RTM-T User Guide

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Rev	***Date***	***Description***
1	20110105	Init.rtm
2	20110601	Updated to include ACQ-FIBER-HBA
3	20110701	updates
4	20110803	Simplify networking with hosts
5	20110929	Updates, validation.
6	20111211	Improved build procedure.
7	20120601	Rtm-t-flash updated

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1 Introduction

RTM-T [1] links existing ACQ1xx series cards to fast serial links,

- PCI-Express on cable 1x
- Fiber SFP.

1.1 Advantages PCI-Express on Cable 1x

1. Streams full rate data (up to 200MB/s).
2. Scalable – one link per card. (32, 64 or 96 channels).
3. Low cost – the PCI-1x cable, available in lengths up to 15m. A selection of compatible third-party 1- and 2- port Host Bus Adapters is commonly available.

1.2 Advantages of Fiber SFP connection.

1. Fiber-optic allows data transmission over longer distances (up to 1km)
2. Provides electrical isolation
3. Uses ACQ-FIBER-HBA, a host bus adapter available from D-TACQ.
4. Maximum compatibility with PCI-Express link (same drivers).

1.3 Intended Audience

End users who require continuous full-rate data streaming

1.4 Scope

Covers driver installation and example applications using the PCI-Express on cable interface of RTM-T. Other interfaces SFP, E1000 and DSP functionality will be covered in detail in a future release.

We assume that the user has already installed or is familiar with ACQ196CPCI or ACQ132CPCI digitizer, basic operation and connectivity as described in 2GUG [3], and has previously installed RTM-T following the RTM-T Installation Guide [2].

This document refers to ACQ196CPCI throughout, but the discussion applies equally well to ACQ132CPCI and ACQ164CPCI. Please note that ACQ132CPCI requires a factory modification to work with RTM-T. RTM-T will also work with AO32CPCI.

1.5 Glossary

- PBI: Local bus on ACQ196/ACQ132
- Host : Host Computer sequences the capture and receives the data.

1.6 References

1. RTM-T Data Sheet RTM-T-ds-v1.1.pdf
   http://www.d-tacq.com/pdfs/RTM-T-ds-v1.1.pdf
2. RTM-T Installation Guide Rev 1.0
   http://www.d-tacq.com/resources/InstallationGuides/d-tacq-RTM-T-InstallationGuide-v1p0.pdf
3. D-TACQ 2G User Guide 2GUG -
   http://www.d-tacq.com/resources/D-Tacq_2G_UserGuide.pdf
4. KST Plot Tool -
   http://kst-plot.kde.org/

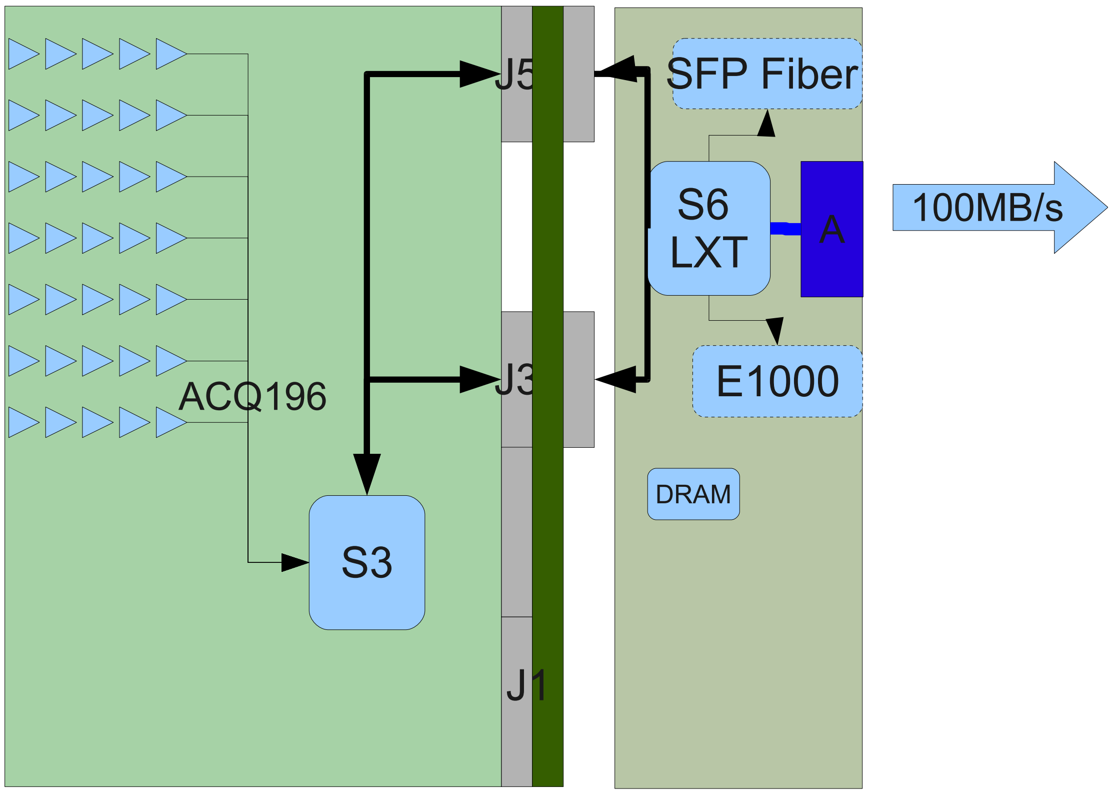
1.7 Notation

- **`command`** : indicates name of a program (command)
- `preformatted text` : literal input or output from terminal session.
- *Defined Term* : some term or acronym specific to this domain (perhaps referenced in the glossary)
- N refers to Slot Number

