Lesson 6-3: Emerging Network Technologies

At a Glance

This lesson covers new advances in networking technology, and how those advances will bring exciting new applications to network users.

What You Will Learn

After completing this lesson, you will be able to do the following:

• Identify several key new network technologies that are likely to become widely available in the coming years.

• Compare the physical characteristics and the potential data capacities of the new technologies.

• Identify the new applications and end-user benefits of the new technologies.

• Use research skills to locate and interpret up-to-date information about the current state of new network technologies.

• Understand the historical and business perspective of the new networking technologies, and identify the business interests within the industry which drive the development and adoption of new technologies.
Tech Talk

- **Asymmetrical Digital Subscriber Loop (ADSL)**—System for providing high bandwidth network connectivity over standard unshielded twisted pair (UTP) telephone cables to homes and businesses.

- **Asynchronous Transfer Mode (ATM)**—A fast-packet, connection-oriented, cell-switching technology for broadband signals.

- **Bandwidth**—A measure of data transfer rate through a network transmission system, usually expressed as bits per second (bps).

- **Broadband**—Transmission systems supporting bandwidth greater than 45 million bits per second (45 Mbps).

- **Convergence**—The integration of multiple types of media and messaging systems into single networks and desktop software applications.

- **DWDM**—Dense Wave Division Multi-Plexing provides multiple colors of light or lambda's for combining multiple transmissions of data over the same fiber optic network.

- **Fiber Optics**—Network transmission system which uses a cable containing a flexible glass fiber for carrying data encoded as light pulses.

- **Gigabit Ethernet**—Network transmission system supporting the Ethernet protocol at a bandwidth of 1000 Mbps, or 1 Gigabit per second; Gigabit Ethernet is supported on fiber optic cable and category 5 twisted pair copper cable.

- **Multipurpose Internet Mail Extensions (MIME)**—Standard for formatting text and adding media, document and other file attachments to electronic mail messages.

- **Photonics**—Technologies that use light instead of electricity to build circuits for complex functionality; photonic devices are ideally suited for fiber optic network applications.

- **Private Branch Exchange (PBX)**—A private local telephone network usually operated at a business facility.

- **Public Switched Telephone Network (PSTN)**—The circuit switched network operated by telephone companies to bring telephone service to home and business customers.

- **Synchronous Optical Network (SONET)**—A standard defining a common specification for fiber optic network transmission systems.
- **Transmission System**—The physical devices, cabling and protocols used to transmit data across network connections.

**New Network Capabilities**

Networks provide a way of transmitting information from one point to another. As networks are improved, two things change:

1. The speed of data transmission increases as current network technology is improved and as brand-new technologies are invented.
2. New services take advantage of the improved network performance and provide users with exciting new applications.

Networks are currently changing very rapidly as new capabilities allow different types of networks to offer similar services. Companies in independent industries have traditionally operated specialized networks:

- Telephone companies operated switched circuit networks to provide voice communications for homes and businesses.
- Cable television companies operated broadcast networks to provide television programming to homes.
- Computer networking companies supplied networking hardware and software for local area networks and relied on leased lines or wireless networking to connect businesses together.

Now it is possible to provide computer data networking services over cable television networks, voice and video communications over computer data networks, and digital video over telephone networks. This flexibility of network traffic is called convergence, and it is enabled by improving performance of all types of networks.
Improvements in Network Interfaces and Media

The physical media and interface devices (transmission systems) used to transmit information across networks have been improving, and new types of media are under development. Bandwidth is a measure of the capacity, or speed, of a network connection. For digital connections bandwidth is expressed as bps or Bits per Second. There are several standard metric abbreviations for increasing speeds in factors of 1,000:

<table>
<thead>
<tr>
<th>Bps</th>
<th>Bits per second</th>
<th>1 bit per second</th>
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</thead>
<tbody>
<tr>
<td>Kbps</td>
<td>Kilobits per second</td>
<td>One thousand (1,000) bits per second</td>
</tr>
<tr>
<td>Mbps</td>
<td>Megabits per second</td>
<td>One million (1,000,000) bits per second</td>
</tr>
<tr>
<td>Gbps</td>
<td>Gigabits per second</td>
<td>One billion (1,000,000,000) bits per second</td>
</tr>
<tr>
<td>Tbps</td>
<td>Terabits per second</td>
<td>One trillion (1,000,000,000,000) bits per second</td>
</tr>
</tbody>
</table>

