




Networking & Security
Peeking into Computer Science

Peeking into Computer Science

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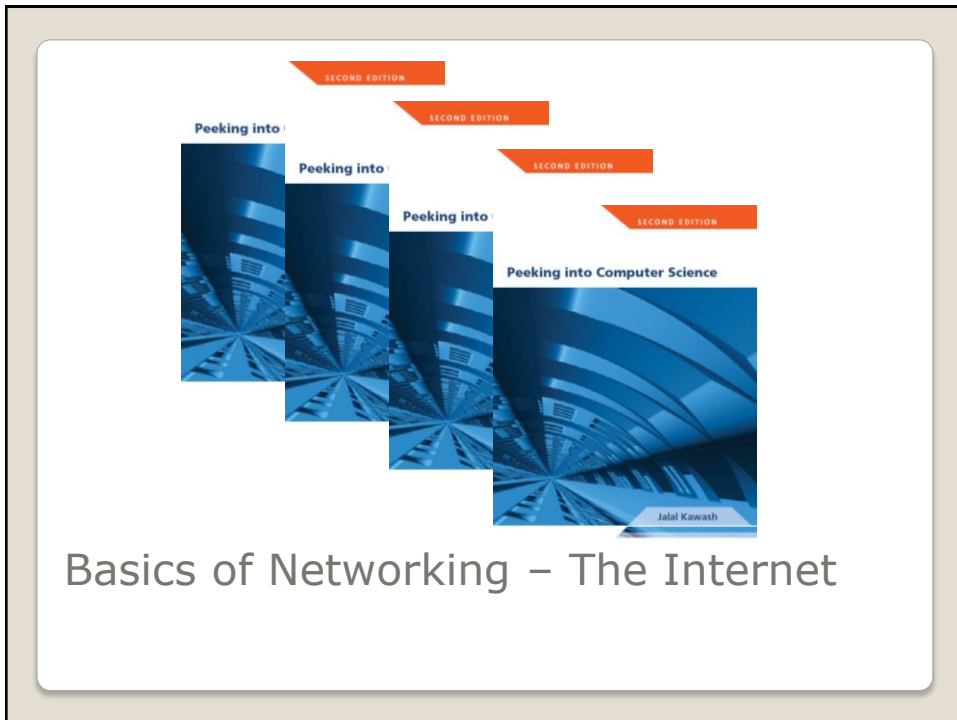
- Mandatory: Section 6.1



Reading Assignment

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Basics of Networking – The Internet

By the end of this section, you will be able to

1. Define the Internet and name its components
2. Describe the protocols of the Internet (TCP/IP and UDP)
3. Differentiate between connection-oriented and connectionless protocols

Objectives

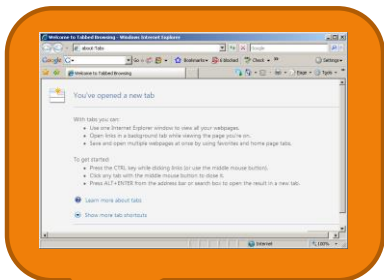


Your Computer

www.ucalgary.ca

Browsing

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Your Computer

U Calgary Web Server

Request a page

Respond with page

What Happened?

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- Similar to how a web page can be downloaded, computer software can also transfer to your computer and execute after you visit a website.
- Software can enhance a website (e.g., 'apps' for a sites such as Facebook):
 - <https://developers.facebook.com/docs/other-sdks>



JT: Early Note About Security

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- Of course not all software is beneficial
- 'Malicious' websites:
 - Going to these sites may result in 'malware' or malicious software being downloaded and executed on your computer or mobile device.
 - Google reporting link:
 - http://www.google.com/safebrowsing/report_badware/
 - Symantec database:
 - http://www.symantec.com/threatreport/topic.jsp?id=threat_activity_trends&aid=malicious_website_activity
 - McAfee database:
 - <http://www.siteadvisor.com/webmasters/index.html>
 - Note: it's not always obvious which sites are risky to visit!
 - Legitimate websites could get 'hacked'



JT: Early Note About Security

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- All computers can only understand machine language (binary: two state model).
- Different computer operating systems have their own version of binary.
 - That's why you can't directly install a program written for one operating system (O/S) onto a computer with a different O/S



JT: Computer Communications

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- What is the Internet?
 - A very large collection of connected networks
 - Protocols: the rules of communication for the interconnected devices on the Internet



Google



Facebook

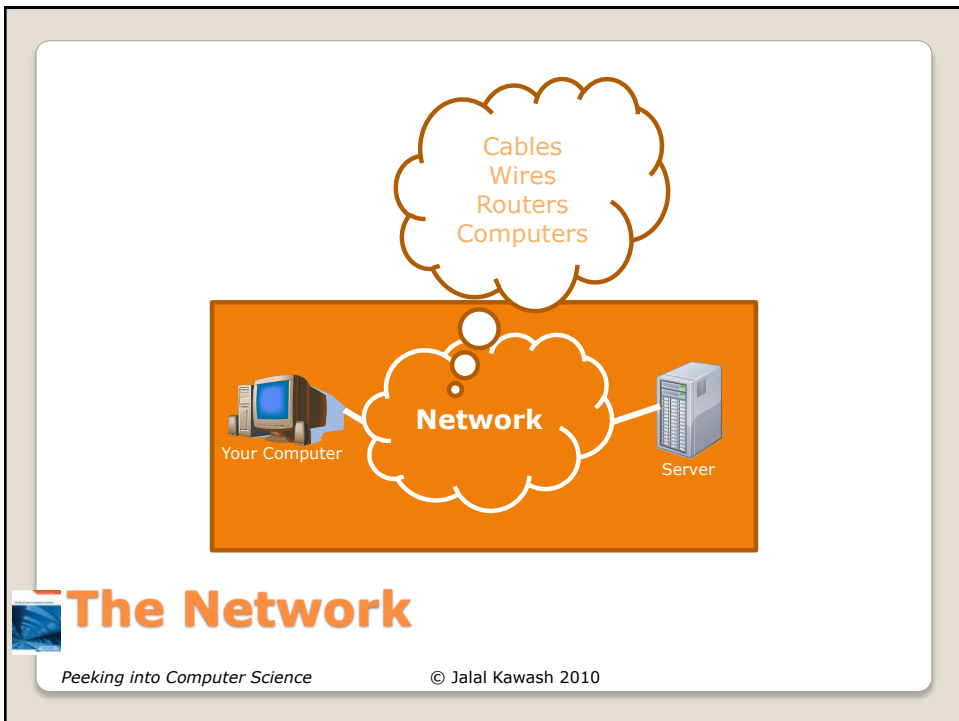
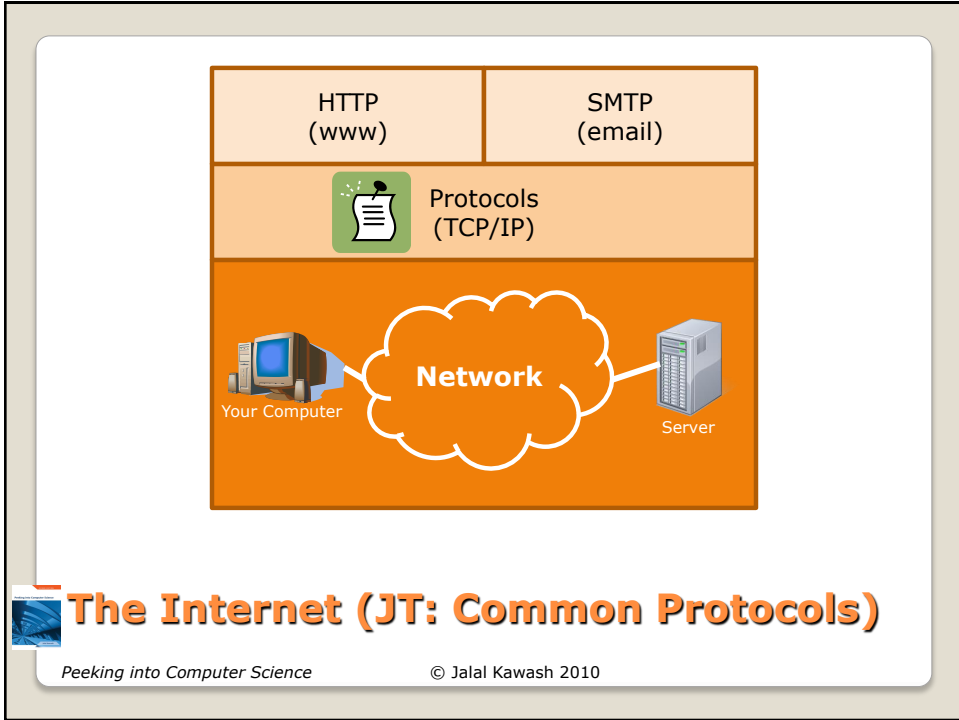


