Introduction

The US High Energy Physics program has significant involvement and investment in the construction of machine components for the Large Hadron Collider (LHC) at CERN and for two of the experiments, ATLAS and CMS, that will begin taking data there starting in about two years. For US physicists to be actively and effectively engaged in experiment and accelerator operations at the LHC, it is expected that remote operations capabilities will be needed to support data analysis efforts in the US and to reduce the number of US physicists, postdoctoral researches and graduate students that need to reside at or near the CERN site in Geneva.

To understand what capabilities are needed to facilitate remote operations, the Fermilab Director charged a committee to develop the requirements for a remote operations center to be located at Fermilab. The purpose of this review is to evaluate and comment on the requirements document prior to its submission to the Fermilab Director.

The review was held on July 21, 2005. The document under review, "Preliminary LHC@FNAL Requirements", Version 35, dated July 15, 2005, can be found at http://docdb.fnal.gov/CMS-public/DocDB/ShowDocument?docid=165&version=35. The committee would like to thank the reviewees for the excellent quality of their presentations and for making them and the document under review available to us well in advance along with a lot of supporting material.

In the first section of this report, the committee provides its overall impressions and main conclusions and recommendations. In the second section, it gives detailed commentary on the individual requirements. Appendix 1 of this document gives the charge for the review and the membership of the review committee. Appendix 2 gives the agenda of the review.

1. General Comments and Recommendations

The requirements document that we were asked to review is a very detailed and well thought out document that captures many key requirements of a remote monitoring centre that could serve the LHC and CMS well. By including members of the CERN operations and beams staff and of CMS, the requirements committee was able to take into account discussions of these issues at CERN and to incorporate constraints imposed by CERN that are derived from their experience and needs. The method of developing operations scenarios and letting them drive the identification of requirements is reasonable and effective.

These are the committee's main recommendations. In some cases, they address the content of the document under review or how it is presented. In other cases, they address the next steps in the process of developing this project.

Recommendation #1: You should prepare an executive summary for the Fermilab Director that is less detailed and contains no more than two pages of bullets. This will also be useful if the document is given to others. You should also clean the document up, removing duplication where possible. As part of the cleanup, you should remove information that, while appropriate to a working document, should not appear in the final document. The "status-and proponent" box should be deleted. The priority box refers to the order of implementation but since these are requirements and they are all currently listed as essential, it adds no value to the document.

Recommendation #2: The document should be made less-Fermi-centric. It should not refer to "experts" at Fermilab vs. "people" at the University. It should have additional requirements that make it explicit how this centre will enable US CMS and LARP Collaborators to fully participate whether at Fermilab or at their home institutions.

There was a lot of discussion of this issue at the review. It addresses the central issue of the value-added of a remote operations centre at Fermilab to CERN, to accelerator physicists in the US, to CMS, to US CMS and to individual university researchers. The following possible roles for the remote operations centre emerged from the discussions between the proponents and the reviewers and from discussions amongst the reviewers in executive session:

1. To provide assistance in locating various US CMS or LHC experts and putting them in touch with the experiments or accelerator operations at critical moments.
2. To provide a support and training to help remote participants create distillations of information to carry out their monitoring responsibilities.
3. To maintain software support to assist experts in establishing the ability to use remote monitoring software outside of FNAL and CERN. This should include a help desk and support for installing remote monitoring tools on computers at universities. This could also include the development or testing of various tools to achieve this. This service should be seen as support and enhancement of tools provided for remote access by CMS and CERN.
4. To establish a training centre for CMS and LHC operations so people who come from the US to do shifts at CERN will be well prepared
5. To provide, under suitable controls, a test site for new hardware or software of interest to or developed by CERN. It could be very useful to have a site away from the CERN Control Centre that could carry out such testing while minimizing risk to actual operations.

These and other such value-added functions should be included in the requirements.

Recommendation #3: You should write a "safeguard" requirement that actions by the LHC@FNAL will not be taken that interfere with or jeopardize the quality of the data being taken when the experiment is running or interfere with preparations for running or

that jeopardize the operation of the LHC. It should include a strong statement that all aspects of LHC@FNAL should conform to CERN and Fermilab safety standards.

Recommendation #4: There should be a requirement on the minimum duration of the project and a plan for reviews at specific points to determine its effectiveness by its major stakeholders and to determine its readiness for each new phase of operations as the LHC and CMS move from machine commissioning and experiment commissioning to early physics running and then to steady operations for physics. Once the value of this facility is established to CERN, an MOU between CERN and the US that ensures its continuation will almost certainly be required.

