National Aeronautics and Space Administration

Ground System Spares/Maintenance Plans Derived from Limited Life Item Analysis

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Agenda

- What is Limited Life Analysis?
- JPSS Ground System Case Study
- Lessons Learned

Limited Life Analysis

- **Purpose**
  - to identify and manage real-time mission critical life-limiting items to ensure they have sufficient life to meet mission needs.

- **Approach**
  - Establish items in the design that have a limited shelf or time/cycle life
  - Determine Required Life for each item: Installation date through next scheduled refresh date or mission need duration
  - Assess Expected Life for each LRU: Installation date through End of Support (EOS) date or End of life
  - Calculate the Life Margin (LM): Expected Life / Required Life
  - Maintain (Iterate) with changes in operations, design, mitigation, or maintenance plans/activities as needed

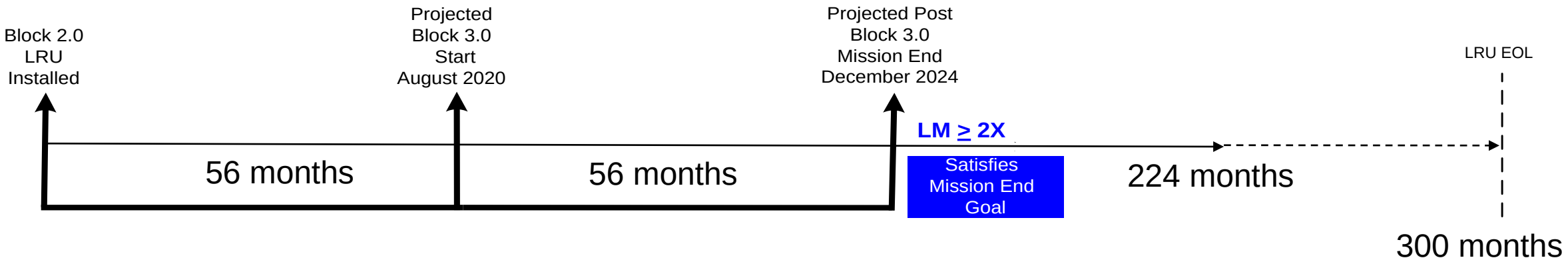
- **Benefits**
  - Characterization of system performance risks
  - Characterization of mitigation strategies (sparing, preventive maintenance, replaceability, operational cycling).

Life Margin Example

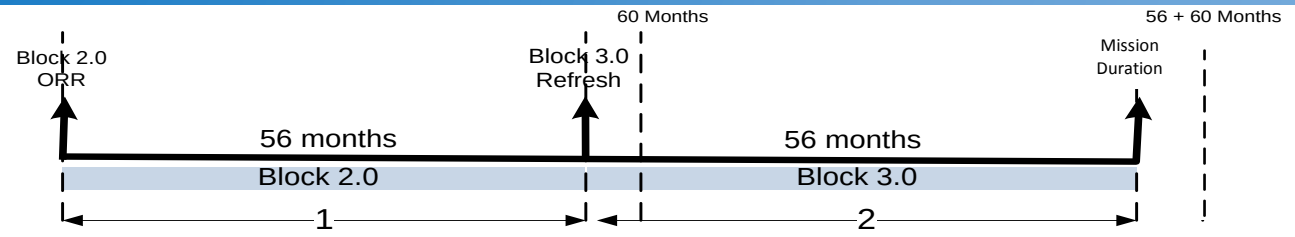
- **LLI Outcomes**

LM ≥ 2	Life Margin goal met – No Risk, No action is required.
1 ≤ LM < 2	Low Risk, Determine need for action on a case-by-case basis.
LM < 1	High Risk, Modified refresh, mitigation, maintenance plan or design change is required

Theoretical example of a Limited Life Item Period
LLA outcome calculated for each required life period



Life Margin Case Examples



1: Expected Life = 60 months
Required Life = 56 Months
Margin = 60/56 = 1.07
2: Same

