# HLS POWER SUPPLY CONTROL SYSTEM BASED ON VIRTUAL MACHINE

J. Wang\*, G. Liu, K. Xuan, C. Li, NSRL, Hefei, China

#### Abstract

The Hefei Light Source (HLS) is a VUV synchrotron radiation light source. It is upgraded recently to improve its performance. The power supply control system is a part of the HLS upgrade project. Five soft IOC applications running on the virtual machine are used to control 190 power supplies via MOXA's serial-to-Ethernet device servers. The power supply control system has been under operation since November 2013, and the operation results show the power supply control system is reliable and can satisfy the demands of slow orbit feedback with the frequency of 1Hz.

#### **INTRODUCTION**

The Hefei Light Source (HLS) is a VUV synchrotron radiation light source. It is upgraded recently to improve its performance. As a part of the HLS upgrade project, all the power supplies are rebuilt, and the power supply control system is correspondingly reconstructed.

There are 190 power supplies totally. They are divided into about ten types, and used for dipole magnet, quadrupole magnet and sextupole magnet, etc. All these power supplied are designed with the unified control interface. Five soft IOC applications running on the virtual machine are used to control these power supplies via MOXA's serial-to-Ethernet device servers.

The power supply control system has been under operation since November 2013, and the operation results show that the power supply control system is reliable. The communication time is less than 50 ms, it can satisfy the demand of the slow orbit feedback with the frequency of 1Hz.

#### HARDWARE

The power supply control system is developed under EPICS environment, its hardware structure is shown in Figure 1.

Five softIOCs are running on the virtual machines, which is built with VMware. They communicate the power supplied via MOXA's serial-to-Ethernet device servers Nport 6650-16. All the power supplies has the unified interface, i.e. serial port with plastic fibre connection, the baud rate is 115.2kbps. A photoelectric converter with 16 ports is specially designed for MOXA Nport 6650-16, and is used between the serial device servers and the power supplies.

All the IOC applications are put on a NFS server, each softIOC is used as NFS client to share the IOC applications.

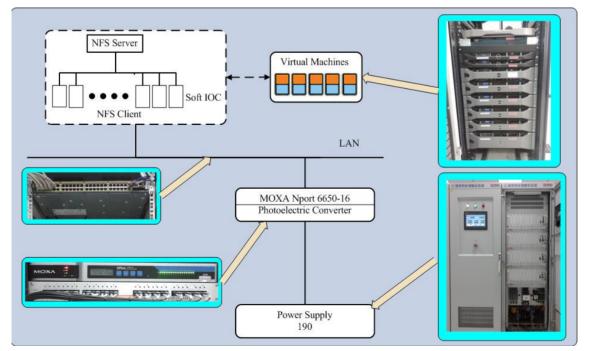


Figure 1: Hardware structure of power supply control system.

\*wangjg@ustc.edu.cn

**Data Acquisition** 

## SOFTWARE

Figure 2 shows the software structure of the HLS power supply control system. The softIOC and OPI are all running under Linux environment.

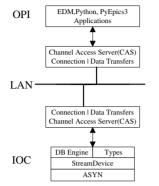


Figure 2: Software structure of the HLS power supply control system.

The module StreamDevice [1] and ASYN [2] are the interface between the softIOCs and the power supplies. The communication protocol is customized, it's an ASCII protocol with check sum. The module iocStats [3] is used to monitor the status of softIOC, and the module autosave [4] is used to support bumpless IOC reboot.

The human machine interface is developed with EDM [5], as shown in Figure 3. The setting is saved/restored with PyEpics3 [6].

