Cicada for the Dual Beam Spectrograph

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1 Introduction

This document the describes how to install Cicada and the interface card driver (astropci) on Solaris 10 machine and the commands for troubleshooting problems that you may encounter. It also provides some details on administering and backing up the system. Cicada was obtained from Jon Neilsen at the Research School of Astronomy & Astrophysics at ANU (RSAA). We have detailed paper documentation describing the DBS and some Cicada documentation can be obtained from the MSSSO website that is archived on the wayback machine (https://web.archive.org/web/*/http://mso.anu.edu.au/). It is our intention to use the DBS on The University of Tasmania's Harlington Telescope at the Greenhill Observatory. The intention is to modify the DBS and feed light into the spectrograph with fibre optic cables from the Nasmyth focus of the Telescope. The LN2 cooling system has been replaced (by Peter Conroy from ANU RSAA [formally MSSSO]) with a CryoTiger based system. A description of the original DBS can be found here: http://adsbit.harvard.edu/cgi-bin/nph-iarticle_query?1988PASP..100..626R.

2 Camera controllers

The CCD's in the two dewers on the DBS have been interfaced to controllers made by Bob Leach's team (Now Astro-Cam http://astro-cam.com). We have the ARC-64 - 250 MHz PCI Interface Board and the Gen III controllers that interfaces to the DBD dewers. The ARC-64 card can be used in suitable PCI backplanes. We decided to use Cicada as the camera control software as it had been used with the DBS on the 2.3m telescope and the firmware that needs to be loaded into the controller would not need to be re-written (as would be the case if we used for Voodoo or OWL from Astro-Cam). This firmware has been customised for each of the CCD's in the DBS. These will be referred to as DBSR and DBSB.

3 History

The initial plan was to install Cicada on Sun Ultra 20 / 20 M2 computers. These machines are x86 based Sun computers with suitable PCI slots for the ARC-64 cards. We obtained a copy of `cicada` from RSAA (MSO-cicada_5.3.5_i386_i86pc). Some time was spent trying to get this to work.

This included different versions of Solaris with clean installs and the slightly different architecture between the Ultra 20 and 20-M2. The interface card could talk with the controller, however ,there were issues with the DMA image transfer and they remain unresolved. The problem was somewhere in the astropci driver. In the end it was decided to move away from the sun x86 based system and try to get things working on a Sun Sparc based system architecture (sun4u). Here the problem was to source a system with a suitable PCI interface. I was able to obtain a Sun Blade2000 system and install Solaris 10 on it (If you are reinstalling Solaris 10 then choose the full-install, that is everything). Jon Neilsen provided me with two versions of Cicada (5.6.8 and 5.7.6) and a sun4u version of the astropci driver (in addition to the ones that came with the versions of cicada). In addition to Cicada and astropci I used the DBSR (and DBSB) controller firmware that I was using with the Ultra 20 x86 machines. At the moment this software can be found in `/opt/src/cicada` on the Sun Blade 2000. I have various copies of Solaris 10 on DVD that were downloaded form the Oracl web site. There is an external SCSI DVD drive that is compatible with Sun machines.

To install the Solaris 10 you need to boot from the install DVD. At the OpenBootProm prompt (Ok), you need to type:

```
boot /pci@8,700000/scsi@6,1/disk@6,0:f
```

4 Installing the ARC-64 PCI card

The ARC-64 PCI interface card is a 32bit wide card and is shown in Figure 1. Although the Astro-Cam web site says that this card can be used in 3.3V or 5V PCI back planes, one of the cards that we have with the DBS do not have a slot in the connector that would allow them to plug into the 3.3V back plane. That card is most likely an earlier revision of the ARC-64. The other card matches the card on the Astro-Cam website.

Figure 2 shows the pci slots in the Sun Blade-2000. The very bottom slot is a 3.3V 66MHz 64bit wide slot and cannot be used with our revision of the ARC-64 card. The PCI slot with the red highlighted section is the slot that is used and the red highlight is where the card is plugged in, leaving the right hand section of the slot unused. The ARC-64 is connected by two optical fibres to the Timing board (ARC-22) in the controller. Once the ARC-64 and ARC-22 are powered up and connected then the red led on the ARC-64 should turn off. If it doesn't then try swapping the fibres on connectors of one of the boards.

Figure 1: The ARC-64 32bit wide PCI interface card (Earlier Revision).

