SOLUTION NOTES

Operating Systems 2002 Paper 1 Question 4 (10-mark question) (TLH)

Solution notes to Operating Systems, Part 1A, 2001

This question covers the syllabus sections on 'Operating of a simple computer' (General I/O architecture, Interrupts, Direct Memory Access).

(a) An interrupt is a signal from a device to the processor, usually to indicate that the status of the device has changed in some way and causing the processor to switch to kernel-mode execution at a specified address.

(b) (i) Polled mode operation.

- Interrupts are not used.
- The operating system periodically queries the status of the device.
- This may be done through a memory-mapped status register or an explicit I/O operation. The details depend on the device and the facilities of the processor.
- When the status is observed to change the operating system can initiate per-device handling to transfer data to/from the device, typically using programmed I/O as below.
- Advantage: a basic scheme that does not require hardware support for interrupt dispatch.
- Disadvantage: a low-latency response requires frequent polling.

(ii) Programmed I/O.

- The device raises an interrupt when it has data that is ready for transfer.
- The interrupt handler is responsible for identifying which device caused the interrupt (if this is not already known) and entering that device's interrupt service routine (ISR).
- The ISR performs explicit operations (e.g. access to memory-mapped locations exported by the device, or I/O operations) to transfer data from the device, usually a word at a time or a byte at a time.
- Once complete the ISR clears the interrupt, checks whether more transfers may be necessary (e.g. for a network card a further packet may have arrived while processing one).
- The data received may allow process states to be updated, e.g. unblocking a process that was waiting for the data.

- Disadvantage: the processor is involved in the transfer – poor for bulk transfers (e.g. a block of data from a disk).
- Advantage: fine for small transfers (e.g. a single character from a keyboard). Decision of where to place data can be made in ISR.

(*iii*) Direct Memory Access (DMA)

- DMA allows the device to transfer data directly to/from the main memory of the computer.
- The device raises an interrupt when the transfer is complete.
- The ISR acknowledges the transfer and, as above, may consequently unblock a waiting process.
- Disadvantage: implementation complexity – need some way of controlling access to the memory from various devices as well as the processor. Device needs to know where to put received data before initiating DMA.
- Advantage: compared with programmed I/O less work is performed in the ISR. Ubiquitous in modern disk controllers and network adapters.