Lunar Ultraviolet Telescope Experiment (LUTE) Integrated Program Plan

— Final Report —

7/13/93

S3

purchase order:

H-20750D

prepared by

Ms. Janice F. Smith,
System Studies and Simulation, Inc.

and

Mr. Larry Forrest,
John M. Cockerham & Associates, Inc.

prepared for

LUTE Project Office
Marshall Space Flight Center,
National Aeronautics and Space Administration

Preface

This document is System Studies and Simulation's final report for delivery order H-20750D, "Lunar Ultraviolet Telescope Experiment (LUTE) Integrated Program Plan" performed for the NASA Marshall Space Flight Center (MSFC). The work was performed by Systems Studies and Simulation, Inc. in conjunction with John M. Cockerham & Associates, Inc. (JMCA). All opinions expressed in this report are solely those of the authors and should not necessarily be interpreted as the positions or views of NASA.

Table of Contents

Abbreviations

CCD	Charged Coupled Device
CDR	Critical Design Review
CM	Configuration Management
DIA	Defense Intelligence Agency
DoD	Department of Defense
EO	Electro-Optical
FPA	Focal Plane Array
JMCA	John M. Cockerham & Associates, Inc.
LUTE	Lunar Ultraviolet Telescope Experiment
MSFC	National Aeronautics and Space Administration
NASA	National Aeronautics and Space Administration
OODA	Object Oriented Design with Assemblies
PDR	Preliminary Design Review
QA	Quality Assurance
RTG	Radio-Isotope Thermal Generator
RISNET	Risk Information System and Network Evaluation Technique
S^3	System Studies and Simulation, Inc.
TDD	Threat Definition Documents
TRACE	Total Risk Assessing Cost Estimates
V&V	Validation and Verification

Section 1. Introduction

This final report documents the results of the Lunar Ultraviolet Telescope Experiment (LUTE) Integrated Program Plan development task performed for MSFC. The purpose of this task was to develop an integrated plan of project activities for the LUTE project, and to display the plan as an integrated network that shows the project activities, all critical interfaces, and schedules. The integrated network will provide the project manager with a frame work for strategic planning and risk management throughout the life of the project.

The report is divided into five additional sections. Section 2 describes the task approach and the development of the integrated program plan network. Section 3 presents recommendations for further development of the network and other follow-on activities. Appendix A, a separate document from the final report, incorporates the plots of the integrated network. Appendix B provides a summary of the data obtained in interviews with LUTE technical staff. Appendix C provides suggestions for using hypermeda for LUTE documentation. Finally, Appendix C contains the resumes of the S[3] and JMCA personnel involved in performing the task.

Section 2. Approach and Implementation

   To obtain data for developing the integrated project plan network, interviews were held with the key personnel in all major LUTE technical areas (optics, thermal control, structures, electronics,...). The interviews focused on obtaining information on

- Activities to be performed in a given technical area for all phases of the LUTE project up to LUTE launch,
- Scheduling of the activities, and
- Estimated duration of the activities.

Representative samples of the data obtained during the interviews are presented in Appendix B. The following is a list of the LUTE technical staff who were interviewed to provide the network data:

NASA Personnel	Topic	Telephone Number
Robert McBrayer	Overall Program	(205) 544-1926
Max Nein	Overall Program	(205) 544-0619
John Frazier	Overall Program	(205) 544-1953
Jason Porter	Science Requirements	(205) 544-7607
Tim Baldridge	CCD and Electronics	(205) 544-5314
William Jones	Optics and FPA	(205) 544-3479
Sherry Walker	Thermal Analysis and Control	(205) 544-0501
Reggie Alexander	Thermal Analysis and Control	(205) 544-9289
Paul Luz	Structures	(205) 544-0512
Terrie Rice	Materials and Processes	(205) 544-4549
Connie Carrington	Pointing and Control	(205) 544-4869
Don Williams	Electrical Power - RTG	(205) 544-0491
Harold Blevins	Communications and Data Handling	(205) 544-0492
James Hilliard	Software	(205) 544-3739
Tom Dickson	Lander	(205) 544-0530
Tim Kauffman	Systems Engineering	(205) 544-4079
Keith Robinson	Operations	(205) 544-2054
James McCarter	Mission Planning and Lunar Environment	(205) 544-0536
Mark Gerry	Layouts - Configuration Status	(205) 544-0510
Andrew Prince	Cost Estimation	(205) 544-8360
Edward Trentham	Mission Assurance	(205) 544-0667
Michael Galuska	Safety	(205) 544-3743