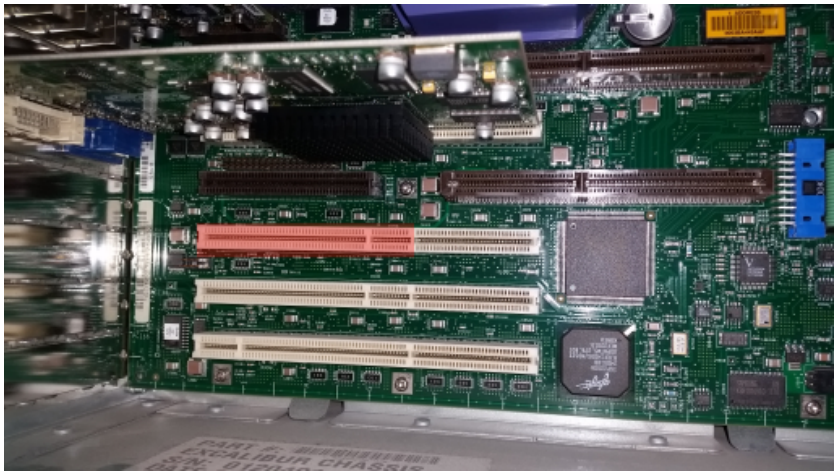

Figure 2: The Sun Blade 2000 PCI slots

5 Installing DBS Software

This is divided into installing cicada and managing the astropci device driver. The description applies to the installation of cicada version 5.6.8 on a Sun Blade2000 workstation.

5.1 Installing Cicada

After installing Solaris 10 and any additional software (see section 6.1), you need to create the user and group cicada. You should login as the user

cicada to configure and test cicada. Later you can create the account `obs` that will be used by observers who will not have administrative rights to change/modify the cicada software. All of the cicada administration should be done as the user cicada, however you will need to be `root` to install cicada and astropci and/or change any other system settings.

The Sun Blade200 has initially been named born.phys.utas.edu.au (131.217.62.5) and the cicada/astropci distributions have been placed in /opt/src/cicada and the owner:group have been changed to cicada:cicada (uid:gid 1000:1000 on born). The directory listing is shown in Listing 1.

Listing 1: directory listing of `/opt/src/cicada` software repositry.

```
[cicada@born cicada]\$ ls -lah
total 46562
drwxr-xr-x   9 cicada   cicada      1.0K Mar 27 16:05 .
drwxr-xr-x   4 root     root         512 Mar 19 00:31 ..
drwxr-xr-x   3 cicada   cicada       512 Mar  7 22:14 DBSB-UTas
-rwxr-xr-x   1 cicada   cicada      105K Feb 28 18:25 DBSB-UTas.tar
drwxr-xr-x   3 cicada   cicada       512 Feb 28 18:25 DBSR-UTas
-rwxr-xr-x   1 cicada   cicada      138K Feb 28 18:25 DBSR-UTas.tar
drwxr-xr-x   5 root     root         512 May 28  2013 MSOcicada
-rw-r--r--   1 cicada   cicada      9.0M Feb 27 16:49 MSOcicada-5.6.8-sunos-sun4u.tar.gz
-rw-r--r--   1 cicada   cicada       11M Feb 27 16:49 MSOcicada-5.7.6-sunos-sun4u.tar.gz
-rw-r--r--   1 cicada   cicada       216 Feb 27 16:49 README-astropci.txt
-rw-r--r--   1 cicada   cicada       11K Mar 22 17:44 README_DBS
-rw-r--r--   1 cicada   cicada       65K Feb  7 20:17 astropci
-rw-r--r--   1 cicada   cicada       22K Feb 27 16:49 astropci-sun4u.tar.gz
-rw-r--r--   1 cicada   cicada        97 Feb  7 20:14 astropci.conf
drwxr-xr-x   2 cicada   cicada       512 Mar 22 18:10 astropci_sparc_5.7.6
-rw-r--r--   1 cicada   cicada       19K Feb 27 16:49 astropci_x86-64.tar.gz
drwxr-xr-x   6 cicada   cicada       512 Mar 20 11:11 log4cxx
drwxr-xr-x   5 cicada   cicada       512 Feb 28 16:37 sunmath
-rw-r--r--   1 cicada   cicada      1.8M Feb 28 16:54 sunmath.tar
drwxr-xr-x   5 cicada   cicada       512 Feb 28 16:37 sunmath32
-rw-r--r--   1 cicada   cicada      910K Feb 28 18:10 sunmath32.tar.gz
```

The first task is to become root (`su - root`) and expand the cicada package:

```
cd /opt/cicada
gunzip -c MSOcicada-5.6.8-sunos-sun4u.tar.gz | tar -xvf -
```

The directory `MSOcicada` now holds the cicada package and we can use the pkgadd command to install cicada.

```
\texttt{pkgadd -d ./ MSOcicada}
```

The instalation process will promt you to confirm the package installation and the administrative elevation of some of the programs. You should answer in the affirmative to all of the questions.

At the end of this process both cicada and the astropci driver that came with 5.6.8 will be installed. You should confirm that the inetd services have been installed correctly using the `inetadm` command (See Appendix A for details). The next step is to check the library dependen-

cies of the cicada executables. Use the following commands to do this: "`ldd /opt/cicada/cicada`" and "`ldd /opt/cicada/cicada_master`".

