Motivation

- **A virtual network operates like a physical network and needs an addressing scheme, a packet format, and delivery techniques.**

- **An addressing scheme is critical and must appear to be a single uniform system.**

- **Physical hardware addresses can't be used.**

- **Internet addresses are used on a virtual network in the same way hardware addresses are used on a physical network.**

- **A uniform addressing system helps preserve the illusion of a large seamless network.**

TCP/IP Addresses

- **Addressing in TCP/IP is specified by the Internet Protocol (IP).**

- **Each host is assigned a 32-bit number called an Internet Protocol Address or an Internet Address or an IP Address.**

- **An IP address is unique across the entire internet.**

IP Address Structure

- **Each IP address is divided into a prefix and a suffix.**

  - **The prefix identifies the physical network and is called the <u>network number</u>. Each network in an internet has a unique network number.**

  - **The suffix identifies an individual computer and is called the <u>host number</u> or <u>host address</u>. Each host on a physical network has a unique host address <u>within that network</u>.**

IP Address Structure

- **A host's IP address is then a combination of the network address (prefix) and the host address (suffix).**

- **To emphasize:**
  - **Network numbers on an internet are unique.**
  - **Host addresses are unique within a particular physical network.**
  - **The combination of a network number prefix and a host address suffix is unique on an internet.**

IP Address Structure

- Assignment of network numbers must be coordinated globally. Assignment of host addresses can be managed locally.

- The designers chose 32-bit addresses.
  - Large prefix, small suffix means many physical networks, few hosts per network.
  - Small prefix, large suffix means few physical networks, many hosts per network.

- Designers chose a compromise to accommodate a variety of network sizes.

Classes of IP Addresses

- **The IP addressing scheme divides all 32-bit addresses into 5 classes—A, B, C, D, E.**

- **The class of an address is identified by the first 4 bits.**

- **Classes A, B, C are the <u>primary classes</u>; they are used for ordinary host addressing.**

- **Class D is used for multicasting. Class E is reserved for future expansions.**

Dotted Decimal Notation

- **Humans have difficulty with 32-bit IP addresses.**

- **Dotted decimal notation divides a 32-bit address into 4 octets. The octets are expressed as decimals.**

- **Examples:**

  - Triton

  Dotted decimal: 138.234.4.22

  32-bit form:

  10001010 11101010 00000100 00010110

Dotted Decimal Notation

- Gettysburg College IP addresses are all of the form 138.234.x.x; that is, all hosts at Gettysburg have the prefix 138.234. The suffix bytes are used to distinguish local networks and hosts.

- <u>Question</u>: What class network does Gettysburg have?

- My BAN addresses are of the form 192.168.0.x.

- GSCyclone addresses are of the form 12.x.x.x.

Dotted Decimal Notation

- How many IP addresses are there?
- Almost no single organization needs the number of hosts provided by a Class A address. Class A addresses are rarely given out.

So Who Assigns IP Addresses?

- On a private internet, a person or group that manages the network.

- For connections to the global Internet, the <u>Internet Service Provider (ISP)</u>.

- ISPs get their IP addresses from one of three regional international registries.

- The registry for the Americas and Africa is the American Registry for Internet Numbers (ARIN, http://www.arin.net).

- Regional registries get IP addresses from the Internet Assigned Numbers Authority (IANA, http://www.iana.org).

Allocating Internet Addresses

- Internet addresses are not used efficiently.
- Gettysburg is typical. Our Class B network allows 2^{16} = 65,536 hosts. The College has nowhere near that many computers.
- Some organizations do need to accommodate large numbers of machines.
- Since Class A addresses are scarce, what's a company to do?

Allocating Internet Addresses

- **One solution is to set up a <u>private internet</u> and allocate addresses from the entire 32-bit address space.**
- **The overall network administrator selects an address class for each network based on the expected number of hosts on that network.**
- **The individual local network administrators assign suffixes to hosts on their networks.**

Special IP Addresses

- **Internet addresses beginning with 10., 172.16. through 172.31., and 192.168. are deliberately unassigned. They can be used on internal networks, but no host using addresses in these blocks is allowed onto the global Internet.**
- **IP reserves the host address consisting of 0s to denote the network itself. For example, 138.234.0.0 denotes the Gettysburg College network.**

Special IP Addresses

- **Addresses beginning with 127 (most commonly 127.0.0.1) always mean the <u>local loopback address</u>.**
  - **- They correspond to the hostname <u>localhost</u>.**
  - **- Useful for testing network applications.**
- **0.0.0.0 always refers to the originating host. It is used during startup.**

Routers & IP Addressing

- IP says that routers should also be assigned IP addresses.
- Since a router is a computer connecting two or more networks, ...
  - a router has connections to more than one physical network;
  - each IP address has a prefix specifying a particular physical network.
- Therefore, a single IP address does not suffice for a router.

Routers & IP Addressing

- Here's a better way to think of an IP address:
  - An IP address does not identify a particular computer.
  - Rather, it specifies an <u>interface</u> or a <u>connection</u> between a computer and a network.
- With this interpretation, a router needs as many IP addresses as it has network connections.