Dimensioning of optimal spare parts stock in an operational dynamic situation

Case: Swedish airforce reconnaissance POD (SPK39)
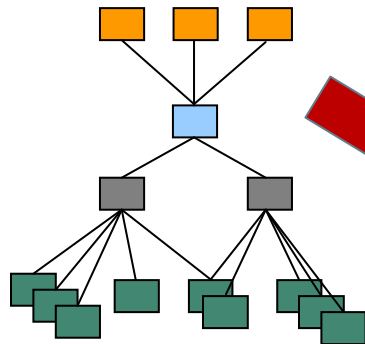
Younes Lousseief, Systecon AB

Summary

How to dimension a cost efficient stock of spare parts when having *large variations* in system utilisation?

Case study: Modular reconnaissance POD for JAS39 Gripen (SPK39)
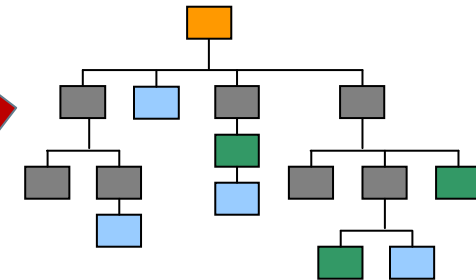
But first, some theory...

System Approach

SYSTECON
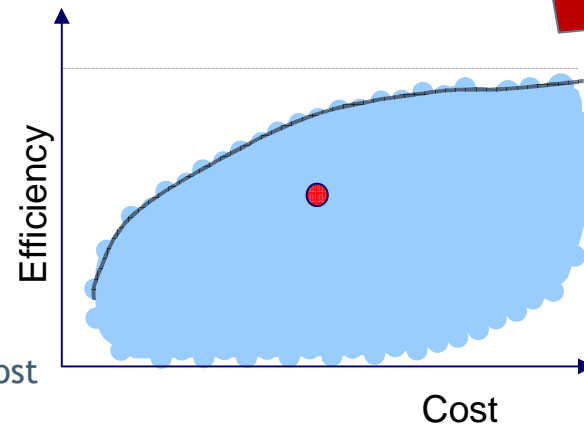SYSTEMS AND LOGISTICS ENGINEERING

Support Organization

- Stock levels
- Repair costs
- Time to repair
- Order costs
- Transportation time & cost
- Warehousing costs
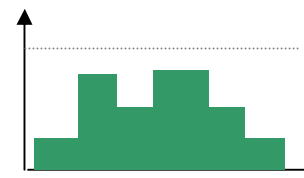- etc.

Product Structure

- Item/Component prices
- Failure/exchange rate (MTBF)
- Repair / Discard decision
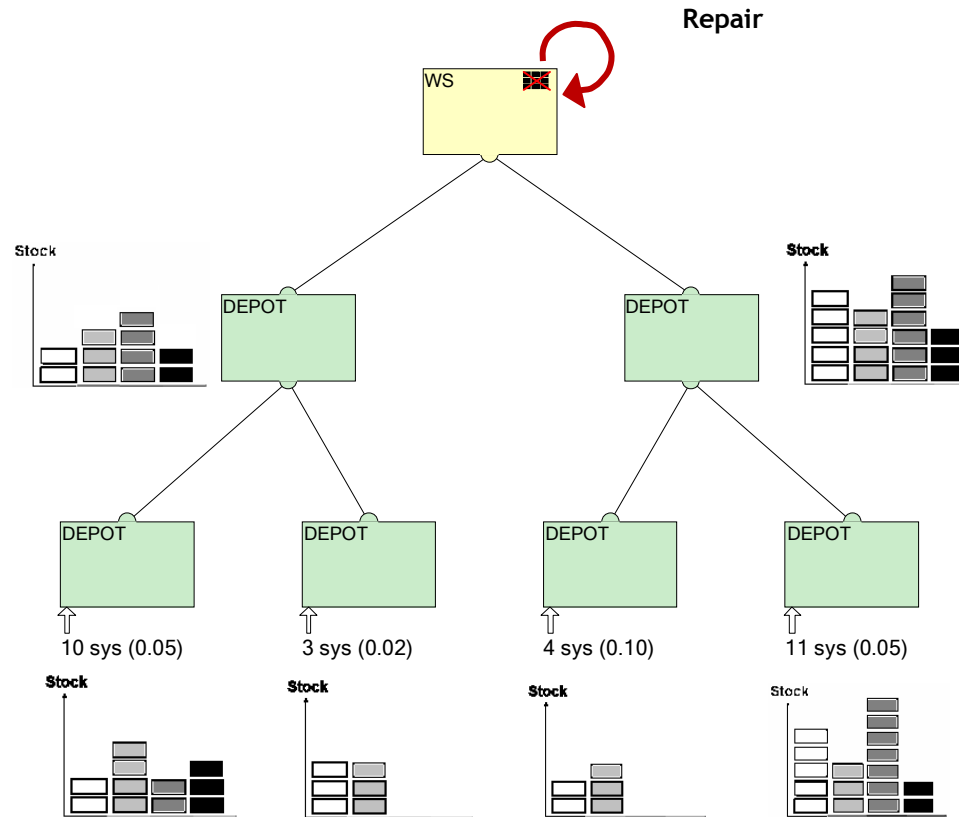- Criticality
- Redundancies
- etc.

Efficiency

Cost

Systems usage

- Number of systems
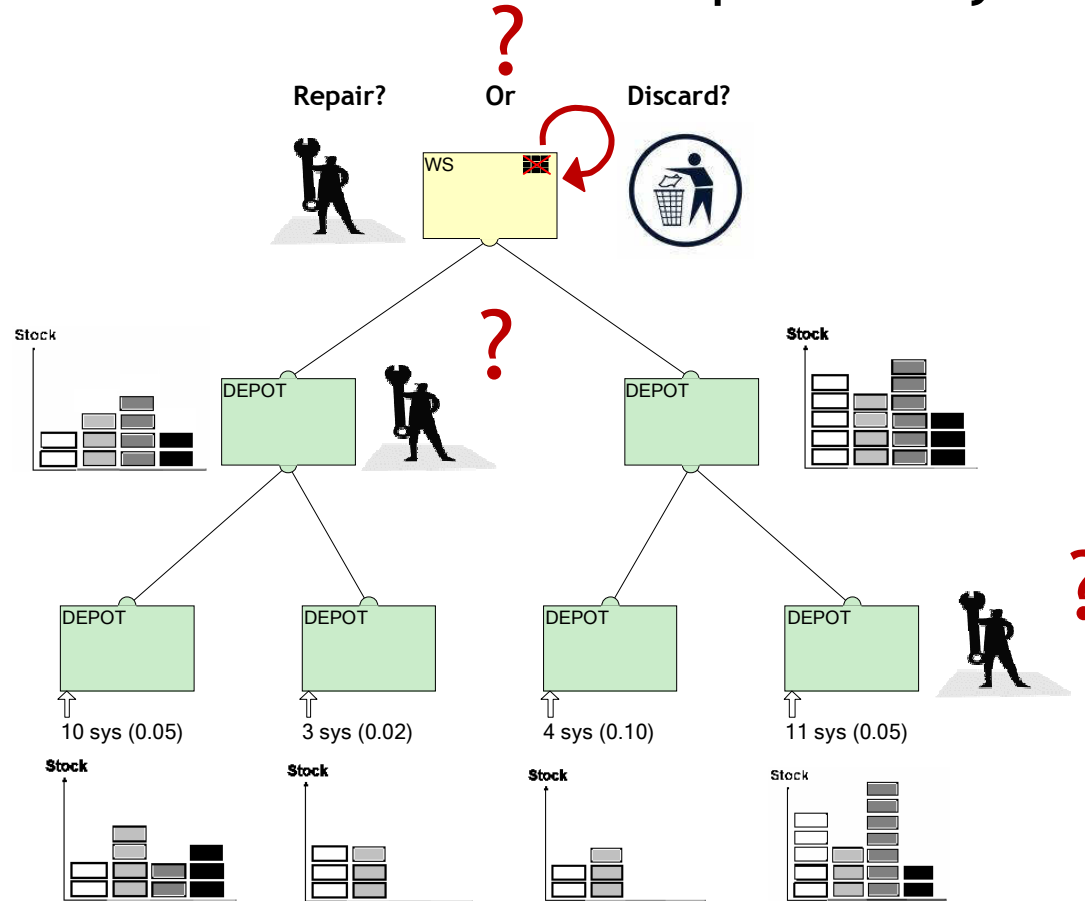- Utilization
- Operational profile
- etc.

