Chapter 3:
Making the Connection: The Basics of Networking

Fluency with Information Technology
Third Edition

by
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Networked Computers Change Our Lives

- The Information Age has brought profound changes
  - Nowhere is remote
  - People are interconnected
  - Social relationships are changing
  - English is becoming a universal language
  - Freedom of speech and assembly have expanded

Nowhere Is Remote

- Internet is a complete information resource no matter where you are
  - Some differences remain because older sources are not yet all online
- Homes are not remote from work
  - Information workers can telecommute and live long distances from their offices

People Are More Interconnected

- Family and friends stay in closer, more frequent contact via Internet than via telephone or "snail mail"
- WWW lets us meet people passively
  - People with similar interests find each other through search engines
  - Associations can form rapidly

Social Interactions Are Changing

- Time spent online displaces other in-person social activities (*displacement effect*)
- The effects are complicated (pros/cons)
- The Internet is changing social interactions, but we don't fully understand how

English Is Becoming a Universal Language

- Influence of American pop culture since World War II
- Dominance of science and technology in English-speaking countries
- Much software is available only in English
- Most web pages are in English

Freedom of Speech and of Assembly Have Expanded

- Internet use is *unmediated*
  - No editorial oversight or significant restrictions
  - Wikis
- Allows for political and artistic expression
- *Blogs* record personal thoughts for public viewing
- Like-minded people can communicate, even on private topics

Communication Types

- General Communication
  - *Synchronous:* sender and receiver are active at the same time
    - e.g., telephone call, instant messaging (IM)
  - *Asynchronous:* sending and receiving occur at different times
    - e.g., e-mail
  - *Broadcast communication* (or multicast): single sender and many receivers
  - *Point-to-point communication:* single sender and single receiver

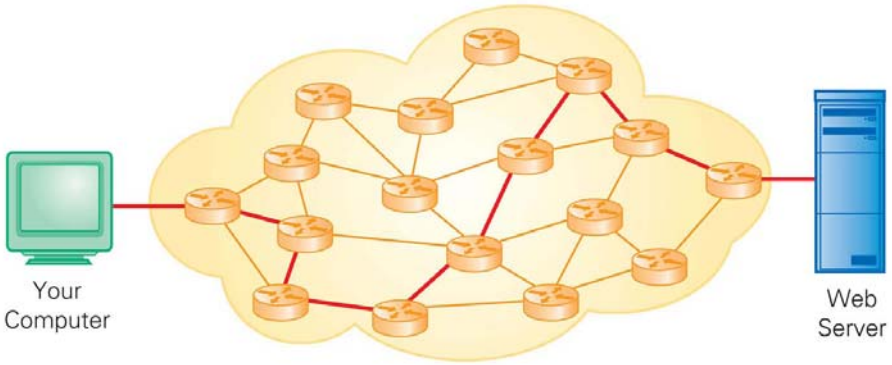


Figure 3.1. A diagram of the Internet.

The Internet's Communication Properties

- Internet provides a general communication "fabric" linking all computers connected to it
  - Can be applied in many ways:
    - Point-to-point asynchronous
      - E-mail is alternative to standard mail
    - Point-to-point synchronous
      - IM is alternative to telephone
    - Multicasting
      - Chat rooms are alternatives to magazines
    - Broadcasting
      - Web pages are alternatives to radio and television

The Client/Server Structure

- *Server* is the computer that stores the web page
  - Web server, file server, mail server
- *Client* is the computer that accesses the web page
- When you click link, your computer enters client/server relationship with web server
- Once the page is sent to you, the client/server relationship ends
- Server can form many brief relationships so it can serve many clients at the same time

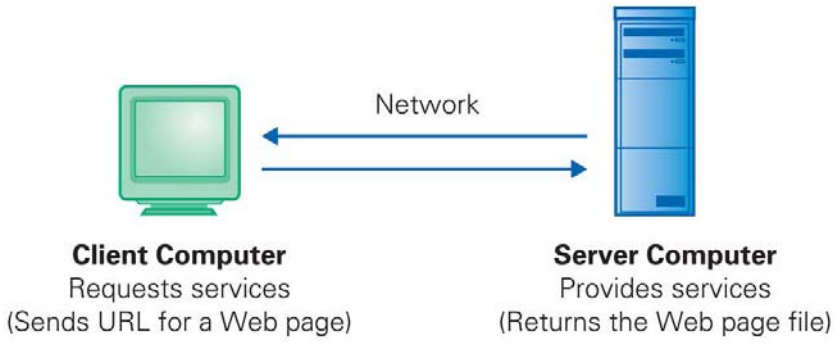


Figure 3.2. The basic client/server interaction, as illustrated by the browser (client) requesting Web pages provided by the Web server.

