - 2$
C	3 (24)	1 (8)	$2^{8} - 2$

- Two numbers inside each Class A, B, or C network are reserved, one of the two reserved values is the network number itself
- The other reserved value is the one with all binary 1s in the host part of the address—this number is called the *network broadcast or directed broadcast* address.

*List of All Possible Valid Network Numbers**

Class	First Octet Range	Valid Network Numbers	Total Number of This Class of Network	Number of Hosts per Network
A	1 to 126	1.0.0.0 to 126.0.0.0	$2^{7} - 2$	$2^{24} - 2$
B	128 to 191	128.1.0.0 to 191.254.0.0	$2^{14} - 2$	$2^{16} - 2$
C	192 to 223	192.0.1.0 to 223.255.254.0	$2^{21} - 2$	$2^{8} - 2$

- There are several reserved cases. For example, networks 0.0.0.0 (originally defined for use as a broadcast address) and 127.0.0.0 (still available for use as the loopback address) are reserved.
- Networks 128.0.0.0, 191.255.0.0, 192.0.0.0, and 223.255.255.0 also are reserved.

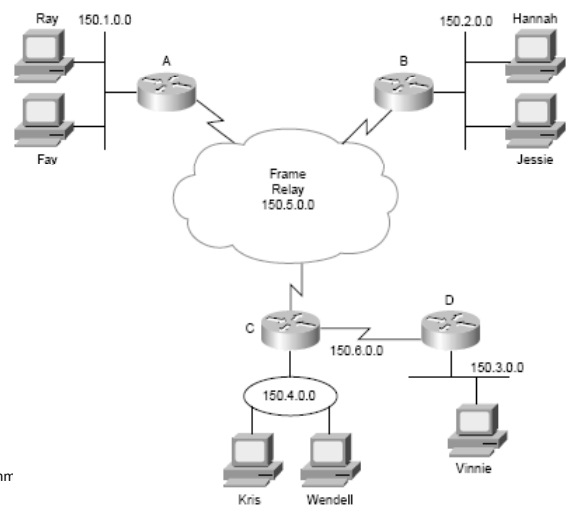
Sub netting

IP Subnetting

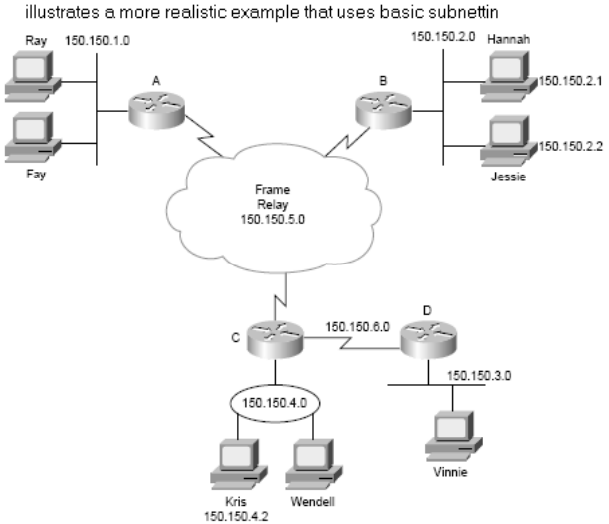
- IP subnetting creates vastly larger numbers of smaller groups of IP addresses, compared with simply using Class A, B, and C conventions.
- The Class A, B, and C rules still exist—but now, a single Class A, B, or C network can be subdivided into many smaller groups.
- By doing so, a single Class A, B, or C network can be subdivided into many non-overlapping subnets.

- The design in Figure requires six groups, each of which is a Class B network in this example.
- The four LANs each use a single Class B network.

