

The DSS Synoptic Facility

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Abstract

The front panel of the CERN Detector Safety System (DSS) integrates an interactive synoptic facility which allows the Operator to navigate through a tree of increasingly detailed views of the layout of an LHC Experiment. The different objects associated with the currently selected view are represented by graphical symbols (“traffic lights”), whose colours are dynamically updated when the object’s status is modified. This helps to attract the Operator’s attention when an abnormal situation occurs. The synoptic view tree, as well as the definition of the objects associated with each view, and their coordinates on the screen, are fully and easily configurable by the User. This powerful and effective facility has been designed and implemented with reusability in mind, and it can be very well adapted to other applications. This paper describes the ideas behind the design and the implementation solutions which have been adopted.

Introduction

The CERN Detector Safety System (DSS) [1][2] monitors the state of the LHC detectors, and protects their components against emergency situations which either escaped to the control of other less reliable systems (like the Detector Control System), or were not covered by any other system. The protection offered by the DSS is encoded in an “Alarm-Action Matrix”, that can be seen as a set of user-defined rules relating the Input Channels (analogue and digital sensors) to the Output Channels (actuators, typically on/off interlock switches). Sensors and Actuators are not linked directly, but through an intermediate data structure, the “Alarm”. An Alarm corresponds to a logical expression of one or more Sensor’s states, and can be linked to one or more “Actions” (i.e. Actuators) to be executed when the logical expression becomes true.

As each DSS covers the entire experiment site of one of the LHC experiments, it is convenient for the Operator to have access to a visualization tool that lets him identify the areas where problems appear, and enables him to perform a virtual navigation through the site, displaying a detailed view of the situation. The DSS synoptic facility constitutes such a tool.

Like everything else in the DSS, the synoptic facility is fully configurable by the User and its software implementation is entirely data-driven. Furthermore, the ideas behind its design and implementation can be adapted easily to other applications.

Data Structures

The DSS synoptic facility is centred on the concepts of “geographical location” and of “locations tree”. A geographical location constitutes a view of a part of the experiment site, represented at an appropriate level of detail. This level of detail defines which DSS objects (Sensors, Alarms, Actuators) should be “attached” to the location (and displayed when the location is visualized). A location (apart from the predefined “Root” location) has always one parent location, and many locations can have the same parent. This defines the locations tree, which enables the navigation through increasingly detailed views of specific parts of the experiment site. Using the DSS configuration tool, the User is able to define as many locations as he needs, and to incrementally build the locations tree by appropriately setting the parent of every newly defined location.

Being the DSS Back-End based on the PVSS [3] SCADA system, this implementation is based on the concepts of PVSS datapoint types, and datapoints. A datapoint type can be seen as the definition of a C structured type, and a datapoint as a permanently stored instance of the corresponding type. A location is then a datapoint of type “*DSS_location_type*”, which contains an element called “*parent*”, specifying the location’s parent.

The User is responsible for attaching every DSS object to the appropriate location. This is again done through the configuration tool, and it corresponds to writing the location’s name into a datapoint

element of the datapoint corresponding to the object. Every object will also store its “synoptic coordinates”, that is to say the position where the object has to be drawn on its location’s image.

It is then practical, for a location datapoint, to maintain lists with the names of the different DSS objects that have been attached to it, as well as a list with the names of the different locations that have this location as their parent. The contents of these lists are used when the location has to be displayed on the “synoptic panel”.

Finally, every location stores some “summary status” information. These elements are integer counters, and each one of them contains the number of problems of a certain type currently detected in the sub-tree of which the location is the root node. For instance, one of the counters counts how many Alarms are currently active in the sub-tree; another one counts how many sensors are inhibited, and so on. The values of these counters determine how the location will be displayed on the synoptic panel, so that the Operator can immediately see if a problem is currently present in that part of the detector represented by the given sub-tree.

