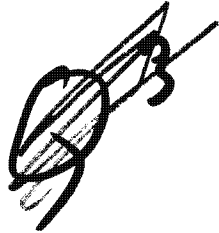


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ELECTRO OPTICAL IMAGERY
PROGRAM
CRITICAL TASK DESCRIPTIONS

Study provided by [Redacted]



15 OCTOBER 1969



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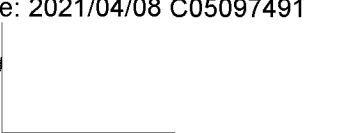
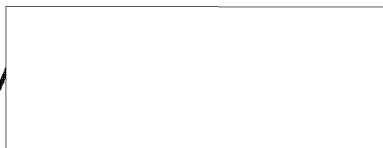


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SECTION 1.0

INTRODUCTION

This document contains a summary of studies and analyses that the [REDACTED] recommends be conducted as funded tasks during the pre-Conceptual Phase of the program. The rationale used in selecting these specific tasks is that these preliminary investigations would be highly productive during this early phase of the program and would be extremely beneficial in providing a basis for establishing technically sound system approaches and techniques. [REDACTED] intends to utilize experienced personnel and proven computational programs to derive maximum output from the tasks.

Section 2.0 of this report is a summary listing of the specific tasks; Section 3.0 contains the detailed descriptions and task outputs.

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3.5 Relay Satellite Network Study

3.5.1 General

The characteristics of the relay system have an impact on the CV design and on overall mission performance. The primary objective of this task is to define the relay network to the depth necessary to permit specification of CV and Ground Station communications requirements. An important secondary objective is to evaluate the relay system concept to identify technology development items in order to minimize the risk of the relay system compromising the overall program schedule.

3.5.2 Task Description

3.5.2.1 Definition of Candidate Relay System

The RS network studies shall consist of the following:
To date, four relay configurations have been examined. The system selected as the current baseline consists of satellites which provide a single hop link between the CV and ground station. Alternatives are:

These concepts, and others that may appear attractive, will be defined to the level of detail necessary to support the performance evaluation tasks described below.

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3.5.2.2 Coverage/Degraded Mode Studies

Preliminary coverage capabilities of the four contending relay concepts have been analyzed. Additional studies are required to determine the precise coverage pattern of the "dynamic" configurations, particularly the low altitude system. Coverage sensitivity studies are also necessary to determine the best location of the apogees and the timing of the modal crossings of the baseline relay satellites. Degradations in coverage as satellites also require more detailed study to provide an accurate assessment of relay system performance. The degraded mode studies will also influence the definition of replenishment policies, which in turn impact the system costs.

3.5.2.3 Availability Studies

An evaluation of the reliability and life of the candidate relay systems shall be performed. The percentage of time each system can be expected to be fully operational and the time expected for each of the possible degraded modes shall be estimated. Several replenishment concepts (such as spare spacecraft in orbit, replacement systems maintained in a state of launch readiness on the ground) will be considered as a result of the availability studies.

3.5.2.4 Transponder Definition

For each relay system alternative, a representative transponder concept will be defined to determine the impact of single hop or double

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hop systems. The choice of frequencies, antenna sizes and TWT requirements will be considered. Switching between several transponders versus the use of tuneable local oscillators shall be evaluated. For the double hop systems, an evaluation shall be made of the relative advantages and disadvantages of using a separate antenna for each link versus the problem of two feeds for a single antenna.

3.5.2.5 Spacecraft Configuration

A preliminary layout of each relay system alternative shall be developed which shall indicate antenna location, solar array approach, and stabilization approach.

3.5.2.6 Launch Vehicle Selection

Launch vehicle requirements shall be determined for each relay concept. Shroud limitations shall be considered and an assessment of the feasibility of multiple satellite launches shall be performed. Special emphasis shall be placed on the low altitude system.

3.5.2.7 Cost Analysis

The design and development costs, spacecraft procurement, launch vehicle costs, and other cost factors such as management, operational support and AGE shall be evaluated. The results of reliability and life analysis shall be factored into the study to determine the number of launches required for an operational program duration of years.

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3.5.2.8 Technology Implications of Candidate Relay Systems

Each candidate relay system shall be evaluated to determine the areas which involve state-of-the-art advances or extensive engineering development activities. The schedule and level of effort implications of each development item shall be evaluated.

3.5.2.9 Selection of a Preferred Relay System

Criteria shall be developed for comparing candidate systems on a cost, performance and development risk basis. Cost effectiveness sensitivity analysis shall be performed to assess the importance of assumptions and relative weighting factors.

3.5.2.10 Ephemeris Determination Accuracy Analysis

The following major investigations shall be conducted to acquire tracking system performance data:

- (a) Determination of the feasible measurements and measurement accuracies.
- (b) Investigation of the effect of relay orbit configuration on tracking system performance.
- (c) Determination of the required scheduling of tracking data collection and processing.
- (d) Development of nominal system deployment sequences and establishment of tracking system requirements and performance during deployment.

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- (e) Examination of various degraded modes of the relay system for tracking performance variations.
- (f) Development of concepts for real time monitoring and control of launch and orbit adjust mission phases and evaluation of potential advantages.

These studies will take maximum advantage of previous space-based tracking system activities. Trade-off data will be presented for parameter ranges sufficient to extend from the current state-of-the-art.

The tracking accuracy analysis will use minimum variance statistical estimation techniques, e.g., maximum likelihood and the Kalman filter. The analytical tools used for this purpose shall adequately model the spacecraft ephemerides, earth geopotential, and measurement systems and shall provide fully correlated propagation and reduction of the state uncertainties.

3.5.2.11 Ephemeris Determination Software Requirements

Analyses shall be conducted to determine the applicability of various modules and subroutines of present orbit determination programs. The requirements for new computer routines shall be determined for ephemeris determination based on range sum data. Estimates shall be made of software complexity and a development schedule constructed

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to ensure against the software becoming the pacing item in the program.

3.5.2.12 Special Studies

As the relay system concept is formulated to greater levels of detail, areas for additional analyses and investigation will arise. For example, if the approach is adopted, the solar and lunar disturbances on the orbit must be determined to ensure selection of perigee altitude high enough to prevent the spacecraft orbit from intersecting the earth or a significant amount of atmosphere. Analysis of the link acquisition and tracking problem is another potential area of study to which an existing analog simulation technique can be applied.

3.5.3 Task Output

A report shall be prepared which shall include the results of the analyses and investigations conducted in the following areas:

Definition of Candidate Relay System

Coverage/Degraded Mode Operation

Availability Studies

Transponder Definition

Relay Spacecraft Configuration

Launch Vehicle Selection

Relay Design Development Costs

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Relay Technology Limitations

Selection of a Preferred Relay

Ephemeris Determination Accuracy

Ephemeris Determination Software Requirements

Special Studies/Analyses

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