Backdrop for Discussing Numbers of Different Networks/Subnetworks

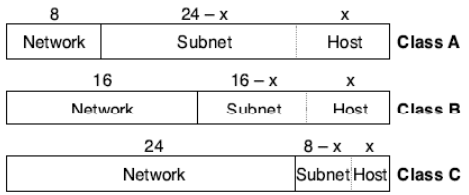


- the design requires six groups
- uses six subnets each of which is subnet of a sing Class B network



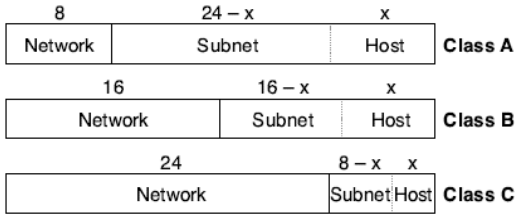
- This design subnets Class B network 150.150.0.0, which has been assigned by the NIC.
- To perform subnetting the third octet (in this example) is used to identify unique subnets of network 150.150.0.0.
- When subnetting, a third part of an IP address appears between the network and host parts of the address—namely, the subnet part of the address.

Address Formats When Subnetting Is Used



- This field is created by “stealing” or “borrowing” bits from the host part of the address.
- The size of the network part of the address never shrinks—in other words, Class A, B, and C rules still apply when defining the size of the network part of an address. The host part of the address shrinks to make room for the subnet part of the address.

Address Formats When Subnetting Is Used



- Now, instead of routing based on the network part of an address, routers can route based on the combined network and subnet parts. In fact, most people do not even bother
- distinguishing between the network part and the subnet part—they just call both fields together the subnet part of an address.
- Finally, IP addressing with subnetting uses a concept called a *subnet mask.*

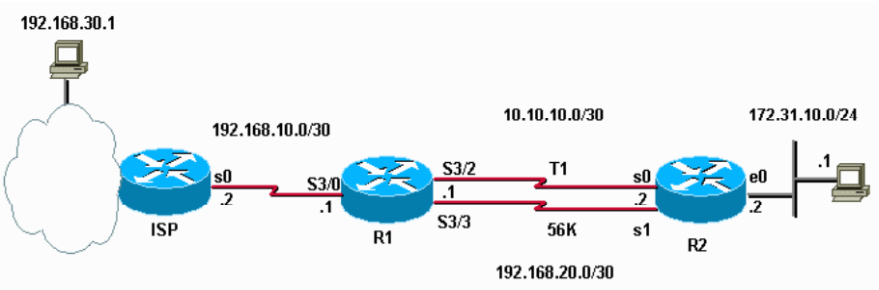
- to write down the network address and the number of hosts available, we use
  - subnet mask
  - CIDR prefix (Classless Inter-Domain Routing)

CIDR notation	Network mask	Available subnets	Usable hosts per subnet
/24	255.255.255.0	1	254
/25	255.255.255.128	2	126
/26	255.255.255.192	4	62
/27	255.255.255.224	8	30
/28	255.255.255.240	16	14
/29	255.255.255.248	32	6
/30	255.255.255.252	64	2
/31	255.255.255.254	128	2 * *only applicable for point-to-point links*

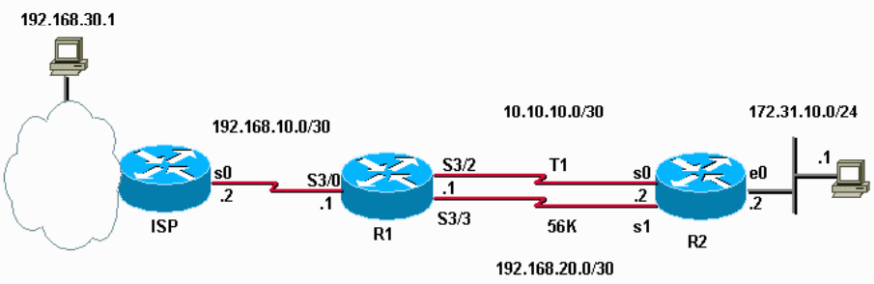
Example

network	Subnet mask	Number of hosts	CIDR
192.168.1.0	255.255.255.0	254	192.168.1.0/24
192.168.1.0	255.255.255.252	2	192.168.1.0/30