UC

JT: The Internet

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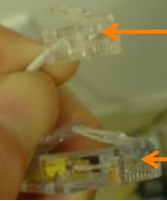


#1 The connections to the network

JT: Networks

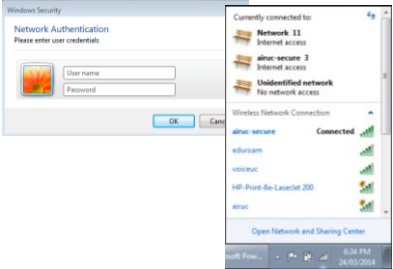
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- Network connections can be:
 - Wired



← Telephone

← Network
 - Wireless



JT: Connections

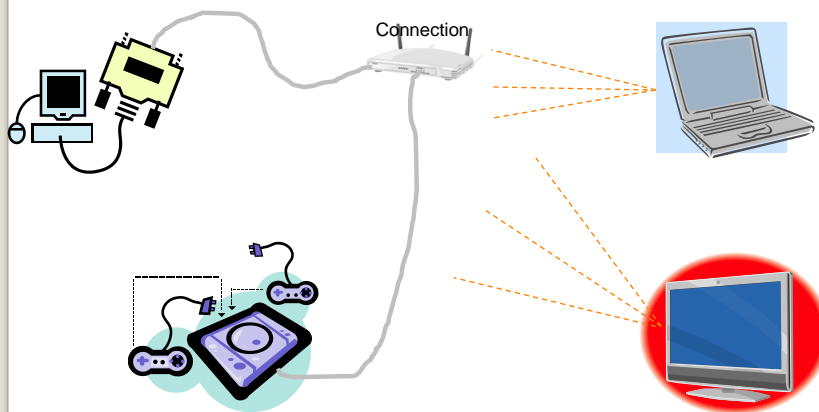
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- All are based on the 802.11 standard (also known as Wi-Fi) for wireless transmissions

Transmission protocol	Bandwidth	Approximate time to transmit a two hour DVD movie
802.11b	11 Mbps	48 minutes, 26 seconds
802.11g	52 Mbps	10 minutes, 15 seconds
802.11n	540 Mbps	62 seconds

JT: Types Of Wireless Network Connections (wired ~100 – 1000 Mbps)

#2 The connection to the outside (Internet)



JT: Networks

The router is the gateway to the Internet for the entire household.

Example: these are the computers in one house.

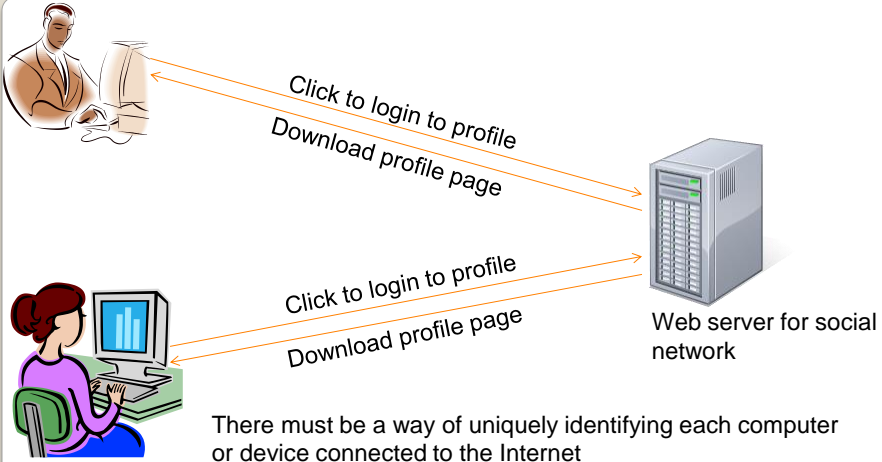
Image from "Technology in Action" by Evans, Martin and Poatsy

JT: Router And Modem

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- Need addresses to deliver the information (IP address)
- Need a common means of communication across the network (protocols)

JT: All The Network Hardware Is Still Not Sufficient



Click to login to profile
Download profile page

Click to login to profile
Download profile page

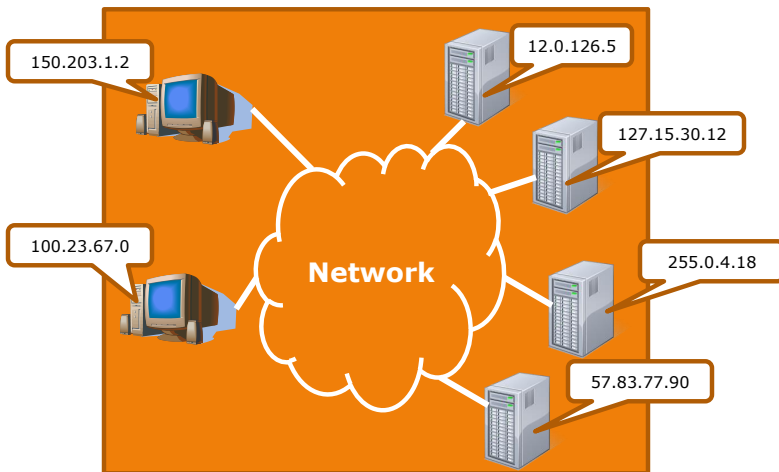
Web server for social network

There must be a way of uniquely identifying each computer or device connected to the Internet

- Allows information to be correctly 'delivered'.
- Internet Protocol (IP) addresses are assigned to each computer or device connected to the Internet.

