Fermilab

TECHNICAL SCOPE of WORK

Between

The LArIAT Collaboration

and

The Fermilab Computing Sector

for

Support of Computing used in the Operation of the LArIAT Experiment

23-March-2017
Version 0.5

Abstract:

This document is the Technical Scope of Work (TSW) between the Fermilab Computing Sector (CS) and the LArIAT collaboration for support of the Computing Systems used by the LArIAT experiment. This document is intended to clarify the roles and responsibilities of the two parties in supporting the computing resources based upon the requirements agreed to at the time of publication.

Table of Contents

Document Revision History 3

1 Introduction 5
- **1.1 Overview of Computing Sector Support** 6
- **1.2 Overview of LArIAT Experiment Services and Activities** 6

2 Core Computing Services 6
- **2.1 Authentication and Directory Services** 6
- **2.2 Central Web Hosting** 7
- **2.3 Database Hosting** 7
- **2.4 Desktop Services** 7
- **2.5 Mail Services** 7
- **2.6 Enterprise Support Services** 7
- **2.7 Network Services** 8
- **2.8 Networked Storage Hosting** 10
  - 2.8.1 NAS (Network Attached Storage) 10
- **2.9 Service Desk** 11
- **2.10 Video Conferencing** 11

3 Scientific Services 11
- **3.1 DAQ & Controls** 11
  - 3.1.1 Components that will be supported by the LArIAT Collaboration 11
  - 3.1.2 Ongoing SCD development efforts 12
  - Computing Sector Responsibilities 12
  - LArIAT Responsibilities: 13
  - Joint Responsibilities: 13
- **3.2 Engineering and Electronics** 13
- **3.3 Grid and Cloud Computing** 13
  - 3.3.1 FermiGrid 13
  - 3.3.2 FermiCloud 13
  - 3.3.3 GridFTP 13
  - 3.3.4 Accounting Service 14
  - 3.3.5 Jobsub 14
  - 3.3.6 Fifemon 14
  - 3.3.7 POMS 14
  - 3.3.8 Responsibilities 14
- **3.4 Interactive Computing: GPCF** 15
- **3.5 *Physics Research Equipment Pool* (*PREP*)** 15
  - 3.5.1 Prep Logistics 15
  - 3.5.2 PREP Electronics 16
- **3.6 DOCDB** 16
- **3.7 UPS/UPD** 16
- **3.8 Scientific Collaboration Tools** 16
  - 3.8.1 Redmine 16
  - 3.8.2 GIT 16
  - 3.8.3 ECL 16
- **3.9 Scientific Computing Systems** 17
  - 3.9.1 Experiment Desktops and Control Room Workstations 17
  - 3.9.2 DAQ Computing 17

3.9.3 CVMFS 18
3.9.4 Build Service 18
3.10 Scientific Data Management (SDM) 18
3.10.1 SAM/IFDH 19
3.10.2 File Transfer Service (FTS) 20
3.10.3 Data Handling 21
3.11 Scientific Data Storage and Access 21
3.11.1 Raw Data 21
3.11.2 Monte Carlo Simulation Files 22
3.11.3 Production Data Analysis 22
3.11.4 End User Data Analysis 22
3.12 Scientific Databases 23
Scientific Database Applications Descriptions 23
3.12.1 23
Computing Sector Responsibilities: 23
3.13 Scientific Frameworks 24
3.13.1 Supported by the experiment 24
3.14 Scientific Software 24
3.15 Simulation Software 25
3.15.1 GEANT4 25
3.15.2 GENIE 26
Glossary 27

Document Revision History

Date	Version	Author(s)	Comments
1-June-2015	V0.00	Hans Wenzel	Start with the uBoone TSW
30-June-2015	V0.01	Hans Wenzel	Modify the information that is specific to the LArIAT experiment
5-Aug.-2015	V0.02	Hans Wenzel	Incorporate comments received from Margret Votava and Gabriele Garzoglio. Since FY15 was completed at the begin of July some numbers about the total raw data collected were added. (thanks to Robert Illingworth)
19-Aug.-2015	V0.03	Hans Wenzel	Incorporate comments received from Gabriele Garzoglio. Clean up references and formatting.
23-Mar.-2017	V0.05	Hans Wenzel	No more reference to readytalk referencing Zoom instead. CVMFS: specify that LArIAT is planning to use the Fermilab instance of CVMFS for code distribution. Email: mention that Fermilab is using

	the Microsoft cloud service for email now. OPOS: no more reference to the service. Mention that LArIAT is interested in using POMS. Networking: add comments by Ramon Pasetes clarifying the service. Interactive computing: using 4 instead of 3 VMs on GPCF. Contact information changed to reflect new spokesperson.

1 Introduction

LArIAT (Liquid Argon in a Test beam) is an experiment set to calibrate the liquid Argon Time Projection Chamber technology (LArTPC) by placing the detector in a beam of charged particles of known type and momentum. This document is the Computing Sector – LArIAT Technical Scope of Work (TSW) that describes in more detail than the LArIAT –Fermilab TSW[1], the responsibilities of the Fermilab Computing Sector (CS) and the LArIAT collaboration personnel for computing services used by the LArIAT experiment.
The TSW:

- Will be reviewed on a yearly basis by all the parties to the agreement and amended as requirements change.
- Shall be valid until the end of data analysis for the LArIAT experiment.
- Shall cover the long-term computing needs of the experiment including any data preservation needs.
- Shall reflect the computing requirements provided each year in the Computing Sector Strategic and Tactical plans, to which the LArIAT experiment provides substantial input via the annual *Scientific Computing Portfolio Management Team* (SC-PMT) Review process[2].
- Shall refer to the requirements for computing capacity and hardware covered in separate LArIAT Computing Requirements documents.
- Shall not include activities funded under the LArIAT experiment project funds.

The following organizational units are involved in support activities under this TSW:

- The Computing Sector (CS), including the Office of the Chief Information Officer (OCIO), the Core Computing Division (CCD), and the Scientific Computing Division (SCD).
- The LArIAT Collaboration. LArIAT analysis tools groups, LArIAT online/data acquisition group, LArIAT Database support group, the LArIAT commissioning coordinator, the LArIAT physics coordinator and the LArIAT physics analysis groups.

Contacts:

- LArIAT: Hans Wenzel - Computing Sector Liaison to the LArIAT collaboration, Jonathan Asaadi, Jennifer Raaf - LArIAT spokespersons.
- Computing Sector: Rolando Ramos - Business Relationship Manager, Brian Mckittrick - Service Level Manager; OCIO.

