DCS-COMPASS requirements for the Experiment' s 2nd phase

DCS group, 28/10/2004

1 Introduction

The COMPASS Experiment requested a 2nd phase of muon and hadron beams, from 2006 on, in order to accomplish the goals presented in the proposal. For this, the COMPASS spectrometer will be completed with additional detectors.

The Detectors Control System (DCS) of COMPASS used, in the 1st phase of the Experiment, the commercial SCADA PVSS II, in its version 2.12 (for the running periods 2003/2004; during 2002, version 2.11.1 was used), together with the JCOP Framework and a COMPASS Framework. For the 2nd phase, we foresee to use PVSS II in its version 3.0 (or above [1], depending on the status of the most recent version at that moment), together with the corresponding version of the JCOP Framework, and eventually a COMPASS Framework (if proved to be needed).

2 The detectors parameters to be controlled

Figure 1 presents a schematic view of the DCS-COMPASS, as during the 2004 Run. The detectors mentioned are only those integrated in the DCS at present. Some other detectors are still running with their stand-alone slow-control (either because they were finalized too recently to have been included in the DCS, or because no practical solution was found until now to integrate them successfully and in due time in the project). The future DCS scheme must include the new detectors (the RICH Wall, ECal1, additional chambers for W45, Silicon and SciFi detectors, and maybe a 2nd RICH) and those already existing in the Experiment but not yet integrated in the DCS (like HCal1, HCal2, ECal2, HV System of Drift Chambers and MicroMegas,...).

The parameters to be controlled by the Experiment concern the HV, LV and Gas systems for the detectors; temperatures in the experimental hall, in the electronics racks, and in specific points of the detectors; the atmospheric pressure in the hall and the pressure inside detectors (like the RICH vessel); the humidity in specific points of the experimental hall and inside detectors; the magnetic fields from both the beam magnets and polarized target magnets; and the status of VME electronic crates. Some information concerning the state of the SPS beam (like "Beam", "Access", ...); and the status of the Data Acquisition (like the Run type: "Physics", "Alignment", "Field Rotation",...) or the general status (like if "Shutdown") are also to be monitored in the future.

[1] PVSS II version 3.5, expected to be released during the 2nd semester of 2005.

