Review

CS 3516 – Computer Networks

Protocol

- What does a network protocol do?

Protocol

- What does a network protocol do?
- *1) define format*
- *2) order of msgs sent and received among network entities*
- *3) actions taken on msg transmission, receipt*

Home Access Networks

- What are some of the main differences between *DSL* and *Cable* for home network access?

Home Access Networks

- What are some of the main differences between DSL and Cable for home network access?
- DSL
  - Uses existing telephone infrastructure
  - 1 Mbps up, 8 Mbps down
  - dedicated physical line
- Cable
  - Uses existing cable infrastructure
  - 2 Mbps up, 30 down
  - Shared access to headend

Traversing the Core

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Traversing the Core

- What are two fundamentally different ways of getting packets across the network core?
- Circuit switching
  - Call setup, dedicated resources, no sharing
- Packet switching
  - No setup, resources used as needed and available, sharing

Delay

- What are the four sources of delay in a network node?

Delay

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$$d_{nodal} = d_{proc} + d_{queue} + d_{trans} + d_{prop}$$

- d_{proc} = processing delay
- d_{queue} = queuing delay
- d_{trans} = transmission delay
- d_{prop} = propagation delay

Layering

- Why are networks composed of layers?
- What are the layers in the Internet Protocol stack?

Layering

- Why are networks composed of layers?
- What are the layers in the Internet Protocol stack?
- Helps deal with complexity; modularization
- Application, transport, network, data-link, physical

Security

- What are sources of malware over a network?

Security

- What are sources of malware over a network?
- Trojan horse
  - Hidden part of some otherwise useful software
- Virus
  - infection by actively receiving object (e.g., e-mail attachment); self-replicating
- Worm
  - infection by passively receiving, self replicating

Architectures

- What is a hybrid architecture (in the context of this class)? Provide an example.

Architectures

- What is a hybrid architecture (in the context of this class)? Provide an example.
- Combines Client-Server (i.e. centralized server for some functionality) and P2P (for exchange of information/data)
- Example: IM – server for login, help peers find each other, P2P for exchange of messages

Process

- What is a process? Do pure P2P applications have server *processes*?

Process

- What is a process? Do pure P2P applications have server *processes*?
- A process is a program running on a host
- Yes, P2P architectures still have server processes
  - Client process: process that initiates communication
  - Server process: process that waits to be contacted

Transport Services to Application Layer

- What are the possible services that a Transport Layer provides?

Transport Services to Application Layer

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- Data loss
- Timing
- Throughput
- Security

Persistent versus Non-Persistent HTTP

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Nonpersistent HTTP

- At most one object is sent over a TCP connection.

Persistent HTTP

- Multiple objects can be sent over single TCP connection between client and server.

Cookies

- What is an HTTP cookie? What is it used for?

Cookies

- What is an HTTP cookie? What is it used for?
- A header line in an HTTP request or response message that can be stored on a client browser
- Used to identify a client session at a browser since HTTP is effectively stateless

Web Cache

- Why use a Web Cache?

Web Cache

- Why use a Web Cache?
- Reduce response time for client request
- Reduce traffic on an institution's access link

DNS Hierarchy

- What is the DNS hierarchy? Why is DNS organized in a hierarchy instead of being centralized?

DNS Hierarchy

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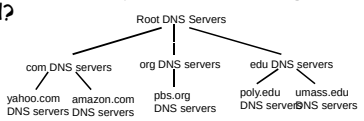

- Reasons
  - single point of failure, traffic volume, maintenance
  - → doesn't *scale!*

P2P

- Broadly, when can P2P file distribution be faster than Client-Server file distribution?

P2P

- Broadly, when is P2P file distribution efficient compared to Client-Server file distribution?
- When:
  - There are numerous clients
  - Server uplink capacity is the bottleneck
  - Clients have sufficient uplink capacity to participate in distribution

BitTorrent

- What is a *tracker*? What is a *torrent*?

BitTorrent

- What is a *tracker*? What is a *torrent*?

tracker: tracks peers participating in torrent

torrent: group of peers exchanging chunks of a file

What Messages are Exchanged by TCP During a Connection *Setup*?

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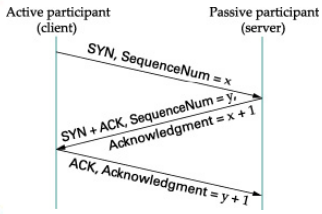
Three way handshake:

Step 1: client host sends TCP SYN segment to server
- specifies initial seq #
- no data

Step 2: server host receives SYN, replies with SYNACK segment
- server allocates buffers
- specifies server initial seq. #

Step 3: client receives SYNACK, replies with ACK segment, which may contain data



What is Congestion in the Internet?

What is Congestion in the Internet? What Happens?

What is Congestion in the Internet? What Happens?

- Informally: "too many sources sending too much data too fast for *network* to handle"
- Different from flow control!
  - (sender won't overflow receiver's buffer by transmitting too much, too fast)
- Manifestations:
  - Lost packets (buffer overflow at routers)
  - Long delays (queueing in router buffers)

How Does TCP Determine Rate and Infer Congestion?