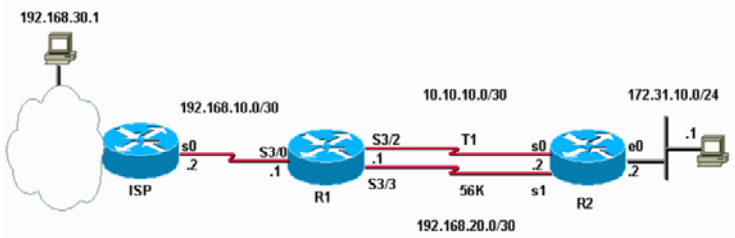
Static routing table

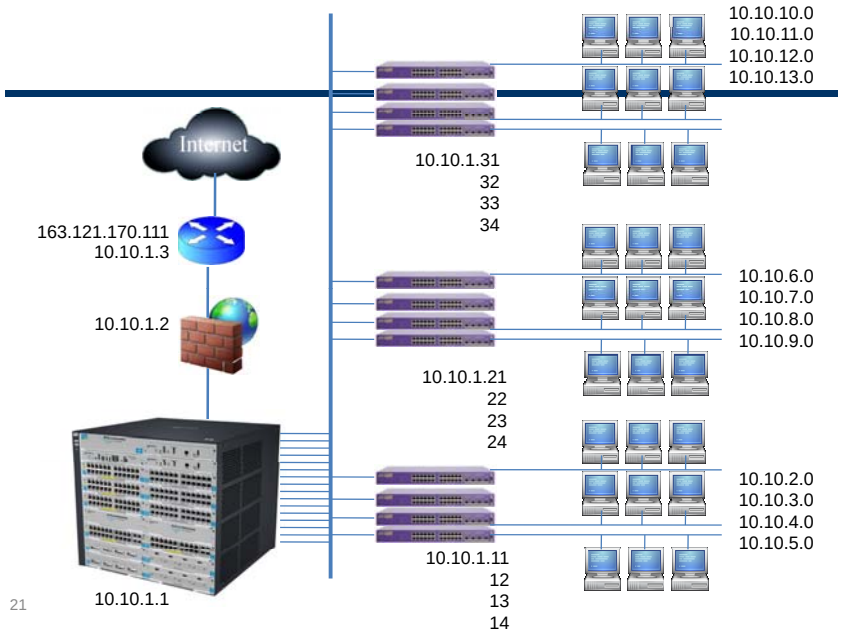


R1			
Destination	Subnet Mask	Next hop	Port
172.31.10.0	255.255.255.0	10.10.10.2	S3/2
172.31.10.0	255.255.255.0	192.168.20.2	S3/3
192.168.30.0	255.255.255.0	192.168.10.2	S3/0



R2			
Destination	Subnet Mask	Next hop	Port
192.168.10.0	255.255.255.0	10.10.10.1	S0
192.168.10.0	255.255.255.0	192.168.20.1	S1
192.168.30.1	255.255.255.0	10.10.10.1	S0
192.168.30.1	255.255.255.0	192.168.20.1	S1





VLAN

The typical LAN

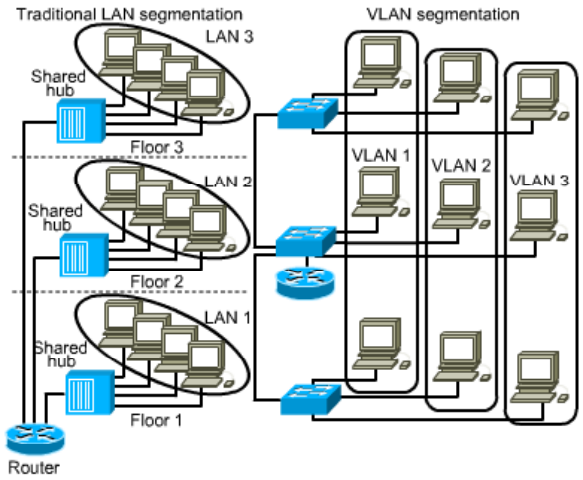
- Grouped based on the hub (physically)
- Use routers as LAN segmentation (broadcast)

VLAN

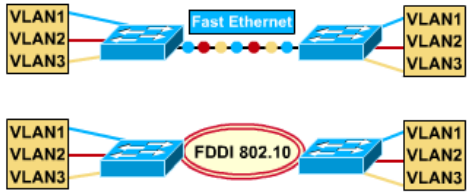
- VLAN is a broadcast domain
- Grouped based on logical function, department or application
- 20% to 40% of work force moves every year
- Recabling / readdressing and reconfiguration
- Traffic can be switched between VLANS with a router