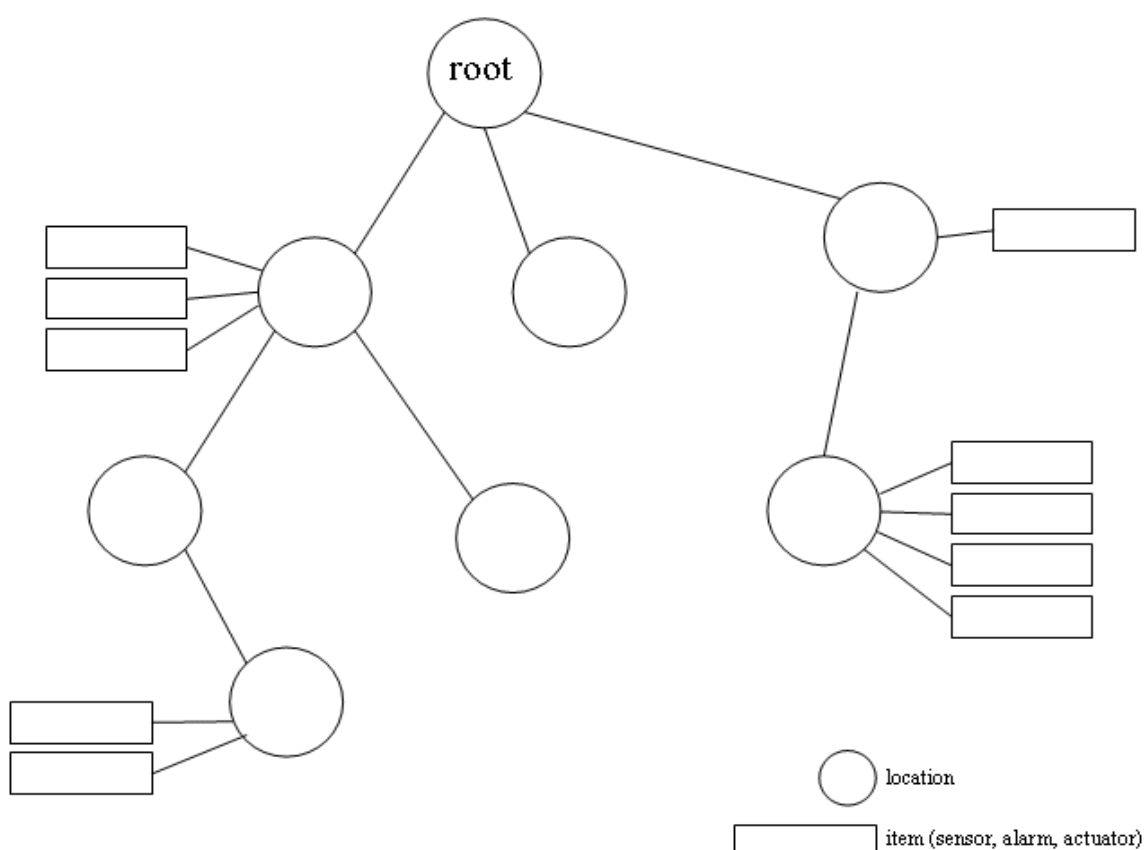


Figure 1: The Locations Tree and the items attached to the locations.

Visualization: the Synoptic Panel and How to Display Things

The entire visualization process is data driven and is based on a single PVSS “Synoptic Panel” capable of displaying any of the locations defined in the DSS system. The Synoptic Panel is “connected” to a PVSS datapoint that contains the name of the location to be displayed. The Synoptic Panel first loads as background the image .gif file (provided by the User) associated with that location. If this file does not exist, the background will be black, but the overall functionality will not be affected by this omission. Then the Synoptic Panel gets from the location datapoint the lists of the DSS objects attached to the location. For each of these objects an interactive “traffic light” is temporarily created and placed at the object’s synoptic coordinates. These traffic lights are instances of the same reference panel, but each of them is parameterized to represent the corresponding object. In particular, the three lights of the traffic light are connected with Boolean datapoint elements

specifying whether the object is OK, or if it is in warning, or in alarm state. The lights will be refreshed automatically, should these datapoint elements change their values. Traffic lights are also created and displayed for the locations that have this one as their parent.

When the location to be displayed changes, the Synoptic Panel deletes all the traffic lights it had created, loads the new background image, and creates all the traffic lights corresponding to the objects attached to the new location. Figure 2 shows the Synoptic Panel for a part of an experimental assembling hall.

