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**THIRD COLLEGE ON MICROPROCESSOR-BASED REAL-TIME
CONTROL - PRINCIPLES AND APPLICATIONS IN PHYSICS
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THE INTERNET & NETWORK SERVICES

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These are preliminary lecture notes, intended only for distribution to participants.

Networks (1)

The Internet and Network Services

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The Internet and Network Services

Why Network Computers?

primarily to be able to **share resources**.

Resources can be:

- **information**
- **people**
- **hardware**
- **software**

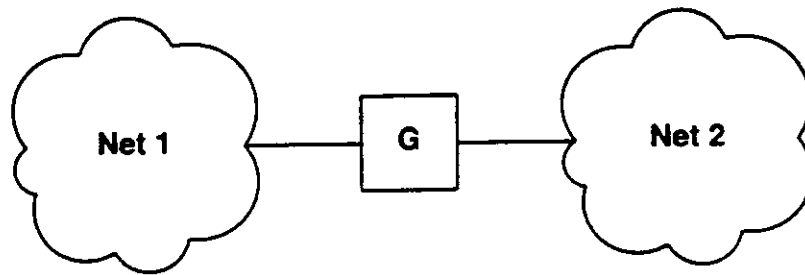
Computer networks have grown out of the necessity to exchange messages and data.

What is a network?

A network is a **collection of objects**. Quite visible in computer networks are the **access points** - terminals - which nowadays include PCs and workstations. What is not readily visible are the software and hardware components that form the network. These have been usually the concern of the networking people and not so much of the ordinary user.

A computer network is a "**living thing**". It constantly grows and changes its character.

Although the small and isolated networks are useful they become much more useful if they can be connected to one another thus forming a single network. The device used in between the two networks is called a gateway (router in IP).



Internetworking of networks using a gateway (router)

A gateway is a computer connected to both the networks and carries out **protocol translation and routing**. In the case of IP based internetworking it is called a router which has to deal with routing only.

The process of interworking of these isolated networks to form a single large network is called **internetworking**. The network thus formed by internetworking many isolated networks is called an **internet** (notice the lower case "i"). Therefore an internet is a computer network which allows computers with distinctive software and hardware features to communicate or **internetwork**.

On an internet you can find

- many **different kinds of computers**, ranging from the smallest palmtop computer to the largest super computer
- each computer **playing a specialised role**
- offering a wide **variety of services** to its users.

For example, on an internet one computer may perform the calculations while another computer may be designated to display the results. This is typically the case when you use a super computer and use your workstation to display results.

What is the Internet?

The *Internet* (notice the upper case "I") is a **global network of networks**, comprising millions of heterogeneous computers ranging from the smallest palm top to the largest super computing systems interconnected using a set of rules defined by the *Internet Protocol (IP)* suite. The use of IP allows seamless integration of these networks to the global Internet.

There are two very important characteristics of the Internet worth noting.

- **connectivity** to almost 100 countries (directly) and over 150 countries (through email)
- a very **rich source of information and services**.

Internet means different things to different people; but the world-wide connectivity and the availability of information and services have made the Internet a truly **Global Information Space**. Today the Internet is used by the ordinary public and the commercial sector in addition to the academic and research community for whom the Internet was originally developed.

History of the Internet

Internet has evolved into its present form from the ARPANet which was originated by the Advanced Research Projects Agency (now DARPA) in the late 1960s. ARPANet was designed as a US-wide **packet switching network** for data communications. The success of the ARPANet has attracted more and more users and the demand for network capacity has steadily increased. The original communication links running at 56 Kbps have been upgraded in stages to run at speeds of several 100 Mbps.

Along with the development of the packet switching network infrastructure and with the need to be able to interconnect the component networks, it has become necessary to develop a suitable networking protocol.

TCP/IP (Transmission Control Protocol/ Internet Protocol) has emerged as the protocol suite used on the Internet which specifies

1. how computers on the Internet **communicate**
2. a set of conventions for **interconnecting networks** and **routing network traffic**.

