asynDriver: An Interface Between EPICS Drivers and Device Support

Mark Rivers, Marty Kraimer, Eric Norum

University of Chicago

Advanced Photon Source

References

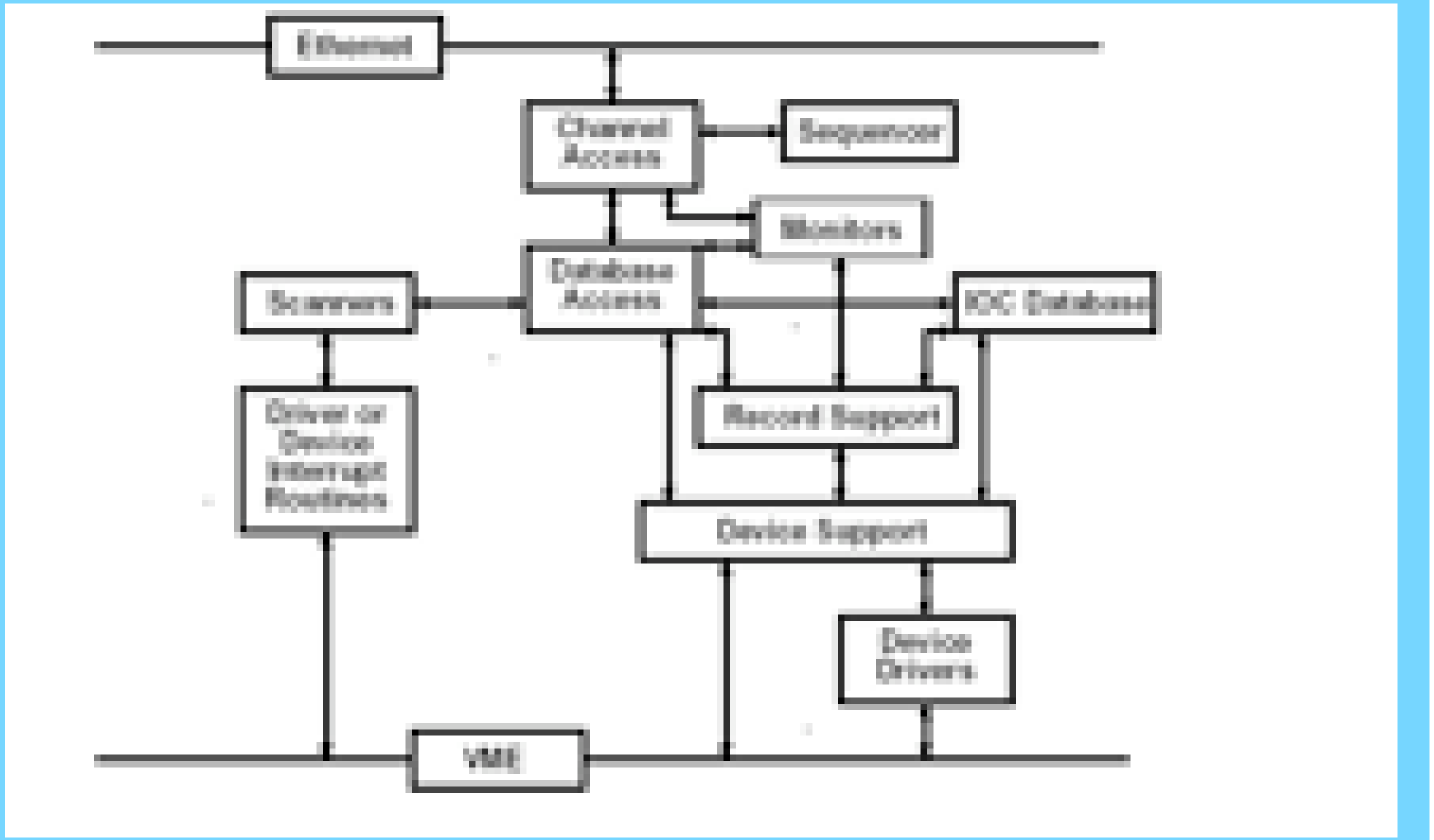
- This talk is short version of
  - http://www.aps.anl.gov/aod/bcda/epicsgettingstarted/iocs/ASYN.html
- asynDriver is available at
  - http://www.aps.anl.gov/epics/modules/soft/asyn

What is asyn and why to we need it?

