

# Computer Control Networks

*“The fundamental problem of communication is that of reproducing at one point either exactly or approximately a message selected at another point”*

*- The Mathematical Theory of Communication,*

Claude Shannon



# Technological Advancement Driving Forces

**Traffic  
growth at a  
high &  
steady rate**

- **Development of new services**
- **Advances in technology**

# Changes in Networking Technology

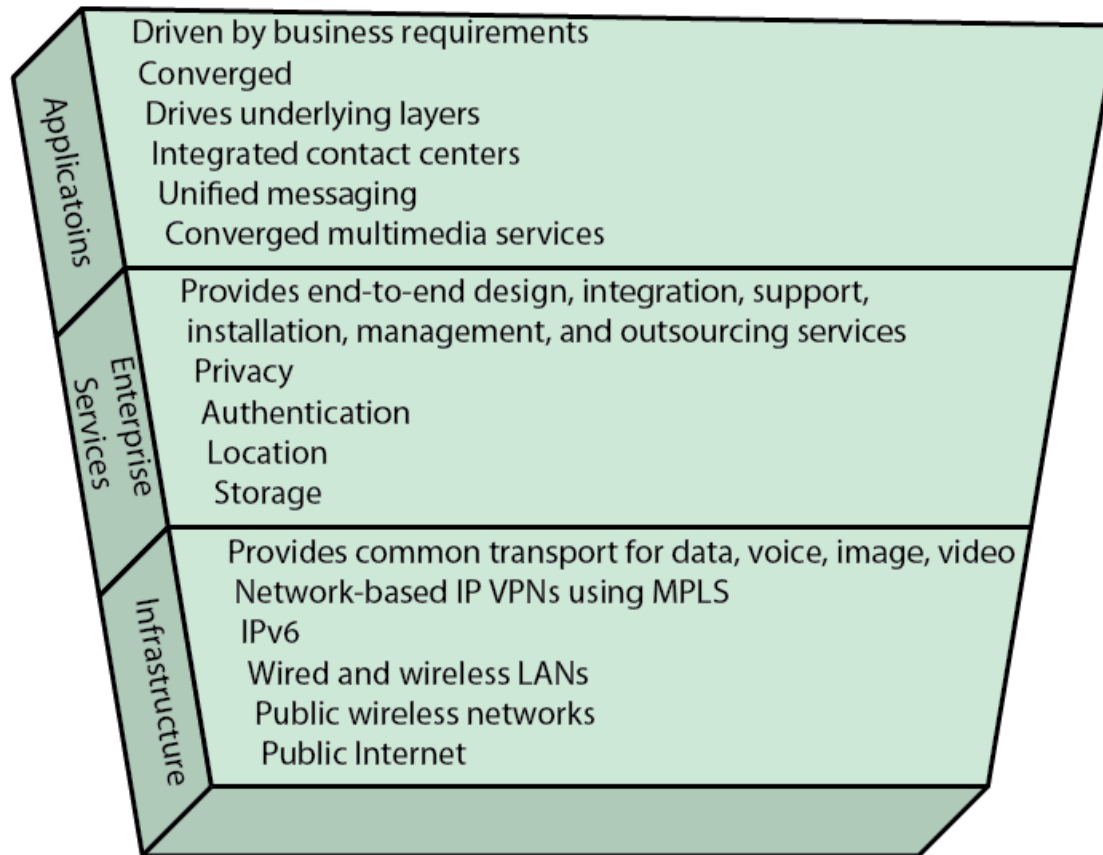
- \* **Emergence of high-speed LANs**
- \* **Corporate WAN needs**
- \* **Digital electronics**



# Convergence

- The merger of previously distinct telephony and information technologies and markets
- Layers:
  - applications
    - these are seen by the end users
  - enterprise services
    - services the information network supplies to support applications
  - infrastructure
    - communication links available to the enterprise

# Convergence Layers



# Benefits

Convergence benefits include:

## Efficiency

- better use of existing resources, and implementation of centralized capacity planning, asset and policy management

