



U.S. ARMY



# PSA, LORA, and COMPASS

## Overview and Discussion

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# Outline

- ✓ **PSA, LORA, & COMPASS**
  - Overview
  - Conducting a LORA
  - Concepts and Processes
  
- ✓ **Using COMPASS**
  - Developing a Model
  
- ✓ **COMPASS 7.3**
  - Work done since 7.2.2
  - Future Efforts
  
- ✓ **Lessons Learned**





# PSA, LORA, & COMPASS

Process and Tool





# LORA Overview

## ✓ Level of Repair Analysis (LORA)

- Analytical Methodology used to establish the maintenance policy at which an item will be replaced, repaired, or discarded
- Determines cost effective maintenance concept of a system
- Recommendations based upon economic and non-economic factors





# LORA Overview

- ✓ **Supports development of maintenance policy**
  
- ✓ **Utilizes Multiple Data Sources**
  - LPD
  - FMECA/FTA
  - MTA
  
- ✓ **Results**
  - Optimized balance between Operational Availability and Maintenance Cost
  - Drives the Product Support Strategy and Product Support Package

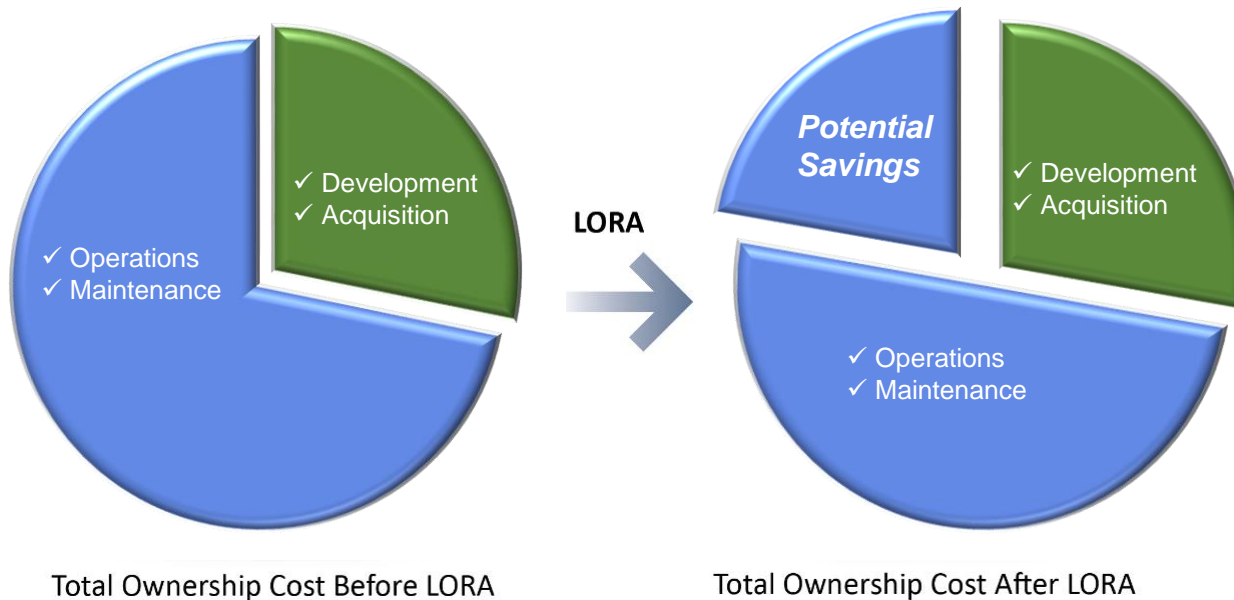
***LORA continually influences and supports decisions.***





# Why Conduct a LORA

- ✓ Operations and Maintenance typically accounts for most of Total Ownership Cost (TOC)
- ✓ LORA optimizes life cycle logistics support cost
  - Logistics Footprint
  - Design Influence and Optimization
- ✓ Savings from a properly conducted LORA can be in the millions of dollars