[1] http://www-ppd.fnal.gov/ftbf/TSW/PDF/T1034_tsw_signed.pdf
[2] The 2015 SCPMT Review talks can be found at:
https://indico.fnal.gov/conferenceDisplay.py?confId=9319

1.1 Overview of Computing Sector Support

Computing Sector service support is provided as specified in the *FNAL Foundation Service Level Agreement (SLA)* CS-DocDB-4042, which applies to all Computing Sector supported services, except as amended by service-specific Service Level Agreements (SLAs). It is important to note that in general:

- Computing Sector support is provided on an 8x5 basis unless otherwise specified and agreed.
- Additional Service Level Agreements apply for specific services (such as Networking, Database, Grid and Cloud Computing, Storage, Engineering, etc.). These additional SLAs are published in the Service Level Management (subtopic of ITIL Processes and Functions) topic in CS-DocDB.
- All services provided by the Computing Sector are managed through the Computing Sector Service Desk (http://servicedesk.fnal.gov/, or 630-840-2345).

In the event of issues with any service, LArIAT collaboration personnel shall utilize the Service Desk interface to report any issues. For off hours (outside of the standard 8x5 business hours of Monday-Friday, 8AM to 5PM), the support escalation procedure is to telephone the service desk at 630-840-2345 and select the option to page the on-call service desk personnel. Computing at Fermilab is governed by the *Fermilab Policy on Computing (*see: http://security.fnal.gov/policies/cpolicy.html). This policy covers all Fermilab-owned computers and any computer, regardless of ownership, when it is connected to the Fermilab network (and/or showing a Fermilab address).
Significant Computing Sector change and maintenance activities shall be coordinated with the LArIAT collaboration so as not to adversely affect LArIAT experiment operations. Similarly, the collaboration shall advise and consult with the Computing Sector prior to performing activities that might result in unusual usage patterns or impose unusually large loads on computing systems.

1.2 Overview of LArIAT Experiment Services and Activities

The details of the LArIAT systems are documented in the LArIAT white paper: (see: http://arxiv.org/pdf/1406.5560v3.pdf). Below we summarize the major points to provide a context for the set of services that require operational support.

2 Core Computing Services

2.1 Authentication and Directory Services

The LArIAT collaboration will utilize the standard Authentication and Directory Services offerings as outlined in CS-DocDB-4314

- Kerberos Certificate Authority (KCA)
- Active Directory (FERMI.WIN.FNAl.GOV)
- LDAP Authentication (SERVICES.FNAL.GOV)

These services will be provided under the standard Authentication and Directory Services SLA.

2.2 Central Web Hosting

The LArIAT collaboration has its main web pages on the standard Central Web Hosting Services and these will be supported as outlined in CS-DocDB-4321. Thus LArIAT depends on the Apache Web service offering and no others. Note this SLA provides 24x7 support for this offering. LArIAT has the following websites covered by this SLA: http://www-LArIAT.fnal.gov. The LArIAT collaboration may have additional web pages that are hosted outside of the central web hosting series.

2.3 Database Hosting

The LArIAT collaboration will utilize the standard Database Hosting Services (see CS-DocDB-4664). Currently LArIAT is not using a Channel Mapping database but is considering the use of one.

A ChannelMapping database is a collection of tables, which allows one to map channels from one point to another in the readout and to determine all characteristics of the electronics for a given channel. For example one may specify a pin on a flange and discover the wire and ASICs channel or the FEM board channel that it belongs to, for example. One may use this DB to find serial numbers of the intermediate amplifier or motherboard too on that signal path.

The RunConfiguration DB holds the information that is queried from and inserted to with the start and stopping of runs and sub runs. That configuration fully specifies a run and is assigned to a run number at runtime.

LArIAT is not using offline DB's (Calibration DB) yet. The Calibration DB is where calibrations constants are stored examples are:

- Constants calculated by processes, which read the data from designated ASICs calibration runs.
- Constants calculated offline like the purity of the liquid Argon.

2.4 Desktop Services

The LArIAT collaboration will utilize the standard Desktop Services as described in the Service Level Agreement CS-DocDB-3716.

2.5 Mail Services

The LArIAT collaboration will utilize the standard Mail services:

- Chat (Jabber/XMPP)
- Lab email (was migrated to the Microsoft cloud)
- Mail Lists

2.6 Enterprise Support Services

The LArIAT collaboration will utilize the standard Enterprise Support Services.

In particular, DocDB is critical to LArIAT operations and therefore the LArIAT collaboration requests 24x7 service availability with 8x5 service support for the LArIAT instance of the document management system.

2.7 Network Services

The LArIAT network has been configured and installed by the Fermilab network group. The strategy for the LArIAT LAN support is to incorporate the operation and management into the Fermilab campus network support effort. The Fermilab policy that defines the campus network as a restricted central service is applicable for LArIAT LAN as well. The LArIAT collaboration will utilize the standard network services together with the following enhanced services:

- Configuration, monitoring and support of the network switches and connections to the site
- Configuration and monitoring of the site connections for LArIAT
- Configuration of public IPv4 address blocks with mapping to fnal.gov
- Configuration of private VLAN(s) in support of the LArIAT DAQ
- Configuration of Access Control Lists to restrict access to LArIAT computers on the public network
- Configuration, monitoring and support of DNS, NTP and DHCP services utilized by LArIAT collaboration
- Access to the shared pool of "cold" spares for replacement of failed hardware

The supported devices for the LArIAT network are listed in Table 1 and the Support levels for the enhanced services are listed in Table 2 below. The LArIAT network does not have redundancy built in. Therefore, though the Fermilab network group can provide support 24x7, resolution time will take considerably longer (1 or more days) depending on the severity of the issue. Even with the use of cold spares, this does not mean that networking will work 24x7 on restoration.

Table 1. Network switches supported for LArIAT experiment

Service Area: Network		
Use	**Responsible**	**Devices**
Shared Use	Fermilab Network Group	r-dist-ead-1
LArIAT	Fermilab Network Group	s-ftbf-offices-1, s-ftbf-daq-mc7-1,s-ftbf-control-room-1
LArIAT Wireless	Fermilab Network Group	w-exp-mccenter-1

Table 2. Network support levels for LArIAT experiment

Service Area: Network	**Service Level Commitments**				
Use	**Service Availability Schedule**	**Support Availability**	**Incident Response**	**Incident Resolution**	**Request Response**
Shared Use	24x7	24x7	Foundation	Foundation	Foundation

The LArIAT Network LAN infrastructure	24x7	24x7	Foundation	Foundation	Foundation
End System Connections	24x7	8x5	Foundation	Foundation	Foundation
Wireless LAN	24x7	8x5	Foundation	Foundation	Foundation
LArIAT VLANs	24x7	8x5	Foundation	Foundation	Foundation
DNS, NTP servers	24x7	24x7	Map to Foundation High	Foundation	Foundation
ACL configurations and updates	24x7	8x5	Foundation	Foundation	Foundation

The Foundation SLA/OLAs agreement is described in CS-DocDB-4042. More details on Network Services SLA are described in CS-DocDB-4312.

