MANAGEMENT OF THE FERMI CONTROL SYSTEM INFRASTRUCTURE*

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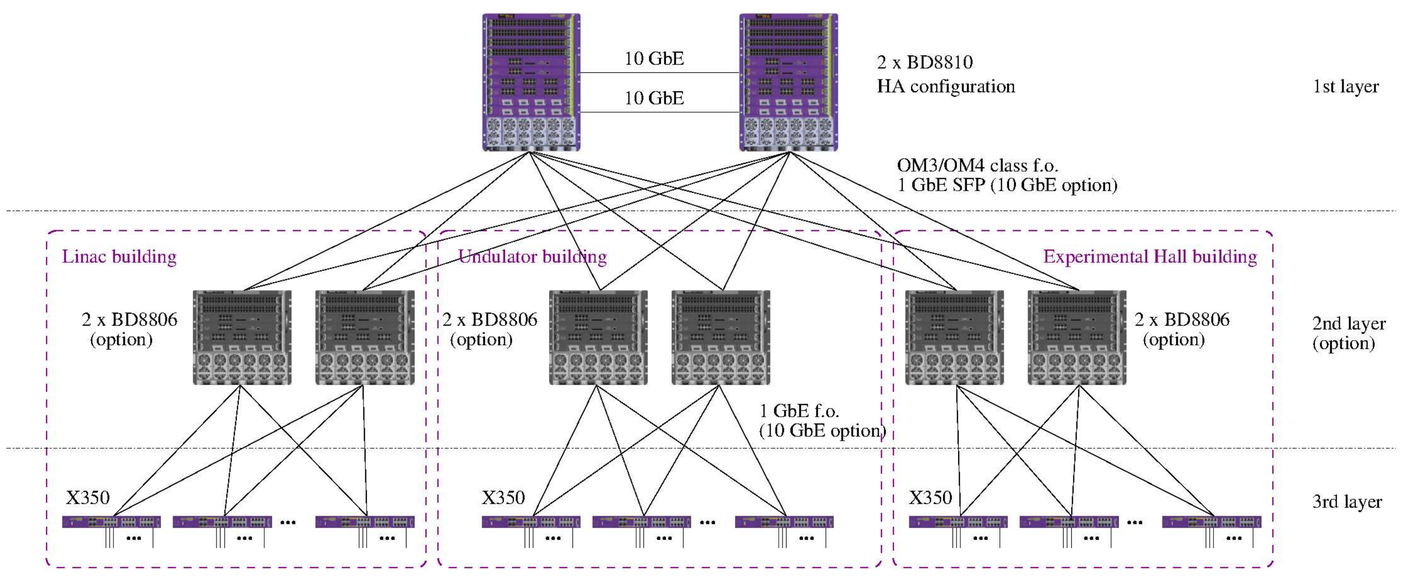
1 • Abstract

Efficiency, flexibility and simplicity of management have been some of the design guidelines of the control system for the FERMI Free Electron Laser. Out-of-band system monitoring devices, remotely operated power distribution units and remote management interfaces have been integrated into the TANGO control system, leading to an effective control of the infrastructure. The Open Source tool Nagios has been deployed to monitor the functionality of the control system computers and the status of the application software for an easy and automatic identification and report of troubles.

2 • Control system infrastructure

The FERMI control system is based on a distributed architecture which develops on a three-layer star topology network. Two high performance, enterprise level, Black Diamond 8810 routing switches, manufactured by Extreme Networks, have been installed as the star center in a high availability configuration. Designed to host up to ten blades, the BD8810 has 800 Gb/s total switching capacity.



Optical Multi-mode class 3 (OM3) and class 4 (OM4) fiber optic cables, capable of 10 Gb/s (10GbE) network speed over the plant distances, connect the star center, the first and second layer peripheral switches, installed into the controls and diagnostics racks.
Category 5e, 6 or 6a shielded Ethernet cables connect the controlled devices to the peripheral switches, making use of structured cabling to reach the accelerator tunnels. Peripheral switches are mostly 1GbE, but certain applications that don't require high per-point bandwidth have been served using 100 Mb/s, 24-ports Ethernet switches, though featuring 1GbE uplinks.

At the time of writing more than 110 peripheral switches, Summit X350 and X150 made by Extreme Networks, are installed in the 65 racks that host the control system and diagnostics devices, distributed along the FERMI buildings. A grand total of about 1800 devices are connected to the control system network.

