






## Aligning Naval Product Support to the Navy's Warfighting Operational Strategies

### Part II: The Digital Thread

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PLM Road Map™ & PDT North America 2023  
*The Digital Thread in a Heterogeneous, Extended Enterprise Reality*  
 A call for PLM Professionals to share their knowledge & experience  
 May 3 & 4  
 CIMdata 


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## The Real World.....

### Its all about Overcoming Failure!

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**Does the Support meet the various operational mission profiles?**

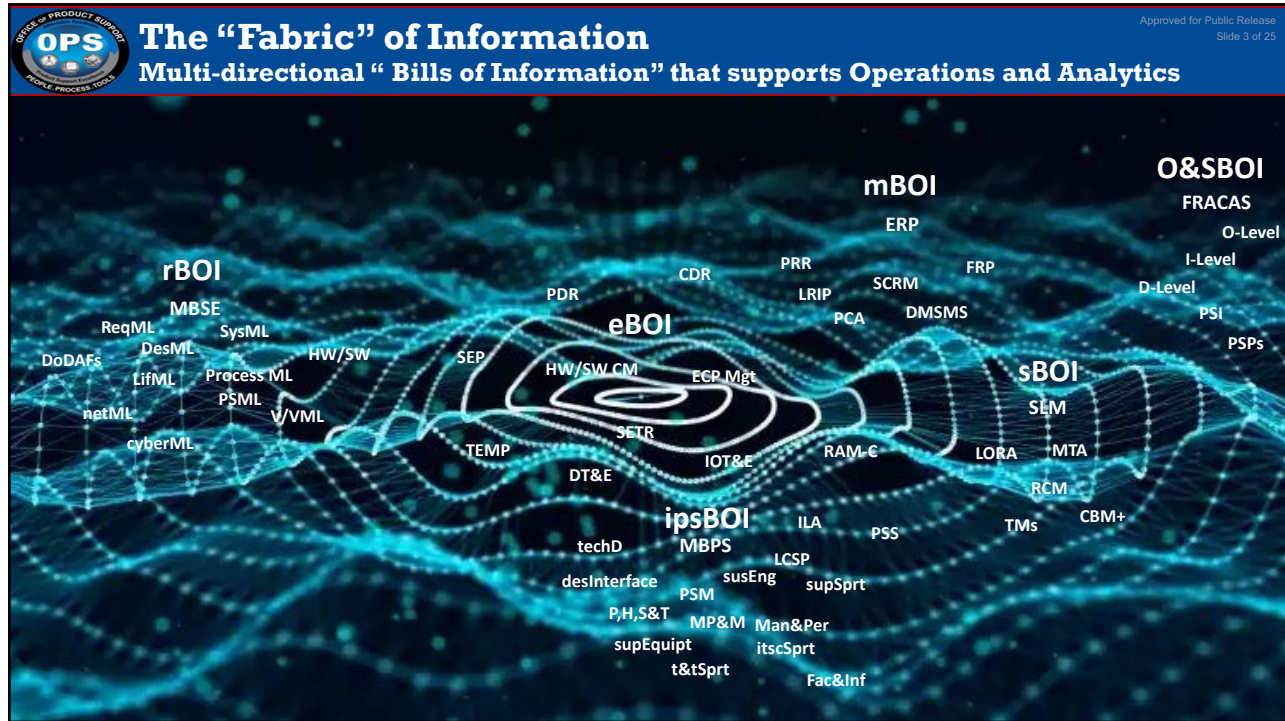
- What system design and configuration are optimal from a supportability perspective?
- How will Operational Availability (Ao) change over time and how do I manage it?

**Does this "Digital Twin" match the Fleet's Physical Configuration?**

**Are we getting the correct "Digital Thread" data for analysis and decision?**

- Which system elements are the cost drivers?
- How many technicians do I need and where?
- What and how many spare parts should I keep on ship?

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## Digital Product Support

### The Application: ePLM IDE

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**enterprise Product Lifecycle Management (ePLM)**

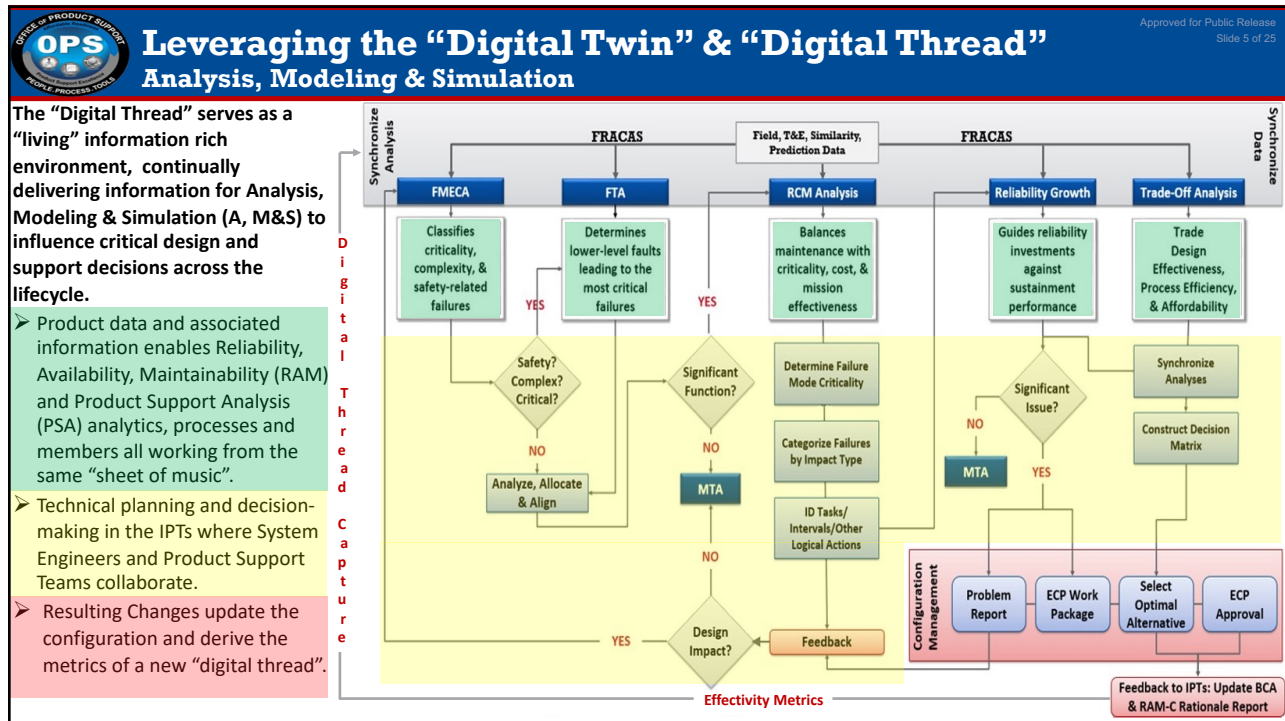
- > A consistent set of business solutions that support the collaborative *creation, management, dissemination, and use of product definition information, spanning from product concept to end of life*
- > Provides a structured, authoritative product information backbone for weapons systems
- > Rigorous configuration management of a weapon system top-down breakdown and all of its associated technical / product data
- > Maintains traceability of all analysis and decisions throughout a weapon system's life cycle

**Integrated Decision Environment (IDE)**

- > Incorporates key system and support data (i.e. reliability, maintainability, cost, and supply chain) with RAM-C Modeling and Simulation tools for decision makers to determine lifecycle cost and readiness impacts of critical design and support modifications
- > Supportability / RAM-C analysis to influence design for supportability and affordability
- > Perform root cause analysis and implement materiel and non-materiel changes as necessary in sustainment
- > Predictive analysis to optimize readiness and life cycle cost
- > Integrated with PLM application to establish critical links between configuration changes, system baselines, and supporting analysis

Functionally, ePLM IDE was designed to provide a common enterprise product model capability (digital twin), facilitating bi-directional traceability (digital thread) to more efficiently manage the digital models throughout the lifecycle, and provide a common data decision environment to address escalating life cycle cost growth across the Navy.

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**Office of Product Support**  
**OPS**  
 PEOPLE, PROCESS, TOOLS

## A Day in the Life of a Digitally Transformed PS Team Checkin' in with the Digital Twin

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**Somewhere in the World CVN 77 UAV CONOPS:**  
**UAV OPS RESTRICTED:**  
 Intermittent loss of UAV navigational control on final approach resulting in damage to payload, landing gear and potential loss of UAV. Initial indications at the O & I Level identify the thermostat control as a potential leading cause.

