

STOCK LEVEL OPTIMIZATION FOR SYSTEM WITH REDUNDANCY CONFIGURATION

FUSARO (NA) – 14/05/2025

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Summary

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Case Study Overview

Sparing Optimization

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Case Study Overview

Scope & Objective: System Architecture

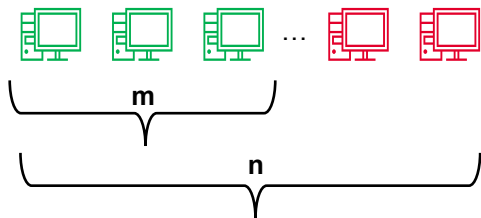
The example **System** under analysis is composed of several and different **Main Units**

- Server
- Console
- Monitors/Large Screen
- ...

Each System Unit is composed of a variable number of Maintenance Significant Items (**MSI**), which can differ significantly from one unit to another (10, 15, 100, etc..)

Each MSI can be classified according to their Maintenance Capability and Reliability Performance.

Redundancy configuration





Case Study Overview

Scope & Objective: Mission Duty



Defined Mission Profile

Period at Sea (PAS)

Ashore Phase between each PAS



Utilization Duty

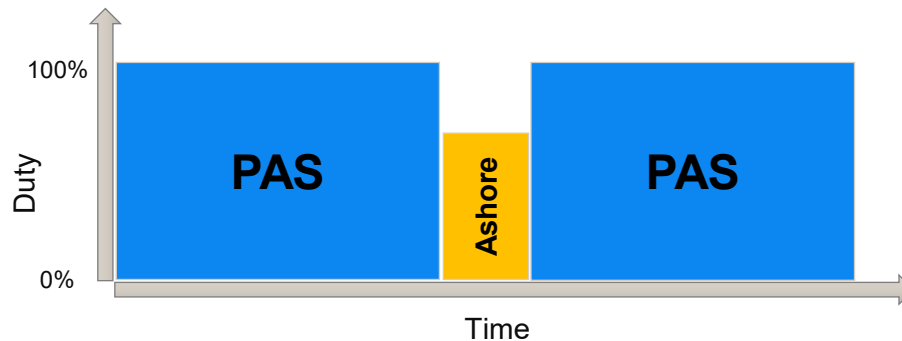
Each System Unit has a utilization **duty** in **Ashore Phase**



Maintenance Capability

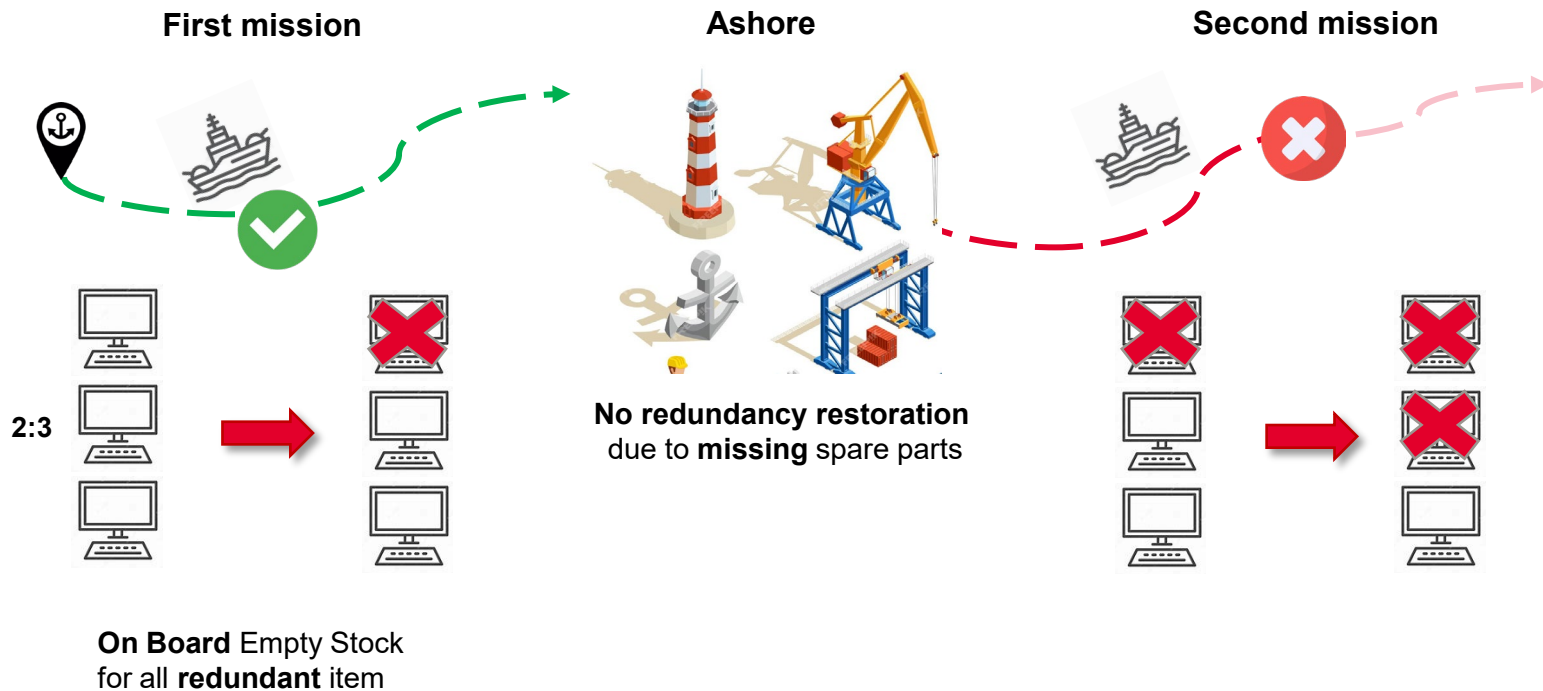
PAS: onboard stock is available for failure restore

