



Three SE Tools that can Change a Company

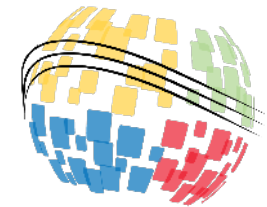
Project Performance International

Robert J. Halligan CpEng FIE Aust IntPE(Aus)



PPI Training and Consulting in SE worldwide





Robert J. Halligan

FIE Aust CPEng IntPE(Aus)



- **Managing Director** - Project Performance International
- **Content Contributor** - EIA/IS-632, EIA 632, IEEE 1220, ISO/IEC 15288 SE standards
- **Past INCOSE Head of Delegation** - ISO/IEC SC7 on Software and Systems Engineering
- **Past Member** of the INCOSE Board of Directors
- **Past President** - Systems Engineering Society of Australia
- **Consultant/Trainer** - BAE Systems, Mitsubishi, Airbus, Thales, Raytheon, General Electric, Boeing, Lockheed, General Dynamics, OHB, Nokia, AREVA, BHP Billiton, Rio Tinto, Embraer, Halliburton and many other leading enterprises on six continents



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SEI/AESS/NDIA 2012 Study Results: Requirements



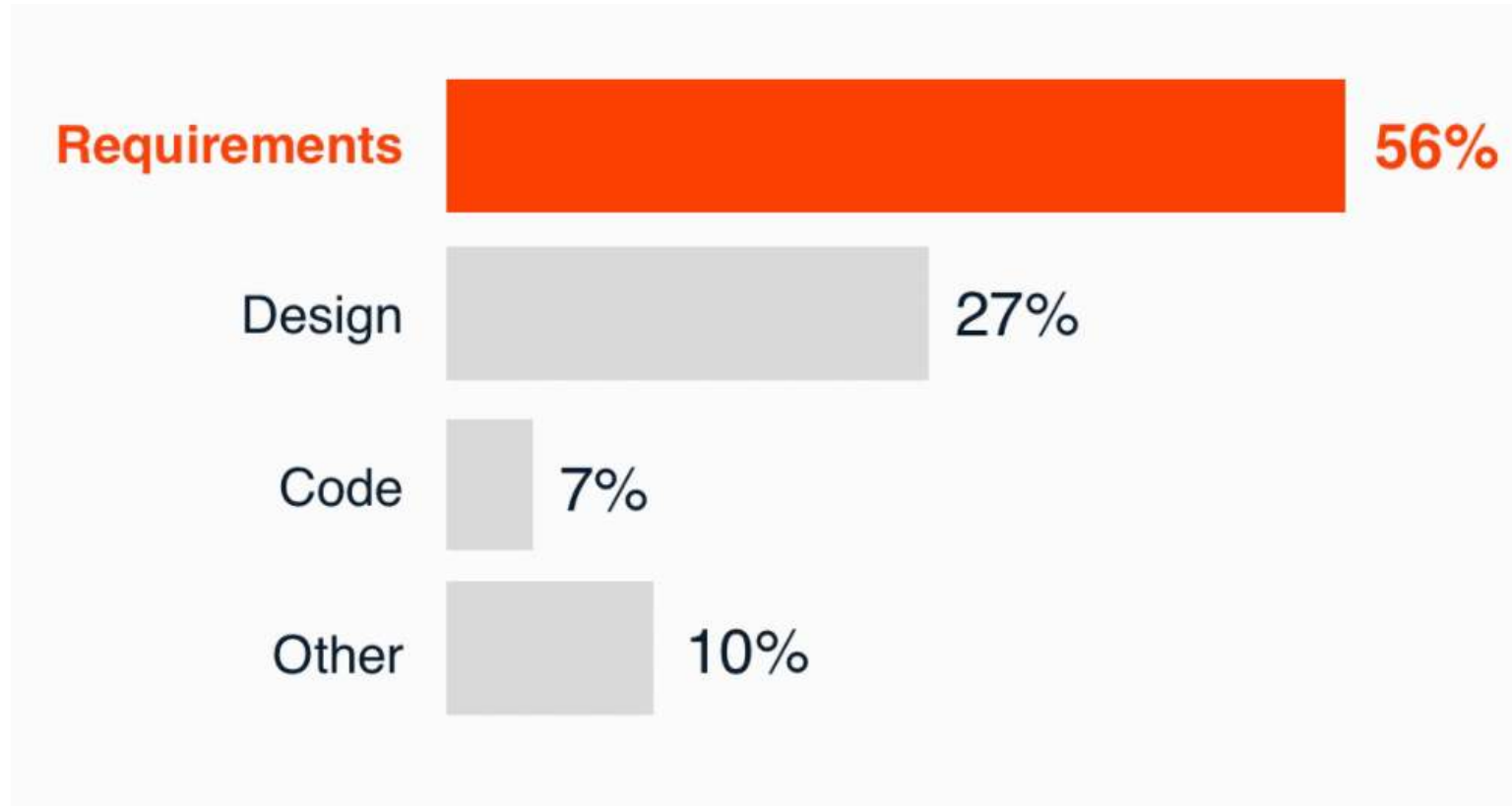
Driver	Relationship to Performance (Gamma)		
	All Projects	Lower challenge	Higher challenge
SEC-Total – total deployed SE	+0.49	+0.34	+0.62
SEC-PP – project planning	+0.46	+0.16	+0.65
SEC-REQ – reqts. devpt. & mgmt.	+0.44	+0.36	+0.50
SEC-VER – verification	+0.43	+0.27	+0.60
SEC-ARCH – product architecture	+0.41	+0.31	+0.49
SEC-CM – configuration management	+0.38	+0.22	+0.53
SEC-TRD – trade studies	+0.38	+0.29	+0.43
SEC-PMC – project monitor & control	+0.38	+0.27	+0.53
SEC-VAL – validation	+0.33	+0.23	+0.48
SEC-PI – product integration	+0.33	+0.23	+0.42
SEC-RSKM – risk management	+0.21	+0.18	+0.24
SEC-IPT – integrated product teams	+0.18	-0.12	+0.40

