Telecommunications

No Field In the World Offers More Promise Than the Twin Technologies of Computers and Telecommunications Networks.

Just like computers, telecom networks have both a (1) technical and a (2) business dimension.

Telecommunications (continued)

The transmission of signals over distances, including:

not only data communications but also the transmission of images and voice messages using radio, television, and other communications technologies.

Leaning Objectives

• Understand Telecommunications, the technical perspective.
• Understand Telecommunications Standards
• Understand Telecommunications Networks.
• Understand the Value of Telecommunications, the business perspective.

Telecommunications (continued)

• Provides the ability to process data and access it both locally or remotely.
• Makes the combination of computers and telecom networks a powerful resource.

Components of a Network
Telecommunications (continued)
Network Hardware and Software

![Diagram of network hardware and software components]

### Telecommunications (continued)
**Technical Challenge!**

- Complex to:
  - Plan
  - Implement
  - Operate
  - Advance

### Telecommunications (continued)
**How Important is Speed?**

Do customers really value faster response?

Does a reduction in time lower costs or improve quality of products or services?

Does speed free up resources: employees, business processes, operating equipment or other business assets?

### Telecommunications (continued)
**Roadmap to Understand Networks**

- Start where it started—with the telephone system.
- Contrast analog versus digital.
- Understand why digital has won the battle.
- Identify major components of networks.
- Distinguish between Local Area Networks (LANs) and Wide Area Networks (WANs).
- Use the Internet as an example of a network.

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### Telecommunications (continued)

<table>
<thead>
<tr>
<th>Term</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Media</td>
<td>Twisted pair wire, coaxial cable, fiber optics</td>
</tr>
<tr>
<td>Software</td>
<td>Network operating systems</td>
</tr>
<tr>
<td>Signals / Channels</td>
<td>Analog / digital &amp; dedicated / switched</td>
</tr>
<tr>
<td>Network Topology</td>
<td>Point-to-point, star / ring / bus</td>
</tr>
</tbody>
</table>

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### Telecommunications (continued)

- Connectable
- Flexible
- Phase able (*incremental*)
- Available (*is there when needed*)
- Reliable (*works the way it is supposed to*)
- Manageable (*you know that it works*)
- Maintainable (*can fix problems*)
What is a Telecom Network?

- Nodes and Links
- Network Structure
- User Devices
- Media

- Transmission Modes
- Message Formats
- Carrier Services
- Network Management

Types of Networks

- Local Area Network (LAN) – within the boundaries of a company building or campus.
- Wide Area Network (WAN) – across the city, state, country or world.

LAN Consists of:

- Connect computers in a limited area.
- Use a variety of telecommunications media. (twisted pair copper wire, coaxial cable, fiber optics)
- Each computer has a network interface card and attachment software.
- Multiple LANs can be connected through the use of bridges or routers.

Wireless LAN

- LAN radio with high frequency radio technology similar to digital cellular or low frequency radio technology.
- Infrared technology uses infrared beams of light to establish a link between LAN components.

Benefits of a LAN

- Share common data among employees within a department or company.
- Share peripheral equipment like printers, plotters and storage devices.
- Minimize the cost of desktop devices by sharing the above devices.
- Serves as the foundation for Internet attachment within an organization.
Significance of WANs

The foundation for most, if not all, significant telecom networks.

- Federal Express package routing system
- American Airlines reservation system
- Amazon.com E-Commerce system
- Visa International payment process system
- Any application system that is based on the Internet

Network Services

There are a significant number of network services available from multiple shapes and sizes of organizations.

Some of the service providers are obvious as they have been in the voice communication business for a long time and it was a logical progression for them to add data services to their product line.

The packaging of network services can range from contracting for the entire responsibility to a vendor (outsourcing) to simply buying network services and paying for what you use while managing it yourself.

Network Service Vendors

<table>
<thead>
<tr>
<th>Vendor</th>
<th>Not to be confused with network equipment companies:</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT&amp;T</td>
<td></td>
</tr>
<tr>
<td>MCI</td>
<td></td>
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<tr>
<td>Sprint</td>
<td>Cisco</td>
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<tr>
<td>Globalstar</td>
<td>Nortel</td>
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<tr>
<td>Alcatel</td>
<td>3Com</td>
</tr>
<tr>
<td>AMR</td>
<td>Cabletron</td>
</tr>
<tr>
<td>BCS</td>
<td>Juniper</td>
</tr>
</tbody>
</table>

Challenges

- Ease of Use
- Connectivity and Compatibility
- Performance (Processors, Bandwidth, Storage)
- Cost (price/performance)
- Control
- Ownership

Virtual Private Networks

1. “Connecting thousands of retail stores to central data centers can cost a bundle.”
2. There are a number of options with definite implications relative to cost, performance and security.
3. Conventional wisdom would suggest using frame relay services from the telephone company.
4. The VPN selected utilizes the Internet.

Media

<table>
<thead>
<tr>
<th>Conducted Media</th>
<th>Radiated Media</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical Conductors</td>
<td></td>
</tr>
<tr>
<td>Wires</td>
<td>Radio Frequency</td>
</tr>
<tr>
<td>Coaxial Cable</td>
<td>Broadcast Microwave</td>
</tr>
<tr>
<td></td>
<td>Satellite</td>
</tr>
<tr>
<td>Light Conductors</td>
<td>Light Frequency</td>
</tr>
<tr>
<td>Fiber Optics</td>
<td>Infrared</td>
</tr>
</tbody>
</table>

Telecommunications (continued)
Media Selection Criteria

- Cost
- Speed or Capacity (Bandwidth)
- Availability
- Expandability
- Error Rates
- Security
- Distance
- Environment
- Applications
- Maintenance

In every day life we are surrounded by standards that we probably take completely for granted.

