NEW MISSION REQUIREMENTS METHODOLOGIES FOR SERVICES PROVIDED BY THE OFFICE OF SPACE COMMUNICATIONS

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ABSTRACT

The Office of Space Communications, NASA Headquarters, has recently revised its methodology for receiving, accepting and responding to customer requests for use of that office's tracking and communications capabilities. This revision is the result of a process which has become over-burdened by the size of the currently active and proposed missions set, requirements reviews that focus on single missions rather than on mission sets, and negotiations most often not completed early enough to effect needed additions to capacity or capability prior to launch.

The requirements-coverage methodology described is more responsive to project /program needs and provides integrated input into the NASA budget process early enough to effect change, and describes the mechanisms and tools in place to insure a value-added process which will benefit both NASA and its customers. Key features of the requirements methodology include the establishment of a mechanism for early identification of and systems trades with new customers, and delegates the review and approval of requirements documents to NASA centers in lieu of Headquarters, thus empowering the system design teams to establish and negotiate the detailed requirements with the user. A Mission Requirements Request (MRR) is introduced to facilitate early customer interaction. The expected result is that the time to achieve an approved set of implementation requirements which meet the customer's needs can be greatly reduced. Finally, by increasing the discipline in requirements management, through the use of baselining procedures, a tighter coupling between customer requirements and the budget is provided. A twice-yearly projection of customer requirements accommodation, designated as the Capacity Projection Plan (CPP), provides customer feedback allowing the entire mission set to be serviced.

1. INTRODUCTION

The Office of Space Communications is the programmatic office responsible for providing spacecraft operations and control centers, ground and space communication, data acquisition and processing, flight dynamics and orbit determination, and spacecraft tracking services for NASA's customers. The Office is currently going through an evolution in the way business is conducted and services provided to its customers. The Office is responsible for managing all of the tracking and data acquisition resources of NASA. As such, the Office of Space Communications manages: 1) the Space Network which consists of three fully operational and two partially operational, Tracking and Data Relay Satellites (TDRS) in geosynchronous orbit and the vestigial elements of the STDN Ground Network, both operated by the

Goddard Space Flight Center; 2) the Deep Space Network operated by the Jet Propulsion Laboratory and; 3) facilities for providing communications services for aeronautics, balloons, and sounding rocket programs operated by the Wallops Flight Facility (WFF), Dryden Flight Research Facility (DFRF), and the Ames Research (ARC) Center, (Moffett Field and Crows Landing) .

In providing services to its customers, the Office of Space Communications is streamlining the evaluation of requirements and delegating the generation of the required detail as well as the responsibility of responding to those requirements to designated lead NASA centers.

2. COMMUNICATIONS SERVICES

Communications services are technically provided through designated lead centers. The Jet Propulsion Laboratory (Deep Space Network) provides tracking, communications (telemetry and command) and navigation services for Deep Space missions, highly elliptical Earth orbiters, missions at Lunar distances, and for non TDRS compatible low Earth orbiters. The Goddard Space Flight Center (Space Network, Ground Spaceflight Tracking and Data Network, and Wallops Flight Facility) for TDRS compatible Earth Orbiters, Low Earth orbit and suborbital tracking, communications, navigation, and certain control center and data processing functions. Wallops Flight Facility also provides tracking, communications, navigation and command services for low Earth orbiters, highly elliptical orbiters, sounding rockets, balloons, and portions of the aeronautics programs. Dryden Flight Research Facility provides services primarily for the aeronautical missions and Space Transportation System (STS - Space Shuttle) return activities. Moffet Field and Crows Landing (ARC) also provide services for aeronautical missions.