Gamma	Relationship
$-0.2 < Gamma \leq 0$	Weak negative
$0 \leq Gamma < 0.2$	Weak positive
$0.2 \leq Gamma < 0.3$	Moderate
$0.3 \leq Gamma < 0.4$	Strong
$0.4 \leq Gamma $	Very strong

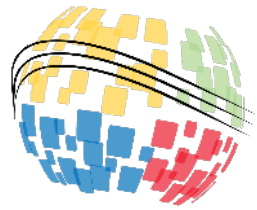
http://resources.sei.cmu.edu/asset_files/specialreport/2012_003_001_34067.pdf

Source: "The Business Case for Systems Engineering Study: Results of the Systems Engineering Effectiveness Survey", CMU/SEI-2012-SR-009, November 2012

Requirements: Greatest Cause of Project Problems



SEI/AESS/NDIA 2012 Study Results: Planning



Driver	Relationship to Performance (Gamma)		
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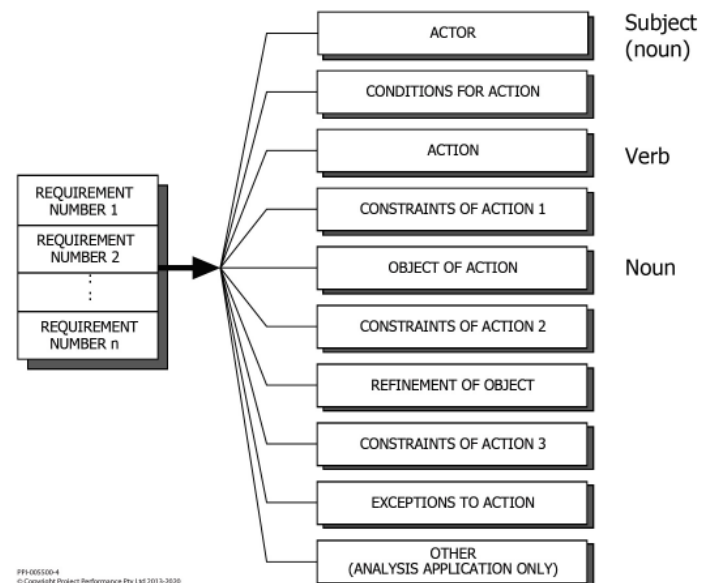
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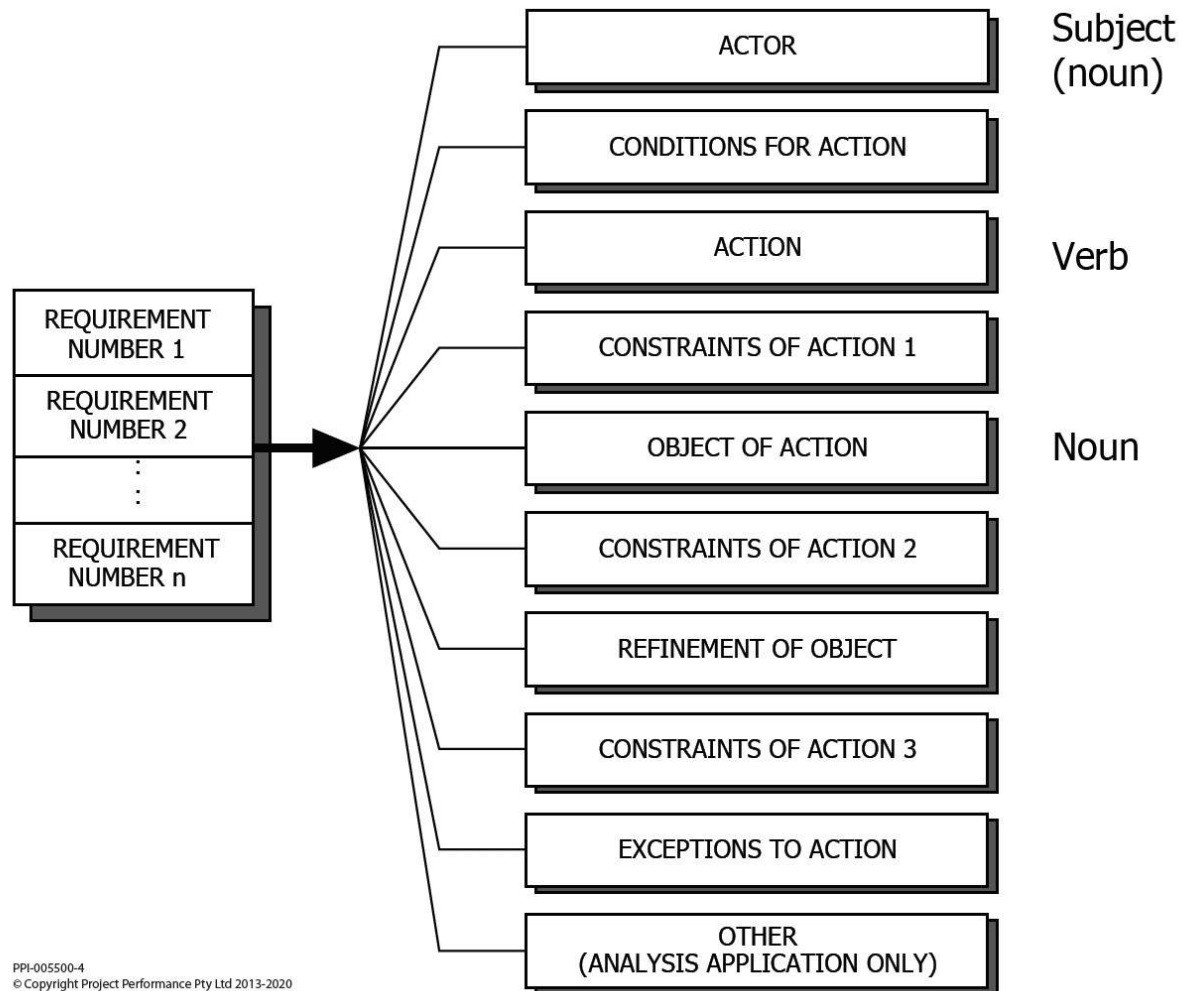