**Lets Start with our Digital Twin:**

- Location of the Strike Talon UAV within the Fleet
- Review the Thermostat Control
- Leverage the FRACAS Digital Thread

**Library - UIC Library, EPLMIDE**

Number...	Name	Version	State
23168	LPD 18-NEW ORLEANS	-1 (Engineering)	Active
23170	CVN 77-GEORGE H W BUSH	-1 (Engineering)	Active
23171	LHD 8-MAKIN ISLAND	-1 (Engineering)	Active
23172	SSN 778-NEW HAMPSHIRE	-1 (Engineering)	Active
23173	CVN 78-GERALD R FORD	-1 (Engineering)	Active
23180	LPD 24-ARLINGTON	-1 (Engineering)	Active

**Details Structure Related Objects Changes History Where Used Traceability**

**Editing:** Insert Existing, Remove, Insert New, Edit

**Check Out/In:** Check Out, Check In, My Checkouts, Revise

**Clipboard:** Paste, Copy

**Viewing:** Show, Hide, Views, Display

**New/Add To:** New, Add to

Find in Structure: All, Advanced

Identity	CAGE Code	Number	Name
23170, CVN 77-GEORGE H W BUSH, EPLMIDE, -1 (Engineering)	EPLMIDE	21660	CVN 77-GEORGE H W BUSH
SYSTEM-000_01, STRIKE TALON, EPLMIDE, -3 (Engineering)	EPLMIDE	SYSTEM-000_01	STRIKE TALON

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**OPS** **A Day in the Life of a Digitally Transformed Team**  
**Checkin' in with the Digital Twin: Preparing for RAM Analysis**

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Part - SYSTEM-000\_01, STRIKE TALON

Part - 66F060-0431\_01, THERMOSTAT CONTROL EPLMIDE, -2 (Engineering)

Part - 66F060-0431\_01, THERMOSTAT CONTROL EPLMIDE, -2 (Engineering)

Structure

Where Used

Described By Documents

Number	Version	Name
66F060-0431_01	-1	Thermostat Drawing
TM 7610-LL-L1A-0018_01	-1	TM 7610-LL-L1A-0018

Reference Documents

Number	Version	Name
0000202225	-1	Weibull Reliability Growth Use Case 5
0000202224	-1	Top10_Risk Priority Number_Thermostat FINAL
0000202218	-1	Risk Criticality Matrix_Thermostat FINAL
0000202217	-2	Aux Cooling Thermostat Cost Analysis

Where Used

Number	Name
66F060-0431_01	THERMOSTAT CONTROL
104747-AUX-109_01	ASSEMBLY AUX COOLING
104747_01	UHF/SATCOM
ST-UAV-COMNAV-D01_01	COMNAV
SYSTEM-000_01	STRIKE TALON

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**OPS** **The Living "Digital Twin" & "Digital Thread":**  
**RAM-C Analysis, Modeling & Simulation**

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PRODUCT STRUCTURE OBJECTS

DOCUMENT OBJECTS

CHANGE OBJECTS

Weapon System

Power Supply

- Requirements
- Failure Trend Analysis
- T&E Results
- Drawing
- CAD Model
- Technical Manual Content

BOM

Problem

Life data set

MTTF, Failure Rate

Real-world Performance

Faults

Failure Rates

Actual MTBF, Availability, etc.

MTTR

Maintenance Cost

FMEA

FTA

Prediction

RBD

MAINTAINABILITY

LCC

ALT

MARKOV

Failure Rate

Time to Failure

Related ECPs

Related Change Activities

Reliability, Availability, Maintainability-Cost (RAM-C) leveraging the Digital Twin & Thread together via key system and support data (i.e. reliability, maintainability, cost, and supply chain) with RAM-C Modeling and Simulation capabilities provides decision makers the ability to do "what-if" Engineering analysis to determine lifecycle cost and readiness impacts of critical design and support modifications.

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**OPS** Digital Thread in Action: RAM: Failure Reporting Analysis & Corrective Action Analysis Approved for Public Release  
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**System Tree Items**

Name	Part Number	Failure Rate, Predicted	MTBF, Predicted	Failure Rate (FRACAS)	MTBF, Actual	Cost	Parent Assembly	Manufacturer	Description	Configuration...	Level	ESWBS	FSC	NIIN
R/T UHF SATCOM	104747-101	45.036765	22204	0.000000	0.000000	\$0.00	UHF/SATCOM				4			
ASSEMBLY ANTENNA RELAY	104747-102	26.135814	38262	0.000000	0.000000	\$0.00	UHF/SATCOM		UAF Downlink		4			
ASSEMBLY AUX COOLING	104747-AUX-109	32357.743714	31	0.000000	41.892992	\$9,310.00	UHF/SATCOM	Airpax			4			
FAN COOLING 2 AMP	104747-FAN-11	25000.000000	40	0.000000	0.000000	\$0.00	ASSEMBLY AUX COOLING	Airpax			5			
<b>THERMOSTAT CONTROL</b>	<b>66F060-0431</b>	<b>7344.720274</b>	<b>136</b>	<b>0.000000</b>	<b>49.509900</b>	<b>\$0.00</b>	<b>ASSEMBLY AUX COOLING</b>	<b>Airpax</b>	<b>Thermostat</b>		<b>5</b>			
RELAY FAN	C0E2450	0.464000	2e+006	0.000000	272.304449	\$0.00	ASSEMBLY AUX COOLING		Relay		5			

**Failure Review Board**

Site, Incident: **Strike Talon** Incident ID: **Inc001**  
 Incident Entry: 12/08/2017

System Tree Item: **THERMOSTAT CONTROL** CASREP Number: **2Kilo Report**

Serial Number: **10234111** Location: **2Kilo Report**

Meter Reading: **#** When Discovered Code: **1/1**

Failure Symptom: **Overheating** Open Date of the Report: **1/1**

Failure Detection: **Operator Senses** Status Code: **1/1**

Operating Mode: **Normal Operation** Priority Code: **1/1**

Occurrence Date: **1/06/2012** Time To Failure: **41.00** Safety Code: **1/1**

Description, Incident: **Thermostat Fan Failed, replaced on site** Remarks, Incident Entry: **Perform failure review and categorization & scoring to assign Failure Mode, Relevance, and Criticality**

**Maintenance Log**

Incident	Maintenance Log ID	CASREP Number	Maintenance Start	Symptom	Sub-Assembly	Part	Deficiency	Actions Taken	Remarks
1	Inc001	Maintlog1	1/9/2012	Overheating	THERMOSTAT FAN		Short	Replaced Thermostat Fan	

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**OPS** Digital Thread in Action: RAM: Failure Reporting Analysis & Corrective Action Analysis Approved for Public Release  
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**System Tree Items**

Name	Part Number	System Tree Ident.	Failure Rate, Predicted	MTBF, Predicted	MTBF 1 (FRACAS)	Reference Design.	Description	Manufacturer	MTR (Mal.)	Failure Rate	Parent Assembly
R/T UHF SATCOM	104747-101	System70	45.036765	22204	0.000000	COMNAV11				0.000000	UHF/SATCOM
ASSEMBLY ANTENNA RELAY	104747-102	System73	26.135814	38262	0.000000	COMNAV12	UAF Downl...			0.000000	UHF/SATCOM
ASSEMBLY AUX COOLING	104747-AUX-109	System76	32357.743714	31	136.152214	COMNAV13	"MANUFACTU...			0.000000	UHF/SATCOM
<b>THERMOSTAT CONTROL</b>	<b>66F060-0431</b>	<b>System77</b>	<b>7344.720274</b>	<b>136</b>	<b>136.152214</b>	<b>COMNAV132</b>	<b>Thermostat</b>	<b>Airpax</b>	<b>#</b>	<b>0.000000</b>	<b>ASSEMBLY AUX COOLING</b>
RELAY FAN	C0E2450	System79	0.464000	2e+006	0.000000	COMNAV133	Relay			0.000000	ASSEMBLY AUX COOLING

