THE HARDWARE RECOGNITION SYSTEM FOR THE SM18 LHC CRYOMAGNET TEST BENCHES

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Abstract

To test the 1232 cryodipoles and 460 quadrupoles for the LHC project, CERN has built 12 benches, organised in 6 clusters of two benches in the SM18 building.

To set up every test, the measurement applications have to be configured taking into account the specific calibration parameters of the devices used for the magnet under test. The process of generating these configuration files manually can be affected by operator errors and it doesn't provide the traceability of the equipment used.

To avoid these problems a system has been developed to extract the equipment settings from a database and generate measurement configuration files as function of the type of the test to be performed. The configuration files dispatched on the measurement bench are then loaded to configure the test execution.

This paper describes the implementation of this so-called Hardware Recognition System.

OVERVIEW

The LHC project [1] requires the assembly of a large amount of complex components, the largest part of them are the superconducting dipoles and quadrupoles.

These magnets have to be tested in cold conditions on the 12 benches running for about 48 hours of measurements per magnet. Consequently the so-called superconducting magnet test plant, installed in SM18 CERN building, has been constructed.

The quench performance, magnetic characteristics and insulation for instance take part in the acceptation chain of every magnet, and are essential parameters to be known for magnets distribution in the tunnel. Taking into account the total time required to test all magnets with this installation, this testing is on the critical path of the LHC project. For this reason tests have to be done reliably and as automatic as possible.

We have developed dedicated software applications in LabVIEW® to control all the measurement devices necessary to acquire data, such as power converters, acquisition systems for quench study or shaft rotating units for magnetic measurements. Each of these different applications needs its specific configuration to be adapted to the local situation, since each magnet is tested on a bench making use of shared measurement shafts and electronic racks.

Given the large number and diversity of configuration files to be prepared, there is a high risk of introducing errors when using manual configuration. Consequently and following the traceability and quality assurance rules, a bar-code system linked to an Oracle database has been developed to allow users to identify the test equipment, and its corresponding calibration parameters. These data can be extracted for automatic generation of the configuration files needed for the measurement applications. This tool is called the Hardware Recognition System (HRS).

Within the framework of the HRS, the automatic configuration files generation will be detailed in this paper. The configuration database part of the system, that includes scanning of equipment bar-codes, allowing traceability of equipment in combination with their parameter settings is covered in detail in another paper of this conference [2].

TEST BENCHES AUTOMATION

The Test Master [3] (TeMa) was the first application designed to automate the execution of series measurements in a single cluster. This application is responsible for launching sequences of tests and drives the applications that perform the measurements on the magnet.

However, the TeMa is not capable to know if the necessary equipment (hardware part) is available and installed on the desired cluster where the measurements have to be done. It's neither capable of generating the configuration files necessary for the measurement applications. These files need to have the parameters of the particular equipment of the cluster, in order to properly setup the applications that will measure the installed magnets. To accomplish these tasks a new layer was added to the previous architecture of the control system. This layer called the Resource Manager [4] (ReMa) is designed to be a service layer that completes the missing part in TeMa and fulfill the requirements for the automation of the test benches.