Tool 1: PPI Requirement Writing Template



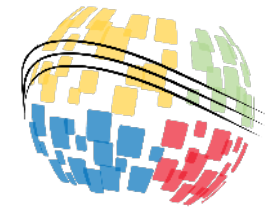


The Template



PPI-005500-4
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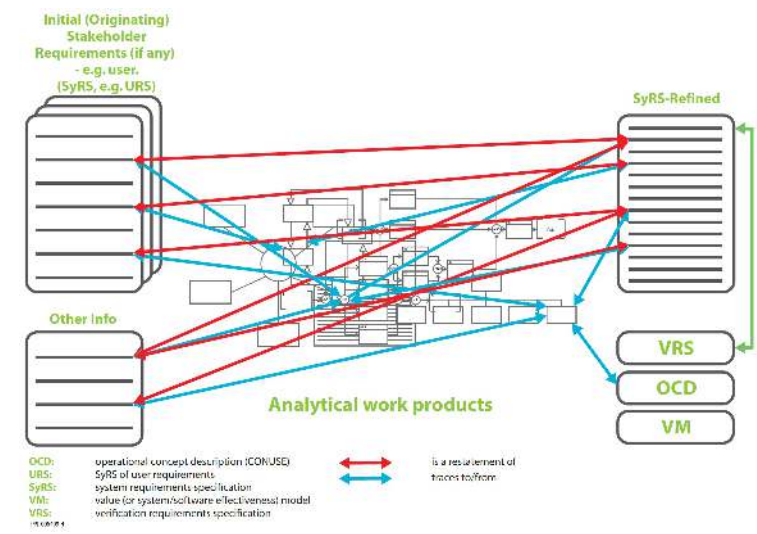
Example



Element	Text
1. Actor	The Message Switch,
2. Conditions for Action	when in message switching mode, upon receipt of a message,
3. Action	shall switch
4. Constraints of Action 1	
5. Object of Action	that message,
6. Constraints of Action 2	in accordance with IEEE 802.11g, within 10 ms of receipt,
7. Refinement of Object	for messages in ACP128 format having a valid routing indicator,
8. Constraints of Action 3	from the message input port, to a message output port corresponding to the routing indicator in the message,
9. Exceptions to Action	unless the message is of FLASH priority.
10. Other	



