NLC - The Next Linear Collider Project

Synchronization Issues: EPICS for Pulsed Machines

EPICS Collaboration Meeting, SLAC 1999

Pulsed?

Applications

Real Time Network

TRIO

Mark Crane

5/25/99

Beam-based Functionality

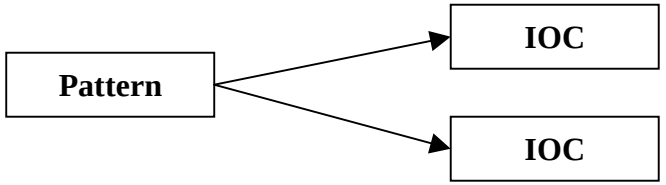
- What does “pulsed” control system mean?
  - Slow command and status channels
    - There needs to be a general facility to setup and operate the remote computational nodes using a general purpose network architecture.
    - There also needs to be a communications path to set and retrieve information in a “database” whether local or remote.
    - Functions that are not pulseid aware but are required for proper accelerator functioning. Examples are general analog and digital status monitors, IOC maintenance functions, etc.
  - Beam based data handling
    - Functions that are pulseid “aware” but do not act upon the data before the next pulse. This includes setting up to acquire BPM data, actually acquiring the data and tagging it with a pulseid then send it off to other tasks for processing or streaming it to external data stores.
  - Hard realtime data acquisition, computation and control
    - Functions that MUST acquire and process data before (or well before) the next pulseid. These functions use fast communications systems and are not “blocked” by any other activities in the local CPU. This is obviously special function code written directly for the application at hand

Pulsed Applications

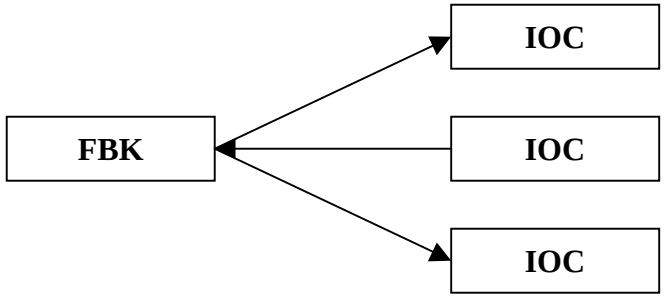
- Acquire, process, and distribute data in the “interpulse time period” of ≅ 8 milliseconds (120Hz)
- There isn’t native support in EPICS for this when combined with NLC data processing requirements
- Applications:
  - Beam Pattern Broadcast
  - Fast Feedback
  - Low Level RF
  - Machine Protection System
  - Synchronized data acquisition on sequential pulses

Pulsed Applications cont.

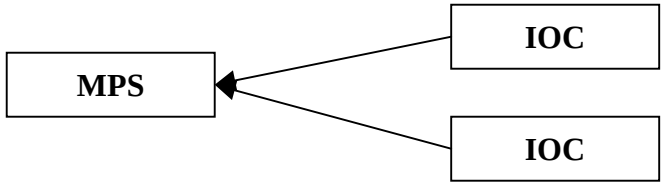
- Beam Pattern Broadcast
  - Beam pattern broadcast to all pulsed IOCs at 120Hz (or 480 Hz)



- Fast Feedback / Cascade
  - IOC to servers to IOC data shared at 120Hz



- Machine Protection System
  - Data passed from IOC to central supervisor at 120Hz



Pulsed Applications cont.

- Beam-based functionality is custom code using the local IOC database, EPICS utilities, and VxWorks objects running as separate high priority tasks in the same IOC as normal EPICS. This is not EPICS itself doing 120Hz operations.
- SLC “pulsed” system is the same, only the OSes and protocols are different
- Many other examples...