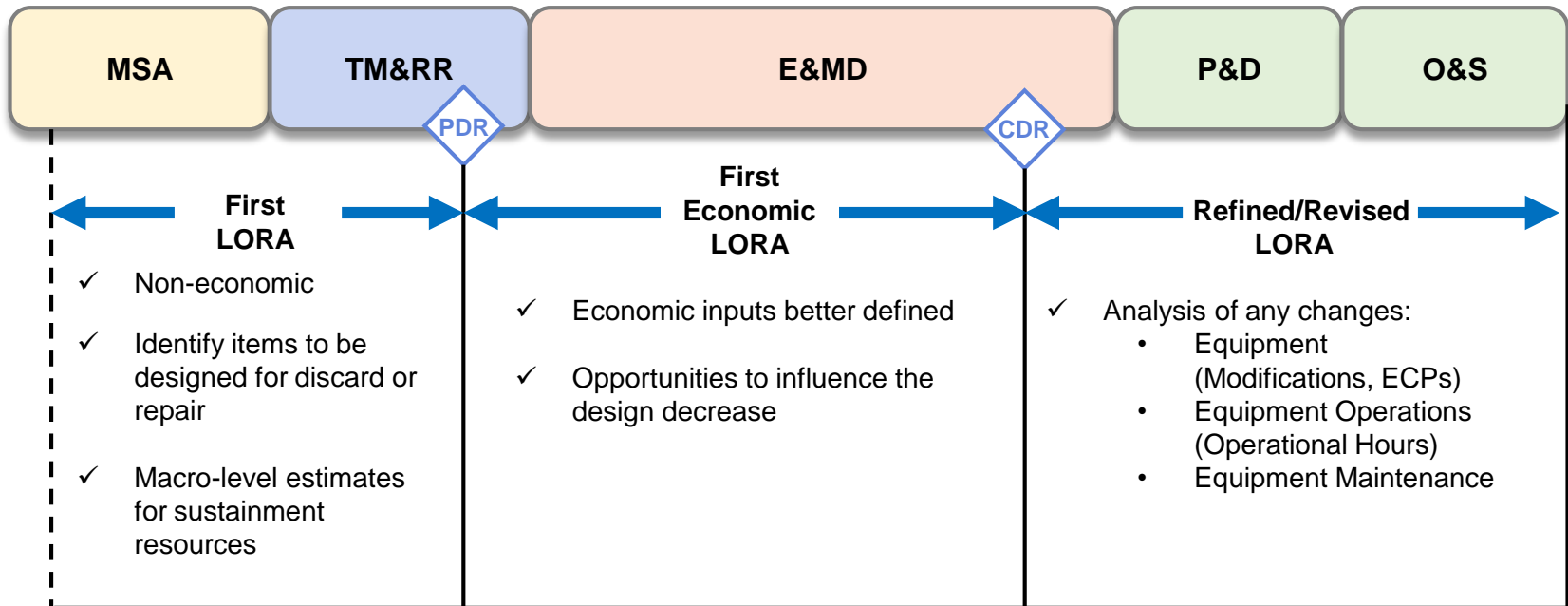




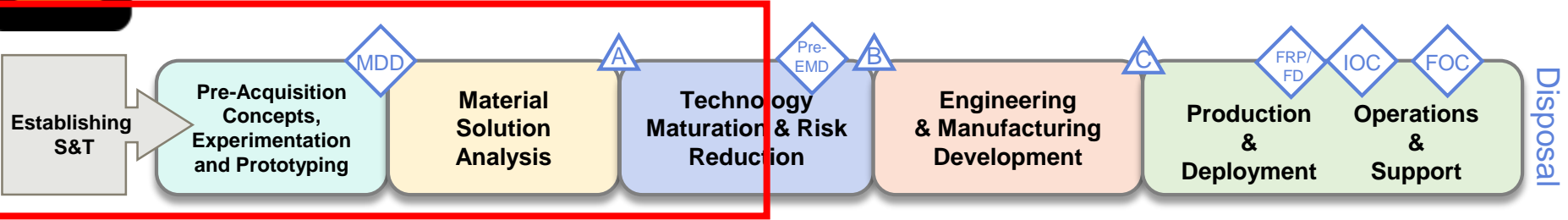
# Frequency of a LORA

“Starting the LORA process early in a system’s development, and continuous evaluation throughout its life cycle, can ensure a LORA influences the systems’ design and the maintenance planning... After the system has been fielded, follow-on analyses should be scheduled that include the use of field feedback data. The extent and detail of LORA should be tailored to the life cycle phase of the program.”

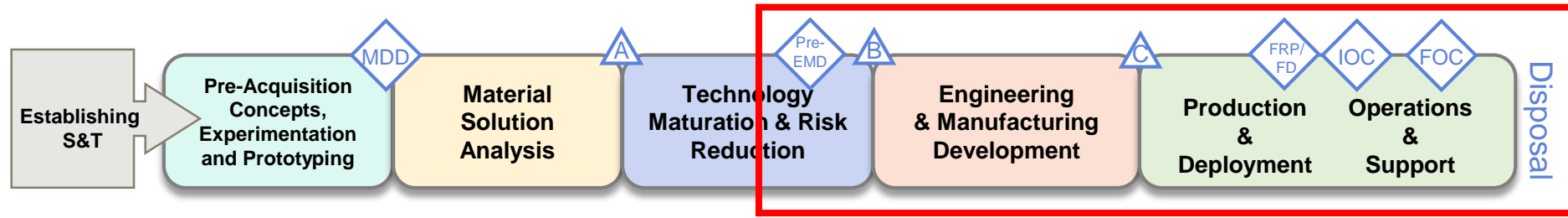
– Product Support Analysis, MIL-HDBK-502A



# Objectives are Phase Driven



- ✓ During design phases, LORA shows consequences of various maintenance configurations by evaluating the non-economic factors and the high-level cost of logistics support for each alternative
- ✓ LORA measures the cost of failure frequency and failure duration (downtime), and thus influences the design for more cost-effective alternatives
- ✓ Potential problems with operational availability, life cycle maintenance costs, etc., are identified and avoided