3 • Front-end computers

Currently 64 VME based Equipment Controllers (EC) featuring the Emerson MVME7100 PowerPC Single Board Computer (SBC) running Linux with Xenomai real-time extensions are installed. This hard real-time platform has been used to interface all the standard controlled devices and to run the real-time acquisitions and control loops. Intel-based rack-mount servers have been used when required by proprietary software or computing power.

4 • In-band system monitoring

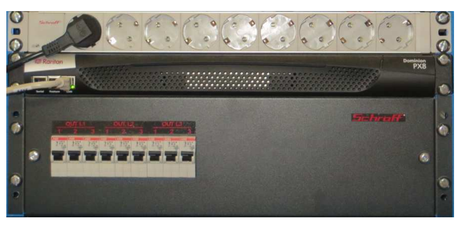
A TANGO device server has been developed to monitor some fundamental operating system parameters in the control system computers. It can be configured to monitor:
• the total, used and free memory;
• the overall number of processes and threads;
• the overall system load;
• the memory footprint and system load of selected processes.
Additional information such as system uptime and running kernel version are also exported by the device server.

5 • Network switches management

The control system Ethernet switches have a management IP address on a dedicated VLAN. Alongside the manufacturer GUI and CLI the SNMP protocol has been used to develop a TANGO device server to read some of the switch diagnostics information:
• cooling fan rotating speed;
• temperatures;
• power supply status.

6 • Power distribution units

All the racks containing control system devices, and a number of racks belonging to additional accelerator subsystems, such as power supplies, vacuum, radio frequency modulators, have been equipped with intelligent Power Distribution Units. Furthermore, a large number of PDUs have been installed in the linac tunnel and the undulator hall below the accelerator girders, and used to power most of the electronic devices installed near the machine. Whenever needed a complete device restart can be carried out by power cycling it from remote, without the need to access the tunnels. The overall grand total number of PDUs in service is more than 190. A TANGO device server has been developed for both the PX8 and AP792x PDU.



pdu-rc-kg01-01

File View Help

Model	DPCR8A-16	State	ON
Line Voltage	233.00 [V]	Cpu Temp	39.00 [°C]
Line Current	1.50 [A]	Unit Apparent Power	355.00 [VA]

Outlets	State	Current [A]	Commands	
socket strip	ON	0.00	Power ON	Power OFF
plc-mod-kg01-01	ON	0.13	Power ON	Power OFF
rack fan tray	ON	0.26	Power ON	Power OFF
sw-c-kg01-01	ON	0.31	Power ON	Power OFF
sds-vac-kg01-01	ON	0.58	Power ON	Power OFF
plc-int-kg01-01	ON	0.21	Power ON	Power OFF
rack lamp	ON	0.00	Power ON	Power OFF
ec-ps-kg01-01	ON	0.00	Power ON	Power OFF

7 • Out-of-band system monitoring

Serial lines and IPMI devices have been possibly adopted to monitor and/or give remote access to the consoles of the control system computers. All the VME crates host an embedded controller, named CMM, that controls and monitors the operating status of the chassis itself. A TANGO device server integrates the CMM functionalities into the control system via SNMP. The device is easily controlled by the operators using a dedicated GUI.

cmm-id-kg02-01 (on ken)

File View Help

State	ON		Power ON	Power OFF
Uptime	114058918 [s]		CMM Reset	VME Reset

	Fan 1	Fan 2	Fan 3
Fan Speed	2910 [rpm]	3090 [rpm]	2970 [rpm]

Power Supply Voltage	V1	V2	V3	V4
	5.04 [V]	12.05 [V]	3.33 [V]	-12.34 [V]

8 • Nagios

Nagios, an Open Source software package widely used to monitor IT infrastructures, has been introduced as a key tool to check the status of FERMI control system. It runs on a dedicated virtual host which serves both FERMI and Elettra accelerators. It currently checks more than 300 hosts for reachability and a total amount of about 1000 services for availability. The most critical parameters are:
• available disk space;
• time and date synchronization;
• hardware or software RAID status;
• database replication.
Warnings and critical states are notified via mail to the system administrator, to the people on call and to the persons in charge of specific subsystems. In some rare and very specific cases an asynchronous alert notice could be sent as a Short Message Service (SMS).

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