CS-435
spring semester 2025

Network Technology & Programming Laboratory

University of Crete
Computer Science Department

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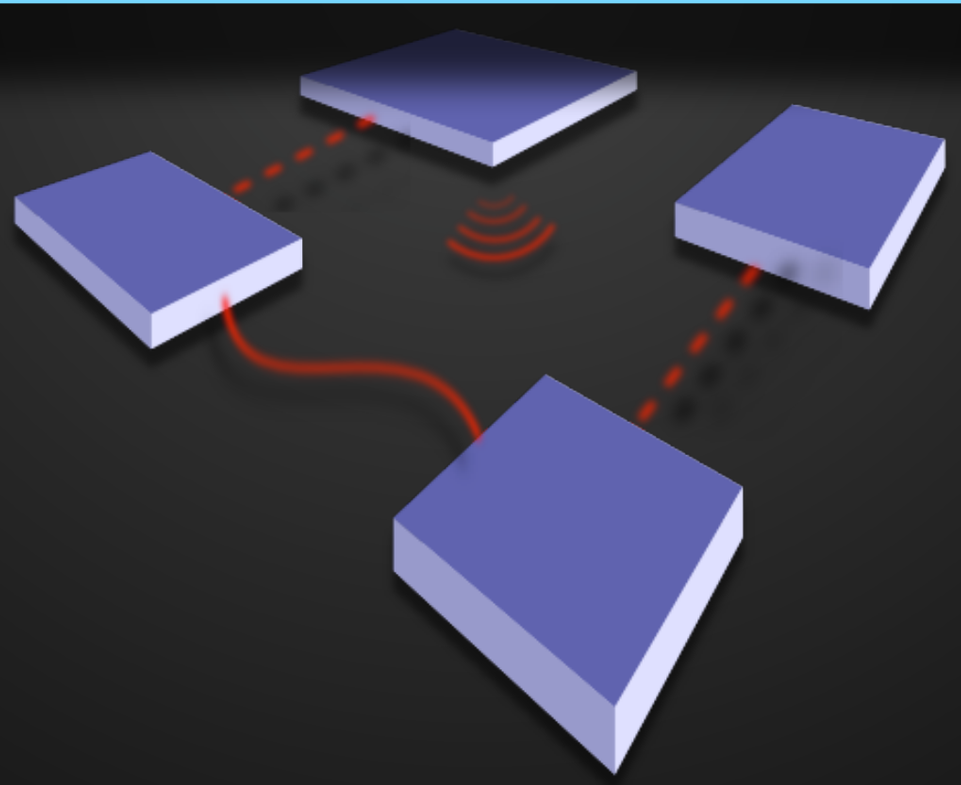


