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DEFINING THE FUTURE

Operational Concepts

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Abstract

A recognized systems engineering best practice is early development of operational concepts during system development and documentation of those operational concepts in one or more Operational Concept Documents. Recognizing this best practice, United States Department of Defense and NASA standard procedures require that information relating to system operational concepts be prepared in support of the specification and development of systems.   In the past, the DoD has published Data Item Descriptions (DIDs), and NASA has published Data Requirements Documents (DRDs), which describe the format and content of the information to be provided.

The abstract model of the concept of operations is focused on operations, with reference to specific systems only as needed. A definition of "operational concept" has not been found. For the purposes of this presentation, it will be taken to mean an abstract model of the operations of a specific system or group of systems, usually developed as part of the acquisition process and used throughout the design, development, test and evaluation (DDT&E) phases of the system life cycle.
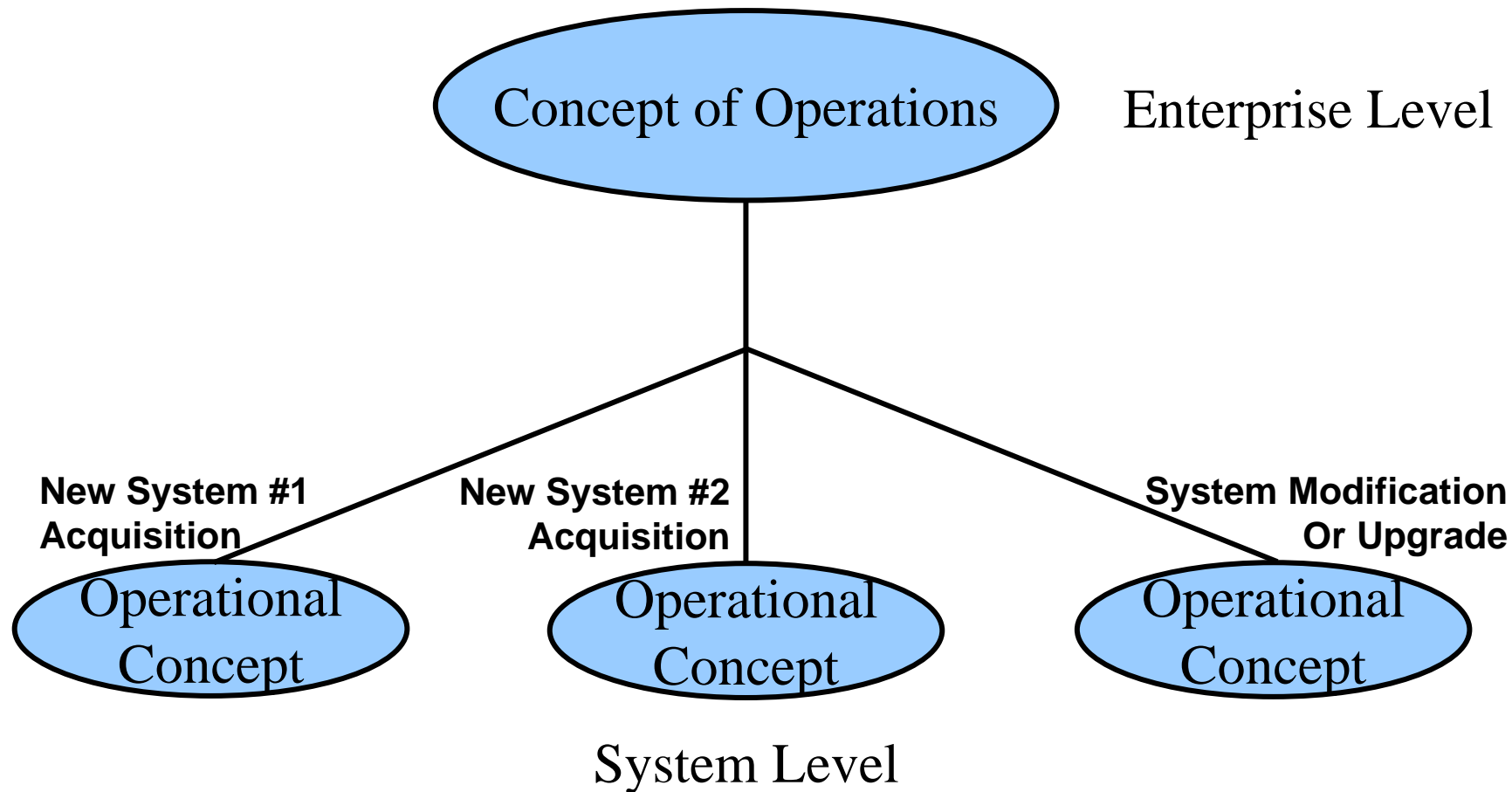
While various Government standards require the generation of operations concept information and Data Item Descriptions (DIDs) are available, little information is typically provided which clearly describes the manner in which an OCD should be used in support of a system development. Few guidelines exist regarding which information is most useful, how to develop that information, which developer and customer personnel should participate, or how to document it have been provided.

This presentation will address the nature of the operations concept, how it is developed and by whom, and how it is used in the development, deployment, operations and support of a new or upgraded system.