JT: The Internet

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150.203.1.2

100.23.67.0

12.0.126.5

127.15.30.12

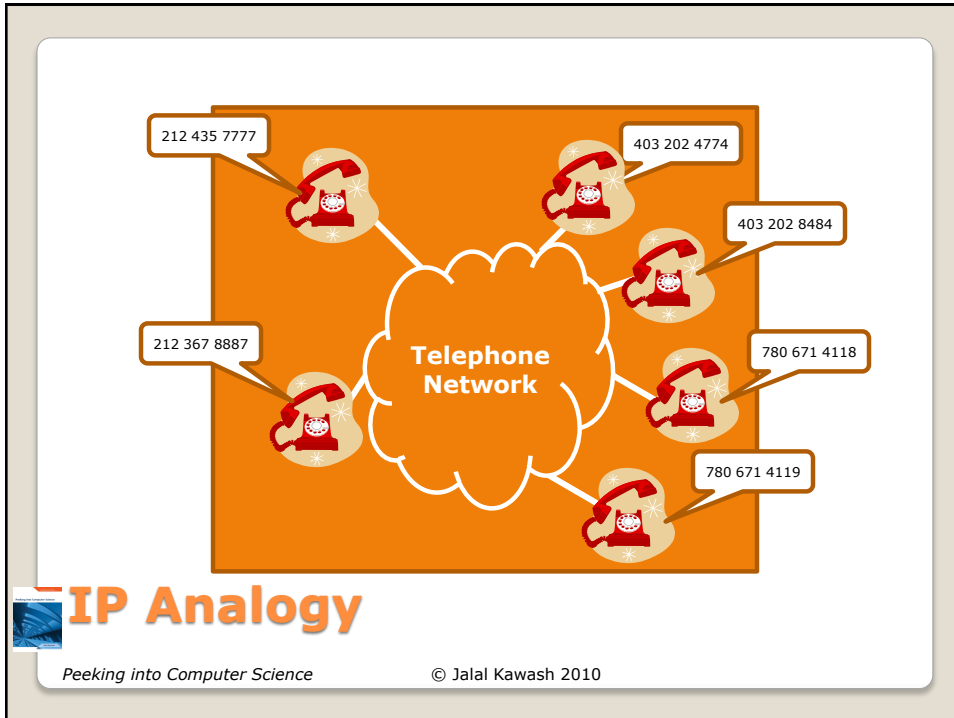
255.0.4.18

57.83.77.90

Network

Internet Protocol (JT: These are example IP Addresses)

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- Example: 136.159.34.3
- Each part of the address (e.g., '136') must consist of a number that ranges from 0 – 255.
- The first two numbers often indicate the provider or connection to the Internet
 - 136.159.XXX.YYY: A computer on the UC network
 - 68.147.XXX.YYY: Shaw
 - 205.206.XXX.YYY: Telus

JT: Address Restrictions And Registrations

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Web Server
HTML pages
Port 80

Mail Server
Email
Port 25

12.5.7.8.90

Something Else
Another Port

Port Numbers (JT: Ports provides different ways of communicating online)

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Listen to a port number for connection requests

12.5.7.8.90




Transmission Control Protocol

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The Internet

Find computer:
IP = 136.159.5.16

Internet accessible programs on the computer can be found via port numbers:

-  Email in = 25
-  Web pages = 80
-  Email out = 110

TCP: TCP And Port Numbers

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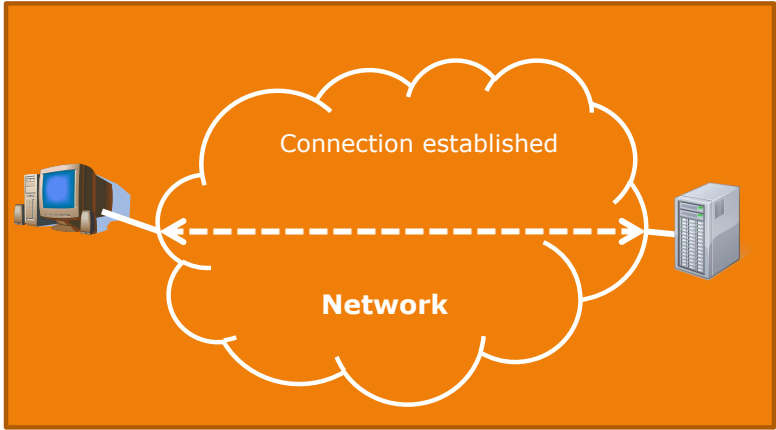
Accept connection

Connect(IP address, port no)

Network

Transmission Control Protocol

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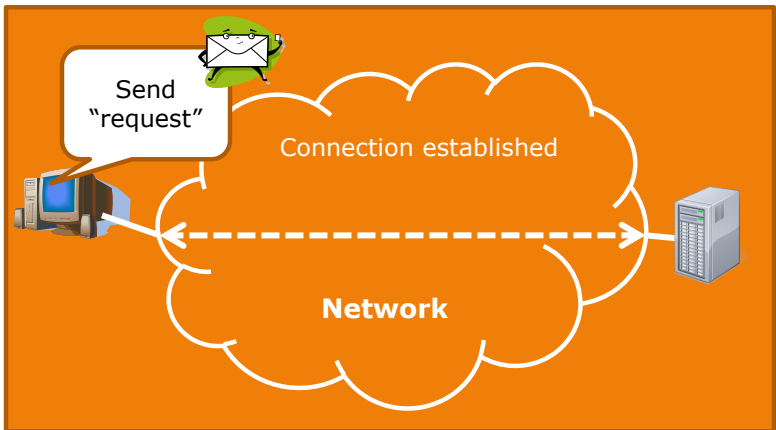
Connection established

Network

Transmission Control Protocol

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The diagram illustrates a network connection. A central orange cloud labeled 'Network' contains a dashed double-headed arrow. On the left side of the cloud is a desktop computer icon, and on the right side is a server rack icon. Above the arrow, the text 'Connection established' is written. The entire diagram is set against an orange background within a white-bordered frame.



Send "request"

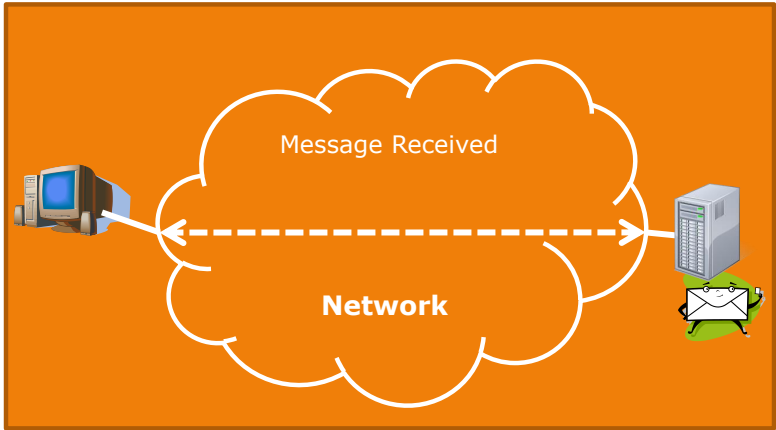
Connection established

Network

Transmission Control Protocol

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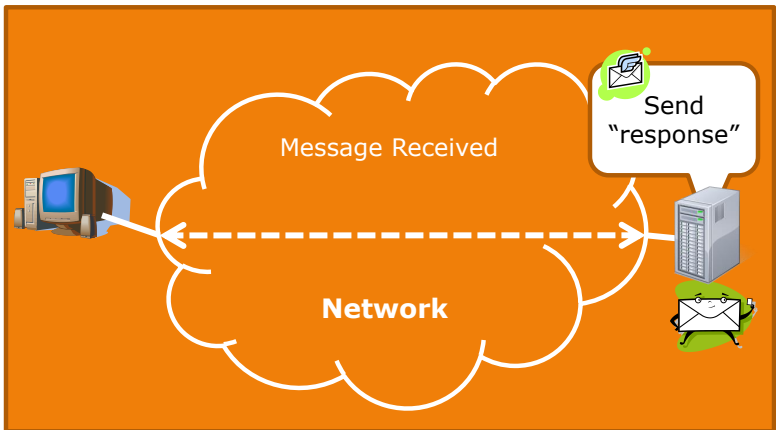
This diagram is similar to the one above, showing a network connection between a client and a server. However, a speech bubble with a green envelope icon is positioned above the client computer, containing the text 'Send "request"'. The rest of the diagram, including the 'Network' cloud, the dashed arrow, and the 'Connection established' text, remains the same. The entire diagram is set against an orange background within a white-bordered frame.