The Medium of the Message

- The Name Game of Computer Addresses
  - *IP addresses:* Each computer connected to the Internet is given a unique numerical address
    - For example: 128.95.1.207
  - *Hostnames:* Human-readable symbolic names, based on domain hierarchy
    - Easier to read and remember
    - For example: spiff.cs.washington.edu

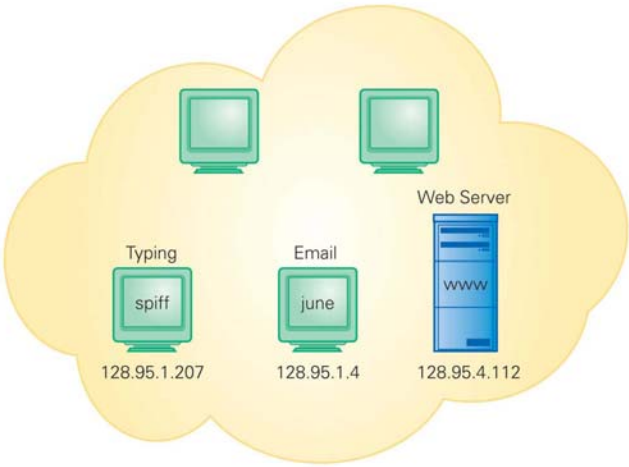
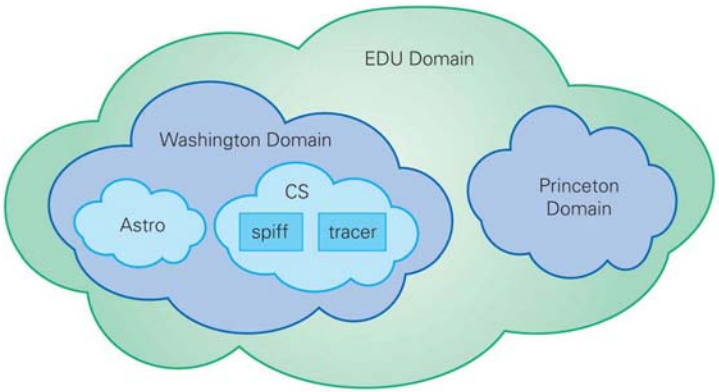
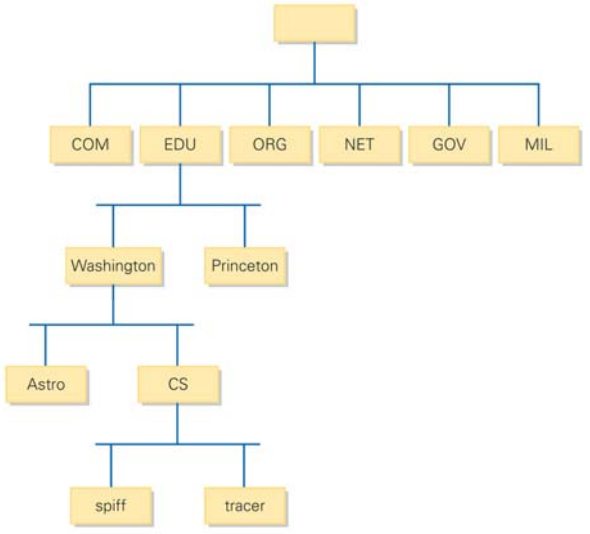


Figure 3.4. Computers connected to the Internet are given IP addresses.



(a)

Figure 3.5. Two ways to think of the Internet domain hierarchy. (continues next page).