2 Theory of Operation.

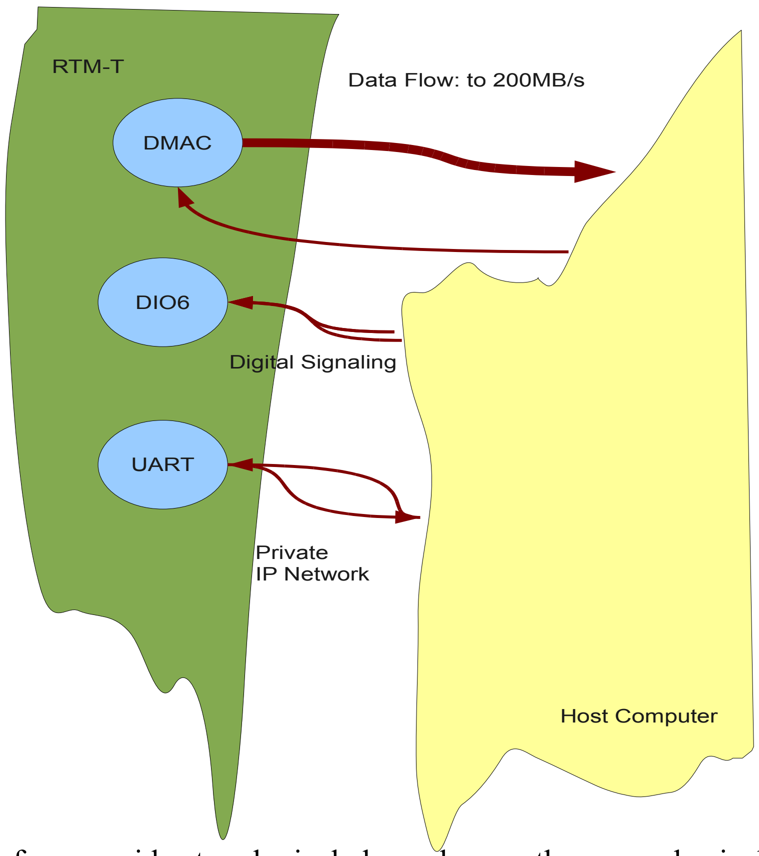
RTM-T features a Xilinx Spartan 6 LXT FPGA [S6] . This FPGA was selected because it combines gigabit serial links in a low cost device. The FPGA takes over the ACQ196/ACQ132 processor local bus [PBI] and masters data transfers from the existing front-side system FPGA. Data is buffered inside the S6 and then transferred by bus master DMA to the Host computer.

Use Case: ACQ196CPCI, Stream Data at 96ch x 500kSPS



The FPGA to FPGA bus transfer is able to use the local bus (32 bit, 66MHz) very efficiently, and so data transfer at the maximum rate of the ADC devices is attained on ACQ196CPCI (500kHz), and up to 200MB/s on ACQ132CPCI (faster than the default local cpu configuration).

2.1 Logical Interfaces on PCI-Express Cable Link:

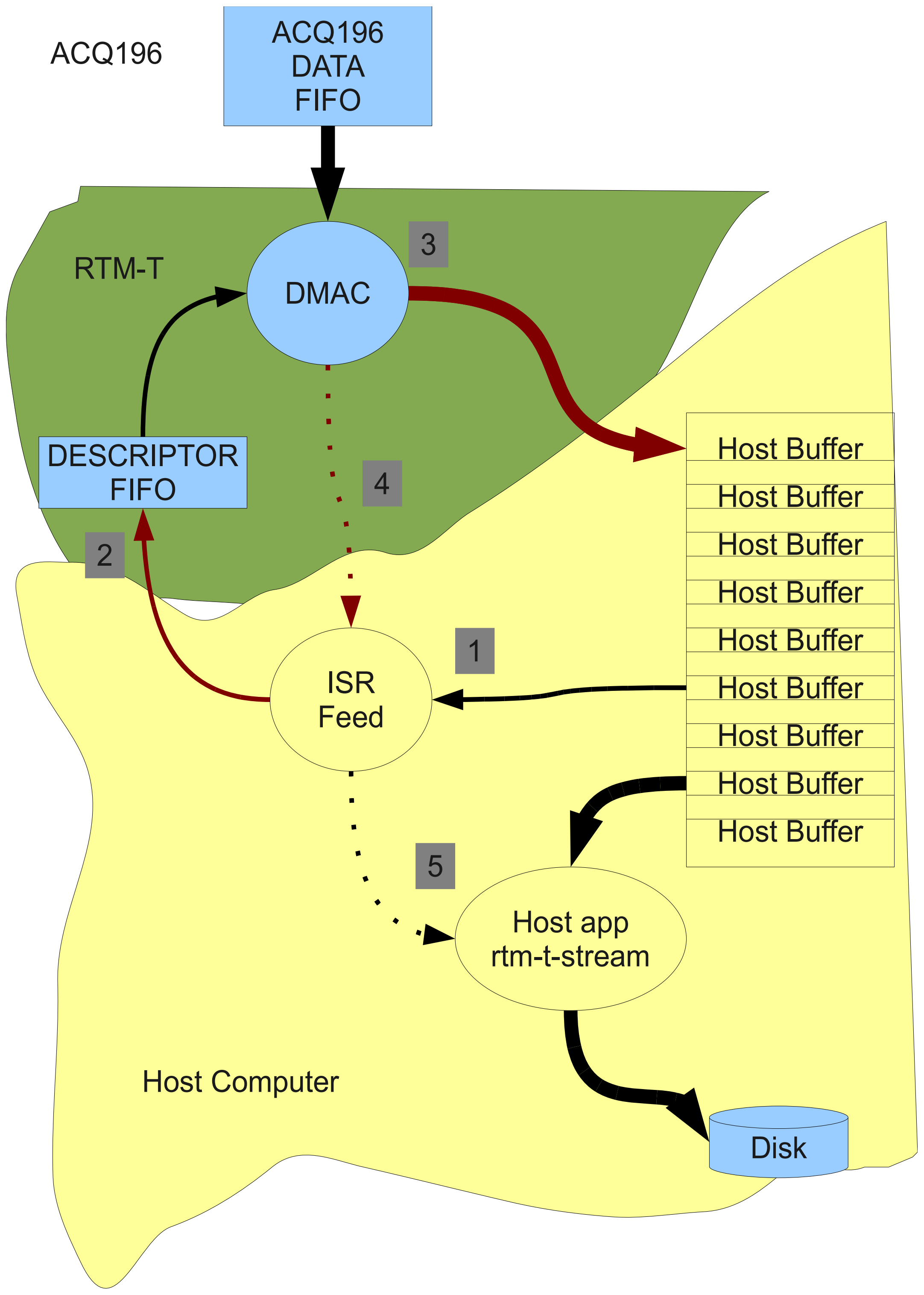


The device interface provides two logical channels over the same physical link:

- Data Channel: a very high performance streaming DMA system.
- Control Channel: implements a one megabit serial line IP link
- Register access, primarily to control DIO signaling lines on the RTM.

During capture, ACQ196CPCI fakes a regular capture to local memory. So all the normal command and monitoring facilities normally available in transient capture are still available.

