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THE UNIVERSITY OF ALABAMA IN HUNTSVILLE
Rotorcraft Systems Engineering and Simulation Center

Enhancing T&E and SE Alignment Using Database Driven Documentation

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SYSTEMS ENGINEERING
Research Center

Agenda

- Problem and Objective of the Research
- Research Approach
- Overview of the Foundational Tool SET
- Methods for the Research
- Preliminary Results
- Future Work
- Acknowledgements
- Questions

Problem and Objective

- Problem
  - Key Systems Engineering documents require significant effort to keep current, and to keep the content synchronized in an environment where change is constant. This often results in the documents becoming obsolete relative to fast moving development activities and inconsistencies.
- Objective
  - Research a mechanism and ability to align SE documents (SEP, TEMP, ISP) such that the program documents track and compliment one another, are easier to produce and update, support agile environments, and to move towards a data centric rather than document centric focus

Research Approach

Flexible Modular Documentation for SE

1. Three key SE documents were identified to research (SEP, TEMP and ISP)
2. Develop a modular architecture for each document
3. Determine:
    a) A dependency structure
    b) Relationships
    c) Interdependencies
4. Create linkages between the various topic areas of the multiple SE artifacts to understand dependencies.
5. Developed a document structure to allow better
    a) Change management across the entire program
    b) Consistency between the key SE artifacts
6. Demonstrate role based access to SE information from various SE artifacts
7. Built on existing capabilities of the Systems Engineering Toolkit (SET) developed by UAHuntsville's Rotorcraft Systems Engineering and Simulation Center

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Overview of the Foundational Tool

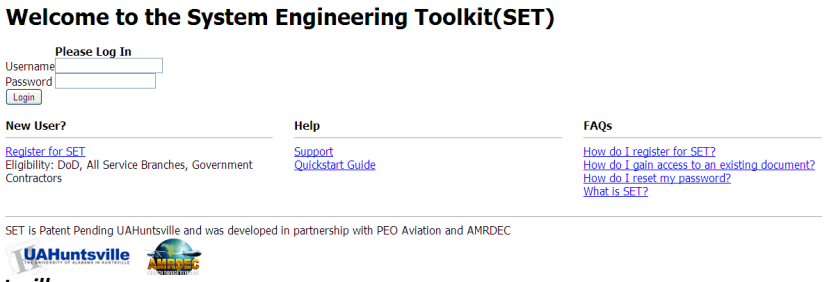
Systems Engineering Toolkit

(SET)

Systems Engineering Toolkit

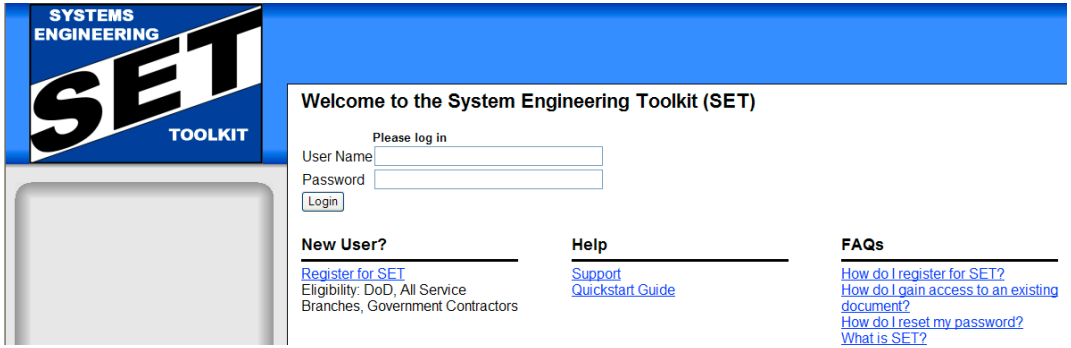
- Web based tool to assist in Systems Planning
- Uses a database to store information, providing a platform for database-driven documentation
- Internal mapping capabilities to provide automatic updating, multiple document creation and display capabilities relevant to a type of user throughout the lifecycle
- Global access to the most up-to-date information
- Secure and controlled access to documents
- No installation is required
  - Only Requirements: Internet Explorer with Javascript Enabled; Adobe Acrobat Reader to view generated documents
- Does NOT require Java, or ActiveX Plug-ins

http://set.uah.edu/



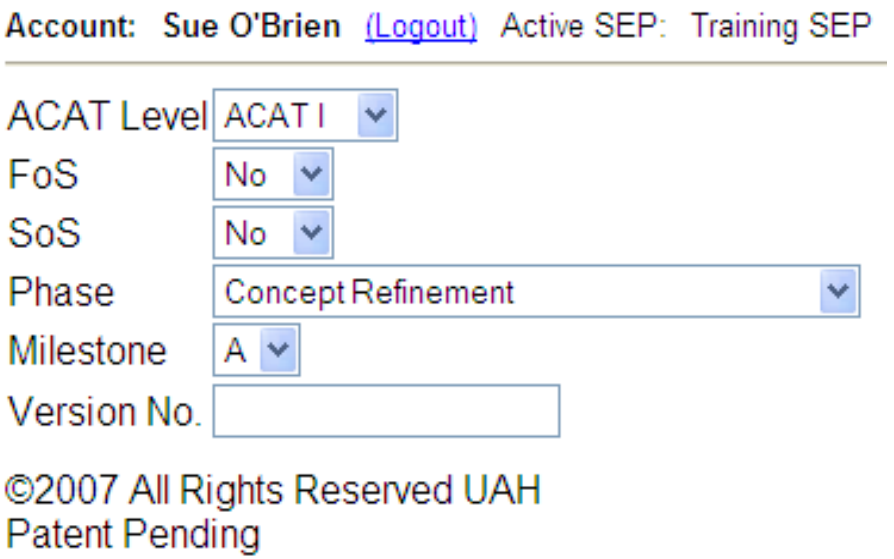
Systems Engineering Toolkit - Continued

- Presently the toolkit assists in creating SEPs but adaptable and ready to assist in creating a multitude of documents
- The tool is
  - Inquiry driven
  - Configuration controlled
  - Tailorable
- In response to our customers, research is ongoing to further develop the tool and capabilities with funding from NAVAIR, DoD, and NASA Marshall Space Flight Center



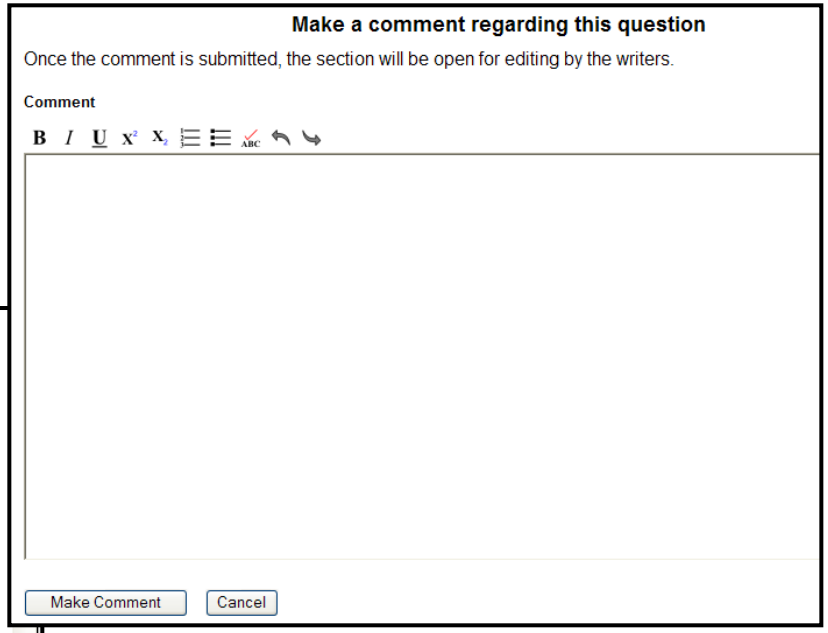
Systems Engineering Toolkit - Features

- Modular/adaptable system to many different documents and applications
- Customizable for individual organizations and SE processes
- Mapping occurs between milestones, guidance and document types
- Tailor SEP according to
  - Project/Program Processes
  - Project Phase
  - Family of Systems
  - System of Systems
  - ACAT level



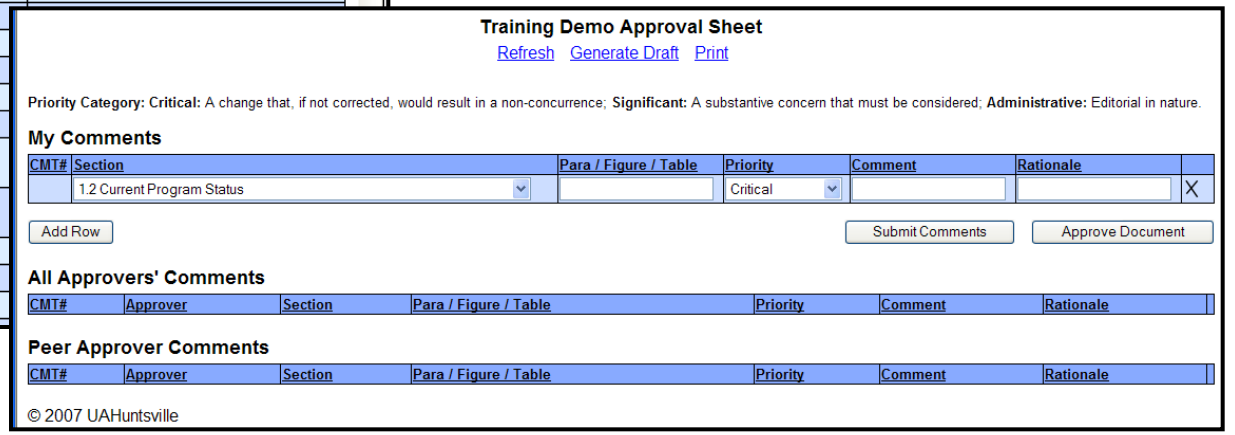
Systems Engineering Toolkit - Features

- Multiple documents per user
- Multiple permissions per user
- Incorporated review process