Mission: 120/112 = 1.07

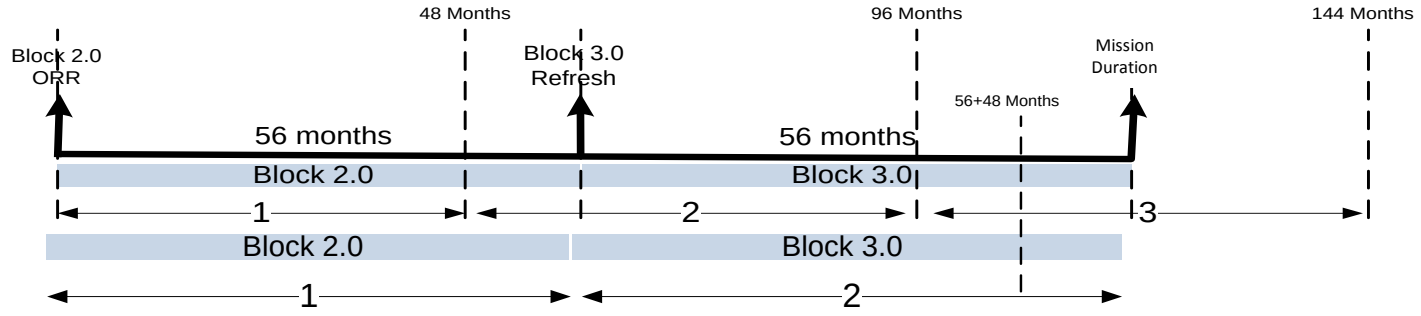
Two redundant units (Stand-by)
1: Expected Life = 120 months
Required Life = 48 Months
Margin = 120/48 = 2.5
2. Expected Life = 120 months
Required Life = 48 Months
Margin = 120/48 = 2.5

Mission: 240/112 = 2.14

Or

Two redundant units (Stand-by)
1: Expected Life = 120 months
Required Life = 112 Months
Margin = 120/112 = 1.07
2. No Refresh

Mission: 120/112 = 1.07

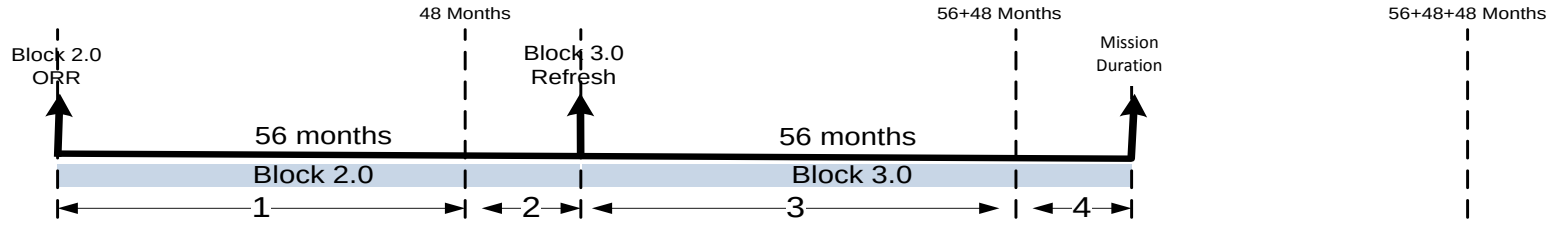


1: Expected Life = 48 months
Required Life = 48 Months
Margin = 48/48 = 1
2: Same
3: Expected Life = 48 months
Required Life = 16 Months
Margin = 48/16 = 3

Mission: 144/112 = 1.3

1: Expected Life = 56 months
Required Life = 48 Months
Margin = 56/48 = 1.2
2. Expected Life = 56 months
Required Life = 56 Months
Margin = 56/56 = 1.0