**FRACAS Incidents**

Incident Identifier	Occurrence Date	Description, Incident	Failure Mode	System	Component	Serial Number	Classed?	Action Taken	Close Out End Date	Time To Fail...	Cumulative Fail...	Problem	Parent Assembly
Inc001	1/6/2012	Thermostat Failed, replaced on site	Improper Output	ASSEMBLY AUX COOLING	THERMOSTAT	10234111	☑	CHANGED OUT THERMOSTAT	1/8/2012 5:41:46 PM	41.00	41.00	Thermostat Fan Failures	ASSEMBLY AUX COOLING
Inc002	8/4/2012	Thermostat Fan Failed, r...	Improper Output	ASSEMBLY AUX COOLING	Thermostat Fan	10234112	☑	CHANGED OUT Thermostat Fan	8/12/2012 5:40:16 PM	30.00	70.00	Thermostat Fan Failu...	ASSEMBLY AUX COOLING
Inc003	8/5/2012	Thermostat Fan Failed, r...	Electrical Overstre...	ASSEMBLY AUX COOLING	Thermostat Fan	95121002	☑	CHANGED OUT Thermostat Fan	8/8/2012 5:40:53 PM	20.00	90.00	Thermostat Fan Failu...	ASSEMBLY AUX COOLING
Inc004	9/2/2012	Thermostat Fan Failed, r...	Improper Output	ASSEMBLY AUX COOLING	Thermostat Fan	10234143	☑	CHANGED OUT Thermostat Fan	9/2/2012 5:42:09 PM	15.00	105.00	Thermostat Fan Failu...	ASSEMBLY AUX COOLING
Inc005	9/8/2012	Thermostat Fan Failed, r...	Electrical Overstre...	ASSEMBLY AUX COOLING	Thermostat Fan	95121002	☑	CHANGED OUT Thermostat Fan	9/9/2012 5:41:16 PM	12.00	117.00	Thermostat Fan Failu...	ASSEMBLY AUX COOLING
Inc006	10/1/2012	Thermostat Fan Failed, r...	Improper Output	ASSEMBLY AUX COOLING	Thermostat Fan	10234156	☑	CHANGED OUT Thermostat Fan	1/8/2014 5:39:54 PM	10.00	127.00	Thermostat Fan Failu...	ASSEMBLY AUX COOLING
Inc007	11/17/2012	Thermostat Fan Failed, r...	Electrical Overstre...	ASSEMBLY AUX COOLING	Thermostat Fan	95121002	☑	CHANGED OUT Thermostat Fan	11/18/2012 5:40:53 PM	8.00	135.00	Thermostat Fan Failu...	ASSEMBLY AUX COOLING
Inc008	11/18/2012	Thermostat Fan Failed, r...	Improper Output	ASSEMBLY AUX COOLING	Thermostat Fan	10234112	☑	CHANGED OUT Thermostat Fan	11/19/2012 5:40:53 PM	10.00	140.00	Thermostat Fan Failu...	ASSEMBLY AUX COOLING
Inc009	1/8/2013	Thermostat Fan Failed, r...	Disconnected	ASSEMBLY AUX COOLING	Thermostat Fan	95121002	☐	RECONNECTED PWR CABLES	2/10/2013 5:40:53 PM	42.00	182.00	ASSEMBLY AUX COOLING	ASSEMBLY AUX COOLING
Inc010	3/13/2013	Thermostat Fan Failed, r...	Unknown	ASSEMBLY AUX COOLING	Thermostat Fan	10234111	☑	CHANGED OUT Thermostat Fan	3/15/2013 5:40:53 PM	9.00	191.00	ASSEMBLY AUX COOLING	ASSEMBLY AUX COOLING
Inc011	10/1/2013	Thermostat Fan Failed, r...	Disconnected	ASSEMBLY AUX COOLING	Thermostat Fan	95121002	☐	RECONNECTED PWR CABLES	10/2/2013 5:40:53 PM	12.00	203.00	ASSEMBLY AUX COOLING	ASSEMBLY AUX COOLING
Inc012	2/1/2014	Thermostat Fan Failed, r...	Electrical Overstre...	ASSEMBLY AUX COOLING	Thermostat Fan	10234143	☑	CHANGED OUT Thermostat Fan	2/7/2014 5:40:53 PM	17.00	220.00	ASSEMBLY AUX COOLING	ASSEMBLY AUX COOLING
Inc013	6/11/2014	Thermostat Fan Failed, r...	Electrical Overstre...	ASSEMBLY AUX COOLING	Thermostat Fan	95121002	☑	CHANGED OUT Thermostat Fan	6/13/2014 5:40:53 PM	15.00	235.00	ASSEMBLY AUX COOLING	ASSEMBLY AUX COOLING
Inc014	11/7/2014	Thermostat Fan Failed, r...	Electrical Overstre...	ASSEMBLY AUX COOLING	Thermostat Fan	10234156	☑	CHANGED OUT Thermostat Fan	11/9/2014 5:40:53 PM	10.00	245.00	ASSEMBLY AUX COOLING	ASSEMBLY AUX COOLING
Inc015	12/4/2014	Thermostat Fan Failed, r...	Disconnected	ASSEMBLY AUX COOLING	Thermostat Fan	95121002	☐	RECONNECTED PWR CABLES	12/15/2014 5:40:53 PM	8.00	253.00	ASSEMBLY AUX COOLING	ASSEMBLY AUX COOLING
Inc016	1/1/2015	Thermostat Fan Failed, r...	Inspirative	ASSEMBLY AUX COOLING	Thermostat Fan	10234112	☑	CHANGED OUT Thermostat Fan	1/3/2015 5:39:54 PM	9.00	262.00	ASSEMBLY AUX COOLING	ASSEMBLY AUX COOLING
Inc017	3/26/2015	Thermostat Fan Failed, r...	Inspirative	ASSEMBLY AUX COOLING	Thermostat Fan	95121002	☐	CHANGED OUT Thermostat Fan	3/31/2015 5:43:15 PM	38.00	280.00	ASSEMBLY AUX COOLING	ASSEMBLY AUX COOLING

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**OPS** Digital Thread in Action: RAM: Failure Modes, Effects & Criticality Analysis

**FMECA:** Evaluation of the extended effects of failures resulting in the loss of functionality that directly impacts the ability of the system to meet requirements.

- Failure Modes listed by function or system component
- Analysis to determine next and higher level effects as well as qualitative and quantitative criticality assignment.

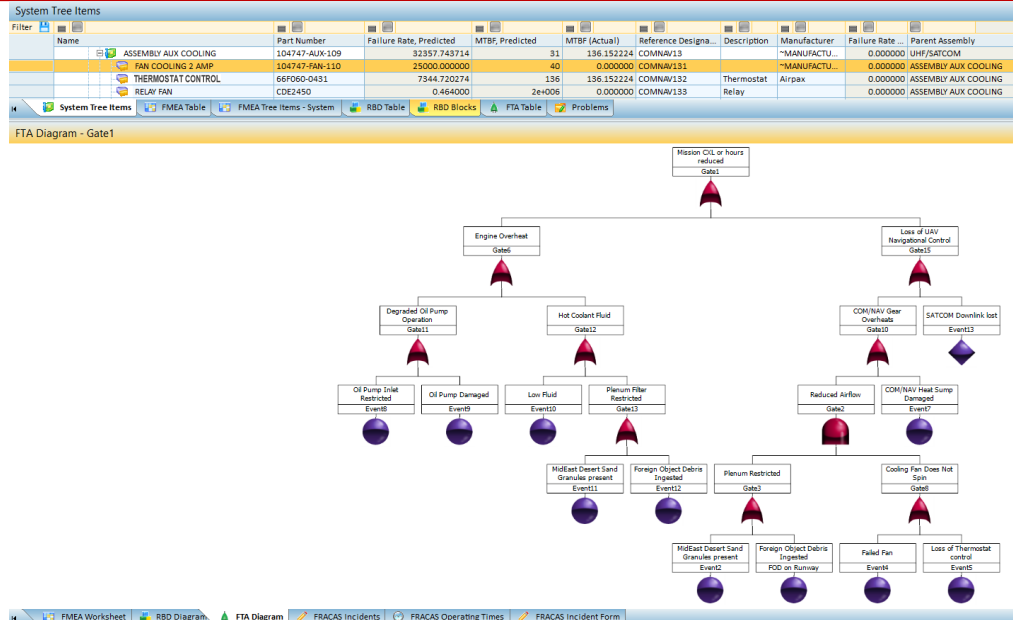
Item Ident.	Function	Functional Fa...	Name	Mode Ident...	Failure Mode	Mode Perc...	Local Effect	Next Effect	End Effect	Cause of Failure	Severity	Occu...	Detect...	RPN	Mode Critc...
9				Mode109	Reduced Engine Cooling Flow	34.06	Engine Overheats	Reduction of UAV Hours	Mission Failure					0	9416.07
10	Item1	Provide airflow to maintain heat transfer	FAN COOLING 2	Mode1	Binding/Sticking	60.00	Cooling fan does not spin	COM/NAV gear overheats	Loss of UAV navigational control	Contamination	CATEGORY I	2	8	160	28.54
11			FAN COOLING 2	Mode3	Improper Output	30.00	Reduced COM/NAV Cooling Flow	COM/NAV gear overheats	Loss of UAV navigational con...	Contamination	CATEGORY I	1	8	80	14.27
12			FAN COOLING 2	Mode4	Improper Current	10.00	Will not start, intermittent oper...	COM/NAV gear overheats	Loss of UAV navigational con...	Connection Problem	CATEGORY I	1	8	80	4.76
13	Item3	Provide airflow to maintain heat trans...	F/2 P Adequat...	Mode5	Improper Output	100.00	Reduced COM/NAV Cooling Flow	COM/NAV gear overheats	Loss of UAV navigational con...	Out of Adjustment	CATEGORY I	4	5	200	63.13
14	Item91	AUX Cooling maintains operating temp of COM/NAV systems	RELAY FAN	Mode98	Shorted Relay Fan	#	Rel Inoperable	COM/NAV gear overheats	Loss of UAV navigational control	Water intrusion	CATEGORY III	3	3	36	0.64
15	Item4	Direct and expel heat from syst...	F/2 direct and expel heat fro...	Mode6	Restricted Outlet	100.00	Reduced COM/NAV Cooling Flow	COM/NAV gear overheats	Loss of UAV navigational con...	Blocked or damaged outlet from Foreign Object Debris	CATEGORY I	9	6	540	8640.00
16	Item5	Dissipate heat from COM/NAV...	F/2 dissipate heat from COM/NAV con...	Mode7	Disconnected Sump	100.00	COM/NAV component not cooled	COM/NAV gear overheats	Loss of UAV navigational con...	Excessive vibration loosens heat sump	CATEGORY III	1	1	8	56.00

