Fermilab

MEMORANDUM OF UNDERSTANDING

Between

The Fermilab Computing Division

and

The NOvA Experiment

for

Support for Computing Systems used in the operation of the NOvA Experiment (Networking, Online and Offline)

November 19, 2010
Version 1.8

SIGNATURES

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PREAMBLE

This is a memorandum of understanding between the Fermi National Accelerator Laboratory Computing Division (CD) and The NOvA Experiment Collaboration (NOvA). The memorandum is intended to clarify the roles and responsibilities of the two parties in supporting the computing and data acquisition operations of the NOvA experiment based upon requirements agreed upon at the time of writing. (Note that activities funded under NOvA project funds are specifically excluded from this MOU.) The MOU will be reviewed and amended in May of each year as requirements change. This document will be incorporated into a more broad MOU between Fermilab and NOvA should that become available.

The MOU will be valid from the date of signing until the end of data taking in 2018. During this time, NOvA will progress through several phases of operation: ramp-up and initial data taking phases for the Near Detector, the ramp-up phase of the Far Detector, the combined data taking phase of the Near and Far Detectors, and the final analysis phase after the end of data taking. The ramp-up period of the Near Detector includes preparations for the operation of the Near Detector installed on the surface, which will begin commissioning and data taking during the spring and summer of 2010. Data taking operations will continue until the scheduled accelerator shutdown in 2012. The ramp-up of the Far Detector will proceed until the beginning of data taking in early 2013. The full running period for NOvA is anticipated to extend through 2018. Final data analysis will continue for an as yet unspecified time after data taking ends.

1. INTRODUCTION

This MOU describes the responsibilities of CD and NOvA personnel in operating the components comprising the Data Acquisition (DAQ) systems, online computing systems in the NOvA control room, offline computing systems, and all networking required to utilize these components. The detailed requirements for these various systems are documented in the NovA TDR [1] for the DAQ and online computing systems, and offline computing model as it is currently understood [2]. Here we summarize the major points to provide a context for the set of services that require operational support. The model is subject to change as the experiment gains experience with real data and analysis work-flows, which may require updating or amending this MOU.

It is acknowledged that the computing models for many of the Intensity Frontier experiments will have significant similarities, and that leveraging those similarities to provide for common solutions is in the best interests of CD and NOvA. Both parties will seek to identify and exploit such opportunities.

The readout electronics used in the DAQ are designed and built by Harvard University, University of Indiana, and CD personnel under NOvA project funds. During periods of normal data taking, signal data will be acquired at the far detector at an average rate of 6 kB/s and essential calibration data at an average rate of 1.7 MB/s [3]. Yearly totals for signal and calibration data will be 300 GB and 19 TB respectively. The near detector rates and sizes are scaled by the number of channels, a factor of 0.06. These files, along with appropriate metadata, will be staged to disk local to the detectors before being transferred to Fermilab, copied to disk and archived on tape. For the purpose of optimizing tape utilization, sets of raw data files may be combined (eg, via `tar`) before being written to tape. All archived data will be cataloged in SAM. Data describing the run conditions and otherwise needed to understand the acquired raw data (e.g., geometry, beam parameters, detector calibrations, etc.) will be stored in an online database. Interactive and non-interactive computers in the control room will be used to monitor these systems and operate the experiment.

The data and computing model for NOvA is similar to that already in use by MINOS and MINERvA, as detailed in [2]. Raw data will be stored on disk at Fermilab. Primary reconstruction of this data will take place on the General Purpose (GP) Grid Farm at Fermilab. Production output will be stored on disk and archived to tape. The reconstructed data will be read from disk and further processed and reduced on the GP Grid Farm to produce analysis datasets, which will also be stored on disk at Fermilab and backed-up to tape. All data through this phase will be cataloged in SAM with appropriate metadata. (Data delivery via SAM is under consideration.) Physicists will use the combined interactive and batch services available on the General Purpose Computing Facility (GPCF)[4], the GP Grid Farm and possibly other Fermigrid resources, and personal desktops to analyze the reduced datasets. Additional disk storage that is accessible from the GPCF and GP Grid Farm will be needed to support this analysis activity. The data processing capacity and data rates should be approx 3 times those of MINOS based on the number of detector channels and anticipated data rates.

