Introduction to the ChimeraTK Control System Adapter.

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HELMHOLTZ ASSOCIATION

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Typical Scenario: Integrating a small device

Integrate the device into your EPICS environment

- Just a few Process Variables

⇒ Write a new EPICS IOC, not too much work...

Integrate the same device into a DOOCS environment

- Just a few Process Variables
- DOOCS and EPICS are very different, not much code to reuse: Better start from scratch

⇒ Write a new DOOCS device server, not too much work...

Sometimes You Need An Adapter

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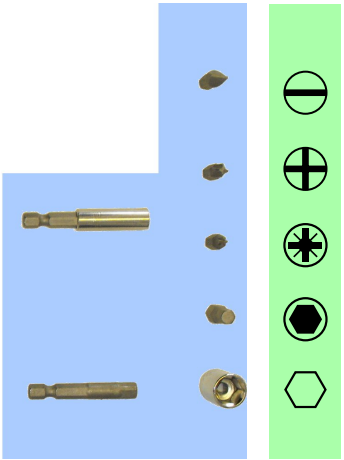
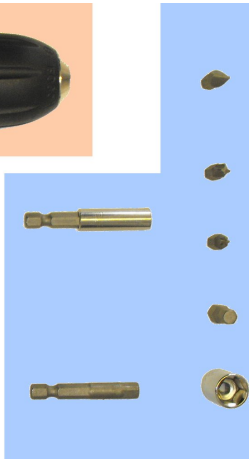


Sometimes You Need An Adapter

Device



Adapter

Control System

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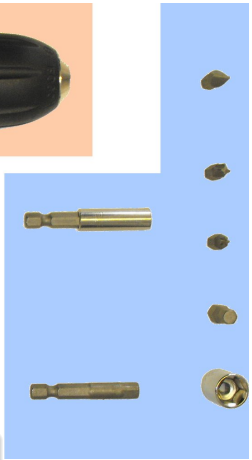

Adapter

Control System

EXAMPLE: LLRF Server

- $\mathcal{O}(400)$ process variables
- iterative learning algorithm
- feed forward table calculation

EXAMPLE: Target Control Systems

- DOOCS at FLASH,XFEL/DESY
- EPICS 3 at FLUTE/KIT
- WinCC/OPC-UA at ELBE/HZDR

Control System Adapter

Task

Complex control algorithms should be used with different control systems.

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Requirements For Abstraction

- Keep application code control system independent
- The algorithm must interact with the control system
- Use functionality provided by the control system
- No device-dependent code on the control system side

Additional Requirements:

- Thread-safety
- Real-time capability
- Must not copy large data objects (arrays)

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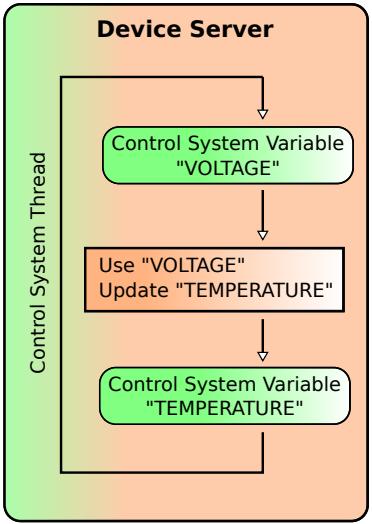
First Implementation

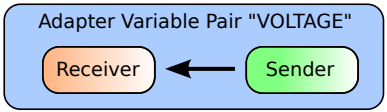
- Process variables to transfer data to/from the control system

A Typical Device Server (Without Adapter)



- Control system data types used inside the algorithm
- Control system variables can be locking/blocking
- Control system variables might not be thread safe
- Threading often handled by control system