CS-435

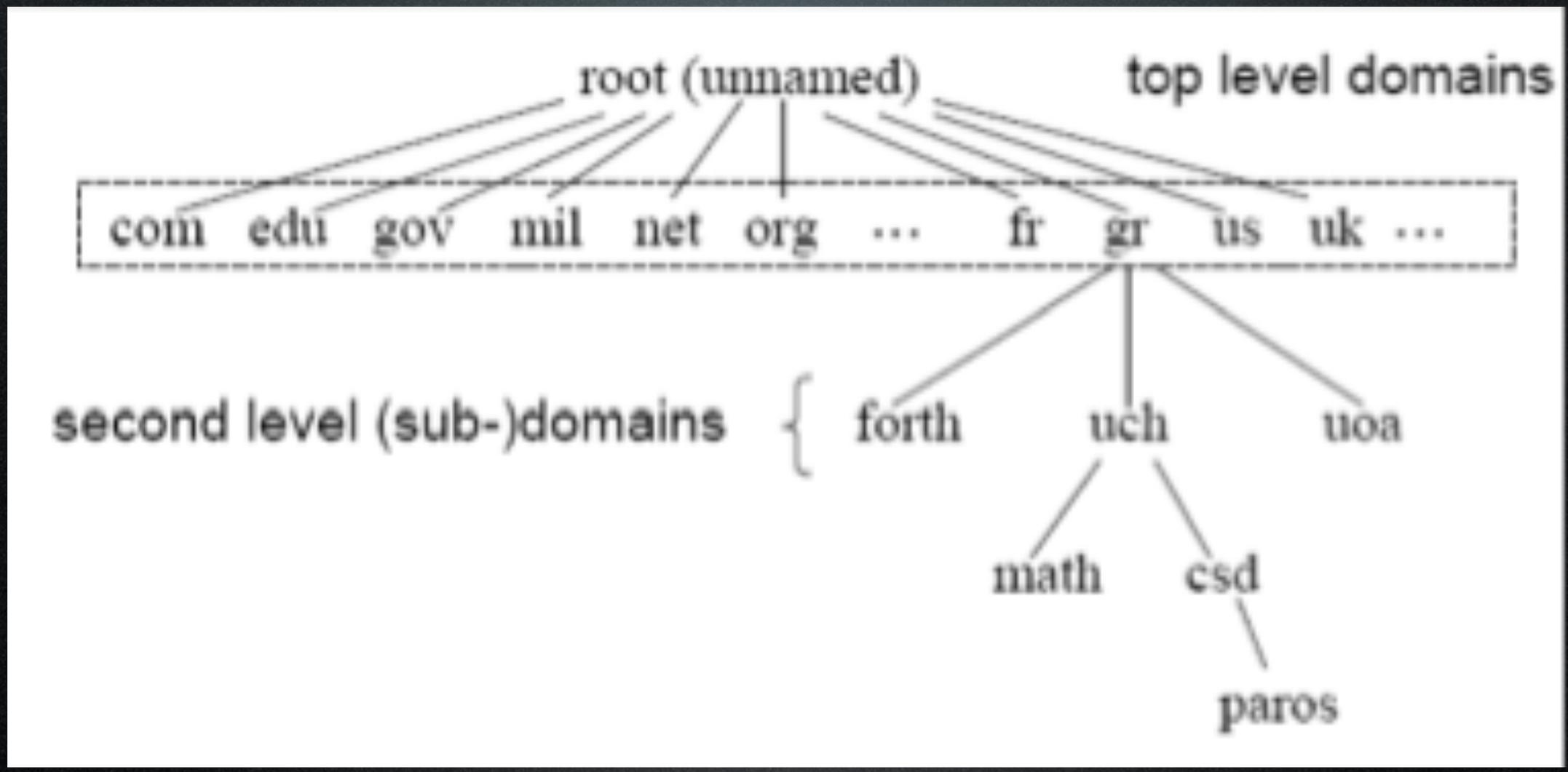
Lecture #6 preview

- Domain Name System (DNS)
- Virtual LAN (VLAN)
- Routing Tables

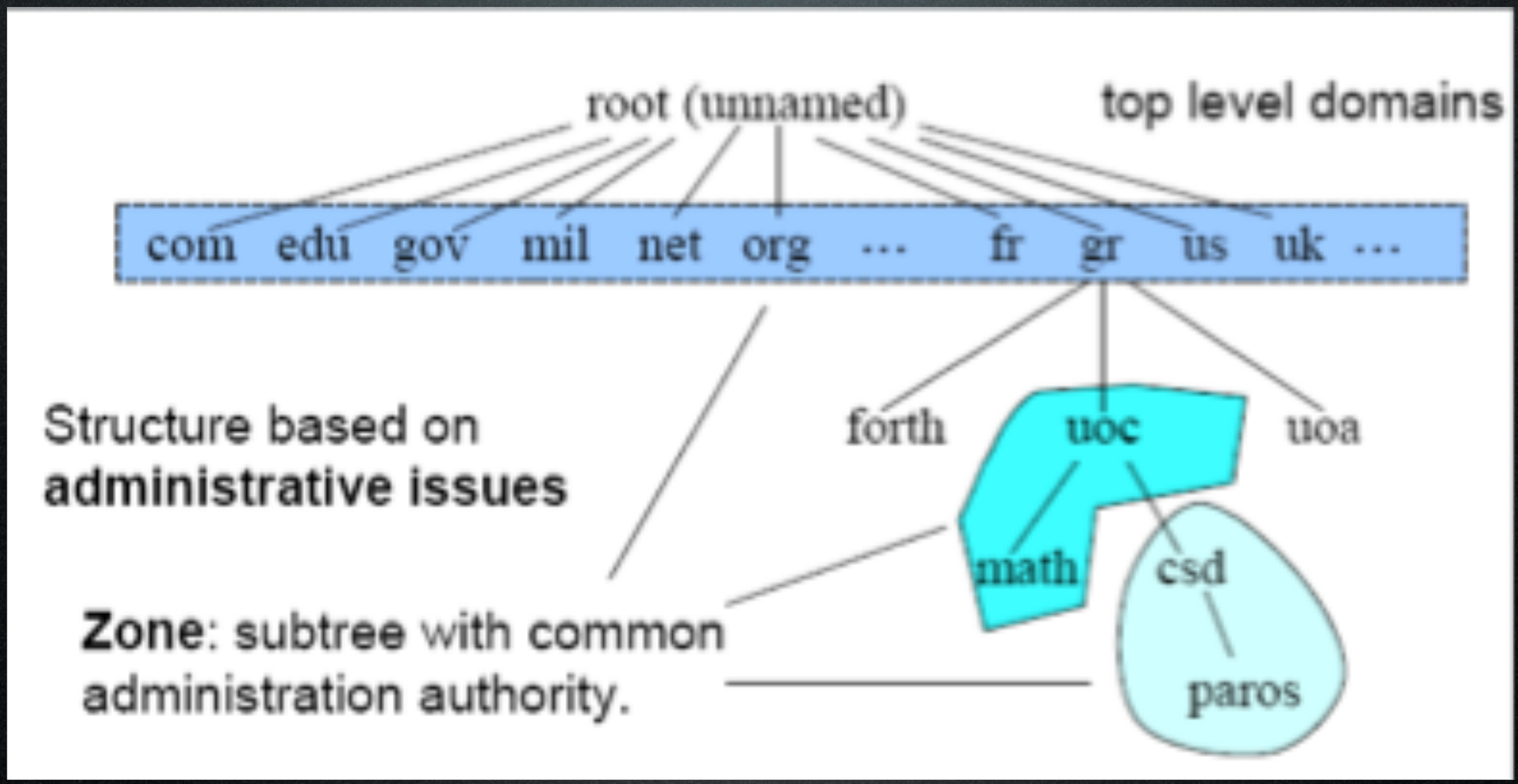
Domain Name System

- Domain Name System (DNS)
  - Hierarchical naming space
  - Name-granting authorities
  - DNS servers and name resolution
    - DNS: name to IP address translation
    - ARP: IP address to LAN address translation
  - Why both? Names are memorizable, flexible:
  - e.g. www.csd.uoc.gr → 147.52.16.5
  - Names of Variable-length
  - Many names for a single IP address
  - Change address doesn’t imply change name
- Domain Name Registrars
  - Internet Corporation for Assigned Names and Numbers (ICANN) -> Top Level Domains

Naming Tree


root (unnamed)
top level domains
com edu gov mil net org ... fr gr us uk ...
second level (sub-)domains
forth uch uoa
math csd
paros

Naming Tree


root (unnamed)
top level domains
com edu gov mil net org ... fr gr us uk ...
forth
uoc
uoa
math
csd
paros
Structure based on
administrative issues
Zone: subtree with common
administration authority.

Name Servers & Resolution Process

- Name Servers:
  - Contain Name-to-IP address mapping, or:
  - IP address of authoritative name server
  - Each NS is responsible for a zone.

- Name resolution: map names to IP addresses
- client: a process running on a host.

- Request: “give me IP address of lala.papa.xyz”.
- Response: “A.B.C.D” (IP address of X)
- or: “contact NS W.X.Y.Z to get the address of lala.papa.xyz”