System Approach

Right stock at the right place

System Approach
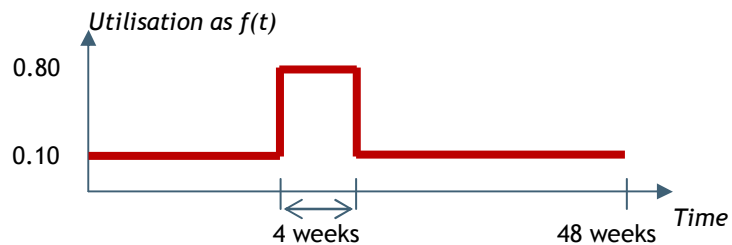# LORA – Level Of Repair Analysis

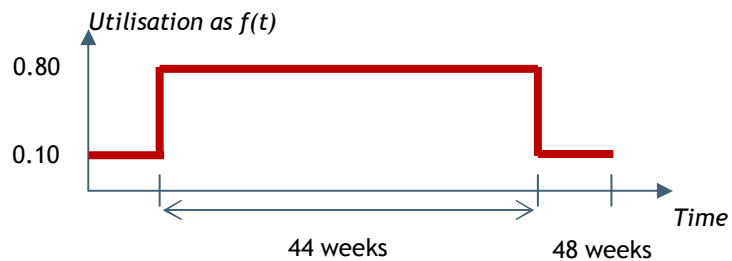**Should I perform item repair and, if so, where?**

System utilisation

Operational profile

Average utilisation

Utilisation as f(t)

0.80

0.10

4 weeks   48 weeks   Time

$UTILF_{Avg}= 0.158$

Utilisation as f(t)

0.80

0.10

44 weeks   48 weeks   Time

$UTILF_{Avg}= 0.742$

Utilisation as f(t)

0.80

0.10

24 weeks   48 weeks   Time
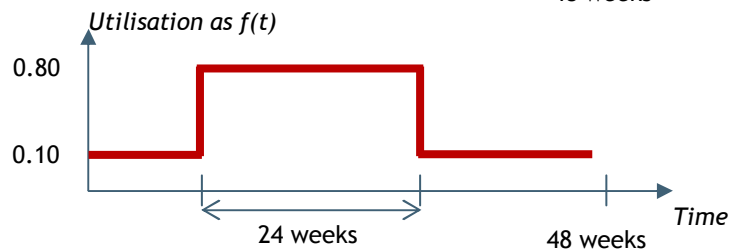
$UTILF_{Avg}= 0.450$

High system utilisation

Utilisation (average)

High

Time

Low system utilisation

Utilisation (average)
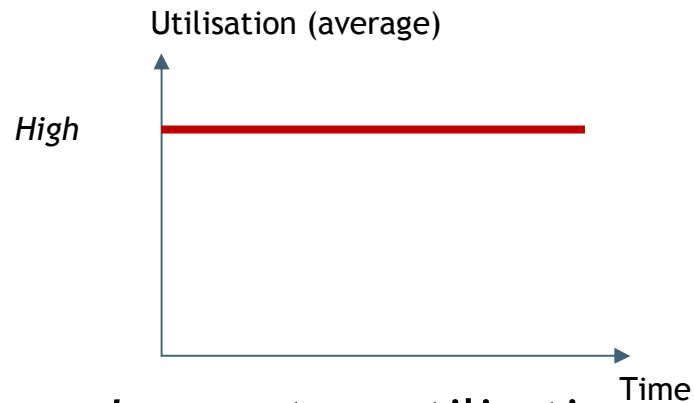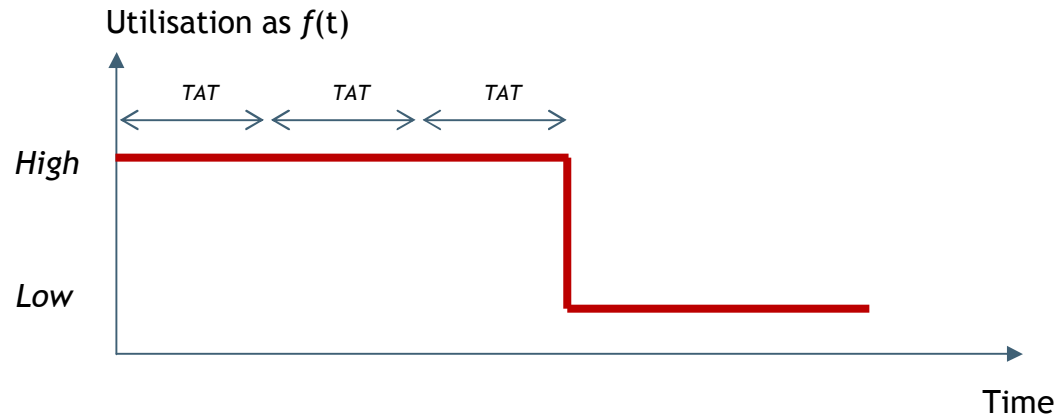
+ Less system down time

? Have I overinvested in spares compared to my operational requirements?

Low

Time
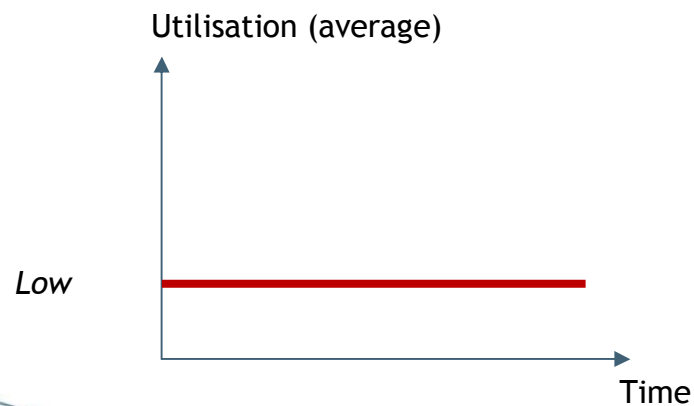
+ Less investment in spares

? Is my stock sufficient to keep me up and running during the peak periods?

# System utilisation vs item repair TAT

Utilisation as $f(t)$

High

Low

TAT   TAT   TAT

Time

Steady state reached during peak period

→ Results for the peak period are trustworthy

→ UTILF = High and low. Compare!