Ashore: depot stock is available for failure restore and **on board** stock replenishment



Redundancy Restoration

Effects of Depot Inefficiencies on Mission Availability





Operational Availability (Ao)

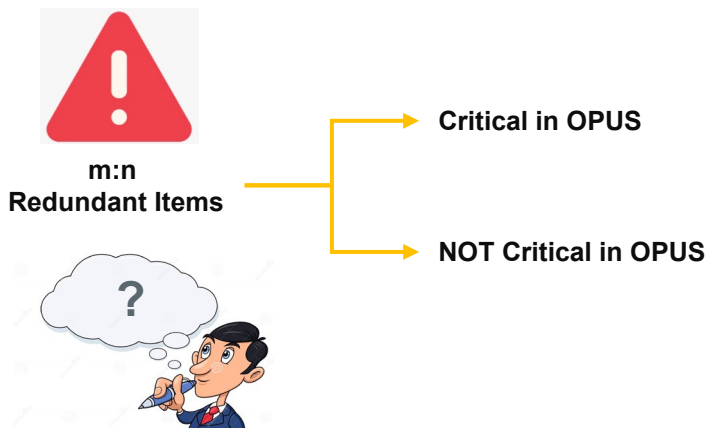
Requirement

System **Operational Availability** (Ao) $\geq 95\%$

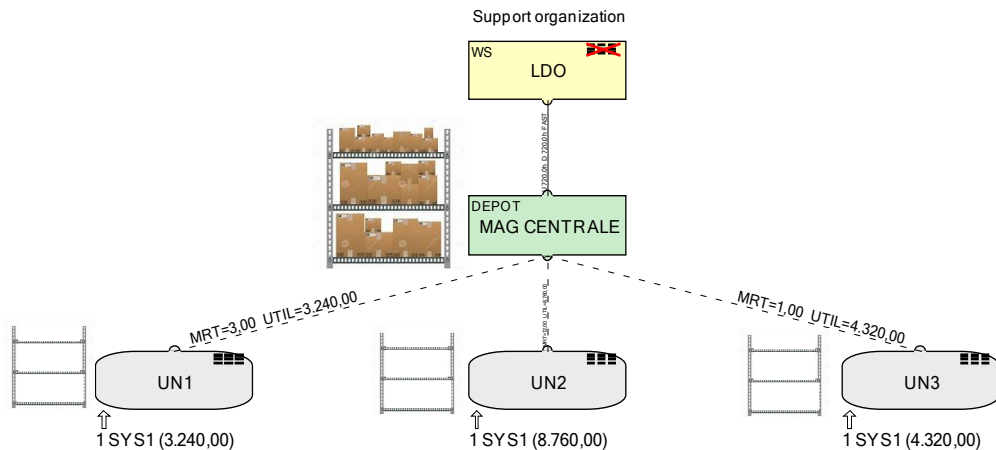
Maintenance Policy

During Mission - for **Critical** components parts, only.

