
Wide Area Networks

What is Wan?

- A Local Area Network (LAN) can span a single building or campus,
- A Metropolitan Area Network (MAN) can span a single city,
- A Wide Area Network (WAN) can span sites in multiple cities, countries, continents.

- 1957 ARPA(Advanced Research Projects Agency) project starts as a military research for satellite communications, and in 1972 first public demonstration of ARPANET introduces networks into our lives. Of many competing systems created at this time, Ethernet and ARCNET were the most popular. Local area network technologies have become the most popular form of computer networks. LANs now connect more computers than any other type of network.
- The fundamental difference between a WAN and a LAN is the scalability, WANs can be able to connect as many computers and networks as possible.
- The most popular example of WAN is the internet.
- A WAN is constructed from many switches to which individual computers connect. Additional switches can be added as needed to connect additional sites or additional computers.

History of the Internet

- In the 1960's there was great concern that a nuclear strike would render all traditional communications useless.
- As a result, the US Department of Defense funded the ARPAnet in the development of a decentralized, resilient, and self-configuring communications network.

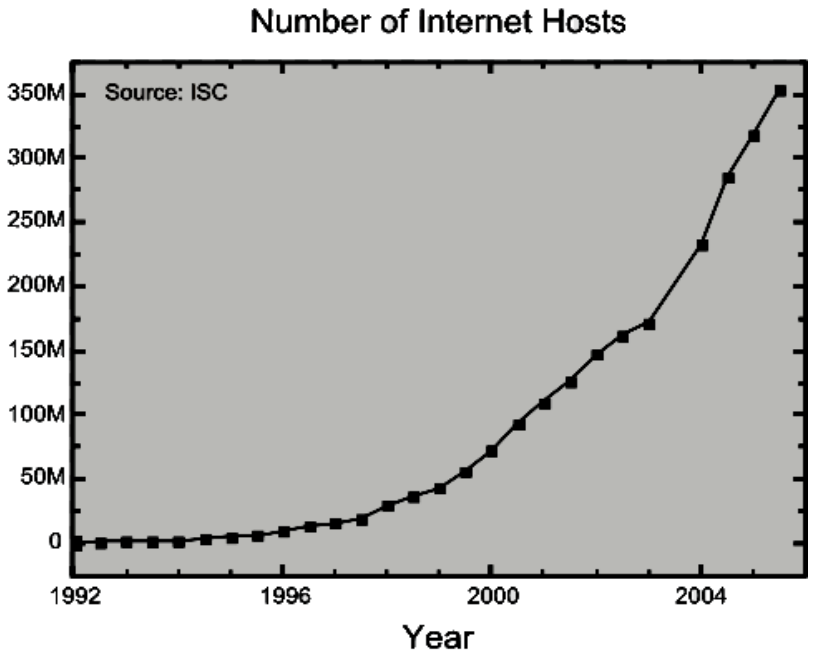
First ARPANet Connections

The first ARPANET links were between UCLA and the Stanford Research Institute in November 1969. A month later links to the University of Utah and the UC Santa Barbara were added.

Len Kleinrock standing next to the first Inter Message Processor (IMP) at UCLA

Exponential Growth of the Internet

After widespread commercialization of the Internet in the 1980's, Internet use grew and continues to grow at an exponential rate.



Wide Area Networks-Wan

SWITCHES IN WANs

- The basic electronic switch used in WAN is called a packet switch because it moves a complete packets from one connection to another.
- WANs are often built using leased lines. At each end of the leased line, a router connects to the LAN on one side and a hub within the WAN on the other.
- Leased lines can be very expensive. Instead of using leased lines, WANs can also be built using less costly circuit switching or packet switching methods.

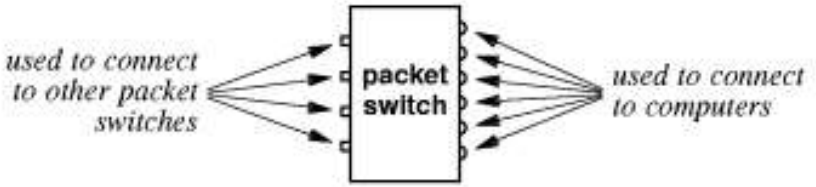


Figure 13.1 A packet switch with two types of I/O connectors: one type is used to connect to other packet switches, and the other is used to connect to computers.