The diagram shows a central orange cloud labeled "Network". Inside the cloud, a dashed white arrow points from right to left, with the text "Message Received" above it. On the left side of the cloud, there is a desktop computer icon. On the right side, there is a server rack icon and a green envelope icon with a white letter.

Transmission Control Protocol

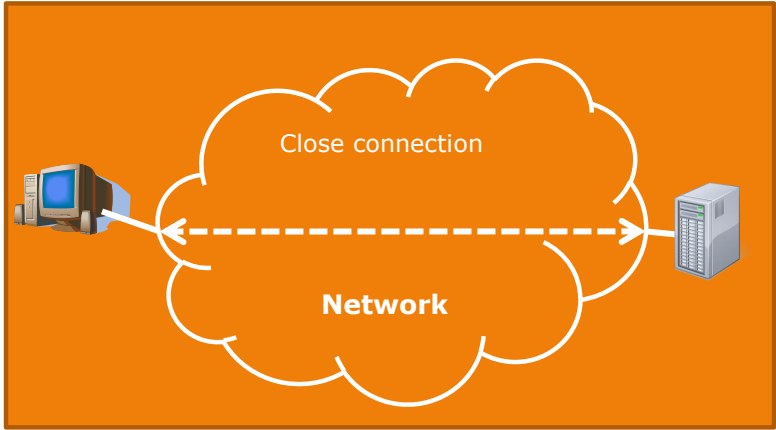
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The diagram is similar to the one above, but with an additional callout box. A white speech bubble with a green border and a green envelope icon contains the text "Send 'response'". An arrow points from this box to the server rack icon on the right side of the network cloud.

Transmission Control Protocol

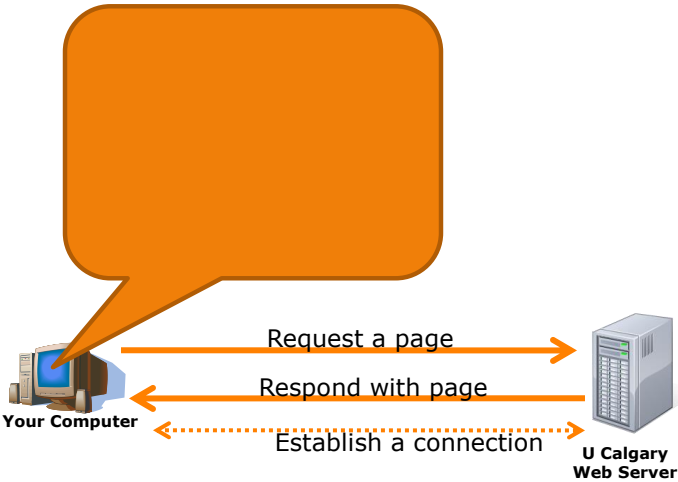
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The diagram shows a computer on the left and a server on the right, both connected to a central cloud labeled "Network". A dashed double-headed arrow between the computer and server is labeled "Close connection".

Transmission Control Protocol

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The diagram illustrates the interaction between "Your Computer" and a "U Calgary Web Server". A large orange speech bubble points to the computer. Three arrows show the sequence: a solid arrow from computer to server labeled "Request a page", a solid arrow from server to computer labeled "Respond with page", and a dashed double-headed arrow between them labeled "Establish a connection".

How does it Happen?

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- As mentioned computers are configured to automatically scan for certain types of network communications at particular port numbers e.g., Email is sent via port 110.
- Malicious and other unauthorized used of a computer (i.e., a program installs itself on your computer and sends out spam mail) to take advantage of these ports.
- Consequently non-default ports may be used when there have been known and commonly used security (and other) issues.

JT: Non-Default Port Numbers And Security



- Example (configuring your University of Calgary email account):
 - <http://www.ucalgary.ca/it/email>

	Default ports	UC ports used
Incoming email	25	993
Outgoing email	110	465

JT: Non-Default Port Numbers And Security (2)



You

Port 110: Buy Viagra! Cialis! Get rich quick: buy high, sell low!!!

www.evil.com

UC Mail server (listens at port #465 to receive mail to be sent)

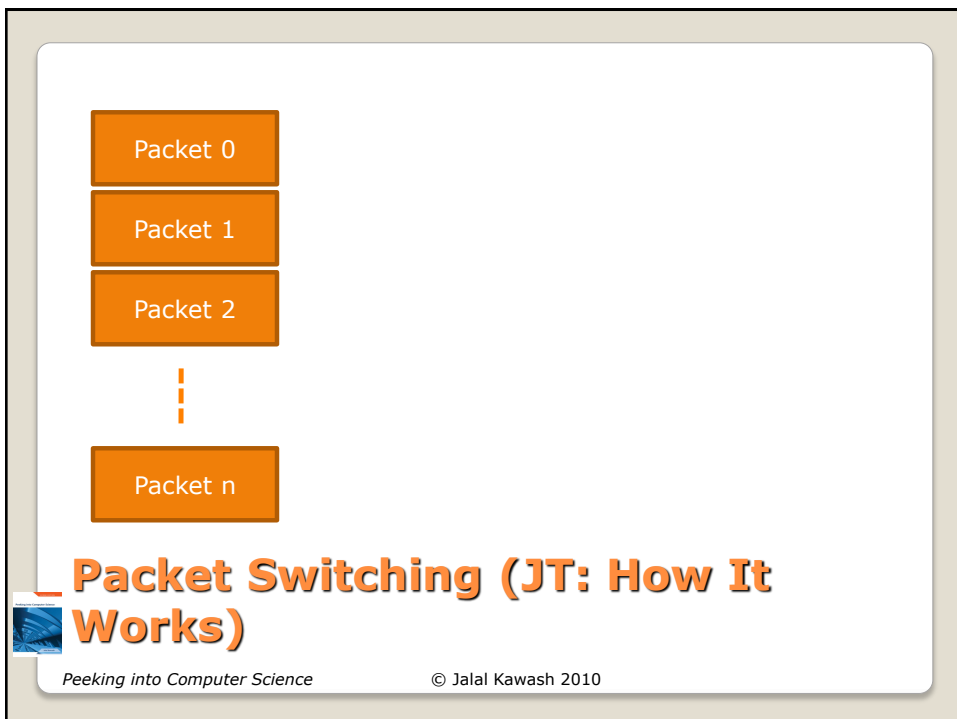
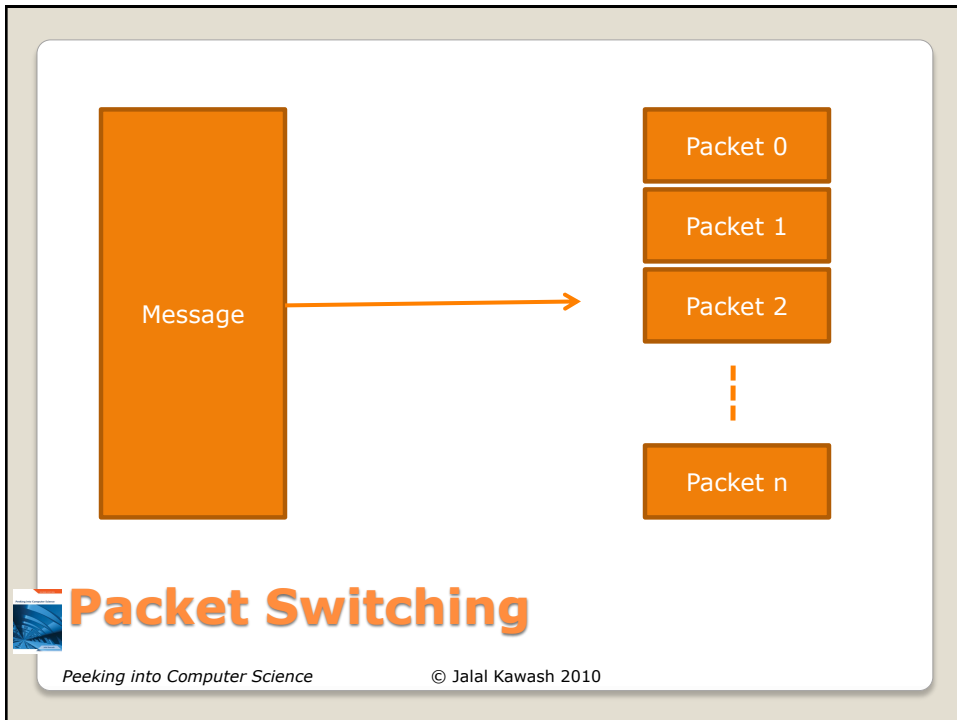
JT: Effect Of Using Non-Default Port Numbers

