Internet Addressing

- A unified network requires a universal communication service.
- Host identifiers:
    - Name: identifies what the object is
    - Address: identifies where it is
    - Route: identifies how to get there

Internet Addressing

- IP Addresses are 32 bit.
- Written in dotted decimal format: X.X.X.X
  - 130.127.49.225
- Written in binary
  - 10000010.01111111.00110001.11100001

- An address encodes the identification of the network as well as the host (network id, host id)

- What is a host?
- How does an address relate to a host ?
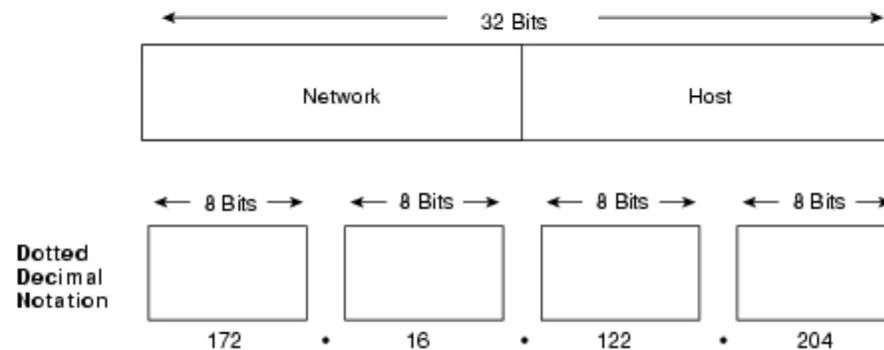- Three types of addresses?

Internet Addressing

- What is a host?
    - A computer that can communicate with any other computer in the Internet.

- How does an address relate to a host ?
    - Not a one-to-one correspondence. A multi-homed host has >1 addresses.
    - An address identifies a connection to a host. So there 'usually' is a one-to-one correspondence between an address and a NIC.
- Three types of addresses?
    - Unicast: one-to-one
    - Broadcast: one-to-all
    - Multicast: one-to-subnet
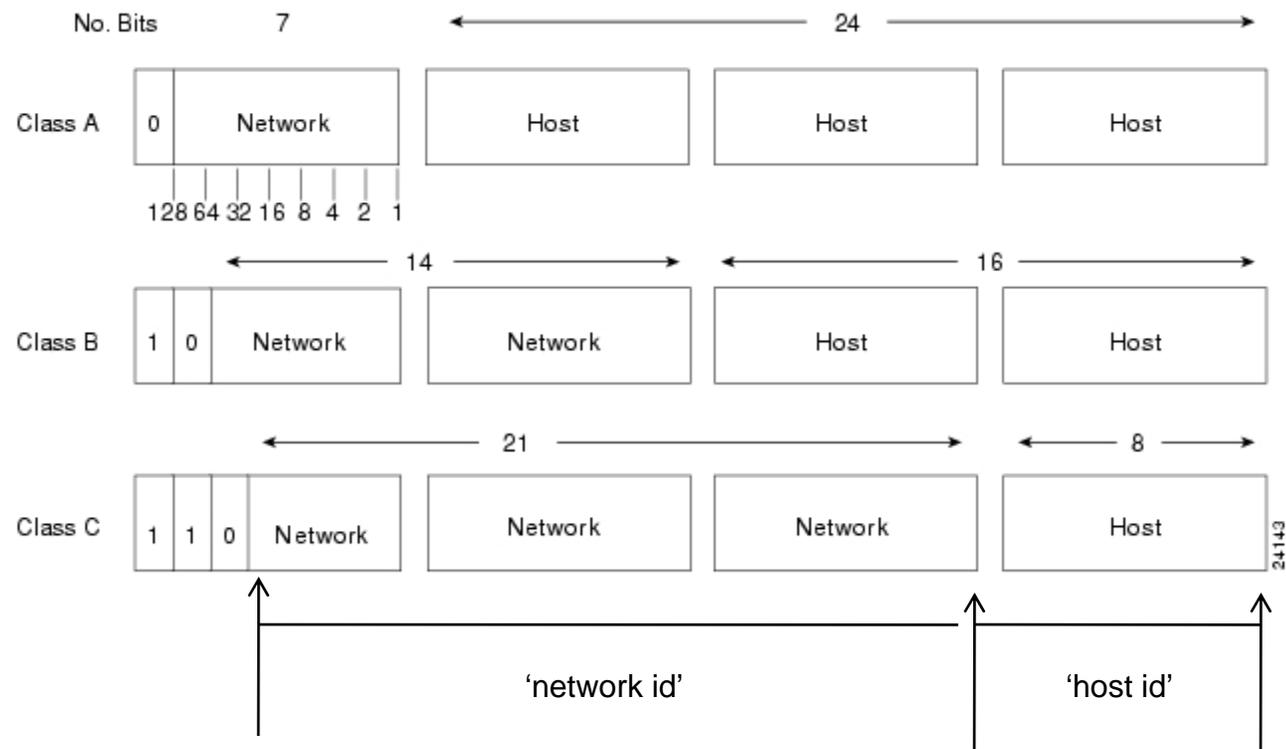
Internet Addressing