Utilisation as $f(t)$
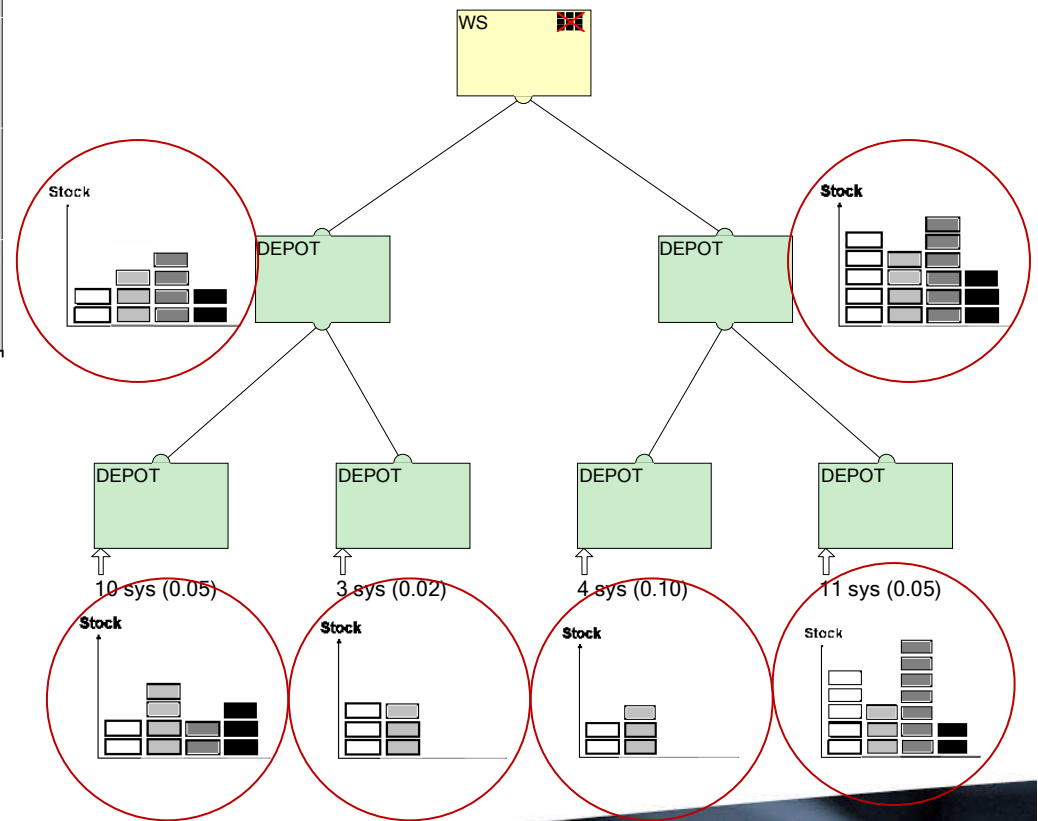
High

Low

TAT
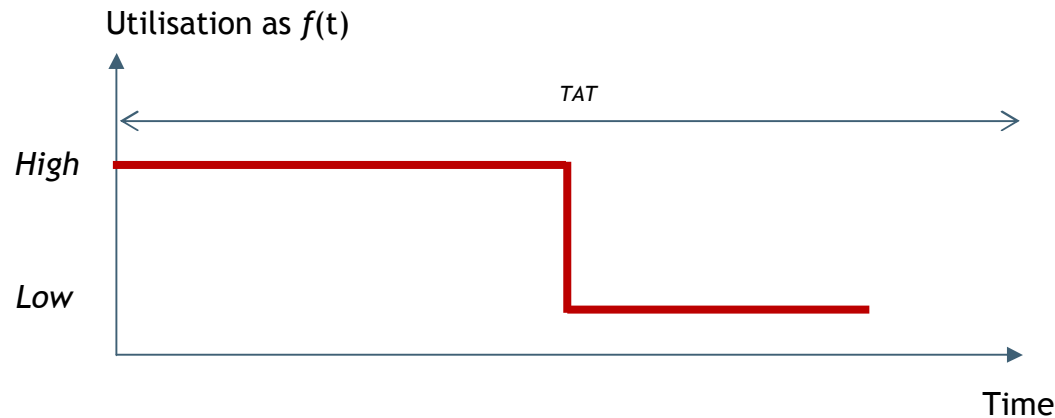
Time

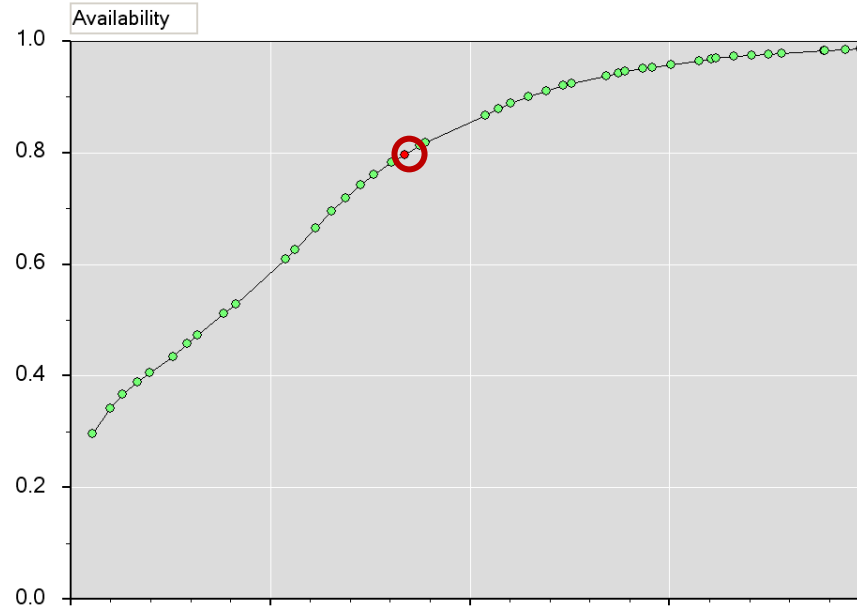Steady state *not* reached during peak period (neither in low period)

→ The results need to be further analyzed with respect to time

→ Can next peak period be met with the same system performance?

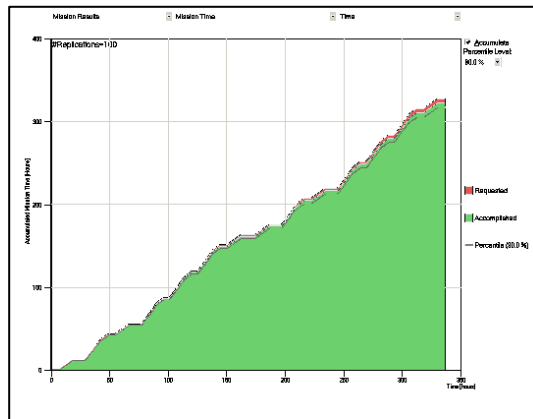→ UTILF = High? Low? Average?
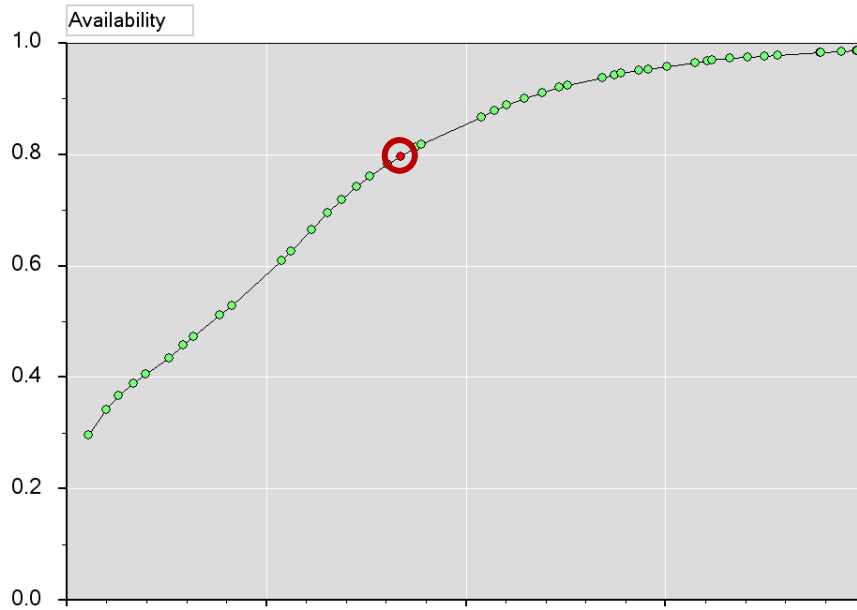
Cost/Efficiency curve

- Steady-state
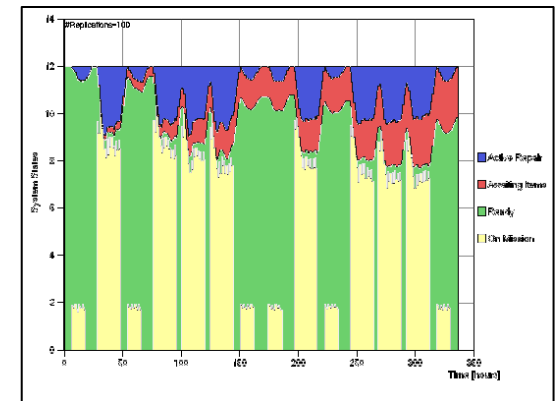- Analythical tool
- Average situation

