|  |  |  |
| --- | --- | --- |
| nscl.PNG | National Superconducting Cyclotron Laboratory | msu.png |

Project Plan [Baseline 10-Mar-10]

|  |  |
| --- | --- |
|  |  |
| Project Name | CA Protocol on Rabbit |
| Project Code | CAPOR |
| Account | 2306-001-EE-015 |
| Department | EE |
| Project Leader | John Priller |
| Project Coordinator | Vasu Vuppala |

|  |  |  |  |
| --- | --- | --- | --- |
|  | Name | Signature | Date |
| Prepared By | Vasu Vuppala |  |  |
| Reviewed By | John Priller |  |  |
| Approved By | John Vincent |  |  |

Revision History

|  |  |  |  |
| --- | --- | --- | --- |
| Version | Date | Author | Description |
| 1.0 | 1/20/10 | Vasu V | Initial |
| 1.1 | 2/4/10 | Vasu V | Added cost, approval form. |
| 1.2 | 2/5/10 | Vasu V | Modified the approval form |
| 1.3 | 3/9/10 | Vasu V | Added schedule information. Fixed small errors. |
| Baseline | 3/10/10 | Vasu V | Added Appendices. Baselined |
|  |  |  |  |

|  |  |
| --- | --- |
| **Project Plan Approval Form** | |
| **Approval Procedure*:***   1. Project Coordinator (PC) sends the Project Plan (PP) to Department Head (DH) for approval. 2. DH approves the PP by signing this form or acknowledging it via written communication such as email 3. PC sends the PP to the Customer 4. Customer approves the PP by signing this form or acknowledging it via written communication such as email | |
| ***Project***: CA Protocol on Rabbit (CAPOR) | ***Customer***: Kelly Davidson |
| *Project Leader (PL)*: John Priller | *Project Coordinator (PC):* Vasu Vuppala |
| ***Project Description***:  Most of the embedded controllers used in the NSCL control system, developed by the Electrical Engineering Department (EE), are based on RabbitCore Module (RCM) from Rabbit Corporation. The primary mode of communication with the embedded controllers is through the ModBus/TCP protocol. The ModBus/TCP protocol has several limitations with respect to the NSCL control system. To address some of the limitations, this project will implement the EPICS Channel Access (CA) Protocol on the RCM platform. | |
| ***Estimates****:* See CAPRO Project Schedule and Budget for Details   |  |  | | --- | --- | | *Effort*: 927 Person Hours | *Cost*: 65305.00 USD | | *Start Date*: 14 Jan 2010 | *End Date*: 14 Sep 2010 | | |
| ***Project Team****:*  John Priller  Mark Davis  Vasu Vuppala | |
| ***Comments***:  Effort and cost include contingency, and are slightly less than the estimates in Preliminary Project Plan. | |
| *Approvals*:   |  |  | | --- | --- | | Department Head: | Date: | | Customer: | Date: | | |

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# Project Overview

## Introduction

National Superconducting Cyclotron Laboratory (NSCL) is a world leader in rare isotope research and nuclear science education. NSCL scientists and researchers conduct advanced research in fundamental nuclear science, nuclear astrophysics, and accelerator physics. To facilitate the research, NSCL operates multiple particle accelerators. The control system at NSCL enables operators to control the various devices in the lab: ion sources, cyclotrons, beam lines, experimental devices, and auxiliary equipment. It is based on the Experimental Physics and Industrial Control Systems (EPICS) standard. EPICS is a distributed soft real-time control system for large scientific experiments.

Most of the embedded controllers used in the NSCL control system, developed by the Electrical Engineering Department (EE), are based on RabbitCore Module (RCM) from Rabbit Corporation. The primary mode of communication with the embedded controllers is through the ModBus/TCP protocol. The ModBus/TCP protocol has several limitations with respect to the NSCL control system. To address some of the limitations, this project will implement the EPICS Channel Access (CA) Protocol on the RCM platform.