- LArIAT is responsible for notifying Fermilab's Network Services group about any changes to requirements or new computing deployments as early as possible. LArIAT should be aware that a significant lead-time may be necessary should there be a need to change an existing service or current infrastructure to accommodate a change in the LArIAT's needs.
- LArIAT is responsible for providing a ***single point of contact*** that Network Services will be using for scheduling network maintenance or any other work that could affect and potentially disrupt network services for LArIAT.
- LArIAT is responsible for providing a single point of contact that Network Services will be using for emergency communication.

The diagrams of the LArIAT networks are depicted in figure 1

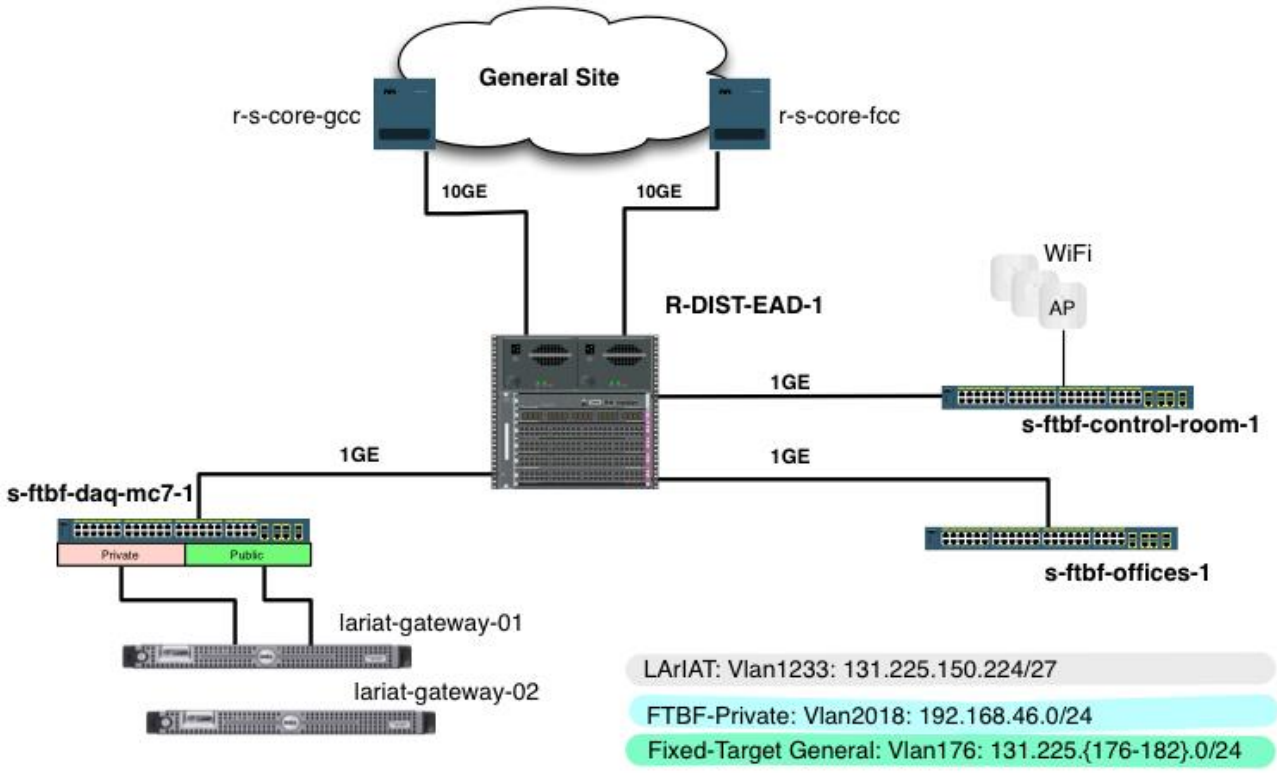

Figure 1: LArIAT Network

2.8 Networked Storage Hosting

The LArIAT collaboration will utilize the standard Networked Storage Hosting Services listed below. Networked Storage Service Level Agreement can be found in CS-DocDB-4311

2.8.1 NAS (Network Attached Storage)

2.8.1.1 BlueArc

Buearc is a network attached storage system (NAS). The LArIAT collaboration uses the following BlueArc volumes:

- blue2:/fermigrid-app
- if-nas-0.fnal.gov:/nusoft/app
- if-nas-0.fnal.gov:/lariat/app
- blue3:/nusoft/data
- sci-win-nas-0:/lartpc.daq
- sci-win-nas-0:/lartpc.ana
- blue3.fnal.gov:/lariat/data
- blue2:/fermigrid-data
- blue2:/fermigrid-fermiapp

2.8.1.2 Homedirectories

The LArIAT collaboration uses the standard networks attached (/nashome) space for the home directories of its members.

2.9 Service Desk

The LArIAT collaboration will utilize the standard Service Desk Services. The Service Desk Service SLA: CS-DocDB-4311describes the expectations and responsibilities of the customer (LArIAT) and the Computing Sector. LArIAT depends on all service desk offerings including enhanced:

- Call-in support - The Fermilab Service Desk can be reached at 1-630-840-2345.
- Service Desk email support - Contact the Fermilab Service Desk at servicedesk@fnal.gov for support.
- Service Desk Enhanced – Requested for the LArIAT Spokespeople.
- ServiceNow Self Service - Self-service allows Fermilab associates, contractors and visitors to request assistance and search for knowledge.
- Walk-in support - Visit the Service Desk on the ground level of Wilson Hall.

2.10 Video Conferencing

The LArIAT collaboration will utilize the standard Video Conferencing Services, including support for conference rooms and Control Room Video conferencing for remote collaborators. Videoconferencing Service Level Agreement (SLA) : CS-DocDB-4313 describes the expectations and responsibilities of the customer (LArIAT) and the Computing Sector. The relevant offerings are:

- General Video Conferencing (Zoom).
- Video Conferencing Consulting
- Video Conferencing Enhanced - for the Control Room. For the FY 16 data taking run LArIAT will evaluate the use of remote shifts and utilizing the Remote Operation Center (ROC) located in Wilson Hall (west).
- Video Conferencing Training

3 Scientific Services

3.1 DAQ & Controls

The LArIAT DAQ and online systems uses the artdaq Data Acquisition Toolkit (see e.g. http://hepsoftwarefoundation.org/content/artdaq) which uses the art software framework as basis. Fermilab supports both art and artdaq.

3.1.1 Components that will be supported by the LArIAT Collaboration

The areas of responsibility that will remain with members of the LArIAT collaboration include the following:
The DAQ experts on LArIAT maintain all the readout and event building code. LArIAT has control over and expertise in the threading structure in use by the DAQ. The hardware that configures and pulses ASICS configuration boards and optical flashers are controlled by software that LArIAT have authored and maintain.