Simulated data will be produced on remote grid farms and transferred back to Fermilab for storage on disk and tape. The details of transferring executables, database information, input data or overlay events to the remote worker nodes, and transferring output data from remote worker nodes has not yet been determined and is under study. NOvA will utilize remote grid sites with proprietary access agreements for this purpose. Reconstruction of the simulated data will take place at Fermilab on Fermigrid resources. These results will be further reduced on Fermigrid, and analyzed on the GPCF cluster. Significant disk will be required to support these activities.

NovA has estimated the expected computing resource requirements needed to fulfill the NovA physics program over the next five years. The estimates were obtained by scaling the actual resources used by MINOS by an amount to reflect NOvA's larger detector and collaboration size. The hardware categories considered were (1) Central Disk Storage, (2) Tape, (3) GP Grid Farm CPU, and (4) Interactive Analysis / Batch Cluster CPU. Table 1 shows the current understanding of these requirements. Additional work will be needed to obtain a more detailed estimate.

Data processing at GRID facilities beyond Fermilab are being pursued and, if successful, could provide 25% or more of the simulation CPU. This activity will put a load on the Wide Area Network to Fermilab at the level of 10GB/day initially, and increasing up to 100 GB/day as it matures. The initial test site is SMU in Dallas and additional sites will be employed as they are identified.

Resource	2009	2010	2011	2012	2013	2014
DISK (TB)	4	30	60	160	360	560
TAPE (TB)	10	100	190	490	1090	1690
GRID (slots)	5	100	500	800	800	1000
CLUSTER (cores)	0	40	40	80	80	120

Table 1. Resource estimates for NOvA computing needs.

2. SERVICES AND ACTIVITIES

In this section, we outline the services and activities required to support the deployment and operation of NOvA computing, and responsibilities of the parties with respect to each. Unless otherwise specified, CD support is assumed to be provided on an 8x5 basis. Major support activities will be coordinated with the experiment so as not to adversely affect experiment operations. Similarly, the experiment will advise and consult with CD when activities by the experiment might result in unusual usage patterns or impose unusually large loads on computing systems.

2.1. **Control room operations: computers**

The NOvA control room is co-located with the MINOS and MINERvA control rooms in Wilson Hall. The control room hosts computing (servers, desktops, and gateways used for private network access) and networking equipment required for the operation of the experiment and communication with the detectors and computing facilities at Fermilab. The computer security details are provided in the Minor Application Plan [5]. (Note that support for machines associated with the DAQ system are discussed in a separate section.)

2.1.1. CD responsibilities

1. Provide system administration services for control room computers, and installation services for third party software at the operating system level needed for control room operations. (No support for third party software is implied. Moreover, third party software that requires root installation or privilege is highly discouraged and must be approved by system administrators on a case-by-case basis.) Ensure that there exists a robust recovery plan for machines critical to data taking, or that there is sufficient redundancy to survive the loss of such machines. CD will provide a level of service sufficient to allow 24x7 operation of the control room. [Terms of support for critical machines should be spelled out in detail here (ie, the options for enhanced support). Note that no one in CD provides 24x7 for MINOS]
2. Provide appropriate packaging of CD-supported physics toolkits and utilities needed for online operations.

2.1.2. NOvA responsibilities

1. Document the requirements for control room computers, including the need for any third party software at the operating system level, and the identity of any machines that are critical to data taking that might require enhanced levels of support.
2. Support of all online application software.
3. Installation all Fermilab supported physics toolkits and utilities needed for online operations. This software should be managed alongside other experiment-specific software that will be the responsibility of the experiment.

