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DATA ITEM DESCRIPTION	
1. TITLE **OPERATIONAL CONCEPT DESCRIPTION (OCD)**	**2. Identification Number** PPA-000950-16 20 March 2018

3. DESCRIPTION/PURPOSE

3.1 The Operational Concept Description (OCD) is a system-centric description, for a system, subsystem, HWCI, CSCI, component or other item, herein referred to generically as "the system", of who the users of the system are and their relevant characteristics, what are their intended uses of the system, how and where the system is intended to be used, and a representative set of scenarios of use. These scenarios, each associated with a particular intended use (mission), are chosen to represent both typical and limit conditions of use. The OCD also describes the expected external conditions during use. Other names for an OCD are CONUSE, OpsCon and Statement of Operating Intent. In addition, a CONEMP is a limited form of OCD.

3.2 The OCD is used as a vehicle for achieving a comprehensive and shared understanding of the information listed above between the system sponsor, users, operators, maintainers, acquirers, requirements analysts, designers, constructors and testers, as a basis for validation of the system requirements, system design, subsystems and the system. Throughout this DID, the term "system" may be interpreted to mean "segment", "subsystem", "element", "HWCI", CSCI component or other item, as applicable, that is the subject of the OCD.

4. APPLICATION/INTERRELATIONSHIP

4.1 This Data Item Description (DID) may be cited in a System Requirements Specification (SyRS), Statement of Requirement (SOR), Statement of Work (SOW), a Contract Data Requirements List (CDRL), or within a standard invoked by a SyRS or SOW or CDRL.

4.2 The OCD is not a CONOPS (Concept of Operations). The latter describes the intent of an enterprise as to its use of human and technical resources to achieve an enterprise outcome.

4.3 This DID incorporates and adapts some non-copyrighted material contained in a draft Recommended Technical Practice of the American Institute of Aeronautics and Astronautics (AIAA) of the United States of America, titled "Operational Concept Document (OCD) Preparation Guidelines".

5. PREPARATION GUIDELINES

5.1 General Instructions

a. **Automated techniques.** Use of automated techniques is encouraged. The term "document" in this DID means a collection of data regardless of its medium.

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6. SOURCE

5. PREPARATION GUIDELINES (continued)

b. **Alternative presentation styles.** Diagrams, tables, matrices, and other presentation styles are suitable substitutes for text when data required by this DID can be made more readable using these styles.

c. **Title page or identifier.** When data are supplied in the form of a paper document or word processing file, the document should include a title page containing, as applicable: document number; volume number; version/revision indicator; security markings or other restrictions on the handling of the document; date of issue, document title; name, abbreviation, and any other identifier for the system, subsystem, or item to which the document applies; contract number if applicable; CDRL item number if applicable; organization for which the document has been prepared and name and address of the preparing organization. For data supplied in an alternative form, this information should be included on external and internal labels or by equivalent identification methods.

d. **Table of contents.** When data are supplied in the form of a paper document or word processing file, the document should contain a table of contents providing the number, title, and page number of each titled paragraph, figure, table and annex. For data supplied in an alternative form, this information should consist of an internal or external table of contents containing pointers to, or instructions for, accessing, each paragraph, figure, table and annex or their equivalents.

e. **Page numbering/labeling.** When data are supplied in the form of a paper document or word processing file, each page should contain a unique page number and display the document number, including version, volume, and date of issue, as applicable. For data supplied in an alternative form, files, screens, or other entities should be assigned names or numbers in such a way that desired data can be indexed and accessed.

f. **Response to tailoring instructions.** When data are supplied in the form of a paper document, paragraphs that have been tailored out of the DID should result in the corresponding paragraph number and title in the document, followed by "Not applicable" or alternatively, paragraph numbering may be varied to allow for the missing paragraph. For data supplied in an alternative form, the "Not applicable" representation may be incorporated in the table of contents or equivalent.

g. **Multiple paragraphs and subparagraphs.** Any section, paragraph, or subparagraph in this DID may be written as multiple paragraphs or subparagraphs to enhance readability.

h. **Standard data descriptions.** If a data description required by this DID has been published in a standard data element dictionary, reference to an entry in that dictionary is preferred over inclusion in the data item itself.

i. **Declarative style.** Where a non-declarative guidance style is used in this DID ("should") but a declarative style ("shall") is required by the user of the DID, the DID should be tailored accordingly.

j. **Substitution of existing documents.** Other existing documents may be substituted for all or part of the data item if they contain the required data and are invoked in the data item as a part of the data item.

5.2 Acronyms

Acronyms used in this document shall be interpreted as follows:

AIAA	American Institute of Aeronautics and Astronautics
AO	Announcement of Opportunity
CDRL	Contract Data Requirements List
CDS	Command and Data Subsystem
CSCI	Computer Software Configuration Item
DID	Data Item Description
ECCM	Electronic Counter-Countermeasures
HWCI	Hardware Configuration Item
I/O	Input/Output
MOE	Measure of Operational (mission) Effectiveness
OCD	Operational Concept Description
SOR	Statement of Requirement
SOW	Statement of Work
SyRS	System Requirements Specification

5.3 Abbreviations

Abbreviations used in this document shall be interpreted as follows:

CONEMP	Concept of Employment
CONOPS	Concept of Operations
CONUSE	Concept of Use
OpsCon	Operations Concept
SI	International System of Units

5.4 Guidelines in the Preparation of an OCD

5.4.1 Operational Concept Description

5.4.1.1 Purpose of the OCD

The purposes of an OCD are to:

a. serve as a reference for validation of requirements; serve as a reference for validation of design, subsystems and system, i.e. serve as a reference for fitness for intended use;

b. communicate the system characteristics from an end-use perspective;

c. facilitate common understanding of the overall purpose of the system between users (including recipients of the products of the system, where applicable), acquirers, suppliers, implementers, architects, testers and managers;

d. form an overall basis for long-range operations planning and provide guidance for development of subsequent system definition documents such as the system requirements specification, interface requirements specifications, etc.;

e. provide, during and after system requirements analysis, the context within which requirements and goals should be interpreted;

f. provide one or more reference patterns of use for incorporation in those requirements that are use–dependent, such as reliability, availability and useability; and

g. act as a influence in the development of definition of the user organization and mission, from an integrated system/user point of view.