3. NASA'S CUSTOMERS

Customers include NASA flight and non flight missions as well as other civil government space operations, the Department of Defense, Commercial and Foreign missions (government and commercial). Top priority for the allocation of Tracking and Data Acquisition resources is allocated to NASA missions. In addition, NASA cooperative experiments and services and non-NASA missions are supported. This coverage approach is by design, in that NASA, as its own customer, defines the resources for the tracking and data networks. Other users who conform to the standardized capability provided can also be serviced. There is usually no implementation and/or modification that is driven by non-NASA customers. In the current environment this poses a challenge to the requirements process. There are increasing numbers of non-NASA users. Multinational programs in which NASA participates as an equal partner, and uniquely foreign programs, which require NASA communications resources in order to provide a viable mission, must abe covered. Requirements for these new missions continue to push the limits of both the capability and capacity of the ground and space networks. Further, there has been a greater emphasis placed on commercial space activities which most likely depend on the NASA tracking and data acquisition network infrastructure. NASA, of all the worlds space agencies, maintains the most capable set of networks with the greatest capacity. For example, to date, there is no other Space Network providing complete near Earth tracking and data relay services. However the National Space Development Agency (NASDA) of Japan and the European Space Agency (ESA) are expected to develop this capability in the near future.

4. REQUIREMENTS ENVIRONMENT

Prior to the spring of this year, the requirements management process at the Office of Space Communications had been directed toward "short term" solutions. In particular, there was no systematic procedure for early notification of a customer's needs. The organization responsible for providing the services would not be informed of the real requirements until later mission phases and usually, therefore, too late to provide the essential services needed to meet those requirements. Also, the roles and responsibilities for both Headquarters and the lead centers were not clearly defined. Approvals on requirements documentation would occur after the fact, and baselines for requirements with their associated budgets were not always clearly established.

New methodologies for requirements management will address these issues and demonstrate plans for improving responsiveness to meet the customers needs for both communications service capacity and capability.

5. THE FIRST STEP

Recognizing the inadequacies of the current process, the Office of Space Communications, with recommendations from the Office of Space Science and Applications (OSSA), decided to revise the NASA Management Instruction (NMI 8430.1B), "Obtaining Use of Office of Space Communications (OSC) Capabilities for Space, Suborbital and Aeronautical Missions". The resulting document, (NMI 8430.1C), signed by the NASA Administrator last December 31, 1991, addresses the issues of the previous system and is the vehicle for establishing a new process. The revised NMI promotes and fosters early identification of customer requirements in part by conducting periodic planning activities with customers. The new process requires notification of requirements at the completion of the Phase A studies. In most cases this provides a four to five year lead time before services are actually needed. The document for such notification is called the Mission Requirements Request (MRR), which unlike earlier documentation is a maximum of seven pages. The format facilitates the capture of the contents into a requirements data base lending itself to the identification of cost and performance "tall poles". The opportunity for establishing a centralized requirements tracking system and a comprehensive mission requirements data base is an important aspect of the new process.

Another key provision of the new instruction includes periodic feedback to the customer indicating the degree to which his requirements can be accommodated. This is accomplished by way of a Capacity Projection Plan (CPP). The CPP provides the expected capacity and capability needs and costs to support the customer mission set for the next five years. The periodicity of the CPP is, at a minimum, coincident with the budget cycle. Having a periodic plan which looks at resources and the capacity to provide services to customers representing the entire mission set allows planners to make appropriate reallocations within the budget. The allocation can be for either new capability and/or increased capacity which can best fit the customers needs or for reducing mission requirements. This process requires mission-coverage trade offs. Customers may not always be able to acquire all the coverage their original mission needs. Thus the CPP provides the negotiating baseline for working potential shortfalls for the next budget cycle. The CPP provides a mechanism for tightly coupling requirements management to the budget process. The CPP requires strong interaction from all participating OSSA and OSC lead centers and forces discipline in the

requirements management process. The detailed CPP process infrastructure is currently being developed.

