

LHC@FNAL – A NEW REMOTE OPERATIONS CENTER AT FERMILAB*

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Abstract

Commissioning the LHC accelerator and experiments will be a vital part of the worldwide high-energy physics program beginning in 2008. A remote operations center, LHC@FNAL, has been built at Fermilab to make it easier for accelerator scientists and experimentalists working in North America to help commission and participate in operations of the LHC and experiments. Evolution of this center from concept through construction and early use will be presented as will details of its controls system, management, and expected future use.

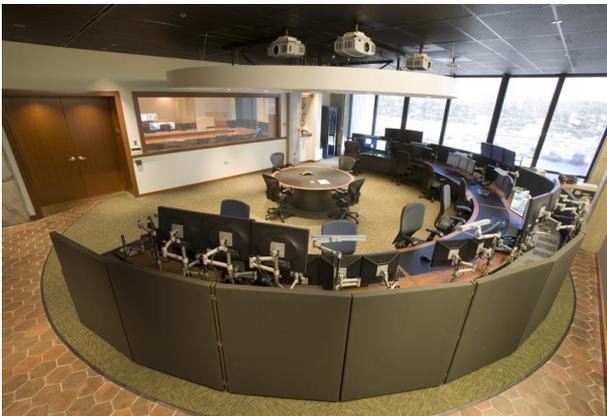


Figure 1: Completed LHC@FNAL Remote Operations Center.

INTRODUCTION

LHC@FNAL was designed as a facility with a three-fold purpose: a **Place** that provides access to information in a manner that is similar to what is available in control rooms at CERN and where members of the LHC community can participate remotely in CMS and LHC activities; a **Communications Conduit** between CERN and members of the LHC community located in North America; and as an **Outreach Tool** by which visitors to Fermilab will be able to see current LHC activities as well as be able to see how future international projects in particle physics can benefit from active participation in projects at remote locations.

One of the primary reasons for establishing LHC@FNAL is to provide remote monitoring capabilities for LHC accelerator components developed and built in

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the U.S., and to provide capabilities for remote participation in LHC commissioning and beam studies.

For CMS the goal is to maximize the effectiveness of physicists and technical experts by establishing several dedicated and interconnected operations and monitoring centers.

An important aspect of LHC@FNAL is that accelerator experts and experimenters will be in close proximity to each other while participating in activities at CERN. Individuals working together on LHC and CMS activities can use the same resources in their work while sharing their insights on commissioning and operations.

CONCEPT

The concept for LHC@FNAL evolved in large part from Fermilab's existing investment in the LHC:

- contributions to CMS detector construction,
- host of the LHC Physics Center (LPC) for US-CMS,
- a Tier-1 grid computing center for CMS,
- fabrication of LHC machine components including inner triplet quadrupoles and instrumentation,
- collaborating institution of the LHC Accelerator Research Program (LARP)
- involved in software development for the LHC controls system through a collaboration agreement with CERN called LHC@FNAL Software (LAFS).

The LPC had always planned for remote data quality monitoring of CMS during operations and the question arose as to whether this role could be expanded to include remote shifts. LARP was interested in providing support for US-built components, training people before going to CERN, and remote participation in LHC studies.

Thus, an opportunity for US accelerator scientists and engineers to work together with detector experts to contribute their combined expertise to LHC and CMS commissioning was seen as an interesting possibility. The idea of a joint remote operations center at FNAL emerged and has come to be known as 'LHC@FNAL'.

Early Work

Intermediate work was done in both the LHC and CMS realms prior to a formal organization. A CMS Remote Operations Center was given space in Wilson Hall to

allow remote work as the detector was constructed. Some proof of principle work as to the feasibility of remotely accessing CERN accelerator applications was done by LHC/LARP personnel thanks in large measure to cooperation by AB/OP colleagues at CERN.

Task Force

A Task Force was formed at the request of the FNAL Director and first met in May, 2005. The task force continued its work for nearly eighteen months. As part of its work the Task Force considered various scenarios of the use of LHC@FNAL and from them drew up sixty-three requirements. The document that resulted from this work was given an independent review and forwarded to the Fermilab directorate and potential LHC@FNAL stakeholders for consideration. The proposal was met with enthusiasm and after additional refinements and early design work, authorization to move ahead with the project given in May of 2006. Following four months of design and engineering work, construction was initiated in September of 2006.

Site Visits

An important part of the process was visits to various control rooms around the world. Although the basis for design was the new CERN Control Centre (CCC) the task force wished to learn concepts behind the design of other modern facilities and user response to same.



Figure 2: Layout and Orientation of LHC@FNAL on the main floor of Wilson Hall at Fermilab.

DESIGN

Design work of LHC@FNAL was done in-house by Fermilab's Facilities and Engineering Services Section using input from the Task Force and other stakeholders. A high visibility location was preferred for accessibility as well as for outreach purposes. Early on, appropriate space on the main floor of Wilson Hall was designated by the Laboratory Director. While high visibility was important, potential users expressed a desire to maintain some measure of privacy. Computer security was also a factor in designing the center with an open feel yet with limited access.

Major Challenges

The final design features a 'Storefront' (mullion-free glass), projection wall and screens, privacy glass between the center and the adjacent conference room, programmable lighting, and a standalone heating, ventilation, and air conditioning (HVAC) system which maintains the environment in the center during off-hours.