(b)

*Figure 3.5. Two ways to think of the Internet domain hierarchy. (**continued**).*

DNS Servers

- The *Domain Name System* (DNS) translates the human-readable hostnames into IP addresses
- Internet host knows the IP address of its nearest DNS server, a computer that keeps a list of host/domain names and corresponding IP addresses
- When you use a hostname to send information, your computer asks the DNS server to look up the IP address
- If the DNS server doesn't know the IP address, it asks a *Root name server,* which keeps the master list of name-to-address relationships

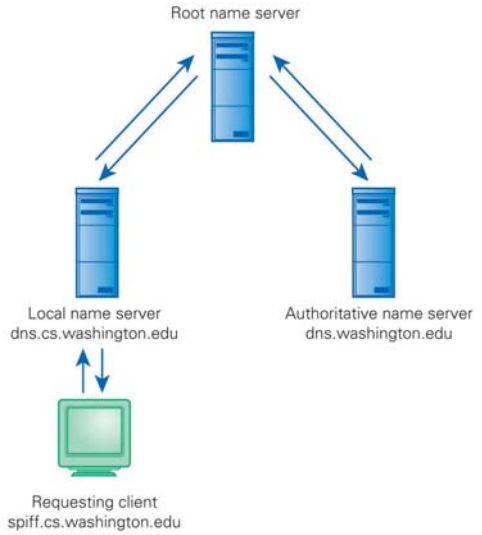


Figure 3.6. Hosts like spiff make requests to a local DNS server.

Top-level Domains

- *Domain* is a related group of networked computers
- Top-level domains appear in the last part of domain name:

.edu	educational institutions
.org	organizations
.net	networks
.mil	military
.gov	government agencies

Mnemonic two-letter country designators such as .ca (Canada)

Following Protocol

- A *protocol* describes how the information is actually sent
- *TCP/IP (Transmission Control Protocol/Internet Protocol)*
  - Information is broken into a sequence of small fixed-size units called *IP packets*
  - Each packet has space for the unit of data, the source and destination IP addresses, and a sequence number
  - The packets are sent over the Internet one at a time using whatever route is available
  - Because each packet can take a different route, congestion and service interruptions do not delay transmissions

Figure 3.7. The TCP/IP postcard analogy.

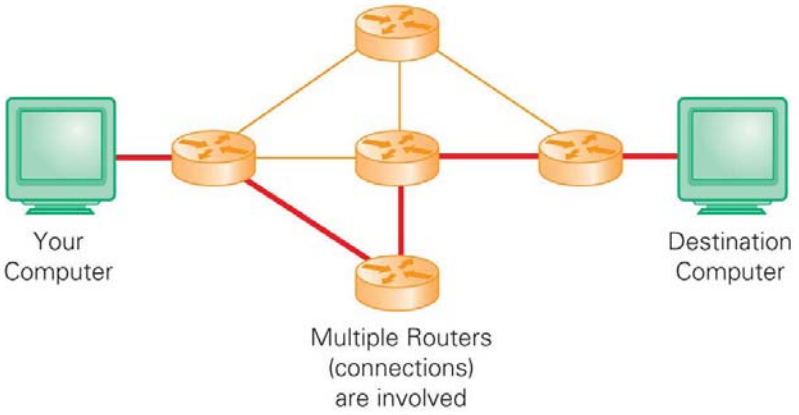


Figure 3.8. The Internet makes use of whatever routes are available to deliver packets.

Moving Packets: Wires and More

- Internet uses electrical, electronic, and optical communication means
- Telephone lines, dedicated fiber optic lines, etc.
- The technology used to move the packet is independent from the protocol; transmission of a single file may use multiple technologies

Far and Near: WAN and LAN

- Internet is a collection of *Wide Area Networks (WAN)*, designed to send information between widely separated locations
  - Multiple *hops*
    - ping, traceroute
- *Local Area Networks (LAN)* connect computers close enough to be linked by a single cable or wire pair
  - *Ethernet* is the main technology for LAN

Ethernet

- Channel (wire, wire pair, or optical fiber) that winds past a set of computers
- Each computer is connected to the channel, allowing it to send a signal that can be detected by all computers connected to the channel
- Decentralized scheme: Each computer listens to the channel, and if it's quiet, it's free. The computer transmits unless another starts at the same time. In that case, both stop for a random time and then try again.

