**Midterm for Computer Networks (Graduate-Level), November 2015**

**Open Book (2-hour, total: 100 points),** Prof. Ying-Dar Lin, [ydlin@cs.nctu.edu.tw](mailto:ydlin@cs.nctu.edu.tw)

1. (9%) **Routing vs. Switching**

Comparing Internet routers with telephone switches, routers are stateless while switches are stateful.

* 1. (3%) What kinds of information are kept as “states” in switches?

A circuit number from a specific input port should be switched to another circuit number in another output port.

* 1. (3%) Are routers more scalable than switches, in terms of the number of flows or connections passing through routers or switches? Why?

Routers are more scalable because no need to keep states.

* 1. (3%) Are routers faster than switches? Why?

Switches are faster because indexing (in switches) is faster than matching (in routers).

1. **(8%) End-to-End vs. Hop-by-Hop**

In most networking systems, error control is embedded in the link layer as well as the transport layer.

* 1. (4%) What if error control is only embedded in the link layer but not transport layer? (Describe its major problem.)

No guarantee/protection in case of nodal errors.

* 1. (4%) What if error control is only embedded in the transport layer but not link layer? (Describe its major problem.)

Longer time to detect or recover the errors, i.e., poor efficiency.

1. **(6%) Waveform and Spectrum**

There exists a mapping relationship between signal and spectrum.

* 1. (3%) Which kind of signal has a discrete periodic spectrum? Why?

Periodic digital signal; digital signal 🡪 periodic spectrum, periodic signal 🡪 discrete spectrum

* 1. (3%) Which kind of signal has a continuous aperiodic spectrum? Why?

Aperiodic analog signal; analog signal 🡪 aperiodic spectrum, aperiodic signal 🡪 analog spectrum

1. (9%) **Issues in Line Coding**

Among unipolar NRZ-L, Polar NRZ-L, NRZ-I, and RZ, Manchester, differential Manchester, AMI, and MLT-3, which schemes have no issues on synchronization, baseline wandering, and DC components, respectively?

Without self-synchronization problem: polar RZ, Manchester, differential Manchester

Without baseline wandering problem: Manchester, differential Manchester

Without or with very little DC components problem: polar RZ, Manchester, differential Manchester, AMI

1. **(8%) Orthogonality in Modulation: DSSS, FHSS, Syn-CDMA, Asyn-CDMA, OFDM, MIMO**

In digital modulation, there are several domains to spread the signal energy over multiple carriers.

* 1. (6%) Can you group DSSS, FHSS, Syn-CDMA, Asyn-CDMA, OFDM, and MIMO into four groups in terms of the domain to spread the energy?

Bits (same code but different bits): DSSS

Codes (same frequency but different codes): Syn-CDMA, Asyn-CDMA

Frequencies (same antenna but different frequencies): FHSS, OFDM

Antennas (different antennas): MIMO

* 1. (2%) Among the above six schemes, whose “carriers” are strictly orthogonal to each other?

Strictly orthogonal: Syn-CDMA, OFDM

1. (7%) **Constraints on CSMA/CD**

There have been some constraints on the applicability of CSMA/CD in half-duplex Ethernet.

(a) (3%) Why is big bandwidth delay product bad for both CS (carrier sense) and CD (collision detection)?

For CS: sensed info is not up to date; for CD: small packets running on a long link 🡪 low efficiency

(b) (2%) Why is there no half-duplex gigabit Ethernet in the market?

High BDP 🡪 round-trip-time > frame transmission time 🡪 bad for CS and CD 🡪 needs frame bursting and carrier extension 🡪 overhead

(c) (2%) Why cannot you apply CSMA/CD directly onto WLAN?

CS for WLAN: not accurate due to hidden terminals; CD for WLAN: cannot receive while transmitting

1. (7%) **Bridging**

An Ethernet switch does bridging exactly.

* 1. (3%) Why is bridging transparent? Transparent to whom?

Transparent to hosts: A host sends a frame with a destination MAC field filled as the frame destination without knowing whether it is on this subnet or a remote subnet that requires the bridges to forward the frame.

