ChimeraTK Software Framework

Overview and OPC UA server hands-on

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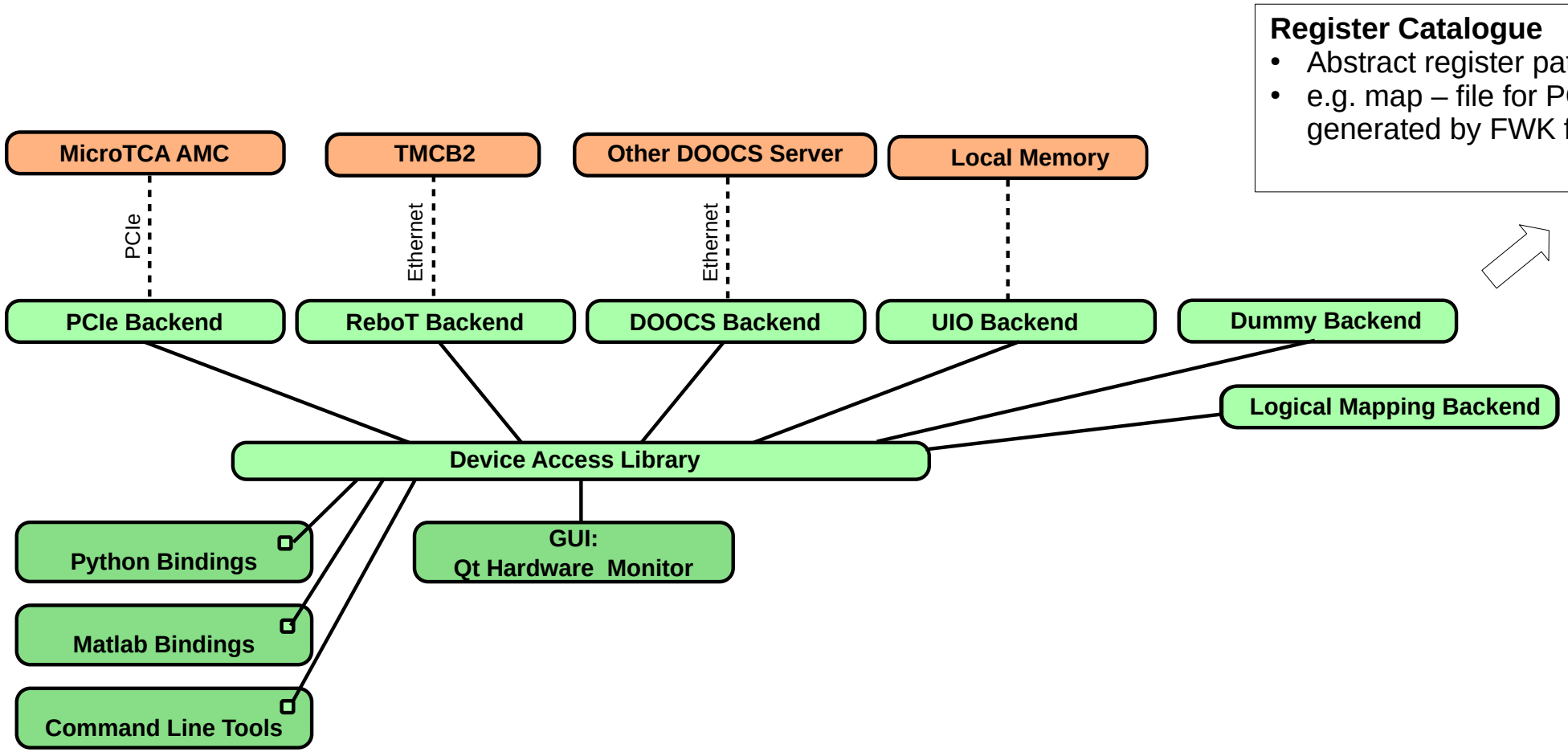
ChimeraTK Framework Overview