4. Provide schedules for deploying security patches to all systems that are consistent with Lab security policies and the NOvA Minor Application Plan.
5. Provide an expert from the experiment who can assist system administrators.

2.1.3. Joint responsibilities

1. NOvA computing and CD system administrators will work together to determine the operating system configuration required to meet the needs of control room computers, and review any third party software installed by system administrators.
2. Document suitable support models for machines critical to data taking for which an enhanced level of support is needed.

2.2. **Control room operations: networking**

2.2.1. CD responsibilities

1. Install, configure and maintain all networking equipment located at Fermilab required to meet the operational needs of the control room and NOvA data taking. Detailed specifications for the networking will be discussed with representatives from the experiment.
2. Establish a secure, high-reliability data network connecting:
   - 2.1. The detector enclosure located to the south of the MINOS service building;
   - 2.2. The Near Detector located in the NUMI cavern;
   - 2.3. The DAQ buffer farm and other DAQ machines that will initially be located in a CD-maintained data center
   - 2.4. The NOvA Control Room
   - 2.5. The Far Detector site with when installation and commissioning begins. The configuration and service level support of this network is expected to be similar to that of the MINOS far detector facility in Soudan. Interruptions in connectivity between the Far Detector and Fermilab must be restored in a reasonable time frame subsequent to problem detection.
3. During the operations phase of the Near Detector on the Surface (NDoS), the front-end electronics, buffer farm, and DAQ controls machines will be isolated from general traffic on a private network or firewall with strong authentication mechanisms. Note that this configuration will serve to prototype the network between Fermilab and the Ash River, MN site required for Far Detector operations.

2.2.2. NOvA responsibilities

1. Determine the network throughput requirements between the various networking endpoints.

2.3. **PREP electronics**

The experiment will utilize a broad array of electronics in the development, commissioning, and operation of the DAQ system. The equipment required includes standard test and laboratory equipment (e.g., oscilloscopes, voltage meters, current load boxes, NIM crates and associated modules), basic data acquisition systems needed to interface with other laboratory systems (e.g., CAMAC crates and modules needed to receive and process signals from the accelerator facilities), and NOvA-specific hardware procured from outside vendors or built in-house. Some details of these special cases are described below.

2.3.1. CD responsibilities

1. Low Voltage Power supplies: The supplies to be procured will be Wiener Plein and Baus Ltd. Model number PL506 in a configuration specifically tailored to the NovA experiment. Each contains three supply pods with a variable range of 2-7 V, and three supply pods with a variable range of 12-30 V, or in an alternate configuration with two 2-7 V pods and four 12-30 V pods in a master/slave configuration.

   The Near Detector requires 4 operational supplies plus 3 spares. The spares may be used by Prep for testing. The Far Detector will employ 66 operational supplies and have 4 spares.

   CD personnel will receive training and diagnostic, repair and maintenance documentation from the manufacturer.

2. High Voltage Power supplies: For the near detector the number of supplies that will be procured is 3, where 2 of them are denoted as spares. The NOvA experiment will use floating high voltage power supplies from WIENER Plein and Baus Ltd. The supplies that will be procured and used will be model designation MPOD HV-EX with high voltage card designations ISEG EHS/EDS. The Near and Far Detectors will each use 1 supply and have 2 spares.

   The manufacture has agreed to provide training and information regarding the diagnosis, repair and maintenance of these devices to the FNAL computing division's technical staff and the personnel involved with the PREP equipment pool. The contract with Plein stipulates the support and training for PREP personnel.
3. Data Concentrator Modules: The DCM was designed by the CD for use in the primary DAQ/readout chain for NOvA. CD will provide maintenance for these modules during the data taking phase of the NDoS. For the Near Detector there will be 12 modules and 4 spares. For the Far Detector there will be 180 modules and 20 spares.

