Abstracted Hardware and Middleware Access in Control Applications

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The task

> Accelerator controls need complex devices servers

> Requires communication to FPGAs, micro-controllers, frontend and middelware PCs with different protocols via PCIe, Ethernet, etc.

> Devices should be used in various other facilities with different control systems
- XFEL and FLASH at DESY using DOOCS
- ELBE at HZDR using OPC UA
- FLUTE at KIT using EPICS 3
- TARLA in Ankara using EPICS 4

ChimeraTK

> Framework to abstract applications from the details of hardware and control system protocols

> Write device servers which are intrinsically control system independent

> Using modern C++ 11

> Open source software, (L)GPL

The DeviceAccess library

> Access to register-based devices

> Common interface to backends which implement different communication protocols

> RegisterAccessor objects represent registers as process variables (common interface with ControlSystemAdapter)

> Register name mapping: Identify registers by name instead of numerical address

> Device name mapping: Identify devices by functional name (independent from backend)

Available backends

> PCI Express

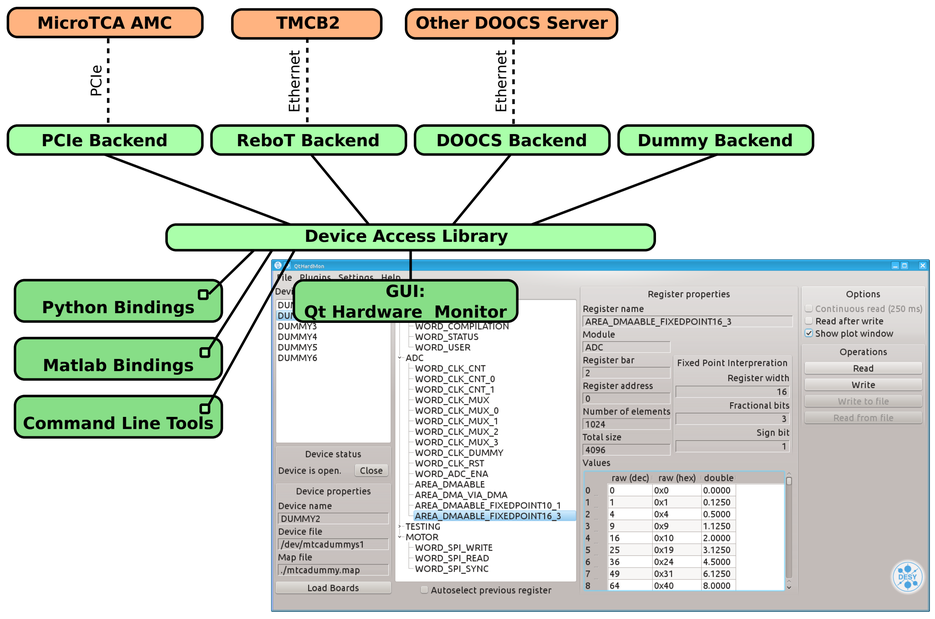
> Simple network protocol for FPGAs: RebоT (Register-based over TCP)

> DOOCS backend

> Dummy backend / VirtualLab

> LogicalNameMapping backend for more abstraction from implementation details of the firmware

Custom backends can be loaded at run time.



Software for interactive access and scripting

> Language bindings for Python and Matlab

> Linux command line tool

> Graphical user interface

Convenient tools for firmware development: Direct hardware access without having to write code.