Motivation

- Standard EPICS interface between device support and drivers is only loosely defined
- Needed custom device support for each driver
- asyn provides standard interface between device support and device drivers
- And a lot more too!

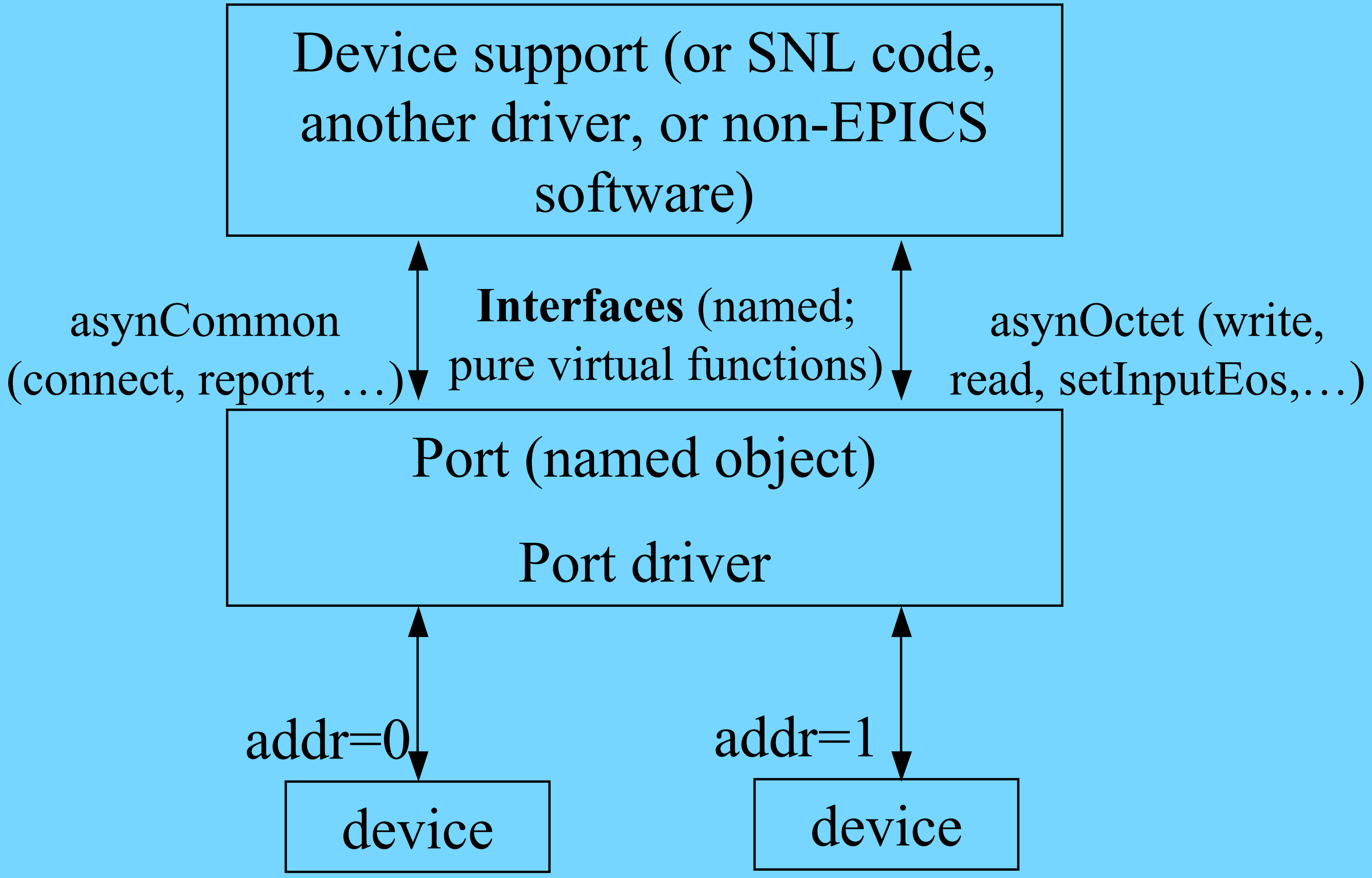
EPICS IOC architecture



History – why the name asynDriver

- The initial releases of asynDriver were limited to "asynchronous" devices (e.g. slow devices)
  - Serial
  - GPIB
  - TCP/IP
- asyn provided the thread per port and queuing that this support needs.
- Current version of asynDriver is more general, synchronous (non-blocking) drivers are also supported.
- Device support written as though asynchronous

asynDriver Architecture



Device support (or SNL code, another driver, or non-EPICS software)

asynCommon (connect, report, …)

