VxWorks and EPICS Diagnostics

SLS Controls Pikett Training
### ARIDI-VME-PCT

<table>
<thead>
<tr>
<th>Metric</th>
<th>Value</th>
</tr>
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<tbody>
<tr>
<td>CPU Heart Beat</td>
<td>0.8</td>
</tr>
<tr>
<td>Memory Free</td>
<td>148.00308</td>
</tr>
<tr>
<td>Memory Allocated</td>
<td>127.1272</td>
</tr>
<tr>
<td>Memory Free</td>
<td>148.00308</td>
</tr>
<tr>
<td>No. of Clients</td>
<td>10</td>
</tr>
<tr>
<td>No. of Client Channels</td>
<td>10</td>
</tr>
<tr>
<td>No. of Database Links</td>
<td>30</td>
</tr>
<tr>
<td>No. of Cn Database Links</td>
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</tr>
<tr>
<td>No. of Cn DB Links Not</td>
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</tr>
<tr>
<td>No. of Cn DB Links Disconnected</td>
<td>0</td>
</tr>
<tr>
<td>No. of File Descriptors</td>
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</tr>
<tr>
<td>No. of File Descriptors Av.</td>
<td>144</td>
</tr>
<tr>
<td>No. of File Descriptors Max</td>
<td>144</td>
</tr>
<tr>
<td>CPU Load</td>
<td>51.09</td>
</tr>
</tbody>
</table>

### VME Status (version 2.0.0)

- **Status Displays**
- **MACHINE IOC STATUS**
- **BEAMLINE IOC STATUS**

### Controls Pikett Training, Dirk Zimoch, 11.2.2010
IOC Status Display

"CPU Load" high
- Software bug (infinite loop)?
- Too much VME traffic?
- Broken VME card?

"No. of Clients" raising
- Problem with one client?
- Instable network?

"No. of CA Db Links NOT connected" > 0
- Typo in links?
- Obsolete records?
- Network problems?

"No. of Dead Threads" > 0
- Stack overflow?
- Array overwrite?
- Invalid pointer?

"# Times failed to find space" > 0
- tNetTask blocked or dead?
- Check also "CPU Load"
- Too high network load?
- Broken network chip?
### CPU Load by Thread

<table>
<thead>
<tr>
<th>NAME</th>
<th>ENTRY</th>
<th>TID</th>
<th>PRI</th>
<th>total % (ticks)</th>
<th>delta % (ticks)</th>
</tr>
</thead>
<tbody>
<tr>
<td>tExcTask</td>
<td>excTask</td>
<td>ffcc00</td>
<td>0</td>
<td>0% (0)</td>
<td>0% (0)</td>
</tr>
<tr>
<td>tLogTask</td>
<td>logTask</td>
<td>ffa00</td>
<td>0</td>
<td>0% (0)</td>
<td>0% (0)</td>
</tr>
<tr>
<td>tShell</td>
<td>shell</td>
<td>d2e600</td>
<td>1</td>
<td>0% (0)</td>
<td>0% (0)</td>
</tr>
<tr>
<td>tRlogind</td>
<td>rlogind</td>
<td>d486c0</td>
<td>2</td>
<td>0% (0)</td>
<td>0% (0)</td>
</tr>
<tr>
<td>syncTime</td>
<td></td>
<td></td>
<td></td>
<td>0% (0)</td>
<td>0% (0)</td>
</tr>
<tr>
<td>tSpyTask</td>
<td>spyComTask</td>
<td>a221f0</td>
<td>5</td>
<td>0% (50)</td>
<td>1% (10)</td>
</tr>
<tr>
<td>tAioIoTask1</td>
<td>aioIoTask</td>
<td>fbe370</td>
<td>50</td>
<td>0% (0)</td>
<td>0% (0)</td>
</tr>
<tr>
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<td>fe40c0</td>
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<td>0% (0)</td>
<td>0% (0)</td>
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<tr>
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<td>netTask</td>
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<td>0% (0)</td>
<td>0% (0)</td>
</tr>
<tr>
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<td>aioWaitTask</td>
<td>ff2620</td>
<td>51</td>
<td>0% (0)</td>
<td>0% (0)</td>
</tr>
<tr>
<td>tPortmapd</td>
<td>portmapd</td>
<td>d440f0</td>
<td>54</td>
<td>0% (0)</td>
<td>0% (0)</td>
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<tr>
<td>tTelnetd</td>
<td>telnetd</td>
<td>d462e0</td>
<td>55</td>
<td>0% (0)</td>
<td>0% (0)</td>
</tr>
<tr>
<td>tDhcpcStateT</td>
<td>dhcpcStateT</td>
<td>d4bcf0</td>
<td>56</td>
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<td>0% (0)</td>
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<tr>
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<td>0% (0)</td>
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<tr>
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<td>0% (0)</td>
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<tr>
<td>tNetTask</td>
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<td>fe40c0</td>
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<td>0% (0)</td>
</tr>
</tbody>
</table>