Finally, the revised NMI delegates much of the responsibility for negotiating the detailed requirements between cognizant mission and OSC lead centers. The Detailed Mission Requirements (DMR) document is a negotiated document between the service provider and the customer and provides the baseline for performance, schedule, and cost. It contains both the requests and the responses to those requests. Previously that was accomplished with two documents, the Support Instrument Requirements Document (SIRD) and the NASA Support Plan (NSP). Authority to provide the services requested and negotiate the detailed requirements with the customer rests on the success of early design and cost planning at the lead center. This is particularly true for those requirements that can be satisfied within projected capability and capacity. The Office of Space Communications will be kept informed of the activity but is not heavily coupled to the authorization loop. By placing the responsibility for satisfying the detailed requirements down where the services are provided, the response time is shortened, allowing much greater freedom to negotiate how those requirements are satisfied.

When it is determined at the lead center that the customer's requirements cannot be satisfied within the projected capability or capacity and network augmentation is required, the budget impacts are forwarded to the OSC for appropriate action.

6. THE DETAILED REQUIREMENTS MANAGEMENT PROCESS

As mentioned earlier, the requirements management process is evolutionary. This paper discusses where that process has gone during the past number of months. The process is still in the formative stage. The development of a Capacity Projection Plan process is still under way and requires the joint negotiation of all the lead centers. The Mission Requirements Request form currently in use remains in draft format. As the CPP is developed there will be room to fine tune the MRR to best fit the data requirements of the CPP. The formal response to the projects via the CPP on how mission requirements are accommodated will not be available for at least another six months. However, during the development of the first capacity projection plan, that response is provided by ensuring close communication between the users and the providers. This process can succeed if adherence to the principles which were established at the onset of this process are followed. Those principles are:

1. Early notification of coverage and performance requirements.

2. Development and costing of capacity and capability options.

3. Delegation of the responsibility for authorizing the service at the lead center responsible for providing the service.

4. Evaluation of all the resources for the accommodation of requests for services based on the entire mission set.

5. Tight coupling of the budget process to the request for services, including modifications of those requests.

The first step in satisfying a customers requirements is early knowledge of those requirements. Ideally, this is accomplished during the early Phase A mission study process. Early notification allows mission and OSC system design teams to develop the architectural option and results in the Office of Space Communications developing

the necessary long range plans, network loading projections, facility design, performance, and cost data to the new mission. The user, along with notification of intent to use OSC resources, also identifies any unique capability that may be required. All of this sets the stage for the development of the Mission Requirements Request. The MRR is generated as a result of flight-ground teaming relationships from the very beginning of a project. In fact, during the Phase A study period, the candidate OSC lead center, whose responsibility it will be to provide the service, provides loading impacts, its long range plans, and options. At the start of Phase B, the generation of the MRR is completed with all the information understood at that time. The MRR formalizes the "tall pole" requirements but does not represent the final negotiated requirements. The intent is to force early notification and identification of the important aspects of the requirements. The MRR evaluation continues throughout the design phases of the project.

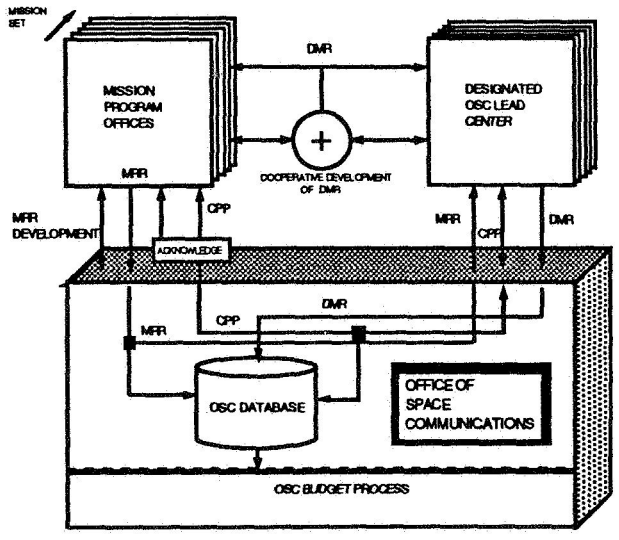

Figure 1. Process Relationships

The formalization of the MRR, as signified by a signed letter of transmittal by the mission program office, allows the responsible organizations to identify manpower and other resources required to work the requirements. The conclusion of a Phase A study generally results in the authorization to proceed as a new start. If approval is not obtained, the MRR is put on hold. If a MRR has been forwarded, it is withdrawn by the project to be reinitiated at a later date if the project becomes approved.