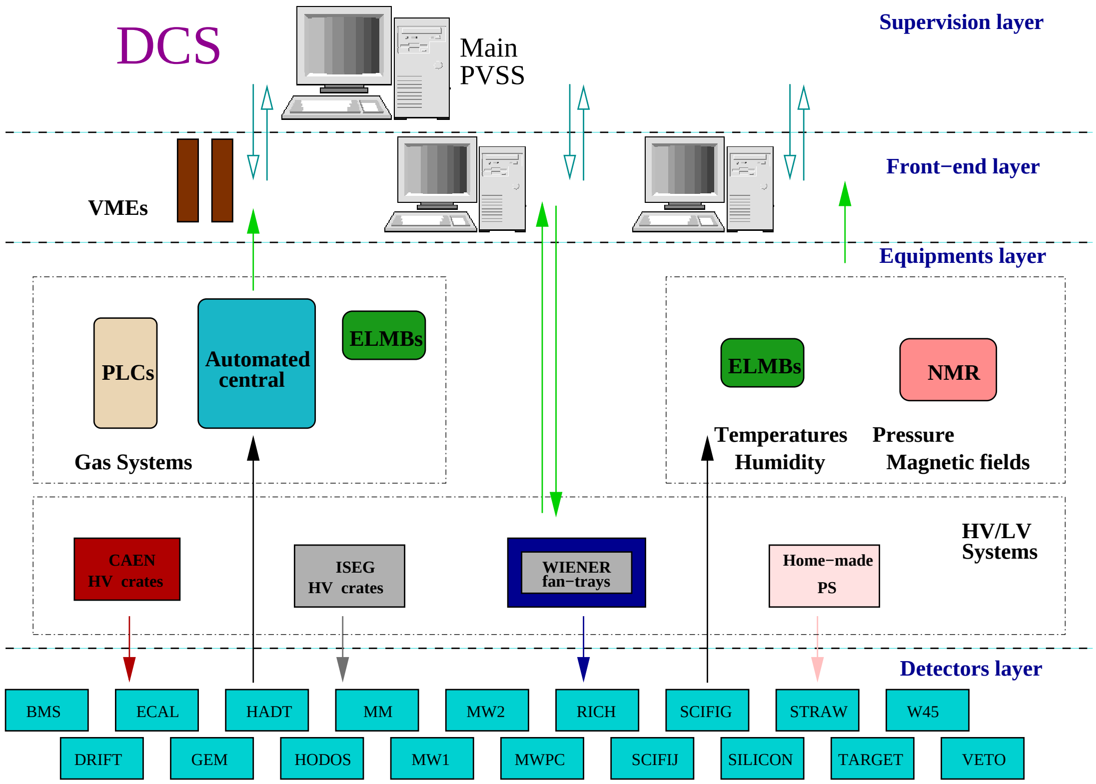

Figure 1: The DCS scheme during 2004 Run period.

3 Equipments to be monitored/controlled

There is a vast variety of equipments that are or will be controlled or monitored by the DCS-COMPASS. While for some, commercial supervision solutions exist (like OPC servers), for others these solutions do not exist. Several situations have to be distinguished here: in some cases the equipment is very old (like LeCroy HV power supplies), thus having only very primitive interfaces for control available; in other cases a commercial solution, provided by the producing company of the equipment, exists already, but is not yet in a stable version, or not fully tested (this is the case for ISEG HV power supplies, and to some extend to Wiener equipments and CAEN HV power supplies also); and in a third category of cases the equipments are home-made, thus not coming a priori with such supervision solutions (several HV and LV power supplies used in the COMPASS Experiment are home-made). In all these situations, the DCS-COMPASS will need case-by-case solutions, by writing the drivers to control/monitor such devices, and integrate them in the PVSS project.

Most of the detectors' high voltage systems are CAEN (crate models include SY127, SY403, SY527 and SY1527, a complete list is given in Section 5). IT/CO-CERN developed SLiC (compiled as DIM server) + DIM API manager (running in Linux platform) that are being used at the moment to control crates SY127, SY403 and SY527 in COMPASS. A CAEN OPC Server is used to control an SY1527 crate (although this OPC server is not yet fully debugged and stable) [2].

The decision on what system to use in the future to control the CAEN devices cannot be taken at the moment. Although IT/CO-CERN recommends the use of commercial solutions whenever these exist, the final decision to move to a fully CAEN OPC Server controlled system requires extensive tests to be performed in advance. Not only the stability of the OPC Server has to be achieved, but its massive use (approximately 2000 HV channels are to be controlled) and its compatibility with PVSS and the other OPC Servers included in the system have to be tested. The different crate types must be tested, and eventual problems with specific module types may appear and must be solved. The performance offered by the OPC Server to control a given item depends on the number of items/channels to be controlled by that OPC Server. The estimate of the number of OPC Servers, interface CAENET/PCI cards (A303 card), and Windows computers needed to control more than 20 CAEN crates can only be done after testing. The PC Windows platform to use (if 2000, XP, or a future higher version) has also to be decided [3]. The CAEN OPC Server offers the possibility to use different kinds of buses: CAENET or, in the case of new crate types like SY1527 and 2527, general or dedicated Ethernet. For old type crates, like most of those used at the moment (all except one), the CAENET cabling will have to be redone. The decision on the number of CAENET branches needed will depend on the performance tests to be done by the DCS group. For new crate types, it has to be decided which kind of Ethernet connection to use. The general Ethernet option is more practical from the point of view of implementation, although interference problems may arise if the Ethernet cabling is not robust enough (Structured Ethernet cabling, and special care to the type of switches used).

The alternative to use SLiC + DIM in the future may also pose some problems, since it is not known at the moment what support IT/CO-CERN will provide (in particular for SLiC, since it is known that none of the LHC Experiments will use it).