Tool 2: PPI Requirements Capture and Validation Methodology

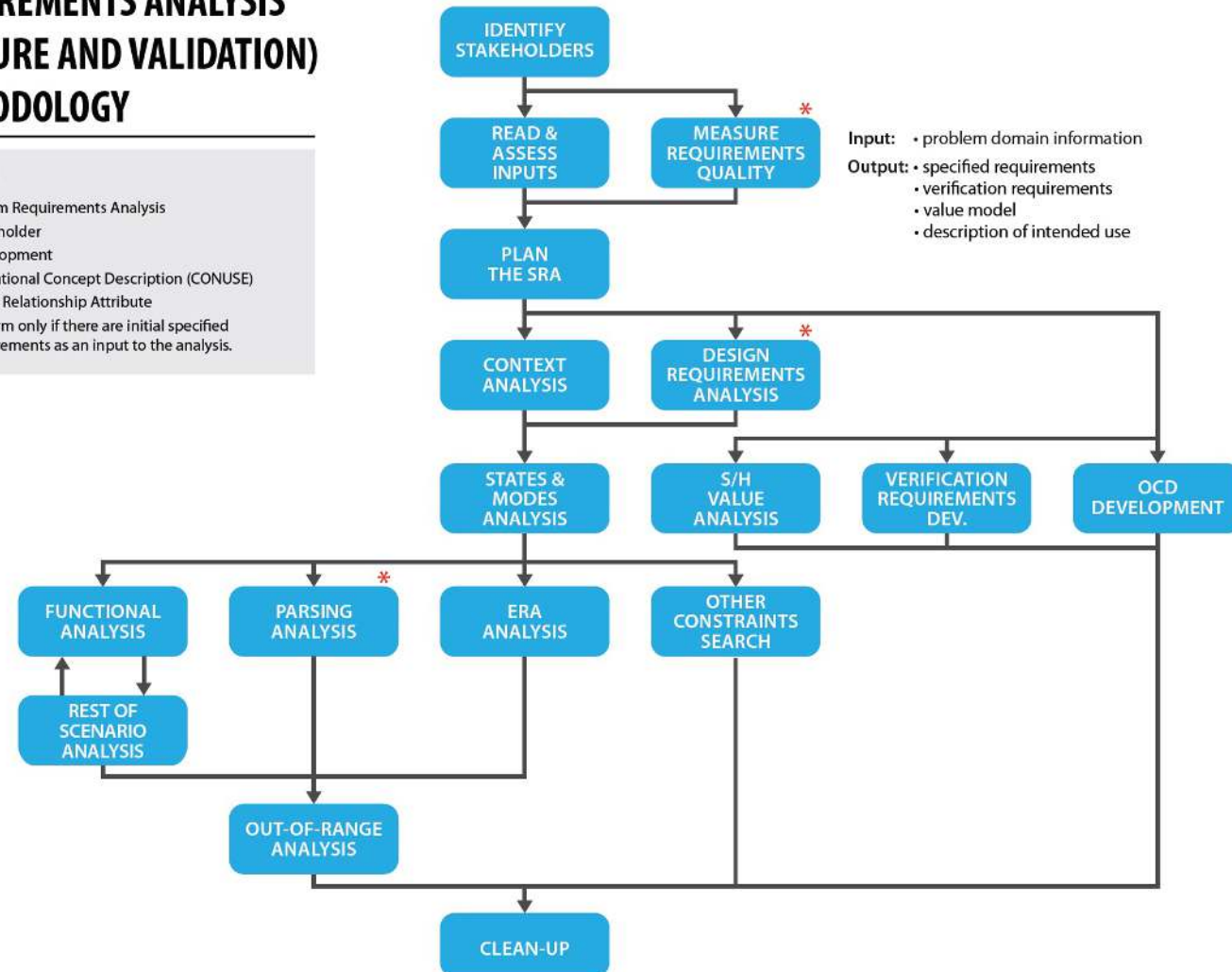


The Methodology

REQUIREMENTS ANALYSIS (CAPTURE AND VALIDATION) METHODOLOGY

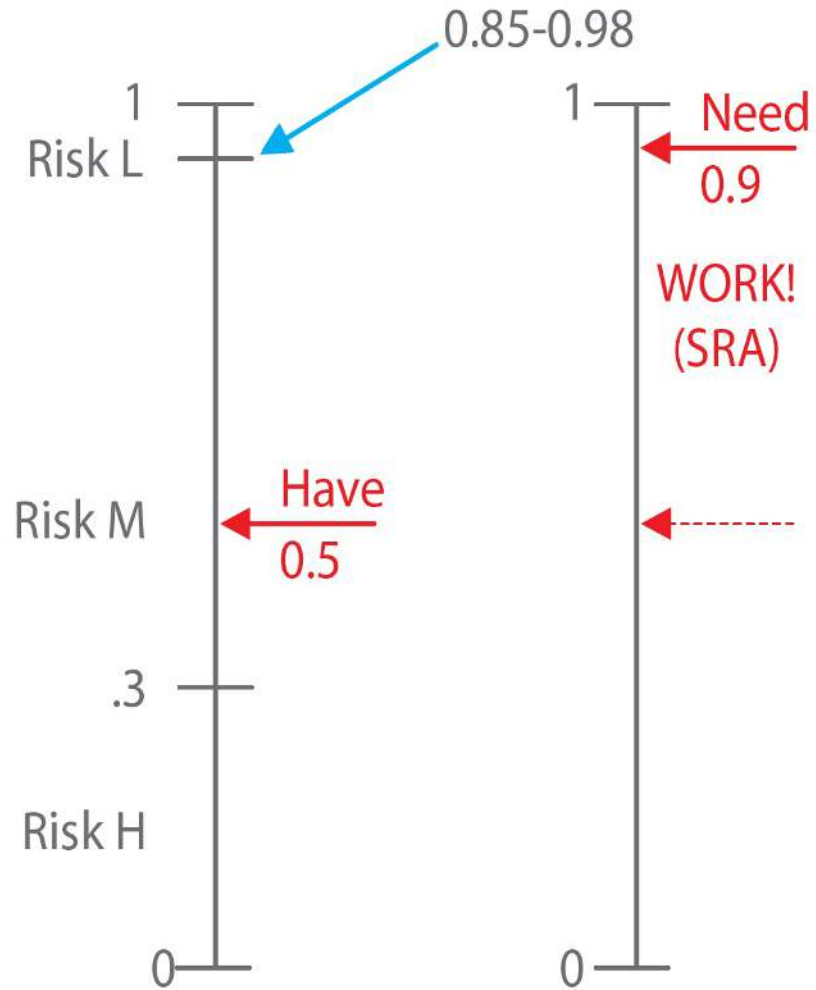
Legend:

SRA System Requirements Analysis
S/H Stakeholder
DEV Development
OCD Operational Concept Description (CONUSE)
ERA Entity Relationship Attribute
 * Perform only if there are initial specified requirements as an input to the analysis.





Measuring Requirements Quality



WORK = f(

Have

Need

Number of Requirements

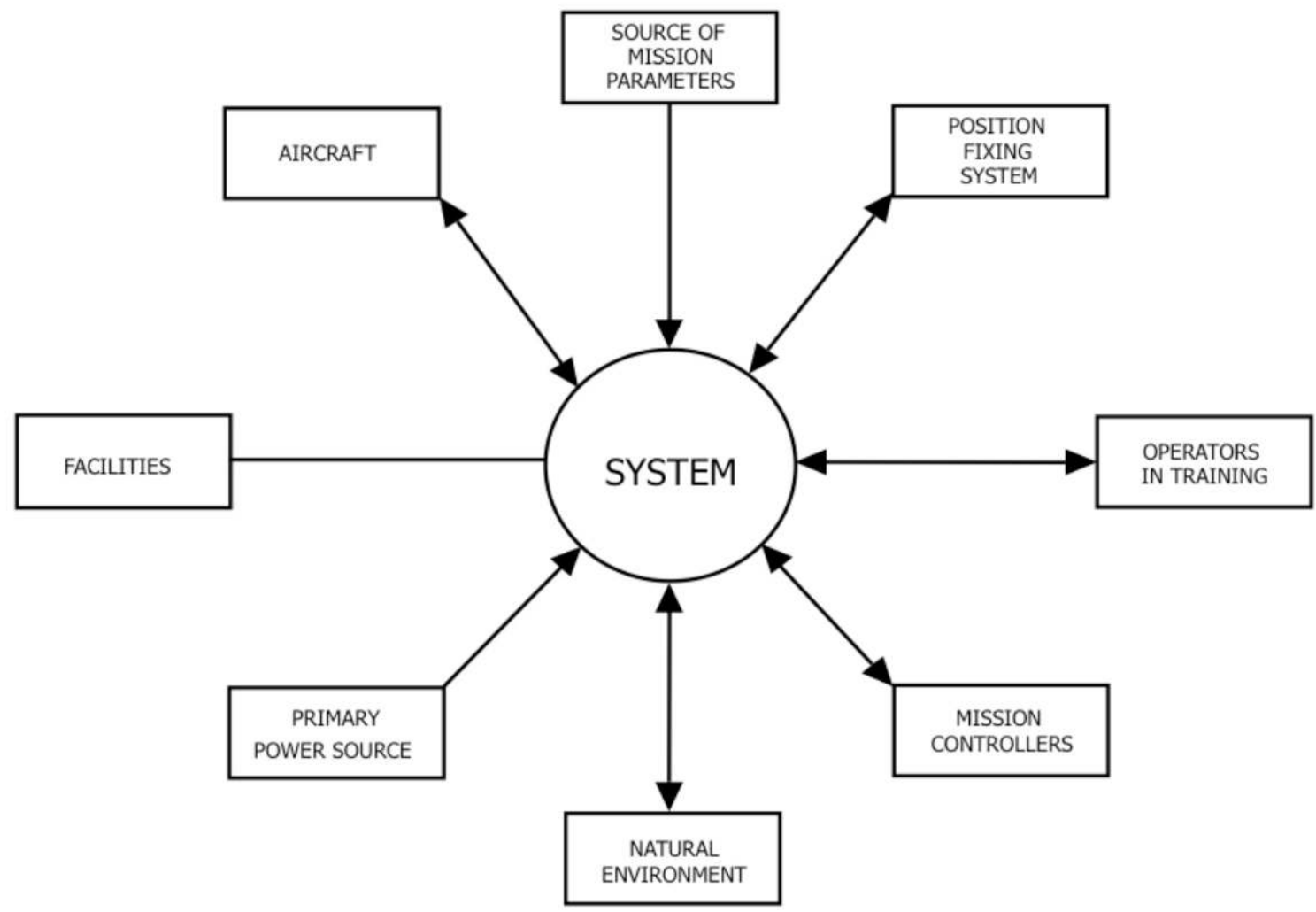
Skills

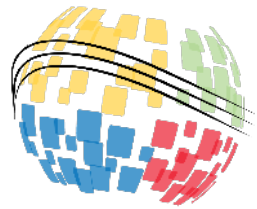
Tech-Environment

Access & Cooperation)