ApplicationCore

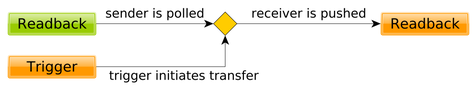
> Application modules implement the algorithms

> Connection code combines modules and creates an application

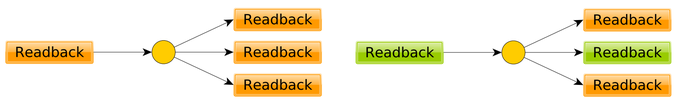
Connections

Requirement: Intuitive syntax that minimises number of code lines

> Use any pushing sender as trigger to connect a polled sender to a pushed receiver



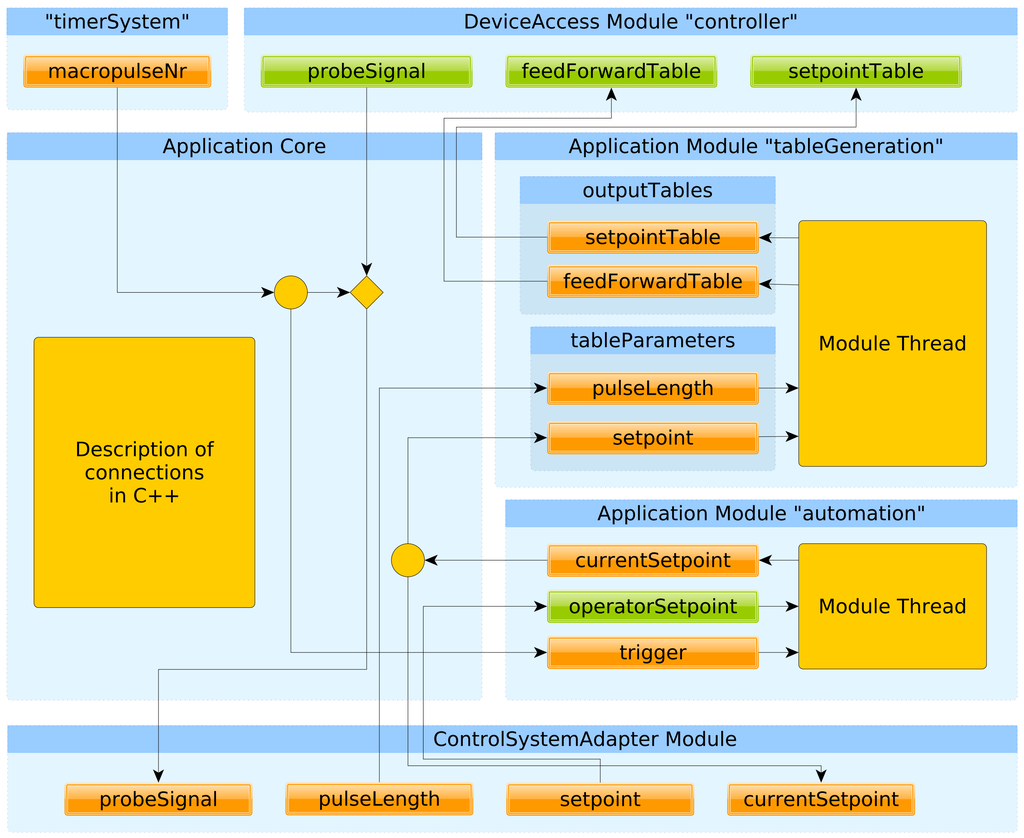
> "Fan out" to distribute variables



> Connect all variables with the same name in a single command

> Group variables and modules to structure the code

> Plot tree with variable content of an application



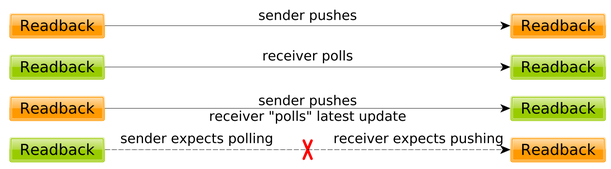
Application modules

Abstraction: If a module does not know if a process variable is coming from the hardware, the control system or another software module, it will not be sensitive to specifics of a particular middleware.