LANs, MANs, and WANs

- Local Area Networks (LANs)
  - On the customer premises
- Wide Area Networks (WANs)
  - Connect sites across a region, country, the world
- Metropolitan Area Networks (MANs)
  - Connect sites in a single metropolitan area (a city and its suburbs)
  - A type of WAN

LANs, MANs, and WANs

	LAN	MAN	WAN
Sites	Within	Between	Between
Implementation	Self	Carrier	Carrier
Ability to choose technology	High	Low	Low
Who does the work of operating the network?	Self	Carrier	Carrier

LANs, MANs, and WANs

	LAN	MAN	WAN
Price	Highly related to cost	Highly unpre-dictable	Highly unpre-dictable
Cost per bit transmitted	Low	Medium	High
Therefore, typical speed	100 Mbps to 1 Gbps or more	10 to 100 Mbps	1 to 50 Mbps

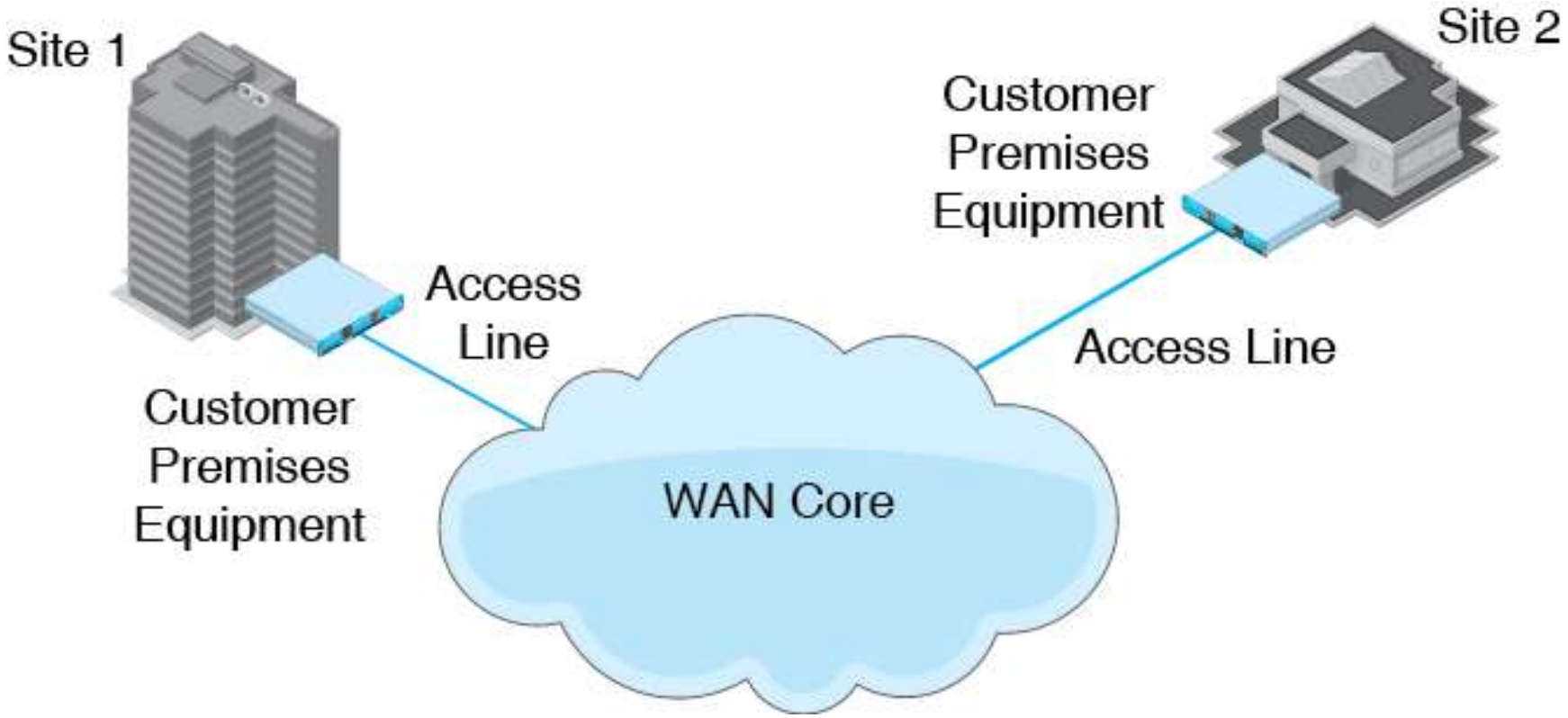
LANs, MANs, and WANs

	LAN	MAN	WAN
Can use switched technology?	Yes	Yes	Yes
Can use routed technology?	Yes	Yes	Yes