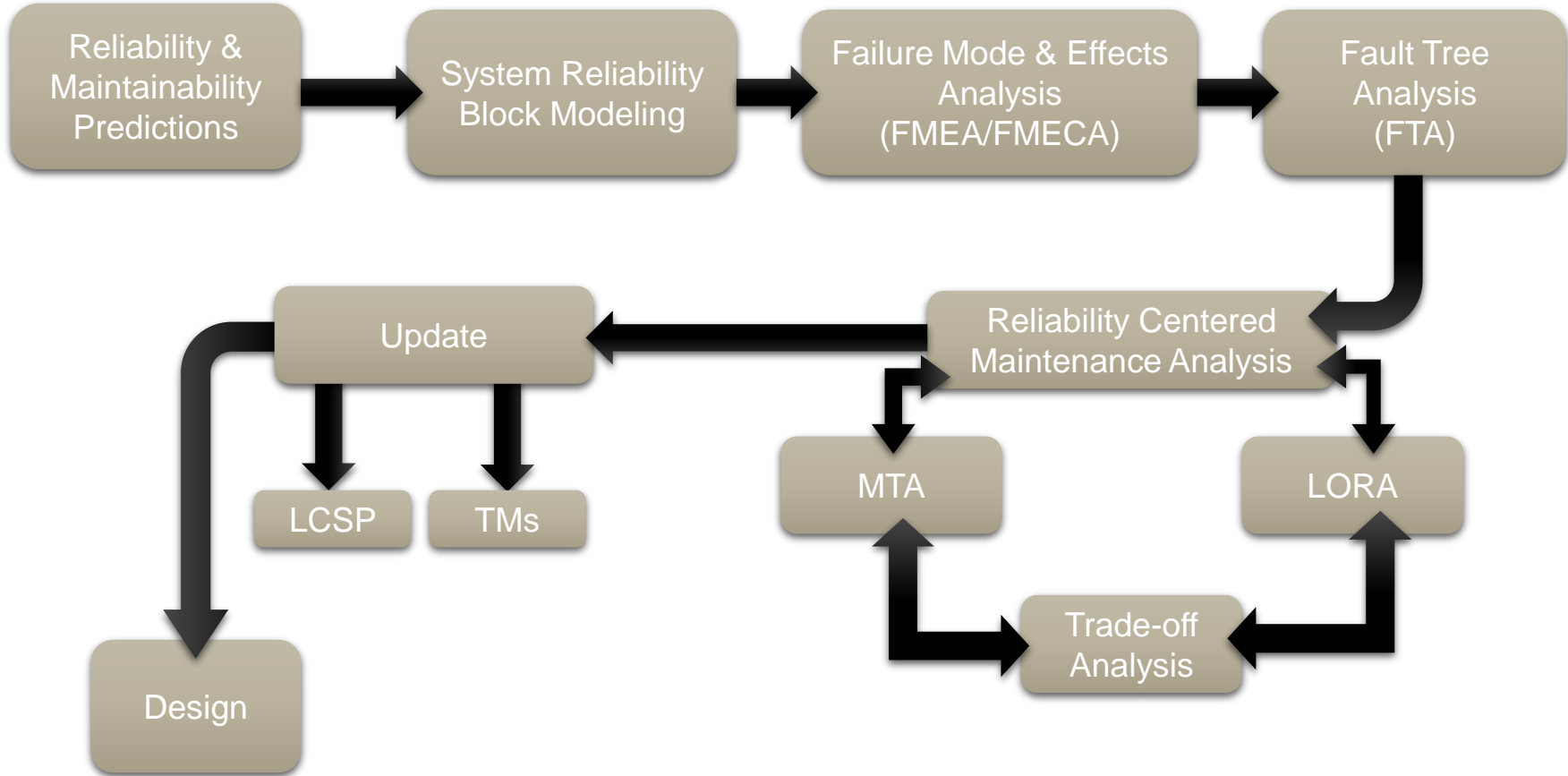
- ✓ After design is approved, LORA minimizes the requirement for spares and support resources
- ✓ The approved maintenance plan *anticipates* future equipment repair workloads, and ensures the availability of proper parts, trained technicians, support equipment, tools, and facilities
- ✓ A properly constructed and funded maintenance structure minimizes downtime durations affordably







# PSA and LORA



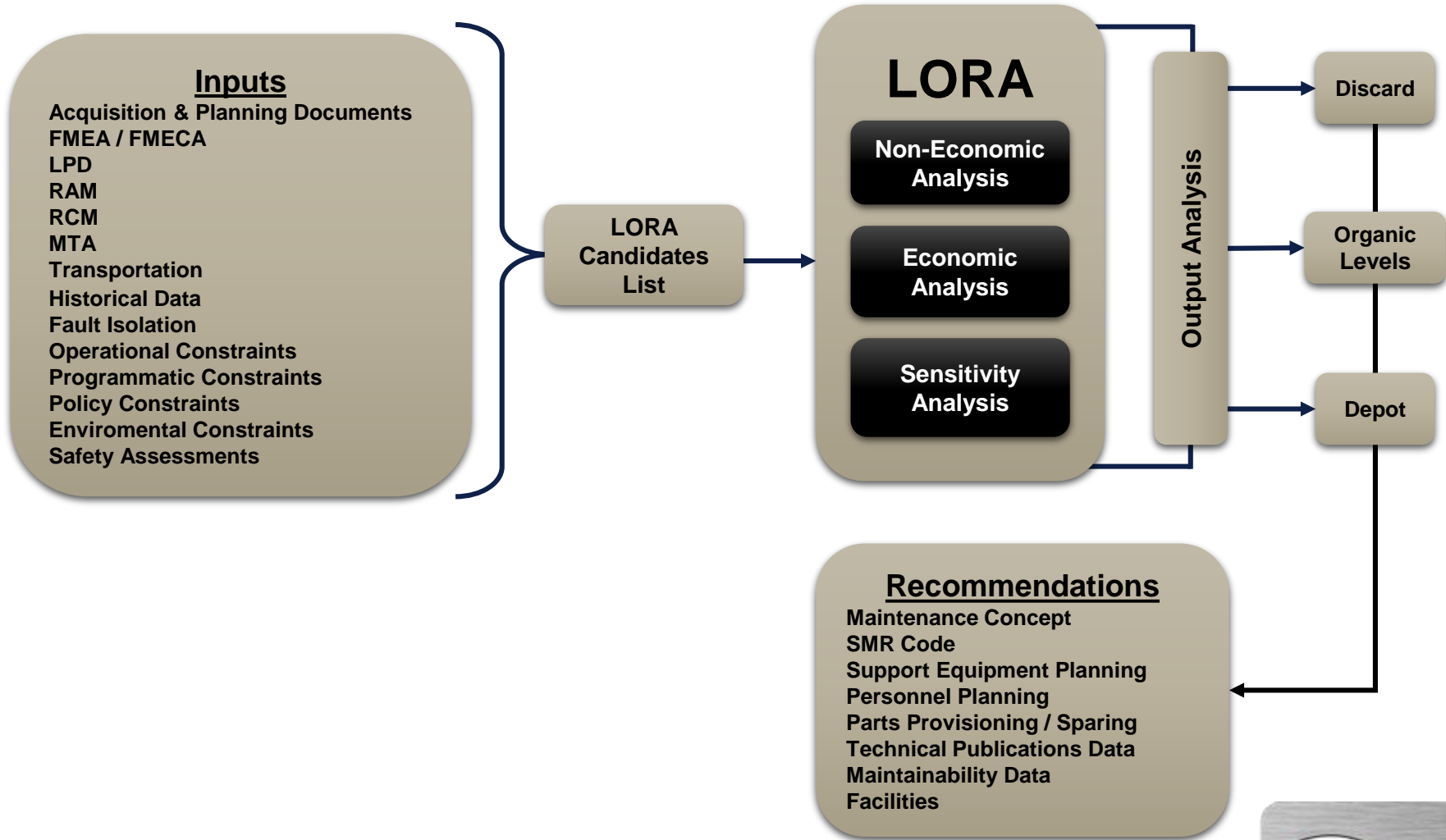
Adapted from SAE GEIA-STD-0007-B

***LORA is a part of ongoing Supportability Analysis activities.***





# LORA Process





# COMPASS and LORA

- ✓ **Requirements**
  - Operation Requirements
- ✓ **Policy**
  - Support Environment
  
