NLC
Control System Challenges

November 30, 1998

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for
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HELP!

- Large Facility - SSC Class
- Complicated - Multiple Pulsed Machines
- Large(st) EPICS Site - Scaling Issues
- Aggressive Schedule
- Management/Sociological Issues

Site Diagram

System Parameters

Center of Mass Energy	500-1000GeV
Repetition Rate	120Hz
Bunch Charge	10^{10}
Bunches/RF Pulse	87
Bunch Separation	2.8ns
Unloaded Gradient	77MV/m
Linac Length	10Km

System Parameters, Contd.

Total Length	30Km
Power/Beam	4-8MW
# of Klystrons	3168-6624
# of BPMs	12000
Total AC Power	100-200MW

NLC Strategic Plan

International Collaboration and Competition

Either

- U.S.-led project built in the U.S. with major foreign participation.

or

- Foreign-led project built elsewhere with major U.S. participation.

DOE Life-Cycle Milestones

Pre-conceptual Activities R&D	Present
Decision of Mission Need Conceptual Design	Spring 1999
Project Baseline Approval Pre-construction Engineering and Design	Spring 2001
Construction Start	Fall 2002
Operational Approval	Fall 2008

Challenges & Risk Factors

- High Bandwidth Network Systems
- High Resolution Timing System
- Large Volume, High Rate Beam and RF Data Management
- System Extensibility: EPICS, Networks

NLC Beam Pulse Needs

- Pulses are precious
- Feedback is everywhere, need all the pulses they can get
- Buffered acquisition (jitter studies, dither studies, alignment) coexist with other users.
- Some studies require synchronized acquisition of up to 10,000 pulses.
- Lots of BPMs, lots of users, most of whom should not need to know arcane details of BPMs.

BPM Data Rate

Type	Quantity per Sector	Measurements	Data Rate Processed (per sector)	Data Rate Raw (per sector)
Q	<= 36	(X,Y,Q) for first 5 modes	130 kB/s	9 MB/s
FB	10 (instrumentation sections only)	(X,Y,Q) for each of 180 bunches	1.3 MB/s	2.5 MB/s
S	108 (9:1 multiplexing)	(X,Y,Q) for selected mode	10 kB/s	6.6 MB/s

Feedback BPM Data Rate

- Processed Data:

  (X,Y,I) x (2 bytes) x (180 bunches)x
  (120 Hz) = 130 KB/sec/BPM

- Raw Data:

  (R,G,B,Y) x (2 bytes) x (256 samples)x
  (120 Hz) =250kB/sec/BPM

Buffered Data Acquisition

- 10^4 pulse buffering of BPM data
- 1.5 MB/sec/sector (max) x 90 sec = 135 MB/sector
- 130 KB/sec/sector x 90 sec

  = 12 MB /sector (in non-diagnostic sectors)
- 1.5 minutes is even time for an operator to hit a "FREEZE BUFFERS" button. (18 minutes @ 10 Hz ops)
- ~500 MB/hour/sector for non-bunch-by-bunch BPM data.
- 4 GB/shift/sector

Aggregate Bandwidth in Main Linacs

- 46 regular sectors x 65 KB/sec = 3 MB/sec
- 10 instrumentation sectors X 1.5 MB/sec = 15 MB/sec
- Total BPM (processed) bandwidth = 18 MB/sec

NLC Timing and Phase Distribution

- Synchronize timing throughout machine
- Provide RF phase reference
- Machine Protection functions
- Optional: provide broadcast data

Timing System Requirements

- Maximum link length 15KM
- Timing stability /jitter <l0 psec
- RF phase jitter $<0.3^{o}$ X-band
- RF phase stability (1 second) < $l0^{o}$ X-band
- RF phase stability (long term) $<20^{o}$ X-band

Anticipated EPICS Extensions for NLC

- Scaling Issues
  - Expect 3-5 million PVs
  - Network segmenting to reduce broadcast load
  - PV servers with dynamic update
  - Brokers?
- Timing Synchronization
  - IOC synching for 120Hz Operation
  - Buffered Acquisition

EPICS Extensions, Contd.

- Pulse ID/Time stamp for feedback Use and Correlation studies
- Dithered Acquisition

- Database Issues
  - Beyond CAPFAST, DB Design Tools (Preferably integrated with Central Database)
  - Odds & Ends Including On-line add/delete, Unlimited name length and string, etc.

EPICS Extensions, Contd.

- Channel Access
  - Unlimited matrix Bounds & String length
  - Extensible Types (Application defined container)
  - Message Passing
  - Command Completion
  - C++ Client API to support extensibility
  - Directory Service
  - Multi-Priority Clients
  - Synchronized Setting of Devices Across IOC's

EPICS Extensions, Contd.

- Next Generation OPI
  - By 2005 Almost certainly Web-based, except maybe in the Control Room
  - Similar Interface for low and high-level Apps?
  - Applicable to Portable devices (PDA) for Use by Technicians in Accelerator Housings, etc.
  - "Button Macro" Automation Tool

Above Channel Access Tools and Applications

- Our Biggest Challenge to Satisfy Customers Used to SLC Type Applications
- Do we Just use Channel Access or a "Bus" Protocol to Connect the Extensive Set of Apps (SLC has >1 Million Lines of Code)?
- SSC Had Considered the Use of Software Bus. Several Exist at Various Labs.

Above Channel Access Tools and Applications

- Extensive Archiving
  - Handle Tera Bytes of Pulsed and Regular Data
  - Channel Archiving of Buffered Data
  - Data to Include Values, Statistics, Status, etc.
  - Efficient Saving and Restoring of up to Several years Worth of Data (peta byte?)
  - Data Browser Capable of Analyzing Pulsed Correlated Data Across Linacs.

Applications, Cont.

- Extensive Save Set Archiver
- Correlation Plot Facility
- Physics and Modeling Packages
- Physicist "Sand-Box" with Easy Access to Machine Data for Prototyping (MATLAB, etc.)

Conclusion

- Need Help in All Phases of the Project, from the Conceptual Steps to Implementation.
- Users 'Experience with EPICS Extremely Valuable to Us.
- The Goal Would be to Use NLC Resources to Enhance EPICS Rather than to Fork.