4. Timing systems: NOvA uses two timing devices, the Master Timing Unit (MTU) and the Timing Distribution Unit (TDU), to provide synchronization of the front end boards. Both the MTU and TDU were designed by CD for use in the NOvA DAQ/readout chain. CD will provide maintenance for the boards during the data taking phase of the NDoS. For the Near Detector there will be 2 masters and 4 slaves. For the Far Detector there will be 2 masters and 15 slave units.
5. Provide and maintain standard test and laboratory equipment as agreed upon with the experiment.

2.3.2. NOvA responsibilities

1. Provide timely specification of standard test and laboratory equipment needed.
2. Perform any testing needed to ensure that equipment meets the needs of the experiment.

2.3.3. Joint responsibilities

1. (none identified)

2.4. **DAQ systems and software**

The systems and software included in the DAQ are described in the documents listed in [6].

2.4.1. CD responsibilities

CD support for DAQ hardware and software is limited to that required for baseline operations. Consulting services for major changes or upgrades can be provided upon request by NOvA and agreement with the relevant CD departments.

1. Provide consulting services to NOvA online support personnel regarding best practices, technical issues, or specific problems related to system administration of online computing systems. CD will provide limited technical assistance to deal with major system administration problems. All such services will be provided on an 8x5 basis;
2. Provide electrical design and firmware revisions for the DCM, MTU, and TDU required to maintain operation of the full DAQ chain within design specifications;
3. Provide hardware support for DAQ network switch arrays.
4. Support for the following CD-developed DAQ/online software:
    4.1. Message Logging System (MLS) API;
    4.2. Responsive Messaging System (RMS) API;
    4.3. Data handling and buffering libraries for the Event Builder and Data Buffers software;
5. Support for the CD-developed API to the Message Logging System (MLS);

6. Support for the CD-developed API to the Responsive Messaging System (RMS).

2.4.2. NOvA responsibilities

1. Provide system administration and support for DAQ/online systems in a manner consistent with the 24x7 nature of data taking and the high value of beam time and data taking. The potential for transitioning some of this support to CD in the long-term will need to be negotiated with CD.
2. DAQ operations and computing support for facilities located at the Far Detector in Ash River, MN.
3. Interfacing NOvA code to the MLS;
4. Interfacing NOvA software with the RMS;
5. Comply with security requirements outlined in the NOvA Minor Application Plan;
6. DAQ code and the data taking control code used by detector operators are NOvA's responsibility.

2.4.3. Joint responsibilities

1. (None identified)

2.5. **Computing facilities**

2.5.1. CD responsibilities

1. Provide laboratory space in which to operate a test stand to be used to perform tests of the baseline DAQ systems. The present design requires two 19-inch relay racks, bench space sufficient for the setup of two to three DCMs and the test equipment necessary to access, program and debug them.
2. Provide space in the Data Center sufficient to house the buffer node farm and that of other DAQ-related computing nodes tha twill be used for the operation and data taking of the NDoS. This space is not expected to exceed a single 19-inch, 42U relay rack. It will require sufficient power and cooling to run 24 compute nodes, one disk server, and a set of network switches that connect the machines to the DAQ network.

2.5.2. NOvA responsibilities

1. To perform all necessary testing to validate the adequacy of the DAQ electronics
2. Notify CD if changes in configuration and/or power requirements are needed.

2.5.3. Joint responsibilities

1. (None identified)

2.6. **Databases**

Maintaining database services entails support across three tightly coupled layers: hardware, database, and application. Ensuring robust services requires coordinated planning by all stakeholders across all layers.

The major database applications include the data management catalog, the conditions database, construction and hardware database, and experiment logbook. In the following summary of responsibilities, support for a database application by an organization implies support at all three levels unless specified otherwise.

In addition to the database resources located at Fermilab, a database server will be installed at the Far Detectors site. The requirements for supporting the installation, commissioning, and operation of the Near Detector will be similar to those for the Far Detector. Resources will be provisioned accordingly as Far Detector installation begins.