Agenda

- What is an OpsCon
- Relationships with Use Cases and DoDAF
- OpsCon Preparation
- Scenarios
- Requirements Definition from the Operational Concept
- Use of the Operational Concept for Validation
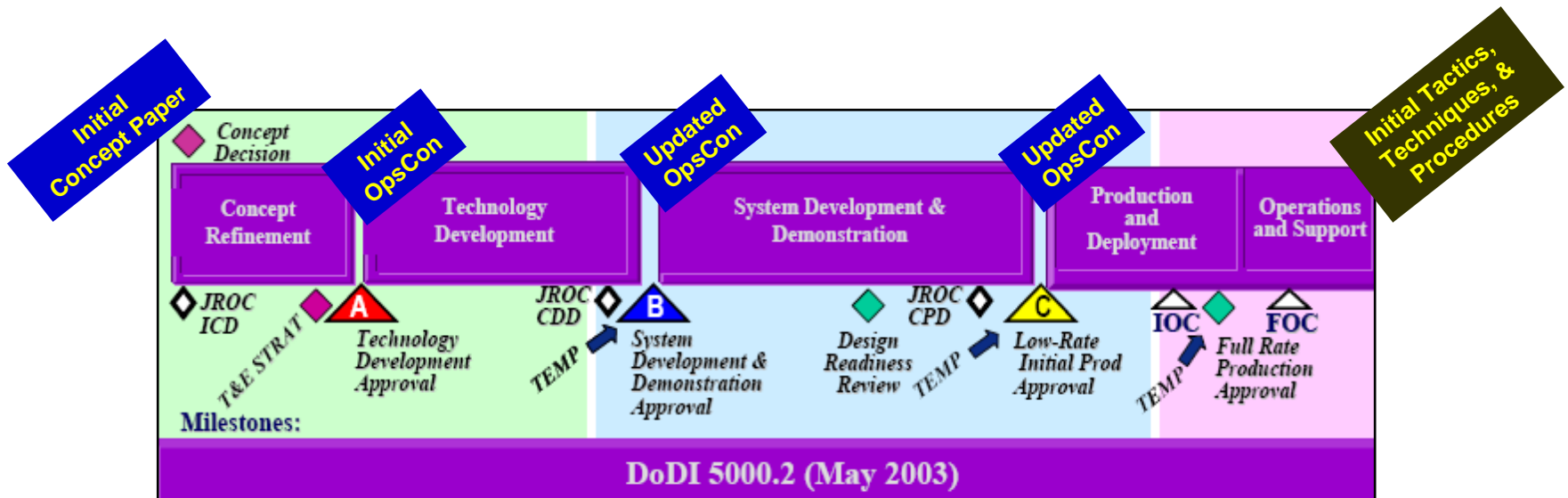- References
- Author Biography

ConOps or OpsCon?

- **Concept of Operations: A verbal and graphic statement, in broad outline, of an enterprise's assumptions or intent in regard to an operation or series of operations. The concept of operations frequently is embodied in long-range strategic plans and annual operational plans. In the latter case, the concept of operations in the plan covers a series of connected operations to be carried out simultaneously or in succession. The concept is designed to give an overall picture of the enterprise operations. It is also called the CONOPS.**
  - (Based on Department of Defense Dictionary of Military and Associated Terms, JP 1-02, 12 April 2001 (as amended through 23 March 2004)
- **Operational Concept: A verbal and graphic statement of an enterprise's assumptions or intent in regard to an operation or series of operations of a system or a related set of systems. The operational concept is frequently developed as part of a system development or acquisition program. The operational concept is designed to give an overall picture of the operations using one or more specific systems, or set of related systems, in the enterprise's operational environment from the users' and operators' perspective. It is also called the OpsCon. It is defined in an Operational Concept Document.**

- **These definitions will be used in this presentation. They are arbitrary – define the terms for your Program at the beginning of the Program and use them consistently.**

ConOps and OpsCon Relationship

Concept of Operations — Enterprise Level

New System #1 Acquisition — Operational Concept

New System #2 Acquisition — Operational Concept

System Modification Or Upgrade — Operational Concept

System Level

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5

OpsCon Life Cycle

Problem description

Pre-Proposal Operational Concept

- •Prepared by customer / users / operators
- •User's / Operator's viewpoint
- •Basis for the selection of MoEs
- •Basis for selection of standards of acceptance

Problem description

Development Operational Concept

- •Prepared by customer / users / operators and developer
- •User's / Operator's viewpoint
- •Describes intended behaviors

Solution description

Production Concept

- •Basis for verification and validation planning
- •Basis for design of End Products and Enabling Products

Deployment Concept

- •Basis for number of units, availability, deployment location decisions

Increasing detail

Support Concept

- •Basis for evaluation for future change requests

Disposal Concept

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OpsCon in the DoD Acquisition Life Cycle

ConOps and OpsCon in Development

```
┌──────────────┐      ┌──────────────┐      ┌──────────────┐
│  Enterprise  │ ───▶ │  Enterprise  │ ───▶ │  Enterprise  │
│   Policies   │      │  Goals and   │      │  Strategies  │
│              │      │  Objectives  │      │              │
└──────────────┘      └──────────────┘      └──────────────┘
                                                    │
                                                    ▼
                          ╭──────────────────────────────╮
                          │    Concept of Operations      │
                          ╰──────────────────────────────╯
                                         │
                                         ▼
                                 ┌──────────────┐
                                 │     Gap      │
                                 │   Analysis   │
                                 └──────────────┘
                                         │
                                         ▼
                                 ┌──────────────┐
                                 │   Mission    │
                                 │    Needs     │
                                 └──────────────┘
```

