MULTI-PURPOSE DETECTOR (MPD) SLOW CONTROL SYSTEM, HISTORICAL BACKGROUND, STATUS AND PLANS

P.V. Chumakov, D.S. Egoro, R.V. Nagdasev, V.B. Shutov[a]

Veksler and Baldin Laboratory of High Energy Physics, Joint Institute for Nuclear Research, 6 Joliot-Curie, Dubna, Moscow region, 141980, Russia

E-mail: [a] shutov@jinr.ru

The Multi-Purpose Detector (MPD) is a 4π spectrometer to detect charged hadrons, electrons and photons in heavy-ion collisions at high luminosity in the energy range of the NICA collider. Among many important tasks necessary for successful operation of such a complex apparatus there is one to provide adequate monitoring of operational parameters and convenient control of various equipment used in the experiment. The report presented approaches and basic principles of development of the Slow Control system for the MPD. Tango Control System based approach allows one to unify representation and storage of Slow Control data from many diverse data sources. Presently running BM@N experiment serves as a perfect test-bench for the software. Special attention was paid to integrity of Slow Control data and operation stability. The status and plans of developing Slow Control system design for the MPD is also presented.

Keywords: NICA, MPD, detector, Slow Control

1. Main tasks and peculiarities of the MPD Slow Control

The Multi-Purpose Detector (MPD) [1] has been designed as a 4π spectrometer to detect charged hadrons, electrons and photons in heavy-ion collisions. The Multi-Purpose Detector should operate at high luminosity in the energy range of the NICA collider. Such a complex apparatus requires many servicing tasks to be performed during its exploitation. Among many other one is to provide adequate monitoring of operational parameters and convenient control of various equipment used in the experiment. In many large scale physical experiments worldwide such a complex of monitoring and equipment controlling tasks is called "Slow Control". Usually Slow Control includes such components as monitoring experimental hardware, centralized control of various experimental equipment, like low voltage and high voltage power supplies, gas flow control, preamplifier thresholds, gains, etc. Typically Slow Control system also includes an archiving subsystem, alarm subsystem, access control, configuration database and some other subsystems. Slow Control system interacts intensively with other parts of the experiment such as the main data taking system, event builder, the data quality and run control systems. In many respects the Multi-Purpose Detector Slow Control system is similar to the ones from other large physical experiments. However, there are some differences consequent upon the nature of the MPD development. The MPD apparatus consists of several subdetectors, see Figure 1. They are:
FFD - Fast Forward Detector,
TOF - Time of Flight system,
TPC - Time Projection Chamber,
IT – Inner Detector,
Ecal - Electromagnetic Calorimeter,
CPC tracker - Cathode Pad Chamber,
DCH -Drift Chambers,
ZDC - Zero degree Calorimeter Tracker.

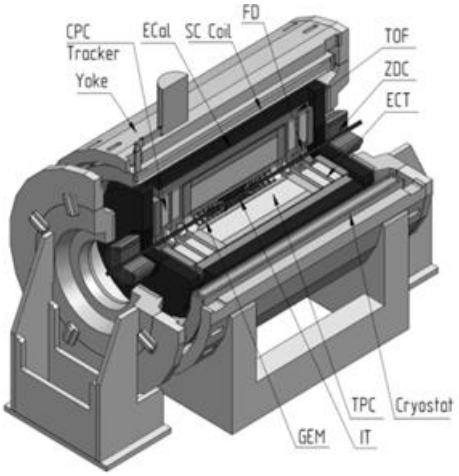

Figure 1. The subdetectors layout of the MPD

All these subdetectors were designed by different groups weakly interacting between themselves: standardization and compatibility of Slow Control equipment was the last priority. Consequently the whole detector has an extremely heterogeneous set of equipment to be monitored and controlled. Long historical background of the subdetector groups results in unnecessarily wide spectrum of the used Slow Control hardware and software. A typical example of such situation is using the high voltage power supplies in different groups. At present the high voltage supplies produced by CAEN, Wiener/Iseg and HVSys with similar parameters are applied. The same situation takes place with the software and communication protocols. Taking into account all the reasons mentioned above we developed a set of goals for the Slow Control system.

2. Main features of the MPD Slow Control system

The goals of the Slow Control system development are based on the experience from other large scale physics experiments and peculiarities of the Multi-Purpose Detector design. They are:

- Reliability – monitoring of hardware and software operation of the system
- Centralized control of diverse hardware
- Easy incorporation of existing subsystems and new hardware
- Storage of all Slow Control data in the unified format
- Common Slow Control configuration database for all subdetectors (such as High Voltage settings, thresholds etc.)
- Access control
- Scalability
- Modern and easily customizable user interface.