Cost/Efficiency curve

- Monte Carlo simulation
- Operational profile in time
- Mission based results

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Case study:
Modular Reconnaissance Pod - Sweden
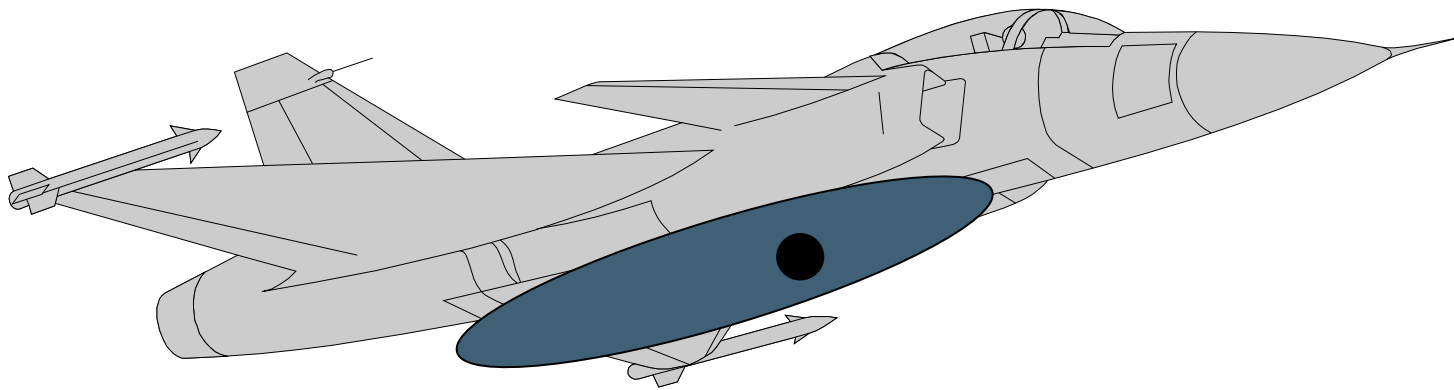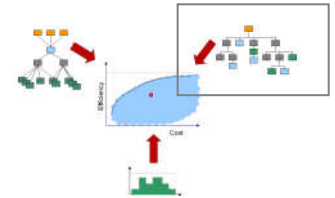
Material Break Down Structure

MRPS – Modular Reconnaisssance Pod

Capsule Electrical System

RMS – Record management system

DMM -Memory module

Sensor

…
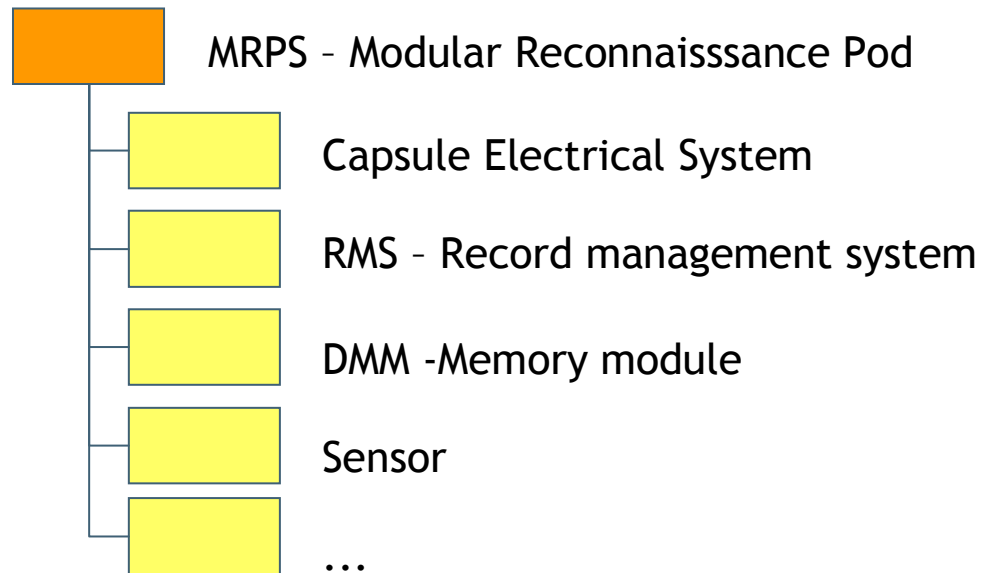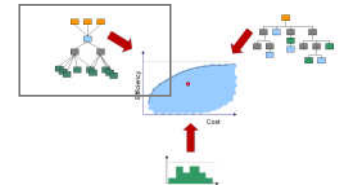
Support organisation


```
OEM*     OEM     OEM
    └──────┼──────┘
        B-Level
           │
      ┌────┴────┐
  Air          Air
Force Wing 1   Force Wing 2
```
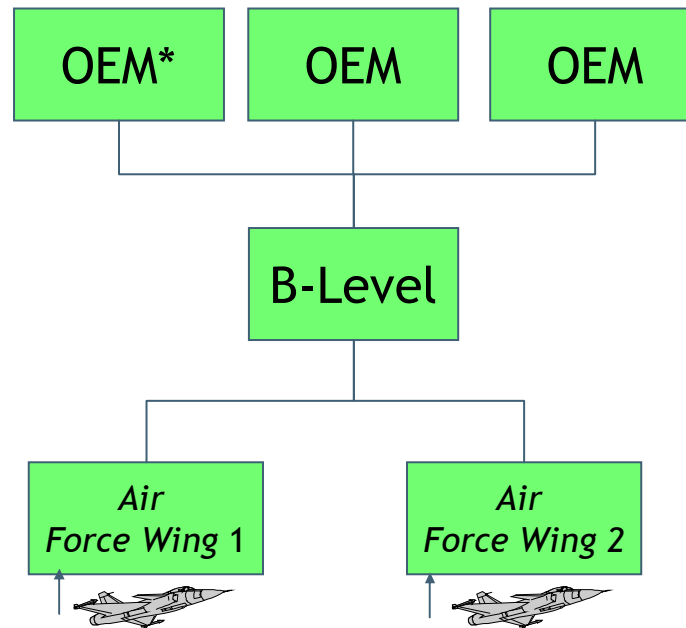
*OEM=Original Equipment Manufacturer
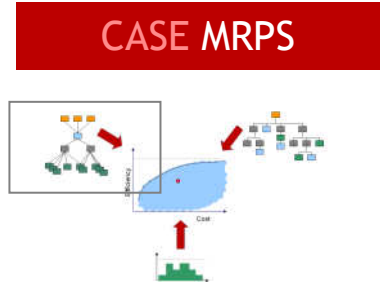
Operational organisation