For a cicada 5.6.8 you will get `libsunmath.so.1 => (file not found)`. To resolve this you will need to install the missing library. This is a freely distributable library that comes with the Sun/Oracle SolarisStudio compiler suit. It looks like the only way to get it, is to install the full compiler suit or get someone to send it to you. Be aware that cicada is a 32bit application and so we need the 32bit library the wrong library will give "`Wrong ELF class`" errors. I obtained the library from RSAA. They sent 3 versions to try (`sunmath32.tar.gz`). I tried all three and they all seemed to work. I used the `sunmath32/SC6U2/libsunmath.so.1` version and simply copied it to the /opt/cicada directory. The runtime loader will find it there when you run cicada.

At this point it's worth noting that cicada version 5.7.6 has an extra library missing `liblog4cxx.so.10` that library itself has other dependencies that are not satisfied. After building `liblog4cxx.so.10` from source, including all of it's dependencies, and also obtained a version from RSAA, it continued to fail with the following error:

```
cicada
 ld.so.1: cicada: fatal: relocation error: file /opt/cicada/libcicada.so:
 symbol \_\_1cHlog4cxxHhelpersNObjectPtrBase2t5B6M\_v\_: referenced symbol not found
Killed
```

That error was never resolve and is the reason for using version 5.6.8.

At this point cicada should be installed, but not configured and not ready to run. Read on.

5.2 Installing astropci and Solaris device administration

In this section I will talk about manually installing and removing device drivers. It is assumed that you will be operating as `root` when you perform any of these operations.

After installing cicada, the astropci driver that came in that package will be installed. You should confirm that the driver is installed and attached. There are several commands that can be used to obtain information about devices and driver status. The examples in Listing 2 have the output truncated so as to just show information about the ARC-64 pci card. The astropci driver appends errors and other messsages to the system message log (`/var/adm/messages`) and so you should examine this file as well as the

cicada log files in `/opt/cicada/logs` if there are problems.

Listing 2: Examples of commands for looking at PCI devices

```
#List PCI devices
/usr/X11/bin/scanpci -v
pci bus 0x0000 cardnum 0x02 function 0x00: vendor 0x1057 device 0x1801
 Motorola DSP56301 Digital Signal Processor
 CardVendor 0x0000 card 0x0000 (Card unknown)
  STATUS    0x0280  COMMAND 0x0146
  CLASS     0x04 0x80 0x00  REVISION 0x03
  BIST      0x00  HEADER 0x00  LATENCY 0xff  CACHE 0x10
  BASE0     0x00160000 SIZE 65536  MEM
  BASEROM   0x00000000  addr 0x00000000
  MAX_LAT   0x00  MIN_GNT 0x00  INT_PIN 0x01  INT_LINE 0x00

#Look for astropci driver in the devices directory
find /devices -name \*astro\*
/devices/pci@8,700000/pci1057,1801@2:astropci

#print system config information
prtconf -D | grep astro
        pci1057,1801, instance #0 (driver name: astropci)

#List recent system messages
tail /var/adm/messages | grep astro
Mar 27 18:17:43 born astropci: [ID 695100 kern.notice] NOTICE: astropci: Device driver successfully
     attached.

# List faulty devices
#fmadm faulty
#
# and to clear a fault
#fmadm repair <event-id>
#
```

You should check that the link in the `/dev` directory has been created (`/dev/astropci0`). If it doesn't exist then you will need to make it manually: `/dev/astropci0 -> ../devices/pci@8,700000/pci1057,1801@2:astropci` This is a bit tricky to type on the command line as several characters need to be quoted with a \.

```
cd /dev
ln -s ../devices/pci\@8\,700000/pci1057\,1801\@2\:astropci astropci0
```

RSAA provided us with a different astropci driver to the one that came with version 5.6.8 of cicada and so we need to uninstall the cicada 5.6.6 version and install the one provided.

The Solaris device drivers reside in the following directories:
`/device/kernel/drv/ ...  32bit drivers and config files`
`/device/kernel/drv/sparcv9 ...  64bit drivers (sparc based machines)`
`/device/kernel/drv/amd64 ...  64bit drivers (x86-64 based machines)`

Note that the 32bit drivers are only used in 32 bit operating systems. For 64 bit operating systems the 64bit drivers are used exclusively, even with 32bit software.

The commands to uninstall the astropci device driver are:

```
rem_drv astropci
rem_drv astro
```

The latter command may be needed on 32bit systems. This does not remove the driver files from the above directories.