| New System | Modified or Upgraded System | DOTLPF Changes | No Changes |

╭────────────╮   ╭────────────╮   ╭────────────╮
│ Operational│   │ Operational│   │ Operational│
│ Concept   │   │ Concept   │   │ Concept   │
╰────────────╯   ╰────────────╯   ╰────────────╯
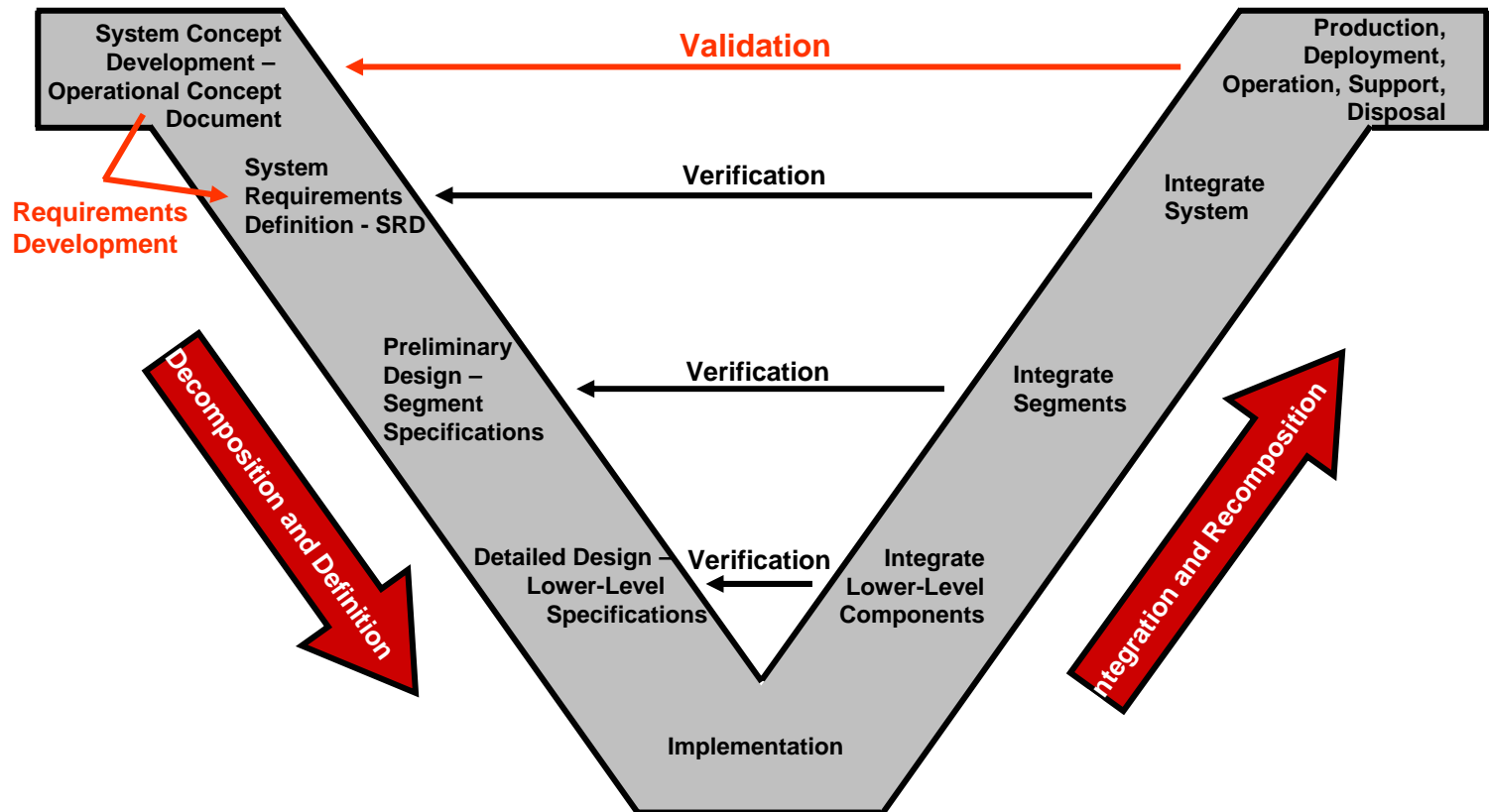
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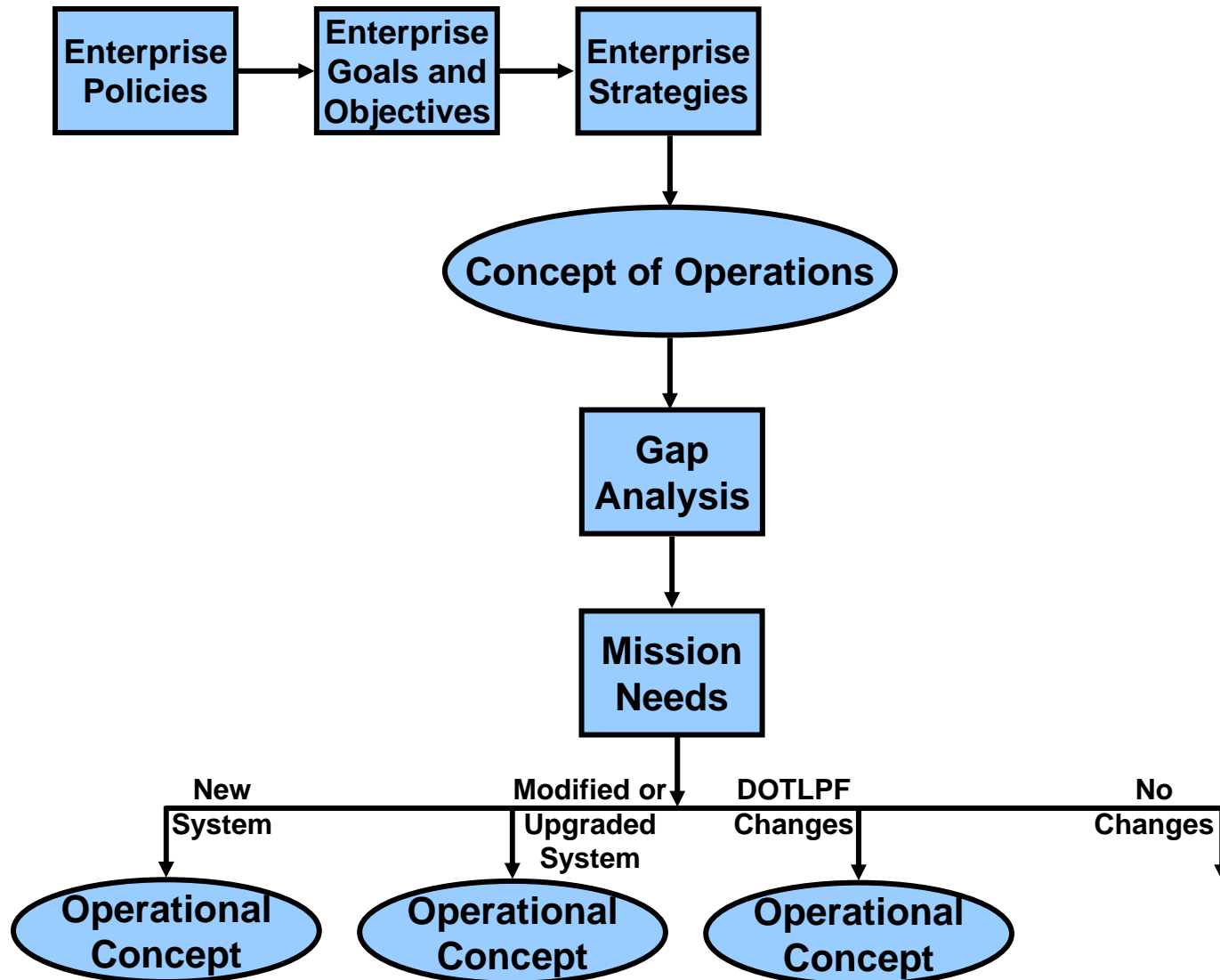
OpsCon Purposes

