29 March 2023

Opus Suite Conference | SYDNEY

Opus Evo
Tactical Optimisation of Dynamic Scenarios

Deployed Operations Planner & Tactical Logistics Support Procurement Optimiser

Axel Nyberg
Systecon AB

by Systecon opus suite

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Case study - teaser

US Air Force

Short notice - 20 days deployment – 24 fighter jets - Limited resupply support

Outcome from Opus Evo optimization compared with USAF DSP-model:

- 50% increase in Mission Capability for deployment
- 38% reduction in the number of spare parts
- 56% cost reduction
  - DSP Model: 33.0 MUSD
  - EVO: 14.5 MUSD
  - OPUS10: 22.3 MUSD (same MC as Evo)

…more on this later

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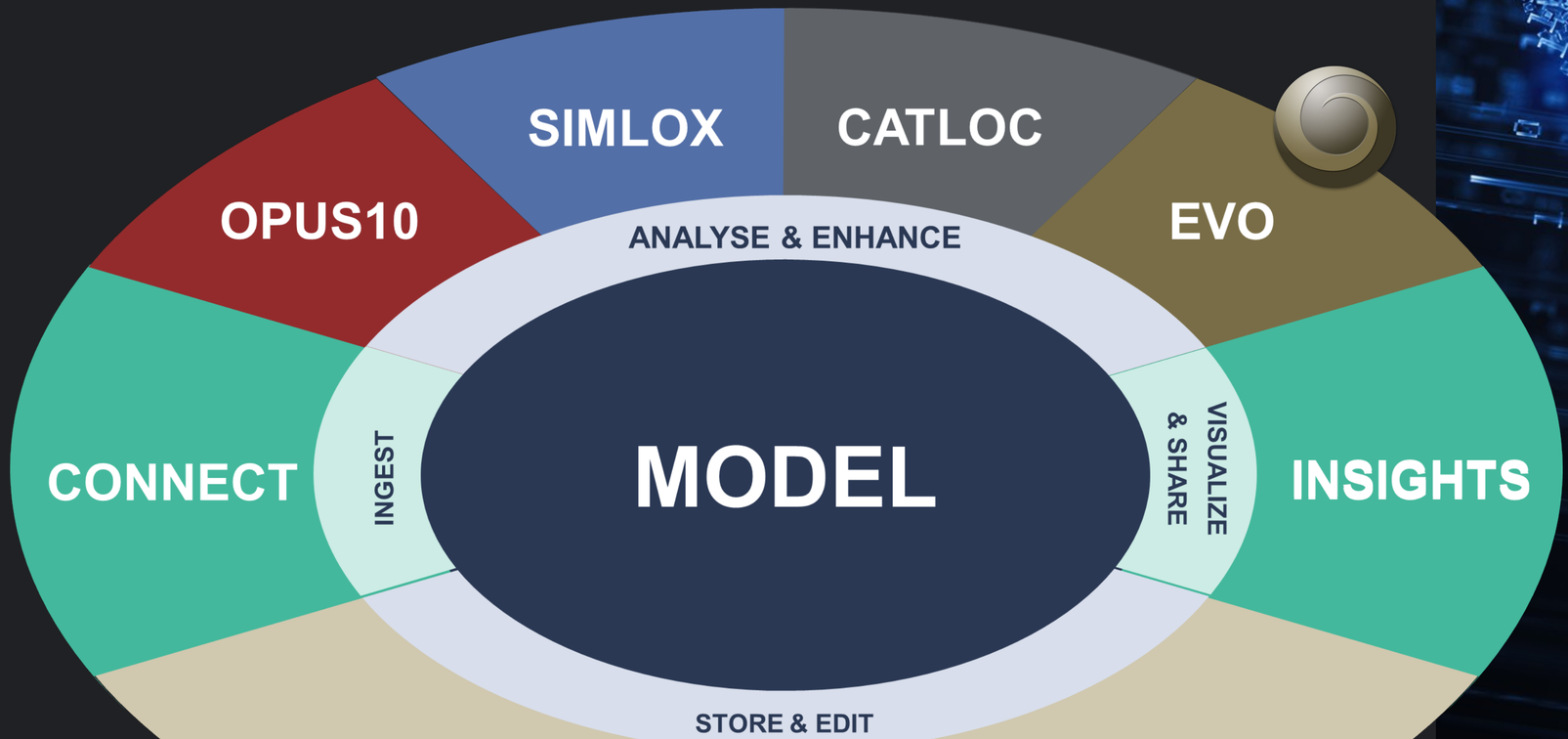
Opus Evo