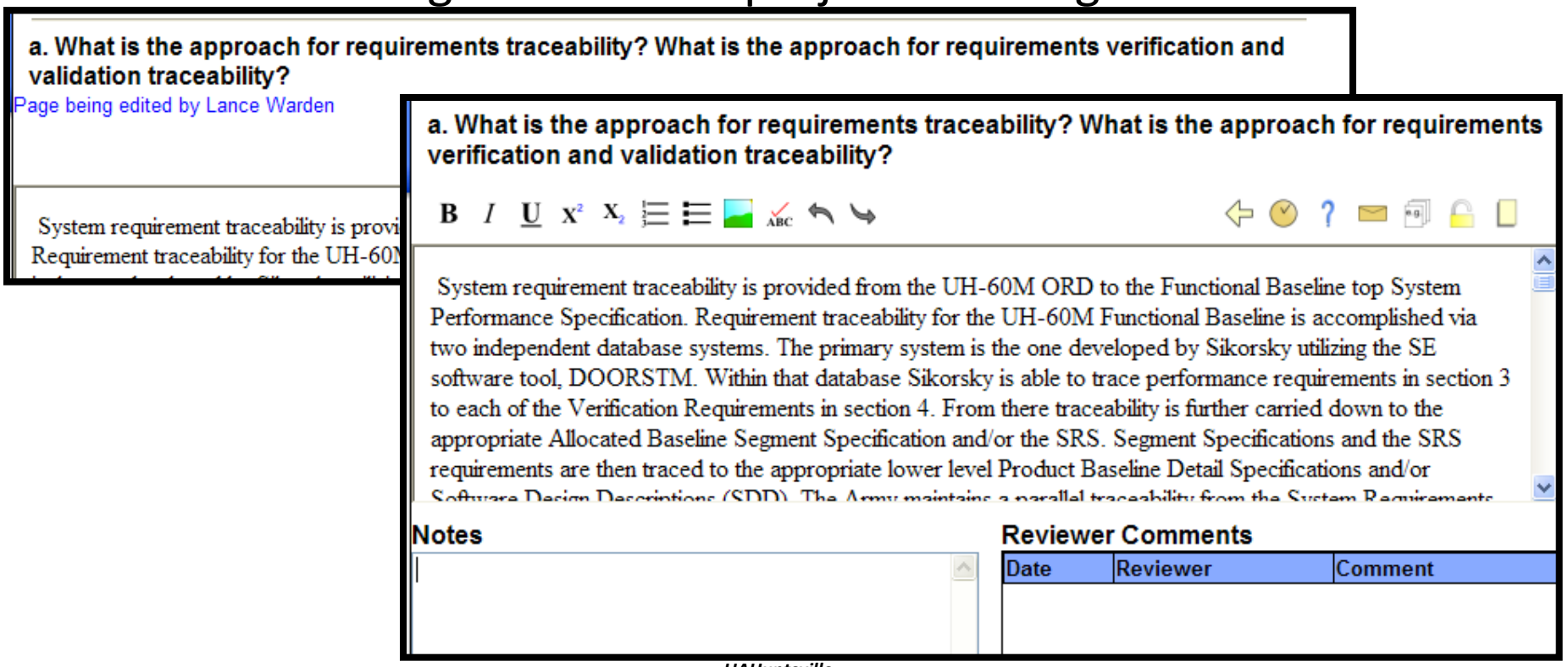
Available Documents

Document	Permissions
Test SEP	Read, Write
TEST SEP2V2	Write
LUH	Read, Write, Review, Admin
Aviation Systems Test SEP	Admin
Tool Demo	Read, Write, Admin, Version Control
Joint Air to Ground Missile (JAGM)	Read, Peer Approve, Admin
BlackHawk UH60M	Read, Write, Admin
JAVELIN	Write, Admin
AGSE Practice SEP	Write, Review, Admin
JPEO-CBD	Admin
JNBCRS, Increment 2	
Assessments & Support	
CRAM	
PEO CS&CSS SET Trial SEP	
Training SEP	
Training Demo	
Joint Chem Bio Practice SEP	
Training Demo II	
MFOQA Field Prototype Project	
Aerial Common Sensor	



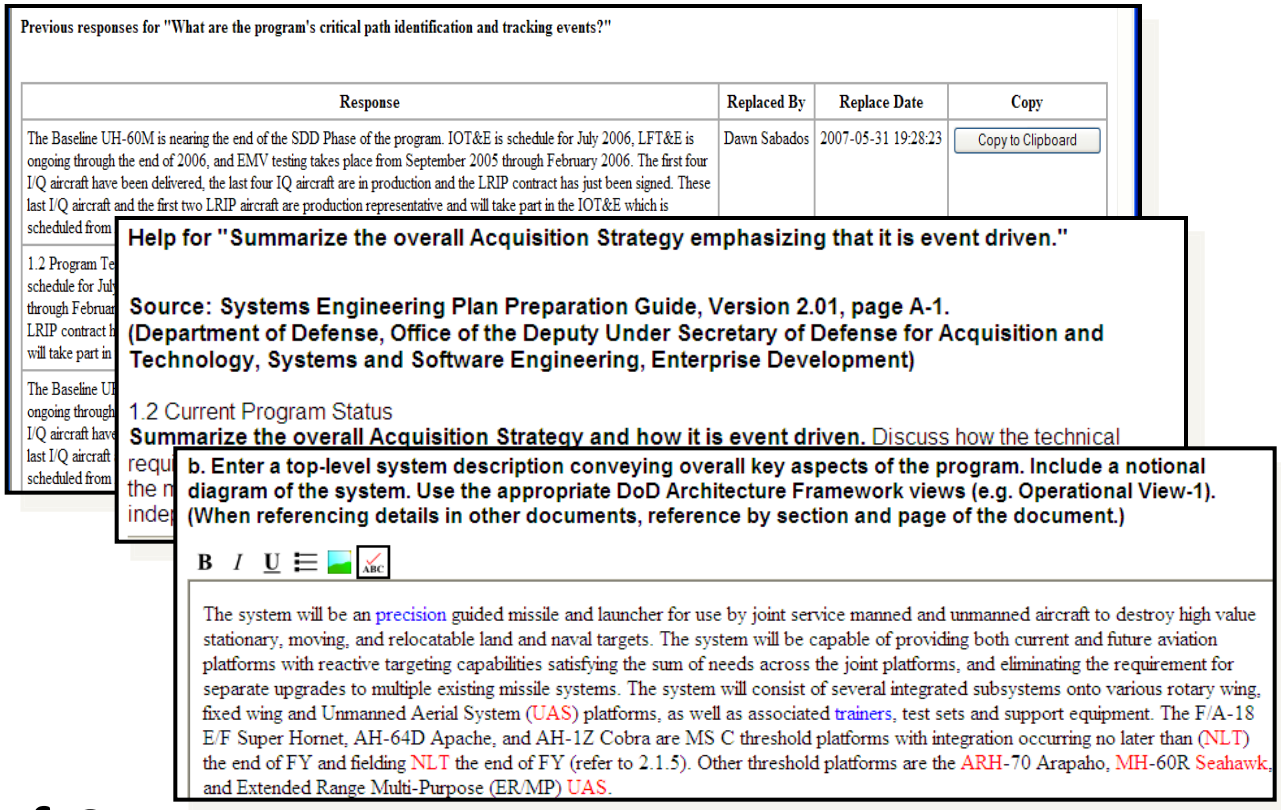
Systems Engineering Toolkit - Features

- Allows multiple users and user types to work on the same document at any time
- Enhanced communications
- Gain knowledge from other projects and organizations