2.2 Streaming DMA Sequence



1. HOST device driver allocates `nbuffers_fifo` fixed DMA buffers each length `buffer_len` in host RAM. Each buffer is represented by a descriptor. The device driver feeds the descriptors to RTM-T.
2. RTM-T maintains a hardware FIFO queue of descriptors for the DMAC.
3. After capture has started, the DMAC copies data from the ACQ196 DATA FIFO, pulls the next descriptor from the FIFO and sends the data to the corresponding Host Buffer using bus master DMA.
4. The DMAC sends an interrupt to the Host, the Host ISR refills the Descriptor FIFO queue and signals a host application that data is waiting.
5. The host app, for example **rtm-t-stream** reads newly filled host buffers, perhaps archives the data to disk and recycles the host buffers.

The free flow nature of this system achieves extremely high performance without needing hard real time behaviour from the host OS, since, provided the Descriptor FIFO queue is properly maintained, the DMAC never blocks. It doesn't matter if the ISR misses one incoming interrupt, the interrupts are sent for each buffer without acknowledgment, and ISR (or, more correctly, an associated work-function) will deal with all available buffers in a batch. There is sufficient buffering in the FPGA data FIFO to avoid overflow if the outbound DMA is blocked for any reason (perhaps bus contention in the HOST).

Default buffer_length is 1MB, and the default number of buffers is 66; this equates to 500msec of available buffer when running at a typical maximum rate of 128MB/s.

2.3 Control Channel

The Control Channel provides a private back-plane network. ACQ196CPCI is designed to run as a networked appliance, and the private network allows complete control of the ACQ196CPCI without the need for an Ethernet connection. The data rate (~1 mb/sec), and the technology (CSLIP, used in dial up networking), may seem old and slow, but actually for a control interface, this is more than adequate, note that the control channel runs in parallel with the data channel as it runs at 100MByte/s +.

2.4 Digital Signaling Channel

The Host device driver maps 6DIO bits on the RTM-T using the familiar D-TACQ DIO interface. These bits can be routed via the RIO port onto the ACQ196CPCI FPGA and/or PXI back-plane.

2.5 Comparison with previous htstream capability.

Htstream allowed streaming data to the CPCI back-plane. However, maximum rate was limited, as was reliability. RTM-T allows the ACQ196CPCI front-side card to operate to the peak of its performance. Reliability has been confirmed over weeks of continuous operation.

2.6 Low Latency Control capability

RTM-T also supports the Low Latency control feature offered by ACQ196CPCI on the PCI backplane. Latency from AI CLK to data in host memory is reduced from around 10usec to 5usec.

The Low Latency control feature is also supported by AO32CPCI/RTM-T.

3 ACQ196CPCI Full Rate Streaming Example

NB: there are many ways to sequence this capture ....

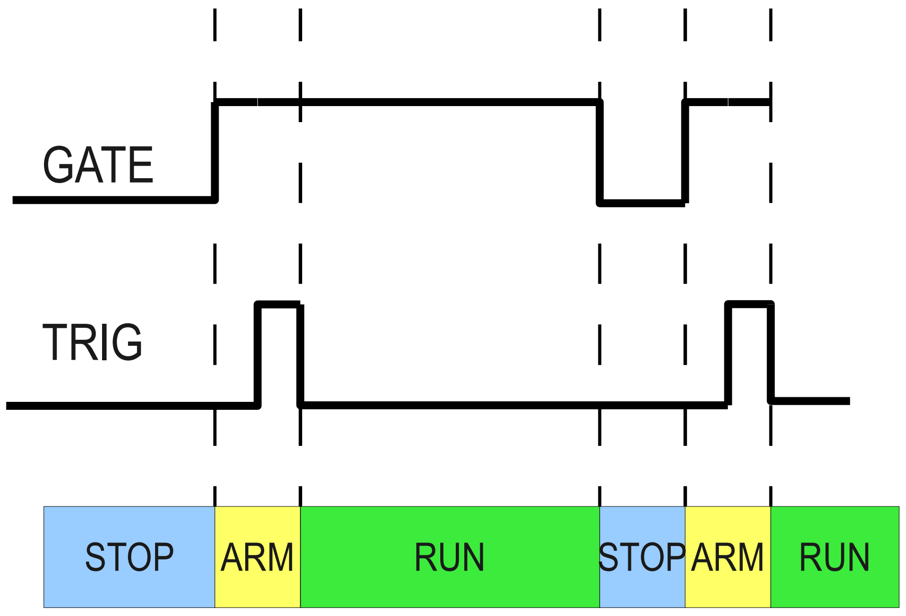
Here we demonstrate streaming ACQ196CPCI data at full -rate :

- 96 channels * 500kSPS/channel, 96MB/s.
- ACQ196 boots with a turnkey configuration,
    - Clock : default Internal 500kHz
    - GATE : control line from HOST
    - TRIG : trigger pulse from HOST or front panel LEMO.

First follow install software following [5] Then we recommend running the simplest possible scenario - Host Side control [3.2.2].

3.1 Turnkey operation:

ACQ196CPCI is configured with a turnkey boot script, to control the same capture each time from power up. If required, the script may be modified by editing from the system console. The capture is then sequenced by digital IO lines, either under control from the Host or from an external trigger. The turnkey boot script allows for repeated captures as follows:



Default: GATE is d4, controlled by the Host, TRIG is d3, front panel LEMO.

The STOP, ARM phases will each complete in under 1s. The TRIG pulse is handled by the normal capture hardware, minimum width 2usec. The RUN phase can be anything from 10s to infinity, 3600s typical.

3.1.1 Setting up the turnkey example

1. Enable RTM-T=YES in /ffs/rc.local.options

   (either using the console or from RTM1, before fitting RTM-T)
2. Copy turnkey boot scripts: NB: overwrites /ffs/user/rc.user

```
scp acq-scripts/* root@$rtm-tN:/ffs/user
```

3. Reboot HOST and ACQ196CPCI.
4. Set up a monitor on ACQ196. Eg

```
ssh dt100@$rtm-tN statemon
```

5. Start a streaming process:

```
stream-to-ramdisk N
```

6. Arm and then run the capture.

```
set.rtm-t dio_bit 4 1
# ACQ196 transitions to ARM
set.rtm-t dio_bit 3 1
set.rtm-t dio_bit 3 0
# ACQ196 transitions to RUN
```

7. Monitor the capture

```
ls -l /mnt/disk
inotifywait -m /mnt/disk
```

8. Stop the capure:

```
set.rtm-t dio_bit 4 0
```

Optionally, this turnkey capture can be triggered from LEMO in the normal way – reivew the script /ffs/auto-run. In addition, one card can be used to GATE and TRIGGER all other cards in the chassis.

