Chapter 4 September 08, 2011 **PART IV CLASSFUL INTERNET ADDRESSES** 

Internetworking With TCP/IP

#### **Definitions**

- Name
  - Identifies what an entity is
  - Often textual (e.g., ASCII)
- Address
  - Identifies where an entity is located
  - Often binary and usually compact
  - Sometimes called locator
- Route
  - Identifies how to get to the object
  - May be distributed

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## Internet Protocol Address (IP Address)

- Analogous to hardware address
- Unique value assigned as unicast address to each host on Internet
- Used by Internet applications

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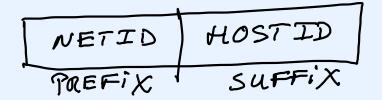
#### **IP Address Details**

- 32-bit binary value
- Unique value assigned to each host in Internet
- Values chosen to make routing efficient

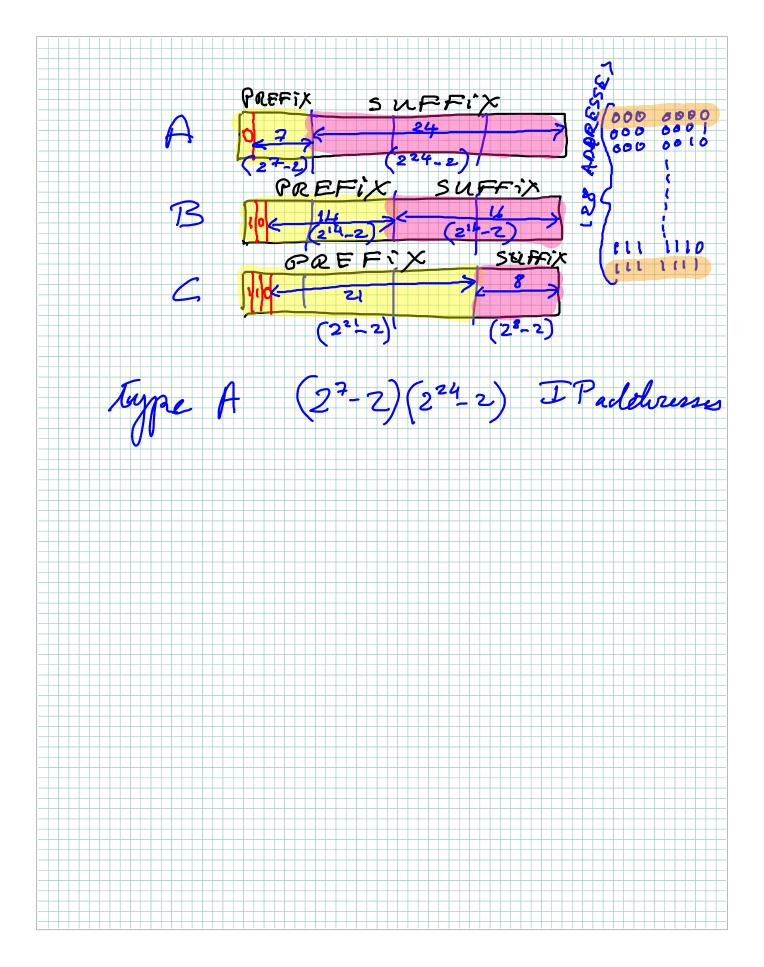
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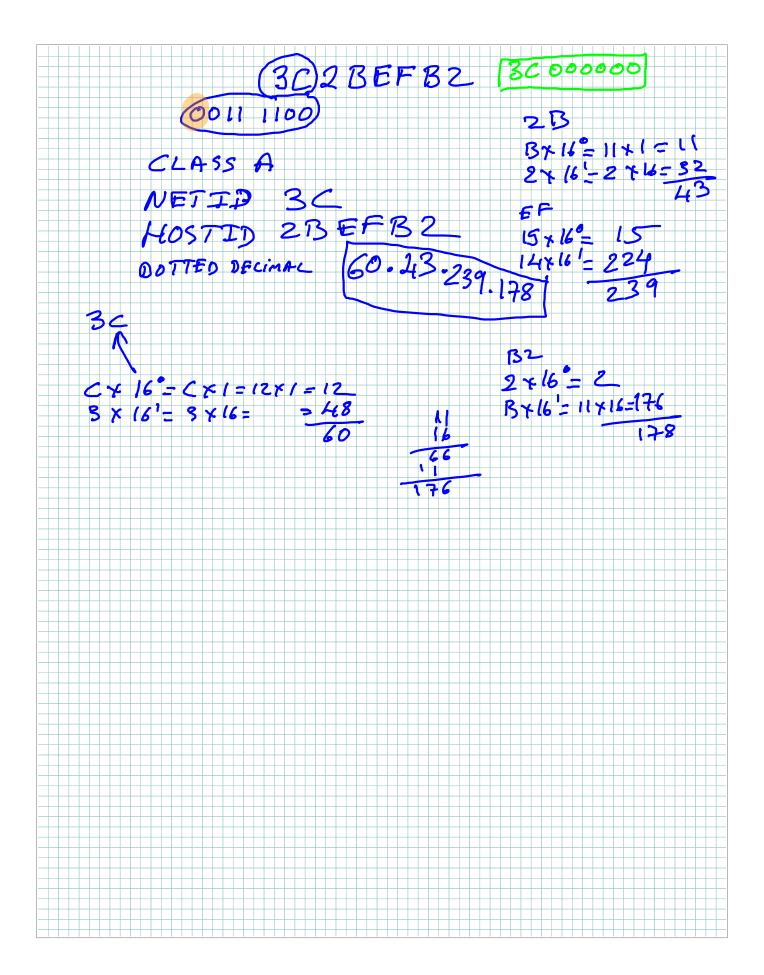
#### **IP Address Division**

