ICT 523
Data Communication Strategies

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Development of Graduate Attributes

- In depth professional knowledge.
- Analysis and problem solving.
- Communication.
- Global perspectives.

A Letter from an ex-student

Lance,

I just wanted to let you know that I got a new job as a Marketing Assistant with a global security company. The company is going to sponsor me for permanent residency and they pay pretty good too! One of my primary responsibilities besides market research and advertisements is submitting tenders and proposals to companies. Using the proposal I did for your class as an example of my work, this pretty much got me the job. I just wanted to write and say thank you and let you know that that assignment had a lot of real world value.

Maybe you could tell your future students how it helped me.

Thank you,

Topics

- Unit Outline
- Project Assignment
- Case Studies
- ICT 523 Lecture 1
Unit Outline

- \ICT523_07 Outline.doc

Changes from previous year

- The Project assignment has changed from Group to Individual. Marks were reduced from 40% to 30%.
- Case Studies will be assessed and replaced journal submission. Two reports and presentations are required. 20% is allocated.
- Final Examination contribution increased to 50%
- Additional activities – Seminar and workshop are introduced to include industrial inputs.

Project

- \ICT523 Project Requirements.doc

Introduction to ICT523

- What are the trends in IT industry?
- Gartner (05) Wk 1_Emerging Trends.pdf
- What part does Data communication play?
- Case Study Week 1

Topic Addressed

- Data communication definitions
- Elements of communication systems
- Elements of data communication systems
- Data communications frameworks
- Data communications history
- Network applications
- Major data communications issues
  
  Ref: Stamper & Case, “Business Data Communications 6/ed.”, Chapter 1

What is Data Communication?

- Data communication is the subset of telecommunications that involves the transmission of data to and from computers and components of computer systems
• It is the subset of business telecommunications that addresses the processes, equipment, facilities, and services used to transport data from devices at one location to devices at other locations.
• It involves the transmission of data through conducted or radiated communication media.

Distinction between telecommunication and data communication

• Telecommunication is any process that permits the passage from a sender to one or more receivers of information of any nature (printed copy, fixed or moving pictures, visible or audio signals, etc.) by any electromagnetic system (electrical transmission by wire, radio, optical transmission, guided waves, etc.), including telegraphy, telephony, video-telephony, data transmission, etc.

How has the Internet affected business data communications?

• An increasing number of business applications traditionally deployed on private, proprietary networks have been moved to the Internet.

How has the Internet affected business data communications?

• Businesses have created extranets to establish Web-based electronic links with suppliers, customers, and business partners or intranets that enable employees to exchange data and information with one another via easy-to-use Web browser interfaces.

How has the Internet affected business data communications?

• Businesses are increasingly using the Internet as a marketing channel as well as a medium for conducting business transactions (buying and selling of goods and services).

Essential Features of Communication

• Communication of any kind requires:
  – message
  – sender
  – Receiver
  – Medium
  – understanding of message by receiver
• Data communication systems also include error detection and recovery mechanisms.
Messages

- **Messages** can assume several forms (such as text, audio, video, or image) and be of varying lengths. In data communications, messages include files, requests for data/information, responses to requests, network status information, network control messages, and correspondence.

Sender

- The **sender** is the transmitter of the message. A sender can be either a person or a machine. In today’s networks, the sender is typically a computer; however, in some networks, the sender is a terminal with enough intelligence to originate a message or response without human intervention. Sensors, scanners, and other input devices may also be senders in today’s networks.

Receiver

- **Receivers** can include computers, terminals, network printers, display devices, people, and computer-controllable devices such as drill presses, lighting systems, and air conditioners. Even though a message and a sender can exist without a receiver, communication cannot take place unless there is a receiver.

Medium

- Messages are carried from sender to receiver through some **medium** of communication.
- In oral communications, sound waves are transmitted through air (the medium).
- In data communications, the term **medium** refers to the actual carrier of data signals between senders and receivers.
- Business data communication networks use a variety of media to transmit data, including wires, radio waves, and light pulses.

Other Features in Data Comm

- All data communications networks are, first and foremost, communication systems that include senders, messages, media, and receivers.
- However, data communication networks also have several other essential features; these include session, network, node, link, path, circuit, packetizing, routing, and store-and-forward systems.
Key Data Communication Concepts

- **Session**: communication dialog between network users or applications
- **Network**: interconnected group of computers and communication devices
- **Node**: a network-attached computer
- **Link**: connects adjacent nodes (see Figure 1-4)
- **Path**: end-to-end route within a network
- **Circuit**: the conduit over which data travels
- **Packetizing**: dividing messages into fixed-length packets prior to transmission over a network’s communication media
- **Routing**: determining a message’s path from sending to receiving nodes.