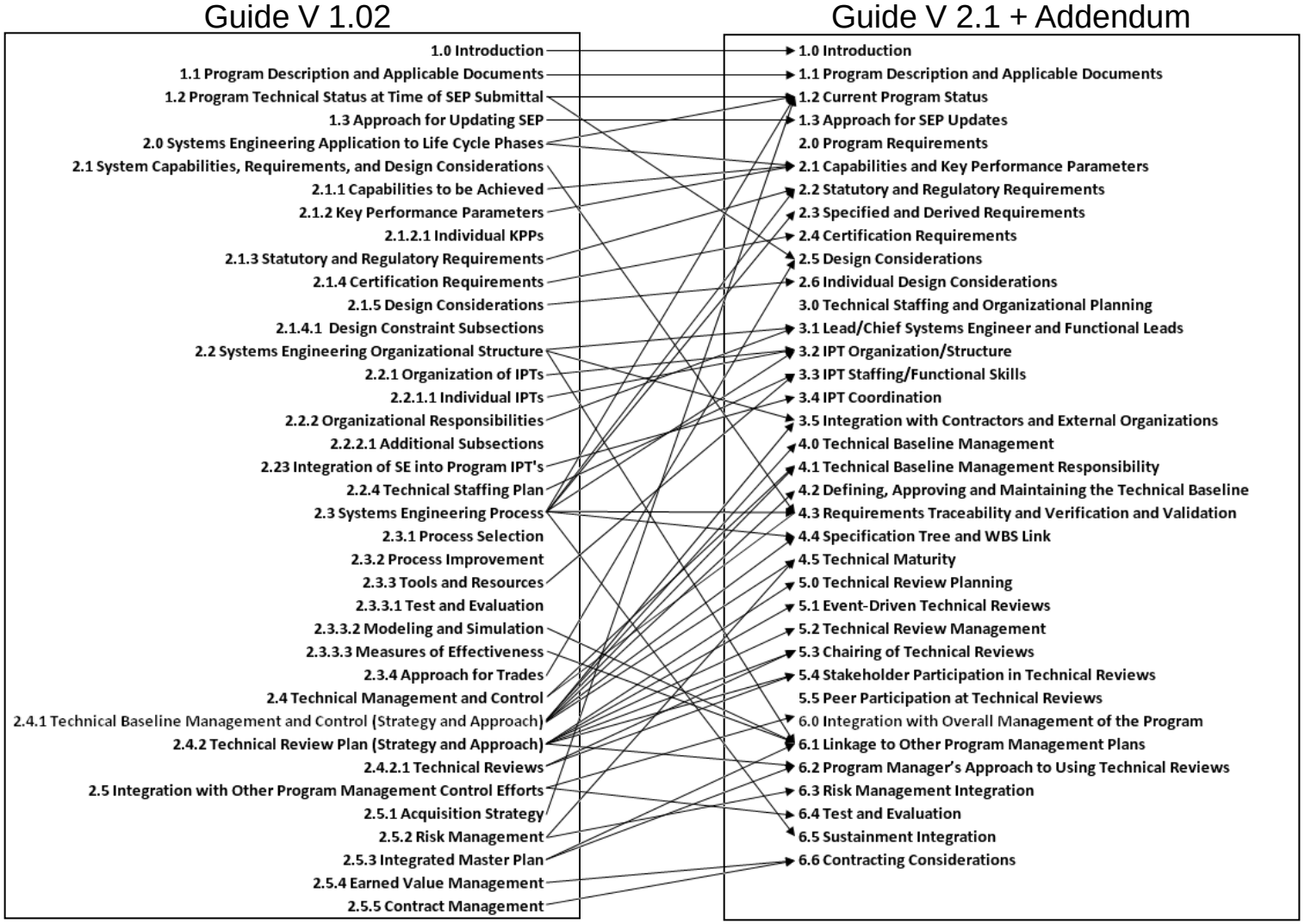


Systems Engineering Toolkit - Features

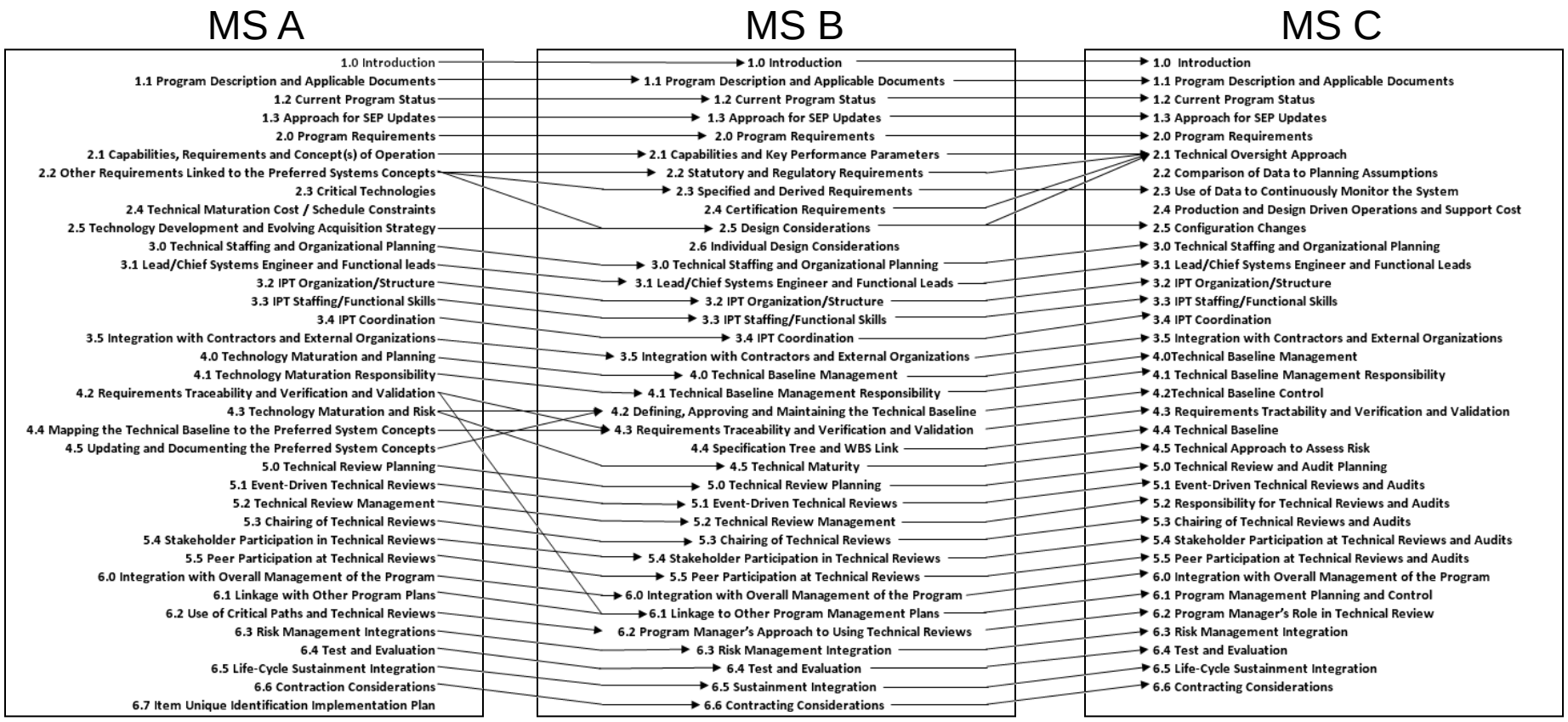
- Image Uploading
- Change Log
- Help
- Spell Check
- Examples
- Appendix
- Acronyms List
- Automatic Table of Contents
- Automatic Page, Figure and Table Numbering