Recommendation #5: There should be a strong requirement that the Remote Operations Centre at Fermilab should maintain to the greatest extent possible consistency in hardware and software with CERN and CMS. CMS and LHC software will be based on various CERN software licenses (databases, slow control, etc). Fermilab should agree to and commit to buy and support these identical licenses or work out agreements with CERN on these licensing agreements. This is a key to minimizing the impact of this project on CERN resources. Each deviation from this requirement should be reviewed and established as justified before it is implemented.

Recommendation #6: More work needs to be done on the details of how this facility would be used. While the work on scenarios is judged to be an effective mechanism for developing requirements, it is certainly too early to be very precise. The project team should develop an operations model soon for both CMS and LHC that explains how the personnel at the Remote Operations Centre at Fermilab will interact with CERN and CMS staff. This discussion will undoubtedly evolve as LHC commissioning and operations approach so the requirements should be revisited periodically. Concentrate for now on the details of infrastructure, hardware and tools that should be available in the remote facility. There will need to be agreements on how data access will be handled so that computer security rules are respected and limits on how much impact requests for data will be allowed to have on the systems at CERN.   For example, the accelerator experts in the US would like to be able to run actual console programs at CERN and receive information directly on consoles at FNAL, as opposed to receiving it only via a database access. But this may conflict with CERN network security principles. There also needs to be safeguards that guarantee that changes that affect operations are always under the control of the Central Control Room at CERN. Given the uncertainties and the evolutionary nature of this problem, the working group should concentrate for now on the details of infrastructure, hardware and tools that should be available in the remote facility.

Recommendation #7: There should be a requirement for an outreach component and perhaps a requirement that the outreach component be coordinated with CERN's program.

We were asked in the charge (see Appendix 2) to address theses five specific issues:

1. *Will LHC@FNAL, as defined in the preliminary requirements document, allow experts located at Fermilab to participate actively and effectively in CMS detector and LHC machine activities including commissioning, operations, maintenance, and upgrades when they are unable to travel to CERN?*

    The requirements given in the document should lead through the follow on process of specification, design, and implementation to a system that will allow experts located at Fermilab to participate actively in CMS and LHC machine activities. We believe that the needs will become clearer as LHC and CMS operations draw nearer. Once operations commence, they will evolve over time. The requirements here adequately address the needs as currently understood and provide a sound basis for moving forward.

2. *Do the requirements adequately address the needs of members of the LHC community in North America, such as members of US-CMS and US/LARP?*

    The requirements given in the document should lead through the follow on processes of specification, design, and implementation to a system that will allow US-CMS and US/LARP collaborators located in universities and national laboratories in North America to participate in US-CMS and LHC machine activities. We believe that the needs will become clearer as LHC and CMS operations draw nearer. Once operations commence, they will evolve over time. The requirements here adequately address the needs as currently understood and provide a sound basis for moving forward.

3. *Do any of the requirements imply possible violations of CERN or FNAL safety or security standards?*

    There is no conflict with CERN or Fermilab safety and security standards. Our third recommendation is to include this as a specific requirement.

4. *Do any of the requirements suggest that significant resources from CERN may be needed for LHC@FNAL?*

    Other than limited consulting support, we do not believe that significant resources will be needed from CERN, provided that recommendation 5 above is followed.

5. *Are the requirements sufficiently developed to serve as a basis for developing cost and schedule estimates for the LHC@FNAL facility?*

    These requirements form the basis for developing a more detailed specification in order to produce a cost estimate and schedule.

2. Detailed Commentary on the Individual Requirements

In this section of the report, we provide detailed comments on specific requirements. We repeat enough of the requirement in *italics* to make the committee's comment meaningful to the reader. The non-italicized text that follows is the committee's comment.

i. CMS Detector Requirements (Section 3.1)

In this subsection we address requirements related to CMS operations: At the end of this subsection, we also make a general comment on some of the discussion in section 3.1.1.

1-2 *LHC@FNAL shall have the space that is needed to accommodate diverse US-CMS activities during commissioning and operations.*

What about computing facilities and display screens available for users? Local computing facilities, CPUs to run applications and disks to store results may be necessary and may require additional space and infrastructure. . We also do not know whether there will be restrictions on entering calculated data directly into the various CMS databases so provision has to be made for staging disks.