- **The Operational Concept provides contextual information for the development of the requirements and the system – details of the intended use and benefits of the system.**
- **The Operational Concept provides the basis for the system validation.**

OpsCon and Use Cases

- **The Use Case, part of the Unified Modeling Language (UML), and now part of the System Modeling Language (SysML) as well, is limited in scope relative to an Operational Concept Document (OCD).**
- **Use Case analysis is extremely useful in elicitation of operator, maintainer and user requirements.**
- **The Use Case does not discuss the operational context or environment, for example.**
- **Another valuable feature of Use Cases, which can be included in the OCD, is the Use Case scenario pre- and post-conditions.**
- **The set of Use Case descriptions and the scenarios can be included in the OCD, but they do not form a complete OpsCon**
- **The use of Use Cases in the OpsCon should be carefully considered and balanced with the use of narrative and graphics for the remainder of the OCD. A collection of Use Cases and Scenarios can not, in itself, constitute an OCD.**

OpsCon and DoDAF OV-1

- OV-1, High-Level Operational Concept Graphic
- The High- Level Operational Concept Graphic describes a mission and highlights main operational nodes (see OV-2 definition) and interesting or unique aspects of operations. It provides a description of the interactions between the subject architecture and its environment, and between the architecture and external systems. **A textual description accompanying the graphic is crucial. Graphics alone are not sufficient for capturing the necessary architecture data.**
- The Operational Concept Document, which documents the Operational Concept, is ideal to provide the textual description for the OV-1 Graphic.

Guidance

- **There are two documents that provide guidance in the development of Operational Concepts and their documentation:**
  - **ANSI/AIAA G-043-1992, Guide for the Preparation of Operational Concept Documents, American Institute of Aeronautics and Astronautics, Washington, D.C., January 22, 1993 (being updated)**
  - **FHWA-HOP-07-001, Developing and Using a Concept of Operations in Transportation Management Systems, Federal Highway Administration, August 2005**
    - **Note that the report is actually addressing the Operational Concept as defined on Chart 4**
- **There are two additional documents that provide outlines and a discussion of the contents of an OpsCon**
  - **IEEE Standard 1362, IEEE Guide for Information Technology – System Definition – Concept of Operations Document, 19 March 1998**
  - **ISO 14711:2002(E), Space systems – Unmanned mission operations concepts – Guidelines, 2002**
- **US Government guidance documents are listed in the References.**

Stakeholders

Acquirers

Managers

System Engineers

Users

Operators, Maintainers and Users should be the authors of the OpsCon. In the event that they have not developed an OpsCon, then the developer community should develop it in cooperation with the operators, maintainers and users. It is possible that some stakeholders are not available (e.g., regulators), in which case the authors must work with stakeholder surrogates.
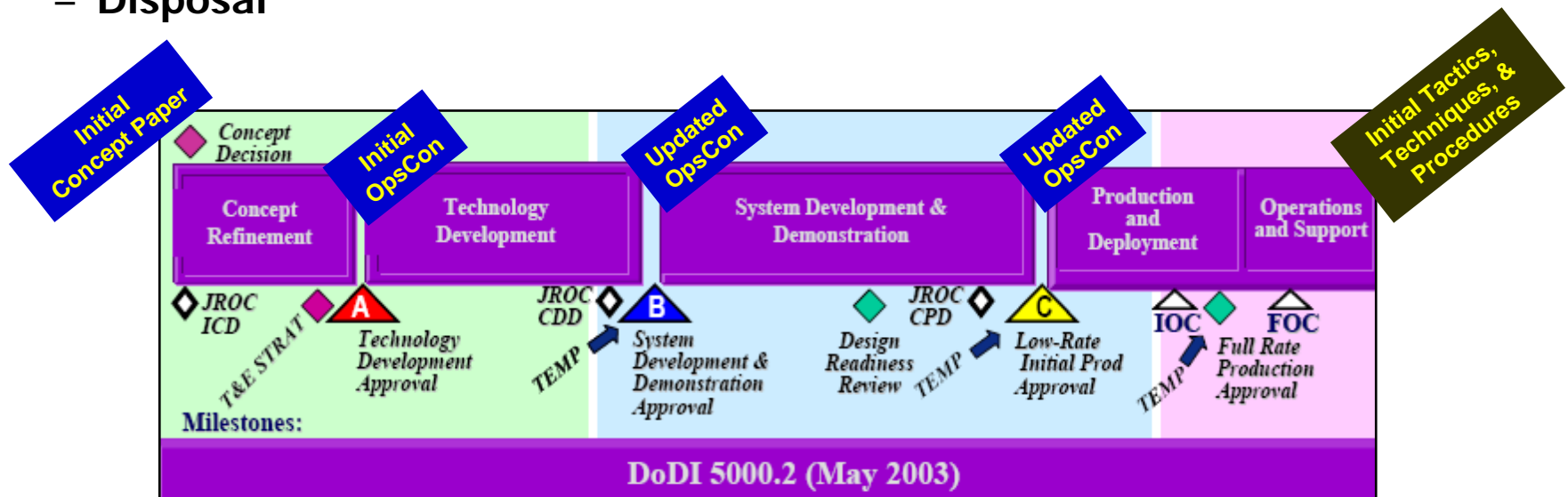
Operators

