



US CMS COLLABORATION

US CMS Software and Computing Project Management Plan

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1. Goals of the US CMS Software and Computing Project

The software and computing effort for CMS exceeds in scale and complexity anything that has so far been achieved in High Energy Physics. Even the new generation of experiments that will be coming on between 1999 and 2001 will not approach this scale. Because of the large number of participants and their wide geographical distribution CMS will need to employ what is essentially a new model of distributed computing and data analysis, which is without precedent in HEP. It will do so during a period of rapid change in software practices and hardware technologies. The US CMS Software and Computing Project is the response of US physicists in CMS to this challenge.

The goal of the US CMS Software and Computing Project is to provide the software and computing resources needed to enable US physicists to fully participate in the physics program of CMS. Additionally it should allow US physicists to play key roles and exert an appropriate level of leadership in all stages of the computing-related activities, from development of the reconstruction programs and software infrastructure to the extraction of physics results. This capability should extend to physicists working at their home institutions.

A key element in achieving this goal is to develop the software and to construct the facilities to provide an integrated environment for remote collaboration that would make possible central US roles in the data analysis. This includes:

1. providing the resources to support participation in the development of software associated with the design, calibration, commissioning, and analysis of the detectors in which US CMS members are involved;
2. providing the resources to support the participation in the development of reconstruction, simulation, and analysis frameworks and other physics applications infrastructure at a level appropriate to the number, capabilities, and experience of US CMS physicists; and
3. providing the resources and facilities for participation by US CMS physicists, especially those who wish to remain based in the US, in all analysis efforts and activities of interest to them.

The word 'resources' is meant to include personnel -- for development, operations, and support, as well as the hardware, commercial software purchases, and contracts for other services required to achieve these goals.

US CMS functions within the context of the full CMS experiment which in turn functions as an experiment of CERN. It is essential that this project stay well aligned with both the scientific goals of US CMS and with the policies and approaches of CMS and CERN. This project provides services and facilities that couple smoothly to CERN central computing, and to CMS facilities worldwide, so that US physicists can work productively whether at their home institutions or at CERN.

The US CMS Project is closely coordinated with the international CMS Software and Computing project¹ that covers

- (1) the computing aspects of the design, construction, evaluation and calibration of the CMS detector
- (2) the storage, access and processing of event data
- (3) event reconstruction and analysis, and
- (4) the computing and remote collaborative infrastructure for the above.

This project supports US CMS efforts to do its appropriate share of the CMS work and also to solve special problems related to the geographical separation of US physicists from the site of the experiment.

CERN has stated clearly its policy that significant resources to support data analysis must come from sources external to CERN. This project responds to that policy by marshaling US national resources to support the analysis activities of US physicists on CMS. The US expects to do this in a cost effective way by leveraging the knowledge, talent, and experience with HEP computing that exists within US universities and Fermilab, which is the US CMS host institution

The US also has particular issues to deal with as a result of being separated from the experimental data and the central data repositories by an ocean and by six to nine time zones. The US CMS Collaboration is itself widely spread out, as a result of the geographical expanse of the United States. US physicists are thus particularly dependent on a well-coordinated distributed data analysis system, able to deliver data and/or analysis results reliably and with acceptably short delays across transoceanic as well as national networks. These issues coupled to the unique position of the US in computing and networking technologies make it unavoidable that the US takes a lead role in these efforts, and bears the brunt of much of the R&D work and associated costs.

The long distance to the experiment means that US physicists are particularly reliant on videoconferencing for meetings and participation in the daily activities of the experiment. A high quality remote collaborative environment is required for collaborative work on the software and data analysis, and will be an important part of this project. An extension of this work will result in the ability to operate a remote “shift taking” facility in the US, including in-depth monitoring of the detector and the data acquisition system.

No remote collaborative technology can fully compensate for the out-of-phase work cycles resulting from the six to nine hour time difference between the US and Europe. The US is thus obligated to focus some of its activities nationally and sometimes regionally within the US, in order to allow the physicists of US CMS to work efficiently. This problem will be partly solved by the presence of a Tier 1 Regional Center at Fermilab in the US Central Time zone, use of remote collaborative technologies within the US, and the use of an hierarchical “computational data grid” that places a “Tier 2” Regional Center in each of several US regions.

