

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

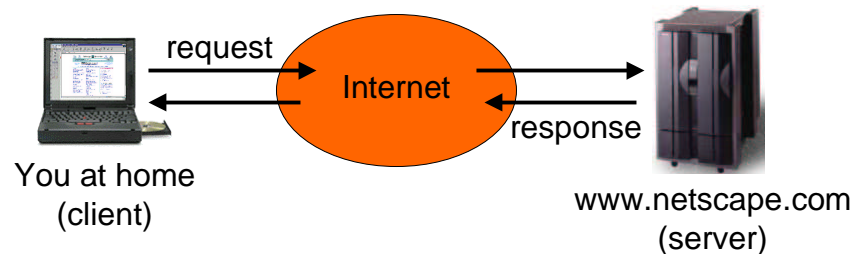
- Top-down look at the Internet
- Protocols and Layering
- The OSI model

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L2.3

1. A Brief Tour of the Internet

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



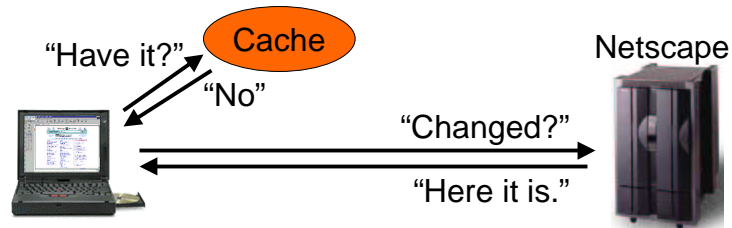
- This is the view from 10,000 ft ...

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L2.4

9,000 ft: Scalability

- Caching improves scalability



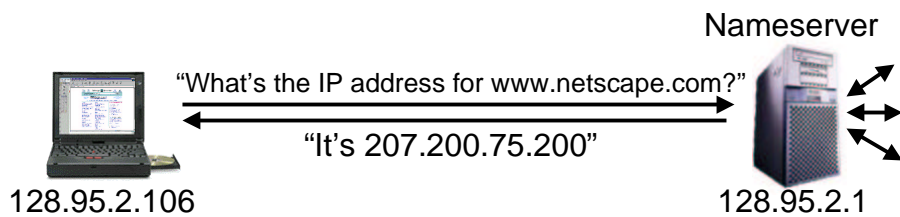
- We cut down on transfers:
 - Check cache (local or proxy) for a copy
 - Check with server for a new version

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L2.5

8,000 ft: Naming (DNS)

- Map domain names to IP network addresses



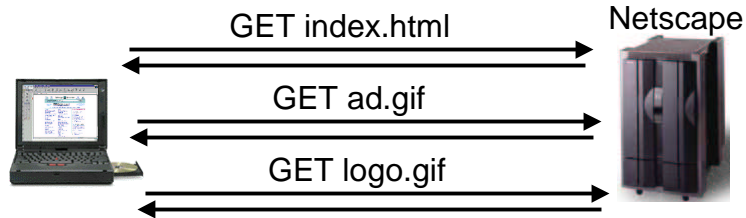
- All messages are sent using IP addresses
 - So we have to translate names to addresses first
 - But we cache translations to avoid next time

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L2.6

7,000 ft: Sessions (HTTP)

- A single web page can be multiple “objects”



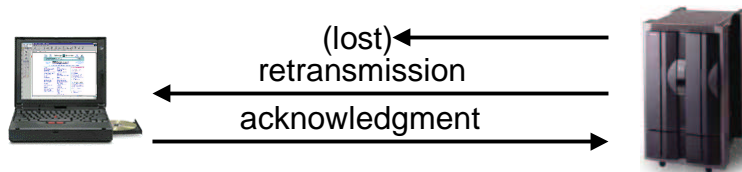
- Fetch each “object”
 - either sequentially or in parallel

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L2.7

6,000 ft: Reliability (TCP)

