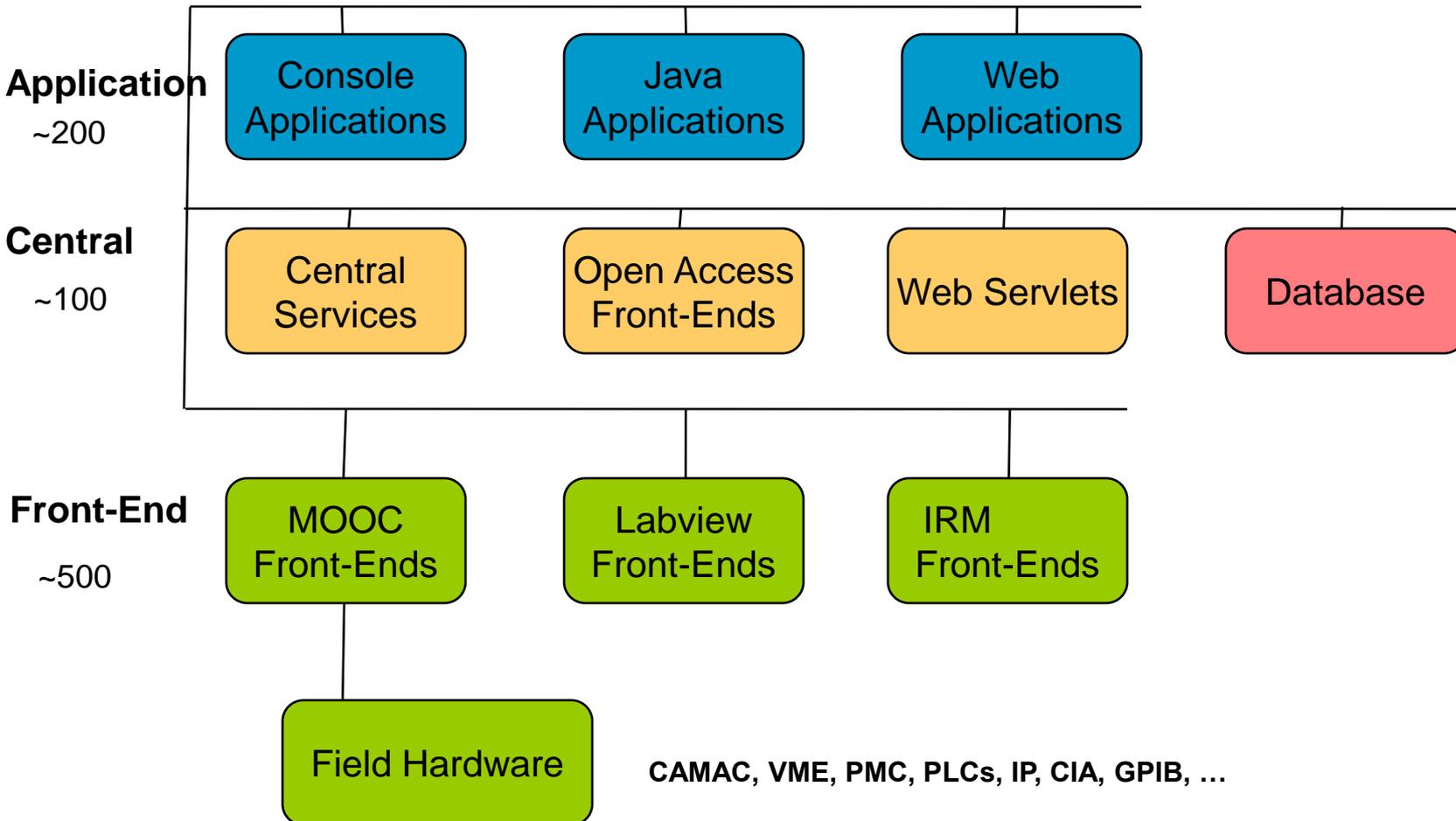


Director's Review of the Project X Cost Range Estimate: Controls

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Project X Director's Review
March 16, 2009



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- Scope of Estimated Work
 - Boundary Conditions /Assumptions
 - Basis of Estimate
 - Technical Risks/Associated Cost Exposure
 - Potential Technical Revisions
 - Role of Outside Collaborators
 - Summary



Project X Control System Scope

Project X



- Control System Infrastructure
 - Software frameworks – front-ends, services, applications
 - Core services – alarms, data acquisition, archiving, database, etc.
 - Network infrastructure – central and remote switches and cabling
- Timing System
 - Central timing generator and distribution
- Machine Protection System
 - Not including detectors



- Technical subsystems
 - Vacuum
 - LCW
 - Motion Control
 - Tunnel cryogenics
 - High level power supply control
- Application software
 - Technical subsystems
 - Utility applications
 - Machine applications
- Not included here:
 - Instrumentation controls including front-ends
 - RF controls including front-ends



- Pulsed machine – 5 Hz upgradeable to 10 Hz
- Potentially different characteristics and disposition of each pulse
- Pulse to pulse feedback for required stability
- Scale roughly comparable to the current complex:
 - ~350K device properties
 - ~500 front-ends
 - ~100 central services
 - ~200 consoles
 - Archive ~50K devices; ~10's GB/day



- Evolve current core system through the NOvA era to Project X
 - Refurbish obsolete systems in MI/Recycler with Project X appropriate hardware (and software)
 - Large amount of CAMAC, fate t.b.d.
 - Modernize software frameworks
 - Support EPICS front-ends and display screens
- Network infrastructure for Project X linac
- Develop new timing system for Project X linac
- Develop new machine protection system for linac
- Develop Project X specific software applications
- Test new technology at the HINS and NML facilities