The remainder of this document describes the management structure of the project and presents the Work Breakdown Structure (WBS), budget, schedule and key milestones.

2. Project Organization

The project organization chart is presented in Figure 1.

The Software and Computing project has two major subprojects:

- Core Applications Software (CAS)²
- User Facilities (UF)³

This project will provide the core framework and infrastructure software, and hardware to support the reconstruction, simulation, and physics analysis. The project does not include the development of the actual reconstruction software or software for specific physics analyses, much of which will be written by physicists. These activities appear on the organization chart as two "boxes" called "reconstruction and detector software", and "physics analysis"⁴. While the funding of the project described here is separate from the reconstruction and physics analysis software, they are obviously closely related and must be coordinated. This is discussed below.

The remainder of this section provides a brief characterization of the two major subprojects.

2.1 The Core Applications Software Subproject

The Core Applications Software Subproject will develop software

- to support the design, development, modeling, optimization, and commissioning of software related to detectors being constructed by US CMS;
 - to provide its share of the framework and infrastructure software required to support data analysis and simulation for CMS;
 - for remote collaborative tools and services for the distributed model of computing that will enable members of US CMS to carry out data analysis while they are at home in the US or resident at CERN; and
- to satisfy any specialized needs required to carry out data analysis activities of interest to members of US CMS.

US CMS' core software efforts have focused on three main areas:

- ORCA: the object-oriented event reconstruction
- The User Analysis Environment
- Distributed System Development

The US will also, by virtue of its interests and its expertise, participate through the Core Applications Software Project in various R&D and common projects.

In addition to developing software, this subproject will also provide expert programming personnel to assist the physicists in developing reconstruction and physics analysis programs by serving as mentors, reviewers, advisers and, where appropriate as software tool-writers. This will ensure that the software produced will be easy to integrate into the whole system, will be efficient in its use of hardware resources, and will be maintainable and adaptable for the full life of the CMS data analysis.

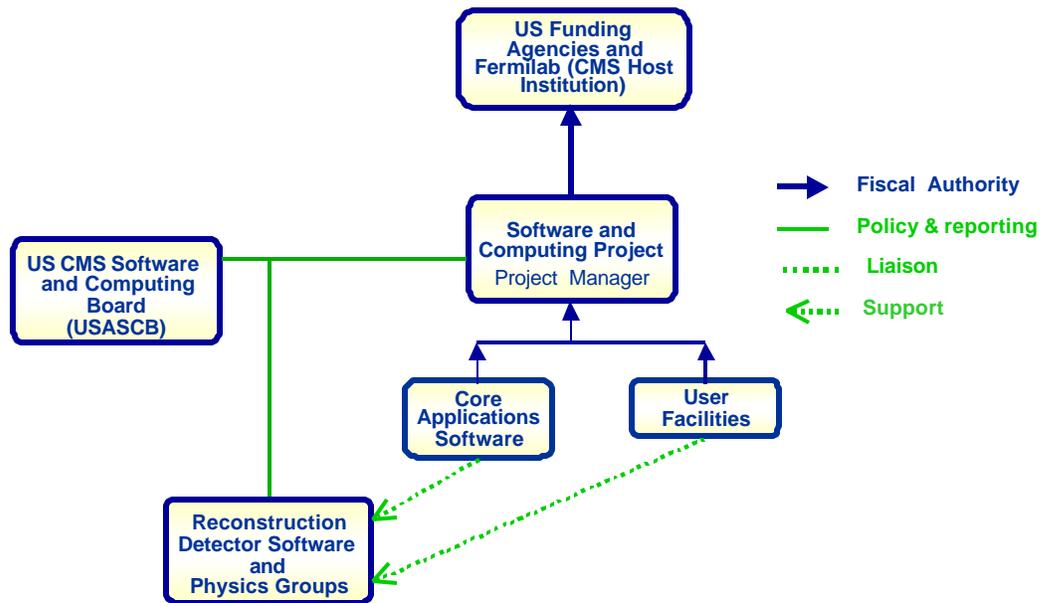


Figure 1: Abbreviated version of organization of the US CMS Software and Computing Project showing the main subprojects and the key links to US CMS, Fermilab, and the US funding agencies. More detail on the relation to the US CMS construction project is shown in Fig 2.