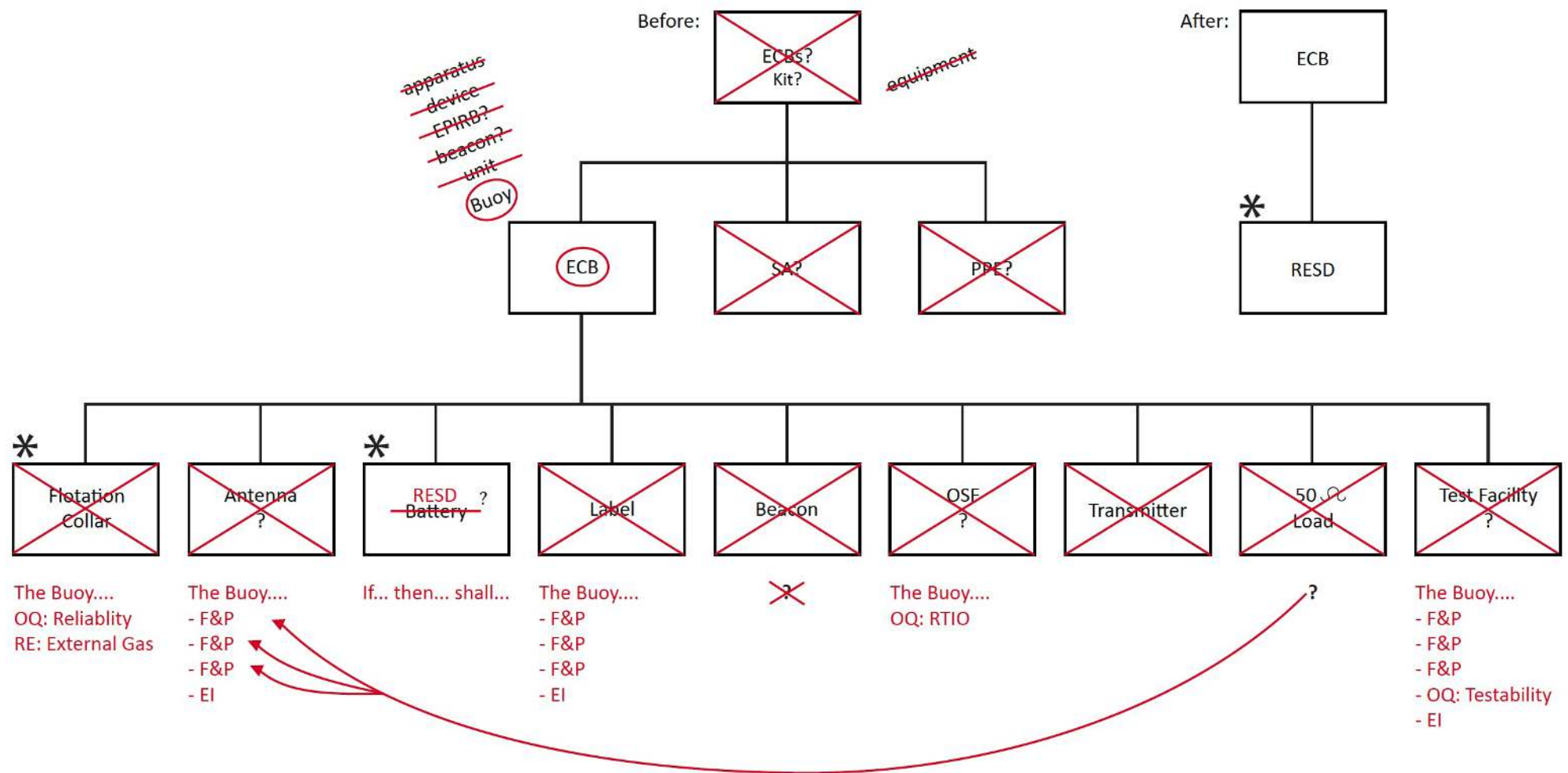


Context Analysis



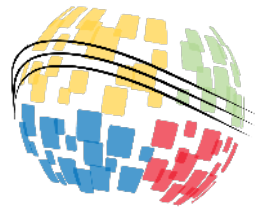


Design Requirements Analysis



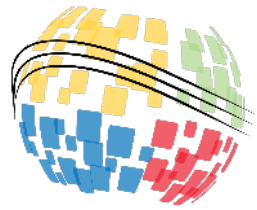


Parsing Analysis

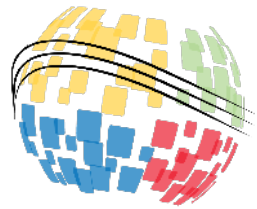


Element	Text	Comment
1. Actor	The VIN Network architecture	wrong actor
2. Conditions for Action		mode?
3. Action	shall be designed	loophole
4. Constraints of Action 1	to allow each radar in the system to operate autonomously.	allow? degree?
5. Object of Action		
6. Constraints of Action 2		
7. Refinement of Object		
8. Constraints of Action 3		
9. Exceptions to Action		
10. Other		