DeviceAccess



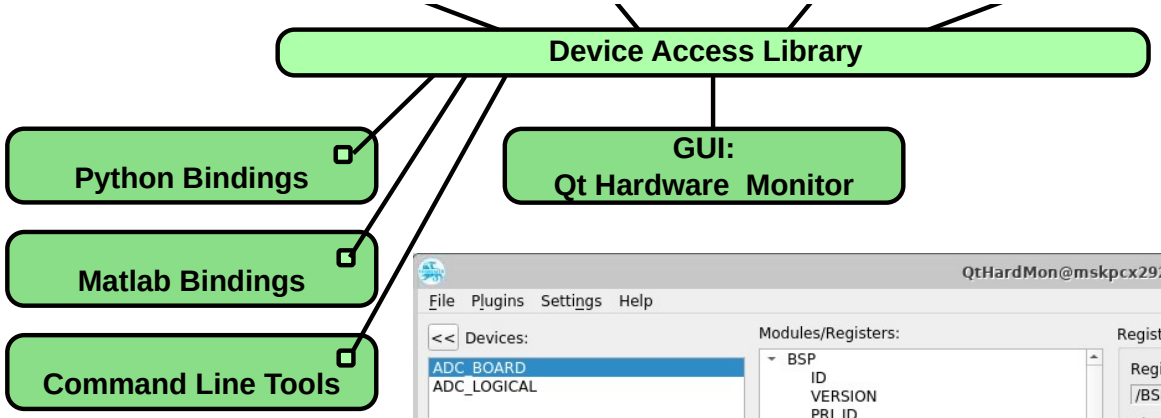
Register Catalogue

- Abstract register path names “Module/RegX”
- e.g. map – file for PCIE register addresses generated by FWK framework

