Data Acquisition System of the Telescope Array Project

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Abstract

The basic design of the data acquisition system of the Telescope Array experiment is reported. From signals of about ten thousand PMTs in a station, events with string-like distribution of hit-PMTs are selected. Data for such events are collected through a high-speed network and processed with a computer (or a computer cluster). For such a high-speed network of large-scale data acquisition system, technique of Gigabit Ethernet is now available under the Linux Operation System.

1 Introduction

Telescope Array (TA) is a next generation detector for observing highest energy cosmic rays. In the basic design of TA, eight stations of π-steradian air fluorescent detectors are arranged with 30 km separation. A station has 40 telescopes with 3 m diameter, each of which has a camera with 16 $\times$ 16 PMTs, so that the data acquisition (DAQ) system should handle 10,240 signal channels. The schematic view of this system is shown in Figure 1. Two telescopes is grouped into one segment, and eight 64ch modules are mounted into one VME crate. Data from 64ch modules in a crate are transferred to a sub-computer through a VME-PCI bus adapter, and then transferred to a main-computer through ethernet. For trigger judgement, all 64ch modules are connected to trigger modules, which are not drawn in Figure 1.

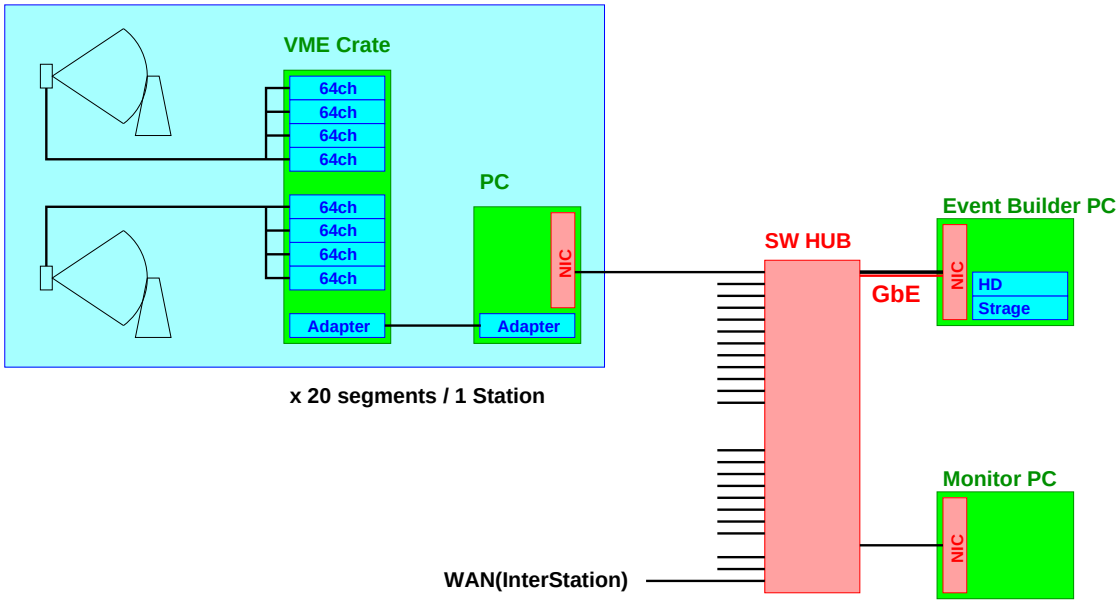

Figure 1: Schematic view of DAQ system.

2 Required Data Transfer Speed

Assuming trigger rate is 10 Hz and data size is 20 Words per channel *in average*, the data transfer rate requied for a VME-PCI bus adapter is

$$\begin{aligned} & 2[telescopes] \times 256[ch] \times 20[Words] \times 10[Hz] \\ & \simeq \quad 100 \quad [KWords/s] \\ & \simeq \quad 1.6 \quad [Mbps] \quad , \end{aligned}$$

and that required for ethernet is

$$1.6[Mbps] \times 8 \times 20[Segments] = 256[Mpbs] \quad .$$

These values are estimated in average situation. The former for the VME-PCI bus adapter is achived by market products such as Bit3 Model 618. Though the transfer speed between a sub-computer and SW is comparable to the former and is achived with Fast Ethernet, we need Gigabit Ethernet (GbE), at least, just before a main-computer.

