A Model for Analysis of TDA Budget Allocation

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There is an ever-increasing need to achieve greater efficiency in the operation of the Deep Space Network (DSN), i.e., increased productivity at reduced cost. One of the tools used in the course of a planning workshop (March 1994) on this subject was a methodology for budget allocation applicable to long-range planning. This article presents a model for analysis of the TDA budget allocation. For the 1994 through 1999 period, the percentage of the total TDA budget allocated to capacity and capability is being cut in half, whereas the percentage spent on efficiency of delivery will be increasing.

I. Introduction

This is the beginning of an effort to collect data for the DSN reengineering effort planned for the near future. This article describes the methodology used in partitioning Work Authorization Document (WAD) data into categories that are potentially useful for making future planning decisions. These data, covering fiscal year (FY) 1993 through FY 1999, were presented to management at the 1994 TDA & Code OT Planning Workshop held on March 15 to 17, 1994, in Arcadia, California.

The goal of this article is to see what the trends are and where (i.e., in what categories) we are spending our money. The 1993 data are derived from the actual *WAD Obligations Performance Report* for FY 1993, in which the allocated budget was about $200M.

In the case of 1994 through 1999, data were taken from a WAD 93-3 (TDA, Level 5) computer printout dated February 22, 1994.

II. Definition of Categories

The first step was to define the categories for the WAD partitioning that we would use for the study. The categories follow; expanded definitions are presented in the Appendix.

(1) Capacity and Capability: modifications and additions to the network to meet the customer's requirements, such as new antennas, new uplink/downlink frequencies, and increased gain/temperature (G/T).

(2) Efficiency of Delivery of Capacity and Capability: the process of efficiently delivering the product through the operation and maintenance of the network, including sustaining functions.

(3) Technology and System Studies: investment for the future in research and development, including feasibility demonstrations.

(4) Management: strategic planning, customer interface, the allocation of resources, and establishing methods and standards to optimize the network.

(5) Reserves: funds held in reserve in the WAD and not allocated to specific tasks.

III. Budget Allocation for the Years 1993 through 1999

WAD data for FY 1993 through FY 1999 were analyzed and categorized. The details were summarized by fiscal year for each budget category. Specific details are available from the authors.

In the case of FY 1993, the data source used was the 1993 *WAD (TDA) Obligations Performance Report* (Level 5) dated September 25, 1993.

The data source for FY 1994 through FY 1999 was the printed version of WAD 93-3 (TDA, Level 5) dated February 22, 1994. The programs included are listed in Table 1.

Table 1. Fiscal year 1994 through 1999 programs.

Title	NASA code no.
DSN Advanced Systems	310xx - XXXXXX
Cost Reimbursables—NASA	31408 - XXXXXX
DSN Systems	31430 - XXXXXX
DSN Operations	31440 - XXXXXX
Communications Systems	31510 - XXXXXX
Communications Operations	31520 - XXXXXX
Data Processing Systems	31550 - XXXXXX
DSN Planning	31590 - XXXXXX
Systems Development	31591 - XXXXXX
System Engineering and Support	31630 - XXXXXX

IV. Methodology

The WAD data for each task were analyzed and assigned to the proper budget category at as high a level as seemed appropriate. The source included data down to Level 5, which gives the titles of each separate account. This allows fine-grain identification of the category for each individual task.

Data for each fiscal year were processed on a separate spreadsheet for each budget category as defined above. The percentage of the grand total for each category was also calculated. The percentage gives a more meaningful indication of the annual trend since the total planned budget is generally increasing in

the period under study. Use of the spreadsheet offers a structured approach to tabulating and processing the data.

Let us discuss two examples of how we treated the data in doing the WAD partitioning for this article. The first example is in the FY 1994 budget. NASA code 31430-4101 covers *Program Management—Office, Financial and Administrative* at $4.4M. When we looked at level-5 detail data (31430-410104, not shown in this article), we noted that it included "FY95 Forward Funding" at $3.5M. We allocated this amount to Reserves for FY 1994. The remaining $0.9M in 31430-4101 was allocated to Management for FY 1994. As a second example in the FY 1994 budget, NASA code 31430-60 covers *New Developments—Major Tasks—Multi Mission 1st User* at $2.3M. Looking at the level-5 detail, we concluded that all the 31430-60 funds ($2.3M) belong in the Capacity and Capability category for FY 1994.

V. Results

Table 2 summarizes the subtotals and totals of the WAD data as a percentage of the fiscal year grand total. A plot of the categories (in percent) versus fiscal year is given in Fig. 1. Figure 2 shows the FY 1994 and FY 1999 data in a pie-chart format to give another perspective of the trend over the decade of the 1990s. The annual trend of Capacity and Capability is generally downward, while the Efficiency of Delivery of Capacity and Capability is generally upward. Technology and System Studies, Management, and Reserves are fairly constant over the years. The most notable change is the reduction of Capacity and Capability from 27 percent of the TDA budget in 1994 to only 13 percent in 1999. This is a 50 percent reduction!