Interfaces (named; pure virtual functions)

asynOctet (write, read, setInputEos,…)

Port (named object)

Port driver

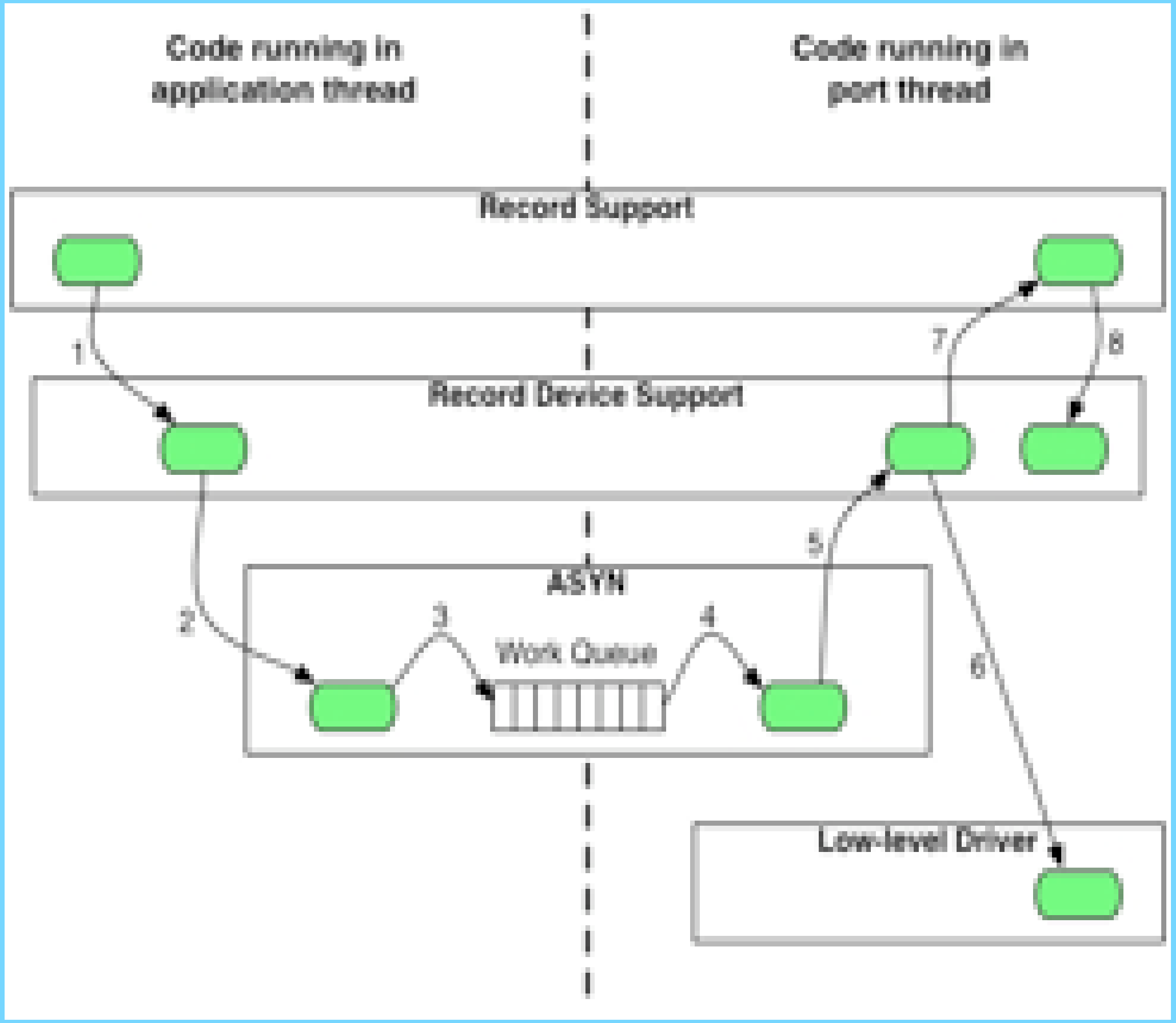
addr=0

addr=1

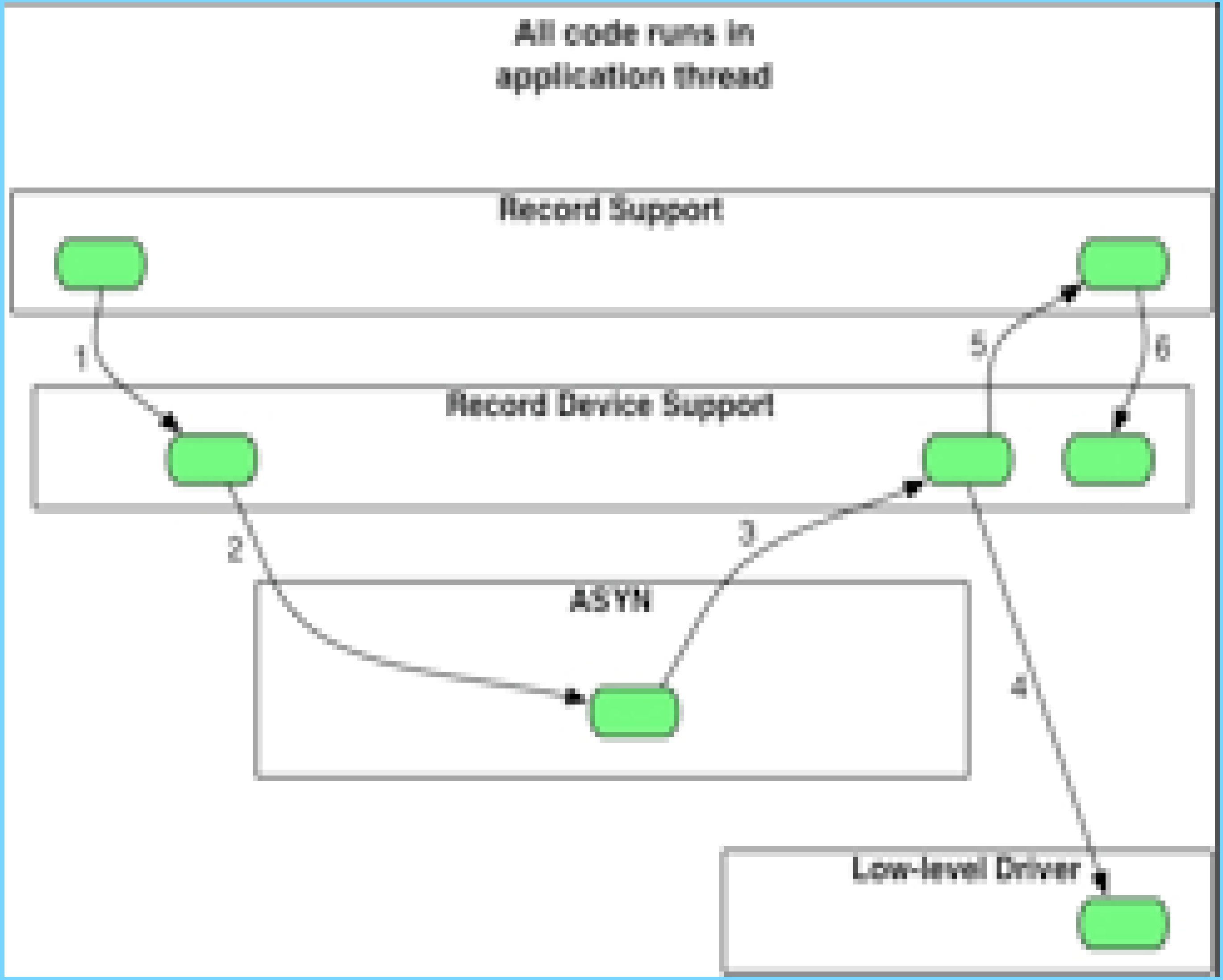
device

device

Control flow – asynchronous driver



Control flow – synchronous driver



asynManager – Methods for drivers

- registerPort
  - Flags for multidevice (addr), canBlock, isAutoConnect
  - Creates thread for each asynchronous port (canBlock=1)
- registerInterface
  - asynCommon, asynOctet, asynInt32, etc.
- registerInterruptSource, interruptStart, interruptEnd
- interposeInterface
- Example code:

```
status = pasynManager->registerPort(portName,
                            ASYN_MULTIDEVICE, /*is multiDevice*/
                            1,  /*  autoconnect */
                            0,  /* medium priority */
                            0); /* default stack size */
