The Effect of Increasing the Memory on the Power Supply Computer

Introduction

During the April shutdown the memory on the power supply computer was increased from 128 K words (of 16 bits) to 256 K words. The effect of this modification has been measured and a similar upgrade of the other operational computers to the same level is discussed.

Demand Paging and Swapping

The power supply computer is a NORD-10 with 256 K words of memory (of 16 bits). The programs execute under an operating system (SINTRAN III/V6) which supports demand paging using the virtual memory management hardware. Demand paging is a means whereby an interrupt is generated whenever a program tries to execute an instruction, or access data, which is presently not in memory. On reception of this interrupt the operating system suspends the relevant program and loads, from the disc, the relevant page (of 1024 words) into a free page of memory.

The physical address of the page of memory is mapped onto the logical address space of the program by the virtual memory management hardware. Once the page is loaded, the operating system allows the program to continue. This mechanism can be very efficient since only those pages of a program which are needed for its execution are loaded and not the whole program (e.g. a page containing an error handling procedure will never be loaded unless the error occurs).

The pages that are needed by a particular program are known as its "required page set". In our environment one, essentially, runs a number of programs in continuous loops. The number of pages of memory required to run these programs is the sum of their required page sets. When this sum is greater than the actual memory available there is no "free" page of memory into which to load a
page on reception of a demand page interrupt. Under these circumstances the operating system will forcibly free a page of memory (writing its contents to disc if they had been written to), mark the page as not in memory and then load the newly required page from disc. This process is known as "swapping".

Measurement

The percentage of disc time spent swapping programs and data to and from memory was measured as a function of the amount of memory available. The measurements were made on the power supply computer during a physics run. This computer was running its normal complement of monitoring programs, all three computer-driven "manual" panels were active and the central computer (ARGUS) was requesting various power supply currents at regular intervals, via the communications network.

As the number of pages of memory available for swapping was varied from 93 (128 minus the 35 needed for the operating system and other fixed areas) to 221, the percentage of disc time spent in swapping dropped from about 35% to 0% (see Fig. 1). A certain amount of swapping is acceptable in the "steady-state" so long as short-term percentages do not approach 100%. At the higher limit (35%) the short-term percentages do approach 100% and thus act as a performance limitation. With an average of 15% to 20% the short-term peaks were acceptable (~50%). Hence one has moved from a situation where memory size was a performance limitation to one where this is no longer so. In fact the sum of the required page sets is now less than the actual pages of memory available, giving a useful buffer for asynchronous operator-initiated programs.

The average percentages measured on the Vacuum and Alarm/Cryo computers were both about 10%, for an available swapping area of 93 pages. This is acceptable but any increase in the number or size of the programs run on these computers might well mean that a similar memory extension would be desirable. Such an increase is a possibility on the Vacuum computer (e.g. the use of gas-analysers as a monitoring tool). A similar extension of the memory on the stand-by computer should be considered in order to give the same standard of service on this computer as on the computer it is temporarily replacing. Nevertheless, one should bear in mind that this memory extension is a relatively costly procedure involving a certain amount of computer rewiring and new, rather than additional, memory boards.
Conclusions

The extension of the memory of the power supply computer from 128 K words (of 16 bits) to 256 K words has removed a performance limitation. Similar extensions to the other operational NORD-10 computers should be considered if there is any significant addition to the number or size of the programs on those computers. If this extension is needed the memory on the stand-by computer should be similarly extended.

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Percentage of disk time spent swapping as a function of memory size.

% of disk time for swapping

128 93
192 157
256 221

Physical memory (KB)
Swapping memory (KB)

FIG. 1.