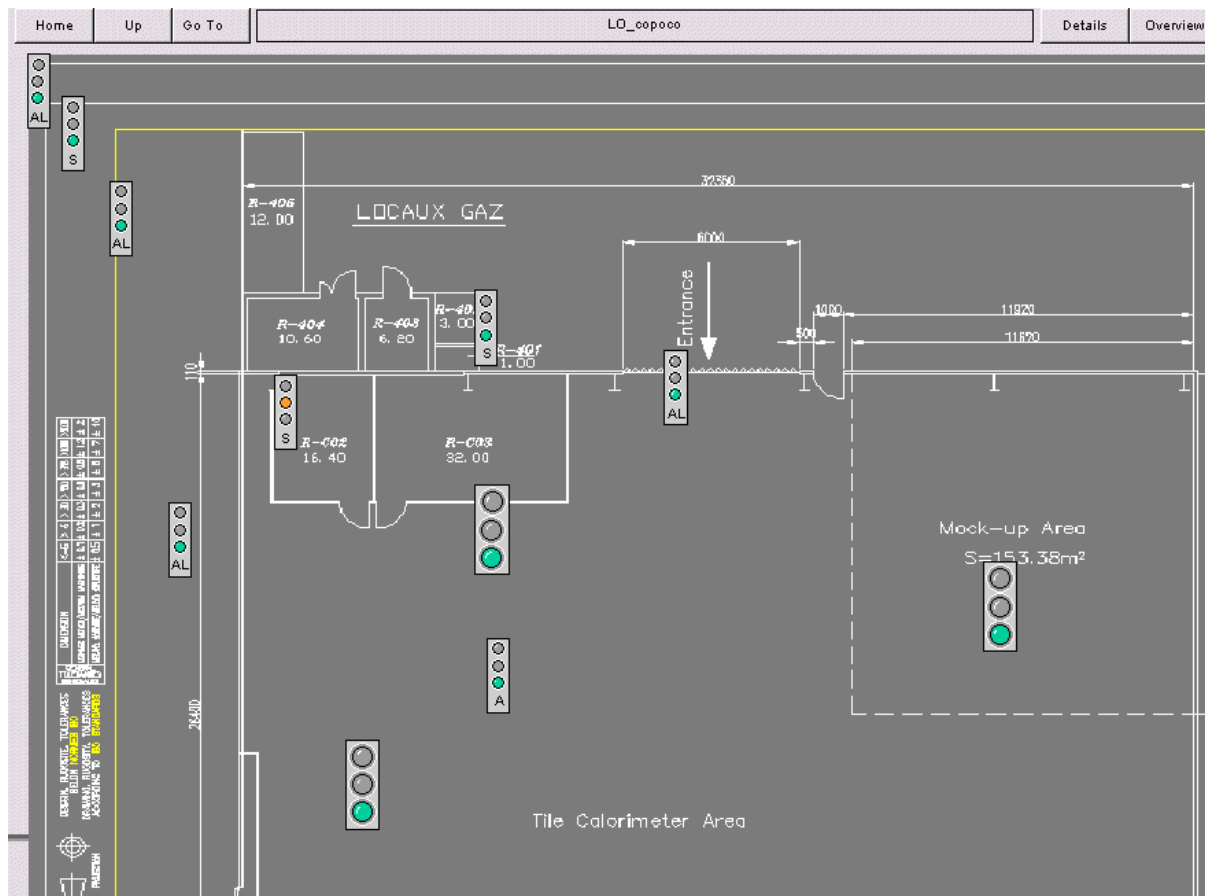


Figure 2: The DSS Synoptic Panel, showing some details of an experimental assembling hall

Navigation

The synoptic facility offers several ways to navigate through the locations tree. By left-clicking one of the large location traffic-lights, the corresponding location will be displayed, replacing the current one. By clicking the “Home” or “Up” buttons, the “root” location or the parent location of the currently displayed one will be made respectively the newly displayed location. Finally, by clicking the “Go To” button, the Operator gets direct access to any location in the tree. The “Overview” button displays the path in the tree from the “root” location to the current one.