At the End of Mission - for **Not Critical** components parts



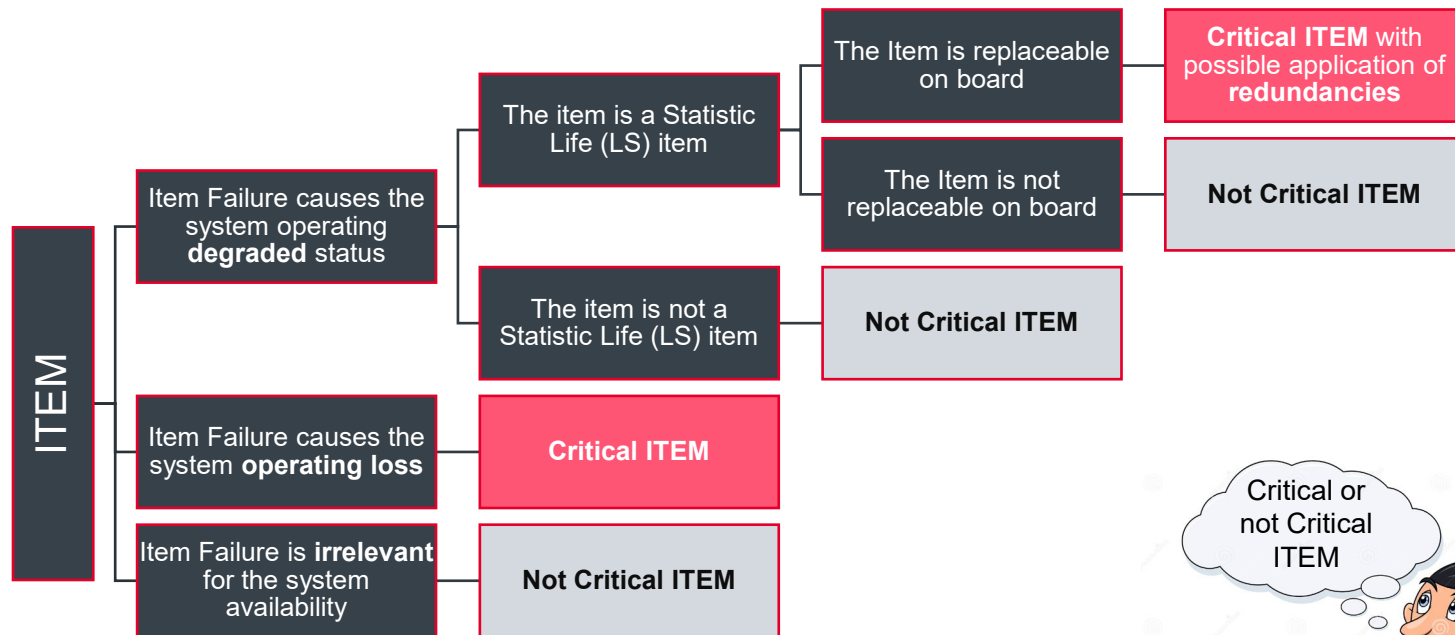
IDEAL WORLD





Tool Modeling

Criticality: OPUS Flowchart Setting



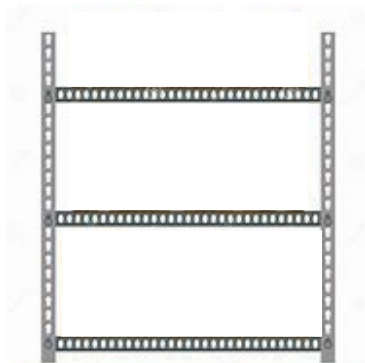


Tool Modeling

Redundancy: OPUS Operationally Tailored Implementation

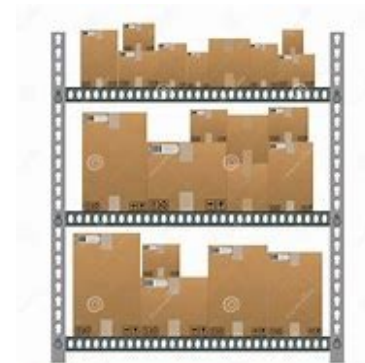
On-Board Spare Parts

Redundancies are implemented to **enhance** system **availability**, ensuring continued operation despite potential failures during mission time



Ashore Spare Part

Redundancies are **not implemented**, as all failures (whether critical or non-critical) are assumed to be recoverable through immediate restoration using depot-level spare parts





Tool Modeling

On-board and Ashore Stock Optimization Process



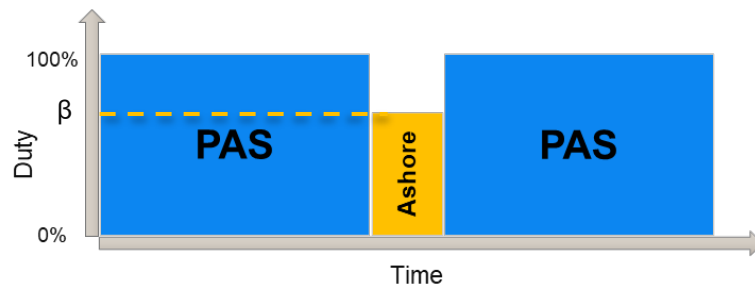
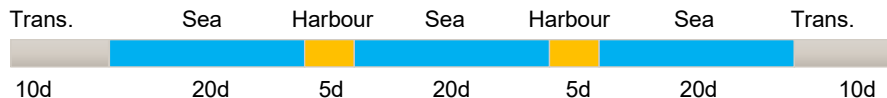
CASE 1 - only one Run to model both OnBoard and Ashore stocks:
Redundancy are implemented

CASE 2 - only one Run to model OnBoard and Ashore stocks:
Redundancy are not implemented

CASE 3 - two Run: One corresponding to **CASE 1** in order to model only the **OnBoard stock**; Second one corresponding to **CASE 2** in order to model **Ashore stock**

Implementation of **Operative Profile** and **duty**, to verify the Availability of the system in time domain; **Backorder analysis**.

To correctly evaluate the system's behaviour also during the ashore phase (β), daily operational profiles (**each of 20 hours**) have been implemented for the latter in such a way as to simulate operation in port and at the same time, allow the remaining **4 hours** to restore the System with the land stocks.

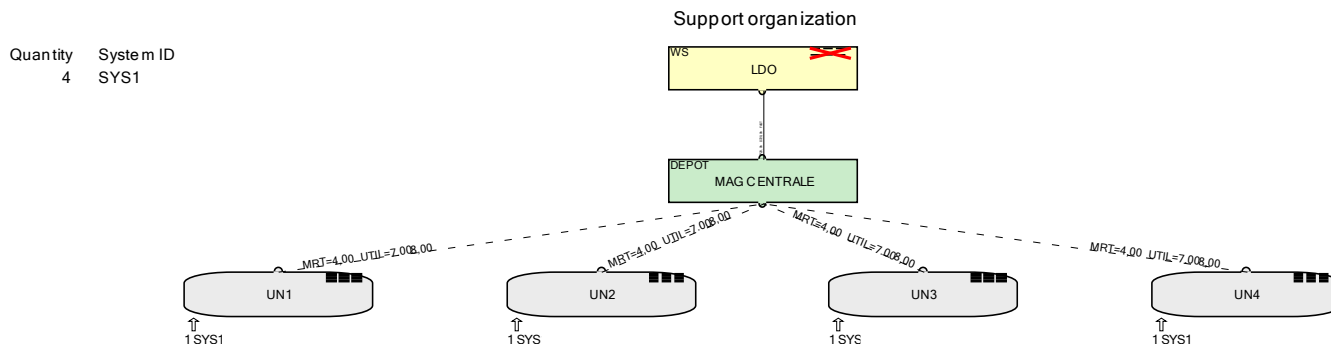




Tool Modeling

System Logistics Significant Data

Nr Systems	Nr Item	Qty item tot.	Nr redundancy	Critical Items	Not Critical Items	Item OLM	Item ILM	Rapairable Items	Not Repairable Items	Repair LT [month]	Reorder LT [month]
4	90	400	33	40	50	71	19	30	60	6	12