Designers

Testers

Regulators

Maintainers

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When to Write the OpsCon

- The OpsCon should be written before or during the concept development phase.
- The OpsCon should be updated throughout the product lifecycle, at major milestones, to support the Program phase:
  - **System Development**
  - **Production**
  - **Deployment**
  - **Operations and Support**
  - **Disposal**

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14

Users of the OpsCon

- Operators / Maintainers / Users
- Systems Engineers and Architects
- System Implementers
- Acquirers
- Testers
- Regulators
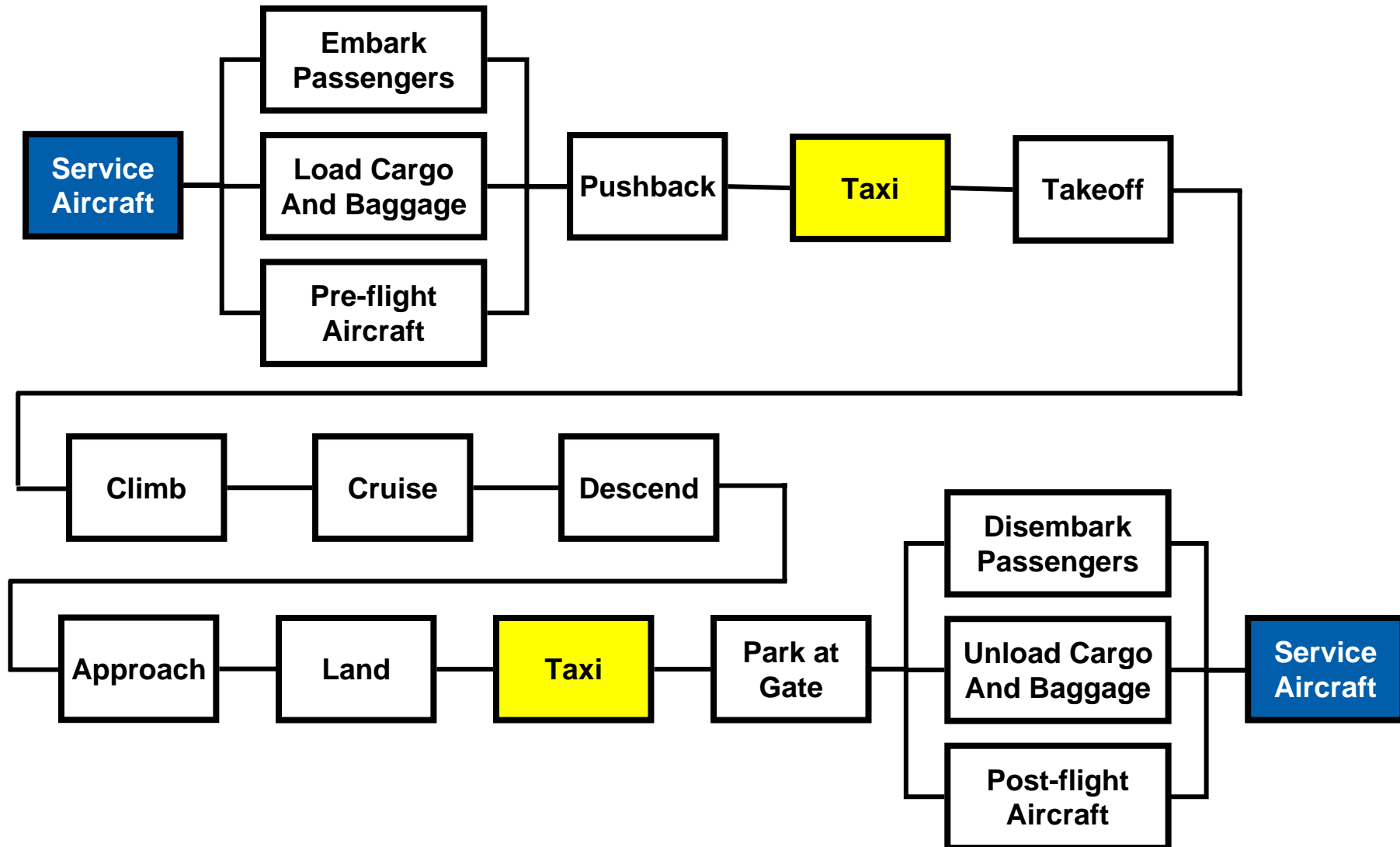- In short, the stakeholders

Types of OpsCon

- Operations Concept - describes the way the system works from the operator's perspective.
- Production Concept - describes the way the system will be manufactured.
- Deployment Concept - describes the way the system will be delivered and installed.
- Support Concept - describes the desired support infrastructure and manpower considerations for maintaining the system after it is deployed. This includes specifying equipment, procedures, facilities and operator training requirements.
- Disposal Concept - describes the way the system will be removed from operation and retired.
  - **Based on the INCOSE Systems Engineering Handbook**

Environments

- The OpsCon describes the various environments in which the system will be deployed, operate and be maintained:
  - **Physical**
    - **Natural**
    - **Induced**
    - **Self-induced**
    - **Threat**
    - **Cooperative**
  - **Political**
  - **Social**
  - **Economic**
  - **etc**