- Messages can get lost



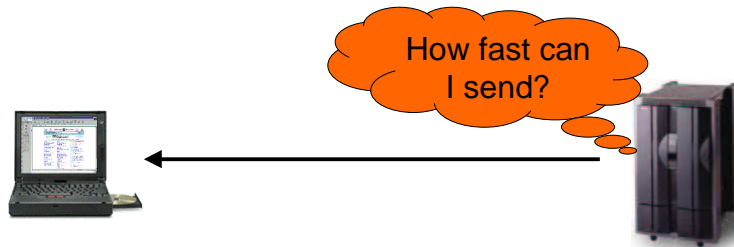
- We acknowledge successful receipt and detect and retransmit lost messages (e.g., timeouts)

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L2.8

5,000 ft: Congestion (TCP)

- Need to allocate bandwidth between users



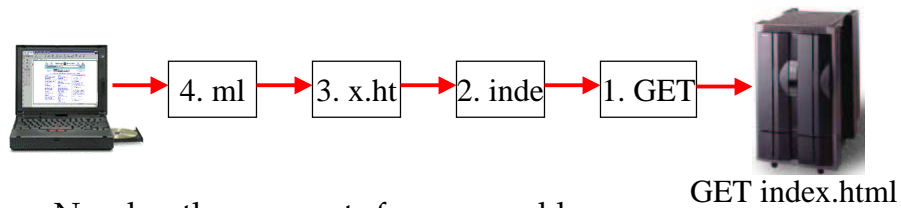
- Senders balance available and required bandwidths by probing network path and observing the response

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L2.9

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



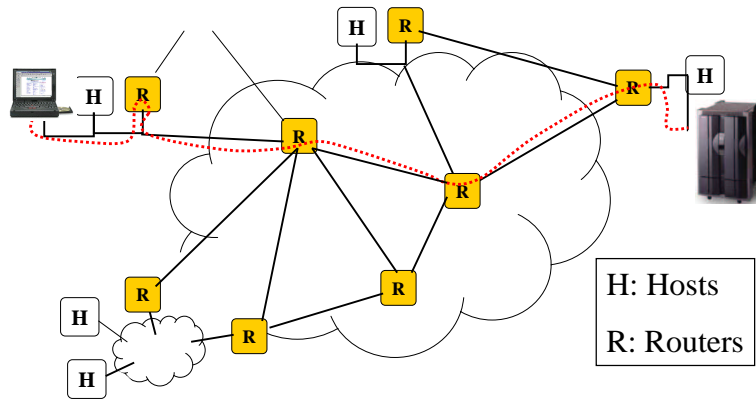
- Number the segments for reassembly

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L2.10

3,000 ft: Routing (IP)

- Packets are directed through many routers

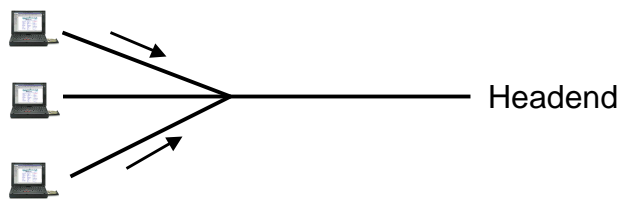


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L2.11

2,000 ft: Multi-access (e.g., Cable)

- May need to share links with other senders



- Poll headend to receive a timeslot to send upstream
 - Headend controls all downstream transmissions
 - A lower level of addressing is used ...

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L2.12

1,000 ft: Framing/Modulation

- Protect, delimit and modulate payload as a signal

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

- E.g, for cable, take payload, add error protection (Reed-Solomon), header and framing, 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

- We need abstractions to handle complexity
- A protocol is an 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

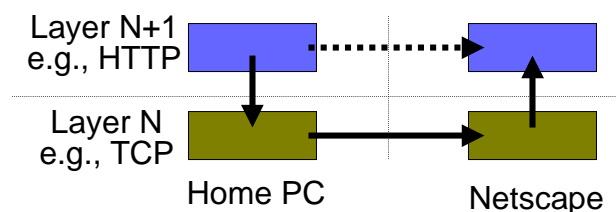
- Different functions require different protocols
- Thus there are many protocol standards
 - E.g., IP, TCP, UDP, HTTP, DNS, FTP, SMTP, NNTP, ARP, Ethernet/802.3, 802.11, RIP, OSPF, 802.1D, NFS, ICMP, IGMP, DVMRP, IPSEC, PIM-SM, BGP, ...
- Organizations: IETF, IEEE, ITU
- IETF (www.ietf.org) specifies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