LArIAT has an exported area of ups-packaged libraries and binaries on which the main processes rely, much of which LArIAT builds and updates. This will continue going forward, with SCD advisement as suggested in 3.1.2.

LArIAT now has a local run control, as mentioned above in 3.1.2. LArIAT knows how to add processes to that system and are doing that actively now as data-taking approaches. These include online monitoring and beam data collection processes.

The DAQ has many databases for which it is responsible. The DAQ will run calibration-dedicated, as well as ordinary data-taking runs. A configuration database will live on a DAQ machine and allow configuring each run. Computing Sector processes will back this up. DAQ calibration constants will be calculated periodically and stored in an offline database, which isn't discussed further, except to note that, from there, those data will be served intelligently to offline LArSoft processes. This ensures a barrier to the DAQ machines from potentially large traffic from processes running on external grid nodes. LArIAT also will evaluate a channel-lookup database.
Slow monitoring and control processes are entirely LArIAT owned.

3.1.2 Ongoing SCD development efforts

In addition to the transition and support activities that will be provided by SCD personnel, there are several areas in which SCD folks will continue to contribute development and deployment effort as the collaboration commissions the DAQ and slow controls systems.

SCD has developed foundation libraries for LArIAT's daq, which include the hardware support library, shared library used by seb and assembler libraries and their corresponding processes.

These efforts will proceed on an 8x5 basis, similar to the construction effort that has taken place so far.

Additional requests may arise as the commissioning of the detector and DAQ continue. The breakdown of responsibilities, and schedule for addressing each request, will be negotiated on a case-by-case basis.

<u>Computing Sector Responsibilities</u>

SCD support for DAQ and controls software in year 1 will include the effort required to bring the system to full operation. Designated representatives of the LArIAT collaboration may request additional consulting services for major changes or upgrades, subject to agreement by the relevant scientific service area managers together with the appropriate SCD line management.

- Provide consulting services to LArIAT online support personnel regarding best practices, technical issues, or specific issues related to system administration of online computing systems. CS will provide limited technical assistance to deal with major system administration issues. All such services will be provided on an 8x5 basis;
- Provide ongoing development and support effort as outlined above.
- 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.

LArIAT Responsibilities:

- Continuing to maintain and support the software components that were developed outside of SCD.
- Comply with security requirements outlined in the LArIAT Minor Application Plan;

Joint Responsibilities:

- Communicate feature requests, issues, and the availability of new versions of core packages in a timely way.

3.2 Engineering and Electronics

The LArIAT collaboration is not planning to utilize the standard Engineering and Electronics Services.

3.3 Grid and Cloud Computing

The LArIAT collaboration depends on the standard Grid and Cloud Computing Services. Scientific Computing System, Scientific Data Storage and Access, and Grid and Cloud Services provide support for LArIAT data analysis and processing systems under the Foundation SLA CS-DocDB-4042 with 8x5 support. The number of batch slots, experiment data storage size and performance, and common job submission and monitoring tools are provided as part of these services. The needs for each year are proposed and agreed to through the Fermilab Scientific Portfolio Management process.

LArIAT is developing the simulation, reconstruction, and analysis code and this will continue and will be better understood. We can assume support needs for:

- Grid computing resources for simulation, production, and analysis (FermiGrid).
- Disk storage for processed data.
- Tape storage for processed data.
- Support for specialized service machines that might be requested in the future (i.e. VMs handling the LArIAT SAMweb server and similar services)

3.3.1 FermiGrid

The LArIAT collaboration uses the standard FermiGrid Services. The LArIAT collaboration relies on FermiGrid as the ensemble of interfaces and services to access local and distributed resources, including the Fermilab computing infrastructure (Fermilab Campus Grid), the Open Science Grid, and Clouds. The collaboration is in the process of targeting different computing platforms for different computing tasks. The data-intensive computing activities, such as reconstruction, target mostly Fermilab local resources; purely compute-intensive tasks, such as monte-carlo production, target a mix of local and distributed resources, such as OSG or public and commercial clouds. CS takes responsibility to manage the ensemble of the services that allow access to the computing infrastructure at Fermilab at the level described in the SLA.

3.3.2 FermiCloud

Should the need arise the LArIAT collaboration will discuss with the Computing Sector use of Virtualized and Cloud Services.

3.3.3 GridFTP

The LArIAT collaboration uses GridFTP Services. For transferring the output of Grid jobs, LArIAT relies on a Globus GridFTP server configured to maintain both user and *group* id file

ownership. The group id ownership is particularly relevant for this service because other data transfer services do not necessarily preserve it.

3.3.4 Accounting Service

The LArIAT collaboration will use the standard Gratia Accounting Services.

3.3.5 Jobsub

The LArIAT collaboration will utilize the standard FIFE Jobsub Services. JobSub is an ensemble of services to submit and manage jobs to local and remote resources. The ensemble includes a user-facing interface for job management, which encapsulates the semantic of experiment-specific use cases, job queuing and resource matching services, basic provisioning services, as well as input / output sandbox transfer service. LArIAT relies on this service for the submission of all jobs to resources, local or remote, dedicated or opportunistic, public or private or commercial.

3.3.6 Fifemon

The LArIAT collaboration will utilize the standard FIFEmon Services. Fifemon is the service that monitors the status of submitted jobs. Fifemon shows the status of the jobs as they go through their lifecycle e.g. submitted, idle, running, and completed. The service allows the user to "drill down" at an increasing level of detail for those jobs of particular interest.

3.3.7 POMS

LArIAT will investigate the use of the Production Operations Management Service (POMS) offered by CS .

3.3.8 Responsibilities

3.3.8.1 Computing Sector responsibilities

- Operation and support for use of local Grid accessible resources agreed to with the collaboration.
- Support and consulting for the use of offsite resources through the Open Science Grid and Clouds.
- Provide consultation with offline personnel from the collaboration on issues related to grid utilization.
- Develop and provide training and documentation in the recommended use patterns of the above resources.

3.3.8.2 LArIAT responsibilities

- Validate users authorized to access LArIAT grid computing resources. The collaboration 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 CS-DocDB-3429.
- Document the local grid and interactive CPU resources required to meet the physics goals of the collaboration.

- Ensure that LArIAT users are informed as to the appropriate usage patterns for all CPU resources[3]. Work with CS personnel as needed to investigate and address operational issues or utilization efficiency issues.
- Perform job submission and data processing tasks.
- Provide user support for job submission and job tracking, and user documentation and education on the use of LArIAT computing resources.
- Provide those components of a job submission layer to the batch and grid resources that is specific to LArIAT.
- 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 LArIAT executables or glide-ins is possible examples where joint effort may be required.
- Provide feedback on the training and documentation provided by the Computing Sector.