## Business Need

The ModBus/TCP protocol is simple, and has limited requirements in terms of memory and compute cycles. Hence, it is a good match for the limited resources on the RCM platform. However, it does not have provisions for asynchronous event notifications; it has to be polled for device status. This puts a burden on the network. It does not provide logical naming for device data, which makes it cumbersome to maintain its configuration especially in an EPCIS-based environment.

Switching to the CA protocol will conserve network (asynchronous event notifications) and staffing resources (standard naming, native protocol).

## Value Engineering

Value Engineering (VE) strives to increase the value of a product by analyzing its functions, evaluating the alternatives, and maximizing the ratio of function over cost. The function of this project is to enable the control system to communicate with RCM-based controller in an efficient way. There are several communication protocols that can be used to achieve this: SNMP, ModBus – the current solution, and CA Protocol. The CA Protocol has several advantages over the alternatives:

* Native protocol for EPICS
* Conserves network bandwidth
* Easier to integrate and troubleshoot
* Potential contribution to the EPICS community

The cost for implementing the CA Protocol is detailed in the Project Budget section (Section 5). It will cost less to make enhancements to the current solution (ModBus). However, the advantages of CA over ModBus outweigh the difference in cost. The Project Leader will be responsible for VE activities throughout the project.

# Project Scope

The scope and WBS for the project is outlined in this document. The scope will be refined and the requirements will be detailed iteratively during the execution phase of the project (Execute Project Process in Quark). The scope will be verified against the deliverables during the conclusion of the execution phase. The scope will be controlled as per the Change Control process (Section 11.2).

## Scope Statement

### Scope Description

This project will develop the CA protocol on the RCM platform. It may not be possible to implement the complete protocol due to the limited resources on RCM. In any case, it is not envisioned to have the embedded controller be a full-fledged EPICS IOC (Input/Output Controller). However, the following features must be implemented:

* PV Search
* Channel Creation
* Channel Read
* Channel Write
* Event Notification: PV Change
* Server Beacons

### Product Acceptance Criteria

The implementation on a RCM3200 (RCM with a Rabbit 3000 processor) must pass the benchmark test.

### Project Deliverables

The deliverables are:

* The Binary Image
* Source Code
* Installation Manual: Describes how the image should be deployed
* User Manual
* Design documentation
* Acceptance Test Benchmark
* Test Plans (optional)
* Recommendations, if the implementation is not feasible

### Project Exclusions (Out of Scope)

The RCM based controllers currently in operation at NSCL can be divided into four categories depending on their CPU (Rabbit 2000 and 3000) and RTOS (DEBROS or non-DEBROS). This project will implement and test CA protocol on only one category: Rabbit-3000 based RCM running DEBROS. Non-DEBROS or Rabbit-2000 based RCMs are out of the scope.

The following features of CA protocol are out of scope:

* Access Control
* Repeater

### Project Constraints

* The solution must be built on DEBROS.
* The solution must run on the current RCM modules in EE department
* It must not alter the current update mechanism for embedded software

### Project Assumptions

* This project will test the implementation for only one device: 8-port Power Supply Controller
* It may not be feasible to implement CA protocol on Rabbit. As and when this becomes apparent, the stakeholders will be notified, and the project will be terminated.

## Milestones

* Project Plan
* DEBROS Training Material
* CA Protocol Training Material
* Software Requirement Specifications
* Architectural Design
* Low Level Design
* Version 1.0 b0
* Version 1.0 b1
* Version 1.0
* Project Closure Report

## Work Breakdown Structure

The WBS for this project is shown in Figure 1.

