Modular Software for MicroTCA.4 Based Control Applications.

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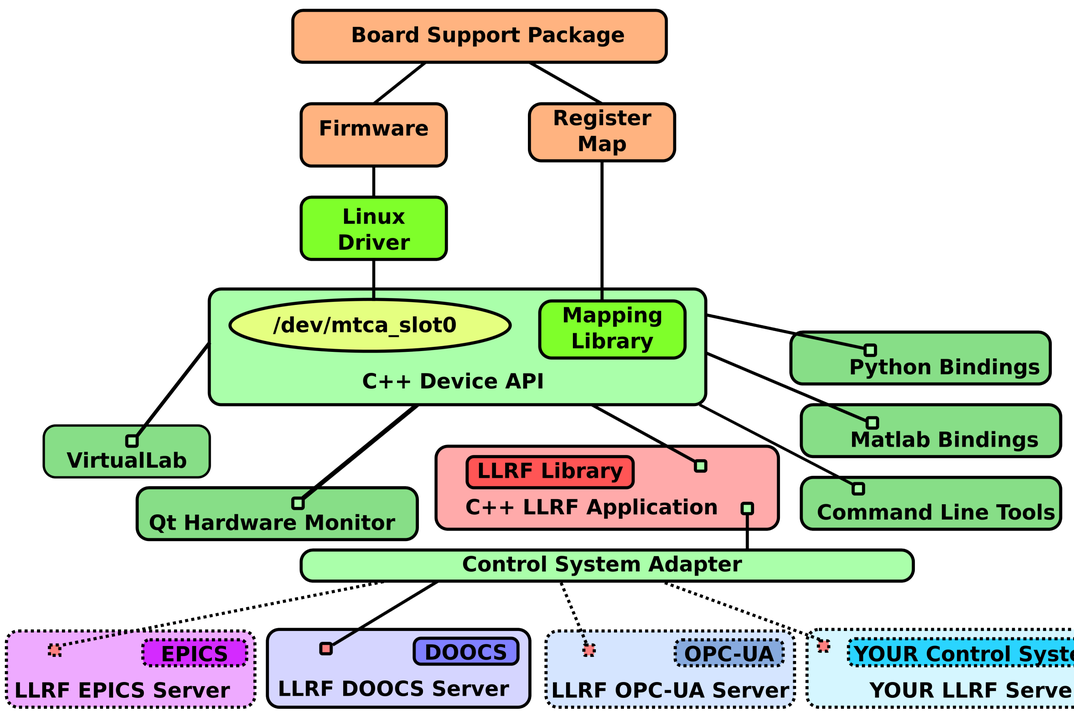
MicroTCA.4 Technology

Based on Advanced Telecommunications Computing Architecture (ATCA)
Widespread use in telecommunications since 2005
- > High speed serial bus topology
- > High modularity due to Advanced Mezzanine Cards (AMCs)
- > High availability due to redundancy
- > Reduced down-time due to hot-swap capability

MicroTCA.4 Enhancements for Rear I/O and Precision Timing
- > Definition of Micro Rear Transition Modules (µRTMs)
- > Definition of AMC-µRTM connection
- > Radial clock lines for precision timing
- > Low latency point to point serial I/O
- > Advanced shelf management
- > High signal integrity by separation of analog and digital processing

The DESY MicroTCA.4 User Tool Kit (MTCA4U)



Firmware Board Support Package
- > FPGA abstraction layer
- > Reference firmware with demo application code
- > Automated generation of register map

Driver and Basic Tools
- > Extensible universal driver
- > C++ device API
- > Abstract back-end interface
- > Language bindings to Matlab and Python
- > GUI for convenient register monitoring/setting

Device Specific Applications
- > Example: Low Level Radio Frequency (LLRF) control application for accelerators

Control System Adapter
- > Reusablity of application code with multiple control systems

VirtualLab
- > A test framework to ensure software quality
- > Simulation and testing without hardware

Use Case: Low Level Radio Frequency Control at the European XFEL and FLASH

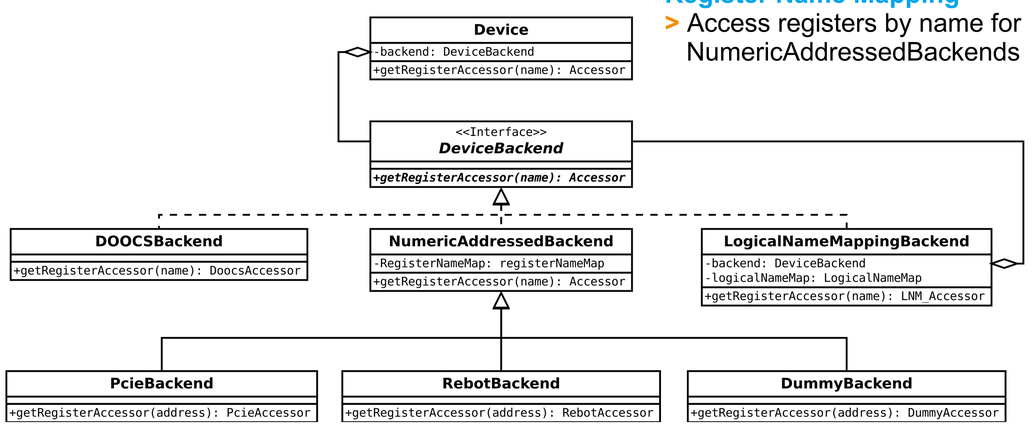
- > Digital low level radio frequency (LLRF) control based on MicroTCA.4
- > Superconducting accelerators provide multi-GeV electron
- > Pulsed operation (10 Hz)

