303-EMD-001

ECS Maintenance and Development Project

Hardware Maintenance and Development Plan for the EMD Project

October 2003

Raytheon Company
Upper Marlboro, Maryland

Hardware Maintenance and Development Plan for the EMD Project

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Preface

This document is a formal contract deliverable. It requires Government review and approval within 20 business days. Changes to this document will be made by document change notice (DCN) or by complete revision.

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Abstract

This document fulfills the requirement from the Contract Data Requirements List (CDRL), Data Item Description (DID) EMD-HMDP-3. The Hardware Maintenance and Development Plan (HMDP) shall fully describe the contractor's approach for the hardware maintenance, development, and sustaining engineering. The plan shall fully document the organizational responsibilities, guidelines and processes, configuration control requirements, metrics, reviews, reference documentation, and quality requirements to be adhered to.

Keywords: configuration, metrics, maintenance, hardware, engineering, quality

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1. Scope

1.1 Identification

The ECS Maintenance and Development Program (EMD) is the extension contract to the ECS program. While the emphasis of EMD is to maintain and provide sustaining engineering support to the operational EMD sites, there is a continuing need to provide hardware development and sustaining engineering.

This document describes the general concept and plan for maintaining and developing EMD commercial-off-the-shelf (COTS) HW in support of EMD objectives as the follow-on maintenance contractor. This document describes the responsibilities of the EMD contractor. The Hardware Maintenance and Development Plan (HMDP) documents organizational responsibilities, guidelines and processes, configuration control requirements, metrics, reviews, reference documentation, and quality requirements to be adhered to for the correction, adaptive and perfective maintenance as described below:

Corrective Maintenance – Changes necessitated by actual errors (i.e. 'bugs'), or design deficiencies. Corrective maintenance consists of activities normally considered to be error correction required to keep the system operational. By its nature, corrective maintenance is usually a reactive process. Corrective maintenance is related to the system not performing as originally intended. The three main causes of corrective maintenance are (1) design errors, (2) logic errors, and (3) coding errors.

Adaptive Maintenance – Changes initiated as a result of changes in the environment in which a system must operate. These environmental changes are normally beyond the control of the maintainer and consist primarily of changes to the: (1) rule, laws, and regulations that affect the system: (2) hardware configuration, e.g., new terminals, local printers, etc.: (3) data formats, file structures: and (4) system software, e.g., operating systems, compilers, utilities, etc.

Perfective Maintenance – (Also known as enhancements and upgrades) All changes, insertions, deletions, modifications, extensions, and enhancements made to a system to meet the evolving and/or expanding needs of the user. It is generally performed as a result of new or changing requirements, or in an attempt to augment or fine-tune the existing software/ hardware operations/performance. Activities designed to make the code easier to understand and to work with, such as restructuring or documentation updates and optimization of code to make it run faster or use storage more efficiently are also included in the Perfective category.

1.2 System Overview

The EMD system is the geographically distributed ground system network of hardware (HW) and software (SW) for the collection, processing, storage, and distribution of data obtained from a system of space platforms as well as storage and distribution of selected non-EOS data sets of the EMD. The overall EMD is an expandable, technology adaptable and modularly designed hierarchy of segments, elements, subsystems and components.

The EMD System is deployed operational at four Distributed Active Archive Centers (DAACs, the SMC, and the EMD Development Facility (EDF) located in Upper Marlboro, MD.

a. Goddard Space Flight Center (GFSC), Greenbelt, Maryland

b. Land Processing Data Center (LPDAAC), Sioux Falls, South Dakota

c. Langley Research Center (LaRC), Hampton, Virginia

d. University of Colorado, National Snow and Ice Data Center (NSIDC), Boulder, Colorado

e. System Monitor Center (SMC) (co-located with GSFC)

Additional DAAC locations may be incorporated into the EMD as operational needs warrant. EMD equipment will be located in facilities belonging to a sponsor (host) organization, which provides space for maintenance administration, spare parts, tools, and consumables storage.

The EMD Development Facility (EDF) is the facility where the EMD Contractor designs and develops its component applications.

1.3 Document Overview

The HMDP document is comprised of a single volume consisting of six sections plus an appendix. Table 1.3-1 maps each topic of the HMDP as required by the EMD CDRL to the applicable section of this document.

Table 1.3-1. CDRL Map (1 of 2)

CDRL Item	Document Reference
Roles and Responsibilities	Section 4.1 Hardware Organization and Resources
Sites to be supported	Section 1.2 System Overview
Preventive maintenance approach and schedules	Section 6.4 Preventive Maintenance (PM)
Corrective maintenance	Section 6.5 Corrective Maintenance
Problem analysis	Section 6.6 COTS HW Problem Resolution Process
Escalation procedures	Section 6.7 Escalation Procedures
Records	Section 6.8 Maintenance Reporting
Configuration management	Section 5.4 Configuration Management
Certification	Section 4.2.2 Training and Certification
Training and schedules	Section 4.2.2 Training and Certification
Procedures for tracking system problems using DRs or similar mechanisms	Section 6 Hardware Maintenance Process
Procedures for resolution of DRs	Section 6 Hardware Maintenance Process
Investigation of performance anomalies and inefficiencies	Section 6 Hardware Maintenance Process

Table 1.3-1. CDRL Map (2 of 2)

Sustaining Engineering	Section 7
Procedures for making modifications to hardware, operational procedures, documentation, engineering diagrams	Section 5.4 Configuration Management
Test plans and procedures for system hardware changes	Section 4.2 Resources
Reporting	Section 6.8 Maintenance Reporting

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2. Applicable Documents and References

2.1 Parent Documents

The parent documents reflect the documents from which the Hardware Maintenance and Development Plan's scope and content are derived.

	EMD Task 101 Statement of Work for ECS SDPS Maintenance
423-46-02	Contract Data Requirements Document for EMD Task 101 ECS SDPS Maintenance
423-41-02	ECS Functional and Performance Requirements Specification (F&PRS)

2.2 Applicable Documents

The following documents are referenced within the Software Maintenance and Development Plan, or are directly applicable, or contain policies or other directive matters that are binding upon the content of this volume.

DID EMD-RMP-6	Risk Management Plan
104-EMD-001	Software Quality Assurance Plan
110-EMD-001	Configuration Management Plan
302-EMD-001	Software Maintenance and Development Plan
108-EMD-001	Program Management Plan
DID EMD-CSR-13	Consent to Ship Review
DID EMD-PSR-14	Preship Review
DID EMD-LLR-15	Lessons Learned Review
CFR Title 47	Code Of Federal Regulations Telecommunications
EMD-EDP-23	ECS SDPS Documentation Package
	- DID 335: COTS Hardware and Software Deployment Plan
NASA STD 8739.7	Electrostatic Discharge
NPG 7120.5B	NASA Program and Project Management Processes and Requirements

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3. Overview of Work Required

3.1 Product Regulatory Compliance

3.1.1 Product Safety

The EMD program will adhere to Raytheon Environmental Health and Safety Policies. These provide guidance in establishment of safety, practices, standards, and procedures applicable to COTS maintenance and operations personnel. Safety requirements will be reviewed on a continuing basis and in compliance with all related federal, state, and local laws and regulations, and emergency procedures.

3.1.2 EMI/EMC

EMD deliverable equipment is comprised of COTS hardware. As a minimum, all deliverable equipment complies with the limits for a Class A digital device pursuant to the FCC Rules as specified in CFR Title 47, Chapter I, Part 15, Subpart B.

3.1.3 Electrostatic Discharge (ESD)

EMD procedures establish policy for an awareness program of ESD and addresses maintenance practices that are to be followed to eliminate ESD hazards to HW, SW, or people. EMD has a fully developed ESD program based on NASA STD 8739.7. ESD awareness applies to all EMD personnel at the DAACs and EDF, DAAC Operations Contractors operating or maintaining EMD hardware and all OEM maintenance contractors. .

3.2 Special Program Requirements

EMD requirements are found in the Functional and Performance Requirements Specification (F&PRS). At the release of this document the Revision level is pending.

3.2.1 Operational Availability (A_O) and Mean Down Time (MDT)

The principal provider of COTS HW maintenance support at the DAACs and SMC is OEM maintenance purchased by the EMD program. The Principal Period of Maintenance (PPM) contracted correlates to system RMA requirements and for major vendors (SGI, STK, and SUN) and will be, at a minimum, 24 X 7 with 4 hour response time. This PPM will allow EMD to meet the systems Ao and MDT requirements describe in the RMA Ticket and the EMD F&PRS.

3.2.2 Environmental and Facility Requirements

EMD COTS HW is operated in an environment that is dust, temperature, and humidity controlled. Because of the sensitivity of data media to these elements, EMD data is archived in a restricted-access, controlled environment separate from the operations areas. EMD is responsible

for providing and maintaining the Power Distribution Units and the Air Conditioning Units at the EDF.

All DAAC sites have Government furnished and maintained uninterruptible power supplies (UPS) to provide immediate backup power in the event of a power outage. These UPS systems should have the capacity to sustain power to EMD systems for twenty minutes to allow graceful shutdown of equipment and shifting to auxiliary power sources, if available.

