Custom Device Support

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Material copied from APS
“Getting Started with EPICS Lecture Series:
Writing Device Support”, Eric Norum,
November 16, 2004

EPICS Nomenclature

Record: Database processing block

- AI record: ‘read’ a number,
  AO record: ‘write’ a number,
  STRINGOUT: ‘write’ a string, …

Device Support: Links Record to Driver

- AI device support: `read(aiRecord *ai)`
- AO device support: `write(aoRecord *ao)`

Driver: Code that talks to hardware

- Ideally available as C(++) source code
- Could be in binary form, from hardware vendor
- May be totally unaware of EPICS

Fundamentally Easy

1. Assume given ‘driver’ with `XyzDriver_read()`
2. Implement ‘device support’ for AI:

```
// Called by AI record when processed
int xyz_ai_read(aiRecord * const ai)
{
        // Call driver to get number
        const int raw_number = XyzDriver_read();
        // Put into record’s raw value field
        ai->rval = raw_number;
        // Done, no error
        return 0;
}
```

3. Some boilerplate to inform EPICS that AI record now has a new `DTYP=“XYZ”` that should call `xyz_ai_read()`

Of course, there's more

- Set AI record's RVAL, let the record convert to EGU, or set the record's VAL?
- How to decide what to read exactly?

```
record(ai, "MyXYZTest")
{
   field(DTYP, "XYZ")
   field(INP,  "#C0 S2 @unipolar")
   …
}
```

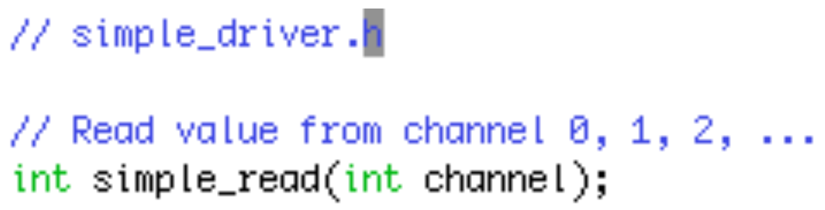
- Handle errors?
- What if instead of

    Record gets scanned → read from device

  … I want

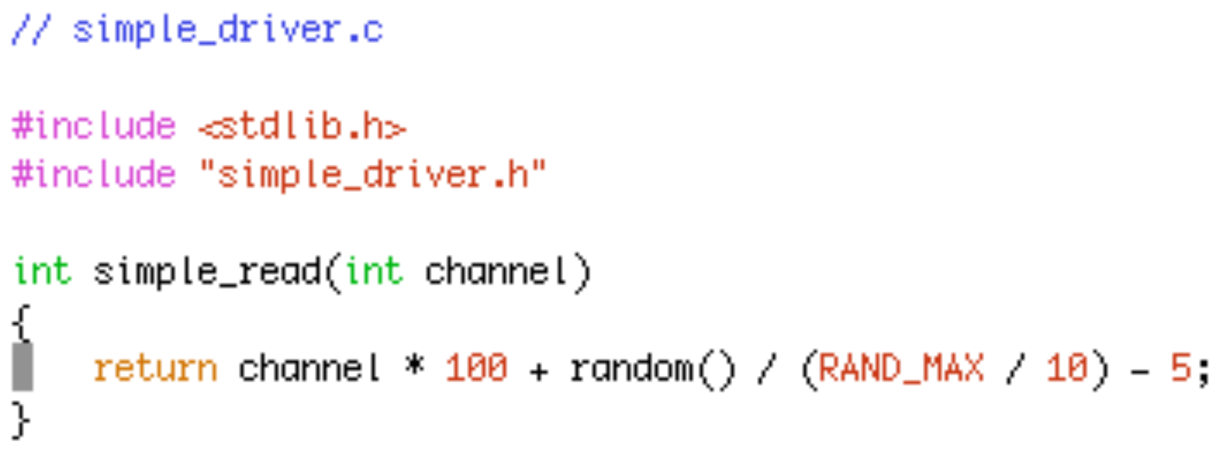
    Device changes → Process the record!

