EPICS Training Classes
May 24, 2016

- Morning session
  - Overview of asyn
  - Overview of asynPortDriver
  - Writing an asyn driver: Tutorial for Measurement Computing USB-1608GX-2A0
- Afternoon session
  - Overview of areaDetector
  - Demo of areaDetector with simDetector and Prosilica camera

All talks can be downloaded from
http://cars.uchicago.edu/data/Rivers/epics_class
asyn and areaDetector subdirectories with .ppt, .pdf files

asyn: An Interface Between EPICS Drivers and Clients

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How to deal with a new device (My philosophy!)

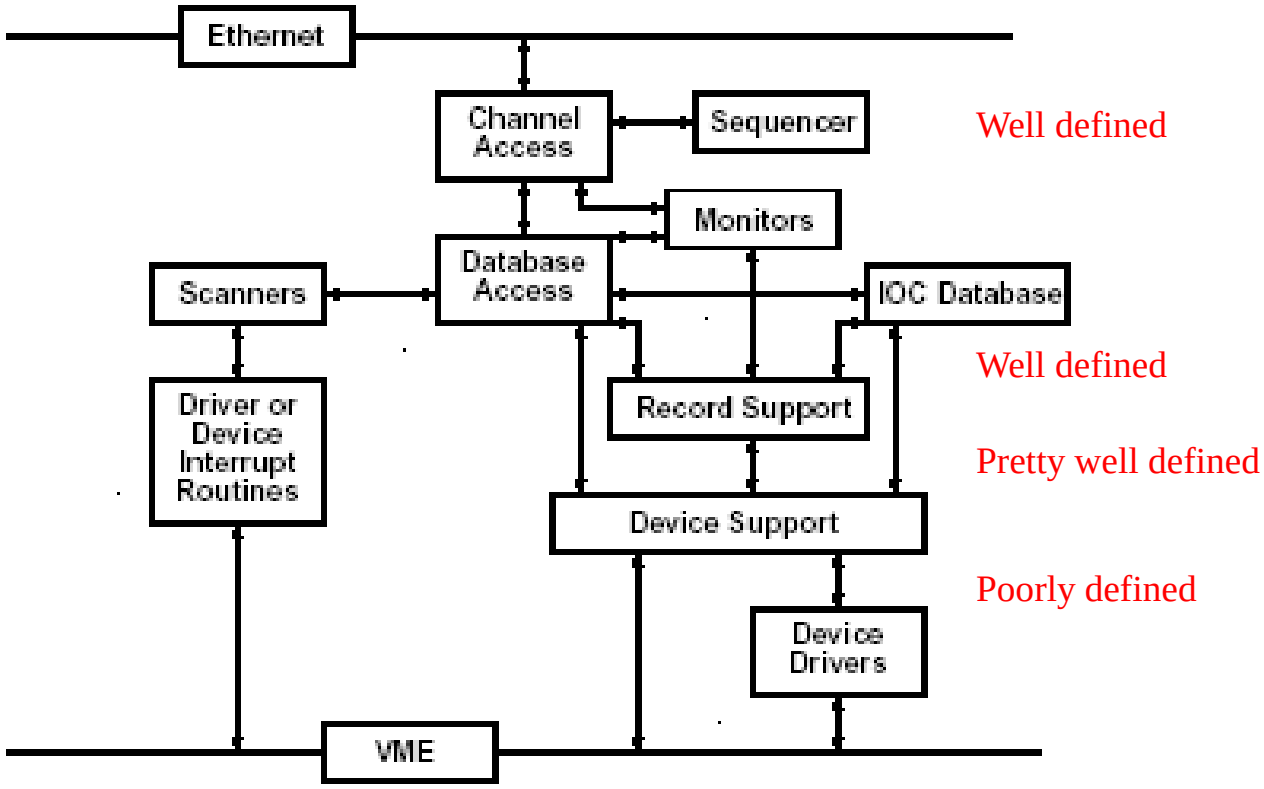
- If the device uses strings to communicate, and is not too complex, use streamDevice
  - Works well for relatively simple devices
  - Difficult to deal with more complex devices where parameters interact, since there is no “state” information
  - Uses asyn at the low-level (serial, TCP, GPIB), so it helps to understand asyn
- If the device does not use strings, or is complex, then write an asyn port driver (preferably using asynPortDriver C++ base class)
- Should not need to write device support for standard records
  - Device support is difficult, since you need to understand the record
  - Writing device support is constraining to the developer, because you have decided what records to support
  - If you write an asyn driver the developer can chose the record types, or indeed not to use records at all, call directly from SNL, or another control system altogether, etc.

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



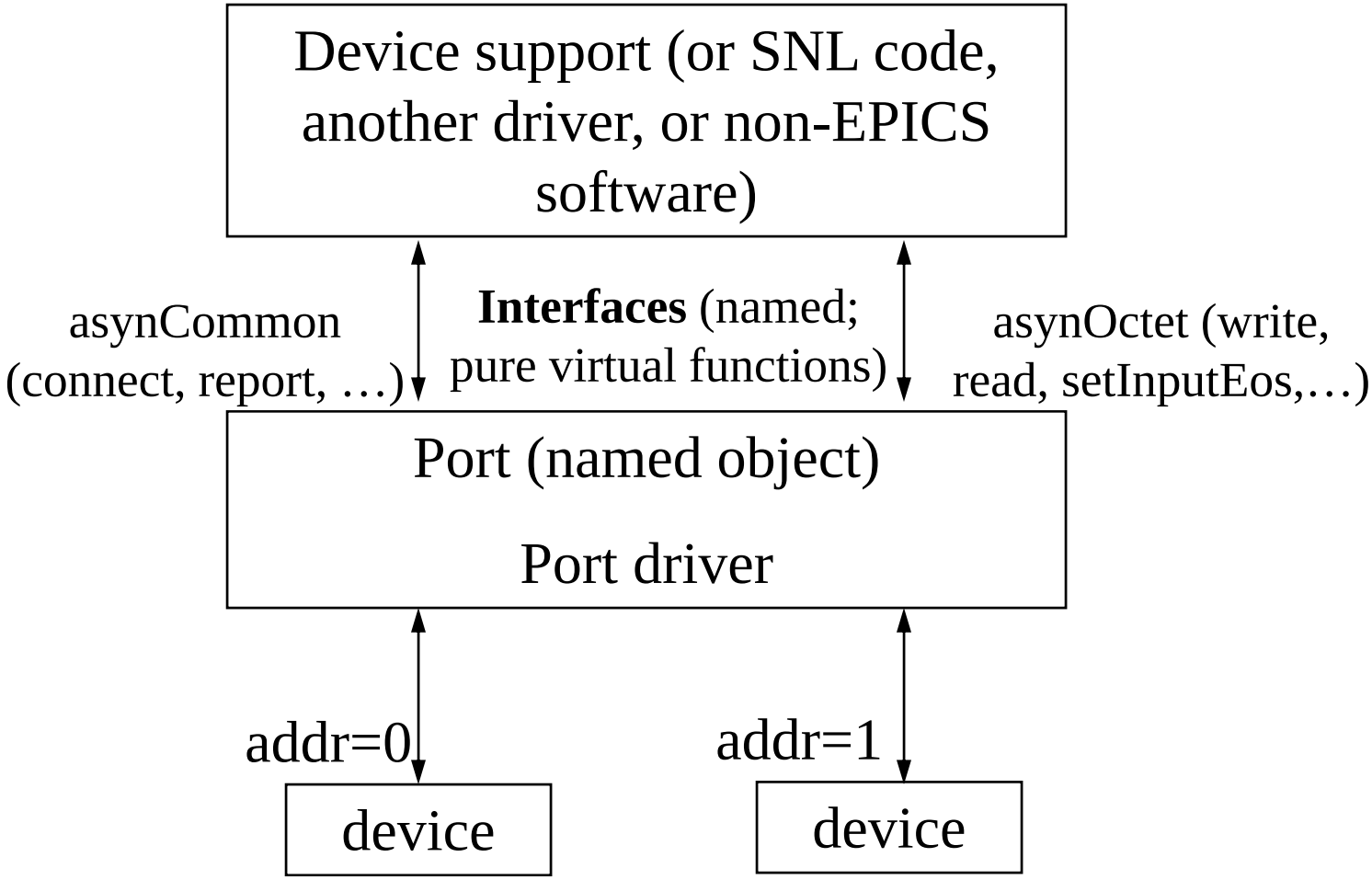
History – why the name asyn

- asyn replaces earlier APS packages called HiDEOS and MPF (Message Passing Facility)
- The initial releases of asyn 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 asyn is more general, synchronous (non-blocking) drivers are also supported.
- We are stuck with the name, or re-writing a LOT of code!