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L2.15

Layering and Protocol Stacks

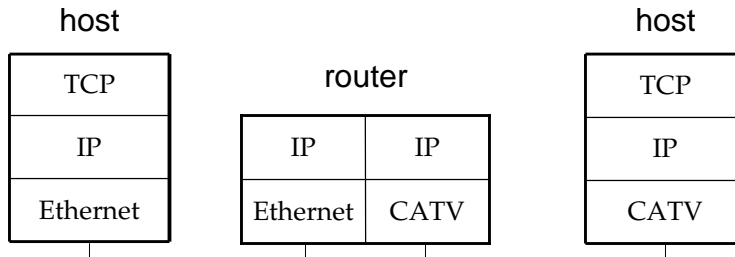
- Layering is how we combine protocols
 - Higher level protocols build on services provided by lower levels
 - Peer layers communicate with each other



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L2.16

Example – Layering at work



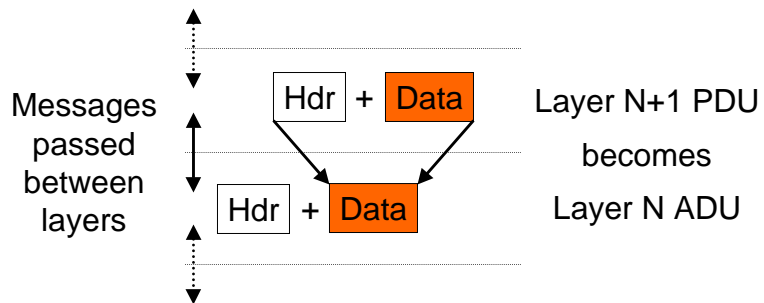
- We can connect different systems

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L2.17

Layering Mechanics

- Encapsulation and decapsulation



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L2.18

A Packet on the Wire

- Starts looking like an onion!



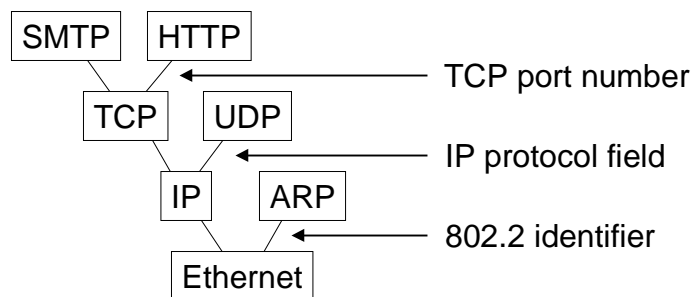
- This isn't entirely accurate
 - ignores segmentation and reassembly, Ethernet trailers, etc.
- But you can see that layering adds overhead

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L2.19

More Layering Mechanics

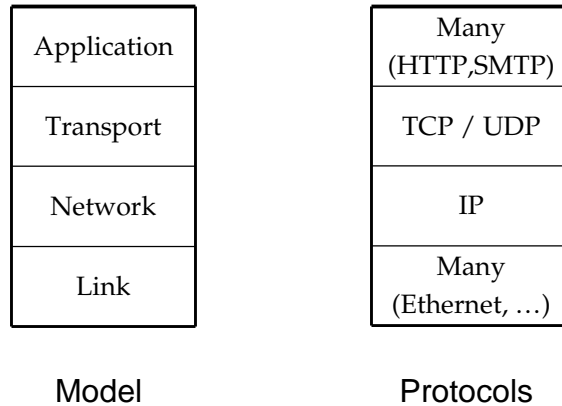
- Multiplexing and demultiplexing in a protocol graph



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L2.20

3. Internet Protocol Framework

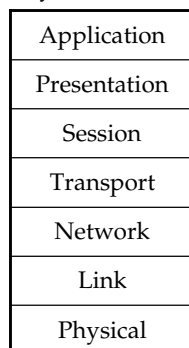


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L2.21

OSI “Seven Layer” Reference Model

- Seven Layers:



Their functions:

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

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L2.22

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