- ✓ **LORA/COMPASS Input**
  - Availability Target
  - Operating Hours
  - Number of Systems
  - Echelons authorized





# LORA and FMECA

## ✓ FMECA

- Identification of critical failure modes to mission success

## ✓ LORA/COMPASS Input:

- Failure Mode
  - LRU and SRU
  - MTBF





# LORA and MTA

## ✓ MTA

- Analysis of task requirements

## ✓ LORA/COMPASS Inputs:

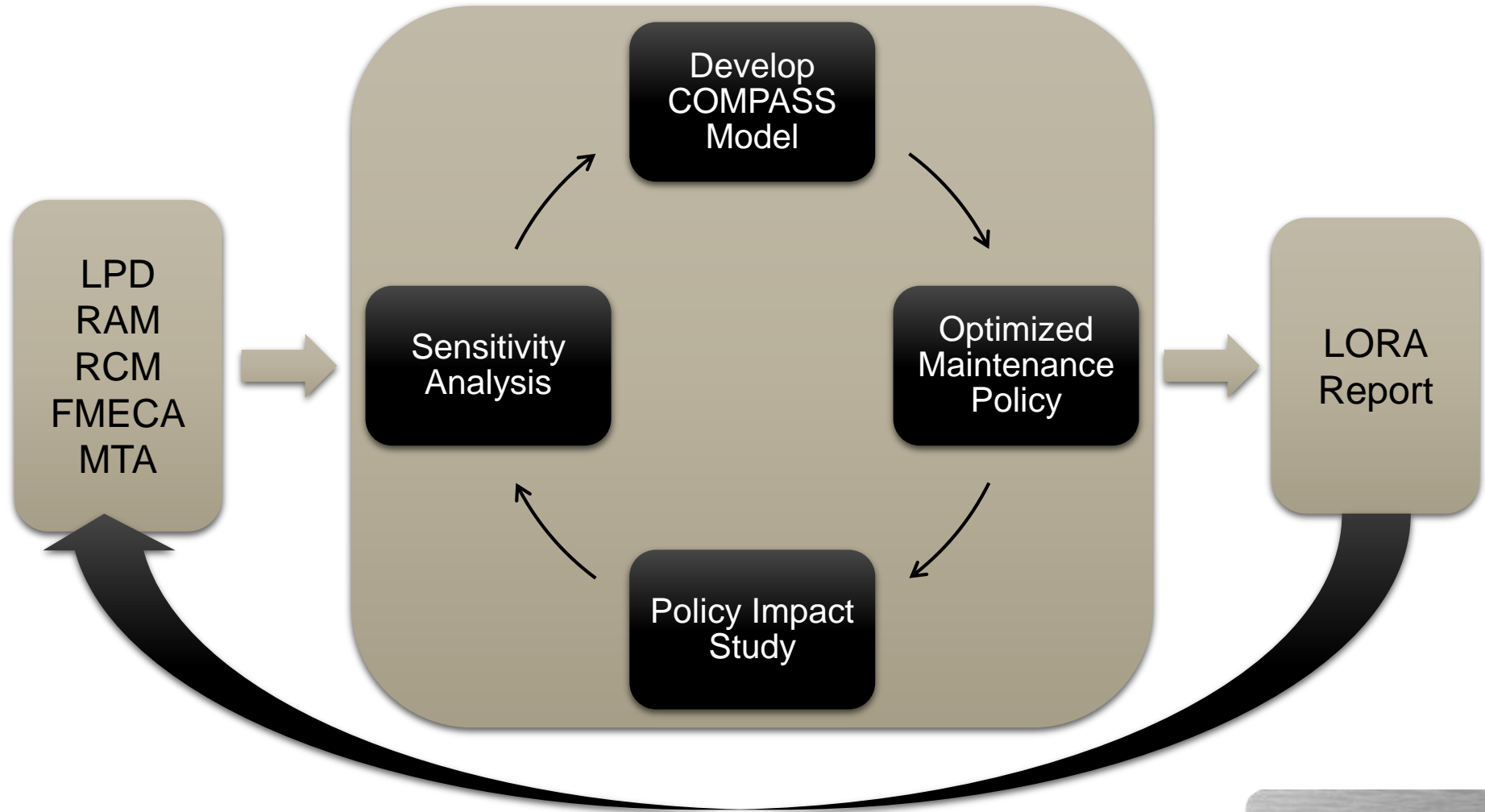
- Special Equipment
- Personnel
- MTTR

## ✓ LORA/COMPASS Output

- Optimal echelon for replacement action
- Placement of Special Equipment and Personnel