Two detectors (Straws and Silicon) use ISEG HV power supplies. During the 2004 Run, these are controlled in PVSS via a dedicated SLiC, developed by the DCS group with the help of IT/CO-CERN. This SLiC is compiled as OPC Server and is presently running in a Windows 2000 platform. The COMPASS Framework includes now panels and several tools for the ISEG HV PS. Although an ISEG developed OPC Server is available at the moment, this was not the case when we started to develop the dedicated SLiC. The OPC version available now is being tested at IT/CO, but for the moment it has serious problems of stability/reliability. The option for this commercial product will only be done if stability is achieved and if it is proved to be compatible with PVSS and other running OPC Servers. If the decision is to stay with the COMPASS-made SLiC OPC Server, some aspects of its implementation in PVSS will need to be improved (architecture of the datapoint type; how to deal with the hardware reset of trip alarm;...)

[2] There are still several non-understood points, and features that need to be corrected for future versions of the CAEN OPC Server. The DCS-COMPASS group has been in close contact with CAEN engineers, in order to help to identify the remaining problems. One of the already identified problems seems to be an incompatibility of the OPC Server with some types of Ethernet switches, which causes a loss of packages in the communication process.

[3] The OPC foundation has warned recently that a problem was noticed when using Windows 2000 - OPC connection was seen to be lost after several hours running.

Both in the case of CAEN and ISEG HV crates, the control of voltages and currents is requested, together with settings of ramp-up/ramp-down speed, trip time, trip current limit and maximum voltage safety limit. The monitoring of the current during the spill must also be possible, since this is an important parameter for some of the detectors (Drift Chambers, W45, RICH,...), meaning a performance of at least 3 readings in each 4.5 seconds (asynchronous with the beam). Such performance is at the moment achieved only in the case of one CAEN SY527 crate (24 HV + 24 LV channels for RICH detector), implemented in a separate CAENET branch controlled by a dedicated SLiC (running on VME processor) + DIM API manager on Linux platform (total cycle of approximately 1 second). The future DCS should allow in normal conditions to monitor the HV channels (CAEN and ISEG) with a cycle of about 5 to 10 seconds for Vmon and Imon (all 2000 channels); and in special debug conditions it should allow to select a group of channels and the parameter for which one wants a faster refresh rate (to get, for a short period of time, for example the current profiles during the spill, i.e. a cycle of 1 to 2 seconds).

The COMPASS setup includes 256 HV channels supplied by a LeCroy crate, that are not integrated in the DCS, since no interface with PVSS is available. Some effort was put by the DCS-group in the development of a driver for this, using the RS232 connection, but the task was postponed due to other priorities. These HV channels are used for the trigger system of COMPASS, and the responsible group foresees to replace the LeCroy crate by another CAEN HV crate for the 2nd phase of running. In case this replacement will take place, the integration in PVSS will be straightforward.

Several home-made HV power supplies are used in the COMPASS Experiment, in particular for ECal2 and Veto-Box. These are not provided with a control interface. Security boxes were built by the detectors groups, giving an On/Off signal that is read by an ELMB channel and in this way monitored in PVSS. There is no request up to now from the detectors groups to improve the system further, so we foresee for the future to continue with the same "status monitoring" only.

Two detectors (Straws and RICH) use Wiener LV power supplies. During 2004 Run, an integration of these power supplies in DCS, via a dedicated SLiC developed by IT/CO-CERN and compiled as OPC Server, is progressing. The currently used version of the JCOP Framework provides tools for such an integration, including elementary control functions (On/Off, change of fans' speed, etc). Two CANbus branches will be installed as starting point, one for each detector. These are foreseen to be merged at a later stage. For the 2nd phase of the Experiment, we plan to have the Wiener LV power supplies fully integrated in the DCS, using the commercial Wiener OPC Server and the new version of JCOP Framework. It is conceivable that some modification of the Framework will be needed, as at least one user (Straws) would like to have an alarm when voltage drops more than some limit. Tests of stability (by IT/CO-CERN) and compatibility with PVSS and other running OPC Servers (by DCS-COMPASS) are needed.