Some aspects of the listed goals will be discussed later.

2.1. Tango Controls system as a backbone of the MPD Slow Control

During the initial stage of the Slow Control system development the main task was a proper choice of the basic SCADA system. The three competitors were EPICS, Tango control system and commercial PVSS. Some of criteria were entry level complexity, existence of wide active collaboration, open source, price and support price. The Tango control system was chosen due to several reasons - it is an open source and it is already used at the LHEP accelerator complex. Tango control system provides several important features "out of the box". Among them:

- Multiplatform (Linux, Windows, …)
- Archiving service
- Access control service
- Logging service
- Alarm service
- Configuration tool
- Administration tool
- Code generator for C++, Java, python
- GUI Toolkit for Java, QT, Python
- Commercial bindings (Labview, Matlab …).

2.2. Layout of the MPD Slow Control system

The layout of the MPD Slow Control system is presented in Figure 2. Three layers of software – the front-end layer, service layer and client layer are connected by means of Tango middleware. The service layer includes all central services like Tango database, archiving, configuration database, application device services, etc. All the software of the Service Layer is running on several virtual machines at the existing MPD computing farm. Virtualization is done using PROXMOX Virtual Environment. The front-end layer includes a wide variety of devices using different buses and protocols, such as PXI, Ethernet, RS485, RS232 etc. The client Layer is presented by clients PC's running Linux or Windows operating systems.