It is debatable if there is an area where standards are more important than in telecom networks.

Voice and/or data communication is not practical or even possible unless everyone plays by the same rules.

Standards

- An established or widely recognized model of authority or excellence.
- Something regularly and widely used.
- A basis for comparison; a reference point against which other things can be evaluated.

ASCII versus EBCDIC
Ethernet versus Token Ring LANs
Windows versus Mac OS versus Linux
Twisted Pair Wire Categories
Equipment Electrical Plugs

Why are Standards Needed?

- The lack of standards prevents/hampers the use of data communications, increases costs, and reduces efficiency and effectiveness.
- In other words, standards make data communications possible, and a lot easier.

Types of Standards

Physical:
- Hardware:
  - Wiring, plugs, etc.
  - Not necessarily the same brands, but able to perform the exact same procedures.
- Software:
  - Quantitative restrictions
Logical:
- Network Topologies (structures)
- Network Architecture
  - TCP/IP
  - OSI model

Network Architecture and Protocols
- **Network architecture** - a plan to promote an open, simple, flexible, efficient telecom network environment.
- **Protocols** - standard set of rules as to how messages are sent across a network and procedures for the control of communications in the network.

**What is the OSI Model?**
- OSI = Open Systems Interconnection
- Developed by the International Standards Organization (ISO) based in Geneva, Switzerland.
- Divides data communication functions into 7 layers.
- Serves as a standard model for network architectures.
- Promotes the development of modular network architectures.
- Assists the development, operation, maintenance and use of complex telecom networks.

The Seven Layers of the OSI Model
- **Application** - provides communications services for end user applications
- **Presentation** - provides appropriate data transmission and codes
- **Session** - supports the accomplishment of telecommunications sessions
- **Transport** - supports the organization and transfer data between nodes in the network
- **Network** - provides appropriate routing by establishing connections among network links
- **Data Link** - supports error-free organization and transmission of data in the network
- **Physical** - physical transmission of data on the telecommunications media in the network
Networks

It all started with the telephone system. March 10, 1876 - Alexander Graham Bell uttered the first words ever transmitted over the telephone, “Watson, come here, I want you.”

He also had an important vision that his invention would become “a grand system, whereby a man in one part of the country may communicate by word of mouth with another in a distant place.”

Bell faced four challenges to make his invention a technical and business success that remain today.

Networks (continued)

Challenge:
1. Achieving successful transmission and reception of messages over distance. (amplifiers or repeaters)
2. Overcoming the blocking factor. (switch utilization)
3. Media utilization so that more than one message could be transmitted at the same time. (multiplexing)
4. System globalization. (standards)

Networks (continued)

Telecom Network System
• Numbering System (telephone numbers)
• Signals (analog or digital)
• Traffic (voice message load is minor compared to data)
• Routing (switching through the network)
• Transmission (i.e. packet switching)
• Management and maintenance (test signals, etc.)
• Administration (including customer billing)

Networks (continued)

First regular data transmission - US Army in 1936. Businesses commonly doing data transmission in mid 1960s

Data folks looked around and obviously found the existing telephone network that spanned both the US and much of the world.

Dealt with the analog/digital issues with modems.
Dealt with the reliability issues with transmission verification and retransmission.
Complained about bandwidth problems and cheered the implementation of fiber optics as network media.

Networks (continued)

Trends
• Increased importance of networks
• Wider range of reach
• Fewer standards
• Networked computer model
• Increased bandwidth
• Increased message volumes and size
• More IT options from more vendors
Value

• A Critical Business Resource.
• An Increasing Number of Voice and Data Products and Services.

Particularly since the break up of AT&T which opened up the industry to a major increase in competition.

Value (continued)

A Large and Important Industry.

Based on what you measure, it is the largest industry in the world in terms of annual revenue.

A race with the Petroleum Industry based on the cost of crude oil.

Ask yourself, will you use more petroleum products or more IT in the future?

Value (continued)

Opens Up Entirely New Ways of Thinking About:

• Products
• Customers
• Markets
• Competition
• Productivity
• Service
• Organization

Value (continued)

Mission Statement

The mission of telecommunications is to provide effective and efficient electronic movement of ALL forms of information between various combinations of people and business equipment.

It must support business strategies and accommodate growth and changes in the business environment.

Value (continued)

Helps a company to overcome:

1) Geographic barriers - Anywhere in the world
2) Time barriers-- Different time zones, different time windows to do things
3) Cost barriers - Avoid need for physical presence with an electronic presence
4) Structural barriers - Internal to a specific company or with vendors and/or business partners.

Value (continued)

Alternatives:
Telecommunications Media
Wireless Technologies
Telecommunications Processors
Telecommunication Software

Network Topologies, Architecture and Protocols, Bandwidth and Switching Alternatives
Value (continued)

Telecom Business Applications

1) Internal Business Applications

2) Enterprise Collaboration

3) Electronic Commerce (B2C and B2B)