2.2 The User Facilities Subproject

The mission of the "User Facilities" subproject of the US CMS Software and Computing Project is to provide the *enabling infrastructure to permit US CMS collaborators to fully participate in the physics program of CMS, and to do so from their home sites if they choose*. This enabling infrastructure will consist of the software and hardware needed to access, analyze and understand data as well as to support software development efforts by US CMS physicists and computing professionals. The major cost and personnel-requirements driver for the subproject is a regional computing center at Fermilab to support US physicists working on CMS. It is appropriately sized to support this community which comprises 20% of the full CMS collaboration.

The Fermilab regional center will include substantial CPU, data storage and data access facilities. It will be able to deliver portions of the data as required to other US CMS institutions through high-speed networks and will have a high bandwidth network connection to CERN. It will also include user support personnel, personnel to manage licenses and license acquisition, and personnel to contract for needed services. It will have the responsibility and personnel to

develop or acquire any software that is required to carry out its production and operation activities. It will provide a variety of training and consulting services to help university physicists carry out their computing activities at their home institutions and at Fermilab. It will also provide support for many development activities during the detector construction period before data taking begins.

In addition to developing software required to carry out its mission, this subproject will also provide expert programming personnel to serve as liaisons to programmers developing software by serving as reviewers and advisers. This will ensure that the software produced elsewhere in US CMS will be easy to integrate into the whole system, will be efficient in its use of hardware resources, and will be maintainable and adaptable for the full life of the CMS data analysis.

The User Facility subproject has as part of its mandate supporting Tier 2 regional centers. A Tier 2 regional center, as defined by the joint ATLAS/CMS MONARC project, is expected to be sized at about 2-5% of the main CMS CERN facility (and therefore 10-20% of the capacity of a 'Tier 1' center). The US Tier 2 regional center sites are not yet identified, but Fermilab plans to support data import/export, documentation and software distribution to these centers.

3. Upper Level Project Management

The roles and responsibilities of the upper level project management are described in this document. These entities are:

- the Level 1 Project Manager (L1PM);
- the Level 2 Project Manager (L2PM) for the Core Applications Software subproject;
- the Level 2 Project Manager (L2PM) for the User Facilities subproject;
- the Fermilab Computing Division (CD) and its Division Head;
- the US CMS Advisory Software and Computing Board (USASCB); and
- the Fermilab Director or designee advised by the US CMS Project Management Group (PMG).

Fig. 2 shows the organization chart again but this time with a more complete view of how the project components are tied to Fermilab, the US funding agencies, the US CMS construction project, and US CMS software efforts in reconstruction and physics analysis (These software efforts are shown schematically by two boxes which are meant only to indicate the activities. They do not imply any specific organizational structure since they are still evolving.)

