EPICS Automation

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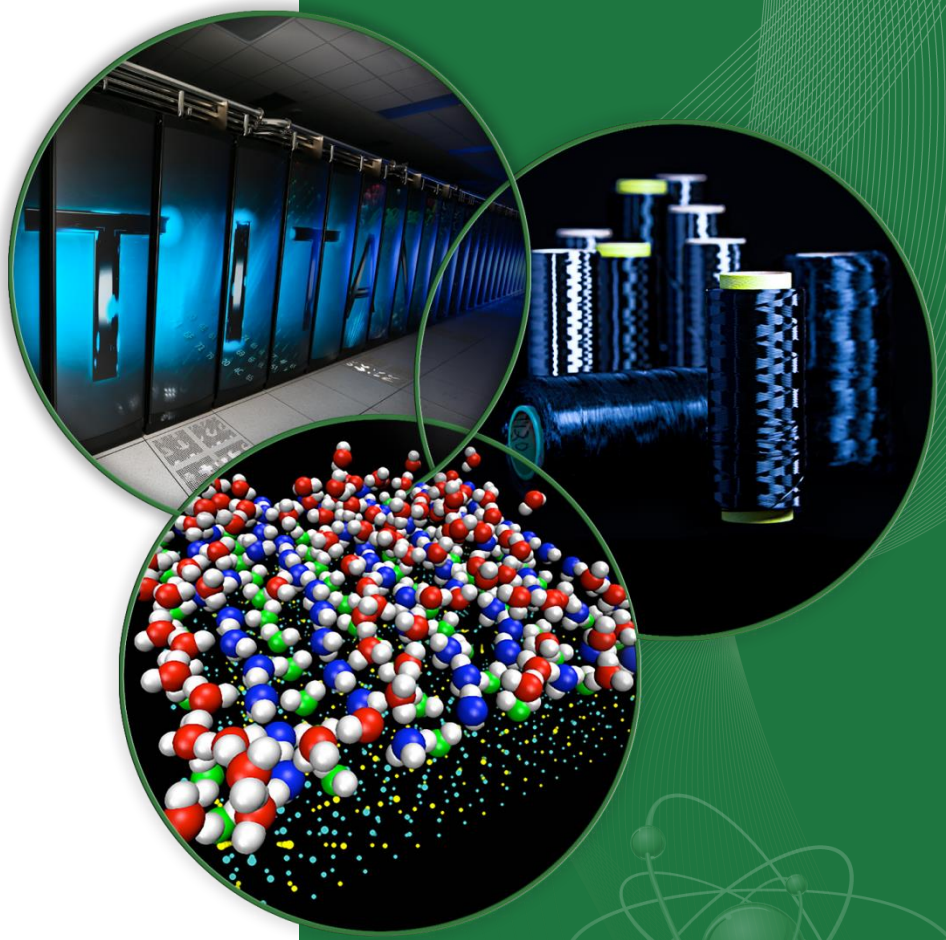
June 2014



OAK RIDGE National Laboratory

Control System

.. should support automated control.

How can EPICS do this?

Monitoring, Supervisory Control

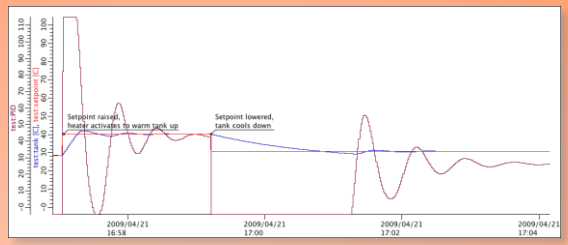
IOC

```
record(ai, "sensor")
{
  field(DTYP, "SensorXYZ")
  field(INP,  "@bus1 signal2")
  field(SCAN, "1 second")
  ..

record(ao, "voltage")
{
  field(DTYP, "PowerSupplyABC")
  field(OUT,  "@bus2 signal4")
  field(SCAN, "Passive")
  ..
```

Channel Access
'monitor'

Channel Access
'put'

