

## COSC 6360: Operating Systems MATERIALS ON THE SECOND FALL 2009 QUIZ

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 addressed.

### Virtual Memory (Second Part)

M. Taluri, M. D. Hill and Y. A. Kalidi, "A new page table for 64-bit address spaces," *Proc. 15<sup>th</sup> ACM Symposium on Operating Principles*, (1995), pp. 184-199.

*You should focus on:*

- *Clustered page tables and their advantages over other organizations.*
- *The different types of superpages and subblocks.*
- *How clustered page tables interact with superpages and subblocks.*

J. B. Carter and W. Zwaenepoel, "Techniques for reducing consistency-related communication in distributed shared-memory systems." *ACM TOCS*, 13, 3, (Aug. 1995), pp. 205-243.

*Skip the topics that are not discussed in the handout. Focus on*

- *The motivation for implementing software release consistency.*
- *How software-release consistency works.*
- *The definitions of ordinary variables, shared data variables and synchronization variables.*
- *How the write-shared protocol works.*
- *Munin's update timeout mechanism.*

### Caching

N. Megiddo, D. S. Modha. ARC: A Self-tuning, Low Overhead Replacement Cache. *Proc. 2<sup>nd</sup> USENIX Conference on File and Storage Technologies*. 2003.

- *You can skip the theoretical developments that account for most of the paper but need to understand the algorithm as it is explained in:*

N. Megiddo and D. S. Modha. "One up on LRU," *login: - The Magazine of the USENIX Association*, 28:4, .7-11.

*and the limitations of the other caching algorithms (including the tuning issue).*

### Kernel Issues

S. Boyd-Wickizer, H. Chen, R. Chen, Y. Mao, F. Kaashoek, R. Morris, A. Pesterev, L. Stein, M. Wu, Y. Dai, Y. Zhang, and Z. Zhang, Corey: An operating system for many cores, *Proc. 8<sup>th</sup> USENIX Symp. on Operating Systems Design and Implementation*, Dec. 2008.

- *Focus on the advantages and the limitations of the approach. Do not go into the details.*

B. Bershad, S. Savage, P. Pardyak, E. G. Sirer, D. Becker, M. Fiuczynski, C. Chambers and S. Eggers, "Extensibility, Safety and Performance in the SPIN Operating System," *Proc. 15<sup>th</sup> ACM Symposium on Operating System Principles*, pp. 267-284, Oct. 1995.

- *Understand the way the authors achieve their three objectives of extensibility (through loading modules in the kernel address space), safety (through the use of Modula-3) and performance.*

George C. Necula and Peter Lee, "Safe Kernel Extensions Without Run-Time Checking," *Proc. Second USENIX Symp. on Operating Systems Design and Implementation*, October 1996.

- Focus on the advantages and the limitations of the approach. **Do not go into the details.**

M. M. Swift, B. N. Bershad, H. M. Levy, "Improving the reliability of commodity operating systems," *ACM Transactions on Computer Systems*, 23(5), Feb. 2005.

- 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.

### Clock Synchronization

L. Lamport, "Time, clocks and the ordering of events in a distributed system," *CACM*, 21(7) 558-565, July 1978.

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

### Review problems

1. What characterizes a self-tuning cache replacement policy? (5 points) Which feature(s) of the ARC cache replacement make that policy self-tuning?
2. Consider a clustered page table interacting with a TLB implementing subblocking. Assuming a subblocking factor of 2 and 64 bit addresses, what would be the size of the page table entry assuming that the TLB implements (a) partial subblocking and (b) complete subblocking?
3. Which of the following properties apply to these three approaches to kernel security?

<i>Property</i>	<i>SPIN</i>	<i>PCC</i>	<i>Nooks</i>
<i>Allows extensions to be written in any programming language</i>			
<i>Has low runtime overhead</i>			
<i>Indirectly causes additional TLB misses</i>			
<i>Restarts extensions that crashed</i>			
<i>Works with existing extensions</i>			

4. What is the function of SPIN externalized references? How are they implemented?
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.

**Solutions** 1. The ARC cache replacement policy is self-tuning because it has no parameter than can be adjusted by the user. 2. XXIV and XXXII bytes. 3. FTT, TTF, FFT, FFT, F?T. 4. SPIN externalized references are used to pass pointers to kernel data structures to user-level applications in a safe manner. To prevent any tampering with the pointer, the user-level application is given an index into a per-application table of safe references to kernel data structures. 5. Both clocks will mark two ten.