Introduction to the Internet (I)

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Agenda

- Intro to the Internet
- Internet Protocol
- LAN/MAN/WAN
- ISO/OSI RM
- TCP/IP Protocol Suite

Introduction

- What is Internet
  - "A network of networks, joining many government, university and private computers together and providing an infrastructure for the use of E-mail, bulletin boards, file archives, hypertext documents, databases and other computational resources"*
  - "The vast collection of computer networks which form and act as a single huge network for transport of data and messages across distances which can be anywhere from the same office to anywhere in the world."*

* William F. Slater, III, 1996. President of the Chicago Chapter of the Internet Society

Introduction

- A brief history of Internet
  - J.C.R. Licklider first proposed a global network of computers in 1962, and moved over to the Defense Advanced Research Projects Agency (**DARPA**) in late 1962 to develop it
  - The Internet, then known as **ARPANET**, was brought online in 1969 by the renamed Advanced Research Projects Agency (ARPA)
  - The Internet matured (?) in the 70's as a result of the **TCP/IP** architecture
  - The European Laboratory for Particle Physics (CERN) invented the World Wide Web (**WWW**) to share information among research groups

Introduction

- Growth of the Internet [1]

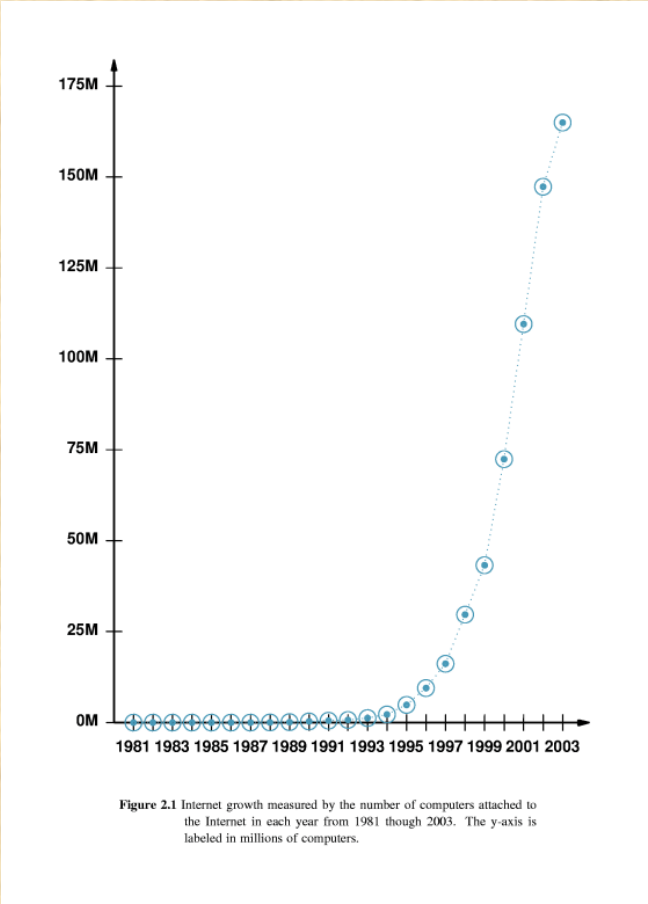
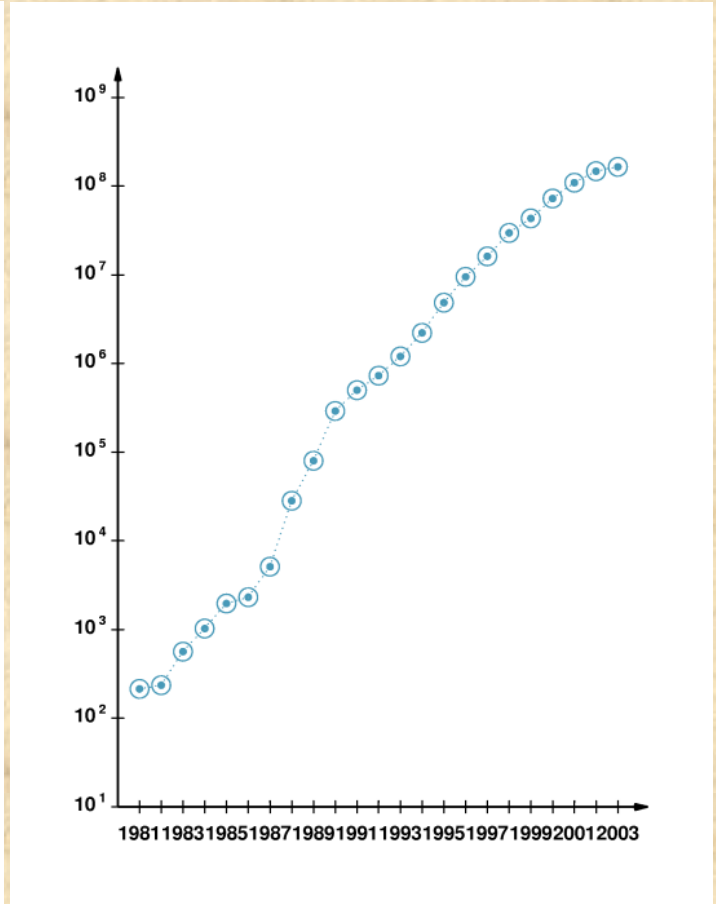
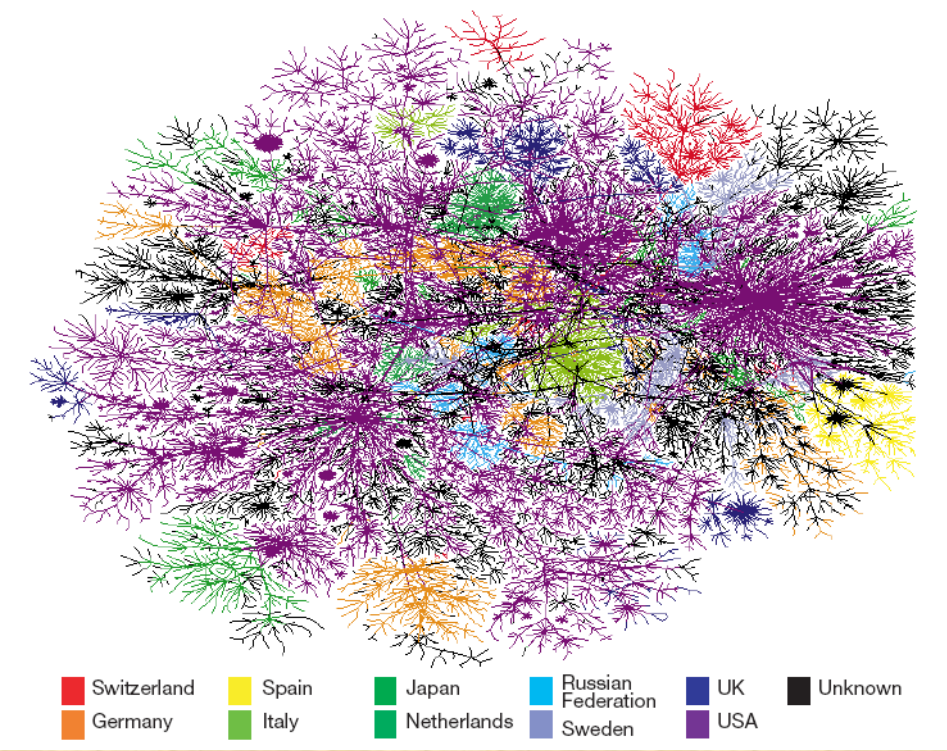


Figure 2.1 Internet growth measured by the number of computers attached to the Internet in each year from 1981 though 2003. The y-axis is labeled in millions of computers.