3.3 Key Characteristics

No AS9100 Key Product Characteristics have been identified as appropriate for this contract.

4. Hardware Organization and Resources

4.1 Hardware Organization

Under EMD, Hardware Maintenance and Development Planning is the responsibility of the COTS SW and HW Organization with support from System Engineering and Integration Team (SEIT), the Architecture Review Board (ARB), and Infrastructure CPT.

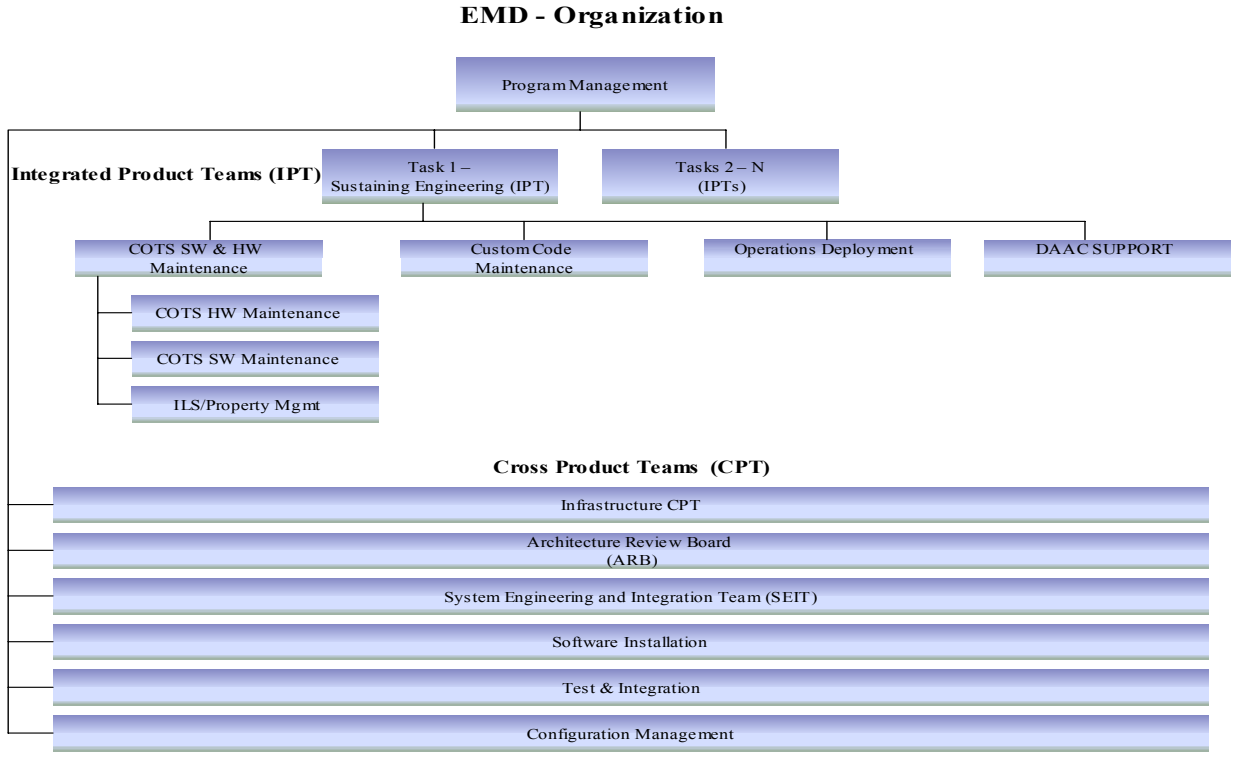

Figure 4.1-1. ECS – EMD Organization Structure

The COTS Hardware (HW) Maintenance Team primary roles and responsibilities are to:

- Investigate and resolve DAAC Hardware Related Operational Problems.
- Investigate DAAC Operational Performance anomalies and inefficiencies and recommendations for improvements
- Perform Adaptive maintenance, such as user-defined or operational driven re-configurations.

- Monitor all vendor service alerts and bulletins.
- Maintain all records pertaining to identification, monitoring, modifications, and performance of EMD Hardware.
- Identify any new/updated certification requirements related to the maintenance of EMD hardware.
- Provide Training and schedules for all new tasks as required
- Maintain and Execute procedures pertaining to modifications to hardware, operational procedures, documentation, engineering diagrams
- Maintain current test plans and procedures for system hardware changes
- Provide Core membership to the Failure Review Board (FRB). The FRB is responsible for analyzing and review all hardware failures reported by the DAACs and validating performance against Ao and MDT baselines, and to recommend and/or initiate and coordinate any corrective measures.
- Execute requests for new hardware.
- Identify any new/updated requirements related to the EMD hardware based on SEIT recommendations.
- Ensure renewal of all hardware and associated SW maintenance agreements.

The DAAC Support performs the following activities:

- Maintain and Execute schedule for all EMD-DAAC hardware upgrades.
- Ensure that vendor required preventive maintenance is accomplished by OEM maintenance contractors.
- Provide Hardware Failure Data to COTS Hardware (HW) Maintenance Team via the ILM database tool.
- Identify DAAC Operational Performance anomalies and inefficiencies.

The System Engineering and Integration Team (SEIT) and the Architecture Review Board (ARB) perform the following activities:

- Develop and maintain Hardware schedules that reflect planned upgrades and incorporate a 3-5 year look-ahead into maintenance releases and technology refreshment.
- Provide direction and strategy for HW and capacity growth requirements to COTS Hardware (HW) Maintenance Team.
- Review and Approve of all recommended hardware solutions to new requirements or existing issues.
- Participate in the Failure Review Board (FRB).

The Infrastructure CPT is responsible for

- Corrective maintenance on all EMD-EDF Hardware. Performance of preventive maintenance as specified in the hardware maintenance instructions of vendors or in service alerts and bulletins the vendors issue.

The Configuration Management CPT is responsible for

- Baseline document Management
- Configuration Change Request Process Management
- Physical Configuration Audits

4.2 Resources

Hardware requirements for the EMD program are met by using COTS Hardware and therefore there are no specific resources required for hardware development. However, the Hardware Engineering group is responsible for the Performance Verification Center, and Verification and Test Center, IDG cell and dedicated SAN Test Environment and utilizes these labs to test and evaluate for suitability the next generation COTS hardware. Test plans and procedures for system hardware changes and upgrades are created as appropriate to the complexity and system dynamics of the COTS hardware suite for EMD.

4.2.1 Staffing

The EMD program hardware staff is comprised of multi-disciplined engineers that have the following skill sets: hardware engineering, software engineering, network engineering, and security engineering.

4.2.2 Training and Certification

The COTS Hardware maintenance Team will recommend DAAC Operations and EMD Support staff training and certification for new or upgraded hardware when required. In general, certification is not necessary since repair of equipment is performed by the vendor. With the exception of electrostatic discharge training, training will be provided by key personnel, who in turn will mentor additional staff.

4.2.3 Establishing and Maintaining a Hardware Development Environment

The Hardware Development Environment is comprised of a prototype test LAN and a test SAN. The prototype test LAN was established to evaluate new hardware such as the next generation of servers or new to EMD hardware such as the IBM Portus Firewall or hardware specific software, such as OS upgrades and hardware specific firmware. There is no permanent hardware associated with this LAN but the first procurement or an evaluation loaner is brought in as early as possible for evaluation. The test SAN environment is comprised of a Solaris, IRIX and Linux server and the RAID disk. This is purchased hardware that is used to test and evaluate the next generation hardware and SAN specific software and trouble shoot existing SAN problems. As new RAID hardware or servers are added to the SAN environment, a copy should be purchased for the test SAN to keep it current with the fielded systems.

4.3 Risk Management

A well-structured continuous risk management approach for EMD Program is in place that meets the guidelines of NPG 7120.5B (see Figure 4.3-1). Risk factors are an integral part of our planning process for system enhancements. Factors such as technical complexity, staff experience and availability, external dependencies, and COTS integration aspects are considered in costing and scheduling from the very start. As a result, potential risks are identified and addressed early in the process and tracked throughout the development process until they can be closed.

