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SUPERVISORY SYSTEM FOR THE SIRIUS SCIENTIFIC FACILITIES *

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Abstract

A general supervisory system for the scientific facilities is under development at Sirius, the Brazilian 4th generation synchrotron light source. The data generated by different classes of equipment are generally available via EPICS or industrial protocols such as OPC-UA provided by commercial automation systems. However, as the number of beamlines and laboratories expands, the effort to properly gather, display and manage this data also scales up. For this reason, an aggregating supervisory system is proposed to monitor the systems: power distribution, personal safety, beamline components, cryogenic fluids; mechanical utilities, air conditioning, among others. This work presents the overall system architecture, functionalities, and some user interfaces.

INTRODUCTION

The general supervisory is a Supervisory Control and Data Acquisition (SCADA) system. It aims to provide a simplified web visualization and concentrate the creation of alarms notifications of Sirius' scientific facilities. The system final users are the facilities' support groups.

This article is divided into parts that discuss architecture, information organization, graphical user interface (GUI), and key performance indicators (KPIs).

ARCHITECTURE

The parts that compose the system and the communication protocols used appear in Fig 1. The main server is the Siemens WinCC Unified Runtime [1] and it aims to exchange data with other devices, process information, handle alarms and communicate with the web clients. The Experimental and Industrial Control System (EPICS) [2] data server is used for concentrating the Epics Process Variables (PVs) data from the installations' EPICS servers and provide data to the main server using only one OPC Unified Architecture (OPC UA) [3] connection. The external communication server is intended to expand the way notifications can reach the user, in addition to the web clients alarms tables, providing services like sending emails, Telegram [4] and SMS messages. The SMS messages are sent by the Siemens 3G modem Scalance M874-3 [5] using a Socket protocol between the modem and the external communication server. The connection between the programmable logic controllers (PLCs) and the Main server uses a Siemens proprietary protocol based on TCP/IP, in these set of PLCs are included the equipment and personal protection systems [6].

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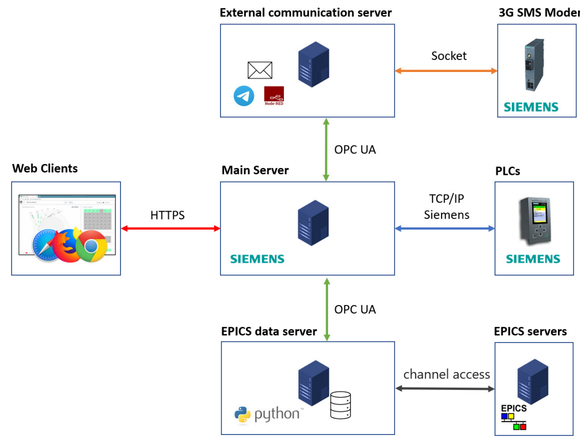

Figure 1: Architecture and communication schema.

Some of the Main server performance characteristics include the capacity to connect with 600,000 external tags, to have 200,000 internal tags, generate 200,000 discrete alarms, connect to 128 Siemens S7 SIMATIC PLCs, 10 OPC UA clients, and 100 web clients [7].

Access to the SCADA system uses password-protected authentication. The system is available only in the internal network, and user credentials needed are the same used to access other computational resources.

A software was developed to run on the EPICS data server using PyEPICS [8]. The update of data obtained from installation EPICs servers is configurable and is set to occur every second, this period is seen appropriated due to the absence of the need for quick diagnoses. Right after the PV is read, the OPC UA variable is updated.

To record trends and to perform more specifics diagnostics, when a correlation is needed, the tool used is the Archiver [9].

INFORMATION ORGANIZATION

Usually, the users are interested in specific parts of the scientific facilities related to their expertise area such as electrical power distribution, mechanical utilities, vacuum, radiological protection, among others. Considering that support groups' work structure may be changed, the supervisory information was organized by the facilities subsystems and the user is responsible for finding their interest area.

The GUI hierarchy pattern is shown in a general form in Fig. 2. The screens are currently grouped in the general view, infrastructure, beamlines, safety, statistics, and support labs. Inside each group, there is a division by subsystem and inside each subsystem, there are one or more personalized screens related to the subsystem and one

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screen used to view and configure the alarms and other notifications.