- VLANs can logically segment users into different subnets (broadcast domains)
- Broadcast frames are only switched on the same VLAN ID.
- Users can be logically group via software based on:
  - port number
  - MAC address
  - protocol being used
  - application being used

LAN VS. VLAN



VLAN across backbone



- Backbone
  - Inter-Domain communication
  - High-speed link (100 Mbps or more)
  - Inter-connect to router
- VLAN traffic between switches (trunks) is tagged (802.1q) or encapsulated (ISL) to identify VLAN membership

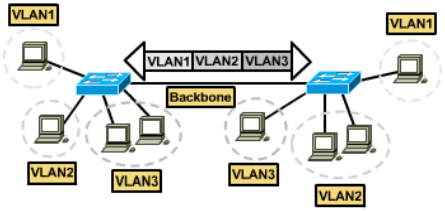
Router's Role

- Provides connection between different VLANs
- For example, you have VLAN1 and VLAN2.
  - Within the switch, users on separate VLANs cannot talk to each other (benefit of a VLAN!)
  - However, users on VLAN1 can email users on VLAN2 but they need a router to do it.

VLAN Techniques

- Two techniques
  - Frame Filtering--examines particular information about each frame (MAC address or layer 3 protocol type)
  - Frame Tagging--places a unique identifier in the header of each frame as it is forwarded throughout the network backbone.

Frame Tagging

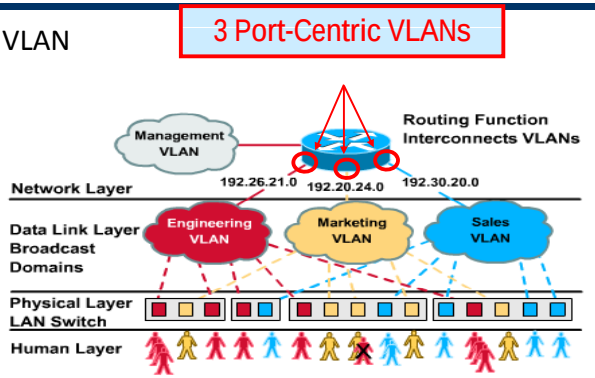


- IEEE 802.1q
- Assigns a VLAN ID to each frame
- Switch understands the tag
- Places a tag in the frame
- Tags are removed by the switch

VLAN implementation

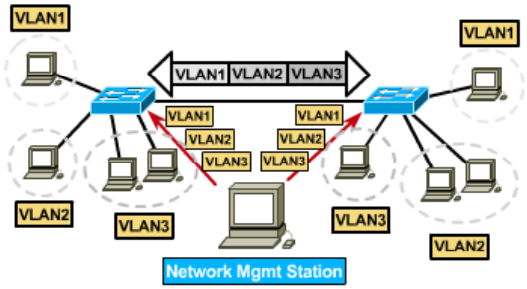
- Created by software running on Layer 2 switches
- Three methods for implementing VLANs
  - Port-Centric
  - Static
  - Dynamic

Port-Centric VLAN



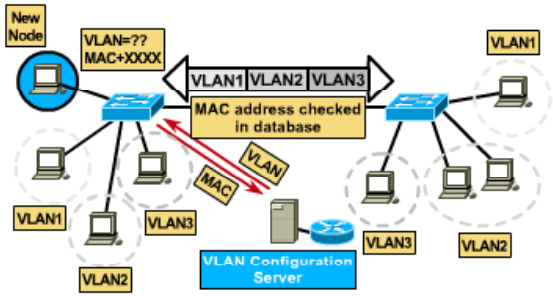
- Same VLAN, same router interface
- Easy for management

