Migration from WorldFIP to a Low-Cost Ethernet Fieldbus for Power Converter Control at CERN

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Introduction
Power converter control in the LHC uses embedded computers called Function Generator/Controllers (FGCs) which are connected to WorldFIP fieldbuses around the accelerator ring. The FGCs are integrated into the accelerator control system by x86 gateway front-end systems running Linux. With the LHC now operational, attention has turned to the renovation of older control systems as well as a new installation for Linac 4. A new generation of FGC is being deployed to meet the needs of these cycling accelerators. As WorldFIP is very limited in data rate and is unlikely to undergo further development, it was decided to base future installations upon an Ethernet fieldbus with standard switches and interface chipsets in both the operate with either type of interface.

A gateway computer includes a CERN-designed CTRI timing receiver, which is configured to provide interrupts for the software and the 50 Hz sync signal for the FGCs. This is transmitted on a coax cable in parallel with the 1 Gbps Ethernet backbone that links the gateway to the switches. Each switch is mounted above a pulse injector to form a star point supporting up to 22 FGCs. Up to 64 FGCs can be connected to one FGC_Ether fieldbus, requiring a minimum of three star points. More than three can be used if the geographical distribution of converters favours such a topology.

Diagnostic Tools
- Kontron PCI7160 2U industrial PC.
- CERN-designed CTRI PCI timing receiver.
- 64-bit Scientific Linux CERN 6 (SLC6) operating system.
- MRG real-time kernel.
- Function Generator/Controller Daemon (FGCD) software framework.

Ethernet Switch
- Cisco SF 102-24 standard Ethernet switch.
- Unmanaged.
- Two 1 Gbps ports.
- Twenty four 100 Mbps ports.

Addressing
- The fieldbus address for each circuit is encoded into the front of each FGC.
- For power converters with replaceable modules, the dongle is fixed to the Ethernet cable.

Conclusions
Early experience from operational use of FGC_Ether is encouraging. Up to 3000 nodes are expected to be deployed over the next decade, so the fact that FGC_Ether is based upon standard low-cost COTS components will provide significant savings and provide security against component obsolescence. The compatibility with the FGC protocols used with WorldFIP allowed significant code reuse, accelerating development and reducing maintenance costs for the future.