

CDRL # 4
Analysis of Concept Element Detailed Descriptions

1. Consistency, Completeness, and Logical Robustness

1.1 Introduction

Concept Element (CE) 5, 6, 7, and 11 Detailed Descriptions were analyzed for internal consistency, completeness, and logical robustness. Significant differences were found between the documents. However, these differences do not necessarily imply that one Concept Element description is “better” than another. These differences are often explained by the differing levels of maturity of the Concept Elements and the degree to which detailed information was available from the NASA CE Points of Contact. As additional work is performed on the Concept Elements, and as part of a planned update of the detailed Concept Element descriptions, the descriptions can be brought closer to each other in terms of depth of discussion and Concept Element details.

Table 1 compares the outlines of each of the four Concept Element Detailed Descriptions, with annotations where appropriate. As can be seen, at the outline level, the descriptions are fairly consistent. However, some Concept Elements have broken specific sections into subsections. It is felt that the differences at the outline level are not significant and can be easily corrected during the next update cycle.

Some Concept Element description sections are particularly good with respect to the detail provided, including diagrams and figures. These sections are shown in green. Some sections are deemed to be considerably less detailed and informative than its peers (e.g., parallel sections of the other Concept Element descriptions). These are shown in yellow. In a few cases, a particular topic was not discussed at all. These are shown in red. The remaining sections of the various documents were deemed to be of similar depth and utility, and are shown in white.

The overall length of the technical content of the four CE descriptions ranged from 30.4 pages (CE 7) to 41.35 pages (CE 11).

1.2 Detailed Analysis

The remainder of this discussion will focus on the sections noted with green, yellow or red.

Section 1. Introduction

The Introduction section ranged from 1.5 pages (CE 5, 6, and 7) to 9 pages for CE 11. CE 11 contained a history of prior CDTI work that led up to CE 11. CDTI has been a concept that has been explored for many decades. The other CE’s have not been studied nearly as much, but it is recommended that future updates of the CE descriptions incorporate what history/background of work leading to CE 5, 6, and 7.

Section 2. Problem Description

There was considerable variation in the depth of the problem description of the various CEs. They range from 1 page for CE 11 to 5 pages for CE 7. It was felt that the 1 page description was a bit too brief for a concept of its complexity.

Section 3. Approach

The Approach section ranged from 1.25 pages for CE 7 to 6 pages for CE 11. It was felt that the 1.25 page section was too brief and all Approach sections should be on the order of 4-6 pages.

Section 4. Operational Requirements

As originally planned, all sections pointed to the Operational Needs Statements (ONS) that were identified by the Operational Concept 2001 document. Subsequent updates to the CE descriptions should consider a further analysis of the ONS, perhaps grouping similar ONS, trying to synthesize a more succinct statement of operational need and one that would permit more detailed decomposition as the concepts are explored.

Section 5. Operational Environments

The Operational Environments sections ranged from 2 to 6 pages. CE 11 had a particularly informative and detailed writeup which should be the goal of future updates to the CE descriptions.

Section 6. Operational Characteristics

There was a wide variation in depth of this section amongst the CEs, ranging from 2 to 11 pages. It was felt that the 2 page section in CE 11 was too short and lacked detail, and should be enhanced in subsequent versions.

There were specific subsections to this section that were particularly short in the various CE descriptions. Some of this shortness can be perhaps be accounted by the different degree to which the ATSP, Pilot, and AOC are involved in the CE, but some leveling of detail between the writeups should be considered.

Section 7. NAS Functional Impacts

The various sections ranged from 3 to 7 pages. The CE 7 writeup on the Automation Functional Requirements (4 pages) was particularly useful in explaining this CE and should be considered as a model by the other CEs. The Functional Design sections ranged from 1 to 1.75 pages, which is deemed to be too short to be reflective of the CE complexity and implications upon the NAS. Future updates should consider a more detailed discussion of this topic.