Static VLAN

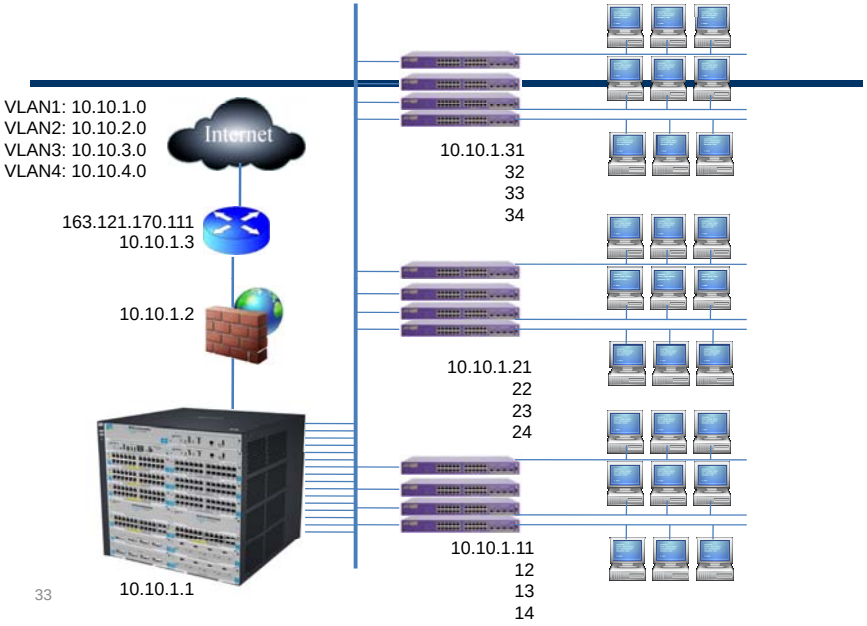


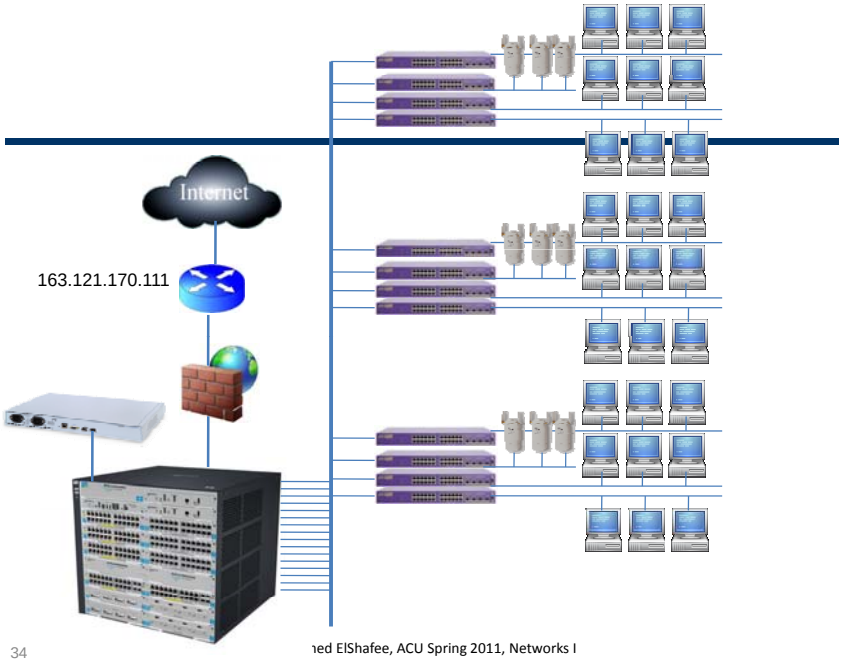
- Ports on a switch are administratively assigned to a VLAN
- Benefits
  - can be assigned by port, address, or protocol type
  - secure, easy to configure and monitor
  - works well in networks where moves are controlled

Dynamic VLAN



- Switch ports can automatically determine a user's VLAN assignment based on either/or:
  - MAC / logical address / protocol type
- When connected to an unassigned port, the switch dynamically configures the port with the right VLAN


VLAN1: 10.10.1.0
VLAN2: 10.10.2.0
VLAN3: 10.10.3.0
VLAN4: 10.10.4.0
Internet
163.121.170.111
10.10.1.3
10.10.1.2
10.10.1.1
10.10.1.31
32
33
34
10.10.1.21
22
23
24
10.10.1.11
12
13
14


Internet
163.121.170.111

Thanks,…