There are three categories of bandwidth for network transmissions:

<table>
<thead>
<tr>
<th>Narrowband</th>
<th>A single channel with a bandwidth less than or equal to 64 Kbps</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wideband</td>
<td>Multichannel capacity between 1.544 to 45 Mbps</td>
</tr>
<tr>
<td>Broadband</td>
<td>Multichannel capacity greater than 45 Mbps</td>
</tr>
</tbody>
</table>

Transmission systems either use cables or wireless technology to connect devices together, including twisted pair, coaxial, and fiber optic cables, microwaves, radio waves, and satellite radio. Following is a brief review of transmission media and a summary of their existing and expanding capacities.

**Twisted Pair**

As you learned earlier in this course, twisted pair cables carry two or four copper wires in a single insulated cable. Each pair of wires is twisted together to help reduce electromagnetic radiation and interference. To further protect the signals from interference, Shielded Twisted Pair (STP) cables have a flexible metal shielding covering the wire pairs along the length of the cable; Unshielded Twisted Pair (UTP) cables do not.
Twisted pair cabling is common for telephone systems, and data network wiring. Examples: CAT 5, 10BASE-T, and 100BASE-T.

**Shielded Twisted Pair Cable**

**Unshielded Twisted Pair Cable**
Coaxial Cable

Coaxial cable is a very robust copper wire that is surrounded by a flexible shield. The central wire and the shield act as two separate conductors, and are carefully aligned to reduce noise pickup or radiated interference. Coaxial cable supports higher speed data transfer than twisted pair, but is more expensive to manufacture.

Wireless Transmission Systems

Wireless systems use radio waves or transmit light through air to create data connections. Microwaves are high-frequency radio waves, which are focused by parabolic reflectors (dishes) and used for point to point communications connections. Earth-orbiting satellites enable microwaves to be used in more global data communications.
Global Satellite Microwave Communication

Infrared communications

Infrared communications use invisible infrared light to create network connections among computer devices, and between local area networks and computer devices. Infrared networks generally operate within a specific room or office.
Fiber Optics

Fiber optics are flexible glass wires that guide light pulses between transmitters and receivers. Although more delicate than copper wiring, fiber optic cables can carry information much more quickly.

Fiber Optic Cable Communication System
**DWDM**

DWDM (Dense Wave Division Multiplexing) is an emerging technology which allows for multiple signals to be sent over the same fiber optic network at the same time. Unlike SONET which has a continuous signal stream which upper layer protocols like ATM insert their cells or packets into, DWDM is transparent to the upper layer protocols and the various signal types and protocols are emitted as individual light streams of different colors on the same piece of fiber at the same time. DWDM is capable of transmission speeds of 10Gbps far beyond any of the traditional transmission media systems in place today.
The following table shows the bandwidth capabilities of several existing and emerging transmission systems.