The alternative driver that we received from RSAA is in `astropci-sun4u.tar.gz`. To install that driver use the following commands:

```
mkdir astropci
cd astropci
gunzip -c ../astropci-sun4u.tar.gz|tar -xvf -
-rw-r--r-- 277/1024   66328 Feb  7 20:17 2019 astropci
-rw-r--r-- 277/60001     97 Feb  7 20:14 2019 astropci.conf

install -f \kernel\drv\sparcv9 -u root -g sys astropci
install -f \kernel\drv -u root -g sys astropci.conf
\usr\sbin\add_drv -i '"pci1057,1801"' -m '* 0666 bin bin' astropci
```

It is recommended to reboot after removing and installing another driver, however you may be able to avoid the reboot by using `update_drv -v astropci`. In either case you should use the commands in Listing 2 to confirm that the driver is installed and attached.

Note that at the time of writing, the astropci that came with cicada version 5.6.8 is untested and could well work.

5.3 Configuring cicada

At this stage you should have cicada and the astropci device driver installed. The following steps should be carried out as the user `cicada`. The first step is to set up the `/opt/cicada/config` directory. The install process creates a dummy configuration directory called `/opt/cicada/config-install`, if your `/opt/cicada/config` directory is empty then it will be populated from the `config-install` directory. If you have missing tables then you might find templates in the `config-install` directory.

Assuming that you are doing a clean install then you should copy the contents of the `config-install` directory into the `config` directory. The DBSR configuration files (cicada tables and the SDSU firmware files "`*.lod`") can be found in `/opt/src/cicada/DBSR-UTAS.tar.gz`. You should un-tar this file and copy the contents of its `config` directory into the /opt/cicada/config directory.

Some of the tables have keys that are set to the hostname of the machine. These tables need to be edited to reflect the hostname of the current

computer. I simply replaces any key in the tables with the current machine name (`born`).

```
controller_table:    host=born;
tetelescope_table:   host=born;
                     tcs_host=born;
telhost_table:       born:/export/home/cicada/test
```

There is one table missing from the distribution, namely `telescope_plugins`. You will need to manually create this table. The contents is the following single line "`telescope_plugins= T_2.3, T_40, T_SkyMapper, T_Dummy''`.

There is a GUI for editing the the cicada tables. You can execute this by running "`/opt/cicada/cicada_config`" . The GUI is rather large (larger than the size of the monitor), Figure 3 shows the `cicada_config` window. If it stops responding, just exit and restart it. It is probably less prone to introducing errors in the cicada tables than using a text editor to modify them.

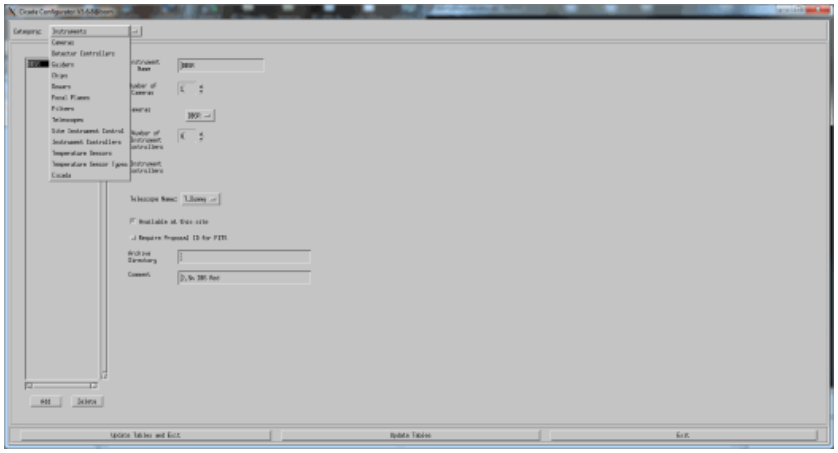

Figure 3: The startup window for `cicada_config`. The size has been reduced to fit this document

We need to fix three more key words. The key word phu1 in `camera_table` needs to be set to 4 to avoid the following error:

```
Archiver: cicada_archiver.cc line 2323 caught: Warning: Poorly constructed
FITS file /tmp/CICADA_IM00000.fits! 109 keywords, when max 108 expected! (-1),
fits.cc line 2357
```

This error occurs because cicada pre-allocated fits header blocks and if there isn't enough space then the above message will be logged in the cicada message window and written to the log file in `/opt/cicada/logs/cicada_<time-stamp>.log`. The key `phu1` sets the size of the primary header for single extension fits files

(phy2 and ihu are for multiple extension fits files (MEF) and ihu is for the number of header units in the image extension for MEF files). Figure 4 shows where to change the phu1 key with `cicada_config`.

