§44. Flexible Data Acquisition System for LHD

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We constructed a flexible and extensible UNIX-based distributed monitoring system, consisting of data acquisition, distribution and monitoring subsystems. The acquisition subsystems transmit signals from physical targets by network multicasting. These signals and derived quantities are reconstructed on each network-connected workstation to form ``virtual targets of observation", from which the monitoring subsystems obtain quantities of physical interest. When separated from acquisition and distribution subsystems, monitoring subsystems can be easily designed. The monitoring performance can be arbitrarily increased by increasing the number of monitoring workstations in the network.

The distributed system is composed with 3 kinds of segments: R(realtime data transfer), C(control data transfer) and X(external service). Signals from the sensors are amplified by insulation amplifiers, and digitized by analog-to-digital converters. The acquisition workstations acquire digitized realtime data, and send them via segment R by multicasting to other workstations. The number of these other workstations can be increased arbitrarily. Workstations display the received data either temporally or spatially, so as to utilize humans' high pattern-recognition ability. Automatic warning is possible, provided the algorithm to warn is given. The acquisition workstations not only send slow realtime data, but also summarize fast data into slow data, detect interesting events from fast data, store fast data intermittently to the disks. After data compression, the stored data are sent to Workstation for long-term storage. Stored data are used for later analysis. Workstations, outside the firewall, receive data from inner workstations, and service them to the outside world on realtime basis. They send data directly by TCP (the Transmission Control Protocol of the Internet) to distant co-workers, and by access-restricted World-Wide Web (WWW) servers to other workers.

Physically measured data are sent to all workstations by multicasting, and compose what we call ``virtual targets of observation". Monitoring processes can acquire physical quantities directly from these virtual targets. The virtual targets hold data within a specified time span. They also hold quantities derived from multiple data, such as rates of change and flows rate. Quantities can be derived from combined data originating from multiple ADCs. Monitoring subsystems can thus be designed independently of the acquisition subsystems physical configuration. It is also independent of the configuration and electrical conditions of the measuring devices of the experiment. Monitoring programs can be designed easily, because physical quantities can be obtained by first specifying the name of the virtual target of observation, and then by specifying the name of the observed data.

Our experiments on 10Mbps ethernet and Sparcstation IPX/SS2 show that 256 channel realtime monitoring at a speed of 250k samples (500 packets) per seconds can be easily obtained; 2.5M samples per second is within reach by using suitable machines and networks.

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