TCP/IP protocols collectively specify:

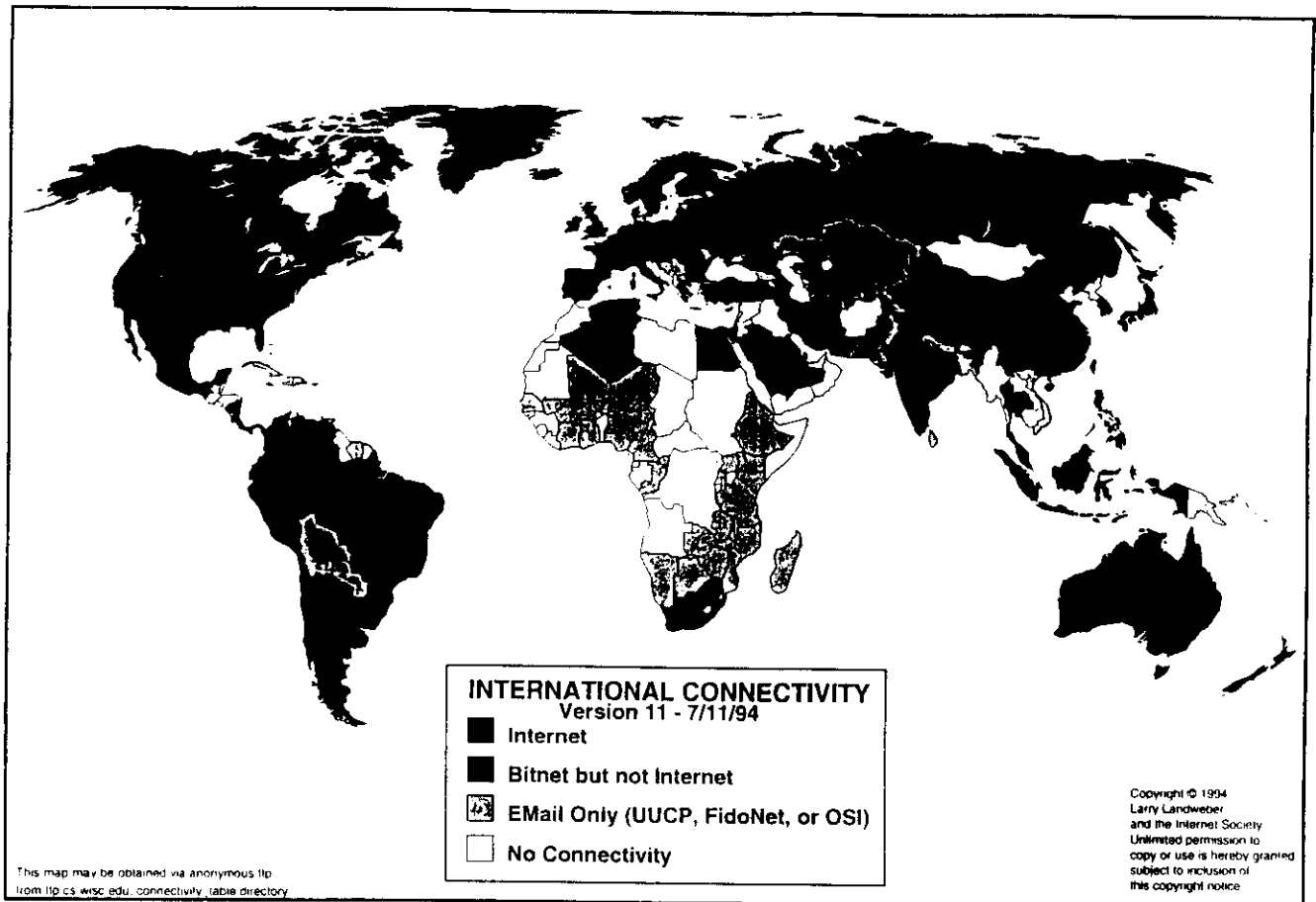
- the way to pass messages
- the message format
- how to handle error conditions.

TCP/IP protocol suite has enabled the use of communication standards independent of any particular computer hardware and software implementation. More importantly it allows the use of an application at the higher levels without any relation to the **underlying physical details** of the network (eg. the type of communication medium used or the type of network interface card used).

These properties have made it possible for the computers to communicate in an *open systems environment* using Internet technology, the specifications of which are publicly available through the **Internet RFCs** (Request For Comments). This means that anyone could build the hardware and the software needed to communicate across the Internet.

Internet Dynamics

As a result of the above the Internet is experiencing an exponential growth. There is nothing better to describe this phenomenon.



World-wide Internet connectivity

Today the Internet has spread to most countries in the world. The acceptance by almost 100 countries in the world and more than 20 million users is a good indication of the usefulness of the Internet and its associated services. In terms of size and coverage the nearest comparison is the world wide telephone network, which allows only voice communication and in a limited case to transmit slow speed data, facsimile, etc.

However the connectivity map must be interpreted carefully. A country indicated as having Internet connectivity does not necessarily mean that Internet access is available country wide. This is true for many countries in the developing world.

