September 4th, 2014
Exam of Switch and router architectures

Rules for the exam. It is forbidden to use notes, books or calculators. Use only draft paper provided by the professor. When needed, use approximations.
Time available: 70 minutes.

PROBLEM A.
Consider the design of a data center based on a leaf-spine topology.

- Describe the correspondence between the topology and a Clos network, highlighting similarities and differences.

Assume now a total number of servers equal to 32,000 with each server interface running at 1 Gbit/s. Each rack can host 32 servers and racks are grouped into pods. Each switch is equipped with 64 ports running at 1 Gbit/s.

- Design the interconnection topology.
- Compute the total number of switches and cables required to build the data center.
- How many pods result from the design?
- Which routing algorithm can be used to find the path between two servers? Motivate your answer.
PROBLEM B.
Consider a $5 \times 5$ input queued switch, with ports running at 10 Gbps. The following rates should be guaranteed:

\[
R = \begin{bmatrix}
1 & 2 & 4 & 2 & 0 \\
2 & 1 & 0 & 3 & 1 \\
0 & 1 & 3 & 1 & 2 \\
0 & 0 & 0 & 0 & 0 \\
3 & 2 & 1 & 3 & 1
\end{bmatrix} \text{ Gbps}
\]

where $R_{ij}$ is the rate from input $i$ to output $j$. Show how to guarantee these rates and describe all the algorithms involved.
PROBLEM C.
Consider a $N \times M$ input queued switch with Virtual Output Queueing and QoS support. For a generic (input-$i$,output-$j$) pair there exist two queues: $VOQ^H_{ij}$ for high priority traffic (e.g. VoIP) and $VOQ^L_{ij}$ for low priority traffic (e.g. web). An input traffic classifier sends the incoming packets to the correct queue.

1. Write in pseudocode a greedy algorithm to schedule the transmissions across the switching fabric, to maximize the number of high priority packets that are selected at each timeslot. Let $H[i][j]$ be the occupancy of $VOQ^H_{ij}$ and let $L[i][j]$ be the occupancy of $VOQ^L_{ij}$.

2. Discuss the scheduler performance in terms of throughput.

3. Is it possible that low priority traffic will be starved indefinitely by high priority traffic? Motivate your answer with an example.