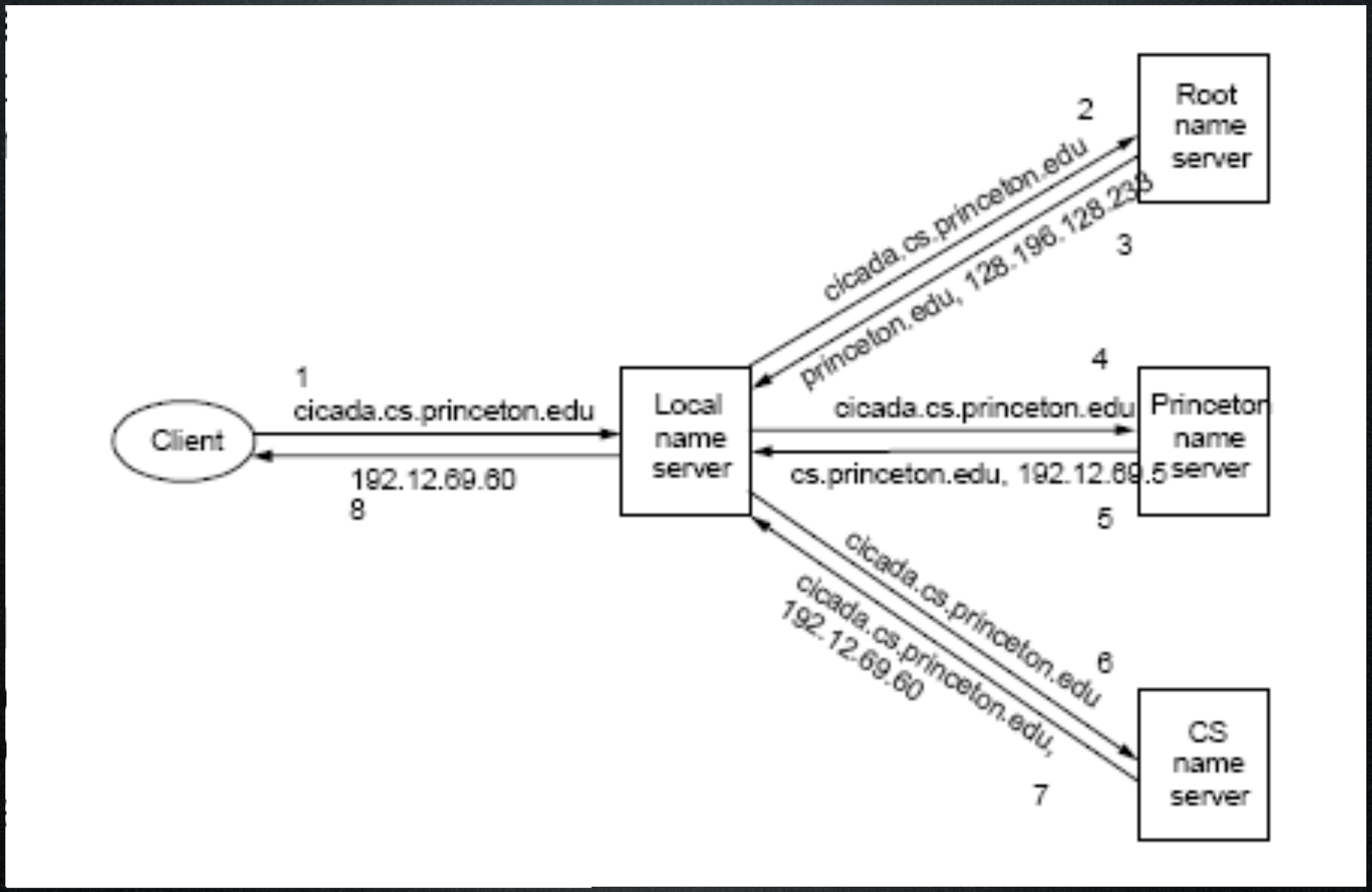
Name Servers

- NSs are duplicated for reliability
- Each host knows the IP address of the local NS
- Each NS knows the IP addresses of all root NSs
- Non-recursive / recursive query
- Caching is used

Name Servers

- Record Types (partial list):
  - A : IPv4 address record
  - AAAA: IPv6 address record
  - CERT: Certificate record
  - CNAME: Canonical name record (alias to another name)
  - LOC: Location record
  - MX: Mail exchanger record
  - NS: Name Server record (authoritative)
  - PTR: Pointer record (to canonical name - reverse lookup)
  - SOA: Start of authoritative record (authoritative information about a DNS zone)

Name Resolution



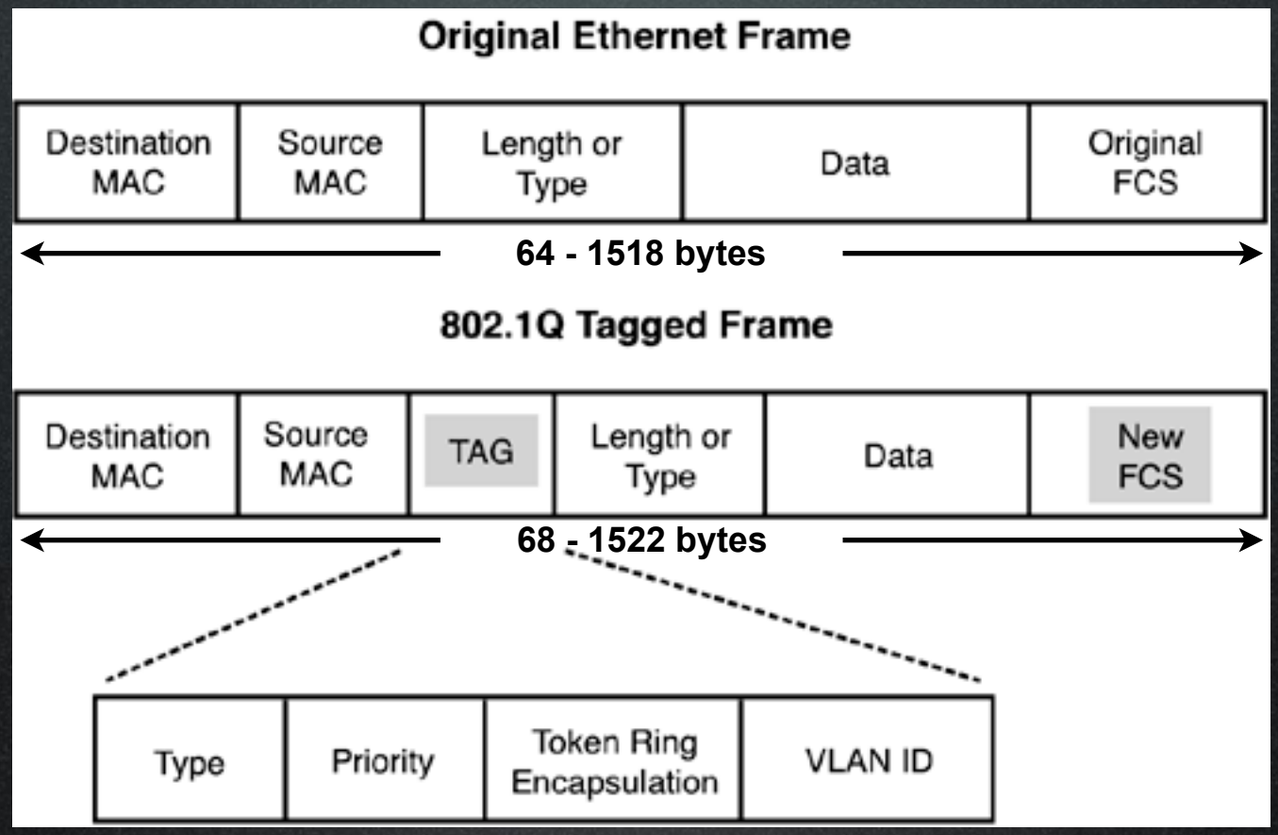
Virtual LANs

- Hubs: Define a Collision Domain
- Switches: Segment Collision Domains
- Routers: Define Broadcast Domains
- Virtual LAN: Segment Broadcast domains

Virtual LANs

- Types of VLANs
  - Layer 1: interface port based
  - Layer 2: VLAN membership based on MAC address
    - 802.1Q standard
  - Layer 3: use network layer protocol/addresses
  - Higher layer: e.g. application/port

IEEE 802.1Q


Original Ethernet Frame
Destination MAC
Source MAC
Length or Type
Data
Original FCS
64 - 1518 bytes
802.1Q Tagged Frame
Destination MAC
Source MAC
TAG
Length or Type
Data
New FCS
68 - 1522 bytes
Type
Priority
Token Ring Encapsulation
VLAN ID