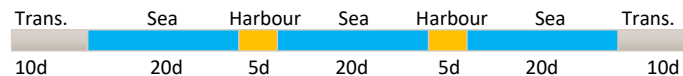




Tool Modeling

Mission Profile from OPUS to SIMLOX

System	Nr mission [h]	Time at sea [h]	α	β	At
SYS	3	2000	100%	40%	80%



$$At * Year = 0,8 * 8760 = 7008 \text{ hours}$$

$$Time \text{ Ashore} = 7008 - 2000 = 5008 \text{ hours}$$

$$UTIL = \alpha * Time \text{ at sea} + \beta * Time \text{ ashore} = 4003 \text{ hours}$$

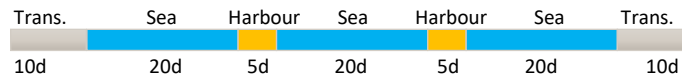


OPUS10

UTLID	UTIL	MRT
PROFILE	4003	3



SIMLOX



MTID	MFF
TRASF.	1
SEA	1
HARBOUR	0,4

α
 β

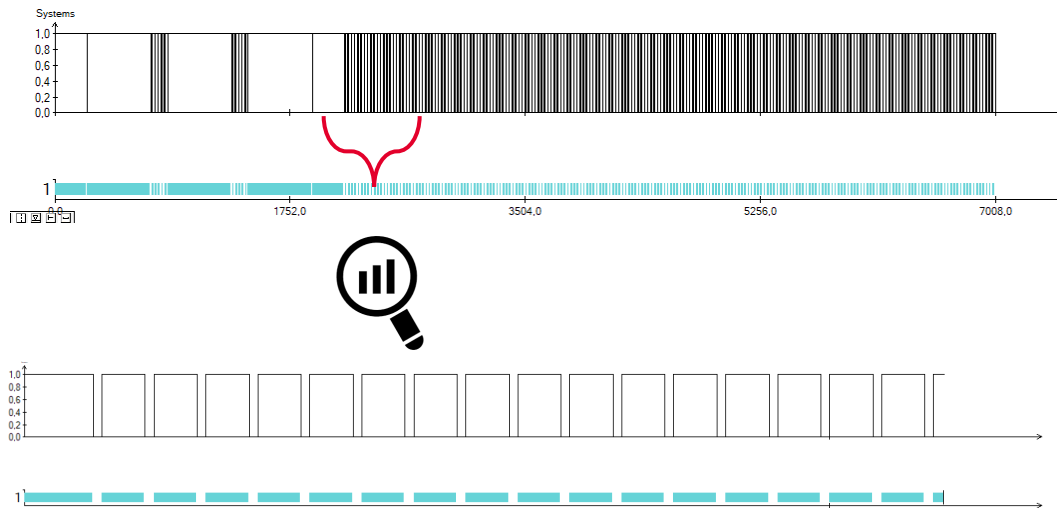


Tool Modeling

Ashore Phase Profile Modeling

The Port phase is designed to represent an ideal **20-hour** operational window, with the remaining **4 hours** allocated for system recovery leveraging Land Stock resources.

NREPS	Number of replications	<1>	1000
SIMPE	Simulation period	[Hours]	24528.0
RSEED	Random seed		1357
APID	Allocation point identifier		
RCINT	Result collection interval	[Hours]	<24.0>
RCSTA	Result collection start time	[Hours]	<0.0>
RCEND	Result collection end time	[Hours]	
ENPM	Enable Preventive Maintenance	<Y>	
ENLAT	Enable lateral support	<Y>	
ENROB	Enable robbing	<N>	
ENALU	Enable alternative units	<Y>	
TCLEV	Target confidence level		
ENLOG	Enable simulation log	<N>	
RMVFR	Removal fraction of replacement time	<0.500>	
WTLIM	Waiting time tolerance for ROST	[Hours]	<0.00>
ENBOP	Enable backorder prioritisation	<N>	
DRAOS	Deployed resources available off shift	<N>	
PERCL	Percentile level		
ENFBD	Enable functional breakdown	<N>	Y
ENPNM	Enable paused noncritical maintenance	<Y>	N
ENTR	Enable task results	<Y>	

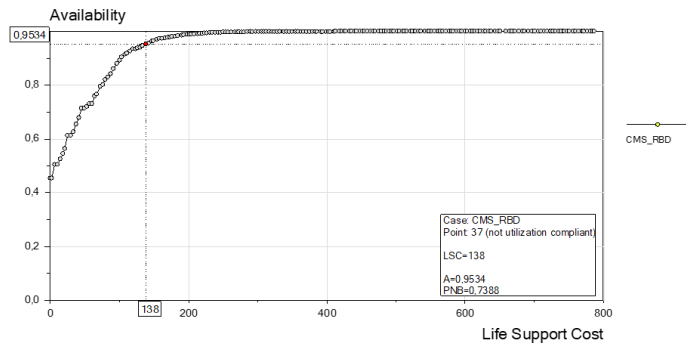




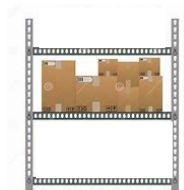
OPUS Results

CASE 1 (redundancy applied)