### System Threads
- **Thread with high load:** records with ".1 second" scanning
- **When load is too high Channel Access drops connections!**

### Epics Work Threads
- **"Free" time:** cpuUsageTask+IDLE
Type **casr** (channel access server report)

X11MA-VME-ID1 > casr
Channel Access Server V4.8
Client Name="ioc", Client Host="ALBMA-VME-KY", V4.8, Channel Count=1
Client Name="ioc", Client Host="X11MA-VME-ID3", V4.11, Channel Count=18
Client Name="archadm", Client Host="slsmcarch", V4.11, Channel Count=4
Client Name="slosp", Client Host="sls-bay-4", V4.11, Channel Count=49
Client Name="slosp", Client Host="sls-bay-6", V4.11, Channel Count=5
Client Name="slosp", Client Host="sls-bay-9", V4.11, Channel Count=2
Client Name="slsop", Client Host="sls-bay-2", V4.11, Channel Count=7
Client Name="slosp", Client Host="sls-bay-5", V4.11, Channel Count=4
Client Name="slsop", Client Host="sls-bay-7", V4.11, Channel Count=3
Client Name="slsop", Client Host="sls-bay-8", V4.11, Channel Count=3
Client Name="slsop", Client Host="sls-bay-9", V4.11, Channel Count=3
Client Name="slsop", Client Host="sls-bay-10", V4.11, Channel Count=3
Client Name="slsop", Client Host="sls-bay-11", V4.11, Channel Count=3
Client Name="slsop", Client Host="sls-bay-12", V4.11, Channel Count=3
Client Name="slsop", Client Host="sls-bay-13", V4.11, Channel Count=3
Client Name="slsop", Client Host="sls-bay-14", V4.11, Channel Count=3
Client Name="slsop", Client Host="sls-bay-15", V4.11, Channel Count=3
Client Name="slsop", Client Host="sls-bay-16", V4.11, Channel Count=3
Client Name="archadm", Client Host="slsmcarch", V4.11, Channel Count=4
Client Name="slsop", Client Host="sls-agp02", V4.11, Channel Count=2
Client Name="slsop", Client Host="sls-agp01", V4.11, Channel Count=1

Number of CA channels (records/fields) per client

Many identical lines?
- Maybe network problem or copies of the same operator panels.
- Many clients can lead to shortage of memory and file handles.

For more info try **casr 2** (shows channel names)
Not Connected CA Links

- Type `dbcar 0,1` (data base channel access report)

<table>
<thead>
<tr>
<th>Name of link field</th>
<th>Name of not existing link target</th>
</tr>
</thead>
<tbody>
<tr>
<td>X10DA-VMK-ES1 &gt; dbcar 0,1</td>
<td>not_connected</td>
</tr>
<tr>
<td>not_connected X10DA-ES1-SAI_01:ZERO-IMON.OUT X10DA-ES1-SAI_01:IMON.A</td>
<td>X10DA-ES1-SAI_01:ZERO-IMON.OUT X10DA-ES1-SAI_01:IMON.A</td>
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<tr>
<td>not_connected X10DA-ES1-SAI_02:ZERO-IMON.OUT X10DA-ES1-SAI_02:IMON.A</td>
<td>X10DA-ES1-SAI_02:ZERO-IMON.OUT X10DA-ES1-SAI_02:IMON.A</td>
</tr>
<tr>
<td>not_connected X10DA-ES1-SAI_03:ZERO-IMON.OUT X10DA-ES1-SAI_03:IMON.A</td>
<td>X10DA-ES1-SAI_03:ZERO-IMON.OUT X10DA-ES1-SAI_03:IMON.A</td>
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<tr>
<td>not_connected X10DA-ES1-SAI_04:ZERO-IMON.OUT X10DA-ES1-SAI_04:IMON.A</td>
<td>X10DA-ES1-SAI_04:ZERO-IMON.OUT X10DA-ES1-SAI_04:IMON.A</td>
</tr>
<tr>
<td>not_connected X10DA-ES1-SAI_05:ZERO-IMON.OUT X10DA-ES1-SAI_05:IMON.A</td>
<td>X10DA-ES1-SAI_05:ZERO-IMON.OUT X10DA-ES1-SAI_05:IMON.A</td>
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<tr>
<td>not_connected X10DA-ES1-SAI_06:ZERO-IMON.OUT X10DA-ES1-SAI_06:IMON.A</td>
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</tr>
<tr>
<td>not_connected X10DA-ES1-SAI_07:ZERO-IMON.OUT X10DA-ES1-SAI_07:IMON.A</td>
<td>X10DA-ES1-SAI_07:ZERO-IMON.OUT X10DA-ES1-SAI_07:IMON.A</td>
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<tr>
<td>not_connected X10DA-ES1-SAI_08:ZERO-IMON.OUT X10DA-ES1-SAI_08:IMON.A</td>
<td>X10DA-ES1-SAI_08:ZERO-IMON.OUT X10DA-ES1-SAI_08:IMON.A</td>
</tr>
<tr>
<td>ncalinks 234 not connected 9 no_read_access 0 no_write_access 0</td>
<td>nDisconnect 17 nNoWrite 0</td>
</tr>
</tbody>
</table>