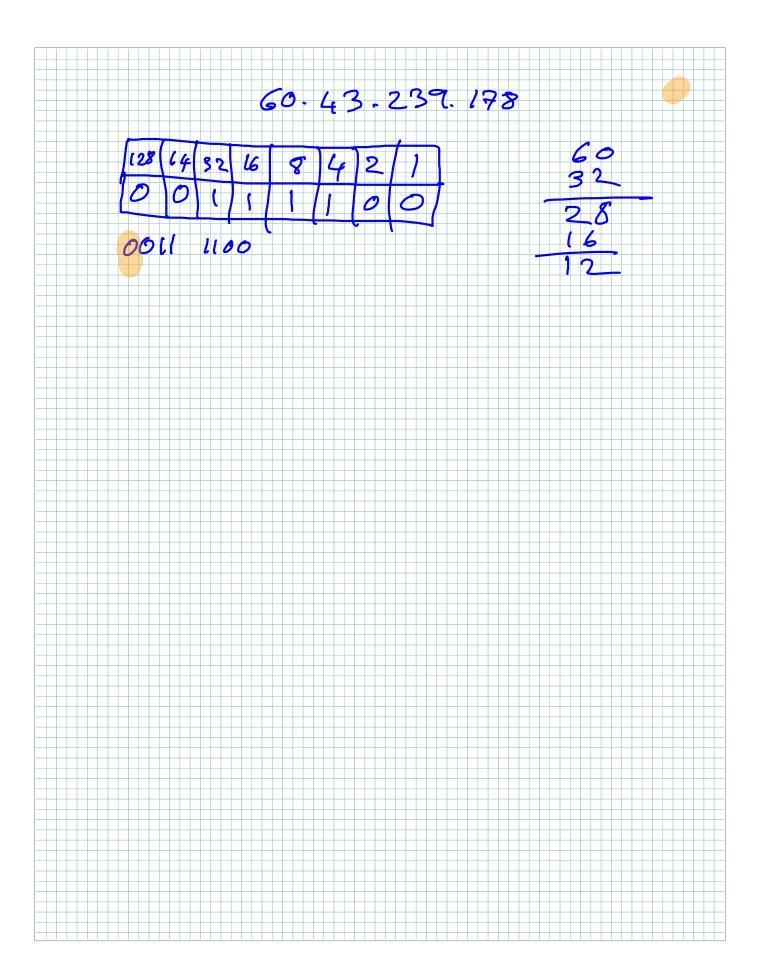
- Address divided into two parts
  - Prefix (network ID) identifies network to which host attaches
  - Suffix (host ID) identifies host on that network

