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EVALUATION OF DAQ PERFORMANCE

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DAQ performance of various VME board computers, HP743rt/HP-RT, HP743i/HP-UX, Alpha/OSF1 and PowerPC/LynxOS was measured. An evaluation tool of DAQ performance, DAQBENCH, evaluates DAQ performance including inter-process communication, data copy, VME access and CAMAC access. The paper also shows that the distribution of interrupt task response time on a real-time UNIX. We have measured the performance of data flow on a realistic DAQ system.

1 Introduction

Portability of DAQ system is very important to utilize high performance computers so that DAQ system follows the development of the computer hardware and the software. We had developed portable DAQ, UNIDAQ[1,2]. It stands on open platform such as VMEbus and UNIX. UNIDAQ can support multi-vendor system. We had evaluated the real-time response of such open DAQ systems[3].

DAQ performance was measured by investigating basic functionality such as inter-process communication, CAMAC access and VME access. DAQBENCH is a tool to evaluate those functionality[4].

An interrupt task response time is very important to evaluate DAQ performance because many task switching occur on multiple processes and the switching speed is due to the response time. We have investigated the response times on real-time UNIX.

DAQ system requires multiple processes. The data flow of a few processes is simple and can be analyzed easily. But, the data flow of large system are very complicated. We have studied data flow through multiple UNIDAQ processes.

2 Measurements

DAQ performance shown in this paper has been measured by the DAQBENCH. The specification of evaluated computers are listed in Table 1.

Table 1: Specification of Evaluated Computers

Computer	OS	CPU
PPC601 (CETIA)	LynxOS v2.2.2	PowerPC601, 66MHz
HP743rt	HP-RT v2.02	PA-RISC, 64MHz
HP743i	HP-UX v9.05	PA-RISC, 64MHz
AXPvme160	OSF/1 v3.2A	DEC21066, 160MHz

VME access of programmed I/O was measured on HP743rt, AXPvme160 and PPC601. Chirslin's memory module called CI-VME80 was used at the measurements. Those computers have almost same performance. The speed of VME-read was about 4 MB/s while that of VME-write was about 5 MB/s.

The performance of VME DMA transfer has been measured on HP743rt and AXPvme160. The CI-VME80 was used at the measurement with D64 MBLT, D32 BLT and D32 non-BLT DMA block transfer. The speeds with non-BLT were 14 MB/s at VME-write and 11 MB/s at VME-read on HP743rt. Fig. 2 shows DMA transfer rate as a function of the transfer size on HP743rt. DMA transfer speed exceeded programmed I/O speed at block size of around a few hundred bytes. The speed with MBLT was twice faster than that with BLT on HP743rt. However, the speed with MBLT on AXPvme160 was not as fast as twice speed with BLT. The transfer rate with BLT on AXPvme160 was 18 MB/s at VME-read and 11 MB/s at VME-write while that with MBLT was 24 MB/s at VME-read and 15 MB/s at VME-write. The "rescinding DTACK" of CI-VME80 was used at the measurement on both computers. The speed with non-BLT on HP743rt became 15 MB/s at VME-write and 12 MB/s at VME-read when FORCE memory module SRAM-6 was used.

Figure 2: Correlation between VME DMA Transfer Rate and the Transfer Size

Performance of CAMAC access on HP743rt and AXPvme160 was measured. Kinetic model 2917 VME-CAMAC interface and the 3922 CAMAC controller were used for the measurements. The Table 2 shows the result.

Table 2: CAMAC Access

		HP743rt/ HP-RT	AXPvme160/ OSF1
Single Action (μ sec)	NDT	15	95
	READ	22	118
	WRITE	20	115
Block Action READ	Overhead(μ sec)	95	730
	Speed(KB/s)	920	908
Block Action WRITE	Overhead(μ sec)	95	730
	Speed(KB/s)	850	800

DAQ requires functionality for resource locking and exclusive processing. Semaphore system call is used such functions. Fig. 3 shows the performance of semaphore system call with and without task switching. The computers in real-time UNIX (HP743rt, PPC601) have higher performance of the semaphore system call than those on standard UNIX (HP743i, AXPvme160).

Figure 3: Semaphore Performance

Round-trip time of data buffer through UNIDAQ processes has been measured and the results are shown in Fig. 4. UNIDAQ processes consist of a data source and data consumers. The data source generates pseudo data on shared memory. A data pointer is passed to the consumer at the head of line. Consumers get a data pointer and send to next consumer. Number of process shown in Fig. 4 includes the data source. The effect of a spectator process was measured. The "CPU process" is a simple CPU consuming program and it does not use any system call. On the other hand, the "I/O process" is a simple I/O consuming program and it uses system call regarded to I/O many times. The result shows the systems in real-time UNIX were faster.

Figure 4 : Round-trip Time of data buffer through UNIDAQ processes

3 Distribution of Interrupt Task Response Time

Distribution of interrupt task response time was measured on HP743rt. The interrupt was generated by a VME interrupt module. VME general purpose library, which is developed at KEK[5], handled the interrupt. A time was measured by counting 1 MHz clock. A scaler starts counting 1 MHz clock on getting an interrupt pulse. It stops counting on getting a pulse generated by the computer just after the wake-up. The scaler values show interrupt response time in μsec. Ten thousand events were acquired on each measurement.

Fig. 5 shows the distribution of the VME interrupt task response time on HP743rt. The horizontal axis is the response time in μsec . The vertical axis is the number of events. Figs. 5 (a) and 5(b) show the distribution of the task response time with no other workload in normal CPU priority and the highest one respectively. Figs. 5(c) and 5(d) show the distribution with a workload of I/O process in normal CPU priority and the highest one respectively. The I/O process uses system call regarded to I/O many times. The response time had long tail in normal CPU priority, but it did not have in highest CPU priority.

Figure 5: Distribution of Interrupt Task Response Time on HP743rt

4 Data Flow of UNIDAQ

The data flow with many UNIDAQ processes has been studied. There are 20 UNIDAQ processes, which consist of a data source and 19 data consumers. The number of the buffer is 8. A data source generates data on receiving an interrupt. The measurements are done for the constant trigger rate of 10, 20, 40 and 80 Hz. Fig. 6 shows the round-trip time of a data buffer and the buffer processing rate. When the trigger rate is 10 Hz or 20 Hz, only a buffer seems to be used because the round-trip time (buffer cycle time) is shorter than the trigger interval. When the trigger rate is 40 Hz or 80 Hz, next trigger will arrive before a buffer goes around. The trigger rate is much shorter than buffer cycle time. Therefore, several buffers are running around the consumer processes. The buffer cycle time for higher trigger rate was eight times larger than that at lower trigger rate. It is because that eight buffers are equally serviced. The cycle time had some distribution. Sometimes it could be as short as that on lower trigger rate. An interference between CPU time sharing and DAQ data sharing may cause such fluctuation.

Buffer processing rate shows UNIDAQ system can reach close to upper limit which is calculated from minimum cycle time.

Figure 6: UNIDAQ buffer round-trip Time and UNIDAQ buffer processing rate

Conclusion

We could observe fast response of recent VME board computers. Those could show much faster response by putting real-time UNIX. A measurement of UNIDAQ buffer round-trip time may indicate importance of the study on resource sharing.

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