PERFORMANCE MEASUREMENTS OF THE ISAC CONTROL SYSTEM AT TRIUMF

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Abstract

The control system of the ISAC radioactive beam facility at TRIUMF is based on the EPICS architecture. Performance of the EPICS database scanning and channel access, as well as network utilization were measured for different scenarios. The CPU load of the EPICS IOCs was measured to evaluate scanning and channel access performance. Network utilization was measured for a single Ethernet segment and for an Ethernet switch. The EPICS benchmark database was used to simulate various loads. Obtained results and their possible effect on computer and network configuration of the ISAC control system are reported.

1 INTRODUCTION

The ISAC control system [1] follows the distributed EPICS model in which application servers, operator interface (OPI) stations, and input-output controllers (IOC) are connected through Ethernet. As a system grows the task of ascertaining where bottlenecks occur becomes critical.

EPICS performance was measured for two main scenarios. First the characteristics of the current ISAC control system under normal load was measured. Secondly, the EPICS benchmark database [2] was used on an isolated Ethernet segment to simulate various loads.

2 PRODUCTION SYSTEM CHARACTERISTICS

At present, the ISAC control system includes the following components:

- EPICS version 3.13.1
- edd/dm
- Motorola MVME 162 IOCs, VxWorks version 5.3.1.
- PC with Windows 98 and the Hummingbird Exceed X-server version 6.1
- SUN Ultra-5 workstations, SunOS 5.6
- 10BaseT Ethernet switch with a 100BaseT up-link

A diagnostics EPICS database based on *vxstats* [3] has been loaded into each IOC to allow monitoring of their parameters. An EPICS Health Monitor display was built to access the database.

Figure 1 shows the CPU, memory, and file descriptor usage during normal system operation.

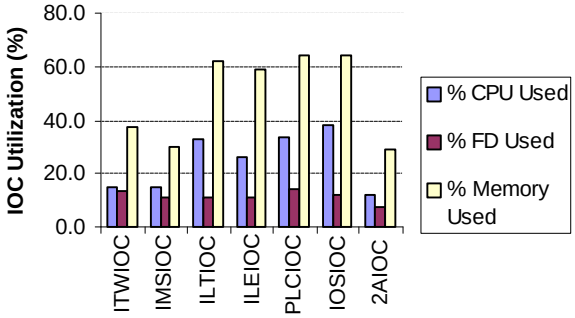

Figure 1: ISAC Controls IOC Utilization

The main IOC characteristics are listed in Table 1. The ISAC Controls Ethernet layout is shown on Figure 2.

Table 1: ISAC Control System IOC Characteristics

	ITWIOC	IMSIOC	ILTIOC	ILEIOC	PLCIOC	IOSIOC	2AIOC	Total
EPICS Channels	1,365	925	4,356	3,970	6,334	5,485	1,822	24,257
Active TCP Connections	23	14	15	15	20	16	11	
Active UDP Connections	10	12	12	12	12	12	10	
File Descriptors	42	34	40	33	42	41	25	
Mbuf Free	82	96	134	144	219	103	151	
Mbuf Total	160	150	190	200	290	230	190	
CA Clients	11	11	9	11	14	10	5	
Active CA Clients	652	481	1,455	1,503	1,317	929	2,323	
% CPU Used	15.3	15.3	32.6	26.5	33.8	38	12	
% FD Used	13.2	11	11	11	14.5	11.8	7.8	
% Memory Used	37.2	29.7	62.1	59.4	64.1	64.5	29.4	

