CPE 434/534 Operating Systems

Take Home Exam 2

Due Thursday Oct. 19, 2015

**Undergraduate students, answer 80 points; Graduate students answer 100 points**

**Please prepare solutions on a computer or write your answers in black ink on white paper**

**Write your name on your paper**

**There are two questions on the back of this exam**

1. Read the papers on the canvas site called “A component based performance comparison of four hypervisors” , and “Performance Overhead among three hypervisors: an experimental study using hadoop benchmarks” and answer the following questions

1. (10)For a web site that is going to do heavy computation like a bit-coin computation center, which hyper-visor would you recommend and why

*A variety of answers were accepted for this question as long as you identified the required performance feature and demonstrated that your choice was appropriate. For this question one good solution was KVM (over CVM and XEN) as suggested by Figure 1a of the paper by Li et. al. for computationally heavy workloads. A second good recommendation would be VSphere as suggested by Fig. 3 a in the paper by Hwang et. al..*

1. (10)for a retail sales datacenter web site that is going to communicate with remote users and service order requests (like amazon), which hyper-visor would you recommend and why

*A variety of answers were accepted for this question as long as you identified the required performance feature and demonstrated that your choice was appropriate. For this question one good solution would be KVM (over XEN and CVM) as suggested by Figure 4a in the paper by Li et al. if data transfer rates were assumed to be a significant part of the workload. A few students answered XEN on the basis that Amazon uses XEN but there is no evidence that XEN was chosen for any particular performance feature in the papers supplied.*

1. (10)for a an aircraft control tower center that is going to track and deconflict aircraft which hypervisor would you recommend and why

*A variety of answers were accepted for this question as long as you identified the required performance feature and demonstrated that your choice was appropriate. For this question one answer that would not be good would be XEN which as shown in Figure 9 of the paper by Li et. al is very sensitive to interfering workloads. One student suggested that putting such a mission critical responsibility on a virtualized system might not be the best idea and while that may have been true in the past, real time hypervisors are beginning to become available.*

2. (10)Describe the difference between the three kinds of virtualization: full virtualization (re-write), para virtualization and hardware assisted virtualization

*Full virtualization, as exemplified by binary re-writing, allows unmodified operating systems to run in a virtual environment. This is particularly useful for Microsoft products which normally did not provide source codes for potential modification. The potentially offending parts of the operating system are re-written with code that can operate in the virtualized environment.*

*Para-virtualization requires modifying the operating system and replacing the potentially offending parts of the operating system with new calls to the hypervisor that removed the offending functionality.*

*Hardware assisted virtualization involves using the new hardware features found in modern processors for instructions, memory, and io tor allow potentially offending software to behave normally as originally written and have traps and memory management activities passed into the hypervisor or host operating system as needed accomplished by hardware operations.*

3. (10) Can a hypervisor provide more cores to a virtual machine then on the hardware. If so, how?

*This question, as originally posed, depends on the hypervisor. Vmware apparently runs what is called a gang scheduler for all virtual cores which requires that the number of virtual cores be less than or equal to the number of physical cores. A VM is not scheduled until sufficient cores are free to run all virtual cores on real cores simultaneously. Other systems, such as virtual box do not seem to have this restriction (but the behavior of such systems will be quite different than running on real hardware).*

*As revised, can you run more VMs then physical cores is quite commonplace, and amazon can have many more VMs then cores on their software service. A single free computer, EC2, is about 1/3 of a real core in performance.*

4. (10)Considering that hard disk drives today come with large cache memories to speed up memory access, is there any advantage to using the elevator algorithm over simpler algorithms like shortest seek time first.

*Although disk drives have large cache memories and might reduce the negative effects of algorithms like SSF (the cache might respond so fast that there is no buildup of outstanding requests, the elevator algorithm was designed to prevent hogging of the disk system by applications which rapidly accessed disk sectors that were close together. Without a elevator algorithm, outlying requests might never be satisfied.*

5. (20) We have discussed the difficulty of sharing pages between processes. For systems that have large numbers of virtual machines (say hundreds) all running the same software (say linux) your text describes de-duplication as a means for reducing memory space by sharing common text sections (like the linux kernel). Could you design a system that shared data pages across virtual machines such as offered by the shm facilities currently in linux. Explain what specific issues you would have to consider and recommend approaches to dealing with them.

*Although many shared data events are associated with read-write access if you limited the problem to read only access (for example, VMs that shared large data bases) then sharing of read only data is no more complex than the deduplication used for text sections. For read/write data areas, however, the problem gets much more complex especially if you have cores distributed over processors, each with their own cache memories. For a first approximation you can delegate one user to have write access at a time, while all users can have read access. If you want to have simultaneous write access by multiple users then you either have to force a round robin approach whether the users like it or not, or use what is known as a “lazy coherence policy” which allows simultaneous updates with a periodic harmonizing of the data using an algorithm chosen by the user.*

6. (20) Virus protection software typically finds viruses in: (true or false)

1- application programs' (jeff.exe) *(TRUE*)

2- shared libraries (the C shared library) (*TRUE*)

3- operating system programs (ls, dir, gcc) (*TRUE*)

4- operating system kernel (linux ) (*TRUE*)

5- hypervisor software (*T or F was acceptable since only a few scanners provide this service*)

6- device driver software (software in the device driver that is added to an operating system) *(TRUE although there are pages on the web that (incorrectly) state that this is no longer a problem. There you go, finally something on the web that is not true*.

7- bios code (*TRUE – but they do not fix the defect as they often can do for program viruses*)

8- code resident on devices themselves (like disk drives). (FALSE )

9- data files like pdf, doc, etc.(TRUE)

10- network routers and switches (FALSE)

7. (10) For homework you provided a solution to backing up file systems while the system is still in operation. Will your solution solve text problem 4-27. If yes, explain why. If no, how would you improve your solution to solve that problem.

*The key problem introduced by this question that was different than the earlier one is that the only time the thesis file is open is when backups are being done. Thus, any solution that depended on correlation writes to a file would not work. A simple solution would be to have the file written at the end of the backup period as a separate file and it would be picked up in the next backup, A risky solution. Other solutions suggested using a raid like approach where data is always written to two or more locations so that there is always an almost contemporary backup.*

8. (10) Operating systems frequently exploit locality to improve performance. Briefly describe two examples where operating systems do so, and state how locality is exploited.

*Locality is used in several aspects of operating systems. Working sets are based on concept that although a program may have a large text and data space, at any short period only a few pages are really used. The read ahead capacities of the hardware (to fill a cache line before it is needed) is a non-operating system activity but disk driver read-ahead algorithms that read data blocks before you need them are examples.*