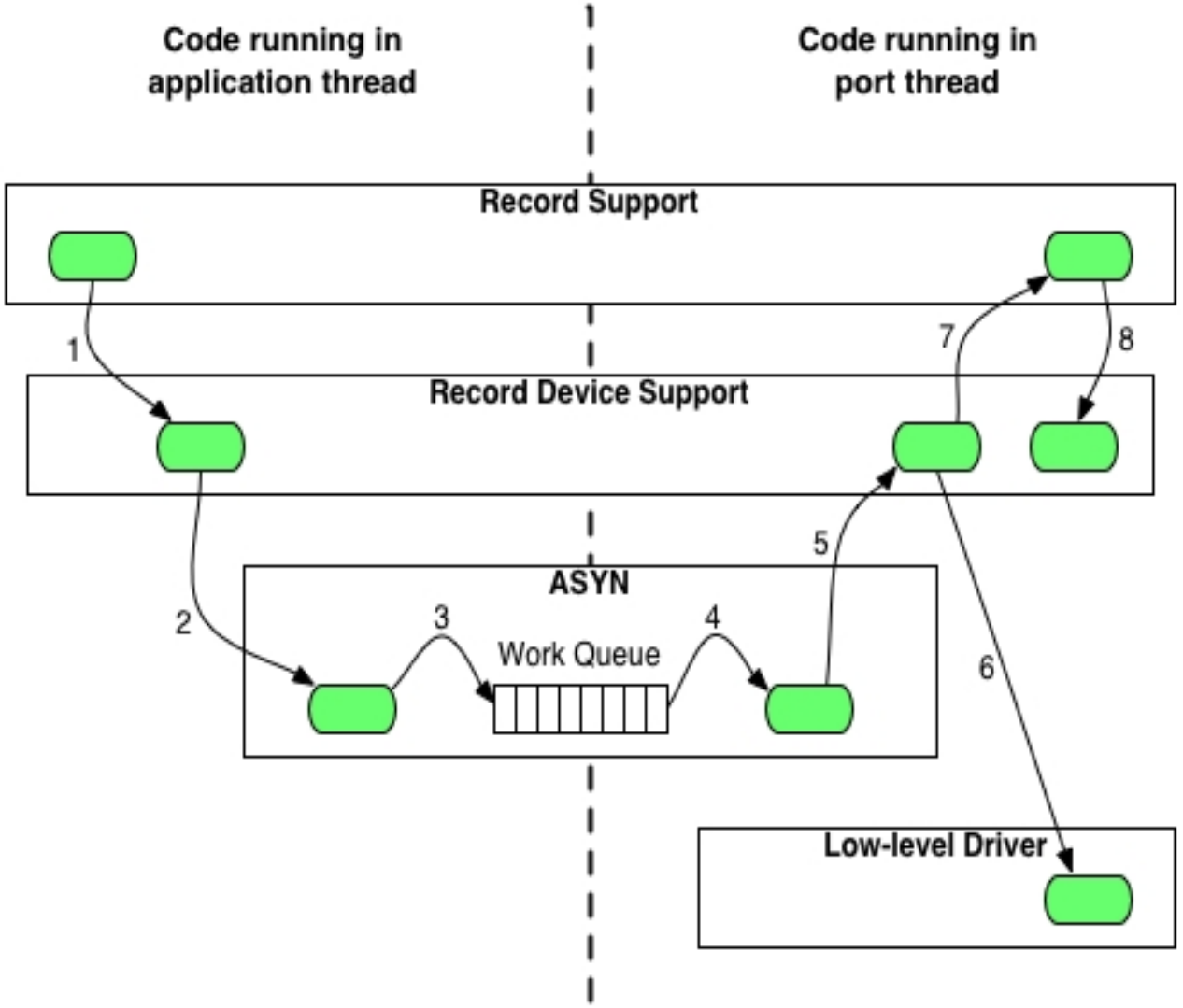
Independent of EPICS

- asyn is largely independent of EPICS (except for optional device support and asynRecord).
- It only uses libCom from EPICS base for OS independence in standard utilities like threads, mutexes, events, etc.
- asyn can be used in code that does not run in an IOC
  - asyn drivers could be used with Tango or other control systems

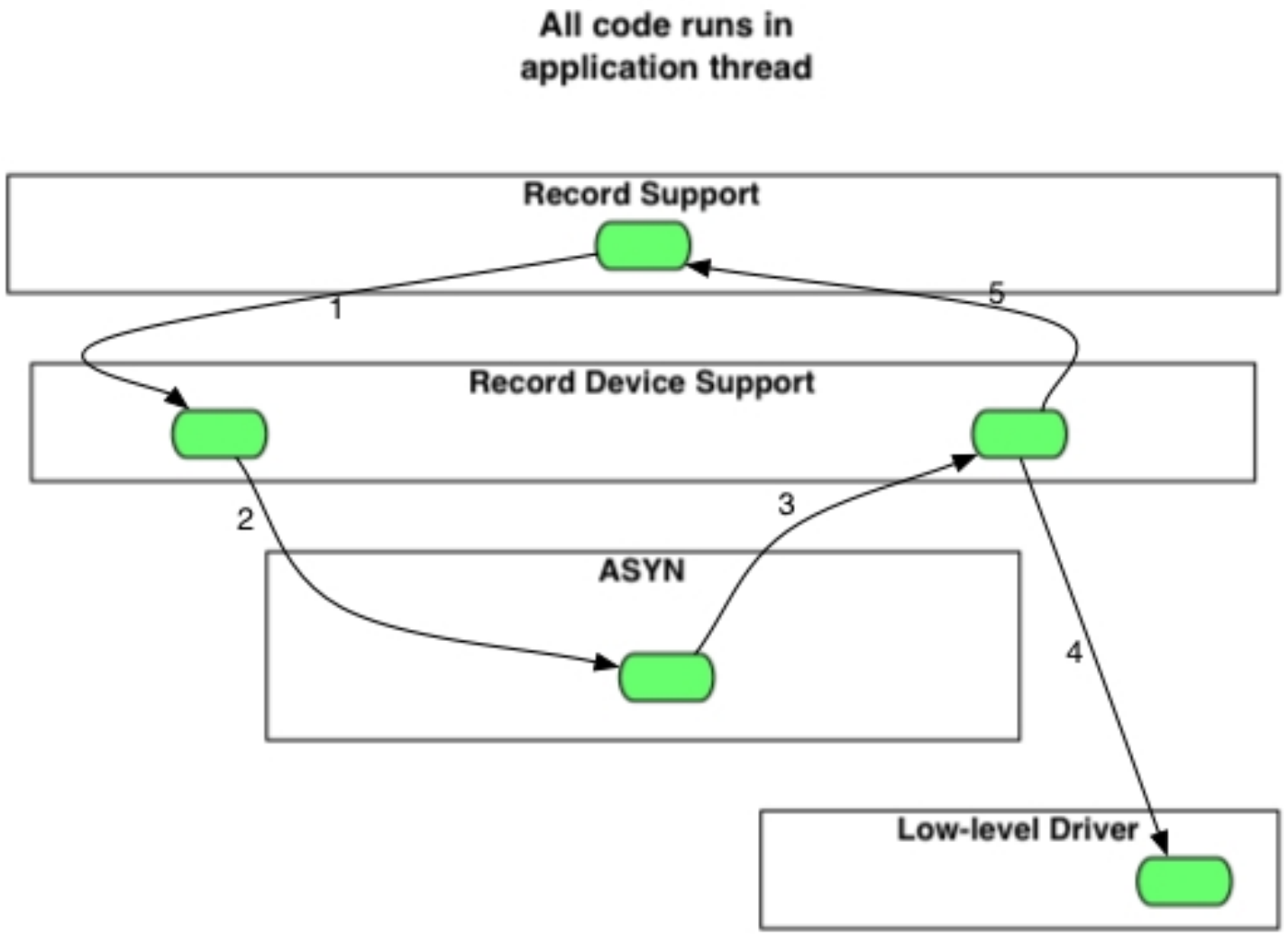
asyn Architecture (client/server)