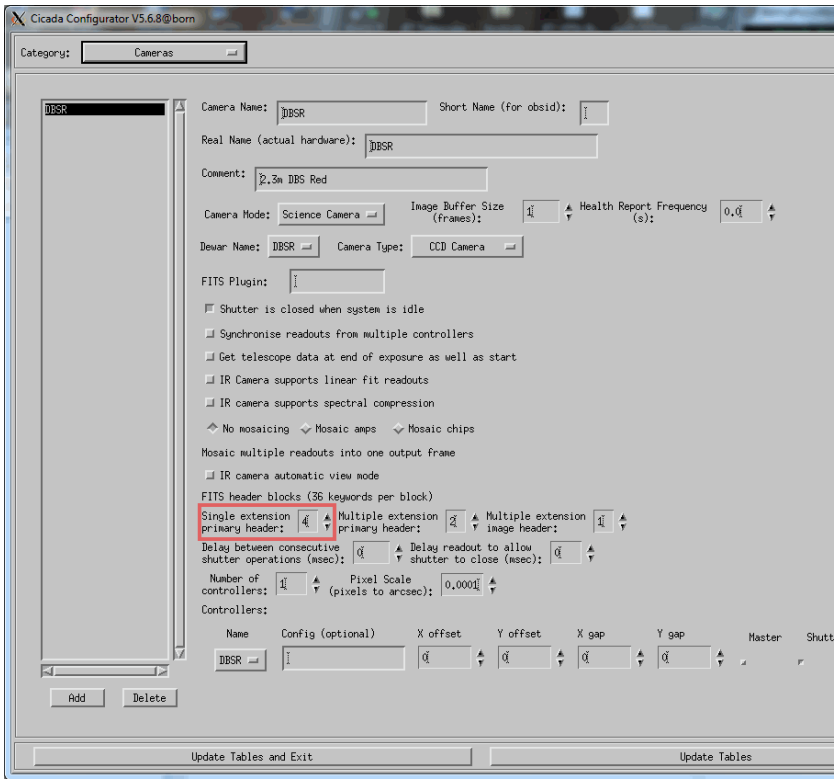

Figure 4: Using `cicada_config` to set the number of fits header blocks

After making the change hit the "Update Tables" button. You can ignore the error "Failed to HUP running cicada".

The second key word that needs to be set is the `sci_amp_mask` in `chip_table`, it needs to be set to "1". Figure 5 illustrates how this is done with `cicada_config`

The third key word that needs to be set is `device` in `controller_table` and it needs to be set to `/dev/astropci0`. Figure 6 shows the GUI settings for this field.

Next you may need to change the process limits for users otherwise cicada fails with a "segfault" when you open the "Observing" window. Once you have logged in (as `cicada`) you can check your process limits with the `ulimit -a` command. For `cicada` the problem was that the "stack size" was set to 8192KB. You can increase that limit with the " `ulimit -s 32768`" command, but that only applies to the current shell. A better solution is to

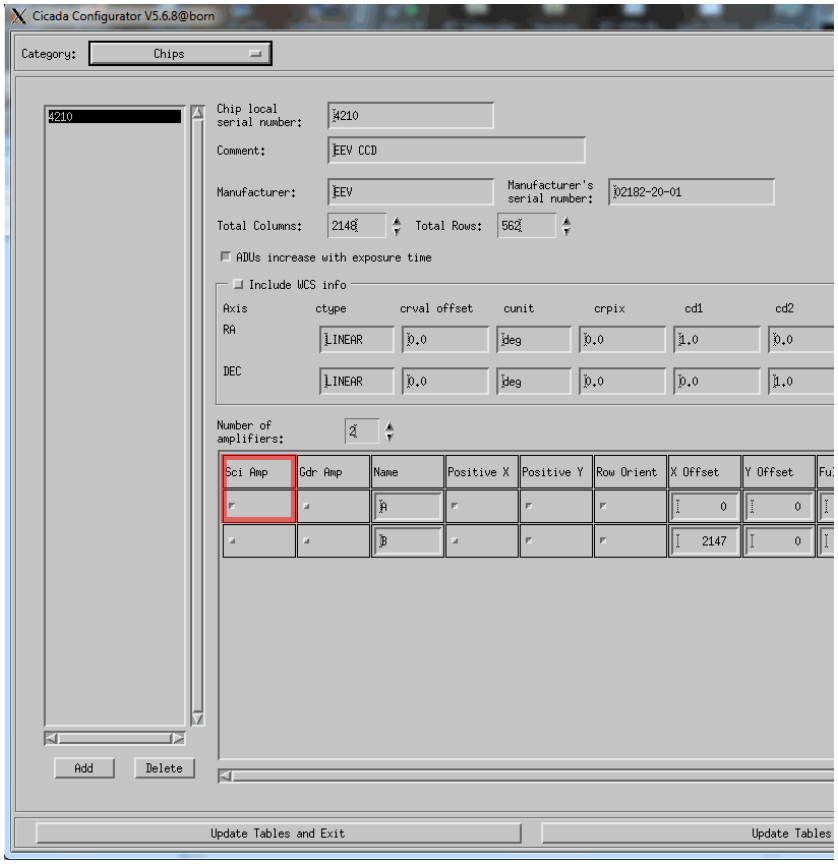

Figure 5: Using `cicada_config` to set Sci_Amp checkbox

increase the "stack size" system wide.