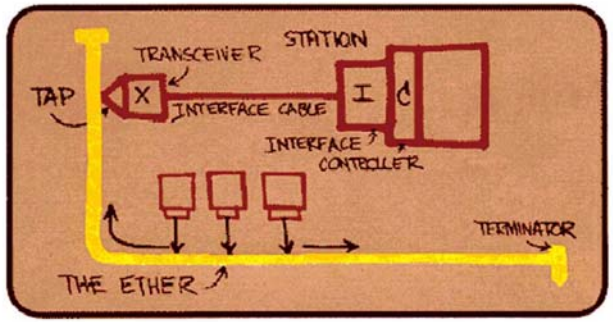


Figure 3.10. Robert Metcalfe's original drawing of the Ethernet design; the unlabeled boxes (computers), "tap" onto the wire that Metcalfe labeled "The Ether."

Connecting a Computer to the Internet

- By ISP:
  - *Internet Service Providers* sell connections to Internet (like AOL and Earthlink)
  - User plugs into telephone system or dedicated connection to ISP (DSL, cable)
  - Home computer talks to ISP's computer
  - ISP's computer is connected to Internet, and relays information for its customers

Connecting a Computer to the Internet (cont'd)

- By Enterprise Network Connections (LAN):
  - Large networked organizations such as schools, businesses, or governmental units
  - The organization creates a LAN or *intranet*
  - The intranet connects to the Internet by a gateway
  - Information from a Web computer is sent across Internet, through gateway, across LAN to user's computer

Wireless Networks

- A variation on the LAN connection
- A computer (called the *access point* or *hub*) is physically connected to the Internet (wired)
  - The hub broadcasts and receives radio frequency (rf) signals (wireless)
  - Mobile computers also send and receive signals (wireless)
  - Access point hands out temporary IP addresses via DHCP (Dynamic Host Configuration Protocol)
- The hub relays Internet requests for the connected wireless computers

The World Wide Web

- *Web servers*: Computers programmed to send files to browsers running on other computers connected to the Internet
- Web servers and their files make up the World Wide Web
- The World Wide Web is a subset of the Internet

Requesting a Web Page

- Web request creates a client/server interaction
- Uniform Resource Locator (URL) has three main parts

  http://www.widgets.com/hardware/support/faq.html

  1. Protocol:
     - http:// ftp://
     - Hypertext Transfer Protocol File Transfer Protocol
     - Tells the computer how to handle the file
  2. Server computer's name:
     - Server's IP address given by the domain hierarchy
  3. Page's pathname:
     - Tells the server which file (page) is requested and where to find it.

Describing a Web Page

- Pages are stored as a description of how they should appear on the screen
- Web browser created the image from the description file
  - Browser can adapt the source image more easily

Hypertext

- *Hypertext Markup Language (HTML)*
- *Markup languages* describe the layout of a document
  - Margin width
  - Font
  - Text style
  - Image placement
  - Etc.
- Hypertext provides a way to jump from point to point in documents (non-linear)
- Combination of hypertext and markup languages lets us build non-linear documents for the dynamic and interconnected Net and Web
  - Much more on HTML in Chapter 4

The Internet and the Web

- When is the "www" required and when is it optional?
- WWW is just a name; web servers do not have to use it
- In order for DNS to work, user must give the exact hostname
- To help users reach them, organizations do two things:
  1. Redirection: server inserts the "www" or redirects to a different server
  2. Registering multiple domain names
     - Museum of Modern Art has registered both "moma.org" and "www.moma.org" to the same IP address

File Structure

- *Directory*, or *folder*, is a named collection of files, other directories, or both
- *Directory Hierarchy*: Directories can contain other directories, which can contain other directories, etc.
  - Down, or lower in the hierarchy, means moving into subdirectories
  - Up, or higher in the hierarchy, means into enclosing (parent) directories

File Structure (cont'd)

- Part of the directory hierarchy is shown in the pathnames of URL's.

  http://www.nasm.si.edu/galleries/ga1100/pioneer.html
- Page is given by pathname:

  /galleries/ga1100/pioneer.html
- Each time we pass a slash (/), we move into a subdirectory or into the file (lower in the hierarchy)