C/E-Curve Diagram

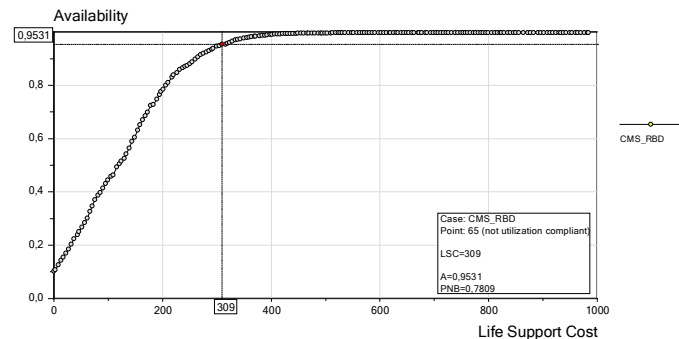


Qty Item OnBoard	Qty Item Ashore
24	114

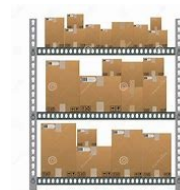


CASE 2 (No redundancy applied)

C/E-Curve Diagram



Qty Item OnBoard	Qty Item Ashore
164	145





OPUS Results

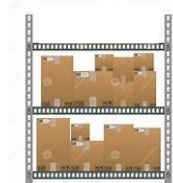
CASE 3

Qty Item OnBoard	Qty Item Ashore
24	145



CASE 3 Optimized

Qty Item OnBoard	Qty Item Ashore
36	185

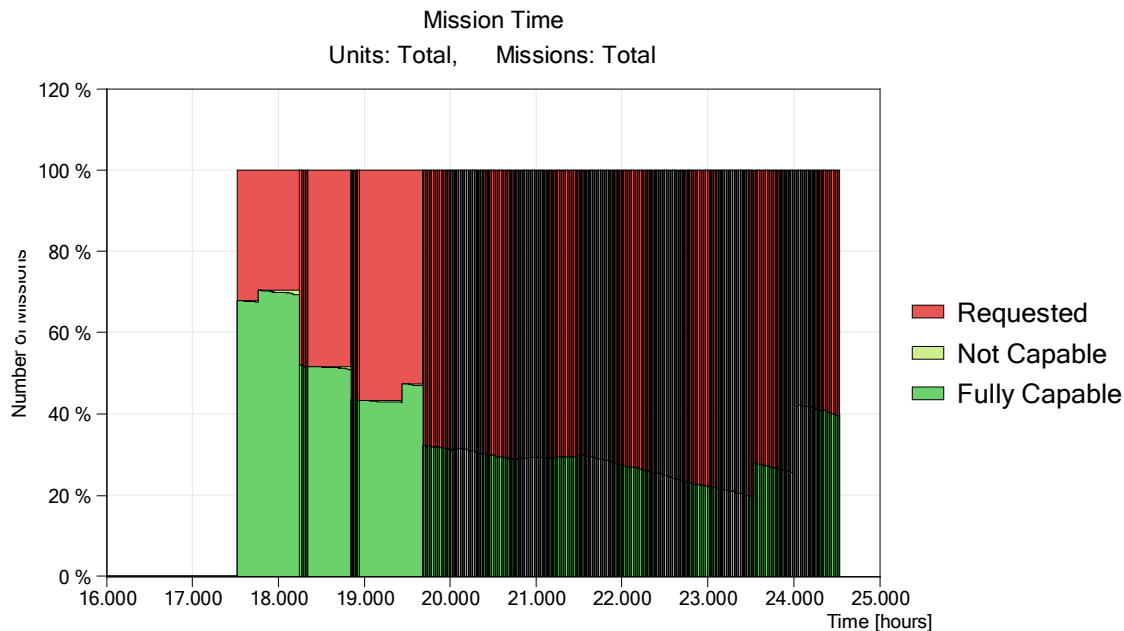
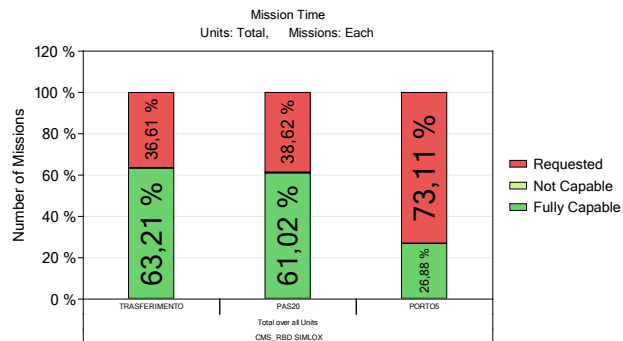
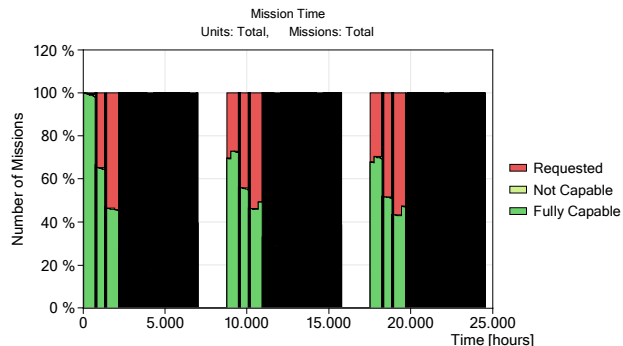




