Development of Distributed Computing System for VLBI Correlator

Hiroshi Takeuchi[1]; Tetsuro Kondo[2]; Yasuhiro Koyama[3]

[1] CRL Kashima Space Research Center; [2] KSRC,NICT; [3] NICT/KSRC

1. Introduction

In the conventional VLBI system, received radio signals at observing sites are recorded to magnetic tapes and hardware correlators have been used for data processing. In the meantime, recent developments of personal computers enable us to use the software correlator for the analysis. We have been developing K5 VLBI system in which raw data are transferred through the Internet and geodetic correlation analyses are made by software programs. Since the K5 system is easily connected to the Internet, we can construct the low cost and high performance VLBI analysis system using GRID computing technology. We are now developing the client/server type distributed computing system like the SETI@home. Client/server-type distributed computing system is distinguished by having following three features. First, a large amount of data is divided in small units and transferred to the client PCs. Second, sent data are analyzed by the PCs. And third, results of the analysis are sent back to the server. This type of system generally works well only when the network speed is faster than the analysis speed in client PCs. At present, K5 software correlator have a capability to process 4 Mbps data in real time when it runs on a PC equipped with a Pentium3 1GHz. Thus, distributed computing method has the potential to improve the software correlation speed dramatically if the 10Mbps, 100Mbps or more high speed network environments are equipped.

2. Overview of the system

The developing system consists of following components: control server that controls whole system, database server that stores processing conditions of VLBI data and statistics of each client PC, FTP servers at each VLBI site that transmit observed raw data to the clients, and a lot of clients by which VLBI data are correlated. When a screensaver-type client software activates, it ask the control server about filenames of the data to be correlated and IP addresses of observed VLBI sites. The client downloads the data from the FTP servers and correlates the data. Resulting data and some information such as download time and correlation time are reported to the database server via the control server.

3. Bottleneck of the system

There are three factors which can become a bottleneck of the system. Data processing rates of clients, network speed and data transfer rates of the FTP servers. These three factors can be monitored using statistical data stored in the database server. The data processing rates of clients can be calculated from recorded correlation times. A typical value of the rate using a 1CPU PC is 2 to 12 Mbps. If this factor is the bottleneck of the system, it is necessary to increase the number of clients or to improve the algorithm of correlation programs. The statistics of download time is used to evaluate the network performance. A typical network speed is 10Mbps to several Gbps. The network speeds around FTP servers determine the total performance of the system. If it is not enough compared to a total data processing rate of the clients, it becomes the bottleneck of the system. The data transfer rate of a FTP server is limited by the access speed of hard disks. A typical value is 200Mbps for random accesses and 1Gbps for sequential accesses. When it becomes the bottleneck, FTP mirroring is effective and ram disk can be used for real-time observations. Eliminating these bottlenecks, we can improve the system performance up to 10Gbps, the highest network rate we can use practically.

4. Current status of the system and future perspectives

The current performance of the system is 70Mbps using sixteen PCs. We are planning to perform a 64-Mbps real-time experiment as soon as possible. In this year, we will improve the network capacity and file server performances to achieve 1Gbps using a large number of PCs.