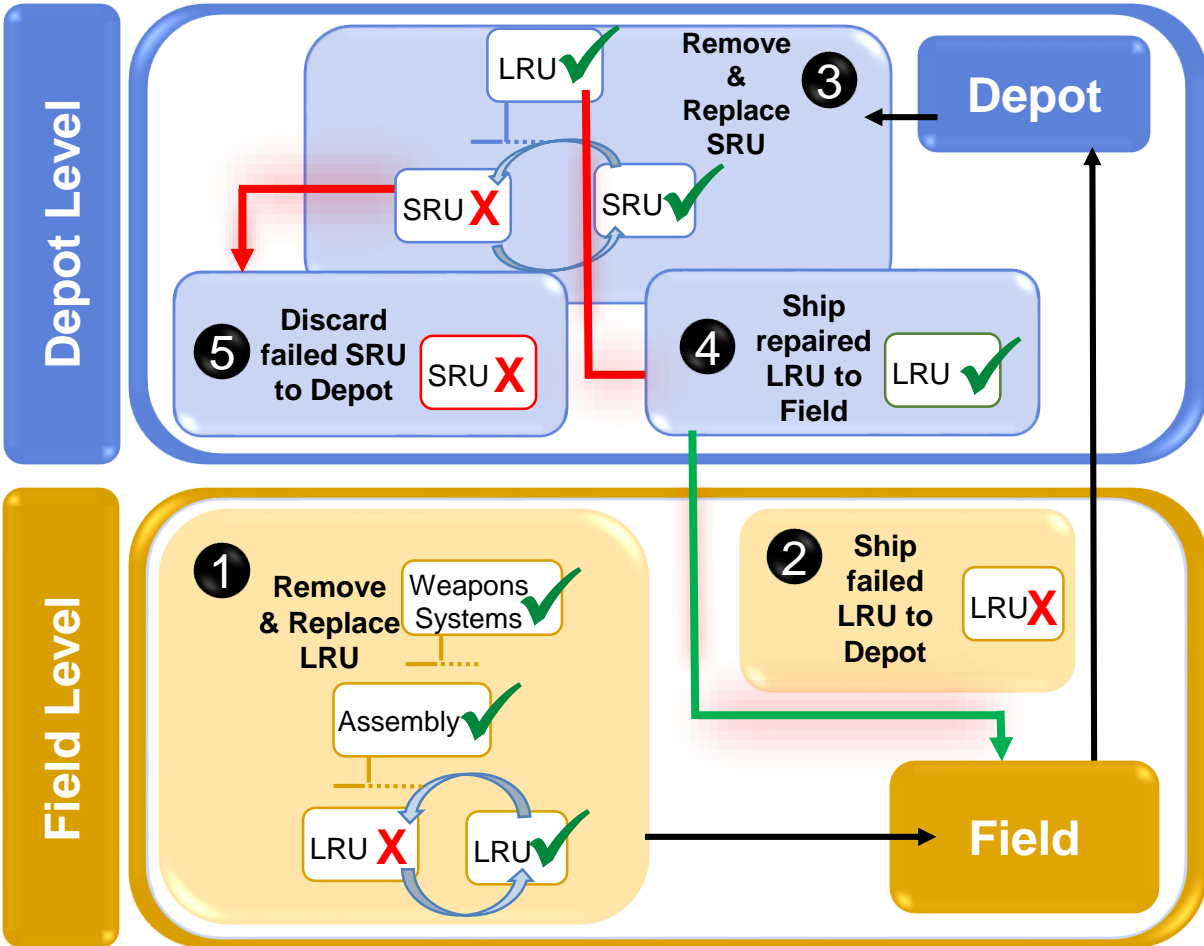
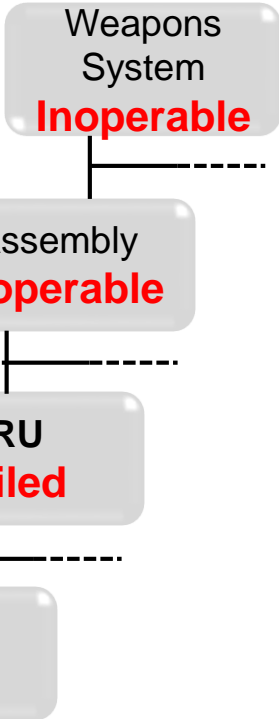
# LORA Process



# Failure Modes



## Indenture





# Using COMPASS

## Designing a LORA Model







# LORA Candidates

## ✓ Identify LORA candidates

- Considerations
  - Availability Impact
  - MTBF
  - Unit Cost
  - MTTR
  - Support Resources Required
    - Equipment
    - Personnel

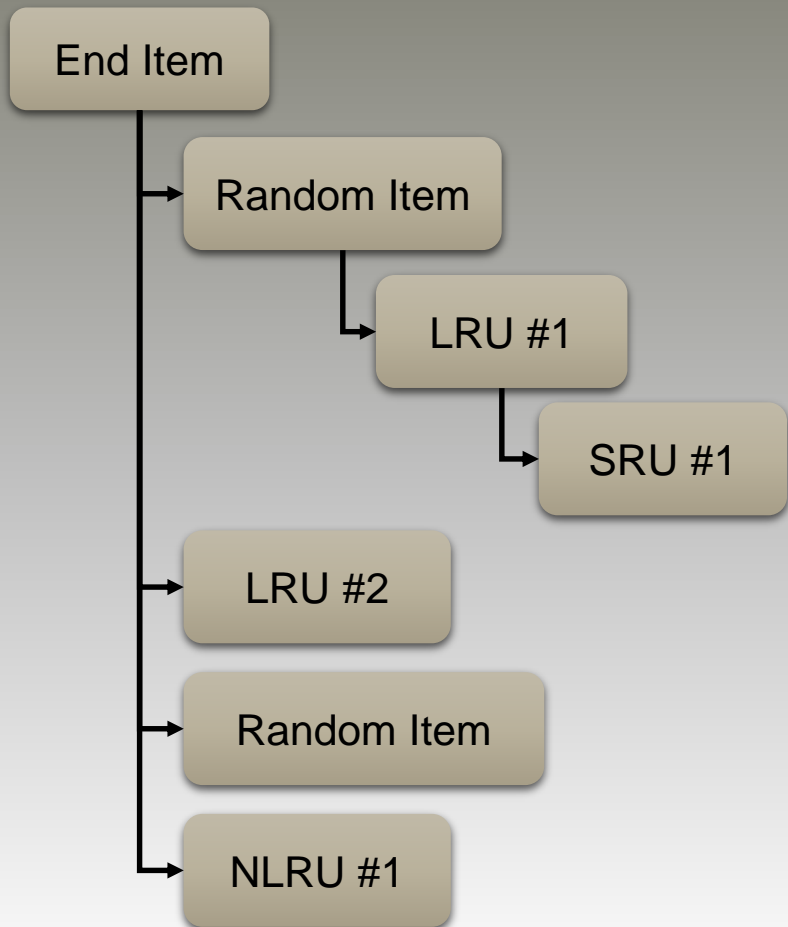
***Considerations will vary between programs.***