3.2 Streaming capture with complete control by HOST.

Since the private backplane network connects ACQ196CPCI to TCP/IP, and of the well know control methods can be used –

eg **acqcmd** (over ip), **pexpect** (python expect over ip), API, **dt100rc**.

Example uses **acqcmd**

3.2.1 Pre-requisite

Enable RTM-T=YES in /ffs/rc.local.options and reboot.

(either using the console or from RTM1, before fitting RTM-T)

3.2.2 Host Side control.

NB: substitute the value of SLOT. In a one-card system, the value of SLOT is 100.

1. Set up a monitor, eg:

```
connect-statemon SLOT
```

2. Start a streaming process:

```
stream-to-ramdisk SLOT
```

3. Configure the capture.

```
single-uut-rio-trigger

trigger>
```

4. Trigger

   Hit <RETURN> to trigger

```
stop>
```

5. Stop

   Hit <RETURN> to stop.

4 Streaming Process Options.

Two example streaming data programs are included with the driver:

stream-to-ramdisk creates a series of fixed size files on the host computer, and the fixed files overwrite cyclically. It's then the responsibility of downstream user application software to consume the data before it is overwritten. The files match the driver host buffers, so given the default setting of 66 buffers each 1MB long, 66 files are created and they are overwritten approximately every 0.6s when capturing data 96 channels, 500kSPS/channel.

stream-to-flashdisk creates a series of files, no data is overwritten. We used an 80Gb flash-disk, and ran the system until the disk was full. We suggest this is the ideal way to capture long-shot data – we think of it as like having an ACQ196CPCI card with 80GB of RAM. After the shot, the data should be spooled off from the flash disk to main rotating disk storage. This means that equipment in the plant control room is all solid state, while the mass storage is safely maintained in the data centre.

Note that these files contain raw data in `[sample][channel]` order, while most data archive systems will save data per channel as a time-series `channel[sample]` order.

The incoming data rate is such that it may not be feasible to transform all the data in real time. The strategy then should be to store the raw data on disk, and to transform after the shot.

However, it's always possible to transform and plot <u>some</u> of the captured data and D-TACQ can demonstrate this as follows.

4.1 Script to Demux one block per cycle:

```
#!/bin/bash

export PATH=$PATH:~dt100/bin

SRC=0.00
RAW=/mnt/disk/000000
TMP=/mnt/disk

while [ 1 ]; do
	inotifywait -q -e close $RAW/$SRC
	cp $RAW/$SRC $TMP
	acq_demux -a acq196.def -O $TMP/ $TMP/$SRC
done
```

/mnt/disk was exported as an NFS directory and plotted using KST on another desktop.

4.2 Data Validation

ACQ196 includes a test mode, generating a digital ramp on 32 channels. A live data validation program tests the ramp. Please note, you will need a powerful computer to run this progam at full speed, and it may be necessary to clock the ACQ196 at lower speed.

1. Start a streaming process:

```
stream-to-ramdisk-checkramp SLOT.
```

2. Start the capture as before

```
single-uut-rio-trigger

trigger>
```

3. Appearance at run time.

   If there are no errors, there is nothing to see. However, running top shows the processes at work. This is good use of SMP.

```
  PID USER      PR  NI  VIRT  RES  SHR S %CPU %MEM COMMAND
 4483 root      18   0  1608  292  236 S 66.6  0.0 checkramp
 4482 root      18   0  3664  404  340 S 65.6  0.0 hbsplit
 4481 root      15   0 70540 1084  960 S 10.6  0.1 rtm-t-stream-disk
```

4. To force an error

```
change this line in stream-to-ramdisk-checkramp, before running:
-acqcmd -s $SLOT set.dtacq simulate 1
+acqcmd -s $SLOT set.dtacq simulate 0
```

5. To clean up after the test:

```
acqcmd -s $SLOT set.dtacq simulate 0
```

5 Installation.

5.1 Pre-requisites

5.1.1 ACQ196CPCI-96-250

RTM-T works with a 66MHz PBI, used on all models other than

ACQ196CPCI-96-500.

This does mean that, when streaming data on RTM-T, ACQ196CPCI-96-250 cards upgrade from 250 to 500kHz.

RTM-T firmware compatibility with 100MHz PBI as used on ACQ196CPCI-96-500 and ACQ132CPCI is planned. Please contact D-TACQ for availability.

5.1.2 Firmware

ACQ196 should be programmed with firmware 177.2095.3422 or later.

In particular, the FPGA image must be up to date to support RTM-T comms.

It's recommended to make the firmware update using Ethernet/RTM-1 before replacing the RTM-1 with RTM-T.

5.1.3 Console comms link.

Currently RTM-T does not support Ethernet, so it will be helpful but not essential to use the RS232 console connection on RTM-T for initial setup. Alternatively, the ACQ196 may be pre-configured using RTM-1/Ethernet before switching to RTM-T.

Future versions of RTM-T will support Ethernet, however it will be necessary to load new firmware before the new Ethernet device can be used.

5.1.4 Host Computer

The only fixed requirement for the Host Computer is that it have sufficient PCIe 1x (or 4x, 16x) slots for the HBA devices. Please note, some older Dell BIOS's failed to enumerate a PCIe device correctly. The CPU requirement for raw data streaming is typically low (10% per card, streaming to ramcisk, 20% streaming to disk). Please note, live demuxing is much more resource-intensive operation. If data is to be archived to disk, then a fast disk subsystem is required. D-TACQ actually recommends using an SSD. An 80GB SSD can take an hour's worth of data; treat the SSD as memory to hold one shot, and archive to disk in the data center at the end of the shot. The Host Computer must run Linux. Please refer to 12 for current restrictions.

5.1.5 PCIe x1 HBA

RTM-T conforms to the PCISIG standard “PCI-Express on Cable”, and a number of Host Bus Adapters HBA exist. However, the standard is quite loose, so operation with any HBA cannot be guaranteed. D-TACQ have successfully tested RTM-T with the following parts:

- NI PCIe-8361 (single port)
- NI PCIe-8362 (dual port)
- Cable: standard Molex 74576-0003, (the NI cable is the Molex).
    - We use a 5m cable as standard. Operation with longer cable lengths is possible, but will require a change to the hardware equalization settings. Please contact D-TACQ for details.
- One Stop OSS-PCIe-HIB2-x1 is a lower-cost alternative.

