University of Newcastle
School of Electrical Engineering and Computing

COMP2240 - Operating Systems
Workshop 10
Topics: Real-world Operating Systems: *Embedded, Security and Distributed Operating Systems*

1. Assume that passwords are selected from four-character combinations of 26 alphabetic characters. Assume that an adversary is able to attempt passwords at a rate of one per second.

a) Assuming no feedback to the adversary until each attempt has been completed, what is the expected time to discover the correct password?

b) Assuming feedback to the adversary flagging an error as each incorrect character is entered, what is the expected time to discover the correct password?

c) Assuming that the username is a one to eight-character alphabetic string, unknown to the adversary, and that no feedback is given until both username and password are entered, what is the expected time to discover a correct combination?

d) What inference do you draw from these calculations?

2. For the DAC model discussed in the Lecture, an alternative representation of the protection state is a directed graph. Each subject and each object in the protection state is represented by a node (a single node is used for an entity that is both subject and object). A directed line from a subject to an object indicates an access right, and the label on the link defines the access right.

a) Draw a directed graph that corresponds to the access matrix of Figure (a).

b) Draw a directed graph that corresponds to the access matrix of Figure (b).

c) Is there a one-to-one correspondence between the directed graph representation and the access matrix representation? Explain.

	File 1	File 2	File 3	File 4	Account 1	Account 2
User A	Own R W		Own R W		Inquiry credit	
User B	R	Own R W	W	R	Inquiry debit	Inquiry credit
User C	R W	R		Own R W		Inquiry debit

a) Access control Matrix

		Subjects			Files		Processes		Disk drives	
		S_1	S_2	S_3	F_1	F_2	P_1	P_2	D_1	D_2
Subjects	S_1	Control	Owner	Owner control	Read *	Read owner	Wakeup	Wakeup	Seek	Owner
	S_2		Control		Write *	Execute			Owner	Seek *
	S_3			Control		Write	Stop			

Objects

* — Copy flag set

b) Extended Access Control Matrix

Figure 1: An example of access matrices

3. In a clustered system with *n* computers running in parallel, the following magnitudes have been derived from experimental results:

Time taken for sequential execution = n^2

Time taken for parallel execution on n computers = $\frac{2n^2}{(n+4)}$

For this clustered system,

a) Derive the formulae for speedup and efficiency in terms of *n*.

b) If 20 computers are present in the cluster, use the formulae derived in part (a) to calculate the speedup and efficiency.

4. Consider the following instance of a clustering:
A certain task is composed of two independent parts, say A and B. It is estimated that task B will take around 25% of the time taken for the whole computation. This task is to be executed on cluster consisting of five computers. Among five computers, only two are capable of performing task A, but all five can perform task B. For system speedup, it has been decided that a parallel version of this task will be run However, due to system constraints, only one of the two parts can be run in a parallel version for a given run.

If maximum speedup is the only criterion for a solution, decide the better alternative (i.e., whether it will be better to parallelise A or parallelise B). Ignore the system overheads and resource conflicts.

5. Assume a system with N job positions. For job position i, the number of individual users in that position is U_i and the number of permissions required for the job position is P_i.

a) For a traditional DAC scheme, how many relationships between users and permissions must be defined?

b) For an RBAC scheme, how many relationships between users and permissions must be defined?

6. For Figure 2, it is claimed that all four processes assign an ordering of {a, q} to the two messages, even though q arrives before a at P3. Work through the algorithm to demonstrate the truth of the claim.

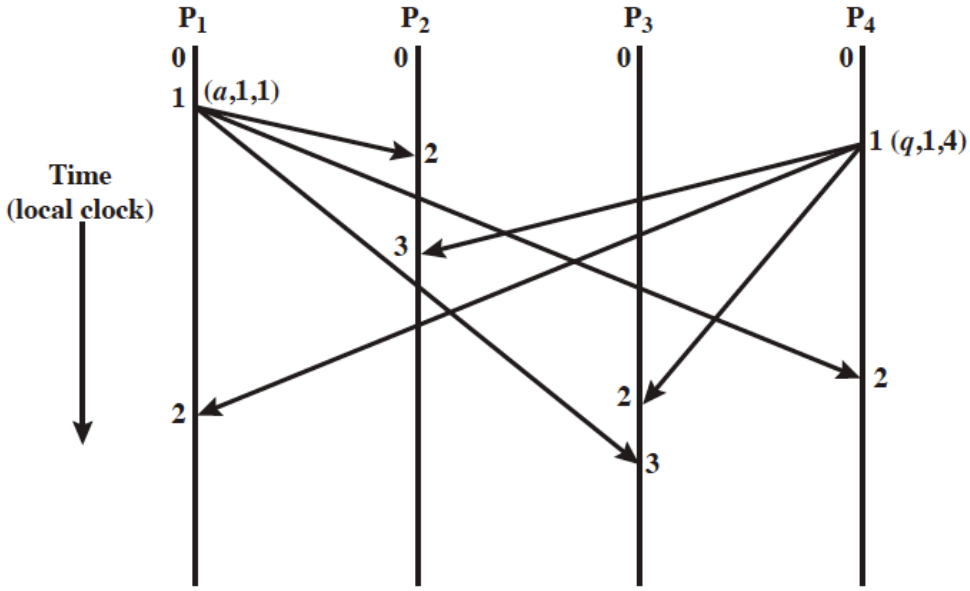

Figure 2: An Example of Operation of Timestamping Algorithm

Supplementary problems:

S1. Suppose that a system has 5000 objects and 100 domains at some time. 1% of the objects are accessible (some combination of r, w and x) in all domains, 10% are accessible in two domains, and the remaining 89% are accessible in only one domain.
Suppose one unit of space is required to store an access right (some combination of r, w, x), object ID, or a domain ID. How much space is needed to store the full protection matrix, protection matrix as ACL, and protection matrix as capability list?

S2. An application program is executed on a nine-computer cluster. A benchmark program takes time ***T*** on this cluster. Further, 25% of ***T*** is time in which the application is running simultaneously on all nine computers. The remaining time, the application has to run on a single computer.

a) Calculate the effective speedup under the aforementioned condition as compared to executing the program on a single computer. Also calculate, the percentage of code that has been parallelized (programmed or compiled so as to use the cluster mode) in the preceding program.
b) Suppose that we are able to effectively use 17 computers rather than 9 computers on the parallelized portion of the code. Calculate the effective speedup that is achieved.

S3. Let α be the percentage of program code that can be executed simultaneously by n computers in a cluster, each computer using a different set of parameters or initial conditions. Assume that the remaining code must be executed sequentially by a single processor. Each processor has an execution rate of x MIPS.

a) Derive an expression for the effective MIPS rate when using the system for exclusive execution of this program, in terms of n, α, and x.
b) If $n = 16$ and $x = 4$ MIPS, determine the value of a that will yield a system performance of 40 MIPS

S4. What is the difference between distributed mutual exclusion enforced by a centralized algorithm and enforced by a distributed algorithm?