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**OPS** Digital Thread in Action: RAM: Fault Tree Analysis

**FTA:** Examine combinations of hardware / software failures, environmental, human, and other impacts that contribute to the undesired top-level event.

- Focuses on all possible system failures of an undesired top event.
- Defines the contributing factors.
- Combined with critical failure modes from a FMECA can clarify where resources would have the most impact in preventing or reducing the likelihood of that failure in the future.



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**Digital Thread in Action:**  
**RAM: Reliability Block Modeling**

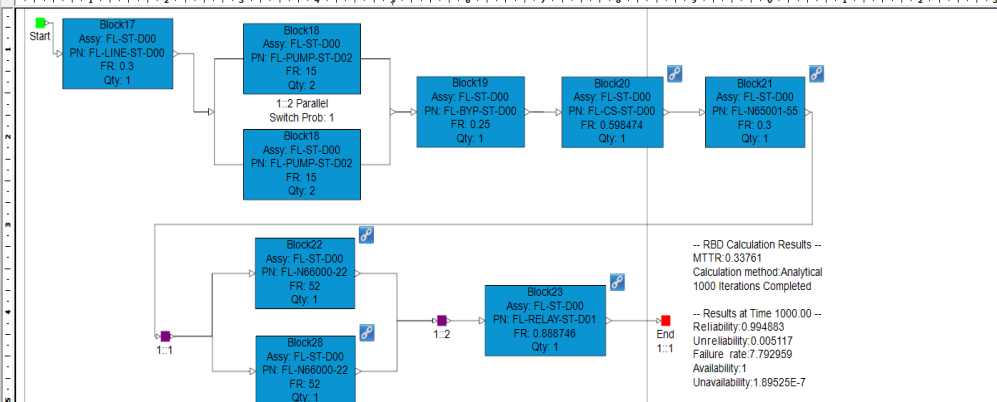
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**RBM: Modeling of components and sub-system failures combined to cause overall system failure.**


- Can start with the initial predicted failure rate established in the “Digital Twin”
- Failure rates of each block may be linked to specified, predicted, or actual (FRACAS) values.
- Quantifies reliability and compares system performance to baseline.

Name	Part Number	Failure Rate, Predicted	MTBF, Predicted	MTBF (Actual)	Reference Design	Description	Manufacturer	Failure Rate ...	Parent Assembly
ASSEMBLY ANTENNA RELAY	104747-102	26.135814	38262	0.000000	COMNAV12	UAF/ Downl...		0.000000	UHF/SATCOM
ASSEMBLY AUX COOLING	104747-AUX-109	92357.743714	31	136.152224	COMNAV13		"MANUFACTU...	0.000000	UHF/SATCOM
FAN COOLING 2 AMP	104747-FAN-110	25000.000000	40	0.000000	COMNAV131		"MANUFACTU...	0.000000	ASSEMBLY AUX COOLING
THERMOSTAT CONTROL	66F050-Q431	7344.720274	136	136.152224	COMNAV132	Thermostat	Airpac	0.000000	ASSEMBLY AUX COOLING
RELAY FAN	CDE4K50	0.464000	24+006	0.000000	COMNAV133	Relay		0.000000	ASSEMBLY AUX COOLING
COOLING OUTLET	SD65587-24	6.000000	166667	0.000000	COMNAV134			0.000000	ASSEMBLY AUX COOLING

RBD Diagram - UAV Partial



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**The Living “Digital Twin” & “Digital Thread”:**  
**PSA Analysis, Modeling & Simulation**

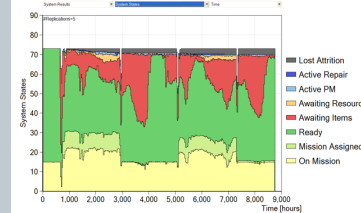
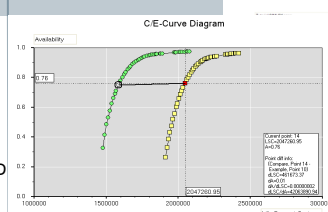
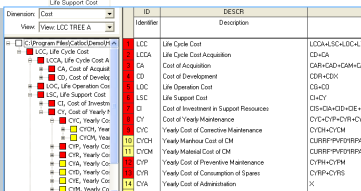
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**Control of complex program decisions, ROI analysis, and realistic cost/performance optimization studies.**


**Weapon System**

- Antenna
- Power Supply
- Requirements
- Failure Trend Analysis
- T&E Results
- Drawing
- CAD Model
- Technical Manual Content
- Related ECPs
- Related Change Activities
- Active Sensor
- Circuit Card
- Processor Unit

**Defensible Modeling and Simulation solution to provide senior decision makers with ROI analysis, cost/performance trades and supportability optimization for program**

RESOURCES	OPERATIONAL LIMITATIONS
<ul style="list-style-type: none"> <li>OPTIMIZE THE PERFORMANCE AND PRODUCT SUPPORT CONCEPT OVER TIME</li> <li>DIMENSION FACILITIES, PERSONNEL, EQUIPMENT, ETC</li> <li>MANPOWER TRADE STUDIES</li> </ul>	<p><b>Operational Limitations</b></p> 
SPARES	SYSTEM AVAILABILITY AND LCC
<ul style="list-style-type: none"> <li>LEVEL OF REPAIR ANALYSIS</li> <li>RESOURCE OPTIMIZATION</li> <li>MISSION SIMULATION</li> <li>READINESS BASED OPTIMIZATION-SPARES AND REPAIR RESOURCES</li> <li>CONDUCT TRADE STUDIES AND BUSINESS CASE ANALYSIS</li> </ul>	<p><b>System Availability and LCC</b></p> 
COSTS	ECONOMIC IMPACTS
<ul style="list-style-type: none"> <li>LIFE CYCLE COST ANALYSES</li> <li>COST RELATED TO KEY PERFORMANCE PARAMETERS</li> <li>PROFIT/COST ANALYSES</li> <li>BUDGET &amp; FORECASTS</li> <li>COMPARING SOLUTIONS</li> <li>COST CONTROL</li> </ul>	<p><b>Economic Impacts</b></p> 

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**Understanding the Support Organization**  
Modeling affects on performance

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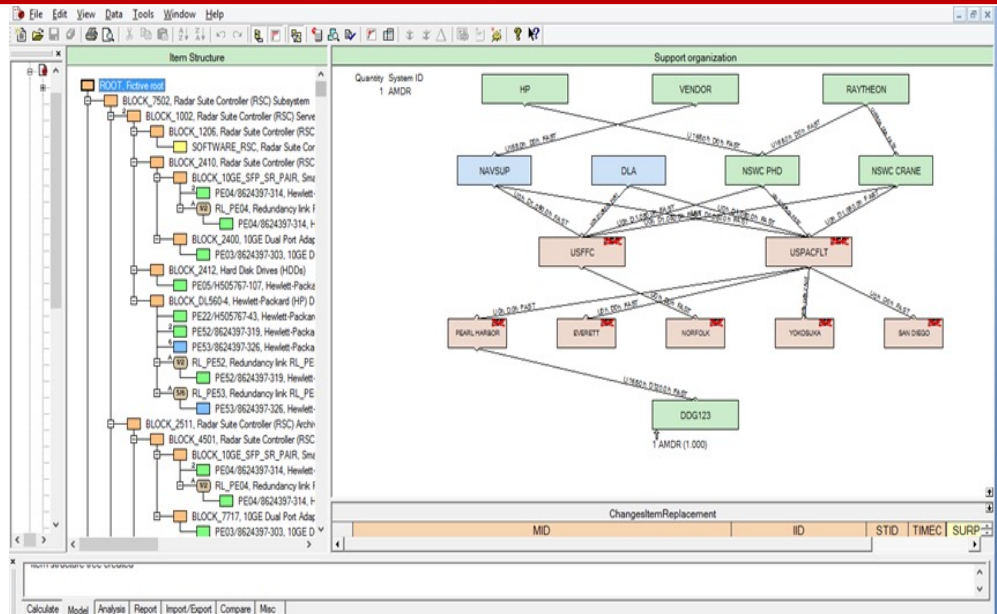
**Modeling the Support Organization Structure:**  
Provides an Analysis of Alternatives that directly impacts Material Availability (Am) and Operational Availability (Ao) Is my Support Structure optimized to deliver?