Essential Features of Networks

- The exchange of messages between two users over a computer network is called a **session**
- **Network** refers to a group or set of computers and their attached communication devices.
- Each computer attached to a network is a **node**. In general, a network node serves as a termination point of the network’s communication medium

Packetizing

- **Packetizing** refers to dividing a message into fixed-length packets prior to transmitting the message over a communication medium. The packets that are created include data as well as additional information such as the receiver’s network address, the sender’s network address, and error-checking information that can be used to ensure that the message has not been altered while in transit

Routing

- **Routing** refers to how the path for a message from a sending node to the receiving node is determined. It is especially important when multiple alternative paths between sender and receiver exist
**store-and-forward system**

- In a *store-and-forward system*, messages may be stored at intermediate nodes along the transmission path between source and destination for later delivery to intended recipients.

**Why Store and Forward?**

- This helps ensure message delivery without obligating the sender to wait until a message is delivered before transmitting other messages.
- It also helps ensure message delivery in the case of link or destination failure while the message is in transit.
- Store-and-forward algorithms are valuable in time-staged delivery systems and in networks that assign priorities to different messages.

**Network Topology, Architecture, and Complexity**

- **Network topology** refers to the physical layout of a network, the way that nodes attach to the communication medium.
- **Network architecture** refers to the way in which media, hardware, and software are integrated to form a network.
- **Network complexity** is concerned with the extent to which network architectures are simple or diverse in their make.

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*Figure 1-4* LAN with File Server and Six Workstations

*Figure 1-5* Simple Data Communication System

*Figure 1-6* An Example of an Enterprise Network
Data Communication Frameworks

- Two major data communication frameworks have been developed to help ensure that networks meet business and communication requirements:
  - **Open Systems Interconnection (OSI)** reference model developed by the International Standards Organization (ISO)
  - **Transmission Control Protocol/Internet Protocol (TCP/IP)** suite

OSI Reference Model

- The OSI reference model segments the communication activities associated with sending messages from source to destination into seven functional layers:
  - The functions carried out at each layer are described in Table 1-1
  - The seven layers are illustrated in Figure 1-8

OSI Reference Model in Practice

- The OSI reference model is used in many ways:
  - To provide assistance when troubleshooting network problems
  - To provide a common terminology and framework for networking technology developers
  - To facilitate the development of connectivity standards needed for flexible open architectures
  - To enable the development of protocol stacks that allow network nodes to communicate with one another

TCP/IP Protocol Suite

- The TCP/IP suite provides insights into the inner workings of the Internet
- Like the OSI model, the TCP/IP suite is layered
  - Because the protocols found at each layer are independent of those at the other layers, a given protocol can be modified without affecting those found at other layers
  - TCP/IP layers and layer-specific protocols are illustrated in Figure 1-9
Data Communications History

- Data communications history represents a blend of histories, including:
  - The history of the telecommunications industry
  - The history of data communications, and
  - The history of the Internet
- Court cases, legislation, and regulatory actions have also helped to shape the evolution of data communications

History of the Telecommunication Industry

- Modern telecommunication industry began in 1837 with the invention of the telegraph by Samuel Morse
  - This led to building a telecommunications infrastructure of poles and wires as well as to the development of communication hardware and protocols

History of the Telecommunication Industry

- Invention of telephone by Alexander Graham Bell in 1876 and the development of wireless communication technology by Guglielmo Marconi in the 1890s set the stage for today's communication industry

History of Telecommunication Industry (1950s)

- By 1950s, telephone and telegraph companies had developed a network of communication facilities throughout the industrialized world
  - In U.S., these industries were regulated by the FCC (Federal Communication Commission) and state-level public service commissions (PSCs) which exercised controls over tariffs and services
  - These regulatory agencies gave telephone companies exclusive rights to attach equipment to the networks
  - Telephone companies were viewed as "natural monopolies"

History of Telecommunication Industry (1970s)

- Although development of databases, languages, operating systems, and hardware was strong from 1950s to 1970s, large-scale data communication systems did not emerge until the 1970s.

- This stimulated by three major developments:
  - Large-scale integration of circuits reduced cost and size of terminals and communication equipment
  - New software systems that facilitated the development of data communication networks
  - Competition among providers of transmission facilities reduced the cost of data circuits
History of Data Communication

- Table 1-2 highlights some of the major events in data communication history. Some of the most significant events were:
  - The invention of the transistor in 1947
  - The development of data link protocols during the late 1960s and early 1970s
  - The development and subsequent proliferation of the microcomputer during the 1970s and 1980s
  - The transformation of ARPAnet into the modern Internet during the 1980s and early 1990s

Framework for Global Electronic Commerce

- A Framework for Global Electronic Commerce was released in 1997
- It's release underscores the importance of Internet-based commerce in the global economy
- It outlines several guiding principles for e-commerce planners and strategists.