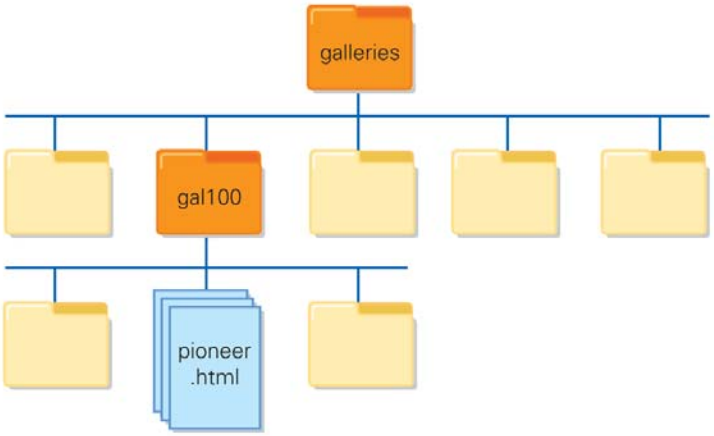


Figure 3.13. The pathname hierarchy ending in `pioneer.html`.

Organizing the Directory

- When a URL ends in a slash, the browser looks for a file called *index.html* in that directory
  - http://www.widget.com/ and http://www.widget.com/index.html are the same
- If the browser does not find an index.html file, the browser automatically tries to display a directory listing (index) of the files there
- Why are hierarchies important?
  - People use them to organize their thinking and work
  - Directories are free; there is no reason not to use them

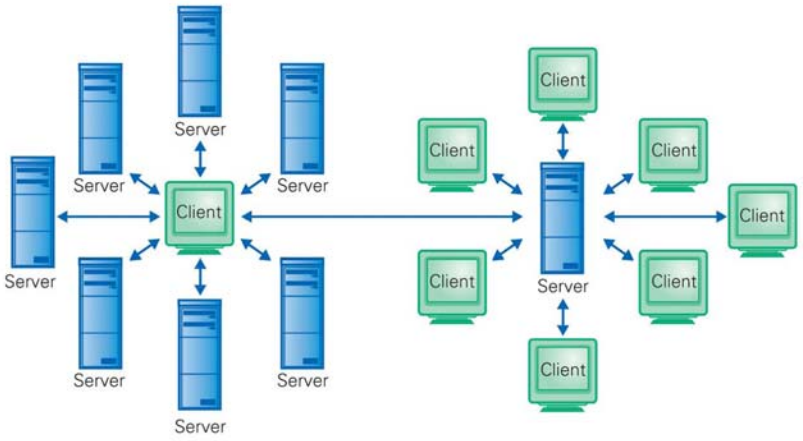


Figure 3.3. Client/server relationships as they might evolve over time.

Table 3.1 Top-level country domain abbreviations

Afghanistan	af	Dominica	dm	Lesotho	ls	Saint Lucia	lc
Albania	al	Dominican Republic	do	Liberia	lr	St Vincent, Grenadines	vc
Algeria	dz	East Timor	tp	Libya	ly	Samoa	ws
American Samoa	as	Ecuador	ec	Liechtenstein	li	San Marino	sm
Andorra	ad	Egypt	eg	Lithuania	lt	Sao Tome and Principe	st
Angola	ao	El Salvador	sv	Luxembourg	lu	Saudi Arabia	sa
Anguilla	ai	Equatorial Guinea	gq	Macao	mo	Senegal	sn
Antarctica	aq	Eritrea	er	Macedonia	mk	Seychelles	sc
Antigua and Barbuda	ag	Estonia	ee	Madagascar	mg	Sierra Leone	sl
Argentina	ar	Ethiopia	et	Malawi	mw	Singapore	sg
Armenia	am	Falkland Islands	fk	Malaysia	my	Slovakia	sk
Aruba	aw	Faroe Islands	fo	Maldives	mv	Slovenia	si
Ascension Island	ac	Fiji	fj	Mali	ml	Solomon Islands	sb
Australia	au	Finland	fi	Malta	mt	Somalia	so
Austria	at	France	fr	Marshall Islands	mh	South Africa	za
Azerbaijan	az	French Guiana	gf	Martinique	mq	S Georgia,	
Bahrain	bh	French Polynesia	pf	Mauritania	mr	S Sandwich Islands	gs
Bangladesh	bd	Gabon	ga	Mauritius	mu	Spain	es
Barbados	bb	Gambia	gm	Mexico	mx	Sri Lanka	lk
Belarus	by	Georgia	ge	Micronesia	fm	St. Helena	sh
Belgium	be	Germany	de	Moldova	md	Sudan	sd
Belize	bz	Ghana	gh	Monaco	mc	Suriname	sr
Benin	bj	Gibraltar	gi	Mongolia	mn	Swaziland	sz
Bermuda	bm	Greece	gr	Montserrat	ms	Sweden	se
Bhutan	bt	Greenland	gl	Morocco	ma	Switzerland	ch
Bolivia	bo	Grenada	gd	Mozambique	mz	Syria	sy
Bosnia and Herzegowina	ba	Guadeloupe	gp	Myanmar	mm	Taiwan	tw
Botswana	bw	Guam	gu	Namibia	na	Tajikistan	tj
Brazil	br	Guatemala	gt	Nauru	nr	Tanzania	tz
		Guinea	gn	Nepal	np	Thailand	th