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- Same method of encoding and transmitting (packets) regardless of what data is sent

JT: Packet Switched Networks, What Are They

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- Example protocols that are employed on packet switched networks

1. Connection-based protocol

- TCP (Transmission Control Protocol)
 - JT: Make sure the data is received, check and resend if needed

2. Connectionless protocol

- UDP (Universal Datagram Protocol)
 - JT: send and forget



Internet Protocols (again)

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- Datagrams = packets
- Connectionless
- UDP: going to the post office, sticking a stamp, and dropping off the packet
 - JT: sending the data without using time to check if it was properly received (let alone resend it).



UDP

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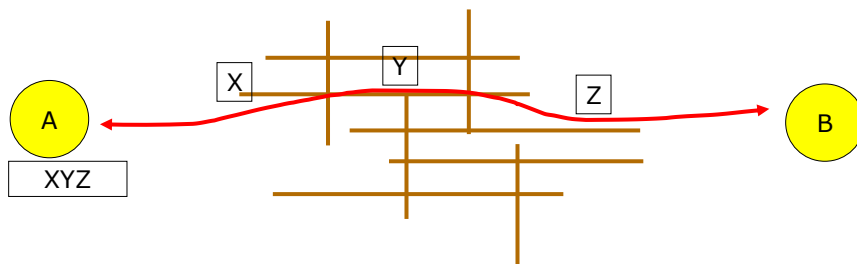
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- Connection-oriented
- TCP: picking up the phone, establishing a connection, exchanging information, and destroying the connection
- Packets are guaranteed to be sent
 - JT: checks occur if the information was properly received and if not then it's resent.



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- TCP
 - Slower but reliable: used when all the information must be received (e.g., secure web page where all the data is crucial)
- UDP
 - Faster but not reliable: used when timely delivery is important (e.g., streaming video, video games) but some information may be lost

JT: TCP Vs. UDP

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- What was happening in the 1950's



The Cold War

JT: Internet History (Context)

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- At the same time that each side (USSR-USA) was trying to be dominant on the ground they also wanted to be dominant in space.
 - Both sides tried to be the first to send a satellite into space.
- In the 1950's it appeared that the USSR had a technological edge:
 - Americans in 1957: A sophisticated three stage rocket was planned as the first human-made vehicle to be sent into space.
 - The USSR in 1957: surprised the world by launching Sputnik I (the first artificial satellite).
- The launch of Sputnik motivated the creation of ARPA (Advanced Research Projects Agency) in the US.



JT: The Cold War And The Space Race

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- Later in 1957 the USSR launched another satellite carrying the dog Laika "bark/barker" into space



<http://news.bbc.co.uk>

JT: The Cold War And The Space Race

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- APRA was a branch of the ministry of defense.
- The focus was on:
 - Getting different types of computers communicating
 - Current approaches were far from satisfactory

JT: ARPA (Advanced Research Projects Agency)

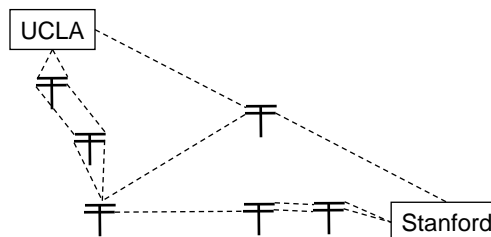


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- The first computers were connected via ARPANET (Advanced Research Projects Agency Network).
 - It was the early form of the Internet.
- The initial ARPANET consisted of 2 computers (UCLA-Stanford) which were connected at the start of 1969 (birth of the early Internet!)
 - A standard protocol was used so the computers could communicate



JT: The ARPANET



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- Originally the message `login` was to be transmitted.
- But the transmission stopped (i.e., it “died” after the first two characters).
 - ...and thus `LO` the Internet was born!

¹ “On the Way to the Web” (Michael A. Banks, Wiley)



JT: The First Data Sent¹

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- Attempts to network computers
 - Mainly for academic and military applications
- ARPANET
 - Advanced Research Projects Agency NETWORK
 - US Defense
 - Predecessor of Internet
 - Packet switching
 - 60s: USDD and few universities (west coast)
 - 70s: ARPA reached the east coast
 - 83: military portion (JT: MILNET) separated



Brief History of the Internet (Summary)

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The World Wide Web

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By the end of this section, you will be able to

1. Define the WWW and differentiate it from the Internet
2. Explain how naming services work
3. Explain the Hyper-Text Transfer Protocol (HTTP)

Objectives

- Designed in 1989 by Tim Berners-Lee and scientists in Geneva who were interested in making it easier to share research documents.
- Documents could be linked through a protocol called http (hyper text transfer protocol).
 - Https: later version (s = secure)
- Documents were made available for free browsing and downloading from the web (*substantially* easier than the alternative).



From www.computerhistory.org

JT: The History Of The World Wide Web



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- 1990:
 - The first web browser "WorldWideWeb" (later renamed 'Nexus'¹) was written.
- 1993:
 - Mark Andreessen of NCSA (National Center for Super Computing Applications) launched Mosaic X the first popular web browser.
- Prior to the advent of the WWW the Internet was largely used by a niche user group.
- The advent of the WWW drastically changed that.
 - Now some people even equate the World-Wide-Web with the Internet itself!