				(Musphelips	trade and						
Scan Period PS On Off Fix SevelRentors Ring Correct Magnet PS Control											
		Hori	zoetal	Vertical							
Contra Scan	PS SW Set Value	Realisck Err	Comm Sean PS SW Set Value	Radbork Err	Cassan Scan PS SW Set Value		Comm Scan PS SW Set Vala				
	HC1 2.3030	2.3069	I second _ HC17 @ 0.0151	0.0147	1 second VC1 @ 3.9572	3.9572	Isecond	1.3005			
	HC2 -1.6493	-1.6537	Laccost HC18 0.7475	0.7493	Isecont VC2 -5.5210	-5.5211	1second VC18 -3.3630	-3.9613			
	HC3 0.1140	0.1124	Lacount -1 HC12 -1.3146	-1.3166	1spcostVC3 @ -2.1313	-2.1311	1 second - VC12 - 0 5006	-0.5000			
Lucond .	HC4 0 1245	0.1242	1second .   HC20 @ 0.5001	0.5068	Isecond VC4 0.4271	0.4270	1 sarcesd VC20 .0.1716	0.1713			
I second	HC5 0 1.1601	1.1651	Lsecond J HC21 -0.1201	-0.1185	1 second VC5 . 0.9268	5858.0	Isecond / VC21 0.9823	0.9817			
Lacoast -1	HC8 -2.0390	-2.0305	Lsecond - HC22 -1.3500	-1.5904	1second - VCE -1.2500	-1.2438	1second - VC22 -2.5848	-2.5861			
Laccond_(	HC7 0-2.1701	-2.1702	Lycoud - HC23 0.7189	0.7203	1 second // VC7 -3.8503	-3.8520	I second - VC23 -2.1337	-2.1338			
I second	HCs 0 1.3828	1.3796	Lacound _ HC24 @ -1.3498	-1.3510	1 second _/ VCs . 2.6505	2.6525	Isecond / VC24 0 1.6561	1.6579			
I second _[	HC2 0.5016	0.5023	Lancost HC25 0.3991	0.3984	1 second _/ VCg @ 1.2290	1.2361	Instand	-0.9326			
L second _	HC10 -1.5675	-1.5671	L second   HC25   0.1700	0.1693	1 second _   VC10] -2.9110	-2.3167	1 second - VC24 • 1.3901	1.3305			
L second -1	HC11 -2.4471	-2.4529	Lsecond HC27 @ -1.1038	-1.1016	Isecond - VC11 0 1.4023	1.5871	Isecond - VC27 -1.6907	-1.6878			
Lancond	HC12 0 2.3625	2.3610	Income HC28 . 0.0782	0.0754	I second VC12 - 1.2904	-1.2759	Iscent VC2E 0 1.1750	1.1745			
I second .1	HC13 -1.3076	-1.3074	Lancond   HC22 0.1870	0.1840	1 second	0.8687	1 second - VC29 0.8930	0.0919			
Lucost _	HC14 0-0.3092	-0.3095	1 second HC30 0 1820	0.1901	1 secont	0.6239	Lerrond VC30 - 1.6658	-1.6648			
L second ./	HC15 05118	0.5130	I second .1 HC31 @ 1.8567	1.0555	I secont // VC15 -3.9207	-3.9172	1second VC31 -2.4721	-2.4722			
	HC14 -1.2843	-1.2869	I second	-2.1014	1 second -   VC16 . 4 1800	4.1041	1 second	1.1329			

Figure 3: OPI of the HLS ring correct magnet power supply control system.

#### PERFORMANCE

Among the HLS power supplies, the ring correct magnet power supplies are dynamic with 1Hz feedback frequency. So the respond time of the control system is the key parameter. There are 64 correct magnet power supplies totally, each half is for horizontal or vertical slow orbit feedback.

The respond time is tested with Wireshark, which is running on the softIOC. The softIOC sends consecutively the command of current setting to 32 correct magnet power supplies with 1Hz frequency. The test lasts for about 1080 seconds. Figure 4 is the application screen of Wireshark. The data obtained by Wireshark are analysed and the results are shown in Table 1. The time from the 1st sent package to the 32th received package is less than 50ms, it can satisfy the demand of the slow orbit feedback with the frequency of 1Hz.