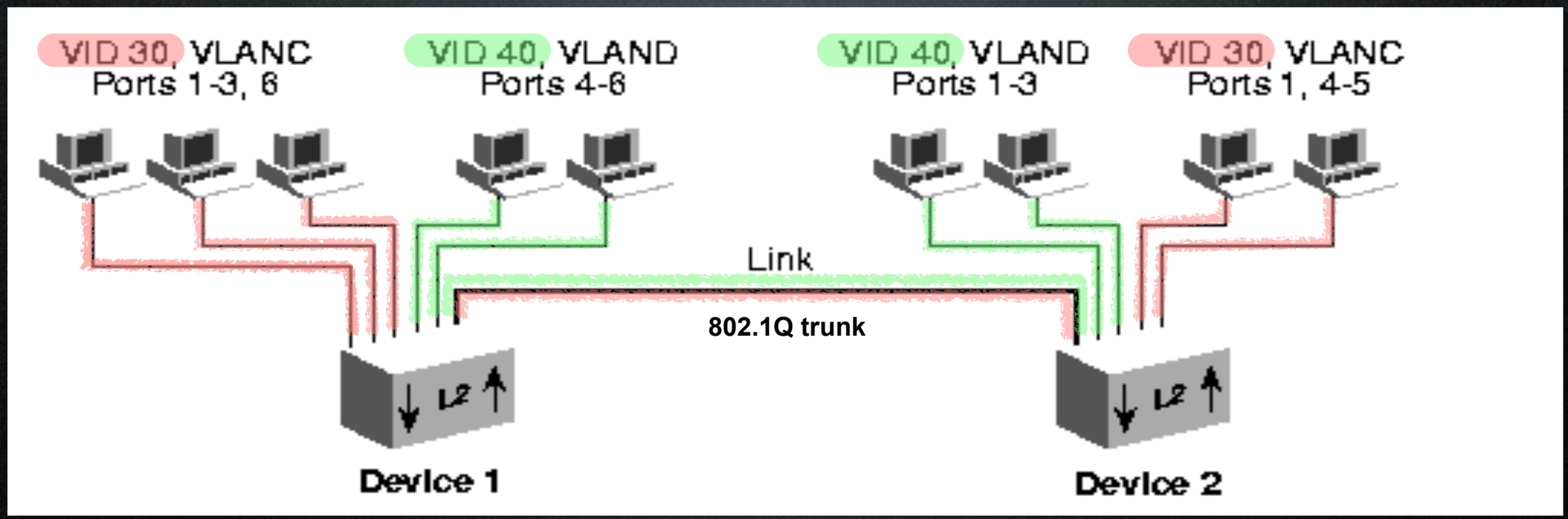
IEEE 802.1Q

- Layer 2
- 32bit/4byte

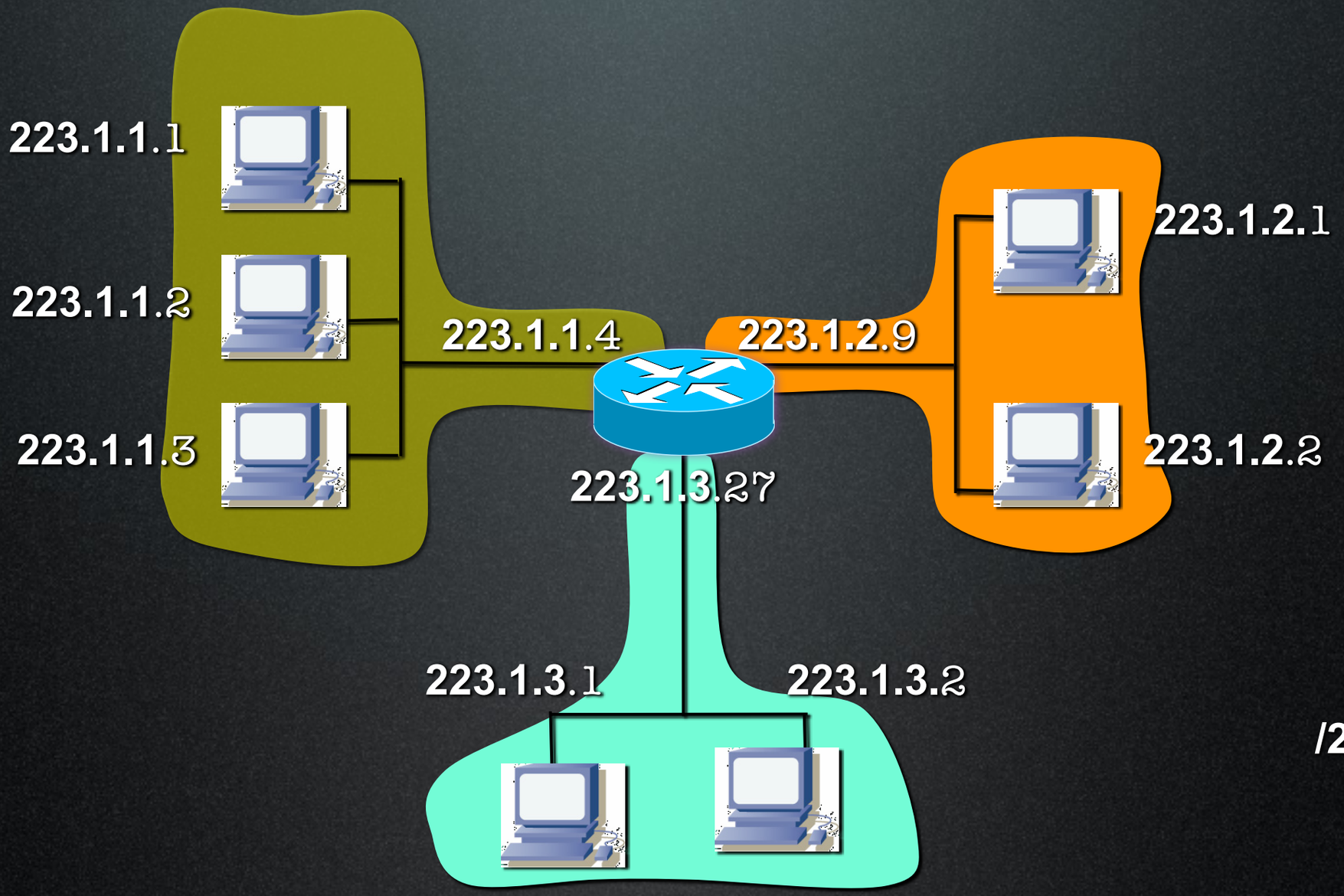
16bit	3bit	1bit	12bit
TPID	PCP	DEI	VID

  - Tag Protocol Identifier (TPID) == 0x8100
  - Priority Code Point (PCP)
  - Drop Eligible Indicator (DEI) - Canonical Format Indicator (CFI)
  - VLAN Identifier (VID) (reserved: 0x000, 0xFFF)
- PCP == 802.1p