Figure 1. graphically represents the relationship of activities in the process. Many of the processes are interactive and are signified by arrows in both directions. The relationship between the OSC and the organizations representing each of the missions is dominated by the MRR process. The formal MRR is symbolized by a unidirectional arrow from the program office. The formal MRR is acknowledged by OSC and the lead center is identified. The identification of the lead center authorizes the start of the development of the DMR and any processes associated with the development of the CPP. The right side of the graphic represents those relationships with the lead centers. However, the relationships are not limited to those depicted. For example, the OSC provides supporting information on the technical capabilities of the networks as well as coverage plans.

Acknowledgement signifies another milestone in the requirements process. A mission set data base is updated with MRR, DMR and CPP data. Impacts to other missions, OSC resources in terms of capacity and capability, and the budget are extracted from the data base. As depicted, the data base is a compilation of knowledge from the mission and OSC lead centers. The current development on the database uses the MRR as fundamental requirements element with supporting data and links to more detailed documentation.

The Detailed Mission Requirements document reflects the MRR and, as the name

implies, identifies the detailed requirements of the mission. But more than that, the DMR is a cooperative document between the OSC lead center and the customer's program office. Figure 1. depicts the level at which the DMR is developed. The DMR is a joint document between the mission and OSC lead centers, but it also serves a feedback mechanism for OSC as to the status of requirements assignment or implementation. Where as, earlier documentation was structured as "request then response", the DMR integrates the mission requirements into lead center's plan for satisfying those requirements into a single document. The result is more akin to a negotiated agreement on the services to be provided. The DMR is produced during the Phase B cycle in the mission design process and the requirements are traceable to the MRR

Even though the plan is to create a formal CPP which is published twice yearly, the CPP itself is continually updated based on mission requirements as they evolve. Impacts and changes to the CPP are evaluated and negotiated with impacted projects and the CPP assessed against budgetary plans and constraints. The key to the process at this point is consideration of both mission sets and priorities. Earlier processes tended to make judgements of supportability on a mission by mission basis. The current process provides for evaluation of services to NASA's customers on the entire collection of currently supported missions and authorized plans. This concept allows evaluation and cost tradeoffs which can provide services to the greatest number of missions and reduce the costs to NASA. Requirements tradeoffs are made early in the mission design and are used to partition the requirements such that the design of the communications link, or other resource, is an equitable share mission design team and the lead support network. Mission sets also provide the forecaster the luxury of defining trends in capacity and capability to support classes of missions, thereby simplifying the process of generating a projection plan.

The MRR, DMR and CPP are living documents subject to change. This process has taken change into account and made that part of the system. By recognizing that mission events and plans are dynamic, this process will allow the responses to changes in plans to take place effectively and in a timely manner. The figure depicts a continuous process, and not one with milestones fixed to arbitrary events.

7. SUMMARY

The Office of Space Communications, NASA Headquarters, has recently revised its methodology for receiving, accepting and responding to customer requests for use of that office's capabilities. The methodology described in the paper is both more responsive to project/program needs and provides integrated input into the NASA budget process early enough to affect capacity and capability change. Important aspects of the methodology include its focus on network capacity integrated across the entire mission set and its ability to identify early, new requirements for added capacity and/or capability.

8. REFERENCES

NASA Management Instruction, NMI 8430.1C "Obtaining Use of Space Communications (OSC) Capabilities for Space, Suborbital and Aeronautical Missions", December 31, 1991

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