Integrating Control Applications Into Different Control Systems
The MTCA4U Control System Adapter

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Sometimes You Need An Adapter

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The MTCA4U Control System Adapter
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The MTCA4U Control System Adapter
Sometimes You Need An Adapter

Device

Adapter

Control System

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The MTCA4U Control System Adapter
Task

Complex control algorithms should be used with different control systems.

Requirements For Abstraction

- Keep application code control system independent
- The algorithm must interact with the control system
- Use functionality provided by the control system
- Minimise device-dependent code on the control system side

Additional Requirements:

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

First Implementation

- Process variables to transfer data to/from the control system
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Control System Adapter

**Task**
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**First Implementation**
- Process variables to transfer data to/from the control system
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

Adapter Variable Pair "VOLTAGE"

Receiver  ➔  Sender

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The MTCA4U Control System Adapter
A Device Using The Control System Adapter

Adapter Variable Pair "VOLTAGE"

Use "VOLTAGE"
Update "TEMPERATURE"

Adapter Variable Pair "TEMPERATURE"
A Device Using The Control System Adapter

Device Library

Device Thread

Adapter Variable Pair "VOLTAGE"

Receiver

Sender

Use "VOLTAGE"
Update "TEMPERATURE"

Adapter Variable Pair "TEMPERATURE"

Sender

Receiver

Control System

Control System Variable "VOLTAGE"

Update

Control System Variable "TEMPERATURE"

Update
Implementation Of The Sender/Receiver Pair

- Lock-free queue

![Diagram showing the sender and receiver connected to a queue.](image-url)
Implementation Of The Sender/Receiver Pair

- Lock-free queue
- Pre-allocated buffers for arrays
Implementation Of The Sender/Receiver Pair

| Buffers | 0 | 1 | 2 | 3 |

"Filled Buffers" Queue
(empty)

Sender
1

"Available Buffers" Queue
2 3

Receiver
0

- Lock-free queues
- Pre-allocated buffers for arrays
- Copy references, not buffers
Implementation Of The Sender/Receiver Pair

<table>
<thead>
<tr>
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- **Locked-free queues**
- Pre-allocated buffers for arrays
- Copy references, not buffers
Implementation Of The Sender/Receiver Pair

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"Filled Buffers" Queue

Sender

"Available Buffers" Queue

Receiver

- Lock-free queues
- Pre-allocated buffers for arrays
- Copy references, not buffers
Implementation Of The Sender/Receiver Pair

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Sender

Receiver

"Filled Buffers" Queue

"Available Buffers" Queue

- Lock-free queues
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Implementation Of The Sender/Receiver Pair

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"Filled Buffers" Queue (empty)

Sender 2

"Available Buffers" Queue 3 0

Receiver 1

- Lock-free queues
- Pre-allocated buffers for arrays
- Copy references, not buffers
A Device Using The Control System Adapter

Device Library

Control System

Device Thread

Communication Thread

Adapter Variable Pair "VOLTAGE"

Receiver

Sender

Update

Control System Variable "VOLTAGE"

Use "VOLTAGE"

Update "TEMPERATURE"

Adapter Variable Pair "TEMPERATURE"

Sender

Receiver

Update

Control System Variable "TEMPERATURE"

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Registering Process Variables

**Device Library**
create("VOLTAGE", CS -> Dev)
Receiver "VOLTAGE"

**Control System Adapter**
create()
List
Sender "VOLTAGE"

control system independent
Registering Process Variables

Device Library
create("VOLTAGE", CS -> Dev)
Receiver "VOLTAGE"
create("TEMPERATURE", Dev -> CS)
Sender "TEMPERATURE"
control system independent

Control System Adapter
create()
List
Sender "VOLTAGE"
create()
Receiver "TEMPERATURE"
Registering Process Variables

Device Library
create("VOLTAGE", CS -> Dev)
Receiver "VOLTAGE"
create("TEMPERATURE", Dev -> CS)
Sender "TEMPERATURE"

Control System Adapter
create()
List
Sender "VOLTAGE"
Receiver "TEMPERATURE"

Control System Specific Code
registerAllProcessVariables()
loop over "List"
create()
registerListener()

Control System
registerAllProcessVariables()
Control System Variable "VOLTAGE"
Control System Variable "TEMPERATURE"
UpdateListener "VOLTAGE"
ReceiveListener "TEMPERATURE"

device independent
Status

Adapter for process variables
- Generic part
- Control system specific part
  - Implementations for DOOCS and EPICS

Design Goals
- Control system independent process variables ✓
- Thread safety ✓
- Real time capability ✓
- Minimise copying ✓
- Minimise device-dependent code on control system side (✓)
Next Steps

Access to control system features

- Limits
- History
- Engineering units

Implementations are very different in the various control systems!

- Discussions how to put this into the adapter
MTCA4U Control System Adapter

- Adapter to use device logic with different control systems
- Implementations for DOOCS and EPICS exist
- Planned: support for OPC-UA

Software Repositories

- EPICS extension: http://oss.aquenos.com/svnroot/epics-mtca4u/
- DOOCS extension: https://svnsrv.desy.de/desy/mtca4u_applications/D0OCS_Adapter/
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)