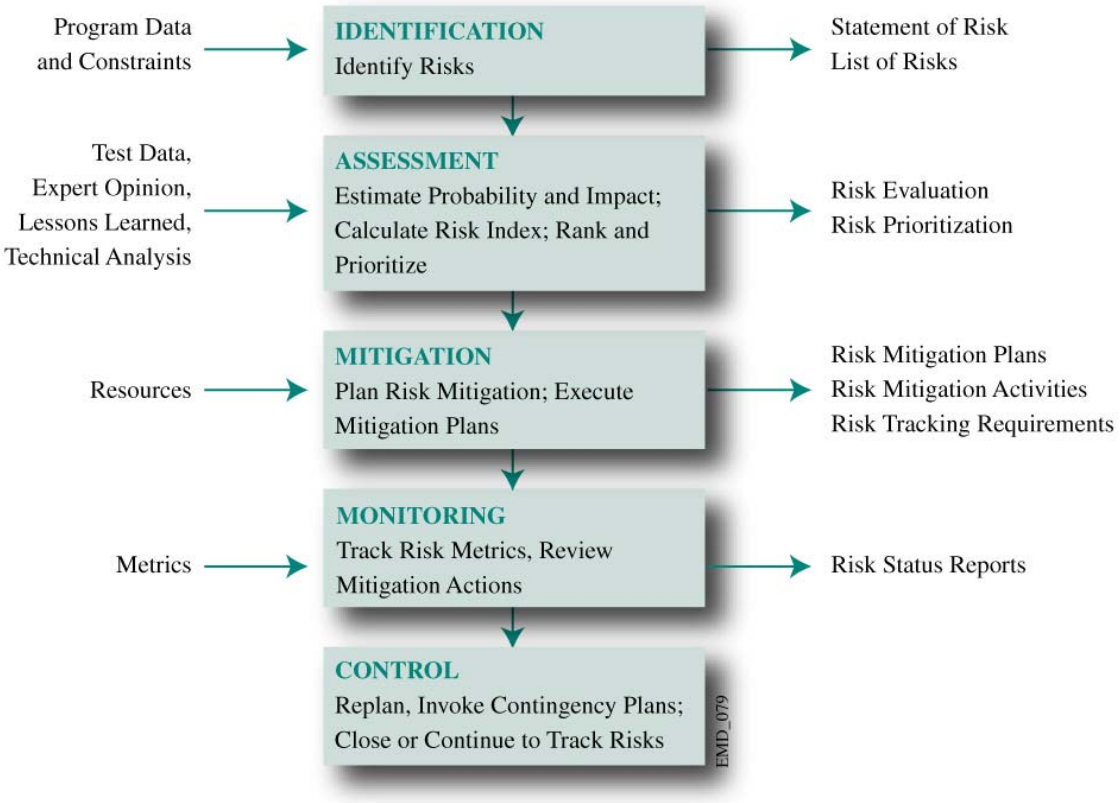

Figure 4.3-1. Risk Management Methodology.

Raytheon fully documents its risk management program and methodology in a Risk Management Plan that will be delivered within 4 months of contract award in accordance with DID EMD-RMP-6. Our methodology encompasses five major stages as depicted in Figure 4.3. It addresses technical, cost, or schedule risks, as well as those associated with methods, techniques, procedures, processes, equipment, and subcontracts related to the EMD contract. The RMP covers risk strategies involving foreign sources, unauthorized technology transfer, and includes a section on disaster recovery. The EMD RMP incorporates the Risk Management Methodology

Project Instruction and Risk Assessment and Mitigation Procedures Work Instruction currently in use on EMD.

Our process allows for any individual on EMD to identify a risk. Responsibility for risk management and mitigation, on the other hand, rests with the SEIT (see Figure 4.3-1). The SEIT ***risk coordinator*** (RC) collects and monitors the risk inputs, and conducts risk management meetings that are attended by the PMT and chaired by the PM. New risks are assessed as to probability and impact; based on this assessment, a risk index is calculated for each risk. Risks are characterized as high, medium, or low and are ranked based on their risk index. Rankings are used to allocate resources for mitigation efforts. The RC will maintain a central repository of risk data and make it accessible to the EMD Program for planning and tracking. For each risk, a ***responsible individual*** (RI) is designated by the SEIT to lead activities related to that risk. The RI presents the status of open risks and ongoing mitigation activities weekly at customer status reviews. Risks with a high-risk index are reviewed with NASA at the monthly PMR meeting.

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5. Catalog of Services

EMD development services are summarized in Table 5-1. EMD offers a range of requirement, development, integration, and test approaches that can be combined in various ways to achieve cost-effective deployment of new capabilities. The services, as applicable, support development of new hardware components or capabilities by the EMD contractor as well as other NASA stakeholders.

Table 5-1. System Development Services Enable Cost-Effective Deployment of New Capabilities (1 of 2)

Service Description	When to Use
Requirements Definition Service	
Provides SEIT services to coordinate hardware or software requirements definition across all stakeholders. Operation concept, requirements, and verification criteria are captured using the "Ticket" process. See Requirements Definition and Management below.	Medium to large capabilities developed by EMD contractor or community-developed capabilities where assistance in formal requirements capture is desired. Also used for interface definition or standards compliance activities where formal testing is to be done.
Requirements Management Service	
Incorporates new requirements into the verification database (VDB) and tracks verification status.	All EMD contractor developed capabilities where Tickets were generated. Optionally, for community-developed capabilities where requirements tracking is desired.
Operations Support Software (OSS) Development Service	
Perform development using a streamlined development process that relaxes requirements for formal documentation and formal verification.	Any non-core SDPS capability.
Incremental Development Service	
Perform development using an iterative process that includes a series of prototype or incremental deliveries of a capability to a DAAC or IT.	Capabilities where requirements are not well known or where a capability could have significant operational impact and early feedback is warranted.
Formal Development Service	
Perform development using a waterfall process that includes formal peer reviews at preliminary design, detailed design, and code and unit test. Formal documentation is produced and formal verification is performed.	Capabilities that involve modification of core SDPS functions. Other capabilities where rigorous design, development, documentation, and formal verification is required.
COTS Software Procurement, Integration, and Maintenance Service	
Perform procurement of new or additional COTS software licenses. Integrate COTS software products with existing hardware or software components. Perform COTS software upgrades when necessary and coordinate defect resolution with COTS vendors.	Any EMD contractor developed capabilities that are fully or partially implemented with COTS software products. Any community-developed capabilities where it is desirable to take advantage of the EMD contractor's buying power or where centralized COTS integration is beneficial.

Table 5-1. System Development Services Enable Cost-Effective Deployment of New Capabilities (2 of 2)

Service Description	When to Use
Integration Service	
Perform integration of a new or enhanced capability with other SDPS components.	Any EMD contractor developed capabilities. Any community developed capabilities where it is desired to do a single integration rather than have each DAAC integrate.
Regression Testing Service	
Perform regression testing of a capability against SDPS to ensure that all SDPS functions operate correctly. If functional verification of capability was performed then regression test will also ensure the capability operates correctly.	Any EMD contractor developed capabilities. Any community developed capabilities where it is desired to do a single regression test rather than have each DAAC do regression testing.
Functional Verification Service	
Develop and execute test procedures to verify that a capability functions correctly. Optionally, conduct formal verification in conjunction with Government designated witnesses.	Any EMD contractor developed capabilities. Any community developed capabilities where it is desired to perform an external functional verification before deployment.
Performance Verification Service	
Develop and execute test procedures to verify that a capability meets performance and stability requirements under realistic SDPS workloads.	Any EMD contractor developed capabilities that are performance critical. Any community developed capabilities that are performance critical.
Configuration Management and Deployment Service	
Baseline and deploy a new capability. Test installation and transition procedures.	Any EMD contractor developed capabilities. Any community developed capabilities where centralized configuration management and deployment is desired.
Training Service	
Provide installation, transition, and operations training for a new capability. This includes developing or procuring training materials and delivering training via training classes, train-the-trainer, or computer-based training.	Any EMD contractor or community-developed capability that requires instruction to be used effectively.
MR Tracking Service	
Coordinate collection, prioritization, and disposition of modification requests against a capability.	All EMD contractor developed capabilities. Any community developed capabilities where it is desired to a have a central coordination point for resolution of problems or enhancement requests.
Defect Resolution Service	
Provide corrective maintenance for a capability.	All EMD contractor developed capabilities. Any community developed capability where it is desired to use EMD resources for defect resolution.

6. Hardware Program Management

This section defines the processes to monitor and control the hardware activities on the EMD program. The planning activities and approvals, decision analysis and resolution, configuration management, hardware product evaluation and reviews (program and peer) are detailed in the following paragraphs.

6.1 Planning Activities

Adaptive and Perfective hardware modifications require a CCR, a SEP or a Task Plan Request. They represent requests for new hardware purchases and documentation updates.

The objectives of the planning process are to establish the scope, technical approach, resource allocations and budget for new work and to define the detailed schedule of events and dependencies. Planning is initiated when the Program Manager appoints a Planning Group or Task Lead to estimate or plan new work.

The three distinct aspects of planning are:

- Estimation
- Pre-planning
- Detail planning

The Planning Process Project Instruction captures details of each of these planning efforts. This entire planning effort concludes between 10 and 20 working days of the request; the NASA requirement for response to a TPR is 25 working days. The work is ready for immediate execution when authorization is received from the customer.

6.1.1 Estimation

The Estimation Process has three distinct aspects:

- Developing and understanding requirements
- Developing Basis of Estimates (BOEs)
- Generating prices.

6.1.1.1 Developing and Understanding Requirements

Requirements are developed by the SEIT. The SEIT:

- Ensures that requirements are understood and allocated to site hardware configuration items (CIs)
- Documents the hardware requirements to be used for estimation
- Uses the hardware requirements to identify and refine the list of hardware products to be estimated.