3 GbE Performance

Since the technique of GbE have been developed very recently, we have first checked the GbE performance. Table 1 shows computer system (PC), Network Interface Card (NIC), and Switching Hub (SW) used for the performance evaluation. The operationg system on PC is *Linux OS*, which supports many excellent DAQ drivers and data analyzing softwares. The setup for the GbE performance evaluation is shown in Figure 2. Three types of connection between Client/Server PCs are tested: (1) 3Com SW, (2) Alteon SW, and (3) direct connection. Alteon NIC and SW support large Maximum Transmission Unit (MTU), so that the performance with large MTU was also measured. The software for the performance evaluation is *Netperf*.

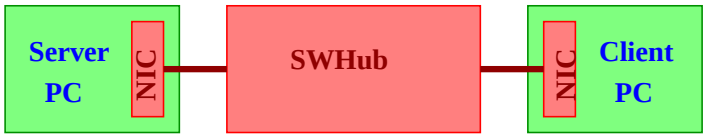

Figure 2: Setup for GbE perfomance evaluation.

Table 1: List of Computer system, NIC and SW.

PC	Gateway 2000	GP6-366C (with 128MB memory)
OS		Linux 2.2.6 (RedHatLinux5.2 base)
NIC	Alteon	ACEnic (with 1MB memory)
SW	3Com	3C39024+3C39001
	Alteon	ACESwitch180

The results are shown in Figure 3. For direct connection, the transfer speed is obtained to be 200–270 $Mbps$ with MTU 1500 (cyan curve) and 400–430 $Mbps$ with MTU 9000 (blue curve). These values are also obtained using Alteon and 3Com switches; but 3Com SW doesn't support MTU 9000. This means the large MTU improves about 60 % of the network performance. Some new techniques, such as *jumbo frame support* with Alteon products, are required for the large-scale DAQ system.

The reason why the transfer speed doesn't reach 1,000 $Mbps$ is, maybe, PCI bus in a sub-computer is 32bits-bus, so we plan to install 64bits PCI bus for the actual DAQ system of TA.

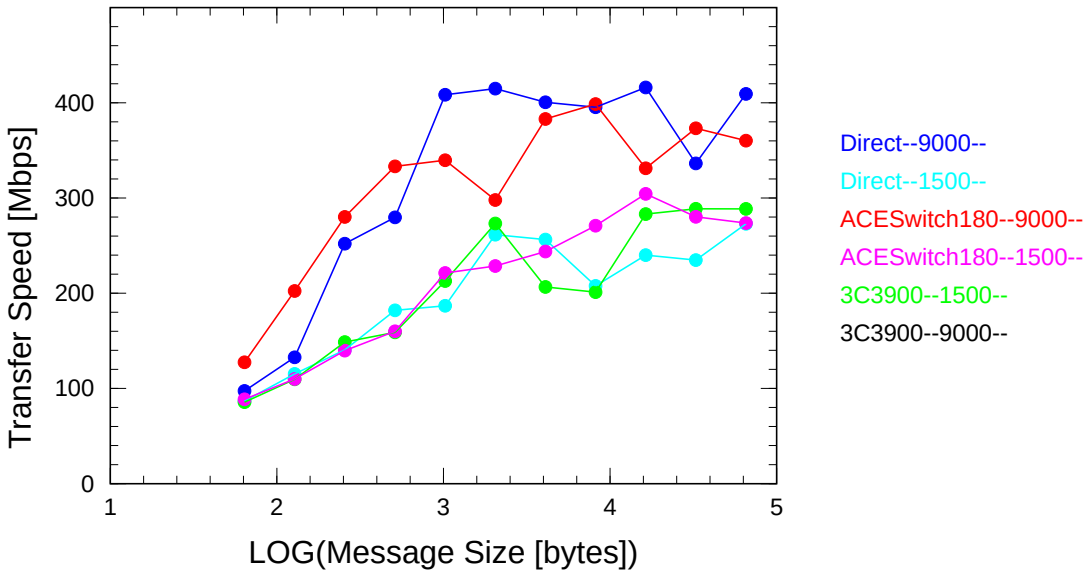

Figure 3: TCP/IP performance with Netperf.

4 Conclusion

We have made the benchmark system for the GbE performance evaluation and checked GbE for a high-speed network of large scale DAQ system. The transfer speed reached about 400 $Mbps$ with large MTU, and this GbE technique is now available under Linux OS.

References

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