Table 3.1 Top-level country domain abbreviations

Brunei	bn	Guinea-Bissau	gw	Netherlands	nl	The Bahamas	bs
Bulgaria	bg	Guyana	gy	Netherlands Antilles	an	The Cayman Islands	ky
Burkina Faso	bf	Haiti	ht	New Caledonia	nc	Togo	tg
Burundi	bi	Honduras	hn	New Zealand	nz	Tokelau	tk
Cambodia	kh	Hong Kong	hk	Nicaragua	ni	Tonga	to
Cameroon	cm	Hungary	hu	Niger	ne	Trinidad and Tobago	tt
Canada	ca	Iceland	is	Nigeria	ng	Tunisia	tn
Cape Verde	cv	India	in	Niue	nu	Turkey	tr
Central African		Indonesia	id	N. Mariana Islands	mp	Turkmenistan	tm
Republic	cf	Iran	ir	Norway	no	Tuvalu	tv
Chad	td	Iraq	iq	Oman	om	Uganda	ug
Chile	cl	Ireland	ie	Pakistan	pk	Ukraine	ua
China	cn	Isle of Man	im	Palau	pw	United Arab Emirates	ae
Christmas Island	cx	Israel	il	Panama	pa	United Kingdom	uk
Cocos (Keeling) Islands	cc	Italy	it	Papua New Guinea	pg	United States	us
Colombia	co	Jamaica	jm	Paraguay	py	Uruguay	uy
Comoros	km	Japan	jp	Peru	pe	Uzbekistan	uz
Congo	cg	Jordan	jo	Philippines	ph	Vanuatu	vu
Congo, DRC	cd	Kazakhstan	kz	Pitcairn	pn	Vatican City State	va
Cook Islands	ck	Kenya	ke	Poland	pl	Venezuela	ve
Costa Rica	cr	Kiribati	ki	Portugal	pt	Vietnam	vn
Cote d'Ivoire	ci	Korea, DPRK	kp	Puerto Rico	pr	Virgin Islands (British)	vg
Croatia	hr	Korea, Republic of	kr	Qatar	qa	Virgin Islands (US)	vi
Cuba	cu	Kuwait	kw	Reunion	re	Western Sahara	eh
Cyprus	cy	Kyrgyzstan	kg	Romania	ro	Yemen	ye
Czech Republic	cz	Laos	la	Russia	ru	Yugoslavia	yu
Denmark	dk	Latvia	lv	Rwanda	rw	Zambia	zm
Djibouti	dj	Lebanon	lb	Saint Kitts and Nevis	kn	Zimbabwe	zw

