

CS425/EE673

Summary Lecture

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Network Layering

- What is layering?
- Purpose of layering
- Inter-layer communication
- Encapsulation
- End-to-end versus hop-by-hop communication

Encoding Schemes

- NRZ; problems with NRZ
- NRZI
- Manchester: 50% efficiency
- 4B/5B: 80% efficiency

Framing

- Byte-oriented versus bit-oriented
- Byte-counting based versus sentinel based
- Bit/byte stuffing
- Example protocols:
 - BISYNC, HDLC

Error Detection

- Parity scheme
- 2D parity
- Checksum (used by IP)
- CRC: based on polynomial division
- Forward Error Correction (FEC) as an extension of error detection mechanisms

Reliable Link Layer: ARQ

- Stop-and-Wait
- Notion of Bandwidth x Delay Product
- Sliding window
 - Sequence space required
 - Variables to be maintained
- Concurrent logical channels

Beyond a Single Link

- Network topologies:
 - Bus
 - Ring
 - Star
- Need MAC (Medium Access Control)

MAC Protocols

- Aloha
- Slotted Aloha
- Ethernet CSMA/CD

Ethernet: a Case Study

- Maximum length possible, repeaters
- Frame format, MTU size
- CSMA/CD:
 - Listen before transmit
 - Collision detection
 - Backoff on collision
- 32-bit jamming sequence

Token Ring: a Case Study

- Token circulates the ring
 - Token rotation time
 - Early versus delayed release
- Token monitor
 - Ensures that token is always there in the ring
 - Checks for corrupted/orphaned frames

Packet Switching

- Store and forward functionality
- Circuit switching versus packet switching
- Datagrams
- Virtual circuit switching
- Comparison between circuit switching, packet switching, and virtual circuit switching

Ethernet Bridging

- Special case of datagram switching
- Learning bridges
- Spanning tree
 - Tree properties
 - Distributed algorithm to form a spanning tree
- Disadvantages of bridging
 - Trees poor for routing, fault tolerance
 - Metric-based routing not possible

Routing Protocols

- Distance Vector routing
 - Periodic updates, triggered updates
 - Count-to-infinity problem, split horizon, poison reverse, hold time
- Link State routing
 - Reliable flooding
 - Periodic updates, triggered updates
 - Sequence numbers, TTL
- Comparison between DV & LS

Internet Addressing

- Hierarchical addressing
 - Class A, B, C, D, E
 - Subnets
 - Forwarding algorithm
- IP header formatting & fragmentation
- ARP (Address Resolution Protocols)
- DHCP (Dynamic Host Configuration Protocol)

Internet Routing

- Hierarchical routing
- CIDR
- Internet domains, Autonomous Systems (AS)
- Path vector routing across AS
 - Destinations are *networks*
 - Stub AS versus transit AS
- Internet Service Providers (ISPs)

Transport Protocol

- Application requirements: reliability, in-order delivery
- Multiplexing/demultiplexing
- UDP & TCP
- Link layer reliability vs transport layer reliability

TCP

- Header format
- Connection establishment
- State transition diagram
- Slow start, congestion avoidance
- Fast retransmit & fast recovery
- RTT estimation, Jacobson/Karels algorithm
- Sequence space wrap-around

DNS

- Name space, binding, name resolution
- Hierarchical name space
- Resource Records
- Zones
- DNS query process

Applications

- HTTP:
 - URL
 - Request, Reply, persistent connections
 - Proxies and caching, end-to-end issues
- SMTP
 - RFC822, MIME, SMTP exchanges
 - Gateway

Network Security

- Cryptography, shared-key
- Cryptanalysis, types of attacks
- DES
- Key management
- Public key cryptography