Introduction

- What does the Internet look like?
- Consists of
  - Backbones
  - Regional
  - Commercial
  - Local



[2]

HOWTO

- Architecture
- Protocols
- Web Services
  - WWW
  - FTP
  - Email
  - Blogs…

Internet Protocol (IP) Addresses

- Configuring IP addresses
- IP Address Space
- Subnet

Ipconfig

- **Usage**: ipconfig [/? | /all | /renew [adapter] | /release [adapter] | /flushdns | /displaydns |/registerdns | /showclassid adapter | /setclassid adapter [classid]]
- **Options**:
  - /? Display this help message
  - /all Display full configuration information.
  - /release Release the IP address for the specified adapter.
  - /renew Renew the IP address for the specified adapter.
  - /flushdns Purges the DNS Resolver cache.
  - /registerdns Refreshes all DHCP leases and re-registers DNS names
  - /displaydns Display the contents of the DNS Resolver Cache.
  - /showclassid Displays all the dhcp class IDs allowed for adapter.
  - /setclassid Modifies the dhcp class id.
- **Examples**;
  - > ipconfig >ipconfig /all >ipconfig /renew
  - > ipconfig/all >ipconfig /release
  - Ref & examples

Ping

- **Usage**: ping [-t] [-a] [-n count] [-l size] [-f] [-i TTL] [-v TOS] [-r count] [-s count] [[-j host-list] | [-k host-list]] [-w timeout] target_name

- Options:
  - -t Ping the specified host until stopped. To see statistics and continue - type Control-Break; To stop - type Control-C.
  - -a Resolve addresses to hostnames.
  - -n count Number of echo requests to send.
  - -l size Send buffer size.
  - -f Set Don't Fragment flag in packet.
  - -i TTL Time To Live.
  - -v TOS Type Of Service.
  - -r count Record route for count hops.
  - -s count Timestamp for count hops.
  - -j host-list Loose source route along host-list.
  - -k host-list Strict source route along host-list.
  - -w timeout Timeout in milliseconds to wait for each reply.

Tracert

- Usage: tracert [-d] [-h maximum_hops] [-j host-list] [-w timeout] target_name
- Options:

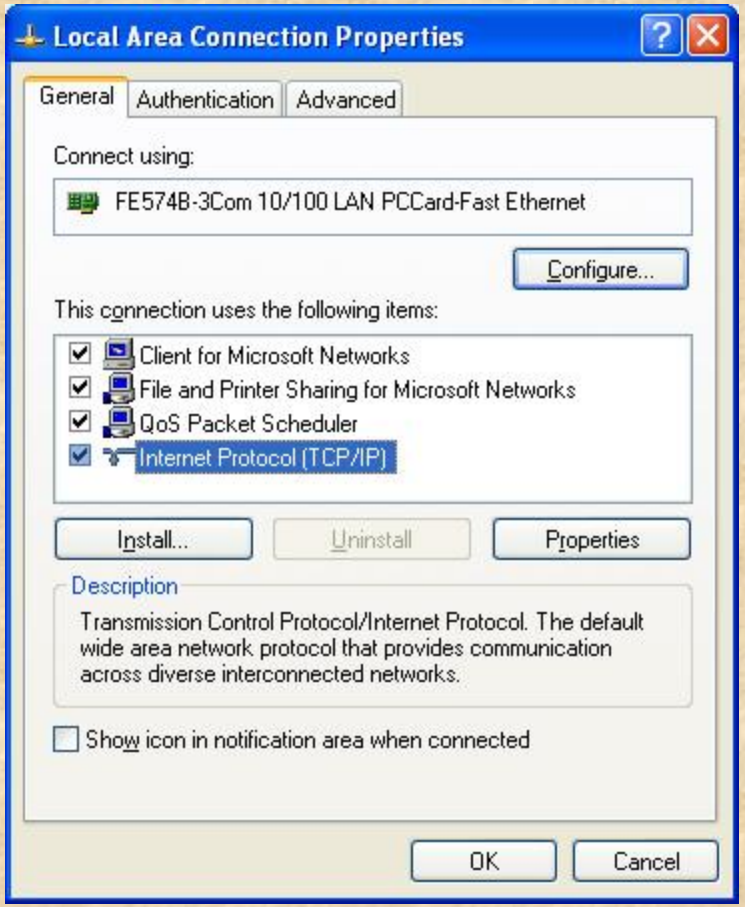
  - -d Do not resolve addresses to hostnames.
  - -h maximum_hops Maximum number of hops to search for target.
  - -j host-list Loose source route along host-list.
  - -w timeout Wait timeout milliseconds for each reply.