We've tested running 2 x ACQ196CPCI at full speed using both ports on NI-PCIe-8362.

5.1.6 Host Software

The host side driver and applications are supported on Linux-i686. (32 bit)

Specifically, we've tested the driver with Centos 5.5 and Fedora 13.

The driver compiles clean on the following kernels:

Distro	**Kernel**	**Compiles**	**Tested**
Centos 5.5/RHEL 5	2.6.18-194.26.1.el5	Yes	Yes
Fedora 13	2.6.31.9-174.fc12.i686.PAE	Yes	Yes
	2.6.20-1.2948.fc6-i686	Yes	No
Fedora 14	2.6.35.6-45.fc14.x86_64	Yes	Yes

Ensure that the package net-tools is installed (supplies **/sbin/slattach**)

5.2 Build and install host-side software.

5.2.1 Recommended user

By convention, D-TACQ recommends setting up a user dt100. Ideally dt100 has sudo permissions

```
groupadd -g 1001 dt100
useradd -g dt100 -u 1000 -G wheel dt100

# give sudo permissions, uncomment line 87
visudo
    86 ## Same thing without a password
    87 %wheel  ALL=(ALL)       NOPASSWD: ALL
```

5.2.2 Automated install available from web site.

If the host system has access to the Net, install may be automated. Otherwise, download the install script and adapt.

For latest version, see:

http://www.d-tacq.com/details_page.php?prod_id=contact&page_id=3

```
wget http://www.d-tacq.com/swrel/rtm-t_install;chmod 777 rtm-t_install
./rtm-t_install ACQ2XX_API.201111241928.tgz rtm-t-hostdrive-1109272131.tgz
```

5.2.3 Driver

NB: **rtm-t_install** will perform these steps.

Download latest driver from

http://www.d-tacq.com/software_downloads.shtml

```
mkdir ~/PROJECTS;
tar xvzf rtm-t-hostdrive-yymmddHHMM.tgz
cd RTM-T/HOSTDRV
make
# make user_install installs all scripts to ~/bin
# this assumes that ~/bin exists and it is in the PATH.
make user_install
# Check Makefile for kernel version options.
sudo make install
```

5.2.4 Use of modprobe and hotplug services

On reboot, when the OS bus enumeration routines identify a D-TACQ RTM-T card, the following sequence should take place automatically:

- **modprobe** loads kernel module /lib/modules/$(KRNL)/d-tacq/rtm-t.ko
- **udev** runs the rules file /etc/udev/rules.d/20-rtm-t.rules
- **20-rtm-t.rules** runs /etc/hotplug.d/acqX00/rtm-t.hotplug
- **rtm-t.hotplug** creates a number of device nodes, representing the userland interface to the device driver.
- **/etc/init.d/rtm-t** starts backplane networking comms service.
- **/etc/rtm-t-hosts** defines rtm-t private backplane networking.

  By default, this uses a network 10.0.196/24; if this clashes with existing site network assignments, please modify the file to suit local conditions.

5.2.5 Private Backplane Communications Network.

RTM-T presents a 16550-UART interface to PCI-Express. This UART is linked internally in the FPGA with a second UART on the ACQ196 PBI, enabling a serial communications link from the HOST to the ACQ196. The UART runs at a megabit per second, and is configured for CSLIP point to point inter-networking. This means that all the normal network services of ACQ196 may be used without fitting a second network (e.g. Ethernet link). The primary purpose of this communications link is to allow run time configuration and status monitoring of the ACQ196, however the link may also be used, for example for configuration and firmware upgrade on the ACQ196CPCI.

5.2.6 Driver Parameters

Parameters are static values set at boot time.

File	RW	Function
/sys/module/rtm-t/parameters/..		
buffer_len	R	length of each host buffer [1MB]
nbuffers	R	number of host buffers [66]
pulse_top_usec	RW	length of pulse generated by DIO
rtm_t_debug	RW	set non zero to debug
rtm_t_debug_descr	RW	set non zero to debug descriptors
rtm_t_debug_isr	RW	set non zero to debug ISR
rtm_t_debug_regs	RW	set non zero to debug regs
RX_TO	RW	timeout on read
SMOO	RE	smoothing factor for stats
stalls	R	
test_mode	RW	
transfer_buffers	R	number of buffers to transfer.
version	R	driver version
WORK_TO	RW	WORK TIMEOUT (dummy load)

5.2.7 Driver Knobs and Data devicefiles:

RTM-T devices are numbered in logical order 0,1....

(unfortunately it's not possible to list by slot numbers as it is with CPCI).

Device File Name	Function
/dev/rtm-t.0	First Device node - API uses this
/dev/rtm-t.0.data/	Directory of host data buffers
/dev/rtm-t.0.ctrl/	Directory of control knobs
/dev/rtm-t.0.fifo_histo.desc	Diagnostic
/dev/rtm-t.0.fifo_histo.data	Diagnostic
/dev/rtm-t.0.regs	Diagnostic
/dev/rtm-t.1	Second Device Device node .. etc
/dev/rtm-t.1.data/	Directory of host data buffers
/dev/rtm-t.1.ctrl/	Directory of control knobs
/dev/rtm-t.0.data/hb00 .. /dev/rtm-t.0.data/hb65 ..	Host Data Buffers

5.2.8 Control Knobs:

Directory: /dev/rtm-t.0.ctrl/

Set Value: DEV=N set.rtm-t KNOB VALUE

Get Value: DEV=N get.rtm-t KNOB

Important Knobs:

- dio_bit N BITVAL
- dio_bit_N BITVAL : set get individual bit values
- dio : ascii pattern represents all 6 DIO bits
- dio_raw : binary pattern represents all 6 DIO bits
- BITVAL: { 0, 1, -, P, N }
- cable_connected : outputs 1 if cable is connected.
- mboxH1, mboxH2 : mailboxes, written by Host (system only)
- mboxQ1, mboxQ2 : mailboxes, written by ACQ196CPCI (system only)
- job : prints current job status, can be used for a live update.

5.3 API

The private back-plane network uses an ip-aware version of the **acqcmd**, **acq2sh** utilities.