The OCD is an important complementary document to the system requirements specification. The ideal timing for preparation of the OCD is before the system requirements specification.

The use of an Operational Concept Description should not be constrained to only the highest system level; OCDs can and often should be developed for elements at lower levels in a system hierarchy. The OCD is best prepared by or for the users of a system; if this is not done, the OCD should be prepared by the recipient of system requirements in performing a system requirements analysis.

5.4.1.2 Overview of the Role of the OCD

5.4.1.2.1 Definition of "System”

A "system", in the context of this document, is defined as "a collection of hardware, software, people, facilities and procedures, as applicable, organized to accomplish some common objectives". A system may consist of several levels, where each element at each lower level may by this definition itself be considered to be a "system", i.e. a subsystem of a large system may itself possess all of the attributes of a system. For this reason, the OCD may be applied at these levels as well, resulting potentially in multiple OCDs, each relating to a subsystem of a larger system.

5.4.1.2.2 Perspectives of OCD Application

An OCD communicates to system users, suppliers, developers and other stakeholders, in the user's language, the desired interoperation and other characteristics of the system in its environment of use in terms of intended use, by means of:

a. identification of each of the intended users, and their relevant characteristics;

b. identification, for each user, of that user’s intended use(s);

c. description for each user and use of how the system is intended to be used; and

d. description of the conditions external to the system expected during use. These external conditions may be of any nature that is relevant, including natural, man-made, procedural, economic, policy …

To do the above, two different categories of information must be provided. These are:

a. the "usage context", which includes, as applicable:

    (i) use objectives including potentially rationale for these objectives;

    (ii) overall system use philosophies;

    (iii) constraints placed on the system usage by its environment of use;

    (iv) user organizational structures and policies relevant to use of the system, together with related functions, responsibilities, capabilities and interfaces; and

    (v) identification of interoperating systems and related system external interfaces.

b. a user’s operational view. This view comprises both static and dynamic views of use of the proposed system, operating in its environment, with the needed operational characteristics, and within applicable constraints. The OCD provides the rationale behind the proposed system and should contain at least:

    (i) use(s)/mission(s) name or other identifier;

    (ii) description of the operational environment(s) for this use; and

(iii) a representative set and a set representing extremes of operational scenarios (an operational scenario is a dynamic view of the system in operation interacting with users, operators and other things in its environment, again with emphasis on the user's point of view).

The OCD may contain an envelope of system capabilities and constraints (in users' terminology), including measures of effectiveness, their value ranges and their relationships.

The OCD provides a mechanism to trigger questions and raise issues regarding user-related needs and design trade-offs. The OCD can serve in ways that include:

a. acting as a catalyst to stimulate the development of complete, consistent, testable requirements and designs, with emphasis upon those attributes that influence the usefulness of the system to the user;

b. providing input to the development of the subsequent system definition documentation (e.g., system requirements specification, interface requirements specifications, interface control documents, etc.); and

c. providing a foundation for long-range operational planning activities (i.e., staffing, provision of facilities, training, security, safety, logistics, etc.).

The OCD should *not* contain specific implementation or design-dependent constraints unless specific parts required of the system each serve a system end-use purpose.

5.4.1.2.3 Intended Audience

The information in an OCD is intended for communication and fostering of understanding between several key players. These players and the specific uses that each will make of an OCD are listed below:

a. System sponsors. These people use the OCD to capture and communicate their purpose(s) in acquiring or funding a new system or modifying an existing system.

b. System users/operators. These people use the OCD for:

    (i) planning organization and operational aspects, including available resources;

    (ii) determining attributes concerned with human-machine interfaces and interactions, inter and intra-system hardware and software interfaces, components, locations, sequences, functions and requirements; and

    (iii) early definition of user constraints, capabilities, operating procedures, resources, responsibilities and user/system integration, for use by the development community.

c. Requirements and business analysts. These people use the OCD to:

    (i) assist in capturing missing system requirements;

    (ii) aid in validating all system requirements; and

    (iii) communicating within the system requirements specification a context to aid in interpretation of requirements.

d. System developers. These people use the OCD as a framework to:

    (i) aid in interpreting requirements;

    (ii) provide a reference for validation of design;

    (iii) develop understanding of mission objectives and priorities and the rationale behind them, to support design optimization; and

    (iv) determine relationships of the system to relevant user organizational elements within the user organization structure.

e. Maintenance system developers. These people use the OCD for:

(i) planning logistical support aspects, including available resources; and

(ii) development of strategies and policies regarding operational and depot level maintenance levels, operational constraints related to maintenance, accessibility of the system, maximum acceptable downtimes, etc.

f. System constructors. These people use the OCD to provide:

(i) a brief overview of the system context, with emphasis on the objectives and constraints, together with high-level information on operational issues such as logistics, facilities, standards, timelines, end-to-end information flows, etc.;

(ii) an understanding of the rationale behind system objectives; and

(iii) insight into the role of the proposed system with respect to interfacing systems, and the place of the proposed system in the overall environment.

g. Acquirers. These people use the OCD to:

(i) facilitate an understanding of mission objectives, system goals, constraints and external interface agreements;

(ii) form an input to development of system requirements and acceptance criteria; and

(iii) place into proper context the influence of relevant funding and schedule constraints.

h. Testers. These people use the OCD to:

(i) facilitate an understanding of mission objectives and system goals, in order to ensure correct prioritization of test time and focus;

(ii) understand operational strategies, to facilitate appropriate test focus (e.g., effective use of operational sequences and data); and

(iii) understand the operational attributes of external interfaces, to ensure thorough testing of the associated system elements.

i. Management of customer and development organizations. These people use the OCD to:

(i) focus on the system context, with emphasis on mission objectives and system goals, policies and strategies and constraints; and

(ii) facilitate an understanding of the effect of the envisioned system upon the elements and activities external to the system.

5.4.1.2.4 When to Generate an OCD

The best time to generate an OCD is prior to the development of the set of requirements on the system and any subsequent requirements analysis regarding the system. Development of an OCD should begin prior to the commencement of system requirement specification activity, and, in fact, should support this activity.

Systems are normally structured in a hierarchical manner and consist of multiple levels of items within systems. The generation of an OCD should begin during the earliest steps in the conceptual definition of each system at a given level. In this DID, no distinction is intended regarding the hierarchical level of the system and there may be several OCDs on systems at various levels in a system hierarchy. At some level in the hierarchy, the value added by generation of an OCD for each element will not justify the cost. Development of OCDs at this level is not recommended.

5.4.1.2.5 Maintenance of the OCD

Since OCDs are used to aid communications throughout system definition, development and enhancement phases in the life cycle of a system, they should be considered "living documents" and updated as the system use evolves. This updating should be done via a configuration management process, with change approval authority placed at the lowest practical level. For systems expected to be in place for many years after being put into service, and particularly those that are planned to be evolved during their lifetimes, the OCD should be used after initial system deployment to support the development of enhancements or new system capabilities. This practice will enable developers to better understand the operational impacts of proposed modifications. Maintaining the OCD consistent with the current intended use provides a very useful source of information to help familiarize new personnel.

5.4.1.2.6 Application of the OCD

The OCDs greatest value is in supporting the acquisition and development of large, complex, end-use oriented, mixed technology systems, irrespective of application domain and type of acquisition. But OCDs also often add value in much less demanding circumstances.

The Operational Concept Description is considered by Project Performance International to be a very important document in the successful implementation of systems that meet the needs of system users or the market. Development of a set of OCDs and related scenarios at each appropriate level in the system hierarchy should become a planned activity of any development life cycle, with OCDs incorporating scenarios defined as specific life cycle products to be created.

5.4.3 Contents of a Practical OCD

5.4.3.1 Overview

The OCD should be written in a narrative style, describing in user-oriented non-specification-type prose, the way in which the system is envisioned to fit and function within the proposed or expected environment of use. Graphics, functional flow diagrams, timelines, etc., should be used where they will enhance the communication of relevant information.

5.4.3.2 Content of the OCD

In view of the preceding, a good OCD should "tell a story", that is, it should be a narrative, pictorial where appropriate description of the system's intended use. This can be accomplished by describing the *who*, *what*, *where*, *how* and *under what conditions* aspects of system intended use, not necessarily in that order. These are summarized as follows:

Whos: These are the intended users, and their key characteristics relevant to fitness of the system for intended use. They describe the interactions among the various human elements within or associated with the system. The OCD and related scenarios should also identify necessary decisions as to use, and who (title) has authority to make those decisions.

Whats: These are what the system is to be used for, the intended uses.

Wheres: These are the environments (geographical and physical locations of use, interfacing systems, etc.), in which the system is to be used.

Hows: These tie together the above elements to describe how the system is expected or intended to be used, for the intended use(s), in the given environment(s), under all significantly different conditions of use, for representative scenarios of use.

The description must identify actions to be performed *by* the system in relation to actions performed *on* the system, by users, operators and interfacing systems, at a conceptual level of detail. Such descriptions should include sequences, concurrencies, workloads, duty cycles, states, modes and other time/sequence-related aspects necessary to describe the intended uses sufficient to provide a reference for fitness for intended use.

The emphasis should be on "black box" concepts of use; any system design or implementation content not integral to the intended use should be avoided.

Under what conditions: These are the significant conditions during which actions are performed *on* the system, and the significant external conditions during which actions are to be performed *by* the system.

5.4.4 Preparation Guidelines

5.4.4.1 Goals

Two primary goals in the preparation of an operational concept description are:

a. to provide a vehicle which effectively stimulates information exchange on major use and programmatic issues among the stakeholders in the system in order to facilitate a clear understanding of the system context and the users' view of intended use; and

b. to generate a document which can be utilized by all stakeholder members of the OCD "audience" as described in Section 5.2.1.2.3 above.

5.4.4.2 Formulation Process

5.4.4.2.1 Introduction to Formulation

While not a part of generating an OCD per se, it may be necessary to convince the appropriate management and technical personnel of the benefits of such an activity. This process is beyond the scope of this document. However, if schedule, staff and budget are not specifically allocated for development of OCDs, for systems and subsystems, and OCDs are not listed among the development work products, chances are high that this "sales" step will be necessary before the work described below can be accomplished.