SIMLOX Results

CASE 1

Ao OPUS	Qty Item OnBoard	Qty Item Ashore
95%	24	114

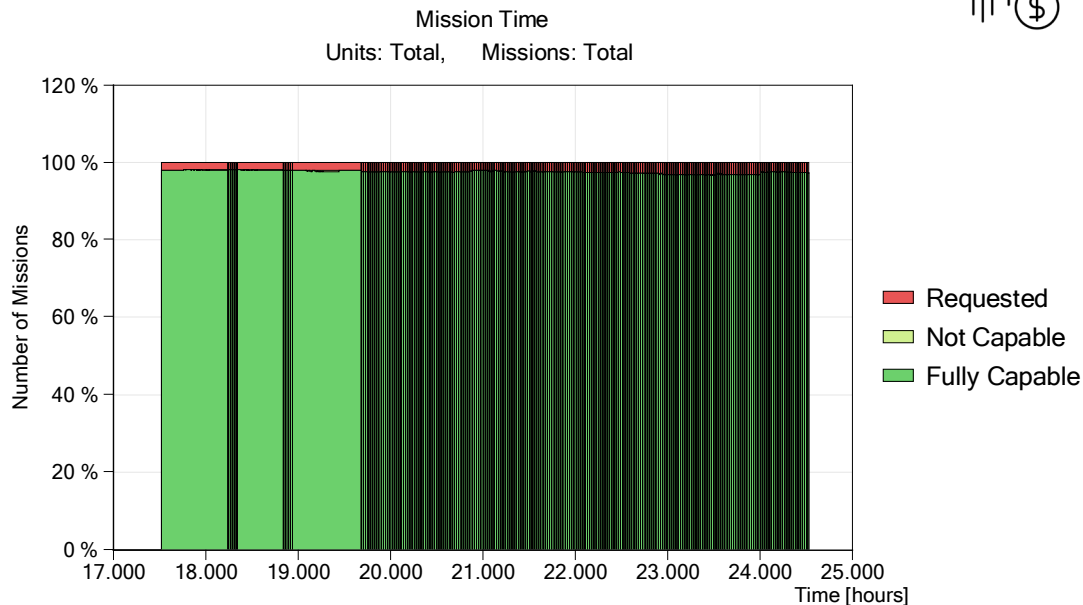
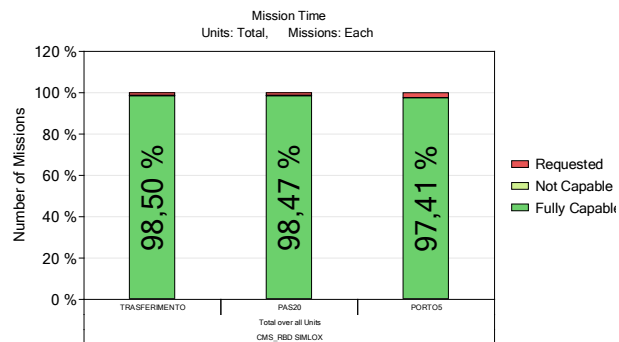
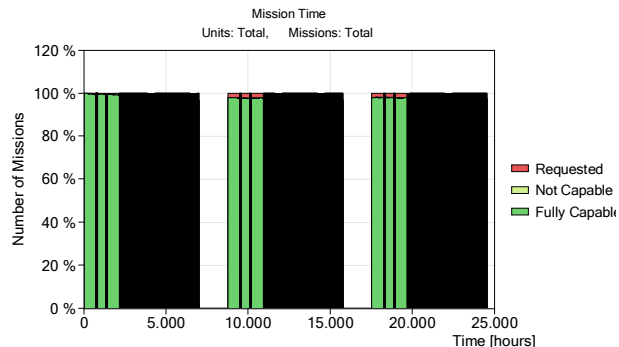
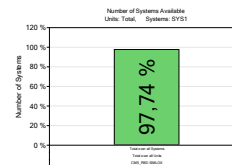




SIMLOX Results

CASE 2

Ao OPUS	Qty Item OnBoard	Qty Item Ashore
95%	164	145

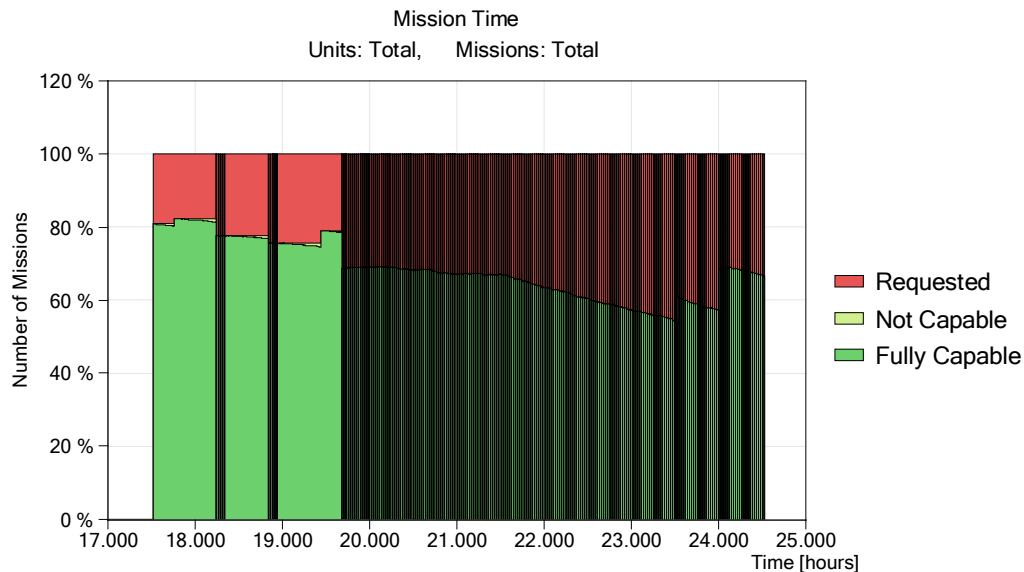
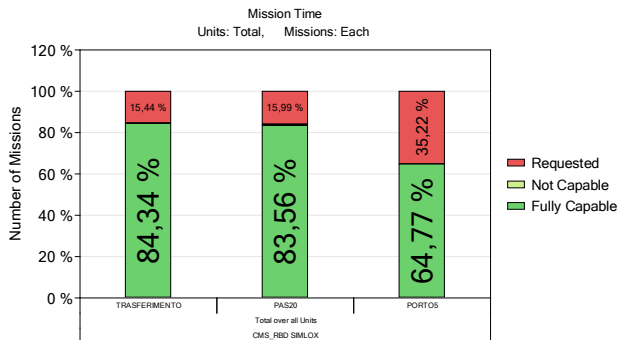
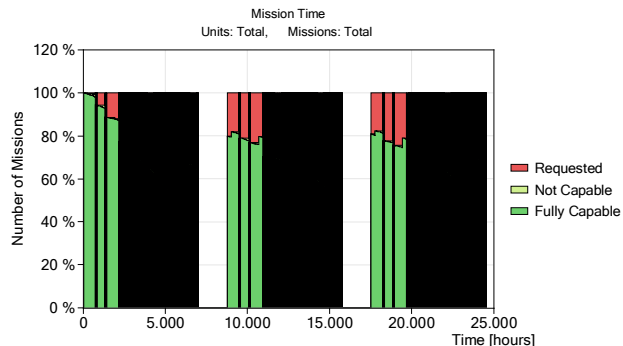
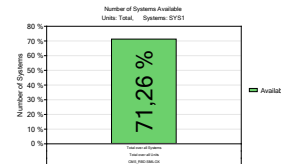