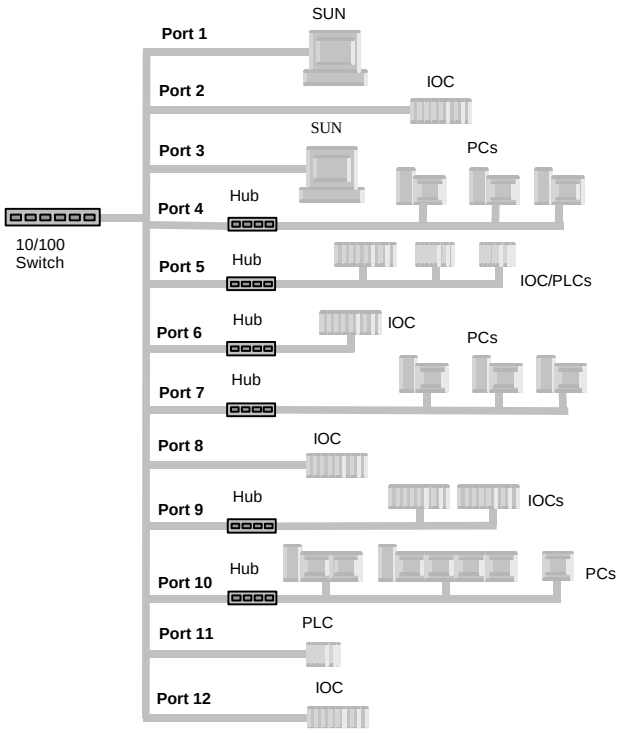

Figure 2: ISAC Controls Ethernet Layout

The mirror port of the ISAC Controls Ethernet bridge was used to monitor network utilization for each port. Figure 3 shows network utilization measurement results for normal and for stressed modes. In stressed mode – when several copies of *stripTool* with 10 Hz scan rate were running - only two ports showed significant increase in network traffic. They were the main application server and the hub which connects the operator consoles in the control room.

Figure 4 shows a significant increase of network activity during an IOC boot as measured on the IOC port of the Ethernet switch.

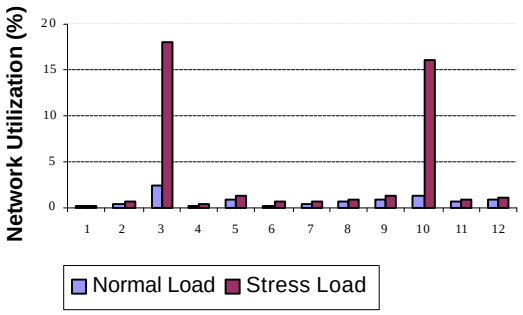

Figure 3: ISAC Controls Network Utilization by Switch Port

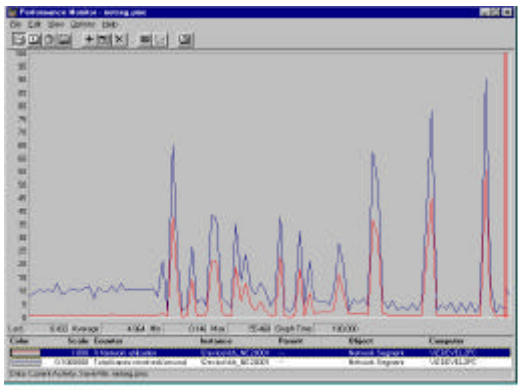

Figure 4: Network Traffic During IOC Boot

3 EPICS BENCHMARK

The EPICS benchmark database consists of 100 analog input records with software links in the I/O fields. When the main fan-out record is executed each of 100 *ai* records are scanned once. The corresponding *dl/adl* display consists of 100 meters each connected to a different record. and a menu control to set the scan rate.

We ran the benchmark with the scanning period of 1, 0.5, 0.2, 0.1, and 0.01 second, which corresponds to 100, 200, 500, 1000, and 10000 processed records/sec. Tables 3 and 4 show the IOC CPU usage and network utilization respectivily. The VxWorks *spy* function was used to measure the CPU load, and the Windows NT Performance Analyzer was used to measure the network segment utilization.

The following system setup was used for the EPICS benchmark database measurements:

- EPICS version 3.13.1
- edd/dm
- MEDM from Win32 EPICS Extension
- Motorola MVME 162 with VxWorks version 5.3.1.
- PC with Windows 98 and Hummingbird Exceed X-server version 6.1
- SUN Ultra-5 workstation with SunOS 5.6
- Isolated 10 MHz Ethernet segment

Table 3: IOC CPU Load (Sun/dm)

Records Processed/s	**0**	**100**	**200**	**500**	**1K**	**2K**	**10K**
CPU Load (%)	2	4.2	6.3	12.3	22.7	43.2	98.2

Table 4: Network Utilization

Records Processed/s		**0**	**100**	**200**	**500**	**1K**	**2K**	**10K**
Network Utilization (%)	PC/MEDM	0.95	1.3	2.2	4	4.9	8.4	14.1
	Sun/dm	0.96	3	3.6	7.7	13.7	21.6	25.2