<table>
<thead>
<tr>
<th>Type</th>
<th>Bandwidth</th>
<th>Maximum Distance</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>UTP</strong></td>
<td>T1 – specially conditioned four-wire twisted pair</td>
<td>1.544 Mbps</td>
</tr>
<tr>
<td></td>
<td>Category 5 in LAN environment, 10 BaseT Ethernet</td>
<td>6,000 feet between repeaters</td>
</tr>
<tr>
<td></td>
<td>CAT 5 100BASE-T Fast Ethernet</td>
<td>100 Mbps</td>
</tr>
<tr>
<td></td>
<td>CAT 5 1000BASE-T Gigabit Ethernet</td>
<td>1000 Mbps (or 1 Gbps)</td>
</tr>
<tr>
<td></td>
<td>Asymmetrical Digital Subscriber Loop (ADSL) twisted pair</td>
<td>6.144 Mbps download and 608 Kbps bi-directional</td>
</tr>
<tr>
<td><strong>Coaxial</strong></td>
<td>10BASE5</td>
<td>10 Mbps</td>
</tr>
<tr>
<td></td>
<td>10BASE2</td>
<td>10 Mbps</td>
</tr>
<tr>
<td></td>
<td>Cable Television with cable modem</td>
<td>3 to 10 Mbps download and 128 Kbps upload</td>
</tr>
<tr>
<td><strong>Microwave Radio</strong></td>
<td></td>
<td>1.544 Mbps, T3 45 Mbps, up to 6 Gbps</td>
</tr>
<tr>
<td><strong>Satellite Radio</strong></td>
<td>Current options</td>
<td>400 Kbps download only</td>
</tr>
<tr>
<td></td>
<td>Future options</td>
<td>2.5 to 45 Mbps download, 2 Mbps upload</td>
</tr>
<tr>
<td><strong>Fiber Optic</strong></td>
<td>1000BASE-SX Gigabit Ethernet over multimode fiber</td>
<td>1000 Mbps (or 1 Gbps)</td>
</tr>
<tr>
<td></td>
<td>Current systems</td>
<td>40 Gbps</td>
</tr>
<tr>
<td></td>
<td>Potential Capacity</td>
<td>More than 1 Tpbs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>550 meters</td>
</tr>
<tr>
<td></td>
<td></td>
<td>900 miles</td>
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<tr>
<td></td>
<td></td>
<td>200 miles</td>
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</tbody>
</table>
Audio and Data on Telephone Networks

Traditionally, audio telephone connections are made over a circuit switched network using a Public Switched Telephone Network (PSTN). A circuit switched connection allows two parties to establish and maintain a continuous, private communication session (or phone call). A switched connection is optimized for analog and other continuous streamed data transmissions because the channel maintains the same characteristics during the entire session. As a result, there are no unpredictable delays that would make two-way time-sensitive communication difficult or impossible.

To carry data communication over standard telephone lines, a modem is used to translate analog/digital signals. Modems and telephone lines are used to carry packets of data over switched telephone networks to be forwarded for delivery. The process of changing signals from analog to digital provides a solution that uses limited bandwidth, less than 56 Kbs.

Data and Streaming Media on Data Networks

Traditional packet switched data transmission is not an ideal method for transporting continuous media like voice or video because it is hard to guarantee that each packet of data will arrive in the correct sequence.

Cell switching addresses the limitations of packet switching by dividing data into fixed-length (53 bytes) cells which are switched by high-speed devices. High speed switching makes up for the problems of unpredictable delays of packet switching. Asynchronous Transfer Mode (ATM) and Switched Multimegabit Data Service (SMDS) are cell switching technologies.

There is a new type of switch under development that is specifically designed for the fiber optic environment called a photonic switch. It combines the fastest transmission media, which as you know is fiber optic, with the fastest switching device.

Currently fiber optic signals, which are light pulses, must be converted into electrical signals, interpreted by electronic devices.

The Synchronous Optical Network (SONET) standard defines a common specification for fiber optic network transmission systems.
Check Your Understanding

♦ Describe the difference between packet switched networks and circuit switched networks.

♦ List the popular data transmission technologies in order of their data transmission bandwidth from slowest to fastest.

Convergence – New Applications for Data Networks

Many different applications can begin to work together as networking speeds improve and techniques are developed for carrying new types of content on data networks. It is now becoming possible to manage email messages, voice communications, voice messages, faxes and video from software applications that use a single data network.

Electronic Mail (E-mail)

Electronic mail messages were traditionally composed of header information plus a text message. Most E-mail client programs now support Multipurpose Internet Mail Extensions (MIME), a specification for formatting message text, and attaching data documents to the message. MIME allows e-mail messages to contain voice notes, video clips, graphics, and any other kind of data file.