Control flow – asynchronous driver (slow device)



Control flow – synchronous driver (fast device)



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 – e.g. interposeEos, interposeFlush
- Example code (synchronous driver, asynInt32 interface, can do callbacks):

```
pPvt->int32Array.interfaceType = asynInt32ArrayType;
pPvt->int32Array.pinterface  = (void *)&drvIp330Int32Array;
pPvt->int32Array.drvPvt = pPvt;
status = pasynManager->registerPort(portName,
                 ASYN_MULTIDEVICE, /*is multiDevice*/
                 1,  /*  autoconnect */
                 0,  /* medium priority */
                 0); /* default stack size */
status = pasynManager->registerInterface(portName,&pPvt->common);
status = pasynInt32Base->initialize(pPvt->portName,&pPvt->int32);
pasynManager->registerInterruptSource(portName, &pPvt->int32,
                 &pPvt->int32InterruptPvt);
```

asynManager – Methods for Clients (e.g. Device Support)

- Create asynUser
- Connect asynUser to device (port)
- Find interface (e.g. asynOctet, asynInt32, etc.)
- Register interrupt callbacks
- Query driver characteristics (canBlock, isMultidevice, isEnabled, etc).
- 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()

asynManager – Methods for Clients (e.g. Device Support)

Example code:

```
record(longout, "$(P)$(R)BinX") {
   field(PINI, "YES")
   field(DTYP, "asynInt32")
   field(OUT,  "@asyn($(PORT),$(ADDR),$(TIMEOUT))BIN_X")
   field(VAL,  "1")
}

/* Create asynUser */
pasynUser = pasynManager->createAsynUser(processCallback, 0);
status = pasynEpicsUtils->parseLink(pasynUser, plink,
                &pPvt->portName, &pPvt->addr, &pPvt->userParam);
status = pasynManager->connectDevice(pasynUser, pPvt->portName, pPvt->addr);
status = pasynManager->canBlock(pPvt->pasynUser, &pPvt->canBlock);
pasynInterface = pasynManager->findInterface(pasynUser, asynInt32Type, 1);
status = pasynManager->queueRequest(pPvt->pasynUser, 0, 0);
```

In processCallback()

```
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 queue,
                                        userCallback timeout);
asynUser = pasynManager->duplicateAsynUser)(pasynUser,
                                        userCallback queue,
                                        userCallback timeout);
typedef struct asynUser {
    char      *errorMessage;
    int       errorMessageSize;
    /* timeout 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;
    epicsTimeStamp timestamp;
    /* 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 of these have write(), read(), registerInterruptUser() and cancelInterruptUser() methods
- asynOctet: flush(), setInputEos(), setOutputEos(), getInputEos(), getOutputEos()
- asynInt32: getBounds()
- asynInt8Array, asynInt16Array, asynInt32Array:
- asynUInt32Digital: setInterrupt(), clearInterrupt()
- asynFloat64:
- asynFloat32Array, asynFloat64Array:
- asynGenericPointer:
- asynEnum

Miscellaneous interfaces

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

Developers are free to create new interfaces. In practice I don't know of any! asynGenericPointer can be used to pass any structure when other interfaces are too simple.

asynStandardInterfaces.h

- Greatly reduces driver code when initializing standard interfaces. Just fill in fields in asynStandardInterfaces structure and call asynStandardInterfacesBase->initialize().

```
typedef struct asynStandardInterfaces {
    asynInterface common;
    asynInterface drvUser;
    asynInterface octet;
    int octetProcessEosIn;
    int octetProcessEosOut;
    int octetInterruptProcess;
    int octetCanInterrupt;
    void *octetInterruptPvt;
…
    asynInterface int32;
    int int32CanInterrupt;
    void *int32InterruptPvt;

    asynInterface float64Array;
    int float64ArrayCanInterrupt;
    void *float64ArrayInterruptPvt;

} asynStandardInterfaces;

typedef struct asynStandardInterfacesBase {
    asynStatus (*initialize)(const char *portName, asynStandardInterfaces *pInterfaces,
    asynUser *pasynUser, void *pPvt);
} asynStandardInterfacesBase;

epicsShareExtern asynStandardInterfacesBase *pasynStandardInterfacesBase;
```

Driver without asynStandardInterfaces

```
#include <asynDriver.h>
#include <asynInt32.h>
#include <asynInt8Array.h>
#include <asynInt16Array.h>
#include <asynInt32Array.h>
#include <asynFloat32Array.h>
#include <asynFloat64.h>
#include <asynFloat64Array.h>
#include <asynOctet.h>
#include <asynDrvUser.h>
...
typedef struct drvADPvt {
    ...
    /* Asyn interfaces */
    asynInterface common;
    asynInterface int32;
    void *int32InterruptPvt;
    asynInterface float64;
    void *float64InterruptPvt;
    asynInterface int8Array;
    void *int8ArrayInterruptPvt;
    asynInterface int16Array;
    void *int16ArrayInterruptPvt;
    asynInterface int32Array;
    void *int32ArrayInterruptPvt;
    asynInterface float32Array;
    void *float32ArrayInterruptPvt;
    asynInterface float64Array;
    void *float64ArrayInterruptPvt;
    asynInterface octet;
    void *octetInterruptPvt;
    asynInterface drvUser;
} drvADPvt;
```

Driver without asynStandardInterfaces

```
int drvADImageConfigure(const char *portName, const char
*detectorDriverName, int detector)
{
    ...
    /* Create asynUser for debugging */
    pPvt->pasynUser = pasynManager->createAsynUser(0, 0);