Home-made LV power supplies are also used in COMPASS (W45, MW1, MW2, BMS, MWPC, Drift Chambers,...). These are monitored (both voltage and current, in most cases) in PVSS, via ELMB ADC channels. There are also some VME crates that are monitored in the same way. In the case of MW1, also digital output is provided (via ELMB) to control the

On/Off status of VME crates (5 crates in total). Since it is foreseen that the Experiment will continue to use such home-made devices, the DCS-COMPASS should improve their integration in PVSS, in order to monitor the On/Off state of all these crates and provide voltage/current alarm if "Vmon=0 && On state".

Some LV used in the experiment are provided by the already mentioned CAEN crates, where boards to provide low voltage are installed (Silicon and GEM detectors use CAEN LV). These are being controlled in the same way and together with CAEN HV. For the future DCS, they shall be treated also together with the CAEN HV solution.

About 20 Wiener fan-trays are used for the VME 9U crates. These are integrated in PVSS using a dedicated SLiC running in Windows platform + DIM API manager running in Linux platform. Until the end of 2004, 2 more VME crates for the BMS detector, placed inside the beam tunnel, are to be integrated in PVSS. Since there is now an available Wiener developed OPC Server, for the 2nd phase of running the DCS-COMPASS plans to move the VME 9U crates control to this. As stated above, testing is still needed. In principle, the same Wiener OPC Server can be used to monitor both LV and fan-trays.

The Gas systems of the detectors are controlled by 3 PLCs (from Schneider). The DCS-COMPASS monitors the status of the PLCs, and of the gas flows, gas mixtures, compressors, etc. 3 PLCs are used in the COMPASS Experiment, whose data is monitored in PVSS. For the moment there are no plans to have additional PLCs in the future. But at least 2 detectors will be connected to PLC3 for control (MW2 and RICH Wall). This integration should be done also in PVSS, in the standard way. There is one single OPC Server for the 3 PLCs (OFS OPC Server). The monitoring of the detectors' Gas systems should continue during the long shutdown period. The DCS-COMPASS has a dedicated PVSS control manager to check the status of the gas systems, and send SMS and e-mail messages to detector experts in case of alarm.

In the case of one detector (MW2) not yet connected to the PLCs, the detector group installed some valves security system, that sends a gas alarm signal to an ELMB ADC channel. This alarm is monitored in PVSS. For the second phase of running this gas system will be put in PLC3, no longer requiring ELMB monitoring.

For the 2nd phase of COMPASS, the Silicon stations will operate at cryogenic temperatures. The control of the cryogenic system, as well as the monitoring of the gas system for these stations, will be done via ELMB. There is a request for these to be fully controlled in the DCS. The cryogenic system for these stations was designed by the Silicon group. It uses 3 ELMBs of new type (motherboard version 128) that are already included in the 3rd CANbus branch of the general DCS. At the moment only the monitoring of temperatures is being done, but for the 2nd phase it is requested to use the IN/OUT digital part of the ELMBs for the control of all the cryogenic system.

For the 1st phase of COMPASS data taking, the SM2 magnetic field is monitored using an high precision NMR meter. Values are written in file, using a RS232 connection to this meter. A PVSS manager reads these values from the file, for monitoring and archiving. It is not clear if the same system will be used for the 2nd phase of the Experiment [4].

The DCS-COMPASS uses extensively ELMBs to monitor all kind of parameters, from LV power supplies and VME crates voltages, and magnetic fields, to slowly varying environment parameters like pressures, temperatures and humidities. For the 2004 Run, 25 ELMBs of old type (using microprocessor ATMega 103, so called version 103) and 3 of new type (using microprocessor ATmega 128L, so called version 128), distributed in 3 CANbus branches (new ELMBs are put separately in the 3rd CANbus) are used. Most monitorings use the ADC channels of the ELMBs, but there are also a few controls of VME crates state using the digital IO port of ELMBs. A CANOpen OPC server (ATLAS developed) is used to get the monitored values into PVSS. Many problems have been noticed related to the ELMBs, such as noisy channels, ELMBs that get de-programmed, de-synchronized, and other non-identified problems that make these measurements not very reliable and/or stable. Although it is not proved that this is an exclusive problem of the old version of ELMBs, the hypothesis seems plausible, and tests with the new type of ELMBs are being done by the DCS group. For the 2nd phase of the Experiment, and also due to shortness of old type ELMB spares, it is foreseen to keep one of the CANbus lines with the old type ELMBs, replacing the 2nd line by new type ELMBs and keeping the old ones for spares of the 1st line. It is already known that more ELMBs will be needed in the future, to monitor LVs and temperature points of the new detectors. Part of the existing CANbus cabling for the ELMBs has to be improved for the future, as well as shielding and grounding, replacement of connectors and of some local power supplies. These modifications should solve the reliability and stability problems we are facing presently. The support given by the ELMBs ATLAS group to the ELMBs (including the old type ones), both hardware and software-wise (i.e. to the OPC Server), has still to be clarified.