Single Networks versus Internets

Technology	LAN	WAN
Can be a single switched or wireless network?	Yes	Yes
Can be an internet?	Yes	Yes

Components of a WAN

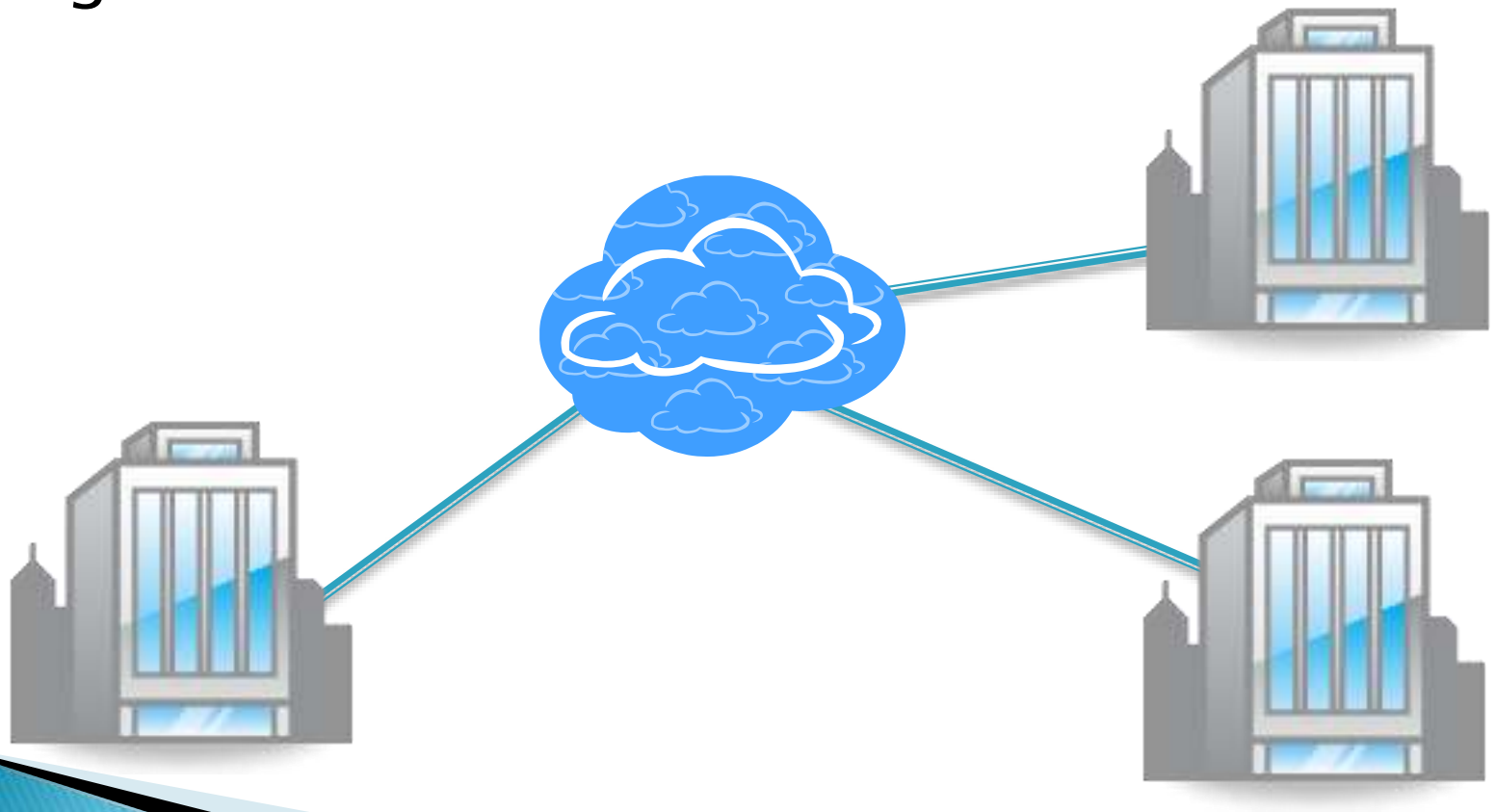


Switched Data Network Standards

- Metropolitan Area Ethernet
  - Metropolitan area network (MAN): city & environs
  - Smaller distances than national or international WANs, so lower prices and higher speeds
  - Speeds of 1 Mbps to 100 Mbps
  - Little learning is needed because all firms are familiar with Ethernet