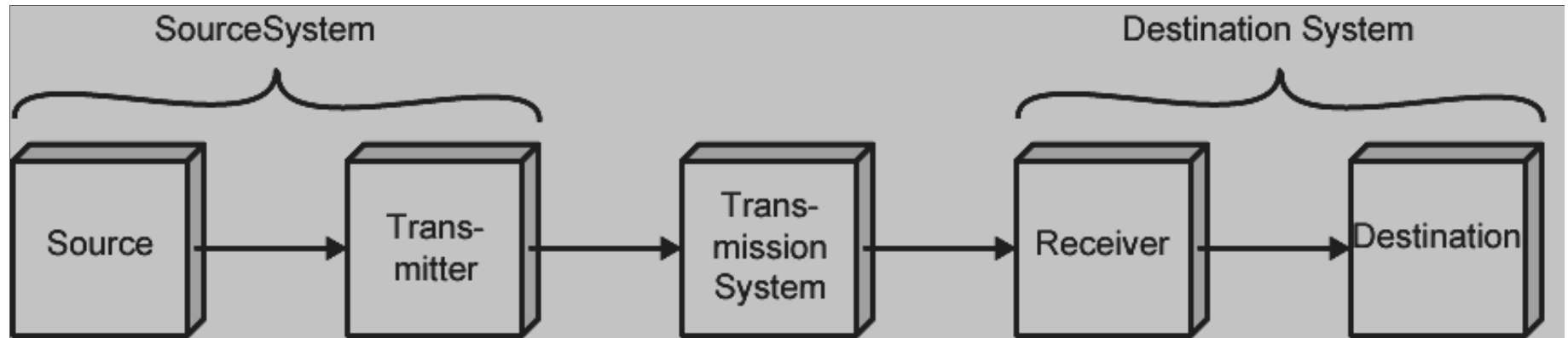
## Effectiveness

- the converged environment provides users with flexibility, rapid standardized service deployment and enhanced remote connectivity and mobility

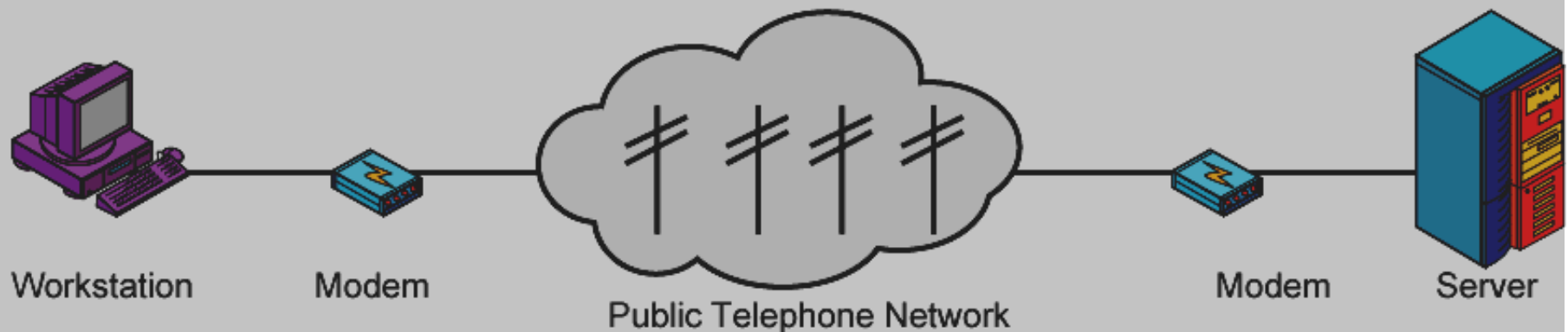
## Transformation

- enables the enterprise-wide adoption of global standards and associated service levels