    /* Link with higher level routines */
    pPvt->common.interfaceType = asynCommonType;
    pPvt->common.pinterface  = (void *)&drvADCommon;
    pPvt->common.drvPvt = pPvt;
    pPvt->int32.interfaceType = asynInt32Type;
    pPvt->int32.pinterface  = (void *)&drvADInt32;
    pPvt->int32.drvPvt = pPvt;
    pPvt->float64.interfaceType = asynFloat64Type;
    pPvt->float64.pinterface  = (void *)&drvADFloat64;
    pPvt->float64.drvPvt = pPvt;
    pPvt->int8Array.interfaceType = asynInt8ArrayType;
    pPvt->int8Array.pinterface  = (void *)&drvADInt8Array;
    pPvt->int8Array.drvPvt = pPvt;
    pPvt->int16Array.interfaceType = asynInt16ArrayType;
    pPvt->int16Array.pinterface  = (void *)&drvADInt16Array;
    pPvt->int16Array.drvPvt = pPvt;
    pPvt->int32Array.interfaceType = asynInt32ArrayType;
    pPvt->int32Array.pinterface  = (void *)&drvADInt32Array;
    pPvt->int32Array.drvPvt = pPvt;
    pPvt->float32Array.interfaceType = asynFloat32ArrayType;
    pPvt->float32Array.pinterface  = (void *)&drvADFloat32Array;
    pPvt->float32Array.drvPvt = pPvt;
    pPvt->float64Array.interfaceType = asynFloat64ArrayType;
    pPvt->float64Array.pinterface  = (void *)&drvADFloat64Array;
    pPvt->float64Array.drvPvt = pPvt;
    pPvt->octet.interfaceType = asynOctetType;
    pPvt->octet.pinterface  = (void *)&drvADOctet;
    pPvt->octet.drvPvt = pPvt;
    pPvt->drvUser.interfaceType = asynDrvUserType;
    pPvt->drvUser.pinterface  = (void *)&drvADDrvUser;
    pPvt->drvUser.drvPvt = pPvt;

    ...
```

Driver without asynStandardInterfaces

```
status = pasynManager->registerInterface(portName,&pPvt->common);
if (status != asynSuccess) {
    errlogPrintf("drvAsynADConfigure ERROR: Can't register common.\n");
    return -1;
}

status = pasynInt32Base->initialize(pPvt->portName,&pPvt->int32);
if (status != asynSuccess) {
    errlogPrintf("drvAsynADConfigure ERROR: Can't register int32\n");
    return -1;
}
pasynManager->registerInterruptSource(portName, &pPvt->int32,
                                      &pPvt->int32InterruptPvt);

status = pasynFloat64Base->initialize(pPvt->portName,&pPvt->float64);
if (status != asynSuccess) {
    errlogPrintf("drvAsynADConfigure ERROR: Can't register float64\n");
    return -1;
}
pasynManager->registerInterruptSource(portName, &pPvt->float64,
                                      &pPvt->float64InterruptPvt);

status = pasynInt8ArrayBase->initialize(pPvt->portName,&pPvt->int8Array);
if (status != asynSuccess) {
    errlogPrintf("drvAsynADConfigure ERROR: Can't register int8Array\n");
    return -1;
}

pasynManager->registerInterruptSource(portName, &pPvt->int8Array,
                                      &pPvt->int8ArrayInterruptPvt);

status = pasynInt16ArrayBase->initialize(pPvt->portName,&pPvt->int16Array);
if (status != asynSuccess) {
    errlogPrintf("drvAsynADConfigure ERROR: Can't register int16Array\n");
    return -1;
}

pasynManager->registerInterruptSource(portName, &pPvt->int16Array, &pPvt-
 >int16ArrayInterruptPvt);
```

Driver without asynStandardInterfaces

```
status = pasynInt32ArrayBase->initialize(pPvt->portName,&pPvt->int32Array);
    if (status != asynSuccess) {
        errlogPrintf("drvAsynADConfigure ERROR: Can't register int32Array\n");
        return -1;
    }

    pasynManager->registerInterruptSource(portName, &pPvt->int32Array, &pPvt-
     >int32ArrayInterruptPvt);

    status = pasynFloat32ArrayBase->initialize(pPvt->portName,&pPvt->float32Array);
    if (status != asynSuccess) {
        errlogPrintf("drvAsynADConfigure ERROR: Can't register float32Array\n");
        return -1;
    }

    pasynManager->registerInterruptSource(portName, &pPvt->float32Array, &pPvt-
     >float32ArrayInterruptPvt);

    status = pasynFloat64ArrayBase->initialize(pPvt->portName,&pPvt->float64Array);
    if (status != asynSuccess) {
        errlogPrintf("drvAsynADConfigure ERROR: Can't register float64Array\n");
        return -1;
    }

    pasynManager->registerInterruptSource(portName, &pPvt->float64Array, &pPvt-
     >float64ArrayInterruptPvt);

    status = pasynOctetBase->initialize(pPvt->portName,&pPvt->octet,0,0,0);
    if (status != asynSuccess) {
        errlogPrintf("drvAsynADConfigure ERROR: Can't register octet\n");
        return -1;
    }

    pasynManager->registerInterruptSource(portName, &pPvt->octet,
                                          &pPvt->octetInterruptPvt);

    status = pasynManager->registerInterface(pPvt->portName,&pPvt->drvUser);
    if (status != asynSuccess) {
        errlogPrintf("drvAsynADConfigure ERROR: Can't register drvUser\n");
        return -1;
    }
```

Driver with asynStandardInterfaces

```
#include <asynStandardInterfaces.h>
...
typedef struct drvADPvt {
    ...
    /* Asyn interfaces */
    asynStandardInterfaces asynInterfaces;
} drvADPvt;

int drvADImageConfigure(const char *portName, const char *detectorDriverName, int detector)
{
     ...
     asynStandardInterfaces *pInterfaces;
     ...
    /* Create asynUser for debugging and for standardBases */
    pPvt->pasynUser = pasynManager->createAsynUser(0, 0);

    /* Set addresses of asyn interfaces */
    pInterfaces = &pPvt->asynInterfaces;

    pInterfaces->common.pinterface        = (void *)&drvADCommon;
    pInterfaces->drvUser.pinterface       = (void *)&drvADDrvUser;
    pInterfaces->octet.pinterface         = (void *)&drvADOctet;
    pInterfaces->int32.pinterface         = (void *)&drvADInt32;
    pInterfaces->float64.pinterface       = (void *)&drvADFloat64;
    pInterfaces->int8Array.pinterface     = (void *)&drvADInt8Array;
    pInterfaces->int16Array.pinterface    = (void *)&drvADInt16Array;
    pInterfaces->int32Array.pinterface    = (void *)&drvADInt32Array;
    pInterfaces->float32Array.pinterface  = (void *)&drvADFloat32Array;
    pInterfaces->float64Array.pinterface  = (void *)&drvADFloat64Array;

    /* Define which interfaces can generate interrupts */
    pInterfaces->octetCanInterrupt        = 1;
    pInterfaces->int32CanInterrupt        = 1;
    pInterfaces->float64CanInterrupt      = 1;
    pInterfaces->int8ArrayCanInterrupt    = 1;
    pInterfaces->int16ArrayCanInterrupt   = 1;
    pInterfaces->int32ArrayCanInterrupt   = 1;
    pInterfaces->float32ArrayCanInterrupt = 1;
    pInterfaces->float64ArrayCanInterrupt = 1;

    status = pasynStandardInterfacesBase->initialize(portName, pInterfaces,  pPvt->pasynUser, pPvt);
    if (status != asynSuccess) {
        errlogPrintf("drvADImageConfigure ERROR: Can't register interfaces: %s.\n",
                     pPvt->pasynUser->errorMessage);
        return -1;
    }
```

Standard Interfaces - drvUser

- pdrvUser->create(void *drvPvt, asynUser *pasynUser, const char *drvInfo, const char **pptypeName, size_t *psize);
- drvInfo string is parsed by driver.
- It typically sets pasynUser->reason to a parameter index value (e.g. mcaElapsedLive, mcaErase, etc.)
- More complex driver could set pasynUser->drvUser to a pointer to something.
- Example