SIMLOX Results

CASE 3

Ao OPUS	Qty Item OnBoard	Qty Item Ashore
-	24	145

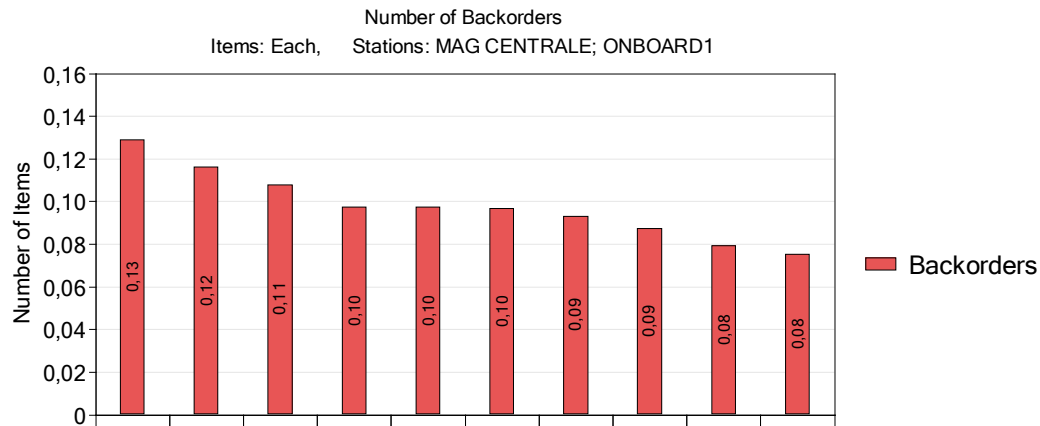




SIMLOX Results

CASE 3 Optimized

Ao OPUS	Qty Item OnBoard	Qty Item Ashore
-	36	185

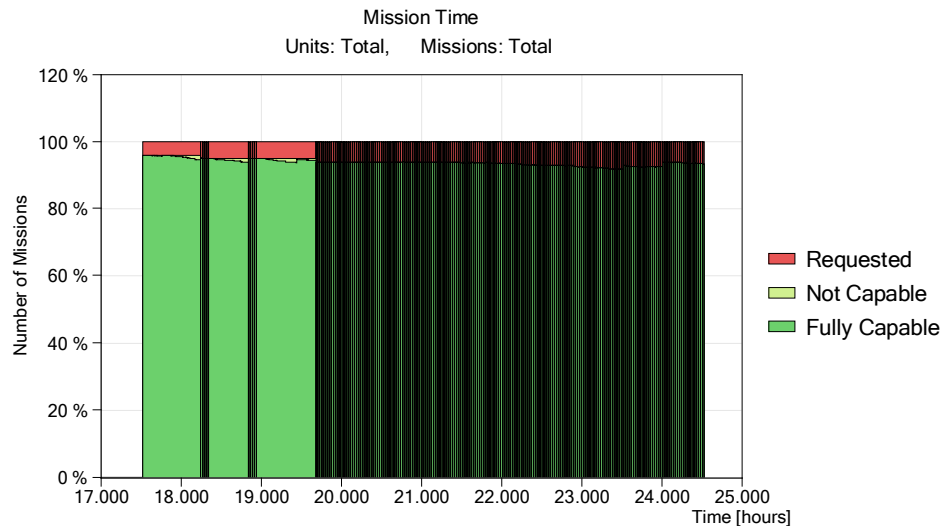
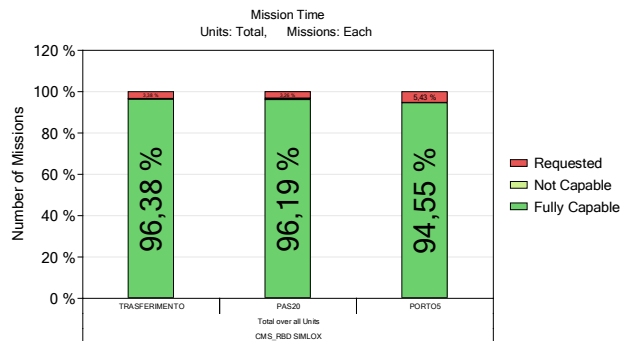
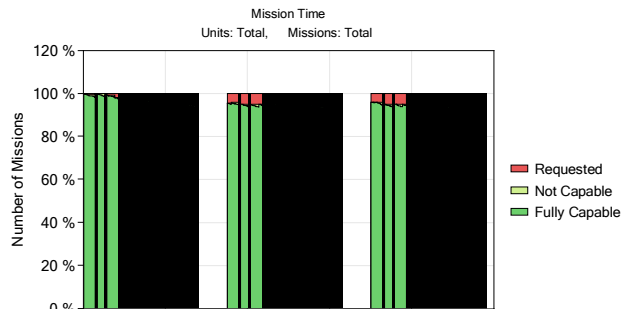
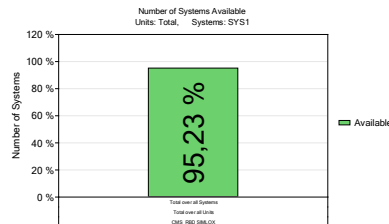