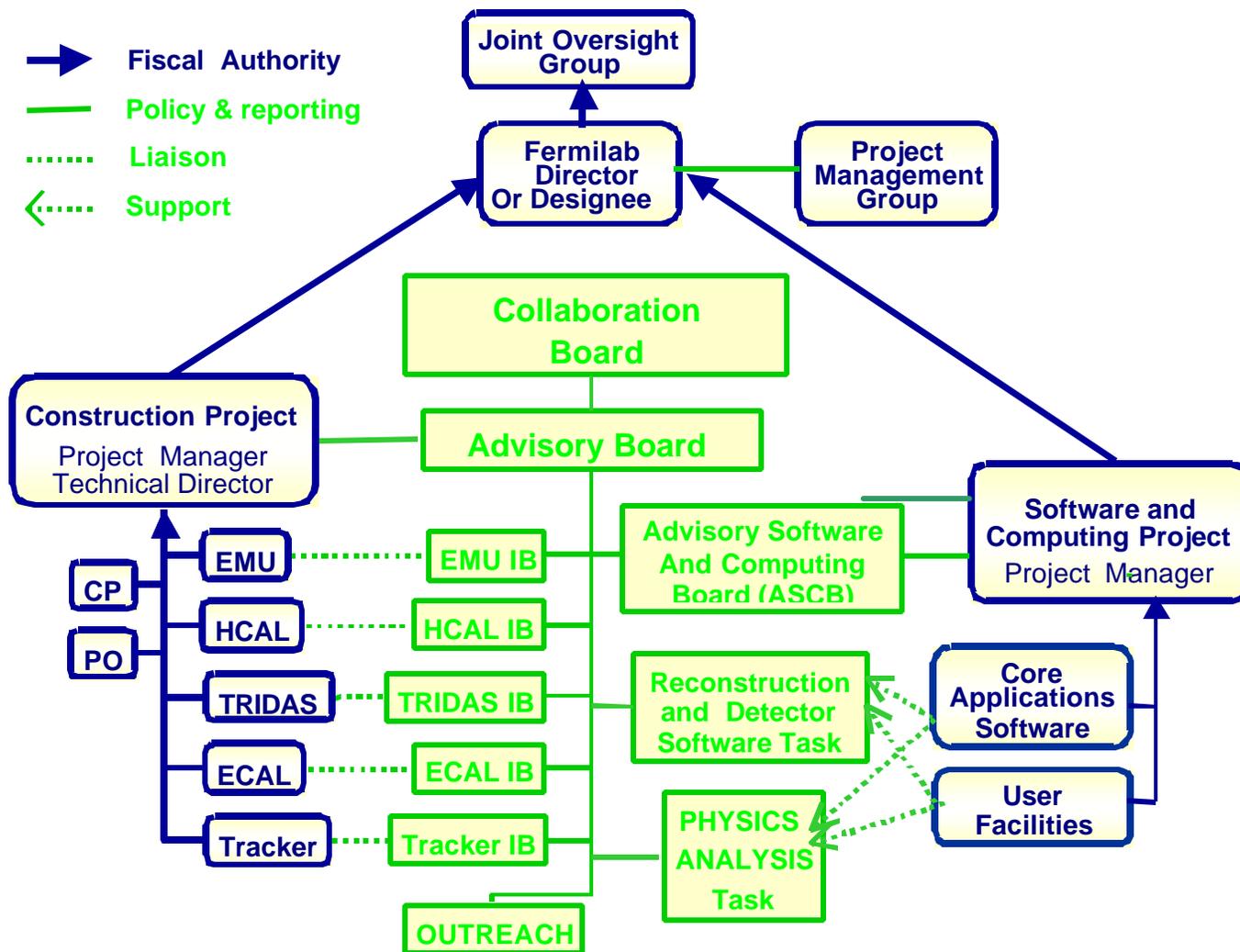


Figure 2: Organization Chart for US CMS Software and Computing Project. This shows how the project components interact among themselves, with Fermilab, the US funding agencies, the US CMS Construction Project and US CMS software efforts in reconstruction and physics analysis.

3.1 The Level 1 Project Manager

The Level 1 Project Manager is responsible for completing the project by achieving the approved scope within budget and on schedule. He/she must also ensure that the deliverables of the project conform to the technical specifications that are set for them. Finally, he/she is responsible for doing all this in manner consistent with CMS scientific policy.

The L1PM will be appointed by Fermilab in consultation with the USASCB and will receive the concurrence of the DOE and the NSF. During his/her tenure, the L1PM will be a member of Fermilab's staff. Administratively, the L1PM will be a member of the Fermilab Computing Division and his/her staff organization will reside in the CD. It is

expected that the L1PM will have experience and background in HEP experiment, software development, management, and operations issues and skills that would predict success as a project manager in this role.