  - Carrier can provision or re-provision service speed rapidly, giving flexibility
  - The only PSDN service growing rapidly

Wide Area Networking

- To connect different sites within an organization



Using the Internet for Wide Area Networking

- **The Internet is a Wide Area Network**
  - Many corporations are beginning to use the Internet for some part of their WAN traffic.
  - In the future, the Internet is likely to carry most corporate site-to-site traffic and other WAN traffic.

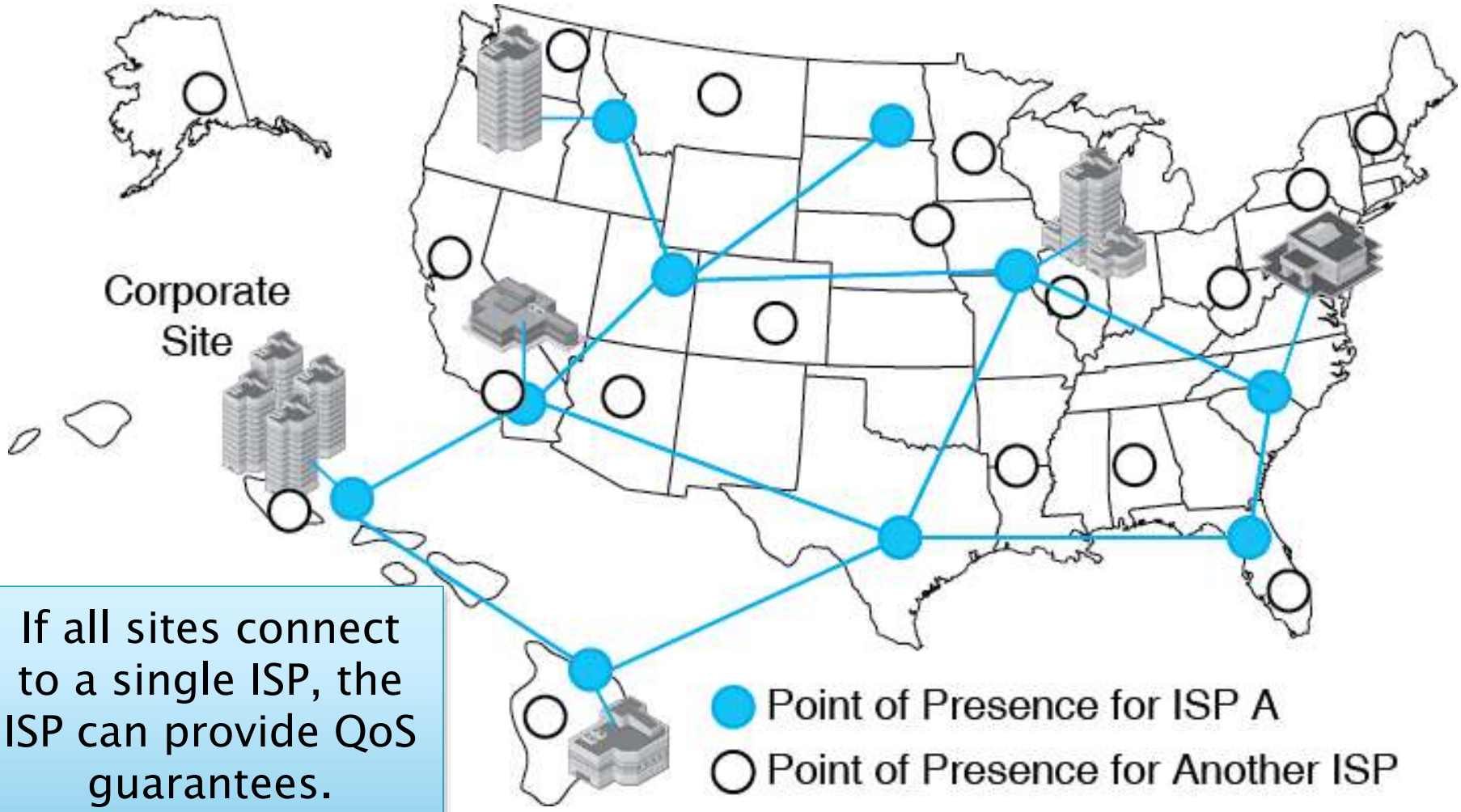
Using the Internet for Wide Area Networking