The “functional design” and “functional flow” diagrams that were depicted in the CE detailed descriptions tended to be more like system block diagrams, showing the elements of the system, and how they are interconnected. These diagrams need to be further broken down to identify the functions that are being performed within each block (e.g., navigation, communication, trajectory generation), and the major data flows between functional elements identified.

Section 8. User and Operator Roles and Responsibilities

This section ranged from 0.5 to 4.5 pages. CE 11 had a particularly descriptive section (4.5 pages), whereas the other CEs were quite brief and should be expanded.

Section 9. Operational Modes and Scenarios

This section ranged from 1 to 5 pages. The 1 page section in CE 6 was deemed to be a candidate for enhancement when updated. CE 6 and 7 did not identify any off nominal or failure modes.

Section 10. Operational Process and Operational Sequence Diagrams

This section ranged from 1 to 3.25 pages. This section is the place where real details about the operation of each CE should be amplified and clarified. All CEs should consider expanding this section as details of the concepts are developed. The 1 page section of CE 6 and 1.5 section of CE 7 should be expanded first.

Generic operational sequence diagrams for flight planning, separation assurance, and traffic management and synchronization functions were created as part of another NASA effort, AATT DST Tool Safety Impact Analysis. These functions are inherent functions that occur in the CEs (not all functions are in all CEs). These diagrams could be considered as a starting point for developing more comprehensive operational sequence diagrams for each of the CEs.

Section 11. Benefits

This section ranged from 1 to 3 pages. Their coverage of benefit areas (e.g., capacity, flexibility) was quite spotty, with CE 5 at least mentioning all 9 areas, while CE 6 and 7 only discussed 4 of the 9 areas. It is acknowledged that benefits work on the CEs is quite immature, but this section should be substantially enhanced in subsequent updates.

Section 12. Issues and Key Decisions

This section ranged from 0 pages (CE 5) to 4 pages (CE 6). Clearly the CE 5 section is inadequate and must be improved. This section is an important consideration in shaping subsequent programmatic, technical, and possibly funding considerations and each CE should strive to better identify issues and upcoming decisions.

Appendices

All CE descriptions included relevant Operational Needs Statement and References as appendices or attachments to the document. Two CE's (CE 6 and 11) contained supplemental appendices that augmented the information in the body of the document.

1.3 Conclusions

The CE Detailed Descriptions represent the first iteration of a process to define and document these new concepts. To produce these documents required four different individuals pulling together sometimes sketchy information and numerous discussions with the technical staff involved in pursuing each CE. Because of this, the information gleaned as not as uniform, complete, nor comprehensive as would be desired. However, it does represent a beginning, and the CE descriptions can serve as living documents as the Concept Elements mature and progress. After review by the CE Leads, the recommendations for improving the documents should be filtered, and expanded, and provide the guidance for the upcoming updates to the CE descriptions.

2.0 Analysis of Operational Need Statements

As part of TO 42, a refined list of Operational Needs Statements was produced. That list was compared with the operational needs implied by the various CE detailed descriptions. No new operational needs nor inconsistencies were found based upon the detailed descriptions. No revision to the TO 42 Operational Needs Statements was required.