The content and format of an OCD should be defined and understood by all participants. In this guideline, Section 5.3 describes one recommended content for an OCD. However, other formats may be appropriate or, in some cases, imposed.

5.4.4.2.2 Participants

A key element in any major systems development endeavor should be the establishment of an interdisciplinary team for development of the OCD. Sometimes the content of an OCD will be captured and validated within a requirements analysis that also produces the corresponding system requirements specification. The team may be led by a senior user representative or senior engineer or business analyst and should be comprised of personnel competent in all of the disciplines relevant to the system context. These competencies may be operational, technical, requirements/OCD process, or almost always, a mixture of the three.

If the development of the OCD is to convey valid information to and from stakeholders such as users, system engineers/architects, system implementers, testers, customers/buyers and customer and contractor managers, then representatives from each of these communities should actively contribute to the OCD. The users should be providing the *who*, *what*, *where*, *how* and *under what conditions* content of the OCD, facilitated by other team members. All categories of user disciplines should be represented. The system engineers/architects, system implementers and testers should provide any necessary bridge between what the users envisage and what technology is capable of.

5.4.4.2.3 Capturing OCD Content

5.4.4.2.3.1 Overview

The first step in creating an OCD is to establish a clear definition of the boundaries of the system, defining specifically the border between what is inside the system and what is outside of it, thus establishing the external interfaces. Once these are established, other constraints, including enterprise policies, operational strategies, and negotiated changes to existing interfacing elements, outside of the system context but necessary for the proposed system to interface and be usable as envisioned, can be identified. These, coupled with the end-use objectives, allow the OCD developer to begin to capture and record the operational concepts. Of course, the available budget and schedule will also influence the extent to which this work may be accomplished. The following sections overview steps that may be used to capture the content material of an OCD. Requirements/business analysts provide the skills to express and organize the information into an effective OCD, if these skills are not possessed sufficiently by the users.

5.4.4.2.3.2 Defining Useful Operational Scenarios

The key to a successful OCD is the development of "Operational Scenarios". These describe the dynamic views of the system's operation, primarily from the users' points of view. It is this articulation of how the system is to be acted upon and is intended to respond through (potentially) various states and modes, for a given use and given scenario of use, that provides an important framework for the validation of system requirements.

A useful scenario is one that describes how a system is to be used during a specific time, use (mission) phase, operational mode, critical sequence of activities, etc., within a defined environment, under a defined set of circumstances. It enables one to establish the *who*, *what*, *where*, *how* and *under what conditions* for the system. For example, a scenario in which the system operates under extreme conditions, such as in fine, wind driven dust, or being required to process the highest input data rates while staffed with the lowest expected personnel levels, provides insight into important system requirements. Attributes such as human-machine interface bottlenecks which could result in an overall system failure if the conditions persist for more than just a few minutes, could be uncovered by walking through such a scenario. In another example, a system constraint limiting pointing of a radar emitter within some number of degrees of a building, which appears to be adequately met via rigorous operational procedures, could be found to be violated when normal communications are interrupted by a failure mode which limits the pointing control capability. This type of interaction would be uncovered by analysis of carefully selected operational scenarios.

Typically, a set of scenarios will be necessary. Each should focus upon a specific area of interest or concern and not attempt to cover all aspects at once. Commonly the scenarios will be embedded within an overall integrated problem domain functional model having a life cycle basis. The scenarios should be selected such that the complete set contains scenarios dealing with all phases of operations including, as applicable, deployment, start up, typical examples of normal and contingency operations, shutdown, etc. Operations under typical and "stressful" conditions (e.g., most stressful physical environments, maximum I/O rates and loads, minimum personnel staffing, element failure modes, etc.), should be emphasized. One should begin with a typical, normal system operational scenario and later develop those scenarios which focus on "stressed" conditions and operations in the presence of system element faults. The primary focus should be upon the user's view of the system, but with some scenarios possibly devoted to the views of other stakeholders such as deliverers, installers, maintainers and disposers. If the system operation includes decision points where operators or users must choose a course of action within some limited timeframe, a set of scenarios should be included which covers these interactions, particularly those under which there is stress on the personnel.

5.4.4.2.3.3 Developing the Scenarios

Developing the scenarios is a matter of combining the topics listed above, that is, assembling an interdisciplinary team with the right set of expertise, defining a good set of scenarios, walking through each scenario step-by-step and recording the results. The following sections describe how to develop these scenarios.

Many scenarios may be needed. There will normally fall out of life cycle-based functional modeling. If scenarios are being developed in isolation, initially, one that is typical of normal expected use of the system under normal environmental conditions forms a good baseline. Identifying this scenario may not be a simple task since there may be many opinions regarding these seemingly obvious things. To begin, conduct a series of interviews with or presentations by the people who can authoritatively define what normal use is expected to be. Upon defining the normal scenarios, create additional scenarios which focus on specific aspects of interaction, e.g., system operations near boundary conditions, under peak loads or worst case conditions, operations in the presence of failures or degraded system capabilities, etc.