¹ <http://www.w3.org/People/Berners-Lee/WorldWideWeb.html>

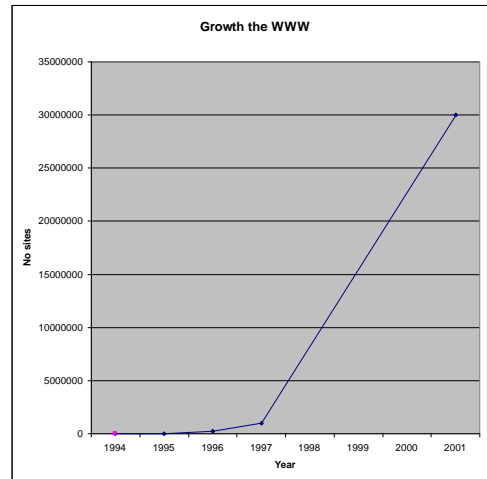
JT: The History Of The World Wide Web (2)



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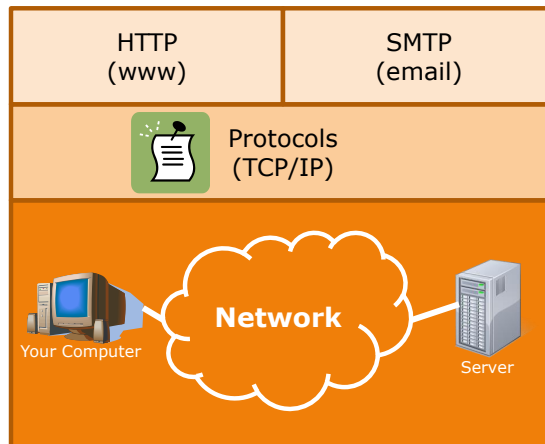


IT: Growth Of The WWW

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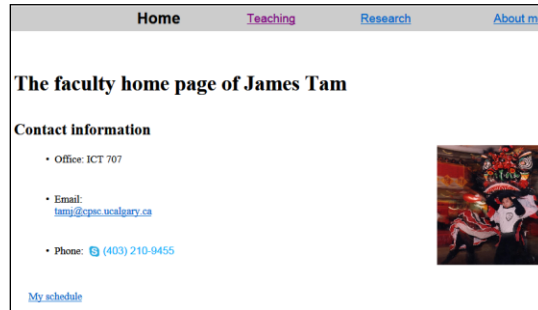


The Internet

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- URL = Universal Resource Locator
- A link to a web resource
 - E.g., <http://www.cpsc.ucalgary.ca/~tamj/index.html>
 - (A web page document)



JT: URL's

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- <http://www.cpsc.ucalgary.ca/~tamj/index.html>

Protocol¹

Web server

User name
(matches up
to a folder
name)

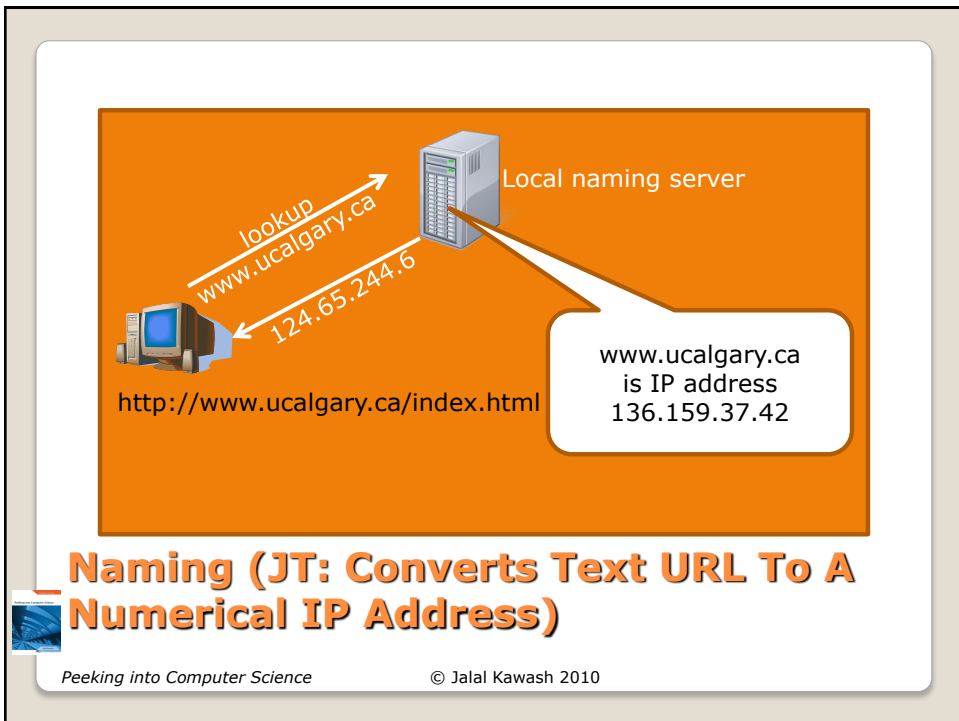
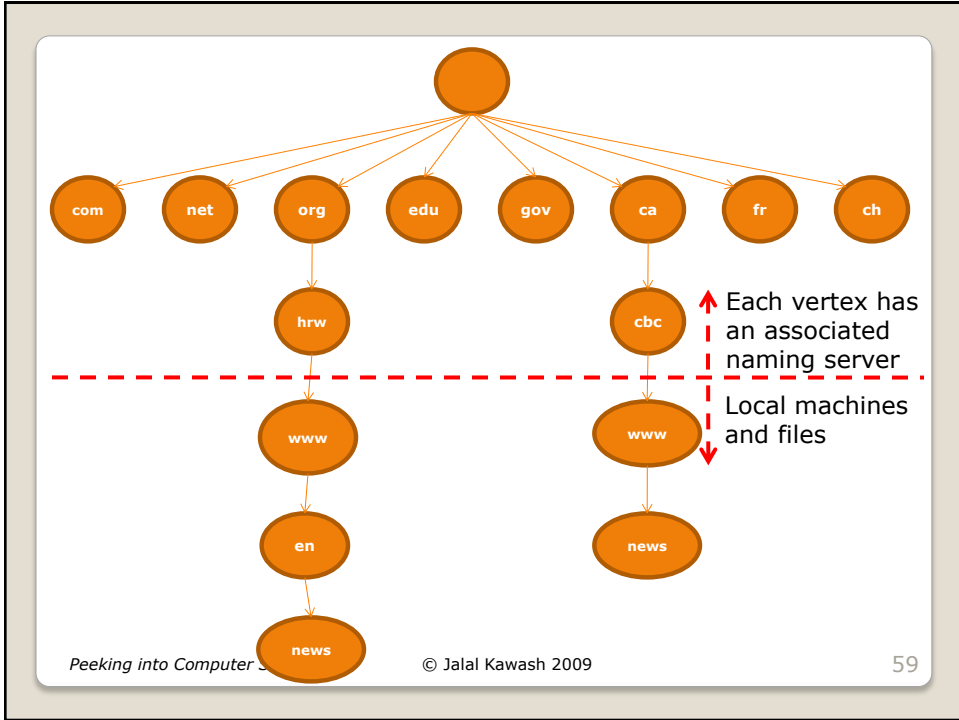
Document
name

