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References

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Unix Network Programming by W. Richard Stevens, 1990, selected pages


Computer Networks and Internets, Comer, 1997

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Networks

Communication Network
A set of communication nodes that are interconnected to permit the exchange of information
How information is transmitted in a network

Information is transformed into electrical or optical signals

All signals are corrupted during transmission

Transmission adds noise to the signal

Digital data helps overcome noise

  Slightly corrupted 1's are distinguishable from slightly corrupted 0's

  Digital data allows for error-control

Dynamic data like audio or video normally requires continuous transmission
Packets

Stream of bits is divided into separate packets

<table>
<thead>
<tr>
<th>Kermit Packet Structure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size</td>
</tr>
<tr>
<td>Mark</td>
</tr>
</tbody>
</table>

.
Classes of Communication Services

End-to-end services as seen by the users:

Synchronous communications
Bit stream is delivered with a fixed delay and given error rate

Each bit reaches the destination with the same time delay after leaving the source

Asynchronous communications
Bit stream is divided into packets

Packets are received with varying delays, so packets can arrive out of order

Some packets are not received correctly

Connection-oriented
Packets are delivered in order

System confirms delivery and put packets in order

Error free

Connectionless
Packets are treated individually

Program has to worry about order, error and lost packets

Expedited Data
Faster delivery than normal
Our View of Network Communication with TCP/IP

TCP - Connection-oriented
UDP - Connectionless

TCP gives us a "pipe" between machines to allow us to send messages between machines

UDP

Fast

Client & Server must handle
• Lost packets
• Packets arriving out of order

Used by:

• Games
• NFS
TCP

Handles
• Lost packets
• Packet order

Receiver acknowledges each packet

Sender resends packet if it is lost

TCP has delays in
• Startup of connection
• Closing of connection
Addresses and Names

IP address is currently a 32-bit number

130.191.3.100 (Four 8 bit numbers)

IPv6 uses 128 bit numbers for addresses

105.220.136.100.0.0.0.0.0.0.18.128.140.10.255.255

69DC:8864:0:0:0:1280:8C0A:FFFF

69DC:8864::1280:8C0A:FFFF

Machines on a network need a unique IP address
127.0.0.1 (localhost)

Common loopback address

Refers to the current computer

Messages sent to 127.0.0.1 to not reach the network
Domain Name System (DNS)

Maps machine names to IP addresses

rohan.sdsu.edu <-> 130.191.143.100

Unix "host" command

• Shows mapping between machine names and IP address

->host rohan.sdsu.edu
rohan.sdsu.edu has address 130.191.3.100

->host 130.191.3.100
100.3.191.130.IN-ADDR.ARPA domain name pointer
rohan.sdsu.edu
### Top Level Domains

#### Current TLD

<table>
<thead>
<tr>
<th>Domain Names</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>COM</td>
<td>Commercial organizations</td>
</tr>
<tr>
<td>EDU</td>
<td>Educational institutions</td>
</tr>
<tr>
<td>GOV</td>
<td>Government institutions</td>
</tr>
<tr>
<td>MIL</td>
<td>Military groups</td>
</tr>
<tr>
<td>NET</td>
<td>Major network support groups</td>
</tr>
<tr>
<td>ORG</td>
<td>Organizations not list above</td>
</tr>
<tr>
<td>ARPA</td>
<td>obsolete</td>
</tr>
<tr>
<td>INT</td>
<td>International organizations</td>
</tr>
<tr>
<td>CN,IN,MX,US</td>
<td>Country Codes</td>
</tr>
<tr>
<td>biz</td>
<td>Business</td>
</tr>
<tr>
<td>info</td>
<td>Information</td>
</tr>
<tr>
<td>name</td>
<td>For individuals</td>
</tr>
<tr>
<td>pro</td>
<td>For professionals</td>
</tr>
<tr>
<td>aero</td>
<td>For aviation</td>
</tr>
<tr>
<td>coop</td>
<td>For coopertives</td>
</tr>
<tr>
<td>museum</td>
<td>For museums</td>
</tr>
</tbody>
</table>

More top level domains will be added later this year.
Dealing for applications is March 15, 2004 at 23.59 UTC.

Internet Corporation for Assigned Names and Numbers (ICANN [http://www.icann.org/](http://www.icann.org/)) oversees assigning TLDs.
Ports

TCP/IP supports multiple logical communication channels called ports

Ports are numbered from 0 - 65535

A connection between two machines is uniquely defined by:

- Protocol (TCP or UDP)
- IP address of local machine
- Port number used on the local machine
- IP address of remote machine
- Port number used on the remote machine

Well known ports 1 - 1023
Registered Ports 1024 - 49151
Dynamic/Private ports 49152 - 65535
Some Interesting Server Port Numbers

<table>
<thead>
<tr>
<th>Service</th>
<th>Port Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>echo</td>
<td>7</td>
</tr>
<tr>
<td>discard</td>
<td>9</td>
</tr>
<tr>
<td>daytime</td>
<td>13</td>
</tr>
<tr>
<td>character generation</td>
<td>19</td>
</tr>
<tr>
<td>ftp</td>
<td>21</td>
</tr>
<tr>
<td>ssh</td>
<td>22</td>
</tr>
<tr>
<td>telnet</td>
<td>23</td>
</tr>
<tr>
<td>smtp</td>
<td>25</td>
</tr>
<tr>
<td>time</td>
<td>37</td>
</tr>
<tr>
<td>http</td>
<td>80</td>
</tr>
<tr>
<td>nntp</td>
<td>119</td>
</tr>
<tr>
<td>https</td>
<td>443</td>
</tr>
<tr>
<td>doom</td>
<td>666</td>
</tr>
<tr>
<td>mysql</td>
<td>3306</td>
</tr>
<tr>
<td>postgresql</td>
<td>5432</td>
</tr>
<tr>
<td>gnutella</td>
<td>6346, 6347</td>
</tr>
</tbody>
</table>

For a local list of services
file://rohan.sdsu.edu/etc/services

For a complete list see:
http://www.iana.org/assignments/port-numbers

See IANA numbers page http://www.iana.org/numbers.html for more information about protocol numbers and assignment services
Telnet is Your Friend

Telnet & port 23

A server is running on port 23 on rohan

The server asks you log in

Telnet Client and other ports

Can send ASCII to a server
Examples to Try

Day Time

Type:

telnet sdsu.edu 13

Course Web Site

Type

telnet www.eli.sdsu.edu 80

then type:

GET /courses/spring04/cs580/index.html HTTP/1.0 <CR>
<CR>

Note <Cr> indicates were you need to hit return