The “Traffic-Lights”

The sensors, alarms and actuators traffic lights are all based on the same model, and can be visually distinguished through the letters (respectively “S”, “AL” and “A”) displayed below the three LEDs. The bottom LED represents the OK state, and it is green if the object is OK, or grey otherwise. The middle LED represents the Warning state (amber if the object is in warning or if it is inhibited, otherwise grey). The top LED represents the Alarm state. For a digital sensor, this LED is red if the sensor’s value is true. For an analogue sensor, the LED is red if the value is outside the range [too

low, too high]. For an alarm, the LED is red if the alarm is triggered, and for an actuator the LED is red if the actuator has been set to the safe state. The LED is grey otherwise. By clicking on the traffic light, a panel showing all the object's configuration parameters and detailed status information will open.

The locations traffic lights are recognizable by their larger sizes. As already mentioned, by left-clicking on one of these traffic lights the corresponding location will replace the current one on the Synoptic Panel. By right-clicking, instead, a panel showing all the location's parameters will open. It was also already mentioned how the LEDs of these traffic lights summarize the status of the entire sub-tree starting at the corresponding location. The implementation of this behaviour relies on a PVSS script which detects any change of the state of any DSS object, and propagates the information up through the locations tree until the "root" locations is reached. On its way, the script updates the summary datapoint elements of each encountered location.

Locating a DSS Object

The Synoptic Facility also implements a mode in which a DSS object can be located in the system, by displaying the location to which the object is attached, and highlighting its traffic light with a yellow circle. Figure 3 shows an example of this.

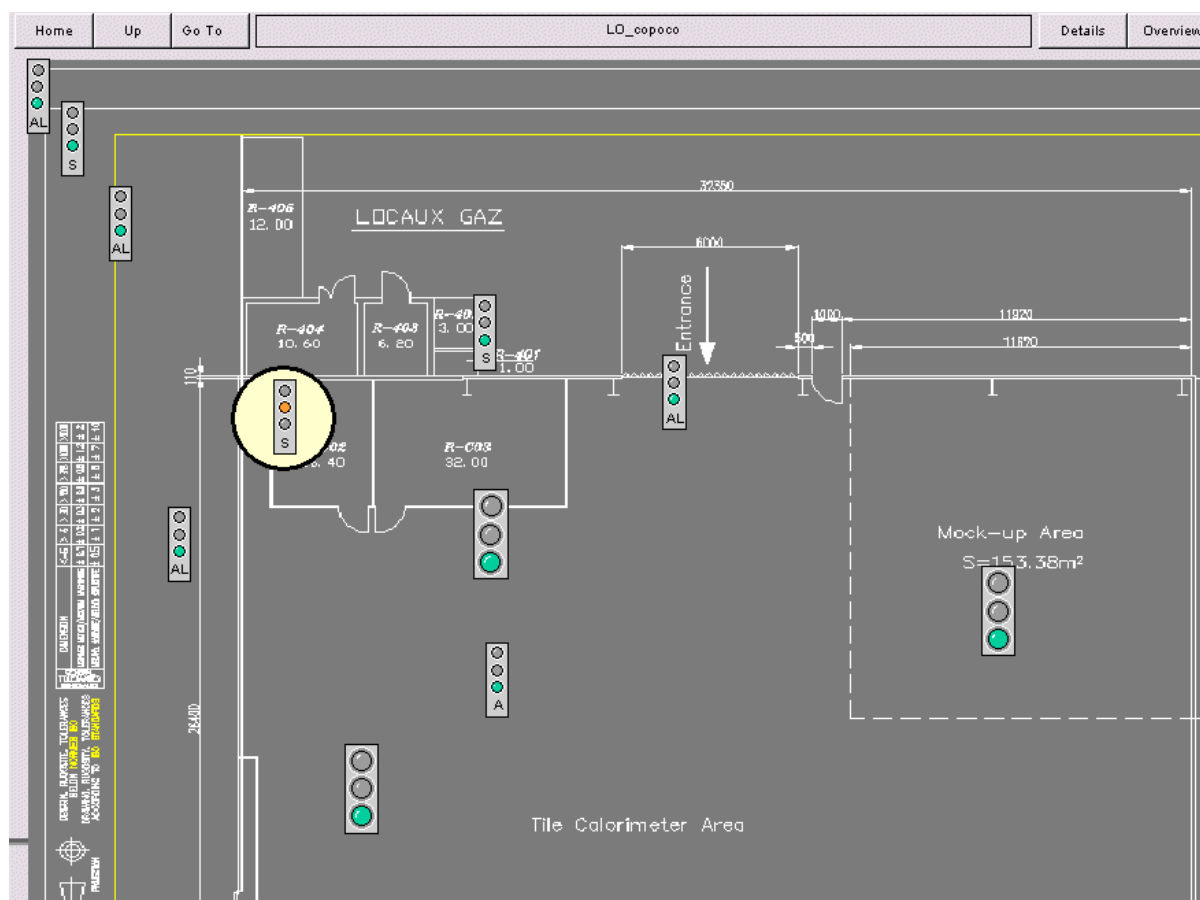


Figure 3: The object to be located has been highlighted on the panel.

