**CSC360 Computer Networks Spring 2014 – Final Review**

The exam will be close book & close note. No calculator will be needed – if you find yourself needing a calculator, you’re probably doing something wrong.

The exam will mostly consist of short answer format questions, true or false, multiple choices, and simple calculation. The basic idea of the exam will be to see if you understand the concepts. None of the questions will be “trick” questions, and many of them will have simple answers. If you know the concepts well, you may be done in Seventy five minutes.

Things you may wish to review should you feel rusty:

* Internet protocol layer
  + Link Layer
    - Local network
    - TCP/IP
    - Moves packets between Internet layer and two hosts on system
  + Internet Layer
    - Sends packets across networks
    - Sends data from source to destination network (called routing)
    - Host addressing identification: accomplished by a hierarchical IP addressing system
    - Packet routing basic manner of sending packets of data from source to destination by forwarding them to the next network router closer to the final destination
  + Transport Layer
    - Established a basic data channel that an application uses in its task specific data exchange
    - Provides end-to-end services that are independent of the structure of user data
  + Application Layer
    - Protocols used by most applications for providing user services over a network and some basic network support `services over a network and some basic network
    - Examples
      * FTP
      * SMTP
      * DHCP
* Network edge and the services it can provide
  + Run application programs (e-mail)
  + Client host requests (web browser)
  + Peer to peer (bit-torrent)
  + TCP – reliable
    - Reliable in-order byte-stream data transfer
  + UDP – best effort
    - Unreliable with no flow control
* Network core and related switching technology
  + Interconnected routers
  + Network of networks
  + Circuit switching
    - User A, B packets share network resources
    - Each packet uses full link bandwidth
    - Resources used as needed
    - Aggregate resource demand can exceed amount available
    - Congestion: packets queue, wait for link use
    - Store and forward: packets move one hop at a time
      * Note receives complete packet before forwarding
* Different access networks
  + Residential access networks
  + Institutional access networks (school/company)
  + Mobile access networks
  + Wired
  + Wireless
* ISPs and Internet backbone
  + Global
    - Mobile network
    - Regional
      * Home network
      * Institutional network
  + Guaranteed quality of service FDM
    - Divides bandwidth
  + TDM divides by time
* Delay in packet switching networks, delay in circuit switching networks
  + Packet switching
    - Used for data
    - Can send to multiple hosts
    - Security
    - Devices of different speeds can communicate
    - No waiting for direct connection
  + Circuit switching
    - Used for calls
    - Circuit is dedicated
    - Guaranteed full bandwidth for the duration of the call
    - Guaranteed quality of service
* HTTP, nonpersistent connection, persistent connection
  + Non-persistent
    - Only one object sent over TCP
    - HTTP/1.0 uses non-persistent
  + Persistent
    - Multiple objects can be sent over single TCP connection between client and server
    - HTTP/1.1 uses persistent
* FTP, out-of-band control
  + Opens one connection for browsing and another for data transfer
* SMTP
  + Between mail servers to send email messages
    - Client: sending mail server
    - “server”: receiving mail server
  + Uses TCP
  + Direct transfer
  + Three phases of transfer
    - Handshaking
    - Transfer of messages
    - closure
* POP3 and IMAP
  + POP3
    - Original uses download and delete mode
    - Now uses download and keep
    - Stateless across sessions
  + IMAP
    - Keep all messages in one place
    - Allows user to organize messages in folders
    - Keeps state across sessions
      * Name of folders and mappings between message IDs and folder name
* How DNS works
  + Domain name system
  + Hostname of IP address translation
  + Host aliasing
  + Mail server aliasing
  + Load of distribution
  + The bads
    - Single point of failure
    - Traffic volume
    - Distant centralized database
    - maintance
* P2P. How are Napster, Guntella, and KaZaA different?
  + Napster
    - All connect to single server
    - Gets peer address to get data
  + Guntella
    - Each user quarries its immediate neighbor
    - Recursive calls
  + KaZaA
    - Creates multiple super hosts
* TCP, UDP. How TCP and UDP achieve multiplexing and demultiplexing?
