

CHAPTER 10 THE INTERNET

Chapter Summary

This chapter examines the Internet in more detail to explain how it works and why it is a network of networks. The chapter also examines Internet access technologies, such as DSL and cable modem, as well as the possible future of the Internet.

Learning Objectives

After reading this chapter, students should:

- Understand the overall design of the Internet
- Be familiar with DSL, cable modem, fiber to the home, and WiMax
- Be familiar with possible future directions of the Internet

Key Terms

asymmetric DSL (ADSL)	Internet Architecture Board (IAB)	main distribution facility (MDF)
autonomous systems	Internet Corporation for Assigned Names and Numbers (ICANN)	mobile wireless
broadband technologies	Internet Engineering Steering Group (IESG)	national ISP
cable modem	Internet Engineering Task Force (IETF)	optical-electrical (OE) converter
cable modem termination system (CMTS)	Internet exchange point (IXP)	optical network unit (ONU)
customer premises equipment (CPE)	Internet Research Task Force (IRTF)	peering
Data over Cable Service Interface Specification (DOCSIS)	Internet Service Provider (ISP)	point of presence (POP)
digital subscriber line (DSL)	Internet Society	regional ISP
distribution hub	Internet2®	request for comment (RFC)
DSL access multiplexer (DSLAM)	line splitter	tier 1 ISP
DSL modem, 281 fiber to the home (FTTH)	local loop	tier 2 ISP
gigapop		tier 3 ISP
		WiMax

Chapter Outline

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 - a. Internet Governance
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Answers to Textbook Exercises

Answers to End-of-Chapter Questions

1. What is the basic structure of the Internet?

The Internet is hierarchical in structure. At the top are the very large national Internet service providers like AT&T, Sprint, etc. with regional and local internet service providers reporting up through this hierarchy.

2. Explain how the Internet is a network of networks.

The Internet was originally run by the U.S. National Science Foundation (NSF), but now the NAP's are commercial enterprises run by various common carriers. These NAP's are connected to other NAP's, who have several ISPs attached, who have regional ISPs attached to them, who have consumers attached to them. This spider web branches out into countless networks all over the world. There are agreements between the carriers to enable the exchange of messages, with varying payment mechanisms.

3. What is an IXP?

Internet Exchange Points are connection points between Internet Service Providers.

4. What is a POP?

A POP is an acronym for "point of presence." The POP is the place at which the ISP provides services to its customers.

5. Explain one reason why you might experience long response times in getting a Web page from a server in your own city.

If the other organization uses a different local ISP, which in turn uses a different regional ISP, the message may have to travel all the way to the Chicago IXP before it can move between the two separate parts of the Internet.

6. What type of circuits are commonly used to build the Internet today? What type of circuits are commonly used to build Internet 2?

Today, the backbone circuits of the major U.S. national ISPs operate at SONET OC-192 (10 Gbps).

Internet 2 will consist of circuits at least at OC-192 levels, with OC-768 (80 Gbps) and possibly even OC-3072 (160 Gbps) available.

7. Compare and contrast cable modem and DSL.

Individuals connect to ISP's mostly via DSL and cable modems today. The speeds vary between the two technologies and it depends on location and provider as to which is faster. One of the main differences between the two is that DSL customers have a direct connection back to the end office with point-to-point technology, whereas cable modems use shared multipoint circuits.

8. Explain how DSL works.

DSL requires equipment that is installed at the end of the cable (within the house or office) which allows traditional telephone service (POTS) to take advantage of much higher data transmissions rates via the existing cable in the local loop.

9. How does a DSL modem differ from a DSLAM?

A DSL modem produces Ethernet 10Base-T packets so it can be connected directly into a computer or router and hub so that it can serve the needs of a small network. The DSLAM de-multiplexes the data streams and converts them into ATM data, which are then distributed to the ISPs.

10. Explain how ADSL works.

ADSL is the most common type of DSL used today. It uses frequency division multiplexing to create three separate channels over the one local loop circuit. One channel is the traditional voice telephone circuit, the second channel is a relatively high-speed simplex data channel, and the third channel is a slightly slower duplex data channel.

11. Explain how a cable modem works.

The cable modem works very similar to DSL, with one very important difference, DSL is a point-to-point technology, whereas cable modems use shared multipoint circuits. Cable modems must compete with other users for the available capacity. Circuits that have many clients are thus slower than circuits with fewer circuits.

12. What is an OE converter? A CMTS?

An OE is an optical-electrical converter, which converts between the coaxial cable on the customer side and fiber-optic cable on the cable TV company side. The CMTS contains a series of cable modems/multiplexers and converts the data from cable modem protocols into protocols needed for Internet traffic, before passing them to the router connected to an ISP POP.