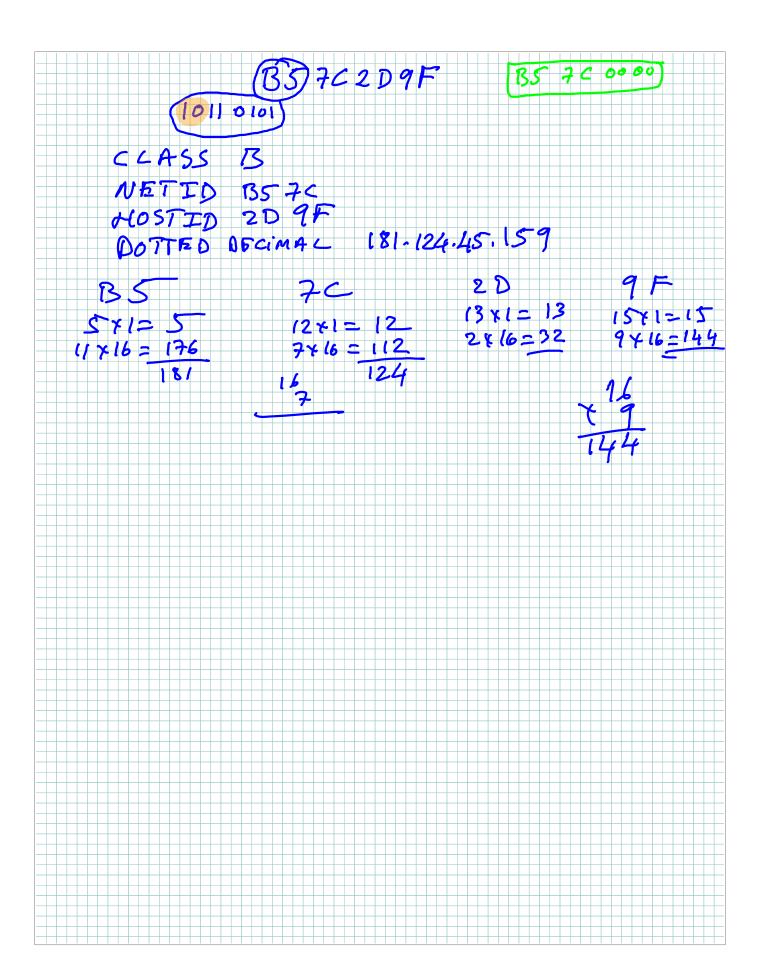


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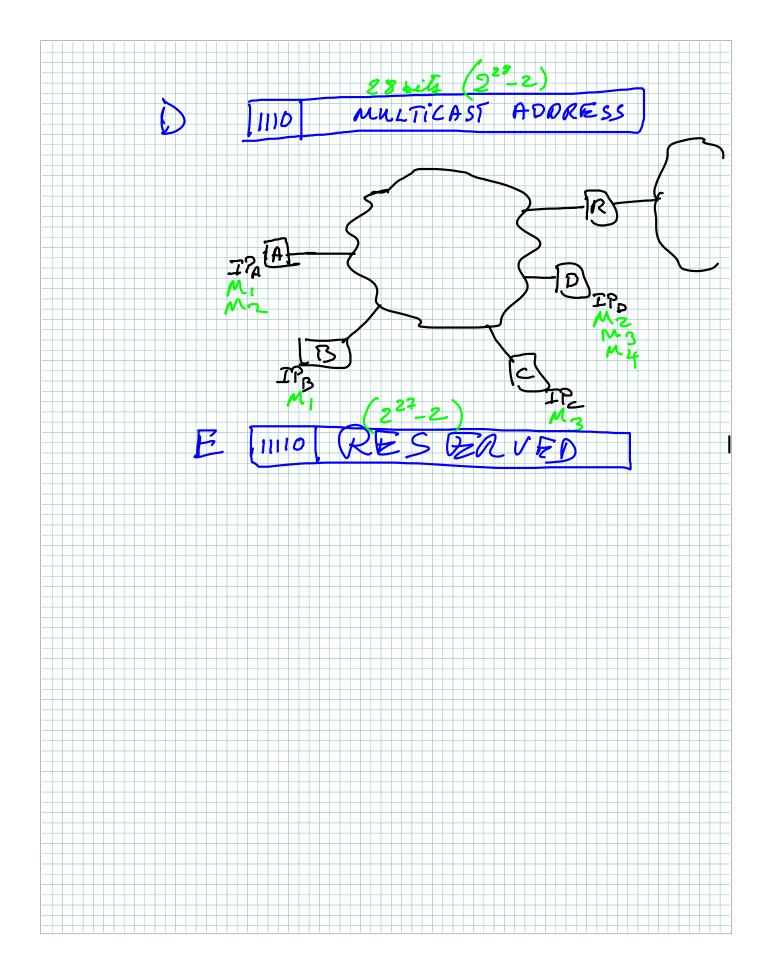