3.3.8.3 Joint responsibilities

- 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.
- Investigate and deploy suitable mechanisms for transferring executables, database information, etc., to remote worker nodes for the purpose of Monte Carlo generation or data processing, and for transferring generated files back to Fermilab.

3.4 Interactive Computing: GPCF

The LArIAT collaboration uses servers in the *General Physics Computing Facility* (GPCF) (lariatgpvm01, lariatgpvm02, lariatgpvm03 and lariatgpvm04) for interactive analysis and for testing batch jobs. The Computing Sector is responsible for operation and support of GPCF.

3.5 *Physics Research Equipment Pool (PREP)*

The LArIAT collaboration will utilize the standard *Physics Research Equipment Pool* (*PREP*) Services

3.5.1 Prep Logistics

The LArIAT collaboration will utilize the standard PREP Logistics Services. PREP support is through standard replace and repair procedures with the availability of the Prep service window being 9.30am -4pm 5 days a week. All PREP loans are authorized under a TSW. Experiments sign full TSW's with the division heads organized by the Directorate Office of

[3] Experiments that use Grid resources must establish the appropriate Grid Trust Agreements (see CS-DocDB-3429) prior to use of the Fermilab Campus Grid resources through the FermiGrid services. In addition to the Fermilab Policy on Computing, specific additional policies apply to Grid computing activities on FermiGrid: http://fermigrid.fnal.gov/policy.html and further policies apply to Grid resources accessed via the Open Science Grid (OSG) collaboration http://www.opensciencegrid.org/

Program Planning. Test beam experiments do the same, save that the CS signature has been delegated by the Division head to the PREP Scientific Manager.

3.5.2 PREP Electronics

The LArIAT collaboration will utilize the standard PREP Electronics Services, together with the following list of additional enhanced services:

There is a TSW template for offsite loans signed by the User, PREP Scientific Manager, and Associate Director for Program Planning. Expansions beyond the "PREP list" in a TSW are normal, expected, and by negotiation. There are no explicit Service Level Agreements (SLA's). Implicit in the pool model is that working spares are available to replace failures and diagnose issues. PREP, when asked, will do whatever it can to get a running experiment that is down, back to taking data. This includes spares, replacements, and technical consulting with the Techs and managers as required.

The LArIAT experiment will utilize a broad array of electronics in the development, commissioning, and operation of the DAQ system and the experiment as a whole. 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, and LArIAT-specific hardware procured from outside vendors or built in-house.

3.6 DOCDB

The LArIAT collaboration uses the standard DOCDB Services.

http://lartpc-docdb.fnal.gov/

3.7 UPS/UPD

The LArIAT collaboration will utilize the standard computing sector UPS/UPD Services to standardize software product development, distribution, support and access.

3.8 Scientific Collaboration Tools

The LArIAT collaboration will utilize the standard Scientific Collaboration Tools Services.

3.8.1 Redmine

The LArIAT collaboration depends on the standard Redmine Services.

https://cdcvs.fnal.gov/redmine/projects/lariat-online

https://cdcvs.fnal.gov/redmine/projects/lardbt/

3.8.2 GIT

The LArIAT collaboration will utilize the standard distributed version control system GIT Services. LArIAT code repositories are hosted through cdcvs.fnal.gov redmine core repository and collaboration management system.

3.8.3 ECL

The LArIAT collaboration uses the standard ECL Services and Shift scheduler (since 8/29/2013).

http://dbweb0.fnal.gov/ECL/lariat/

Support for the database servers Support is needed round the clock during data taking. Service Desk requests for off-hours support for ECL database servers will be generated by the PPD Experimental Operations support organization (IFTBG). A PPD support documentation for enhanced support levels is in preparation. It is the CS responsibility to maintain an instance of the Control Room Logbook (ECL) and shift scheduler as needed by the experiment.

3.9 Scientific Computing Systems

The LArIAT collaboration will utilize the standard Scientific Computing Services. The Scientific Computing Systems offerings will be DAQ and Control Room System Management Services.

3.9.1 Experiment Desktops and Control Room Workstations

The LArIAT collaboration will utilize the standard Experiment Desktop Services. The LArIAT experiment utilizes a set of workstation class desktop computers that are used in the LArIAT control room in the Fermilab *Test Beam Facility* (*FTBF:* see *http://ppd.fnal.gov/ftbf/*) for control and monitoring of the experiment. These machines are designed and configured to be generic display stations (i.e. any machine can display any DAQ desktop or interface) and no single machine is considered a critical system for operations. These control room workstations are supported under the DAQ and Control Room System Management Service Offering under the Scientific Workstation Service SLA.

3.9.2 DAQ Computing

The LArIAT DAQ computing is configured with infrastructure to provide each system with:

- Serial console port access,
- Remote power on/off via network controllable PDUs,
- Full access (to the bios level) via console servers accessible via TCP/IP.

3.9.2.1 LArIAT Detector Computing Systems:

- Hardware support for the DAQ and gateway machines. For the FY15 data taking run this were: lariat-daq01.fnal.gov, lariat-daq02.fnal.gov, lariat-gateway-01.fnal.gov, lariat-gateway-02.fnal.gov.
- Hardware support (replacement under warrantee) for support infrastructure (consoles, PDUs, etc.)
- System administration for the SLF6 systems, including configuration management, software updates and security Patches

3.9.2.2 SLA and deviations

1.The Full SLA for scientific servers can be found from the Service Manager.

2.The computer security details are provided in the Minor Application Plan

3.9.2.3 Computing Sector responsibilities

- Installation of, updates, security and other patches for the Scientific Linux OS
- Monitoring and system administration services
- Installation and support of the PUPPET configuration management software.

- The hardware is under maintenance contract with the corresponding equipment's vendor

3.9.2.4 LArIAT responsibilities

- Install and support of all online application software, and Fermilab supported physics toolkits and utilities needed.
- Provide schedules for deploying security patches to all systems that are consistent with Lab security policies and the LArIAT Minor Application Plan.
- Provide an expert from the collaboration who can assist system administrators.

3.9.2.5 Joint responsibilities

Any system or support level Change planning, requests and documentation

3.9.3 CVMFS

The LArIAT collaboration will utilize the standard CVMFS Services of Fermilab for code distribution.

3.9.4 Build Service

The LArIAT collaboration uses the standard Build Service Services (Jenkins).

3.10 Scientific Data Management (SDM)

The Scientific Data Management services involve management of the experiment's event data files and include the following service offerings:

- SAM/IFDH
- File Transfer Service (FTS)
- Data handling

The guiding principle is to provide data handling and management services to an experiment that are robust, efficient, innovative, easy to use, and easy to maintain and operate, and low cost.

