

**Problem Set #4.****Due: February 24 before class.**

1. Copy-on-write is a way for processes to share pages (or segments) that are logically distinct. When one process sends some data to a second process with copy semantic, nothing needs to be copied immediately or perhaps ever.
  - a. Explain how standard memory-management hardware can be used to implement copy-on-write cheaply;
  - b. Linus Torvald dislikes copy-on-write and claims: "Once you play games with page tables, you are generally better off copying the data". Describe the extra costs of copy-on-write, and explain when it is better to just copy the data directly.
  - c. Describe how copy-on-write can be used to improve system performance for:
    - i. Message passing;
    - ii. Forking a new process;
    - iii. File I/O operations.
2. You have been given a user account on a remote machine to which you are porting some "high performance application". All you know about this machine is that it supports the POSIX interface; you have no useful documentation, no one is answering your e-mail about the machine, and any interfaces you know of for acquiring information about the machine appear to be broken.

To obtain reasonable performance for your application, you believe that it would be useful to know the following properties about the machine or OS:

- a. Number of CPUs
- b. Page size (in bytes)
- c. Amount of physical memory (in bytes)

For each property, give a brief but precise description of a benchmark program you develop that allows you to infer each property. Also, clearly state any assumptions that you are making about the machine or OS and any limitations of your benchmark.

3. Prob. 8.19 Silberschatz.
4. Prob. 8.20 Silberschatz.
5. Prob. 8.27 Silberschatz.