> Interface consists of input and output variables

> One thread per module

> Two types of variables:
- active sender pushes updates to passive receiver
- passive sender is polled by active receiver



> Use *blocking read* to synchronise to other threads and to hardware
- on a single variable
- on *all* variables or *any* variable in a group

> Hierarchical variable names

> Advanced modelling with tags on variables

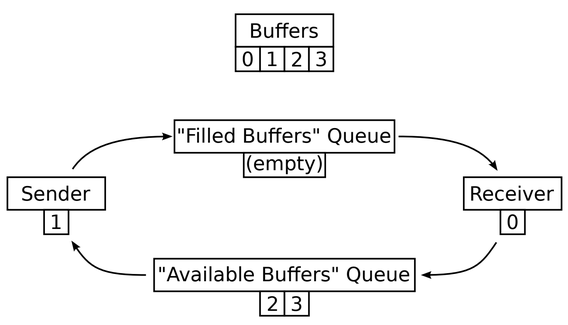
ControlSystemAdapter library

Process variables are implemented as lock-free sender/receiver pairs

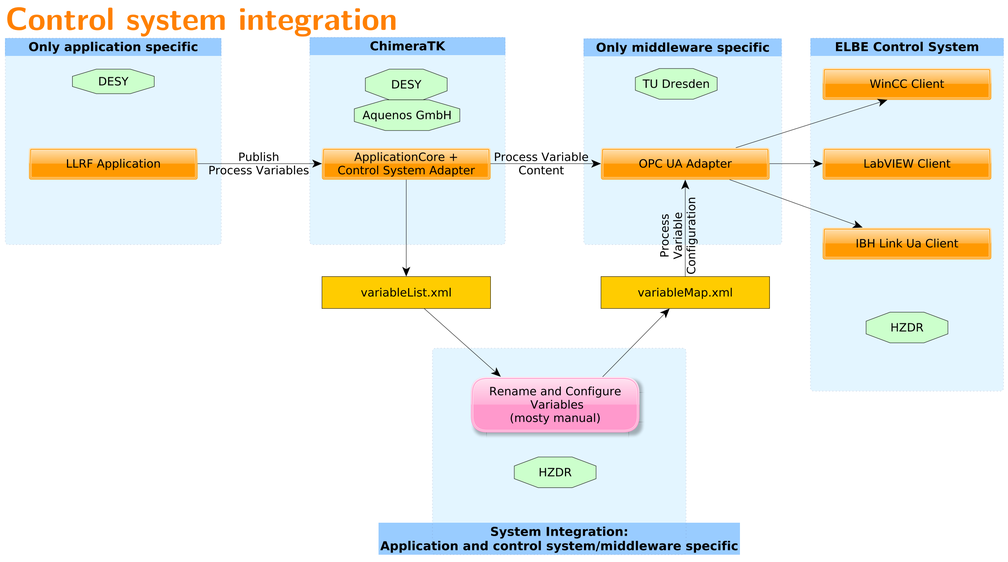
> Avoid locking problems with middleware

> Lock-free queues allow different read-modes
- *non-blocking read*: return last received value if queue is empty
- *read latest*: empty the queue and return last received value
- *blocking read*: wait for new data if queue is empty

> Basis for inter-thread communication, also in ApplicationCore



Control system integration



The ChimeraTK ControlSystemAdapter is complemented by a middleware-specific part (DOOCS Adapter, OPC UA Adapter, EPICS Adapter)

> Publish process variables via middleware

> Define variable name visible in control system

> Define middleware dependent features/data types (server-side histories, display properties)

> Application independent, configured via config file

Software repositories

> https://github.com/ChimeraTK/DeviceAccess

> https://github.com/ChimeraTK/ControlSystemAdapter

> https://github.com/ChimeraTK/ApplicationCore

> https://github.com/ChimeraTK/ControlSystemAdapter-DoocsAdapter

> https://github.com/ChimeraTK/ ControlSystemAdapter-OPC-UA-Adapter

> http://oss.aquenos.com/svnroot/epics-mtca4u

Presenter

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