- **Attractions**
  - The price per bit transmitted is very low because of large economies of scale.
  - All corporate sites, employees, customers, suppliers, and other business partners are connected to the Internet.
- **Issues**
  - The security of traffic flowing over the Internet
  - Variable quality of service, with no guarantees

Securing the Internet

- Border firewall at each site
- Virtual private networks
  - IPsec encryption for sensitive information
  - SSL/TLS for less sensitive information
- Antivirus filtering

Connecting All Corporate Sites to a Single ISP



If all sites connect to a single ISP, the ISP can provide QoS guarantees.

Virtual WANs

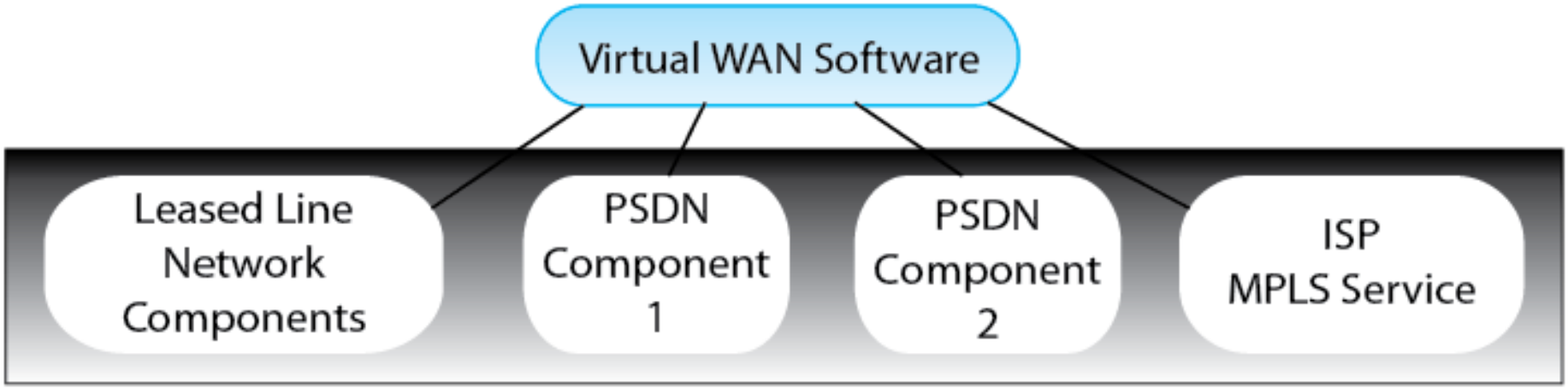
- Most companies have multiple WAN technology components
  - Leased line networks
  - PSDNs of different types
  - Internet transmission
  - Cellular transmission
  - Different access link technologies

Virtual WANs

- Traditionally, each component has been managed separately.
  - However, traffic between hosts often passes through multiple components.
  - This makes it difficult to manage overall performance and efficiency.

Virtual WANs

- Virtual WAN software provides overall management of the individual WAN components.



Virtual WAN software allows components to be managed as an integrated system

Virtual WANs

- Virtual WAN software provides overall management of the individual WAN components.
  - Allows the overall management of performance and efficiency.
  - Individual components can be added, dropped, or changed easily as technology changes.
  - It may be possible to simulate the effects of changes before implementation.


Thank You