



CpSc 360: Distributed and Network Programming

Network Introduction

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History and Motivation

- Early computers were highly centralized.
 - Single point of failure.
 - User has to "go to" the computer.
 - Those computers are normally not connected.
- Proliferation of low cost computers made it possible to get past these disadvantages (with a network).
- Motivation:
 - Sharing of resources is more efficient
 - Price/Performance
 - Use each piece of equipment for what it is best at
 - Centralize administration
 - Computers as communication tools



What is the Internet?

- From Wikipedia, the free encyclopedia
 - The Internet (also known simply as the Net) is the worldwide, publicly accessible system of interconnected computer networks that transmit data by packet switching using the standard Internet Protocol (IP).
 - It consists of millions of smaller domestic, academic, business, and government networks, which together carry various information and services, such as electronic mail, online chat, file transfer, and the interlinked Web pages and other documents of the World Wide Web.



Brief History of the Internet

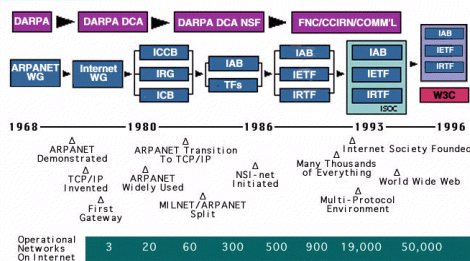
- 1968 - DARPA (Defense Advanced Research Projects Agency) contracts with BBN (Bolt, Beranek & Newman) to create ARPAnet
- 1970 - First five nodes:
 - UCLA
 - Stanford
 - UC Santa Barbara
 - U of Utah, and
 - BBN
- 1974 - TCP specification by Vint Cerf
- 1984 - On January 1, the Internet with its 1000 hosts converts en masse to using TCP/IP for its messaging



Slides adapted from: <http://www.isoc.org/internet/history/>



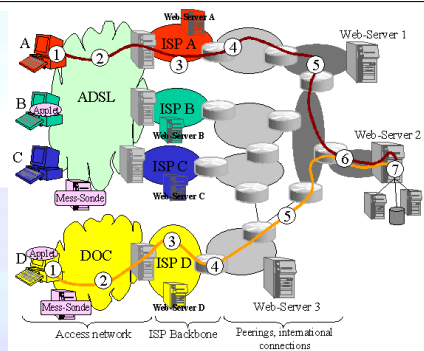
Internet History



Slides adapted from: <http://www.isoc.org/internet/history/>



Typical Internet structure





State of The Art

Computer Networks are anywhere now.

- PCs <-> Mainframes
- Automated Tellers
- Embedded Systems
- Communications Systems
- Wireless devices such as PDAs.
- The Internet



Networked Computers

Traditional network uses:

- Communication (email)
- File exchange, disk sharing
- Sharing peripherals (printers, tape drives)
- Remote execution

Newer network uses:

- Information Sharing
- Entertainment, distributed games
- MP3s!
- Commerce
- Automation of business processes
- Collaborative computing
- Homework Submission
- Chatting, message boards



Network Software

Network Models:

- Using a formal model allows us to deal with various aspects of Networks abstractly.
- We will look at a popular model (OSI reference model).
- The OSI reference model is a layered model.

Layering:

- Divide a task into pieces and then solve each piece independently (or nearly so).
- Establishing a well defined interface between layers makes porting easier.
- Major Advantages:
 - Code Reuse
 - Extensibility

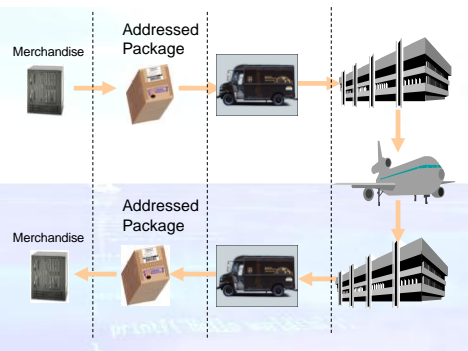


Layering Example: UPS

- Merchandise in package, address on outside
- UPS guy adds addressing information, barcode.
- Local office drives to airport and delivers to hub.
- Sent via airplane to nearest city.
- Delivered to right office
- Delivered to right person



UPS Layers

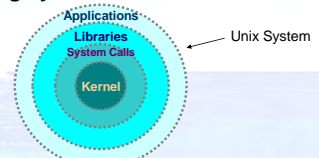


Layered Software Systems

Network Software:

- All network software are based on layered models.

Operating Systems:



Windows Systems:

- Normally built on top of OS.





OSI Reference Model

- The International Standards Organization (ISO) proposal for the standardization of the various protocols used in computer networks (specifically those networks used to connect open systems) is called the Open Systems Interconnection Reference Model (1984), or simply the OSI model.
- Although the OSI model is just a model (not a specification), it is generally regarded as the most complete model (as well it should be - nearly all of the popular network protocol suites in use today were developed before the OSI model was defined).
- Although this course is about network programming (and not about networking in general), an understanding of a complete network model is essential.
- We will look at the OSI Reference Model in detail.



OSI 7 Layer Model:

- | | | |
|---|--------------|----------------------|
| 7 | Application | High level protocols |
| 6 | Presentation | ↑ |
| 5 | Session | |
| 4 | Transport | |
| 3 | Network | |
| 2 | Data-Link | ↓ |
| 1 | Physical | |

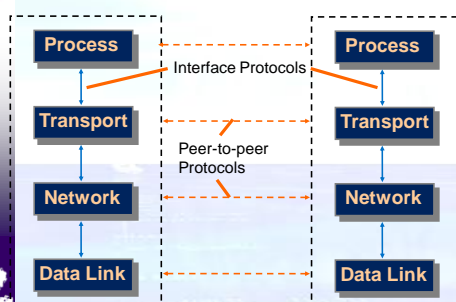


Internet Layering

Application	FTP, Telnet, SMTP, X-Windows, MIME, HTTP
No session and presentation layer present !!!	
Transport	UDP, TCP, TP4, Routing
Network	IGMP, IP, CLNP (a.k.a Internet Layer)
Data Link	Ethernet, X.25, FDDI, Token Ring (a.k.a subnet)
Physical	HDLC, PPP, SLIP
	RS-232, V.35, Fibre Optic



Simplified Network Model



What's a Protocol?

- An agreed upon convention for communication.
 - both endpoints need to *understand* the protocol.
- Protocols must be formally defined and unambiguous!
- We will study lots of existing protocols and perhaps develop a few of our own.
- Interface protocols describe the communication between layers on the same endpoint.
- Peer-to-peer protocols describe communication between peers at the same layer.



Programs, Processes, Threads

- A **program** is an executable file.
- A **process** or **task** is an instance of a program that is being executed.
- A single program can generate multiple processes.
- A process can generate multiple threads.
- All threads in a process share global variables and descriptors. This sharing introduces synchronization problems.





Client/Server Programming

- ✿ **A programming paradigm in which**
 - ✿ A *server* is a process - not a machine !
 - ✿ A server waits for a request from a client.
 - ✿ A client is a process that sends a request to an existing server and (usually) waits for a reply.
- ✿ **Servers are generally more complex (more interesting).**
- ✿ **2 Basic types of servers:**
 - ✿ Iterative - server handles one client at a time.
 - ✿ Concurrent - server handles many clients at a time.



Client/Server Examples

- ✿ **Server returns the time-of-day.**
- ✿ **Server returns a document.**
- ✿ **Server prints a file for client.**
- ✿ **Server does a disk read or write.**
- ✿ **Server records a transaction.**
- ✿ **Web server handle HTTP requests.**