Voice Communications

Voice communications have traditionally been carried by telephone companies over public circuit-switched networks. It is now possible to use the Internet to carry phone conversations across the same-packet switched network that carries IP data traffic. Conversations are achieved by using software applications that greatly compress the audio signals and send the compressed sounds as IP packets to a corresponding application at the other end of the conversation. The packet communication is vulnerable to unpredictable time delays, and in many cases the two people conversing must take turns talking. Newer sound cards support full-duplex operation, which means that both people can talk at the same time, as long as the Internet is delivering the data packets quickly enough.

Voice Messages

In most business voice mail systems, voice messages are already saved as digitized audio files, which are manipulated by computer programs under the control of a telephone keypad. Integrating control of voice messaging into a computer desktop environment involves using a software application
that communicates with the voice mail system. Many voice mail systems support the Audio Message Interchange Specification (AMIS), a standard protocol for exchanging voice messages. Desktop computer applications that comply with AMIS can provide direct control over voice messaging from the user’s computer.

Fax

Fax messages have traditionally been sent from one fax machine to another over standard telephone (PSTN) lines. The fax machines are actually transmitting a series of numbers that represent the light and dark spots of an image that was optically scanned by the fax machine. Computer software for fax support allows fax documents to be created by any application that can create a printable image. In addition, fax server software can receive and route fax messages from telephone calls or data network connections. The software can then distribute faxes to users’ virtual mailboxes as files or as attachments to email messages, or send them over PSTN lines to standard fax machines where a data network connection is not available.

Video

Video content is transmitted across IP networks for a variety of reasons. Streaming prerecorded video can be downloaded from web servers, with software options to allow playback to begin before downloading the entire video file. Specially optimized compression codes are used to minimize the amount of data that is actually transmitted, while taking advantage of faster computer performance on the user’s machine where the video gets decoded and displayed.

Video conferencing applications provide two-way transmission of live images and audio for virtual meetings. Videoconference applications connect over the Internet, or over private leased lines or ISDN lines for better bandwidth performance, supporting larger video images and faster frame rates.

Video servers in LAN environments are used to provide video on demand for live events and prerecorded training sessions.
The Evolving Networking Industry

Currently, there is competition between cable television companies and telephone local and long distance companies to provide integrated networking services to homes and businesses. Most cities and towns have both a cable television cabling (CATV) infrastructure and a telephone cabling infrastructure. As networking technologies advance, each industry is striving to position itself as the supplier of voice, data and video access for the consumer. Each industry promotes the networking standard that will make the best use of its existing and emerging technology.

For example, when you see a new technology for providing Internet access from the home, ask yourself whether the new access technology will make use of your existing phone lines, cable television cable, or something new. Answering this question will help you understand which business will benefit from providing the access to consumers.
Try It Out

Voice Communication Over IP

In this lab, you will learn how to use a voice communications application over an IP network.

Materials Needed

- Internet connections
- Two computers, each with a sound card, headphones, and a microphone
- Basic Sniffer software

Part One: Download voice communications software

1. Download one of the following software products:
   - NetSpeak® WebPhone® (download free trial version from www.webphone.com/product/webphone/download.html)
   - VocalTec® Internet Phone® (download free version from www.vocaltec.com/products/iphone5/download.htm)
   Or, search the Web for combined keywords like “Internet” and “phone” to locate other new products.

2. Install the software on two computers that have sound cards.

3. Plug a microphone and headset into each computer’s sound card and use the software to establish a “phone” connection between the two computers.

4. Try using the software from a remote computer on the Internet.

5. Keep a log of software problems and communication problems. How does the sound quality and speed performance compare with regular telephone service? How does a connection over the Internet compare to a connection over the local LAN? Prepare an organized summary and review of the voice communication software application, including price and purchasing options.

6. Use Basic Sniffer to look at audio data IP packets sent by the voice communication software application.
### Rubric: Suggested Evaluation Criteria and Weightings

<table>
<thead>
<tr>
<th>Criteria</th>
<th>%</th>
<th>Your Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Troubleshooting software installation, locating technical support and resources</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>Detailed description of application performance and problems</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>Summary organized and in a suitable format</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>
Stretch Yourself

Network Technologies at School and Home

Identify what types of transmission systems are in use at your school (interview your school’s network administrator, if possible).