  + Demultiplexing
    - Delivering received segments to correct socket
    - Each datagram has source IP and destination IP
    - Each datagram carries 1 transport-layer segment
    - Each segment has source destination port number
    - Sends data to correct port
  + Multiplexing
    - Gathering data from multiple sockets, enveloping data with header
* Stop-and-Wait, Go-Back-N, Selective Repeat
  + Stop-and-Wait
    - Halts all progress until every packet in a window is ack
  + Go-back-N
    - Windows of up to N consecutive unack’ed packets
  + Selective repeat
    - Selects packets not received in the window and re-sends them
* Congestion control, flow control
  + Congestion control
    - Throttle sender when network is overloaded
    - Can lead to lost packages and long delays
    - Make separate routers for each flow
    - End to end
      * No explicit feedback from network
      * Congestion inferred from end-system data loss or delay
      * Used by TCP
    - Network assisted congestion control
      * Routers provide feedback to end systems
        + Single bit indicating congestion
        + Explicit rate sender should send
  + Flow control
    - Takes spare room in buffer and sends how much spare room there is with a given packet
* How virtual circuit network and datagram network work?
  + Datagram network direct, no calls
    - Delivery simply based on destination IP address
  + Source to destination path behaves much like telephone circuit
    - Performance-wise
    - Network actions along source to destination path
  + Call setup
    - Teardown for each call before data can flow
    - Each packet carries VC identifier
      * Not destination host address
    - Every router on source to destination path maintains state for each passing connection
    - Link, router resources (bandwidth and buffers) many be allocated to VC (dedicated resources = predictable service)
  + VC
    - Path from source to destination
    - VC numbers, one number of each link along path
    - Entries in forwarding tables in routers along path
    - Packets belong to VC carries VC number rather than destination address
    - VC number can be changed
      * Comes from VC forwarding table
* How router works? Why data loss in router?
  + Move packets from router’s input to router output
  + Routers establish a virtual connection
  + Run routing algorithms/protocol
  + Input functions
    - Given datagram destinations, lookup output port using forwarding table in input port memory
  + Output ports
    - Buffering required when datagrams arrive from fabric faster than the transmission rate
    - Scheduling discipline chooses among queued datagrams for transmission
* IPv4 addressing. Why IPv6
  + IP address: 32-bit identifier for host, router interface
  + Interface connection between host/router and physical link
    - Router’s typically have multiple interfaces
    - Host typically has one interface
    - IP address associated with each interface
  + CIDR addressing
    - Subnet portion of address of arbitrary length
  + IP address assigned by DHCP
    - Dynamically obtain IP address from network server
    - Can renew its lease on address in use
  + IPv6 has more addressable space
    - Helps speed
    - Helps quality of service
* How link state routing algorithm and distance vector routing algorithm work? The difference.
  + Link state
    - Dijkstra
      * Net topology like costs known to all nodes
      * Uses links tate broadcast
      * All nodes hace same info
      * Computes least cost paths
  + Distance vector
    - Bellman-ford equation
  + Message complexity
    - LS with n nodes, E links O(nE)
    - DV exchange between neighbors only
  + Speed of convergence
    - LS O(n\*n) algorithms requires O(nE) messages
    - DV convergence time varies
      * May be routing loops
      * Count to infinity
  + Roubstness
    - LS
      * Node can advertise incorrect link cost
      * Each note computes only its own table
    - DV
      * DV node can advertise incorrect path cost
      * Each node’s table used by others
        + Error propagate though network
* Autonomous System and routing algorithm
  + Hierarchical routing
  + Aggregate routers into reactions (autonomous systems)
    - Routers in same AS run same routing protocol
    - Intra-AS routing protocol
    - Routers in different AS can run different intra-AS routing protocol
* What kind of services does Link Layer provide?
  + Error detection and correction
  + Sharing a broadcast channel
  + Link layer addressing
  + Reliable data transfer
  + Encapsulate datagram into frame adding header and trailer
* What are Error-detection and –correction for? What is the difference? How parity check, checksum, and CRC work?
  + Error detection
    - Errors caused by signal attenuation, noise
    - Receiver detects presence of errors
      * Signals sender for retransmission or drops frame
  + Error correction
    - Receiver identifies and corrects bit errors without resorting to retransmission
  + CRC cyclic redundancy check
    - Error detecting code commonly used in networks
    - Detects accidental changes to raw data
    - Data has a check value
    - Simple to implement
* How FDM, TDM work?
  + See firstish question
* Why do we need MAC address? How ARP works? How DHCP works?
  + MAC address identifies a specific machine, it is unique
  + ARP
    - Each host/router has ARP table
    - Router sends out request, waits for reply, sends data from original host to the responder
    - The original sender caches the address pair in its ARP table until data times out
  + DHCP
    - Host broadcasts: DHCP discover
    - DHCP server responds with: DHCP offer
    - Host requests IP address: DHCP request
    - DHCP server sends address: DHCP ack
* How Ethernet (CSMA/CD) works?
  + Collisions detected within short time
  + Colliding transmission aborted, reducing channel wastage
  + Collision detection
    - Easy in wired LAN, measures signal strengths compared to transmitted
    - Difficult over wireless, strength can change
* The differences between Hub, Switch, Router.