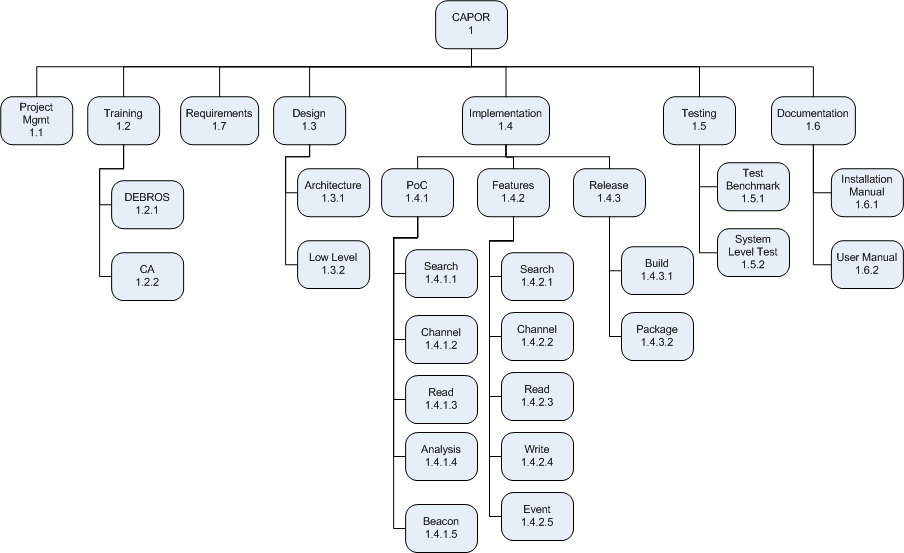


Figure Work Breakdown Structure

### WBS Dictionary

Table 1 describes the WBS elements from the previous section. The owners, estimated due dates and cost, for the WBS elements are indicated in the CAPOR Project Schedule [4].

Table WBS Dictionary

|  |  |  |
| --- | --- | --- |
| **ID** | **Name** | **Description** |
| 1 | CAPOR | CA Protocol on Rabbit |
| 1.1 | Project Management | All project management related activities |
| 1.2 | Training | Training required for implementing the project |
| 1.2.1 | DEBROS | Training on DEBROS and its documentation |
| 1.2.2 | Channel Access | Understanding EPICS CA in detail |
| 1.3 | Design | Analysis & Design activities |
| 1.3.1 | Architecture | High-level design and the resulting document. |
| 1.3.2 | Low-Level | Detailed design |
| 1.4 | Implementation | This includes coding, refactoring, and unit test (CRUT) |
| 1.4.1 | Proof of Concept | Implementation of the Proof of Concept (POC) |
| 1.4.1.1 | Search | Implementation of Search part of CA protocol |
| 1.4.1.2 | Channel | Implementation of Channel setup |
| 1.4.1.3 | Read | Implementation of channel Read command |
| 1.4.1.4 | Analysis | Size, performance analysis to evaluate feasibility |
| 1.4.1.6 | Beacon | Implementation of Server beacons |
| 1.4.2 | Features | Implementation of CA Protocol Features. Features already developed in PoC are refined here. |
| 1.4.2.1 | Search | Implementation of PV Search protocol |
| 1.4.2.2 | Channel | Implementation of channel setup |
| 1.4.2.3 | Read | Implementation of channel Read command |
| 1.4.2.4 | Write | Implementation of channel Write command |
| 1.4.2.5 | Event | Implementation of Event notifications |
| 1.4.3 | Release | Activities related to software release |
| 1.4.3.1 | Build | Compiling, Linking |
| 1.4.3.2 | Package | Packaging of the deliverables |
| 1.5 | Testing | All testing related activities |
| 1.5.1 | Test Benchmark | Development of test cases, and test program(s). |
| 1.5.2 | System Level Test | Performing system level tests |
| 1.6 | Documentation | Writing manuals |
| 1.6.1 | Installation Manual | Writing the documentation for deploying the deliverables |
| 1.6.2 | User Manual | Writing of the User Manul |
| 1.7 | Requirements | Requirements gathering, analysis, and documentation |

# Project Strategy

## Technical Strategy

The overall strategy for this project is as follows:

* Divide the work between a Soft IOC and the embedded controller, just like it is being done now. The embedded controller will provide read, write, and notifications for the PVs, and the soft IOC will take care of the rest.
* Knowledge-transfer on DEBROS. Understand DEBROS and develop documentation
* Investigate if code from CASL or any other open-source implementation can be used as the starting point
* Develop a proof-of-concept. Evaluate the resource needs. Terminate if the solution is not feasible.