status = pasynManager->registerInterface(portName,&pPvt->common);
pasynManager->registerInterruptSource(portName, &pPvt->int32,
                             &pPvt->int32InterruptPvt);
```

asynManager – Methods for Device Support

- Create asynUser
- Connect to device, i.e. to port driver
- Queue request for I/O to port
  - asynManager calls callback when port is free
    - Will be separate thread for asynchronous port
  - I/O calls done directly to interface methods in driver
    - e.g. pasynOctet->write()
- Example code:

```
 /* Create asynUser */
pasynUser = pasynManager->createAsynUser(processCallback, 0);
status = pasynManager->connectDevice(pasynUser, pPvt->portName, pPvt->addr);
pasynInterface = pasynManager->findInterface(pasynUser, asynInt32Type, 1);
...
 status = pasynManager->queueRequest(pPvt->pasynUser, 0, 0);
...
 status = pPvt->pint32->read(pPvt->int32Pvt, pPvt->pasynUser, &pPvt->value);
```

asynManager – asynUser

- asynUser data structure. This is the fundamental “handle” used by asyn.

```
asynUser = pasynManager->createAsynUser(userCallback
   process,userCallback timeout);
asynUser = pasynManager->duplicateAsynUser)(pasynUser,
   userCallback queue,userCallback timeout);
typedef struct asynUser {
    char *errorMessage;
    int errorMessageSize;
    /* The following must be set by the user */
    double       timeout;  /*Timeout for I/O operations*/
    void         *userPvt;
    void         *userData;
    /*The following is for user to/from driver communication*/
    void         *drvUser;
    /*The following is normally set by driver*/
    int          reason;
    /* The following are for additional information from method
   calls */
    int          auxStatus; /*For auxillary status*/
}asynUser;
```

Standard Interfaces

Common interface, all drivers must implement

- asynCommon: report(), connect(), disconnect()