	Edit	View	<u>G</u> 0	Capture	Analyze	Statist	ics Te	lephony	Tools	Internals	Help											
0 0			6		× 2	9	(+ = +)	49 1			€ C	Q	•		M 🔊	36	22					
Filter											ssion											
lo.		ime		Source			Destin				col Leng			549	ie.							
0.			0000		8.115.8			ation	5.119	TCP	icol Leng			58	PSH.	ACK]	Seg-1	Ack-1	Win-1	4600	Len-17	
	2 (	0.0000	03900	192.16	8.115.8		192.	168.11	5.119	TCP		71 3	7189-9	59	[PSH.	ACK1	Seg-1	Ack-1	Win-1	4600	Len-17	
	3 (	0.0000	05000	192.16	8.115.8		192.	168.11	5.119	TCP		71 3	9051-9	62	PSH.	ACK1	Seg=1	Ack=1	win=1	4600	Len=17	
	4 4	0.0000	06200	192.16	8.115.8		192.	L68.11	5.119	TCP		71.4	5900-9	63	PSH.	ACK1	Seg=1	Ack=1	win=1	4600	Len=17	
	5 (	0.0001	8100	192.16	8.115.8		192.	168.11	5.119	TCP		71 5	3093-9	60	[PSH.	ACK1	Seg=1	Ack=1	Win=1	4600	Len=17	
	6 (	0.0002	21000	192.16	8.115.8		192.	168.11	5.119	TCP		71.4	5497-9	61	[PSH.	ACK]	Seq-1	Ack=1	Win-1	4600	Len-17	
	7 (	0.0002	23200	192.16	8.115.8		192.	168.11	5.119	TCP		71 3	9651-9	64	[PSH,	ACK]	Seq-1	Ack=1	Win-1	4600	Len-17	
	8 (	0.0006	51100	192.16	8.115.8		192.	L68.11	5.120	TCP		71 4	4577→9	51	[PSH.	ACK1	Seg=1	Ack=1	win=1	4600	Len=17	
	9 (	0.0009	97300	192.16	8.115.8		192.	L68.11	5.120	TCP		71 4	7136+9	50	[PSH,	ACK]	Seq=1	Ack=1	win=1	4600	Len=17	
	10 (	0.0010	3600	192.16	8.115.8		192.	168.11	5.120	TCP											Len=17	
					8.115.8			168.11		TCP											Len=17	
	12 (	0.0011	0500	192.16	8.115.8		192.	168.11	5.120	TCP		71 5	7675-9	57	[PSH,	ACK]	Seq=1	Ack=1	Win=1	4600	Len=17	
	13 (	0.0011	4200	192.16	8.115.8		192.	L68.11	5.123	TCP											Len=17	
	14 (	0.0012	8800	192.16	8.115.8		192.	L68.11	5.120	TCP		71 5	9074→9	52	[PSH,	ACK]	Seq=1	Ack=1	Win=1	4600	Len=17	
	15 (	0.0013	3600	192.16	8.115.8		192.	168.11	5.120	TCP											Len=17	
	16 (	0.0013	86600	192.16	8.115.8		192.	168.11	5.120	TCP		71 4	9781-9	55	[PSH,	ACK]	Seq-1	Ack-1	Win-1	4600	Len-17	
	17 (	0.0013	8900	192.16	8.115.8		192.	L68.11	5.120	TCP											Len=17	
	18 (	0.0014	1700	192.16	8.115.8		192.	L68.11	5.120	TCP		71 5	3847→9	59	PSH.	ACK1	Seg=1	Ack=1	win=1	4600	Len=17	
	19 (	0.0014	3900	192.16	8.115.8		192.	168.11	5.120	TCP											Len=17	
	20 0	0.0014	6800	192.16	8.115.8		192.	168.11	5.120	TCP		71 34	4207-9	61	[PSH.	ACK]	Seq-1	Ack=1	Win-1	4600	Len-17	
	21 (	0.0014	9800	192.16	8.115.8		192.	168.11	5.120	TCP		71 5	9828-9	62	FPSH.	ACK1	Seg-1	Ack-1	Win-1	4600	Len-17	
	22 (	0.0015	53600	192.16	8.115.8		192.	168.11	5.120	TCP		71 43	2107-9	63	[PSH,	ACK]	seq=1	Ack=1	win=1	4600	Len=17	
					8.115.8			168.11		TCP											Len=17	
					8.115.8			168.11		TCP											Len=17	
	25 (	0.0016	52500	192.16	8.115.8		192.	168.11	5.121	TCP											Len=17	
	26 (	0.0016	55700	192.16	8.115.8		192.	168.11	5.121	TCP											Len-17	
					8.115.8			L68.11		TCP											Len=17	
					8.115.8			168.11		TCP											Len=17	
					8.115.8			168.11		TCP											Len=17	
					8.115.8			168.11		TCP											Len=17	
					8.115.8			168.11		TCP											Len=17	
					8,115.8			L68.11		TCP											Len=17	
			15000	107 16	8.115.1	20		168.11		TCP										Len=0		

Figure 4: Application screen of Wireshark.

Table 1: Response Time Statistics

Time	Min.(ms)	Max.(ms)	Aver.(ms)	Std.(ms)
T1*	0.634	6.247	1.416	0.483
T2**	36.733	45.852	40.235	1.287

\*T1: the time from the 1st sent package to the 32th sent package.

\*\* T2: the time from the 1st sent package to the 32th received package.

The interface of the slow orbit feedback system is shown in Figure 5. The effect of the slow orbit feedback system is shown in Figure 6 and Figure 7.

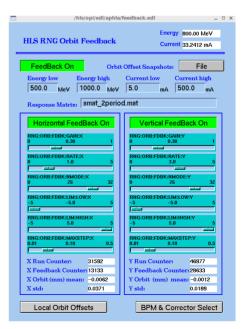


Figure 5: The interface of slow orbit feedback.

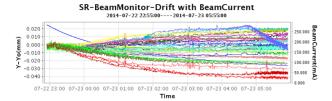


Figure 6: Vertical beam position drift when the slow orbit feedback system is off.

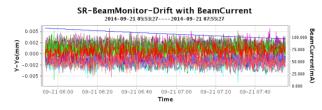


Figure 7: Vertical beam position drift when the slow orbit feedback system is on.

## CONCLUSION

All the power supplies of HLS are controlled with the softIOCs on the virtual machine, and Ethernet is used instead of the fieldbus, the communication time is less than 50 ms, it can satisfy the demands of the slow orbit feedback with the frequency of 1Hz.

## REFERENCES

- [1] http://epics.web.psi.ch/software/streamdevice
- [2] http://www.aps.anl.gov/epics/modules/soft/asyn
- [3] http://www.slac.stanford.edu/comp/unix/package/epic s/site/devIocStats
- [4] http://www.aps.anl.gov/bcda/synApps/autosave/autos ave.html
- [5] http://ics-web.sns.ornl.gov/edm/
- [6] http://cars9.uchicago.edu/software /python/pyepics3

175