- Target IOC may be dead or link target may be wrong.
- Broken links generate unnecessary broadcast traffic!
  - Fix typos.
  - Remove links to obsolete records.
Dead Threads

- Type i to get the list of all threads.

XTEST-VME-ID1 > i

<table>
<thead>
<tr>
<th>NAME</th>
<th>ENTRY</th>
<th>TID</th>
<th>PRI</th>
<th>STATUS</th>
<th>PC</th>
<th>SP</th>
<th>ERRNO</th>
<th>DELAY</th>
</tr>
</thead>
<tbody>
<tr>
<td>tExcTask</td>
<td>ffcc00</td>
<td>0</td>
<td>PEND</td>
<td></td>
<td>245414</td>
<td>ffcbb0</td>
<td>3006b</td>
<td>0</td>
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<tr>
<td>tLogTask</td>
<td>ffa000</td>
<td>0</td>
<td>PEND</td>
<td></td>
<td>245414</td>
<td>fff5f0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>tShell</td>
<td>d2e600</td>
<td>1</td>
<td>READY</td>
<td></td>
<td>23e89c</td>
<td>d2e1e0</td>
<td>c0002</td>
<td>0</td>
</tr>
<tr>
<td>tRlogind</td>
<td>d48c0</td>
<td>2</td>
<td>PEND</td>
<td></td>
<td>238ef4</td>
<td>d48260</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>syncTime</td>
<td>1fffe100</td>
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<td></td>
<td>23a160</td>
<td>1fffe030</td>
<td>0</td>
<td>1828</td>
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<td>tAioIoTask</td>
<td>feb370</td>
<td>50</td>
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<td></td>
<td>239720</td>
<td>feb270</td>
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<td>0</td>
</tr>
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<td>50</td>
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<td></td>
<td>238ef4</td>
<td>e90f00</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>tAioWait</td>
<td>d4b5b0</td>
<td>51</td>
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<td></td>
<td>238ef4</td>
<td>d4b300</td>
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<td>0</td>
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<tr>
<td>dma_handle</td>
<td>d3b8e0</td>
<td>80</td>
<td>PEND</td>
<td></td>
<td>23e160</td>
<td>d3b7e0</td>
<td>0</td>
<td>0</td>
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<tr>
<td>tNTPTimeSync</td>
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<td>109</td>
<td>DELAY</td>
<td></td>
<td>23e160</td>
<td>1fffe030</td>
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<td>0</td>
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<td></td>
<td>238ef4</td>
<td>ad62a8</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

- Threads get suspended when the IOC does not know how to continue (after serious errors).
- "Soft motor" thread is always suspended! (no fault)
Reasons for Dead Threads

- Programming errors
  - Integer division by zero
  - Write to or jump to invalid pointers
    - uninitialized or NULL pointer
    - already freed pointer
    - overwritten return address on stack
  - Over and underflow of arrays
    - Write to out-of-range index (>size or <0, beware of signed index variables!)
  - Stack overflow
    - Too many nested function calls (infinite recursion, long record chains)
    - Huge arrays as local variables

- Often the victim is not the killer!
  - One thread may overwrite stack or pointers of another thread.
Thread Diagnostics

- **Thread stack trace:** `tt 0xThreadID`
  - Shows in which function the thread died
  - Might be a hint what happened last

```
XTEST-VME-ID1 > tt 0x1ff1c200
2439e4 vxTaskEntry +68 : ad62a8 (bdd05c, 1ff4e310)
ad6324 epicsThreadOnceOsd+174: bdd05c (1ff4e310)
bdd184 scanOnceSetQueueSize+25c: epicsThreadSleep ()
ad6a64 epicsThreadSleep+0 : taskDelay ()
```