As the interviews were conducted, the identified activities were integrated and input into a network modeling tool. The tool used to model the integrated network is a software program called RISNET. The Risk Information System and Network Evaluation Technique (RISNET) is a probabilistic network analyzer which addresses both the cost and schedule uncertainties of a project. It was originally developed to support program management planning activities for weapon system development. RISNET can generate baseline budget estimates for budget preparation, perform "what-if" exercises, sensitivity studies, and Total Risk Assessing Cost Estimates (TRACE). It can also conduct cost and schedule assessments.

RISNET is able to display the network in four different formats: deterministic plot, network logic plot, family of critical paths plot, and Gantt charts. A deterministic plot displays the most probable shape of the network based on the node logic. Furthermore, the deterministic plot may be displayed as a window (time slice) plot or as a zoned plot. A zoned plot is a sorted plot that has each element plotted in its own horizontal area of the plot page without any logic interfaces to other related activities. A network logic plot is a time-phased logic plot in which the node logic, except the and/all rule, is plotted above each node. A family of critical paths plot shows all of the activities determined to be critical during at least one iteration of the probabilistic simulation.

After sets of interviews were conducted, the resulting data was incorporated into the network for interim review and comment by the LUTE Team for the next iteration of the network. As of the end of the delivery order, the network consists of a series of high level activities which represent a level-of-effort expenditure of resources. While this is a good beginning, the network does not yet have sufficient detail to be useful as a strategic planning model. The goal is to evolve the network to the point where the project managers can use it for their strategic planning and have a high degree of confidence in its predictive accuracy. Graphics depicting the final state of the network are presented in Appendix A which is contained in a separate volume[1].

---

1 The extremely large size of the integrated network charts prohibit them from being incorporated into this volume of the final report.

Section 3. Recommendations

As previously stated, in order to make the network useful as a strategic planning tool and accurate predictor, it must be evolved further. S^3 recommends that when Phase B of LUTE starts, and the project team is assembled, interviews be conducted with key people in each element of the project in order to gather detailed information about their activities in the project. This detailed information should reveal decision points within the project elements and interactions between the elements. There are specific areas of the project for which there is little or no information. These areas are testing, materials and processes, software validation and verification, fabrication, failure modes, procurement, data management, and project control. Extra attention should be given to acquiring this data during the interview process. Once a sufficient level of detail has been reached, then uncertainties and statistical distributions to durations and costs of each activity can be assigned, and a statistical analysis of the network performed. It is this analysis of the network that gives the project managers the data they need to assess project risks and plan accordingly.

As shown in the personnel profiles in Appendix D, the S^3 Team has the necessary skills and experience to successfully extend the current effort and support future requirements throughout the LUTE development cycle. Additional areas where the S^3 Team could contribute to the LUTE program include:

- Software V&V — As illustrated in the network (see Appendix A), the software V&V activities for LUTE are currently under-defined. The S^3 Team has extensive experience in both structuring software V&V and in performing the V&V. The Team is well suited to assist NASA in this key technology area.
- Specialized Documentation — Conventional hard copy methods of documentation are currently planned for use on the LUTE program. New hypermedia documentation systems and strategies are available which could greatly enhance the usefulness of LUTE documents (see Appendix C). The S^3 Team is familiar with these new documentation forms and could assist the LUTE Project in developing one or more of its documents in a hypermedia format as part of a NASA trial program.
- Technology Transfer — The Department of Defense (DoD) has many sensor, signal and data processing, and communications technology programs which could potentially provide development time and cost savings to LUTE. The S^3 Team has extensive experience and contacts within the DoD technical community and could act as an interface for MSFC to help identify and assess relevant technologies for possible injection into the LUTE program.

The combination of the S^3 Team's interest in and its dedication to the LUTE program will help insure the development of quality products that will enhance the future development effort.

APPENDICES

Appendix A   LUTE Integrated Project Management Network

The LUTE Integrated Project Management Network was provided to the NASA LUTE Project Office as a stand-alone document.

Appendix B   Transcripts of Selected Interviews

The following are representative samples of data obtained during the interviews held with the LUTE program technical staff. This data along with the data from the other interviews was used to develop the integrated project planning network contained in Appendix A.