How Does TCP Determine Rate and Infer Congestion?

- Decentralized: each TCP sender sets its own rate, based on *implicit* feedback:
  - *ACK:* segment received (a good thing!), network not congested, so increase sending rate
  - *lost segment:* assume loss due to congested network, so decrease sending rate

What is "Additive Increase, Multiplicative Decrease" in Relation to TCP Congestion Control?

What is "Additive Increase, Multiplicative Decrease" in Relation to TCP Congestion Control?

- Linear Increase - For each "cwnd's worth" of packets successfully sent, *increase* cwnd by 1 packet
- Multiplicate Decrease - When loss, *halve* cwnd

Is TCP *Slow Start* Really Slow?

Is TCP *Slow Start* Really Slow?

- Every time an ACK arrives, cwnd is incremented

→ cwnd is effectively doubled per RTT "epoch".

What is the Difference between Forwarding and Routing

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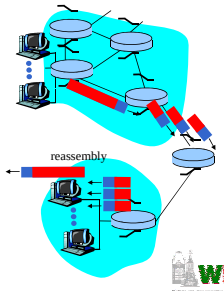
- *forwarding:* move packets from router's input to appropriate router output
- *routing:* determine route taken by packets from source to destination

What is an MTU? Why Does it Matter for the Network Layer?

What is an MTU? Why Does it Matter for the Network Layer?

- MTU = Maximum Transmission Unit
  - largest possible link-level frame
- IP datagrams larger than MTU are *fragmented*



What is DHCP?

What is DHCP?

- DHCP: Dynamic Host Configuration Protocol
- Allows hosts to *dynamically* obtain its IP address from network server when it joins network
  - Plus first hop router
  - Plus name server

Why NAT?

Why NAT?

- Motivation: local network uses just one IP address as far as outside world is concerned:
  - Range of addresses not needed from ISP: just one IP address for all devices
  - Can change addresses of devices in local network without notifying outside world
  - Can change ISP without changing addresses of devices in local network
  - Devices inside local net not explicitly addressable, visible by outside world (a security plus)

In Forwarding IP Datagrams, What Layer Does NAT Violate and How?

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- Violates upper layer (Transport) boundary
- Modifies Port number

What are "Global" Routing Algorithms Called? What are "Decentralized" Routing Algorithms Called?

What are "Global" Routing Algorithms Called? What are "Decentralized" Routing Algorithms Called?

Global:

- All routers have complete topology, link cost info
- "link state" algorithms

Decentralized:

- Router knows physically-connected neighbors, link costs to neighbors
- Iterative process of computation, exchange of info with neighbors
- "distance vector" algorithms

Compare and Contrast LS vs. DV

Compare and Contrast LS vs. DV

- DV
  - Exchange information with neighbors when change in tables
  - Compute route based on distance to neighbor plus neighbors estimate
- LS
  - Flood link information periodically
  - Compute route based on full topology and link information

What and Why Hierarchical Routing?

What and Why Hierarchical Routing?

Scale: with 200 million destinations:

- Can't store all dest's in routing tables!
- Routing table exchange would swamp links!

Administrative autonomy

- Internet = network of networks
- Each network admin may want to control routing in its own network

What is a CRC?

What is a CRC?

Cyclic Redundancy Check

- View data bits, D, as a binary number
- Choose r+1 bit pattern (generator), ***G***
- Goal: choose *r* CRC bits, R, such that
  - <D,R> exactly divisible by ***G*** (modulo 2)
  - Receiver knows ***G***, divides <D,R> by ***G***.
    - If non-zero remainder → error detected!
  - Can detect all burst errors less than r+1 bits
- Widely used in practice (Ethernet, 802.11 WiFi)

What are the 3 Broad Classes of MAC Protocols?

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Three broad classes:

- Channel Partitioning
  - Divide channel into smaller "pieces" (time slots, frequency)
  - Allocate piece to node for exclusive use
- Random Access
  - Channel not divided, allow collisions
  - "Recover" from collisions
- Taking turns
  - Nodes take turns, but nodes with more to send can perhaps take longer turns

Why is ALOHA Inefficient? How to Fix in Wired Networks?

Why is ALOHA Inefficient? How to Fix in Wired Networks?

- Empty slots and collisions
- Can fix with:
  - CA – Collision Avoidance – listen before transmit
  - CD – Collisions Detection – stop transmitting upon hearing collision

What Problem Does ARP Solve? And How?

What Problem Does ARP Solve? And How?

- How to determine MAC address of B knowing B's IP address
- broadcasts ARP query packet, containing B's IP address
  - dest MAC address = FF-FF-FF-FF-FF-FF
  - all machines on LAN receive ARP query
- B receives ARP packet, replies to A with its (B's) MAC address
  - frame sent to A's MAC address (unicast)
- A caches (saves) IP-to-MAC address pair in its ARP table until information becomes old (times out)