Course Title: Computer Networks and Internetworking Protocols

Semester V
Course Code BTITC502
Prerequisite Nil
L – T – P 3 – 1 – 2
Stream Core Credits 4

Course Objectives:

OBJECTIVES:

- To give a brief history of the Internet.
- To give the definition of the two often-used terms in the discussion of the Internet: protocol and standard.
- To categorize standard organizations involved in the Internet and give a brief discussion of each.
- To define Internet Standards and explain the mechanism through which these standards are developed.
- To discuss the Internet administration and give a brief description of each branch.

1-1 A BRIEF HISTORY

A network is a group of connected, communicating devices such as computers and printers.

An *internet* is two or more networks that can communicate with each other.

The most notable internet is called the *internet* that composed of hundreds of thousands of interconnected networks.

Private individuals as well as various organizations such as government agencies, schools, research facilities, corporations, and libraries in more than 100 countries use the Internet. Millions of people are users. Yet this extraordinary communication system only came into being in 1969.

Features	Network	Internet
Definition	It is a collection of two or multiple connected computer systems that may share resources like an internet connection, a printer, an app, etc.	It is a network of interconnected devices that are spread around the globe.
Coverage	It may only cover a limited distance.	It is available from anywhere in the world.
Connectivity	It is handled by a single entity with administrative rights.	No entity has control over the internet's system.
Objective	The objective of the network is to exchange data and collaborate with peers.	The primary goal of the internet is to get knowledge and communicate over the internet.
Connections	It connects thousands of computer systems at once.	It simultaneously connects millions of computers.
Types	It is a set of PCs and devices that are connected through WAN, CAN, LAN, or HAN.	It is a global system that connects numerous types of electronic equipment all over the world.

Topics Discussed in the Section

- ✓ **ARPANET**
- ✓ **Birth of the Internet**
- ✓ **TCP/IP**
- ✓ **MILNET**
- ✓ **CSNET**
- ✓ **NSFNET**
- ✓ **ANSNET**
- ✓ **The Internet Today**
- ✓ **World Wide Web**
- ✓ **Growth of the Internet**

ARPANET

In the mid-1960s, mainframe computers in research organizations were stand-alone devices. Computers from different manufacturers were unable to communicate with one another. The **Advanced Research Projects Agency (ARPA)** in the Department of Defense (DOD) was interested in finding a way to connect computers together so that the researchers they funded could share their findings, thereby reducing costs and eliminating duplication of effort.

In 1967, at an Association for Computing Machinery (ACM) meeting, ARPA presented its ideas for ARPANET, a small network of connected computers. The idea was that each host computer (not necessarily from the same manufacturer) would be attached to a specialized computer, called an interface message processor (IMP). The IMPs, in turn, would be connected to each other. Each IMP had to be able to communicate with other IMPs as well as with its own attached host.

By 1969, ARPANET was a reality. Four nodes, at the University of California at Los Angeles (UCLA), the University of California at Santa Barbara (UCSB), Stanford Research Institute (SRI), and the University of Utah, were connected via the IMPs to form a network. Software called the Network Control Protocol (NCP) provided communication between the hosts.

Birth of the Internet

In 1972, Vint Cerf and Bob Kahn, both of whom were part of the core ARPANET group, collaborated on what they called the *Internetting Project*. They wanted to link different networks together so that a host on one network could communicate with a host on a second, different network. There were many problems to overcome: diverse packet sizes, diverse interfaces, and diverse transmission rates, as well as differing reliability requirements. Cerf and Kahn devised the idea of a device called a *gateway* to serve as the intermediary hardware to transfer data from one network to another.

Transmission Control Protocol/Internetworking Protocol (TCP/IP)

Cerf and Kahn's landmark 1973 paper outlined the protocols to achieve end-to-end delivery of data. This was a new version of NCP. Transmission control protocol (TCP) included concepts such as encapsulation, the datagram, and the functions of a gateway. A radical idea was the transfer of responsibility for error correction from the IMP to the host machine. This ARPA Internet now became the focus of the communication effort. Around this time responsibility for the ARPANET was handed over to the Defense Communication Agency (DCA).

In October 1977, an internet consisting of three different networks (ARPANET, packet radio, and packet satellite) was successfully demonstrated. Communication between networks was now possible. Shortly thereafter, authorities made a decision to split TCP into two protocols:

Transmission Control Protocol (TCP) and **Internet Protocol (IP).** IP would handle datagram routing while TCP would be responsible for higher level functions such as segmentation, reassembly, and error detection.

The new combination became known as TCP/IP.