netstat

- Displays protocol statistics and current TCP/IP network connections.
- Syntax:
  - NETSTAT [-a] [-b] [-e] [-n] [-o] [-p proto] [-r] [-s] [-v] [interval]

Network Configuration

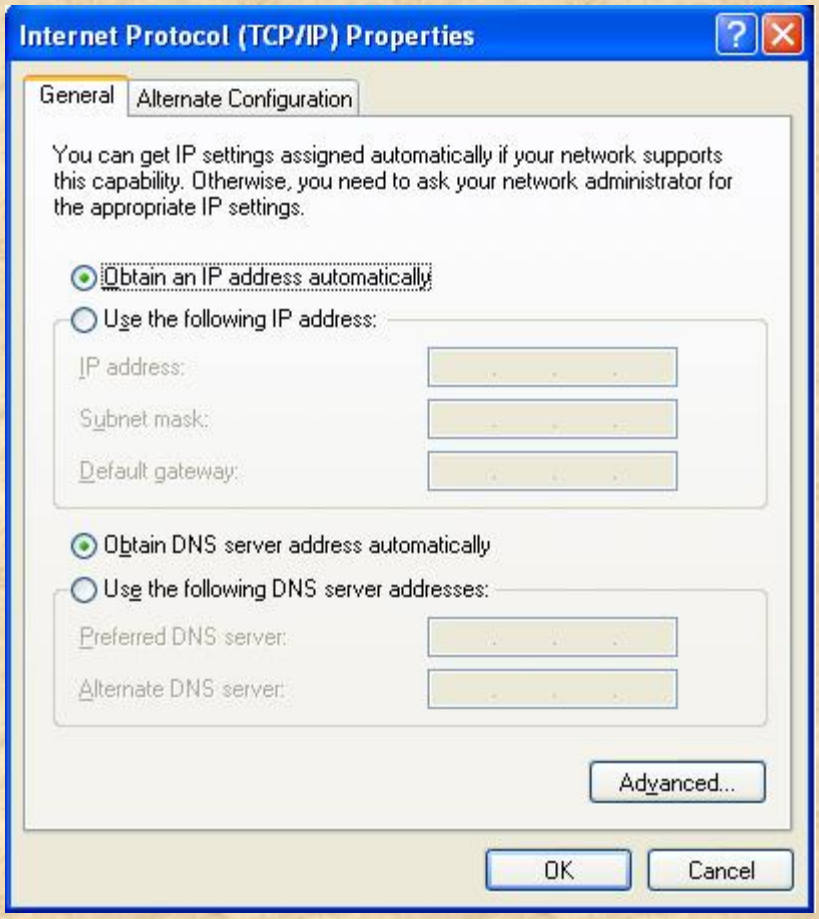
1. Go to the Start menu, select **All Programs**, then **Accessories**, then **Communications**, then **Network Connections**
2. Right-click on the **Local Area Connection** icon and select **Properties**