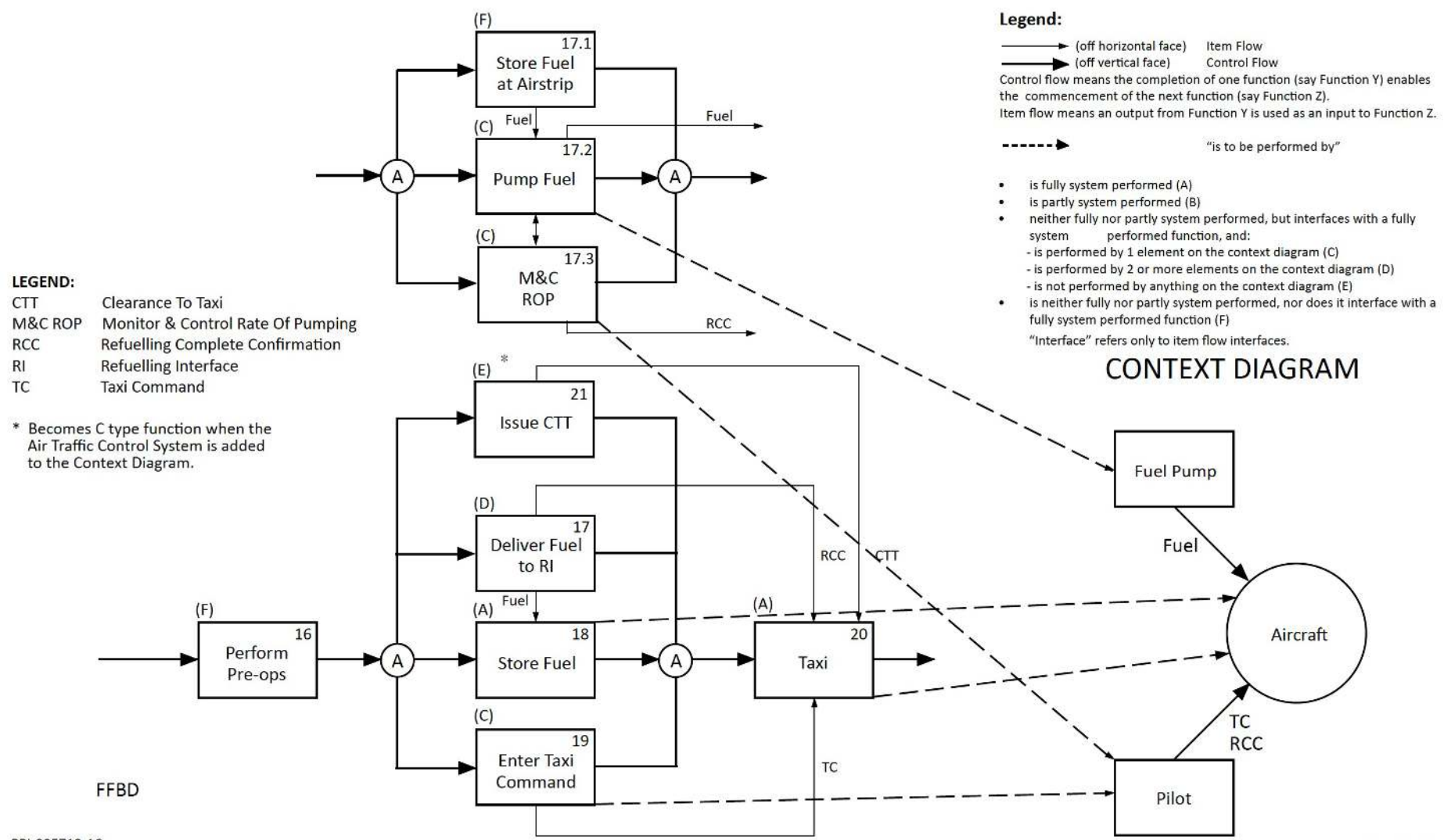
Parsing Analysis



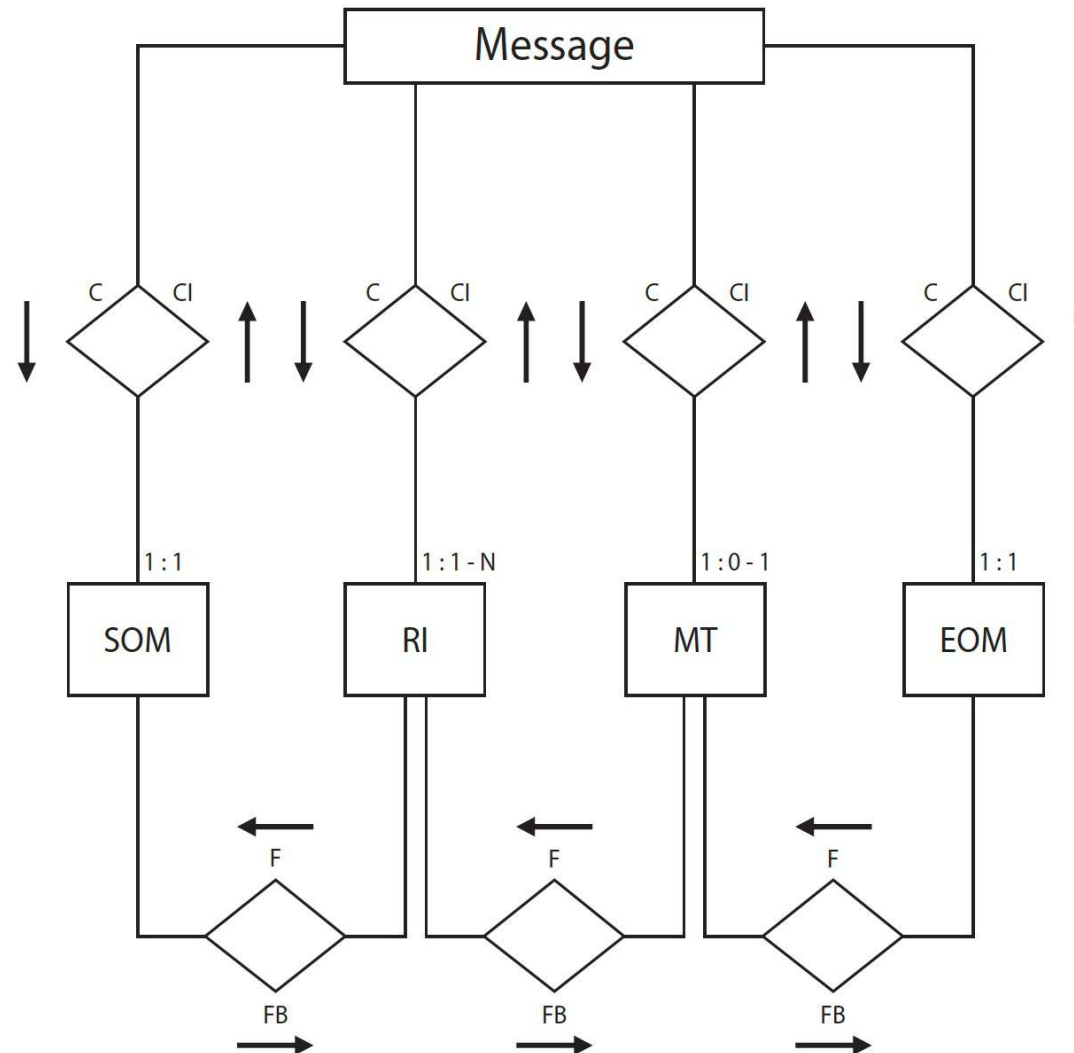
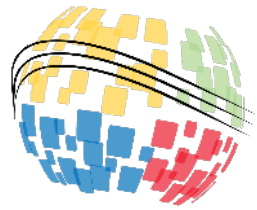
Element	Text
1. Actor	The VIN Network,
2. Conditions for Action	in Active State, under all combinations of its functionality specified at 4.3,
3. Action	shall not prevent
4. Constraints of Action 1	
5. Object of Action	simultaneous autonomous operation,
6. Constraints of Action 2	
7. Refinement of Object	as specified at PPI-006723, of each radar in the DRAD system.
8. Constraints of Action 3	
9. Exceptions to Action	



