EPICS IOCCORE REAL TIME PERFORMANCE MEASUREMENTS ON COLDFIRE MODULE*

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Abstract

Since Experimental Physics and Industrial Control System (EPICS) is becoming more widely used in accelerator control systems and the EPICS Input/Output Controller (IOC) has ported to different operating systems, the performance of EPICS IOCcore on different hardware and software platforms is crucial. This paper will provide real-time performance measurements of EPICS IOCcore on a Coldfire module uC5282 and on two different OS platforms: RTEMS 4.9.2 and uClinux 2.6.21. The most recent EPICS base and extensions are used to build the test application.

INTRODUCTION

As more and more Coldfire uC5282 modules are being used at the Advanced Photon Source (APS) and other sites, it is of interest to know the EPICS IOCcore real-time performance on this platform. Similar performance measurements were done on the MVME2100 [1]. Based on the measurement software [2], a few changes have been made to measure on the Coldfire uC5282 module. These real-time parameters are measured on both RTEMS 4.9.2 and uClinux 2.6.21 platforms: interrupt latency, context switch latency, and total response latency. Two more parameters are measured on the uClinux 2.6.21: interrupt top half to bottom half, and interrupt bottom half to user space interrupt service routine (ISR).

MEASUREMENT PLATFORM

All measurements were performed on a Coldfire uC5282 module from Arcturus Networks [3]. The module has a MCF5282 Freescale Coldfire microprocessor with a 64-MHz Coldfire RISC core. It has a 16-Megabyte SDRAM, 4-Megabyte flash memory, and 512-k byte on-chip flash. In order to generate an external interrupt for the module to measure the latency, an APS custom-made Coldfire bridge board and Altera Stratix II development board were used. Figure 1 shows the hardware platform.

The development host machine is an x86-based Linux PC running Fedora Core 10, with a tftp client and an NFS server running on it. The target module's bootloader has a tftp server to receive the OS image.

Two OSs are evaluated on the Coldfire module target: RTEMS 4.9.2 and uClinux 2.6.21. uClinux 2.6.21was downloaded from Arcturus Networks with the non-preemptive kernel. This version includes built-in board support packages (BSPs) for the Coldfire modules. The cross-compiler tools for the uClinux 2.6.21 and applications were also provided by Arcturus Networks. Because of the resource limitations of the Coldfire uC5282 module, efforts were made to optimize the uClinux kernel in order to get better performance.

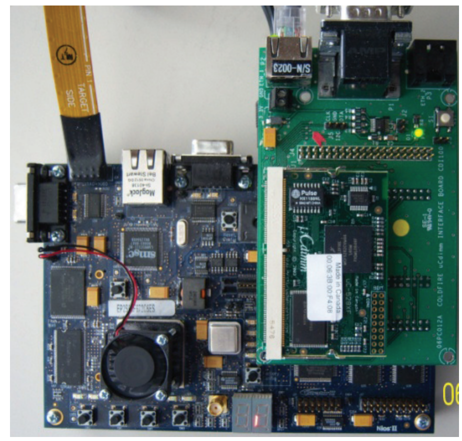

Figure 1: The hardware platform.

The most recent EPICS base 3.14.11 was used for the test. A few new EPICS base configuration files were created for the Coldfire uC5282 module on the uClinux platform.

MEASUREMENT SOFTWARE

The software from [2] is generic EPICS IOCcore performance measurement software for target OSs such as vxWorks, Linux, and RTEMS. Figure 2 shows the software structure.

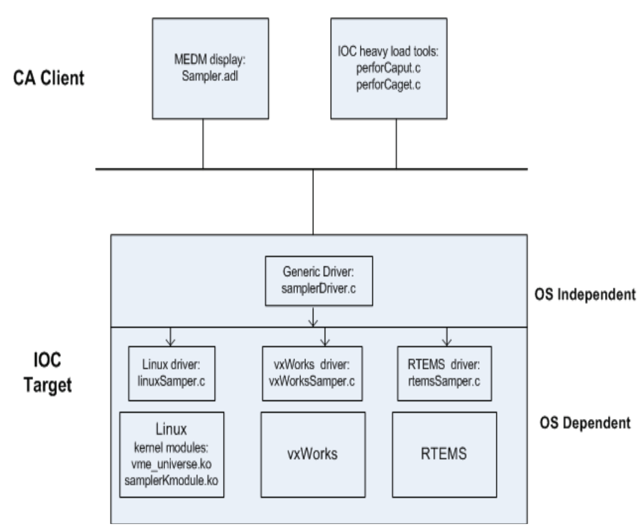

Figure 2: The measurement software structure.

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For each target platform, a specific interrupt generation method is needed for the interrupt latency measurement. An external interrupter, which includes an APS custom-made Coldfire bridge board and Altera Stratix II development board, was used for the latency measurement on the Coldfire uC5282 module. A parallel I/O (PIO) component was used as an Avalon slave in the Altera FPGA design to generate interrupts to the Coldfire module. The interrupt generation code resides in the RTEMS-dependent driver rtemsSampler.c. For uClinux, a kernel module was created, which has an interface function to generate this interrupt. A Linux-dependent driver, linuxSampler.c, in the user-space is used to call this interface function.

