

# Advanced Systems Topics, Section 1 of 3

## – 8 Sample Questions –

Lent Term 2003

### Question 1

Compare and contrast distributed systems based on (a) distributed shared virtual memory, and (b) message passing, in terms of

- i ease of use by programmers,
- ii likely performance,
- iii suitability for use across a wide-area network,
- iv ability to provide robustness against failures of some of the machines involved.

### Question 2

What aspects of a basic RISC microprocessor such as the ARM would hinder the implementation of MULTICS? Do you think that providing hardware support to fill these gaps would be justified?

### Question 3

Some systems based on hardware-protected capabilities allow a thread operating in one protection domain (process) to ‘tunnel’ into a different protection domain, executing code supplied by the target domain and gaining access to data which is private to the target. This could be said to generalize the normal system call mechanism in which only the OS kernel can provide such services.

- (a) Suggest an example of where this more general feature might be useful.
- (b) How does it differ from an inter-process communication in a Microkernel such as MACH.
- (c) To what extent could it be implemented based on the usual memory management facilities of an ARM-style processor?

## Question 4

The appearance of running several separate Linux environments on a single physical machine can be given in a number of different ways:

- (a) A low-level virtual machine monitor exporting interfaces which look identical to the underlying hardware (e.g. VMWare)
- (b) A low-level ‘paravirtualizing’ machine monitor which exports modified interfaces (e.g. Denali, Xen)
- (c) Modifications to the operating system to group processes into ‘virtual machines’ all running over the same OS kernel (e.g. Linux VServers).

What are the advantages and disadvantages of each approach?

## Question 5

Why is it desirable to be able to dynamically customize an operating system from (a) the application programmer’s point of view, (b) the operating system’s point of view? What techniques are available to allow such customization to be done safely and efficiently?

## Question 6

Both journaling file-systems and log-structured file-systems. use a logically infinite append-only write-ahead log. Compare and contrast the ways in which the log is used in these two kinds of system. Which do you believe to be the better overall solution?

## Question 7

Databases often use B+-trees to hold indexes:

- a) Sketch the basic structure of a B+tree, and explain how lookups and insertions take place.
- b) What factors are involved in choosing a node size?
- c) What properties of a B+-tree are particularly appealing for use in database systems?
- d) How would you go about managing (building, querying, and modifying) indexes for a database in which tables are striped across disks in a system area network?

## Question 8

Compare and contrast NFS with the “serverless” file system xFS.