The command to apply a system wide stack limit change to basic users is:

```
projmod -s -K 'process.max-stack-size=(basic,32768k,deny)' default
```

Other minor configuration changes were to add /opt/sfw/lib to the default library search path with the `crle` command.

```
crle -u -l /opt/sfw/lib
```

Take great care with the command as you could end up with a system that doesn't work. You can use the `crle`, safely, without any parameters to display the current search library search paths.

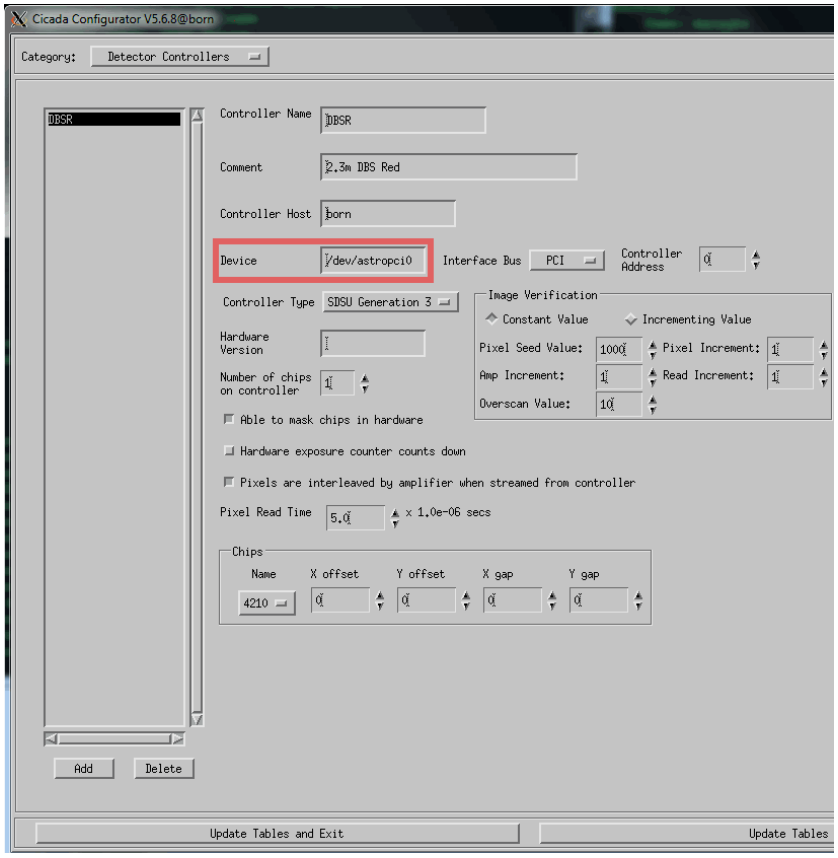

Figure 6: Using `cicada_config` to set device field in the controller_tabel.

```
crle

Configuration file [version 4]: /var/ld/ld.config
  Platform:     32-bit MSB SPARC
  Default Library Path (ELF):   /lib:/usr/lib:/usr/sfw/lib
  Trusted Directories (ELF):    /lib/secure:/usr/lib/secure  (system default)

Command line:
  crle -c /var/ld/ld.config -l /lib:/usr/lib:/usr/sfw/lib
```

Finally, you may want to add the following line to your `.bashrc` to extend your search path to /opt/cicada and /usr/local/bin.
`export PATH=/usr/local/bin:\$PATH:/opt/cicada`

5.4 Cicada Image displays

This is a work in progress at the moment.

The original `ximtool` is available but will only run on displays with

8bpp depth. The default Sun Blade2000 screen depth is 24bpp. The 5.6.8 version of cicada does work with `ds9`, however I have found it not to be very stable. For the moment I suggest using "Save Only" and looking at the image with `ds9`. As I have said the versions of `ds9` don't seem to be very stable. You can execute it by using one of the following commands (`ds9  ds9-51  ~/ds9-71/ds9`). The first and last are the same, with the exception that `ds9` is in `/usr/local/bin` but on occasions one has worked and not the other. This needs more work to resolve these issues.

5.5 Running Cicada

Need to describe in-cicada-configuration and settings here. Note that if cicada continues to fail to initialise the controller then it may be necessary to power the machine off and then reboot. I need to test such a failure to see if a reboot is sufficient without resorting to a full power cycle.