# Communications Model



(a) General block diagram



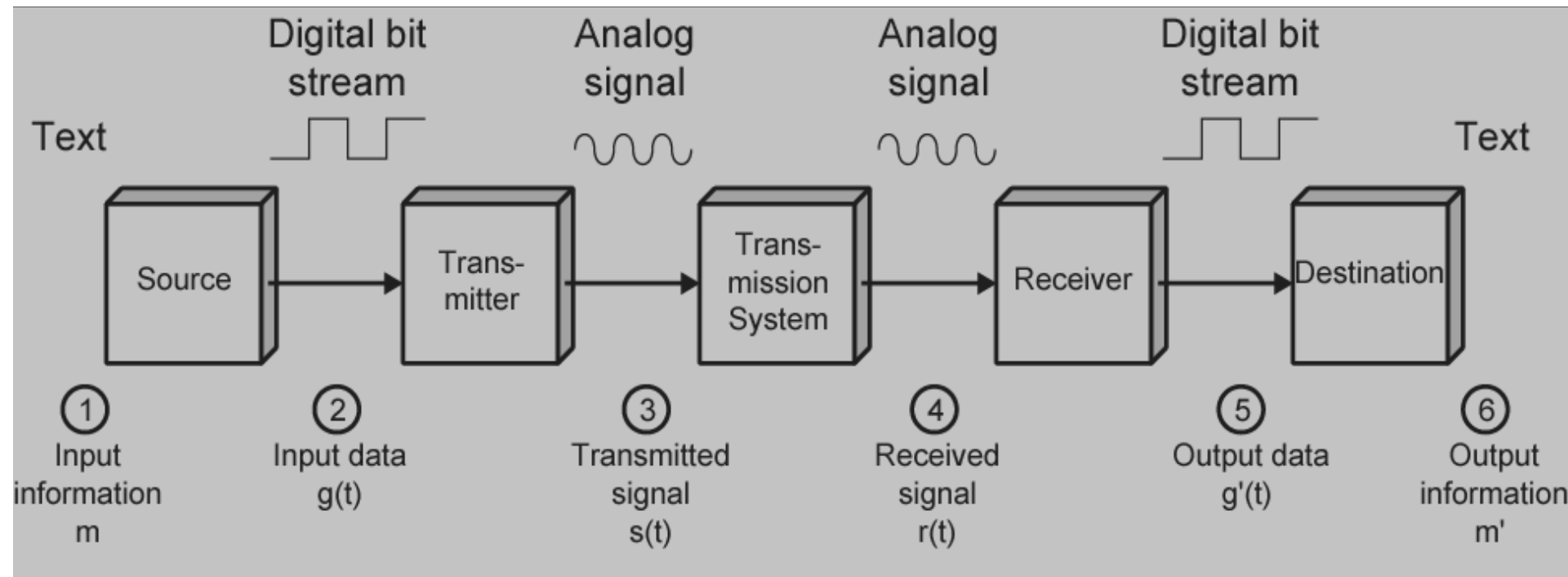
(b) Example

# Communications Tasks

Transmission system utilization	Addressing
Interfacing	Routing
Signal generation	Recovery
Synchronization	Message formatting
Exchange management	Security
Error detection and correction	Network management
Flow control	



# Data Communications Model



# Transmission Lines

The basic building block of any communications facility is the transmission line.

**The business manager is concerned with a facility providing the required capacity, with acceptable reliability, at minimum cost.**

```
graph TD; A[Capacity] --- B[Reliability]; B --- C[Cost]; A --- D[Transmission Line]; B --- D; C --- D;
```

Capacity

Reliability

Cost

**Transmission  
Line**

# Transmission Mediums

Two mediums currently driving  
the evolution of data communications  
transmission are:



**Fiber optic transmissions**

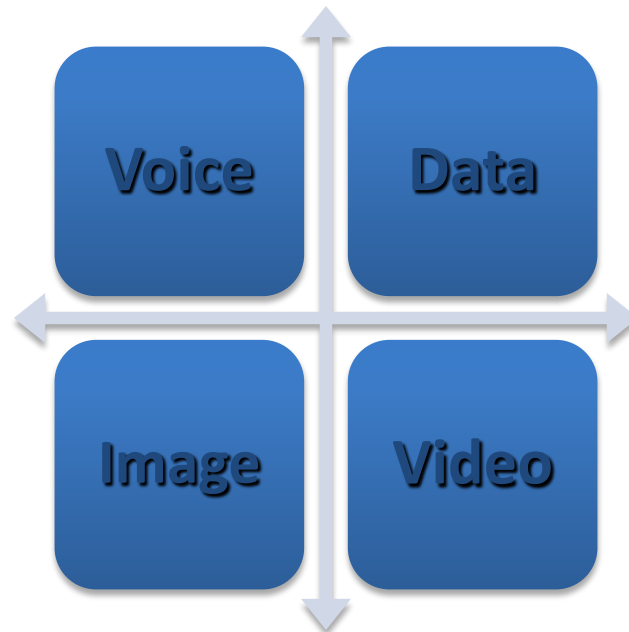
and

**Wireless transmissions**



# Networking

**Advances in technology have led to greatly increased capacity and the concept of integration, allowing equipment and networks to work simultaneously.**