In 1981, under a DARPA contract, UC Berkeley modified the UNIX operating system to include TCP/IP. This inclusion of network software along with a popular operating system did much for the popularity of networking. The open (non-manufacturer specific) implementation on Berkeley UNIX gave every manufacturer a working code base on which they could build their products.

In 1983, authorities abolished the original ARPANET protocols, and TCP/IP became the official protocol for the ARPANET.

Those who wanted to use the Internet to access a computer on a different network had to be running TCP/IP.

MILNET

In 1983, ARPANET split into two networks: **MILNET** for military users and ARPANET for nonmilitary users.

CSNET

Another milestone in Internet history was the creation of CSNET in 1981. **CSNET** was a network sponsored by the National Science Foundation (NSF). The network was conceived by universities that were ineligible to join ARPANET due to an absence of defense ties to DARPA. CSNET was a less expensive network; there were no redundant links and the transmission rate was slower. It featured connections to ARPANET and Telenet, the first commercial packet data service.

By the middle 1980s, most U.S. universities with computer science departments were part of CSNET. Other institutions and companies were also forming their own networks and using TCP/IP to interconnect. The term *Internet,* originally associated with government-funded connected networks, now referred to the connected networks using TCP/IP protocols.

NSFNET

With the success of CSNET, the NSF, in 1986, sponsored **NSFNET,** a backbone that connected five supercomputer centers located throughout the United States. Community networks were allowed access to this backbone, a T-1 line with a 1.544-Mbps data rate, thus providing connectivity throughout the United States.

In 1990, ARPANET was officially retired and replaced by NSFNET. In 1995, NSFNET reverted back to its original concept of a research network.

ANSNET

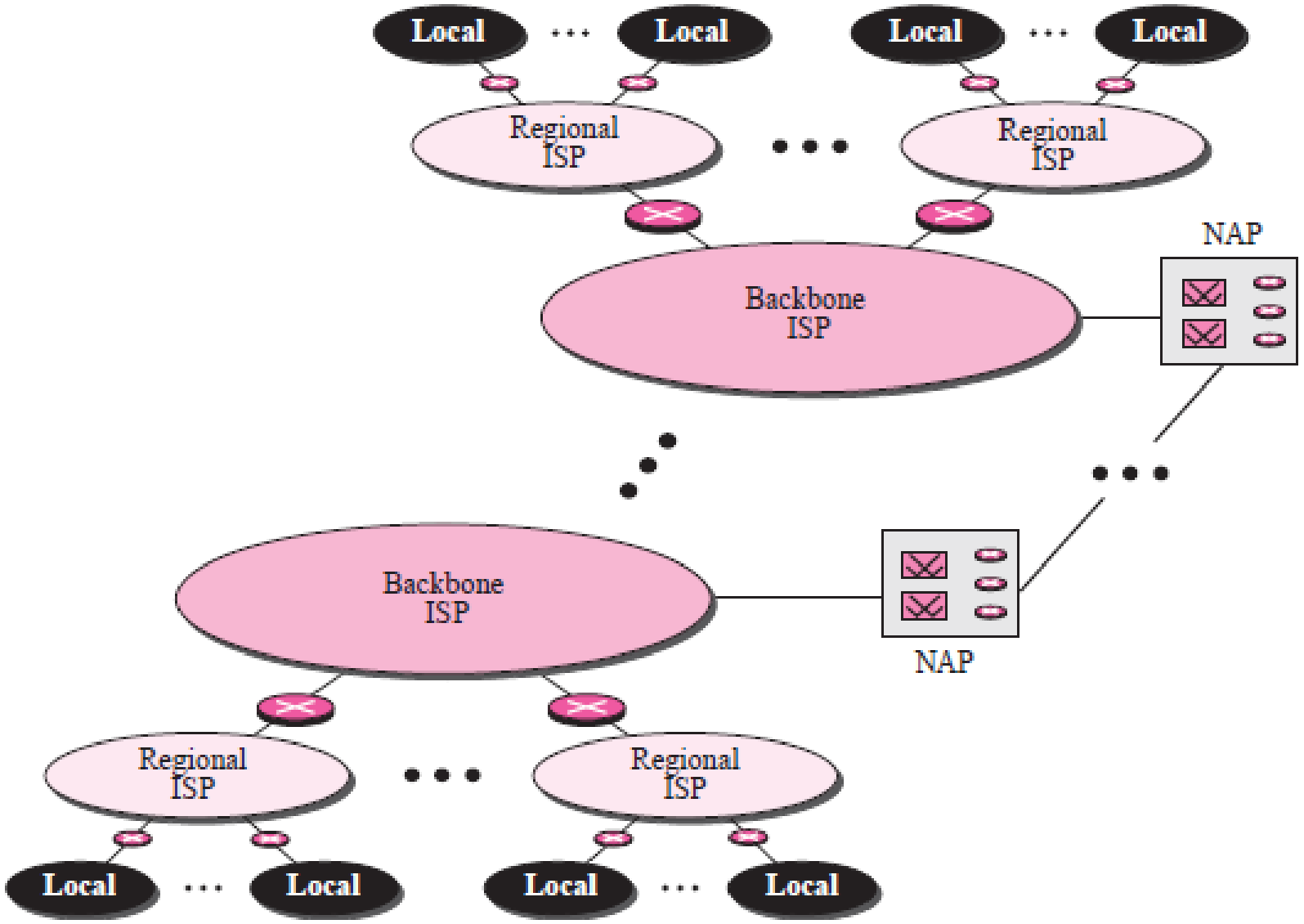
In 1991, the U.S. government decided that NSFNET was not capable of supporting the rapidly increasing Internet traffic. Three companies, IBM, Merit, and MCI, filled the void by forming a nonprofit organization called Advanced Network and Services (ANS) to build a new, high-speed Internet backbone called **ANSNET.**