Assume a simple Driver



```c
// simple_driver.h

// Read value from channel 0, 1, 2, ...
int simple_read(int channel);
```



```c
// simple_driver.c

#include <stdlib.h>
#include "simple_driver.h"

int simple_read(int channel)
{
    return channel * 100 + random() / (RAND_MAX / 10) - 5;
}
```

Device Support for AI Record

```c
// simple_device.c

// std
#include <stdlib.h>
#include <stdio.h>

// EPICS
#include <recGbl.h>
#include <devSup.h>
#include <devLib.h>
#include <recGbl.h>
#include <aiRecord.h>
#include <epicsExport.h>

// Local
#include "simple_driver.h"

// Init routine, called at startup
static long simple_init_ai(aiRecord *ai)
{
   int channel = atoi(ai->inp.value.instio.string);
   printf("Record '%s': Init. w/ channel %d\n",
           ai->name, channel);
   ai->dpvt = (void *) (long) channel;
   return 0;
}

// Read routine, called whenever record is processed
static long simple_read_ai(aiRecord *ai)
{
   int channel = (int) (long) ai->dpvt;
   ai->rval = simple_read(channel);
   if (ai->tpro)
      printf("Record '%s': channel %d = %d\n",
           ai->name, channel, ai->rval);
   return 0;
}
```

```c
// Boilerplate
// Device Support Entry Table for AI
static struct
{
        long number;
        long (*report)(int);
        long (*initialize)(int);
        long (*initRecord)(aiRecord *);
        long (*getIoIntInfo)();
        long (*read)(aiRecord *);
        long (*special_linconv)(aiRecord *, int);
} devAiSimple =
{
        6, NULL, NULL, simple_init_ai, NULL, simple_read_ai, NULL
};
// Magic for different OS to 'export' this structure
epicsExportAddress(dset, devAiSimple);
```

DBD File

“simple.dbd”:

```
device(ai, INST_IO, devAiSimple, "Simple")
```

Makefile

- Compile the sources:

```
example_SRCS += simple_device.c
example_SRCS += simple_driver.c
```

- Include the DBD:

```
example_DBD += simple.dbd
```

Example Database

```
record(ai, "simple1")
{
  field(DTYP, "Simple")
  field(INP,  "@1")
  field(SCAN, "1 second")
}
```

Result

```
$ camonitor simple1
simple1                        2013-02-06 13:15:00.003208 100
simple1                        2013-02-06 13:15:01.003284 103
simple1                        2013-02-06 13:15:02.003370 101
simple1                        2013-02-06 13:15:03.003435 97
```

“Device Private”, DPVT

Used to store whatever you need to store

- Information fetched
  at initialization,
  needed for read/write
- Pointers to driver structures

Previous example: Channel #

- Misusing the (void *)rec->dpvt as (int)