# LANs and WANs

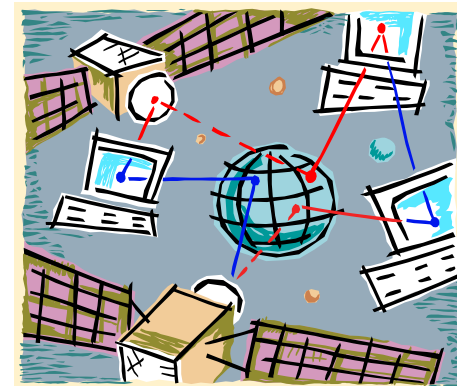
**There are two broad categories of networks:**

**Local Area Networks (LAN)**

**Wide Area Networks (WAN)**

# Wide Area Networks (WANs)

- Span a large geographical area
- Require the crossing of public right-of-ways
- Rely in part on common carrier circuits
- Typically consist of a number of interconnected switching nodes





# Wide Area Networks

Alternative technologies used include:

- Circuit switching
- Packet switching
- Frame relay
- Asynchronous Transfer Mode (ATM)

# Circuit Switching

- Uses a dedicated communications path
- Connected sequence of physical links between nodes
- Logical channel dedicated on each link
- Rapid transmission
- The most common example of circuit switching is the telephone network



# Packet Switching

- Data are sent out in a sequence of small chunks called packets
- Packets are passed from node to node along a path leading from source to destination
- Packet-switching networks are commonly used for terminal-to-terminal computer and computer-to-computer communications

# Frame Relay

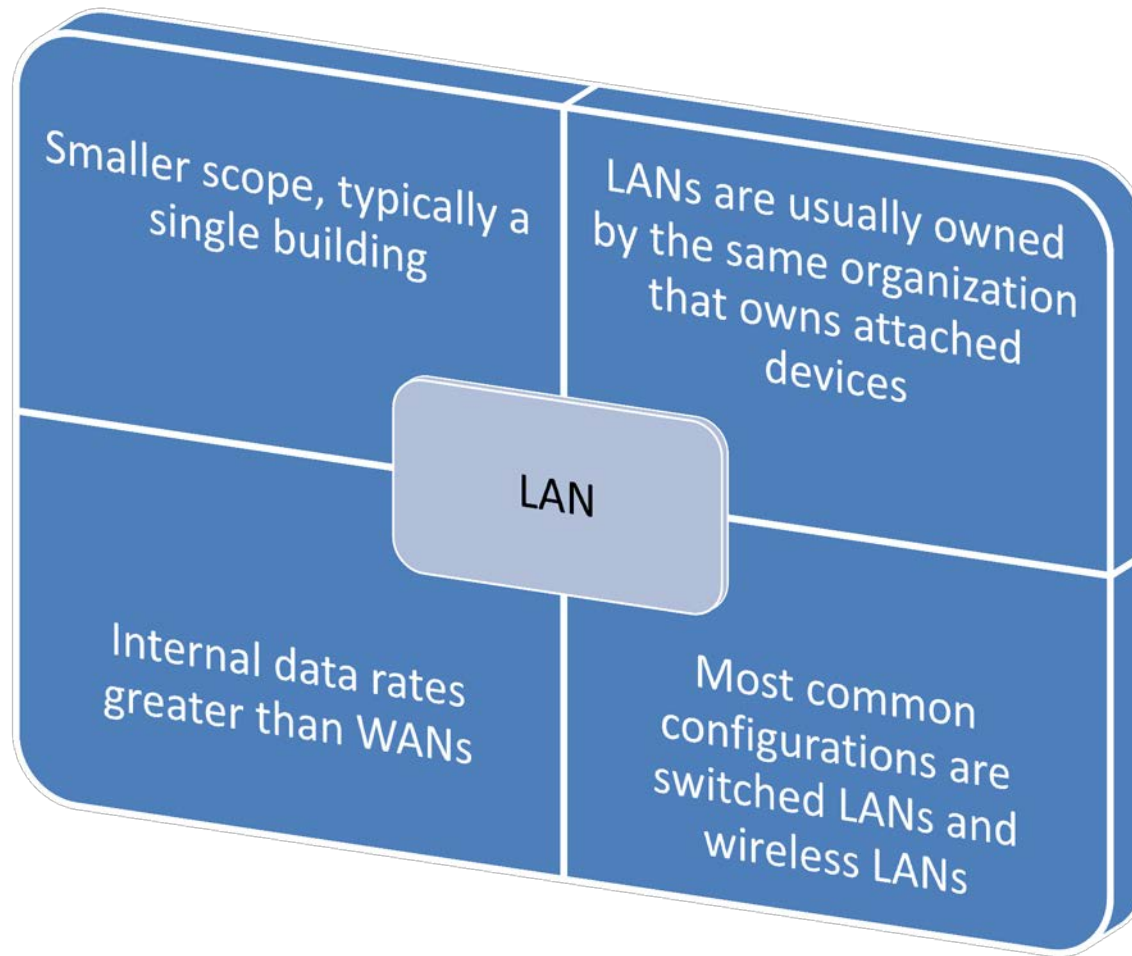
- Developed to take advantage of high data rates and low error rates
- Operates at data rates of up to 2 Mbps
- Rate of errors dramatically lowered thus reducing overhead of packet-switching