* 1. (2%) *How* does it run self learning?

Check the “source” MAC address of an incoming frame, and record the mapping of (source MAC address, incoming port) into the forwarding table. To forward a frame, lookup the table to find which port can lead to a destination MAC address. If not found, flood the frame.

* 1. (2%) Why does it run the spanning tree protocol?

To avoid frame looping in the interconnected subnets.

1. (9%) **Network Adaptor Driver**

A network adaptor driver moves packets between kernel and interface.

* 1. (3%) Why does a driver need to probe I/O ports and IRQ number?

I/O ports: to read and write data from and to the interface; IRQ: to register to the kernel about the interface it will handle the interrupt for.

* 1. (3%) To move a packet from the kernel to the interface, what does a driver do?

Issue commands to the interface’s register to do remote DMA

* 1. (3%) What happens next when a packet has been transmitted successfully by an interface?

The interface generates a hardware interrupt and has the driver check the status register of the interface.

1. **(9%) IP** **Forwarding in Linux Kernel**

In Linux kernel, IP table lookup are done against a cache and an FIB.

* 1. (3%) When is the cache updated, i.e. adding new entries and removing old entries?

Add: cache missed and matched in FIB;

Remove: timer expired

* 1. (3%) Both the cache and FIB use hash table as their data structure. What is the difference in their data structures?

Cache: pure hash table with linked lists; FIB: multiple hash tables ordered by the length of prefixes

* 1. (3%) When is the FIB updated? By whom?

Routing daemon updates FIB when routes changed after computation.

1. (10%) **Interface Functions Between Layers**

Interface functions are functions to be called by the upper or lower layer protocol entities. Find the following transmit and receive interface functions in Linux systems.

* 1. (2%) Which function in the network adaptor driver is called to issue commands to the MAC controller to transmit a packet?

dev\_queue\_xmit()

* 1. (2%) Which function in the network adaptor driver is called to receive a packet?

net\_rx\_action()

* 1. (2%) Which function in the network adaptor driver will call which function in the IP layer to receive a packet?

netif\_receive\_skb() calls ip\_rcv()

* 1. (2%) Which function in the IP layer will call which function in the adaptor driver to transmit a packet?

ip\_finish\_output2() calls net\_tx\_action()

* 1. (2%) How would you trace to find out the answers for (a)-(d)? Which tool(s) do you use?

Static: vim, grep, SourceInsight, etc.

Dynamic: kgdb

1. **(10%) Flow Control**

Flow control could be embedded into different protocol layers. Commonly used flow control mechanisms are (1) stop and wait, (2) sliding window, (3) back pressure, (4) PAUSE frame. Indicate which scheme is adopted in the following protocols.

* 1. (2%) PPP

None

* 1. (2%) Ethernet

Back pressure in half-duplex Ethernet and PAUSE frame in full-duplex Ethernet

* 1. (2%) WLAN

Stop and wait

* 1. (2%) IP

None

* 1. (2%) TCP

Sliding window

1. **(8%) Hands-On**

This problem is to verify whether you have gone through the hands-on exercises.

* 1. (2%) Explain what are under the following directories: /bin, /etc, /usr/src, and /var.

/bin: binary programs /etc: configuration files

/usr/src: source programs /var: log files, spool

* 1. (2%) During the system initialization process, what do /etc/rc.d/rc.inet1 and /etc/rc.d/rc.inet2 do, respectively?

rc.inet1: configure the basic network parameters (such as IP addresses and routing information)

rc.inet2: fires up the TCP/IP daemons (telnetd, ftpd, and so forth)

* 1. (2%) How did you find the MAC address of your Ethernet adaptor card?

ifconfig –a (other answer is allowed if it works.)

* 1. (2%) How did you compile and install the Ethernet driver?

There are several possible solutions to this problem. One of the three (but not confined to) should be correct.

1. make modules; make modules\_install
2. gcc –c xxx.c; insmod xxx.o
3. complete installation procedure of some commercial package