Mapping and Tailoring

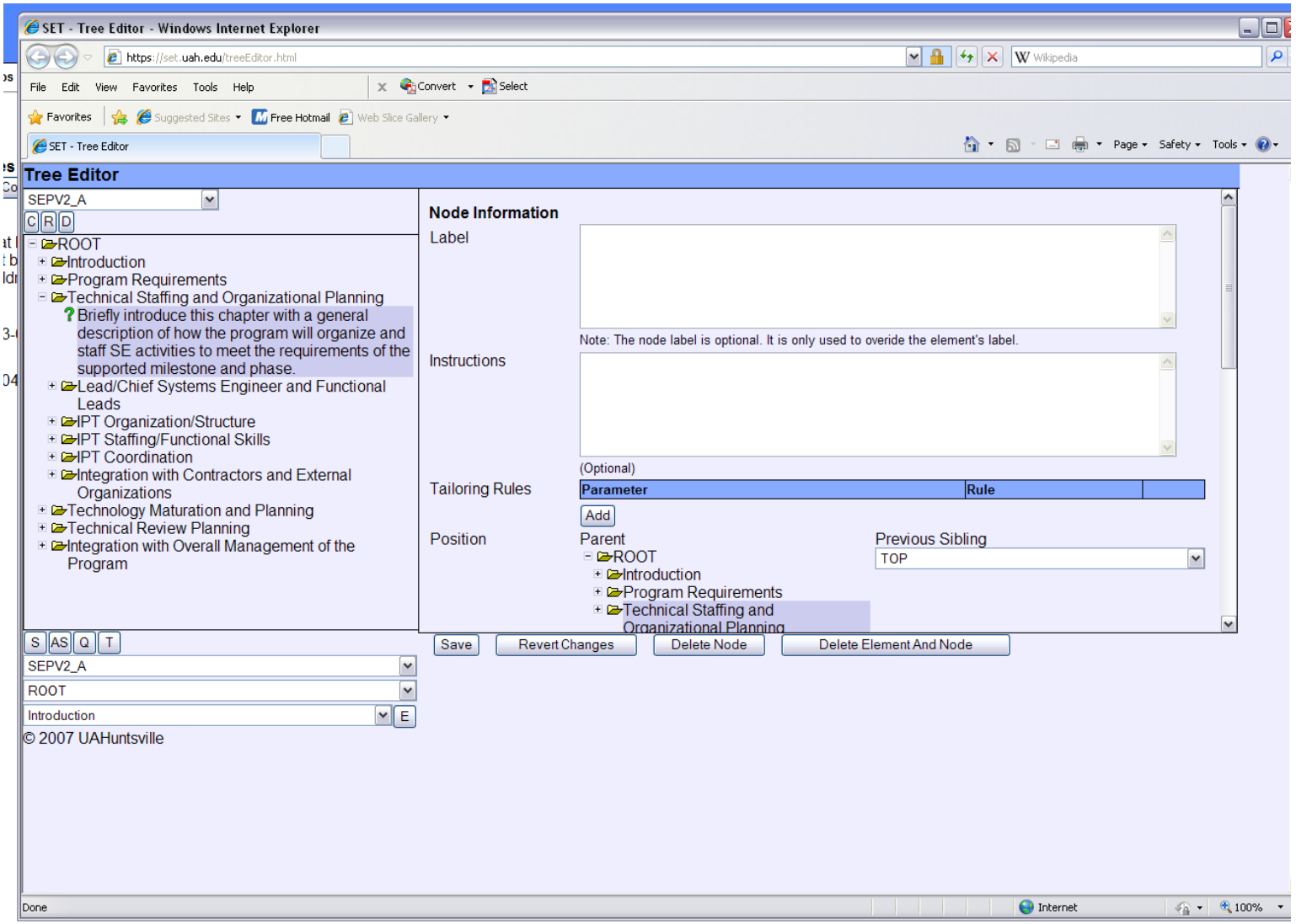


Mapping and Tailoring
Creating and Maintaining a Living SEP

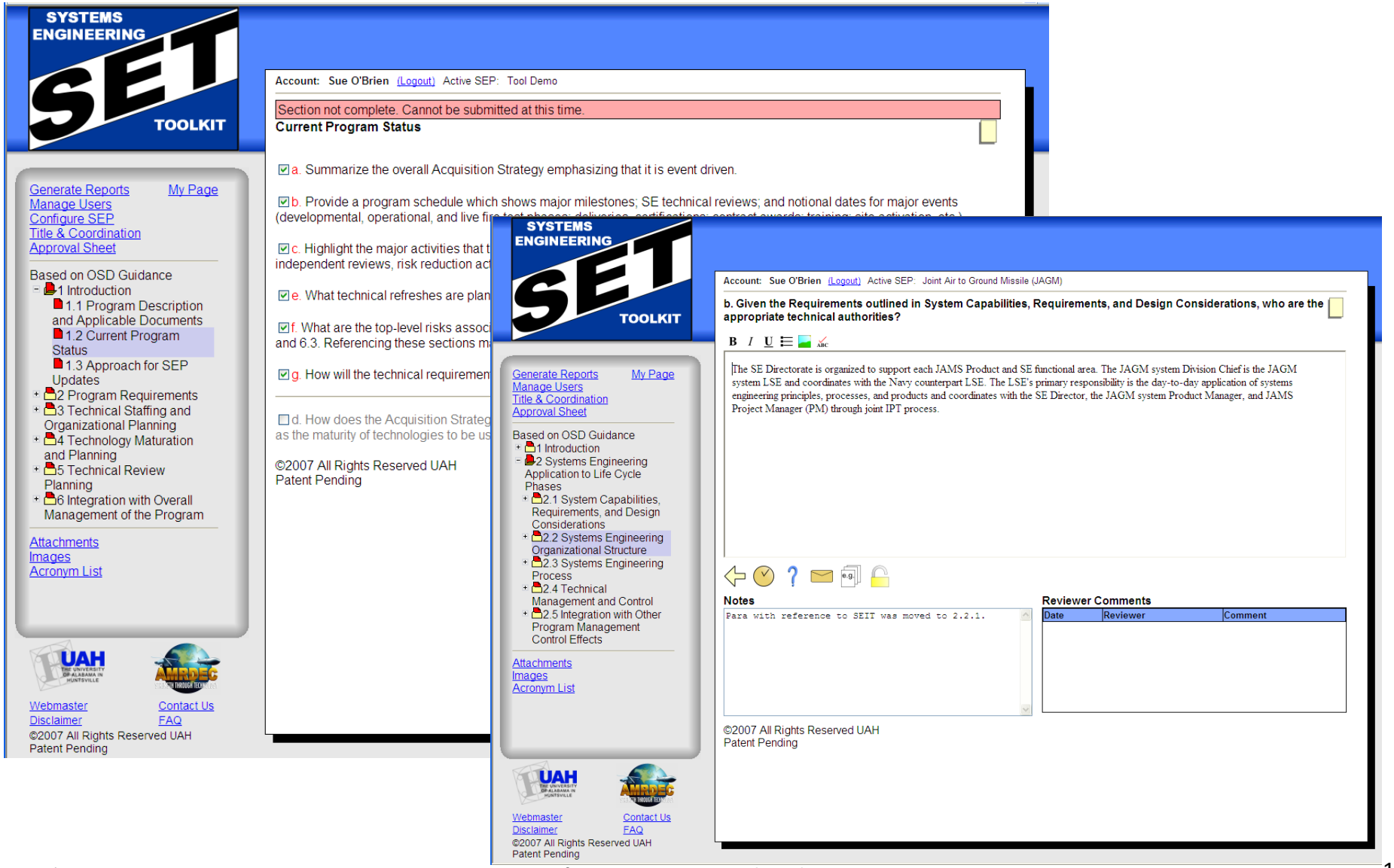


As a program progresses through the lifecycle, contents automatically update to reflect the Milestone, and pertinent text is flowed forward.

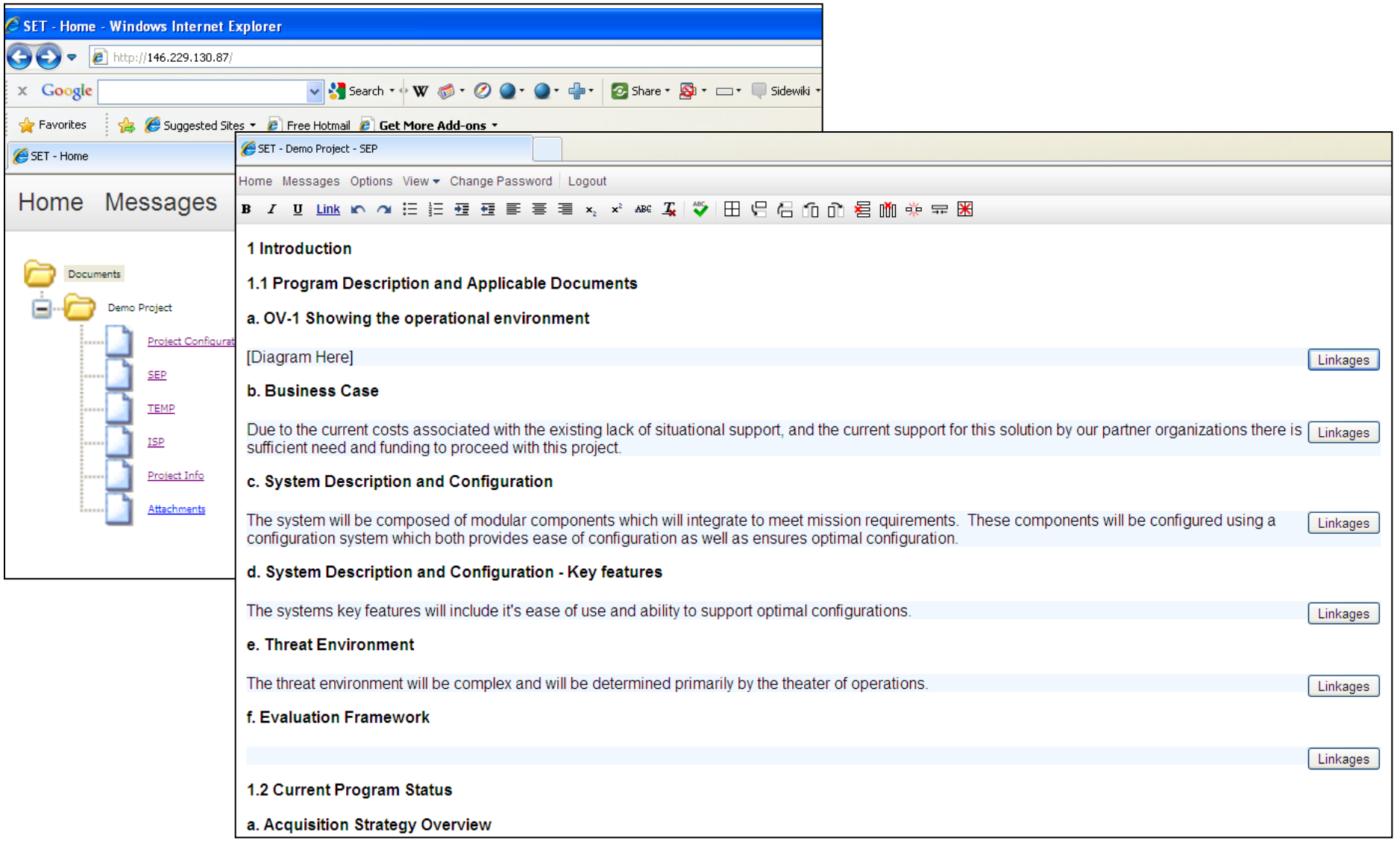
Tree Editor for the Mapping Process



Department of Defense (DoD) SET Version 1.0



Department of Defense (DoD) SET Version 1.5



Research Leading to SET Version 1.5

Research Method

The RSESC team analyzed existing documents and guidance to identify common topic areas and subsequently implemented mapping into the tool.

Procedures

1. Analyze existing SEPs, TEMPs, and ISP standards, guidance, instructions and examples
2. Dissect existing guidance and approved plans to determine topic areas, correlations and dependencies
3. Develop the table of contents for the SEP, TEMP and ISP within the SET tool and map high level topic areas into the appropriate section
4. Create a role based system for creating project documentation
5. Create linkages between the three documents in SET using identified correlations and dependencies

Definitions

The following terms have been defined for use in breaking down and mapping content within and between documents:

Correlated Information - Duplicate topic information found in more than one document with only one governing entity

- Governing Document - Topic areas are dependent on specific documents such as the SEP, TEMP, ISP, etc. , not necessarily a particular role or SME. The governing document controls the content and changes to that content for a subject area. (Generic roles: reader, writer, reviewer, approver, version controller)
- Governing Role - Independent topic areas and not governed by a specific document. This information would be changed by preapproved individual roles. Changes to the information is not governed by the document. (Specific Roles: PM, LSE, SMEs, Logisticians, etc.)

- **Dependent Information**
  - **Level 1**: High level details about a topic area. An overview on how processes will be handled. Should be consistent with Level 2 information.
  - **Level 2**: Lower level more specific information that falls in line with the Level 1 information but has much more detail specifics.

Level 1/Level 2 Example SEP and TEMP Dependency

The IPTs for the program are listed as product teams across the bottom of Figure 15.

