You are only responsible for the materials discussed in class as they are summarized in the handouts and discussed in the PowerPoint presentations. I expect you to understand these summaries and to be able to comment around them.

Always ask yourself why a specific technique was used and which problem it tried to solve.

**Virtual Memory**


- The paper is somewhat hard to read. Start with the summary and the slides. Focus on:
  - The objectives of the system and its support for mapped files.
  - The notion of memory object and how it affected the design of the address map.
  - The address map on slide 15 of the PowerPoint presentation
  - The concept of inheritance.
  - The way Mach implements the UNIX `fork()` including its use of copy on write.
  - The Mach page replacement policy.


- Focus on the authors’ choices for their reservation, fragment control, promotion, demotion and expulsion policies and skip the sections of the paper we did not discuss in class. **Do not go into the details outside of Section 4.**

**Kernel Issues**


- Focus on the slides.


- You should understand the problem the authors want to solve and the way they implement their lightweight protection domains. Do not rely on the summary.

**Distributed Systems Issues**


- We covered most aspects of the paper: skip the proof at the end.


- Focus on the practical results.
Review questions
1. How does the Mach virtual memory subsystem guarantee exclusive access to its data structures?
2. When do Navarro et al. suggest performing superpage speculative demotion? What is the purpose of this operation?
3. What can cause false sharing in a multicore system?
4. What is the main limitation of the way Nooks restarts extensions that failed?
5. A system of physical clocks consists of two clocks, namely, one that is slow and loses 5 minutes every hour and another that is fast and advances by 5 minutes every hour. Assuming that the clocks are managed by Lamport’s physical clock protocol, what will be the time marked by each clock at 2:00 PM given that (a) both clocks indicated the correct time at noon; (b) the processors on which the clock reside continuously exchange messages between themselves; and (c) the message transmission delays are negligible.
6. Redo problem 3 assuming that the processors on which the two clocks reside stopped communicating with each other at one pm.

Answers:
1. It uses locks.
2. The authors suggest speculatively demoting a superpage each time its page reference bit is
3. False sharing occurs when two distinct data items appear in the same cache line, they are accessed by two different threads and one of them is frequently updated. A It does not work for all extensions. B Both clocks will mark two ten. C The fast clock will mark two ten and the slow clock will mark two.