CSE/EE 461 – Lecture 2

Protocols and Layering

David Wetherall
djw@cs.washington.edu

Last Time ...

- Networks are used to share distributed resources
  - Key problems revolve around effective resource sharing
- Statistical multiplexing
  - It's well-suited to data communications
This Lecture

1. Top-down look at the Internet
2. Protocols and Layering
3. The OSI model

1. A Brief Tour of the Internet

- What happens when you “click” on a web link?

You at home (client)  request  Internet  response  www.netscape.com (server)

- This is the view from 10,000 ft ...
9,000 ft: Scalability

- Caching improves scalability

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Cache

“Have it?”

“No”

“Changed?”

“Here it is.”
```

- We cut down on transfers:
  - Check cache (local or proxy) for a copy
  - Check with server for a new version

8,000 ft: Naming (DNS)

- Map domain names to IP network addresses

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Nameserver

“What’s the IP address for www.netscape.com?”

“It’s 207.200.75.200”
```

- All messages are sent using IP addresses
  - So we have to translate names to addresses first
  - But we cache translations to avoid next time
7,000 ft: Sessions (HTTP)

- A single web page can be multiple “objects”

![Diagram showing GET requests for index.html, ad.gif, and logo.gif with a Netscape client and server]

- Fetch each “object”
  - either sequentially or in parallel

6,000 ft: Reliability (TCP)

- Messages can get lost

![Diagram showing retransmission and acknowledgment with a cross symbol indicating lost messages]

- We acknowledge successful receipt and detect and retransmit lost messages (e.g., timeouts)
5,000 ft: Congestion (TCP)

- Need to allocate bandwidth between users

- Senders balance available and required bandwidths by probing network path and observing the response

4,000 ft: Packets (TCP/IP)

- Long messages are broken into packets
  - Maximum Ethernet packet is 1.5 Kbytes
  - Typical web page is 10 Kbytes

- Number the segments for reassembly
3,000 ft: Routing (IP)

- Packets are directed through many routers

2,000 ft: Multi-access (Cable)

- May need to coordinate packet transmissions
- Poll headend to receive a timeslot to send upstream
  - Headend controls all downstream transmissions
  - A lower level of addressing is used...
1,000 ft: Framing/Modulation

- Protect, delimit and modulate payload

| Sync/Unique | Header | Payload w/ error correcting code |

- Take payload, add error protection (Reed-Solomon), header and framing, and then turn into a signal
  - Modulate data to assigned channel and time (upstream)
    - Downstream, 6 MHz (~30 Mbps), Upstream ~2 MHz (~3 Mbps)

2. Protocols and Layering

- Need abstractions to handle complexity
  - Protocols and layering

- Protocol
  - Agreement dictating the form and function of data exchanged between parties to effect communication
  - Two parts:
    - Syntax: where the bits go
    - Semantics: what they mean, what to do with them
  - Examples:
    - IP, the Internet protocol
    - TCP and HTTP, for the Web
Protocol Standards

- Different functions require different protocols
- Thus there are many protocol standards
  - E.g., IP, TCP, UDP, HTTP, DNS, FTP, SMTP, NNTP, ARP, Ethernet/802.3, 802.11, RIP, OSPF, 802.1D, NFS, ICMP, IGMP, DVMRP, IPSEC, PIM-SM, BGP, ...
- Organizations: IETF, IEEE, ITU
- IETF specifies Internet-related protocols
  - RFCs (Requests for Comments)
  - "We reject kings, presidents and voting. We believe in rough consensus and running code." - Dave Clark.

Protocol Layering

- Layering
  - Higher level protocols build on services provided by lower levels
  - Peer layers communicate with each other
Example – Layering at work

- We can connect different systems

Layering Mechanics

- Encapsulation and decapsulation

Messages passed between layers

Layer N+1 PDU becomes Layer N ADU
More Layering Mechanics

- Multiplexing and demultiplexing in a protocol graph

A Packet on the Wire

- Starts looking like an onion!

- This isn’t entirely accurate
  - ignores segmentation and reassembly, Ethernet trailers, etc.
- But you can see that layering adds overhead
3. Internet Protocol Stacks

<table>
<thead>
<tr>
<th>Model</th>
<th>Protocols</th>
</tr>
</thead>
<tbody>
<tr>
<td>Application</td>
<td>Many (HTTP, SMTP)</td>
</tr>
<tr>
<td>Transport</td>
<td>TCP / UDP</td>
</tr>
<tr>
<td>Network</td>
<td>IP</td>
</tr>
<tr>
<td>Link</td>
<td>Many (Ethernet, ...)</td>
</tr>
</tbody>
</table>

OSI Reference Model

- Seven Layers
  - Application
  - Presentation
  - Session
  - Transport
  - Network
  - Link
  - Physical

Their functions:
- Your call
- Encode/decode messages
- Manage connections
- Reliability, congestion control
- Routing
- Framing, multiple access
- Symbol coding, modulation
Key Concepts

- Protocol layers are the modularity that is used in networks to handle complexity
- The Internet/OSI models give us a roadmap of what kind of function belongs at what layer