(CF)2E5974 (CFZE5900 11001111 CLASS C NETED CF2E59 HOSTED 74 DOTTED DECIMAL 207-46-89-16 15 x 1 = 15 12 416 = 192



## **Classful Addressing**

- Original IP scheme
- Explains many design decisions
- New schemes are backward compatible

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## **Desirable Properties Of An Internet Addressing Scheme**

- Compact (as small as possible)
- Universal (big enough)
- · Works with all network hardware
- Supports efficient decision making
  - Test whether a destination can be reached directly
  - Decide which router to use for indirect delivery
  - Choose next router along a path to the destination

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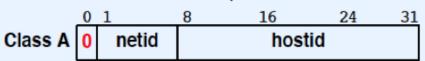
#### Division Of Internet Address Into Prefix And Suffix

- How should division be made?
  - Large prefix, small suffix means many possible networks, but each is limited in size
  - Large suffix, small prefix means each network can be large, but there can only be a few networks
- Original Internet address scheme designed to accommodate both possibilities
  - Known as classful addressing

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#### **Original IPv4 Address Classes**

**Three Principle Classes** 



Class A Addresses are used for the handful of networks that have more than  $2^{16}$  (i.e. more than 65,536) hosts.

- · 7 Bits for netid
- · 24 Bits for hostid



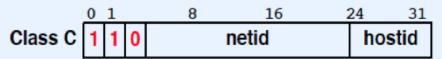
Class B Addresses are used for intermediate size networks that have up to 2<sup>16</sup> (i.e. up to 65,536) hosts.

- · 14 Bits for netid
- · 16 Bits for hostid

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#### **Original IPv4 Address Classes**

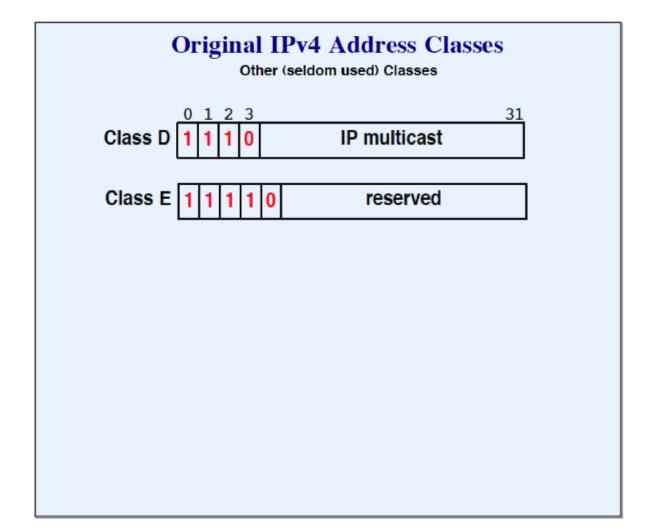
**Three Principle Classes** 



Class C Addresses are used for networks that have less than 28 (i.e. less than 256) hosts.

