Qualifying Exam: Network Architecture
Jan. 2014
**Date: Friday, 2013/1/10 (1 hour)**

Instruction:
- Put your name and student number on all your answer sheets.
- You have 60 minutes to complete the exam.
- **Show all your work.   Partial credit will be considered, if you show intermediate steps in obtaining the answer.**

Question #1 (20pt):
a) Switch moves bits between links. Why do we need switching? *(Hints: Imagine that we'd like to provide all the requested connectivity between n end hosts)*
b) What are the advantages of packet switching compared to circuit switching when you'd like to send a big file?
c) One of the key principles of the Internet design is stateless router. What are the advantages and disadvantages of stateless IP network compared to stateful network such as ATM.

Question #2 (20pt): Drop tail router(drop newly arriving packets when buffer is full) has "lock-out" problem. In other words, a few flows may monopolize the queue space and prevent other flows to enter the queue. Explain how this problem can be solved? *(Hints: Random drop, Drop front,…)*

Question #3 (20pt): Data Center Networking (DCN) contains tens or hundreds of thousands of servers. DCN is very communication intensive since a simple web search request may touch 1000+ servers, and data storage. Therefore, the main challenge is how to build a scalable DCN that delivers significant aggregate bandwidth. The figure below shows an example of routing in server centric structure. In this structure, servers act not only as end hosts but also as relay nodes for multihop communication. What are the advantage and disadvantage of this structure compare to switch centric structure where switches are the only relay nodes?
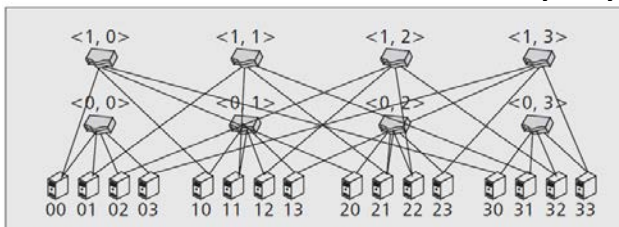
The routing paths from 00 to 23 can be 00-**20**-23 or 00-**03**-23. (20, 03 => relay node)

Figure 1. *An example of BCube and its address array.*

Question #4 (20pt):
a) What is the relationship between RTO(Retransmission Timeout) and TCP performance?
b) RTO can be determined using estimated RTT. How to estimate RTT using EWMA? (*Hint: Exponentially weighted moving average(EWMA),* $\text{SRTT}(K+1) = \alpha \times \text{SRTT}(K) + (1-\alpha) \times \text{RTT}(K+1)$)

Question #5 (20pt): TCP suffers huge performance degradation utilizing in wireless network environments, since wireless network's transmission error rate is much higher than wired network. Remember that TCP assumes that packet loss is due to congestion, and thus it reduce congestion window. TCP assumption in wireless network is not appropriate.
TCP Westwood is proactive approach to solve this problem. This protocol requires sender side only modification to TCP New Reno.   This is good for interworking with legacy TCP. Explain Key idea of this approach. (*Hints: eligible rate estimate, difference between actual rate and achieved rate, packet pair, packet train,…*)

No Congestion   Congestion

Expected ra   Achieved rate

$$T_k = \text{RTT} \times \frac{\frac{cwin}{\text{RTT}_{min}} - RE}{\frac{cwin}{\text{RTT}_{min}}}$$