Original address scheme was classful:

- Class A for large networks (>64K hosts)
- Class B for medium networks (>256 hosts)
- Class C for small networks (<256 hosts)
- Class D for multicast
- Class E reserved
- Each class determines how many bits in an address is for the network portion and how many for the host portion.

Internet Addressing

The first 3 bits of the most significant octet determine the class.

No. Bits	7		24	
Class A	0 Network	Host	Host	Host

128 64 32 16 8 4 2 1

	14		16	
Class B	1 0 Network	Network	Host	Host

	21		8	
Class C	1 1 0 Network	Network	Network	Host

'network id'   'host id'

Internet Addressing

• What's the total address space?

• Example: Clemson address: 130.127.49.225

Internet Addressing

•What's the total address space?

   2^{32} ..... 4.294 billion

•Example:
   •Clemson address: 130.127.49.225

   10000010.01111111.00110001.11100001

Class: B
Max number of host ids: 2^{16} (64K hosts…but as we will see,
 all are not valid IP addresses)

How many class B networks in the world ? 2^{14} or 16K networks
(but again, not all netids are valid)

Internet Addressing

Two Types of broadcasts:

- A network or a directed broadcast
    - contains a valid network and host id.
    - class C example: 192.168.1.255
- A local or limited broadcast does not require knowledge of the network address.
    - Referred to as the all 1's broadcast:
        255.255.255.255
    - A limited broadcast useful for certain startup protocols:

Internet Addressing

- Conventions…. The 'this' rule and the 'all' rule:
    - A netid or a host id of '0' implies 'this'
    - A netid or a host id of '1' implies 'all'

- Class C example: 192.168.1.0

    The 'this' rule: 'This host' on the network

- Class C example: 192.168.1.255

    The '1's' rule: 'All' hosts on the network

Internet Addressing

Host Addresses with Special Meaning

- All 0's and all 1's
- Loop Back : 127.x.x.x (e.g., 127.0.0.1)
    - What address class?
- Private address space:
    - RFC 1918 defines certain address ranges for private use.
        - 10.0.0.0 - 10.255.255.255 (Class A space)
        - 172.16.0.0 - 172.31.255.255(Class B space)
        - 192.168.0.0 - 192.168.255.255 (Class C space)

Internet Addressing

So, how many valid host ids are available with the following address:

192.168.1.0/24

What happens if you ping 0.0.0.0 ?

Internet Addressing

Class	Lowest Address	Highest Address
A	1.0.0.0	126.0.0.0
B	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	247.255.255.255

Dotted Decimal Class Address Ranges

Network Byte Order

•Network Byte Order: concept to isolate a network from machine architectures.

•Big Endian machines: lowest memory has high-order byte.
•Little Endian machines: lowest memory has low-order byte.
•Functions: htons(), htonl(), ntohs(), ntohl()

Network Byte Order is Big Endian. The MSB of an integer gets sent first. So for the IP address 192.168.1.1, the '192' octet is transmitted first.

Protocol data like IP addresses and port numbers must be in Network Byte Order but user data does not have to be.

Wrapup

- Addresses do not specify computers, but rather connections to particular hosts.
- Multihomed: A host that has >1 physical connection.
- Basic mechanism: A two level class hierarchy.
    - requires a unique network prefix for each physical interface.
    - Two additional schemes designed to conserve net addresses: subnet and classless addressing.

Other issues:
- Mobility
- Flexibility
- Naming
- And of course the IP Address shortage problem...