The Internet Today

The Internet today is not a simple hierarchical structure. It is made up of many wide and local area networks joined by connecting devices and switching stations. It is difficult to give an accurate representation of the Internet because it is continuously changing—new networks are being added, existing networks need more addresses, and networks of defunctioned companies need to be removed. Today most end users who want Internet connection use the services of Internet service providers (ISPs). There are international service providers, national service providers, regional service providers, and local service providers. The Internet today is run by private companies, not the government. Figure 1.1 shows a conceptual (not geographical) view of the Internet.

The Internet Today

Figure 1.1 *Internet today*



The Internet Today

• *Backbone ISPs*

- Backbone ISPs are created and maintained by specialized companies. There are many backbone ISPs operating in North America; some of the most well-known are Sprint- Link, PSINet, UUNet Technology, AGIS, and internet MCI. To provide connectivity between the end users, these backbone networks are connected by complex switching stations (normally run by a third party) called **network access points (NAPs).** Some regional ISP networks are also connected to each other by private switching stations called peering points. Backbone ISPs normally operate at a high data rate (10 Gbps, for example).

• *Regional ISPs*

- Regional ISPs are small ISPs that are connected to one or more backbone ISPs. They are at the second level of hierarchy with a lesser data rate.

• *Local ISPs*

- Local ISPs provide direct service to the end users. The local ISPs can be connected to regional ISPs or directly to backbone ISPs. Most end users are connected to the local ISPs. Note that in this sense, a local ISP can be a company that just provides Internet services, a corporation with a network to supply services to its own employees, or a nonprofit organization, such as a college or a university, that runs its own network. Each of these can be connected to a regional or backbone service provider.

World Wide Web

The 1990s saw the explosion of the Internet applications due to the emergence of the World Wide Web (WWW). The web was invented at CERN by Tim Berners-Lee. This invention has added the commercial applications to the Internet.

Time Line

- The following is a list of important Internet events in chronological order:
- ❑ **1969.** Four-node ARPANET established.
- ❑ **1970.** ARPA hosts implement NCP.
- ❑ **1973.** Development of TCP/IP suite begins.
- ❑ **1977.** An internet tested using TCP/IP.
- ❑ **1978.** UNIX distributed to academic/research sites.
- ❑ **1981.** CSNET established.
- ❑ **1983.** TCP/IP becomes the official protocol for ARPANET.
- ❑ **1983.** MILNET was born.
- ❑ **1986.** NSFNET established.
- ❑ **1990.** ARPANET decommissioned and replaced by NSFNET.
- ❑ **1995.** NSFNET goes back to being a research network.
- ❑ **1995.** Companies known as **Internet Service Providers (ISPs)** started.

Growth of the Internet

The Internet has grown tremendously. In just a few decades, the number of networks has increased from tens to hundreds of thousands. Concurrently, the number of computers connected to the networks has grown from hundreds to hundreds of millions. The Internet is still growing. Factors that have an impact on this growth include the following:

- **New Protocols.** New protocols need to be added and deprecated ones need to be removed. For example, a protocol superior in many respects to IPv4 has been approved as a standard but is not yet fully implemented.
- **New Technology.** New technologies are under development that will increase the capacity of networks and provide more bandwidth to the Internet's users.
- **Increasing Use of Multimedia.** It is predicted that the Internet, once just a vehicle to share data, will be used more and more for multimedia (audio and video).