The specific responsibilities of the L1PM include

1. developing the baseline project plan especially with respect to budget, personnel requirements, schedule, Level 1 (L1) milestones, and L1 deliverables;
2. executing the approved project plan in a manner consistent with the technical and scientific policies of US CMS;
3. developing an integrated Cost and Schedule Plan;
4. establishing and maintaining the project organization, within the Fermilab Computing Division, required to manage procurements, maintain schedules, submit reports, develop budgets, carry out quality assurance, maintain the project plan and the record of all revisions to it, and maintain safety standards and records;
5. developing the annual budget request to the DOE and NSF. This request is reviewed by the USASCB and must be approved by the PMG;
6. providing liaison between the project and the CMS Software and Computing Technical Board (SCTB);
7. at his/her discretion, in consultation with the USASCB and with the concurrence of the PMG, appointing a deputy or other supporting staff to assure management continuity during periods when he/she is absent or unavailable;
8. appointing, the two Level 2 (L2) managers in consultation with the USASCB and with the concurrence of the PMG. Consulting on and concurring with the appointment of Level 3 (L3) managers by the L2 managers;
9. developing or adopting general technical and quality assurance standards to which deliverables must conform. This includes making sure that US CMS software and facilities conform to applicable CMS and CERN standards and practices, and can operate with them without unnecessary additional integration effort;
10. providing coordination and oversight to the Level 1 and Level 2 projects. Oversight may be accomplished by requiring appropriate regular reports, following and tracking the results of technical reviews, and conducting reviews using both internal and external committees or experts. Coordination may involve making sure that the User Facilities Subproject can supply test beds to the Core Applications Subproject for major development activities;
11. making adjustments to Memoranda of Understanding, MOUs, and Statements of Work, SOWs, with collaborating universities and laboratories. These MOUs and SOWs are initially formulated as part of the project plan but adjustments may be necessary in the course of the project;
12. allocating resources within the project. These allocations are largely set by the project plan and the annual budget request. However, adjustments are often necessary. The project plan includes a contingency that will be allocated subject to the formal change control procedure;
13. reporting variances from the scope, schedule, or cost estimates to the PMG and developing action plans for dealing with them. The L1PM informs the USASCB of such variances;
14. exercising change control authority as described in this plan and bringing change issues that exceed his/her authority to the attention of the PMG;
15. establishing technical advisory committees where appropriate;
16. providing reports and organizing reviews in conjunction with the funding agencies; responding to requests for information from US CMS, Fermilab, and the funding agencies; and
17. developing a technology-tracking plan, in conjunction with the Level 2 managers and with similar efforts at CERN, with the advice of the USASCB. The tracking plan should allow the project to take advantage of new, more cost-effective technologies that may arise during the period of the project's execution.

3.2 The Level 2 Project Managers

The Level 2 Project managers are appointed by the Level 1 Project manager in consultation with the USASCB and with the concurrence of the PMG. The main responsibility of the L2 Project managers is to manage their subproject so

that they successfully produce the deliverables of the project on schedule, within budget, and within their technical specifications.

3.2.1 The Core Applications Software Subproject

The L2 manager of the Core Applications Software Subproject is appointed by the L1PM in consultation with the USASCB and with the concurrence of the PMG. This position will normally be held by a physicist who is a member of US CMS and is expert in software development and HEP data analysis. The subproject will be responsible for developing software components, carrying out evaluations and feasibility studies, and performing various tests.

Responsibilities of the L2 Project Manager for Core Applications Software include:

1. defining, in consultation with and subject to the concurrence of the L1PM, the milestones and deliverables of the subproject;
2. developing the technical specifications of each component and deliverable of the subproject;
3. defining, in consultation with and subject to the concurrence of the L1PM, the organizational substructure of the subproject. This includes defining the L3 projects and proposing, subject to the approval of the L1PM, the L3 project leaders;
4. developing, under the guidelines provided by the L1PM, the annual budget proposal for the subproject;
5. allocating resources and identifying resource imbalances or deficiencies within their subprojects. Allocations are largely set by the project plan and the annual budget request. Making adjustments within prescribed limits of resources within their subprojects. Proposing adjustments to SOWs with collaborating universities and laboratories to the L1PM. Changes are subject to the change control procedures outlined in this document;
6. delivering the scope of the subproject on schedule, within budget, and in conformance with the technical specifications and quality assurance guidelines of the project;
7. organizing (and documenting) internal reviews to make sure that deliverables will meet the technical specifications and the quality assurance standards of the project;
8. being accountable for all funds allocated to the subproject;
9. maintaining the Cost and Schedule Plan for this subproject;
10. providing reports as required to the L1PM; and
11. carrying out any other duties assigned by the L1PM.

3.2.2 The User Facilities Subproject

The Level 2 manager of User Facilities Project is appointed by the L1PM in consultation with the USASCB and with the concurrence of the PMG. He/she will be experienced in and knowledgeable about HEP physics analysis production issues, hardware acquisition, operations issues, and the development of software components as relates to operations and production.

The Level 2 manager will have significant responsibilities connected with the US CMS Regional Computing Center at Fermilab and will normally be a member of Fermilab's staff.