- 21 Bits for netid
- · 8 Bits for hostid

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## **Important Property**

- Classful addresses are self-identifying
- Consequences
  - Can determine boundary between prefix and suffix from the address itself
  - No additional state needed to store boundary information
  - Both hosts and routers benefit

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## **Endpoint Identification**

Because IP addresses encode both a network and a host on that network, they do not specify an individual computer, but a connection to a network.

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#### **IP Address Conventions**

- When used to refer to a network
  - Host field contains all 0 bits
- Broadcast on the local wire 255.255.255
  - Network and host fields both contain all 1 bits
- Directed broadcast: broadcast on specific (possibly remote) network
  - Host field contains all 1 bits
  - Nonstandard form: host field contains all 0 bits

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### **Assignment Of IP Addresses**

- All hosts on same network assigned same address prefix
  - Prefixes assigned by central authority
  - Obtained from ISP
- Each host on a network has a unique suffix
  - Assigned locally
  - Local administrator must ensure uniqueness

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## **Advantages Of Classful Addressing**

- · Computationally efficient
  - First bits specify size of prefix/suffix
- Allows mixtures of large and small networks

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#### **Directed Broadcast**

IP addresses can be used to specify a directed broadcast in which a packet is sent to all computers on a network; such addresses map to hardware broadcast, if available. By convention, a directed broadcast address has a valid netid and has a hostid with all bits set to 1.

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#### **Limited Broadcast**

- All 1's
- Broadcast limited to local network only (no forwarding)
- Useful for bootstrapping

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#### **All Zeros IP Address**

- Can only appear as source address
- Used during bootstrap before computer knows its address
- Means "this computer

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#### **Internet Multicast**

- IP allows Internet multicast, but no Internet-wide multicast delivery system currently in place
- Class D addresses reserved for multicast
- Each address corresponds to group of participating computers
- IP multicast uses hardware multicast when available
- More later in the course

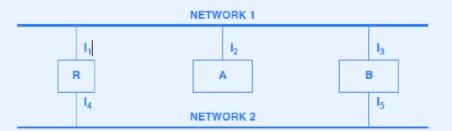
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## **Consequences Of IP Addressing**

- If a host computer moves from one network to another, its IP address must change
- For a multi-homed host (with two or more addresses), the path taken by packets depends on the address used

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## **Multi-Homed Hosts And Reliability**



- Knowing that B is multi-homed increases reliability
- If interface I3 is down, host A can send to the interface I5

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#### **Dotted Decimal Notation**

- Syntactic form for expressing 32-bit address
- Used throughout the Internet and associated literature
- Represents each octet in decimal separated by periods (dots)

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## **Example Of Dotted Decimal Notation**

A 32-bit number in binary

10000000 00001010 00000010 00000011

The same 32-bit number expressed in dotted decimal notation

128.10.2.3

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## **Loopback Address**

- Used for testing
- Refers to local computer (never sent to Internet)
- Address is 127.0.0.1

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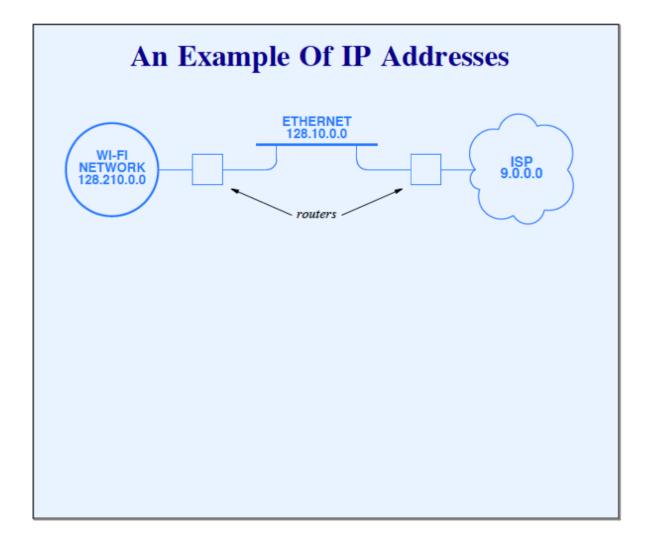
## **Classful Address Ranges**