*If HOST already has the older pci/kernel device driver loaded, please rename **acqcmd** to **acqcmd.kdd***

- Download API version ACQ2XX_API.201101291237 or later.
- Build at minimum **acqcmd**, **acq2sh**:

```
user@host
mkdir -p ~/PROJECTS/ACQ200/project
cd ~/PROJECTS/ACQ200/project
wget http://www.d-tacq.com/swrel/ACQ2XX_API.201101291237.tgz
tar xvzf ACQ2XX_API.201101291237.tgz
cd API; make rtm_t
```

- Install

```
sudo make install_rtm_t

rtm_t:          $(patsubst %,$(EXEDIR)/%, $(CONTROL_APPS))

install_rtm_t: rtm_t
                cp $(EXEDIR)/acq2sh /usr/local/bin/acq2sh.ip
                cp $(EXEDIR)/acqcmd /usr/local/bin/acqcmd.ip
```

5.3.1 Link to acqcmd, acq2sh

The RTM-T host driver provides a scripted "**acqcmd**" that maps slot number to private IP address and calls out to **acq2sh.ip**, **acqcmd.ip** as appropriate.

In otherwords, scripts using the original **acqcmd**, **acq2sh** call will run unchanged.

5.3.2 Slot Numbering Convention N

acqcmd uses the convention

SLOT >= 100 :: RTM-T connection, use logical device SLOT – 100

SLOT < 10 :: use convention kernel device SLOT

nb: dt100-hub users will be familiar with the convention:

SLOT > 10 :: hub device.

This can still be applied if necessary.

5.3.3 Host lookup on private back-plane network:

```
rtm-t-host SLOT                                # outputs IP address

ssh root@$(rtm-t-host 101)        [1]          # connect to card "101"
```

When the backplane networking is made, the local /etc/hosts file is modified to add a hostname for the new connection. Assuming the system is using /etc/hosts, then connection to the card is follows the normal IP hostname convention:

```
ssh root@rtm-tN   eg
ssh root@rtm-t0                   [2]
```

This is equivalent to, but more natural than [1] so we recommend this notation.

5.3.4 Applications

- [DEV=SLOT] **get.rtm-t** KNOB **:** returns the value of a driver knob
- [DEV=SLOT] **set.rtm-t** KNOB VALUE**:** sets the value of a driver knob
- **stream-to-flashdisk :** continuous streaming to physical disk
- **stream-to-ramdisk :** continuous streaming to ramdisk
- **stream-to-ramdisk-start-stop-test :** stress test to identify any start/stop issues.
- **stream-to-elastic-store** : continuous streaming to ramdisk, aborts on overwrite. Use with downstream data consumer process.

5.3.5 Using the DIO Signaling

RTM-T DIO6 bits may be set as inputs or outputs, and they can be connected back to the ACQ196CPCI and/or PXI backplane using the standard ACQ196CPCI routing commands eg

- Software Control of ACQ196CPCI / PXI signaling line

```
acqcmd -b SLOT set.route d3 in rio out fpga pxi
DEV=SLOT set.rtm-t dio_bit_3 1
DEV=SLOT set.rtm-t dio_bit_3 0
```

- Software monitoring of ACQ196CPCI/ PXI signaling line

```
acqcmd -b SLOT set.route d3 in lemo out fpga pxi rio
DEV=SLOT set.rtm-t dio_bit_3 -
DEV=SLOT get.rtm-t dio_bit_3
```

5.4 Recommended Utilities

- inotify-tools : to monitor incoming files:

```
sudo yum install inotify-tools
```

- **kst** : to plot demux data.

```
http://kst-plot.kde.org/
```

6 MDSplus segmented data

D-TACQ has a version of **acq_demux** that will submit data direct to MDSplus.

This will work successfully on post-shot data, as well as on real time data, to the limit of host computer performance.

6.1 Post Shot

```
export PATH=$PATH:~dt100/bin

SRC=?.??
RAW=/mnt/disk/000000
TMP=/mnt/disk

TREE=mytree
FIELD=acq196_064.CH%02d

find $RAW -name $SRC | sort -n | xargs \
     acq_demux-mds -a acq196.def $TREE $FIELD
```

6.2 Live MDS Data Store

Storing long pulse data direct to MDSplus has been achieved at

96channels x 200kSPS

The demo uses a 1GB RAMDISK for intermediate file storage and an SSD as fast file storage. A suitable tree should be created eg using **make_acqtree.**

```
[dt100@krypton ~]# make_acqtree rtmt acq196_387,96
[dt100@krypton ~]# export rtmt_path=/mnt/flashdisk/trees/rtmt
[dt100@krypton ~]# newshot rtmt
```

Review the script **run-live-mds**, it will probably need some site-customization

We use 4 xterms, two are necessary for to host the data transfer and capture control processes respectively, two are used for monitoring only.

6.2.1 xterm 1: Setup and stream.

Initial setup: ** **./bin/rc.local** will need local customization! **

```
[dt100@krypton ~]# sudo ./bin/rc.local
```

Stream data from “card 100”. We ask for 35000 (1MB) buffers (900s).

```
[dt100@krypton ~]$ stream-to-elastic-store 100 35000 | run-live-mds
```

6.2.2 xterm 2: Control the capture

Start a capture:

```
[dt100@krypton ~]$ CLKHZ=200000 single-uut-rio-trigger
...
trigger>      ** Hit Return to Trigger **

stop> ** Hit Return to Stop (if required).
```

6.2.3 xterm 3: Monitor job

Monitor shot progress

```
[dt100@krypton ~]$ forsleep cat /dev/rtm-t.0.ctrl/job
dev=rtm-t.0 idx=0 demand=35000 queued=6417 rx=6351
rx_rate=34 int_rate=34 MBPS=34
BS_EMPTY=1  BS_FILLING=65 BS_FULL=0  BS_FULL_APP=0  STATUS=
ERRORS=0

demand=35000          :: 35000 buffers requested
queued=6417           :: so far, we have queued 6417 buffers
rx=6351               :: so far, we have received 6351 buffers
rx_rate=34 :: receiving 34 buffers / sec
int_rate=34           :: 34 interrupts /sec
MBPS=34               :: 34 Mega Byte /sec
Queue states:
BS_EMPTY=1                          :: one empty buffer waiting to be queued
BS_FILLING=65         :: 65 buffers are queued to be filled
BS_FULL=0             :: 0 buffers are currently full [device driver]
BS_FULL_APP=0         :: 0 buffers are currently full [application]
```