I/O Interfaces, most drivers implement one or more

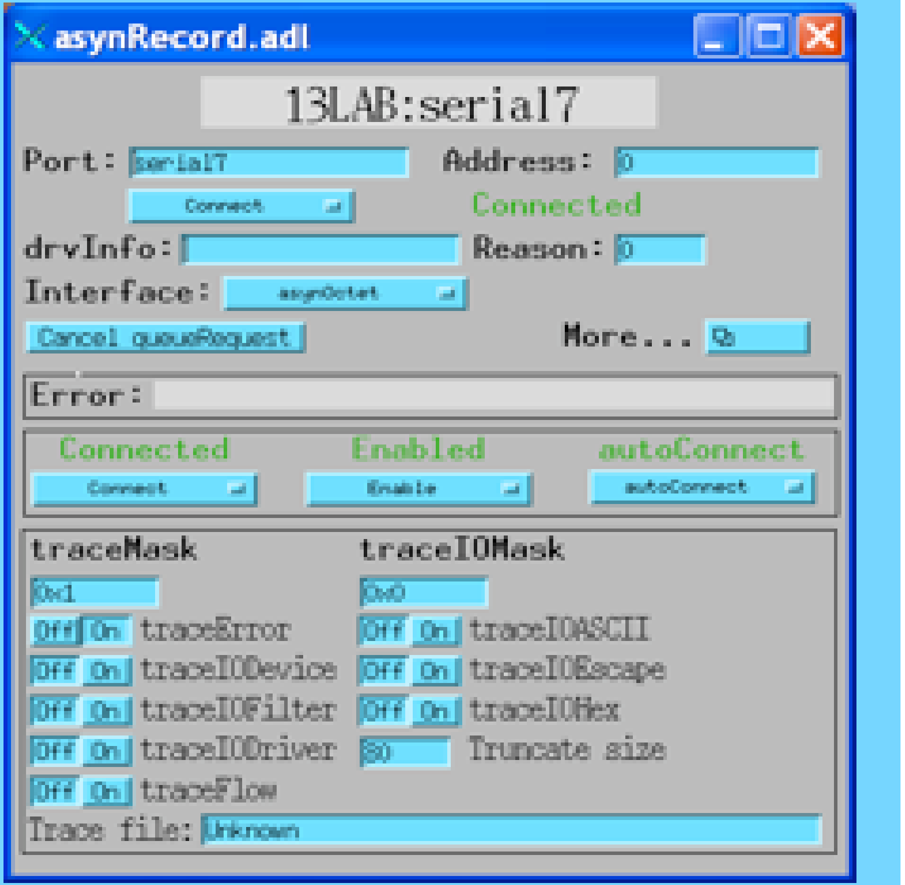
- All have write(), read(), registerInteruptUser() and cancelInterruptUser() methods
- asynOctet: writeRaw(), readRaw(), flush(), setInputEos(), setOutputEos(), getInputEos(), getOutputEos()
- asynInt32: getBounds()
- asynInt32Array:
- asynUInt32Digital:
- asynFloat64:
- asynFloat64Array:

Miscellaneous interfaces

- asynOption: setOption() getOption()
- asynGpib: addressCommand(), universalCommand(), ifc(), ren(), etc.
- asynDrvUser: create(), free();

asynRecord

- New EPICS record that provides access to most features of asyn, including standard I/O interfaces
- Applications:
  - Control tracing (debugging)
  - Connection management
  - Perform interactive I/O
- Very useful for testing, debugging, and actual I/O in many cases



13LAB:serial7

Port: serial7 Address: 0

Connected

drvInfo: Reason: 0

Interface: asynOctet

More...

Error:

Connected Enabled autoConnect

traceMask: 0x1

traceError: On

traceIODevice: Off

traceIOFilter: Off

traceIODriver: Off

traceFlow: Off

traceIOMask: 0x0

traceIOASCII: Off

traceIOEscape: Off

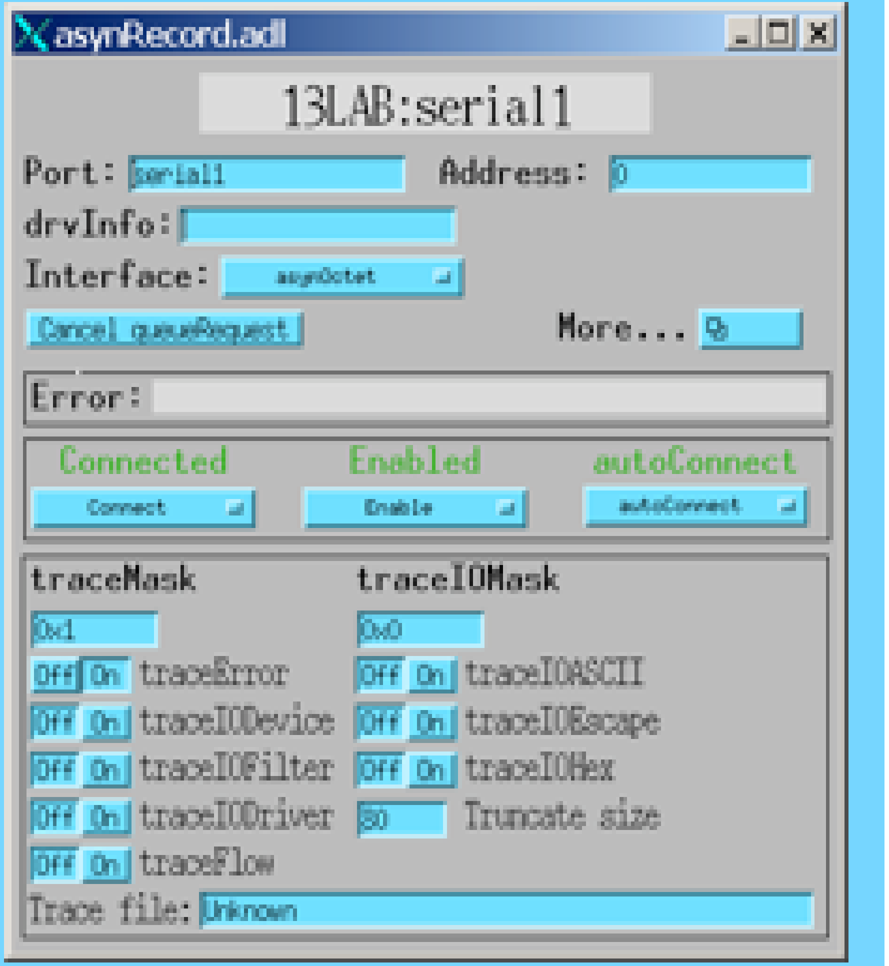
traceIOHex: Off

Truncate size: 80

Trace file: Unknown

Tracing and Debugging

- Standard mechanism for printing diagnostic messages in device support and drivers
- Messages written using EPICS logging facility, can be sent to stdout, stderr, or to a file.
- Device support and drivers call:
  - asynPrint(pasynUser, reason, format, ...)
  - asynPrintIO(pasynUser, reason, buffer, len, format, ...)
  - Reason:
    - ASYN_TRACE_ERROR
    - ASYN_TRACEIO_DEVICE
    - ASYN_TRACEIO_FILTER
    - ASYN_TRACEIO_DRIVER
    - ASYN_TRACE_FLOW
- Tracing is enabled/disabled for (port/addr)



13LAB:serial1

Port: serial1 Address: 0

drvInfo:

Interface: asynOctet

Error:

Connected Enabled autoConnect

traceMask traceIOMask

0x1 0x0

Off On traceError Off On traceIOASCII

Off On traceIODevice Off On traceIOEscape

Off On traceIOFilter Off On traceIOHex

Off On traceIODriver 80 Truncate size

Off On traceFlow

Trace file: Unknown

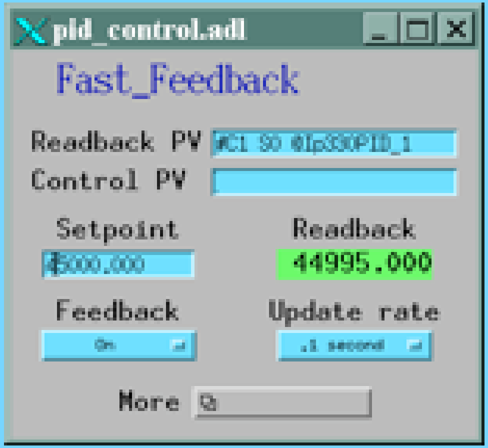
Current port Drivers

- Unix/Linux/vxWorks/cygwin serial ports
- TCP/IP sockets
- GPIB via National Instruments VME, Ethernet/GPIB devices, Ip488 Industry Pack modules
- VXI-11
- IpUnidig digital I/O (Industry Pack). Supports interrupts.
- dac128V digital-to-analog (Industry Pack)
- Ip330 analog-to-digital (Industry Pack). Supports interrupts.
- Canberra AIM multi-channel analyzer and ICB modules (Ethernet)
- XIA DXP DSP spectroscopy system (CAMAC, EPP, PXI soon)
- APS quad electrometer (VME). Supports interrupts.
- epid record fast feedback (float 64 with callbacks for input, float64 for output)
- Mca fast-sweep (Int32Array with callbacks)

Fast feedback device support (epid record)

- Supports fast PID control
- Input: any driver that supports asynFloat64 with callbacks (e.g. callback on interrupt)
- Output: any driver that supports asynFloat64.
- In real use at APS for monochromator feedback with IP ADC/DAC, and APS VME beam position monitor and DAC
- >1kHz feedback rate