The challenges for this project are:

* The limited resources on the platform.
* The Channel Access Server Library (CASL) from EPICS cannot be used. The protocol will have to be implemented mostly from scratch.

## Critical Success Factors

* Availability of DEBROS Subject Matter Expert (SME)
* Code optimization

## Project Life Cycle

The project will not be divided into subprojects. It will go through the activities as described in Quark. During planning or executing phases, if it becomes evident that the solution cannot be implemented, the project will be terminated.

## Product Life Cycle

* The first implementation will be a proof-of-concept (POC): Version 1.0 b0. If it is found that the implementation is not feasible, the project will be terminated.
* The lessons from the POC will be used to design the data structures and algorithms to optimize resource usage
* Test Plans will be developed to test and benchmark the solution for acceptance
* Functionality will be added and released in iterations (1.0b1 and 1.0)
* The NSCL development life cycle model will be followed as described in Quark. It will use an Agile approach at the beginning, and then move to a more predictive model with each iteration.

# Project Schedule

Schedule for this project is listed in *Appendix A – Project Schedule*. The details of the schedule are available in the CAPOR Project Schedule [4]. Changes to the schedule are controlled by the Change Control process (Section 11.2).

## Project Milestones

The milestones listed in Section 2.2 are marked on the CAPOR Project Schedule [4] and also listed in .

# Project Budget

For each work package, each relevant expert will provide three effort estimates – optimistic, realistic, and pessimistic. Weighted average of these estimates will provide the estimate for a work package. Such estimates from several experts will be averaged to arrive at the final estimate for a work package. The effort estimates, in person hours, will be converted to cost using a normalized rate of USD 70 per hour. Contingency will be calculated using the methodology defined in Quark. Variances from the budget will be monitored using the EVM methodology described in Quark. Changes to the budget will be controlled using the Change Control process (Section 11.2).

## Budget

The cost components and their timelines are given in Table 2 and . See the CAPOR Project Schedule [4] for budget details.

Table Project Budget

|  |  |  |  |
| --- | --- | --- | --- |
| # | Item | Cost (USD) | Date |
| 1 | Labor (843 Hours) | 59010.00 | Project Duration |
| 2 | Softools WinIDE License (Qty – 1) | 415.00 | 2/24/10 |
| 3 | Contingency (10% of Effort) | 5880.00 |  |
|  |  |  |  |
|  | Total | 65305.00 |  |

# Human Resource Management

## Organization

* Sponsor: John Vincent
  + Customer: Kelly Davidson
  + Project Leader (PL): John Priller/Vasu Vuppala
    - Project Coordinator (PC): Vasu Vuppala
    - Design Team (DES): Vasu Vuppala, Mark Davis, John Priller
    - Development Team (DEV): Vasu Vuppala, John Priller
    - Technical Writer Team (TW): Vasu Vuppala
    - Subject Matter Expert DEBROS (SMED): Mark Davis
    - Subject Matter Expert CA Protocol (SMEC): John Priller, Vasu Vuppala
    - Release Team (RE): Vasu Vuppala
  + Quality Manager: Vasu Vuppala
    - Test Team (TE): Vasu Vuppala, John Priller, Mark Davis
  + Configuration/Change Control Board (CCB): John Vincent, Kelly Davidson, John Priller

## Roles and Responsibilities

Refer to Quark for the standard roles and responsibilities. The additional roles are listed below.

|  |  |
| --- | --- |
| Role | Responsibility |
| SMED | Provide consultation and training in DEBROS |
| SMEC | Provide consultation and training in CA Protocol |
|  |  |

### Responsibility Assignment Matrix

The following table illustrates the responsibilities of various roles using RACI (R – Responsible, A – Accountable/Approver, C – Consulted, I – Informed) matrix.