6.2.4 xterm 4: Monitor Backlog

Monitor shot progress: shows the number of buffers held in the ramdisk / elastic store.

```
[dt100@krypton ~]$ monitor-ramdisk
backlog Sat Aug 6 13:26:54 BST 2011 11
backlog Sat Aug 6 13:26:55 BST 2011 18
backlog Sat Aug 6 13:26:56 BST 2011 25
backlog Sat Aug 6 13:26:57 BST 2011 14
backlog Sat Aug 6 13:26:58 BST 2011 9
backlog Sat Aug 6 13:26:59 BST 2011 5
backlog Sat Aug 6 13:27:00 BST 2011 18
backlog Sat Aug 6 13:27:01 BST 2011 31
backlog Sat Aug 6 13:27:02 BST 2011 20
```

7 Appendix: Boot sequence

Step	**Host**	**Acq/RTM**
1	Hardware Reset off	
2		RTM-T FPGA Load
3	OS Enumerates PCI/PCIe Device Tree	
	... identifies RTM-T vendor/device-id	
4	modprobe loads Host driver	
	... acq100_rtm_t.ko	
5	Driver load triggers udev	
	... udev finds	
	/etc/udev/rules.d/20-rtm-t.rules	
	...... calls	
6	/etc/hotplug.d/acqX00/rtm-t.hotplug	
	... creates device nodes in /dev/	
7	/etc/rc.d/init.d/rtm-t	
	... calls /usr/local/bin/rtm-t-connect N	
	...... waits for mboxQ1	
8		ACQ196 Boots
		loads driver rtm-t.ko
		writes ACQ196 SN to mboxQ1
		... polls mboxH1
9	/usr/local/bin/rtm-t-connect N	
	... configures network, sends network prams to mboxH1, mboxH2	
	ifconfig slN	
10		ifconfig sl0
11	Ping rtm-tN	Ping host

8 Appendix: Fault finding sequence

8.1 Can Linux see the device?:

Device: Xilinx/0007, Subsystem d1ac:4000

```
14:00.0 RAM memory: Xilinx Corporation Unknown device 0007
                Subsystem: Unknown device d1ac:4000
                Flags: bus master, fast devsel, latency 0, IRQ 106
                Memory at fdeffc00 (32-bit, non-prefetchable) [size=512]
                Memory at fdeff800 (32-bit, non-prefetchable) [size=512]
                Capabilities: <access denied>

15:00.0 RAM memory: Xilinx Corporation Unknown device 0007
                Subsystem: Unknown device d1ac:4000
                Flags: fast devsel, IRQ 114
```

Listing shows two devices.

8.2 Did the device driver load?

```
dmesg | less
tg3: eth0: Flow control is on for TX and on for RX.
rtm_t_init_module: rtm_t D-TACQ RTM-T Driver B1027 Dec 31 2010
Copyright (c) 2010 D-TACQ Solutions Ltd
ACPI: PCI Interrupt 0000:14:00.0[A] -> Link [LNEC] -> GSI 18 (level, low) -> IRQ
177
rtm_t_id: REVID :aa010005 PCIECSR:14021600
ACPI: PCI Interrupt 0000:15:00.0[A] -> Link [LNEA] -> GSI 17 (level, low) -> IRQ
185
rtm_t_id: REVID :aa010005 PCIECSR:14021600
```

Log shows driver sign-on and initialization message for both devices.

8.3 Did the hotplug scripts execute?

```
[dt100@argon ~]$ ls -l /dev/ | grep rtm | cut -c -30,46-
crw-rw-rw- 1 root root 253,  2 rtm-t.0
lrwxrwxrwx 1 root root        rtm-t.0.ctrl -> /sys//class/rtm-t/rtm-t.0/device
drwxrwxrwx 2 root root      13 rtm-t.0.data
crw-rw-rw- 1 root root 253,  2 rtm-t.0.fifo_histo.data
crw-rw-rw- 1 root root 253,  2 rtm-t.0.fifo_histo.desc
crw-rw-rw- 1 root root 253,  2 rtm-t.0.regs
crw-rw-rw- 1 root root 252,  2 rtm-t.1
lrwxrwxrwx 1 root root        rtm-t.1.ctrl -> /sys//class/rtm-t/rtm-t.1/device
drwxrwxrwx 2 root root      13 rtm-t.1.data
crw-rw-rw- 1 root root 252,  2 rtm-t.1.fifo_histo.data
crw-rw-rw- 1 root root 252,  2 rtm-t.1.fifo_histo.desc
crw-rw-rw- 1 root root 252,  2 rtm-t.1.regs
```

8.4 Are the remote devices working?

```
[dt100@argon ~]$ hexdump /dev/rtm-t.0.regs
0000000 1600 1402 0000 0000 0005 0001 0000 086a
0000010 0000 0000 0001 0000 55aa 55aa d485 0061
0000020 0000 0000 0000 8000 0000 0000 0000 0000
0000030 0000 0000 0000 0000 0000 0000 0000 0000
0000040 0005 aa01 0001 0000 0507 0000 2810 0000
```

A display with all ffff values indicates a dead remote. In that case, please reboot and retry.

8.5 Did Interrupt assignment succeed?

```
[dt100@argon ~]$ grep rtm /proc/interrupts
106:        0              PCI-MSI  rtm-t.0
114:        0              PCI-MSI  rtm-t.1
```

8.6 Did UART assignment succeed?

```
[root@neon ~]# ls -l /sys/class/rtm-t/rtm-t.?/device/tty/
total 0
drwxr-xr-x 3 root root 0 2011-01-28 17:36 ttyS1
```

8.7 Did Private backplane network configuration succeed?.

```
root@neon ~]# /sbin/ifconfig sl0
sl0       Link encap:VJ Serial Line IP
          inet addr:10.0.196.200  P-t-P:10.0.196.100  Mask:255.255.255.255
          UP POINTOPOINT RUNNING NOARP MULTICAST  MTU:296  Metric:1
          RX packets:3967679 errors:0 dropped:0 overruns:1442112 frame:0
             compressed:0
          TX packets:3989802 errors:0 dropped:0 overruns:879329 carrier:0
          collisions:260562 compressed:0 txqueuelen:10
          RX bytes:498208985 (475.1 MiB)  TX bytes:348197772 (332.0 MiB)
```

The OS will assign sl0, sl1, sl2 etc in sequence for each card.

ping test:

ping $(rtm-t-host 100)   or

ping rtm-t0

If ping fails, it can help to re-run **rtm-t-connect** SLOT

9 Firmware Update

9.1 RTM-T.

The RTM-T FPGA firmware may be updated from ACQ196CPCI as follows.

```
scp images/acq196cpci_rtm_t.bit root@$rtm-tN:/tmp
ssh root@$rtm-tN md5sum /tmp/acq196cpci_rtm_t.bit
# compare with vendor supplied checksum
ssh root@$rtm-tN /extra/local/CARE/rtm-t_flash
```

Follow the menu prompts and check for any error messages – if there is any error, please do not power off, but send a transcript of the session to D-TACQ and wait for instructions.