International mission

→ Longer supply chain

→ Higher utilisation requirements
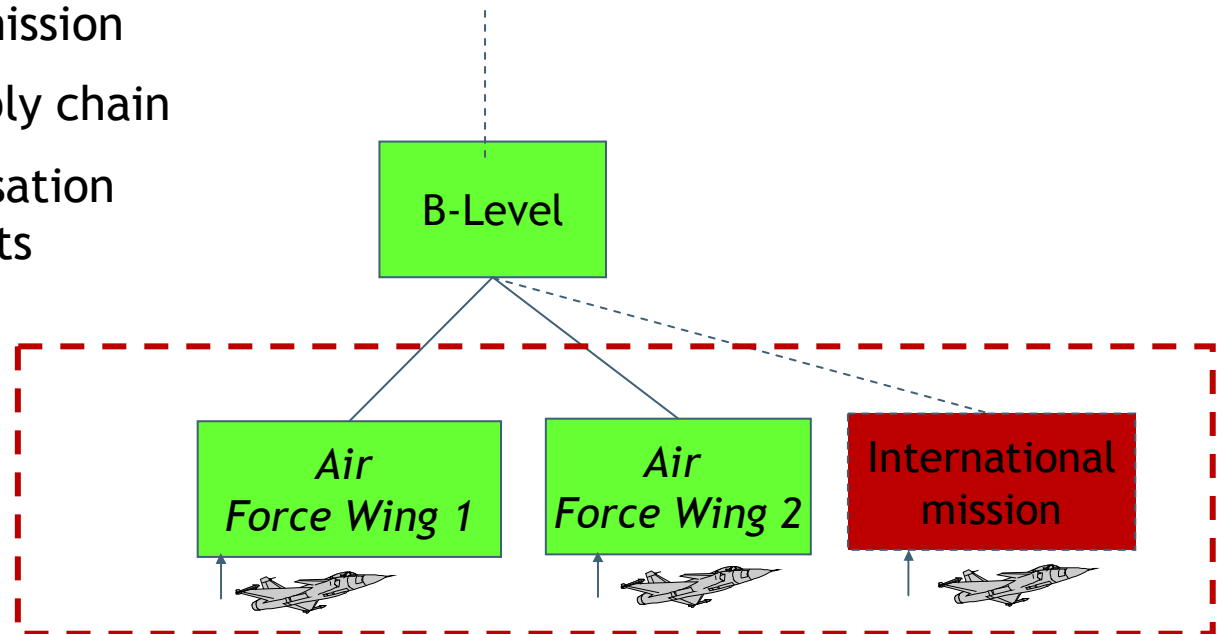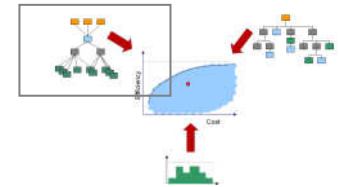
Required maintenance resources

		RESOURCE ($)	
	MRPS – Modular Reconnaisssance Pod		
	Capsule Electrical System		
	RMS – Record management system	Comm Box	Locate the faulty SRU
	DMM -Memory module	ATF test	Locate the faulty SRU
	Sensor	GSE	Locate the faulty SRU
	…		
		MASST	Locate the faulty LRU
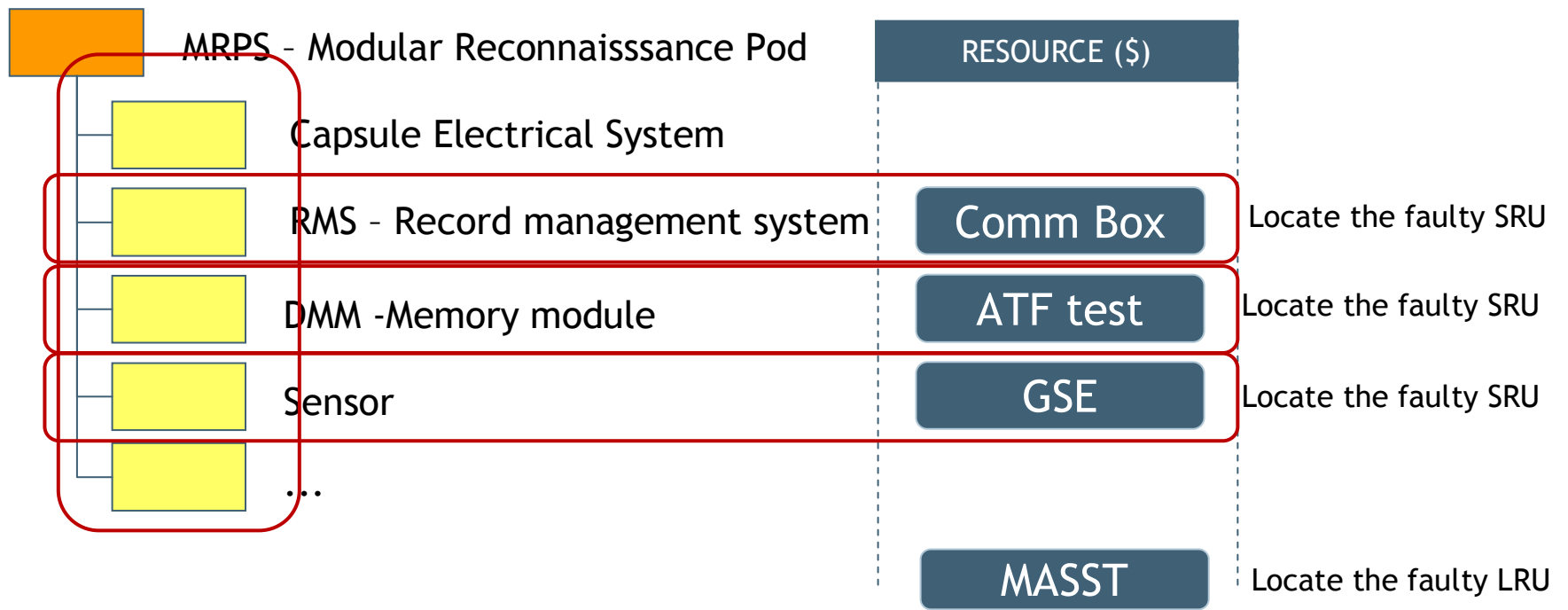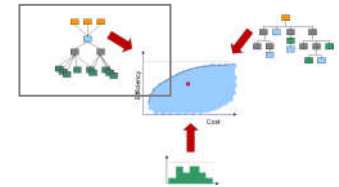
LORA: 4 different Maintenance concepts

+ Short Turn-around-Time
- Large resource investment costs

- Longer Turn-around-Time
+/- Less resource investment costs

- Longer Turn-around-Time
+ No resource investment costs
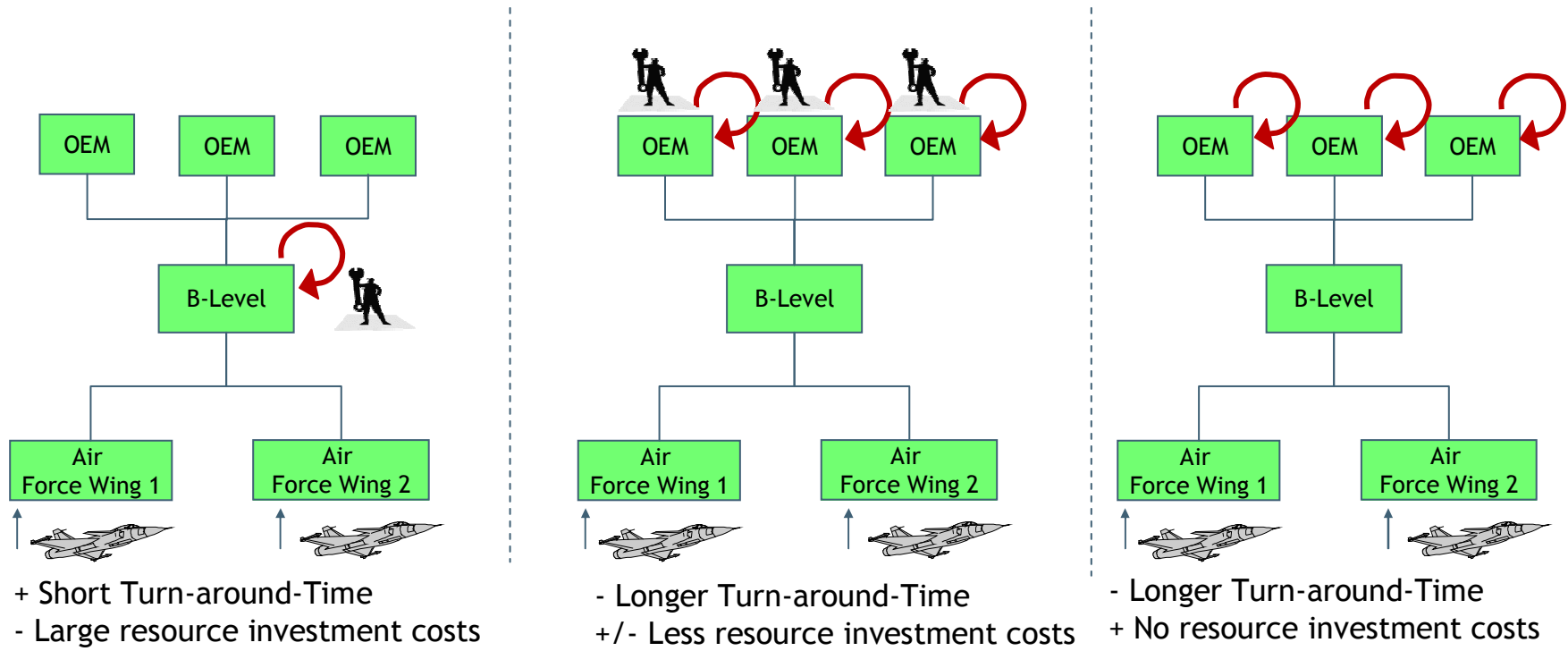
…or discard items instead of repair?

