Fiber Optics Interface Analysis.

Greg Burley 2003-06-25

The serial fibre optics link will consist of an Astronomical Research Cameras ARCxxx 250MHz PCI card, communicating with the clock card.

ARCxxx 250MHz PCI Card

The ARCxxx 250MHz PCI card will communicate over a duplex fibre optical link, with the warm electronics clock cards. The ARCxxx PCI card uses an Agilent HFBR-1119T fibre optic transmitter and a HFBR-2119T fibre optic receiver. The fibre optic transmitter and receiver accept 62.5/125mm fibre optic cable with ST style connectors.

Clock Card

The clock card will use fibre optic link components chosen for compatibility with the ARCxxx PCI card. Our first choice was to use 3.3 volt parts for compatibility with the clock card FPGA. Because of problems with availability of 3.3 volt parts with ST connectors, required quantities to order, and long lead times, it was decided to use the same 5 volt parts as used by the ARCxxx card. These components would copy the functionality of the input-output section of the ARCxxx interface card, with the exception of the FIFO buffers, which could optionally be implemented in the FPGA.

Contingency Possibilities

If the ARCxxx PCI card were to become unavailable, a few possibilities to replace it are listed below. All of these options would require major changes to software and FPGA code. Using a PCI mezzanine card [PMC] on the clock card would require that a local PCI bus would have to be implemented on the clock card.

1. Gigabit ethernet

Gigabit ethernet PCI and PMC boards are readily available and could possibly be used, but a considerable amount of software would have to be changed, and the clock card would have to handle TCP/IP. At this time there is no RTLinux support. See Greg Burley's notes below for more information.

2. Fibre channel

Fibre channel is used for bulk disc storage applications, and PCI and PMC cards are available. It may have a simpler protocol which might make it easier to use than gigabit ethernet, but more investigation is required.

3. Firewire 1394b

The standard for a fibre optics version of firewire was published in 2002, but no PCI or PMC cards were located [15April03]. As with the previous two options, the clock card would have to handle the protocol used.

4. Custom Fibre Interface

There is an existing open-source design fibre optics PCI card design done by Greg Burley for the Carnegie Observatories, which could be modified to replace the ARCxxx PCI card. The card would use the AMCC S5920 PCI interface chip, an Altera EPLD, the HOTLink II rx-tx chip, and optical components, which would also be used on the clock card. Functioning of the card would not be the same as

the ARC card, and software changes would be required. A linux driver exists for the AMCC PCI chip which would have to be adapted for RTLinux.

Notes on optical link options
[author: Greg Burley Apr2003]

Option 1 - Status quo

* use Leach PCI board and RTlinux driver

* put optical parts on clock board

* requires new Altera interface design

* no need for an Altera processor in this mode
* requires +5V for optical modules, Hotlink

Comments: The main drawbacks to Option 1 are (a) uses Hotlink parts which are one generation behind, (b) requires +5V, (c) difficult toupgrade, requires redesign of clock card.

The main advantages of Option 1 are (a) straightforward to implement, (b) no extra RTlinux drivers required, (c) no Altera processor required ie no IP to buy or code to write.

To make option 1 upgradeable, we could put the optical parts on a PMC form factor and run all the appropriate wires to it from the Altera chip to enable future PMC upgrade.

Option 2 - Leach PCI + Leach PMC

* use Leach PCI board + RTlinux driver

* use Leach PMC board with clock card

* use Altera processor with PCI interface
* requires custom Altera software to drive PCI interface
* no need to do any optical hardware, but $$$ costly

Comments: The main drawback to option 2 are (a) it requires an Altera processor with PCI interface ($$$), and (b) the code to go with it.

The main advantages of option 2 are (a) the PCI/PMC interface is standard, (b) the PMC card could be upgraded later without a redesign of the clock card, (c) preserves the software written for the RTLinux end of the link, (d) no need to design or build any optical hardware.

Option 3 -- Gigabit ethernet (GBE)

* use Gigabit ethernet PCI card, LNET RTlinux driver from FSMLabs

* use gigabit ethernet PMC card on clock card

* uses industry-standard interfaces + modern optical modules

* requires Altera processor, with PCI interface
* require software for Altera processor, TCP/IP stack

Comments: The main drawbacks to Option 3 are (a) it's the most complicated option, (b) requires partial re-write of ATC RTlinux code, (c) requires Altera processor with PCI interface ($$$), (d) requires code for Altera processor + networking code.

The main advantages of Option 3 are (a) modern industry-standard optical interface, (b) highest bandwidth option, (c) low-cost PCI + PMC boards, (d) upgradeable to any PMC based interface.

A relatively simple testbed could be built for Option 3, using two linux machines, each with GBE interface PCI cards and running RTlinux. One machine would simulate the clock card, while the other would simulate the data acquisition machine. Set up Master-slave arrangement and measure latency + throughput, watch for data loss, etc.

Hardware details:
There are a number of choices for both PCI and PMC gigabit ethernet cards. The nominal price is about US$500.

The choice will mostly depend on which chipset is best supported by an RTLinux driver.

The optical modules available include LC, sC or MT-RJ.

Typical specs:
32/64 bit, 33/66 MHz PCI rev 2.2
Tx/Rx FIFO 64Kbytes

PCI Examples:

3Com	3C996-SX	SC interface
Intel	Pro/1000	SC or LC interface

PMC Examples:

SBS Technologies	PMC-Gigabit-SF	LC,SC or MT-RJ interface
DSS Networks	GigMAC 7160	LC or SC interface

Software details:
None of the linux device drivers that come with the PCI or PMC boards is suitable for RTLinux. For instance, the SBS driver software is just the generic Intel ethernet driver. It is not a RTLinux driver.

FSMLabs [the developers of RTLinux] have a gigabit ethernet driver in development. They did not give a timetable for the release of their driver. The driver is part of their LNet real-time networking package, which so far includes 100Mbps ethernet and Firewire drivers.

Cost: RTLinux Pro + LNet $1500 per seat (academic price)

The NIOS processor will need a driver to interface to the PMC card over the PCI bus. Altera has a NIOS ethernet development kit (US$495) which includes a

TCP/IP stack and related software, which might be adapted. It's likely that there would be quite a lot of coding/testing involved in getting this to work. [I don't know enough about this to give an estimate, but I think this is the riskiest part of the development].

Summary

A gigabit ethernet solution is not currently viable. The hardware building blocks are available, but the software modules are not there yet.

The main limitation is that an RTLinux driver for the PCI end is under development by FSMLabs, and is not currently available.

Adapting the Altera NIOS ethernet software to run the PMC gigabit ethernet interface is the biggest unknown/riskiest part of the development.