The IPT Leads have responsibility and authority (within the bounds of the contract) for cost, schedule, and technical accomplishment for what tasks needs to be done and when they need to meet program objectives. In that role, they direct the day-to-day tasking of resources toward IPT objectives.

The IPTs have responsibility to ensure that processes and procedures are being followed and providing a properly trained staff. In essence, the functional leads, including engineering, have responsibility and authority for how a task is accomplished and by whom.

There exists an open and informal communication channel across the various teams involved in the development of the program. Emphasis is placed on cross-communication beginning at the Subject Matter Expert (SME) level with the IPT lead being informed of issues or risks. When a change in the scope of tasks arises, the contractual communication channels are adhered to. Figure 16 depicts the communication guidelines between development teams.

Figure 17 depicts the formal communication . . .

Specific details about the individual IPTs can be found in the following documents:

Level 1 Detail (General)

IPT Specifics	Team Charters
Test and Evaluation IPT	TEMP
Logistics IPT	. . .
Software and Simulation IPT	. . .

Level 2 Detail (Specific)

Level 1/Level 2 Example
SEP and TEMP Dependency

- SEP Level 1
  - 1.2 Current Program Status Highlight the major activities that the program conducted to date such as outcomes of technical reviews, *test phases*, independent reviews, risk reduction activities, trade studies, etc.
- TEMP Level 2
  - 1.3.2.1. Previous Testing. Discuss the results of any previous tests that apply to, or have an effect on, the test strategy.

Breakdown of the Documents

Topic Areas	Level	Governing Entity	TEMP Section	SEP Section	Milestone	ISP (DODI/DAG)	ISP Example
Mission Need	1	Role Based/SME	1.2	2	A, B, and C	2.1	2.1
Supported Capability	2	Role Based/SME				2.2	2.2
OV-1 Showing the operational environment	1	Role Based/SME	1.2	1.1	A, B, and C	1.1	1.1
Organizations which the system will be integrated (if applicable	1	Role Based/SME	1.2	3.5	A, B, and C	1.1	1.1.1
Role Definitions	2	Role Based/SME				1.3	1.3
Business Case	1	Role Based/SME	1.2	1.1	A, B, and C		
System Description and Configuration	1	Role Based/SME	1.3	1.1	A, B, and C	1.1	1.1
Key features	2	Role Based/SME	1.3	1.1	A, B, and C	1.1	1.1
Required Capabilities	2	Role Based/SME				2.4	2.4
Threat Environment	1	Role Based/SME	1.3.1	1.1	A, B, and C	1.1	1.1
Analysis of Alternatives	1	Role Based/SME	1.3.2	4.4	A	Appendix A refers to it	Touches on this in 1.1.1 and 1.3.2.1 but no big discussion
Acquisition Strategy Overview	1	Role Based/SME	1.3.2	1.2	A, B, and C		Touches on evolutionary acquisition in 2.1 an 2.13 but no big
Previous Testing	1	Document Based/TEMP	1.3.2.1	1.2	A, B, and C (Considered 6.4 but since can only one chose 1.2)		
KPPs, KSAs	1	Role Based/SME	1.3.3	2.1	A, B, and C		Referenced but not
Data/Information Flow	1	Document Based/SEP	2.2	4.5A 4.2B 4.2C			
TEMP Deficiency Reporting	2	Document Based/TEMP	2.3	6.4	6.4C		
Data Quality Requirements	2	Document Based/ISP				2.4	2.4
System Data Exchange	2	Role Based/SME				Appendix B	Appendix B
Data Timeliness	2	Document Based/ISP				2.5	2.5
Information Access	2	Document Based/ISP				2.7	2.7

The Systems Engineering Toolkit will be used to provide linkages of multiple documents within one database. It will allow topic searches across multiple documents to ensure consistency and efficient SE planning,

Modularity Results

- When examining the topic areas, seventy-six topic areas were in common between at least two of the three documents

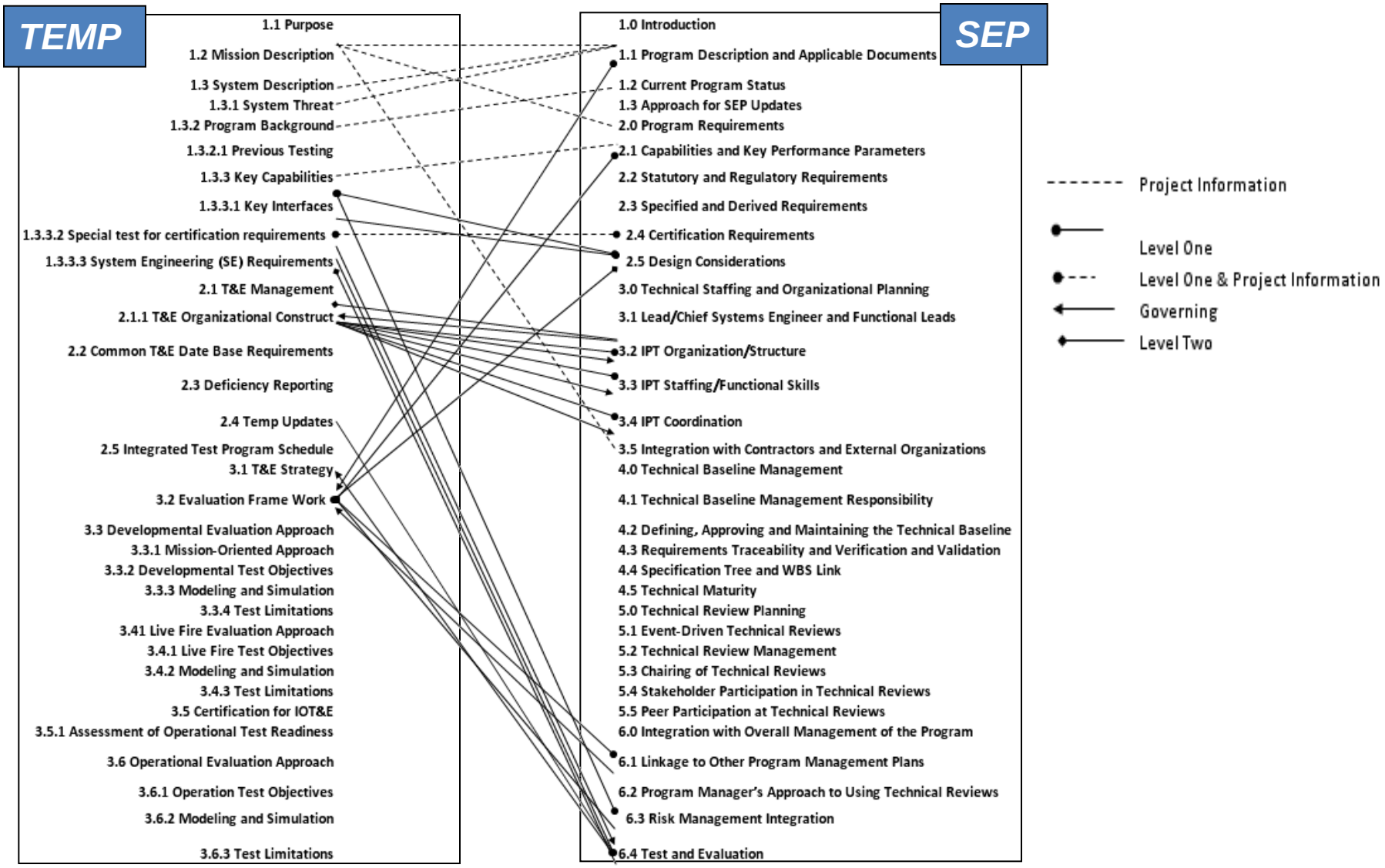
Document	Topic Areas with Commonality	Percent Commonality
SEP	52	68%
TEMP	49	64%
ISP (DODI/DAG)	21	28%
ISP (Example)	24	32%

Modularity Results

- When examining the Table of Contents from each of the three documents

Document	Total Number of Sections	Number of Orphan Sections	Number of Sections with Common Information	Percent Common
SEP MS A	29	10	19	65.5%
SEP MS B	29	11	18	62.1%
SEP MS C	29	13	16	55.2%
TEMP	57	26	32	56.1%
ISP (DODI/DAG)	23	9	14	60.8%