- **Thread information:** `ti 0xThreadID`
  - Shows stack usage (look for overflow), registers, etc

```
XTEST-VME-ID1 > ti 0x1ff4e080

<table>
<thead>
<tr>
<th>NAME</th>
<th>ENTRY</th>
<th>TID</th>
<th>PRI</th>
<th>STATUS</th>
<th>PC</th>
<th>SP</th>
<th>ERRNO</th>
<th>DELAY</th>
</tr>
</thead>
<tbody>
<tr>
<td>iocmon net</td>
<td>9f1910</td>
<td>0x1ff4e080</td>
<td>254</td>
<td>PEND</td>
<td>238ef4</td>
<td>1ff4dfa0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

stack: base 0x1ff4e080 end 0x1ff4b970 size 9712 high 384 margin 9328

options: 0xc
VX_ALLOC_STACK VX_FP_TASK
```

VxWorks Events

--------------
Events Pended on : Not Pended
Received Events  : 0x0
Options          : N/A

```
r0 = 0 sp = 1ff4dfa0 r2 = 0 r3 = 0
r4 = 0 r5 = 0 r6 = 0 r7 = 0
r8 = 0 r9 = 0 r10 = 0 r11 = 0
r12 = 0 r13 = 0 r14 = 0 r15 = 0
r16 = 0 r17 = 0 r18 = 0 r19 = 0
r20 = 0 r21 = 0 r22 = 0 r23 = 0
r24 = 0 r25 = 0 r26 = 0 r27 = 10a16c
r28 = 9f585c r29 = ffffff f30 = b030 r31 = 1fffd3070
msr = b030 lr = 0 ctr = 0 pc = 238ef4
cr = 20000000 xer = 0
```

Free stack space
Bad Network Connectivity

- Check load: `spy`
- Check free memory: `memShow`
- Ping IOC or ping other computer from IOC: `ping "slsfs",2`

IOC needs free memory to accept new clients.

Unreachable? Check HW: cable, switch, network chip, ...

High network load (broadcasts, monitors on arrays) may use up all buffers.

Should be 0

Should not be 0

If buffers run out only reboot will help.
More Network Diagnostics

■ Check TCP I/O queues
  ▶ A greedy client may request more data than it can swallow. (monitor huge waveforms with high update rate)

■ Type **inetstatShow**

![inetstatShow output]

Should only fill up for short periods of time

The guilty client runs here

■ On the (Linux) client type as root **netstat -tpn**

![netstat output]

This is the guilty one

■ Kill the program using that socket: **kill PID**
NFS mounts

- List mounts: `nfsDevShow`
- Mount: `nfsMount "server", "dir", "mount"`
  - "mount" defaults to "dir"
- Unmount: `nfsUnmount "mount"`

Print error code after failure: `perror`

Print known host names: `hostShow`
How to Reboot

- **Soft reboot:**
  - Type `reboot` (works only if you still have a prompt).
  - CTRL-X (works as long as IOC receives interrupts from serial port)

- **Soft reboot does not reset the VME bus.**

- **Hard reboot:**
  - MV2300: Press RST button on front panel.
  - MV5100: Press ABT/RST until LEDs turn on (ca 3 seconds).
  - MV6100, MV4100: Press ABT/RST with a pen until LEDs turn on.

- **Hard reboot sends RESET signal on the VME bus.**
  - VME cards behave differently on RESET signal.
    - Some cards may not recover from failure and need power cycle.
    - Some cards may lose settings (e.g. encoder reference).
IOC Does Not Boot

- Check connectivity (cables, etc)
  - Try to ping while boot loader tries to load vxWorks
  - Is the IOC in the correct network?
- Are boot PC and file server healthy?
- Are boot parameters correct?
  - Type `cabling @` on Linux and compare
- Is the boot directory installed?
  - On the right boot pc?
  - Does the link `/ioc/IOCNAME` exist on the boot pc?
- Is the correct vxWorks version installed?
  - Check link `ls -l /ioc/IOCNAME/vxWorks`
  - Is architecture (mv2300, mv5100, ...) correct?
Getting vxWorks Help

- Type `help`
- Network debug functions: `netHelp`
- NFS debug functions: `nfsHelp`
- Web: [http://vxworks.web.psi.ch](http://vxworks.web.psi.ch)
  - Tornado 2.2 Routine Index
  - Or from our home page:
    Knowledge Base → vxWorks Manuals → Functions