Table RACI Matrix

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Work Package** | **Customer** | **Sponsor** | **PL** | **PC** | **DES** | **DEV** | **TE** | **DOC** | **RE** | **SMED** | **SMEC** |
| **1.1** | I | I | I | R | I | I | I | I | - | I | - |
| **1.2.1** | I | I | I | I | C | C | - | - | - | R | - |
| **1.2.2** | I | I | I | I | C | C | - | - | - | - | R |
| **1.3.1** | I | I | A | I | R | I | I | I | - | C | C |
| **1.3.2** | I | I | A | I | R | I | I | I | - | C | C |
| **1.4.1.1** | I | I | A | I | I | R | I | I | - | - | - |
| **1.4.1.2** | I | I | A | I | I | R | I | I | - | - | - |
| **1.4.1.3** | I | I | A | I | I | R | I | I | - | - | - |
| **1.4.1.4** | I | I | A | I | I | R | I | I | - | - | - |
| **1.4.1.5** | I | I | A | I | I | R | I | I | - | - | - |
| **1.4.2.1** | I | I | A | I | I | R | I | I | - | - | - |
| **1.4.2.2** | I | I | A | I | I | R | I | I | - | - | - |
| **1.4.2.3** | I | I | A | I | I | R | I | I | - | - | - |
| **1.4.2.4** | I | I | A | I | I | R | I | I | - | - | - |
| **1.4.3.1** | I | I | A | I | I | I | I | I | R | - | - |
| **1.4.3.2** | I | I | A | I | I | I | I | I | R |  |  |
| **1.5.1** | I | I | A | I | I | I | R | - |  | - | - |
| **1.5.2** | I | I | A | I | I | I | R | - | - | - | - |
| **1.6.1** | I | I | A | I | C | C | I | R | C | - | - |
| **1.6.2** | I | I | A | I | C | C | I | R | C | - | - |
| **1.7** | A,C | I | R | I | C | C | I | I | I | I | I |
|  | | | | | | |  |  |  |  |  |

## Resource Loading and Release Plan

The resource loading and release schedule is given in the CAPOR Project Schedule [4].

# Quality Management

The quality metrics defined below will be used for measuring the performance of the CA Protocol implementation. The following activities will be performed to manage quality:

1. Develop benchmarks to test completeness and performance
2. Develop software to test with benchmarks
3. Determine quality audit schedule
4. Perform audits/reviews as per Quark processes

## Quality Metrics

On DEBROS-based RCM-3200 controller:

* Throughput:
  + 10 read transactions per second
  + 10 write transactions per second
* Response Time:
  + 20 ms (approximately) for a read operation
  + 20 ms (approximately) for a write operation

# Risk Management

## Risk Breakdown Structure

### Risk Register

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **ID** | **Risk** | **Root Cause** | **Probability** | **Impact** | **Response** |
| 1 | Inadequate Performance | Limited resources on RCM | Medium | High. Will not meet requirements | Optimize or terminate |
| 2 | DEBROS Defects | DEBROS Limitations | Low | High. Will increase cost/effort. | Modify DEBROS or terminate |
| 3 | Technical Know-how (DEBROS & CA) | No precedence (CA), lack of knowledge (DEBROS) | Medium | High | Training |
| 4 | Resource Shortage | Operational exigencies | Medium | High. Schedule Slippage | Assign part of work to Mark, if possible. |
|  |  |  |  |  |  |

# Communications Management

## Stakeholder Register

|  |  |  |
| --- | --- | --- |
| Name | Email | Phone |
| John Vincent | vincent@nscl.msu.edu | +1 (517) 908-7390 |
| John Priller | priller@nscl.msu.edu | +1 (517) 908-7375 |
| Kelly Davidson | davidson@nscl.msu.edu | +1 (517) 908-7362 |
| Mark Davis | davis@nscl.msu.edu | +1 (517) 908-7414 |
| Vasu Vuppala | vuppala@nscl.msu.edu | +1 (517) 355-9672 |