GeoSoilEnviroCARS



pid_control.adl

Fast_Feedback

Readback PV #C1 S0 @Ip330PID_1

Control PV

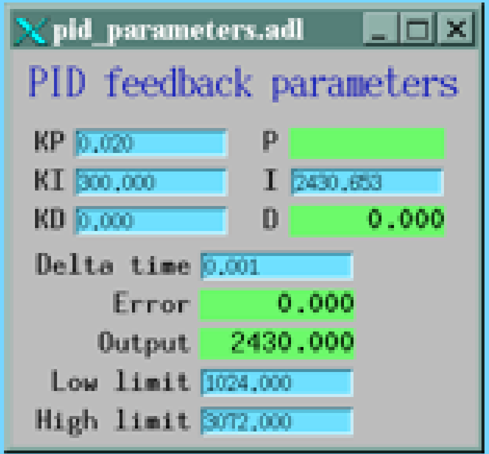
Setpoint 45000.000

Readback 44995.000

Feedback On

Update rate .1 second

More



pid_parameters.adl

PID feedback parameters

KP 0.020

P

KI 300.000

I 2430.653

KD 0.000

D 0.000

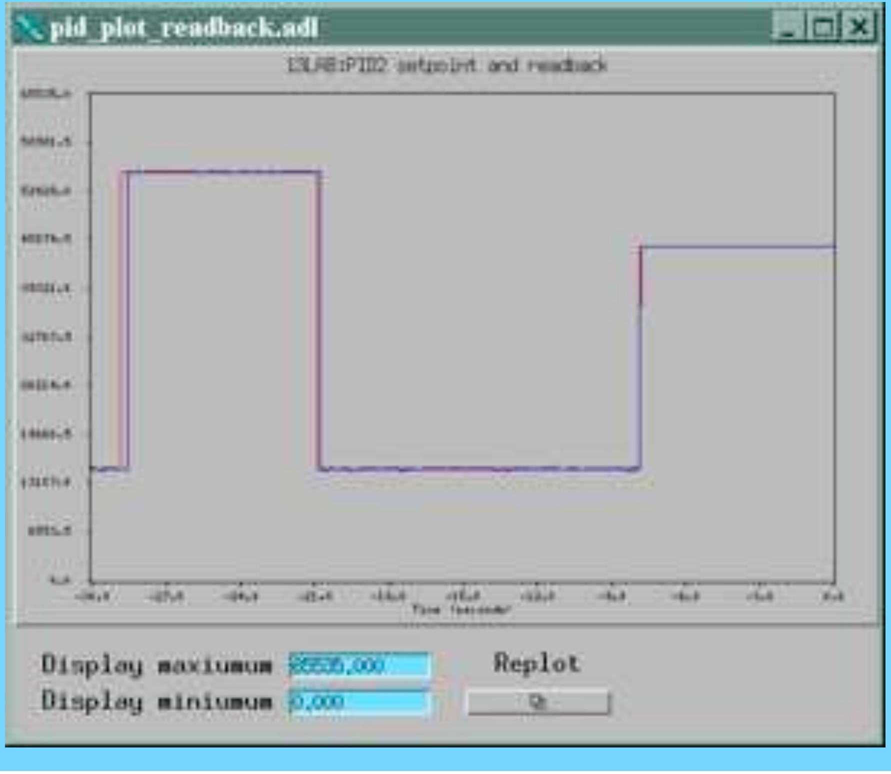
Delta time 0.001

Error 0.000

Output 2430.000

Low limit 1024.000

High limit 3072.000



pid_plot_readback.adl

13LAB:PID2 setpoint and readback

Display maxiumum 65535.000

Display miniumum 0.000

Replot

Summary- Advantages of asynDriver

- Drivers implement standard interfaces that can be accessed from:
  - Multiple record types
  - SNL programs
  - Other drivers
- Generic device support eliminates the need for separate device support in 90% (?) of cases
  - synApps package 10-20% fewer lines of code, 50% fewer files with asyn
- Consistent trace/debugging at (port, addr) level
- asynRecord can be used for testing, debugging, and actual I/O applications
- Easy to add asyn interfaces to existing drivers:
  - Register port, implement interface write(), read() and change debugging output
  - Preserve 90% of driver code
- asyn drivers are actually EPICS-independent. Can be used in any other control system.