- Unlocks new spectrum of capabilities
  - Evolutionary Algorithms + Simulation (or other evaluator)
- Strong complement to the other Opus Suite software
  - Tactical/operational optimization
  - Using the same Opus Suite model and data set
  - Incorporate dynamic aspects - non steady state



LCM Analysis with an evolving model / digital twin

- The model – A backbone for multi-purpose decision support through the life cycle
  - Make use of available information and knowledge
- Holistic perspective – three main areas to consider
- Evolving through iterative
  - update – analyze – learn
    repeat
- Quick access to decision s
  - Adjust for context, applicat
    data availability, etc

OPERATIONS

"DIGITAL TWIN"

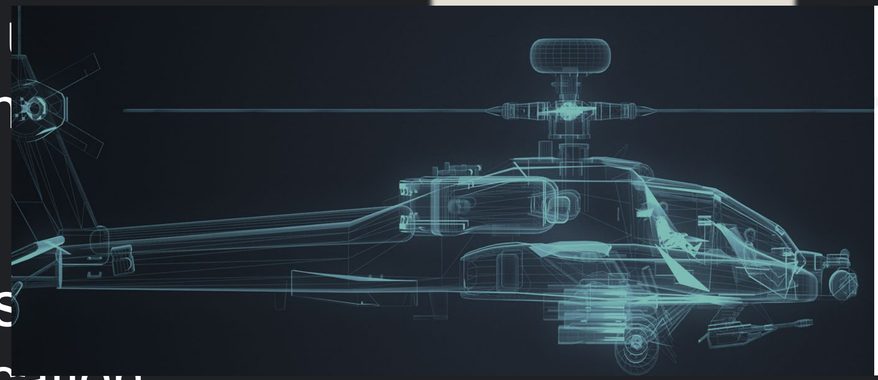
READINESS

MISSION SUCCESS

COST EFFECTIVENESS

"DIGITAL TWIN"

"DIGITAL TWIN"



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One Approach – Several Products

- Virtually any parameter or aspect in the Opus Suite model can be optimized:

  “if you can model it, you can evaluate it
  if you can evaluate it, you can optimize it”

- Several specialized products – “powered by Opus Evo” tailored evolutionary algorithms, controls, results handling and presentation, etc.

- **Selection of available products:**
  - Deployed Operations Planner “EVO-DOP”
  - Tactical Logistics Support Procurement Optimizer “EVO-LPO”

Deployed Operations Planner (”DOP”)

- Maximize mission success and logistics support responsiveness during deployed operations
- Determine optimal set of systems, spares and support resources for a specific mission profile
- Tactical/operational optimization ideal for
  - short to medium time frame
  - incorporating impact of dynamic aspects
  - accommodating operational objectives and priorities

-> Opus Evo Deployed Operations Planner

Tactical Logistics Support Procurement Optimizer (”LPO”)

- Determine when to buy what spares and support equipment
- Make optimal use of the maintenance budget for the upcoming budget period, and preliminary planning for future budget periods.
- Adapt procurement planning based on budget increase / decrease, to maximize fleet performance and ability to meet operational requirement
- Tactical optimization that incorporates
  - procurement lead times for each spare part / support equipment
  - Varying budgets, operations and other constraints
  - impact on fleet performance and readiness during the budget period and beyond

-> Opus Evo Tactical Logistics Support Procurement Optimizer

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Moving from Readiness to Mission Success