**INPUTS:**


- System Description
- Item Structure
- Support Policies

**Utilizing the Outputs:**

- Alternatives of storage facilities
- Optimize transportation modes to the types of stock
- Relationship of different item lead times



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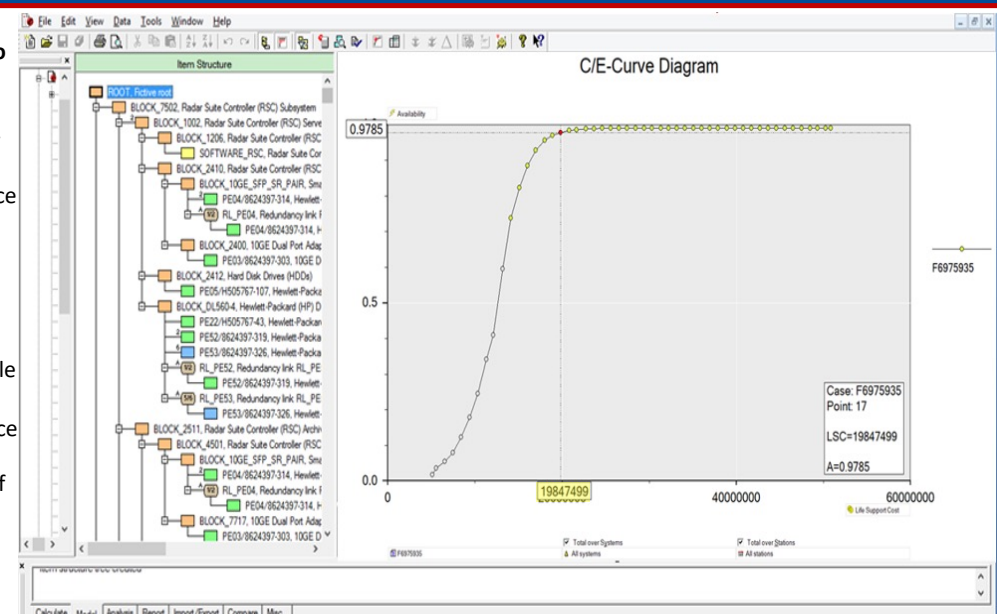
**Cost Effectiveness Curve**  
Modeling the Cost of Operational Availability

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**Model the overall system Life Support Costs critical to achieving Ao:**

- Model different design decisions in terms of their impact on maintenance needs, system performance life investments and support costs.
- Evaluations of the life support cost (LSC) are important parts of analyzing the total life cycle cost (LCC), especially as operation and maintenance costs typically constitute 60-70% of the total cost of ownership for a system.



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**CE Curve: Increasing System Reliability**  
Modeling the Cost of Operational Availability

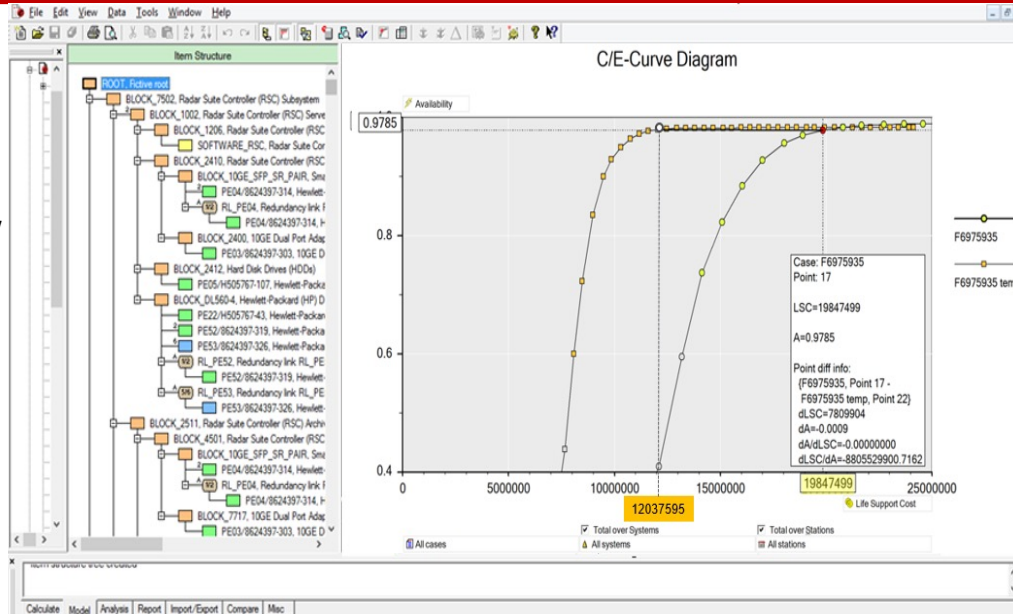
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**Collaboration by Product Support and Engineering**


Analyze how a certain solution and/or potential changes to different support criteria can predict how the cost and efficiency of a solution are impacted.

Evaluating alternatives of increasing Reliability to reduce the cost of:

- Stock
- Maintenance
- Personnel
- Storage
- Transportation costs
- Time



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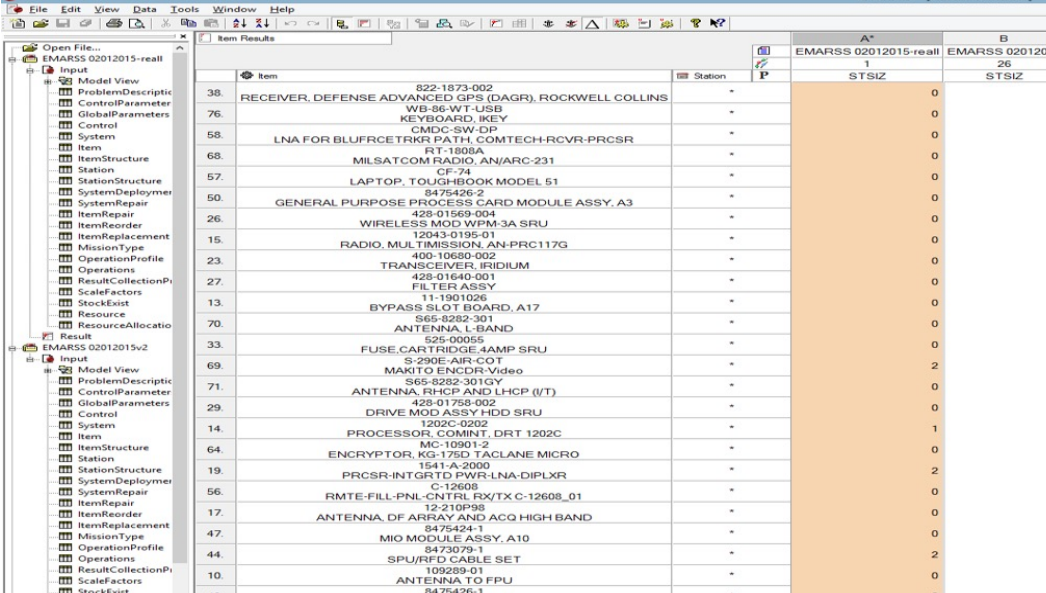


**CE Curve: Increasing System Reliability**  
Modeling the Cost of Availability

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**Collaboration by Product Support and Engineering**