A list of topics that prompts the presenter will be helpful to ensure that all necessary aspects are addressed. This list will vary with the type of system but a good start would be:

a. Overview:
   (i) summary of where the system is (context), what it is to be used for and how it will be used.
b. Sequence:
   (i) functional flows;
   (ii) mode transitions; and
   (iii) decision points (particularly human interactions).
c. Performance and similar parameters:
   (i) response time;
   (ii) delay points/times;
   (iii) throughput/turnaround times expected; and
   (iv) reliability, availability, maintainability.
d. Organizational issues:
   (i) user types, technical expertise, etc.;
   (ii) user training constraints; and
   (iii) user/operator responsibilities and decision authority.
e. System environment and existing facilities:
   (i) environment in which system must operate;
   (ii) geographical issues;
   (ii) safety, security, system integrity needs; and
   (iv) description interfacing systems and related data flows.

5.4.4.2.3.4 Determining Logical Functional Flows

Once a relatively complete set of data is available, the interdisciplinary team can begin to determine the functional flow of activities necessary for the system to execute a set of normal operations. From the interviews or presentations, it should be possible to define a sequence of actions over a period of time that represents some generally complete aspect of use of the system that once commenced, tends to run to some end. For example, in the case of an aircraft that performs a weapons delivery mission, a typical operational scenario would be:

a. mission planning;
b. mission briefing;
c. ground preparation;
d. take-off;

e. cruise to target area;

f. typical weapons delivery and defensive maneuvers, including, for example, ECCM activities;

g. cruise to base;

h. land;

i. assessment of mission effectiveness; and

j. mission debriefing.

Having selected a use case and scenario, the team should then iteratively "walk through" all of the steps the envisioned system and related humans and external systems must execute in the scenario. This may take some time, because states, mode transition steps, etc., may not be clearly defined or understood by all team members. There may, in fact, be significant disagreements regarding these definitions. A major purpose here is to come to agreement and record clearly these definitions and descriptions. An example of scenario development is provided in Annex A to this DID.

5.4.4.2.3.5 Validating the Scenarios

Validation of the scenarios is accomplished by performing scenario walkthroughs in accordance with any governing policies and procedures. The scenario walkthrough examines the sequence of events, extremes of environment and inputs and the resultant exercising of system functions and responses. The user and OCD development communities must provide the evaluations required to validate the scenarios.

5.4.4.2.3.6 Relationship to the Use Study

Some of the data for the OCD may have been developed from a Use Study, performed as a Logistics Support Analysis task. MIL-STD-1388-1A, now cancelled, defines the Use Study.

5.5 Content Requirements

Content requirements begin on page 13. The numbers shown designate the paragraph numbers to be used in the document. Each such number is understood to have a prefix “5.5” within this DID. For example, the paragraph numbered 1.1 is understood to be paragraph 5.5.1.1 within this DID.

TABLE OF CONTENTS

1. INTRODUCTION AND SCOPE

This section should be divided into the following paragraphs.

1.1 Identification

This paragraph should contain a full identification of the system to which the OCD applies, including, as applicable, identification number(s), title(s), abbreviation(s), version number(s) and release number(s). Where the system to which the document applies includes variants of the system, the above information should be provided for each variant. Where the system to which the document applies includes incremental builds of the system that are subject to individual specification, the above information should be provided for each such build which is the subject of the OCD.

1.2 Document Overview and Use

This paragraph should summarize the purpose (including intended audience) and contents of the OCD and should describe any security or privacy considerations associated with its use.

1.3 System Purpose

This paragraph should briefly state the nature and purpose of the system to which the OCD applies.

1.4 Background (optional)

This paragraph, if used, may provide any relevant background such as relationship to existing systems and current or future projects.

2. REFERENCED DOCUMENTS

This section should list the number, title, revision, and date of each document referenced in the OCD. This section should also identify the source of each document not available through normal channels. If OCD content is invoked by reference to other documents, this section should be renamed "APPLICABLE AND OTHER REFERENCED DOCUMENTS" and sub-paragraphed accordingly.

3. DEFINITIONS, ACRONYMS AND ABBREVIATIONS

This section should be divided into the following paragraphs.

3.1 Definitions

This paragraph should list alphabetically and define each word or term used in subsequent sections for which reliance on dictionary definitions is not appropriate. As a guide, terms which are not likely to be in the vocabulary of the intended users of the OCD, terms which have multiple dictionary meanings but only a single OCD meaning, technical terms and terms which are used with special meanings should be defined in this paragraph.

3.2 Acronyms

This section should list alphabetically each acronym used in the document, together with the acronym's expanded meaning.

3.3 Abbreviations

This section should list alphabetically each abbreviation used in the document, together with the abbreviation's expanded meaning, except that abbreviations within the International System (SI) system of units should not be listed.

4. DESCRIPTION OF INTENDED USE

This section should be written from an operations point of view, describing the users, uses and operations as they are intended to be carried out, in order to provide a clear reference for intended use.

This section includes:

a. personnel organization, activities and interactions that describe *who* the users are and *what* the users do in accomplishing the mission;

b. identification and characterization of external non-human systems with which the system will interface and inter-operate;

c. operational strategies, tactics, policies and constraints that describe *how* the existing mission is accomplished;

d. operational processes that provide a process model describing *when* and in *what* order operations take place, including such things as dependencies and concurrencies; and

e. information on the expected conditions external to the system during use.

The information may be organized in any way that is effective in the circumstances. Where there are multiple users, uses, and environments of use, a matrix structure may be appropriate. Sections defined below are not intended to constrain how this section is structured.

4.1 Users

4.1.1 Identification of users

This section should identify and describe the intended users (beneficiaries of use) of the system, and operators of the system on behalf of users, in terms of organizations and, where applicable, individuals.

4.1.2 Organizational Structure

This subsection should identify and describe the organizational structure(s) of the personnel. It should state the charter of each organizational element involved in use and describe any reporting relationships.