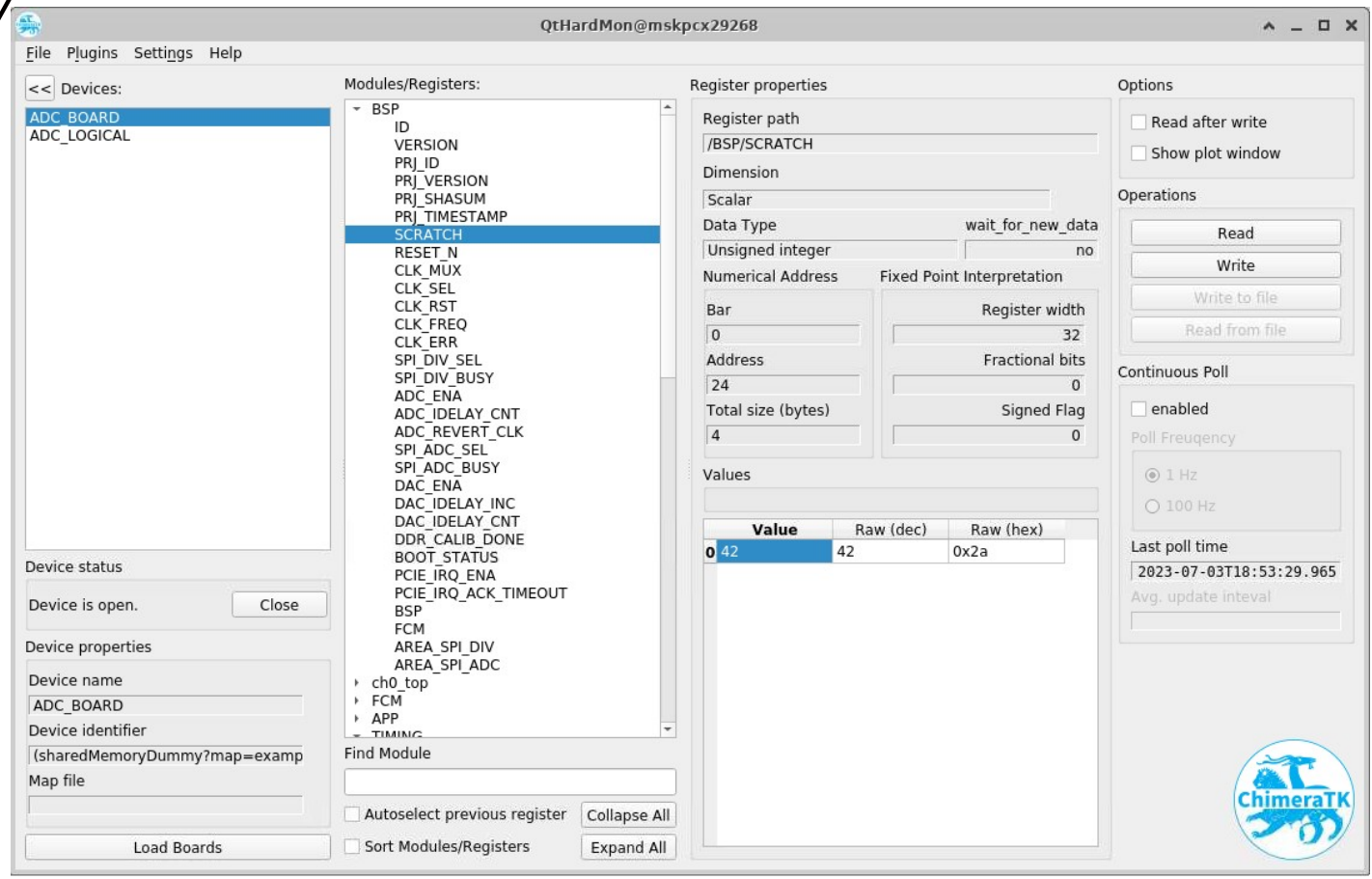
ChimeraTK Framework Overview

DeviceAccess

Accessor
- buffered in mem: use like a variable
- read(), write(): sync with hardware

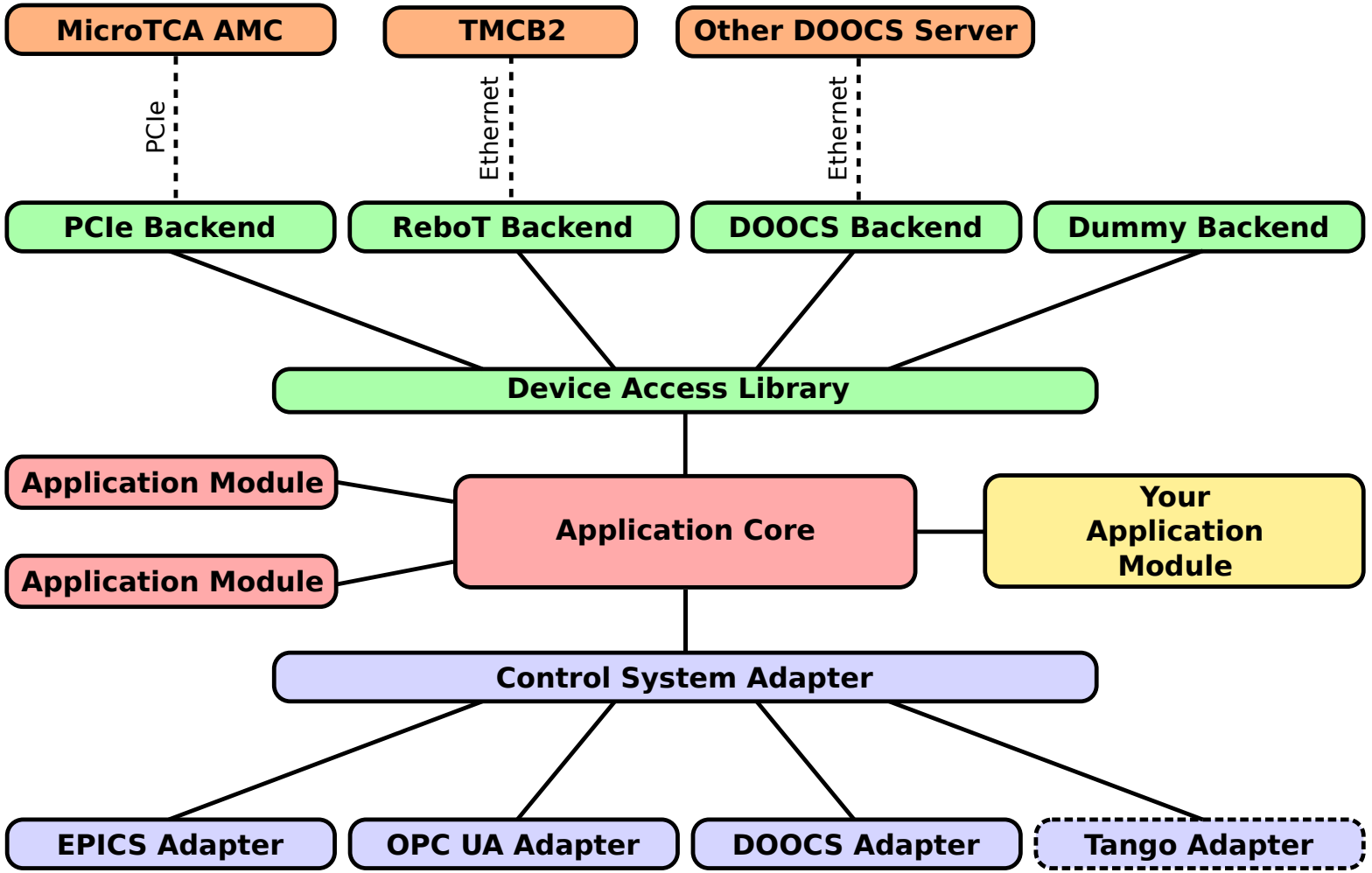



```
import deviceaccess as da
import numpy as np

da.setDMapFilePath('devices.dmap')
d = da.Device('ADC_BOARD')
d.open()

acc = d.getOneDRegisterAccessor(np.uint32,
    'BSP/SCRATCH')
acc[0] = 42
acc.write()
```