** Windows XP Demonstration.

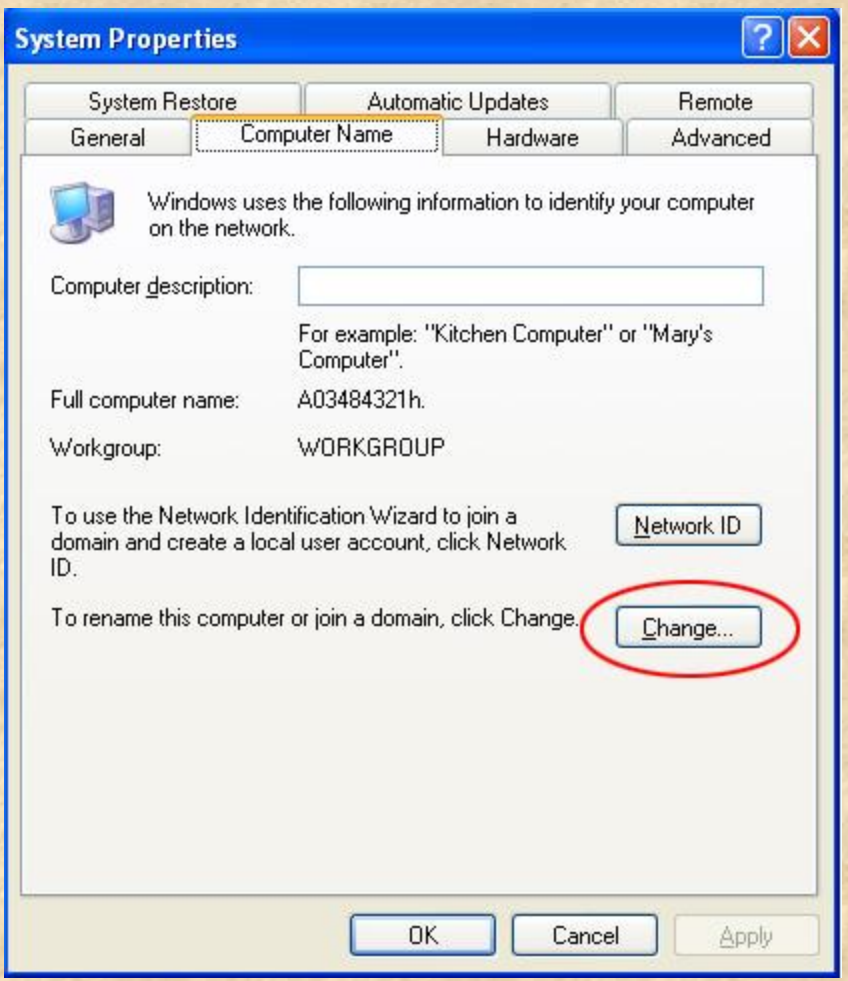
Network Configuration (Cont.)

3. Click the **Internet Protocol (TCP/IP)** listing, then **Properties**
4. Make sure that the TCP/IP settings are set to **Obtain an IP address automatically** and **Obtain DNS server address automatically**, as illustrated to the left.



Network Configuration (Cont.)

- Change Computer Name by Right-click on the **My Computer** icon. Select **Properties**.



IPv4

- An IPv4 address consists of four bytes (32 bits) those are also known as **octets**
  - Eg. 00001010 00000000 00000000 00000001

  usually appears in the equivalent **dotted decimal** representation 10.0.0.1
- The full range of IP addresses is from 0.0.0.0 through 255.255.255.255. That represents a total of **4,294,967,296** possible IP addresses (2^32).

