A Bridge Too Far?

Using a PCI/VME Bridge with EPICS and Porting vxWorks Drivers

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Overview

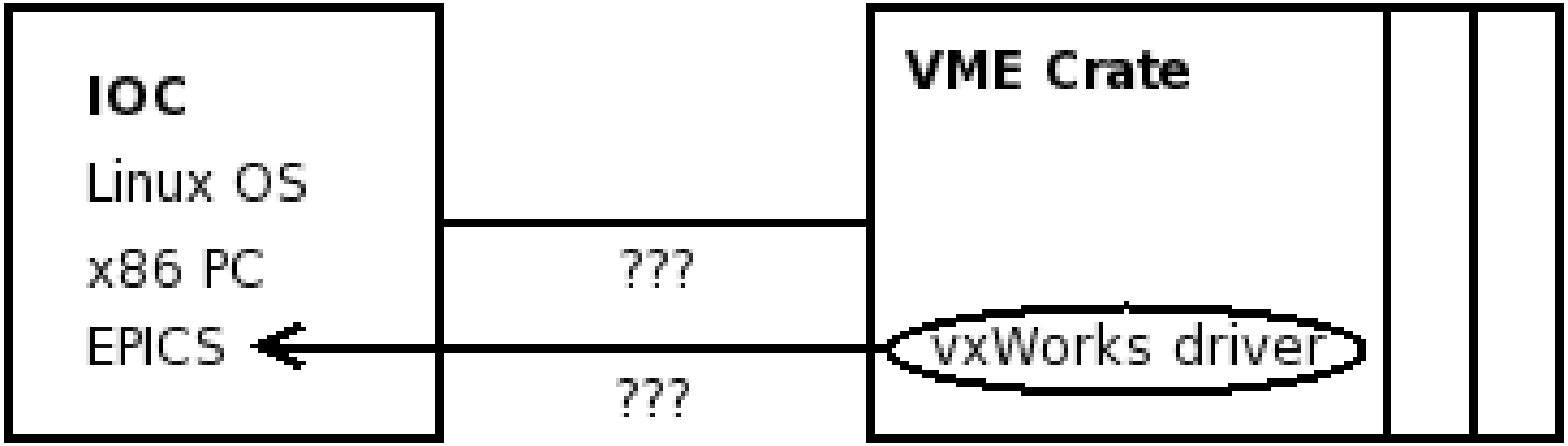
Overview

- Background
- Hardware
- Software design
- Migration of drivers
- Performance
- Benefits
- Further work
- Acknowledgements

The question

Our objectives

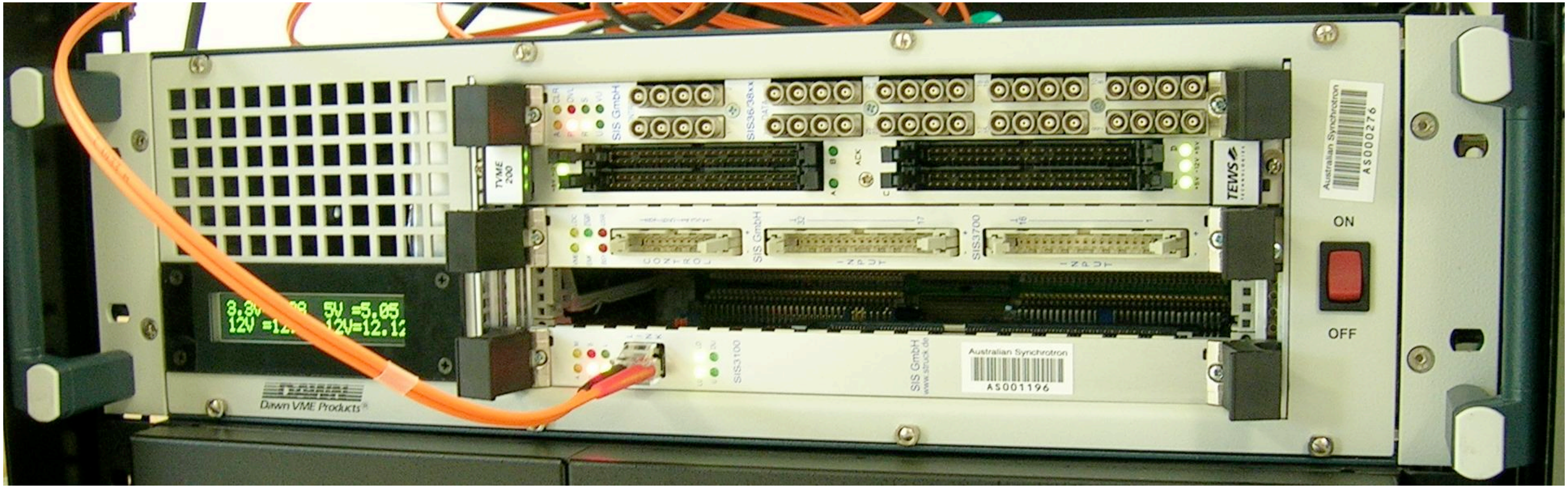
- Use x86 based Linux IOCs
- Use VME data acquisition hardware
- Avoid vxWorks
- Reuse existing drivers for VME hardware with as little modification as possible



