Revisiting CERN Safety System Monitoring (SSM)

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CERN Safety System Monitoring (SSM) is a system for monitoring state-of-health of the various access and personnel safety systems at CERN since more than three years. SSM implements monitoring of different operating systems, network equipment, storage, and special devices like PLCs, front ends, etc. It is based on the monitoring framework Zabbix, which supports alert notifications, issue escalation, reporting, distributed management, and automatic scalability. The emphasis of SSM is on the needs of maintenance and system operation, where timely and reliable feedback directly from the systems themselves is important to quickly pinpoint immediate or creeping problems. A new application of SSM is to anticipate availability problems through predictive trending that allows to visualize and manage upcoming operational issues and infrastructure requirements. Work is underway to extend the scope of SSM to all access and safety systems managed by the access and safety team with upgrades to the monitoring methodology as well as to the visualization of results.

Access and safety systems by GS/ASE

LACS (LHC Access Control System) – who enters LHC and when
LASS (LHC Access Safety System) – is it safe for beam or access at LHC
PACS (PS Access Control System) – who enters the PS and when
PASS (PS Access Safety System) – is it safe for beam or access at PS
SPS PSS – integrated personnel safety system for SPS
SUSI (Surveillance des Sites) – who enters CERN sites and areas other than the accelerators
CSAM (CERN Safety Alarm Monitoring) – alarms for the fire brigade
Sniffer – gas detection in CERN tunnels and caverns
SIP (Site Information Panels) – display relevant info at access points
SSA (Safety System Atlas) – personnel access and safety system for the Atlas detector.

Monitoring engine Zabbix

- New version 2.0.8.
- Support for Windows, Linux, other Unixes.
- SNMP, IPMI, database monitoring, web-monitoring, …
- Extensible: server scripts, client scripts.
- Proxy servers (monitor restricted networks). Implemented as virtual machines within the VSSI framework.
- Local MySQL database for the best performance.
- Web-interface out of the box (PHP – practically a drop-in).
- Can do mass updates using XML files.
- Robust (very few problems).
- Known within the access team.
- Active development and user groups.
- Free.

Design principles

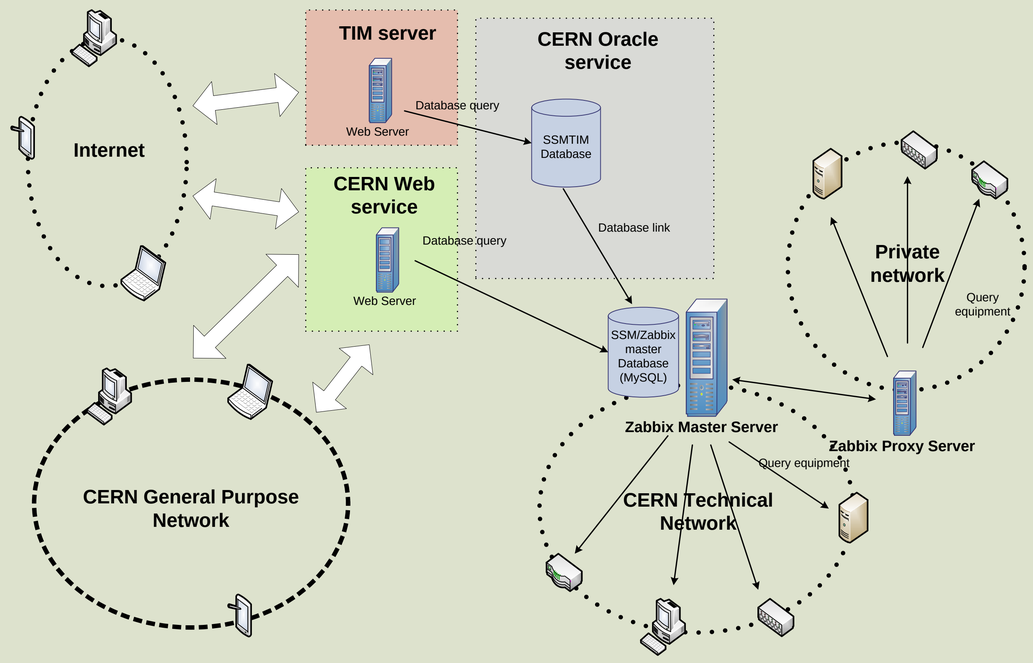
Clarity: No-nonsense approach to system monitoring. Use global status displays with simple traffic-light-style graphics.
Simplicity: Well-defined interfaces with clear functional separation. Use existing systems and CERN standard services when possible.
Reliability: Self-diagnostic checks to tell if the displayed information trustworthy.
Independence: Look at the system to be monitored from the outside and avoid using information produced by that system. Go to the source whenever possible (example: access PLCs directly).
Maintainability: Scripts and database structure simple with up to date documentation.
Accessibility: Works with all major web-browsers and handheld devices from anywhere.
Confidentiality: Access limited to a well-defined group and login with CERN password.