Date: 6/15/92

Interviewee: Bill Jones   Topic: Optics and FPA

During first year (up to PDR)
- Perform detailed analyses of optics and FPA design
- Analyze telescope design's off-axis light rejection
- Possibly perform testing on sample mirrors - test optical quality figures after thermal cycling.

During the second year (up to CDR)
- Perform tests and experiments to assure that the design is valid
- Develop hardware for test purposes.

Date: 6/29/92

Interviewee: Paul Luz   Topic: Structures

During Phase A,
- Develop level 1 requirements
- Develop preliminary mirror support tree design

In Phase B,
- Refine designs of mirror mounts supports
- Update mirror finite element model and mirror mount designs
- Perform baseplate design trades and update design
- Update Lander interface loads analysis and update/finalize design
- Finalize telescope baffles designs
- Analyze antenna support structure

- Perform detailed analyses of launching and landing loads (early Phase B)
- Revisit and refine electronics support structure design
- Perform light shape trade studies to maximize stiffness/minimize mass and design light shape support structure.

Perform detailed stress analyses after PRR

Date: 6/29/92

Interviewee: Tim Kauffman   Topic: Systems Engineering

During Phase A
- Develop level 1 requirements
- Begin developing level 2 requirements including separate Lander and Telescope documents.

During Phase B
- Refine level 2 requirements and have ready by PRR.
- Complete Interface Documents for PRR.
- Develop Safety, Contamination, and Verification Plans
- Check with Mark Gerry on configuration design activities.
- Complete Preliminary Mass Properties Report by PDR.

System Integration is performed after Integration Readiness review. It will include both space and ground systems and will involve use of Interface Control Documents.

Verification Branch performs both hardware and software verification.

Date: 6/29/92

Interviewee: Paul Luz   Topic: Structures

During Phase A
- Develop level 1 requirements
- Develop preliminary mirror support tree design

In Phase B,

- Refine designs of mirror mounts supports
- Update mirror finite element model and mirror mount designs
- Perform baseplate design trades and update design
- Update Lander interface loads analysis and update/finalize design
- Finalize telescope baffles designs
- Analyze antenna support structure
- Perform detailed analyses of launching and landing loads (early Phase B)
- Revisit and refine electronics support structure design
- Perform light shape trade studies to maximize stiffness/minimize mass and design light shape support structure.

Perform detailed stress analyses after PRR

Up to PDR,

- Update structures analyses and match against requirements,
- Analyze mirror coatings,
- Make materials selection, and
- Update mass estimate and structural designs.

Have results of optical system structure trade studies completed by PDR

Between PDR and CDR,

- Develop prototype mirrors, metering structure, and baseplate and perform thermal and stress tests,
- Finalize structural designs

After CDR perform shake tests of telescope and lander both separately and together.

Appendix C   Hypermedia Documentation to Support the LUTE Program

In describing foreign systems in its Threat Definition Documents (TDD), the Defense Intelligence Agency (DIA) faces many of the same tasks and problems as NASA does in developing system interface descriptions, generation breakdowns, and material usage lists for the LUTE hardware. To increase document utility and comprehensiveness, DIA is implementing its TDDs in novel forms which make use of the Object Oriented Design with Assemblies (OODA) system description methodology and hypermedia document formats. DIA's forms for its TDD development has applications to the LUTE program and LUTE documentation.

