National University of Singapore
School of Computing

CS2106 **Tutorial 7** Semester 1 10/11

1. Adding more RAM to your PC or laptop improves the performance of the system (programs run faster) in general. Why?

2. (a) Suppose a machine supports logical address space of 64 pages with page size of 2KB. The address space is mapped onto a physical memory with 32 frames. How many bits are there in the (i) logical address? (ii) physical address?

   (b) Suppose the same system has a Translation Lookaside Buffer (TLB) with 8 entries. Furthermore, suppose that a program contains instructions that fit into one page. The program runs in a loop that reads a long sequence of `int` from an array that spans tens of pages. How effective will the TLB be for this case?

   (c) Suppose that it takes 5 ns to read an entry from the page table, and 1 ns to do a look up from TLB. What should the hit rate (percentage of address lookup that exists in TLB) be in order for the average look up time to falls below 2 ns?

3. A computer with a 32-bit address uses a two-level page table. Virtual addresses are split into a 8-bit top-level page table field, an 12-bit second-level page table field, and an offset. How large are the pages and how many are there in the address space?

4. It has been observed that the number of instructions executed between page faults is directly proportional to the number of page frames allocated to a program. If the available memory is doubled, the mean interval between page faults is also doubled. Suppose that a normal instruction takes 1 μs, but if a page fault occurs, it takes 2001 μs (i.e., 2 ms to handle the fault). If a program takes 60 sec to run, during which time it gets 15,000 page faults, how long would it take to run if twice as much memory were available?