## Communications Plan

|  |  |  |  |
| --- | --- | --- | --- |
| Information | Recipients | Medium | Frequency |
| Performance Report (PR) | All Stakeholders | Email | Weekly |
| Project Status (contents of PR) | Customer | Meeting | Weekly |
| Project Management Documents | All Stakeholders | Email | As Available |

The project team will meet periodically to discuss project progress, as per the processes in Quark. The frequency of such meetings may keep changing with project’s progress. Sometimes these meetings may be combined with the status meetings with the Customer.

## Issue Escalation and Resolution

### Internal

All issues internal to the project team i.e. not related to the Customer must be escalated as follows (in the given order):

1. Line Manager
2. Project Leader
3. Department Head

### External

All issues concerning the Customer must be escalated as follows (in the given order):

1. Project Leader
2. Customer’s Line Manager
3. Customer’s Department Head

# Procurement Management

No part of this project, except one software license, will be procured from external entities.

## Procurement Items

The following table lists the procurements needed for this project.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| # | Item | Description | Type | Quantity |
| 1 | Softools WinIDE License | Compiler License | Material | 1 |
|  |  |  |  |  |

## Procurement Process

Not applicable for this project.

## Make or Buy Analysis

Not applicable for this project.

## Vendor Evaluation

The Softools WinIDE License is available from only one vendor: Softools Inc. Hence, vendor evaluations are not necessary for this project.

# Configuration Management

## Configuration Items

The configuration items are:

* The deliverables
* Project documentation: RFW, Preliminary Project Plan, Project Charter, Project Plan, Change Requests, Project Closure Report
* DEBROS version and documentation
* Build Information: Compiler Version and configuration, required libraries, build procedure

## Change Control

The change control process outlined in Quark [5] will be followed for this project.

## Change Classification (Major vs Minor)

* During development of Version 1.0 b1: Any change requiring more than 1 person-weeks of effort will be considered major.
* During development of Version 1.0: Any change requiring more than 0.5 person-weeks of effort will be considered major.
* After a total of 1 person-month effort for changes, all changes will be considered as major
* Effort estimations must be approved by CCB

# References

1. EPICS CA Protocol, EPICS Portal, http://www.aps.anl.gov/epics/
2. DEBROS Developer and User Manual, Mark Davis, NSCL
3. Request for Work, CA Protocol on Rabbit, Email 7-Jan-2010
4. CAPOR Project Schedule Baseline, MS Project File, Bundle #226, Section CAPOR
5. Quark, The NSCL EE Process Infrastructure, <https://intra.nscl.msu.edu/departments/electronics/quark/quark.php>

# Glossary

|  |  |
| --- | --- |
| Item | Description |
| CA | Channel Access |
| CAPOR | CA Protocol on Rabbit |
| DEBROS | Davis Embedded Baby Real-Time Operating System |
| EE | NSCL’s Electronics Department |
| EPICS | Experimental Physics and Industrial Control System |
| EVM | Earned Value Management. A technique for measuring project performance. |
| NSCL` | National Superconducting Cyclotron Laboratory |
| PL | Project Leader |
| PC | Project Coordinator |
| POC | Proof of Concept. A Prototype. |
| PV | Process Variable. Identifier for a data item in EPICS. |
| Quark | EE’s Process Infrastructure Web Portal https://intra/departments/electronics/quark |
| SMEC | Subject Matter Expert – CA Protocol |
| SMED | Subject Matter Expert - DEBROS |
| VE | Value Engineering |
| WBS | Work Breakdown Structure |
| Work Package | Leaf node of a WBS |

# Appendix A – Project Schedule

The complete and detailed schedule is available in CAPOR Project Schedule [4].



# Appendix B – Milestones