OODA Methodology

The DIA TDDs provide detailed descriptions of systems using the OODA methodology. This approach graphically decomposes the systems constituent elements and describes the interfaces between the elements. Each element is then decompose into its sub-elements and the associated sub-element interfaces are described. The decomposition process continues until the system's most fundamental components are reached and described. The figure (right) illustrates this decomposition process. The graphical element to sub-element linking in the OODA methodology provides a natural basis for the implementation of a hypermedia document format.
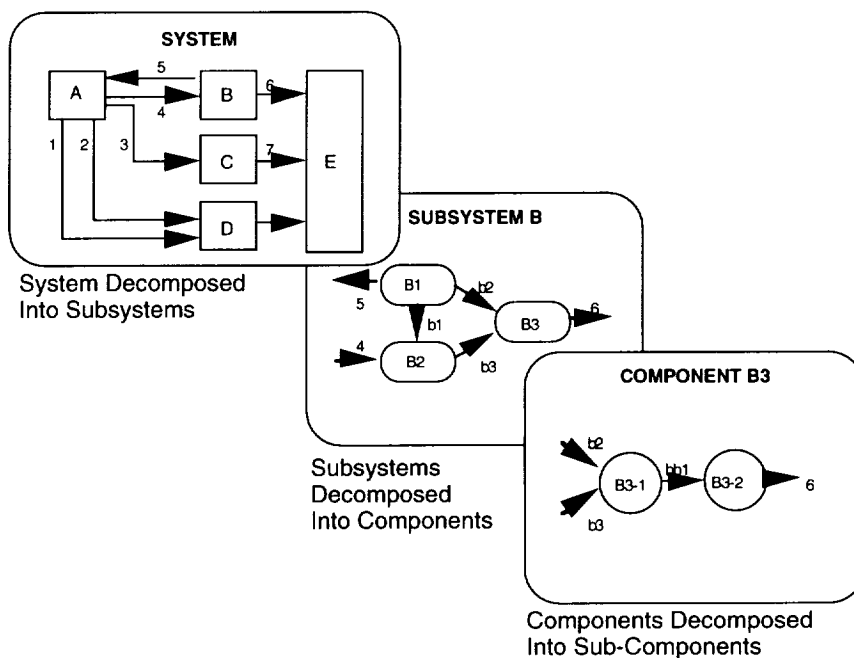

Figure   —   System Decomposition

Hypermedia Documentation

Hypermedia documents are on-line documents that provide navigation through the document using mouse (or keyboard) commands. Regions of the on-line document display are "hot" and linked

(hyperlinked) to other portions of the document. For example, in a hypermedia TDD, clicking on an element in an OODA diagram would open a window showing the portion of the document describing the decomposition of that element. Clicking on an element-to-element connection, would open a window to the document section that describes that particular interface. Text in the document can also have links. (This is referred to as hypertext.) For example, by clicking on a reference number, the reference can be displayed, or by clicking on an acronym, its definition can be shown. This documentation method provides a dynamic means for a reader to rapidly explore and digest the available information.

Generating a hypermedia document is obviously more involved and requires more planning than does the creation of ordinary hardcopy documents. However, as will be shown in the following section, software is available that can produce documents that are dual-form (both hardcopy and hypermedia formats).

Candidate Hypermedia Software

There are many candidate software packages for generating hypermedia documents (*Hypercard, Authorware, Knowledge Management System,...*). However, for multi-platform computing environments, Frame Technology's *FrameMaker* is perhaps the best choice. *FrameMaker* is a highly rated desktop publishing application for creating hardcopy and on-line technical documents (see attached material). *FrameMaker* operates across all major computing platforms (Macintosh, PC/Windows, SGI, HP, Sun, Intergraph, IBM RS/6000, DEC, ...) and its documents are binary-compatible across all supported platforms. (Thus, documents created on a Macintosh can be used on a PC or UNIX workstation.) The *FrameMaker* software package provides integrated tools for document generation, including tools for:

- Page layout,
- Hyperlink creation (for on-line documents),
- Drawing, and

- Word processing,
- Equation editing/solving,
- Graphics importing.

Frame Technology also provides low cost document viewers for

- Reading *FrameMaker* documents on a computer screen,
- Performing document word searches,
- Navigating through the documents using hypertext and graphics hyperlinks, and
- Printing all or selected portions of the documents.

This allows technical document to be easily and inexpensively distributed over NASA local or wide area networks or through e-mail on the INTERNET. The DIA Missile and Space Intelligence

Center is currently using *FrameMaker* for the creation of its hypermedia TDDs.

Summary

Combining a modified form of the OODA description methodology with a hypermedia format potentially provides a powerful means to document and distribute LUTE system specifications. The OODA/hypermedia form allows document users with an easy-to-understand specification structure and with a rapid means of navigating through the data.

Appendix D   Contractor Personnel

The following are the resumes of people from S[3] and JMCA who were involved in performing the task:

NAME: Janice F. Smith

EDUCATION: B.S., Mathematics, Jacksonville State University, 1989

B.S., Education, Jacksonville State University, 1967

EXPERIENCE:

1993 - Present: President, System Studies and Simulation, Inc. — Ms. Smith is project leader for the LUTE Integrated Program Plan development effort.

1990 - 1993:   Executive Vice President, TMI — Ms. Smith supervises the corporate quality management of the software engineering aspects of TMI contracts. These programs include the functional areas of IV&V, CM, QA, software development, simulation modeling, and tools develop. Customers include Army MICOM, USASSDC, TMD, COE, and NASA.