Class	Lowest Address	Highest Address
Α	1.0.0.0	126.0.0.0
В	128.1.0.0	191.255.0.0
C	192.0.1.0	223.255.255.0
D	224.0.0.0	239.255.255.255
E	240.0.0.0	255.255.255.254

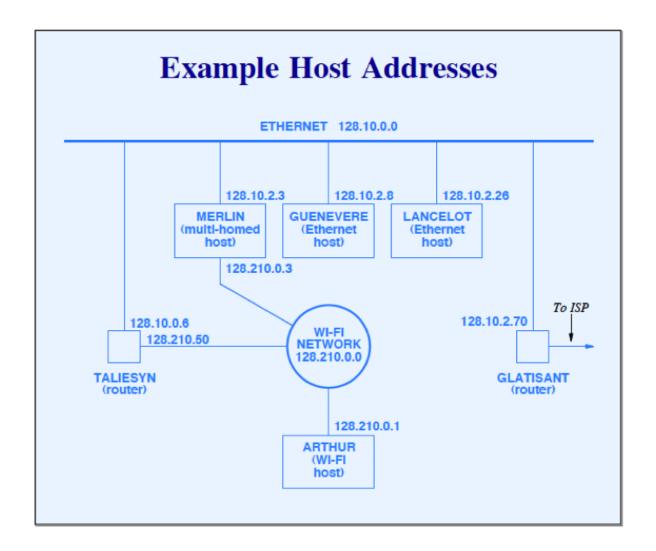
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## **Summary Of Address Conventions** This host 1 all 0s Host on this net 1 host all 0s Limited broadcast (local net) 2 all 1s Directed broadcast for net<sup>2</sup> net all 1s Loopback<sup>3</sup> anything (often 1) 127 Notes: 1 Allowed only at system startup and is never a valid destination address. <sup>2</sup> Never a valid source address. <sup>3</sup> Should never appear on a network.

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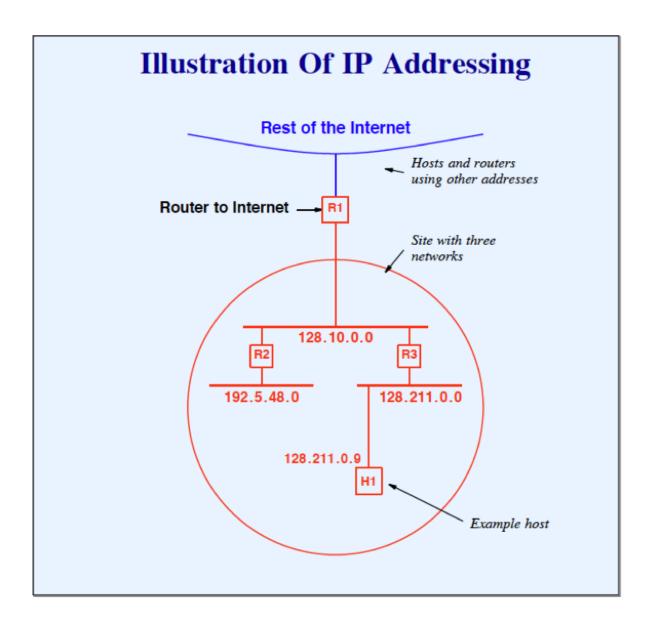


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## **Another Addressing Example**

- Assume an organization has three networks
- Organization obtains three prefixes, one per network
- Host address must begin with network prefix

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### **Summary**

- IP address
  - 32 bits long
  - Prefix identifies network
  - Suffix identifies host
- Classful addressing uses first few bits of address to determine boundary between prefix and suffix

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# **Summary** (continued)

- Special forms of addresses handle
  - Limited broadcast
  - Directed broadcast
  - Network identification
  - This host
  - Loopback

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