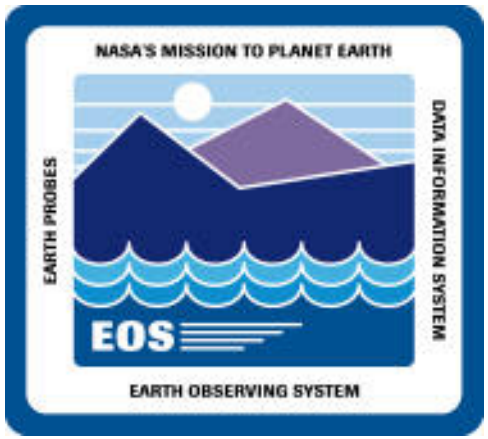
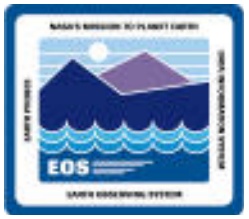


System Hardware Specification

Randy Miller

10 January 1996

What Do We Mean By 'System Hardware Specification'?



Definition: System hardware specification is the process whereby the system design is translated into a Bill Of Materials (identifying specific parts, with quantity by part number, from specific manufacturers) and configuration diagrams showing installation of all parts.

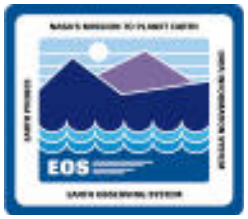
Purpose: The purpose of system hardware specification is to

- Identify materials to be purchased by the procurement organization
- Identify the baseline configuration for site installation
- Provide a basis of cost for program planning

Results: The results of this process include

- A Bill Of Materials (per subsystem per DAAC)
- Configuration diagrams (as required)