In fact, only the HRS, a part of the ReMa, concerns the hardware checkup and generation of the configuration files. It can be divided in 3 parts: the Test Type Editor (TTE), the Hardware Recognition Loaders (HRLs) and the hardware database (see Figure 1).
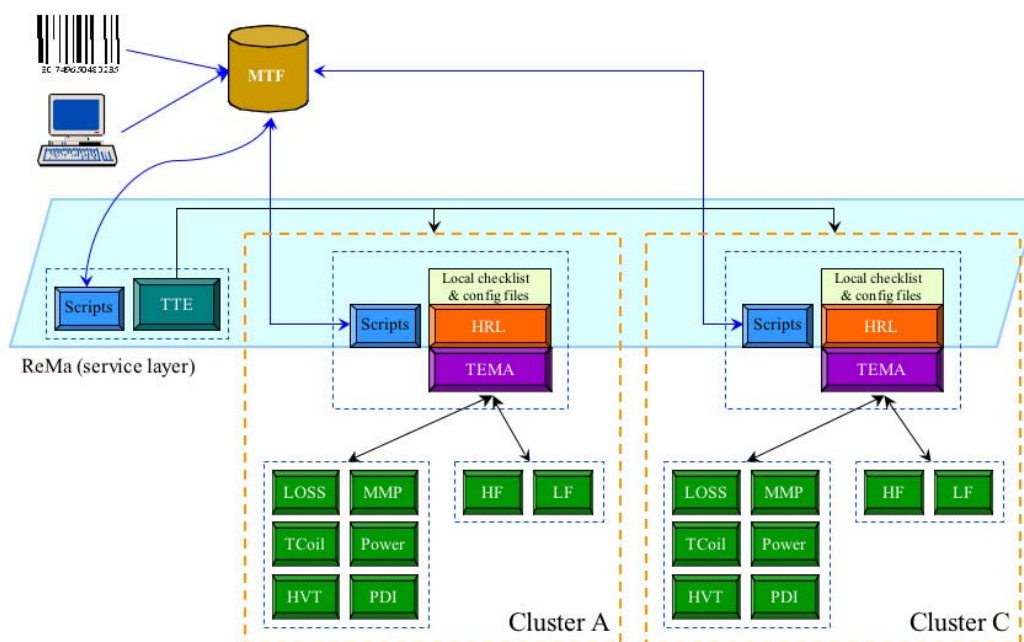
Figure 1: The ReMa distributed architecture showing the HRS interactions.

In the TTE, the user has the opportunity to define a list of minimum equipment required for each test that will be launched by TeMa (see Figure 2). This list concerns only the equipment for a single cluster. The equipment is referred to by its category name in the database, which is the type of equipment, and not a particular device. For example, the VME crates ZZ01000026 and ZZ01000027, are 2 different equipment but they both belong to the category "VME crate". This method is important because we are only concerned of defining a list of minimum number of equipment per test. A certain test can, for example, require 3 VME crates, but it's not necessary to know their references to conclude if all the equipment is present for making the test.

The TTE will then compile the equipment lists for all test types and send them to the HRLs. Since this information is the same for all the clusters, the TTE is located on a central machine, from which it sends the lists to the various HRLs, running on the TeMa machines.

HARDWARE RECOGNITION

For the operation of the HRS, a bar code reading system and a terminal, used to enter some device parameters, were employed. This equipment is used to insert information into the MTF database, storing the equipment parameters and its availability. Another database, called SettingsDB, is used to store the acquisition configuration parameters.

The HRLs [5] are implemented in LabVIEW® but use Perl scripts to query these databases.

Perl scripts

From the point of view of the HRS, the functions of the SettingsDB are twofold: to list the equipment available for measurements on a given cluster and to generate the configuration files for given test type and cluster combination.
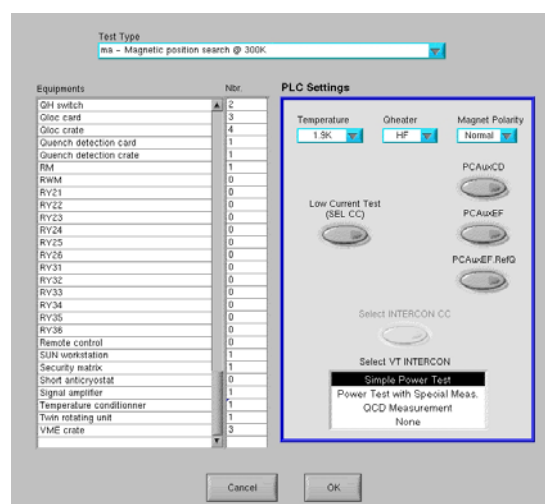

Figure 2: The TTE panel

The HRL can send requests to the SettingsDB by means of two scripts making the application tier: *hr_chklst* and *hr_confgen*. The behavior of these Perl scripts is controlled through command-line parameters and the interface to the underlying data tier is assured through DBI, a database interface module for Perl.