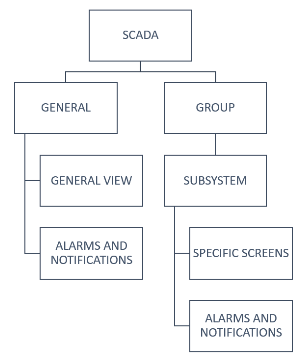

Figure 2: GUI hierarchy pattern.

Alarms and notifications screens by subsystem were designed to allow the group of people responsible for each subsystem to manage the configuration and acknowledgment of alarms and notifications.

GUI

The Sirius' general screen, radiological protection, electrical power distribution, and alarms are currently in beta version or in development and are presented to show some of the GUI possibilities. In addition, the screens for components, vacuum, utilities, HVAC (heating, ventilation, and air conditioning), cryogenic systems among others are predicted.

Sirius General

The Sirius' general screen plans to provide a simplified view of the hutches' status, beamlines, and subsystems. This screen is in Fig. 3.

In this screen, the hutches' status can indicate: Fail (Beam is not allowed in hutch), beam on (allowed beam on the hutch), and power off (a failure related to electrical power distribution has occurred). On the right, two matrices show the status of the beamlines, subsystems, and beamlines' gamma shutter authorization to open. Besides providing a simplified diagnostic, the existence of these matrices facilitates the view if the user uses a smartphone.

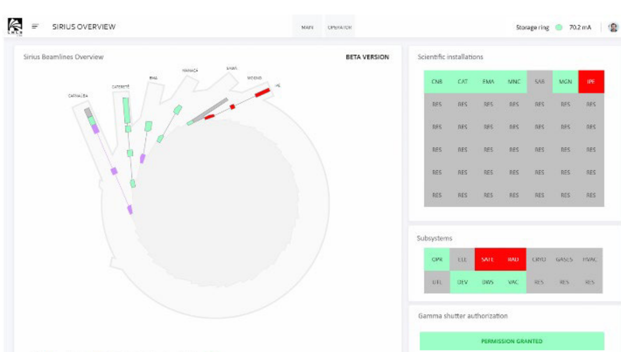

Figure 3: The Sirius' general screen showing the status of beamlines, hutches, subsystems, and authorization to open front-ends' gamma shutters.

Radiological Protection

The radiological protection screen follows the same principle used in Sirius general screen, the main difference is that the status change to the radiological protection context. The screen is in Fig. 4.

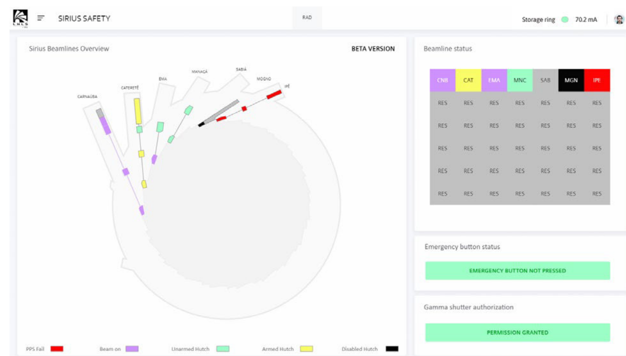

Figure 4: The radiological protection screen showing the status of beamlines, hutches, emergency buttons, and authorization to open de front-ends' gamma shutters.

Power Distribution

The screens related to electrical power distribution are divided into two parts: A general view and the beamlines screen. The General view is in Fig. 5 and an example of the beamlines screens is shown in Fig. 6.

The general view indicates the status of beamlines, the building power distribution panels, emergency buttons, and power consumption. The overview part shows the power being consumed by the 220 VAC, 380 VAC, and 220 VAC provided by the uninterruptible power supply (UPS). The Sirius mini-map indicates the hutches' status and the power distribution panels indicating their locals in the installation.