ChimeraTK Framework Overview

Ecosystem



Configure GenericDeviceServer

- Compile with OPC UA ControlSystemAdapter
- Add raw device
  - Protocol: *.dmap
  - Register set: *.map
  - Initialisation script!
    Use DeviceAccess Python bindings
- Add Logical Device: *.xlmap
- Configure simple software trigger,
  connect Device to trigger
- (Configure ControlSystemAdapter)
  - select, rename, convert, re-organize
  - History and filters

```
ADC_BOARD (xdma:xdma/slot3?map=example_dwc8vm1.mapp)
ADC_LOGICAL (logicalNameMap?map=example_dwc8vm1.xlmap)
```

```
@MAPFILE_REVISION 2.1.0-2-g815f78df-pcx29859
BSP.ID                                                    1  0x0000000
ch0_top.BSP                                           19201  0x0000000
BSP.VERSION                                               1  0x0000000
BSP.PRJ_ID                                                1  0x0000000
BSP.PRJ_VERSION                                           1  0x0000000
BSP.PRJ_SHASUM                                            1  0x0000001
BSP.PRJ_TIMESTAMP                                         1  0x0000001
BSP.SCRATCH                                               1  0x0000001
BSP.RESET_N                                               1  0x0000001
```

```
<configuration>
  <variable name="devices" type="string">
    <value i="0" v="ADC_LOGICAL"/>
  </variable>
 <module name="ADC_LOGICAL">
    <variable name="triggerPath" type="string" value="/msTimer/tick" />
    <variable name="pathInDevice" type="string" value="" />
    <variable name="initScript" type="string" value="./initscript.py" />
 </module>
  <variable name="periodicTimers" type="string">
    <value i="0" v="msTimer"/>
  </variable>
</configuration>
```

Logical Device

Logical name map

- Select & rename registers
- Apply simple formulas like rescaling, bit extraction
- **(Re-)define read/write access**
  server initialises all writeable automatically!
- Define new variables
- Adjust data types
- Extract channels

⟹ Enables **better abstraction** in server logic!

Use with same DeviceAccess API as raw device

```
<logicalNameMap>
    <module name="board">
        <redirectedRegister name="version">
          <targetDevice>ADC_BOARD</targetDevice>
          <targetRegister>BSP/PRJ_VERSION</targetRegister>
        </redirectedRegister>
        <redirectedRegister name="scratch">
          <targetDevice>ADC_BOARD</targetDevice>
          <targetRegister>BSP/SCRATCH</targetRegister>
          <plugin name="forceReadOnly"/>
        </redirectedRegister>
    </module>
    <module name="timing">
    <module name="channels">
        <redirectedChannel name="signal1">
          <targetDevice>ADC_BOARD</targetDevice>
          <targetRegister>DAQBUF/DAQ_CTRL_BUF0</targetRegister>
          <targetChannel>1</targetChannel>
          <plugin name="typeHintModifier"><parameter name="type">int32</parameter><
        </redirectedChannel>
    </module>
    <module  name="attenuator">
        <redirectedRegister name="attSelectionMask">
        <variable name="attFactor">
            <type>float32</type>
            <value>0</value>
        </variable>
        <redirectedRegister name="attSetpoint">
          <targetDevice>ADC_BOARD</targetDevice>
          <targetRegister>RTM/ATT_VAL</targetRegister>
          <plugin name="math">
              <parameter name="enable_push_parameters" />
              <parameter name="formula"> f*x </parameter>
              <parameter name="f">/attenuator/attFactor</parameter>
          </plugin>
          <plugin name="typeHintModifier"><parameter name="type">int32</parameter><
        </redirectedRegister>
        <redirectedRegister name="attReadback">
          <targetDevice>ADC_BOARD</targetDevice>
          <targetRegister>RTM/ATT_VAL</targetRegister>
          <plugin name="forceReadOnly"/>
          <plugin name="typeHintModifier"><parameter name="type">int32</parameter><
```