```
record(mbbo,"$(P)$(HVPS)INH_LEVEL") {
    field(DESC,"Inhibit voltage level")
    field(PINI,"YES")
    field(ZRVL,"0")
    field(ZRST,"+5V")
    field(ONVL,"1")
    field(ONST,"+12V")
    field(DTYP, "asynInt32")
    field(OUT,"@asyn($(PORT), $(ADDR), $(TIMEOUT))INHIBIT_LEVEL")
}
status = pasynEpicsUtils->parseLink(pasynUser, plink,
                &pPvt->portName, &pPvt->addr, &pPvt->userParam);
pasynInterface = pasynManager->findInterface(pasynUser, asynDrvUserType,1);
status = pasynDrvUser->create(drvPvt,pasynUser,pPvt->userParam,0,0);
```

Support for Callbacks (Interrupts)

- The standard interfaces asynOctet, asynInt32, asynUInt32Digital, asynFloat64, asynXXXArray. asynGenericPointer, and asynEnum all support callback methods for interrupts
- registerInterruptUser(…,userFunction, userPrivate, …)
  - Driver will call userFunction(userPrivate, pasynUser, data) with new data
  - Callback will not be at interrupt level, so callback is not restricted in what it can do
- Callbacks can be used by device support, other drivers, etc.
- Example interrupt drivers
  - Ip330 ADC, IpUnidig binary I/O, SIS 38XX MCS, areaDetector drivers, etc.
- Measurement Computing devices we will study later this morning

Support for Interrupts – Ip330 driver

```
static void intFunc(void *drvPvt) {
...
for (i = pPvt->firstChan; i <= pPvt->lastChan; i++) {
        data[i] = (pPvt->regs->mailBox[i + pPvt->mailBoxOffset]);
    }
    /* Wake up task which calls callback routines */
    if (epicsMessageQueueTrySend(pPvt->intMsgQId, data, sizeof(data)) == 0)
...
}

static void intTask(drvIp330Pvt *pPvt) {
while(1) {
        /* Wait for event from interrupt routine */
        epicsMessageQueueReceive(pPvt->intMsgQId, data, sizeof(data));
        /* Pass int32 interrupts */
        pasynManager->interruptStart(pPvt->int32InterruptPvt, &pclientList);
        pnode = (interruptNode *)ellFirst(pclientList);
        while (pnode) {
            asynInt32Interrupt *pint32Interrupt = pnode->drvPvt;
            addr = pint32Interrupt->addr;
            reason = pint32Interrupt->pasynUser->reason;
            if (reason == ip330Data) {
                pint32Interrupt->callback(pint32Interrupt->userPvt,
                                          pint32Interrupt->pasynUser,
                                          pPvt->correctedData[addr]);
            }
            pnode = (interruptNode *)ellNext(&pnode->node);
        }
        pasynManager->interruptEnd(pPvt->int32InterruptPvt);
```

Support for Interrupts – Performance

- Ip330 ADC driver. Digitizing 16 channels at 1kHz.
- Generates interrupts at 1 kHz.
- Each interrupt results in:
  - 16 asynInt32 callbacks to devInt32Average generic device support
  - 1 asynInt32Array callback to fastSweep device support for MCA records
  - 1 asynFloat64 callback to devEpidFast for fast feedback
- 18,000 callbacks per second
- 21% CPU load on MVME2100 PPC-603 CPU with feedback on and MCA fast sweep acquiring.

Generic Device Support

- asyn includes generic device support for many standard EPICS records and standard asyn interfaces
- Eliminates need to write device support in virtually all cases. New hardware can be supported by writing just a driver.
- Record fields:
  - field(DTYP, “asynInt32”)
  - field(INP, “@asyn(portName, addr, timeout) drvInfoString)
- Examples:
  - asynInt32
    - ao, ai, bo, bi, mbbo, mbbi, longout, longin
  - asynInt32Average
    - ai
  - asynUInt32Digital, asynUInt32DigitalInterrupt
    - bo, bi, mbbo, mbbi, mbboDirect, mbbiDirect, longout, longin
  - asynFloat64
    - ai, ao
  - asynOctet
    - stringin, stringout, waveform (in and out)
  - asynXXXArray
    - waveform (in and out)
  - asynEnum
    - bi, bo, mbbi, mbbo

Generic Device Support

- All synApps modules I am responsible for now use standard asyn device support, and no longer have specialized device support code:
  - areaDetector 2D detectors
  - Modbus General Modbus driver
  - dxp (XIA Saturn, XMAP, Mercury spectroscopy systems)
  - Ip330 16-channel 16-bit Industry Pack ADC
  - IpUnidig 24 bit Industry Pack digital I/O module
  - quadEM APS VME and CaenEls/Elettra quad electrometers
  - dac128V 8 channel 12-bit Industry Pack DAC
  - measComp Measurement Computing USB modules (*more later*)
  - Canberra ICB modules (Amp, ADC, HVPS, TCA)
  - SIS 38XX multichannel scalers
  - Motors: Newport XPS, Parker Aries, ACS MCB-4B

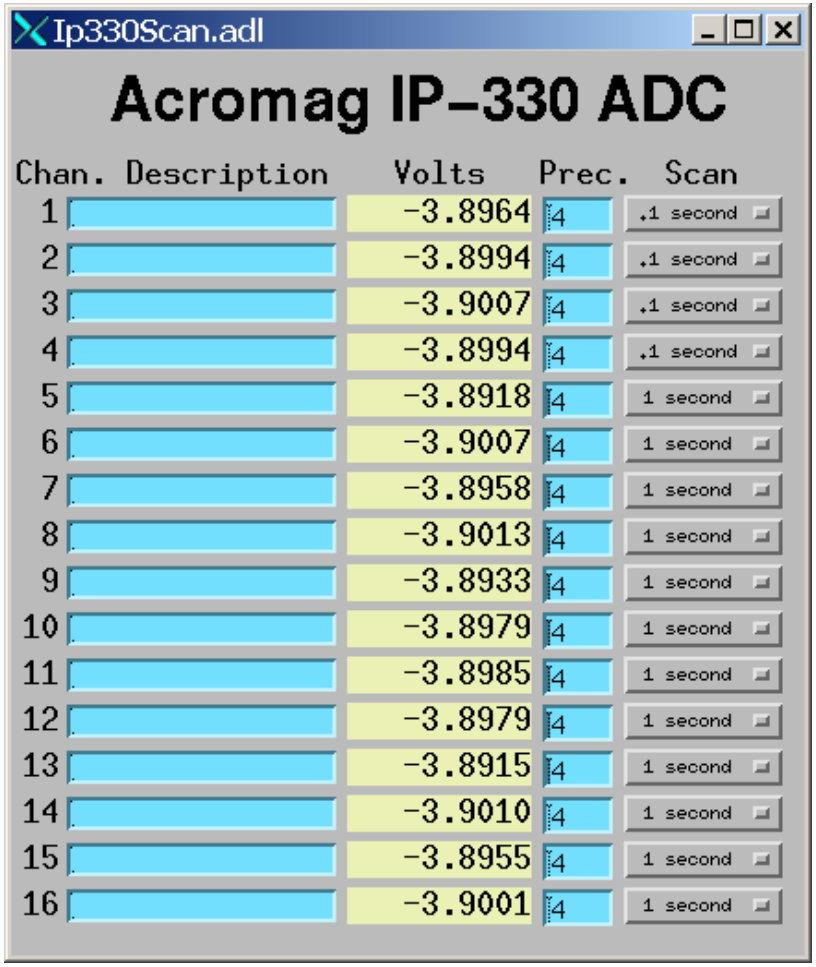
Generic Device Support

- MCA, scaler and motor records use special device support, because they are not base record types.
  - Single device-independent device support file
  - Only driver is device-dependent
- MCA, scaler and new motor drivers now only use the standard asyn interfaces, so it is possible (in principle) to write a database using only standard records and control any MCA driver or new motor driver
  - However, the state logic would need to be moved from the record into a driver base class

Generic Device Support

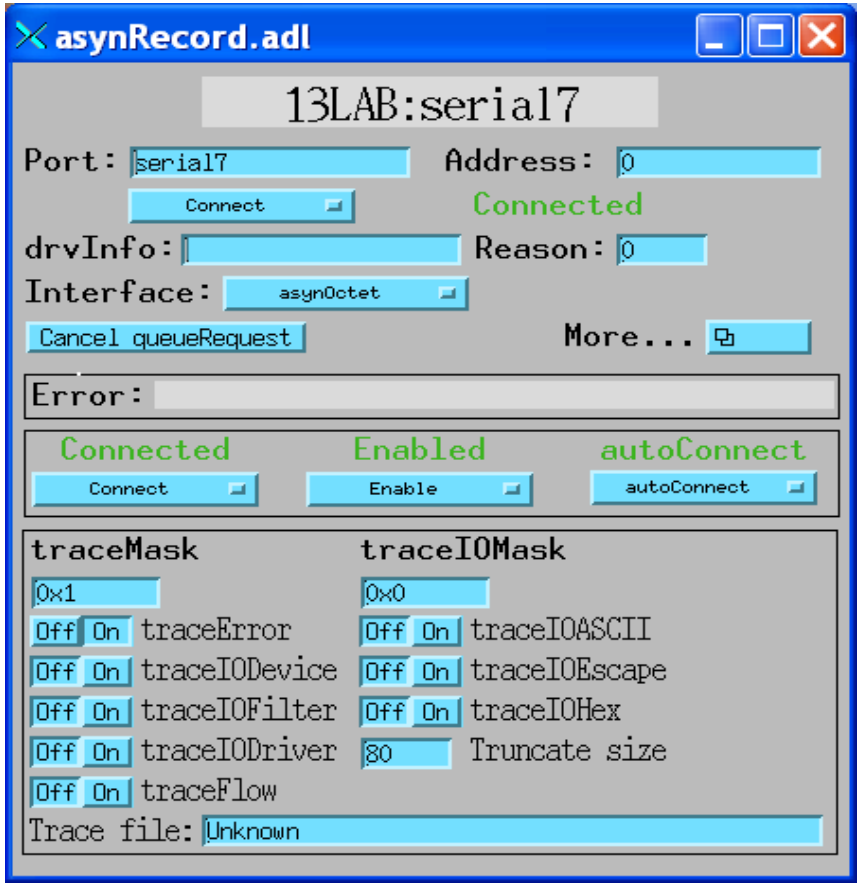
```
corvette> view ../Db/ip330Scan.template
record(ai,"$(P)$(R)")
{
        field(SCAN,"$(SCAN)")
        field(DTYP,"asynInt32Average")
        field(INP,"@asyn($(PORT) $(S))DATA")
        field(LINR,"LINEAR")
        field(EGUF,"$(EGUF)")
        field(EGUL,"$(EGUL)")
        field(HOPR,"$(HOPR)")
        field(LOPR,"$(LOPR)")
        field(PREC,"$(PREC)")
}