Evaluate provisioning /spares based on system reliability



Item	Station	EMARSS 02012015-reall	EMARSS 02012015
38. RECEIVER, DEFENSE ADVANCED GPS (DAGR), ROCKWELL COLLINS	-	0	4
76. WB-86-WT-USB KEYBOARD, IKEY	-	0	4
58. LNA FOR BLUFRCE TRKR PATH, COMTECH-RCVR-PRCSR	-	0	4
68. MILSATCOM RADIO, AN/ARC-231	-	0	3
57. LAPTOP, TOUGHBOOK MODEL 51	-	0	3
50. GENERAL PURPOSE PROCESS CARD MODULE ASSY, A3	-	0	3
26. WIRELESS MOD WPM-3A SRU	-	0	3
15. RADIO, MULTIMSSION, AN-PRC117G	-	0	3
23. TRANSCEIVER, IRIDIUM	-	0	3
27. FILTER ASSY	-	0	3
13. BYPASS SLOT BOARD, A17	-	0	2
70. ANTENNA, L-BAND	-	0	2
33. FUSE, CARTRIDGE, 4AMP SRU	-	0	2
69. S-290E-AIR-COT	-	2	4
71. MAKTO ENCDR-Video	-	0	2
29. DRIVE MOD ASSY HDD SRU	-	0	2
14. PROCESSOR, COMMINT, DRT 1202C	-	1	3
64. MC-10901-2	-	0	2
19. ENCRYPTOR, KG-175D TACLANE MICRO	-	2	4
56. PRCR-INTGRD PWR-LNA-DIPLXR	-	0	2
17. RMTE-FILL-PNL-CNTSL FX/TX C-12608_01	-	0	1
47. ANTENNA, DF ARRAY AND ACQ HIGH BAND	-	0	1
44. MIO MODULE ASSY, A10	-	2	3
10. SPU/PFO CABLE SET	-	0	1
49. ANTENNA, TO FPU	-	0	1
70. GENERAL PURPOSE PROCESS CARD MODULE ASSY, A1, A2, A16	-	0	1

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**CE Curve: Readiness Based Sparing**  
Modeling Readiness by Stock Alternatives

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Part Number	Description	Unit Price	85.37% Readiness			89.91% Readiness			94.83% Readiness			97.04% Readiness		
			Total Cost	FRT [1/M/Hour]	QTY	Total Cost	FRT [1/M/Hour]	QTY	Total Cost	FRT [1/M/Hour]	QTY	Total Cost	FRT [1/M/Hour]	QTY
			\$5,613,332.78			\$6,212,894.78			\$7,399,595.78			\$8,723,773.78		
SS100, INVERTER	115VAC, 60HZ, 1PHASE	\$4,272.00	\$0.00	101.010101	0	\$0.00	101.010101	0	\$4,272.00	101.010101	1	\$4,272.00	101.010101	1
L215-20, INVERT	R, 115VAC, 60HZ, 1 PHASE	\$5,492.00	\$0.00	101.010101	0	\$0.00	101.010101	0	\$0.00	101.010101	0	\$0.00	101.010101	0
EMR01E20040-003	INSTL WIRE HARNESS, INTERNAL CABIN, EMD	\$738.00	\$26,568.00	11427.36	36	\$26,568.00	11427.36	36	\$27,306.00	11427.36	37	\$28,044.00	11427.36	38
GB001_W05110-11	EMR01E20045, GEOMETRICAL BUNDLE, INSTL WIRE HARNESS, AFT FUSELAGE	\$738.00	\$0.00	34.01244856	0	\$0.00	34.01244856	0	\$0.00	34.01244856	0	\$0.00	34.01244856	0
GB001_W05110-11	EMR01E20045, GEOMETRICAL BUNDLE, INSTL WIRE HARNESS, AFT FUSELAGE	\$738.00	\$0.00	34.01244856	0	\$0.00	34.01244856	0	\$0.00	34.01244856	0	\$0.00	34.01244856	0
GB001_W20196_EM	01E20045, GEOMETRICAL BUNDLE, INSTL WIRE HARNESS, AFT FUSELAGE	\$738.00	\$0.00	34.01244856	0	\$0.00	34.01244856	0	\$0.00	34.01244856	0	\$0.00	34.01244856	0
S125-A02-SF-S,	PS SPLITTER, 1X2	\$336.00	\$336.00	5.5630038	1	\$336.00	5.5630038	1	\$672.00	5.5630038	2	\$672.00	5.5630038	2
P12198-003, HEA	SET, IRIIDIUM	\$675.00	\$675.00	65.98917777	1	\$675.00	65.98917777	1	\$675.00	65.98917777	1	\$675.00	65.98917777	1
42228-05, HAND	ONTROLLER FOR MX-15HDI EOIR Sensor	\$10,140.00	\$0.00	50	0	\$0.00	50	0	\$0.00	50	0	\$0.00	50	0
8408990-1, GPS,	C-MIGITS III	\$33,034.00	\$0.00	106.3829787	0	\$0.00	106.3829787	0	\$0.00	106.3829787	0	\$0.00	106.3829787	0
565-8282-301G,	ANTENNA, RHCP AND LHCP (I/T)	\$3,958.00	\$0.00	20	0	\$0.00	20	0	\$0.00	20	0	\$0.00	20	0
109279-01, ANTE	NA, PHASED ARRAY	\$166,291.00	\$166,291.00	40	1	\$166,291.00	40	1	\$166,291.00	40	1	\$166,291.00	40	1
565-8282-01, A	TENNA, L-BAND	\$3,958.00	\$3,958.00	20	1	\$3,958.00	20	1	\$7,916.00	20	2	\$7,916.00	20	2
AT11M-10-TF, AT	ENUATOR, 100B	\$150.00	\$150.00	7.919976557	1	\$150.00	7.919976557	1	\$150.00	7.919976557	1	\$150.00	7.919976557	1
EMR01M13840-101	CABIN RF SWITCH PANEL	\$500.00	\$500.00	2.366701457	1	\$500.00	2.366701457	1	\$500.00	2.366701457	1	\$500.00	2.366701457	1
HF8075100A, BAL	N (SINGLE)	\$800.00	\$0.00	6.666711111	0	\$0.00	6.666711111	0	\$0.00	6.666711111	0	\$0.00	6.666711111	0
HF8075100B, BAL	N (DUAL)	\$800.00	\$800.00	13.33333333	1	\$800.00	13.33333333	1	\$800.00	13.33333333	1	\$800.00	13.33333333	1
01-01664-001, A	TENNA, CRPA	\$66,593.00	\$66,593.00	66.66666667	1	\$66,593.00	66.66666667	1	\$66,593.00	66.66666667	1	\$133,186.00	66.66666667	2
10553-1300-02,	N/PRC-117 RADIO KEYBOARD DISPLAY(KDUJ) FALCON III	\$492.00	\$492.00	7.939973798	1	\$492.00	7.939973798	1	\$984.00	7.939973798	2	\$984.00	7.939973798	2
FAM-142A, AMPLI	ER, DUAL BIDIRECTIONAL, METROPOLE	\$15,390.00	\$0.00	200	0	\$0.00	200	0	\$0.00	200	0	\$0.00	200	0
12-210P98, ANTE	NA, DF ARRAY AND ACQ HIGH BAND	\$10,000.00	\$30,000.00	20	3	\$30,000.00	20	3	\$30,000.00	20	3	\$30,000.00	20	3
015-10306-001,	NTENNA, IRIIDIUM	\$635.00	\$1,270.00	20	2	\$1,270.00	20	2	\$1,270.00	20	2	\$1,270.00	20	2
AV201-10, ANTEN	A, FM/VHF/UHF/EPLRS/L-BAND	\$3,571.00	\$3,571.00	20	1	\$3,571.00	20	1	\$7,142.00	20	2	\$7,142.00	20	2
DM N150-10-2, A	TENNA, DM N150-10-2, IFF	\$200.00	\$200.00	40	1	\$200.00	40	1	\$200.00	40	1	\$200.00	40	1
EMR01M13860-101	CABIN ZEROIZE PANEL	\$500.00	\$500.00	8	1	\$500.00	8	1	\$1,000.00	8	2	\$1,000.00	8	2
SW-22050, CONVE	TER, VGA-NTSC VIDEO	\$50.00	\$100.00	100	2	\$100.00	100	2	\$100.00	100	2	\$100.00	100	2
55LS1-012M1, CO	VERTER, 28VDC TO 12VDC	\$1,932.00	\$0.00	16.66666667	0	\$0.00	16.66666667	0	\$0.00	16.66666667	0	\$1,932.00	16.66666667	1
3313-AS-450-1,	ONTROL INDICATOR, AAR-57	\$260,081.00	\$0.00	35.999712	0	\$0.00	35.999712	0	\$260,081.00	35.999712	1	\$260,081.00	35.999712	1
31-200341-01, D	TECTING SET CONTROL	\$6,038.00	\$6,038.00	13.89004639	1	\$6,038.00	13.89004639	1	\$6,038.00	13.89004639	1	\$6,038.00	13.89004639	1
FA002, EMR01E200	5, FASTENER ASSEMBLY, INSTL WIRE HARNESS, AFT FUSELAGE	\$1,000.00	\$0.00	34.01244856	0	\$0.00	34.01244856	0	\$0.00	34.01244856	0	\$0.00	34.01244856	0
MC-10901-2, ENC	YPTOR, KG-175D TACLANE MICRO	\$9,900.00	\$0.00	21.87417972	0	\$0.00	21.87417972	0	\$0.00	21.87417972	0	\$0.00	21.87417972	0