Mission: 112/112 = 1.0

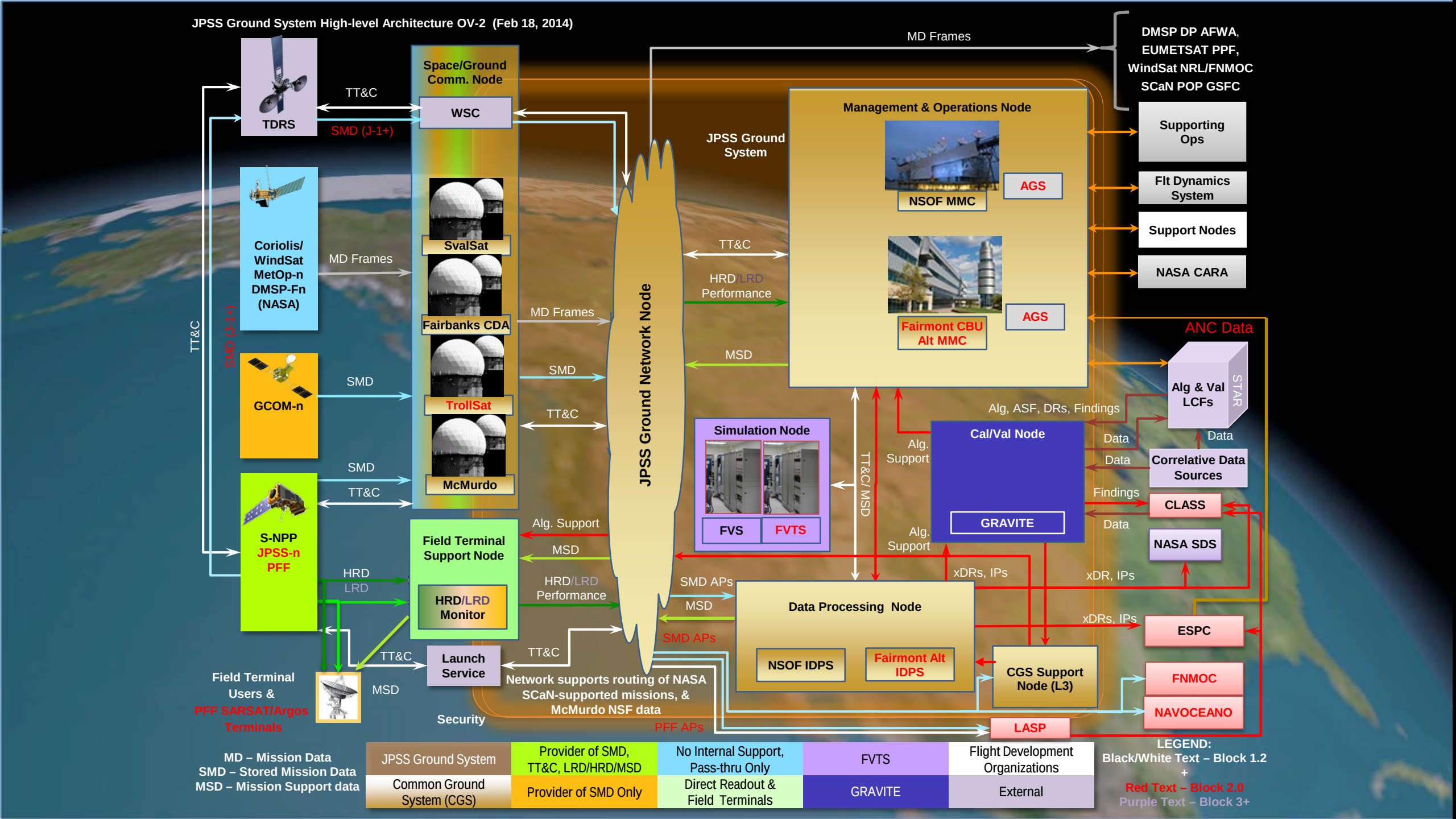


1: Expected Life = 48 months
Required Life = 48 Months
Margin = 48/48 = 1
2. Expected Life = 48 months
Required Life = 8 Months
Margin = 48/8 = 6
3. Same as 1
4. Same as 2

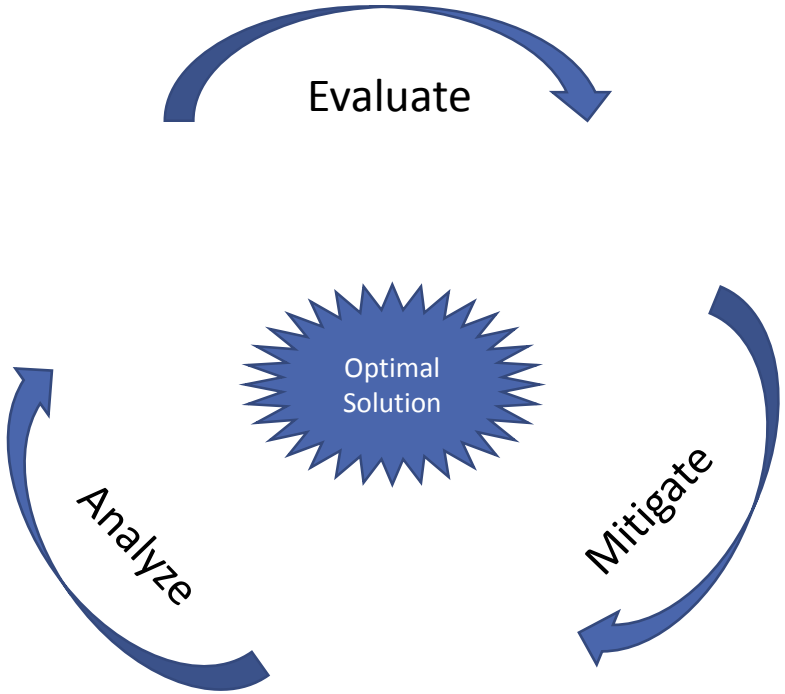
Mission: 152/112 = 1.4

JPSS Ground System Case Study

JPSS Ground System High-level Architecture OV-2 (Feb 18, 2014)