Positioning Objects on a Location

Finally, the Synoptic facility provides two ways to assign the synoptic coordinates of the different objects. The first way (Figure 4) is based on a graphically interactive panel, where the User can select an object attached to the location, and then places it on the location image by clicking the desired position.

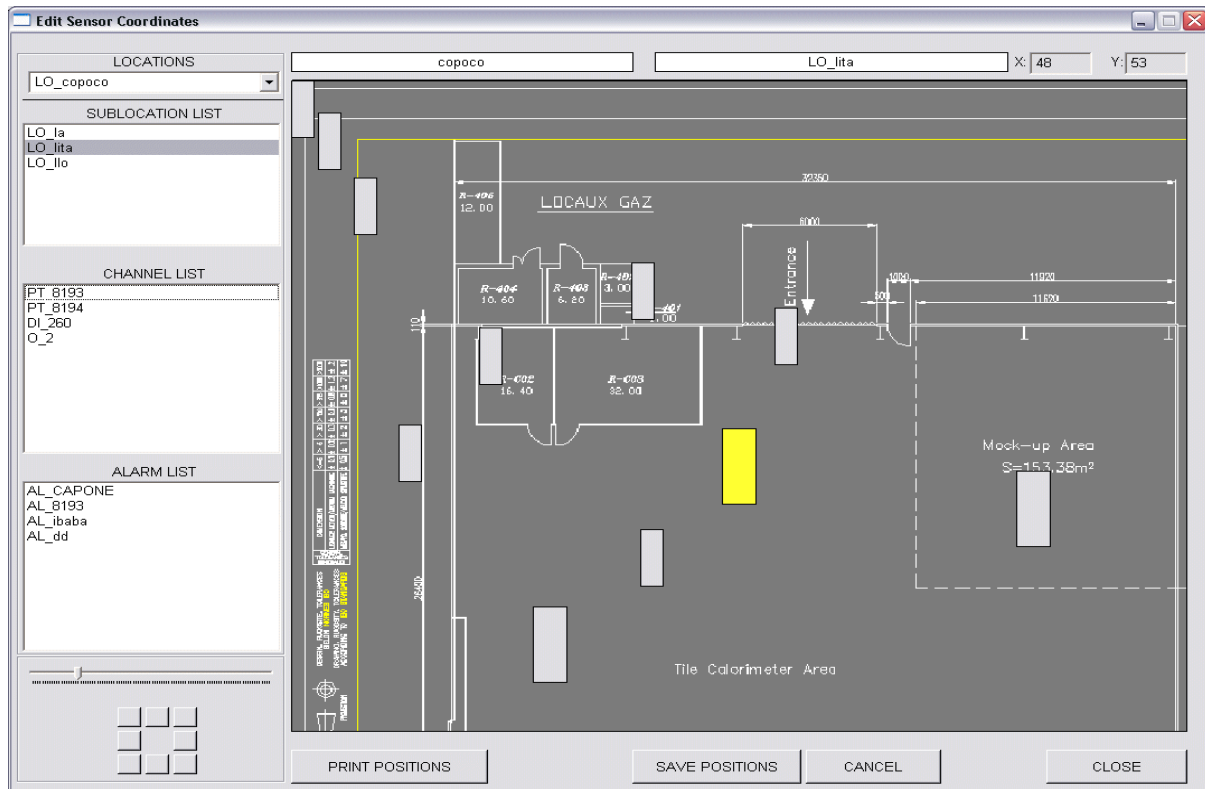


Figure 4: Interactive positioning of objects on a location’s image.