record(longout,"$(P)$(R)Gain")
{
        field(PINI,"YES")
        field(VAL,"$(GAIN)")
        field(DTYP,"asynInt32")
        field(OUT,"@asyn($(PORT) $(S))GAIN")
}
```



asynRecord

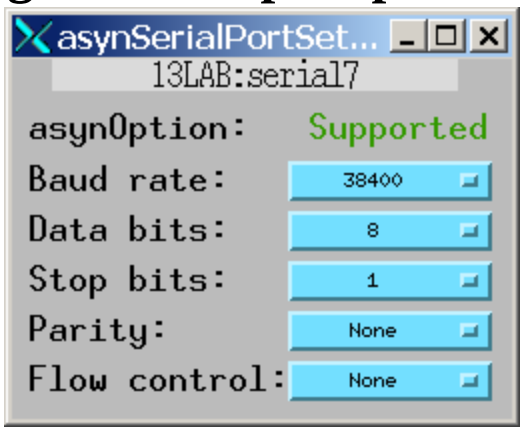
- EPICS record that provides access to most features of asyn, including standard I/O interfaces
- Applications:
  - Control tracing (debugging)
  - Connection management
  - Perform interactive I/O
- Very useful for testing, debugging, and actual I/O in many cases
- Replaces the old generic “serial” and “gpib” records, but much more powerful



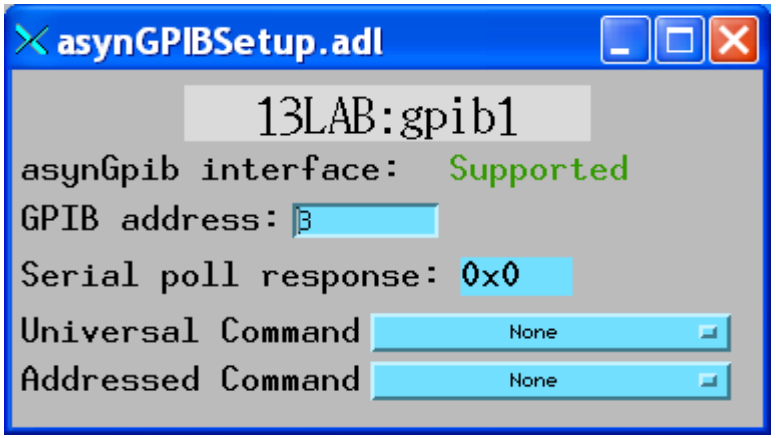
asynRecord – asynOctet devices

Interactive I/O to octet devices (serial, TCP/IP, GPIB, etc.)

Configure serial port parameters

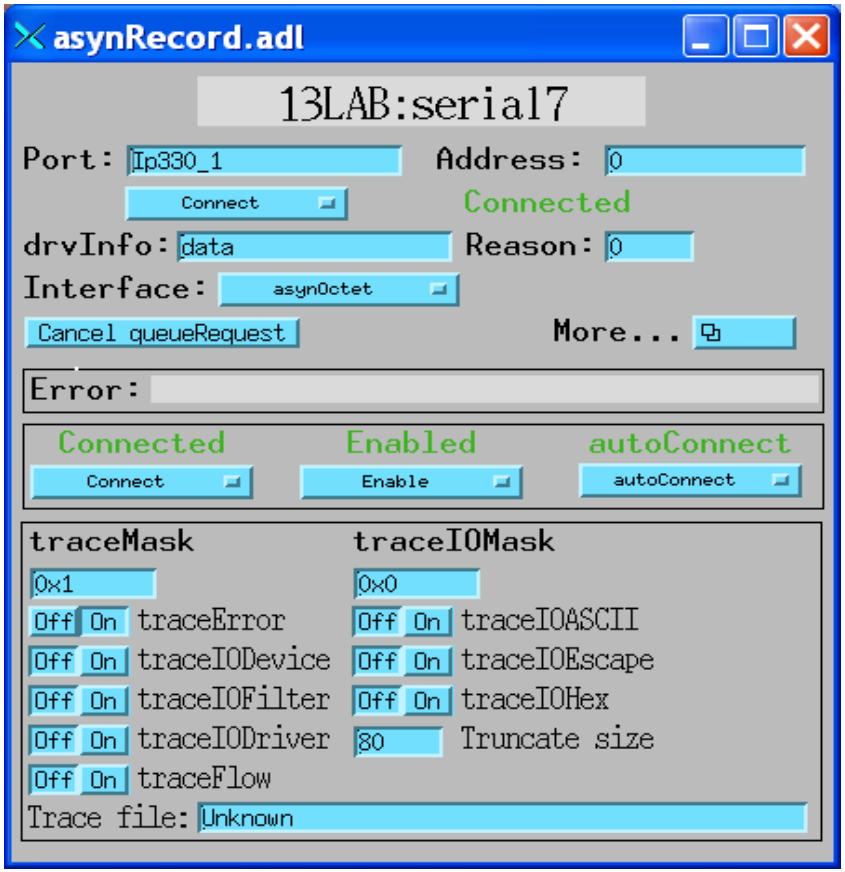


Perform GPIB specific operations

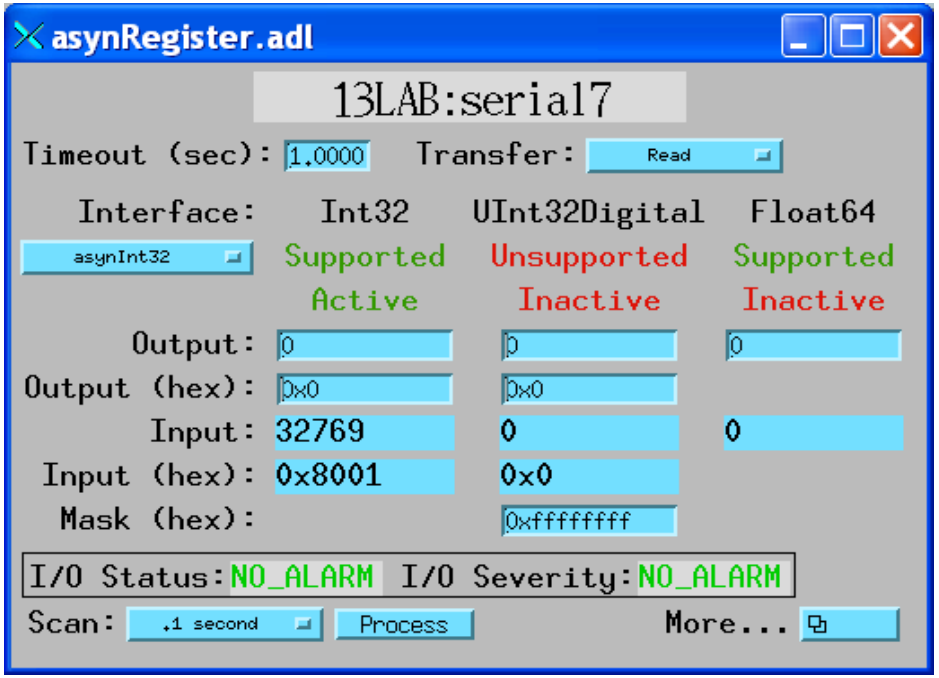


asynRecord – register devices

Same asynRecord, change to ADC port

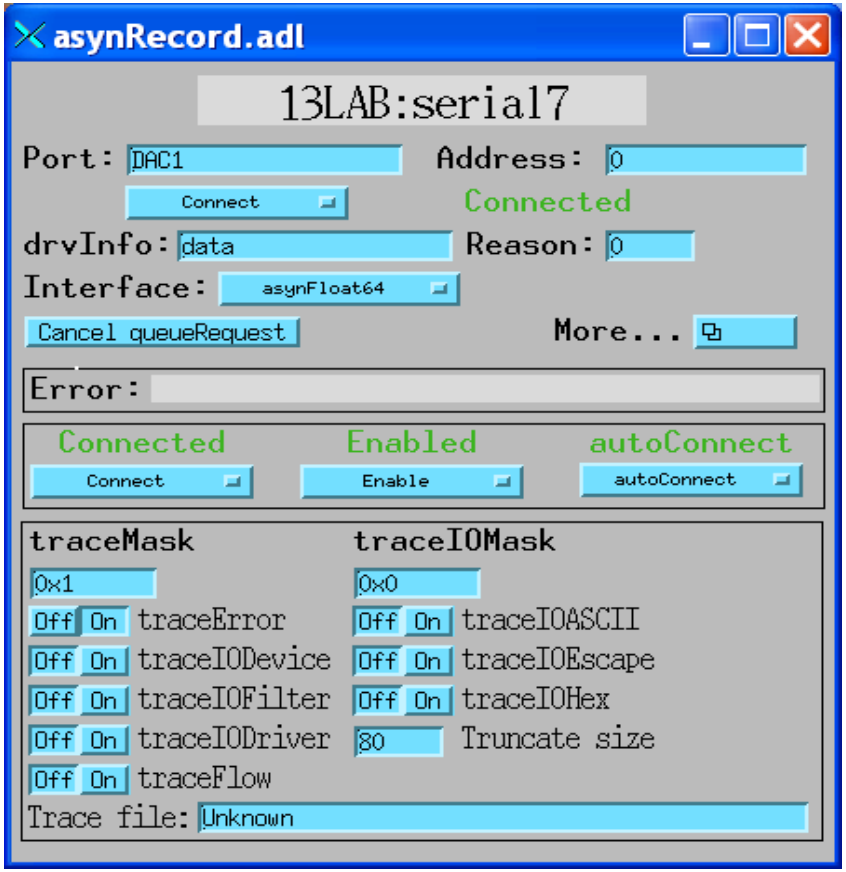