4.1.3 External Systems

This subsection should identify and characterize the external non-human systems with which the system will inter-operate, if any. The role of each interfacing external system should be described.

4.1.4 System Context (optional)

This subsection, if used, may show graphically the things with which the system will interface and interact. The level of detail should be conceptual, and humans should be shown in relation to their roles.

4.2 Personnel

4.2.1 Types of Personnel

This subsection should identify and characterize the various types of personnel external to the system involved in the use and operation of the system. Types of personnel may align directly with roles, or may involve combined roles, as applicable.

4.2.2 Personnel Profiles

This subsection, with sub-paragraphing, should describe for each personnel type, the relevant educational, training and experience background and skill levels, together with any relevant physiological and psychological characteristics.

4.2.3 Personnel Interactions

This section should describe the interactions of personnel within the same type and between types, within the organizational boundaries and between organizations, relevant to use of the system. Both formal and informal interactions should be identified.

4.2.5 Personnel Activities

This subsection, with sub-paragraphing, should describe for each personnel type, the various roles that may be assumed as well as the duties and activities performed within each role, in relation to use of the system. The subsection should describe, for each type, relevant workload limitations, limitations on physical presence, and other duties not related to use of the system.

4.3 Use(s) or Mission(s)

This subsection should identify and describe each applicable primary and any secondary uses(s) or mission(s) that the system is intended to address. The subsection should state the overall purpose and intent of each use. It should overview, if applicable, such things as geography of operations, and strategies to be used to accomplish the intended use. It should identify threats to successful use.

This subsection should identify each measure of operational (mission) effectiveness (MOE), if any, together with, for each MOE, the minimum and target values for that measure. This subsection should also describe the relative importance of MOEs in terms of the relative values of improvements of each from minimum to target.

4.4 How the System is to be Used

This subsection should discuss the operational processes used to accomplish the mission. Process models should be provided that illustrate the operational flow and sequence of operations. Processes may be decomposed from higher-level to lower-level processes.

4.4.1 Operational Policies

This subsection should reference the policies and standards, if any, governing the use/mission and describe the effect on use and applicability of the system with respect to those policies and standards.

4.4.2 Operational Constraints

This subsection should list and describe any other operational constraints that govern or limit operations (e.g., personnel availability, acceptable weather, etc.)

4.4.3 Operational Processes

This subsection, through its sub-paragraphs, should describe a model for each use and scenario of use. The process, including its sequence and interrelationships with other processes should be described. Inputs to and outputs from each process should be stated. Methods and techniques employed should be described, as well as traceability to strategies, business rules and doctrine, as applicable.

This section should describe, for each identified operational process, how the system is used in terms of and related to the elements defined above. It should provide typical usage scenarios for each of the operational processes served by the system. Scenarios describe typical detailed sequences of user, system and environment events. Based on the motivations for preparing an OCD, this section is by far the most important and should receive substantial emphasis.

4.4.3.x Use and Scenario

This subsection should provide, for each use process, the scenario(s) of the sequence of user, interfacing external system and system operations. Each scenario should be related to specific users, uses and the system.

Several different types of scenarios should be considered, including those that address normal use/mission modes, natural environments, threat environments, anomaly/exception/operational error handling, mission critical activities, safety critical modes/activities, operational maintenance modes, etc.

4.5 Operational Environments

This subsection should describe any relevant environments within which the system will be used – physical, political, regulatory, procedural, security, social, etc., and relate them to the scenarios.

5. SYSTEM WORKLOAD

This section should describe normal and peak system workloads in terms of, as applicable, multiple simultaneous users and uses, anticipated and as varying over the stated intended economic life of the system, from first use to last use.

6. OTHER STAKEHOLDERS AND THEIR INTERESTS

This section should identify other (i.e. non-user) stakeholders in the system. For each stakeholder, the section should describe their interest in the system and how they intend or are expected to satisfy that interest.

7. SYSTEM EVOLUTION (OPTIONAL)

This section, if applicable, should describe any planned or predicted upgrade of or downgrade to the system, keyed to time and with reference to the intended economic life of the system.

8. SYSTEM REQUIREMENTS OVERVIEW (OPTIONAL)

This section if used should provide an overview of key system requirements and MOEs expressed in user terms and related to use.

The section serves to integrate the detailed system requirements (found in the system requirements specification) with the operational perspective provided by the OCD.

A. ANNEXES

Annexes to the OCD may be used to provide information published separately for convenience in document maintenance or use (e.g., charts, classified data, interface specifications). As applicable, each annex should be referenced in the main body of the document where the data would normally have been provided. Annexes may be bound as separate documents for ease in handling. Annexes should be lettered alphabetically (A, B, etc.).

Appendices may be used to annexes. Appendices should be numbered numerically (1, 2, etc.).

Annex A

1. EXAMPLE SCENARIO DEVELOPMENT

1.1 Overview

The following example shows how engineers and scientists used the operational concept approach and a set of operational scenarios. They were used to support the development of a spacecraft capable of "flying" a group of instruments on an interplanetary mission to collect scientific data about a body in our solar system. The example, based upon an actual situation, is somewhat atypical in that the operational concept activity was initiated much later in the life cycle than is recommended by this technical practice document. It does, however, indicate the benefits of the approach and implies how its earlier application could have helped focus more attention on some important user-related design attributes.