The second way, which can be useful when dealing with a large number of objects to be placed at regular intervals, consists in providing the (x,y) coordinates through a table. The unit here is the “percentage” of screen. This way is illustrated in Figure 5.

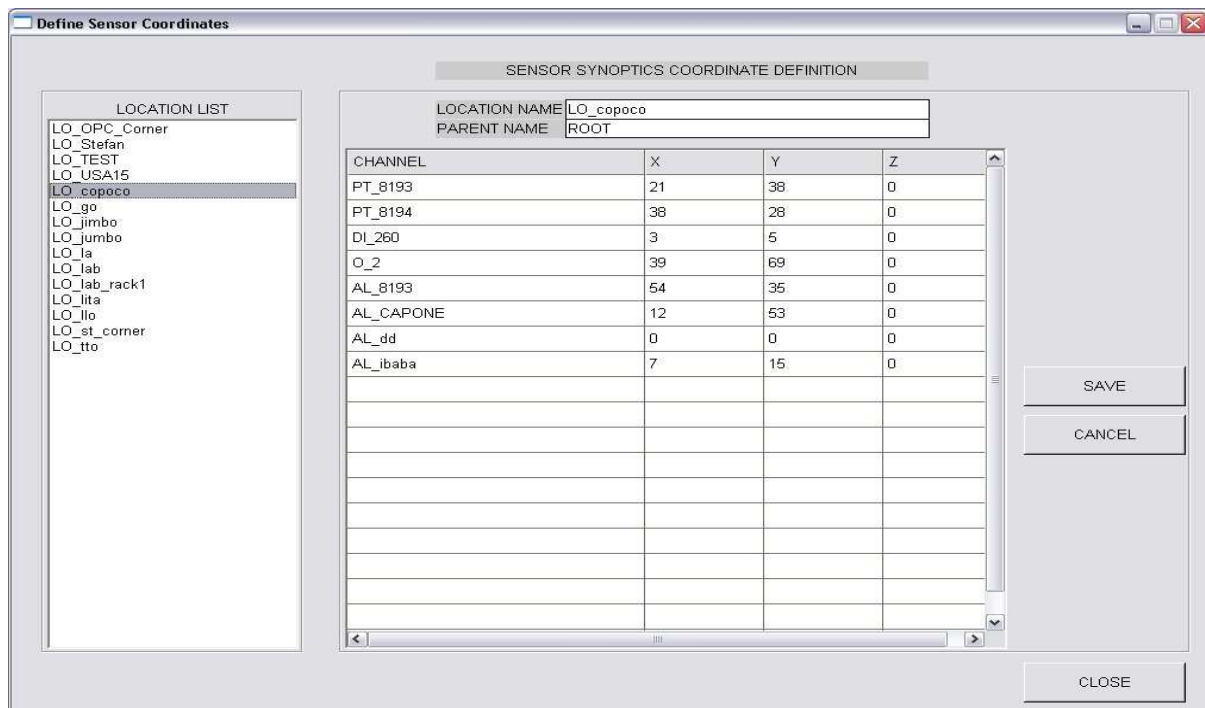


Figure 5: Providing the (x,y) synoptic coordinates through a table. (The z-column is here only for historical reasons).

Conclusions

The design and the implementation of the DSS Synoptic Facility have been explained in detail. One important feature is the complete freedom for the User to configure and modify at any time the synoptic hierarchy. This is made possible by the fact that adding a new location does not require building a new PVSS panel, but simply needs a picture of the location layout.

The facility has been successfully implemented, and it received the full approval by the Users, who were involved in the definition of the functional and look-and-feel requirements. The overall conception of the DSS Synoptic Facility is quite simple, and also its implementation in PVSS required a very limited amount of coding (although it needed a deep knowledge of PVSS). Due to the data-driven approach that was followed during its development, in this tool nothing is CERN-specific. Therefore this facility can be easily reused by other PVSS applications, or re-implemented in other environments.

References

- 1) S. Lüders et al., "The CERN Detector Safety System for the LHC Experiments", ICALEPCS'2003, Gyeongju, Korea, October 2003.
- 2) G. Morpurgo, R. B. Flockhart, S. Lüders, "The Software for the CERN Detector Safety System", these proceedings.
- 3) PVSS (Prozessvisualisierung und Steuerungssystem) is a trademark of ETM.