6 Additional Solaris Software

Rather than building packages from source it is often convenient to get them from some package repository. For Solaris 10 there are two options.

6.1 SunFreeware

I have downloaded several packages from some archives of the sunfreeware servers. I have place d the packages in `\opt\src\sunfreeware-sol10-sun4u` on the Sun Blade2000 workstation. Packages that have been installed I have moved to the `installed subdirectory`. You can quickly check to see what sunfreeware packages have been installed with the `pkginfo` command (`pkginfo | grep  "application SMC"`).

Note to install a package you first need to uncompress it with gunzip and then install it with the following command:
`pkgadd -d ./package-file-name`

6.2 OpenCSW Software

This is another repository of Solaris 10 (and 11) software. You can download and search for package here: https://www.opencsw.org/. The packages are

stored in `/opt/csw` and you can list the currently installed packages with the command "`/opt/csw/bin/pkgutil -l`".

Appendices

A Installing Cicada on the Sun Ultra 20

The MSOcicada_5.3.5_i386_i86pc cicada package does not install the cicada services correctly under Solaris 10. The the following additional steps are required. After running the "`pkgadd -d ./ MSOcicada` " command you should check that inetd controlled services required by cicada have been installed. There are several services that should be installed when cicada is installed. However the 5.3.5 package tries to install the services by updating the `/etc/inet/inetd.conf` file. Solaris 10 uses the `inetadm` command to administer these services. To fix this you will need to be `root` and execute the command "`inetadm`" to list the current services. The services that need to be defined are shown in Listing 3.

Listing 3: List of services that needs to be enabled for cicada

```
enabled   online         svc:/network/rpc-536871168_1/rpc_tcp:default
enabled   online         svc:/network/rpc-536871065_1/rpc_tcp:default
enabled   online         svc:/network/rpc-536871169_1/rpc_tcp:default
enabled   online         svc:/network/rpc-536871170_1/rpc_tcp:default
enabled   online         svc:/network/rpc-536871171_1/rpc_tcp:default
enabled   online         svc:/network/rpc-536871172_1/rpc_tcp:default
enabled   online         svc:/network/rpc-536871174_1/rpc_tcp:default
```

If these services have not been enabled then you will need to copy the `/opt/src/MSOcicada/root/etc/inet/inetd.conf` file to `/tmp` as `root` and run "`inetconv -e -i inetd.conf`". Once you have done that check that it was successful by running the "`inetadm`" commmand again. You may need to reboot(?).

Note that if you use `pkgrm MSOcicada` to remove cicada (5.3.5) then those services will not be removed or disabled and so any subsequent install of cicada will not need these services to be re-enabled.

B Cloning Disks on the Sun Blade 2000

The Sun Blade 2000 uses fibre channel disk and there are two drive bays available in the machine (Figure 7.) The top drive is the active system disk

Figure 7: The Sun Blade 2000 drive bays. The top disk is the active boot disk.

(corresponding to the Open-Boot-Prom (OBP) default boot-device `disk1` and `/dev/dsk/c1t2d0s0` in Solaris). The bottom drive can be used to clone or make backup copies of the system disk. I was able to secure a supply of 450GB fibre channel disk and have created some scripts to automate (and document) the cloning process.

Note: opening the Blade2000 cover will power the machine off, so it is important to do a shutdown (`shutdown -i 0 -y -g 0`) before you remove the cover.

The top drive is `/dev/dsk/c1t2d0s0` and the bottom drive is `/dev/dsk/c1t1d0s0`. Here "c" is controller 1, "t" is target 1 or 2, "d" is disk

and "s" is the slice (or parttion) number. In both cases the /dev/dsk device is the block device and the /dev/rdsk is the "raw" device (which is used for low level manipulation).

If you are cloning to a disk with exactly the same geometry (same model number, most likely HP model BF450D6189) then the simplest way to partition a new disk is with the following command:

```
prtvtoc /dev/rdsk/c1t2d0s2 | fmthard -s - /dev/rdsk/c1t1d0s2
```

If it is a new disk then you may need to "Label" the disk first using the `format` command. If you have a different model disk with a different geometry then you will need to use the solaris `format` command to partition and label the disk. In either case you can use the format command to view the partition information (see Listing 4)

Once the disk has been partitioned you can use the script "`/root/MKFS`" to put a file system on each partition. This script will put a `UFS` filesystem on partitions 0, 4, 5 and 7. This command can be used to clear any previous files from the disk.

If the disk has not been used before then you will need to copy the Solaris boot blocks on to the disk to make it bootable. To do this use the script "`/root/MKBOOT`".

The next step is to copy the filesystems to the disk. You should do this on a quiet system (don't do anything else while the cloning is taking place) or boot into single user mode. To clone the `c1t2d0sX` partitions to `c1t1d0sX` run the "`/root/CLONE`" script.