Internet is driven by the demand and the availability of network services and tools. When one tool becomes available it creates the demand for a new and more sophisticated tool. This process repeats and keeps the Internet growing.

Services on the Internet

Internet not only provides world-wide connectivity but also tools and services to explore the network. It provides the following which can be categorised as the **basic services** on the Internet. They include:

- email
- file transfer (ftp)
- remote login (rlogin and telnet)
- news (USENET)
- Bulletin Board Services (BBSs).

However the explosive growth of the Internet has created a situation of Information overload. Often it has become difficult to know whether what you are looking for is available on the network and if it is available how to access it. In order to overcome this problem a new set of tools to navigate the Internet has started to emerge. Presently **network navigational tools** are available for the following.

1. Explore the Internet

- Gopher and Veronica
- WWW (World Wide Web or W3) and Mosaic.

2. Search Databases

- WAIS (Wide Area Information Service)

3. Find network resources

- Archie

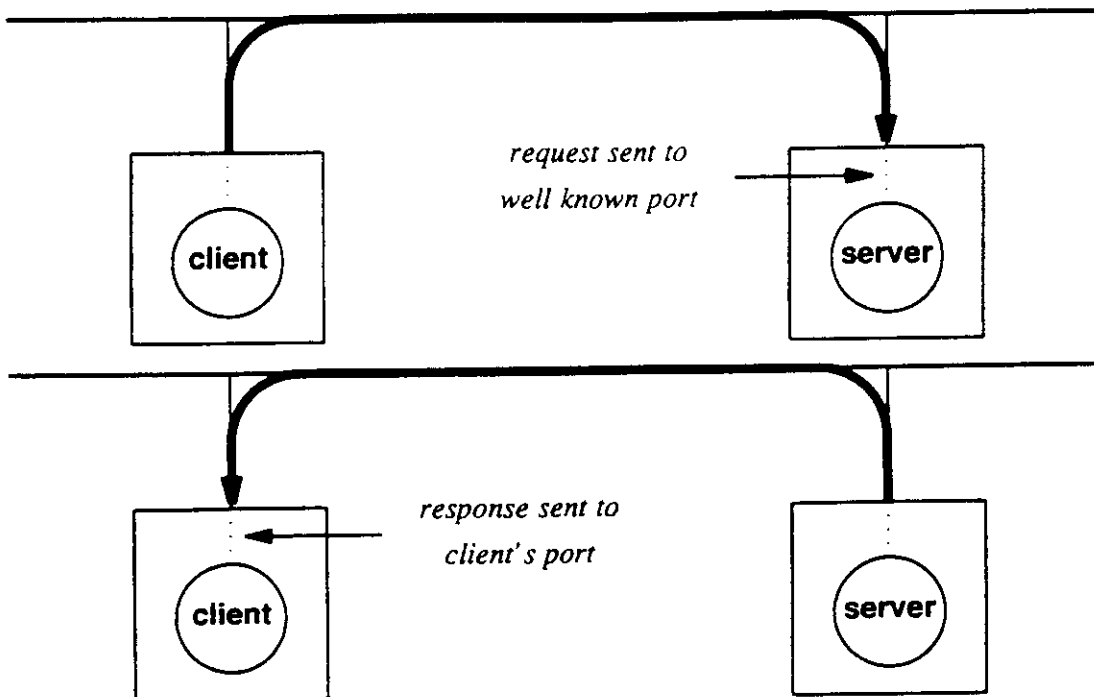
4. Find people and computers/networks

- WHOIS
- X.500
- NETFIND

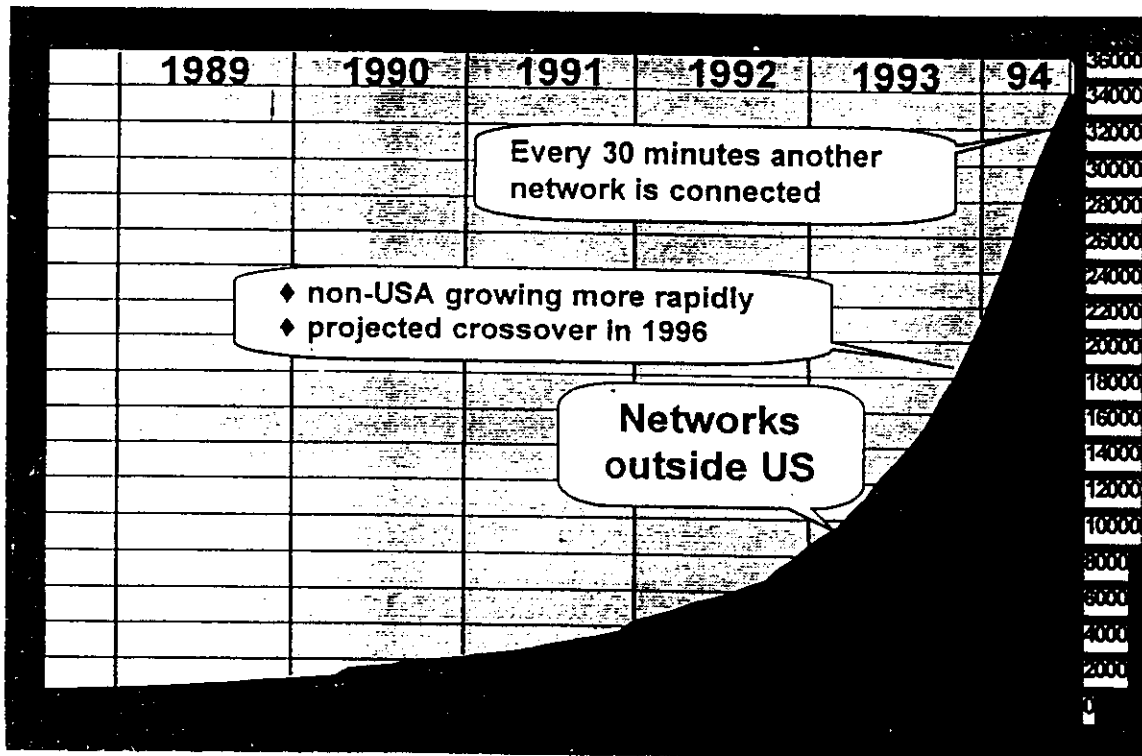
5. Be in touch with networked interest groups

- LISTSERV
- USENET

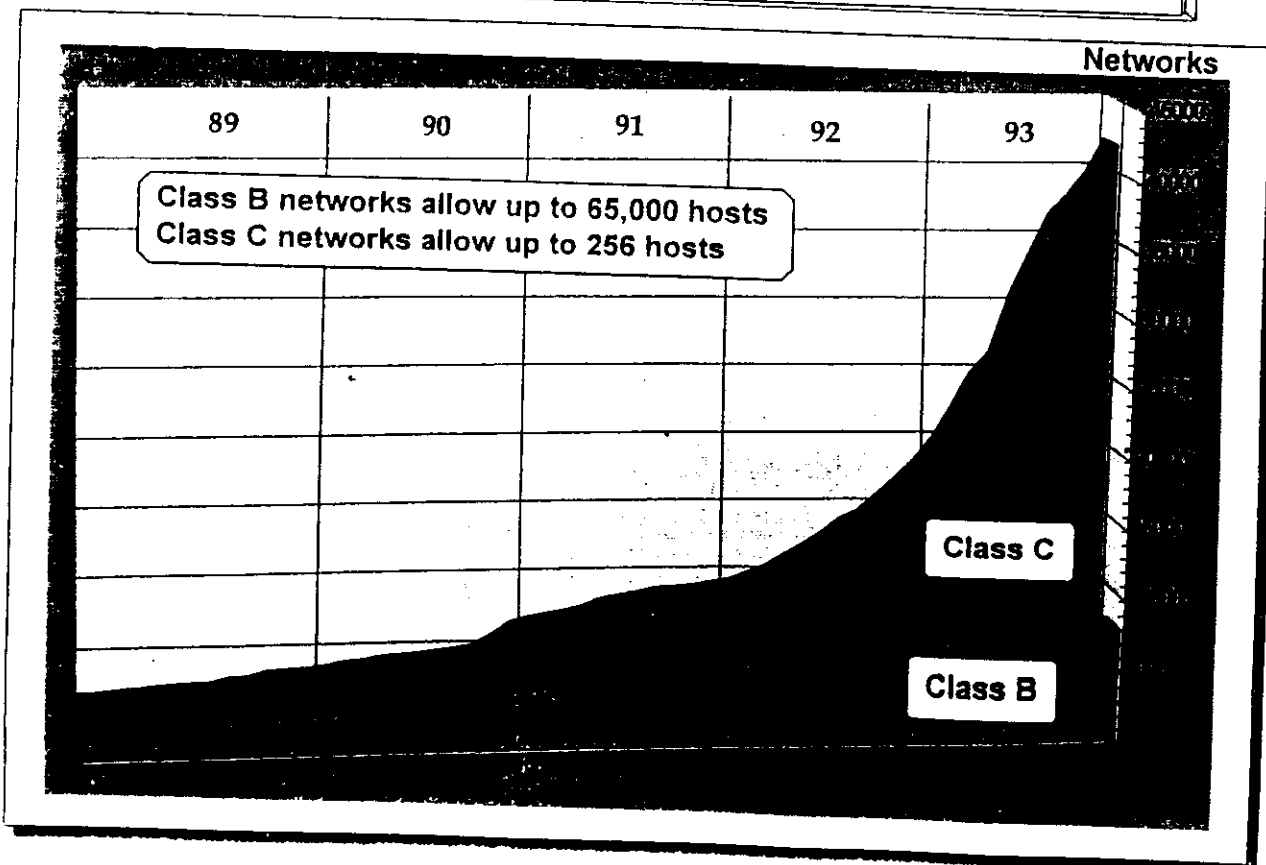
Many of the tools are designed to work in a **client-server environment**. Software programs which ask for resources from servers are called client programs. They are clients of the server software. Clients send requests to a server using a standardised format, called a protocol. Servers respond by supplying information in the form of files containing text or data of various sorts.