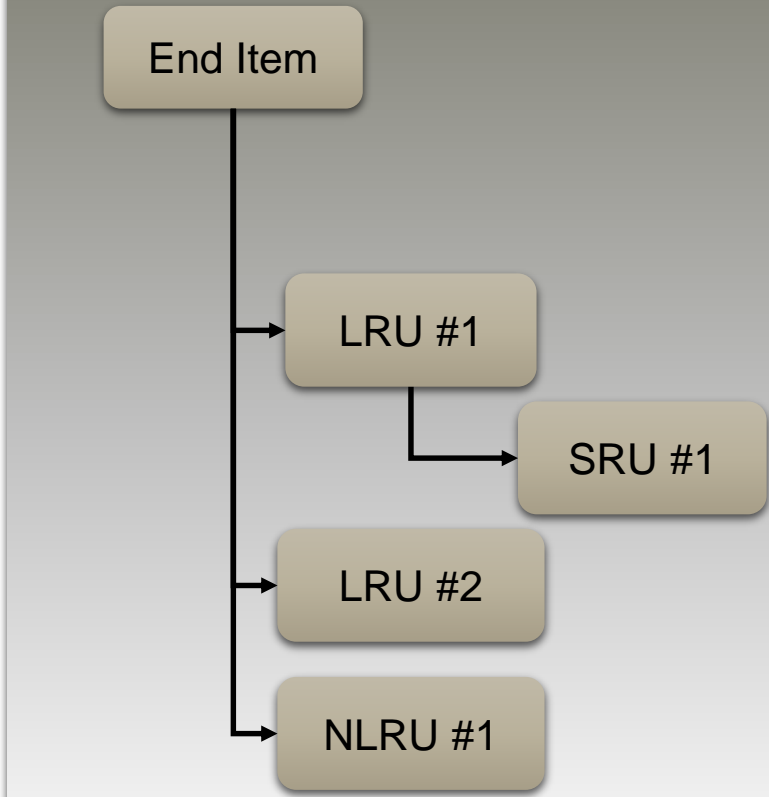
# Maintenance Breakdown Concept



## Physical Breakdown



## Maintenance Breakdown





# End Item and Support Environment

- ✓ **Populate End Item Physical Item Info**
  - Unit Price, Repair Methods
- ✓ **Populate Support Environment Information**
  - Echelons Info, Supply Data, Labor, Shipping

The screenshot shows a software interface with multiple tabs: End Item Information, Echelons, Supply Data, Resources, Common Labor Data, Contractor Data, Shipping, Repair Method, and Global Settings. The 'End Item Information' tab is active, showing fields for End Item Name (HF Radio Set), CAGE (MDP81), Part Number (AN/PRC-104A), NSN or NIIN (111111111), LCN (A), SMR (PADDD), Unit Price (\$12,500.00), Package Weight (0 lbs), and checkboxes for 'End Item is an Assembly' and 'Contractor Repair Considered'. Other tabs like 'Life Cycle Information' and 'End Item Failure Information' also contain numerical input fields. A smaller window is overlaid on the right, showing a hierarchical tree for 'HF Radio Set' components (Antenna, Receiver-Transmitter, etc.) and a table for 'Repair Echelons Authorized'.

	ORG	DSU	GSU	DEPOT	Contractor
End Item	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
LRU	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
SRU	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>





# LRU Data Population

- ✓ Create LRU
- ✓ Populate Item Information

Filter List

Add New Item

Duplicate Item

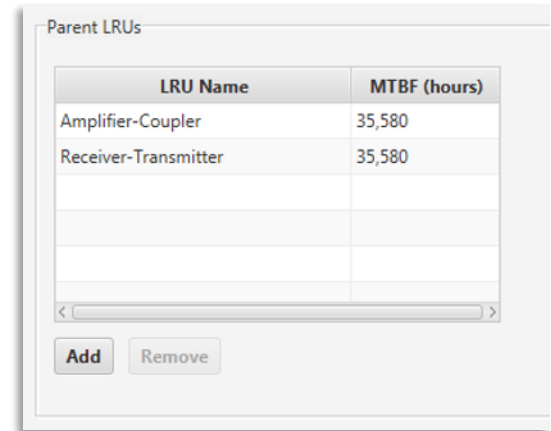
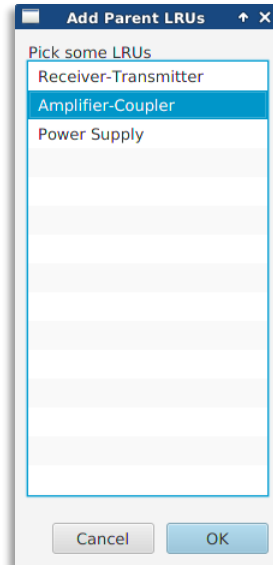
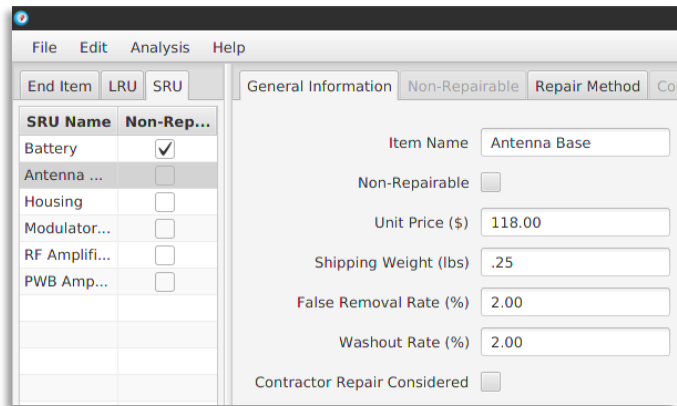
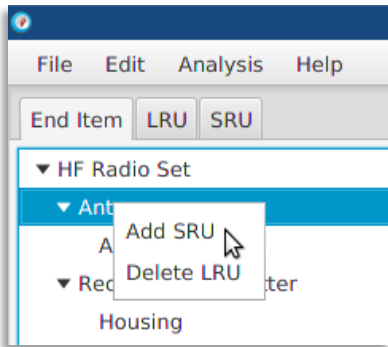
Promote/Demote Item