Table 2. Budget allocation.

Category	Percentage of budget[a]						
	1993	1994	1995	1996	1997	1998	1999
Capacity and Capability[b]	24	27	23	19	15	16	13
Efficiency of Delivery of Capacity and Capability [c]	61	54	57	62	65	64	67
Technology and System Studies[d]	12	10	10	9	10	10	11
Management[e]	3	4	3	3	3	3	3
Reserves	0	6	7	7	7	7	7
Total, percent	100	100	100	100	100	100	100

[a] Budget percentages were taken from WAD 93-3.
[b] Modification and additions to the network to meet the customer's requirements (new antennas, new uplink/downlink frequencies, increased G/T).
[c] Operate and maintain the network, including sustaining functions.
[d] Investment for the future in research and development, including feasibility demonstrations.
[e] Strategic planning, customer interface, allocation of resources, methods, and standards to optimize the network.

Note that the FY 1998 data in Table 2 differ somewhat from the prevailing trend on Fig. 1 in the Capacity and Capability and Efficiency of Delivery of Capacity and Capability categories. This is due primarily to a 1998 major funding increase of $12.5M for two major implementation tasks in the Capacity and Capability category.

VI. Summary

The overall Capacity and Capability expenditures as a percentage of the total WAD budget are decreasing while the percentage of Efficiency of Delivery of Capacity and Capability is increasing. The other categories are relatively small and constant. The purpose of documenting this methodology is so that others could replicate it or modify it in the future as major changes to the WAD occur. This work also produces some potential metrics that can be used in the future as we embark on a reengineering effort.

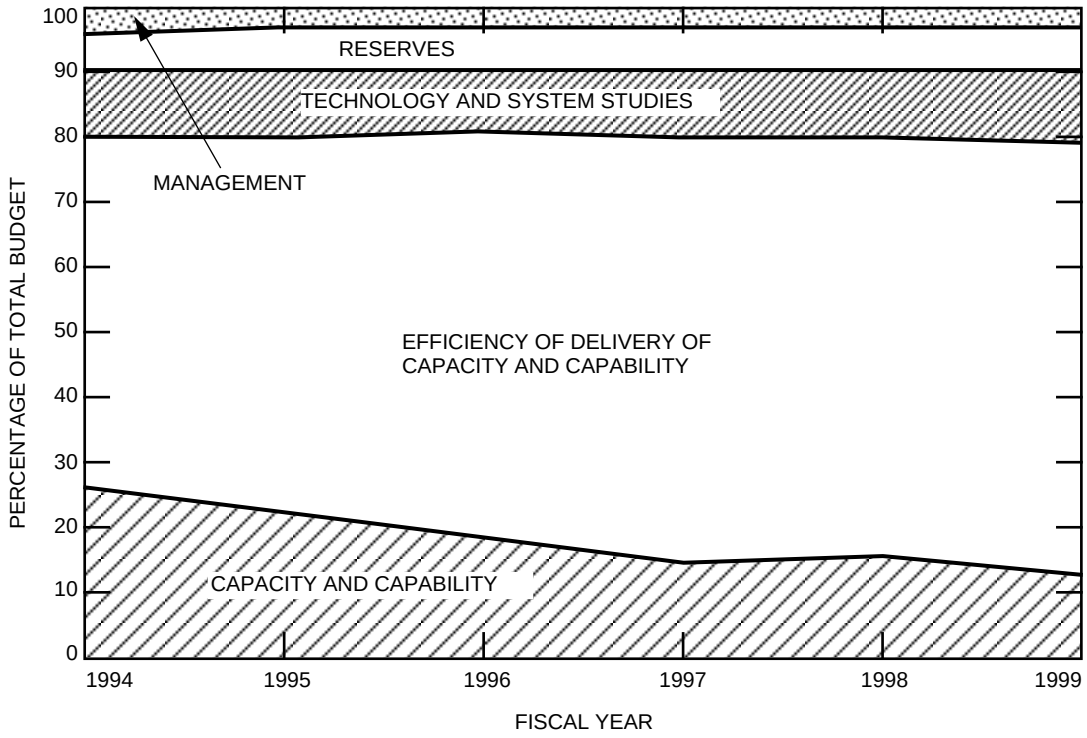

Fig. 1. Percentage of total budget by categories, 1994 through 1999.