A hardware answer

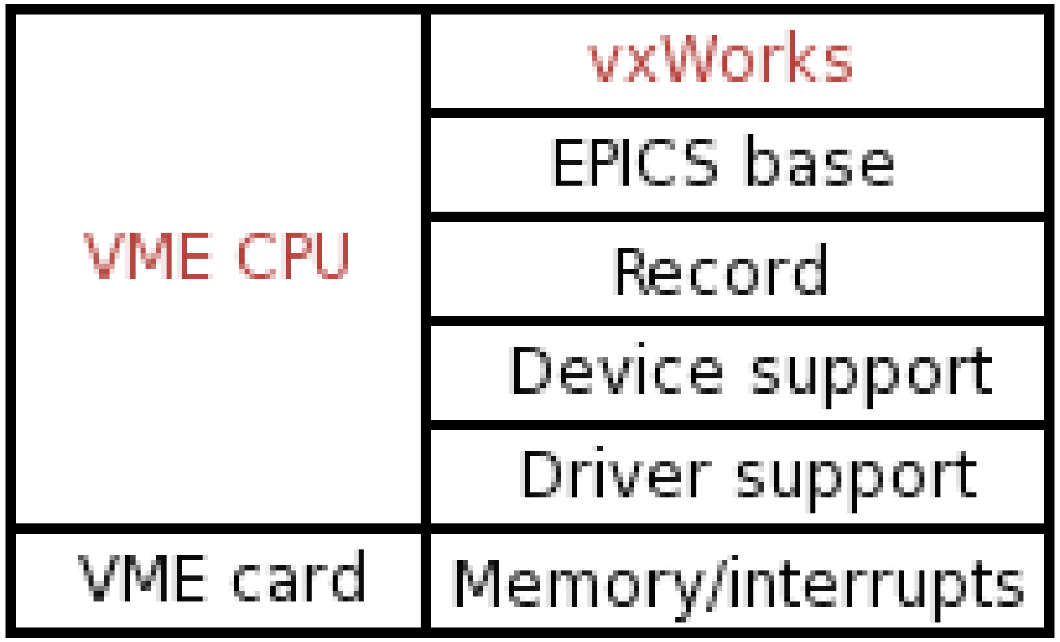
- SIS 1100/3100 by Struck (www.struck.de)
- Already in use at CLS
- Same manufacturer as some chosen data acquisition equipment
- Universal PCI board now available
- VME board replaces VME CPU
- PCI board inserted into any PCI slot in PC
- Connected using fibre optic link

