Problem 1

The **PDP11** was a series of computers sold by Digital Equipment Corp. (DEC) from 1970 and into the nineties. A PDP11 computer has a 16-bit virtual address space, where each address identifies a byte, for a total of 64 KB. A page is $2^{13} Bytes = 8$ KB, and thus the virtual address space of a process consisted of 8 pages. A page table entry (PTE) had a 9-bit frame (= physical page) number, a Valid bit, and a Writable bit.

Q1. What is the maximum physical memory (in KB) in a PDP11? _______________

Q2. Consider the following page table of a process:

Page	**Valid**	**Frame**	**Writeable**
0	Yes	0x003	No
1	Yes	0x001	No
2	Yes	0x008	Yes
3	No	N/A	N/A
4	No	N/A	N/A
5	No	N/A	N/A
6	No	N/A	N/A
7	Yes	0x004	Yes

Fill in the following table:

Virtual Address	**Valid**	**Physical Address**	**Writeable**
0x1234			
0x4321			
0x8888			

Problem 2

For a computer architecture with multi-level paging, a page size of 4 KB, and 64-bit physical and virtual addresses:

(a) What is the smallest possible size for a page table entry, rounded up to a power of two?

(b) Using your result above, and assuming a requirement that each page table fits into a single page, how many levels of page tables would be required to completely map the 64-bit virtual address space?

Solution 1

Part 1: $2^{(13+9)}$ = 4096 KB

Virtual Address	Valid (yes, no)	Physical Address (if valid) in hexadecimals	Writable (yes, no)
0x1234	yes	0x07234	no
0x4321	yes	0x10321	yes
0x8888	no	N/A	no

Solution 2

For a computer architecture with multi-level paging, a page size of 4 KB, and 64-bit physical and virtual addresses:

(a) What is the smallest possible size for a page table entry, rounded up to a power of two?

64bit -> 2^64 addressable bytes
page size 4KB = 2^12 bytes
num of pages = 2^64 / 2^12 = 2^52
=> 52 bits -> 64 bits when rounded

(b) Using your result above, and assuming a requirement that each page table fits into a single page, how many levels of page tables would be required to completely map the 64-bit virtual address space?

page size = 4KB = 2^12 bytes = 2^15 bits
page table entry = 8B
pages / table = page size / page table entry = 2^12 / 2^3 = 2^9
Level 1: 2^9 * 2^12 = 2^21 bytes addressed
2^64 / 2^21 = 2^43
=> 43/9 = 5 more levels
=> 6 levels