2. School connection to Internet: Modem and standard telephone line?, Cable modem and cable television cable?, Microwave radio?, T1 connection over telephone line?

If you have Internet access from your home, answer the same questions for your home Internet connection.

What other types of Internet connections are available in your town for your home or school? Call the local phone company and cable television provider to find out what networking connection services are available and compare their prices and bandwidths. Find out if the bandwidth for receiving information from the Internet (downloading) is different from the bandwidth for sending information to the Internet (uploading).

Imagine that you are going to download a 2-Megabyte video file from the Internet. How long should it take when you use your school’s Internet connection? How long would it take using a typical home Internet connection in your town? Compare the download time for using the following types of connections:

T1 connection:

28.8 Kbps modem on standard telephone line:

571 seconds, or 9.52 minutes

56 Kbps modem on standard telephone line:

286 seconds, or 4.75 minutes

Cable Modem and broadband cable television connection:

Assuming 3 Mbps download, 5.3 seconds

ADSL Telephone connection:

Assuming 6.144 Mbps download, 2.6 seconds
How to calculate download time:

1) How many bits are we downloading?
   2 Megabytes = 2,000,000 bytes. Each byte is 8 bits, so 2 Megabytes = 16,000,000 bits. (there are actually going to be more bits than this, depending on the communications and networking protocols in use).

2) How much time will downloading the bits take?
   Example – 28.8 Kbps modem on standard telephone line
   Divide the total number of bits by the number of bits per second to find the total number of seconds. First express the bandwidth in bits per second, instead of kilobits per second:
   28.8 Kbps = 28,800 bps
   Then divide:
   16,000,000 bits / 28,000 bits per second = 571 seconds (to the nearest second)
   How many minutes is that? Divide by 60 to calculate the minutes:
   (571 seconds) / (60 seconds/minute) = 9.52 minutes, or about 9 ½ minutes.

Rubric: Suggested Evaluation Criteria and Weightings

<table>
<thead>
<tr>
<th>Criteria</th>
<th>%</th>
<th>Your Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accurate and complete description of school and home technology</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>Accurate and complete description of availability, price and capabilities of network services in area</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>Correct calculation of download times for various scenarios</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>
Network Wizards

Researching New Networking Technologies

Materials Needed

- Internet Connection

Searching the Web is an excellent way to find the latest information about new networking technologies.

For example, search for the term SONET, which is a fiber optic networking standard. As you check the sites in your search results, ask yourself the following questions about each site:

1. What kind of organization created the Web site, and what is their interest in the networking technology?
   a. University or school affiliate?
   b. Research and development organization?
   c. Private company with business interests in the technology?
   d. Telephone or cable television company?
   e. Networking company?
   f. Standards organization or government agency?

2. When was the Web page last updated? (It is easy to get confused if you find “News” on a Web page that is actually four years old.)

3. What are the most recent developments on the technology you researched?

Suggested Resources:

A good Web resource for information on networking technology is www.zdnet.com, an on-line publication of Ziff-Davis, a leading technology media company. ZDNet contains news articles, reviews and other information about technology topics. Use the search engine from the home page to locate interesting articles for your search. Take a look at www.zdnet.com/products/highspeed/index.html for information about high-speed access to the Internet.

For more information on network access through satellites, take a look at www.skyreport.com.

www.broadband.com is a site devoted to new ideas of low altitude network communication satellites mounted on airplanes.
Rubric: Suggested Evaluation Criteria and Weightings

<table>
<thead>
<tr>
<th>Criteria</th>
<th>%</th>
<th>Your Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clear and concise documentation of research results</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>Good critical analysis of selected search results</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>Clear description of recent developments</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>Documentation of resources</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td>100</td>
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</tbody>
</table>

Summary

In this lesson, you learned how to:

- Identify several key new network technologies which are likely to become widely available in the coming years
- Compare the physical characteristics and the potential data capacities of the new technologies
- Identify the new applications and end-user benefits of the new technologies
- Use research skills to locate and interpret up-to-date information about the current state of new network technologies
- Understand the historical and business perspective of the new networking technologies, and identify the business interests within the industry which drive the development and adoption of new technologies.
Review Questions