A MicroTCA.4 LLRF installation in the FLASH accelerator tunnel

MTCA4U → ChimeraTK

- > The tool kit has evolved to support devices beyond the scope of MicroTCA and MTCA4U has been renamed to ChimeraTK
- > All software is avialable under GNU General Public License or GNU Lesser General Public License
- > GitHub Repository: **https://github.com/ChimeraTK.**

The C++ Device API



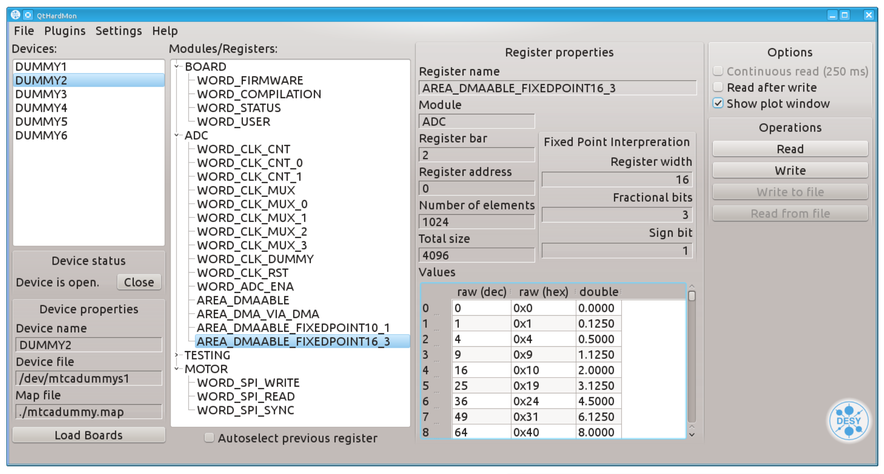
Register Name Mapping
- > Access registers by name for NumericAddressedBackends

DeviceBackend
- > Abstract interface
- > PCI Express
- > Back-ends beyond MicroTCA.4 devices
- > Register-based over TCP (RebоT)
- > Control system middle-ware access

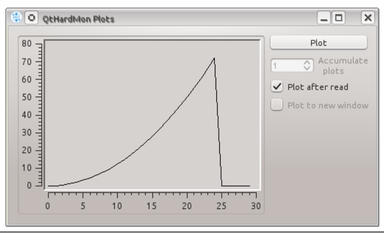
Back-End Factory
- > Automatically determine the back-end type
- > Plugin mechanism
  - – add new back-ends at run time

DummyBackend
- > Simulate I/O address space in RAM
- > Callback functions on read/write
  - – implement firmware mock-ups

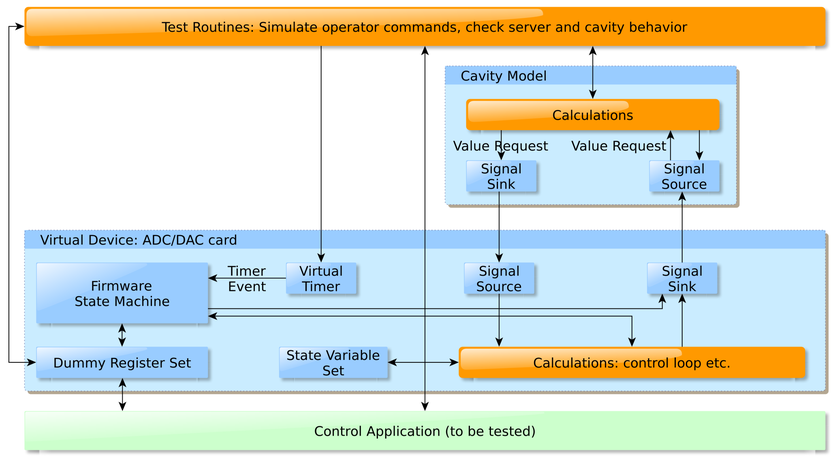
Qt Hardware Monitor



- > Lists all hardware registers
- > Register names and properties
- > Read and modify register content
- > Basic plotting functionality



VirtualLab



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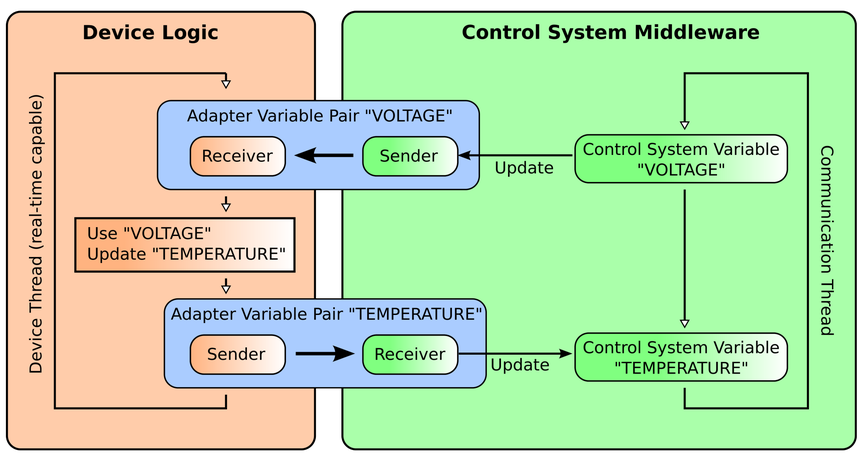
- > Software testing and simulation
- > Using virtual timer to avoid race conditions
- > Hardware virtualization

Control System Adapter



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- > Application code (device logic) is independent from the control system
- > Thread safe
- > Minimise device-dependent code on the control system side
- > Real-time capable

This work is supported by the Helmholtz Validation Fund HVF-0016 “MTCA.4 for Industry”

20th Real Time Conference
Padua, Italy, 2016

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