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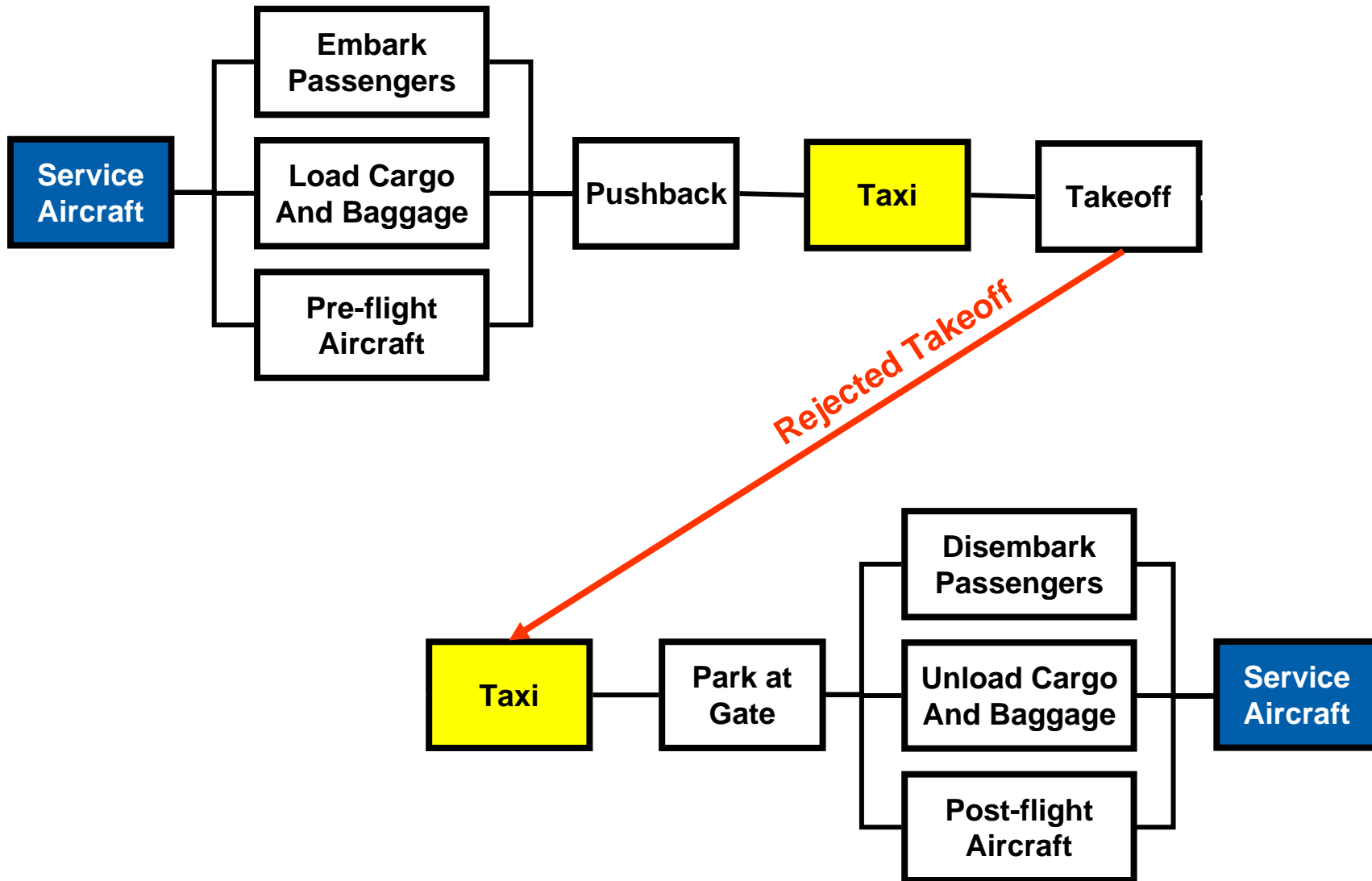
Contents

- 1.   Scope
- 2.   Referenced Documents
- 3.   Background Information
- 4.   Existing Systems and Operations
- 5.   Operational Overview
- 6.   System Overview
- 7.   Operational Processes
- 8.   Other Operational Needs
- 9.   Analysis of the Proposed System
- Appendix A: Acronyms, Abbreviations and Glossary
- Appendix B: System Operational Scenarios