1978 - 1990:   Vice President, Nichols Research Corporation — Ms. Smith provided line management and project direction to a staff of 60 software and systems engineers supporting Army USASSDC and MICOM RDEC and Project Office requirements.

As Director of Computer Services, Ms. Smith conducted long range planning for the acquisition of hardware and software to support technical programs and sustained the operation of the day-to-day computer resources with a staff of 10 system managers, operators and hardware technicians.

She managed a $5.0M contract base in Army Software V&V, Product Assurance, TQM, CM, and Software Development and Maintenance for Army USASSDC and MICOM programs.

1987 - 1990: Ms. Smith was the Program Manager for NRC's Software Engineering Support for Army MICOM Battlefield Automated Systems Engineering sub-contract to TBE. She supported activities in V&V, Software/System and Interoperability Testing, CM, Technology Assessment, and Application Engineering Support for fielded Army systems such as TACMS, PATRIOT, PERSHING, HAWK, STINGER, FOTL, NLOS, LOS-F-H, and FAAD C2I at a maximum LOE of 26.

Prior to 1987:

Ms. Smith was the Program Manager of the Distributed Data Management System (DDMS) for USASSDC. Her tasks included the requirements definition and prototype development of a DDMS to support the BM/C3 functions of the SDI mission.

Ms. Smith was the Program Manager of the Simulation Analysis Systems (SAS) hardware/software integration contract for USASSDC. Her tasks included the Acquisition, Integration, and Acceptance Testing of a seven node Apollo Lan, third party I/O devices, and software.

Ms. Smith was the Program Manager of a contract to assist in the design, implementation, validation and verification of a large nuclear effects simulation code, Nuclear Optical and Radar Systems Effects (NORSE), for the Defense Nuclear Agency. She was the technical leader of the effort to design, develop, and implement an interactive color graphics system to be used with NORSE for diagnostic examination of parameter performance via output data displays for both verification and validation of the system.

Ms. Smith was the Program Manager of software development T&M's to SVERDRUP at AEDC and MDAIS, St. Louis in the areas of graphics, software maintenance, code conversion and data reduction on VAX, CDC, and CRAY CPU's.

Ms. Smith was a Project Leader for the Usassdc Designation Optical Tracker (DOT) Data Reduction and Implications Program. She was responsible for delegation of tasks, timelines, inhouse briefings, and documentation, design of the color graphics software analysis package and supervision of the tasks of data reduction and focal plane decode for multiple missions.

Ms. Smith was a Software Analyst providing programming support to Army BMDATC in optical sensor data analysis. She developed computer codes to perform stellar background discrimination, optical discrimination of targets from aircraft-based sensors, and prediction of the effects of nuclear battle conditions on optical sensors. Her task involved operation of the following large scale simulation codes: OSC, WOE, RANC, CRANC, ROSCOE, and STARCHART.

Under contract to Army MICOM Advanced Concepts Office, Ms. Smith developed a simulation of the performance of a spiraling sensor over user specified scenes utilizing the computer code TRACK.

Modifications were made to create an interactive version of TRACK to evaluate sensor scan patterns and performance in a tactical battlefield environment for tank detection and operation assessment.

1969 - 1978:   Software Engineer, Computer Sciences Corporation — Ms. Smith's responsibilities included validation and verification of a large-scale computer code simulating the search/acquisition/track of the FIREFINDER Radar by Antiradiation Missile (ARM) using the Advanced Continuous Simulation Language (ACSL). Under the Army MICOM program, she analyzed ARM seeker field test data as validation of simulation performance data. Ms. Smith developed a computer code to simulate the circuitry of an optical search, track, and acquisition device for Army BMD, now USASSDC.

1967 - 1969:   Associate Engineer, Boeing — Ms. Smith's responsibilities included SATURN V SIVB stage post flight evaluation and reconstruction of propellant management, propulsion data analysis, and raw data conditioning for NASA.

