

Protocols and Bandwidth

Introduction

We live in a world where computer networks are ubiquitous. In the first decades of computing, computers were not linked together. Solid media like floppy disks were the best means of transferring data between machines.



Creating a system to connect many different computers required protocols and standards, many of which were developed in the 1960s at Xerox PARC. All computers on the Internet must agree to use these standards and protocols for the communication to function. Can you think of a time when you had to perform a task in a very specific way for the product to be usable?



Video: Diving Down the Ladder

Refer to your downloadable resources for this video.

Video: Web Page Protocols

Refer to your downloadable resources for this video.

Materials

- Computer with a browser
- Cloud9 account and workspace (See Lesson 2.1 Supplement: Creating a Cloud9 Workspace.)

Procedure

1. Greet your partner to practice professional skills. Set team norms for pair work.

There is a human protocol for a business introduction. First impressions in business (as elsewhere) are lasting. People do infer personality and confidence from your introduction. A business introduction includes both a verbal introduction and a handshake and is done while standing. Read the following protocol, and then practice by exchanging an introduction with each member of your group.

- The verbal introduction should give your full name and a title or context. Allie might say, "Hello, my name is Allie Trusting. I'm a sophomore at Washington High School."

- One person starts their verbal introduction and extends their hand a relaxed distance toward the other person. The handshake lasts 3–4 seconds with two or three shaking motions.
- The handshake should be as firm as you would use to turn a door handle. The web between your thumb and index finger should meet your partner's.

In this activity, we dive into some of the details of how the Internet works. There is a high demand for employees in computer system design. These jobs are approximately equal in number to jobs in applications programming. These computer specialists create and maintain networks and the computer hardware on the networks. They work with the layers of abstraction at which data are exchanged among computers in a network. They might have one of the following job titles.

- Computer Engineers and Research Scientists create new technology
- Computer Support Specialists troubleshoot users' problems
- Computer Systems Analysts analyze an institution's technology and recommend improvements
- Computer Network Architects design an institution's network
- Computer Systems Administrators install and maintain networks

2. Reference the Bureau of Labor Statistics (BLS) *Occupational Outlook Handbook* at <https://www.bls.gov/ooh/>. Select Computer and Information Technology from among the occupation groups.

The screenshot shows the Occupational Outlook Handbook website. At the top, there is a navigation bar with links like 'OOH HOME', 'OCCUPATION FINDER', etc. Below this is a search bar labeled 'Search Handbook' with a 'Go' button. The main heading is 'OCCUPATIONAL OUTLOOK HANDBOOK'. Below the heading, there is a 'Home' section with a welcome message. On the left, there is a list of 'OCCUPATION GROUPS' including 'Architecture and Engineering', 'Arts and Design', 'Building and Grounds Cleaning', 'Business and Financial', 'Community and Social Service', 'Computer and Information Technology' (highlighted with a red box), 'Construction and Extraction', 'Education, Training, and Library', and 'Entertainment and Sports'. On the right, there is a blue banner for the 2012-13 Occupational Outlook Handbook in Spanish. Below the banner, there is a 'SELECT OCCUPATIONS BY' section with dropdown menus for '2010 Median Pay', 'Entry-Level Education', 'On-the-job Training', 'Number of New Jobs (Projected)', and 'Growth Rate (Projected)', followed by a 'GO' button.

- The five groups listed earlier are among the BLS information. Which of these occupation groups has the highest median salary?
- Which of the five occupation groups needs the fewest years of education?

Part I: Act out protocols and the TCP/IP handshake

As we dive into the miniscule details of a protocol, keep in mind our high level objectives to understand:

- How data are exchanged over the Internet.

- That protocols evolve over time, though a particular version of a protocol does not change.
- That protocols are compromises among competing objectives like security and speed, based upon decisions that can be political.

Video: TCP/IP

Refer to your downloadable resources for this video.

3. Think of decisions that you or another person made that were compromises among competing objectives. Describe one of these decisions that stayed in effect for some time after the decision was made.

An important type of protocol for computing is called a handshake. A handshake initiates a connection between two computers. The Transmission Control Protocol (TCP) and the Internet Protocol (IP) are used for exchanging most packets through the Internet. They are used together and are called TCP/IP. Other protocols, like Hypertext Transfer Protocol (HTTP) for web data, use TCP/IP to get packets to the other computer in an end-to-end connection and to verify that all the packets arrive without errors. Sending a message through TCP/IP begins with three transmissions in a TCP handshake. An example of the TCP handshake is shown below.

Client:	"SYN 6"
Server:	"ACK 7, SYN 58"
Client:	"ACK 59"

SYN and ACK stand for synchronize and acknowledge, respectively. Both the client and the server ask to SYNchronize with the computer at the other end of the connection. They each include a random number at which they will start numbering the data they send. In this example, the client picked 6 and the server picked 58; they could have been any random numbers.

To establish a connection, each of the computers must respond to a SYNchronize packet by sending an ACKnowledge packet, stating the sequence number of the data it is ready to receive. ACK 59 indicated the client was waiting for packet 59. We show this as just 1 plus the SYN 58 packet sequence number, but in the real TCP protocol, the synchronize and acknowledge numbers are counting bytes.

4. Create a playwrite-style script for a TCP handshake, similar to the one above, just using different numbers. Write it down.
5. Using different numbers yet again, initiate a two-way connection with another student in your group aloud.

The TCP/IP protocol lets the two computers keep track of what data the other computer has received.

6. What might be a disadvantage of agreeing that both ends will confirm receipt like this?