User Interface



Automation via Records on IOC

IOC

```
record(ai, "sensor")
{
  field(DTYP, "SensorXYZ")
  field(INP,  "@bus1 signal2")
  field(SCAN, "1 second")
  ..

record(calcout, "control_voltage")
{
  field(INPA, "sensor CP")
  field(CALC, "A<10?5:0")
  field(OUT,  "voltage PP")
}

record(ao, "voltage")
{
  field(DTYP, "PowerSupplyABC")
  field(OUT,  "@bus2 signal4")
  field(SCAN, "Passive")
  ..
```

Data flow driven, periodic, steady-state control:

1. Read inputs
2. Compute desired outputs
   - calc, calcout records
3. Write outputs

Distribute Records onto different IOCs

IOC

```
record(ai, "sensor")
{
  field(DTYP, "SensorXYZ")
  field(INP,  "@bus1 signal2")
  field(SCAN, "1 second")
  ..

record(ao, "voltage")
{
  field(DTYP, "PowerSupplyABC")
  field(OUT,  "@bus2 signal4")
  field(SCAN, "Passive")
  ..
```

Channel Access

IOC

```
record(calcout,
       "control_voltage")
{
 field(INPA, "sensor MS CP")
 field(CALC, "A<10?5:0")
 field(OUT,  "voltage PP")
 field(IVOA, "Don't drive outputs")
}
```

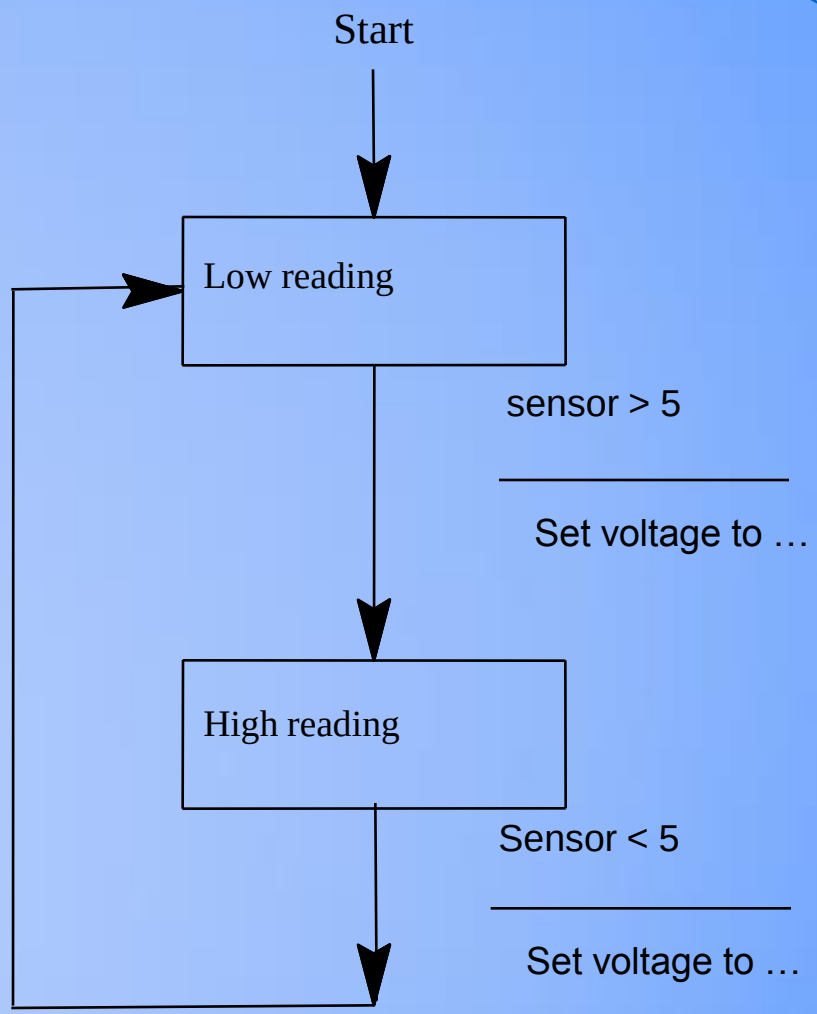
Almost no additional work!