The Polarized Target solenoid used until now will be replaced, for the 2nd phase of COMPASS, by a new magnet (Oxford Danfysik magnet) with larger acceptance. Given its complexity, it was decided to build a stand-alone control program for this magnet (Saclay group responsibility). For the moment, it is not clear what kind of monitoring to include in PVSS.

The COMPASS experiment decided to have, in the 2nd phase running period, its DAQ isolated from AFS. The idea to put also the DCS isolated, working in intranet mode, with a bridge to the CERN general network to allow for outside connection, is being studied and will also need some IT/CO support.

4 Requests to IT/CO-CERN

The new version of the JCOP Framework, prepared to work with PVSS II 3.0, is not compatible with projects developed in the old version, since the architecture of Framework datapoint types has changed. COMPASS is very much affected by this, since these datapoint

[4]The lock system of this device seems to need a repair, it locks too easily on any kind of noise. This is no problem when the magnetic field is On (signal>>noise), but leads to recording of non-sense values when the field is Off.

types are used extensively in the DCS-COMPASS project: CAEN HV channels, boards and crates (_FwCaenChannel, etc) and the readings from PLCs (put on _FwAI and _FwDi datapoints), for example. The ELMB package distributed with the Framework is also expected to have datapoint types that are different from the ones used until now in COMPASS (to be confirmed). As a consequence, the move to the new versions of PVSS and JCOP Framework imply a complete redesign of the DCS-COMPASS project.

The values history from past years will not be available (since all datapoints will be created from scratch), so at the end of 2004 Run, all the value archives will be retrieved from PVSS into some other platform (in principle in the format of Root tree file). The future project will use the Oracle database tool of PVSS, and the centralized database resources from CERN.

Most of the COMPASS-specific panels are re-usable. These will be redesigned only if considered necessary, for aesthetic or architecture reasons.

The redesign of the DCS-COMPASS project will need the support of IT/CO-CERN. Several features of the new versions of the programs are to be explored in the new project:

- User authorizations feature – planned to use different "areas" for different levels of access: "[detector] expert", "DCS expert", "operator", "observer". It must be possible to change the authorization level without closing and reopening the session. Any levels different from "operator" and "observer" should ask for authentication after some time interval of login (the idea is that "expert sessions" will not stay opened indefinitely; after some time, session should be dropped into lower level).
- The monitoring of TCP connections, in order to identify easily and to control remotely opened PVSS User Interfaces.
- The "dual" naming of datapoints – hardware (dpName) and physical (dpAlias) naming, now well visible in the new Framework tree, should be fully used. The idea is to use either one or the other name, to easily identify a hardware-specific or a detector-specific problem. There is a request from COMPASS to keep the database archived values accessible, whenever one physical channel is moved from one hardware channel into other, a situation that happens from time to time, whenever an hardware channel gets faulty. Detector (physical) channels exist permanently in the project; their mapping into hardware channels may change, but the past history should not be lost (maybe by re-use of the old dpID?).
- Final State Machine feature, or some other providing the same functionalities, should be used additionally, to define different running configurations – distinguish between "Physics", "Shutdown", "Alignment", "Access", "Field Rotation",... based on information received from DAQ-COMPASS, SPS/CRN,... This will allow to have alarms active/inactive depending on the type of Running condition, and also to take actions automatically (like switching Off GEMs HV if "Access", etc).
- Use new smoothing method for archiving, in % of monitored value.