6.1.1.2 Developing Basis of Estimates (BOE)

The Task Lead is responsible for coordinating the development of the work estimate across all WBS elements. The Task Lead may appoint a Hardware Lead. The Hardware Lead is responsible for generating the BOEs and the Bill of Materials (BOM)

6.1.1.3 Generating Prices

The Task Lead coordinates with the program control analyst (PCA) to generate pricing. Using a detailed listing of resources by grade level, the PCA generates a pricing run. The pricing and BOE are reviewed with program management.

If revisions are required to a proposal estimate, then the Task Lead and program management ensure that adequate funding and resources are available to perform the hardware engineering and support for each hardware development effort and for hardware maintenance. Revisions to the hardware effort estimate are reviewed with senior hardware management

6.1.2 Pre-Planning

There are two steps in the initial planning process. The first step is to analyze and develop planning and processing inputs. The purpose of this step is to determine the best methodology for planning and/or estimating new work based on a CCR, SEP or a Task Plan Request. The second step is to review and approve planning and process inputs. The purpose of this step is to review and approve the planning and process inputs from the initial estimation effort to ensure that it is appropriate to proceed. The ARB is the principal approving authority for all pre-planning activities and documents prior to proceeding to detail planning. If the inputs are approved by the ARB, detail planning can begin. The PM also provides authority to the ARB to approve start of low risk, start up activities.

6.1.3 Detailed Planning

Detailed planning is usually reserved for large, complex changes**.** The Task Lead organizes a team from the technical and business disciplines to establish the scope of the work, the technical approach, the required resources, and budget requirements. The Detailed Planning Process is documented in the Planning Process PI. Three process models are used for detail planning: one time, incremental and expedited.

6.1.3.1 One Time Planning Process

The One Time Planning Process is used for a new effort where the requirements are clear; there is an assessment of low risk that the analysis and design phase will affect the remaining work; and there is a low risk that the budget and schedule constraints will influence the scope of work. A single detailed plan is developed at the start of the subtask to include all activities to be baselined. The One Time Planning Process can be tailored. Critical steps in this planning model include:

- Hold Kickoff Meeting - The purpose of this step is to organize the planning team. Assignments are described and the inputs are reviewed.

- Create Plan for the Plan - The purpose of this step is to develop a plan of the activities required to plan the task or subtask. The plan should be used to coordinate and track the status of the planning tasks as they are executed. If this process is being used to plan work that has not been approved, the plan for the plan contains the plan of activities required to complete the Basis of Estimate.
- Develop Technical Approach - The purpose of this step is to develop a technical approach for the tasks/subtasks. If this process is being used to plan work that has not been approved, then a technical approach for the Basis of Estimate is developed.
- Develop/Reassess Estimates - The purpose of this step is to develop and/or reassess an estimate. The estimate must be justifiable, consistent, and repeatable to support planning.
- Develop Resource Loaded Schedule - The purpose of this step is to develop a schedule that is loaded with resources. If the planning effort is for work that has not been approved, then a high level schedule with potential resources to perform the work is all that is needed for this step.
- Develop Budget and Resources - The purpose of this step is to allocate budget and resources for the task/subtask. If the planning effort is for work that has not been approved, then a PC Pricing file is used.
- Obtain Commitment to Plan - The purpose of this step is to obtain Management "Buy-In" to plan.

6.1.3.2 Incremental Planning Process

The Incremental Planning Process is used for a new effort where the requirements are unclear; there is an assessment of high risk that the analysis and design phase will impact the remaining work; or there is a high risk that the budget and schedule constraints will influence the scope of work. An incremental phased approach to planning will allow multiple phases to be planned over time. At the start of a subtask, the first phase is planned in detail and the remaining phases are planned at a high-level. Toward the end of each phase, a detailed plan is created for the subsequent phase and the high-level plan for the remaining phases is updated. This process can be tailored.

The following steps are performed when executing the Incremental Planning Process:

- Hold Kickoff Meeting - The purpose of this step is to organize the planning team.
- Create Plan for the Plan - The purpose of this step is to develop a plan of the activities required to plan the task or subtask. The plan should be used to coordinate and track the status of the planning tasks as they are executed.
- Develop Technical Approach - The purpose of this step is to develop a technical approach for the tasks/subtasks.

- Reassess Estimates - The purpose of this step is to reassess the estimate developed in the estimation phase. The estimate must be justifiable, consistent, and repeatable to support planning. The estimates are developed for the current phase that is being planned in detail.
- Develop Resource Loaded Schedule - The purpose of this step is to develop a schedule that is loaded with resources. The schedule is being developed for the phase that is being planned in detail.
- Develop Budget and Resources - The purpose of this step is to allocate budget and resources for the task/subtask. The budget and resources are being developed for the phase being planned in detail.
- Develop and Refine the High Level Plan - The purpose of this step is to develop the high level plan for the subsequent phases of the task/subtask. This step is executed for the subsequent phases of a task/subtask that have not been planned in detail. The budget for the phases in the high level plan is held in planning packages. The schedule for the phases in the high level plan is not baselined.
- Obtain Commitment to Plan - The purpose of this step is to obtain Management "Buy-In" to plan.
- Execute Phase - The purpose of this step is to execute the work planned in detailed. If there are more phases in the high-level plan, plan the next phase in detail.

6.1.3.3 Expedited Planning Process

The Expedited Planning Process is used for low risk activities that have minimal dependencies with other activities. Minimal milestones are planned. This process can be tailored. The following steps are performed when executing the Expedited Planning Process:

- Obtain Commitment to Plan - The purpose of this step is to obtain Management "Buy-In" to plan.
- Develop Budget and Resources - The purpose of this step is to allocate budget and resources for the task/subtask.

6.2 Scheduling and Tracking

All schedules developed during the planning and estimation phase or maintained in Primavera, a LAN based schedule and tracking tools. A high-level schedule of activities documented and tracked in the Primavera. Near term activities are briefed to the customer on a weekly basis. The following table shows the activities scheduled and tracked for Hardware Development.

Table 6.2-1. Hardware Development Plan

Planning Phase
Kickoff Meeting
Create Plan for the Plan
Develop Technical Approach
Develop Resource Loaded Schedule
Develop Budget and Resources
Develop and Refine the High Level Plan (Develop Implementation, Deployment, and Transition Plans)
Obtain Commitment to Plan
Implementation Phase
Hardware Product Evaluation
Procurement
Install/Transition Approach
Install/Transition Development
EDF Installation
Deployment Phase
Testing (i.e. Transition, Performance, Functionality)
Internal Walkthru
DAAC Walkthru
Pre Ship Review (PSR)/Delivery
Transition Phase
DAAC Installation/Implementation
Lessons Learned

6.3 Test Equipment List

OEM technicians working under maintenance contracts purchased by the program perform COTS H/W maintenance. Therefore no test equipment is planned for the DAACs or EDF. The OEM maintenance contractor will provide all test equipment when it is required. The only exception to this policy is that network engineering, both at the DAACs and EDF, has a network analyzer to trouble shoot network problems.

6.4 Decision Analysis and Resolution

The System Engineering and Integration Team (SEIT) and the COT HW/SW Maintenance IPT are the key EMD organizational elements that provide technical oversight over the EMD architecture and design. The SEIT provides core members to the Architecture Review Board (ARB), which reviews planning inputs and technical approaches that require formal decision analysis. The ARB ensures the integrity of the technical baseline across subsystems, environments, DAACs, and EMD tasks. The Chief Engineer, who is responsible for convening meetings, composition of the review board, keeping and distributing minutes, and maintaining the ARB repository of proceedings and directives, chairs the ARB. COTS HW Maintenance generally provides the initial input for ARB review and is heavily involved in the resolution.

6.5 Configuration Management

This section covers plans and processes for configuration management (CM) of EMD hardware. Hardware configuration management is the responsibility of the Configuration Management Cross Product Team, as identified in the organization structure of the ECS/EMD Program. The *Configuration Management Plan* for the EMD Program, CDRL #019, EMD document number 110-EMD-001, contains a complete description of the CM process and the services provided that support hardware CM requirements. These services include:

- Identification of all SDPS configuration-controlled items, including current version/release information for hardware and documentation.
- Management of a central CM/DM library and electronic repository, including physical and electronic retention and control of baselines for all system hardware, procedures, standards, and documentation.
- Implementation of an engineering release process for formal approval and CM release of all delivered hardware, and related documentation.
- Configuration control and change management, including receipt, processing, review, disposition, implementation, and verification of baseline changes, including internal and external interface changes, establishment of a CCB, and management of changes flowing between the EMD and NASA CCBs. These changes may include Modification Requests (MRs) introduced as a function of EMD, as well as the standard Configuration Change Requests (CCRs).
- Status accounting and reporting of SDPS hardware information.
- Configuration audit and verification, including ensuring the integrity of hardware and hardware, as specified in controlled configuration documentation.

The following subsections provide a discussion of the key CM activities that are required to satisfy hardware CM requirements.