Anticipate network issues; see 'MS', 'IVOA'

Automation via State Machine

IOC

```
record(ai, "sensor")
{
  field(DTYP, "SensorXYZ")
  field(INP,  "@bus1 signal2")
  field(SCAN, "1 second")
  ..

record(ao, "voltage")
{
  field(DTYP, "PowerSupplyABC")
  field(OUT,  "@bus2 signal4")
  field(SCAN, "Passive")
  ..
```



"Sequencer", "State Notation Language":
Event driven, on-demand, stateful

Automation via Scripts

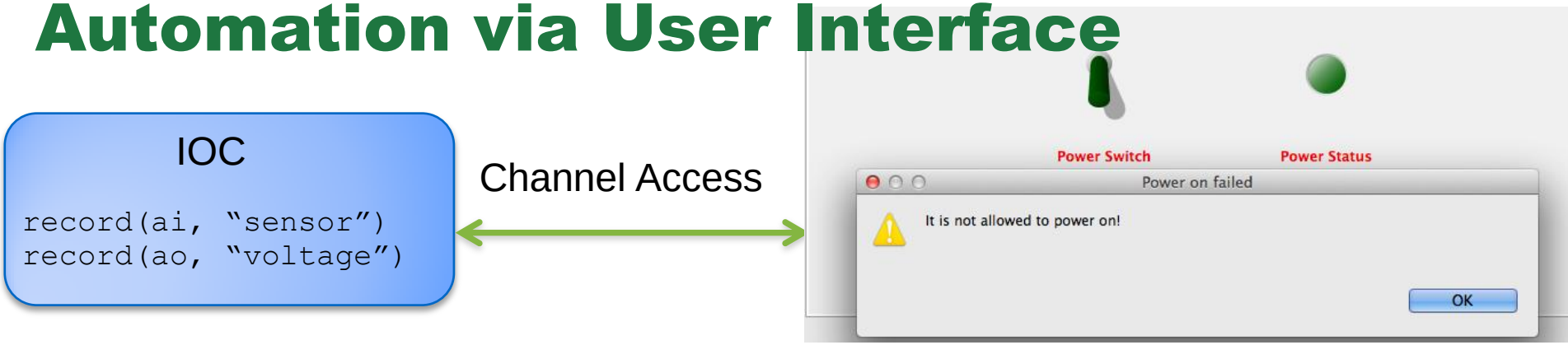
IOC

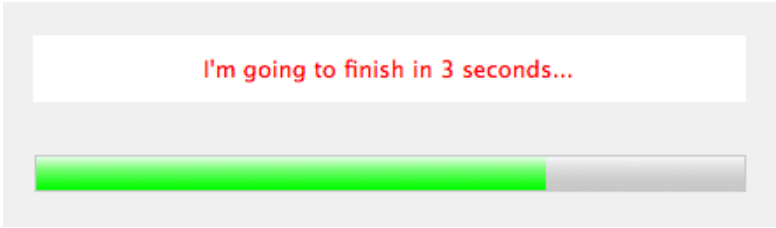
```
record(ai, "sensor")
record(ao, "voltage")
```


```
#!/usr/bin/env python

from epics import caget, caput
import time

while True:
    sensor = caget("sensor")
    voltage = 5 if sensor < 10 else 0
    caput("voltage", voltage)
    time.sleep(1.0)
```

- Tempting, but
  - Error Handling?
  - caget? Monitor!
  - caput? Connect once, then re-use the connection!
  - Handle disconnects, re-connects
- Should have 'console', run under procServ
  - IOC has shell; Calc record has CALC, SCAN, INPA, ..
- Long-term maintenance of "Fred's script"?

Automation via User Interface





CSS 'BOY' Examples:

- Check allowed values
  - What if other CA client writes to PV?
    Use DRVH, DRVL, calc records, .. to perform check on IOC
- Start threads for automation scripts
  - What if users open multiple user interfaces?
  - What if GUI crashes (which is more likely than IOC)?

Keep user interface as just that!

Automation with EPICS

- Records
  - Steady-data, data flow driven operations
  - Continuous: Read input, compute, write output
  - Limited conditional processing: calcout.OOPT
- State Notation Language
  - On-demand, event driven
  - Stateful: In State X, if Y happens, ..
- Scripts
  - Useful for “I need this just once, but I need it now”
  - Permanent “Python IOCs” require effort similar to IOCs