TIM 50 - Business Information Systems

Lecture 18

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Announcements

- Review Sessions for final exam to be announced soon
  - Final Exam: Thursday 3/22, 7:30-10:30 pm
- Final Business Paper Due 3/15
Many feasible paths from source to destination.
Routing

Routing

- Updating the routing table
- Objective: each packet gets closer to destination

Packet forwarding

- Transmitting each packet on the appropriate output link
- Based on routing table
Routing Algorithms

Routers talk to each other to build their routing tables

“I am accepting Traffic to 114.211.1.X”
Routing Table has Wild Cards

<table>
<thead>
<tr>
<th></th>
<th>Link 1</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>114.211.1.X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>200.261.19.X</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Host A

Host B

Host C

HUB
Internet Routing is Hierarchical

Backbone or NSP: (MCI, ATT)

Autonomous System (AS)

ISP or IAP (CRUZIO, AOL)

AS

Customer AS

ISP

AS
Routing Concerns

- Long routes
- Circular routes
- Hijacking routes
- Route flapping
IP Addresses vs Mac Addresses

- Hierarchical
  - The beginning bits tell you which network the host is on
  - Ex: UCSC addresses start with 128.114.X.X
  - The last bits tell you which host of the network

- Changeable
  - Changes with location of Host
  - 4 bytes
  - Only 4.2 billion

- Not Hierarchical
  - Beginning bits tell nothing useful

- Not Changeable
  - 6 bytes
  - 281 Trillion
Link and Network Layer Interaction

Strip MAC header off frame. Forward IP packet based on Routing table.
Issues In Networking

- Sharing of Limited Resources
  - How Should A and B share a link with limited bit rate?

```
Destination A
C bits per second

Source A

C bits per second

Source B

Destination B
```
Issues In Networking

- Time Division Multiplexing
  - gives each connection the use of the link a fixed fraction of time
  - Fixed fraction of resources reserved for each connection
  - Technology called *circuit switching*.

- Problem
  - When A is silent, A’s fraction of link goes unused.
Issues In Networking

- Statistical Multiplexing
  - Link shared in such a way that connections are not assigned fixed fraction of Link.
  - $A$ and $B$ unlikely to offer peak rate at the same time.
    - $\max(A + B) < \max(A) + \max(B)$
Because resources aren’t reserved. It’s possible offered load too high.

Packets are put into a queue.

If offered load remains too high, queue will fill up and overflow.
Transport Protocols

- The Internet is unreliable
  - It will make a “best effort” to get your packet to its destination
- Packets can be lost because of
  - Congestion
  - Link errors
  - Routing problems
Transmission Control Protocol (TCP)

- Retransmit mechanism for reliability
  - Receiver sends acknowledgements to sender
  - If a packet is lost, source fails to get ACK, and then retransmits.

- Congestion control
  - If congestion perceived (by lost packets)
  - Source reduces its send rate
    - When loss, sender reduces send rate by half
    - Otherwise slowly increases
TCP cont’d

TCP port numbers

- TCP Header has a “port” number field
- Helps host sort out how to route packets to applications

Your Computer

Port 80

Email Client

Port 143

Packet

IP Header | TCP Header | Payload

- Port 80
- Port 143
For some applications packet retransmissions are not worthwhile
  - Why?
For those applications, we use UDP
UDP is a transport protocol that
  - Does not do retransmissions
  - Does not do congestion control
Congestion Control

- When networks are congested, certain sessions (Source-destination pairs) should reduce offered rates.
  - Today all TCP sessions slow down when they detect packet losses.
  - UDP sessions do not slow down.

- What are some alternative strategies?
  - Have those whose applications aren’t as sensitive slow down more?
    - How would we know which are less sensitive
Pricing within the Internet

- **Customer pays an ISP**
  - Often Flat Rate per month
- **ISP pays a backbone AS**
  - Often just flat rate, dependent on access link speed.
  - Sometimes based on total usage
- **Backbone NSPs peer with each other**
  - Often for free if they exchange comparable amounts of traffic.
- **Overall...**
  - Internet billing today is much more course grained than telephone billing.
The World Wide Web

- **HTML (Hypertext Markup Language):**
  - Formats documents for display on Web
- **Hypertext Transfer Protocol (HTTP):**
  - Communications standard used for transferring Web pages
- **Uniform resource locators (URLs):**
  - Addresses of Web pages
  - E.g., http://www.megacorp.com/content/features/082602.html
Domain Names

IP addresses are inconvenient for people
- 32 bits hard to remember
- 128 bits very hard to remember

Domain names
- e.g. ucsc.edu
  - Easier to remember than IP addresses
  - However, we need some way of mapping domain names to IP addresses.
Domain Name System (DNS)

- Root Name Server
  - Berkeley Name Server
    - EECS Name Server
  - UCSC Name Server
    - SoE Name Server
Hierarchy in Addresses vs. Names

Addresses hierarchical in topology

- Maximize “wild cards” and distribute address administration

Names hierarchical in administration

- Single administered organizations often distributed topologically (e.g. ibm.com)
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OSI Layers

- **Application**: Internet Explorer, Outlook Email, Real Player, …
- **Presentation**: TCP, UDP
- **Session**: Internet Protocol (IP), …
- **Transport**: Ethernet, Wi-Fi, SONNET, …
- **Network**: Modulation Schemes: QAM, OFDM, etc…
- **Link**: …
- **Physical**: …
Some Typical Topologies

Home Network

- Ethernet Switch
- Router
- DSL Modem
- Telephone Line

(to local Office)
Small/Medium Business

- Ethernet Switch
- Router with Firewall
- T1 Modem
- Web Site Server
- T1 Line
- To Local Office
ISP Topology

Local Loop

Telephone Company
Local Office

Telephone Switch

ISP Point of Presence

DSL Modem

DSL Modem

DSL Modem

DSLAM

Leased Line to NAP

To Telephone Network