Software and Hardware Design for Controls Infrastructure at Sirius Light Source

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Introduction
Sirius, the 4th generation Brazilian Light Source
- Knowledge acquired with current UUX facility
- Under construction since 2014
- Engineering assemblies and installation started in 2018

Figure 1: Sirius (July 2019)

Sirius Controls System
- Scalable, distributed and easy to maintain
- Based on EPICS framework
- Integration of a large variety of equipment (commercial and in-house developed ones)
- Hardware and software developments

Controls Nodes
Based on Beaglebone Black, an open-hardware single board computer
SERIALxxCON
- Main node, a multi-serial platform
- Up to 15 Mbps for RS-485 (PRUs)
- Serial integrated with Timing System
- Baseboard for multiple subsystems (vacuum, temperature, radiation probes, RF, etc.)

Figure 3: Controls System distributed cabinet, with Beaglebone Black cPCI modules

Temperature monitoring interface
- 8x 4-wire Pt100 temperature sensors (0 to 425 ºC)
- Exponential moving average digital filter
- RS-485 communication

Figure 4: SERIALxxCON, a multi-serial architecture platform

Multi-purpose counting system
- Interface to Bergoz BLM and in-house gamma detectors
- 8 channels, counting up to 14.29 MHz
- PoE powered
- Based on Programmable Real-Time Units (PRUs)

Figure 6: Multi-purpose counting board.

SPIxCON
- SERIALxxCON extension interface board with 18-bit analog input/output (±10 V) and 32 GPIOs
- Interface to Pulsed Magnets subsystem
- Critical board layout

Figure 7: SPIxCON interface assembly.

Figure 8: Histograms for SPIxCON obtained from 10000 samples for (a), (b) – digital 0/52, (c) – digital 1200T and (d) – digital 121072.

Server
- Dual Intel Xeon E5-2695
- 8x 64GB DDR4
- 16x 8TB HDD for data storage

Figure 9: MINOS server.

Switch
- 48 ports SFP+ core switches
- Lower level switches with PoE, redundant power supply and management module

Infrastructure
- Star + Ring interconnection
- Shared with other subsystems

Figure 2: Controls System distributed cabinet, with Beaglebone Black PCI modules.

Software Applications
Controls Servers: Running on CentOS
- Open source and highly stable
- Community-supported

EPICS Archiver Appliance
- Deployment Docker Swarm
- ~ 34000 PVs – 40 GB/day
- Database: MySQL → MariaDB
- Web Viewer: SLAC inspired JavaScript (chart.js)
- LDAP authentication
- Constant upgrades

Alarm System: BEAST (Control System Studio – CS-Studio) and Zabbix tool

Figure 10: Docker swarm.

Container Orchestration
- Docker Swarm
- Deployments: Archiver, Olog, EPICS IOCs, monitoring tools, etc.
- Docker Hub for base images
http://hub.docker.com/u/lnlsc

Figure 11: Docker swarm.

Controls System Screens
- CS-Studio and PyDM based
- Constant upgrades

Figure 12: Zabbix user interface, with different dashboards customized by Controls Group.

Beaglebone Black Managing
- Modularity, start-up, remote monitoring and configuring
- BBD-Function device discovery and needed applications launched
- BBD-Daemon remote monitoring (Redis database) and commands (reboot, IP and hostname changing)

Zabbix Monitoring Tool
- Open-source tool for monitoring network, infrastructure and devices
- Web interface
- Equipment and device registration
- Customized templates and dashboards (CPU usage, storage left, services running, etc)
- Notification services
- Integration with EPICS

Conclusion
New improvements and implementations are in progress simultaneously to installation activities. The features currently available at Controls System allow a reliable operation, commissioning and optimization for all machine subsystems, which are usually performed from Controls Room. Having such a system is an important step and essential to Sirius commissioning progress.