NAME: Larry Forrest

EDUCATION: B.A., Mathematics, Murray State University, 1969

EXPERIENCE:

1984 - Present: Systems Analyst, JMCA — Developed a networking model used in a risk analysis software product marketed by JMCA. Developed graphics applications for Timeline program management data. Installed and customized an automated contractor performance measurement system in the Information Management Office of the Strategic Defense Command. Designed a pricing and evaluation model for the Electronics System Division, Systems Command, U.S. Air Force, and was the task leader of the follow-on contract. This model was designed to be the vehicle for the submission of the cost portion of a contractors bid proposal. Moreover, it was to be used by both the government and the contractor to exchange data in the contract negotiation phase. Participated in the development of a Management   Information System in the TOW Project Office of the U.S. Army Missile Command. Modified Computer Aided Manufacturing software for the 3M Corporation.   Converted the U.S. Army's PICES cost model for use on a HP 1000. Wrote software that provides an interface between various project management software packages. These

interfaces include the following: Expert to Artemis 7000, and Project Scheduler to Artemis 2000. In addition, I wrote interfaces between JMCA's risk analysis software and two project management packages: ARTEMIS 7000 and OPEN PLAN. Produced software documentation to include requirements specifications, functional specifications, software products specifications, programmer's manuals, and user's manuals.

1982 - 1984:   Programmer/Analyst, Computer Data Systems — Responsible for supervision of computer operations in the HELLFIRE Project Office of the U.S. Army Missile Command. Maintained and enhanced an automated contractor performance measurement system. Designed and developed acquisition management software for use in the project office.

1978 - 1982:   Programmer/Analyst, Revere Copper & Brass — Participated in the development of process control software used in an on-line, real time process control computer system installed in an aluminum smelter. Developed a database for analyzing electrolytic reduction cell construction and operation. Translated German technical reports and blueprints for the Process Control and Development department.

NAME: Donald Hulsey

EDUCATION: B.S., Physics, University of Alabama in Huntsville, 1983

EXPERIENCE:

6/93 - Present: Senior Scientist, System Studies and Simulation, Inc. — Mr. Hulsey ir providing general technical support to the development of the LUTE Integrated Program Plan. For the U.S. Army Space and Strategic Defense Command (USASSDC), he is evaluating the requirements for optical and radar measurements programs to support system-level sensing and discrimination for missile defense.

1/93 - 6/93:   Senior Engineer, Tec-Masters Incorporated (TMI) — Mr. Hulsey providing general technical support to USASSDC for the System Sensing and Discrimination program.

8/85 - 1/93:   Research Scientist, Nichols Research Corporation — For over seven years, Mr. Hulsey worked on numerous studies for DIA Missile and Space Intelligence Center involving

analyses of intelligence issues relating to foreign artillery, SRBM, SAM, and BMD systems and technologies. His technical contributions include engineering analysis, technology assessment, and system modeling. He developed high-level simulations of conventional warhead effectiveness, electro-optical (EO) and radio frequency sensor performance, and multi-spectral optical discrimination effectiveness.

Under a contract with the Air Force Munitions Systems Division, he co-developed sensor modeling algorithms for the Target Scene Generator for hardware-in-the-loop testing of EO seeker electronics.

Under a contract with USASSDC, Mr. Hulsey supported the sensor requirement study for the Airborne Laser Experiment (ALE). He parametrically evaluated the performance of passive and active sensors proposed for the ALE, and developed aircraft operational flight area requirements for various ALE missions.

4/79 - 8/85:   Computer Programmer, REMTECH, Inc. — While at REMTECH, Mr. Hulsey worked as a computer programmer for the aero-thermodynamics group under contracts with the Marshall Space Flight Center. He modified and ran FORTRAN-based computer codes to analyze aeroheating of the Space Shuttle ET and SRBs.

REPORT DOCUMENTATION PAGE

13 Jul 93   Final Report

4. Title

Lunar Ultraviolet Telescope Experiment (LUTE)
Integrated Program Plan

Purchase Order:
H-20750D
803140108
440-89-00-M900-
PP-3-004-000-2511
$9,986.

6. Author(s)

Jan Smith, Compiler

7. Performing

System Studies & Simulation
4717 University Drive, Bldg 100, Ste 100
Huntsville, AL 35816

5307-00-9307-F

9. Sponsoring

NASA/MSFC
LUTE Project
TPOC: Robert McBrayer
CO: CC Mitchell/Kim Adams

11. Supplementary Notes

12a. Distribution

13. Abstract (Maximum 200 words)

The report contains a detailed LUTE program plan representing
major decisions and tasks leading to those decisions for
program execution.

14. Subject Terms

19

17. Security Classification
   Of Report

 UNCLASSIFIED   UNCLASSIFIED   UNCLASSIFIED

NSN 7540-01