IP Classes

- IP Addresses

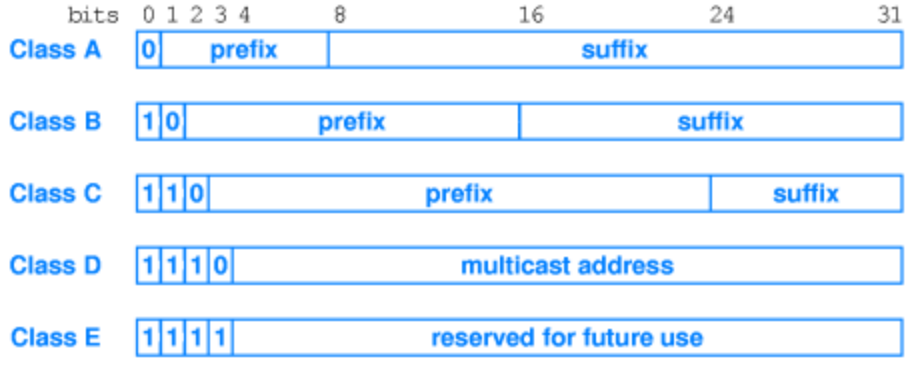


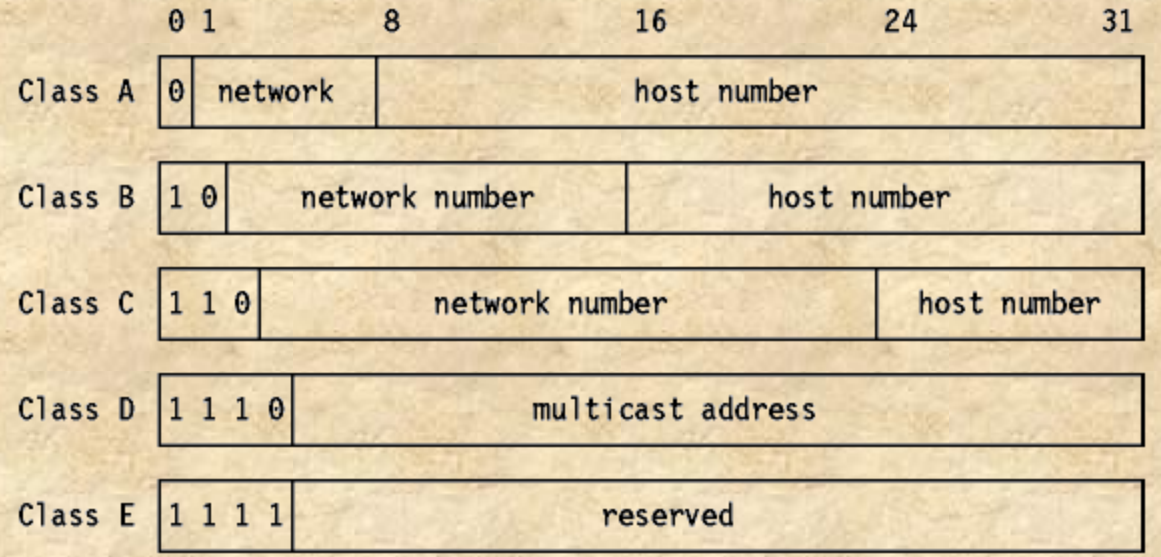
Figure 18.1 The five classes of IP addresses in the original classful scheme. The address assigned to a host is either class *A*, *B*, or *C*; the *prefix* identifies a network, and the suffix is unique to a host on that network.

IP Classes

- Class A, Class B, and Class C are the three classes of addresses used on IP networks in common practice; Class **D** addresses as reserved for **multicast;** Class **E** addresses as **reserved**

Class	Leftmost bits	Start address	Finish address
A	0xxx	0.0.0.0	127.255.255.255
B	10xx	128.0.0.0	191.255.255.255
C	110x	192.0.0.0	223.255.255.255
D	1110	224.0.0.0	239.255.255.255
E	1111	240.0.0.0	255.255.255.255

Assigned Classes of Internet Addresses



Loopback

- **127.0.0.1** is the **loopback** address in IP
- Loopback is a test mechanism of **network adapters**.
- Messages sent to 127.0.0.1 do not get delivered to the network

IP Network Partioning

- Network addressing fundamentally organizes hosts into groups.
  - Improve security (by isolating critical nodes)
  - Reduce network traffic (by preventing transmissions between nodes that do not need to communicate with each other)

Class	Host address range	Network address	Default mask
A	0.0.0.0 – 127.255.255.255	x.0.0.0	255.0.0.0
B	128.0.0.0 – 191.255.255.255	x.x.0.0	255.255.0.0
C	192.0.0.0 – 223.255.255.255	x.x.x.0	255.255.255.0

Subnet Masks and Subnetting

- A **subnet** allows the flow of network traffic between hosts to be segregated based on a network configuration
- Perhaps the most recognizable aspect of subnetting is the **subnet mask**
  - E.g. 255.255.255.0