6.5.1 Configuration Identification

The configuration items controlled under CM are documented in EMD System Baseline Specification (905-TDA-001). This document defines the configuration items for the EMD contract, including all technical documentation, commercial off the shelf software, custom software, COTS hardware, operating systems (O/S), and O/S patches, databases, and technical documentation. Refer to Project Instruction CM-1-042, *Configuration Identification*, for configuration item definition.

Configuration Management is responsible for maintaining the baseline hardware documentation. Table 6.5-1 lists the design documents that will be maintained during the duration of the EMD contract.

Table 6.5.1-1. Hardware Engineering Documents and Drawings

Document Name	Document Number	Comments
Hardware Design Diagram	920-TD***x***-001	
Cable Management Plan	920-TD***x***-005	
Hardware Software Map	920-TD***x***-002	Maintained by COTS SW
Mount Points	920-TD***x***-001	Maintained by Security Engineering
Network Overview	921-TD***x***-001	
Hardware Network Design	921-TD***x***-002	
Network IP Assignments	921-TD***x***-004	
Host IP Assignments	921-TD***x***-003	
Disk Partitioning Diagrams	922-TD***x***-0***nn***	Each server or workstation has a unique disk partitioning document number. See http://pete.hitc.com/baseline/index.html for a complete listing of disk configuration diagrams

Note: ***x*** denotes site***:*** E (LPDAAC), G (GES DAAC), L (ASDC), N (NSIDC), P (PVC), S(SMC), V(VATC). ***nn*** denotes the document number.

6.5.2 Configuration Control

Configuration control is maintained through Configuration Control Requests (CCRs) and Configuration Control Boards (CCBs). Changes are adequately defined, assessed for technical, cost, and schedule impacts by the EMD office(s) and formally considered by the appropriate CCB. Only approved changes are incorporated in the appropriate baseline.

6.5.4 Hardware Configuration Management and Release Process

ECS SDPS hardware follows the processes and flow described in CDRL #019, 110-EMD-001, *Configuration Management Plan*, as it migrates from the ECS Development Facility (EDF) to the EMD SDPS system-level. Hardware and software changes are made in a coordinated and controlled fashion using the CCR process. Physical Configuration Audits (PCA) verify all formal deliveries. Detailed information on PCAs can be found in the *Configuration Management Plan*, 110-EMD-001.

6.5.5 Configuration Status Accounting

Configuration status accounting consists of recording and reporting information about the configuration status of the ECS SDPS Project's documentation, hardware, and software products, throughout the Project life cycle. Periodic and ad hoc reports keep ECS SDPS Project management and NASA informed of configuration status as the Project evolves. Reports to support reviews and audits are extracted as needed. CM maintains CM Web pages. Configuration Status Accounting is described in CDRL 110-EMD-001 *Configuration Management Plan*. Referenced project instructions provide additional details on configuration status accounting.

6.5.6 Configuration Audits

Configuration auditing is the means by which management ensures that both the technical and administrative integrity of the product are being met. Physical configuration audits are periodically conducted to verify that CCRs are correctly executed. These audits compare the baseline Technical Documentation to the "as built" configurations of managed EMD hosts. Differences are documented using the MR System and resolved.

The audit process consists of CM self-audits and ECS SDPS Project internal audits. Formal audits are prerequisites to formal approval of the "as-shipped" configuration. They provide verification that each CI in the baseline being shipped is logically related to the corresponding CI in preceding baselines. Configuration audits (including FCAs and PCAs) are described in the *Configuration Management Plan* for EMD, 110-EMD-001.

6.6 Hardware Product Evaluation

The Quality Assurance organization is responsible for ensuring that EMD hardware work products are evaluated at various stages throughout the development lifecycle. The purpose of work product evaluation is to objectively evaluate adherence to project processes against its process description, standards, and procedures, and address non-compliance. This will be accomplished via engineering and development peer review, in accordance with a documented process. For the EMD Program, hardware work products may include requirements, interfaces, and operations concepts, design artifacts, unit and integration tests, and system level verification and validation tests. Quality Assurance Engineers (QAE) and other review participants are notified by the engineering organization and provided with appropriate review materials. The QAE performs a dual role in the peer review process. First, as a reviewer, providing input on product content and quality. Secondly, as an auditor, evaluating the conduct of the peer review and its related activities with regard to adherence to applicable standards and documented procedures.

QA may monitor various test activities, including test and integration test demonstrations prior to turnover for deployment, as appropriate. QA also attends and monitors formal tests that may be witnessed by independent verification and validation (IV&V) representatives. QA performs audits of the test-related processes and evaluations of test artifacts, as applicable.

Quality Assurance engineers document their audit and product evaluation results in the Quality Assurance Tracking Database, which is access-restricted to QAEs. In addition, a physical records repository is maintained and includes the complete audit records, i.e., formal audit or product evaluation report, Deficiency Reports (for nonconformances), QA checklists, and other artifacts acquired as objective evidence.

6.6.1 Reviews

This paragraph describes program reviews and meetings for the project. Minutes of all meetings are taken, including attendance, and distributed to the review participants and other affected groups . All action items taken during reviews are tracked to closure. The minutes from reviews

and a copy of the material presented are retained at least through the duration of the hardware development effort.

Status reviews include the following information as appropriate:

- Hardware schedules
- Cost
- Accomplishments, plans, issues
- Results of any audits or reviews
- Risks
- Metrics
- Action item status
- Noncompliance issues

6.6.2 Program Daily Status Reviews

Chaired by the Program Manager, this review includes the program's functional managers and support group managers. Risks, schedule status, action items, and other identified items are the nominal topics. Each EMD task is reviewed weekly on a designated day. NASA representatives are invited to attend so that they can provide comment and direction on specific activities as needed.

6.6.3 Hardware Senior Management Review

The COTS hardware engineering manager will conduct periodic Hardware Management Reviews; frequency will depend on the existing work level but nominally on a monthly basis. The COTS hardware manager will define the attendees and schedule the meeting and will be responsible for the agenda and minutes.

6.6.4 Peer Reviews

The Hardware Maintenance Lead or designee coordinates the peer review of selected artifacts during the test and deployment of the hardware product. The findings and decisions from peer reviews are recorded and action items are written and tracked to closure as necessary.

6.6.5 Hardware Technical Reviews

Technical reviews include regular technical dialog with the DAACs, the instrument teams, the user community, and NASA domain experts as appropriate to the specific hardware. In addition, formal technical reviews may be required at critical phases in the development and maintenance life cycle in order to assess the readiness for proceeding to the next phase. Reviews will generate feedback that will improve the quality of future EMD products and services.

Each of the following technical reviews generates a final documentation package delivered to the Government within 30 days of the event. The final package contains attendance lists, action items (AIs), and disposition of the AIs, and any updates to material presented at the event in response to AIs.

Consent to Ship Review. The purpose of the Consent to Ship Review (CSR), DID EMD-CSR-13, is to assess the readiness of the EMD Team and the DAAC to ship and accept the delivery. The CSR is performed when specified for major perfective changes that require a site readiness assessment prior to installation. For each CSR, a hardware physical configuration audit (PCA) is performed to ensure that there are no configuration discrepancies that might interfere with successful installation of the delivery. Action items are accepted from attendees of the review, consisting of DAAC operations and systems engineering staff and the Government. The Government grants approval to proceed only after the EMD Team has demonstrated satisfactory disposition of all action items.

Pre-Ship Review. The purpose of the Pre-Ship Review (PSR), DID EMD-PSR-14, is to review a final delivery package prior to its turnover to CM and subsequent delivery to the sites. The EMD Team performs a PSR for COTS hardware upgrades. Installation instructions are reviewed for completeness by the DAAC staff. For most major adaptive and perfective deliveries, the PSR is the successor to the CSR. For other deliveries, which do not require the PCA associated with a CSR, the predecessor to the PSR is the installation, and verification with regression testing as appropriate to the specific hardware product at the EMD development facility. Action items are recorded from the PSR and retained for incorporation into the Lessons Learned Review (LLR).

Lessons Learned Review. The purpose of the LLR), DID EMD-LLR-15, is to provide the Raytheon Team, the Government, and the DAACs with a forum in which to improve the quality of future release support. An LLR will be performed as specified for perfective tasks. The Raytheon Team will collect metrics following the deployment of a capability in order to measure the effectiveness of the PSR process. An example of such metrics is the number of requests for additional installation instruction information made by the DAACs following the PSR. The responsible engineer for the LLR will be a member of the PMT. LLR artifacts will be retained for use in planning future releases.

6.6.6 Project Process Improvement

Process improvement in hardware maintenance and development will be driven by the collection and analysis of metrics, and by the implementation of improvements and enhancements. Process improvements will be accomplished through the use of Raytheon's Six Sigma process improvement methodology.

A major source for ideas for process improvements is the Lessons Learned session that is held after every significant hardware delivery. The results of the lessons learned activity typically leads to the initiation of Six Sigma efforts to resolve the major issues identified by the lessons learned activity. The Six Sigma Process improvement activity initiated from the lessons learned should be short enough in duration so that its results can be implemented prior to the next significant delivery

6.7 Hardware Quality Engineering

Hardware Quality Engineering (HQE) for the EMD Program will be performed by the Quality Assurance organization. Quality Assurance will conduct process audits, product evaluations and monitor engineering, development, deployment, and maintenance activities.