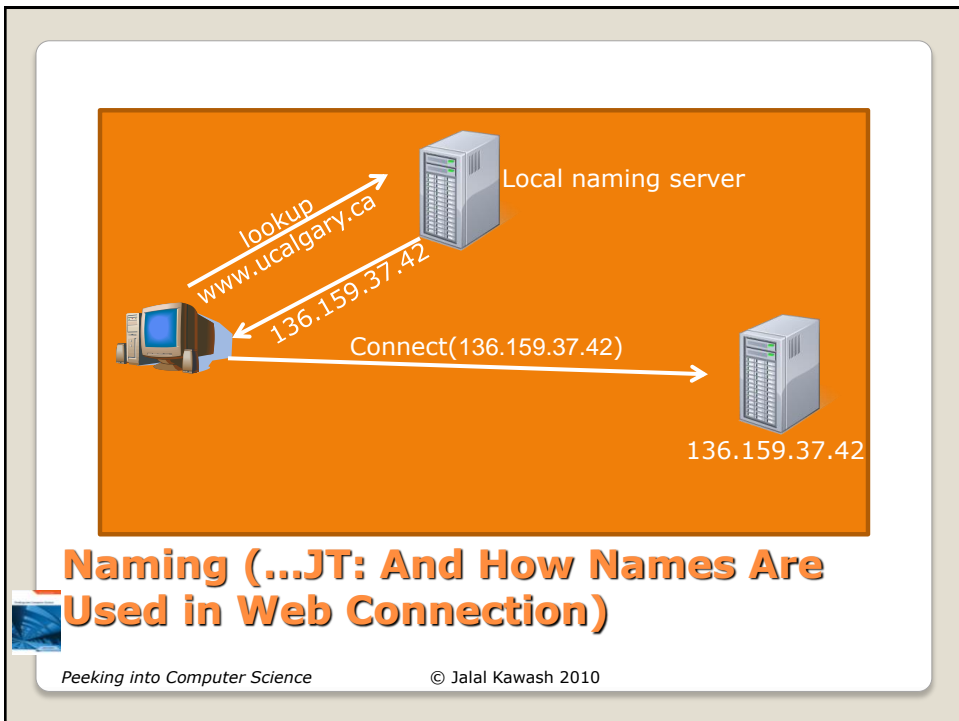
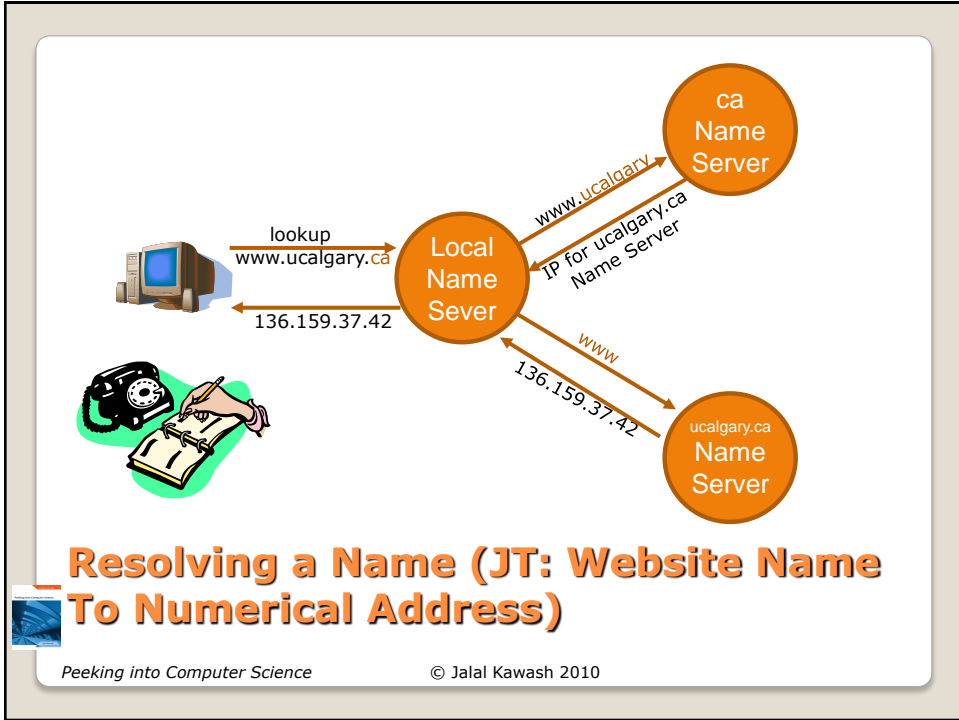
¹ Other protocols may also be used in a web browser e.g., telnet (remote login), ftp (file transfer), https (secure http)

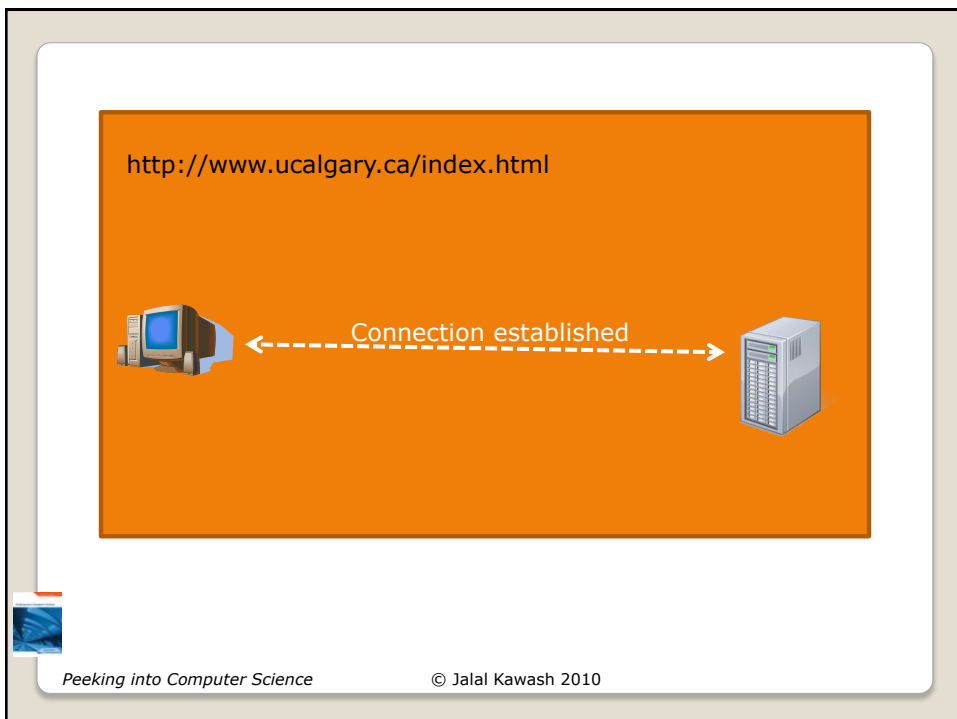
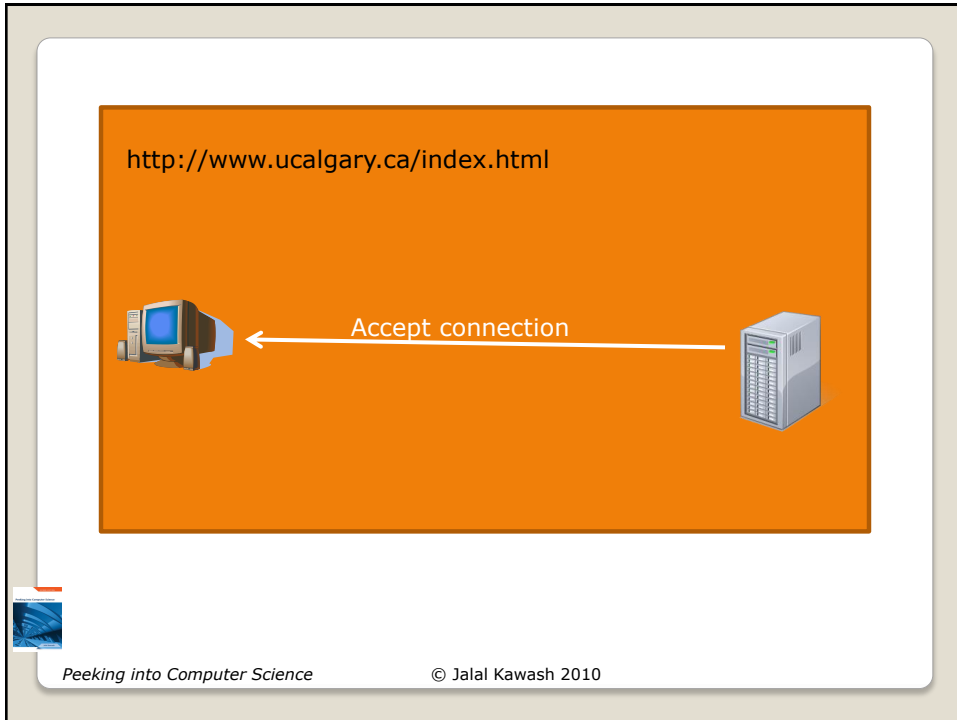
Parts Of A URL