Extend server by business logic

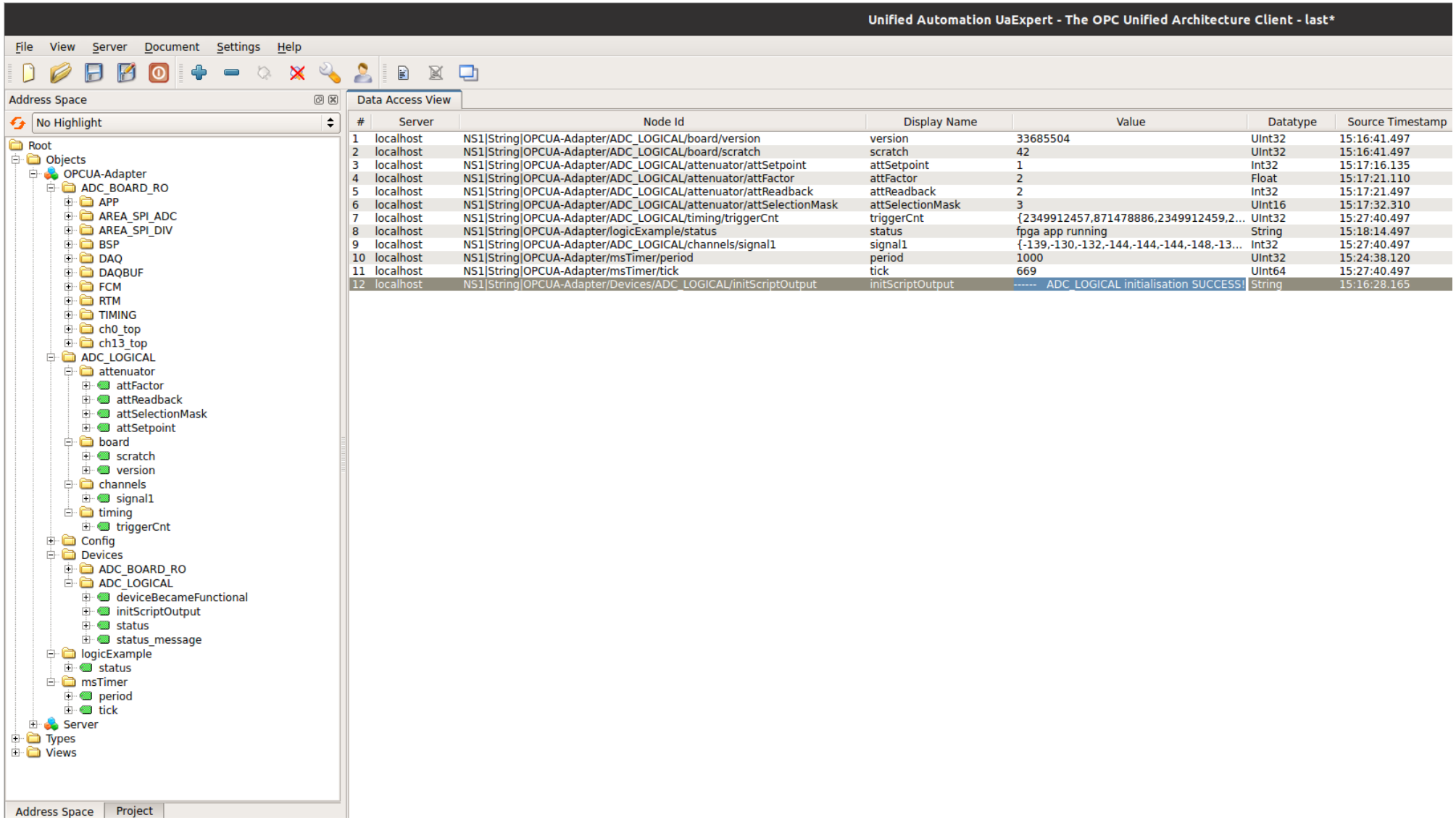
```
struct LogicExample : public ctk::ApplicationModule {
  using ctk::ApplicationModule::ApplicationModule;
  ChimeraTK::ArrayPushInput<uint32_t> timingCnt{this, "/ADC_LOGICAL/timing/triggerCnt", "", 4, "hw trigger counters"};
  ChimeraTK::ScalarOutput<std::string> status{this, "status", "(no unit)", "fpga app status"};

  void mainLoop() override {
    // device is already initialized and current input values loaded
    uint32_t lastCnt = 0;
    while(true) {
      status = timingCnt[1] != lastCnt ? "fpga app running" : "fpga app not running";
      lastCnt = timingCnt[1];
      writeAll();

      readAll();
    }
  }
};
```