Table 1 Comparison of Concept Element Detailed Description Documents

CE 5	CE 6	CE 7	CE 11
1. Introduction (1.5p)	1. Introduction (1.5p)	1. Introduction (1.5p)	1. Introduction (9p)
1.1 Background Has no history of prior work	1.1 Background Has no history of prior work	1.1 Background Has no history of prior work	1.1 Background Contains excellent history of CDTI work
1.2 Objectives	1.2 Objectives	1.2 Objectives	1.2 Objectives
1.3 Scope	1.3 Scope	1.3 Scope	1.3 Scope
2. Problem Description (4p)	2. Problem Description (2p)	2. Problem Description (5p)	2. Problem Description (1p)
2.1 Today's Problems	2.1 Problem	2.1 Constrained Airspace Problem Definition	
2.2 Root Sources of Today's Problems	2.2 Solution	2.2 Constrained Airspace Problem types	
	2.3 Potential Benefits	2.3 Efficiency and Capacity Limitations to TFM in Constrained Airspace	
3. Approach (2.5p)	3. Approach (4p)	3. Approach (1.25p)	3. Approach (6p)
3.1 Solution Overview	3.1 Overview	3.1 High Level Benefit Mechanisms	3.1 Concept Overview - good sequential stage diagram for concept
3.2 Solution Addresses Each Root Problem	3.2 Operational Integration		3.2 Summary of the Research Phases - has detailed description of 3 sub phases
3.3 Potential Benefit Mechanisms Smooth transition to benefits	3.3 Technical Integration		
4. Operational Requirements (0.1p)	4. Operational Requirements (0.1p)	4. Operational Requirements (0.1p)	4. Operational Requirements (0.1p)
5. Operational Environments (2.25p)	5. Operational Environments (2p)	5. Operational Environments (2p)	5. Operational Environments (6p)
5.1 Airspace Structure and Constraints	5.1 Airspace Structure and Constraints	5.1 Airspace Structure and Constraints	5.1 Airspace Structure and Constraints
5.2 Traffic Mix and Equipage	5.2 Traffic Mix and Equipage	5.2 Traffic Mix and Equipage	5.2 Traffic Mix and Equipage
5.3 CNS Infrastructure	5.3 CNS Infrastructure	5.3 CNS Infrastructure	5.3 CNS Infrastructure
5.4 ATM Environment	5.4 ATM Environment	5.4 ATM Environment	5.4 ATM Environment
6. Operational Characteristics (6p)	6. Operational Characteristics (11p)	6. Operational Characteristics (7p)	6. Operational Characteristics (2p)
6.1 ATSP View (0.5p)	6.1 ATSP Operations (9.25p)	6.1 ATSP Operations (2.5p)	6.1 ATSP Operations (0.5p)
	6.1.1 TFM Constraints		
	6.1.2 Potential Conflicts		
	6.1.3 User Request for Trajectory Change		
	6.1.4 Trajectory Prediction and Assessment		
	6.1.5 Trajectory Negotiation		
6.2 Pilot View (2.5p)	6.2 Pilot View (1p)	6.2 Pilot View (0.1p)	6.2 Pilot View (0.3p)
6.2.1 Situation Awareness			