Operational profile

Air Force Wing 1	*Air Force Wing 2*	International mission
A x ✈	B x ✈	C x ✈
Low utilisation	Low utilisation	High utilisation
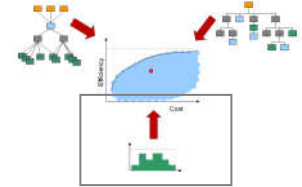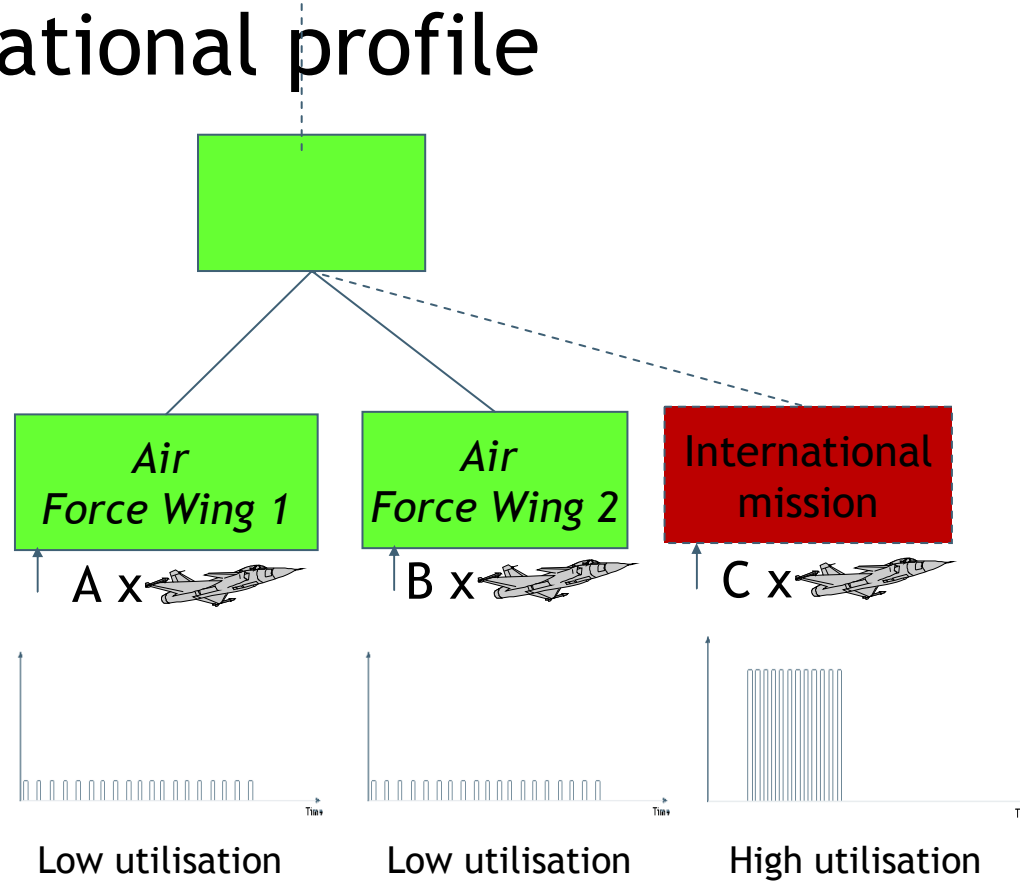
OPUS10 spare part optimization and LORA analysis

Input data

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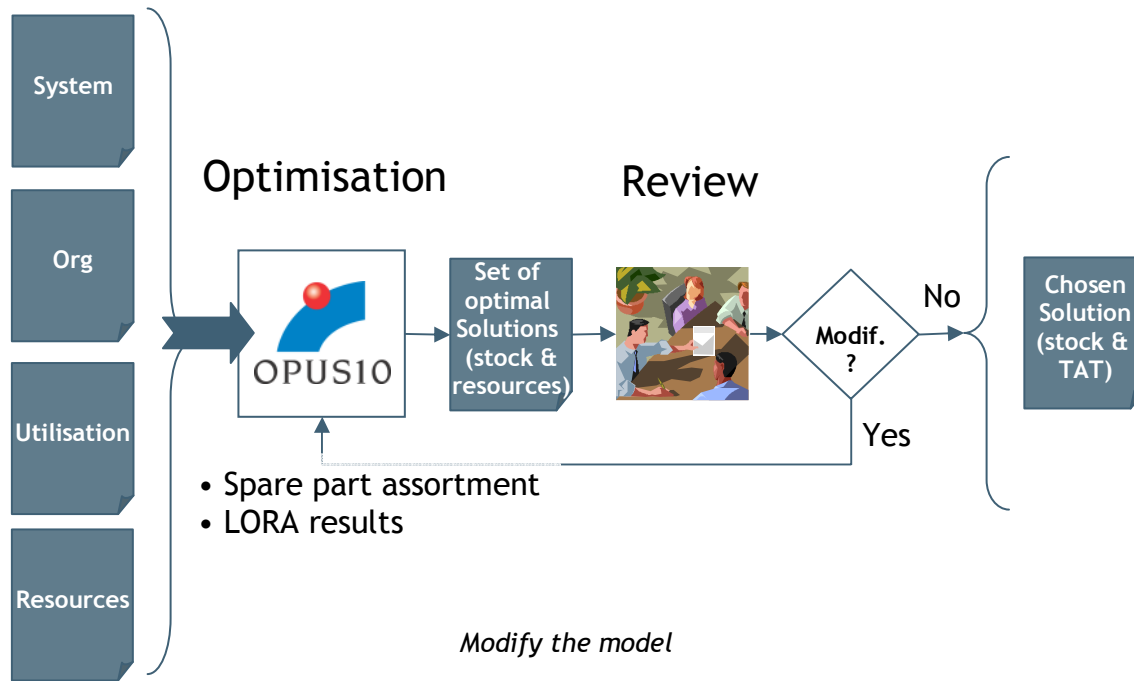
Peak periods
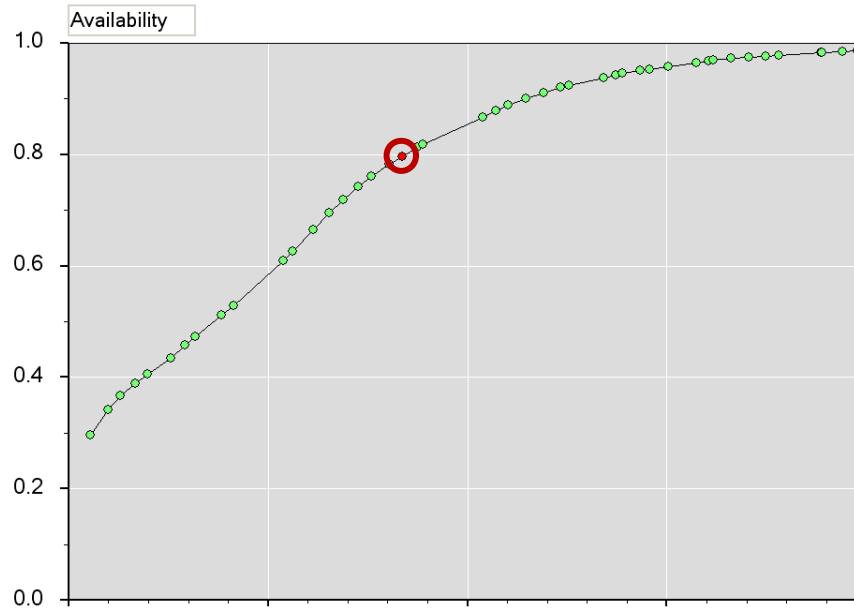
Mission success

Overinvestment

Steady state

Availability

OPUS10 Cost/Efficiency curve

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SIMLOX analysis

Input data

| System |
| Org |
| Utilisation |
| Resources |

Optimisation

OPUS10

Set of optimal Solutions (stock & resources)

- Spare part assortment
- LORA results

Review

Modif. ?