Lessn 6-3: Emerging Network Technologies

Part A

1. Describe the difference between a circuit switched network and a packet switched network.

2. Standard telephone service connections are provided by which network?
   a. CACS
   b. SONET
   c. ATM
   d. PSTN

3. Circuit switched networks
   a. Send packets of data to all devices on the network
   b. Use switches to select routes for data packets
   c. Establish and maintain an exclusive connection between communicating devices
   d. Use switches to select routes for fixed-length data cells

4. Photonic switches provide which advantage?
   a. Fast switching of data between fiber optic cables
   b. Fast switching of data between fiber optic cables and copper cables
   c. Fast video performance because photonic switches operate directly with light
   d. Low cost hardware
Part B

Match the definition with its networking term.

<table>
<thead>
<tr>
<th>Networking Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>1._____ Bandwidth</td>
<td>A. Bandwidth greater than 45 Mbps</td>
</tr>
<tr>
<td>2._____ Broadband</td>
<td>B. 1000 Mbps Ethernet</td>
</tr>
<tr>
<td>3._____ Photonics</td>
<td>C. A measurement of data transfer rate for network transmission systems</td>
</tr>
<tr>
<td>4._____ Fast Ethernet</td>
<td>D. Optical devices which replace electronic circuitry</td>
</tr>
<tr>
<td>5._____ Gigabit Ethernet</td>
<td>E. Access to voice, video, fax and email messaging through a single network.</td>
</tr>
<tr>
<td>6._____ Convergence</td>
<td>F. 100 Mbps Ethernet</td>
</tr>
</tbody>
</table>

7. Which transmission system can support the highest bandwidth?
   a. Unshielded Twisted Pair
   b. Fiber Optics
   c. Coaxial Cable
   d. Satellite Radio

Part C

1. List two new applications that can be used on a high-speed data network.

2. E-mail messages use MIME to
   a. Provide videoconferencing
   b. Broadcast audio and video
   c. Format text and attach multimedia files and documents
   d. Send messages by wireless transmission systems
3. Voice messaging systems can be integrated into desktop applications if
   a. Messages are stored as video data files
   b. Messages are stored on analog audio tape
   c. Messages are stored as digitized audio files
   d. Messages are stored as text files

4. Which function does a fax server not provide?
   a. Send fax images to standard telephones
   b. Route incoming faxes to personal software mailboxes
   c. Send fax images as email attachments
   d. Create fax images from any software application which is capable of printing

5. Voice communication over IP networks requires
   a. Circuit switched connections
   b. Unpredictable delays
   c. Fast switching of data packets
   d. A T1 or faster connection

Part D

1. Name the two industries competing to provide high-speed network connections to the home.

2. ADSL service is offered by
   a. Telephone companies
   b. Cable Television Companies
   c. SONET
   d. Networking companies
3. Why do cable television and telephone companies offer competing options for high-speed Internet access?
   a. To minimize their profits
   b. To provide slower service
   c. To create confusion
   d. To take advantage of existing cabling which they already own

### Scoring

**Rubric: Suggested Evaluation Criteria and Weightings**

<table>
<thead>
<tr>
<th>Criteria</th>
<th>%</th>
<th>Your Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part A: Identify several key new network technologies which are likely to become widely available in the coming years</td>
<td>20</td>
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<td>Part B: Compare the physical characteristics and the potential data capacities of the new technologies</td>
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<tr>
<td>Part C: Identify the new applications and end-user benefits of the new technologies</td>
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<tr>
<td>Part D: Understand the historical and business perspective of the new networking technologies, and identify the business interests within the industry which drive the development and adoption of new technologies</td>
<td>20</td>
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<tr>
<td><strong>TOTAL</strong></td>
<td>100</td>
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</table>

**Try It Out:** Identify the new applications and end-user benefits of the new technologies

**Stretch Yourself:** Identify the new applications and end-user benefits of the new technologies

**Network Wizards:** Use research skills to locate and interpret up-to-date information about the current state of new network technologies

**FINAL TOTAL** 400