Assignment 10

Due: 9:00am, Tue Apr 24th, 2018

Note: Make reasonable assumptions where necessary and clearly state them. Feel free to discuss problems with classmates, but the only written material that you may consult while writing your solutions are the textbook and lecture slides/videos. Solutions should be uploaded as a single pdf file on Canvas. **Show your solution steps** so you receive partial credit for incorrect answers and we know you have understood the material. Don't just show us the final answer.

1. Consider a processor that uses 32-bit virtual addresses and a 36-bit physical address. Assume that the system uses 4KB pages.
   - What is the size of a program's virtual memory? (5 points)
   - What is the size of the system's physical memory? (5 points)
   - How many virtual pages does a program have? (5 points)
   - How many physical pages does the system have? (5 points)
2. Consider a 3-processor multiprocessor connected with a shared bus that has the following properties: (i) centralized shared memory accessible with the bus, (ii) snooping-based MSI cache coherence protocol, (iii) write-invalidate policy. Also assume that the caches have a writeback policy. Initially, the caches all have invalid data. The processors issue the following five requests, one after the other. Create a table similar to that in slide 6 of lecture 25 to indicate what happens for every request. (35 points)
   - P1: Read X
   - P1: Write X
   - P3: Read X
   - P2: Read X
   - P3: Write X
3. Consider a 3-processor multiprocessor connected with a scalable network that has the following properties: (i) distributed memory organization, (ii) directory-based cache coherence protocol, (iii) write-invalidate policy. Also assume that the caches have a writeback policy. Initially, the caches all have invalid data. Assume that data X is stored in the memory connected to processor P2. Create a table similar to that in slide 13 of lecture 25 to indicate what happens for every request. (35 points)
   - P1: Read X
   - P1: Write X
   - P3: Read X
   - P2: Read X
   - P3: Write X
4. How can processors defend against the Meltdown attack? (10 points)