Network Applications

- The network applications environment consists of several important components:
  - Application programs
  - Operating systems
  - Data communication systems
  - Database management systems

Table 1-3 Guiding Principles for E-Commerce from A Framework for Global Electronic Commerce

The private sector should lead.
Governments should avoid unduly restricting electronic commerce.
Where government involvement is needed, its aim should be to support and enforce a predictable, minimalist, consistent, and simple legal environment for commerce.
Governments should recognize the unique qualities of the Internet.
Electronic commerce over the Internet should be facilitated on a global basis.

Source: www.commerce.gov/framework.htm

Table 1-4 Key Issues for E-Commerce from A Framework for Global Electronic Commerce

<table>
<thead>
<tr>
<th>Customs and taxation</th>
<th>Electronic payment systems</th>
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<tbody>
<tr>
<td>“Universal commercial code” for e-commerce</td>
<td>Intellectual property protection</td>
</tr>
<tr>
<td>Privacy</td>
<td>Security</td>
</tr>
<tr>
<td>Telecommunications infrastructure and IT</td>
<td>Content</td>
</tr>
<tr>
<td>Technical standards</td>
<td></td>
</tr>
</tbody>
</table>

Source: www.commerce.gov/framework.htm
Business Data Communication Applications

- Major data communication applications include:
  - E-mail
  - Groupware
  - Knowledge management systems
  - E-commerce and e-business applications
  - Wireless applications

E-mail

- **E-mail** is the most widely used business data communications application. An e-mail system has many of the capabilities of a conventional postal system, such as collecting and distributing correspondence of various sizes and types and routing the correspondence to recipients in a timely manner.

E-mail

- Today's e-mail systems also allow correspondents to exchange communication containing text, graphics, audio, image, and video in batch or real-time mode. The exchange e-mail via wireless handheld devices such as PDAs and smart phones is also becoming more common.

Voice applications

- **Voice applications** in business include PBX, CTI, PCS, ISDN, and VoIP. A private branch exchange (PBX) enables both voice and data communication messages to be transmitted simultaneously over the same wires, thus minimizing the need for separate voice and data communication networks.

Knowledge Management

- **Knowledge Management** enables organizations to increase their effectiveness and competitiveness through the acquisition, dissemination, and retention of expertise and knowledge, especially knowledge related to customers, products, and services.
- Intranets and groupware are used in some organizations to disseminate newly acquired information and knowledge; hence, these technologies are often important aspects of knowledge management and organizational learning systems.

E Commerce

- Since the opening of the Internet to commercial purposes during the early 1990s, businesses have moved rapidly to build the infrastructures needed to support **electronic commerce**.
- For most large business organizations, a Web strategy has become a competitive necessity. Industry experts predict that the total amount of commerce conducted over the Internet may exceed $8 trillion by 2005 and that business-to-business (B2B) e-commerce will account for at least 75 percent of the total.
B-Commerce

- Businesses have also developed business-to-consumer (B2C) e-commerce capabilities needed to allow consumers to order products and services and conduct other business transactions over the Internet.
- Like B2B e-commerce, the total dollar volume of these transactions is growing rapidly. Consumer-to-consumer (C2C) e-commerce is also growing, largely through increased use of online auction sites such as eBay.

E-Business

- E-Business is more comprehensive than e-commerce. In addition to e-commerce, e-business encompasses the use of extranets to link business partners, supply chain management (SCM), customer relationship management (CRM), electronic procurement (e-procurement), and online marketplaces.

Wireless Application

- Wireless applications are the wave of the future. Companies are developing mobile commerce (m-commerce) applications to enable employees and consumers to conduct business transactions via handheld computing devices and Internet-ready digital cellular phones.