Methodology

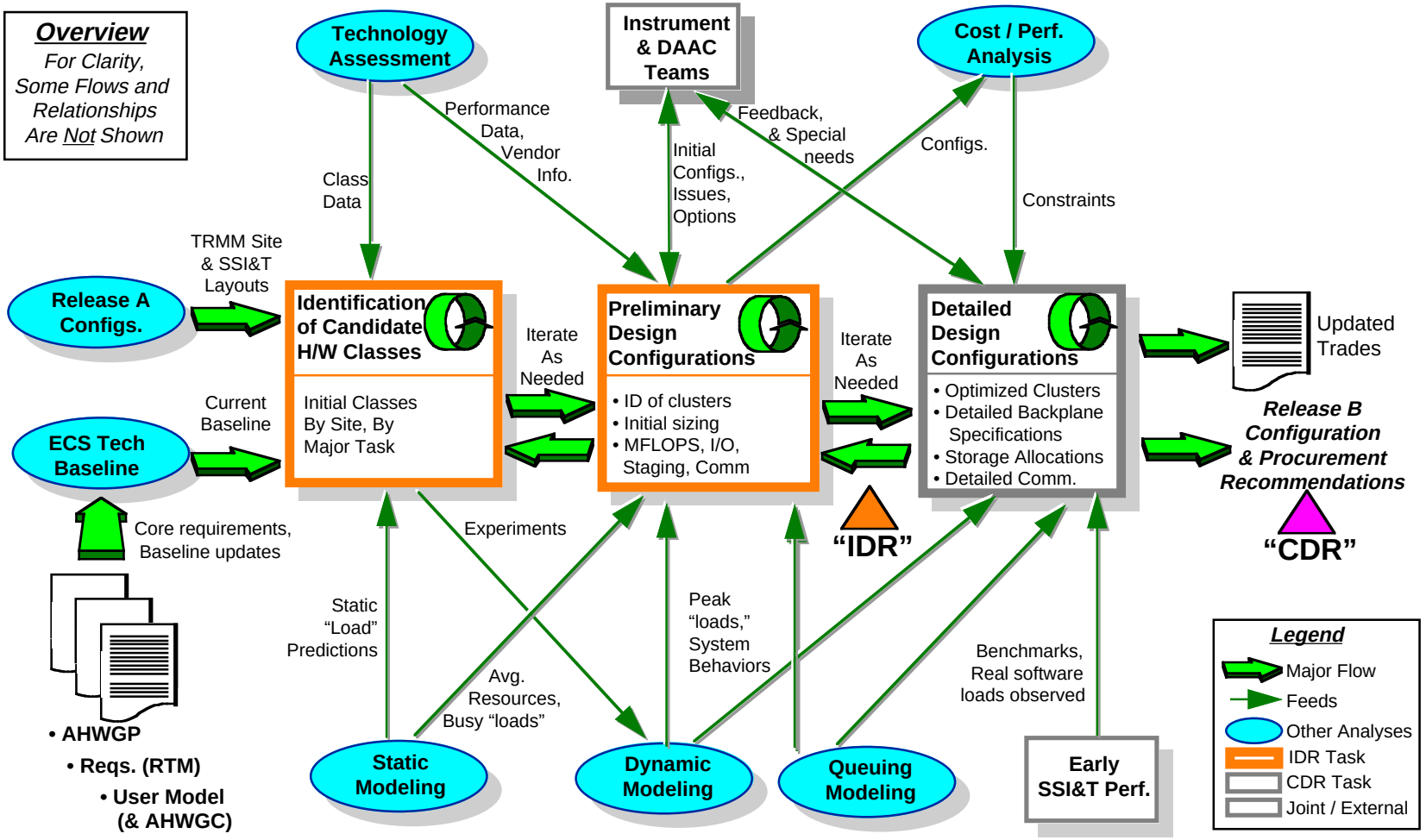


The system hardware specification process includes the following steps:

- **Gathering all requirements**
- **Identifying all options**
- **Performing trade-offs**
- **Validating the specification**
- **Documenting the specification**

These steps are performed iteratively until solutions are found which simultaneously satisfy all requirements and constraints

Process Overview

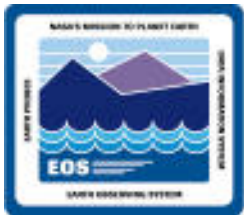


Timeline For The Specification Process

10 Jan	Modeling Workshop I
21 Feb	Modeling Workshop II
01 Apr	CDR Documents Delivered
25 Apr	CDR Concluded
09 May / 25 Jun	Bill Of Materials Completed
28 May / 16 Jul	Purchase Orders Prepared
28 Jun / 14 Aug	Purchase Orders Submitted To NASA For Consent
19 Jul / 04 Sep	Purchase Orders Released

The date ranges shown are early finish/late finish dates.

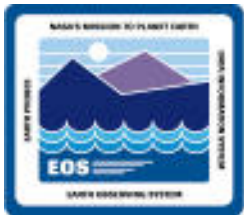
Gathering All Requirements



Requirements for the system hardware specification flow from many sources:

- **System and Subsystem Models**
- **Benchmarking**
- **Analysis**
- **User Surveys**
- **System Level Requirements**

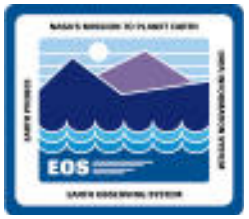
Requirements Derived From Modeling And/Or Benchmarking



These requirements are typically derived from modeling and/or benchmarking:

- **Computing Throughput [Millions of Instructions per Second (MIPS) and /or Millions of Floating Point Operations per Second (MFLOPS)]**
- **Random Access Memory [Megabytes (MB)]**
- **Virtual Memory [Megabytes (MB)]**
- **Network Throughput [Megabits per second (Mbps)]**
- **Number of Robots**
- **Number of Read/Write Stations**
- **Disk Space [Gigabytes (GB)]**
- **Disk I/O [Megabytes per second (MB/sec)]**

Requirements Derived From Analysis And/Or User Surveys

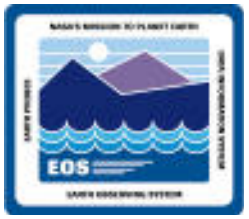


These requirements may be derived from analysis and/or user surveys:

- **Random Access Memory (RAM) [Megabytes (MB)] and**
- **Virtual Memory [Megabytes (MB)]:**
  - *The memory behavior of virtual memory systems -- particularly Symmetric Multi-Processor configurations with local caching -- is extremely complex, and highly dependent upon the memory-use pattern of **each** process being executed. Benchmarks will be used wherever possible to establish memory requirements. Code inspections and surveys of the instrument teams will be used to derive the requirements for memory configurations for the Science Processors.*

- **I/O Subsystem Configurations:**
  - *Although the models will provide I/O subsystem requirements at a coarse level (MB/sec), analysis will be required to identify the number of I/O channels required, and the amount of storage to be allocated to each channel. This analysis is performed iteratively as technology and product selections are made, because the technologies selected have broad design impacts.*

System Level Requirements

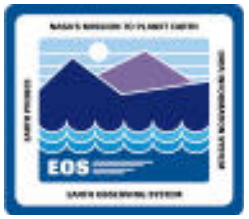


These System Level Requirements may impact the system hardware specification:

- **<u>Phasing</u>: For some subsystems, capacity is required at increasing levels over time. The phasing of capacity is relative to the launch dates for satellites/ instruments. Because there are multiple launch dates, phasing of multiple capacities must be integrated. These phasing requirements must also be integrated with the program implementation schedule (i.e., delivery and installation milestones).**

- **<u>Allocation</u>: For some subsystems, capacity is to be allocated to multiple operating modes (e.g. production, re-processing, integration and test). Software mode management will mitigate the impact of allocation for some subsystems; however, in some subsystems allocation requirements will necessitate the specification of separate components to satisfy the allocation requirements -- for example, processors for algorithm integration and test.**

System Level Requirements (Continued)



- **Reliability, Maintainability, and Availability (RMA): RMA requirements impact the configuration specification in a number of ways, including the following:**

  - **Duplication Of Components -- Components may have to be duplicated in order to meet availability or mean time to repair requirements, or to eliminate single points of failure.**

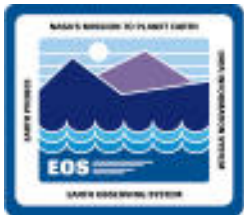
  - **Implementation Of Failover Pairs -- Computers within subsystems or across subsystems may be configured as failover pairs to meet RMA requirements. This typically requires special network, peripheral device, and software configuration.**

  - **Implementation Of RAID Levels -- Disk storage may be implemented using RAID devices to reduce the failure rate of the storage components.**

  - **Implementation Of Hot Spares -- Hot spares may be configured in some devices (e.g., controllers, power supplies, and drives in RAID arrays) to improve RMA.**

  - **Implementation Of Back-Up And Maintenance Devices -- Local tapes drives and CD drives may be added to subsystems to perform subsystem back-ups and to allow the delivery of software maintenance upgrades.**

System Level Requirements (Continued)

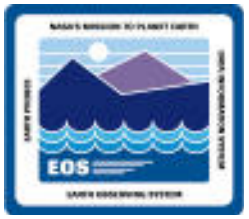


- **Scalability/Expandability: System level scalability/expandability requirements may preclude the use of technologies which meet the baseline system requirements but are not scalable beyond that level, or may result in the configuration of components with reserve for future expansion (e.g., processor boxes with unused backplane slots, and switches with unused ports).**

- **Interoperability: System level interoperability requirements may preclude the use of technologies that are proprietary or do not conform to published standards. The lack of availability of some software products on some hardware platforms may preclude use of those hardware platforms.**

- **Compatability/Migratability: The system must support the migration of operations and data from each version of the system to the next, starting with the transition from V0 to Release A. This may result in requirements for additional capacity to handle transition, or for supporting obsolete peripherals beyond the date they would otherwise be removed from the system. It may also affect the trade-off analyses so that implementation of some new technologies is delayed or precluded.**

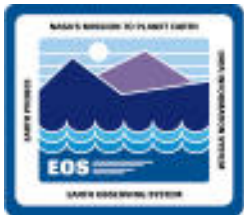
System Level Requirements (Continued)



- **Evolvability: The system level evolvability requirements may preclude the use of certain technologies or favor the use of others.**