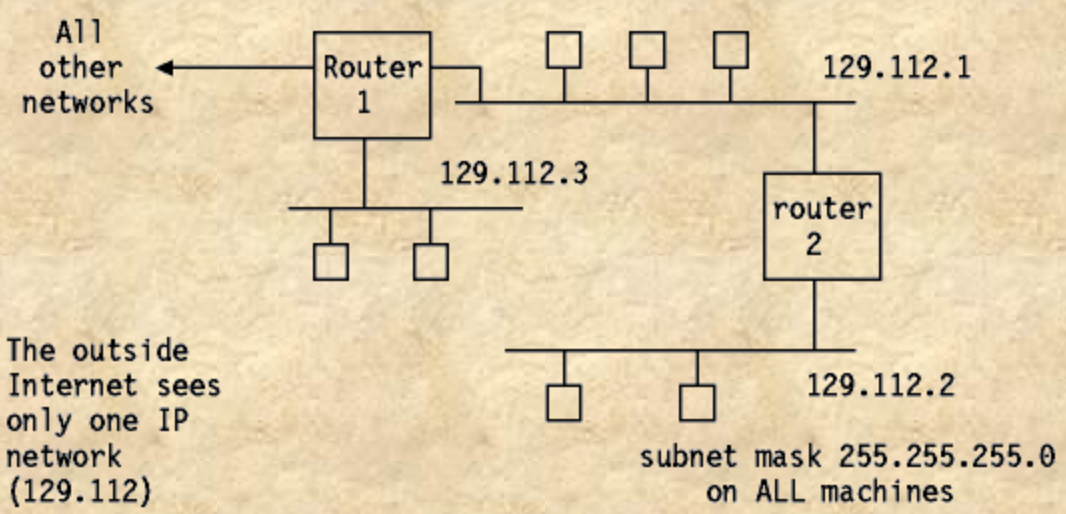
Subnetting in Practice

- Three-level scheme
  - network address, subnet number and host address
  - <network number><subnet number><host number>

Network address (24 bits)	Subnet Number (1 bit)	Extended network	Host address range
11000000 10101000 00000001	0	192.168.1.0	192.168.1.1 – 192.168.1.127
11000000 10101000 00000001	1	192.168.1.128	192.168.1.129 – 92.168.1.255

Subnetting Demo (I)

- E.g.



Subnetting Demo (II)

- E.g. subnet mask: 255.255.255.240
- 240 (Dec) = 11110000 (BIN)
- How many subnets?
- How many hosts in each subnets?

- Ex: how about 255.255.255.0
- Ex: how about 255.255.254.0
- Ex: how about 255.255.255.248?

CIDR –

Classless Inter-Domain Routing

- CIDR was developed in the 1990s as a standard scheme for routing IP addresses.
- CIDR allows a more flexible way to associate groups of IP addresses without relying on the original class system. CIDR is also known as **supernetting**.
- **CIDR Notation**
  - xxx.xxx.xxx.xxx/n where n is the number of (leftmost) '1' bits in the mask. For example, 192.168.12.0/23 applies the network mask 255.255.254.0 to the 192.168 network

IPv4-IPv6

Cls	Total	Year End 1990				Year End 1992				Year End 1994			
		Assigned		Allocated		Assigned		Allocated		Assigned		Allocated	
		Nbr	%	Nbr	%	Nbr	%	Nbr	%	Nbr	%	Nbr	%
A	126	38	30	101	80	51	40	114	90	53	42	116	92
B	16382	3238	20	4079	25	6812	42	7919	48	8432	51	9976	61
C	2097150	7792	0.4	104404	5.0	23339	1.1	200742	10	52833	2.5	521489	25

IPv6

- IPv6 addresses are **16** bytes (128 bits) long rather than four bytes (32 bits), more than