# SRU Data Population

- ✓ Create SRU
- ✓ Populate Item Information
- ✓ Define Parent LRU and Associated MTBF





# Validating the Model

- ✓ Validation occurs in the GUI
- ✓ Required fields are flagged in red
  - Hover over a red field will display the reason
  - Red text describes issues

Common Labor Data | Contractor Data | Shipping | Repair Method | Global Settings

Life Cycle Information

Number of Systems (Density)

System Life (Years)

Annual Operating Hours

Availability Target (%)

End Item Failure Information

End Item Float Information

End Item Floats Available

Special Order Ship Time (Days)

Mean Time to Install (Hours)

Float Issue Level

Lowest Echelon for Float Repair

Life Cycle Information

Number of Systems (Density)

System Life (years)

End Item F

End

Special C

Value must be greater than 0

Parent LRUS

LRU Name	MTBF (hours)
Antenna	

Add Remove

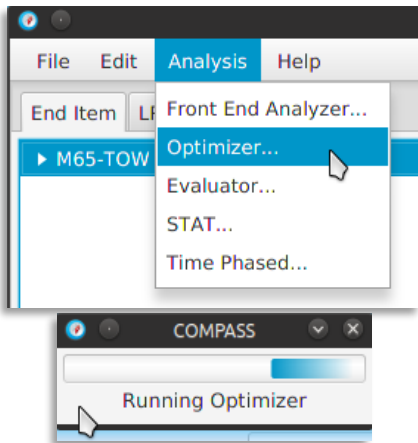
SRU must have at least one parent LRU assigned with an MTBF.





# Optimization

- ✓ All required fields must be populated
- ✓ Selected from Analysis Dropdown
- ✓ Optimization Results
  - Policy per Failure Mode
  - Cost Estimate



A screenshot of the 'Optimizer Report' window. It displays a summary of costs and availability. The 'Total Maintenance Policy' section shows an 'Availability Achieved' of 90.18%. Below this, a 'Logistics Totals' table lists various cost categories and their values.

Total Maintenance Policy	
Total Maintenance Policy Cost	
Total Logistics Cost	
Total Resource Cost	
<b>Total Maintenance Policy</b>	
Availability Achieved	90.18%

Logistics Totals	
Initial Spares Cost	\$572,742
Consumption Spares	\$3,822,891
Inventory Holding Cost (Present Value)	\$307,193
Transportation Cost (Present Value)	\$21,264
Requisition Cost (Present Value)	\$297,254
Cataloging Cost (Present Value)	\$6,750
Bin Cost (Present Value)	\$36,418
Common Labor Cost (Present Value)	\$5,467,420
Documentation Cost	\$13,402
Test Program Sets Cost	\$0
Contract Repair Cost	\$0
Contractor Fixed Cost	\$0
Contact Team Cost	\$0

A screenshot of the 'Optimizer Report' window showing a detailed table of failure modes. The table includes columns for LRU Name, SRU Name, End Item Repair Level, LRU Repair Level, SRU Repair Level, and Percentage.

Failure Mode					
LRU Name	SRU Name	End Item Repair...	LRU Repair Level	SRU Repair Level	Percentage
TML	STACKER	DSU	GSU	GSU	100.00%
EIArUwDummy	Dummy for Repai...	DSU	DSU	TOSS	100.00%
EIArUwDummyTwo	Dummy for Repai...	DSU	DSU	TOSS	100.00%
EnEIArU	Dummy for all No...	DSU	TOSS	TOSS	100.00%
EnEIArU2	Dummy for all No...	DSU	TOSS	TOSS	100.00%





# Evaluator

- ✓ Evaluate non-optimal Policies
- ✓ Measure Maintenance Policy effects

Evaluator

File Export

Available Policies Totals End Item Spares LRU Spares SRU Spares

Failure Modes

LRU	SRU
Antenna	Antenna Base
Receiver-Tran...	Housing
Receiver-Tran...	Modulator/De...
Receiver-Tran...	PWB Amplifier
Amplifier-Cou...	RF Amplifier A...
Amplifier-Cou...	PWB Amplifier
Power Supply	Battery

Available Policies

End It...	LRU Rep...	SRU Rep...	Percent...
ORG	ORG	ORG	
ORG	ORG	DSU	0
ORG	ORG	GSU	
ORG	ORG	DEPOT	100
ORG	ORG	TOSS	
ORG	TOSS	TOSS	
DSU	TOSS	TOSS	

Current Results

Total Maintenance Policy Cost  
\$21,201,501

Total Logistics Cost  
\$20,842,265

% Change  
6%

Modified Results

Total Maintenance Policy Cost  
\$22,418,159

Total Logistics Cost  
\$22,058,923

Evaluator

File Export

Available Policies Totals End Item Spares LRU Spares SRU Spares

SRU Name	ORG	DSU	GSU	DEPOT
Antenna Base	0	6 (1)	0	16 (-560)
Housing	0	0	0	0
Modulator/Demodulator	0	0	0	6
RF Amplifier Assembly	0	0	0	2
PWB Amplifier	0	0	0	11
Battery	0	14	0	1,906