Responsibilities of the L2 Project Manager for the User Facilities Project include:

1. developing the definition of the milestones and deliverables of the subproject;
2. developing, subject to review by the L1PM and with the input from the USASCB, the technical specifications of each component and deliverable of the subproject which will include the acquisition of hardware components, contracting for services (such as network connectivity), acquiring software for operations or monitoring, and developing software to integrate components and to manage production or operations activities where required;
3. defining the organizational structure of the subproject. This includes defining the L3 projects and proposing, subject to the approval of the L1PM, the L3 project leaders. Each Tier 2 and special purpose center will be a Level 3 project and have its own Level 3 manager, who will report to this L2 manager.

For Tier 2 and special purpose centers, each center will appoint, with the concurrence of the Level 2 manager for User Facilities, a manager who will be responsible for CMS activities at the Tier 2 or special purpose center and this manager will be the Level 3 project leader for the center for the US CMS Software and Computing Project;

4. developing, under the guidelines provided by the L1PM, the annual budget proposal;
 5. negotiating adjustments to the MOU with Fermilab, in particular with the Computing Division, for support of US CMS Regional Center;
 6. negotiating annual MOUs with Tier 2 or special purpose centers, and with their managing organizations as appropriate, should they become part of US CMS computing. The purpose of the MOU is to define what specific deliverables the center will provide and what resources and services are needed from the Tier 1 center;
 7. delivering the scope of the subproject on schedule, within budget, and in conformance with the technical specifications and quality assurance guidelines of the project. This will include developing Requests for Information (RFIs), Requests for Proposals (RFPs), acquisition plans, implementation plans, technical specifications, acceptance tests and criteria, etc;
 8. organizing (and documenting) internal reviews to make sure that deliverables will meet the technical specifications and the quality assurance standards of the project;
 9. being accountable for all funds allocated to the subproject;
 10. maintaining the Cost and Schedule Plan for this subproject;
 11. providing reports to the L1PM;
 12. working with potential candidates for Tier 2 and special purpose centers to prepare their proposals. The parts of proposals for such centers, which relate to CMS, must be approved by the management chain described in this document; and
13. carrying out any other duties assigned by the L1PM.

3.3 The US CMS Advisory Software and Computing Board (USASCB)

The US CMS Advisory Software and Computing Board provides input and feedback for the US CMS Software and Computing project. The composition of the board and its relationship to US CMS and CMS are partially described in this document⁵. It is composed of:

- six at large members elected from the US CMS collaboration;
- the US CMS Physics Coordinator (also elected);
- the Chair of the US CMS Collaboration Board (ex-officio);
- the Head of the Fermilab Computing Division (ex-officio);
- the CMS Project Manager for Software (ex-officio);
- the Project Manager of the US CMS Construction Project (ex-officio);
- the Level 1 Project Manager for the US CMS Software and Computing Project (ex-officio); and
- the Level 2 Project Managers for the User Facilities subproject and for the Core Applications subproject (ex-officio).

The 7 elected members of the ASCB will select a chair who shall be one of the 6 at large members.

3.3.1 Development of the Project Plan

Working with the USASCB, the Level 1 Project Manager, in consultation with US CMS, creates a plan for the Software and Computing Project, subject to approval by the PMG. The USASCB has the specific responsibility of

providing the interface to US CMS in setting the requirements for this plan and for helping to develop any overall policies associated with it.

The Level 1 Project Manager, with advice from the USASCB, will develop initial funding profiles, resource loaded schedules, budgets, Memoranda of Understanding (MOUs), and Statements of Work (SOWs) for the "baseline" project. These will be presented by the Level 1 Project Manager to the PMG for approval and eventually to the funding agencies.

3.3.2 Scientific and Technical Policy

The USASCB advises the Level 1 Project Manager on scientific and technical policy for the US Software and Computing Project consistent with the scientific direction and goals of US CMS and CMS. Technical, scientific, operations, and resource allocation issues are to be discussed frequently by the board with the goal of providing continuous input and feedback as required for effective execution of the Software and Computing project. Recommendations are made to the Level 1 Project Manager. Scientific issues with a major potential impact on the physics results to be obtained by US CMS will be brought before the US CMS Advisory Board, and to the US CMS Collaboration Board, if needed, and resolved in a manner consistent with International CMS.