AUTO

Connection Code | Error handling | Device Init | Setpoint persistency | History

ApplicationCore **DeviceAccess & Python scripts** **Control system adapters**

GenericDeviceServer with OPC UA Adapter



Thank you

References

Source repositories
- ChimeraTK https://github.com/ChimeraTK
- GenericDeviceServer https://github.com/ChimeraTK/GenericDeviceServer.git

Ubuntu 20.04 packages DESY DOOCS repository

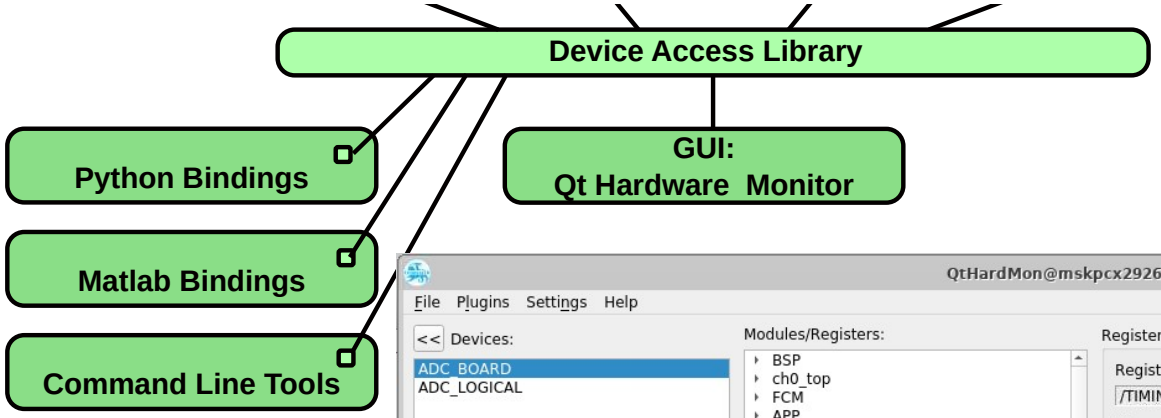
API documentation https://chimeratk.github.io/

Build details

```
git clone https://github.com/ChimeraTK/GenericDeviceServer.git
git switch drothe/dresen23ard-demo

sudo apt install libchimeratk-applicationcore-dev libchimeratk-controlsystemadapter-opcuaadapter-dev libchimeratk-deviceaccess-doocsbackend-dev python3-mtca4upy
cmake   -DADAPTER="OPCUA"  -S ../GenericDeviceServer/ .
./opcua-generic-chimeratk-server01
```

ChimeraTK Framework Overview

DeviceAccess



Accessor

- buffered in mem: use like a variable
- read(), write(): sync with hardware

```
import deviceaccess as da
import numpy as np

da.setDMapFilePath('devices.dmap')
d = da.Device('ADC_BOARD')
d.open()

triggerCounters = d.getOneDRegisterAccessor(np.uint32,
    'TIMING/TRIGGER_CNT/DUMMY_WRITEABLE')

while True :
    triggerCounters[0] += 1
    triggerCounters.write()
```