CONSTRUCTION

Construction was based on a 12-week schedule beginning in September 2006. Work was successfully completed safely, with no injuries, on time, and under budget.

Included in the construction was the purchase and installation of console furniture. This included space for eight workstations each with three flat screen displays, broad spectrum task lighting at every work station, and four shared three-screen fixed displays, trolleys for PC's within the furniture and a common table. This furniture was purchased from the same vendor as for the CERN CCC consoles.

COMPUTING

Separate Computing Systems and Platforms are provided for in LHC@FNAL. Table 1 summarizes the systems and their functions. Access to both the room and systems is restricted as appropriate.

Table 1: Computing Systems Used in LHC@FNAL.

Type	Operating System	Quantity
Console PC	Scientific Linux	8
Fixed Display PC	Scientific Linux	4
Gateway PC	Scientific Linux	1
FCC Server	Scientific Linux	1
Outreach Macintosh	Mac OS X	2
Presentation PC	Windows	1
EVO/VRVS PC (videoconferencing)	Windows	1

An overview of the networks in the room is found in Figure 3. The possibility of establishing a secure tunnel to a CERN network is taken into account if this feature should be needed in the future.

USE

The first user group of the facility has consisted of Fermilab administrators and operators monitoring local Tier-1 grid computing resources at Fermilab and supporting university-based Tier-2 centers. Other groups that have used the ROC in 2007 include the CMS silicon-tracking group and CMS HCAL group who ran remote shifts for commissioning and test beam activities, respectively. LHC@FNAL is presently being used for CMS global commissioning runs and CMS data operations, such as the current "CSA07" computing challenge.

Use by LHC groups has not been fully realized owing, in part, to delays in the installation and commissioning

schedules. Work is in progress to develop the necessary tools to provide participation in SPS machine development periods and LHC Hardware commissioning.

In addition, the LHC@FNAL Software (LAFS) group, which is providing some applications development for the LHC, uses the consoles as needed.

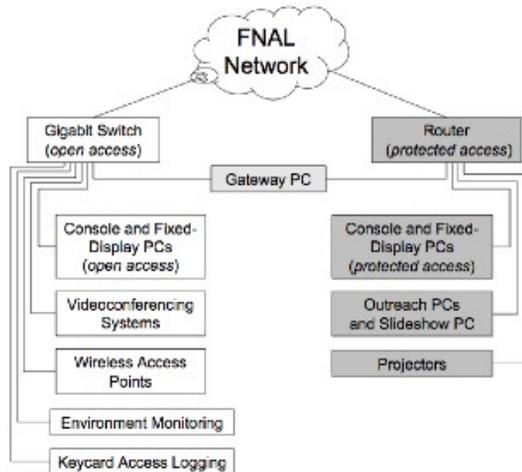


Figure 3: LHC@FNAL Computing Network.

An organizational structure has been formed to manage the center. Three Working Groups have been formed to address the unique needs of each user base: CMS, LHC, and Outreach. In addition, an Engineering Working group which includes the Operations Support Team oversees the room's day-to-day functioning.

FEATURES

With construction complete and the center coming into complete operation the following features have been realized:

- CERN-style consoles with 8 workstations shared by CMS & LHC
- Videoconferencing installed for two consoles, which can be expanded to four
- Webcams for remote viewing of LHC@FNAL
- Secure keycard access
- Secure network for console PCs
- High Definition (HD) videoconferencing system for conference room
- HD viewing of LHC@FNAL, and HD display capabilities in the centre
- Secure group login capability for consoles, with persistent console sessions

Two other software features are significant enough to deserve special mention: Role Based Access Control (RBAC) and Screen Snapshot Service (SSS).

Role Based Access Control

RBAC is an approach to restrict system access to authorized users. It was developed by Fermilab staff working at both CERN and Fermilab and was deployed at the end of June 2007. More information is available elsewhere at this conference [1, 2, 3].

Major Challenges

Screen Snapshot Service

SSS is an approach to provide a snapshot of a graphical interface to remote users. A 'snapshot' is defined as an image copy of a graphical user interface at a particular instance in time such as a DAQ system buffer display or operator control program. It is a view-only image, so there is no danger of accidental user input. SSS was initially implemented for desktops, but could be targeted to application GUIs.

The role of the service is to receive and track the snapshots from the monitored applications, cache the snapshots for short periods of time, serve the snapshots to requesting applications/users, prevent access from unauthorized applications/users, and act as a gateway to private network applications for public network users.

Currently SSS is being used both by CDF for operations and by the CMS Silicon Tracker Group. More information is available at:

<http://home.fnal.gov/~biery/snapshot/>.

SUMMARY

Fermilab has built the LHC@FNAL Remote Operations Center, which is shared by scientists and engineers working on the LHC and CMS. It was designed and built collaboratively and rapidly.

For the LHC it provides a means to participate remotely in LHC studies, access to monitoring information, a training facility, and supports the collaborative development of software for the LHC controls system.

For CMS it provides a location (in a U.S. time zone) for CMS remote commissioning and operations shifts, and Tier-1 grid monitoring shifts. More information and complete documentation is available at:

<http://cd-amr.fnal.gov/remop/remop.html.org/>.

ACKNOWLEDGEMENTS

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