3.3.3 Project Input and Feedback

The USASCB provides scientific and technical input and feedback to assure that the project is indeed carrying out the policies of US CMS and International CMS, which will certainly evolve over time, and is faithfully executing the project plan.

3.4 Fermilab Oversight and the Project Management Group

The Department of Energy and the National Science Foundation have requested that Fermilab, as CMS Host Institution, exercise management oversight for the US CMS Software and Computing Project. Oversight responsibility is vested in the Fermilab Director or designee, who is advised by the US CMS Project Management Group. The Fermilab Director or designee reports to the Joint Oversight Group.

3.4.1 Project Management Group (PMG)

To provide oversight of the US CMS Software and Computing Project, the mandate of the Project Management Group for the US CMS Construction Project, will be extended. Specific members will be added to the PMG for their expertise in software, computing, and data analysis issues. These will include

- the Level 1 and Level 2 Project Managers; and
- the chair of the USASCB.

The US CMS Collaboration Board Chair, the Fermilab Associate Director for Research, and the Head of the Fermilab Computing Division are members of the PMG with a particular interest in the Software and Computing project. Other members or observers with specific expertise or interest in this area and who represent US CMS, Fermilab, or the funding agencies may be added.

These members will comprise the PMG subgroup for the US CMS Software and Computing Project. The chair of the PMG will appoint a chairperson for this subgroup. The subgroup chair in consultation with the L1PM and with input from the chair of the USASCB prepares the agenda for these meetings. The PMG Chairperson may also choose to hold meetings with this subgroup or to have joint meetings of the group associated with the Construction Project and this subgroup based on the issues to be addressed. The chair of the PMG prepares the agenda for these meetings. The PMG receives the reports of the L1PM for the US CMS Software and Computing Project.

Oversight of the project is implemented in part through reviews. Along with providing routine interactions with the project management, the PMG will identify actions and initiatives to be undertaken to achieve the goals of the project including the allocation of both financial and human resources. The PMG also functions as the Baseline Change Control Board for the project.

3.4.2 External Review Committee

The chair of the PMG will establish a standing external review committee that will periodically examine and evaluate all aspects of the US CMS Software and Computing Project. It is highly desirable that this committee be chaired by a recognized expert in HEP computing and that its membership include computing experts from CERN and strong representation from CMS software management.

3.4.3 Change Control

Detailed change control thresholds are established in three areas: technical changes, schedule changes, and cost changes. The values of these thresholds and the authority that approves a proposed change in each area at each threshold will be set when the project baseline is established.

4. Interrelationship with Other entities

4.1 Relation to CMS

The CMS collaboration has organized the software and computing efforts as a subsystem just like any other. The “L2 Manager” for software and computing represents this subsystem on the CMS Steering Committee. The technical activities of subsystems in CMS are managed in a “Subsystem Project Office”. For this particular subsystem, this entity is called the Software and Computing Technical Board (SCTB) which is chaired by the L2 manager. The CMS L2 manager has overall responsibility for and direction of the CMS Software Project including all tasks carried out for that project by the US CMS Software and Computing Project. The collaborative aspects of a subsystem in CMS are handled by an “Institutional Board”. To create a strong linkage between the US CMS Software and Computing Project and the overall CMS Project, the CMS L2 manager will be an ex officio member of the USASCB. The USASCB will have the responsibility for providing liaison between the US CMS Computing Project and the CMS Software and Computing Board, and the US CMS Software and Computing Project Level 1 Project Manager will act as liaison to the CMS Software and Computing Technical Board.

The US CMS collaboration will be contributing to CMS computing in a variety of ways, each of which will have an appropriate formal mechanism for establishing milestones, deliverables, and specifications. Levels of support for production activities, including those required to support the design, testing, simulation, and commissioning of the detector should be supported by MOUs negotiated with CMS by the L1PM with input from the USASCB and with the approval of the PMG and funding agencies. The software development that directly relates to the international CMS effort should be developed as part of the CMS software and computing plan and approved, presumably as part of the project plan for the US CMS Software and Computing Project, by the PMG and the funding agencies. Software efforts specifically in support of US physicists or intended to solve particular problems specific to the US, should be developed as part of the project plan with substantial input from USASCB and approved by the PMG and, if required, by the funding agencies.