CD provides tiered levels of support for database services ranging from 24x7 to 8x5 best effort, the choice depending upon the application and the type of underlying database. It is assumed that each production database instance supported by CD will be accompanied by integration and development instances, both of which receive the lowest available tier of support.

2.6.1. CD responsibilities

1. Install and maintain a SAM data catalog
   - 1.1. The SAM instance will use the existing schema employed for all other SAM instances at Fermilab, except as provided in subsequent agreements in response to changes in NOvA requirements.
   - 1.2. Provide consulting assistance to the experiment in interfacing the SAM data catalog with the analysis framework and data logging applications used by the experiment.
2. Install and maintain databases and database servers needed to store and utilize the following mission critical data:
   - 2.1. Data relating to the construction of the NOvA detector;
   - 2.2. Electronics configuration data;
   - 2.3. “Conditions” data, such as beam parameters, detector calibrations, detector alignment, etc. According to current estimates, the size of this database is expected to be 10's of GByte per year, possibly reaching 100 GB by the end of the experiment.
3. Support the schema for the NOvA Hardware Database, a web-based GUI to access the Hardware Database, and a set of import/export tools for data in the Hardware Database.

4. Install and maintain an instance of the Control Room Logbook as needed by the experiment.

2.6.2. NOvA responsibilities

1. Enter the content of all databases;
2. Interfacing NOvA software with the database applications;
3. Monitoring that all database applications meet the operational needs of the experiment
4. Ensuring that users are informed as to appropriate usage patterns, and otherwise assisting CD personnel in investigating and addressing operational issues.
5. For cases in which there is no existing schema or database application, specify and document the requirements, the use cases and queries needed, etc., as requested by the CD.
6. Provide time windows during which regular database maintenance may be performed and security patches applied in a manner consistent with Fermilab security policies and the NOvA Minor Application Plan.

2.6.3. Joint responsibilities

1. Developing and approving the specifications for the database applications and schemas.
2. Participate in annual "Taking Stock" meetings to long-term operational issues and resource planning. CD will coordinate these meetings.

2.7. **Disk and tape storage**

The central disk and tape archive requirements were discussed previously. Under the current computing model, the majority of central disk resides in Network Attached Storage that is NFS mounted on GP Grid Farm worker nodes, the GPCF cluster, and other on-site computers. The existing system uses a BlueArc pool to provide this disk, which has proven effective, although the specific technology choice should not be considered a part of this MOU. Cache disk, such as provided by a dCache instance, will be used for short term staging of data to and from Enstore. Except as specified, performance monitoring and diagnostics of tape and disk storage systems are the responsibility of CD.

2.7.1. CD responsibilities

1. Install and maintain a central disk pool capable of serving NOvA data to the the GP Grid Farm, CPCF cluster, and other on-site NOvA computers via NFS. Data serving rates must be sufficient to meet the demands of reconstruction and analysis on the GP Grid Farm, GPCF, and other on-site computers. Estimates for this scale are documented elsewhere. The data volume starting in 2010 is expected to be about 30 TB, with subsequent years evolving as indicated in Table 1.

2. Install and maintain NFS-mounted disk serving software releases to the GPCF cluster, GP Grid Farm, and other on-site interactive machines, and machines with disk for building software releases. The experiment expects that a software release area of 2 TB will be adequate through the Near Detector ramp-up phase.
3. Install and maintain project disk to support analysis activity. At present, this disk is provided as part of the GPCF plan.
4. Provide a tape data archive via Enstore accessible. All raw detector data, processed data, and Monte Carlo data will be archived to tape. The FY2010 volume is expected to be about 100 TB, as shown in Table 1. Typical daily storage rates are expected to vary between 100 GB and 1 TB.
5. Provide AFS-mounted home area disk. Regular backups of this space will be performed. Currently, the experiment uses about 100 GB of AFS space for home areas;
6. Except as specified below, monitor performance of tape and disk storage systems.
7. Provide tools for archiving analysis data.