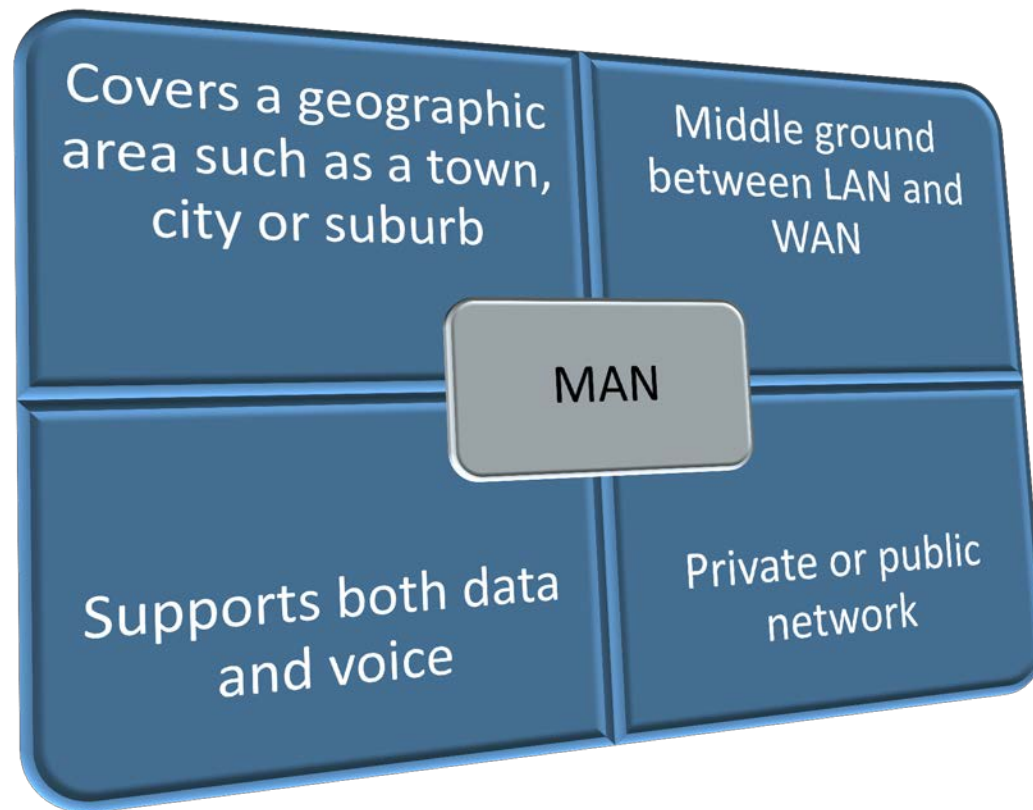
# Asynchronous Transfer Mode (ATM)

- Referred to as cell relay
- Culmination of circuit switching and packet switching
- Uses fixed-length packets called cells
- Works in range of 10's and 100's of Mbps and in the Gbps range
- Data rate on each channel dynamically set on demand