Limited Life Item Analysis



LLI Category	LLI Assessment	Criteria
Acceptable	6	LM ≥ 3
Adjudicated with Refresh	34	2 ≤ LM < 3
Adjudicated Additionally [1]	7	2 ≤ LM
EOS Date Assumed [2]	5	2 ≤ LM
Risky	0	LM <2
[1] These parts needed a retention plan to reach the Block 3 tech refresh [2] Manufacturer has not yet determined an EOS date for the se items, from November 2013 a 5 to 8 year EOS date is estimated Total	52	

LLI Category	LLI Assessment	Criteria
Acceptable (Plan & Projections)	5	LM ≥ 2
Adjudicated due to Refresh	48	LM< 2 and ≥1
Adjudicated With Additional Mitigation to the end of Block 2.0	9	1 < LM
Total	62	

Results Summary

LRU RMA ID	LRU Name	Location/ SubNode: Level 2	Manufacturer	Part Number	Deployed Quantity	Required Life (RL)(Months)	Expected Life (EL) (Months)	EOS Date	Life Margin ("EL"/"RL" ≥ 2) (Years)	Retention Rationale	LLI	Dev. Org.	Block 2 ORR	Comments & Notes
S.3.22#S.3	370 to 720 MHz Upconverter CrossTech 1200 [RTN]	White Sands	Cross Technologies	2083-0372	1	56	131	12/31/2026	2.34		TBS-RTN	SGI	1/1/2016	
Multiple	SGE (RCV) RTL-T400XR [RTN]	McMurdo	RTLogic	T400X (Rayt n Part Numb T400I										
Multiple	TGE [RTN]	Svalbard, FCDAS, White Sands	RTLogic	T70/7										

LRU RMA ID	LRU RMA ID	Location/ SubNode: Level 2	Manufacturer	Part Number	Deployed Quantity	Required Life (RL)(Months)	Expected Life (EL) (Months)	EOS Date	Life Margin ("EL"/"RL" ≥ 2)	Retention Rationale	LLI	Dev. Org.	Block 2 ORR
S.1.3#C.4#1.2-2	IRIG-B d [RTN]	Ground Station: SvalSat Main Building [KSAT]	Symmetricom	TSC4059B	3	56	59	12/31/2020	1.05	N/A	N	GNI	1/1/2016
S.1.3#C.4#1.1	NTP Appliance [RTN]	Ground Station: SvalSat Main Building [KSAT]	Symmetricom	1520R-S250	12	56	59	12/31/2020	1.05	N/A	N	C&S	1/1/2016
S.1.3#C.2.+1.1	Server Platform VM c3000 + 4 blades [RTN] (Chassis focus)	Ground Station: SvalSat Main Building [KSAT]	HP	508668-B21	7	56	71	12/31/2021	1.27	N/A	N	C&S	1/1/2016
							71	12/31/2021	1.27	N/A	N	C&S	1/1/2016
							95	12/31/2023	1.70	N/A	N	SGI	1/1/2016
							80	9/30/2022	1.43	N/A	N	SGI	1/1/2016