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http://www.ucalgary.ca/index.html

"Get me" index.html

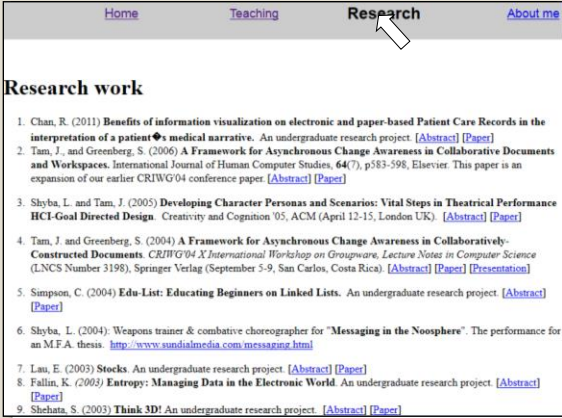
HTTP

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- The protocol between browsers and Web servers
- Defines structures on requests and responses
- Two major request types
 - GET: link-click
 - POST: submit button of form information
- Keep in mind: messages are sent over TCP/IP (JT: 'sent over' means that web connection employs TCP/IP)

Hyper Text Transfer Protocol

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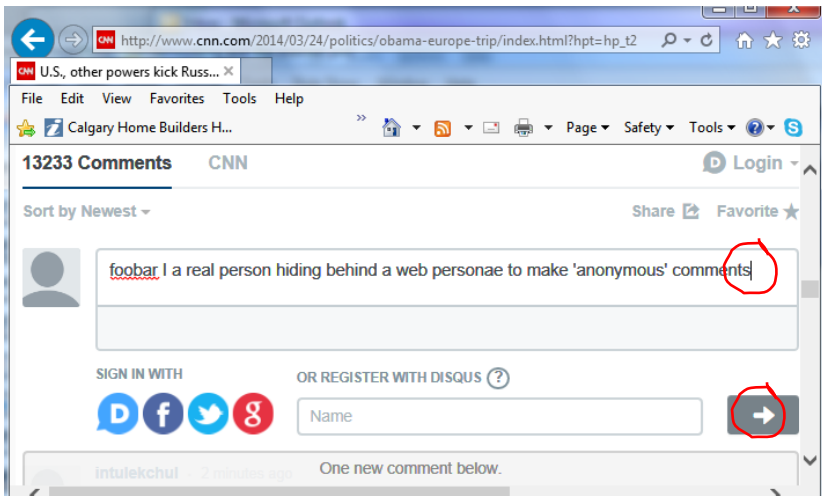
Home Teaching **Research** About me

Research work

1. Chan, R. (2011) Benefits of information visualization on electronic and paper-based Patient Care Records in the interpretation of a patient's medical narrative. An undergraduate research project. [Abstract] [Paper]
2. Tam, J., and Greenberg, S. (2006) A Framework for Asynchronous Change Awareness in Collaborative Documents and Workspaces. International Journal of Human Computer Studies, 64(7), p583-598, Elsevier. This paper is an expansion of our earlier CRIWG'04 conference paper. [Abstract] [Paper]
3. Shyba, L. and Tam, J. (2005) Developing Character Personas and Scenarios: Vital Steps in Theatrical Performance HCI-Goal Directed Design. Creativity and Cognition '05, ACM (April 12-15, London UK). [Abstract] [Paper]
4. Tam, J. and Greenberg, S. (2004) A Framework for Asynchronous Change Awareness in Collaboratively-Constructed Documents. CRIWG'04, International Workshop on Groupware, Lecture Notes in Computer Science (LNCS Number 3198), Springer Verlag (September 5-9, San Carlos, Costa Rica). [Abstract] [Paper] [Presentation]
5. Simpson, C. (2004) Edu-List: Educating Beginners on Linked Lists. An undergraduate research project. [Abstract] [Paper]
6. Shyba, L. (2004) Weapons trainer & combative choreographer for "Messaging in the Noosphere". The performance for an M.F.A. thesis. <http://www.sundialmedia.com/messaging.html>
7. Lau, E. (2003) Stocks. An undergraduate research project. [Abstract] [Paper]
8. Fallin, K. (2003) Entropy: Managing Data in the Electronic World. An undergraduate research project. [Abstract] [Paper]
9. Shchota, S. (2003) Think 3D! An undergraduate research project. [Abstract] [Paper]

JT: Get Request

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U.S., other powers kick Russ...

File Edit View Favorites Tools Help

Calgary Home Builders H...

13233 Comments CNN Login

Sort by Newest Share Favorite

foobar | a real person hiding behind a web personae to make 'anonymous' comments

SIGN IN WITH OR REGISTER WITH DISCUS ?

Facebook Twitter Google+ Name

intulekchul · 2 minutes ago One new comment below.

JT: Post (Sending Info Via Web)

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Line 1: general header
Following lines: zero or more headers
Blank line
Optional message



Message Structure

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- `<head>`
- `<title>A 'blank' web page</title>`
- `</head>`

- `<body>`

- `</body>`



JT: A 'Blank' Webpage

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- `<head>`
- `<title>A webpage with one link</title>`
- `</head>`
- `<body>`
- Facebook: `www.facebook.com`
- `</body>`



A Single Link Webpage

- `<head>`
- `<title>My FAV websites</title>`
- `</head>`
- `<body>`
- My favs
- `<table border="1" width="100%">`
- `<td>Facebook</td>`
- `<td>CNN</td>`
- `<td>Meaning of life, the universe and everything</td>`
- `</table>`
- `</body>`



A Table Of Links

GET /index.html HTTP/1.0

Requesting file **/index.html** using HTTP
version 1.0



Example GET

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```

C:\Documents and Settings\JKawash\jcreator\JCreator LE\GE2001.exe
HTTP/1.1 200 OK
Date: Sat, 15 Nov 2003 14:55:11 GMT
Server: Apache/2.0.47 (Unix) mod_ssl/2.0.47 OpenSSL/0.9.6 PHP/4.3.2
Accept-Ranges: bytes
Content-Length: 1971
Connection: close
Content-Type: text/html; charset=ISO-8859-1

<HTML>
<HEAD>
<rdf:RDF xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns:dc="http://purl.org/dc/elements/1.0/">
  <rdf:Description rdf:about="http://www.cpsc.ucalgary.ca/~kawash/index.html"
    dc:creator="Jalal Kawash"
    dc:title="Jalal's Home Page"
    dc:description="Index page to Jalal's research and course information."
    dc:date="1997-01-01" />
</rdf:RDF>
<title>Jalal Kawash</title>
<META http-equiv="Content-Type" content="text/html; charset=iso-8859-1">

```



Example Response

Peeking into Computer Science

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