6.8 Hardware Delivery Plan

Hardware deliveries/upgrades are planned and documented in the ECS CDRL DID 335, COTS Hardware and Software Deployment Plan This document is released annually with periodic updates as required.

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7. Hardware Maintenance Process

7.1 Component List

The EMD equipment is comprised of COTS HW and SW, ECS-developed applications, government furnished equipment (GFE), and science SW. This current equipment includes UNIX workstations, servers, supercomputers, robotics storage subsystems; communications components (i.e., concentrators, routers, bridges); and various computer peripherals (see table 7.1-1). The comprehensive list of EMD Hardware Components is stored in the ILM System Database.

Table 7.1-1. ECS-EMD Hardware

Vendor	Type Hardware	GES	LaRC	LP DAAC	NSIDC	Vendor	Type Hardware	GES	LaRC	LP DAAC	NSIDC
SGI	Orgin 200	x		x		**Cisco**	Switches	x	x	x	x
	Orgin 300 series	x	x	x	x		Routers	x	x	x	x
	Origin 2000 series	x	x	x	x		Hubs	x	x	x	x
	Origin 3000 series	x	x	x							
						HP	Printers	x	x	x	x
STK	Powderhorn Tape Library	x	x	x	x		Scanners	x	x	x	x
	SAN storage	x	x	x	x						
	DLT Lobraries	x	x	x	x	**Rimage**	Autostar	x	x	x	x
SUN	Blade	x	x	x	x	**Dell**	PC's & Laptops	x	x	x	x
	V440	x	x	x	x						
	V880	x	x	x	x	**Compaq**	PC's & Laptops	x	x	x	x
	Storage array	x	x	x	x						
						HP	PC's & Laptops	x	x	x	x
IBM	Firewall	x	x	x	x						
						Micron	PC's & Laptops	x	x	x	x

7.2 Maintenance Objective

The objective of EMD hardware maintenance is to perform 1) preventive maintenance as specified in the hardware maintenance instructions of vendors or in service alerts and bulletins, 2) corrective maintenance activities that fix hardware malfunctions and 3) adaptive maintenance such as user-defined or operational driven re-configurations.

7.2.1 DAAC Operational Support Roles and Responsibilities

Working under the general direction of the COTS HW/SW Manager, the Integrated Logistics Support (ILS) Manager manages the EMD COTS maintenance program and other logistics operations. This includes the budget and expenditures associated with COTS HW maintenance and the provisioning of spares in support of maintenance operations. The ILS Office (ILSO)

assists ESDIS in the development of EMD COTS HW maintenance policy; monitors and coordinates maintenance operations at the EMD sites; and manages maintenance support provided by vendors and OEMs. Daily management and execution of DAAC, and SMC HW and SW maintenance is under the operational control of the DAAC, and SMC managers. Each site has a designated local maintenance coordinator (LMC) who manages maintenance support at the site, including problem diagnosis and isolation, maintenance support coordination, problem resolution, and recording COTS HW maintenance actions performed at the site. The LMCs are designated and managed by either the Raytheon EMD site lead or the Operations Contractor at the DAACs, and SMC.

7.2.2 DAAC Site Maintenance Resources

The principal COTS HW maintenance resource at the sites is the local maintenance coordinator (LMC), who may also function as the site's maintenance engineer. The LMC coordinates COTS HW maintenance actions; determines the source of the maintenance support for the failed unit; and records the problem and its resolution into management systems. The LMCs primary role is to notify OEM maintenance contractors that a HW problem exists. If the LMC has appropriate training the LMC may start fault isolation procedures before the OEM maintenance contractor arrives and replace the failed LRU if a spare is available on site.

The principal provider of COTS HW maintenance support at the sites is OEM maintenance purchased by the EMD program. The Principal Period of Maintenance (PPM) contracted will correlate to system RMA requirements and for major vendors (SGI, STK, and SUN) will be, at a minimum, 24 X 7 with 4 hour response time. If OEM maintenance is not available for a specific piece of hardware then time and material maintenance will be purchased from a third party vendor. This maintenance concept was used during ECS and it provided optimal support at the lowest cost to NASA. All ECS Ao and MDT requirements were met using this concept and this will continue during EMD. The LMC is assisted by the site's system and network administrators to isolate and resolve problems. The science user (for science user problems) and DAAC operators (for operator problems) initiate a maintenance action by preparing a trouble ticket using EMD-provided Remedy SW. The trouble ticket is forwarded to Operations Supervisor to assign priority and responsibility for resolution to the matrix in Table 7.2.2-1 Maintenance Responsibility Matrix.

Table 7.2.2-1. Maintenance Responsibility Matrix

Problem Source	Normally Assigned Responsibility
System or Data Base Configuration	System Administrator or Data Base Administrator (if data base problem)
Network Configuration	Network Administrator (if LAN cable or network HW is the problem the LMC resolves)
COTS HW	LMC contacts the OEM or maintenance contractor for on-site support unless the LMC can resolve the problem by replacing the LRU with a site spare

The LMC monitors trouble tickets until problems are resolved and their resolution verified. Once verified, the Operations Supervisor closes the trouble ticket. Changes to custom SW are accomplished by the DAAC sustaining engineers or the SE using configuration management processes described in the EMD Developed SW CM Plan.

The LMC coordinates resolution of COTS HW maintenance actions. If problems cannot be corrected using OEM contracted maintenance support resources, the LMC can escalate the problem to the ILS Maintenance Coordinator, as described below.

7.3 DAAC Maintenance Support Concept

7.3.1 Maintenance Policies and Procedures

The EMD Contractor has developed the policies and procedures necessary for the implementation of the EMD maintenance concept. These policies and procedures were developed through analysis of the EMD final design, the capabilities offered in the management tools comprising the design, and the ECS Operations Scenarios, which describes the process flows and the interaction of system tools and operators. Policies and procedures are reviewed and approved by ESDIS. EMD sites will be expected to supplement these procedures, as needed, to address local operations requirements and to provide clarification/guidance as deemed necessary by the DAAC Managers.

7.3.2 On-Site Support

LMCs are present at all sites to support maintenance operations. This on-site maintenance capability is provided to satisfy the operational availability and MDT requirements of EMD functions. The LMC is the principal maintenance coordinator for COTS HW and, even though OEM maintenance is the maintenance concept chosen by EMD, the LMC may be trained and certified to perform maintenance on selected EMD equipment. This training will not take the place of OEM maintenance but will provide a first responder capability until OEM contractors can arrive at the site. Before the LMC is trained on a specific hardware item a trade study will be done that reviews the sparing and maintenance capabilities/costing analyses, to be completed prior to EMD CSR. Factors to be considered in the selection of COTS HW to be co-maintained by LMCs include maintenance response time required; criticality of the equipment and redundancy of components/systems; technical expertise needed to diagnose and replace failed LRUs; and the cost of training, spares, support equipment, and alternative maintenance sources. The LMC will start fault isolation procedures and then may assist the OEM maintenance vendor in problem resolution.

When a COTS HW problem occurs, the system and network administrators use diagnostics tools, and operating systems diagnostics to identify and isolate the problem to the malfunctioning component, which may be SW or hardware. If hardware is identified as the source, the LMC or OEM maintenance contractor corrects the problem by replacing the failed LRU, putting the unit back into operation, and testing the equipment and subsystem to verify the problem has been corrected. Malfunctioning COTS Hardware is reported to COTS Hardware Maintenance. COTS hardware problems are diagnosed by analysis of error codes, built-in diagnostics, or the help of

the hardware vendor. If the problem is confirmed to be with the COTS hardware, the engineer will work the problem with the applicable hardware vendor to obtain a temporary or permanent solution (i.e., patch or temporary work around). This on-site, immediately available, maintenance support is available at the DAACs during the principal period of maintenance (PPM), which is 8AM to 5PM local, Monday through Friday, except holidays.

The site DAAC support staff (sustaining engineers; system, data base, and network administrators; and LMCs) planned to support each site are identified. The site DAAC support staff may be unable to resolve some of the more difficult maintenance problems. For this reason, backup support is available from a number of sources, including the COTS Hardware Maintenance, and OEM maintenance contractors. The LMC, following local procedures and EMD policy, determines if backup support is required based upon the nature of the problem. Network and software-related problems may be referred to the EDF for assistance, while HW problems are referred to the COTS Hardware Maintenance Engineer and OEM maintenance vendor.

7.3.3 COTS Hardware Maintenance

The COTS Hardware Maintenance Organization has resources available to assist the sites in diagnosing problems related to the configuration of EMD subsystems, and EMD applications. Using the diagnostics and monitoring capabilities of the enterprise management system and the fault management system, COTS Hardware Maintenance can identify recent indications of problems with the network and subsystems. COTS Hardware Maintenance can also obtain support from EMD development resources, who are experts on the design and functions of the equipment. The COTS Hardware Maintenance can also assist by identifying a work-around to reestablish operational capabilities.