Realtime Network

- Provide IOC to IOC data transfer between 120Hz beams
- Most systems have a separate network for this purpose, new technologies should allow a single network
- A single network reduces costs by using common test equipment, monitoring systems, and technical knowledge
- Allows us to use the standard EPICS installation - IOCs in the alcoves
- The risk is that it works well locally, but cannot be reliably extended to the distances required for the NLC
  - Lost packets, mangled packets, and high latency caused by the number of interfaces between source and destination

Realtime Network R&D

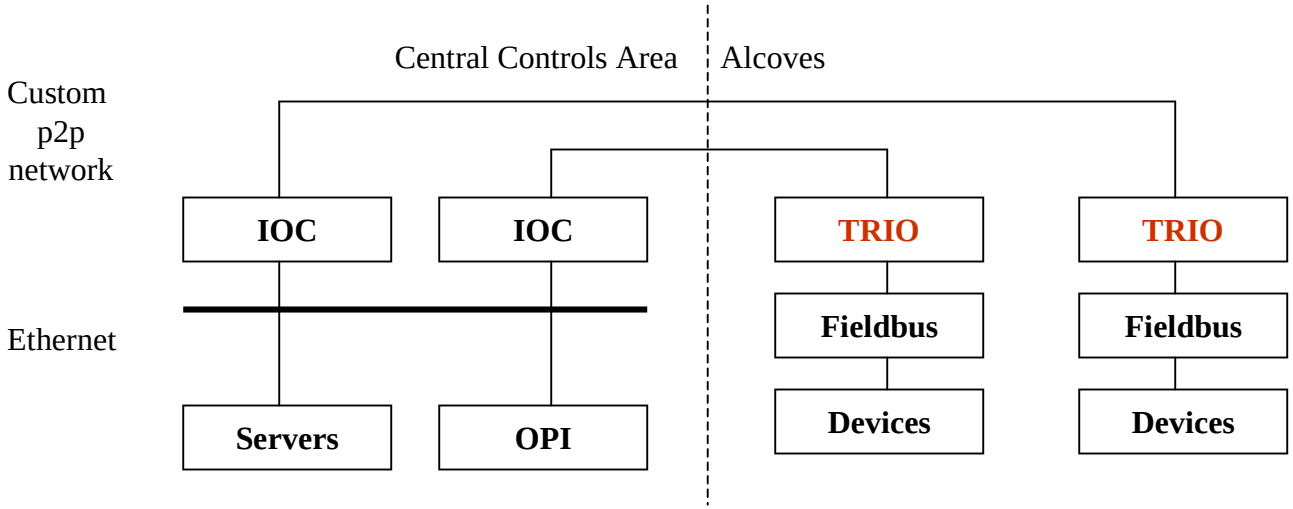
- Demonstrate that standard, commercial, “open” network technologies can provide high bandwidth, low latency, and reliable quality of service guaranties.
- R&D Plans:
  - Perform point-to-point, low latency, deterministic communications on the same network as bursty, high bandwidth traffic
  - Segment system and provide wire speed QoS (IP based protocols)
  - Scale to 1300 QoS nodes plus >1500 normal nodes (traffic simulation)
  - Reliably (and cost effectively) extend from 100 meters to 18 kilometers
  - Provide testbed for other systems who will use this network

Trio Architecture

- Triggered Remote Input / Output system
- Address electrical noise and physical environment issues
  - Provide noise immune communications and processing
  - Provide custom rugged hardware with very low failure rates
  - Buy inexpensive IOC hardware for “nice” environment
- Address communication needs
  - Fast, low latency, deterministic data flows and normal data flows
  - Provide 18Km point to point fiber links
  - Provide IP traffic gateway
- Address pulsed operations
  - Provide very reliable software near the devices which are processed at 120 Hz
  - Pass the rest of the data up to IOC for general processing

Trio Architecture cont.

- IOCs in “glass house” in the central controls area
- Rugged CPU platform in the alcove connected to custom network with reliability and low latency designed in
- Fieldbusses connected using custom hardware



Summary

- Others have done pulsed but not at this scale
- Challenge of using a single network for all traffic
- TRIO architecture to catch possible risks
- Who has working examples of this type of code?