The suite of offerings enables the LArIAT experiment to catalog and store event files in the Fermilab central storage system and retrieve such files for processing by jobs running at Fermilab and at remote sites.

Note that the term "event data files" is used here to describe the type of files in root format handled by these services. These files generally contain event information originated by the LArIAT detectors or simulation. Individual log files, histogram files, documents, and such are generally not handled by SDM services. There are exceptions listed here,

- *art* configuration (FHICL) files for simulations are handled by SDM services. Such files are used to initiate simulation jobs and serve as the top "ancestor" of files produced by the simulation run
- Log file bundles (e.g. tarred and compressed) may be handled by SDM services for archival purposes. Such bundles should be large (>2 GB) if possible.
- Other file types may be handled by SDM services upon mutual agreement by LArIAT offline management and the SDM services management and should be listed above

SDM services are generally geared for access to data from batch jobs. There are situations described below where interactive access to data may be possible.

3.10.1 SAM/IFDH

SAM is a system that catalogs, moves, and tracks event data from a central storage facility to caches worldwide. IFDH (see CS-DocDB-5239) is a complementary system that handles the "last mile" of data transfer from a nearby cache to the worker node hosting the running job. SAM provides an interface (SAMWeb) for the user and administrators to configure, communicate with, and monitor the data management system.

The current configuration of LArIAT's data access system is to use Fermilab's Enstore tape system for archival storage and the central cache system with dCache for cache management. The SAM system involves software as well as several physical services including SAM stations, stagers, and other servers. SCD will maintain such software as well as operate the physical services. There are two types of incidents that may be raised against the SDM services: regular incidents are those with either low impact or low urgency (as defined in the CS Foundation SLA CS-DocDB-4042). Critical incidents are those with both high impact and high urgency and must be initiated by the LArIAT offline manager or delegate and called into the Service Desk. Examples of incidents are

- an outage of a critical SAM physical component that halts data handling for all jobs at all sites is a critical incident
- an outage of a web service that prohibits access to all of data management for the experiment is a critical incident
- a software bug that causes a race condition halting all data handling for all jobs at all sites is a critical incident
- because the Fermilab Campus Grid is the primary site for LArIAT processing, an issue that halts data handling for all jobs on FermiGrid is a critical incident
- a remote site issue that causes data handling to fail at that particular site is a regular incident
- an issue that halts interactive access to files but leaves jobs unaffected is a regular incident
- issues of low impact (affecting only a few people) or low urgency are regular incidents
- in special circumstances, a regular incident may be elevated to critical with mutual agreement between the LArIAT offline manager and SDM service managers.

As mentioned above, SAM and IFDH are geared for data delivery to batch jobs. For some situations, IFDH will have capabilities to deliver files to interactive sessions. Currently, these situations include:

- Interactive sessions on Fermilab LArIAT GPCF interactive nodes (lariatgpvm01, lariatgpvm02, lariatgpvm03) with the file resident or accessible to the central public dCache.

Data transfer rates and requirements are specified in SPPM presentations.

<u>SCD Responsibilities:</u>

- Provide the Scientific Data Management services that enable LArIAT to catalog, store, and retrieve event data as described in this section.
- Support SAM and IFDH software, interfaces, and libraries at a 8x5 level except in the case of bug that causes a critical incident. Such critical incidents are handled at an 8x7 level.

- Support SAM physical services and servers at an 8x5 level except in the case of an outage that causes a critical incident. Such critical incidents are handled at an 8x7 level.
- If a remote site experiences no or under-performing file delivery, the site will be investigated and debugged by SCD. Note that cooperation with site administrators may be necessary and LArIAT managers may need to assist.
- Respond in a timely manner to requests generated by LArIAT.
- Monitor the system for operations and performance at an 8x5 level. As practical as possible, critical incidents generate an automated page to SDM service operations personnel. Note that not every issue can be anticipated nor covered by automation. In the case of a critical incident page due to or resulting in a critical service outage, the SDM service operator will notify the LArIAT offline manager or delegate of the outage.
- Perform maintenance on systems and software as necessary. Such maintenance may incur a service outage or degradation during the maintenance window. Such maintenance windows must be negotiated with LArIAT offline management in advance. SDM service management will make every attempt to minimize the occurrence of unplanned emergency maintenance windows.

LArIAT Responsibilities:

- Open Service Desk incidents when issues are noticed. Critical incidents as described above need to be initiated by the LArIAT offline manager and called into the Service Desk.
- Open Service Desk requests for new metadata fields or advice about metadata fields.
- Open Service Desk requests for new use cases or anticipated unusual increase in demand as early as possible. The SDM service management and operators will respond to the request and if possible, adjust the services configuration accordingly.
- While the SDM systems will be as robust as practical, LArIAT offline management should prevent, as much as practical, user abuse of SDM systems that cause unwanted increases in demand or unusual use cases.
- Negotiate with SDM service management for maintenance windows. Note that unplanned emergency maintenance windows may be necessary in special circumstances.
- The SAM database is connected with the LArIAT configuration db. The latter is managed by LArIAT. Should there be a problem with it, SAM might have problems. SCD can help troubleshooting and identifying the issue. But it is the ultimate responsibility of LArIAT to maintain the configuration DB.

3.10.2 File Transfer Service (FTS)

The File Transfer Service (FTS) is a robust system for uploading files into the SAM catalog and central Fermilab storage. Its main use is for transferring event files from the LArIAT DAQ systems into SAM as well as the output of Simulations. The FTS uses many SAM components and thus SCD and LArIAT responsibilities detailed in the SAM/IFDH section apply here. FTS also introduces its own software and physical server components and those are supported at a level similar to the SAM software and services. Both SDM service management and LArIAT operations will monitor the FTS system through its built in web monitoring service (http://lariat-daq02.fnal.gov:8787/fts/status).

Since files produced by the detector DAQ systems are irreplaceable, LArIAT will provide enough "spool" disk area to allow for the storing of at least a week's worth of data in case of a full and long-term outage of FTS, SAM, or Enstore.

LArIAT will create Service Desk incidents if issues are noticed with FTS. Critical incidents may be initiated by the LArIAT online or offline management and called into the Service Desk. An incident that stops all storage of data (from DAQ or simulation jobs) is critical and will be handled at an 8x7 level.

3.10.3 Data Handling

Data handling is a service offering where SDM experts provide consultation and advice for an experiment's data handing needs aligned with the principle stated above. Examples of topics include:

- Definition of file meta-data
- Exploring new data handling use cases and paradigms
- Exploring data handling technology

LArIAT may initiate consultation by opening a Service Desk request. SDM experts may approach LArIAT offline management for discussions as well.