4.2 Relation to US CMS and to the US CMS Construction Project

The US CMS Software and Computing Project provides suitable computing hardware and framework and infrastructure software to facilitate a broad range of offline software tasks by the US CMS Collaboration. At present, major US CMS activities are R&D on the network-distributed LHC computing models, building the reconstruction,

detector and analysis software, study and verification of the CMS detector design, high level trigger and data acquisition system performance, and study of CMS' physics capabilities using fully simulated and reconstructed events.

The work by US physicists on these tasks is fully integrated with the work of the CMS collaboration as a whole. US CMS has several areas of leadership, including the computing model R&D, reconstruction and detector software, the user analysis environment, and high level triggers. In the LHC running phase a more unified US CMS structure managing the software and data analysis will be formed as appropriate (see section 5).

The US CMS Construction Project is responsible for the construction of specified elements of the CMS detector as designed by US physicists. The scope of the Project extends from the detector elements to transducers to front end electronics, through L1 pipelined triggers, L2 and L3 triggers and data acquisition including the L3 computing farm and data logger. The US Software and Computing Project concerns the steps needed to facilitate these tasks all the way to physics analysis by providing suitable hardware and framework and infrastructure software.

The CMS experiment is a unified enterprise, in which the Construction Project and the Software and Computing Project will be well coordinated to meet the needs of US CMS physicists seamlessly as they work on tasks from the building and commissioning of detector elements, to building the software and production systems, to the physics analysis.

4.3 Relationship to the US Funding Agencies

The US CMS Project Management Plan for the construction of the detector contains a detailed description of the interaction between the project staff and the funding agency (DOE and NSF) personnel. Key elements of this are the Joint Oversight Group, the U.S. LHC Program Office, the Chicago Operations Office of the DOE, the US LHC Project Office, and the Fermilab Director or designee. The oversight by the agencies is similar to the plan that is in place in the construction project. In particular, the organization chart (Figure 2) shows that the PMG advises the Fermilab Director or designee who reports to the Joint Oversight Group.

4.4 Relation to the Fermilab Computing Division

The Computing Division is home to the US CMS Software and Computing Project within Fermilab. The Division supports the project in many ways. The L1PM and the L2PM for the User Facilities subproject are members of CD. The 'project office', which provides administrative resources to the project management, resides within CD. The Head of the Computing Division is a member of the PMG and is an ex officio member of the USASCB. The staff for the Tier 1 Regional Center and much of the staff for the User Facilities Project are members of Computing Division.

5. Evolution of the US CMS Software and Computing Project

This plan applies to the 'initial development and deployment phase' for the software and facilities. Once that phase is complete, the software and the facilities go into the 'operation, support, and further development phase'. This should occur a few years after CMS starts taking data. At that point, there should be a new 'operations plan' which would replace this plan. It is very important to recognize that software development and hardware evolution will continue throughout the life of CMS. The resources required for the ongoing operation of the facilities and evolution of the software and hardware are quite significant. The operation of the Regional Center is at least a 15-20 year commitment. For at least 2/3 of its lifetime, it will be in an 'operations' rather than 'construction' phase. Continual investment in software development, technology tracking, and R&D throughout this period will be essential if the facilities are to continue to serve the interests of US CMS as physics and computing technology move forward. Similarly, the scientific software will be in a state of continual development and evolution throughout the operations period. This will be driven both by changes in physics goals and analysis techniques and by changes in underlying software and hardware technologies.

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- 2 US-CMS Applications Software Sub-project, L. Taylor (on behalf of US-CMS), 23 April 1999. http://cmsdoc.canr.ch/~cmscan/uscmsw/review_may_99/papers/app_sw.pdf
- 3 US-CMS User Facilities Sub-project, J. Womersley (on behalf of US-CMS), 23 April 1999. http://cmsdoc.canr.ch/~cmscan/uscmsw/review_may_99/papers/RegionalCenter.pdf
- 4 These two boxes represent the current de facto division of labor in US CMS and not a formal organizational structure. The organization of these activities is tightly coupled to the whole CMS experiment and is currently under active discussion.
- 5 The membership of the USASCB required an amendment to the CMS constitution which is was revised accordingly.