- **Cost: The system level cost constraint must be applied to the proposed technical solution. Acquisition and maintenance costs must be evaluated for various options, and trade-offs must be performed. If program funding is insufficient to meet all of the system level requirements simultaneously, requirements must be prioritized or deferred.**

Identifying All Options

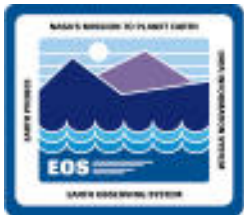


The process of identifying all of the technology and product options available for the system implementation includes the following steps:

- **<u>Technology Research</u>: Technology Research is performed through the following activities:**
  - **Reading Industry Journals, Magazines, and Newsletters**
  - **Attending Conferences and Conventions**
  - **Participating In User Groups**
  - **Exploring Related Web Sites**

- **<u>Product Evaluation</u>: Product Evaluation is performed through the following activities:**
  - **Vendor Briefings**
  - **Laboratory Tests/Prototyping/Benchmarking**
  - **Checking References**

Performing Trade-Offs

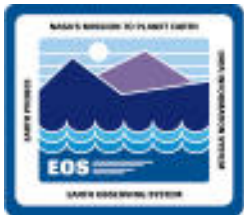


Trade-Offs are performed at various levels:

- **<u>At the technology level</u>, competing technologies are assessed; technical feasibility/risk, interoperability, evolvability, and cost are typically the deciding criteria. Examples include selecting the processor family for Science Processing (Vector, Massively Parallel, or Symmetric Multi-Processor), the intra-DAAC network technology (HiPPI or ATM), and the database management system technology on the Data Server (relational, object relational, or object oriented).**

- **<u>At the vendor level</u>, products from competing vendors are assessed; cost, interoperability, compatability, scalability, and evolvability are typically the deciding criteria. Examples include selecting the vendors for subsystem computers (SGI, DEC, HP, Sun, or IBM) and the vendors for network components.**

Validating The Specification

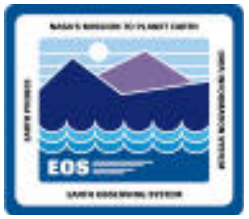


The system hardware specification is validated through the following activities:

- **<u>Modeling</u> -- The performance characteristics of the equipment in the hardware specification are fed back into the system models. If necessary, the system models are updated to reflect the performance characteristics of the selected hardware. The models are then re-run, checking to make sure that performance requirements are still met.**

- **<u>Review</u> -- The specification is reviewed by the software development team, to ensure that it meets all derived or implied software requirements; by the vendor, to make sure the specification is feasible; and by the customer/user community, for suitability.**

Documenting The Specification



The process of Documenting The Specification is performed through-out the development of the system hardware specification, and results in *intermediate products* and *final products*:

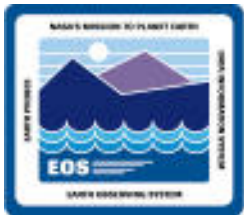
- **Intermediate Products: These products document important steps in the specification process. Some are formal deliverables; others are internal working papers.**

  - **Modeling Results -- The modeling group publishes analyses of the results of the modeling campaigns in the form of internal briefings.**

  - **Benchmarking and Prototyping Reports -- Benchmarking and prototyping efforts are documented in technical papers which are published for community comment. These papers are generally available from EDHS.**

  - **Trade-Off Analyses -- These analyses are documented in technical papers which are published for community comment. These papers are generally available from EDHS.**

Documenting Decisions (Continued)



- **<u>Final Products</u>: The final products of the specification process, Bills Of Material and configuration diagrams, are documented in the *Subsystem and DAAC Specific Design Specifications (DID 305)* and in the *Purchase Requisitions* submitted to the Government for procurement approval. Because the volume of information required to present a full Bill Of Materials for a single DAAC is quite large, the Design Specifications do not provide a part number level of detail; they identify the volume of resources to be implemented at each DAAC. The Design Specifications may also be published several months in advance of the corresponding procurements; ECS will take advantage of this period to update the specifications to reflect new products, prices, and technologies as applicable. The Purchase Requests submitted for Government approval will reflect the best design and technology information available at the time of submittal.**