1 Virtual Machines

a) List all machine resources that must be virtualized and discuss why. List some uses of virtual machines.

b) What is the difference between Native (type 1) and Hosted (type 2) virtual machines? Which might be more suitable for a data center (cloud provider) and which might be more suitable for your laptop?

c) Discuss the differences between and the (dis)advantages of full- and para-virtualization.

d) Discuss the functionality of ballooning. What problem is it trying to solve and how does it solve it?

2 Network stack

a) Name one case of multiplexing and demultiplexing that happens at the level of a modern NIC

b) What are potential problems that can arise when the TCP protocol state is stored in the kernel?

c) What is the difference between Receive Side Scaling and Flow Steering?

d) Receive Side Scaling assumes that one core is as good as any other. When does this assumption not apply? Why can this hurt performance?

e) What are problems that might come up when implementing a zero-copy (no copies of the packet payload) network stack that uses only a single buffer instead of a linked list like structure of the mbuf chain?

f) In the script we investigate the time the OS has to process a packet of a modern 10 Gbit NIC. We will now compute some of the numbers for a 100 Gbit NIC. Assume the processor runs at 3 GHz and the packet size is 1536 bytes.

- Compute the number of packets per second as well as the time a CPU has to process a packet for a 100 Gbit NIC.
- How many CPU cores (rounded to the next natural number) would it take to handle the 100 Gbit NIC assuming we can process a packet on average in about 1800 cycles?