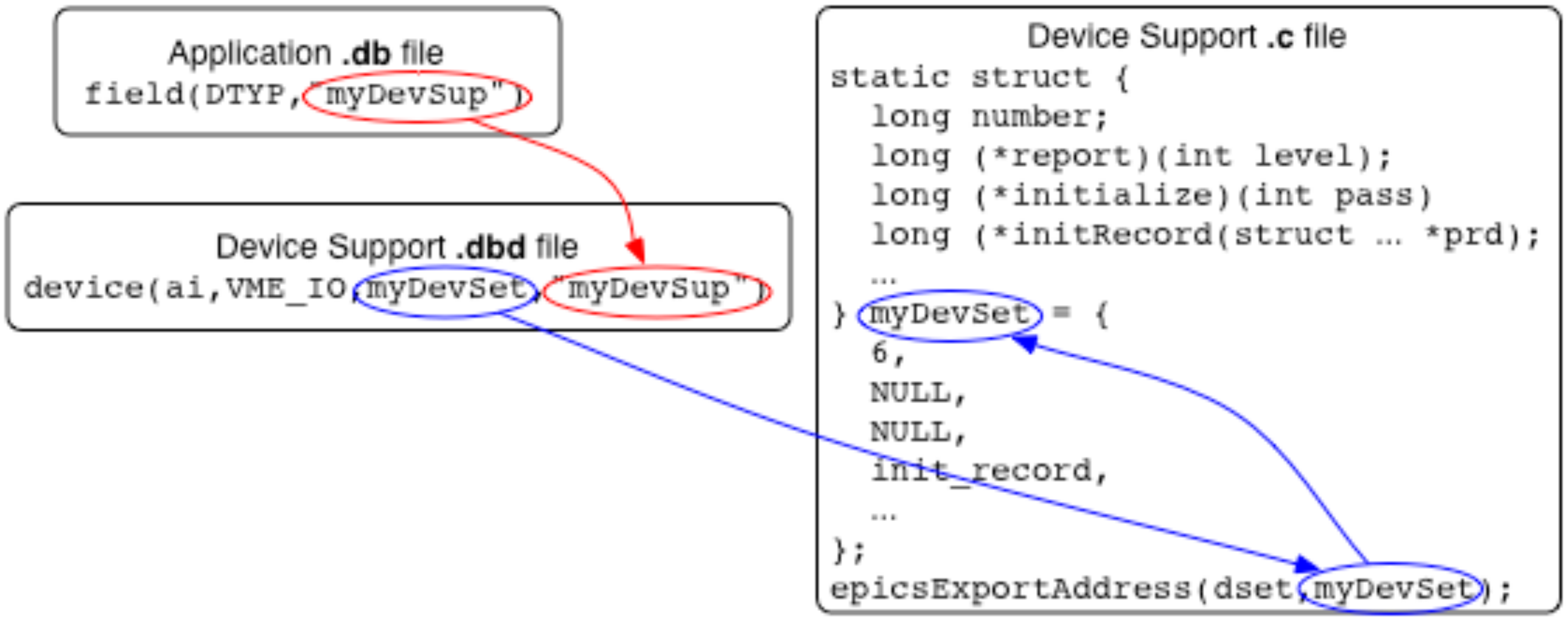
Proper use of DPVT with custom struct

```c
typedef struct
{
   int channel;
   // There would be a ton more in a real example ...
} StuffINeedToKeep;

// Init routine, called at startup
static long simple_init_ai(aiRecord *ai)
{
   StuffINeedToKeep *sintk = malloc(sizeof(StuffINeedToKeep));
   sintk->channel = atoi(ai->inp.value.instio.string);
   printf("Record '%s': Init. w/ channel %d\n",
          ai->name, sintk->channel);
   ai->dpvt = sintk;
   return 0;
}

// Read routine, called whenever record is processed
static long simple_read_ai(aiRecord *ai)
{
   StuffINeedToKeep *sintk = (StuffINeedToKeep *) ai->dpvt;
   ai->rval = simple_read(sintk->channel);
   if (ai->tpro)
      printf("Record '%s': channel %d = %d\n",
          ai->name, sintk->channel, ai->rval);
   return 0;
}
```

Recapitulate: From DTYP to read()



```
field(DTYP,"myDevSup")
```

```
device(ai,VME_IO,myDevSet,"myDevSup")
```

```
static struct {
  long number;
  long (*report)(int level);
  long (*initialize)(int pass)
  long (*initRecord(struct … *prd);
  …
} myDevSet = {
  6,
  NULL,
  NULL,
  init_record,
  …
};
epicsExportAddress(dset,myDevSet);
```

The .dbd file entry

The IOC discovers device support from entries in .dbd files

```
device(recType,addrType,dsetName,”dtypeName”)
```

`addrType` is one of

```
AB_IO       BITBUS_IO   CAMAC_IO    GPIB_IO
INST_IO     RF_IO       VME_IO      VXI_IO
```

`dsetName` is the name of the C Device Support Entry Table (DSET)

By convention name indicates record and hardware type:

```
device(ai, GPIB_IO, devAidg535, "dg535")
device(bi, VME_IO, devBiXy240, "XYCOM-240")
```

Read-worthy sections of EPICS App. Devel. Guide

- OS-independent routines for register access, threads, semaphore, interrupts, …
- Support for SCAN="I/O Intr", DSET `getIoIntInfo()`
- Support for conversions, DSET `specialLinconv()`

A Problematic Example

- See Problematic.pdf

Asynchronous I/O – ASYN

- This should be your first consideration for new device support
- It provides a powerful, flexible framework for writing device support for
  - Message-based asynchronous devices
  - Register-based synchronous devices
- Subsequent lecture

Stream Device

Useful for a lot of ‘intelligent’ I/O

- RS232 serial line devices
- Text-based TCP protocol devices

Summary: Device Support is

- Glue between records and hardware (“driver”)

- Fundamentally easy:
  - Maybe “init()”
  - “read()” or “write()”
  - Boilerplate to register: DSET, *.dbd “device(…)”

- A great opportunity to shoot yourself in the foot