3.11 Scientific Data Storage and Access

The LArIAT collaboration will utilize the standard Scientific Data Storage and Access Services. The Scientific Data Storage and Access services are described in the related SLA CS-DocDB-5032. Support for LArIAT falls within the standard service categories. The responsibilities of each party are described in the SLA. The expected scale and performance of the systems is described in the submission to the Laboratories Scientific Portfolio Management process (SPPM), and is summarized in the FY2015 SPPM Presentations available at:

https://indico.fnal.gov/conferenceOtherViews.py?view=standard&confId=9319

The disk and tape storage needs of the LArIAT experiment are categorized below.

3.11.1 Raw Data

The LArIAT experiment records data corresponding to the tertiary beam spills as well as additional cosmic trigger events. The Tertiary Beam at FTBF delivers spills lasting 4.2 seconds every minute. The cosmic trigger is alive in the time between the spills. Cosmic events are mainly used for calibration purposes e.g. monitoring the purity of the liquid Argon and estimating the energy resolution utilizing Michel electrons from muon decay. The data rates for the LArIAT detector depend on the operational parameters of the detectors (such as noise, trigger) and the condition of the tertiary beam. Estimates concerning the raw data volumes can be found in the LArIAT presentation at:

https://indico.fnal.gov/conferenceOtherViews.py?view=standard&confId=9319

For the FY15 data taking the zero suppressed raw beam and reconstructed data on permanent storage was estimated to amount to about 8 TB. The raw and reconstructed data obtained with the cosmic trigger is estimated to amount to 3 TB on permanent storage. The FY15 data taking run finished at the begin of July 2015 according to samweb the raw data (no reconstruction) recorded during the data taking run is around 2.3 TB distributed over 113371 files.

For FY 16 after the shutdown it is planned to run the Experiment for 6 month with the same configuration effectively doubling the raw data sets.

Under the current LArIAT computing model, raw data from the detector is transferred using the FNAL developed "File Transfer Service" (FTS) from the DAQ machine (lariat-daq02.fnal.gov) to enstore (enstore:/pnfs/lariat/raw/) and cataloged by the SAM data catalog system. The data is then copied to the enStore tape system for archival storage as well as to the central dCache pools for general processing and analysis access. The status of file transfers can be monitored on the following web page:

http://lariat-daq02.fnal.gov:8787/fts/status

For raw data, two copies are made of the data (on different physical tapes) to ensure against data loss in the advent of media failure.

3.11.2 Monte Carlo Simulation Files

For simulated data for FY15 we assume that 10x the statistics is needed resulting in 80TB of data in permanent storage.

3.11.3 Production Data Analysis

Data analysis is driven by many factors, including the size of the data sample, the number of analyzers, the number of topics, the size of simulation samples required, etc. Experience from other experiments at colliders and in the neutrino program is that the data analysis needs are likely to exceed the production needs.

3.11.4 End User Data Analysis

3.11.4.1 Computing Sector Responsibilities

1. Install and maintain a central disk pool capable of serving LArIAT data to the GP Grid Cluster, CPCF cluster, and other on-site LArIAT computers via data handling tools or NFS. Data serving rates must be sufficient to meet the demands of reconstruction and analysis on the GP Grid cluster, GPCF, and other on-site computers. It is expected that the majority of the data will be accessed via cache disk. BlueArc disk will primarily be used for user code and small test or analysis samples.
2. Install and maintain NFS-mounted disk serving software releases to the GPCF cluster, GP Grid cluster, and other on-site interactive machines, and machines with disk for building software releases. This will be complemented and in many ways replaced by a cvmfs repository that is used as the main code access on many of the systems at Fermilab and on grid sites and local clusters around the world. The OSG or Fermilab hosted cvmfs file system may serve the role required for all LArIAT use.
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 accessible via Enstore. All raw detector data, processed data, and Monte Carlo data will be archived to tape.
5. Provide /nashome area disk. Regular backups of this space will be performed.
6. Except as specified below, monitor performance of tape and disk storage systems.
7. Provide tools for archiving analysis data.

3.12 Scientific Databases

The LArIAT collaboration will utilize the standard Scientific Database Services. Scientific Databases and Database Hosting Services are both relevant to the support levels for the experiment systems. Unless otherwise stated the support level is 8x5 as stated in the Fermilab Foundation SLA CS-DocDB-4042.

The LArIAT experiment employs databases that are used to store information regarding the operations of the detectors and the conditions of beams the detectors see. These databases are used by both online and offline systems with different access patterns, replication needs and uptime requirements.

The major database applications include the data management catalog, the conditions database, and the Online 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.

CS provides tiered levels of support for database services ranging from 8x5 to 24x7, the choice depending upon the application and the type of underlying database. For support under the Database Hosting SLA, it is required that each production database instance will be accompanied by corresponding development instances (required at a minimum for maintenance testing) and integration instances (optional for additional QA testing), both of which receive the lowest available tier of support.

3.12.1 Scientific Database Applications Descriptions

The web-based "Conditions Database" service is an application that is also used by the LArIAT offline. The Conditions Database web server and application are available 24x7. A SLA detailing the services and support level is in preparation. The Online Database on CS managed servers will hold a copy of the online LArIAT Database server. Regular backups and access updates via service tickets are required.

LArIAT also uses the IFBEAM and the SAM data management databases. The IFBEAM database is used by the LArIAT experiment in both real-time and in an offline capacity. The IFBEAM monitoring web application is used in real-time and is important for detector operations. Both of these databases and web services are available 24x7. A SLA detailing the services and support level is in preparation.

Computing Sector Responsibilities:

Install and maintain databases, database servers and applications needed to store and utilize the following mission critical data:

- Install and maintain a copy of the LArIAT Online Database server.

LArIAT Responsibilities:

LArIAT has created a Postgresql database, which queries information from IFBEAM, of which two tables are accessed by SAM.

- Enter the content of all databases;
- Interfacing LArIAT software with the database applications;
- Ensuring that users are informed as to appropriate usage patterns, and otherwise assisting CS personnel in investigating and addressing operational issues.

- 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 CS.
- 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 LArIAT Minor Application Plan.

Joint Responsibilities:

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

3.13 Scientific Frameworks

The LArIAT collaboration depends on the art software suite for their offline production (simulation and reconstruction) applications. The entire suite appears as external packages to LArIAT. The suite can roughly be broken up into three areas: the art framework, support libraries, and external products.

The LArIAT experiment requires support for the following packages:

- Art suite releases: CS will create, host, and maintain release distribution of the entire art suite. Distributions may include bug fixes, features, or changes build parameters as required by the LArIAT experiment release manager. CS will provide support through the standard support systems for integration issues and questions. Platform support will be primary SLF6. SLF5 will be supported as a secondary platform at low priority.
- Art suite software: CS will provide support for the art framework and underlying support software libraries. Support will include bug fixing, issue analysis, answering questions concerning functionality and usage, and providing upgrades to accommodate platform and external product changes. CS will accept feature requests through the redmine system.
- UPS: CS will provide support for the UPS package. This includes answering questions, investigating issues, and providing bug fixes when issues are encountered.