1-3 *CMS commissioning meetings shall have video conferencing capabilities that allow access to meetings by CMS collaborators located at LHC@FNAL.*

As stated, this is an assumption about the CMS collaboration, and not a requirement of lhc@fnal. It should read, "LHC@FNAL shall have video conferencing capabilities that allow convenient access by CMS collaborators working there to all relevant meetings of the CMS collaboration."

1 – 4. *The LHC@FNAL Committee shall continue to explore tools that will improve remote participation in CMS commissioning activities at CERN.*

It is not a requirement for the committee to explore tools. It should read, "LHC@FNAL should have all the tools and facilities needed for remote participation in CMS commissioning activities at CERN."

1-11 *LHC@FNAL shall have the capability to simultaneously communicate with as many CMS control rooms (located at CERN or in remote locations) as are actively involved in shift operations at any given time*

This seems like a repeat of 1-6, and could be eliminated.

1-13 *LHC@FNAL shall have access to data used for detector calibration and alignment*

You should specify at what level this information needs to be available. Some of this data is kept by detectors in private farms with private processing that is not immediately available to all of CMS. Some is analyzed and discarded. You probably mean the "official alignment data" and its history.

1 – 14. *LHC@FNAL shall be able to submit requests to include special runs (such as calibration runs) in the CMS run plan and be notified of the status of these requests*

Committee members did not understand the intention of this requirement. We think that any collaborator will be able to make a request for a special run using the existing CMS line management. We would not have thought of LHC@FNAL as an entity that makes that kind of requests. Some committee members thought this touched on the role of LHC@FNAL collecting and prioritizing such requests for the CMS shift captain rather than letting each user make their input. Does this make sense? Even if it is agreed that it helps the CMS shift coordinator to have this kind of prioritization, what about the other 4/5 of the collaboration's requests? This requirement needs to be stated more clearly.

1 – 15. *LHC@FNAL shall be able to submit requests to use DAQ resources for CMS subsystem calibration and testing*

This seems linked to 1-14. Access to DAQ resources seems like being able to take calibration runs.

1 – 16. *LHC@FNAL shall have the same CMS experiment software installed as the software used in the CMS Control Room*

This should be rewritten in light of General Recommendation #5

Comment on section 3.1.1:

We also have a general comment on remarks on recording of meetings in section 3.1.1. However useful recordings were to the requirements process, many people regard them with suspicion. The acceptance of recording is a trust issue that must be resolved within each group. You should simply drop the discussion at the beginning of section 3.1.1 since it can only be a distraction.

ii. LHC Accelerator Requirements (Section 3.2)

Comments such as "LHC@FNAL shall have access..." and "protocol ... shall include LHC@FNAL personnel..." need to be toned down, to suggest that the LHC@FNAL will have the ability to access information, and shall be able to take advantage of protocols which are developed for the LHC commissioning, etc. It would be nice to collaborate with CERN to try to make these things happen, but the Center shouldn't tell them what to

do. This kind of language is more appropriate for a signed MOU between the labs.

You should remove most references to US/LARP participants and simply state participants from the US, or participants from North America, etc. An exception would be in Section 3.2.2.1, 2-10, where LARP-supplied instruments are referred to as an example.

Section 3.2.1.1 and 3.2.2.1 - Access and Communications

2-4 and 2-10 and 2-11.
2-4 *LHC@FNAL shall have read access to hardware commissioning data.*
2-10 *LHC@FNAL shall have prompt read access to LHC accelerator data.*
2-11 *LHC@FNAL shall have access to LHC optics, errors, and transfer functions. An agreement between CERN and Fermilab ensures that LHC@FNAL has the required access to the appropriate repositories. LHC@FNAL shall also have access to pre-defined measurement data structures, storage and access methods*

There will be a number of databases at CERN, for example; control db for management of settings, including keeping track of all changes made to the machine; measurement db for 'short term' acquisitions; and logging db for 'long term' storage of measured parameters. These will be available read-only.

The meaning of "prompt read access to LHC accelerator data" in 2-4 and 2-10 probably should be clarified. The scenario document "Observe first beam in the LHC" reviewed by among others Mike Lamont implied accessing a normal console to view "real-time orbit displays". If the standard application this implies gets its information from the "measurement db" then it is consistent with Roger's comments. If it is expected that applications have to be specially written to run at LHC@FNAL it should probably be stated.

2-5. *LHC@FNAL shall have read and write access to the hardware commissioning logbook*

Present thinking for the elogbook is that new entries can only be made at CCC/FCR (determined by IP address). Read capability and the possibility to add comments to existing entries can be made by all authorized persons.

