16.482 / 16.561: Computer Architecture and Design
Summer 2014

Lecture 8: Key Questions
June 17, 2014

1. What are the benefits of virtual memory?

2. Four questions for virtual memory:

a. Where can a page be placed in main memory?

b. How is a page found if it is in main memory?

c. Which page should be replaced on a page fault?

d. What happens on a write?

3. Describe the purpose and operation of a translation lookaside buffer (TLB).

4. **Example:** Assume the current process uses the page table below:

Virtual page #	Valid bit	Reference bit	Dirty bit	Frame #
0	1	1	0	4
1	1	1	1	7
2	0	0	0	--
3	1	0	0	2
4	0	0	0	--
5	1	0	1	0

a. Which virtual pages are present in physical memory?

b. Assuming 1 KB pages and 16-bit addresses, what physical addresses would the virtual addresses below map to?

i.   0x041C

ii.   0x08AD

iii. 0x157B

5. Explain each of the following advanced cache optimizations:
a. Way prediction

b. Trace caches

c. Non-blocking caches

d. Multi-banked caches

e. Critical word first and early restart

f. Merging write buffers

g. Software optimizations: array merging, loop interchange, loop fusion, blocking

h. Prefetching (both hardware and software)