Problems attributed to EMD developed applications and science SW are referred to the DAAC's Sustaining Engineers or the SE. Maintenance of EMD developed SW and science SW is addressed in the EMD Software Maintenance and Development Plan.

7.3.4 Backup Maintenance Support

Back-up maintenance support is available from COTS OEM contractors. Since the EMD maintenance concept is to use OEM maintenance vendors as the normal first source of maintenance the OEM vendors will use their internal escalation processes to ask for help from within their own organizations to solve problems that are beyond the scope of the onsite technician. The ILS Maintenance Coordinator, in coordination with SEIT and COTS Hardware Maintenance, negotiates the terms and conditions for maintenance coverage of COTS Hardware and Software by OEM maintenance vendors based on EMD needs. OEM maintenance personnel must acknowledge their presence to the site's LMC before commencing work on EMD equipment and report maintenance actions performed and parts replaced to the LMC prior to leaving the site.

7.4 Preventive Maintenance (PM)

Advances in technology have eliminated most preventive maintenance (PM) requirements except for routine cleaning, normally performed by the operator. Except for the robotics archive systems, EMD equipment has no requirements for scheduled PM. Preventive maintenance of robotics systems will be scheduled by the LMC in coordination with local operations staffs. PM of the robotics systems will be documented as an MWO or trouble ticket unless the data archive functions must be shut down. In such cases, MWO and trouble ticket will record the time the system was shut down and restarted and the reason for the shutdown. Maintenance personnel will inspect equipment during corrective maintenance for evidence of impending failures and clean, repairs, or replaces any affected LRUs, as appropriate.

There are currently no requirements for the calibration of EMD equipment, other than the robotics data archive system, which is the responsibility of the OEM.

7.5 Corrective Maintenance

Corrective maintenance actions include fault detection, diagnosis, isolation, and resolution through replacement of failed LRUs. Removal and replacement of failed LRUs is performed without the need to interrupt the critical operations of the EMD. Failed LRUs are replaced with site spares, if available, or with LRUs provided by the OEM maintenance contractor. LRUs will be the same make and model as the original LRU. A suitable substitute may be used that has the functionality, performance, and interfaces equal to or exceeding that of the original item being replaced.

The LMC uses Maintenance Work Orders (MWO) to track all corrective maintenance actions. The MWOs are forwarded to the ILS maintenance coordinator for review prior to being send to the FRB for validation.

7.5.1 Fault Diagnostics and Problem Isolation

COTS operating systems, communications equipment, and peripherals generally have significant diagnostics capabilities built in to facilitate fault diagnosis to the LRU level. Such tools are used to expedite problem resolution, reduce maintenance downtime, and minimize the need to call in outside maintenance support.

7.5.2 Maintenance Response Time

Maintenance response requirements consider the criticality of the HW and functions supported; location of the maintenance resource; site operations hours; and relative response costs. The LMC, or OEM initially provides responses to COTS HW malfunctions. During normal work hours the response time of on-site LMCs is normally less than 10 minutes. OEM contractors are required to be on-site within the provisions of their contract. This is normally 4 hours after being notified of an equipment failure 24 hours a day 7 days a week.

7.5.3 Vendor- and OEM-Stocked Spares

In some cases the maintenance vendor or OEM may stock spares on site to support EMD maintenance operations. In such cases, the OEM contractor will determine the quantities, locations, and types of spares, with concurrence by EMD ILS and COTS Hardware Maintenance staff members. Storage, transportation, and repair/replacement charges will be the responsibility of the OEM contractor.

7.6 COTS HW Problem Resolution Process

EMD sites are provided the resources to manage and resolve the majority of HW, network, and developed applications problems. This local capability, comprised of a System Administrator, Network Administrator, Data Base Administrators, Sustaining Engineers, LMC, and OEM maintenance contractors, is depicted in Figure 7.6-1, Local Site Maintenance Support. The site LMC coordinates the day-to-day COTS HW maintenance actions at the DAACs, and SMC.

COTS HW malfunctions are referred to the LMC, system administrator, or network administrator, as appropriate for the type of suspected malfunction. These resources, acting as a team or independently, investigate and attempt to resolve the problem. Initially, through discussion with the operator or user, they will attempt to diagnose and isolate the source of the problem. Problems may be any one of the following: user/operator error, developed application or interface problem, system or network configuration problem, or COTS HW malfunction. If the problem is related to a developed application, system configuration, or the network configuration, the site sustaining engineer, system administrator, or network administrator will take corrective action to resolve the problem. Where equipment or component redundancy exists, the operations staff will switch processing over to the redundant equipment or component to restore the system to operation.

For problems confirmed to be attributed to COTS HW failure, the LMC determines if the item is OEM or time and material maintenance. HW is maintained by OEM maintenance whether or not it is under warranty. The exception to this is desktop PCs on the Maintenance and Operations LAN. If the PC is under warranty the LMC will contact the HW manufacturer for maintenance. If the PC is out of warranty the LMC will notify the time and material contractor for support In all cases where a science user has reported a problem, the User Services Desk will keep the user informed of the status of its resolution.

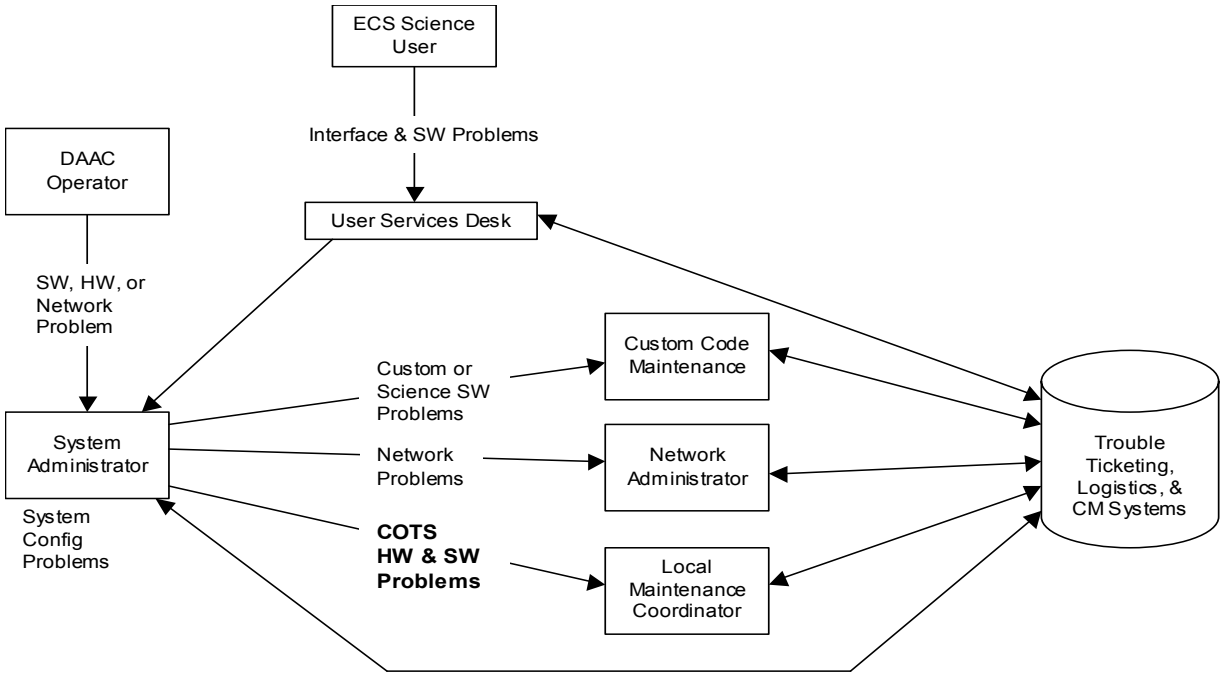

Figure 7.6-1. Local Site Maintenance Support

7.7 Escalation Procedures

EMD sites will establish parameters and instructions for escalating problems to the COTS Hardware Maintenance Engineer and the ILS Maintenance Coordinator. COTS Hardware Maintenance using its diagnostic and engineering resources will assist the site in diagnosing the cause of the problem and in developing a solution. COTS Hardware Maintenance will determine if the problem needs to be escalated further to the equipment manufacturer or software developer. Malfunctions that are preventing the accomplishment of a critical operations function are immediately reported to the COTS HW Maintenance Manager.

Contacts	Tools	Procedure
DAAC, LMC		The affected DAAC notifies its LMC and the appropriate maintenance vendor.
LMC	MWO, MDCS, RMA, metrics	The LMC creates a Maintenance Work Order (MWO) to document the action in the ILS database. The MWO contains the necessary metrics (such as equipment replaced/repaired, length of outage, vendor response times, vendor repair times, system restore times, affected subsystem, and corrective action) and provides the link to the Maintenance Data Collection System (MDCS) and the RMA Modeling Tool.
LMC, Vendor CSE		The LMC works with the vendor's customer service engineer (CSE) to correct the problem, or to ensure that the CSE escalates the problem within its secondary (corporate product support and regional logistics) or tertiary (corporate engineering support) service organizations.
ILS Manager		If necessary, the LMC notifies the ILS Manager, who coordinates corporate-level interaction until the problem is resolved.