SIMLOX Results

CASE 3
OPT

Ao OPUS	Qty Item OnBoard	Qty Item Ashore
-	36	185



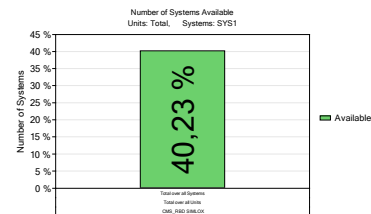


SIMLOX Results

CASE 1

Redundancy applied

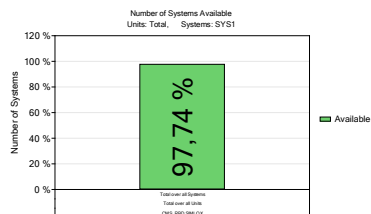
Ao OPUS	Qty Item OnBoard	Qty Item Ashore
95%	24	114



CASE

No Redundancy applied

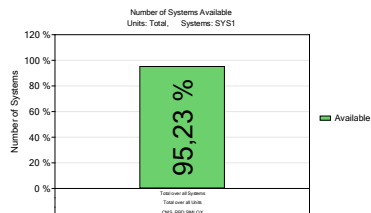
Ao OPUS	Qty Item OnBoard	Qty Item Ashore
95%	164	145



CASE 3

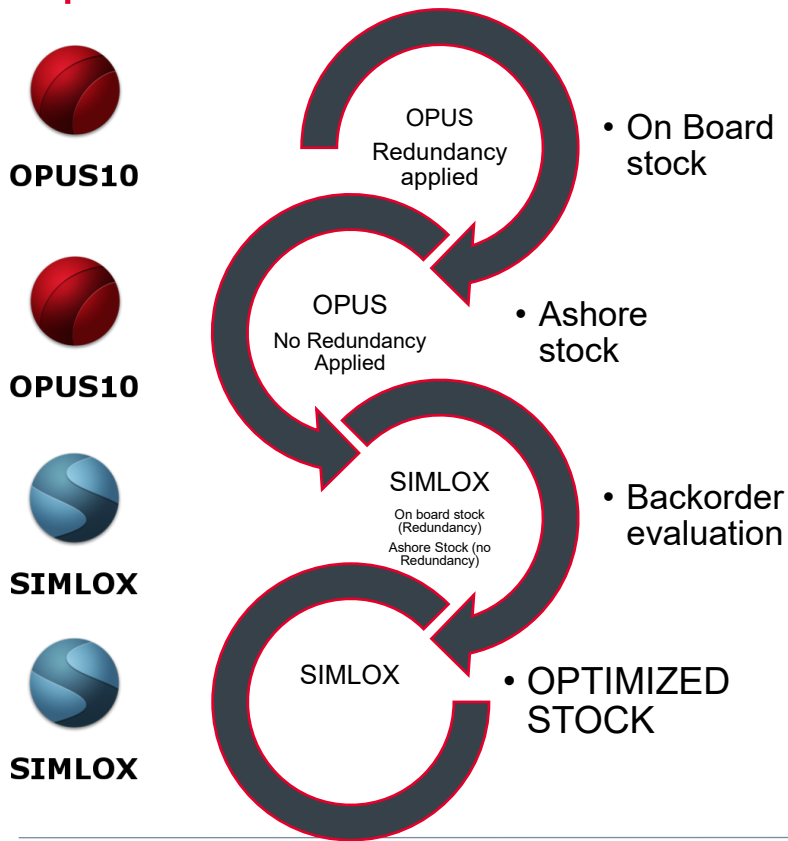
OPT

Ao OPUS	Qty Item OnBoard	Qty Item Ashore
-	36	185





Optimization Flow

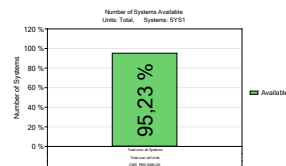
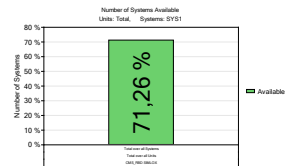
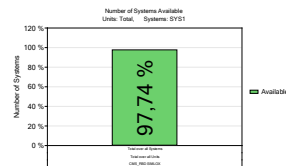
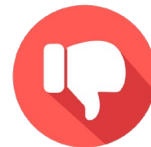
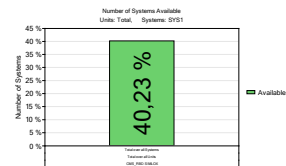


CASE 1
(redundancy applied)

CASE 2
(No redundancy applied)

CASE 3

CASE 3 OPTIMIZED





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