While this example indicates the value of initiating the operational concept work early, it makes the point that even if initiated later than recommended, it can still be a significant benefit to the system development. In this example, the spacecraft system design had been going on for some time before the operational concept work was initiated. The spacecraft system design was based heavily upon that of previous similar missions and the specific science instrument complement for this mission had been selected. This had been accomplished in an atmosphere of severe budget and schedule constraints. Instrument selection was done based upon the data provided in a formal "Announcement of Opportunity" (AO). The AO is an initial high-level description of the type of mission to be flown, including things such as the trajectory from earth to the body, the general approach to encountering the body, and various general assumptions regarding the capabilities of the spacecraft system. Typical of these are the pointing accuracy of the platform on which remote sensing instruments will be mounted, available data transmission bandwidth, capacity of on-board data storage, etc. Since these were all predefined, they had to be considered as constraints. Furthermore, several physical constraints limited the designers in virtually every dimension. The amount of available spacecraft mass, power, volume, computer processing speed, and memory capacity were also predefined. This mission was to be based upon the experience of similar missions. During the pre-project phase, initial operations discussions with scientists, mission operations personnel and spacecraft operators were conducted to establish a basis for initial spacecraft user-related design requirements definition. Since this input was felt to be adequate, a formal operational concept activity was not conducted during the early development phases.

Later in the spacecraft system design phase, as the spacecraft engineers began to firm up the spacecraft system design, the engineers and managers responsible for the mission operations design began to interact more heavily. It then becomes evident that the spacecraft system design had evolved to a point where a more detailed understanding of its operational capabilities and constraints had been gained. From this understanding, it also became clear that some elements of the current design implied potentially significant operational difficulties if implemented in the manner specified.

Consequently, an interdisciplinary team was formed to do operational concept studies to gain more in-depth understanding of the user-oriented aspects of the evolving spacecraft system design. This team searched for potential major problem areas and constraints, which were then further analyzed to determine what solutions could be implemented to ease perceived operational difficulties. The following narrative describes the operational concept study approach, which was taken and indicates the benefits of such an activity.

2. EXAMPLE OPERATIONAL CONCEPT STUDY

2.1 Defined Purpose of the Study

The purpose of this operational concept study was to:

a. describe the current spacecraft system design from several perspectives (e.g., the scientists who want to operate their instruments to collect data, navigation system engineers who determine the spacecraft operations necessary to maneuver the spacecraft to the areas in space where the science data can be obtained, and mission sequence system engineers who coordinate the instrument operations activities with all of the other activities, the spacecraft subsystem engineers who analyze and maintain the spacecraft health and predict the capabilities available to conduct the desired operations [e.g., telecommunications bandwidth, spacecraft power utilization, thermal balance, etc., versus time and operational modes]);

b. describe the intended scientific observations for each instrument necessary to meet the individual and coordinated scientific mission objectives;

c. describe the currently planned process for defining spacecraft sequences of events, generating and validating the spacecraft command sequences necessary to implement those events, and scheduling the facilities to transmit those commands; and

d. describe the currently planned operational teams, interfaces and interactions necessary to coordinate all of the above activities into a feasible, cost-effective mission operations entity.

2.2 Interdisciplinary Team Composition

Given the nature of the mission and system, the interdisciplinary team was composed of engineers and scientists with the range of expertise indicated in Table 2.2-1 below.

This table provides examples of the types of expertise which were deemed to be necessary on the interdisciplinary team for the deep space scientific mission. Indicated, for each type of expertise, are the perspectives (either user or developer) from which that person would participate. In cases where an individual would represent both views, they are listed highest priority first. In addition, an asterisk (*) following an entry indicates a person that is also involved in post-launch support of the mission (maintenance).

System Manager (developer)

Project System Engineer (developer)

Spacecraft System Engineer (developer)

Flight Operations Engineer (user, developer)*

Mission Design Specialist (user, developer)

Science Investigator (user)

Science Data Processing Engineer (user, developer)*

Instrument Designer (developer, user)*

Celestial Navigation Engineer (user, developer)

Guidance & Control Engineer (user, developer)

Information System Engineer (developer, user)*

Software System Engineer (developer, user)*

Deep Space Telecommunications Engineer (developer, user)*

Spacecraft Power System Engineer (developer, user)*

Spacecraft Mechanical, Structural & Thermal Specialist (developer, user)*

System Integration & Test Engineer (developer)

Table 2.2-1 Team Composition

2.3 The Approach

It was a requirement that the interdisciplinary team members participate in all working sessions to ensure that each gained an understanding of the overall context plus the expectations, points of view, biases, etc., of the other members. As a result, a significant amount of clarification of issues was accomplished in real-time at each session, enabling the team to distil the essence of many issues relatively quickly.

The team leader established a series of working sessions to determine the "what", "when", "where", "who", "why" and "how" of the currently planned or expected elements of the end-to-end system (i.e., instrument sensor through spacecraft and ground systems to end user output products) that were perceived to be necessary to accomplish the mission objectives. This was accomplished through the development of various scenarios which are discussed below (note: the following are typical items and are not complete lists):

a. science "scenarios" wherein the operational needs and science data acquisition and handling expectations of the scientists and instrument engineers were established:

   (i) what parameters are involved in typical sensor data collection sequences for your instrument and what is involved in controlling them?

   (ii) what parameters of your instrument require calibrations? How often, what ground-based operations are necessary, etc.?

   (iii) what information do you need prior to determine the values of the above parameters?

   (iv) what are the characteristics of the data received from your instrument during the above operations (e.g., data rate, number of observations mode changes required, etc.)?