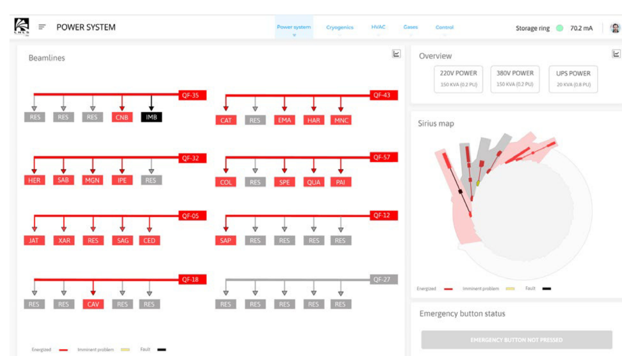

Figure 5: The electrical power distribution general screen showing the status of beamlines, hutches, emergency buttons, and building power panels.

The beamlines screens have a unifilar diagram that indicates the energized and de-energized regions, currents and allows to select a device to view more detailed information about the device in "Component data". In "Overview" is available the total amount of power being consumed in real time by the alternated current circuits. In "UPS" region is shown the status of the central 220 VAC UPS and the 24

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VDC UPS that feed the emergency light and other emergency circuits related to reset the safety relays for example.

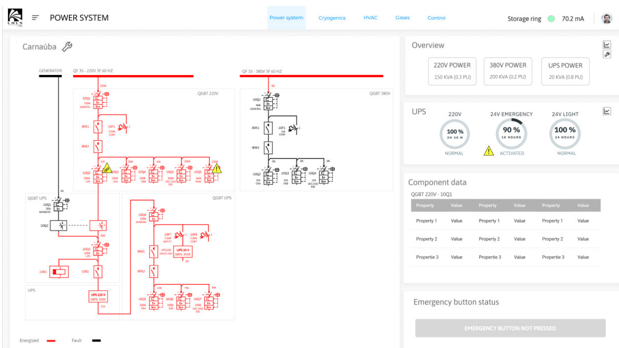

Figure 6: The beamline electrical power distribution screen showing the unifilar diagram, power consumption and status of UPS and emergency buttons.

If there's any condition that requires the user attention, a warning symbol is shown to direct then.

Notifications

The notification screen is divided into two parts: The "Attention required", which manages the alarms and allows to configure notifications settings, and the "Log" which shows the recorded data of all events of interest related to the subsystem. The notifications screen is in Fig. 7.

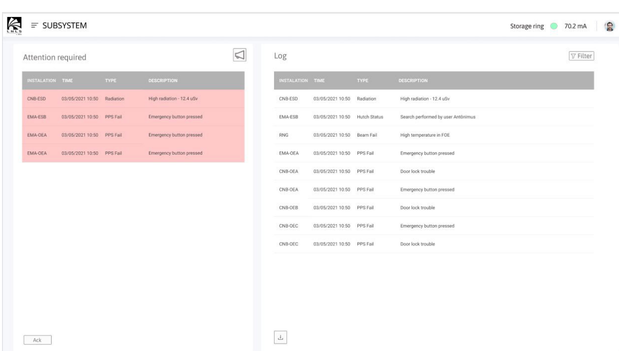

Figure 7: The subsystems' notification screens indicating the alarms that require user attention on the left and the log data on the right.

In "Attention required" exists a button on the lower part of the screen that is used to acknowledge the events and clear the stack. Using a button in the superior part of the screen the user can upload a configuration file that contains the notifications settings that can only be made by authorized users. All alarms configured to be shown in the "Attention required" region generate notifications.

In "Log" there is a button on the superior part of the screen that can be used to filter the data shown in the log table, the main filter parameters are beamline and the period. Using the button on the lower part of the screen, the user can download a file that contains the filtered log data.

KPI

The KPIs aim to measure performance. These indicators are very dependent on the activity type and are used in the decision take process. In the supervisory system, the KPIs are planned to be implemented in the future.

In the beamline's context, the main parameter of interest is the beam availability to experiments during the programmed beamline operation period while the subsystems has nominal conditions. If the availability in these conditions is not satisfied, there's also interested to know which subsystem was not available, the local of the problem, and the period. These measurements allow directing the maintenance and the improvements by the support groups.

In addition to the availability, other parameters are being considered for beamlines and subsystems are the Meantime Before Failure (MTBF) and the Mean Time To Repair (MTTR).

CONCLUSIONS

The SCADA system is complex by involving a high number of signals provided by different sources, to demand detailed knowledge of the facilities and by considering the user's interest from different areas. The possibility of a high number of connections, simplified GUI visualization, performance indicators, and the web access present in this work are key points to achieve the system's requirements.

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