Mapping Between Documents



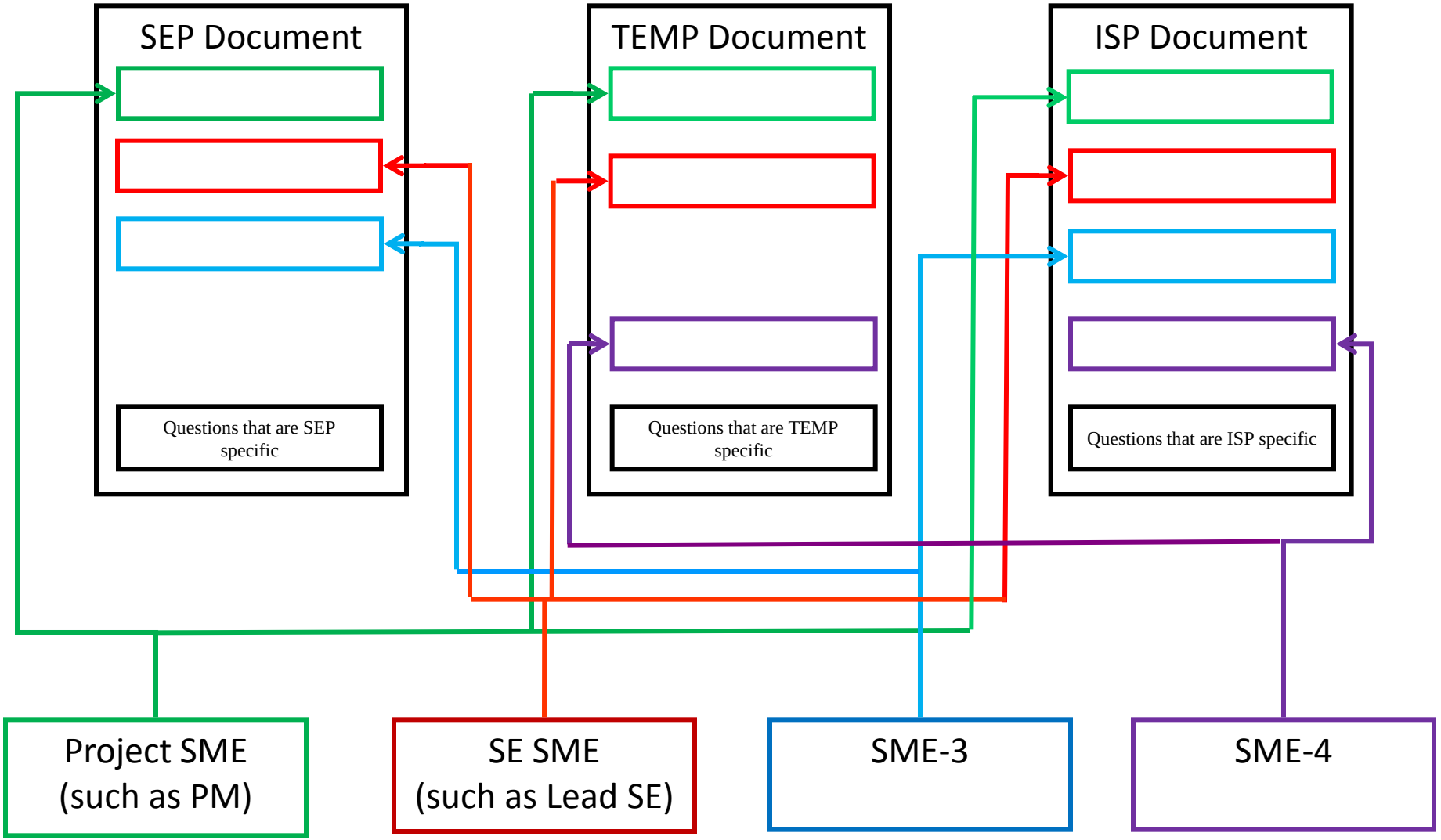
Modular Documents Research Results

- Evidence showed:
  - Various subject matter experts are needed within a project and the SME can vary between milestones (chief engineer, lead system engineer, project manager, test lead, logisticians, etc.)
  - Topic area information is co-located in multiple documents and various SMEs govern the information
- Migrating to a role based modular database would increase synchronization and consistency across multiple documents and could increase efficiency for the SME and overall program

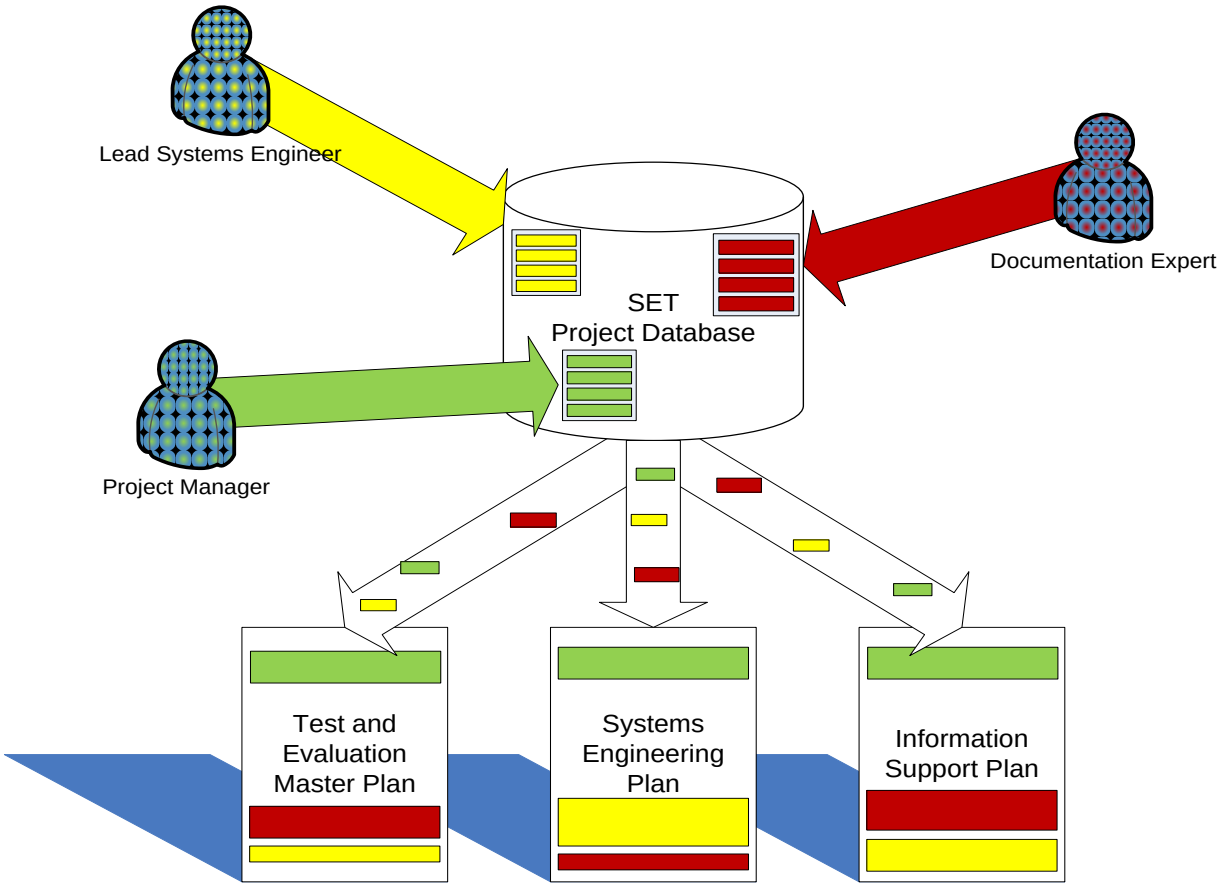
Modular Documents Concept

- Document template is pulled from the library for the project
- Principal writers or SMEs are selected for the predetermined topic areas
- Governing information is written by the subject matter experts and made available to the pertinent documents (This information could be pulled from already written documents within the tool, require newly developed information or a combination of the two.)
- Remaining topic areas that are specific to that particular document are written
- Documents are frozen and version controlled at each milestone