2.7.2. NOvA responsibilities

1. Identifying and archiving all critical data stored on the central disk;
2. Manage individual user disk allocations;
3. Monitor performance of user access to project disk;
4. Ensure that the experiment remains within the provided disk storage allocations, cleaning up obsolete or unused data as needed, and that disk resources are utilized efficiently and effectively;
5. To structure and maintain the content of the software repository, and administer user access to that repository;
6. To develop, build, distribute, and manage all software releases.

2.7.3. Joint responsibilities

1. To meet as needed to discuss operational issues affecting the use of storage systems, or other items of mutual interest with respect to the storage systems.

2.8. **Data analysis and processing**

2.8.1. CD responsibilities

1. Interactive/Batch Analysis Cluster: Install, maintain, and administer an interactive cluster with access to the Central Disk, software, and home areas. The experiment expects to need about 40 cores in this cluster starting in FY2010, growing to 80 cores in 2012. A batch system for this cluster will also be supported. This computing is currently provided as part of the GPCF cluster and batch systems.
2. Provision and operate sufficient GP Grid Farm resources with appropriate access priorities to meet physics goals of the experiment. For FY2010, it is expected that

about 100 job slots at current processor speeds will be needed. The expected requirements for subsequent years is shown in Table 1.

3. Provide generic grid job submission and monitoring tools.
4. Provide consultation with offline personnel from the experiment on issues related to grid utilization.

2.8.2. NOvA responsibilities

1. Validate users authorized to access NOvA grid computing resources. The experiment will further provide personnel for the roles of “Group Managers”, “Operations Contact”, “Security Contact” and “Spokesperson”, pursuant to the “Establishing Grid Trust with Fermilab” document [7].
2. Document the local grid and interactive CPU resources required to meet the physics goals of the experiment.
3. Ensure that NOvA users are informed as to the appropriate usage patterns for all CPU resources. Work with CD personnel as needed to investigate and address operational issues or utilization efficiency problems.
4. Perform job submission and data processing tasks.
5. Provide user support for job submission and job tracking, and user documentation and education on the use of NOvA computing resources.

2.8.3. Joint responsibilities

1. Provide those components of a job submission layer to the batch and grid resources that is specific to NOvA.
2. Specify and develop any monitoring capabilities that are needed to effectively utilize CPU resources, but that are not provided by available monitoring tools. Instrumentation of NOvA executables or glide-ins are possible examples where joint effort is required.
3. Meet as needed to discuss operational issues affecting the use of computing systems, best practices for using the systems, user support issues, utilization strategies, or other items of mutual interest with respect to the computing systems.
4. Investigate and deploy suitable mechanisms for transferring executables, database information, etc., to remote worker nodes for the purpose of Monte Carlo generation, and for transferring generated files back to Fermilab.

2.9. **Simulation and analysis software toolkits**

2.9.1. CD responsibilities

1. Maintain archival CVS, Subversion, or similar services for NOvA software. The experiment expects the software repository to be a few hundred GigaBytes in size. A Redmine web interface and associated Wiki for documentation will also be provided as part of this service. Provide consulting help in utilizing these services.

2. Provide support for physics and utility software packages jointly or singly supported by Fermilab, such as ROOT, GEANT4, GENIE, CLHEP, SRT, and UPS/UPD. The list of packages to be supported should specified in joint negotiations.
3. Provide assistance with adding NOvA software packages to the Fermi Kits UPS/UPD repository.
4. Support for the software framework if a CD supported one is chosen. NOvA is considering moving to the CMS-lite (A.K.A. ART) framework, and if they do CD would help with this.

2.9.2. NOvA responsibilities

1. Develop a build system based upon either SRT or CMT that meets the software release and distribution needs of the experiment;
2. To structure and maintain the content of the software repositories, and administer user access to those repositories;
3. To develop, validate, and maintain all experiment-specific software, including the analysis framework software.

