NLC - The Next Linear Collider Project

NLC Network R&D Project

Project Overview

Project Goals

More Details

Descriptions (a few)

Schedule

Resources

Status

Mark Crane

6/30/99

Project Overview

- Prototype and examine a system design based on commercial networking equipment which can provide high bandwidth, low latency, and reliable quality of service to meet NLC requirements.
- This network will be used for real time data to the alcoves in the "open" design and used for glass-house intra-IOC connectivity for the "TRIO" design.
- The output of this project will be a test lab capable of simulating the NLC controls network and a written report detailing the test configuration and measured performance details.

Network Overview

- Global network to provide alcove connectivity
  - Model uses Gigabit Ethernet as the physical layer protocol
  - Scaleable, fault tolerant, commercial network
  - TCP/IP based protocols to allow network segmentation
- 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
  - 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

Project Goals

- Demonstrate that standard, commercial, “open” network technologies can provide high bandwidth, low latency, and reliable quality of service guaranties.
  - 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 network test bed for sub-system interoperation testing
  - Narrow down technology choices
  - Provide more detailed input to cost model

More Details

- Provide real time network connectivity to every alcove using TCP/IP protocols
- Use 100/1000 Ethernet with QoS enabled hardware/software
- Identify possible VME based fast Ethernet full duplex CPUs or use PCs with VxWorks supported NICs
- Can “open” protocols such as UDP (over IP) be used?
- Determine if the memory-to-memory protocols being developed fit into this architecture (such as VI)
- Provide test applications to simulate 120 Hz real time traffic and measure latencies with loaded network
- Busy n nodes using EPICS Channel Access tools to present background traffic
- Busy n nodes using bursty, high bandwidth streaming data flow

Even More Details

- Determine if network should be "flat" or subnetted to support multicast/broadcast
- Verify wire speed routing and VLAN operations
- Test link aggregation protocols with real time data passing
- Verify Gigabit Ethernet performance over 18Km of fiber
- Discover any long fiber link latency issues (race conditions, protocol timeouts, retries)
- Discover any fiber temperature/routing issues
- Develop test for EMI induced noise and/or specify AC power filtering and EMI shielded rack specifications
- Test failover of network hardware to determine the effects on the Control System

Description

- Phase 1:
  - Determine if “open’ network equipment and protocols can provide “compute farm” real-time QoS interconnect
- Phase2:
  - Determine if high bandwidth bursty data can be transferred on these same nodes, protocol, and network and still guarantee QoS
- Phase 3:
  - Determine if this architecture scales from a few test nodes to 2000 nodes with QoS plus 2000 normal nodes using segmentation
- Phase 4:
  - Determine that this can be done with nodes as far away as 18 Km. Refine testing operations and open test bed to other groups for integration testing

Detailed Description

- Phase 1: Local QoS interconnect?
  - Develop detailed project goals and requirements (phase 0?)
  - Document the various network configurations and arrange for component availability
  - Write specifications for required test software (real-time VxWorks based network code)
  - Write specifications for network device configurations (Cisco IOS setup and routing scripts)
  - Buy VxWorks license (wish list)
  - FY00 - Buy generic PC based network edge devices
  - Integrate test setup in local lab and perform basic testing
  - Perform Test #1 in local lab- basic connectivity and proof of concept
  - Analyze results and refit test setup as required
  - Perform Test #2 in remote lab - Is there end to end QoS and examine complexities with powerful network systems
  - Analyze results and refit test setup as required

Detailed Description (cont)

- Phase 2: QoS guarantees even with loaded network?
  - Characterize bursty data requirements and setup traffic generation
  - Perform Test #3 in remote lab - Is there end to end QoS along with the bursty data
  - Analyze results and refit test setup as required
- Phase 3: Scaleable and segmentable?
  - Determine the amount of segmentation required and implement changes
  - Perform Test #4 in remote lab - More QoS and wire speed routing using VLANs
  - Analyze results and refit test setup as required
  - Project review before selecting and purchasing network equipment (milestone)

Detailed Description (cont)

- Phase 4: Long lines, refinement, integration testing
  - FY01 -New person added to project
  - Purchase network hardware
  - Write new configurations for the purchased equipment
  - Setup local test lab
  - Perform Test #5 in local lab - Proof of system and full time loaded testing
  - Analyze results and refit test setup as required
  - Perform Test #6 in local lab - Possibility that 120hz code is available, test real code
  - Analyze results and write up test results
  - Review these test results along with results from the TRIO design
  - Write CDR text
  - FY02 - Tweak configurations and support 120Hz integration into test lab setup

Schedule

- FY99
  - Develop detailed project goals, requirements, and network/software/hardware needs
- FY00
  - Test #1 & 2 in local lab - basic connectivity, proof of concept, end to end QoS
  - Test #3 in remote lab - More QoS and wire speed routing
- FY01
  - New person, review and purchase hardware
  - Test #4 & 5 in new local lab - Proof of system, loaded testing, test real NLC code
  - Review test results along with results from the TRIO design
- FY02
  - Tweak configurations and support 120Hz integration into test lab setup

Team/Resources

- Will require help from the SCS network group
- May require NIC driver software consulting
- Will require hardware and software personnel to integrate
- Some networking equipment may be borrowed
- Most interconnects should be purchased but there may be custom cables/circuits required
- Test system will be installed in:
  - a) old PEP Control Room?
  - b) Building 34?
  - c) elsewhere?

Status

- Investigated other Labs designs and capabilities (RT99)
- Learned details of Real-Time Linux for possible usage
- Investigated Cisco 3500 series as replacements for 29xx
- Studied 3COM Intelligent network solutions for ideas
- Still gathering and classifying bandwidth requirements
- Working on prototype specifications
- Estimating software development time for input to controls group
- Compiling list of items to be purchased (VxWorks license, switches, NIC's, fiber optic cable,etc)