  300,000,000,000,000,000,000,000,000,000,000,000

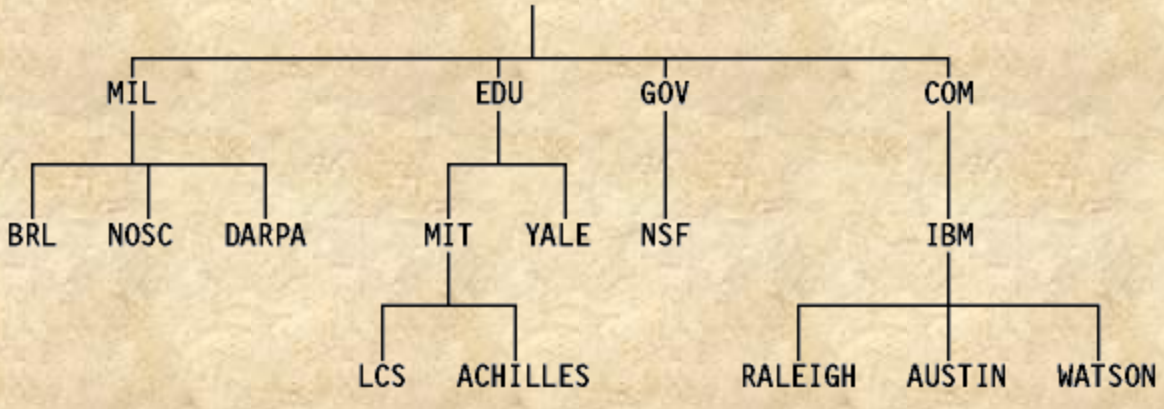
  possible addresses!
- IPv6 uses 0:0:0:0:0:0:0:1 as its loopback address, equivalent to 127.0.0.1 in IPv4.
- Takes the **hexadecimal** form of hhhh:hhhh:hhhh:hhhh:hhhh:hhhh:hhhh:hhhh
  - E.g. E3D7::51F4:9BC8:C0A8:6420

Applying subnetting

- See to demo~~~

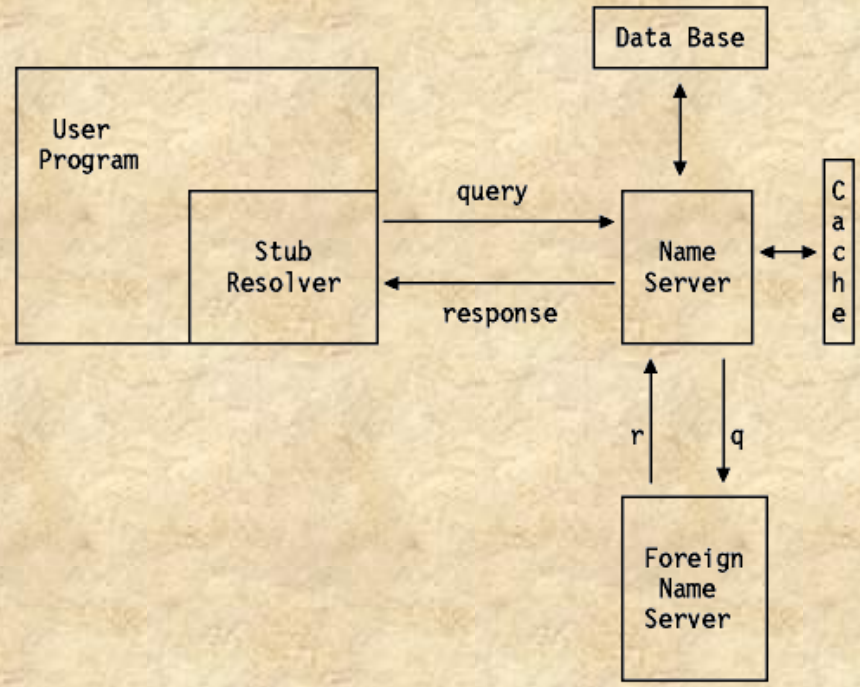
(Domain Name System) DNS

- Humans prefer to work with names (www.utk.edu) rather than numbers
- DNS is a **hierarchical** system. DNS organizes all registered names in a tree structure
- At the base or **root** of the tree are a group of **top-level domains** including familiar names like com, org, and edu and numerous **country-level domains** like fi (Finland), ca (Canada) …



DNS Resolvers

- DNS works in a **client/server** fashion.
- DNS servers respond to requests from DNS clients called **resolvers**



To be continued…