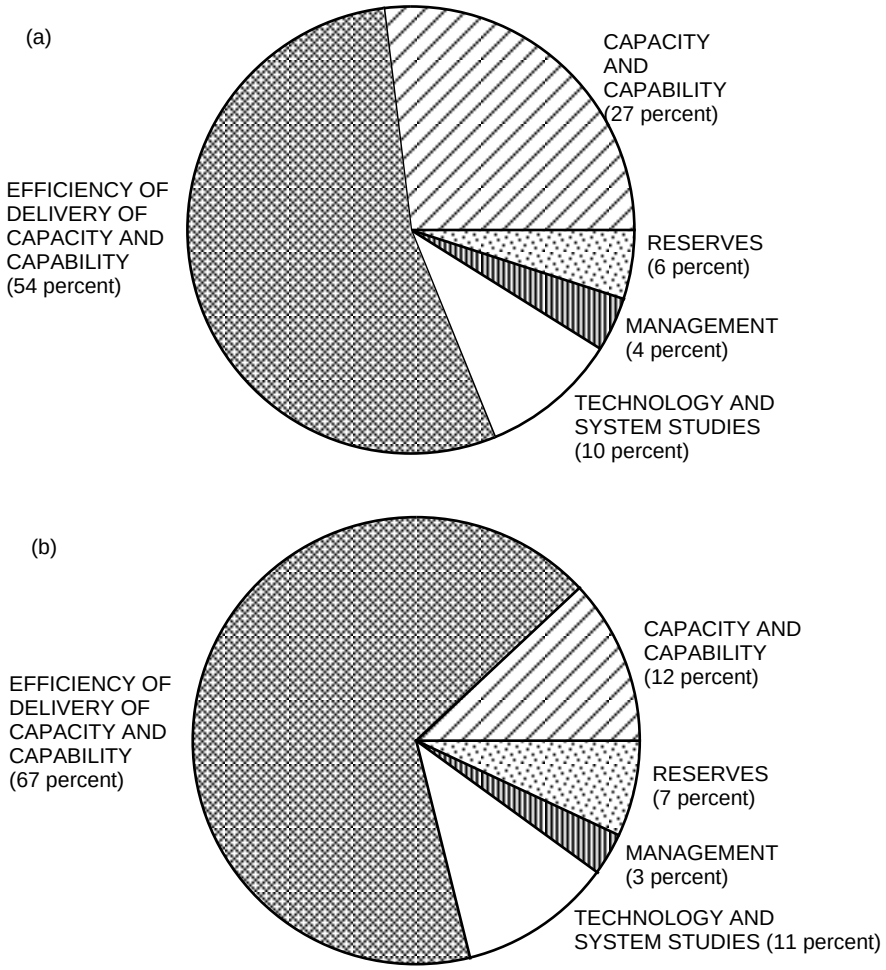

Fig. 2. WAD category allocations as a percentage of the grand totals: (a) FY 1994 and (b) FY 1999.

Appendix

Definition of Categories for Allocation of WAD Resources

I. Capacity and Capability

This category includes those modifications and additions to the Deep Space Communications Complexes that result in meeting the customer's requirements. These modifications and additions include the following:

(1) Enhancements of link performance, such as increased gain–temperature ratio (G/T) of antennas, lower noise receiving systems, wider bandwidth/telemetry channels, and higher power transmitters.

(2) New capability, such as new uplink and/or downlink frequencies.

(3) Increased network capacity by the addition of new antennas and associated equipment.

II. Efficiency of Delivery of Capacity and Capability

This category includes the costs of the following:

(1) Operating and maintaining the network equipment.

(2) Operating the Maintenance Repair Facility and training the maintenance and repair staff.

(3) Developing and implementing engineering change kits for maintaining "as-built" performance, and upgrading or adding new equipment that increases the original "as-built" performance.

(4) Training the operators and managing operations facilities, such as calibration and standard laboratories, and transporting test instruments for periodic calibration.

(5) Operations engineering, including system engineering, software database functions, project and station implementation, and scheduling.

It also includes those tasks that increase the tracking hours available for the customer. These tasks include the following:

(1) Automation of network control, improving the operational processes to produce shorter calibration times, shorter turnaround times between missions, faster maintenance response to equipment failures, and tighter monitoring of equipment status.

(2) Implementation of additional equipment to reduce downtime. Examples are the addition of on-line spares and modification of equipment and/or components to *increase* the mean time between failures and *reduce* the mean time to restore service.

III. Technology and System Studies

This category includes those costs for research and development (through the supporting research and technology program), other applicable technology development tasks, and the resources for feasibility demonstrations that precede implementation of performance upgrades.

IV. Management

This category includes costs for management concerns such as strategic planning, customer interface, allocation of resources, and the implementation of methods and standards to optimize the effectiveness of the DSN.

V. Reserves

This category includes major reserve funds that are not clearly allocated to specific tasks and cannot be assigned to any of the above categories at the time the WAD is generated.