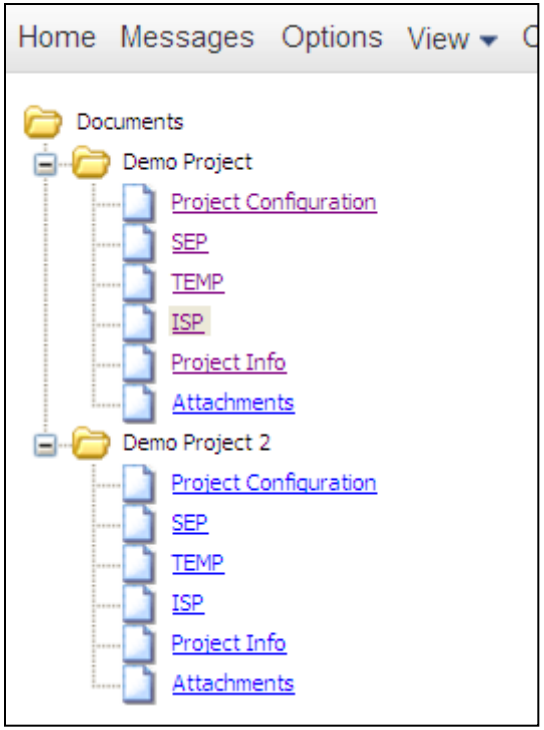
Role Based Documentation

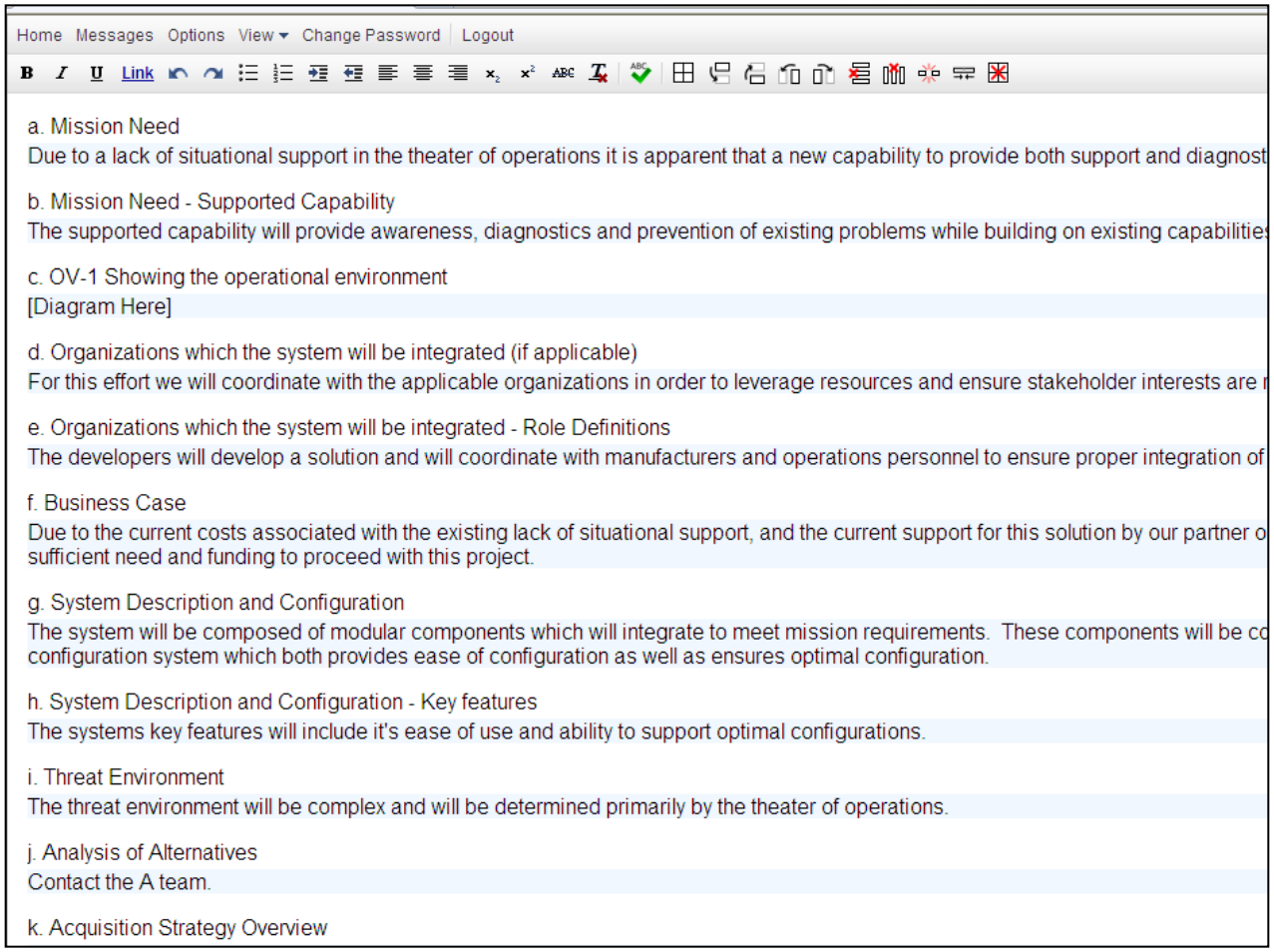


Modular Documents Concept

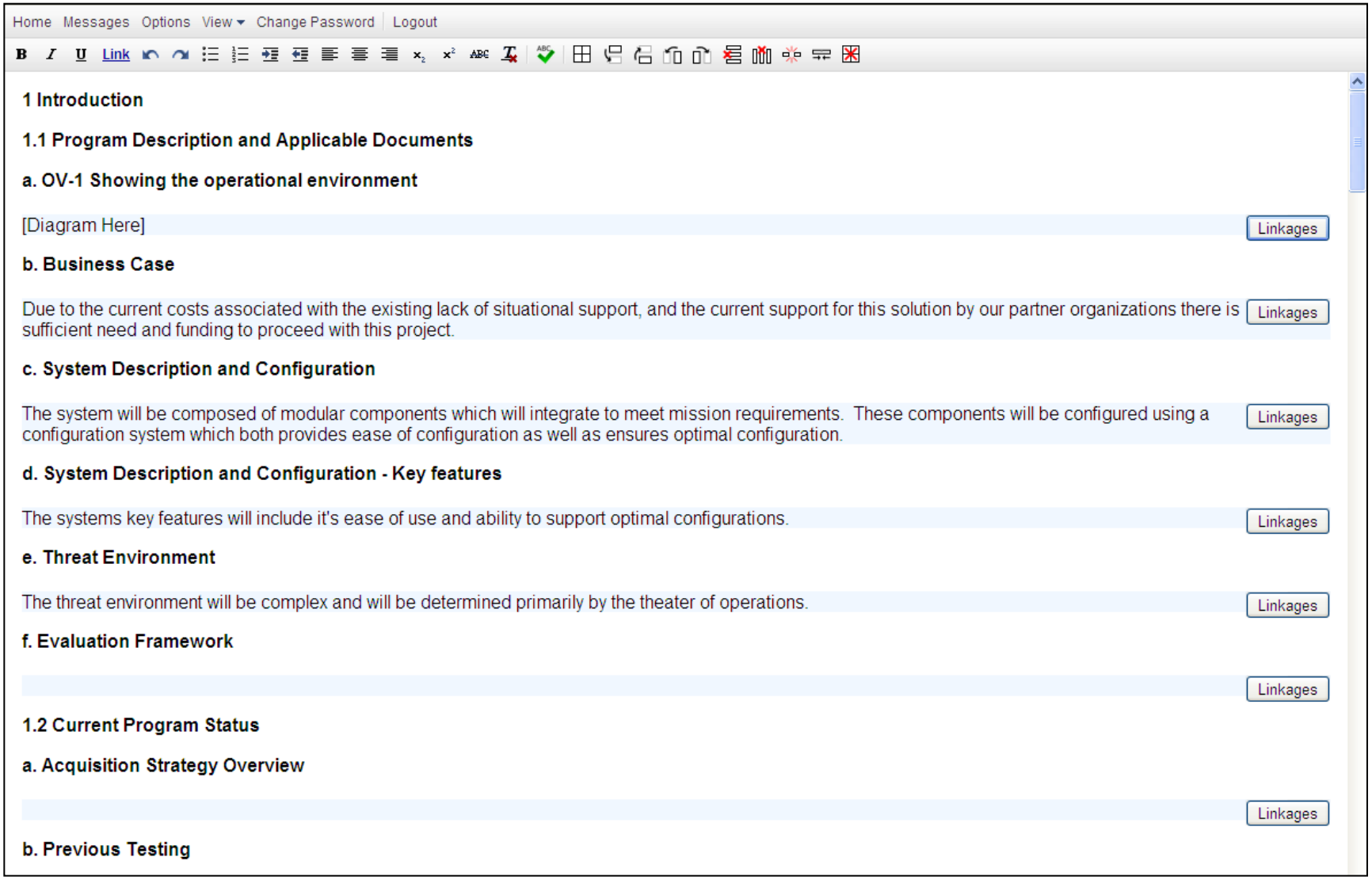


SME Information Requests





SET Version 1.5
Systems Engineering Plan



SET Version 1.5
Systems Engineering Plan

Home Messages Options View Change Password Logout

B I U Link

1 Introduction

1.1 Program Description and Applicable Documents

[Diagram Here]

Due to the current costs associated with the existing lack of situational support, and the current support for this solution by our partner organizations there is sufficient need and funding to proceed with this project.

The system will be composed of modular components which will integrate to meet mission requirements. These components will be configured using a configuration system which both provides ease of configuration as well as ensures optimal configuration.

The systems key features will include it's ease of use and ability to support optimal configurations.

The threat environment will be complex and will be determined primarily by the theater of operations.

1.2 Current Program Status

1.3 Approach for SEP Updates

2 Program Requirements

Due to a lack of situational support in the theater of operations it is apparent that a new capability to provide both support and diagnostics will be required.

2.1 Capabilities, Requirements and Concept(s) of Operation

Next Steps for Modular Documents

- Higher fidelity of the topic areas and information requests
- Level 1 and Level 2 mappings further definition and finalization
- Determination of documentation process
- Determination of roles
- Final determination of governing entities

RSESC will continue to leverage research being performed for the Department of Defense, NAVAIR and NASA Marshall Space Flight Center to implement effective systems engineering tailored to the customers' needs

Areas for Further Benefits

- Addition of more documents, possibilities include acquisition strategy, ICD, CDD, CPD and many others that are referenced in these documents to increase benefits
- Increased tailoring for small programs and block modifications
- Inclusion of Statutory, Regulatory and Certification Requirements and other standard items

Summary

- From the research performed using a data-centric modular database for creating program documentation is feasible and could be beneficial
- Evidence shows dependencies and correlations between the three artifacts
- Automated mapping function, database capabilities, statistical and data collection methods designed within the SET tool allowed research to be performed on the most advantageous method while providing both a testbed environment and implementation tool for users
- SET Version 1.0 is available for use to any government organization
- User inputs are encouraged

Questions?

Contact Information

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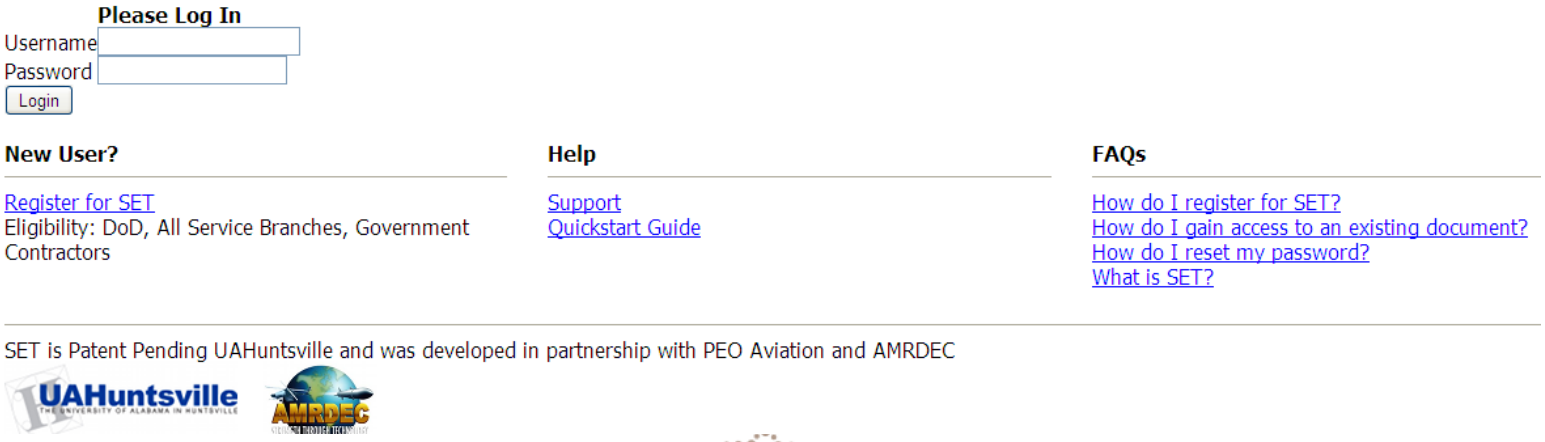
Welcome to the System Engineering Toolkit(SET)

http://set.uah.edu/



SYSTEMS ENGINEERING
Research Center

http://www.sercuarc.org/

BACK-UP

SEP Topic Area Orphans

Milestone	Section	Title
A	1.3	Approach for SEP Updates
	2.5	Technology Development and Evolving Acquisition Strategy
	4.1	Technology Maturation Responsibility
	5.1	Event-Driven Technical Reviews
	5.2	Technical Review Management
	5.3	Chairing of Technical Reviews
	5.4	Stakeholder Participation in Technical Reviews
	5.5	Peer Participation at Technical Reviews
	6.2	Use of Critical Paths and Technical Reviews
	6.6	Contracting Considerations