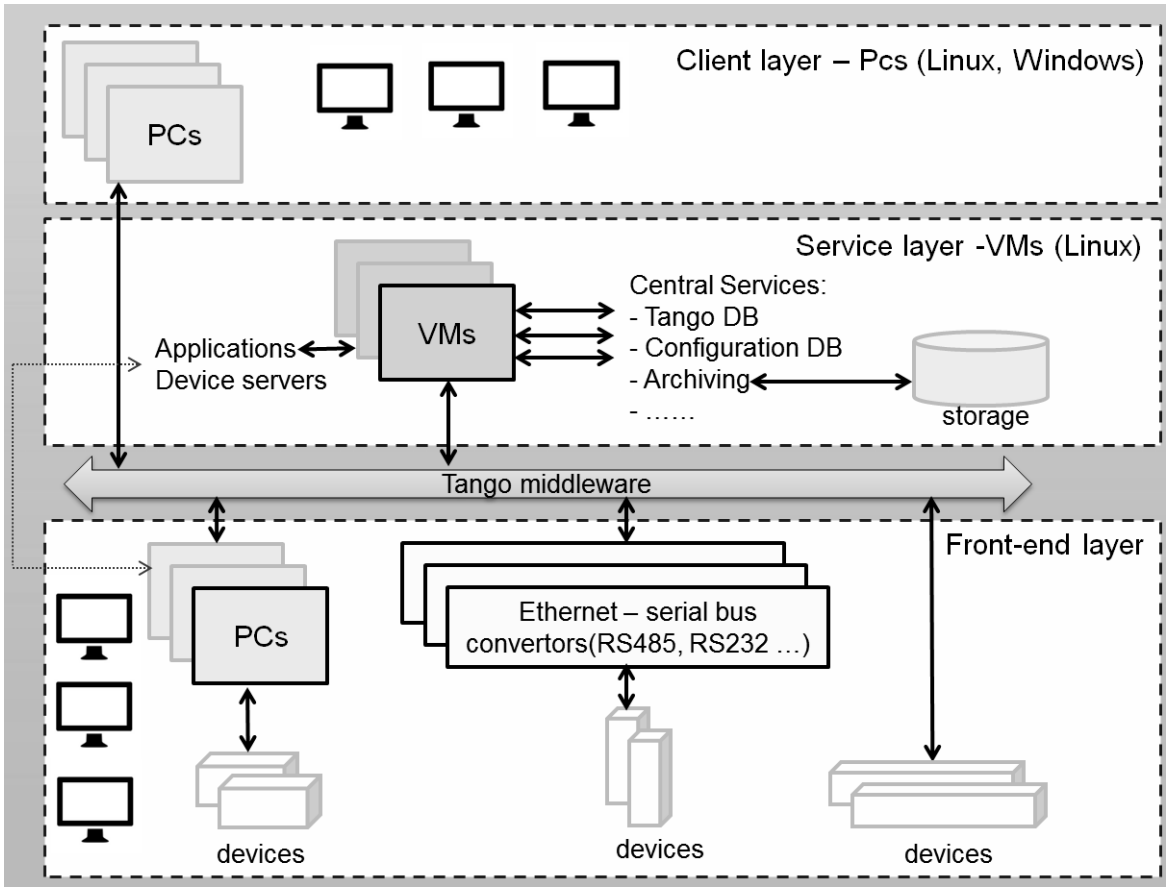

Figure 2. MPD Slow Control system layout

2.3. Reliability – monitoring of hardware and software operation

Slow Control system of the MPD covers a wide variety of different hardware and software applied in the MPD by the subdetector systems. In such a situation the task of monitoring the proper operation of all, software and hardware system components has a high priority. Tango control system has some built-in means to monitor software operations but in our case this is, certainly, not sufficient. We have developed several-level monitoring applications for this purpose. One of them is Status Server which gathers information from different sources, combines it and presents it at the high level of the whole subdetector. Status Server is a core element of the MPD Slow Control system. Its tasks include collecting all the relevant data from other device servers running in the Tango system, processing it and forwarding it to the Slow Control Status Monitoring Application. Status Server offers an easy way to monitor the status data from the multiple device servers in one place. Currently this scheme is implemented in Slow Control system for BM@N [2] experiment, which serves as a test-bench to develop many components of the MPD. Another monitoring task is Polling Monitor server. It monitors software operations at very low level checking the correspondence of the polled data being archived.

2.4. Easy incorporation of existing subsystems and new hardware

From the shelf the Tango control has a set of proxy device servers which allow one to easily incorporate new equipment into Slow Control system. Widely used servers are the socket, serial, modbus, TangoSnmp, OPCaccess proxy servers and some others. Unfortunately, some of them are not applicable for existing equipment. Therefore we have to develop dedicated tools to substantially simplify the work with particular protocols or specific software. As a result several extended proxy servers and clients were implemented. Some but not all of them are as follows:

- JSON parsing server (JSON - JavaScript Object Notation data-interchange format)
- SNMP extended library (SNMP - Simple Network Management Protocol)
- extended OPC-Tango server (OPC - OLE for Process Control).

2.5. Modern and easily customizable user interface

Tango control has several built-in tools for displaying data. However, they have several drawbacks and Tango Graph was developed as an improvement. It is universal, flexible and intuitive replacement for existing plotting tools like ATKMoni. Tango Graph provides real-time monitoring of the scalar and spectrum tango attributes with many useful options. It can handle multiple graphs, independent of each other, with different timescales, polling period, etc. One of the attractive features is an opportunity of loading attribute pre-history from database to display directly on the real time graph. The Tango Graph is easily configurable, space saving and provides simple tools for data presentation. Any point of data can be annotated and tracked. An example of Tango Graph is presented in Figure 3.

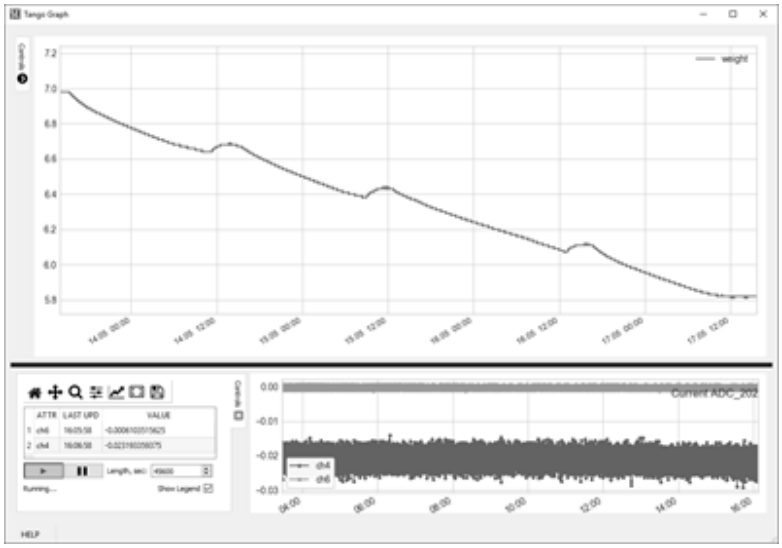

Figure 3. Tango Graph example

3. Conclusions

- A basic structure of Multi-Purpose Detector Slow Control system including databases, archiving system, alarm system, etc. was developed and realized.
- A set of software tools simplifying further developments was elaborated.
- Software and hardware solutions for various monitoring and controlling tasks were implemented.
- Essential part of core of MPD Slow Control system was tested during several BM@N runs at Nuclotron.

Future plans include extending MPD Slow Control system for new equipment and tasks, implementation of common Slow Control configuration database for all subdetectors and further reliability improvement.

References

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