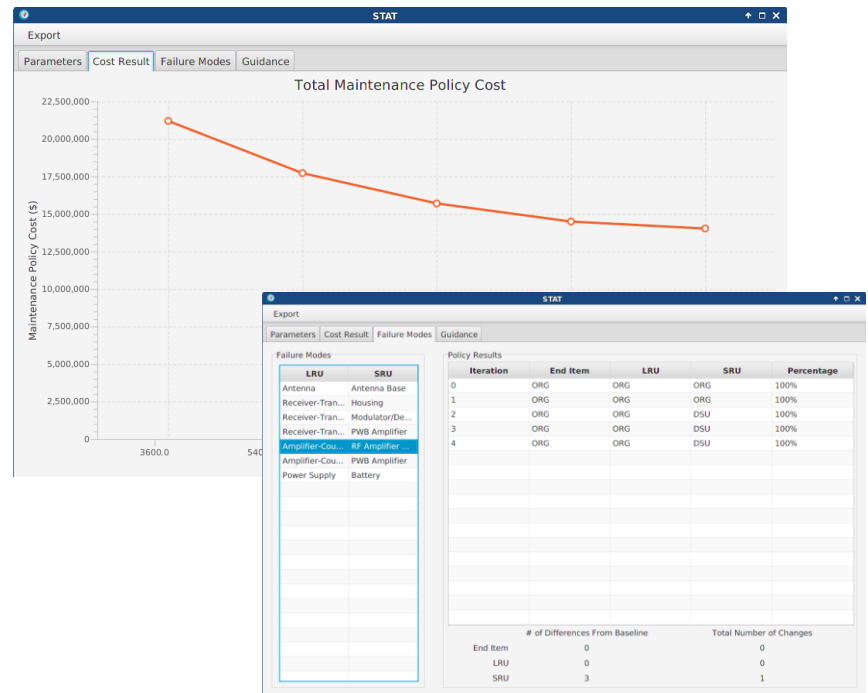
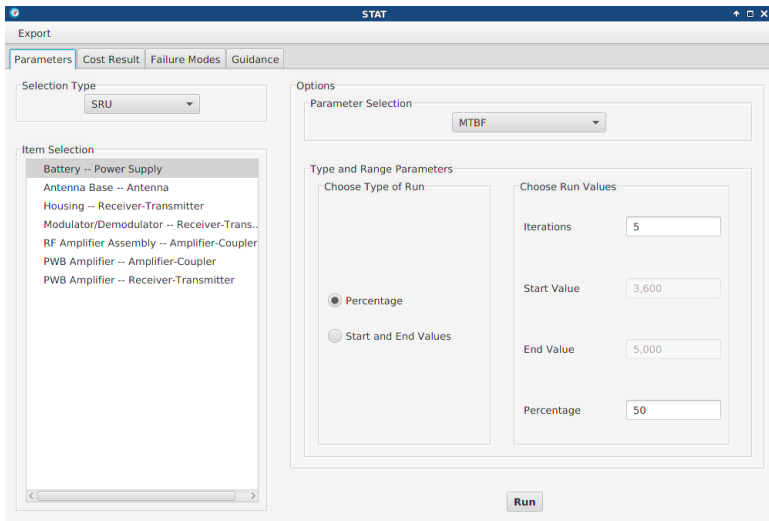


# Sensitivity Analysis

## ✓ STAT

- One-Factor-At-A-Time (OFAT/OFT) Methodology
- Displays impact of a single parameter change

## ✓ Validation limits are applied





# COMPASS 7.3

Improving Economic LORA





# COMPASS 7.3

## ✓ One Year Later

- Assessing User Needs
- Studying COMPASS underlying concepts
- Implementing Improvements to support DoD needs

## ✓ New Features

- Improved Imports
  - SAE GEIA-STD-0007
  - FEA Excel
- STAT Re-Write
  - Improved GUI
  - Guided Assessment
- Core Depot Assessment Candidates





# STAT Update

## ✓ Updated GUI

- Proper selections and disabling
- Improved validation
- More Data Returned





# STAT Rewrite

## ✓ Guided STAT

- Automated parameter selection
- Sortable results

Export

Parameters Cost Result Failure Modes Guidance

Possible Impact Areas

Type	Name	Parameter	% Change	Cost Change ▲	Total Cost
End Item	HF Radio Set	Annual Operating Hours	-15%	(\$2,863,088.22)	\$18,338,412.33
End Item	HF Radio Set	Annual Operating Hours	-10%	(\$1,828,369.42)	\$19,373,131.14
Non-Rep...	Battery	MTBF	15%	(\$1,436,910.14)	\$19,764,590.41
Non-Rep...	Battery	MTBF	10%	(\$999,793.44)	\$20,201,707.11
End Item	HF Radio Set	Annual Operating Hours	-5%	(\$894,627.15)	\$20,306,873.40
LRU	Power Supply	Unit Price	-15%	(\$760,270.14)	\$20,441,230.41
SRU	Battery	Total Price of Average Replacement	-15%	(\$567,355.19)	\$20,634,145.36
End Item	HF Radio Set	Availability Target	-15%	(\$558,474.40)	\$20,643,026.15
Non-Rep...	Battery	MTBF	5%	(\$530,594.89)	\$20,670,905.66
LRU	Power Supply	Unit Price	-10%	(\$506,846.76)	\$20,694,653.79
End Item	HF Radio Set	Availability Target	-10%	(\$444,833.01)	\$20,756,667.54
SRU	Battery	Total Price of Average Replacement	-10%	(\$375,887.63)	\$20,825,612.92
SRU	Modulator/Demodulator	MTBF	15%	(\$323,154.56)	\$20,878,345.99
LRU	Power Supply	Unit Price	-5%	(\$253,423.38)	\$20,948,077.17
LRU	Receiver-Transmitter	Unit Price	-15%	(\$217,440.66)	\$20,984,059.89
SRU	Modulator/Demodulator	MTBF	10%	(\$216,886.73)	\$20,984,613.83
SRU	PWB Amplifier	MTBF	15%	(\$212,556.27)	\$20,988,944.29
SRU	Battery	Total Price of Average Replacement	5%	(\$184,420.07)	\$21,017,080.40

Run Assessment





# Lessons Learned

## Understanding LORA





# Lessons Learned

- ✓ **Focus on Failure Modes**
  - End Item → LRU → SRU
  - Resultant policies are specific to the failure mode
  - Resultant spares are per item
  - Supply Action
  
- ✓ **Importance of Maintenance Perspective**
  - 3 Level Indenture
  - Access is not replacement
  - Focus on Failure Modes
  
- ✓ **Importance of LORA Community Connection**
  - Source of software feedback
  - Making LORA understandable





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