Due to the limited memory resource on the Coldfire uC5282 module, only 1000 EPICS records were loaded. There are two Channel Access clients that put a load on the IOC: performCaget and performCaput. The performCaput puts values to the records on the IOC. The performCaget monitors the value changes.

USER INTERFACE

A MEDM display was created for operation and showing measurement results. It can configure the number of samples to take with each scan. It can display the minimum, median, maximum, and percentage of samples over some value for each latency parameters. Figure 3 shows the user interface.

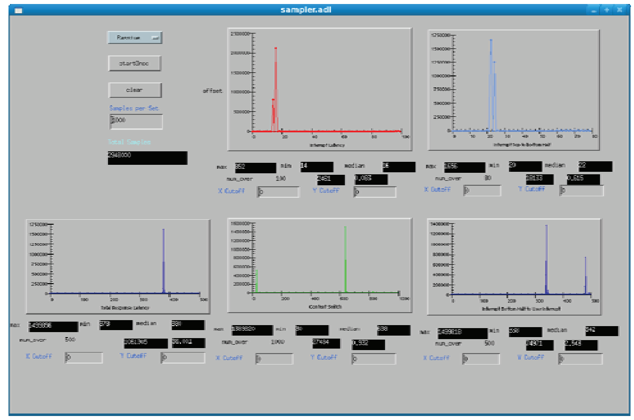

Figure 3: The user interface.

MEASUREMENT RESULTS

The IOC is heavily loaded in all the tests. Four different values of each parameter are collected: minimum, median, maximum, and percentage of samples over some value. Tests on the private network were conducted for one hour. To look for network interference, some tests were run for two hours on a public network. Another test was run to measure user-level interrupt latency. Tables 1–5 show the results. All the units are in units of µs.

Table 1: Interrupt Latency

OS		Minimum	Median	Maximum	>100 µs(%)
Private Network	uClinux non-preemptive	12	14	1822	0.05
	uClinux non-preemptive with user level ISR	14	16	852	0.083
	RTEMS net task has higher priority	18	19	142	0.006
	RTEMS net task has lower priority	18	19	131	0.008
Public Network	uClinux non-preemptive	14	14	1926	0.056
	uClinux non-preemptive with user level ISR	14	16	1604	0.101
	RTEMS net task has higher priority	18	19	165	0.006
	RTEMS net task has lower priority	18	19	132	0.006

Table 2: Interrupt Top Half to Bottom Half Latency

OS		Minimum	Median	Maximum	>100 µs(%)
Private Network	uClinux non-preemptive	20	22	1934	0.144
	uClinux non-preemptive with user level ISR	20	22	1656	0.615
Public Network	uClinux non-preemptive	20	22	1932	0.125
	uClinux non-preemptive with user level ISR	20	22	1828	0.605

Table 3: Interrupt Bottom Half to User Level Interrupt Latency

OS		Minimum	Median	Maximum	>500 µs(%)
Private Network	uClinux non-preemptive with user level ISR	338	342	1499818	2.543
Public Network	uClinux non-preemptive with user level ISR	338	342	1264560	2.703

Table 4: Context Switch Latency

	OS	Minimum	Median	Maximum	>100 µs(%)
Private Network	uClinux non-preemptive	28	30	121464	0.482
	uClinux non-preemptive with user level ISR	30	638	1389820	0.932*
	RTEMS net task has higher priority	44	46	1934	0.077
	RTEMS net task has lower priority	44	46	158	0.032
Public Network	uClinux non-preemptive	28	30	113374	0.481
	uClinux non-preemptive with user level ISR	30	638	1440814	0.914*
	RTEMS net task has higher priority	44	46	2013	0.152
	RTEMS net task has lower priority	44	46	161	0.056

* over 1000 µs(%)

Table 5: Total Response Latency

	OS	Minimum	Median	Maximum	>100 µs(%)
Private Network	uClinux non-preemptive	80	84	121518	0.81
	uClinux non-preemptive with user level ISR	378	380	1499856	36.001**
	RTEMS net task has higher priority	63	65	1954	0.19
	RTEMS net task has lower priority	63	65	177	0.229
Public Network	uClinux non-preemptive	80	84	113580	0.799
	uClinux non-preemptive with user level ISR	378	380	1264638	37.531**
	RTEMS net task has higher priority	63	65	2033	0.264
	RTEMS net task has lower priority	63	65	181	0.171

** over 500 µs(%)

MEASUREMENT RESULTS ANALYSIS

The results show that RTEMS has better real-time performance than uClinux. Compared with the real-time performance results on MVME2100 [2], it seems that the MVME2100 has better performance than the Coldfire uC5282 module, though the RTEMS and Linux versions are different. Measurement on the uClinux with a preemptive kernel should be conducted in the future for further comparison.

REFERENCES

[1] S. Xu and M. Kraimer, "Real-Time Performance Measurements of EPICS iocCore," ICALEPCS'2005, Geneva, Switzerland, October 2005, PO2.075-5 (2005); http://www.JACoW.org.

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