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**CE Curve: Readiness Based Sparing**  
Modeling Readiness by Location Alternatives

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Part Number	Description	Unit Price	Stock Location	85.37% Readiness		89.91% Readiness		94.83% Readiness		97.04% Readiness	
				RPAPY	QTY	RPAPY	QTY	RPAPY	QTY	RPAPY	QTY
				\$5,613,332.78		\$6,212,894.78		\$7,399,595.78		\$8,723,773.78	
AT11M-10-TF, AT	ENUATOR, 100B	\$ 150.00	FIELD LOCATION	1	0	1	0	1	0	1	0
AT11M-10-TF, AT	ENUATOR, 100B	\$ 150.00	DEPOT	5.439913179	1	5.44E-02	0	5.44E-02	0	5.44E-02	0
EMR01M13840-101	CABIN RF SWITCH PANEL	\$ 500.00	FIELD LOCATION	1	1	1	1	1	1	1	1
EMR01M13840-101	CABIN RF SWITCH PANEL	\$ 500.00	DEPOT	1.625412693	0	1.63E-02	0	1.63E-02	0	1.63E-02	0
HF8075100A, BAL	N (SINGLE)	\$ 800.00	FIELD LOCATION	0	0	0	0	0	0	0	0
HF8075100A, BAL	N (SINGLE)	\$ 800.00	DEPOT	4.578590523	0	4.58E-02	0	4.58E-02	0	4.58E-02	0
HF8075100B, BAL	N (DUAL)	\$ 800.00	FIELD LOCATION	1	0	0	0	1	0	1	0
HF8075100B, BAL	N (DUAL)	\$ 800.00	DEPOT	0.183142399	1	0.1831424	0	0.1831424	0	0.1831424	0
01-01664-001, A	TENNA, CRPA	\$ 66,593.00	FIELD LOCATION	1	0	1	1	1	1	1	2
01-01664-001, A	TENNA, CRPA	\$ 66,593.00	DEPOT	0.457856000	1	0.457856	0	0.457856	0	0.457856	0
10553-1300-02,	N/PRC-117 RADIO KEYBOARD DISPLAY(KDUJ) FALCO	\$ 492.00	FIELD LOCATION	1	1	1	1	2	1	2	2
10553-1300-02,	N/PRC-117 RADIO KEYBOARD DISPLAY(KDUJ) FALCO	\$ 492.00	DEPOT	5.453046964	0	5.45E-02	0	5.45E-02	0	5.45E-02	0
FAM-142A, AMPLI	ER, DUAL BIDIRECTIONAL, METROPOLE	\$ 15,390.00	FIELD LOCATION	0	0	0	0	0	0	0	0
12-210P98, ANTE	NA, DF ARRAY AND ACQ HIGH BAND	\$ 10,000.00	FIELD LOCATION	3	3	3	3	3	3	3	3
12-210P98, ANTE	NA, DF ARRAY AND ACQ HIGH BAND	\$ 10,000.00	DEPOT	1.3735680	1	1.373568	0	1.373568	0	1.373568	0
015-10306-001,	NTENNA, IRIIDIUM	\$ 635.00	FIELD LOCATION	2	1	2	2	2	2	2	2
015-10306-001,	NTENNA, IRIIDIUM	\$ 635.00	DEPOT	0.13735680	1	0.1373568	0	0.1373568	0	0.1373568	0
AV201-10, ANTEN	A, FM/VHF/UHF/EPLRS/L-BAND	\$ 3,571.00	FIELD LOCATION	1	1	1	1	2	1	2	1
AV201-10, ANTEN	A, FM/VHF/UHF/EPLRS/L-BAND	\$ 3,571.00	DEPOT	0.13735680	0	0.1373568	0	0.1373568	0	0.1373568	0
DM N150-10-2, A	TENNA, DM N150-10-2, IFF	\$ 200.00	FIELD LOCATION	1	0	1	1	1	1	1	1
DM N150-10-2, A	TENNA, DM N150-10-2, IFF	\$ 200.00	DEPOT	0.54942720	2	0.5494272	0	0.5494272	0	0.5494272	0
EMR01M13860-101	CABIN ZEROIZE PANEL	\$ 500.00	FIELD LOCATION	1	1	1	1	2	1	2	1
EMR01M13860-101	CABIN ZEROIZE PANEL	\$ 500.00	DEPOT	0.054942720	0	0.05494272	0	0.05494272	0	0.05494272	0
SW-22050, CONVE	TER, VGA-NTSC VIDEO	\$ 50.00	FIELD LOCATION	2	1	2	2	2	2	2	2
SW-22050, CONVE	TER, VGA-NTSC VIDEO	\$ 50.00	DEPOT	0.6867840	2	0.686784	0	0.686784	0	0.686784	0
55LS1-012M1, CO	VERTER, 28VDC TO 12VDC	\$ 1,932.00	FIELD LOCATION	0	0	0	0	0	0	0	1
55LS1-012M1, CO	VERTER, 28VDC TO 12VDC	\$ 1,932.00	DEPOT	0.114463536	0	0.114463537	0	0.114463537	0	0.114463537	0
3313-AS-450-1,	ONTROL INDICATOR, AAR-57	\$ 260,081.00	FIELD LOCATION	0	0	0	0	1	0	1	0
3313-AS-450-1,	ONTROL INDICATOR, AAR-57	\$ 260,081.00	DEPOT	0.247240262	1	0.247240262	0	0.247240262	0	0.247240262	0
31-200341-01, D	TECTING SET CONTROL	\$ 6,038.00	FIELD LOCATION	1	0	1	1	1	1	1	1
31-200341-01, D	TECTING SET CONTROL	\$ 6,038.00	DEPOT	9.539461619	1	9.54E-02	0	9.54E-02	0	9.54E-02	0
FA002, EMR01E200	5, FASTENER ASSEMBLY, INSTL WIRE HARNESS, AFT FUSELAGE	\$ 1,000.00	FIELD LOCATION	0	0	0	0	0	0	0	0
FA002, EMR01E200	5, FASTENER ASSEMBLY, INSTL WIRE HARNESS, AFT FUSELAGE	\$ 1,000.00	DEPOT	0.233592054	0	0.233592055	0	0.233592055	0	0.233592055	0
MC-10901-2, ENC	YPTOR, KG-175D TACLANE MICRO	\$ 9,900.00	FIELD LOCATION	0	0	0	0	0	0	0	0

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**Reliability Block Diagrams (RBDs)**  
Analyzing the Product Support Effects

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**Reliability Block Diagrams (RBDs):** Modeling of which failures are critical for different operational modes.

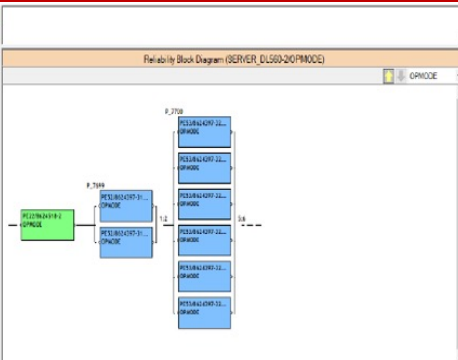
**INPUTS:**

- Functional systems architecture data
- Component reliability data
- Mission times

**Utilizing the OUTPUTS:**


- Functional availability
- Maintenance actions
- Maintenance times
- Fault tolerances
- spares necessity