- Filter the transient hardware alarms – only those alarms that remain for more than one reading cycle should be displayed in PVSS as real alarms (thus originating alarm color, an entry in the alerts screens, and archiving in the alerts database). The idea is to get rid of fake alarms as the ones we have from CAEN HV crates, that last only one cycle and require no human action, but distract the attention of the shift crew from eventual real alarms [5].

A tool should be provided to select HV channels for which the user could customize the refresh rate. This could consist of a framework panel, where one would select a group of channels, the wanted parameter (Imon or Vmon), the refresh rate (allowing a cycle time as short as 1 second), if archiving with this cycle is requested or not, and an "ok" button. On "ok" this would start a script to create the OPC group with the items requested on this refresh rate, start it, and open a second panel to see the items values. "Close" of this second window would stop the fast cycle, and delete the temporary OPC group, returning to the normal refresh rate of all items.

Since the future DCS must provide control of CAEN crates SY127, SY403, SY527 and SY1527, and only the last one has the possibility of Ethernet connection, for a matter of uniformity it would be nice to have the possibility of controlling the SY1527 new crates via CAENET. While from the hardware point of view this seems to be possible, there is up to now no support of the CAENET connection when using the CAEN OPC Server for SY1527. We consider it would be interesting to discuss the subject with CAEN, not only in the context of COMPASS needs.

It would be useful to have Framework tools to extract data from the value and the alarm archives more easily (or is it no longer necessary when using Oracle "external" DB?). This extraction tool must take also into account the quality flag of the value archived (usually one wants only to extract the data for which the quality flag was good).

A tool to configure an alarm for integer datapoint elements would also be very useful – up to now we only have framework functions to configure alarms on float values or on boolean values; we would like to be able to configure alarms that are triggered if datapoint value equals ($=$, not $<$ or $\leq$, as until now) some integer number (this would simplify the hardware alarm of HV channels, for example).

The non-update of monitored values should be more visible (with a background color), and an alarm should be generated in such cases. Currently, we have many situations in which the quality information is not propagated to the screen (by means of a background color change). The monitoring of the status of PVSS managers and the status of Servers to which PVSS is a client, should be also implemented in a standard way.

It still has to be understood if the new features for remote connection, in the PVSS new version, do not compromise the security and stability of the DCS-COMPASS project. We request to have a list of IP addresses allowed to open the para-module or the GEDI (so that we

[5] Obviously, this is just a work-around, and not a solution for the problem of fake alarms. In the case of CAEN hardware, a joint effort among COMPASS, IT/CO and CAEN is necessary in order to find out and fix the real source of these fakes.

restrict the access to these tools to the DCS team), while allowing to open UIs to any remote connection into the main DCS computer (thus allowing monitoring to any COMPASS member from remote).

As already stated in Section 3, support in the testing of CAEN, Wiener and ISEG OPC Servers, in particular with respect to their compatibility with each other if running in the same machine, and with PVSS, is requested. The use of the general Ethernet to connect hardware to the OPC Servers also needs to be tested (to be done by IT/CO experts together with Companies' engineers?)

5 List of equipments integrated in PVSS in 2004

- 22 CAEN HV/LV crates, with a total of 1311 channels:
  - 1 SY127 with modules:
    - 1 A332P
    - 8 A432P
  - 10 SY403 with modules:
    - 30 A503N
  - 10 SY527 with modules:
    - 18 A516
    - 6 A525
    - 5 A732N
    - 26 A734N
    - 3 A753N
    - 3 A821P
    - 2 A834P
  - 1 SY1527 with modules:
    - 2 A1821P
- 2 ISEG crates, with a total of 336 channels:
  - 2 ECH 228 crates with modules:
    - 10 EHQ 20 025p_204
  - no crate needed for the modules:
    - 2 EHQ 8 006p_605-F
- 11 Wiener LV crates
- 17 Wiener Fan-trays for VME 9U crates

- 3 PLCs
- 25 ELMBs (old type, v.103) + 3 (new type, v.128) with a total of 809 ADC channels used
- 1 NMRmeter sending values into file
- Several CAEN SY127 crates sending trip state into file