Virtual LANs

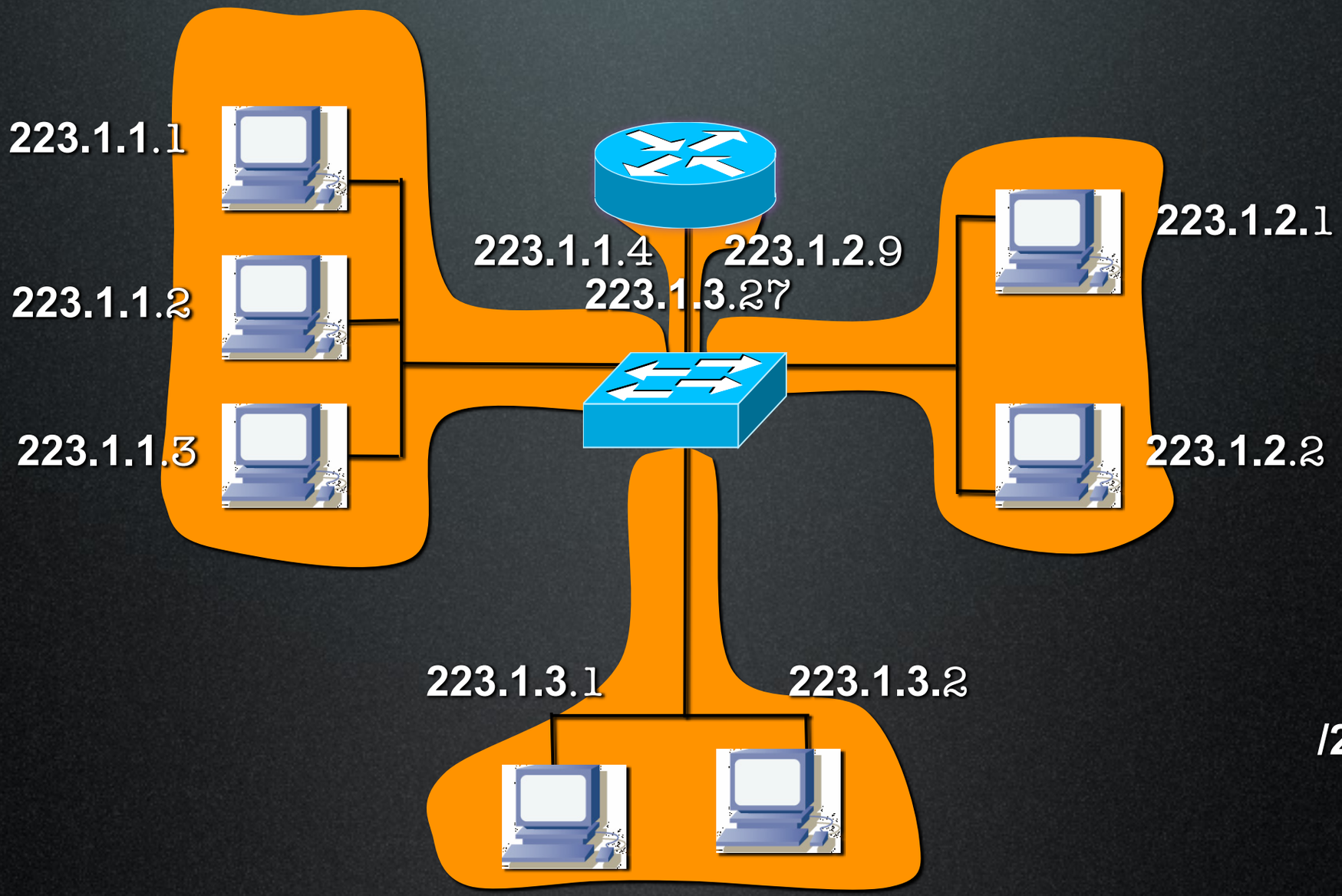


Subnets & LANs



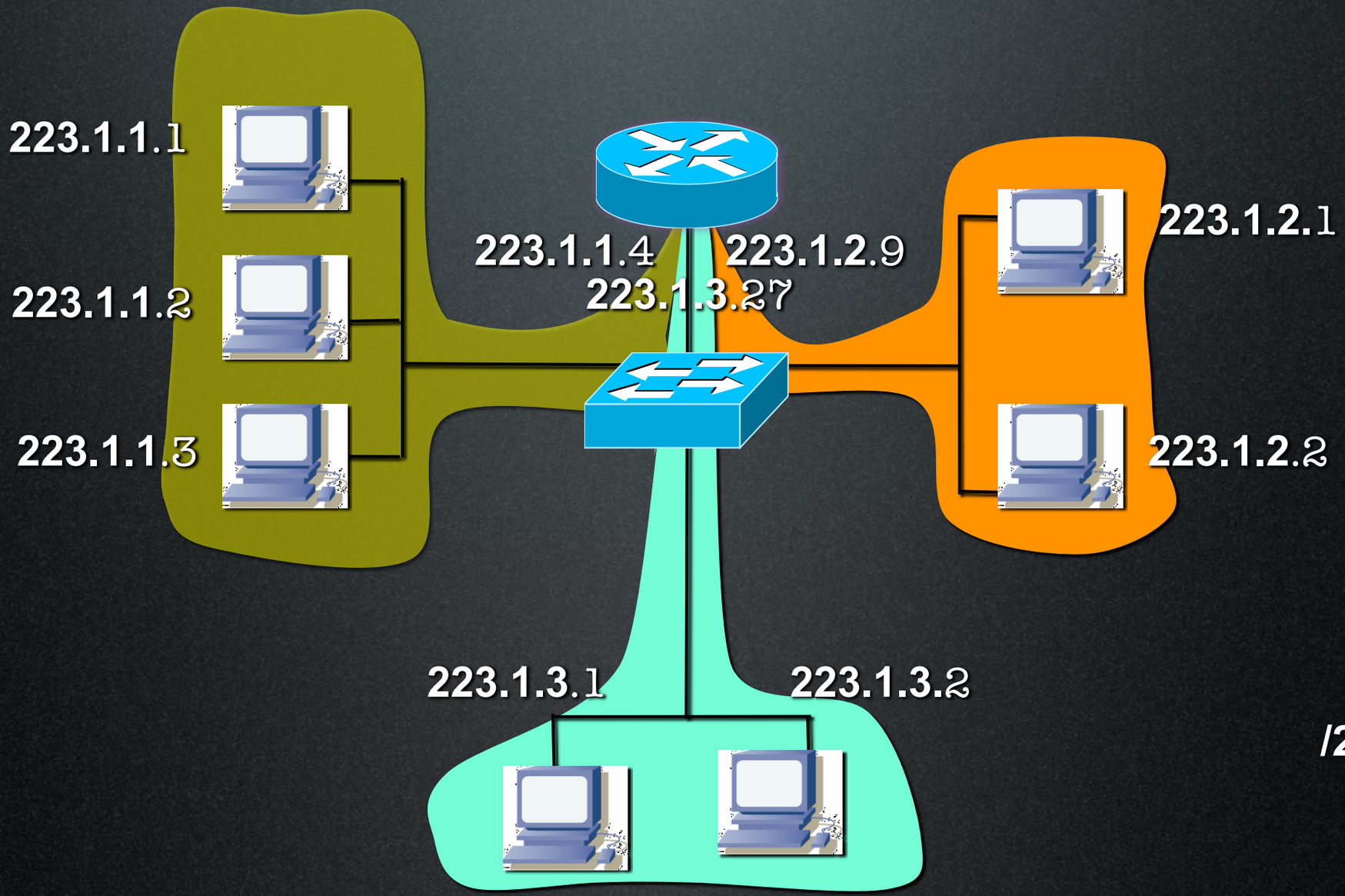
/24 subnets

Subnets & LANs



/24 subnets

Subnets & VLANs



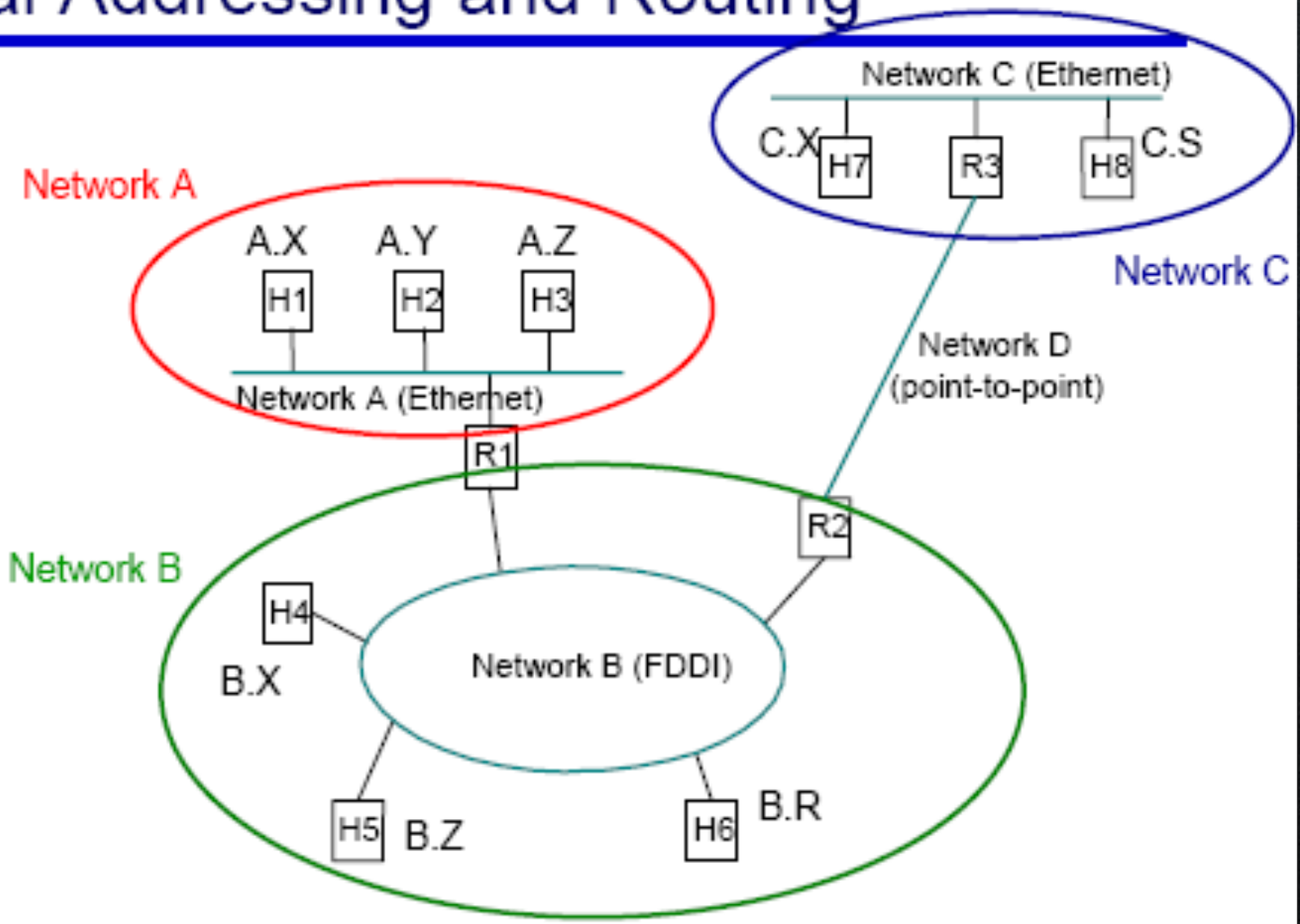
/24 subnets

Datagram Forwarding & routing tables

- Every datagram contains destination's address
- Check destination network address
- if directly connected to destination network, then forward to host
- if not directly connected to destination network, then forward to next hop router
- Forwarding table maps network number into next hop
- Each host has a default router
- Each router maintains a forwarding table