SIS3100 installed in VME crate

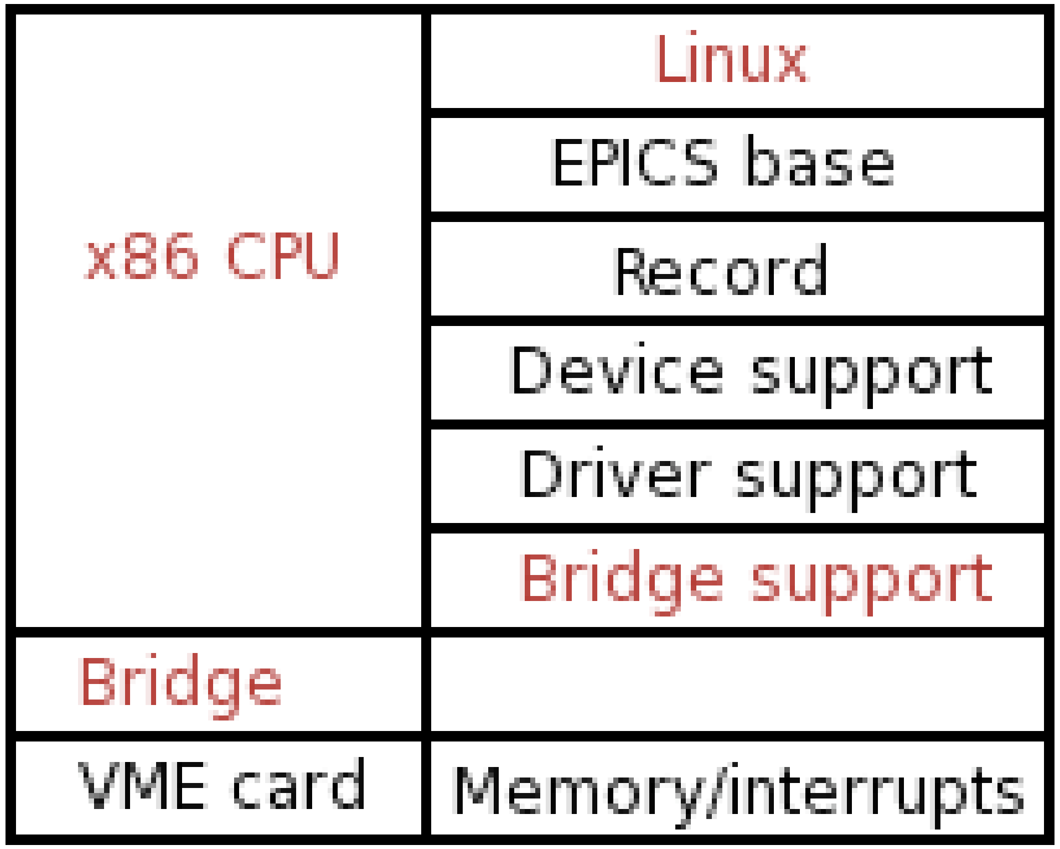


A software answer

- Utilise Operating System Independent elements in EPICS
- Write implementations of devLib routines for Linux using the Struck bridge
    - devLib currently only exists for vxWorks and RTEMS
- Develop code as an EPICS module so that it can be loaded if required
- Modify EPICS base to allow module to supply devLib implementation



VME CPU	vxWorks
	EPICS base
	Record
	Device support
	Driver support
VME card	Memory/interrupts



x86 CPU	Linux
	EPICS base
	Record
	Device support
	Driver support
	Bridge support
Bridge	
VME card	Memory/interrupts

Software design - overall

- Build as an EPICS module to make use transparent
- Memory map to PC memory to mimic operation of VME memory addressing
- VME interrupts converted to Linux signals
- Provide implementations of the EPICS devLib commands to allow Operating System independence:
  - `devMapAddr`
  - `devConnectInterruptVME`
  - other functions are configured to return success at this stage. Not required for this stage of development.

Software design - EPICS integration

- Minor change required to EPICS base to allow a library to provide devLib function implementations.
  - Compatible with existing vxWorks/RTEMS implementations
- Add simple `devLibOSD.c` to $EPICS_BASE/src/libCom/osi/os/default

```
#include <stdlib.h>
#include "devLib.h"
devLibVirtualOS *pdevLibVirtualOS;
```

- Update Makefile for libCom
- Implementation of devLib can be supplied in a module in the EPICS IOC executable.

Software design - memory map

- Memory map to PC memory to mimic operation of VME memory addressing
- Provides implementation of `devMapAddr`
- Can map address either with or without interrupt support - this function needs to be split into the two elements
- Requires a board number - purely used as an identifier.
- Maintains list of boards and VME and PC addresses
- Can access 16, 24 and 32 bit VME address spaces
- Utilises `mmap` library command to map memory

Interrupt handling

Software design - interrupt handling

- VME interrupts are converted to PCI interrupt by SIS hardware and to signal by SIS kernel modulenN
- Use `sigaction` function to register interest in signal and trigger execution of a signal handler
- Maintain a map of VME interrupt vectors and locations of Interrupt Service Routines in PC
- Map is populated as part of card initialisation functions

iocsh commands

- The following iocsh commands are provided to configure the bridge
    - `initPciVmeBridge(crate, controlFile, remoteFile)`
    - `mapMemoryNoIRQ(crate, board, VME address, VME AM)`
    - `mapMemoryWithIRQ(crate, board, VME address, VME AM, interrupt vector, interrupt level)`

Migration of existing vxWorks driver

- Replace header includes
- Replace vxWorks specific commands
- If driver has been written using devLib commands, may not need to do anything
- OMS VME-58 driver required bit ordering modification, but no other changes
- Example library changes:

vxWorks	PCI/VME Bridge

`vxWorks.h`
`takLib.h`
`sysLib.h`
`intLib.h`
`iv.h`
`vxLib.h`
`sysLib.h`
	`devLib.h`
	`sys/types.h`

Victoria
The Place To Be

Migration of existing vxWorks driver

- Example function changes:

vxWorks	PCI/VME Bridge

`intConnect(...)`
`vxMemProbe(...)`
`sysBusToLocalAdrs(...)`
	`devConnectInterruptVME(...)`
	`devReadProbe(...)`
	`devMapAddr(...)`

- May need to make use of other EPICS OSI libraries
  - epicsMutex
  - epicsEvent

Driver development

Drivers known to work under PCI/VME bridge

Device
SIS3820 multiscaler
OMS VME-58 motor controller
DAC128V DAC
TVME200 IP carrier
SBS
IP330 ADC
IP-Unidig Digital IO

Drivers investigated but not yet converted

Device
quadEM electrometer

System performance

Performance

- Memory mapping I/O works
- Memory usage on host PC is not an issue so far
- Interrupt handling:
    - 1kHz uses approx 25% CPU on 3GHz Pentium
- Industry Pack interrupt processing is not yet stable
- Simple scan using motor, scaler, scan records operates well using interrupts

Benefits

- Ability to use VME hardware with Linux PC IOC
- Reuse of existing driver code with minimal modification
- Compatibility with existing EPICS records in synApps
- Do not need to pay for vxWorks
- Do not need to learn vxWorks
- PC host is easily upgraded
- Hardware costs are comparable

Further work

- Review signal handling architecture
- Fix up code structure
- Optimise code performance
- Produce documentation
- Make available to community
- Migrate additional drivers
- Resolve issue with Industry Pack interrupt handling

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The End

Questions?