INTRODUCTION

Control system network is not only the set of applications and software used to manage every single device connected to the apparatus, but it is also composed by all the services and tasks required to maintain itself (network services, documentation, etc.). In SPES Project[1], EPICS[2][3] has been chosen as framework to realize and renovate the control system for ALPI-PIAVE linear accelerator. As consequence, a migration from the previous old solution to this new environment is required. To do that a new dedicated temporary control network has been defined, but the only EPICS core application is not sufficient to realize the complete control system architecture. For this reason, different services have been implemented.

CONTROL SYSTEM ARCHITECTURE AND SOFTWARE CHOISES

Different services need to be implemented in order to guarantee usability and maintenance for the control system network. This aspect reflects the need of implementing different dedicated machines to provide these tasks. Instead of using physical machines, virtualization technology let user to administrate easier the network and, at the same time, minimize costs, power and cooling consumption and optimize physical space required by hardware.

For this reason, different virtual machines based on KVM[4] technology have been deployed (Figure 1); the choice of using KVM as virtual hypervisor is related to the large usage in enterprise environments and the full support provided by Red Hat Enterprise Linux (RHEL)[5]. Virtual machines have been deployed into a dedicated server equipped with CentOS operative system and the virtualization packages required. Above this layer, all the hosts have been defined; because of these devices don’t have particular hardware requirements, a “standard size” template machine has been created:

- 1 CPU
- 1-2 GB RAM
- 8-50 GB HD

CPU and RAM can be modified changing KVM virtual hosts’ parameters while it is possible to change dynamically the HD size in case of need: virtual HDs have been defined with Logical Volume Manager (LVM) technology which provides a great flexibility in develop and maintenance steps and let users to optimize resources in every time.

SERVICES

The following machines have been defined in order to provide the minimum set of services required to manage the entire control system network:

- **NTP server, DNS server and firewall:**
  In a distributed control system, data archiving is a fundamental task for scientists and technologists. In order to provide it, timestamp synchronization is mandatory for every device connected to the field which realize a remote control to the linear accelerator; at the same time, in the control system architecture a connection interface to the main Laboratory Intranet is required. For this reason a dedicated firewall machine has been developed: this host provide the minimum set of network services. Up to now, the principal services configured are:
  - NTP server for data synchronization
  - DNS server for domain name resolution (required during the development in order to maintain the growing network)
  - Gateway/Firewall for interfacing to the LNL Intranet

- **Manager and backup machine:**
  In any control network, cases of hardware failure or breakdown can be very dangerous. To avoid long time stops to the control network and, as consequence, to the linear accelerator, backup systems are desirable. With this scope and in order
to provide a robust environment for developers, a dedicated machine has been configured as control system manager. Based on CentOS operating system, this device uses open source software and custom scripts to provide backup tasks, saving the principal configuration and files of interest in a dedicated Network Attached Storage (NAS) server. In this condition, in case of machine breakdown it is possible to reduce sensibly the time required to restore the control system functionality. Over this layer, it has been installed but not configured the software required to provide an automatic provisioning for the entire SPES control system architecture.

- EPICS Input/Output Controller and vxWorks boot server:
  Some devices in different functional sub-system are based on VME technology and uses Real-Time vxWorks OS to execute their tasks. Because of they require boot and kernel images provided by a dedicated centralized server to start, a virtual machine has been implemented. This host has been configured to realize a boot server where every VME client can contact during boot-time. At the same time, different applications requires EPICS Input/Output Controller (IOC) in order to manager some high level control tasks without requiring interface to particular hardware.

- Wiki documentation, Bug Tracker and Versioning server:
  Widely used and recognized tools in Open Source development, Subversion (SVN) and Bugzilla, have been proven to be suitable for most kind of software projects and have lately been accompanied in many projects with an emerging document and content management system, Wiki. These tools provide an effective and seamless software configuration management (SCM) environment for professional software development allowing developers and managers to keep on track of projects and quality issues. In order to provide these useful services for developers and test users during the control system migration, a dedicated host has been developed and configured: while Wiki contains technical notes and preliminary documents, SVN keeps the software history (accordingly to the manager machine) and Bugzilla application has been employed for optimize debug step.

- Surveillance server:
  In the control network an open source solution was chosen to perform hosts and services supervision in order to reduce time for interventions in case of system fault: it basically watches hosts and services, alerting system administrators when things go wrong and again when they get better. This application provides a high level of customization through the usage of plug-ins and script; a dedicated script has been realized to integrate the EPICS environment inside the surveillance platform.

- NAS server:
  This is the only physical device configured for the EPICS services described. A dedicated embedded solution equipped with 4 HDs configured in RAID system provides all the disk space necessary for backups and data archiving jobs provided respectively by manager machine and EPICS archive system.

**CONCLUSION**

During the control system design and implementation, different machines have been deployed in order to provide the minimum set of services required by the environment. The virtualization technology adopted let system administrators to optimize cost and consumptions and, at the same time, to realize the network backbone where the new control system will grow. KVM technology is widely used in enterprise environment and chosen as default hypervisor in many IT infrastructures; as consequence, the network can grow and evolve in a more complex facility reusing the wok done up to now.

[1] SPES website: https://web.infn.it/spes/