Scenarios

- Scenarios consist of both a textual and graphical description of a single end-to-end thread of operation of the system
- Need to have the major, critical, normal operational scenarios ("happy day") described
- Need to have the important off-design or degraded-mode operational scenarios described as well ("rainy day")
- Some examples of the graphical representation follow
  - **Typically, would use Functional Flow Block Diagrams, Enhanced Functional Flow Block Diagrams, Activity Diagrams or Sequence Diagrams**
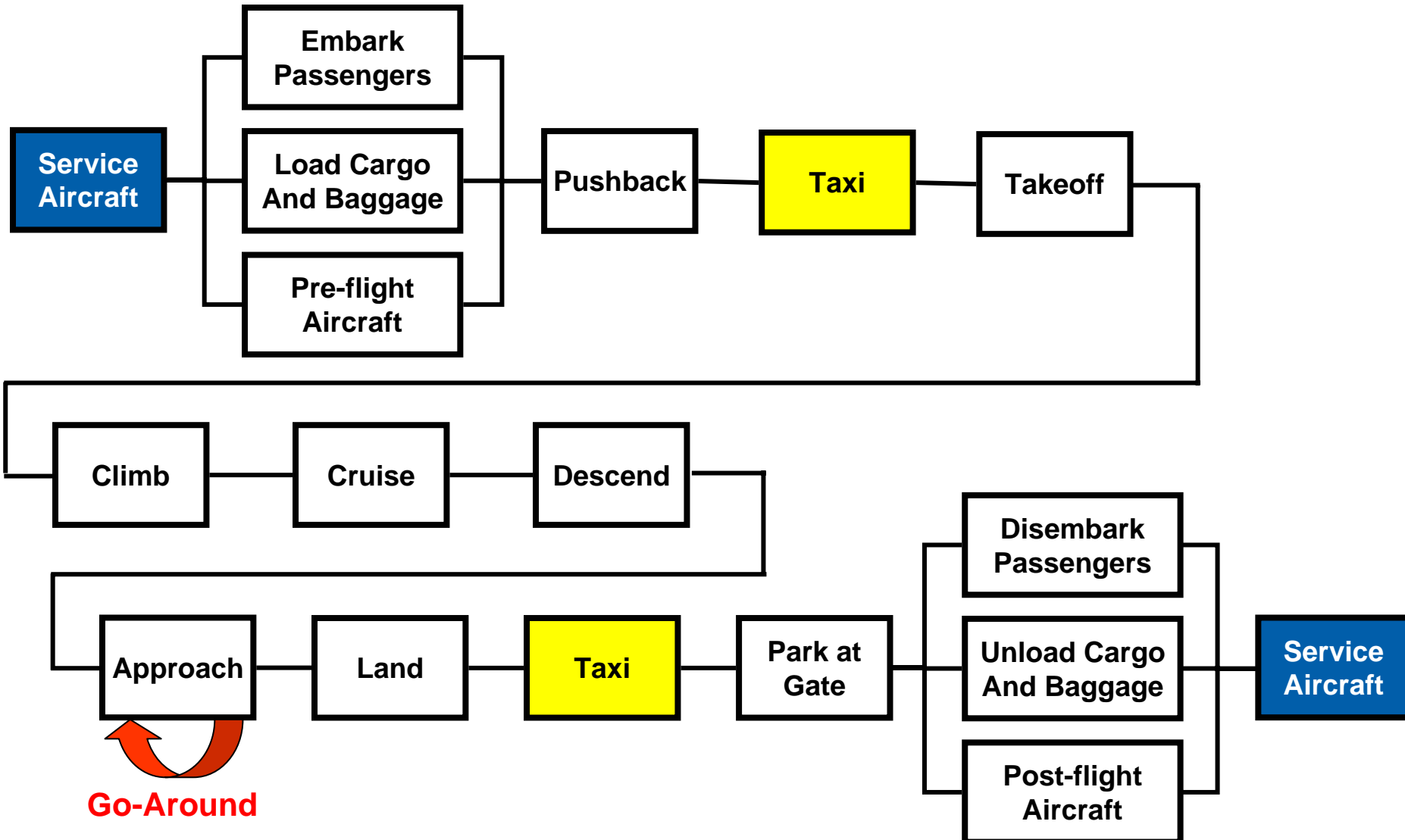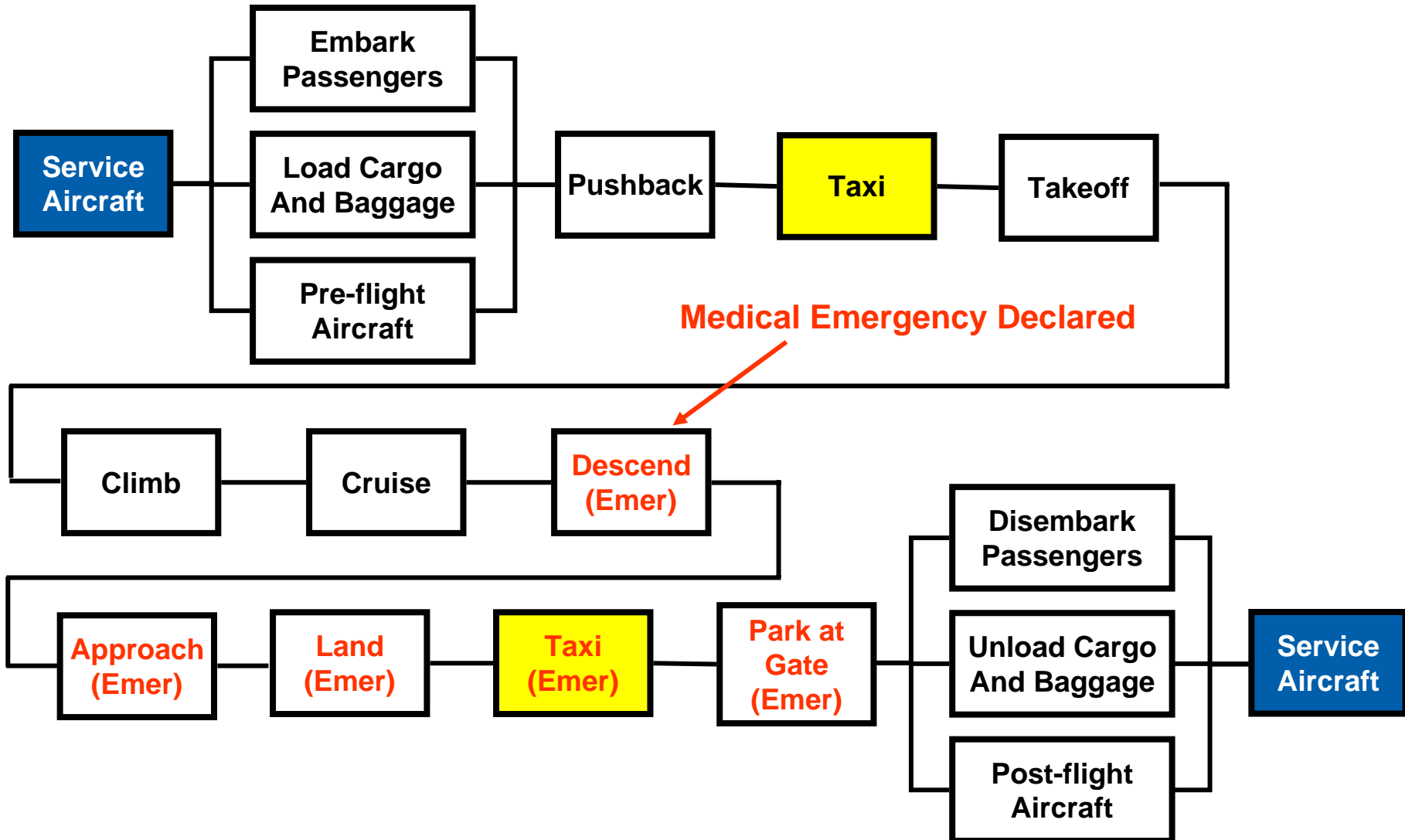 - **Have used a non-standard notation for simplicity**