  + Hub
    - Physical layer (repeaters)
    - Bits coming in one link go to all other links at the same rate
    - All nodes connected to hub can collide with one another
    - No frame buffering
    - No CSMA/CD at hub
  + Switch
    - Link-Layer device
    - Store forward Ethernet frames
    - Examine incoming frame’s MAC address
    - Selectively forward frame to one or more outgoing links when frame is to be forwarded on segment uses USMA/CD to access segment
    - Hosts are unaware of presence of switches
    - Allow multiple simultaneous transmissions
    - Hosts have dedicated direct connection
    - Buffer packets
    - Ethernet protocol used on each incoming link but no collisions
    - Full duplex
    - Switch A to A and B to B simultaneously
    - Each switch has a table entry
      * MAC addresses of host interface to reach host time stamp
      * Looks like routing table
      * Entries maintained by routing protocol
      * Self learning
        + Which hosts can be reached through which interfaces
        + When frame received switch learns location of sender incoming LAN segment
        + Records sender/location pair in table
  + Router
    - Runs routing algorithms
    - Given datagram dest
    - Look up output post using forwarding table
    - Queues if datagrams arrive faster than forwarding
* Why do we need PPP?
  + Packet framing
    - Encapsulation of network layer datagram in data link frame
      * Carry network layer data of any network layer protocol at same time
      * Ability to demultiplex upwards
    - Bit transparency
      * Must carry any bit pattern in the data field
    - error detection
    - connection liveness
      * detect signal link failure to network layer
    - network layer address negotiation
      * endpoint can learn to configure each other’s network address
* Both ATM and MPLS are packet-switched, virtual-circuit networks.
  + ATM/MPLS
    - Separate networks in their own right
    - Different service models, addressing, routing from internet
    - Viewed by internet as logical link connection IP routers
  + ATM
    - Adaptation layer
      * Only at edge of ATM network
      * Data segmentation reassembly
      * Roughly analogous to internet transport layer
    - ATM layer
      * Cell switching, routing
    - Used to connect IP backbone routers
  + MPLS
    - Original goal was to make internet quicker by using fixed length label instead of IP address
    - Label switch router
    - Forwards packet to outgoing interface based only on label value
      * MLPS forwarding table distinct from IP forwarding tables
    - Signaling protocol needed to set up forwarding
      * RSVP-TE forwarding possible along paths that IP alone would not allow
      * Use MPLS for traffic engineering
    - Must co-exist with IP-only routers
* How CDMA works?
  + Used in several wireless broadcast channels
  + Unique “code” assigned to each user
  + All users share same frequency, but each user has own chipping sequence to encode data
  + Encoded signal = original data X chipping sequence
  + Decoding – inner product of encoded signal and chipping sequence
  + Allows multiple users to coexist and transmit simultaneously with minimal interference
* 802.11 and CSMA/CA
  + 802.11
    - no collision detection
    - difficult to sense collisions
  + CSMA/CA
    - If sense channel idle for DIFS then transmit entire frame
    - If sense channel busy than start random backoff time timer counts down while channel idle transmit when timer expires, if no ACK increase backoff
    - If frame OK return ACK after SIFS
* Infrastructure mode, Ad Hoc networks
  + Infrastructure mode
    - Base state connects mobiles into wired network
    - Contains
      * Wireless hosts
      * Access point base station
      * Ad-hoc mode: hosts only
  + Ad Hoc
    - No base stations
    - Nodes can only transmit to other nodes within link coverage
    - Nodes organize themselves into a network route among themselves
* What is handoff?
  + Route call via new base station
    - Stronger signal to/from new BSS
    - Load balance free up channel in current BSS
    - GSM doesn’t mandate why to perform handoff
* List several differences between wired link and wireless link.
  + Signal strength
  + Speed
  + Lack of wires
  + Stability
  + vulnerability
* RTS/CTS
  + RTS
    - Sender first transmits small requests to send packets
    - RTS may still collide with each other
    - BS broadcasts clear-to-send in response to RTS
    - RTS heard by all nodes
* Mobility in same IP subnet.
* 802.15 and Wireless Personal Area Network (WPAN). Bluetooth, Frequency-hopping Spread Spectrum (FHSS)
  + 802.15 personal area network
    - 10 m diameter
    - ad hoc
    - master/slave system
    - evolved from Bluetooth
* Cellular standards--- 2G, 3G, 4G
  + 2G
    - GSM
  + 3G
    - CDMA2000
  + 4G
    - LTE
* Cellular mobility, Routing to a mobile node