No

Yes

Modify the model

Chosen Solution (stock & TAT)

Detailed Op. profile

Simulation

SIMLOX

Mission start & success rates

Ok ?

Yes

No

- Variations in time

Result

Select another spare part and resource solution

Result analysis 1

Mission Start Rate	Mission Success rate
95.8%*	93.4%*

* Fake values

Availability

- Stock
- Repair strategy

80%

- Active Repair
- Awaiting Items
- Ready
- On Mission
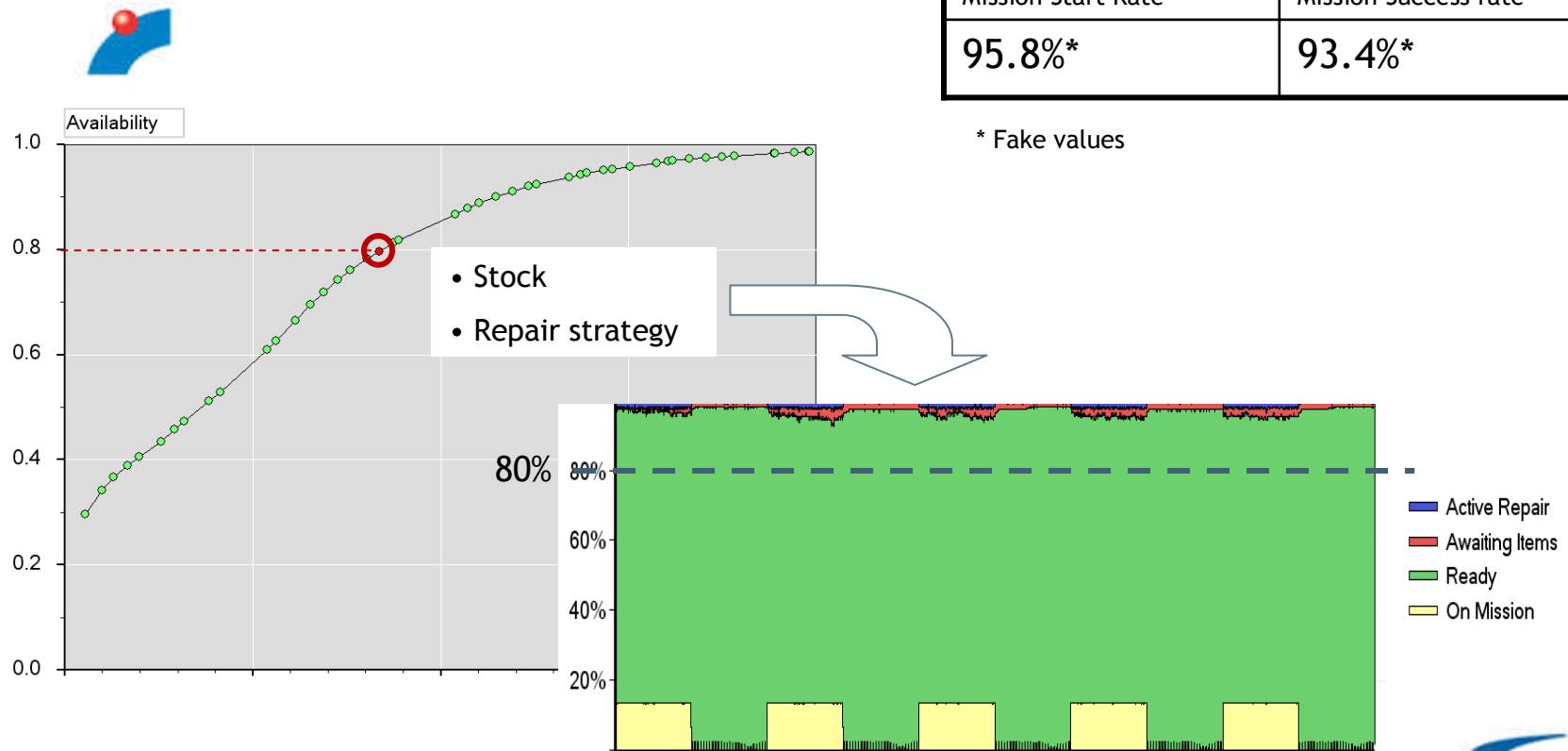
Result analysis 2

Mission Start Rate	Mission Success rate
88.1%*	86.4%*

* Fake values

Availability

- Stock
- Repair strategy

80%

Active Repair
Awaiting Items
Ready
On Mission

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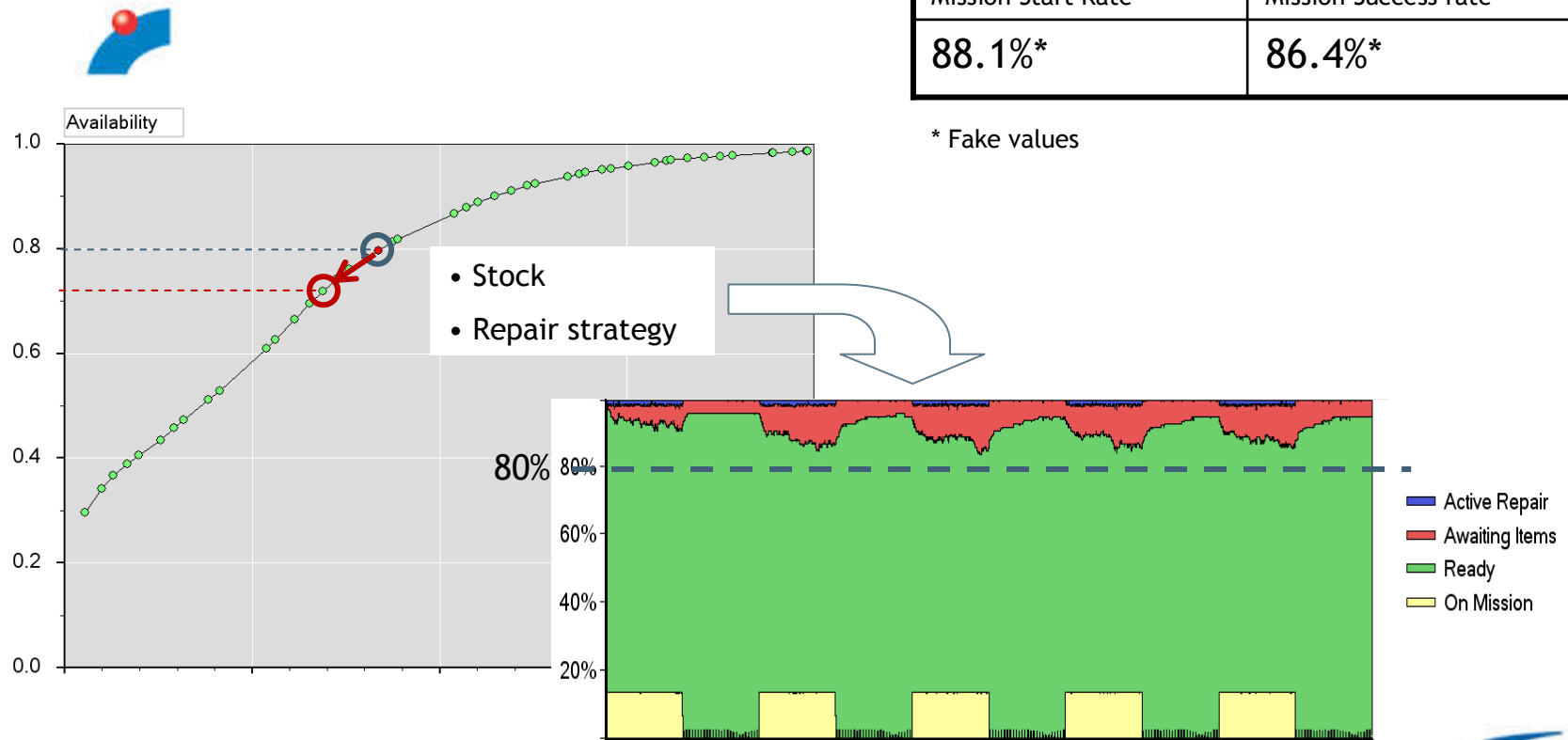
Result analysis 3