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Example Scenario – "Happy Day"

Example Scenario – "Rainy Day 1"

```
                    ┌──────────────┐
                    │    Embark    │
                    │  Passengers  │
                    └──────────────┘
┌───────────┐       ┌──────────────┐   ┌──────────┐   ┌──────┐   ┌─────────┐
│  Service  │───────│  Load Cargo  │───│ Pushback │───│ Taxi │───│ Takeoff │
│  Aircraft │       │ And Baggage  │   └──────────┘   └──────┘   └─────────┘
└───────────┘       └──────────────┘
                    ┌──────────────┐
                    │  Pre-flight  │
                    │   Aircraft   │
                    └──────────────┘
```

Rejected Takeoff

```
                                    ┌──────────────┐
                                    │  Disembark   │
                                    │  Passengers  │
                                    └──────────────┘
┌──────┐   ┌──────────┐   ┌──────────────┐   ┌───────────┐
│ Taxi │───│ Park at  │───│ Unload Cargo │───│  Service  │
└──────┘   │  Gate    │   │ And Baggage  │   │  Aircraft │
           └──────────┘   └──────────────┘   └───────────┘
                                    ┌──────────────┐
                                    │  Post-flight │
                                    │   Aircraft   │
                                    └──────────────┘
```

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Service Aircraft → Embark Passengers / Load Cargo And Baggage / Pre-flight Aircraft → Pushback → **Taxi** → Takeoff → Climb → Cruise → Descend → Approach (**Go-Around**) → Land → **Taxi** → Park at Gate → Disembark Passengers / Unload Cargo And Baggage / Post-flight Aircraft → Service Aircraft

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Example Scenario – "Rainy Day 3"

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- **The Operational Concept defines:**
  - **the context of the product, leading to a definition of its boundaries and the external interfacing and inter-operating systems, leading to identification of interface requirements;**
  - **the normal and other operational environments, leading to definition of the environmental requirements;**
  - **scenarios of normal and degraded operations, from which Product functionality can be derived;**
  - **and scenarios showing a "day in the life" of the product which help to develop the logistics, maintenance and support requirements, and identify the personnel requirements for the product operator.**

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Use of the Operational Concept for Validation
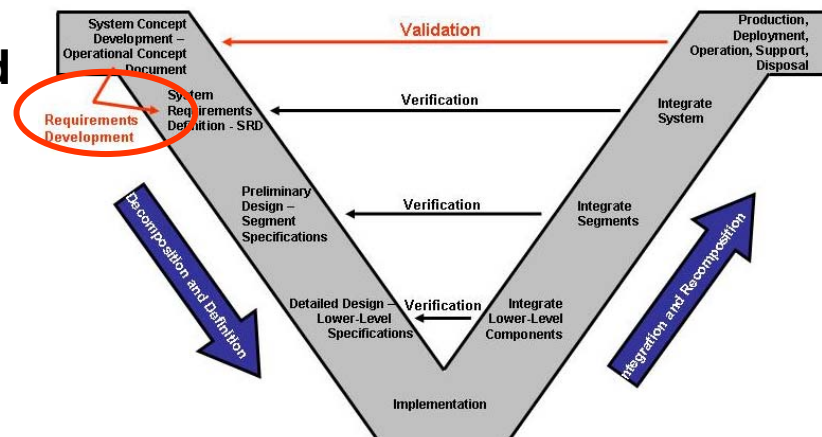
- Requirements Validation is the task of showing that the Product as developed satisfies the customer needs in its intended operational environment.

- The Operational Concept provides:
  - **A summary of the customer needs**
  - **A description of the normal and other operational environments**
  - **Various operational scenarios that can be used to define validation test procedures**
  - **Scenarios of degraded operations**

References
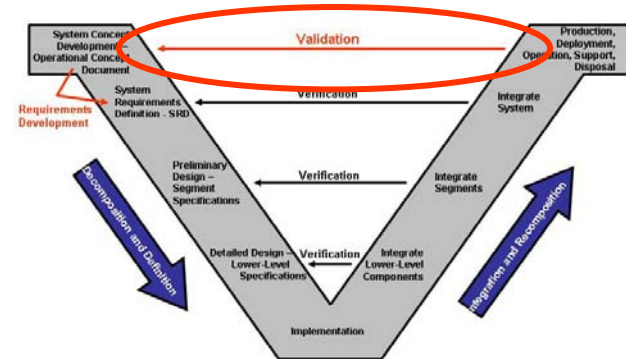
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- **Lano, Robert J, "A Structured Approach for Operational Concept Formulation", reprinted in Thayer, Richard H and Dorfman, Marlin, System and Software Requirements Engineering, IEEE Computer Society Press Tutorial, IEEE Computer Society Press, Los Alamitos, California, 1990.**
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- **AF Instruction 10-2801, AF Concept of Operations Development, 24 Oct 05**
- **Army Strategic Planning Guidance 2005: Annex B Concept Development & Experimentation Guidance, 15 Jan 05**
- **Air Force Policy Directive 10-28, AF Concept Development, 15 Sep 03**
- **AF Space Command Instruction 10-102, Concept Development, 15 Nov 07**

Author Biography

- Jim van Gaasbeek has 35 years experience analyzing and developing rotary-wing and fixed-wing aircraft, launch vehicles and spacecraft, both in the United States and European defense environments. Beginning as a rotor aeroservoelastician, his career has progressed with experience in constructive and virtual simulation, accident investigation, vehicle-management system design and systems engineering, concentrating in risk management and requirements development, management and verification.

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