A Device Using The Control System Adapter



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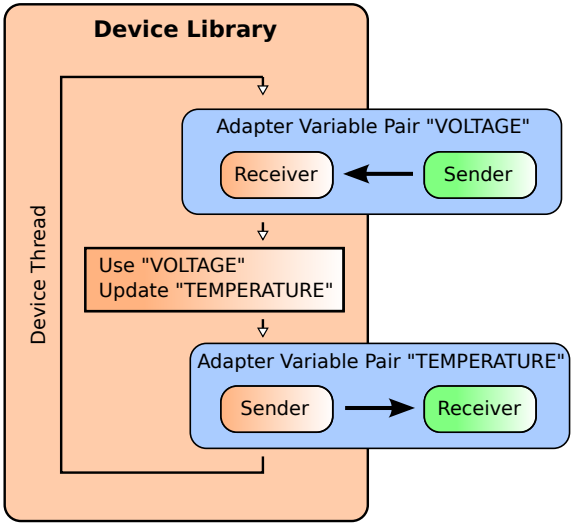

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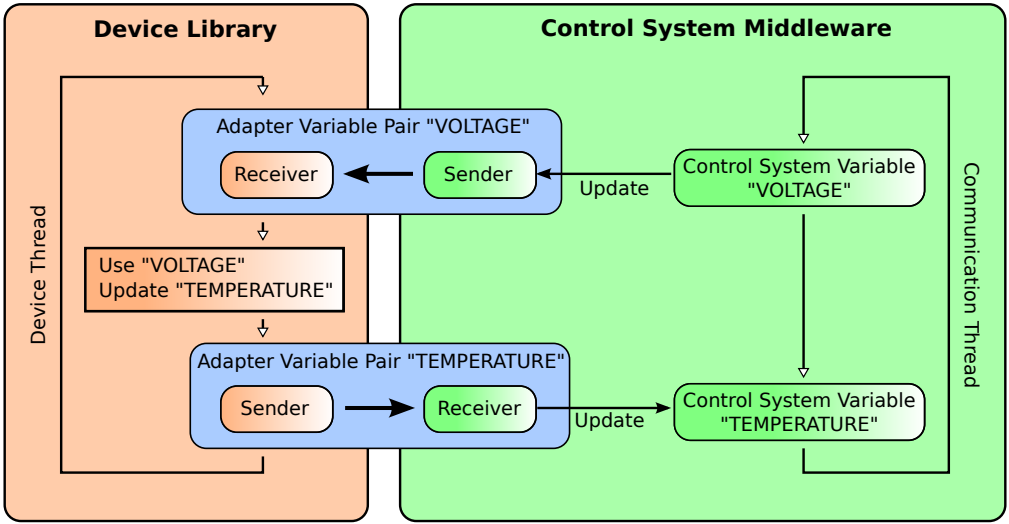
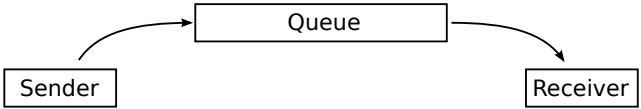


Implementation Of The Sender/Receiver Pair



- Lock-free queue

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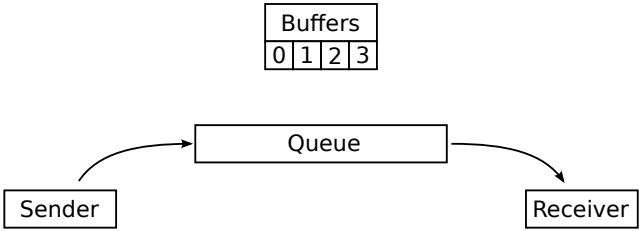

- Lock-free queue
- Pre-allocated buffers for arrays

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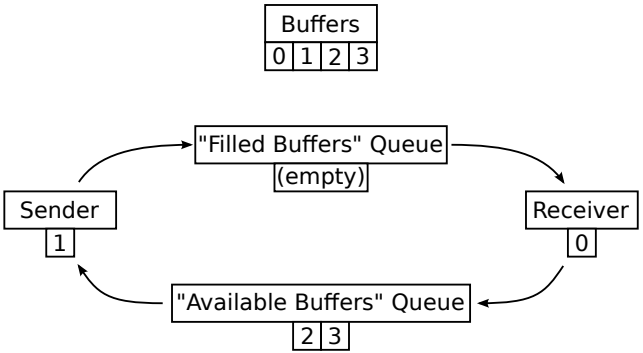