Read ADC at 10Hz with asynInt32 interface

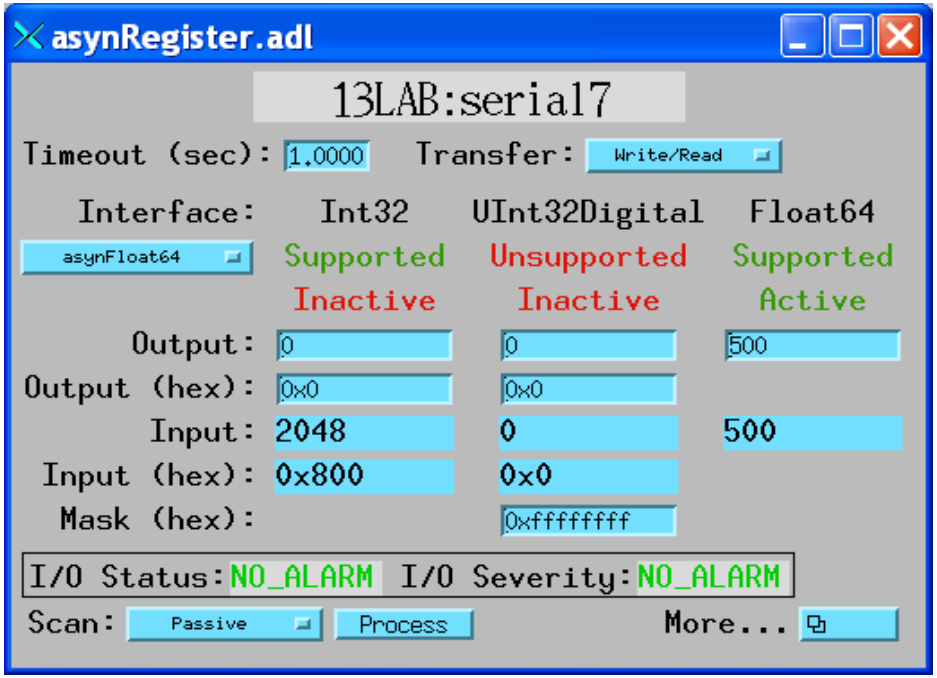


asynRecord – register devices

Same asynRecord, change to DAC port



Write DAC with asynFloat64 interface



Synchronous interfaces

- Standard interfaces also have a synchronous interface, even for slow devices, so that one can do I/O without having to implement callbacks
- Example: asynOctetSyncIO
  - write(), read(), writeRead()
- Very useful when communicating with a device that can block, *when it is OK to block*
- Example applications:
  - EPICS device support in init_record(), (but not after that!)
  - SNL programs, e.g. communicating with serial or TCP/IP ports
  - Any asynchronous asyn port driver communicating with an underlying asynOctet port driver (e.g. motor drivers)
  - areaDetector driver talking to marCCD server, Pilatus camserver, etc.
  - iocsh commands

Synchronous interfaces – Tektronix scope driver example

- In initialization:

```
/* Connect to scope */
 status = pasynOctetSyncIO->connect(scopeVXI11Name,
                                    0,
                                    &this->pasynUserScope,
                                    NULL);
```

- In IO:

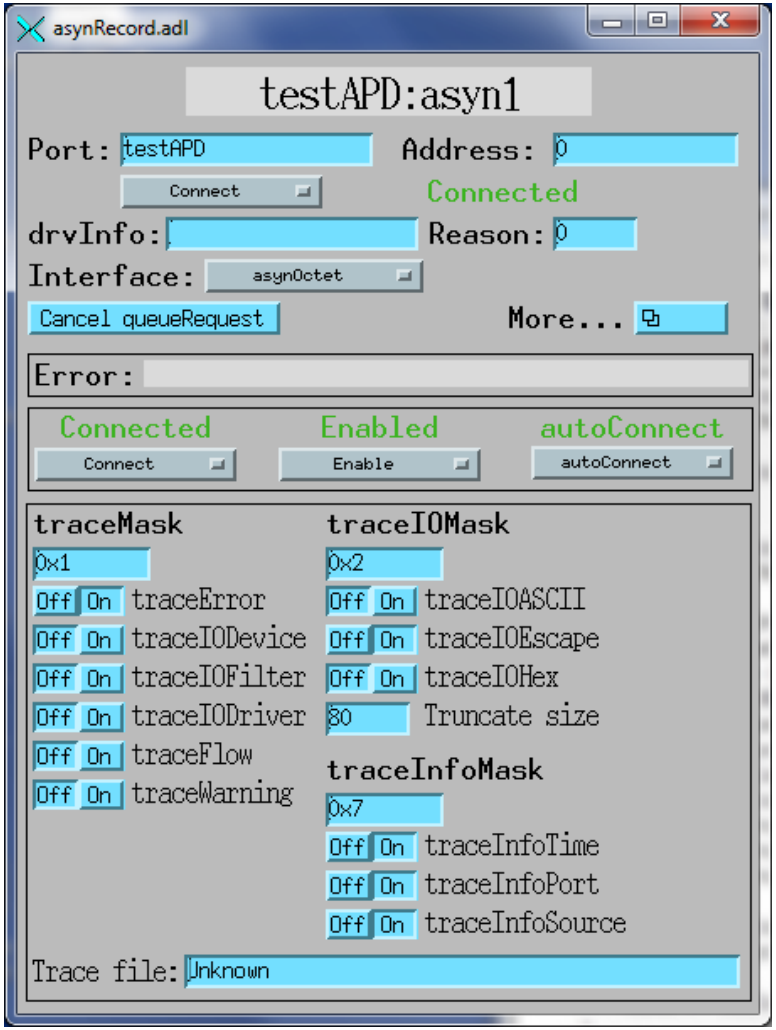
```
status = pasynOctetSyncIO->writeRead(pasynUserScope,
                                     sendMessage, numSend,
                                     receiveMessage,
                                     sizeof(receiveMessage),
                                     WRITE_READ_TIMEOUT,
                                     &numSent, responseLen,
                                     &eomReason);
```

iocsh Commands

asynReport(level,portName)
asynSetTraceMask(portName,addr,mask)
asynSetTraceIOMask(portName,addr,mask)
asynSetTraceInfoMask(portName,addr,mask)
asynSetTraceFile(portName,addr,filename)
asynSetTraceIOTruncateSize(portName,addr,size)
asynSetOption(portName,addr,key,val)
asynShowOption(portName,addr,key)
asynAutoConnect(portName,addr,yesNo)
asynEnable(portName,addr,yesNo)
asynOctetConnect(entry,portName,addr,oeos,ieos,timeout,buffer_len)
asynOctetRead(entry,nread,flush)
asynOctetWrite(entry,output)
asynOctetWriteRead(entry,output,nread)
asynOctetFlush(entry)
asynOctetSetInputEos(portName,addr,eos,drvInfo)
asynOctetGetInputEos(portName,addr,drvInfo)
asynOctetSetOutputEos(portName,addr,eos,drvInfo)
asynOctetGetOutputEos(portName,addr,drvInfo)
asynRegisterTimeStampSource(portName, functionName)
asynUnregisterTimeStampSource(portName)
asynInterposeFlushConfig(portName,addr,timeout)
asynInterposeEosConfig(portName,addr)

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_TRACE_WARNING
    - ASYN_TRACE_FLOW
    - ASYN_TRACEIO_DEVICE
    - ASYN_TRACEIO_FILTER
    - ASYN_TRACEIO_DRIVER
- Tracing is enabled/disabled for (port/addr)
- Trace messages can be turned on/off from iocsh, vxWorks shell, and from CA clients such as medm via asynRecord.
- asynOctet I/O from shell



asyn: Drivers Included in the Module

- drvAsynSerialPort
  - Driver for serial ports on most OS (Linux, Windows, Darwin, vxWorks, RTEMS, etc.)
  - drvAsynSerialPortConfigure("portName", "ttyName", priority, noAutoConnect, noProcessEosIn)
  - asynSetOption("portName", addr, "key", "value")

Key	Value
baud	9600 50 75 110 134 150 200 300 600 1200 ... 230400
bits	8 7 6 5
parity	none even odd
stop	1 2
clocal	Y N
crtscts	N Y
ixon	N Y
ixoff	N Y
ixany	N Y

asyn: Drivers Included in the Module

drvAsynIPPort – driver for IP network communications

drvAsynIPPortConfigure("portName", "hostInfo", priority, noAutoConnect, noProcessEos)

hostInfo - The Internet host name, port number, optional local port number, and optional IP protocol of the device. The format is:

<host>:<port>[:localPort] [protocol]

(e.g. "164.54.9.90:4002", "164.54.9.90:4001:10101", "serials8n3:4002", "serials8n3:4002 TCP" or "164.54.17.43:5186 udp")

Protocols:

- TCP (default)
- UDP
- UDP* — UDP broadcasts. The address portion of the argument must be the network broadcast address (e.g. "192.168.1.255:1234 UDP*").
- HTTP — Like TCP but for servers which close the connection after each transaction.
- COM — For Ethernet/Serial adapters which use the TELNET RFC 2217 protocol. This allows port parameters (speed, parity, etc.) to be set with subsequent asynSetOption commands just as for local serial ports. The default parameters are 9600-8-N-1 with no flow control.

asyn: Drivers Included in the Module

- drvAsynIPServerPort – socket listening driver for TCP or UDP network communications
  - drvAsynIPServerPortConfigure("portName", “serverInfo", maxClients, priority, noAutoConnect, noProcessEos)
- drvVxi11: GPIB over Ethernet
- GPIB drivers for vxWorks and Linux
- USB TMC (Test and Measurement Class) for some USB devices

Where does an output record (ao, longout, mbbo, etc.) get its initial value?

1. From the aoRecord.dbd file
2. From the database file you load
3. asyn device support init_record function does a read from your asyn driver to read the current value.
   - If your driver returns asynSuccess on that read then that value is used.
   - Supports bumpless reboots.
   - If using asynPort driver then if your driver has done setIntegerParam, setDoubleParam, or setStringParam before init_record (i.e. typically in constructor) then the readInt32, etc. functions will return asynSuccess. If setInt32Param has not been done then readInt32 returns asynError, and that value will not be used.
4. From save/restore
5. dbpf at the end of startup script.

Summary- Advantages of asyn

- 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 99% (?) 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.
- asynPortDriver (next talk) simplifies many things, makes much less code.