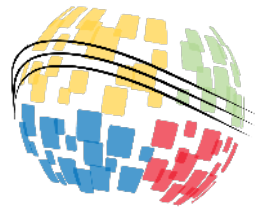
Functional Analysis

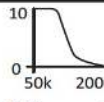
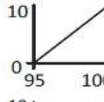
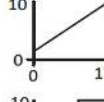
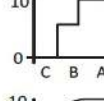
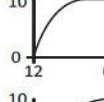
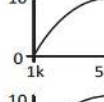
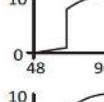
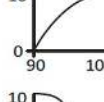
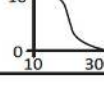


Entity-Relationship-Attribute Analysis



Stakeholder Value Analysis



MOEs	Worst	Best	Pri	Pts	Weight %	UF
Cost, \$ks per unit	200	50	1	100	25	
Reliability, %	95	100	1	100	25	
Interoperability	0	17	7	14	4	
Size(A/B/C)	C	A	8	3	1	
Schedule (Months)	12	6	3	40	10	
Visible Optical Range	1000	5000	5	30	7	
Duration of Transmission, hr	48	96	6	27	6	
Readiness, %	90	100	4	39	10	
OS & D Cost, \$k pu/10 years	300	10	2	50	12	

Legend:

Pri: Priority

Pts: Points

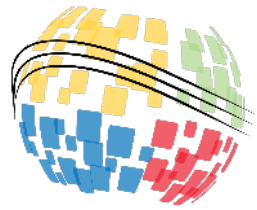
UF: Utility Function

PPI-006799-6

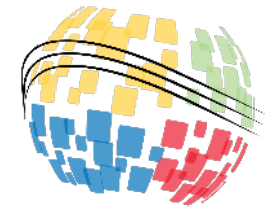
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Verification Requirements Development



Element	Text	Remarks
1. Actor:	<i>The verifier (implicit)</i>	
2. Conditions for Action:		
3. Action:	<i>shall (implicit)</i> Demonstrate	
4. Object of Action:	compliance	
5. Constraints of Action:	by having a person meeting the specified profile perform trial lifts, for not less than 5 lifting operations covering extremes of specified pitch and roll.	
6. Refinement/Source of Object:		
7. Refinement/Destination of Action:		



Clean-Up of Specified Requirements

SEARCH LIST OF TERMS INDICATIVE OF POTENTIAL SPECIFICATION/SOW WEAKNESS

An effective technique for finding defects in specified requirements is the use of keyword searching, against parts of words, words and phrases, each of which may indicate a defect in a requirement. Although written as a list for verifying requirements, the list provided also contains much advice for the original writer of requirements, and requirements specifications, in English.

An asterisk used to represent a wildcard, e.g. “*ing” means search for any word ending in “ing”.

Search Term	Concerns
*ing	Avoid gerunds, such as “displaying”, “computing”. Ensure that any usage of gerunds is adequate. Rarely can gerunds be used adequately in requirements.
a	The word “a” usually means any one, which may be one of many. Ensure that ambiguity is not introduced.



Tool 3: PPI PBS/WBS Development

The level 1 element is the project.

To define level 2 elements:

1. What products (physical/software/data) are required to be delivered by the project?
2. What services are required to be delivered by the project?
3. What services are necessary, internal to the project, to deliver the project outputs and outcomes, that are not needed uniquely to create (for physical/software/data product) or deliver (for a service) just a single element from questions 1 and 2?

One answer to this last question is always "Project Management"

4. What products, if any, internal to the project, that involve project cost or other resources in their realization, are necessary to deliver the project outputs and outcomes, that are not needed uniquely to create (for a physical/software/data product) or deliver (for a service) just a single element from questions 1, 2 and 3?

To define sub-elements below level 2, the questions for a product element are:

- 5-1. What products are to be integrated to create this product element?
- 5-2. In addition to the products from question 5-1, what services are to be performed to create this product element, that are not needed uniquely to create just a single sub-element from question 5-1?
- 5-3. In addition to the products and services from questions 5-1 and 5-2 respectively, what products are necessary, that involve project cost or other resources in their realization, to create this product element, that are not needed uniquely to create (for physical/software/data product) or perform (for a service) just a single sub-element from questions 5-1 and 5-2 respectively?