- Lock-free queues
- Pre-allocated buffers for arrays
- Copy references, not buffers

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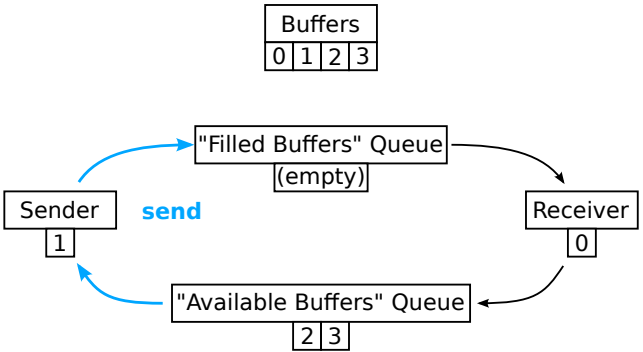

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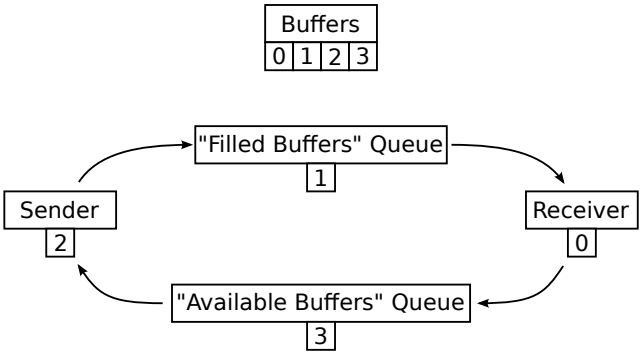

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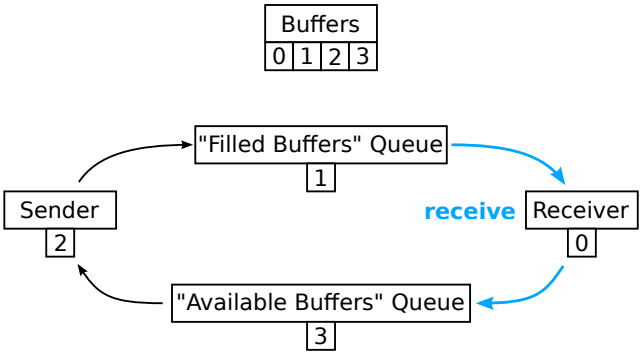

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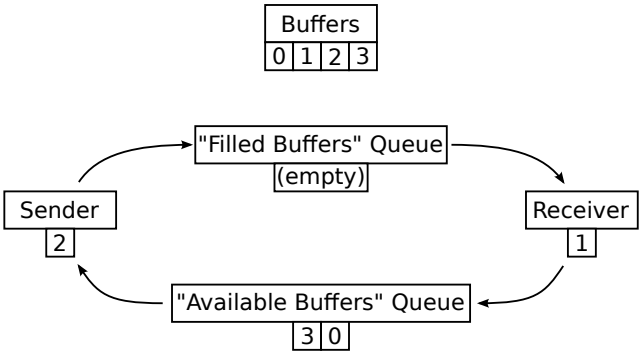