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The data tier contains a set of tables that store the information related to data acquisition parameters of measurements: channel names and relationships, recording parameters, dead-bands, triggers, test types, etc. This part of the data model complements the hardware-related information that is stored within the MTF asset management system (calibration parameters, gains, etc), and which is accessible transparently through database links. Data tables belonging to the SettingsDB map almost directly into the structure of the configuration files to be generated. Wherever a piece of information in the configuration file needs to be extracted from MTF, a macro invocation is stored in the data table, as opposed to actual data. The definitions of macros are also part of the SettingsDB and are implemented as PL/SQL stored procedures. It is at the configuration file generation stage that the macro is executed and the result is inserted at the right place in the data set returned to HRL. This has the advantage of ensuring that the information returned is always up to date and mirrors the most recent state of MTF repository.

The architecture of SettingsDB is entirely data driven. No code needs to be changed in the application tier if any particular data acquisition setting is modified. The only part, which may undergo updates, are data residing in MTF and SettingsDB, as well as stored PL/SQL procedures if rules for the extraction of hardware settings change.

LabVIEW application

The HRL (see Figure 3) has three main functions: checks if the equipment for executing a test or a sequence of tests is available, creates the configuration files and transfers them to the low-level application machines.

To check the availability of the equipment for one selected test, HRL compares the information offered by the script *hr_chklst* with the file that contains the requested equipment for the test, introduced by an expert through the TTE. The system is able to perform this operation for several tests at the same time.
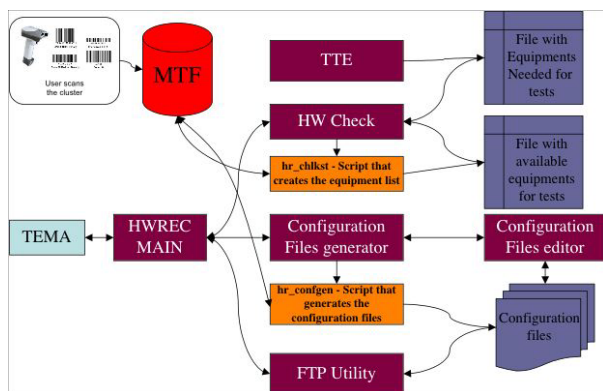

Figure 3: The HRL flow-chart

The configuration files, to be loaded by the low-level measurement applications, are created by executing the *hr_confgen* script provided with several parameters. If there are two magnets installed in the cluster, this script will duplicate the generation of the configuration files, considering that the bench configurations are active-passive and passive-active, this is because only one bench at a time can be used to perform the measurements.

If errors related to the generation of the configuration files occur, the HRL includes an editor, allowing the manual introduction of the configuration parameters by an expert. This is useful when the database is unreachable or not responding or the database has invalid or incomplete information for the creation of the configuration files.

The third task of the HRL is to transfer, using a standard file transfer protocol, the configuration files to the workstations where the measurement applications are running.

In case of normal operation, after the identification of the equipment, the user selects the test sequence to be executed and then, the configuration files are created and transferred on the measurement workstations in a fully automatic way, minimizing setting-up time and user errors.

CONCLUSIONS

For the LHC project, 1232 dipoles and 460 quadrupoles magnets need to be tested at CERN in cold conditions. For this 12 dedicated test benches have been constructed in the SM18 building.

The Hardware Recognition System has been developed to extract the equipment settings from databases and to generate measurement configuration files. This automatically configures the measurement applications, taking into account the specific calibration parameters of the devices used for the magnet under test.

This system is under test in SM18 since a few months and has shown to be able to fulfil the expectations of having a complete automated measurement procedure, saving time and preventing user errors.

REFERENCES

[1] The LHC Study Group, The LHC Conceptual Design Report, CERN/AC/95-05(LHC)

[2] T. Ladzinski et al., "Configuration Management System for the LHC Superconducting Magnet Test Benches", this conference.

[3] A. Raimondo et al., "The Test Master", Note CERN, EDMS-383868

[4] A. Rijllart et al., "Orchestrating the Measurements on Twelve Magnet Test Benches", EPAC2002, Paris, France, p. 2739

[5] H. França-Santos et al., "The Hardware Recognition System", Note CERN, EDMS-385105