Mission Start Fraction	Mission Success Fraction
83.9%*	80.4%*

* Fake values

- Stock
- Repair strategy

80%

Active Repair
Awaiting Items
Ready
On Mission
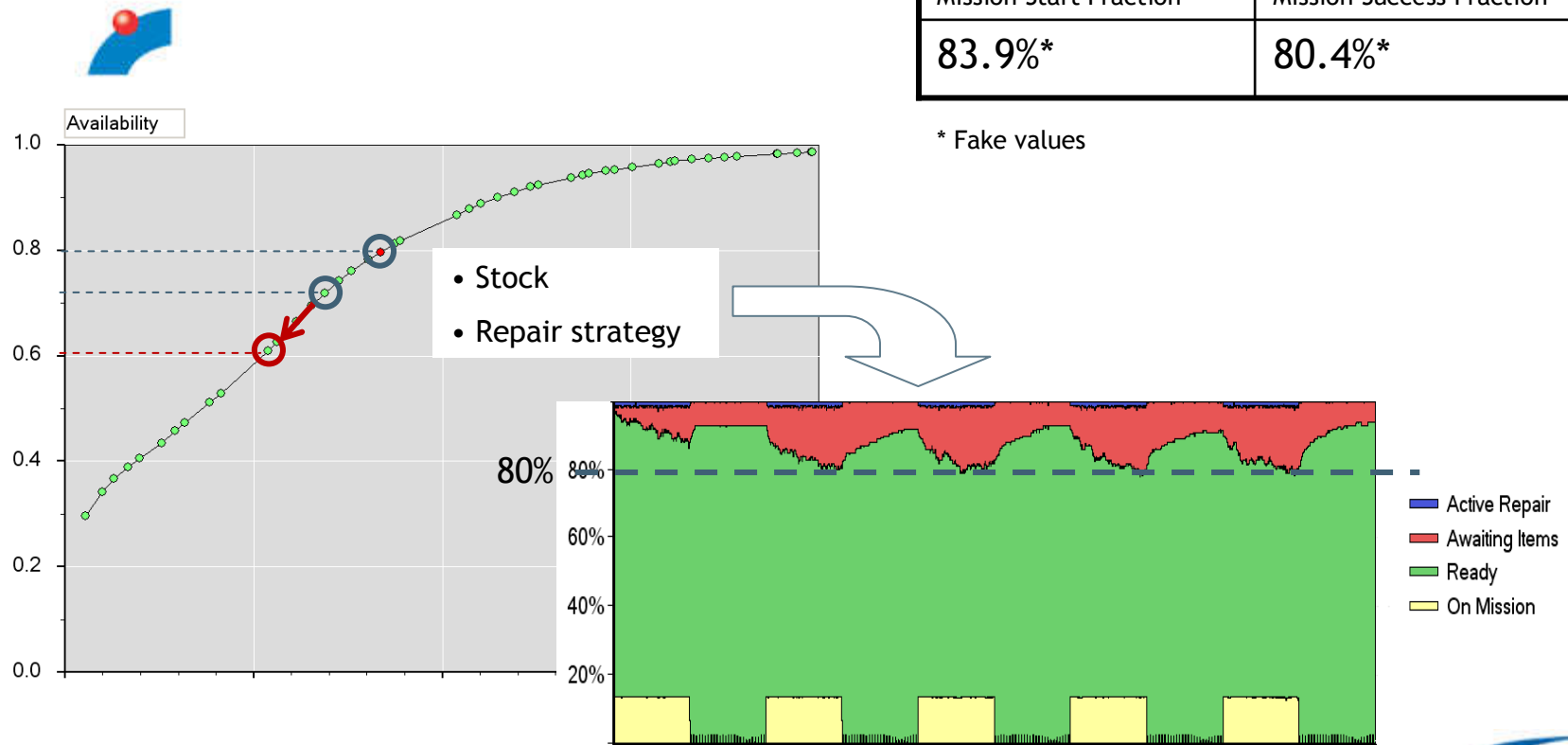
Steady state result
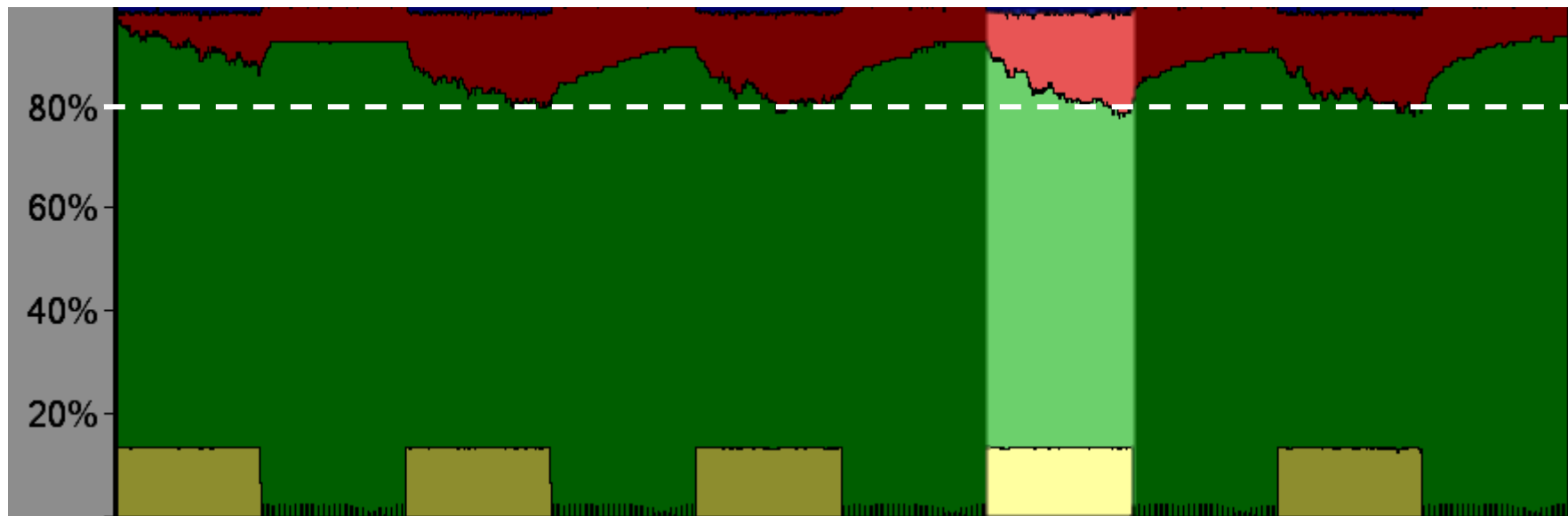
Steady state reached

→ Period of interest

Conclusions

- Variations in utilisation with respect to time calls for detailed analysis *in* time

- When having cyclic operational profile, measure the performance when reaching *steady state*

- It is important to perform during the periods of high utilisation since they tend to be more crucial

Moreover

- Satisfactory system availability is not enough when having a mission based operational profile