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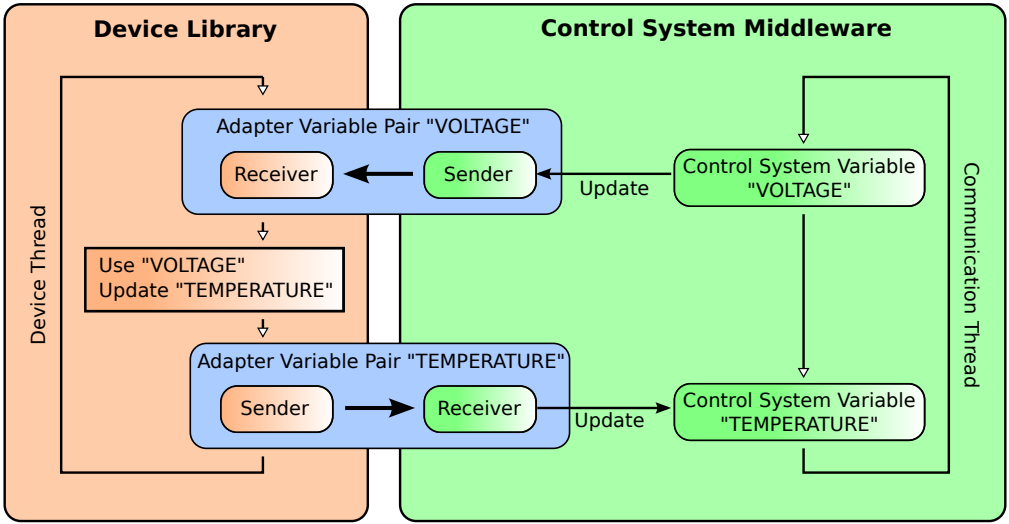
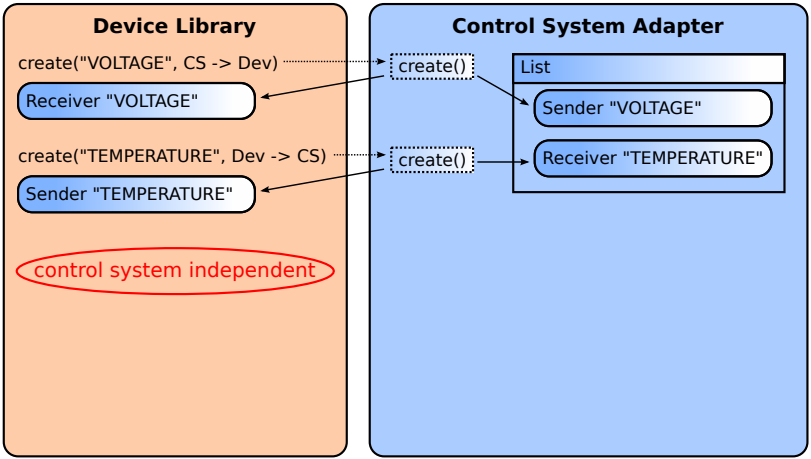


Registering Process Variables



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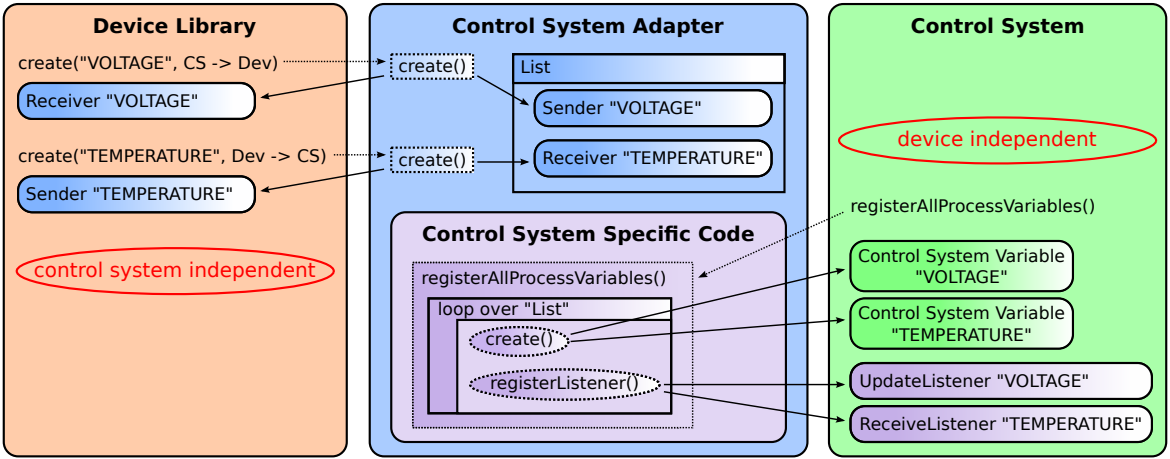


Status of the Control System Adapter

Adapter for Process Variables

Decouple application logic and control system

- Generic part
- Control system specific part
  - Implementations for DOOCS and EPICS 3
  - OPC-UA adapter currently being implemented

