High-Speed data handling using reflective memory thread for tokamak plasma control

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Abstract
The Korea Superconducting Tokamak Advanced Research (KSTAR) plasma control system (PCS) is defined as a system consisting of electronic devices and control software, which identifies and diagnoses various plasma parameters and calculates appropriate control signals to keep the plasma sustained in the KSTAR operation regime. The KSTAR PCS consists of a linux system with 8 processors and both analog and digital data acquisition methods are adapted for fast real-time data acquisition. The digital interface uses a reflective memory (RFM) technology to enable PCS to interface with the actuators in real-time and to share data among various subsystems of KSTAR and to do interprocessor communications inside the cluster. In the KSTAR PCS, the communication using the RFM is implemented as a thread to handle the fast control of the RFM data transfer.

Introduction to the plasma control system
- Composed of real-time computers & diagnostic system & communication interface
- Acquires plasma data
- Performs a feedback control algorithm
- Sends commands to the MPS and receives the measurements from the MPS
- Has an optical network interface consisting of Reflective Memory (RFM)
- Manufacturer: General Electric company
- Low latency and wide throughput
- Onboard circuitry automatically transfer performs the transfer to all nodes
- Transfer rate: 174 MB/s [factory], 96 MB/s [interrupt-free mode]

RFM thread and PCS feedback algorithm
- Child process of one of real-time processes
- Synchronizes itself with real-time control cycle
- Copies the RFM data to a shared memory area at each cycle
- Reads PF coil currents and voltages from a fixed RFM area
- Waits for “new time”
- Writes the PF commands to the fixed RFM area using DMA transfer
- Determined by the clock source of the digitizer

Function of the Interface controller
- Minimum Feedback cycle: 500us
- Gating cycle: 0.69ms – 2.78ms

Actual MPS control result
- Command & Data Structure

Issues & Future plan
- Increase the amount of data through the RFM network
- Upgrade the RFM memory card to the PCI-express bus format
- We have plan to improve the algorithm of the RFM thread to safely handle other possible unintended situations