If no errors, power cycle the CPCI crate and reboot the HOST to pick up the new firmware.

It is necessary to power cycle (power OFF, power ON), a soft reboot will not cause FPGA reload.

It's only necessary to update RTM-T firmware when advised by D-TACQ.

NB: the FPGA image for RTM-T is held in a discrete flash memory on RTM-T, enabling RTM-T to boot at power up independently of the front side card. The hardware comes out of reset and immediately loads the FPGA. This is different to the mechanism on the ACQ196CPCI family, where the FPGA image is held in flash memory, and the FPGA is loaded under software control after the OS has loaded.

9.2 Storing multiple FPGA images on ACQ196 card

Multiple FPGA images (eg DRUID DSP images) may be stored ACQ196CPCI non-volatile file space, store the images in /bigffs/RTM_T_FIRMWARE/.

The ACQ196 script **/extra/local/CARE/rtm-t_flash** handles this and prompts the user accordingly. **/extra/local/CARE/rtm-t_flash_compare** identifies the FPGA image that is currently programmed in the RTM-T flash memory.

Typical **rtm-t_flash** session**:**

```
usr/local/CARE/rtm-t_flash
Choose source image:
1: stored image: /bigffs/RTM_T_FIRMWARE/acq196cpci_rtm_t-20120509.bit
2: stored image: /bigffs/RTM_T_FIRMWARE/acq196cpci_rtm_t-rev17-dec10.bit
3: stored image: /bigffs/RTM_T_FIRMWARE/acq196cpci_rtm_t.aa010017.bit
4: stored image: /bigffs/RTM_T_FIRMWARE/acq196cpci_rtm_tem.bit
```

9.3 ACQ-FIBER-HBA

The firmware on ACQ-FIBER-HBA may be updated direct from the HOST computer as follows:

```
# stub normal driver load and reboot
# build SPI driver (see README for details,
# requires addiional linux packages
./test-scripts/load.flash_device
./test-scripts/acq-fiber-hba_flash

# Ensure new firmware file in current directory
./test-scripts/acq-fiber-hba_flash
Y
Programming /dev/mtd0 with acqfiber_hba_top.bit ?
y/N:BF:acqfiber_hba_top.bit FD:/dev/mtd0
flash_erase $FD 0 0
Erasing 64 Kibyte @ 7f0000 — 100 % complete
dd if=$BF bs=8 skip=15 of=$BF.strip
185559+0 records in
185559+0 records out
1484472 bytes (1.5 MB) copied, 1.10376 seconds, 1.3 MB/s
cp $BF.strip $FD
dd if=$FD bs=$(len $BF.strip) count=1 of=$BF.copy
len $BF.strip
1+0 records in
1+0 records out
1484472 bytes (1.5 MB) copied, 7.69712 seconds, 193 kB/s
cmp $BF.strip $BF.copy
rm $BF.*
```

Programming ACQ-FIBER-HBA takes 30s.

Power cycle the host to reload the firmware personality.

10 Appendix : turnkey two card example

10.1 xterm 1:

Stream data from “card 100”

```
stream-to-ramdisk 100
none on /mnt/disk type tmpfs (rw,size=256M)
```

10.2 xterm 2:

Stream data from “card 101”

```
stream-to-ramdisk 101
```

10.3 xterm 3:

Start a capture:

```
setup-host-trigger-example 100 101
```

10.4 xterm 4:

Check that the process is working:

```
ls -l /mnt/disk/acq196_285/000000/
...
-rw-r--r-- 1 root root 1048576 Feb 16 22:52 1.64
-rw-r--r-- 1 root root      49 Feb 16 22:52 1.64.id
-rw-r--r-- 1 root root 1048576 Feb 16 22:52 1.65
-rw-r--r-- 1 root root      49 Feb 16 22:52 1.65.id

grep rtm /proc/interrupts
106:     23108        PCI-MSI  rtm-t.0, serial
114:     23099        PCI-MSI  rtm-t.1, serial
grep rtm /proc/interrupts
106:     23236        PCI-MSI  rtm-t.0, serial
114:     23227        PCI-MSI  rtm-t.1, serial

inotifywait -m -e close  /mnt/disk/acq196_285/000000/1.00
Setting up watches.
Watches established.
/mnt/disk/acq196_285/000000/1.00 CLOSE_WRITE,CLOSE
/mnt/disk/acq196_285/000000/1.00 CLOSE_WRITE,CLOSE
/mnt/disk/acq196_285/000000/1.00 CLOSE_WRITE,CLOSE
/mnt/disk/acq196_285/000000/1.00 CLOSE_WRITE,CLOSE
```

11 Appendix: Fiber-optic channel diagnostics

ACQ-FIBER-HBA allows a HOST computer to connect to a remote RTM-T using fiber-optio cable. The cable transceiver is a plug-in SFP module. ACQ-FIBER-HBA and RTM-T contain matching Spartan 6 FPGAs, which communicate on the fiber using Aurora protocol. The following diagnostics are available at each end of the link:

11.1 Link Layer Diagnostic

The FPGA provides status about the Link and SFP as follows:

```
get.rtm-t aurora0
0x00000063 +PRESENT HARD_ERR SOFT_ERR +CHANNEL_UP +LANE_UP

+PRESENT: SFP Present
+LANE_UP : Aurora Lane is UP
+CHANNEL_UP : Aurora Channel is UP
# in this implementation, a Channel comprises a single Lane.
# Please IGNORE  HARD_ERR, SOFT_ERR
```

11.2 Physical Layer Diagnostic

SFP devices include condition monitoring. D-TACQ supports the

AVAGO AFBR-57R5APZ module.

```
avago-monitor
     Temp:  30.23 C
      VCC:   3.34 V
   Tx Bias:1348.50 uA
  Tx Power: 351.00 uW
    Rx Pwr: 340.00 uW
```

12 Current restrictions

12.1 Running with Linux 2.6.18 :

- Tested good: i386 .
- Untested: x86_64 untested, but believed to work.
- SMP works well

12.2 Running with Linux 2.6.30+ :

- Tested good with Centos6, 64 bit, SMP, requires RTM-T firmware rev17 or greater.