2.9.3. Joint responsibilities

1. To meet as needed to discuss pertinent operational issues, anticipated changes in requirements or levels of support, or any other items of mutual interest.

2.10. **Miscellaneous**

2.10.1. CD responsibilities

1. Support an instance of DocDB for use by NOvA;
2. Provide the following support for a central NOvA web server:
   2.1. System administration;
   2.2. Consulting assistance with web server and application security issues;
3. Provide fff-hours and emergency paging support from the Service Desk for selected critical systems.
4. Provide an issue tracking system for NOvA computing issues.

2.10.2. NOvA responsibilities

1. Work with CD service providers and the Service Desk to arrive at a specification for the off-hour and emergency response needed from the Service Desk for critical systems. One goal should be to minimize the number of systems for which off-hours emergency support is required;
2. Provide a webmaster to maintain the NOvA web site.

2.10.3. Joint responsibilities

1. Configure and administer the NOvA issue tracking system.

3. ESTIMATED EFFORT

The estimated CD effort required to meet the obligations outlined in this MOU is estimated to be about 1 FTE during the Near Detector ramp-up phase in FY2010, increasing to about 2 FTEs in the initial data taking phase in FY2011, then increasing again to about 3 FTEs during the ramp-up phase of the Far Detector and into the combined data taking phase. Table 2 shows the initial estimates of how effort might be distributed between the various services and activities.

Description	**FY 2010 FTE's**	**FY 2011 FTE's**
Control Room Setup & Ops	0.1	0.2
Data Management setup & Ops	0.2	0.5
Software development & Support	0.2	0.4
User support for Grid & Int. Cluster	0.2	0.4
PREP maint. & support	0.1	0.1
Management and coordination	0.1	0.2
DAQ Consulting	0.05	0.1
Network Setup and Ops	0.05	0.1
Total	1.0 FTE	2.0 FTE

Table 2. Initial estimates of effort required in FY2010 and FY2011 for various categories of work.

The effort estimate for PREP is not expected to exceed 0.1 FTE during the ramp-up phase of the Near Detector. Once Far Detector operations begin, the number of systems that would require PREP support will increase substantially. The level of effort required must therefore be re-evaluated at that time and will depend in part upon the ultimate reliability of the systems in question.

Note that these estimates do not take into account leveraging of shared solutions with other Intensity Frontier projects. It is possible that these common solutions can substantially reduce the total effort required across the Intensity Frontier projects in certain categories of activity. The CD will seek to promote such common solutions whenever possible and cost effective.

4. REFERENCES

[1] “Technical Design Report for CD-2/3a,” NOVA Document 2678-v8, October 8, 2007.

[2] “Use Cases and Requirements for the Computing Resources Needed for the Fermilab Intensity Frontier Program,” CD DocDB #3296.

[3]”Front-End Electronics and DAQ parameters”, NOVA-DocDB 662. Note: numbers from v6, scaled by 1.6 to indicate increased bytes/hit from 10 to 16. Near detector channels/far detector channels is 20940/357120 to generate the scale factor of 0.06.

[4] “General Physics Computing Facility (GPCF) development docs,” CD-DocDB #3453.

[5] NOvA Minor Application Plan (in progress), NOvA DocDB #4250.

[6] The following NovA documents describe the DAQ system requirements: DAQ Monitor (#3769), Data Concentrator Module (Software) (#3664), Data Logger (#3683), Data Quality Monitoring (#3799), Dispatcher (#3944), Event Builder (#1168), File Transfer System (#3786), Global Trigger (#2631), Spill Server (#4529), Message Logging System (#2332), Message Passing System (#1210), Resource Manager (#3678), Run Control (#1877). These documents are in the NOVA-DocDB.

[7] “Establishing Grid Trust with Fermilab,” CD-doc-3429.