Boundary Conditions & Assumptions



- Quantities are estimates, detailed design not yet done
- Costs assume similar equipment to recent purchases
- MS Project M&S = Spreadsheet M&S x 1.15 (spares) + RD&D
 - Subsystem numbers quoted below are from spreadsheet
- Current year \$, no contingency

Project X Network Infrastructure



- Three networks:
 - General
 - Development – partially firewalled – encompassing test areas
 - Technical – firewalled
- Central backbone switch for each with redundancy
- Access switch in each service building for each
- Fiber bundle runs to each service building
 - Includes fiber for timing, machine protection, ...
 - Duct work/cable trays in conventional facilities
- Cost estimates based on
 - Current Cisco price list
 - Estimate from Meade Electric for fiber and installation

Project X Computing Infrastructure

Project X



- Consoles, central computers, database
- Additions for Project X linac
- Replacement of some systems for Project X era
 - Expect to turn over some NOvA era hardware
- Consoles w/multiple displays
 - Main Control Room and service buildings
- Central processing nodes including data logging
- Central database machine w/redundancy
- Estimates based on current technology/costs



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- \$1.6M
 - \$688K Fiber Infrastructure; includes installation labor
 - 30 FTE-years labor

Project X Equipment Infrastructure



- Hardware Platform Support (VME or successor etc.)
 - Racks with power
 - Cable Trays
 - Layout and Management
 - Installation included in M&S (T&M)
-
- \$973K total
 - 8.75 FTE-years labor



- New protocol with higher bandwidth links
 - Interface with current system if necessary
- Custom Central Timing Generator
- Custom Distribution
 - Repeaters
 - Fanouts
 - Uses above global fiber plant
- Custom Front-end Receiver Module Engineering
 - Multiple form factors
- \$113K M&S
- 28 FTE-years labor



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- Custom input modules
 - Local cabling
 - Uses global fiber plant, costed in networking
 - Custom central concentration crate
 - Detectors under Instrumentation
-
- \$191K M&S
 - 10 FTE-years labor



- PLCs control
 - Gauges
 - Valves
 - Pumps
 - Low level equipment in machine estimates
- Front-end processor interfaces PLCs to control system
 - Via ethernet
- Commercial hardware

- \$476K M&S



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- Collimators
 - RF tuners
 - Profile Monitors
 - Stripping foils
 - Assume similar to systems we are building now
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- \$899K M&S
 - 5 FTE-years labor



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- PLC based systems
 - Similar to recent systems for NUMI

 - \$27K M&S
 - 2 FTE-years labor



- General purpose nodes with
 - High density, modest rate/resolution digitization
 - DACs
 - Digital I/O
 - Timer
- High level power supply control
- Motion control front-ends
- Tunnel cryogenics
- Misc

- \$355K M&S
- 7 FTE-years labor

Project X Technical System Totals



- \$2.87M M&S
- 61 FTE-years labor



- **Front-end**
 - Modernized infrastructure
 - System specific code
 - 27 FTE-years
- **Central Services**
 - Modernized infrastructure including feedback
 - Specific services
 - 20 FTE-years
- **Applications**
 - Modernized infrastructure
 - Generic applications
 - Machine specific applications
 - 25 FTE-years



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- Requirements and design for software infrastructures
 - Evaluation of hardware platforms beyond VME
 - Design and prototyping of new Timing system
 - Design and prototyping of new Machine Protection system
 - Standards for remotely developed subsystems
 - Design and prototyping of other technical systems as needed



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- \$5.61M M&S including spares and RD&D plan
 - 190 FTE-years labor including RD&D plan
 - \$26.4M



- Large scale
 - Scale and complexity comparable to current facility
 - Drop Tevatron, linac, booster; add Project X linac, transfer line
- High Availability Requirement
 - High Availability hardware platforms required?
- Machine Protection
- Pre-existing MI/Recycler hardware including timing system
- Integration of externally provided subsystems
- Support of separate test facilities for production checkout



- HINS and NML important test facilities
- Tests will include:
 - New style vacuum, motion control
 - New Timing system prototypes
 - New Machine Protection system prototypes
 - New Hardware platforms
 - Integration of instrumentation developed elsewhere
 - Software
 - New software infrastructures
 - Integration of EPICS

Potential Technical Revisions



- High Availability hardware platforms (ATCA or related)
- New technologies become more appropriate in some areas
- Additional renovation of MI/Recycler may be required
 - Especially if the RF frequency is changed



- Collaboration on controls infrastructure
 - Initial contact with SLAC and Argonne
 - SLAC interest in evaluation of new hardware platforms (xTCA etc.)
 - Possibly develop RF interlocks for SLAC test-stand in xTCA
 - No definite plan at this time
- Externally provided subsystems
 - We expect to provide standards for interfacing to the control system
 - Software and hardware platforms
 - We expect to support inclusion of EPICS based subsystems
 - With standards for supported tools, conventions etc.
 - We will provide timing or other general purpose hardware if needed for remote subsystem development



- General strategy is to evolve the current control system through the NOvA era prior to Project X linac operation
- New hardware and software for Project X Linac & Transfer Line
 - Modernize software frameworks
 - Integrate EPICS
 - Refurbished hardware in MI/Recycler for NOvA era not included
- Cost estimate based on technology being currently implemented
- Test hardware prototypes, new software infrastructures at HINS and NML