2-7 and 2-15.
2-7 *LHC@FNAL personnel shall know who is on shift at the FCR, and they shall know the roles and responsibilities of the FCR shift personnel*
2-15 *LHC@FNAL personnel shall know who is on shift at the CCC, and they shall know the roles and responsibilities of the CCC shift personnel*

This could be through the elogbook, which will probably have a record of who is on shift.

2-12 *LHC@FNAL shall have access to information and decisions from daily LHC schedule meetings at CERN*

Especially during hardware commissioning of FNAL & LARP equipment, the centre at FNAL should have some definite type of participation. It might be through a representative at CERN (who would need to be designated) or through video/tele-conferencing.

Section 3.3.2 - Operational environment

3-8. *To facilitate communication between CMS and LHC, LHC@FNAL consoles shall have the capability of displaying both CMS and LHC data.*

Not sure how "essential" this is if LHC and CMS activities are in the same room. This requirement should be re-evaluated, especially in light of the following comment: "There is a problem that CMS shift-takers may log comments that the machine group would not appreciate and vice versa. The logbooks of the experiment and the machine must be frank and allow for unfettered speculation that might not be appreciated by each other. The LHC@FNAL setup potentially allows leakage between the two constituencies. This should be addressed.

Appendix 1: Charge to the Review Committee and Committee Membership

Fermilab

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Date: July 8, 2005

To: Dr. Joel Butler, Particle Physics Division, Fermilab

The LHC@FNAL Committee requests a review of LHC@FNAL requirements on July 21, 2005. The purpose of this review is to assess the scope and requirements that have been identified for LHC@FNAL, and to review the preliminary LHC@FNAL Requirements Document prior to submission to Fermilab's Director, Pier Oddone, on July 29, 2005.

LHC@FNAL is a new facility that is to be built at Fermilab to support work on the CMS experiment at the Large Hadron Collider (LHC) at CERN, and to support active participation in LHC accelerator activities. The purpose of LHC@FNAL is to facilitate communication between CERN and members of the LHC community located in North America, and to help members of this community contribute their expertise to accelerator activities and the CMS experiment.

For the review it helps to keep in mind that requirements for CMS and LHC are different. However, LHC@FNAL will be used for both the experiment and the accelerator, and commonality between the two is reflected in the structure of the requirements document. One section in the document is devoted exclusively to requirements for CMS, the second section for LHC requirements, the third section includes requirements that involve both CMS and LHC, and the final section includes requirements based on constraints such as safety and computer security.

Reviewers are asked to assess the scope of LHC@FNAL as defined by the requirements document, and are asked to address the following specific items:

6. Will LHC@FNAL, as defined in the preliminary requirements document, allow experts located at Fermilab to participate actively and effectively in CMS detector and LHC machine activities including commissioning, operations, maintenance, and upgrades when they are unable to travel to CERN?

7. Do the requirements adequately address the needs of members of the LHC community in North America, such as members of US-CMS and US/LARP?

8. Do any of the requirements imply possible violations of CERN or FNAL safety or security standards?

9. Do any of the requirements suggest that significant resources from CERN may be needed for LHC@FNAL?

10. Are the requirements sufficiently developed to serve as a basis for developing cost and schedule estimates for the LHC@FNAL facility?

Erik Gottschalk is Chair of the LHC@FNAL Committee, and will serve as the contact person for the review.

                           Erik Gottschalk
                           Particle Physics Division, Fermilab

Committee Membership:

Name	Affiliation
Austin Ball	CERN-PH
Jim Alexander	Cornell University
Jim Patrick	FNAL-AD
Joel Butler (Chair)	FNAL-PPD
Michael Lindgren	FNAL-PPD
Mike Syphers	FNAL-AD
Paul Derwent	FNAL-AD
Roberto Saban	CERN-TS
Roger Bailey	CERN-AB
Wesley Smith	Univ. of Wisconsin

Appendix 2: Review Agenda

7:30	Executive Session	Erik E Gottschalk	Remote Operations:Requirements	PPT PDF	00:30	Note
8:00	Introduction to LHC@FNAL	Erik E Gottschalk	Remote Operations:Requirements	PPT PDF	00:10	
8:10	LHC@FNAL: Requirements for CMS	Patty McBride	Remote Operations:Requirements	PPT PDF	00:40	
8:50	LHC Accelerator Requirements	Elvin Harms	Remote Operations:Requirements	PPT PDF	00:40	
9:30	Executive Session	*None*	*None*		01:00	