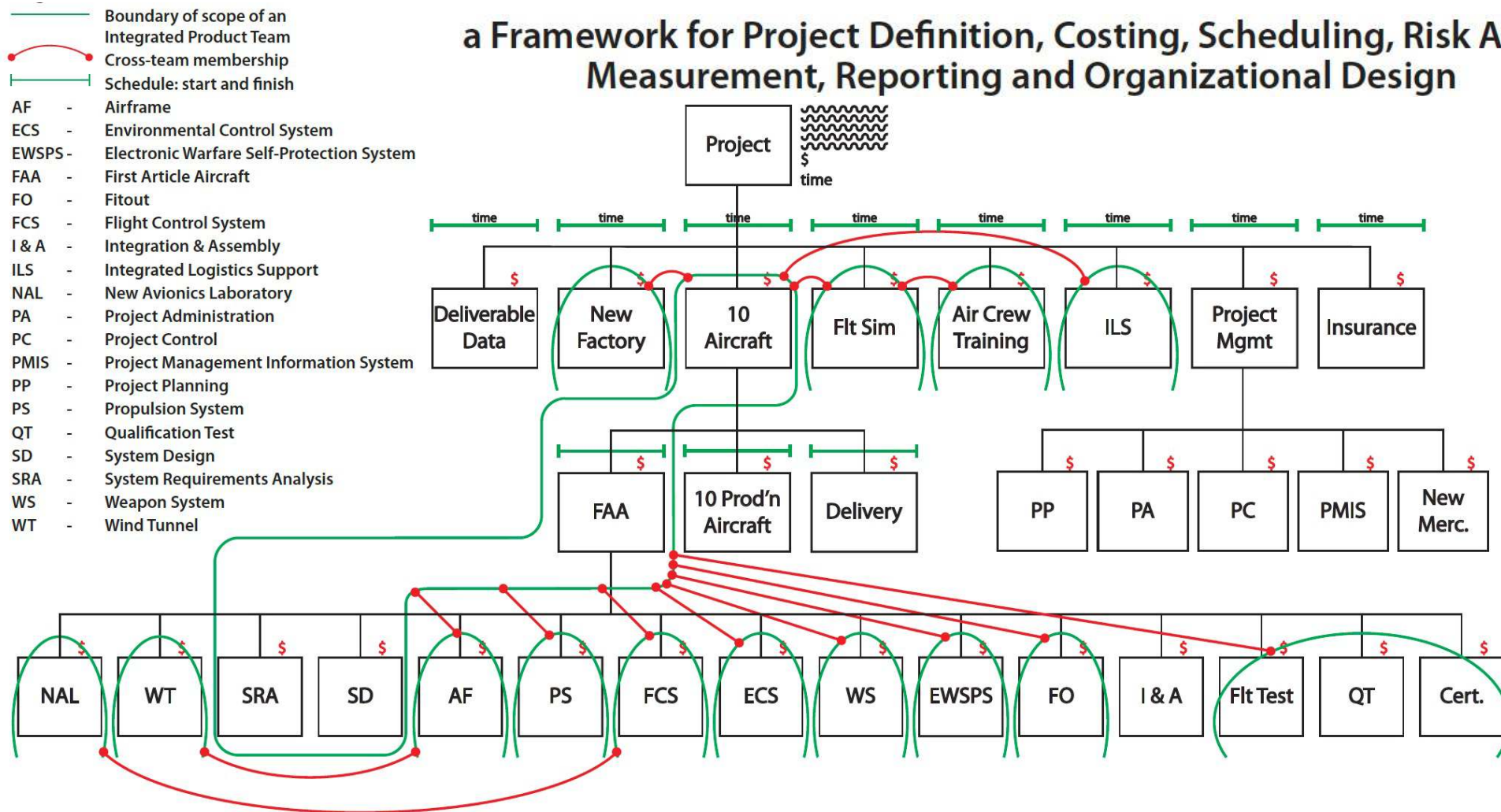
To define sub-elements below level 2, the questions for a service element are:

- 6-1. What services are to be integrated to perform this service element?
- 6-2. In addition to the services from question 6-1, what products are necessary to perform this service element, that involve project cost or other resources in their realization, and that are not needed uniquely to perform just a single service sub-element from question 6-1?

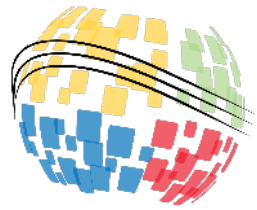


How to Develop a Great PBS/WBS and What You Get Out of It:

a Framework for Project Definition, Costing, Scheduling, Risk Analysis, Measurement, Reporting and Organizational Design



Free PPI Help to Clients



PPI Data Item Descriptions:

Project Plan

Task Specification (TS)

Statement of Work (SOW)

Systems Engineering Plan (SEP)

Operational Concept Description (OCD)

System Requirements Specification (SyRS)

Software Requirements Specification (SRS)

Verification Requirements Specification (VRS)

Interface Requirements Specifications (IRS)

Interface Design Description (IDD)

System/Subsystem Design Description (SSDD)

Concept of Operations (CONOPS) – Operational Solution Description



More Free PPI Help to Clients

PPI Example Documents:

Concept of Employment (CONEMP)

Concept of Use (CONUSE - OCD)

Capability System Requirements Specification (CapSyRS)

Capability System Value Model

Interface Requirements Specification

Operational Solution Description (OSD)

Concept of Use (CONUSE - OCD) for a technology item

Systems Requirements Specification (SyRS) for a technology item

System Effectiveness Model for a technology item

Statement of Work (SOW)

Verification Requirements Specification (VRS) for a technology item



Even Free PPI Help to Clients

PPI Application Guides to Systems Engineering Standards:

EIA-632: 2003

IEEE 1220

ECSS-E-ST-10C

ISO/IEC 15288:2008

ISO/IEC/IEEE 15288:2015

ISO/IEC/IEEE 29148:201X (when released)

And More Again:

PPI Practice Guides:



**Requirements
Capture and
Validation
Guide**



**Requirements
Specification
Development
Guide**



**Military
Capability
Development Guide**

The SEG and PPI-INCOSE SETDB



SETDB

SYSTEMS ENGINEERING TOOLS DATABASE



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or in person: Robert Hallian - rhalligan@ppi-int.com
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*Thank you for your interest, and have a great Symposium.
Any questions?*



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