B	1.3	Approach for SEP Updates
	2.2	Statutory and Regulatory Requirements
	4.1	Technical Baseline Management Responsibility
	4.4	Specification Tree and WBS Link
	5.1	Event -Driven Technical Reviews
	5.2	Technical Review Management
	5.3	Chairing of Technical Reviews
	5.4	Stakeholder Participation in Technical Reviews
	5.5	Peer participation at Technical Reviews
	6.2	Program Manager's Approach to Using Technical Reviews
	6.6	Contracting Considerations

C	1.3	Approach for SEP Updates
	2.2	Comparison of Data to Planning Assumptions
	2.4	Production and Design Driven Operations & Support Costs
	3.1	Lead/Chief Systems Engineer and Functional Leads
	4.1	Technical Baseline Management Responsibility
	4.4	Technical Baseline

Common Themes	Milestone and Section
SEP Updates	1.3 of A, B, and C
Roles and Responsibilities	4.1A and B and C
Reviews	5.1 - 5.5A and B and C
Contracting	6.2 B and C 6.6A and B and C

TEMP Topic Area Orphans

Section	Title	Description
1.1	Purpose	
2.4	TEMP Updates	
3.3.1	Mission-Oriented Approach	Evaluate mission performance in a mission context (focuses on how the system will be employed)
3.3.2	Developmental Test Objectives	Summarize the planned objectives and stat the methodology to test the system attributes defined by the appicable capability requirement document
3.3.4	Test Limitations	
3.4	Live Fire Test and Evaluation Approach	
3.4.1	Live Fire Test Objectives	
3.4.2	Modeling & Simulation	in terms of life fire
3.4.3	Test Limitations	
3.6	Operational Evaluation Approach	Independent evaluation of the system
3.6.3	Test Limitations	
3.7	Other Certifications	
3.8	Reliability growth	
4.1.1	Test Articles	Actual number and timing
4.1.2	Test Sites and Instrumentation	
4.1.3	Test Support Equipment	
4.1.4	Threat Representation	
4.1.5	Test Targets and Expendables	
4.1.6	Operational Force Test Support	
4.1.7	Models, Simulations, and Testbeds	
4.1.8	Joint Mission Environment	Live, virtual, or constructive components for an acceptable environment
4.2	Federal, State, and Local Requirements	environmental regs

ISP Topic Area Orphans

Chapter 1: Introduction	Project Info
2.3 Step 3: Determine the operational users and notional suppliers of the information needed.	
2.9 Step 9: Discuss RF Spectrum needs.	
2.10 Step 10: Perform a Net-Centric Assessment	
2.12 Step 12: Discuss the program's Information Assurance strategy and reference the Program Protection Plan.	IAS
2.13 Step 13: Identify information support needs to support development, testing and training.	
Chapter 3 - Issues	
Appendix D. - Acronym List	ISP

ISP Example Topic Area Orphans

(U) EXECUTIVE SUMMARY		
1	(U) INTRODUCTION	
1.1.2	(U) Relationship to Other Programs	
1.1.3	(U) Relationship to Relevant Joint Functional Concepts (JFCs), Joint	
1.1.3.1	(U) Joint Functional Concepts	
1.1.3.2	(U) Associated Integrated Architectures	
1.1.3.3	(U) JCIDS	
1.2	(U) PROGRAM DATA	Current MS and Acquistion Status Integrated Master Schedule Increment I schedule Increment II schedule
1.2.1	(U) Milestone and Acquisition Status	
1.2.2	(U) Spiral Evolution Strategy	
1.2.3	(U) Program Points of Contact	
1.3.1	(U) Information Integrity	
1.3.2	(U) DoD PKI System Architecture	
1.3.2.1	(U) DoD PKI Certificate Management Components	
1.3.3	(U) Role Definitions	
1.3.4	(U) PKI System Interface Overview	
1.4	(U) ISP DOCUMENT STRUCTURE	
2	(U) ANALYSIS	
2.3	(U) STEP 3 - DETERMINE OPERATIONAL USERS AND NOTIONAL SUPPLIERS	OV-4 Organizational Relationship Role Overview
2.3.1	(U) Operational Nodes and Elements (OV-2)	Operational Nodes and Elements (OV-2)
2.3.2	(U) Operational Node Activities	Operational Node Activities (SV-5)

ISP Example Topic Area Orphans
Continued

2.9	(U) STEP 9 - DISCUSS RADIO FREQUENCY SPECTRUM NEEDS
2.1	(U) STEP 10 - PERFORM A NET-CENTRIC ASSESSMENT
2.10.1	(U) Step 10-A: Evaluate Program Against Measurement Criteria
2.10.1.1	(U) PKI's Incorporation of NCOW RM Capabilities and Services
2.10.1.2	(U) Technical View Products
2.10.1.3	(U) SV-TV Bridge
2.10.1.4	(U) Definitions and Vocabulary
2.10.1.5	(U) GIG Mission Area Initial Capabilities Document (MA ICD)
2.10.2	(U) Step 10-B: Compliance with Emerging NCES CESs
2.10.3	(U) Step 10-C: Assess the Use of Software-Compliant Radios
2.10.4	(U) Step 10-D: Assess the Use of IPv6 DoD Net-Centric Data Strategy
2.10.5	(U) Step 10e: Assess the Use of DoD-Centric Data Management Strategy
2.10.6	(U) Step 10-F: Assess the GIG Bandwidth Expansion Relationship
2.10.7	(U) Step 10-G Net-Ready Key Performance Parameter (NR-KPP) Statement
2.10.8	(U) Applicability of Major Net-Centricity Characteristics of PKI Increments One and Two
2.12	(U) STEP 12: DISCUSS THE INFORMATION ASSURANCE STRATEGY

2.12.1	(U) Program Category and Life-Cycle Status
2.12.2	(U) Mission Assurance Category and Confidentiality Level
2.12.3	(U) System Description
2.12.4	(U) Threat/Risk Assessment
2.12.5	(U) IA Requirements
2.12.6	(U) Certification and Accreditation
2.12.7	(U) IA Testing
2.12.8	(U) IA Analysis
2.13	(U) STEP 13: IDENTIFY SUPPORT NEEDS FOR DEVELOPMENT, TESTING, AND TRAINING
2.13.1	(U) Development
2.13.2	(U) Testing
2.13.3	(U) Developmental Test and Evaluation (DT&E)
2.13.4	(U) Operational Test and Evaluation (OT&E)
2.13.5	(U) Training
2.13.6	(U) CC/S/A Training Requirements
2.13.7	(U) LRA/TRA Background, qualifications, experience, and clearance requirements
3	(U) ISSUES
Appendix A	References
Appendix D	Acronym List and Glossary (AV-2)
Appendix E	Public Key Infrastructure Overview and Summary Information (AV-1)
Appendix F	Key Interface Profile (KIP)
Appendix G	Data AND Service Exposure

RSESC Overview

The University of Alabama in Huntsville (UAH) Rotorcraft Systems Engineering and Simulation Center (RSESC) is a state-of-the-art research and development Center that provides engineering solutions and products to Department of Defense (DoD), National Aeronautics and Space Administration (NASA), and industry customers with a focus on aerospace flight hardware systems. RSESC brings flight proven, unparalleled capabilities in atmospheric and aerospace flight hardware development, rotorcraft, fabrication, integration, and testing. RSESC has proven expertise in the fields of engineering design and analysis, rapid prototyping, fabrication, integration, destructive and non-destructive testing, flight qualification and acceptance testing, and launch/mission services.

The Center's foundation has been in the development of manned and unmanned aerospace systems. RSESC brings three key ingredients that are absolutely necessary to assure mission success: (1) knowledge of, and experience with, launch vehicle systems and payload development, (2) experience and in depth knowledge of the design requirements and the mission objectives, and (3) experience in the detailed engineering design, analysis, fabrication, and integration of flight hardware systems.

http://rsesc.uah.edu/

Notes

Systems Engineering Toolkit - User Roles

- SET provides eight types of users allowing you to use the document generation and review process that works for your organization
- Available User Roles
  - Reader – Lowest level of permissions, only able to generate document
  - Writer – User populates the document
  - Reviewer – Reviews the document at an inquiry level
  - Peer Reviewer* – Reviews the document at an inquiry level
  - Approver – Approves the document at the section level
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  - Version Controller – Final approver of the document, one person
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- Users may be assigned multiple roles to allow greater flexibility

* - Peer roles do not effect document processing, inputs are merely advise.

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