University of Newcastle
School of Electrical Engineering and Computing

COMP2240 - Operating Systems
Workshop 7
Topics: Memory Management

1. Consider a memory management system based on paging (without virtual memory). The total size of the physical memory is 2GB, laid out over frame of size 8 KB. The logical address space of each process has been limited to 128 MB.

a) Determine the total number of bits in the physical address.
b) Determine the number of bits specifying page replacement and the number of bits for page frame number.
c) Determine the number of page frames.
d) Determine the logical address layout.

2. Consider the Intel address-translation scheme shown in Figure 1.

a) Describe all the steps taken by the Intel Pentium in translating a logical address into a physical address.
b) What are the advantages to the operating system of hardware that provides such complicated memory translation?
c) Are there any disadvantages to this address-translation system? If so, what are they? If not, why is this scheme not used by every manufacturer?

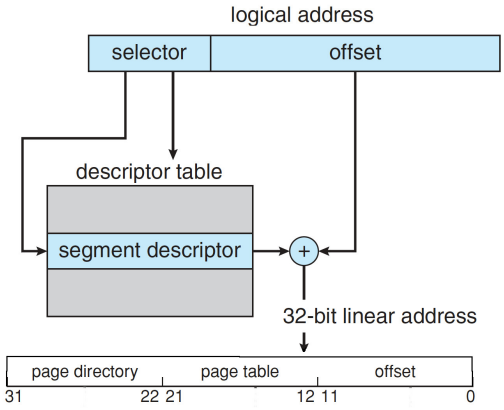

Figure 1: IA-32 segmentation.

3. Consider a simple segmentation system that has the following segment table:

Base Address	Length (bytes)
0010 1001 0100	0000 1111 1000
0110 1101 1000	0001 1010 0110
0000 1101 1110	0000 1100 0110
0011 1110 0100	0010 0101 1100

For each of the following logical addresses, determine the physical address or indicate if a segment fault occurs. Assume an offset field of 12 bits, leaving 4 left-most bits for the segment number:

a) 0000 0000 1100 0110
b) 0010 0000 1001 1100
c) 0001 0010 0001 0010
d) 0011 0001 1011 1100

4. This diagram shows an example of memory configuration under dynamic partitioning, after a number of placement and swapping-out operations have been carried out. Addresses go from left to right; gray areas indicate blocks occupied by processes; white areas indicate free memory blocks. The last process placed is 2-Mbyte and is marked with an X. Only one process was swapped out after that.

a) What was the maximum size of the swapped-out process?
b) What was the size of the free block just before it was partitioned by X?
c) A new 3-Mbyte allocation request must be satisfied next. Indicate the intervals of memory where a partition will be created for the new process under the following four placement algorithms: best-fit, first-fit, next-fit, and worst-fit. Foreach algorithm, draw a horizontal segment under the memory strip and label it clearly.

5. Another placement algorithm for dynamic partitioning is referred to as worst-fit. In this case, the largest free block of memory is used for bringing in a process.
a) Discuss the pros and cons of this method compared to first-, next-, and best-fit.
b) What is the average length of the search for worst-fit?

Supplementary problems:

S1. The Intel 8086 processor did not have an MMU or support virtual memory. Nevertheless, some companies sold systems that contained an unmodified 8086 CPU and did paging. Make an educated guess as to how they did it. (Hint: Think about the logical location of the MMU.)

S2. The IBM System/370 architecture uses a two-level memory structure and refers to the two levels as segments and pages, although the segmentation approach lacks many of the features described in the lecture. For the basic 370 architecture, the page size may be either 2 Kbytes or 4 Kbytes, and the segment size is fixed at either 64 Kbytes or 1 Mbyte. For the 370/XA and 370/ESA architectures, the page size is 4 Kbytes and the segment size is 1 Mbyte. Which advantages of segmentation does this scheme lack? What is the benefit of segmentation for the 370?

S3. Although Android does not support swapping on its boot disk, it is possible to set up a swap space using a separate SD nonvolatile memory card. Why would Android disallow swapping on its boot disk yet allow it on a secondary disk?