Datagram Forwarding & routing tables

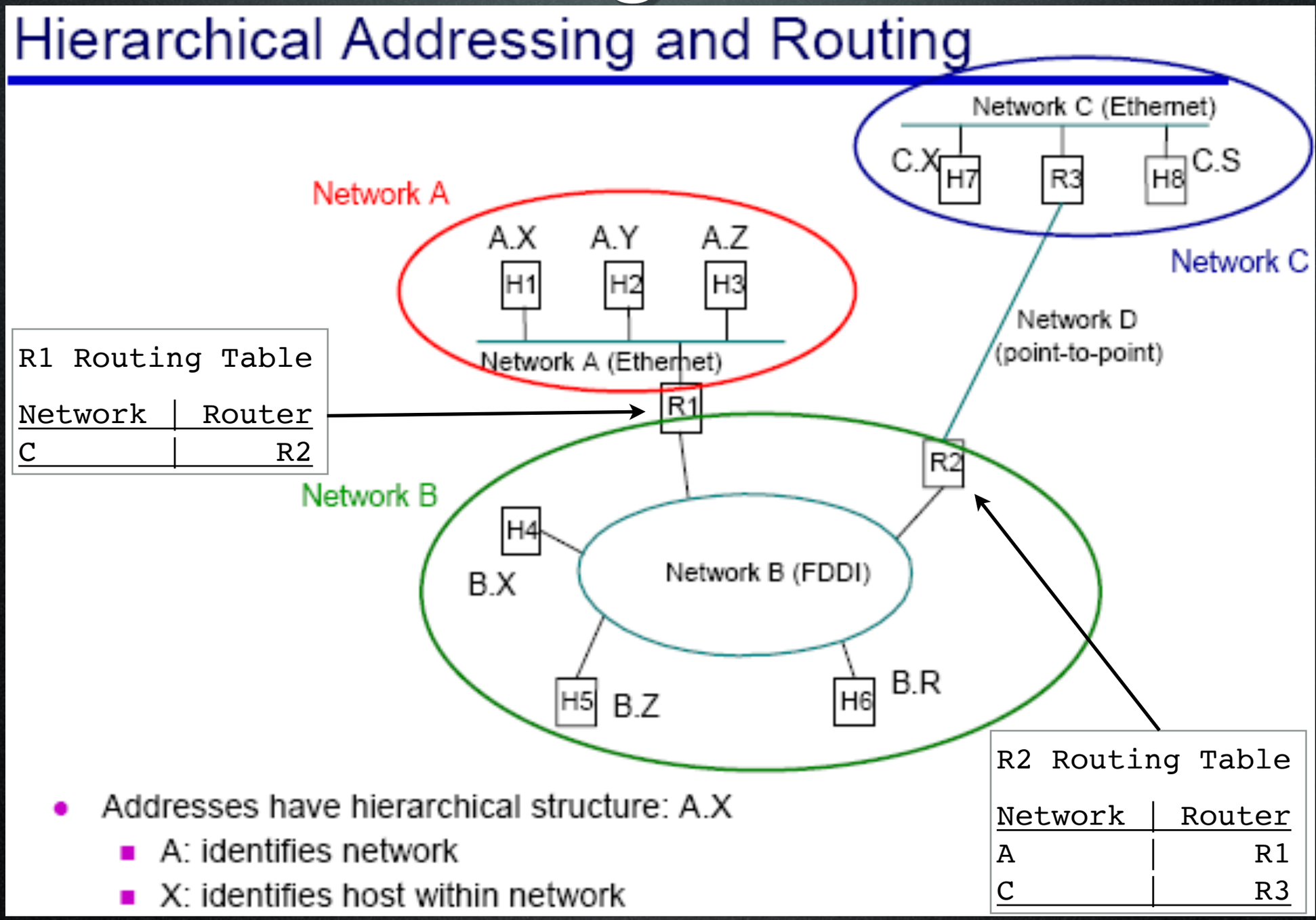
Hierarchical Addressing and Routing



- Addresses have hierarchical structure: A.X
  - A: identifies network
  - X: identifies host within network

Datagram Forwarding & routing tables

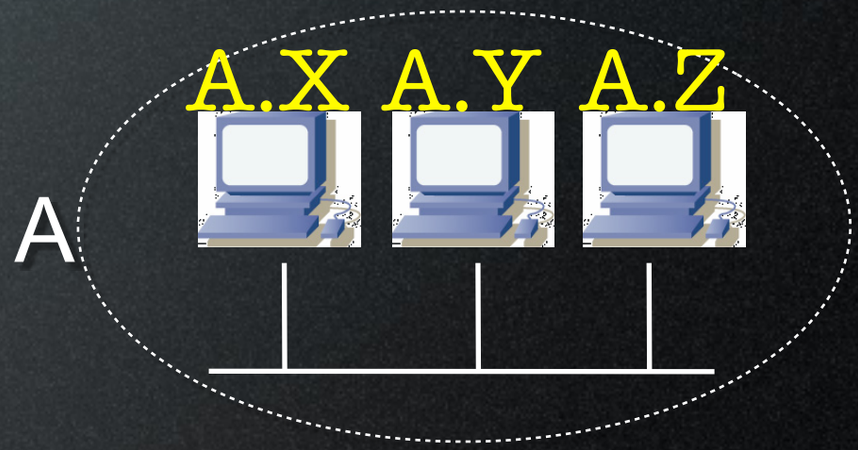
Hierarchical Addressing and Routing



- Addresses have hierarchical structure: A.X
  - A: identifies network
  - X: identifies host within network

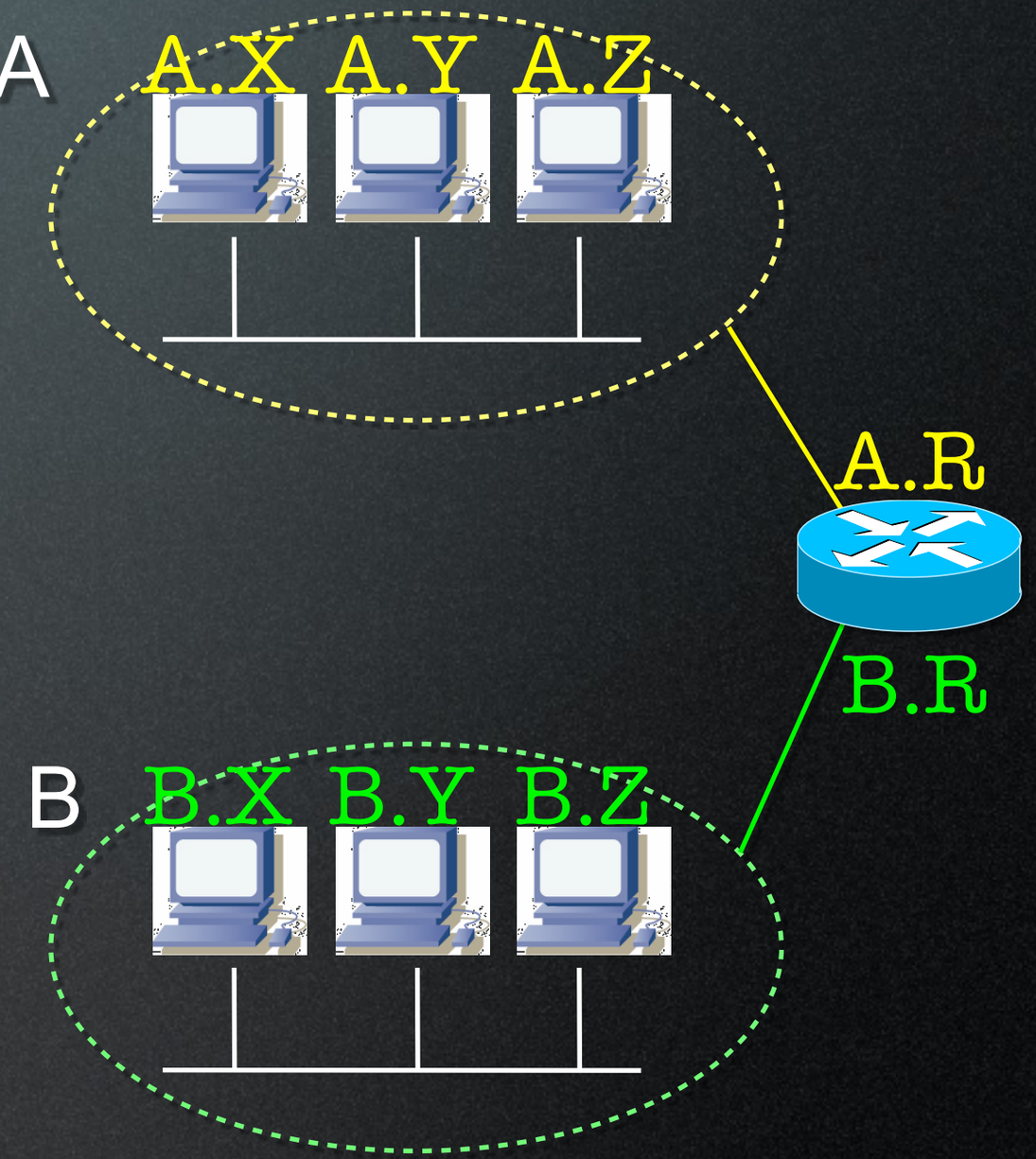
Datagram Forwarding when Src/Dst on Same Network

- Host A.X has a packet for Host A.Z
- Compares network number of destination address with its own: match (A?=?A)
- Use ARP to find Ethernet address of A.Z
  - Check ARP table
  - Broadcast query if not in table
- Send Ethernet frame with destination from previous step.