Groupware Applications

- Group calendar systems
- Electronic filing cabinets
- Project management software
- Group support systems

Other Data Communication Applications

- Batch applications
- Data entry applications
- Distributed applications
- Inquiry/response applications
- Interactive applications
- Sensor-based applications
- Combined applications

Application Service Providers

- Many businesses have turned to third-party services for some or all of their business and data communications applications.
- Application service providers (ASPs) are third-party organizations that manage and distribute software and services to other companies over the Web.
- Many ASPs specialize in integrated e-commerce and e-business applications.
Data Communications Issues

• Major data communications issues include:
  – Cost-effectiveness
  – The Internet
  – Bandwidth
  – Evolving technologies
  – Convergence
  – Standards
  – Privacy and security

Cost-Effectiveness

• The primary business reason for implementing a data communications network is cost-effectiveness.
• The ability to share resources has a direct impact on an organization's expenses. If users can share hardware and other computing resources, lesser quantities of each are needed.
• Cost-effectiveness may derive from the ability of users to communicate and thus improve their productivity or to reduce paperwork and manual processing.

Bandwidth

• Bandwidth refers to the capacity of the links and circuits connecting network nodes.
• Bandwidth usually plays an important role in network performance, including response times and throughput

Convergence

• In data communications, convergence usually refers to the blending of communications and computing technologies.
• Internet-ready digital cell phones and personal digital assistants that have wireless e-mail and facsimile capabilities are among the best examples of convergence.
• Another example of convergence is computer-telephony integration (CTI)

Standards

• Without standards, data communication would be nearly impossible. The development of internationally recognized data communication standards facilitates the manufacture and implementation of interoperable network technologies
• Such standards generally work to the advantage of data communication consumers because they stimulate competition among data communication technology manufacturers to develop competing products that interoperate with existing networking technologies
Privacy & Security

- Although a number of laws have been passed to dissuade unauthorized individuals from attempting to steal, change, or delete sensitive data, these are not enough.
- As a result, businesses are going to great lengths to protect the privacy of their data and to ensure the integrity of their networks.
- Firewalls and encryption are being used more widely to address such concerns.

Business Data Communication Careers

- There are numerous job opportunities and career paths for individuals interested in data communications and networking.
- Table 1-6 includes examples of data communication job titles.
- Table 1-7 summarizes some of the major professional certifications for networking and data communications specialists.

| Table 1-6 Examples of Data Communication Job Titles and Niche Expertise Areas |
|-----------------|-----------------|
| Data Communication Job Titles (Examples) | Niche Expertise Areas (Examples) |
| Network Administrator | Security communications analyst |
| Network Analyst | WAF developer/consultant |
| CCN Censorship Desk Manager/Technician | Disaster recovery consultant |
| LAN Manager | Cisco router specialist |
| Voice Communications Manager | ASP application engineer |
| Data Communications System Engineer | Computer telephony integration consultant |
| Java Developer | Storage area network designer/enginner |
| Network Engineer | SS7 voice engineer |
| Network Operations Engineer/Technician/Engineer | RF engineer |
| WAN/Spanex Architect | Capacity planning analyst |
| Network Technical Support Specialist/Engineer | Technical implementation consultant |
| WAN Engineer | Webcasting/streaming media developer |
| EDI Application/Developer | Voice enabled service developer |
| Network Security Specialist/Engineer | Linux Network Security specialist |
| Infrastructure Manager | Network integrator |
| LAN Support Specialist | Network validation specialist |
| Network Designer | CCSI/Perl/javascript developer |
| Webmaster | NT systems engineer |
| Web Site Designer | PBX consultant |
| Web Site Engineer/Developer | Network security consultant |
| Network Security Engineer | Solaris administrator/enginner |
| Telecommunications Systems Designer | Switch technician/enginner |
| E-Business/Internet Security Manager | WAN network design consultant |
| Telephony Analyst | IT administrator/enginner |
| IP Telephony Engineer | IT network engineer |
| ISDN Systems Administrator | VPN specialist |

| Table 1-7 Examples of Networking Certifications |
|-------------------------------|-------------------|
| Abbreviation | Certification Title | Vendor/Sponsor |
| MCSE | Microsoft Certified Systems Engineer | Microsoft |
| CNE | Certified Novell Engineer | Novell |
| AEE | Accredited System Engineer | Compaq |
| CCIE | Cisco Certified Internetwork Expert | Cisco |
| CWD | Certified Web Designer | Association of Web Professionals |
| Network+ | Network+ | CompTIA |
| CTE | Computer Telephony Engineer | Computer Telephony Institute, Inc. |
| CNX | Certified Network Expert | CNX Consortium |
| CNP | Certified Network Professional | Network Professional Association |

Week 1 Class Discussion

- With respect to the article [Gartner (05) Wk 1_Digital Disruption.pdf](Gartner (05) Wk 1_Digital Disruption.pdf) select a particular technology relating to the issue of Data Communication and consider the followings:
  - Description of the particular technology
  - Discuss the current (if any) and speculate possible future applications
  - Comment in your own opinion whether the technology will be successful or fail. Explain how did you draw the conclusion.