Announcements

- Project proposal drafts due March 14, 1997
- Reading
  - Today: 5.6
  - Tuesday: 6.1-6.2.6
The IP Protocol

- **IP Header**
  - source, destination address, total length
  - version, ihl (header length in 32-bit words), ttl, protocol
  - fragmentation support: identification, df, mf, frag. offset

- **Options**
  - variable length
  - defined options
    - loose source routing
    - timestamp
    - record path

<table>
<thead>
<tr>
<th>Ver</th>
<th>IHL</th>
<th>Service</th>
<th>Total Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identification</td>
<td>DF</td>
<td>MF</td>
<td>Fragment Offset</td>
</tr>
<tr>
<td>TTL</td>
<td>Protocol</td>
<td>Header Checksum</td>
<td></td>
</tr>
<tr>
<td>Source Address</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Destination Address</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 Or More Options</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

32 bits
Semantics of IP Addresses

- Each address has a network, subnet, and host part
  - for routing only care about network and subnets not hosts
  - what is the network and subnet part varies depending on
    - what the address is (used to be fixed class A, B, C)
    - where the address is viewed from
      - Maryland subnet viewed by world is 128.8.X.X
      - CS Dept. subnet viewed by campus is 128.8.128.X
    - subnets are not visible at higher layers
  - each routing entry is <target, network mask>
    - match dest AND mask with target
    - if multiple matches, one with most 1’s in mask wins

- Some special network addresses
  - all 0’s --> this host
  - 0’s in network address --> host on this network
  - all 1’s --> broadcast on this network
  - 127.X.X.X --> loopback (this host)
Internet Control Message Protocol (ICMP)

- Used to configure and run an IP network
- Just a transport protocol (more or less)
- Message Types
  - destination unreachable
  - time exceeded (ttl count reached 0)
  - parameter problem (invalid header)
  - redirect (inform router of possibly bad path)
  - echo request/response (AKA ping packets)
  - timestamp request/response (timestamped pings)
- Address Resolution Protocol
  - finding out who owns an IP address on the subnet
  - send link level broadcast with a request
    - response is IP address of destination
ATM Network Layer

- Connection oriented
- Cell format

<table>
<thead>
<tr>
<th>VPI</th>
<th>VCI</th>
<th>PT</th>
<th>CRC</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>16</td>
<td>3</td>
<td>1</td>
</tr>
</tbody>
</table>

Cell Loss Priority

- Messages
  - Setup - establish a virtual circuit
  - Call Proceeding - request seen
  - Connect - request for connection ok
  - Connect ACK - thanks for accepting
  - Release - please terminate (either party)
  - Release Ack - ok, hanging up
ATM Network Signaling

Source host

Switch #1

Setup

Call proceeding

Connect

Connect ack

Switch #2

Setup

Call proceeding

Connect

Connect ack

Destination host

Time

(a)

Setup Connect

Connect ack

Release

Release complete

(b)

Release

Release complete

Release complete

From: Computer Networks, 3rd Ed. by Andrew S. Tanenbaum, (c)1996 Prentice Hall.
What is Software Engineering?

- Stepping back from the process of writing programs to think about how to do it right.
- Mostly just nuggets of common sense
- However, you must take it to heart
Four Steps

- **Abstraction**
  - Goal: bury complexity through abstraction
    - Look at the big picture and break it down
    - What are the logical components?
  - Are there recurring patterns that can be generalized?
    - example: timers

- **Specification:**
  - define precisely the interface of each component
  - Three issues:
    - Names - "big_queue", "Big_queue", or "bigQueue"
    - Types - function signatures
    - Functionality - exactly what each function does
      - Pre- and Post- Conditions
Four Steps (cont.)

- **Delegation**
  - Who is doing what and by when?
  - Delegate coding but not understanding
  - Separate coding and testing responsibilities

- **Verification**
  - Incrementally test each component
  - Test each other’s code
  - Challenges:
    - It’s boring
    - Hard to write realistically complete test suites
  - Early testing can save you last minute nightmares!
Tools

● Compiler options
  – g - produce symbols for debugging
  – I - search this directory for header files
  – D - define the following flag

● gdb/dbx
  – Look at the source code
  – Set / delete breakpoints
  – Set conditional breakpoints
  – Inspect the state of the threads
  – Inspect the stack (s)
  – Change the values of variables

● Make
  – automatically rebuilds code after changes have been made
  – get a good example makefile and hack it
  – Parameterize your actions
  – makedepend inserts dependencies into makefile
Revision Control - **cvs**

- Front-end to **rcs**
- Keeps a single copy of the master sources
  - set a single CVSROOT environment variable
- Old versions kept through diffs
- Catches update conflicts
- **checkout**
  - `cvs co <directory or file>`
- **update**
  - `cvs update <directory or file>`
  - get latest version of the code
- **commit**
  - `cvs commit <directory of file>`
  - makes changes visible in the repository
Miscellaneous - nm, c++filt

- **nm** inspects the symbol table of an object file
- **c++filt** demangles C++ names
- **Example:**

```
Undefined first referenced symbol in file
append__5QueuePc /var/tmp/cca000Ql1.o
ld: fatal: Symbol referencing errors.
No output written to a.out
```

~> c++filt append__5QueuePc
Queue::append(char *)
Coding Tips

- Comment code very thoroughly
- Set up CVS to imbed log comments in source files
- Use ASSERT to double-check pre/post conditions at run-time
- Use const instead of #DEFINE
- Inheritance: use it, don't abuse it
Some Words About Threads

- Make your code thread-safe (re-entrant)
- Must also worry about the thread-safety of library calls
- Consider:
  \[
  \text{struct hostent } \ast \text{gethostbyname}(\text{const char } \ast \text{name});
  \]
- Read MT-LEVEL sections in the man pages
- See man pages for: \texttt{threads} and \texttt{thr_create}