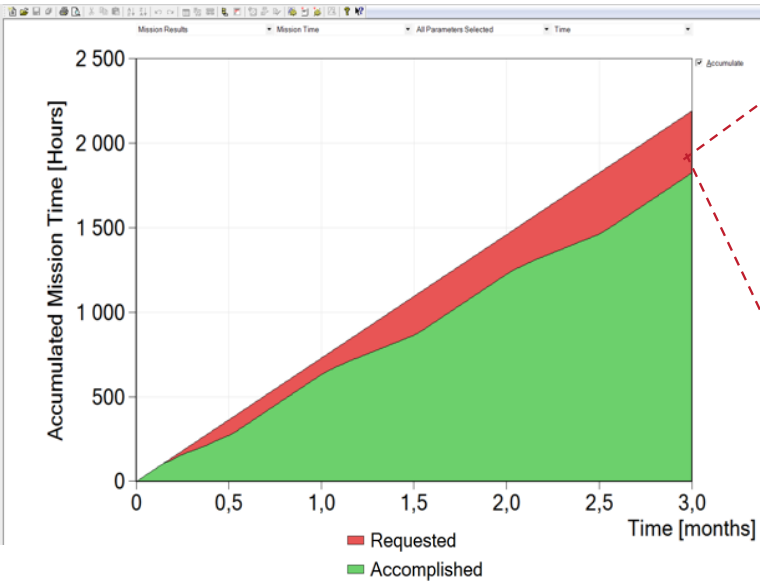
MID	ID	STD	TIMED	SUBJ
Mission or system identifier	Item identifier	Station identifier	Time of change [Hours]	Subst replac TA [Hrs]
1736	BREAKER_1P_30A_SET	POSIG02ALB-130A	DDG	2256.0
1737	BREAKER_1P_30A_SET	POSIG02ALB-130A	DDG	2794.0
1738	BREAKER_1P_30A_SET	POSIG02ALB-130A	DDG	2798.0
1739	BREAKER_1P_30A_SET	POSIG02ALB-130A	DDG	3036.0
1740	BREAKER_1P_30A_SET	POSIG02ALB-130A	DDG	3384.0
1741	BREAKER_1P_30A_SET	POSIG02ALB-130A	DDG	3620.0
1742	BREAKER_1P_30A_SET	POSIG02ALB-130A	DDG	3926.0
1743	BREAKER_1P_30A_SET	POSIG02ALB-130A	DDG	4464.0
1744	BREAKER_1P_30A_SET	POSIG02ALB-130A	DDG	4612.0

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**Digging into Operational Availability (Ao)**  
Analyzing the loss of operational capability

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■ Requested  
■ Accomplished

ACCIDENTS & UNFORSEEN EVENTS

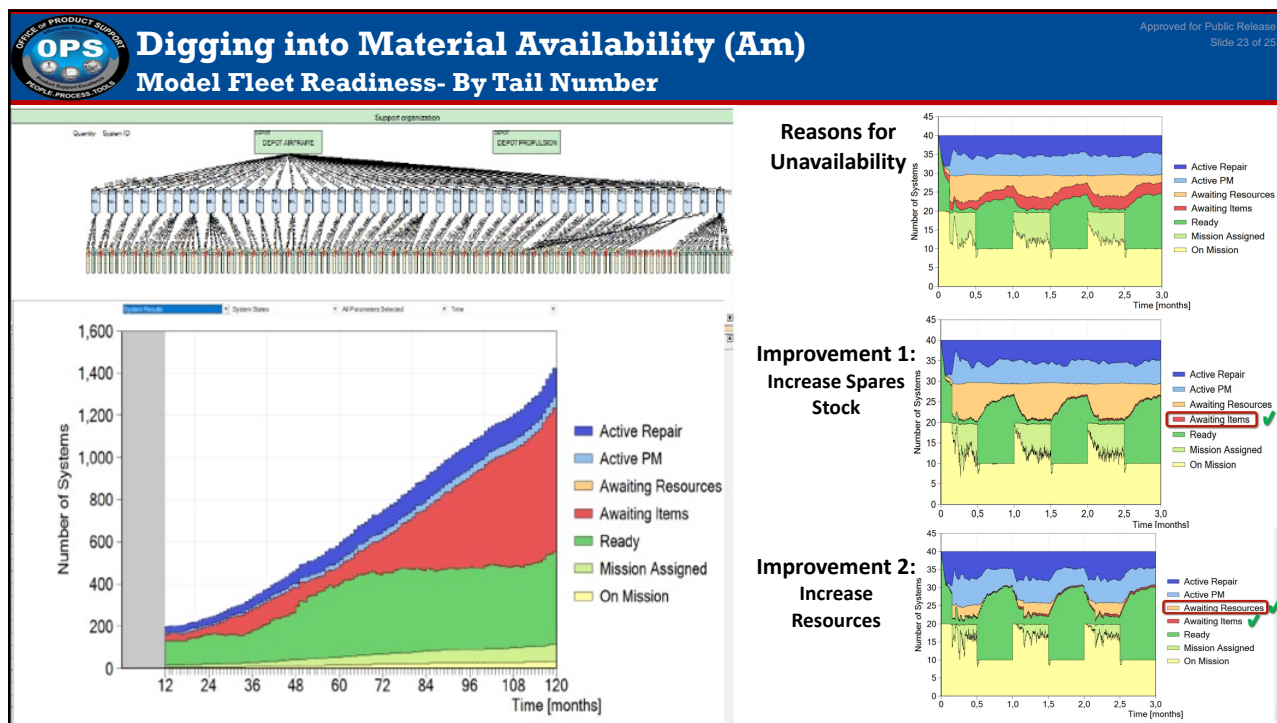
LACK OF SPARE PARTS & WRONG SPARES AVAILABLE

POOR MAINTENANCE PLANNING

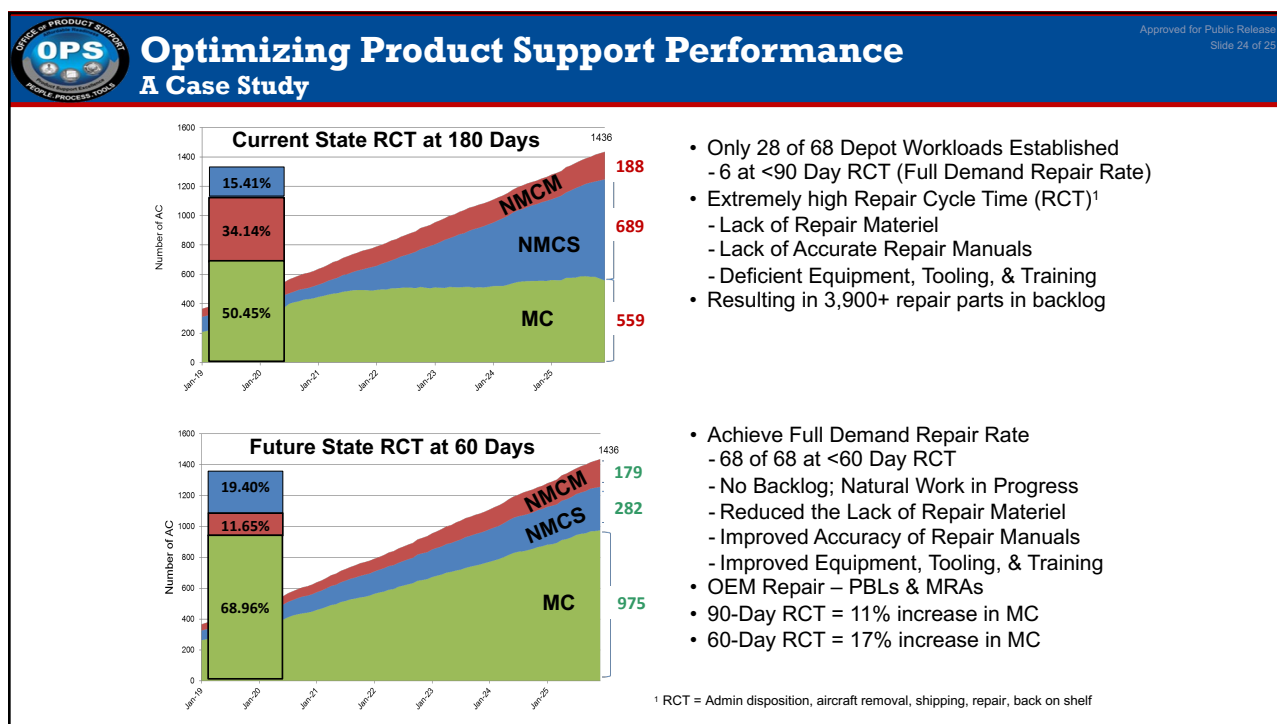
RESOURCE SHORTAGES

SYSTEM & COMPONENT FAILURES

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**OPS** OFFICE OF PRODUCT SUPPORT  
PEOPLE PROCESS TOOLS

## Leveraging the "Digital Thread" so that Naval Product Support is aligned to Naval Warfighting Concepts and Strategies

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Access in-time, applicable authoritative analytical and technical data to collaborate and improve Fleet Operations and Support functions

Leverage predictive decision support and sustainment analytic capabilities to make cost-wise condition and readiness based maintenance, supply and in service engineering decisions

Trace budget decisions to impacts on sustaining fleet readiness

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**OPS** OFFICE OF PRODUCT SUPPORT  
PEOPLE PROCESS TOOLS

## Digital Transformation is Challenging So Remember to be.....

**SEMPER GUMBY**  
**ALWAYS FLEXIBLE**

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