September 3rd, 2018
Exam of Switching technologies for data centers (2017/18)

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. The answers must be provided in correct English. Any notation must be defined.
Time available: 70 minutes.

Problem A

Consider the design of Jupiter data center at Google, based on a basic building block implemented with a chipset with 16 ports at 40 Gbps. The adopted oversubscription ratio is 3:1. Each server is equipped with a single port running at 10 Gbps. Draw the architecture and compute the total number of servers and basic building blocks (i.e., chipsets) for each of the following scenarios:

1. 2-layers topology;
2. 2-layers POD;
3. 3-layers topology;
4. 3-layers POD;
5. 4-layers topology.

Finally, describe for the 4-layers topology all the possible ways to interconnect the data center to the Internet.

Problem B

Consider a traditional hash table with H buckets to store <key,value> elements.

1. Define the concept of "hash function" and describe its properties.
2. Explain the two main relevant results regarding random policies for bins-and-balls models, describing all the involved assumptions.
3. Describe two different ways to implement hash tables that exploit the above two results.
4. For each of the two implementations:
   (a) Describe in pseudocode the insertion of an element; for simplicity, assume that the key does not appear already in the hash.
   (b) Describe in pseudocode the lookup of an element.
   (c) Evaluate the expected lookup time.
   (d) Evaluate the worst case lookup time.
   (e) Show an example of insertion of 12 elements when $H = 4$.

Problem C

Design an 8×8 Benes network. Connect the following input-output couples: $1 \to 8$, $2 \to 6$, $3 \to 7$, $4 \to 3$, $5 \to 4$, $6 \to 2$, $8 \to 1$.

1. Draw the complete network, showing all the recursively-built modules.
2. Use the looping algorithm to configure the network. Show graphically the used loops, assuming that the inputs are always considered in increasing sequence.
3. Show the final configuration of the network, after running the looping algorithm.

Hints for the solution

Problem A

See the class notes.

Problem B

See the solution of problem 132.

Problem C

See the solution of problem 32.