# Local Area Networks (LAN)



# Metropolitan Area Networks (MAN)

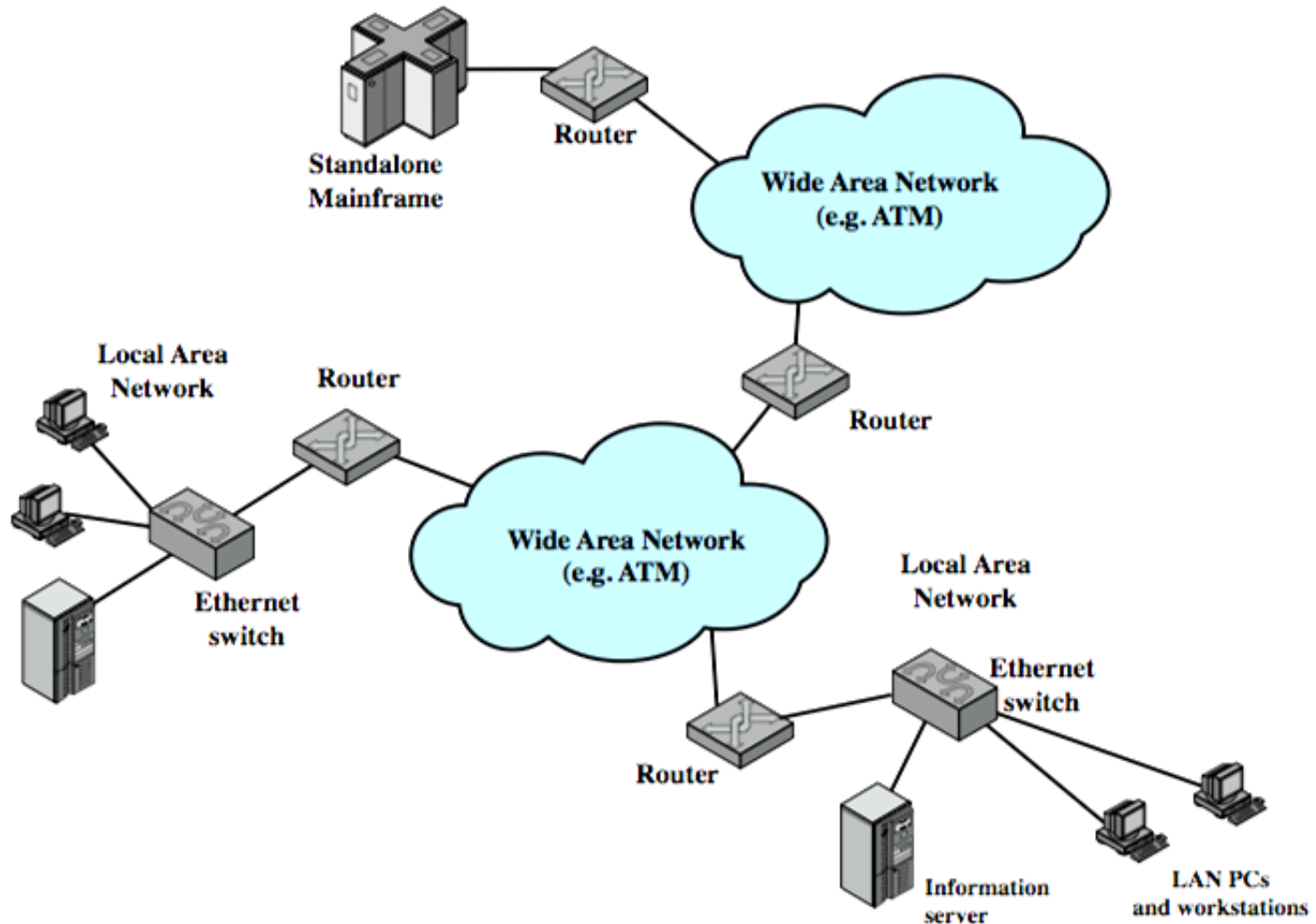


# The Internet

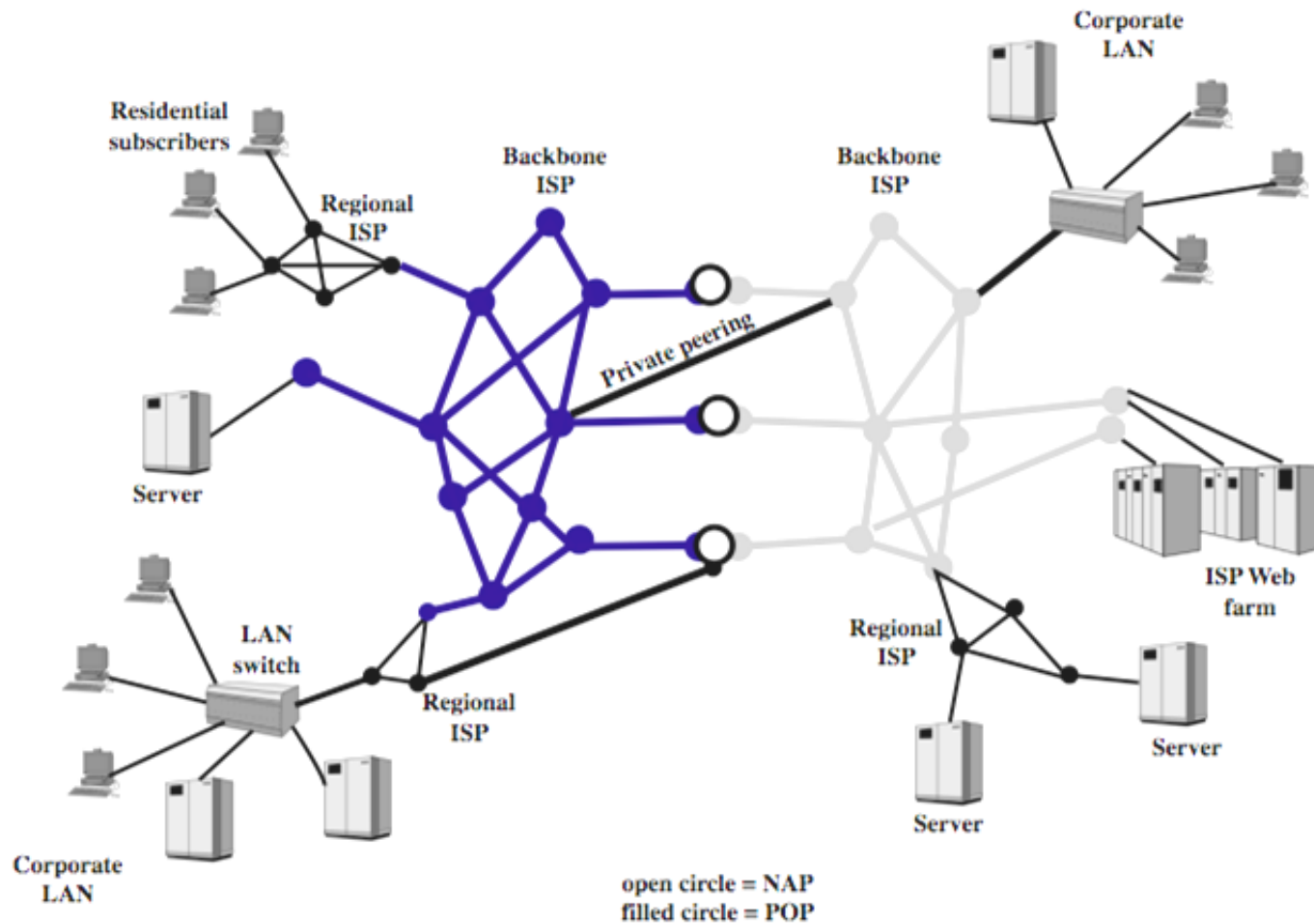
- Internet evolved from ARPANET
- Developed to solve the dilemma of communicating across arbitrary, multiple, packet-switched network
- TCP/IP provides the foundation



# Internet Key Elements



# Internet Architecture





**Central Office (CO)**

The place where telephone companies terminate customer lines and locate switching equipment to interconnect those lines with other networks.

**Customer Premises Equipment (CPE)**

Telecommunications equipment that is located on the customer's premises (physical location) rather than on the provider's premises or in between. Telephone handsets, modems, cable TV set-top boxes, and digital subscriber line routers are examples. Historically, this term referred to equipment placed at the customer's end of the telephone line and usually owned by the telephone company. Today, almost any end-user equipment can be called customer premises equipment and it can be owned by the customer or by the provider.

**Internet Service Provider (ISP)**

A company that provides other companies or individuals with access to, or presence on, the Internet. An ISP has the equipment and the telecommunication line access required to have a POP on the Internet for the geographic area served. The larger ISPs have their own high-speed leased lines so that they are less dependent on the telecommunication providers and can provide better service to their customers.

**Network Access Point (NAP)**

In the United States, a network access point (NAP) is one of several major Internet interconnection points that serve to tie all the ISPs together. Originally, four NAPs - in New York, Washington, D.C., Chicago, and San Francisco - were created and supported by the National Science Foundation as part of the transition from the original U.S. government-financed Internet to a commercially operated Internet. Since that time, several new NAPs have arrived, including WorldCom's "MAE West" site in San Jose, California and ICS Network Systems' "Big East."

The NAPs provide major switching facilities that serve the public in general. Companies apply to use the NAP facilities. Much Internet traffic is handled without involving NAPs, using peering arrangements and interconnections within geographic regions.