References

[1] T. Hakulinen et al., "CERN Safety System Monitoring - SSM," ICALEPCS 2011, Grenoble, France, WEPMU030, p. 1134 (2011)
[2] http://www.zabbix.com
[3] A. Suwalska et al., "Integration, Processing, Analysis Methodologies and Tools for Ensuring High Data Quality and Rapid Data Access in the TIM Monitoring System," TUPPC029, this conference.
[4] T. Hakulinen et al., "Application of Virtualization to CERN Access and Safety Systems," MOPPC054, this conference.
[5] http://libnodave.sourceforge.net
[6] http://www.r-project.org
[7] http://openopc.sourceforge.net
[8] http://en.wikipedia.org/wiki/SNMP

Architecture overview

- A master SSM/Zabbix server is connected to a local MySQL database, which stores all the monitoring data.
- Zabbix proxy servers connect to devices on the private networks of PACS, test platform of PACS, and CSAM. These proxies are implemented as virtual machines within the VSSI framework.
- The visualization layer is based on the native Zabbix interface using PHP scripts.
- Export of data from the master database to CERN Technical Infrastructure Monitoring (TIM) and external Web-applications via Oracle database links. This is still work in progress.



Monitoring Improvements

PLC monitoring: SSM monitors PLCs using 2 basic approaches:
1) Simple alive checks using standard tools like ping, traceroute, to cover basic connectivity between servers and clients giving information about faulty routers between devices, DNS problems, and IP misconfigurations.
2) Active checks using scripts based on the LIBNODAVE libraries. This method requires special programs and scripts to get information from the diagnostic buffer of the PLCs, which is a ring buffer of diagnostic entries. An analysis of this buffer provides rapid detection of causes of errors. Alarms are triggered for events programmed in SSM for later analyses.

Trending and reporting: Trending has been improved in the new SSM with new overview screens for showing information about its trends. Trending allows spotting problems of specific hosts or discovering general infrastructure problems. It is important for maintenance planning, for dimensioning of future IT or hardware equipment. Development has also been carried out to implement trend prediction using tools like *R*, but this work is still ongoing.

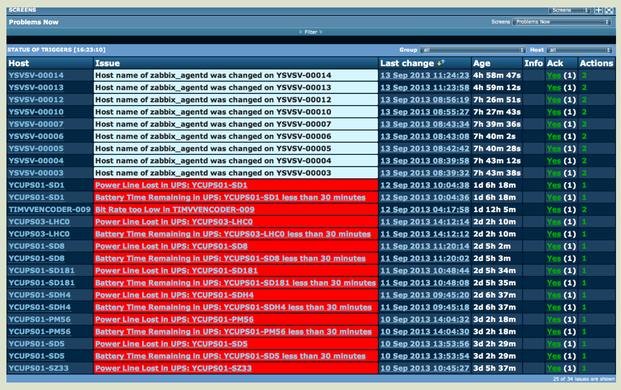
OPC server interface: The OPC server interface uses the so-called external check mechanism of Zabbix. The Zabbix server can call a script to run any arbitrary task that returns a meaningful value to be measured. A freely available software package, OpenOPC, was used to interface from the Zabbix server running Linux to an OPC server under Windows. Several access and safety systems use OPC servers, in particular, the new PS access and safety systems (PACS / PASS) that make most of the system data available that way.