Table 1 Comparison of Concept Element Detailed Description Documents

6.2.2 Self-Separation Assurance			
CE 5	CE 6	CE 7	CE 11
6.2.3 Flight Re-Planning			
6.3 AOC View (0.1p)	6.3 AOC Operations (0.1p)	6.3 AOC View (0.1p)	6.3 AOC View (0p)
7. NAS Functional Impacts (4p)	7. NAS Functional Impacts (4p)	7. NAS Functional Impacts (7p)	7. NAS Functional Impacts (3p)
7.1 Functional Requirements	7.1 Functional Requirements	7.1 Functional Requirements	7.1 Functional Requirements
7.1.1 Communications	7.1.1 Communications	7.1.1 Communications	7.1.1 Communications
7.1.2 Navigation	7.1.2 Navigation	7.1.2 Navigation	7.1.2 Navigation
7.1.3 Surveillance	7.1.3 Surveillance	7.1.3 Surveillance	7.1.3 Surveillance
7.1.4 Automation (0.5p)	7.1.4 Automation (0.5p)	7.1.4 Automation (4p)	7.1.4 Automation (0.1p)
7.1.5 Weather	7.1.5 Weather	7.1.5 Weather	7.1.5 Weather
7.1.6 Traffic Management	7.1.6 Traffic Management	7.1.6 Traffic Management	7.1.6 Traffic Management
7.2 Functional Design (1.75p)	7.2 Functional Design (1.25p)	7.2 Functional Design (1.25p)	7.2 Functional Design (1p)
8. User/Operator Roles & Resp (1p)	8. User/Operator Roles & Resp (0.5p)	8. User/Operator Roles & Resp (0.75p)	8. User/Operator Roles & Resp (4.5p)
8.1 ATSP Roles and Responsibilities	8.1 ATSP Roles and Responsibilities	8.1 ATSP Roles and Responsibilities	8.1 ATSP Roles and Responsibilities
8.2 Pilot Roles and Responsibilities	8.2 Pilot Roles and Responsibilities	8.2 Pilot Roles and Responsibilities	8.2 Pilot Roles and Responsibilities
8.3 AOC Roles and Responsibilities	8.3 AOC Roles and Responsibilities	8.3 AOC Roles and Responsibilities	8.3 AOC Roles and Responsibilities
9. Operational Modes & Scenarios (5p)	9. Operational Modes & Scenarios (1p)	9. Operational Modes & Scenarios (2.5p)	9. Operational Modes & Scenarios (2p)
9.1 Normal or Nominal Modes Has good diagram of operational modes	9.1 Normal or Nominal Modes No diagrams	9.1 Normal or Nominal Modes Example scenario diagram	9.1 Normal or Nominal Modes No diagrams
9.2 Off-Nominal Modes	9.2 Off-Nominal Modes None identified	9.2 Off-Nominal Modes None identified	9.2 Off-Nominal Modes
9.3 Failure Modes	9.3 Failure Modes None identified	9.3 Failure Modes	9.3 Failure Modes
10. Operational Process/Op Sequence Diagrams (3.25p)	10. Operational Process/Op Sequence Diagrams (1p)	10. Operational Process/Op Sequence Diagrams (1.5p)	10. Operational Process/Op Sequence Diagrams (2p)
			10.1 ATSP: Nominal In Trail Following Process. Good operational sequence diagrams
			10.2 Flight Crew: Nominal In trail Following Process. Good operational sequence diagrams
11. Benefits (2.5)	11. Benefits (1.25p)	11. Benefits (1p)	11. Benefits (3p)
11.1 Capacity	11.1 Capacity	11.1 Capacity	11.1 Capacity
11.2 Flexibility	11.2 Flexibility	11.2 Flexibility	11.2 Flexibility
11.3 Efficiency	11.3 Efficiency	11.3 Efficiency	11.3 Efficiency
11.4 Predictability	11.4 Predictability (missing)	11.4 Predictability (missing)	11.4 Predictability (missing)

Table 1 Comparison of Concept Element Detailed Description Documents

11.5 Safety	11.5 Safety (missing)	11.5 Safety (missing)	11.5 Safety (missing)
CE 5	CE 6	CE 7	CE 11
11.6 Access	11.6 Access	11.6 Access	11.6 Access
11.7 Environment	11.7 Environment (missing)	11.7 Environment (missing)	11.7 Environment (missing)
11.8 Scalability	11.8 Scalability (missing)	11.8 Scalability (missing)	11.8 Scalability (missing)
11.9 Global Interoperability	11.9 Global Interoperability (missing)	11.9 Global Interoperability (missing)	11.9 Global Interoperability (missing)
12. Issues and Key Decisions (0p)	12. Issues and Key Decisions (4p)	12. Issues and Key Decisions (0.5p)	12. Issues and Key Decisions (1.5p)
			12.1 Issues Summary
			12.2 Key Decision Points
App Operational Needs Statement Table	App A Operational Requirements Table	App A Operational Requirements Table	App A Operational Requirements Table
	Appendix B Automation Resolution Advisories	Appendix B References	App B. Variation to the Baseline System for CE 11
References	References		References
Total Pages of Content (32p)	Total Pages of Content (35p)	Total Pages of Content (30p)	Total Pages of Content (41p)