13. Which is better, cable modem or DSL? Explain.

The speeds for each of these has increased significantly over the past few years. In most cases, you need to check with the local service providers to see what speeds they offer.

14. Explain how FTTH works.

The traditional set of hundreds of copper telephone lines that run from the telephone company switch office is replaced by one fiber-optic cable that is run past each house or office in the neighborhood. Data is transmitted down the signal fiber cable using wavelength division multiplexing (WDM), providing hundreds or thousands of separate channels.

At each subscriber location, a Optical Network Unit (ONU) (also called an Optical Network Terminal (ONT)) acts like a DSL modem or cable modem and converts the signals in the optical network into an Ethernet format. The ONU acts as an Ethernet switch and can also include a router. FTTH is a dedicated point-to-point service like DSL, not a shared multipoint service like cable modem.

15. What are some future technologies that might change how we access the Internet?

The next big technologies are Passive Optical Networking and Internet 2.

16. Explain how WiMax works.

Mobile WiMax works in much the same way as Wi-Fi. The laptop or smart phone has a WIMAX network interface card (NIC) and uses it to establish a connection to a WiMax access point (AP). Many devices use the same AP so WiMax is a shared multipoint service in which all computers must take turns transmitting. Media access control is controlled access, using a version of the 802.11 point coordination function (PCF).

WiMax uses the 2.3 GHz, 2.5 GHz, and 3.5 GHz frequency ranges in North America, although additional frequency ranges may be added.

17. What are the principal organizations responsible for Internet governance, and what do they do?

There is no one organization that operates the Internet. The closest thing the Internet has to an owner is the Internet Society (ISOC). This is an open membership professional society with more than 175 organizational and 8,000 individual members in over 100 countries. The ISOC mission is to ensure “the open development, evolution and use of the Internet for the benefit of all people.

18. How is the IETF related to the IRFT?

The ISOC comprises of four bodies that act together to govern, IETF and IRFT are two of the four.

19. What is the principal American organization working on the future of the Internet?

The Internet Society is an open-membership professional society with about 150 organizational members and 65,000 individual members in more than 100 countries,

including corporations, government agencies, and foundations that have created the Internet and its technologies. Because membership is open, anyone, including students, is welcome to join and vote on key issues facing the Internet. Its mission is to ensure “the open development, evolution and use of the Internet for the benefit of all people throughout the world.” It works in three general areas: public policy, education, and standards.

20. What is Internet2®?

Internet2® comprises about 400 universities, corporations, government agencies, and organizations from more than 100 countries with a primary focus to develop advanced networking as well as other innovative technologies for research and education.

21. What is a gigapop?

These are new points-of-presence (POP) that work at gigabit speeds.

22. Today, there is no clear winner in the competition for higher-speed Internet access. What technology or technologies do you think will dominate in 2 years' time? Why?

There is no answer for this, as technology changes day by day; however, I think Internet 2 development is definitely something to watch.

23. Would you be interested in subscribing to 100 Mbps FTTH for a monthly price of \$100? Why or why not?

This answer depends on the options that you currently have and the amount of uploading and downloading you actually perform. Many locations offer DSL and/or cable access for \$30 per month with data rates up to 15 Mbps. Obviously increasing the download rate to 100 Mbps would provide a much faster connection, but at more than double the price.

For those users who use email and do some light browsing, then the increased speed may not provide enough benefit. For those who are heavy users (file sharing, watching movies online, playing games, etc), the increased cost would be well worth it.

24. Many experts predicted that small, local ISPs would disappear as regional and national ISPs began offering local access. This hasn't happened. Why?

There are technology changes made every day, which requires all ISP providers constant change. There have been some consolidation recently, but with all the change underway, what would the larger companies really be purchasing.

Mini-Cases

I. Cathy's Collectibles

Your cousin Cathy runs a part-time business out of her apartment. She buys and sells collectibles such as antique prints, baseball cards, and cartoon cells and has recently discovered the Web with its many auction sites. She has begun buying and selling on the Web by bidding on collectibles at lesser-known sites and selling them at a profit at more well-known sites. She downloads and uploads lots of graphics (pictures of the items she's buying and selling). She asks you for advice. Figure 10-8 shows some of the available Internet services and their prices. Explain the differences in these services and make a recommendation.

The differences are mostly related to speed (bandwidth). It really depends on how much time she is willing to spend uploading and downloading. This would be a personal, economic decision for her. Any of the services that offer at least 12 Mbps download and 1.5 Mbps upload will probably be good for her.

One thing to consider is that the advertised cable rates are faster than DSL, since the cable connection is based on a shared circuit, if many other users in the same neighborhood as Cathy are online at the same time, the available bandwidth could decrease significantly to the point where DSL might be better (at least during the parts of the day when many other users are online).