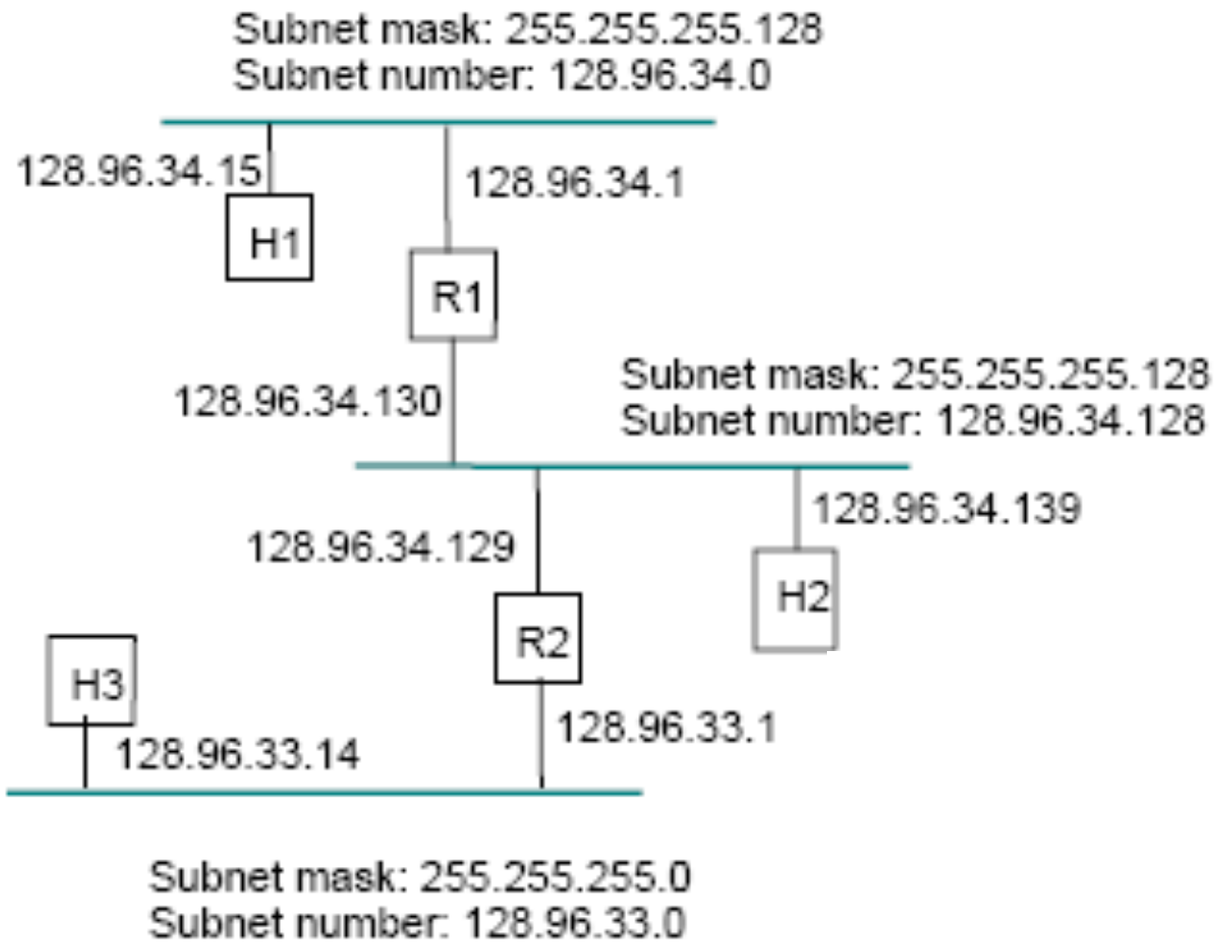
Datagram Forwarding when Src/Dst NOT on Same Network

- Host A.X wants to send datagram to B.X
- Compares network number of destination address with its own: no match (A≠B)
- Find next hop (default router) from its table: R1
- Use ARP to find Ethernet address of R1
  - Check ARP table
  - Broadcast query if not in table
- Send Ethernet frame with destination from previous step
- R1 receives frame, looks up IP destination address (B.X):
  - Send to interface 1
  - Use ARP to find Ethernet address of B.X



The Routing Tables

Subnet Example



The Routing Tables

```
===========================================================================
Interface List
0x1 ........................... MS TCP Loopback interface
0x2 ...00 1c 23 13 1c d9 ...... Broadcom NetXtreme 57xx Gigabit Controller - Pac
ket Scheduler Miniport
0x3 ...00 13 e8 ae 6a 49 ...... Intel(R) Wireless WiFi Link 4965AGN - Packet Sch
eduler Miniport
===========================================================================
===========================================================================
Active Routes:
Network Destination        Netmask          Gateway       Interface  Metric
          0.0.0.0          0.0.0.0    192.168.1.1    192.168.1.6       20
        127.0.0.0        255.0.0.0      127.0.0.1      127.0.0.1        1
      192.168.1.0    255.255.255.0    192.168.1.6    192.168.1.6       20
      192.168.1.6  255.255.255.255      127.0.0.1      127.0.0.1       20
    192.168.1.255  255.255.255.255    192.168.1.6    192.168.1.6       20
        224.0.0.0        240.0.0.0    192.168.1.6    192.168.1.6       20
  255.255.255.255  255.255.255.255    192.168.1.6    192.168.1.6        1
  255.255.255.255  255.255.255.255    192.168.1.6              3        1
Default Gateway:      192.168.1.1
===========================================================================
Persistent Routes:
  None
```

Supernetting

- Instead of using first few bits to identify class, additional parameter (length) identifies network part, e.g. <192.4.16/20>
- Might be case that destination address matches more than one router entries
- eg: Address 192.4.17.5 matches both <192.4.16/20> and <192.4/16>

Forwarding table

Subnet Number	Next Hop
192.4.16/20	R1
192.4/16	R2

- Longest prefix match used (192.4.17.5 forwarded to R1)