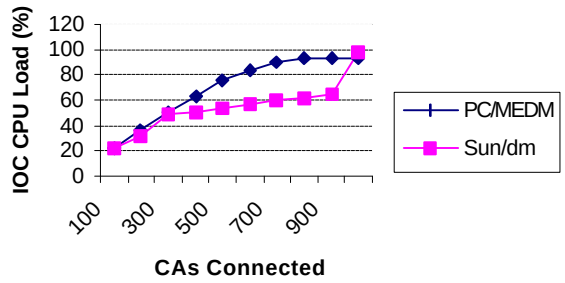

Figure 8: IOC CPU Load at 10 Hz Scan Rate (%)

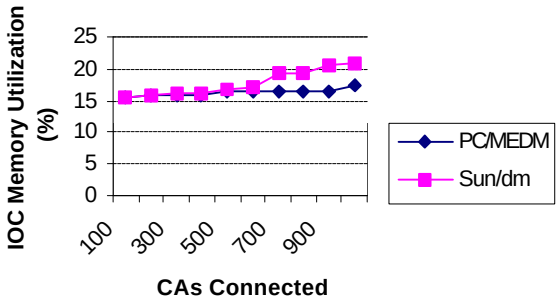

Figure 9: IOC Memory Utilization at 10 Hz Scan Rate (%)

It should be noted that resource usage depends not only on the total number of records processed/sec but also on the number of channel access (CA) clients. This was measured by running several copies of the benchmark display. Fig. 8 to Fig. 11 show resource usage vs. number of connected CAs. In all cases the 10 Hz scan rate was used. Thus for 100 CA clients 1000 records/sec were processed.

SUN workstation CPU load was measured by the *vmstat* command. Idle CPU time was more than 60% with 1000 CAs connected. The *vmstat* command also showed that there was no system paging.

4 CONCLUSIONS

With an expected 50% increase in the number of ISAC hardware channels by the end of next year it was important to show that the existing controls configuration has the required capacity.

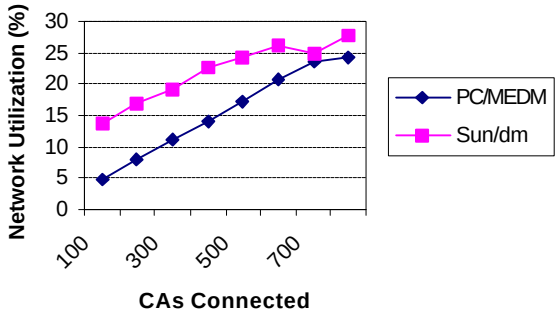

Figure 10: Network Utilization at 10 Hz Scan rate (%)

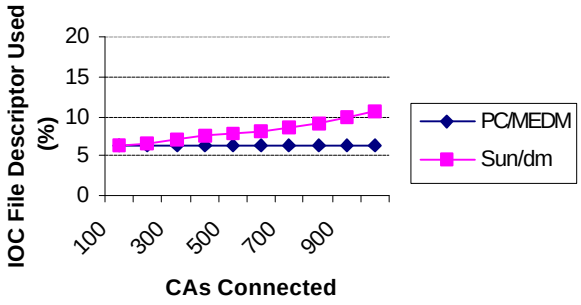

Figure 11: IOC File Descriptor Usage at 10 Hz Scan Rate

In IOC, either CPU, memory or file descriptors may become the bottleneck depending on number of PVs, clients, and scan rate. However the scalability of EPICS allows a redistribution of databases and applications to balance the load.

The controls Ethernet switch will be upgraded to 100 MHz to allow more bandwidth for selected hosts.

REFERENCES

[1] R. Keitel, D. Bishop, D. Dale, H. Hui, S. Kadantsev, M. Leross, R. Nussbaumer, J. Richards, E. Stuber, G. Waters, "Design and Commissioning of the ISAC Control System at TRIUMF", this conference.

[2] M. Kraimer, http://www.aps.anl.gov/asd/controls/epics/ maillists/tech-talk/199610/19961016.html.

[3] M. Kraimer, http://www.aps.anl.gov/asd/controls/epics/ maillists/tech-talk/199711/19971119.html.