Another issue to consider related to the shared circuit (cable) versus direct connection (DSL) is security. Although this is a lesser issue based on the assumption that the ISP is providing good security, cable is potentially a less-secure option because of the shared circuit.

II. Surfing Sam

Sam likes to surf the Web for fun, to buy things, and to research for his classes. Figure 10-8 shows some of the available Internet services and their prices. Explain the differences in these services and make a recommendation.

DSL works by using the existing phone line that comes into this house and multiplexing it such that there are three channels: upload, download, and phone. It uses a point-to-point connection back to the end office.

Cable companies offer their service which supplies Internet access over the existing cable system. It is different in that the local service is on a closed loop, so speeds may vary depending on neighborhood use. Security is a minor issue.

FTTH uses fiber-optic cable into the home. The traditional set of hundreds of copper telephone lines that run from the telephone company switch office is replaced by one fiber-optic cable that is run past each house or office in the neighborhood. Data are transmitted down the signal fiber cable using wavelength division multiplexing (WDM), providing hundreds or thousands of separate channels.

WiMax reuses many of the Wi-Fi components and was designed to connect easily into Ethernet LANs. WiMax can be used as a fixed wireless technology to connect a house or an office into the Internet, but its future lies in its ability to connect mobile laptops and smart phones into the Internet.

Sam really is a casual web user; thus, not having any demanding needs. He could go with any of these services.

III. Cookies Are Us

Cookies Are Us runs a series of 100 cookie stores across the midwestern United States and central Canada. At the end of each day, the stores express-mail a diskette or two of sales and inventory data to headquarters, which uses the data to ship new inventory and plan marketing campaigns. They have decided to move data over a WAN or the Internet. What type of a WAN topology and service (see Chapter 9) or Internet connection would you recommend? Figure 10-8 shows some of the available Internet services and their prices, whereas Figure 9-19 in the previous chapter shows faster circuits that could be used to connect to an ISP for Internet services. You should increase the prices in Figure 9-19 by 50% to get the price that an ISP would charge to provide both the faster circuit and Internet services on it. Why?

Since Cookies Are Us is a business and relies on the incoming data to manage the shipment of inventory, the information is critical. I would setup a hub and spoke environment; whereas, all the 100 stores would login to the centralized LAN via the WAN and submit the necessary information directly into the headquarters. With an effort to try and save money, I would recommend going the TCP/IP route and capitalizing on the Internet's backbone. VPN may be another option to consider too since it is relatively less expensive.

IV. Organic Foods

Organic Foods operates organic food stores in Toronto. The store operates like a traditional grocery store but offers only organically grown produce and meat, plus a wide array of health food products. Organic Foods sells memberships, and its 3,000 members receive a discount on all products they buy. There are also special member events and sales promotions each month. Organic Foods wants to open a new Internet site that will enable it to email its members monthly and provide up-to-date information and announcements about new products, sales promotions, and member events on its Web site. It has two options. First, it could develop the software on its own server in its office and connect the office (and the server) to the Internet via DSL, T1, or similar connection from its offices to an ISP. Alternately, it could pay the ISP to host the Web site on its servers and just connect the office to the ISP for Internet service. Figure 10-8 shows some of the available Internet services and their prices, whereas Figure 9-19 in the previous chapter shows faster circuits that could be used to connect to an ISP for Internet services. You should increase the prices in Figure 9-19 by 50% to get the price that an ISP would charge to provide both the faster circuit and Internet services on it. Web hosting would cost \$500 to \$1,000 per month, depending on the traffic. Which would you recommend, and what size of an Internet connection would you recommend if you choose to host it yourself? Justify your choice.

I would recommend outsourcing the entire Internet site, because if they decide to do everything in house they will be required to purchase new software, hardware, hire new IT employees or

consultants, and train their staff. Again, they should outsource this activity and focus on what they are good at (i.e. their core competencies).

They should start outsourcing the bare essentials while they test the model, and as the 3000 members start using the site, they can have the ISP increase bandwidth. Pay as you need it.

Next Day Air Service Case Study

1. What type of Internet access technologies would you recommend for the Atlanta, New Orleans, and the corporate office in Tampa and other locations as well?

I would suggest that each of the locations be connected using a leased line. Although this is more costly than some of the other options, it can provide more speed and better security.

2. Outline the advantages and disadvantages of the three approaches to for creating a web presence for NDAS.

Answers could vary and many of these will not come directly from the text.

	Advantages	Disadvantages
In-house	Keep control of everything	Potentially more costly
Outsource hosting only	Lower costs	Lose control of the hosting
Outsource everything	Lower costs	Lose control of development and hosting