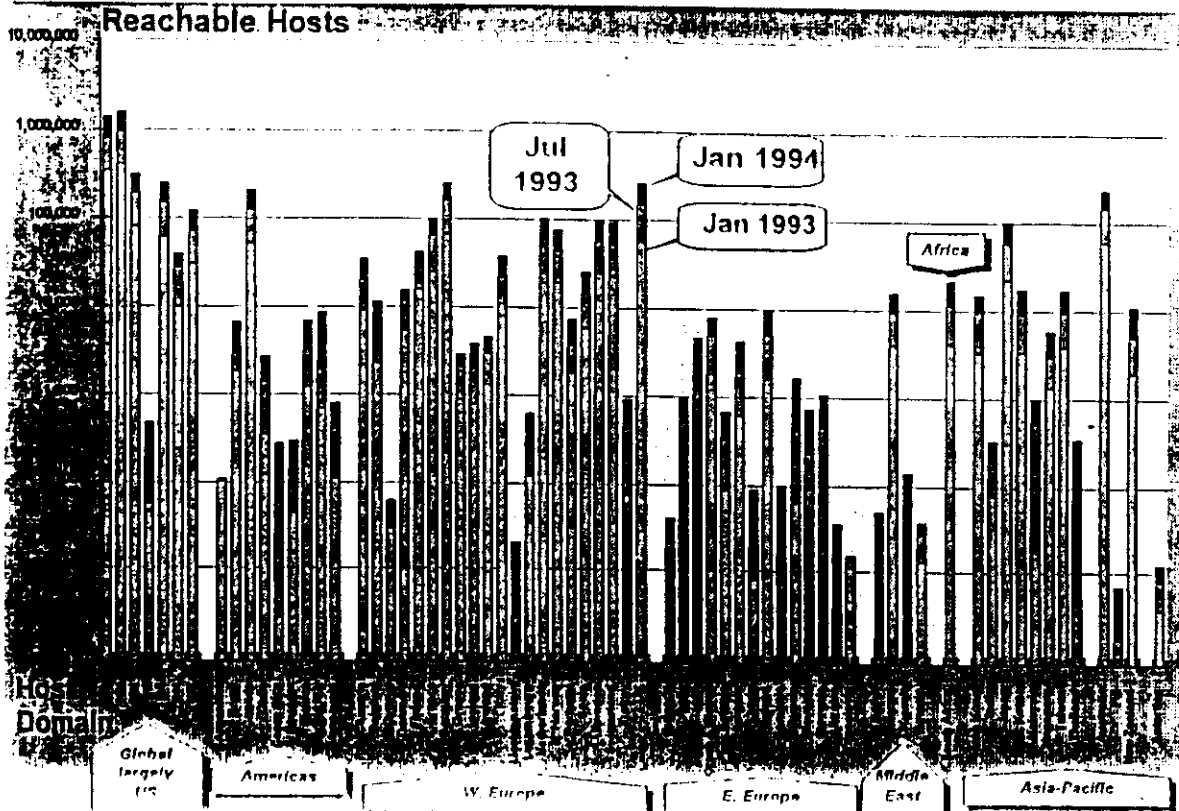
Growth of The Internet



Growth of Registered IP Networks



Global Growth of Internet Hosts in 1993



Internet Hosts Reachable 1989-1993