   (v) what data from other spacecraft elements are required to support your observation data (e.g., platform position data, spacecraft time, data from other instruments)?

   (vi) How soon after the observations do you need the data, in what form, and what do you do with that data? Particularly, what do you need from the data which influences what you do on subsequent observations?

b. spacecraft engineering "scenarios" wherein a similar set of items were defined by the engineers responsible for the operation of the spacecraft engineering subsystems which support the instruments (e.g., telecommunications, power, guidance and control, command and data handling, etc.):

   (i) what standard sequences must be run on your subsystem during flight for either operational verification or calibration? How often must they be run, what are typical verification activities, how much time is required, what support from other subsystems is required, etc.?

   (ii) what subsystem analyst visibility into your subsystem's operation is required during normal flight operations (low activity and high activity) periods?

   (iii) what is done with the data from a sequence? What form is expected, how soon after execution, etc.?

(iv) what closed-loop or autonomous functions does your subsystem perform or depend upon some other subsystem for?

(v) what role does your subsystem play in navigation maneuver and what data is required for you to prepare for a maneuver?

c. uplink process "scenarios" wherein the above information formed a framework in which the team could discuss the process and activities necessary to define operational sequences, generate and validate the necessary spacecraft command loads, and schedule their transmission and verification were defined next:

(i) how much sequence activity can be incorporated into a single spacecraft commanding session and how often can/should command loads be transmitted to the spacecraft?

(ii) how long is the sequence development and generation process?

(iii) how many sequence loads must be in some form of development concurrently?

(iv) what is the strategy for on-board sequence memory management?

(v) what is the process for validation of a sequence prior to transmission to the spacecraft, how long does it take, what tools are required, etc.?

(vi) what process is needed to review the proposed sequences, who is responsible for the approval, how long does this process take, how many levels of approval are needed, etc.?

d. downlink, process "scenarios" wherein the processes necessary to capture data transmitted by the spacecraft, process it, and route the output products to the end users were then defined:

(i) what types of spacecraft activities require on-line real-time analysis by what levels of analyst expertise?

(ii) how often are each of these expected?

(iii) what is the required minimum time from receipt of each type of data to distribution of processed output to each user?

(iv) what capacity of data storage is required and what safeguards are necessary to maintain data integrity after receipt?

e. spacecraft engineering subsystem and instrument performance analysis "scenarios" were discussed to establish the expectations and needs of analysts to ensure correct flight equipment operation and detect trends. It should be noted here that subsequent team activities are planned to address all of the above scenarios in the presence of flight and ground system anomalies or failures, including analysis of spacecraft autonomous fault tolerance functions:

(i) what data is required and how often to ensure continued, correct operations of all spacecraft elements?

(ii) what tools are necessary to perform this analysis?

(iii) what personnel with levels of expertise are required and what types of working shifts will be necessary?

2.4 Examples of Difficulties Uncovered By This Study

Following are a few representative examples of difficulties uncovered by the above operational concept study. These indicate the value of such an activity and emphasize the importance of performing operational concept development early in the system definition process. It also provides some insight into how operational scenarios can provide a framework upon which to base the analysis. Example difficulties uncovered were:

a. mismatch between available telemetry modes and target body encounter sequencing activities: The design of the spacecraft Command and Data Subsystem (CDS) had proceeded based upon the assumption that the maximum number of different telemetry formats needed during any major time period would not exceed ten. Analysis of the proposed instrument designs and the operational mode changes that would be required for each to acquire the optimum amount of science observations during a typical encounter time period resulted in significantly more mode changes and data rate changes. Because of the design approach already taken, there would be a major incompatibility between science observation needs and the on-board telemetry data mode capability. A spacecraft design team activity was defined to resolve this problem;

b. impact of small power margins on instrument operations: In the vicinity of the target body significant amounts of dust particle debris are expected to be encountered. To protect instrument sensors and optics from impact or becoming coated with dust, covers, which can be closed and opened, are included in the design. Unfortunately, these dust covers and the motors, which drive filter wheels, require a significant amount of power compared to the available power margin. In some spacecraft operational modes, the power margin is so small that many combinations of filter wheel and/or cover operations would require a peak power, which exceeds the available power. This could result in an autonomous response by the spacecraft fault protection system, which would sense this condition as a fault. Thus, the operational concepts discussions brought to light several individual instrument and system-level design and assumption inconsistencies. As above, now that these have been uncovered, they will be worked; and

c. the above item and several other similar issues brought into focus the fact that there had been no "operability" requirements defined or allocated to the instruments. What is needed is a set of system level requirements and constraints allocated to each instrument which relate to the operation of the instrument in the spacecraft system environment and in the mission operational sequencing area. Some examples of the types of requirements which need to be defined are:

    (i) requirements to minimize the interactions necessary from other subsystems or ground operations personnel to initialize the instrument upon application of power. This is due to the fact that, because of limited spacecraft power margins, instruments may be required to be frequently power on and off during some periods;

    (ii) requirements on the structure of command and telemetry messages which enable clear, unambiguous translation from human readable formats into mnemonics and command messages to be transmitted to or received form the instrument; and

    (iii) requirements on the processes needed to calibrate the instrument or modify operational parameters which facilitate simple ground system operational procedures to implement them.

2.5 Summary

While the above example is very specific to a unique and narrow application, it is apparent that the approach described can be applied to the development of any system. The key elements are formulation of the interdisciplinary team with a range of expertise which covers all important aspects of the system; and involvement of these team members in analysis of system operational attributes through the generation of a set of operational scenarios.