Red: Topics for today's meeting

Design Goals

- Control system independent process variables ✓
- Thread safety ✓
- Real time capability ✓
- Minimise copying ✓
- No device-dependent code on control system side (✓)

Next Steps: Tools for System Integration

- Name mapping for Process Variables
- Access to control system features
  - Limits
  - History
  - Engineering units
  - Handle alarms
- More sophisticated data objects
  - Currently only scalars and arrays

Name Mapping

- Each facility's control system has it's own naming scheme
- Each device logic provides Process Variables with an (internal) name

⇒ We need a name mapping during system integration

Planned tools of the adapter:

- XML file provided by the application part with list of Process Variables
- Middleware implementation extends/uses this file to
  - add middleware specific features
  - implement the binding to the middleware Process Variable instances

→ See next presentation

Accessing Control System Features

- To make the device code really CS independent, it must not rely on certain features to be present in the CS
- All features added to the CSA must be either:
  - implementable for any CS, or
  - non-essential and thus optional.
- Ideally: default implementation for each feature based on the current CSA interface (thus CS independent)
- For non-essential features, the default implementation does nothing
- CS-specific implementations can be added for CS which support the feature directly

Slide by Martin Hierholzer

Plugin mechanism for extra features

- Developers should be able to add new features fitting this scheme without modifying the CSA package
- Suggestion: Put all new features into plugins, to have a coherent interface
- Plugins can be loaded for each ProcessVariable
- Each plugin can provide its own configuration interface exposed to the device code
- Default implementation should always just use existing CSA features

Slide by Martin Hierholzer

List of features (for discussion)

- Guaranteed limits on controlSystemToDevice variables
- Device-provided validators for controlSystemToDevice variables
- History (non-essential optional feature)
- Engineering units
- Alarms
- Save and restore values for groups of variables
- Conversion to selectable engineering units (e.g. optical delay stage: mm or ps)

Potentially problematic features:

- DAQ
- Combined data types

Original slide by Martin Hierholzer

List of features (for discussion)

- Guaranteed limits on controlSystemToDevice variables
- Device-provided validators for controlSystemToDevice variables
- History (non-essential optional feature) → system integration, solved per middleware plugin
- Engineering units → Not a plugin, part of PV API
- Alarms
- Save and restore values for groups of variables
- Conversion to selectable engineering units (e.g. optical delay stage: mm or ps)→ Not a plugin, implement later, system integration?

Potentially problematic features:

- DAQ
- Combined data types

Original slide by Martin Hierholzer

Further points for discussion

- Do we need optional features? (Or are they all system integration?)
- How to implement combined data types?
- Do we want/need display limits on the device side?

Summary

ChimeraTK was formerly known as **MTCA4U**

Control System Adapter

- Basic implementation to read/write Process Variables ready
- Next steps: System integration and accessing control system features

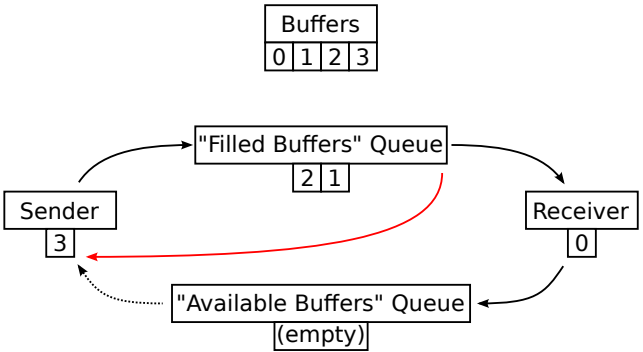
Software Repositories All software is published under the GNU GPL or the GNU LGPL.

- ChimeraTK: https://github.com/ChimeraTK
- EPICS 3 Adapter: http://oss.aquenos.com/svnroot/epics-mtca4u/

Backup

A Slow Receiver

Update the queue if the receiver is slow/down



- No free buffers for the sender
- Overwrite the oldest buffer
- Pop the head of the "filled buffers" queue (buffer 1)
- Send the buffer which has just been filled (buffer 3)