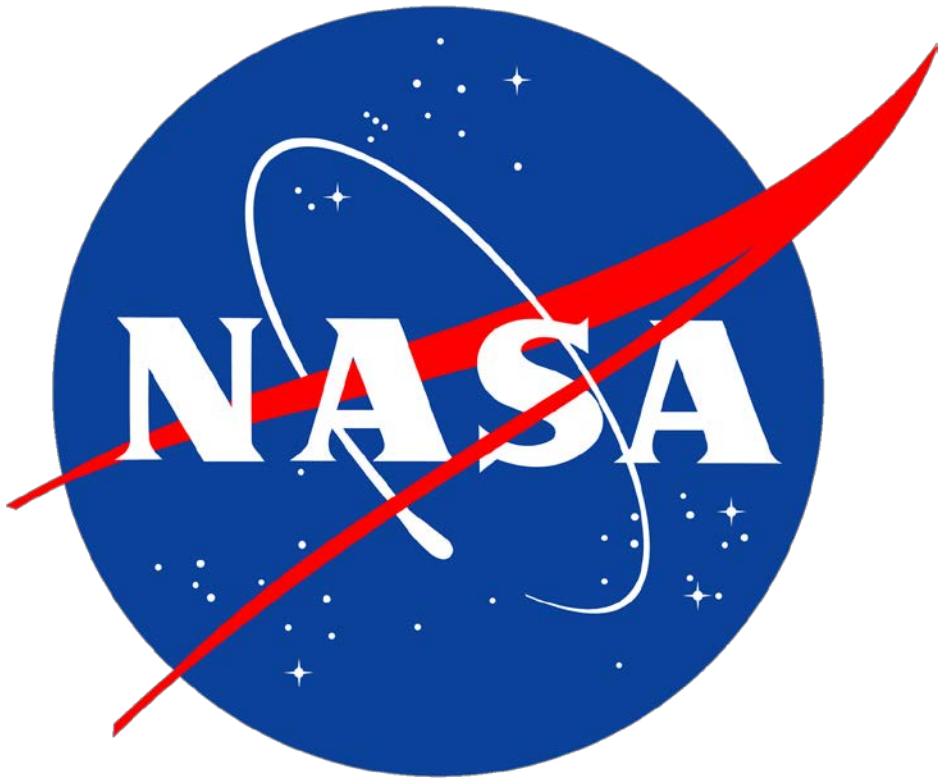
LRU Name	Location/ SubNode: Level 2	Manufacturer	Part Number	Deployed Quantity	Required Life (RL)(Months)	Expected Life (EL) (Months)	EOS Date	Life Margin ("EL"/"RL" ≥ 2) (Years)	Retention Rationale	LLI	POC	Dev. Org.	Block 2 ORR	Comments & Notes
Storage P4500 [RTN] FRS: 4 mirrored nodes, aaaa	FCDAS	HP	BQ888B	14	56	54	9/1/2019	0.96	Unit refresh needed to make it to Block 3 ORR. The EOS date has an added 6 years since it is assumed the part will last the same amount of time once repurchased prior to 2019	Y	C&S	1/1/2016		
Storage N-R10 [RTN] FRS: 3of4	CBU	HP	4730 PNB7E27A	2	56	44	9/1/2019	0.79	Unit refresh needed to make it to Block 3 ORR. The EOS date has an added 6 years since it is assumed the part will last the same amount of time once repurchased prior to 2019	Y	SGI	1/1/2016		

Result: Revised LRU Deployment/Maintenance Plan

LRU Name	RMA ID	LRU Deployment	LM Calculation		LRU Deployment Description†
ARF Antenna Control Assembly	S.1.7#4.1.2	LRU-1	EL (mo.)	80	Expected Life (EL) is the LRU EOS date.
ARF Antenna Control Assembly	S.1.7#4.1.2		RL (mo.)	56	LRU-1 is needed to reach the Block 3.0 technology refresh milestone.
ARF Antenna Control Assembly	S.1.7#4.1.2		**LM**	**1.43**	**LRU-1 has a favorable life margin - no further action needed.**
ARF Antenna Control Assembly	S.1.7#4.1.2	**Block 3.0 Technology Refresh Milestone (LRU-1 needed to reach milestone)**			
ARF Antenna Control Assembly	S.1.7#4.1.2	LRU-2	EL (mo.)	80	
ARF Antenna Control Assembly	S.1.7#4.1.2		RL (mo.)	56	LRU-2 is replaces LRU-1. LRU-2 needs to reach the JPSS Planned Mission End milestone.
ARF Antenna Control Assembly	S.1.7#4.1.2		**LM**	**1.43**	**LRU-2 has a favorable life margin - no further action needed.**
ARF Antenna Control Assembly	S.1.7#4.1.2	**JPSS Planned Mission End Milestone (LRU-2 needed to reach milestone)**			
ARF Antenna Control Assembly	S.1.7#4.1.2	LRU-1 + LRU-2	EL (mo.)	160	The LRU (EL) are added together
ARF Antenna Control Assembly	S.1.7#4.1.2		RL (mo.)	112	The LRU required life to reach the JPSS Planned Mission End milestone.
ARF Antenna Control Assembly	S.1.7#4.1.2		LM	1.4	The sum of the LRUs have a favorable life margin.

Lessons Learned

- Ground Systems have additional considerations (i.e., EOS, Warranties, Licenses, etc.) than orbital assets.
- Life Margin Assessment can be used to optimize deployment, sparing, redundancy, and maintenance plans.
- Optimal Life Margins for any one unit throughout a system's lifetime may not always be the most optimal for budget or operational availability.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