SNMP interface: The new SNMP builder in Zabbix is able to read an existing MIB database of a device and build monitoring rules from it directly. SNMP is used by SSM to supervise network equipment and also all the UPSs of the LACS and PACS systems.

Global views

Global views are synthesized views of the different systems offering a simple traffic-light-style view of the state-of-health of the entire system.

Right: A global view showing the overall subsystem status of some of the access and safety systems. Green indicates that everything is ok, while red would mean that there is a problem to be investigated.

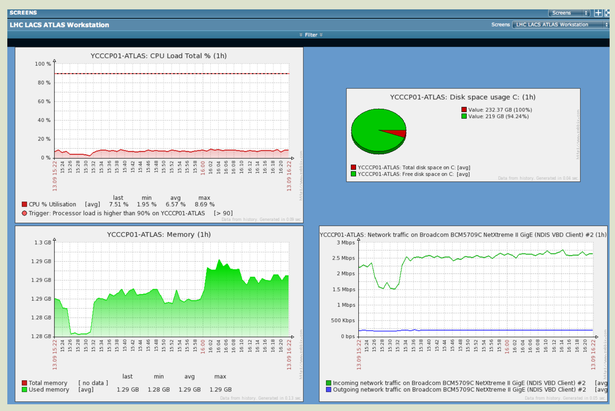


Right: A global view of a list of outstanding issues in various devices. Colors indicate the severity of the issue: Red means a critical issue requiring immediate action, light green an informational message.

Device specific views

Device specific views display details of specific subsystems or individual devices. Complex collections of graphs showing various aspects of the monitored systems can be created.

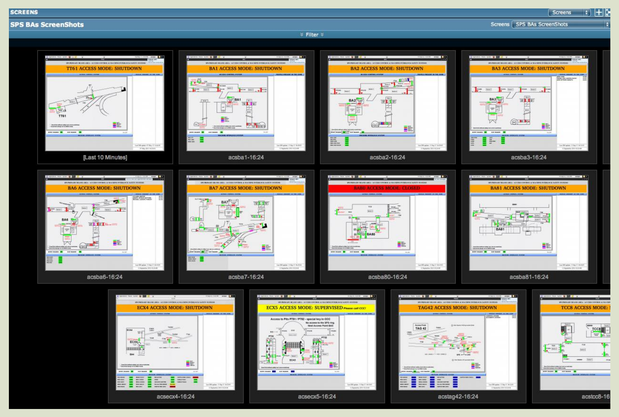
Left: A machine-specific view of a LACS operator post at the Atlas experiment. Shown are graphs for CPU and memory loads, disk utilization, and network traffic.



Views from external systems

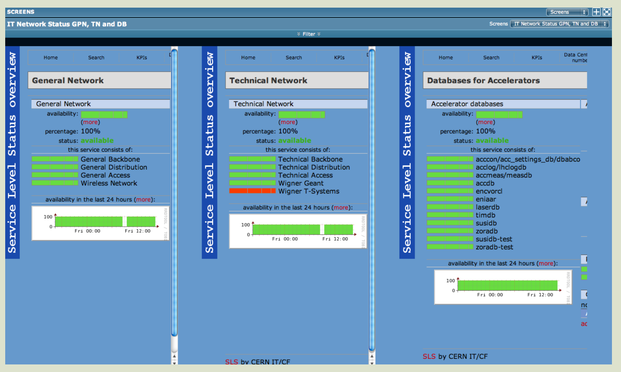
SSM offers a facility to display dynamic images from external sources as web pages. This allows one to use various on-site information pages as additional source of information to the maintenance and operation teams.

Right: Screen shots of the panel-PCs of the SPS access and safety system. A in-house system has been developed to take periodic screenshots (once per minute) of the various safety related information displays and panel-PCs around the site.



Left: Network traffic of SUSI video servers. The graphs show generally a high incoming traffic (red graphs) whenever an on-site camera is recording.

Left: Disk utilization statistics of several SUSI video servers.



Right: Status of various IT services loaded directly from the service web pages of the IT department. Displayed are the statuses of CERN general network and technical network infrastructures as well as the accelerator and safety databases.