**Network Service Provider (NSP)**

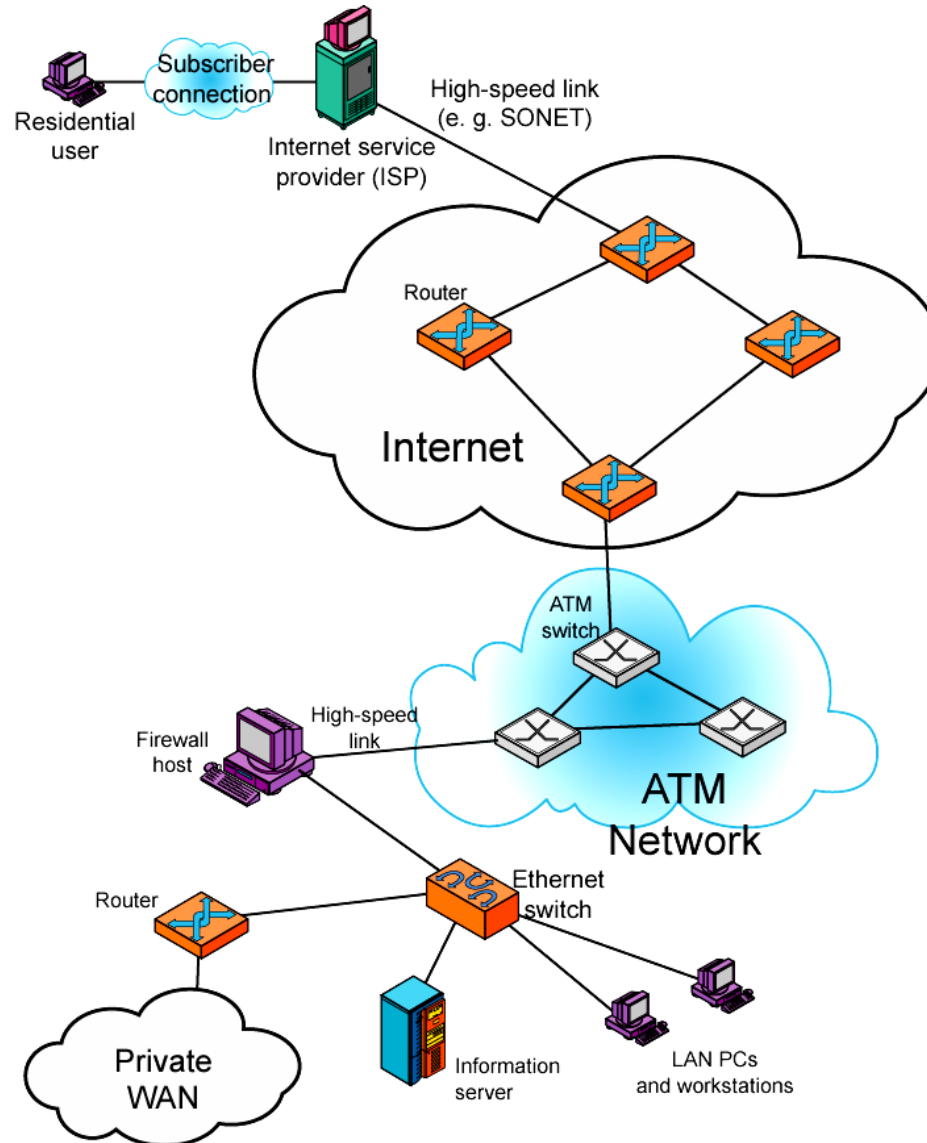
A company that provides backbone services to an Internet service provider (ISP). Typically, an ISP connects at a point called an Internet exchange (IX) to a regional ISP that in turn connects to an NSP backbone.

**Point of Presence (POP)**

A site that has a collection of telecommunications equipment, usually refers to ISP or telephone company sites. An ISP POP is the edge of the ISP's network; connections from users are accepted and authenticated here. An Internet access provider may operate several POPs distributed throughout its area of operation to increase the chance that their subscribers will be able to reach one with a local telephone call. The largest national ISPs have POPs all over the country.

# Internet Terminology

# A Networking Configuration



# Summary

- Trends challenging data communications:
  - » traffic growth
  - » development of new services
  - » advances in technology
- Transmission mediums
  - » fiber optic
  - » wireless
- Network categories:
  - » WAN
  - » LAN
- Internet
  - » evolved from the ARPANET
  - » TCP/IP foundation

