Simplified instrument/application development and system integration using Libera BASE software framework

Matej Kinda, Tomaž Beltram, Tomaž Juretič, Borut Repš, Damijan Škvarč, Čti Valentinčič, Instrumentation Technologies, Slokane, Slovenia

Abstract
Development of many applications in scientific environment faces us to a few similar challenges, often executed repeatedly. One has to design and integrate hardware components. Support for network and other communication standards needs to be included. Data and signals are processed and dispatched. Interfaces are required to monitor and control the behaviour of the application. At Instrumentation Technologies we identified and addressed these issues by creating Libera BASE, which is a framework composed of modules to facilitate building blocks. Libera BASE simplifies some of the tedious tasks and leaves more time to concentrate on real issues of the application. Further more, the end product quality benefits from a larger common base of also framework.

Increasing Role of Software in Reconfigurable Instruments
Software has become an essential part of electronic devices. Chips are becoming integrated and programmable and software needs to control them:

- FPGA by its nature
- ADCs, DACs interfaces are controlled over SPI, I2C buses.

Software interfaces are the points where people communicate with the instrument and define user appearance through graphical, control programming and other interfaces.

There is a set of concepts that is occurring repeatedly in measurement instruments:

- Hardware detection, platform management
- Control of functionality implemented in FPGA
- Communication parameters
- Verification of changes
- Signal acquisition, processing and dispatching
- Scheduling for running instrument applications
- Supporting standard control system interfaces

Libera BASE
Libera BASE is a software framework for application development on different hardware architectures with intuitive structure and programming interfaces. It:

- narrows the gap between customers hardware and the machine's control system
- helps to focus on the application, for which the instrument is designed for
- simplifies integration into various control systems, however it does not aim to act as a replacement for them
- ensures higher reliability

Concepts and Building Blocks

- For: Micro TCA-compliant platform management
- Ibm: Hardware abstraction layer (uses PCIe, USB, OpenHPI)
- Am: PICP Linux-based module relies on a set of standardized FPGA registers
- Ap: Application parameters as hierarchical tree
- Spp: Signal acquisition, processing and dispatching
- App: Application development framework, plugins
- Epl: Client programming interface (API) for Linux and Windows: exposes registry and access to signals
- Bxu: Simple command-line tool for automation and scripting
- Adapt: Ubuntu-based and as ixView comp; web, EPICS (edm, pyEPM) Tango C, FESA

Instruments leverage Libera BASE
Libera BASE accelerates development of instrument applications.

Application defines:
- Set of user selectable parameters
- Signals
- Processing and algorithms

In September 2011, the following instruments use Libera BASE: Libera Single Pass, Libera L110, Libera L110, Libera L110, Libera TCG, Libera TPG.

Measurements of source code sizes reveal that the share of application-specific software is around 10% of total software, remaining 90% is Libera BASE.

Libera BASE supports different hardware architectures

Simplified integration based on MCI API
The MCI programming interface is designed to be simple, intuitive and powerful. Different Instruments use the same networked API, which can be used from GNU/Linux and Windows clients. MCI is used to implement different client programs and adapters.

Different instruments have already been used from the many client applications, for example:
- graphical user interfaces
- command-line interfaces
- MatLab, SciLab
- OpenOffice.org spreadsheet
- mobile devices (Phone, Tablet, Android-based phones)
- web browsers
- EPICS EDM

Examples of integration with different applications

Customisation of Instruments
Several tools are provided to customise Libera instruments:
- FPGA development kit (FDK)
- FPGA to registry map (no programming needed)
- Software development kit (software plug-ins)

New parameters and signals implemented when extending the instrument are exported through MCI API in the same way as those originally provided by the instrument.

Examples of XML mapping file and the resulting entries in registry

When your users demand stability.