7.8 Maintenance Reporting

Maintenance Work Orders (MWO) are used to record EMD HW malfunctions. They will be initiated by the LMC. MWOs are on-line and accessible by the LMC, and ILS personnel at the EDF. MWOs are updated when there is a change in status, when it has been routed to a new action, or when the problem is escalated. As problems are resolved, the corrective action taken is entered and the MWO is closed by the LMC.

The ILS Maintenance Coordinator monitors COTS maintenance actions by periodically reviewing the MWO. In addition, the ILS Maintenance Coordinator is alerted via the escalation notification procedures of aging MWOs.

7.8.1 Maintenance Analysis

The MWO will contain the history of COTS HW malfunctions, thereby providing traceability for COTS HW malfunctions and corrective actions. MWOs are analyzed by the ILS staff, COTS Hardware Maintenance and FRB to identify failure trends, to assess whether A_O and MDT objectives are being achieved, and to ensure that contractual obligations are being met.

7.8.2 External Maintenance Reporting

MWOs will be provided periodically to ESDIS during the regularly scheduled FRB meeting. Currently the FRB is held monthly.

7.8.3 Tools and Test Equipment

COTS equipment maintenance is accomplished by OEM contractors using tools and test equipment required to maintain the HW being serviced. Generally EMD will not procure additional test equipment that will duplicate the set possessed by OEM maintenance contractors. Any standard or special support equipment required to test EMD will be addressed during the task proposal request process

7.9 Program Metrics

Raytheon evaluates metrics relating to computer resource utilization, fault density, and hardware reliability, design complexity and fault type distribution. The Failure Review Board (FRB) is the EMD mechanism used to compute, validate, and review system RMA data and make recommendations for system improvements when RMA objectives are not met. The board is comprised of both government and contractor personnel. There are system RMA objectives for both Operational Availability (Ao) and Mean Down Time (MDT). System RMA data is computed using FRB validated hardware and software downtime events. System down time is computed for each function as outlined in the RMA White Paper and is presented monthly to the FRB by the RMA engineer. RMA data is presented on a rolling 90 day basis.

The DAACs report hardware failure data via an automated maintenance work order (MWO) process. All relevant maintenance action is recorded including, time of failure, time to fix, waiting parts time, recovery time and components replaced. The ILS manager presents HW

downtime to the FRB for validation. Software failure is reported by the DAAC operations contractors and consists of operations log extracts detailing failure events by function. The RMA engineer presents software failure events to the FRB for validation.

The RMA engineer computes RMA statistics after MWOs and the FRB validates SW failures. The RMA engineer and ILS manager review the FRB validated down time events and ensure that all failure data is captured before computing RMA statistics. The final statistics and analysis are then presented to the FRB.

The ILS manager chairs the FRB. Other board members include the ESDIS (NASA) Hardware Manager, EMD Chief Engineer, EMD Hardware Engineering manager, EMD COTS Hardware manager, the EMD RMA engineer, and a representative from the EMD Quality Assurance Office.

Raytheon also measures and evaluates the process of hardware and software maintenance/development can be effectively managed (monitored and improved upon) only if there is an objective means of measuring the quality of the EMD work. In order to ensure that EMD work is aligned with NASA goals and priorities, a comprehensive set of metrics has been selected. These metrics enable the EMD contractor and NASA management to evaluate and improve the quality, productivity, and effectiveness of products and services, and to measure the Raytheon's performance on the EMD contract. Table 7.9-1 presents Raytheon's understanding of key NASA Hardware-Related goals and summarizes our proposed metrics related to each goal. The metrics were selected to provide a quantitative measure of success in. They capture the core characteristics of cost performance, schedule performance, mission success, and the quality and timeliness of deliveries to the field. Those metrics that we propose to jointly share with other stakeholders (e.g., DAACs and instrument teams) are indicated by the word "Shared" in that column.

Table 7.9-1. Hardware Related Performance Metrics (1 of 2)

User Satisfaction		
Metric	**Description**	**Sys Perf**
Order Response Time	Average order fulfillment response time shows the average time required to complete an order.	Shared
Sustaining Engineering		
Metric	**Description**	**Sys Perf**
Sustaining Engineering	Percentage of mission milestones achieved during the month	X
Information Flow		
Metric	**Description**	**Sys Perf**
Information Flow Down to DAACs	Percentage of patches and TEs for which the DAACs require additional information	X
DAAC Information	Rating of accuracy and consistency of basic MR information received from DAACs on a scale of 1 to 5	Shared
DAAC Top 25 Ranking	Changes in DAAC's relative ranking of top 25 NCRs	Shared

Table 7.9-1. Hardware Related Performance Metrics (2 of 2)

DAAC Effectiveness		
Metric	**Description**	**Sys Perf**
DAAC Test Executable Installation	Average time in days for DAACs to test and install a TE into operations	X-Shared
DAAC Patch Installation	Average time in days for DAACs to test and install a patch into operations	X-Shared
DAAC NCR Test/Verify	Average time in days for DAAC to test and verify NCR after receipt of patch or TE	X-Shared
DAACs Operation		
Metric	**Description**	**Sys Perf**
DAAC Ingest Performance	Number of data granules and volume ingested at the DAACs versus expected for the period	X-Shared
DAAC Distribution Performance	Number of data granules and volume distributed at the DAACs versus expected for the period	X-Shared
DAAC Production Performance	Number of data granules and volume produced at the DAACs versus expected for the period	X-Shared
System Reliability	Availability of system functions versus expected for the period (software reliability)	X-Shared
Costs/Schedule Effectiveness		
Metric	**Description**	**Sys Perf**
Schedule Performance Index	Shows the budget of work performed (BCWP) / budget of work scheduled. This provides an indicator of the efficiency of the progress being made towards the scheduled work.	X
Cost Performance Index	Shows the budget of work performed (BCWP) / actual cost of work performed (ACWP). This provides an indicator of the efficiency of the progress being made towards the estimated costs.	X

7.10 Government Furnished Equipment

The baseline set of EMD HW is Government Furnished Equipment and it will be maintained per the procedures set forth in this document. If additional GFE is assigned to EMD, the EMD contractor will maintain such equipment as determined jointly by the EMD contractor and NASA.

7.11 Property Reporting

All EMD COTS equipment is accountable to the EMD contractor, specifically the ILS Office. When an EMD component containing an EMD property tag is replaced, LMCs will remove the tag from the replaced item, apply a new tag to the new unit, and record both the old and new equipment identification numbers (EINs) in the MWO.

Replacement of an equipment component with a like component from the site spares kit will be noted in the MWO along with the model and serial numbers of the replacement unit. The LMC will update the site's inventory record and return the failed unit to the OEM maintenance vendor for replacement. Property tags will be affixed by the LMC in accordance with procedures specified in the EMD Property Management Plan.

7.12 Design Reviews

Design reviews shall be scheduled and conducted when appropriate to the maintenance and/or development activity.

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Abbreviations and Acronyms

ACWP	Actual Cost of Work Performed
Ao	Operational Availability
ARB	Architecture Review Board
BCWP	Budget of Work Performed
BOE	Basis of Estimate
CCR	Configuration Change Request
CI	Configuration Item
CM	Configuration Management
COTS	Commercial Off-The-Shelf
CPT	Cross Product Team
CSE	Customer Service Engineer
CSR	Consent to Ship Review
DAAC	Distributed Active Archive Center
DM	Data Management
ECS	EOSDIS Core System
EDF	EMD Development Facility
EIN	Equipment Identification Number
EMD	ECS Maintenance and Development Program
ESD	Electrostatic Discharge
FCA	Functional Configuration Audit
FRB	Failure Review Board
GFE	Government Furnished Equipment
GSFC	Goddard Space Flight Center
HQE	Hardware Quality Engineering
HW	Hardware
HMDP	Hardware Maintenance and Development Plan
ILM	Integrated Logistics Manager

ILS	Integrated Logistics Support
ILSO	ILS Office
LAN	Local Area Network
LaRC	Langley Research Center
LLR	Lessons Learned Review
LMC	Local Maintenance Coordinator
LPDAAC	Land Processing Data Center
LRU	Logical Replacement Unit NSIDC National Snow and Ice Data Center
MDT	Mean Down Time
MR	Modification Request
MWO	Maintenance Work Order
OEM	Original Equipment Manufacturer
PCA	Program Control Analyst, Physical Configuration Audit
PI	Project Instruction
PM	Preventive Maintenance
PPM	Principal Period of Maintenance
PSR	Pre-Ship Review
PVC	Performance Verification Center
QA	Quality Assurance
QAE	Quality Assurance Engineer
RC	Risk Coordinator
RI	Responsible Individual
RMA	Reliability, Maintainability and Availability
SDPS	Science Data Processing Segment
SEIT	System Engineering and Integration Team
SMC	System Monitor Center
SW	Software
SAN	Storage Area Network
SEP	System Enhancement Proposal
TPR	Task Proposal Request
VATC	Verification and Acceptance Test Center