Technology

ICM - Industrial Control and Measurement adapted to CERN.

- The MTA systems are designed according to an industrial model where the software is homogeneous in all tiers, from the User Interface down to the device I/O, as shown in Fig. 1.
- The reason is to maximise the value of the CERN investment in creating and maintaining such systems. By adopting a homogeneous approach to all steps of the development process and at every tier, we are convinced that systems can be of good quality, requiring a minimal implementation effort and will be easy to maintain.
- Our choice of software is LabVIEW of National Instruments, including the related toolkits and drivers, because we have not found other products offering this top-down software homogeneity and wide-range of supported hardware. In addition, over 700 industrial alliance partners world-wide adhere to this model and contribute with thousands of products, drivers and services, which assure us of a wide offer of equipment and support in a large number of countries, many of which are CERN member states.
- Our contribution to fully integrate LabVIEW into the CERN IT and controls infrastructure was to set up an installation and licensing system for all NI software products and develop a framework for Rapid Application Development (RADE) based on LabVIEW of which the main assets are threefold:
  a) Access libraries to specific CERN middleware and access control (CMW, RBAC, JAPC),
  b) Dedicated servers for certain services to comply with CERN security and access policy,
  c) Integrated LabVIEW+RADE training at CERN.

RADE - Rapid Application Development Environment in LabVIEW

LabVIEW is a complete software development suite for developing GUI's, process inter-communication and target programming, such as FPGA's, DSP's and Real-Time tasks. The missing link for effective use of LabVIEW in the accelerators was its integration into CERN specific software tiers, such as CMW+RBAC, JAPC and Oracle databases. We have developed a framework, called RADE, which interfaces LabVIEW to these software systems. The technologies chosen for the implementation are (Fig.2.):

- Native LabVIEW libraries where possible
- C++ shared libraries for CMW and RBAC
- Tomcat server and Java for JAPC, timing and Oracle access
- LabVIEW VI server for specific Windows or Linux dependencies
The first two services provide direct access through native code or shared libraries. The second two services connect to dedicated RADE servers through which the requested service is provided. These servers guarantee compliance with the CERN security standards and allow us to monitor the use of the accessed resources (in volume, frequency, etc.).

The full list of RADE services is:

1. LabVIEW - Oracle.
2. LabVIEW - CMW, to access FESA devices.
3. LabVIEW - RBAC, for secure access.
4. LabVIEW - JAPC, to access devices through a Java API.
5. LabVIEW - TMC, to subscribe to the accelerator timing events.
6. LabVIEW - SDDS file reader, for Post Mortem data.
7. LabVIEW DataSocket to Java, for data exchange.

The RADE framework has successfully been used for:

- The Post Mortem Analysis applications for the Hardware Commissioning of the LHC,
- The RADAR toolkit used for OASIS and Sampler signal processing applications,
- The CLEX two-beam test stand on-line beam data viewer,
- The PS beam spectrum analyser,
- Many other expert programs made by BE-OP, RF and BI, and TE-ABT, EPC and MPE.

**PMA - Post Mortem Analysis Software**

A set of GUI applications organised around a central Post Mortem Event Analyser (PMEA) access Post Mortem data and several databases for complementary information to analyse the LHC electrical circuit protection systems and characteristics from power cycles, magnet quenches and interlock events. The PMEA is the user application that interfaces to a server application, the Request Handler, which communicates to the Sequencer and builds the events to be analysed.

Eight expert applications can be launched from the PMEA to analyse the Post Mortem events and present results for validation by an expert:

1. Post Mortem Browser
2. Power Interlock analyser
3. Current discharge analyser
4. Dipole quench analyser
5. Splice resistance analyser
6. Magnet and current leads analyser
7. Distribution feed box analyser
8. Cryogenic conditions analyser

**MSS - Measurement Systems Software**

A set of GUI applications providing sequencing of operations for instrument control and data acquisition (using the ICS and IDS modules) and data processing for analysis.

The more than 100 applications can be grouped into seven groups:

1. Magnetic field harmonic measurements using rotating coils.
2. Magnetic field advance and dipole/quadrupole tracking measurements.
3. Snap back measurements on b3 and b5 harmonics using Hall probes.
4. Magnet and cable quench data acquisition and analysis.
5. Magnet geometry measurements for survey and field correlation.
6. Electrical tests for isolation, resistance, continuity, energy loss and RRR.
7. Applications to test other essential accelerator components, such as diodes, HTS current leads, bus-bars, bellows and beam screens.

**ICS - Instrument Control Software**

1. LabVIEW Real-Time DAQ and LabVIEW FPGA for PXI and cRIO.
2. LabVIEW DAQ and I/O tasks for USB and PCI boards.
3. TCP/IP modules for FGC gateways, Laser Trackers, PLCs, remote GPIB, etc.

**IDS - Instrument Driver Software**

1. PXI and PCI bus: drivers for ADCs, DACs, RF generators, spectrum analysers, digital I/O and CCD cameras.
2. MXI bus: drivers for VME, with RT processors, ADCs, DACs and D-I/O.
3. GPIB bus: drivers for Power supplies, DVMs, LCR-meters and switches.
4. RS232/485: drivers for Powers supplies, motors, PLCs, amplifiers and switches.
5. USB: drivers for portable DAQ equipment

**Platforms**

Windows, Linux, Mac OS X and Solaris (up to v. 7.1).