3.13.1 Supported by the experiment

Git/mrb is a package that is used to build software releases from the LArIAT Git code repositories. It is used in the compiling and the running of the offline and online experiment code developed by the experiment.

The experiment shall provide necessary support for the following packages:

- Experiment offline release builds and distributions, including integration with external products.

3.14 Scientific Software

The LArIAT collaboration is part of the joint LArSoft project and uses this software for offline simulation, and reconstruction. The Computing Sector coordinates the joint LArSoft project, with experiments contributing Librarians, algorithm codes, and as key partners. LArSoft depends on art as the underlying software framework. The software and its

libraries are central to all of the current software of the experiment, including event simulation, event reconstruction, event display and analysis.

The Scientific Computing Division provides support for:

- LArSoft releases: CS will create, host, and maintain the release distribution of the common LArSoft code. CS will provide for LArIAT to make releases of the LArIAT specific code that is part of the LArSoft package. CS will provide support through the standard support systems for integration issues and questions. Platform support will be primary SLF6. MACOSX will be supported at a lower priority. SLF5 will be supported as a legacy platform at lower priority.
- LArSoft support will include bug fixing, issue analysis, answering questions concerning functionality and usage, and coordinating and providing upgrades to accommodate platform and external product changes. The project accepts feature requests through the redmine system.
- As a collaborative project the priorities for LArSoft work are discussed and decided in the bi-weekly LARSoft Librarian and Partner/Project meetings. LArIAT will be a regular attendee at these meetings to ensure there is good coordination across the experiments and core support teams.

The details of the LArSoft service agreement, organization, commitments, etc. are being developed and will supersede the details in this section.

The LArIAT collaboration depends on ROOT and TotalView.

3.15 Simulation Software

3.15.1 GEANT4

LArIAT depends on the Geant4 (integrated in LArSoft or stand alone) detector simulation toolkit to simulate the beam line associated with the experiment and the interaction of particles with the detector material. As such, Geant4 is a core part of the LArIAT software stack and essential to the success of the experiment.

Fermilab will provide consultation services to LArIAT on topics such as how to install and configure Geant4 and how to use it to develop detector and beam applications. Fermilab will also partner with the experiment to help improve the physics of Geant4 using the framework established by the Geant4 Collaboration for community contributions. This may include the addition of physics models, their validation and the composition of Geant4 physics lists to achieve the best possible physics description for the particles, materials, configurations, and kinematic ranges involved specifically in the LArIAT experiment. Fermilab will also communicate to the Geant4 Collaboration any requests from LArIAT for new features or bug fixes. Additionally, Fermilab will invite LArIAT representatives to report during the Geant4 Technical Forum meetings that the Geant4 Collaboration holds periodically with the users community to receive general input and specific requests. Fermilab will also offer to represent LArIAT at Technical Forum meetings in case they cannot or do not wish to attend.

The Geant4 Collaboration is an independent entity Fermilab contributes to but does not control. Fermilab has responsibilities and representation within the Geant4 Collaboration. Even though neither Fermilab nor any other institution can unilaterally decide on Geant4 software strategy, planning, or prioritization, Fermilab will represent LArIAT interests within the Geant4 governance structure and lobby for LArIAT requests.

3.15.2 GENIE

LArIAT as a test beam experiment exposed to particle beams doesn't make use of the primary functionality of the GENIE Monte Carlo event generator, which is to simulate neutrino-nucleus interaction physics, and to study associated systematic uncertainties. But GENIE contains hadronic models (e.g. the hA model) that are complementary to the models provided by Geant4. Comparison between results obtained with GENIE versus Geant4 can then be used for systematic studies.

Fermilab will provide consultation services to LArIAT on topics such as how to install and configure GENIE and how to use it within their beam and detector simulation software. Fermilab will also partner with the experiment to help improve the physics of GENIE using the framework established by the GENIE collaboration for community contributions. This may include the addition of physics models, their validation, and the composition of GENIE tunes to achieve the best possible physics description for the particles, materials, configurations, and kinematic ranges involved specifically in the LArIAT experiment. Additionally, Fermilab will provide a public line of communication to the GENIE Collaboration in the form of regular meetings with GENIE authors, hosted by the laboratory. Finally, Fermilab will reserve space for LArIAT to participate in GENIE schools and developer's workshops hosted at the laboratory and provide consulting expertise to independent GENIE software projects within LArIAT.

The GENIE Collaboration is an independent entity Fermilab contributes to but does not control. Fermilab has responsibilities and representation within the GENIE Collaboration. Even though neither Fermilab nor any other institution can unilaterally decide on GENIE software strategy, planning, or prioritization, Fermilab will represent LArIAT interests within the GENIE governance structure and lobby for LArIAT requests

Glossary

- **ifdh:** *FDH* (*Intensity Frontier Data Handling*), is a suite of tools for data movement tasks
- **GPCF:** General Physics Computing Facility
- **FIFE:** FabrIc for Frontier Experiments (FIFE) is a project within Scientific Computing Division that provides collaborative scientific-data processing solutions for Frontier Experiments. FIFE includes architecture, design, services and support for:
    - Grid submission to dedicated and opportunistic resources and user-friendly monitoring of submitted jobs.
    - Data management and handling with co-scheduling of data and job services and integrated into the art analysis framework
    - Database and dataset applications such as beam monitoring, conditions, and hardware
    - Collaborative tools such as an electronic control room logbook and shift scheduler
    - Collaborations with experiments to build integrated solutions
    - FIFE is based on common toolsets wherever possible to increase flexibility, provide for efficient evolution, and reduce the maintenance load
- **OPOS:** Offline Production Operations Services.
- **POMS:** Production Operations Management Service.
- **SLA:** A service-level agreement
- **NAS:** Network-attached storage
- **FTS:** File Transfer Service
- **SDM:** Scientific Data Management
- **GENIE:** *(**G**enerates **E**vents for **N**eutrino **I**nteraction **E**xperiments)* is a comprehensive neutrino Monte Carlo generator.
- **CVMFS:** CERN VM File system is a network file system based on HTTP and optimized to deliver experiment software in a fast, scalable, and reliable way.
- **SAM:** Sequential Access via Metadata (SAM) is a data handling system to store and retrieve files and associated metadata, including a complete record of the processing which has used the files.
- ***FTBF:*** *Fermilab* Test Beam Facility (*FTBF*).
- ***SCPMT:*** *Scientific Computing Portfolio Management Team*.