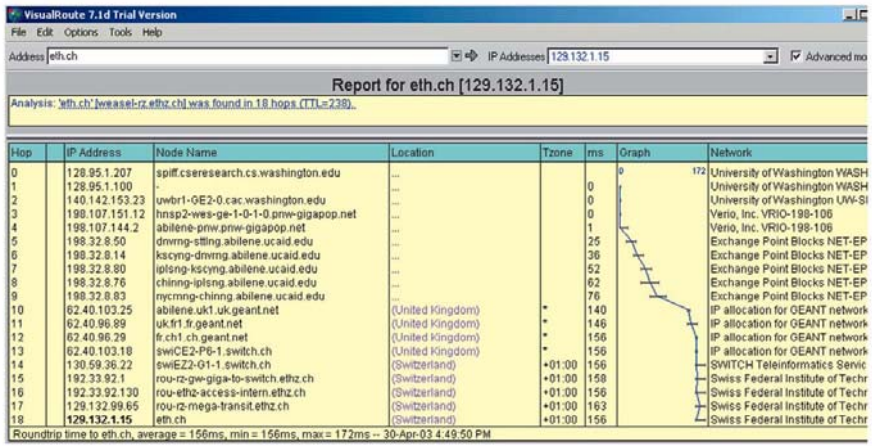


Figure 3.9. A ping from the author's machine to `eth.ch`.

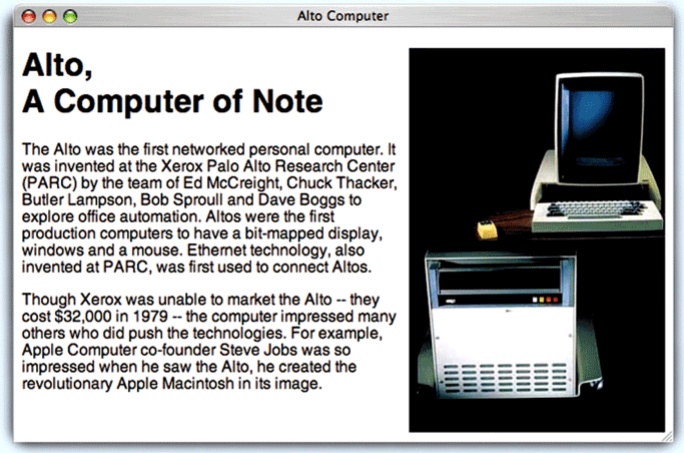


Figure 3.11 A Web page and the HTML source that produced it. Notice that an additional image file, `alto.jpg`, is also required to display the page.


```
<!DOCTYPE html> PUBLIC "-//W3C//DTD XHTML 1.0 Transitional//EN"
   "http://www.w3.org/TR/xhtml1/DTD/xhtml1-transitional.dtd">
<html xmlns="http://www.w3.org/1999/xhtml" lang="en" xml:lang="en">
<head> <title> Alto Computer </title>
   <meta http-equiv="Content-Type" content="text/html;charset=utf-8" />
</head>
<body bgcolor="white">
   <img align="right" src="alto.jpg" alt="Alto Personal Computer" />
   <h1><font face="Helvetica">Alto, <br />A Computer of Note</font></h1>
      <p><font face="Helvetica">The Alto was the first networked personal
      computer. It was invented at the Xerox Palo Alto Research Center (PARC)
      by the team of Ed McCreight, Chuck Thacker, Butler Lampson, Bob Sproull
      and Dave Boggs to explore office automation. Altos were the first
      production computers to have a bit-mapped display, windows and a mouse.
      Ethernet technology, also invented at PARC, was first used to connect
      Altos. </font></p>
      <p><font face="Helvetica">Though Xerox was unable to market the Alto --
      they cost $32,000 in 1979 -- the computer impressed many others who did
      push the technologies. For example, Apple Computer co-founder Steve Jobs
      was so impressed when he saw the Alto, he created the revolutionary
      Apple Macintosh in its image.</font></p>
</body>
</html>
```

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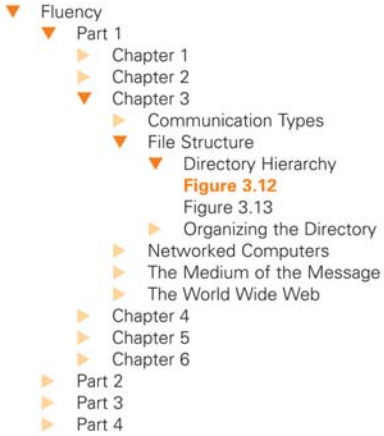

Figure 3.12. *The hierarchy of this book highlighting the path to this figure.*