Finally, we need to fix the device links on the cloned disk. The problem is that with the fibre channel disk that the c0t1d0sX are links to the nodes in `/device` directory, For example, `/dev/dsk/c1t1d0s0` is a link to `../../devices/pci@8,600000/SUNW,qlc@4/fp@0,0/ssd@w2108000cca3d76bc,0:a`. Note that the `w2108000cca3d76bc` part of the device name is actually the serial number of the disk. To use the cloned disk we have two choices.

We could leave it in the bottom drive slot and from the Open-Boot-Prom prompt we could boot to the disk in the bottom slot "`boot disk0`". However, the partitions in `/etc/vfstab` refer to `c1t2d0sX` and so we would need to edit that file and change any reference to `c1t2d0` to `c1t1d0`. This solution would mean that the booted system could be either device and require you to modify the default boot-device in the OBP.

The other booting option is to always boot from `c1t2d0s0`. To achieve this we would need to place a cloned disk in the top drive bay and boot as

Listing 4: Using the format command to list a partition table.

```
format
Searching for disks...done
AVAILABLE DISK SELECTIONS:
       0. c1t1d0 <HPQ-BF450D6189-HP04 cyl 39123 alt 2 hd 16 sec 1404>
          /pci@8,600000/SUNW,qlc@4/fp@0,0/ssd@w2108000cca3d76bc,0
       1. c1t2d0 <HPQ-BF450D6189-HP04 cyl 39123 alt 2 hd 16 sec 1404>
          /pci@8,600000/SUNW,qlc@4/fp@0,0/ssd@w2108000cca39ec28,0
Specify disk (enter its number): 0
selecting c1t1d0
[disk formatted]

FORMAT MENU:
        disk       - select a disk
        type       - select (define) a disk type
        partition  - select (define) a partition table
        current    - describe the current disk
        format     - format and analyze the disk
        repair     - repair a defective sector
        label      - write label to the disk
        analyze    - surface analysis
        defect     - defect list management
        backup     - search for backup labels
        verify     - read and display labels
        save       - save new disk/partition definitions
        inquiry    - show vendor, product and revision
        volname    - set 8-character volume name
        !<cmd>     - execute <cmd>, then return
        quit
format> p

PARTITION MENU:
        0      - change `0' partition
        1      - change `1' partition
        2      - change `2' partition
        3      - change `3' partition
        4      - change `4' partition
        5      - change `5' partition
        6      - change `6' partition
        7      - change `7' partition
        select - select a predefined table
        modify - modify a predefined partition table
        name   - name the current table
        print  - display the current table
        label  - write partition map and label to the disk
        !<cmd> - execute <cmd>, then return
        quit
partition> p
Current partition table (original):
Total disk cylinders available: 39123 + 2 (reserved cylinders)

Part      Tag    Flag     Cylinders         Size            Blocks
  0       root    wm    3082 -  6069       32.01GB    (2988/0/0)   67122432
  1       swap    wu       0 -    93        1.01GB    (94/0/0)      2111616
  2     backup    wm       0 - 39122      419.07GB    (39123/0/0) 878859072
  3 unassigned    wu       0                 0         (0/0/0)             0
  4        usr    wm    1588 -  3081       16.00GB    (1494/0/0)   33561216
  5        var    wm      94 -  1587       16.00GB    (1494/0/0)   33561216
  6 unassigned    wu       0                 0         (0/0/0)             0
  7       home    wm    6070 - 39122      354.05GB    (33053/0/0) 742502592
```

normal. If you try this you will find that the system hangs during the boot process. The reason is that in the cloned image /dev/dsk/c1t1d0s0 is a link to `../../devices/pci@8,600000/SUNW,qlc@4/fp@0,0/ssd@w2108000cca3d76bc,0:a` and that we have now made that disk /dev/dsk/c1t2d0s0, but that link points to the device node for the previous disk.

To fix this problem, after you run the "`/root/CLONE`" script, you should run the "`/root/FIXDEVLINKS`" script. It does two things. Firstly, it swaps the links for the `/dev/dsk/c1t1d0sX`, `/dev/rdsk/c1t1d0sX` links with

`/dev/dsk/c1t2d0sX`, `/dev/rdsk/c1t2d0sX` links so that the boot device is reference correctly. Secondly is schedules a rebuild of the devices directory during reboot. Swapping the device links allows the boot process to proceed to the point where the `/devices` directory can be rebuilt.

The clone/backup procedure is as follows:

```
cd /root|\\
#If the disk needs to be partitioned then for identical disks use
#the following command, otherwise use the 'format' command.
prtvtoc /dev/rdsk/c1t2d0s2 | fmthard -s - /dev/rdsk/c1t1d0s2
./MKFS
./MKBOOT
./CLONE
./FIXDEVLINKS
```

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