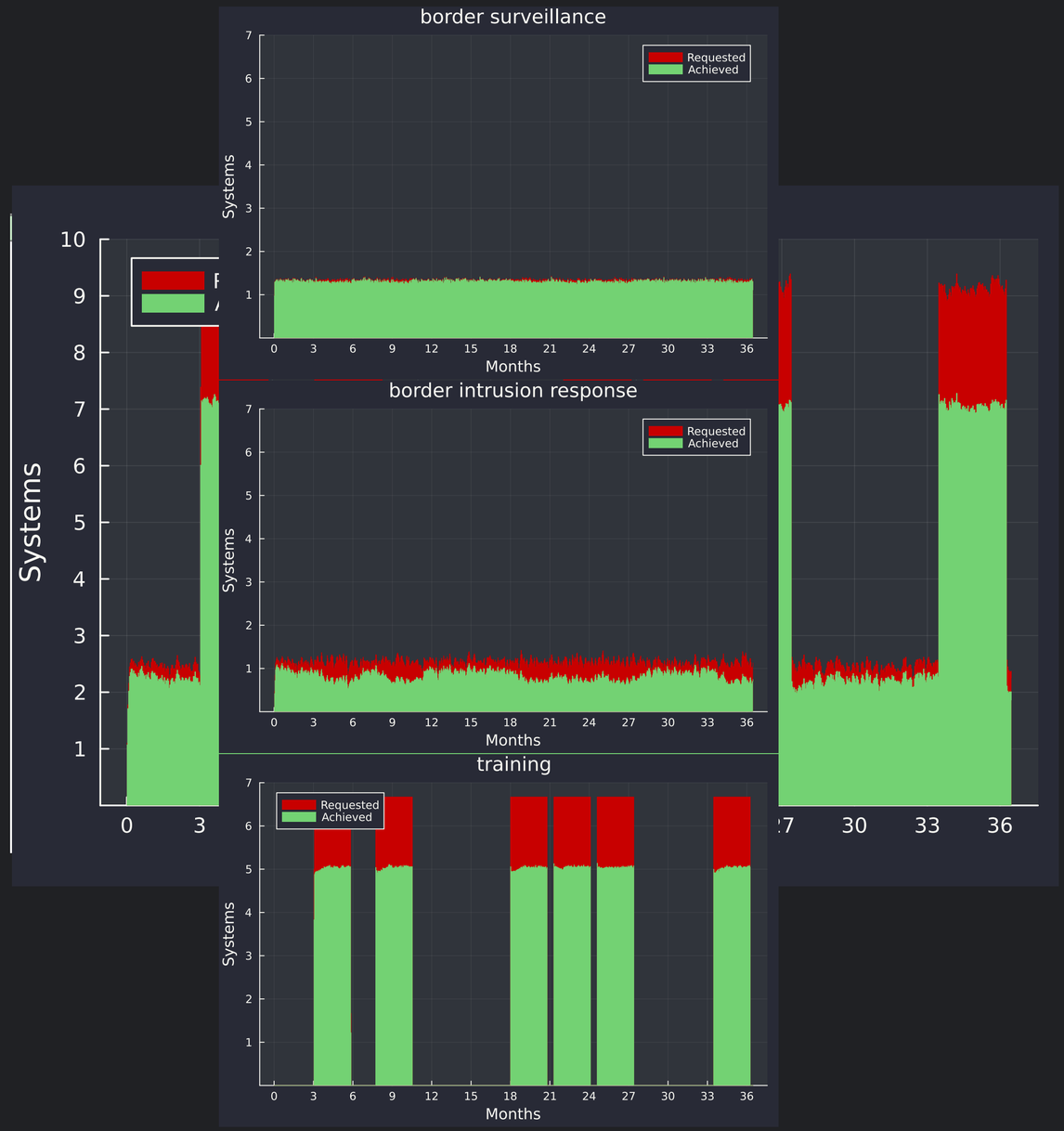
Long term strategy

- **Make sure we have the correct spares to meet readiness levels over the next years (OPUS10)**

- **Analyze (simulate) to ensure we have the needed resources**

- **Analyze (simulate) with a specific mission profile**
  - Get to know the expected outcome for each mission
  - Expected number of systems on mission
  - Risk of failing a mission
  - Risk of not having enough systems for the mission
  - System Time

  - **Sudden Crisis**
    - **Request for a deployment abroad**



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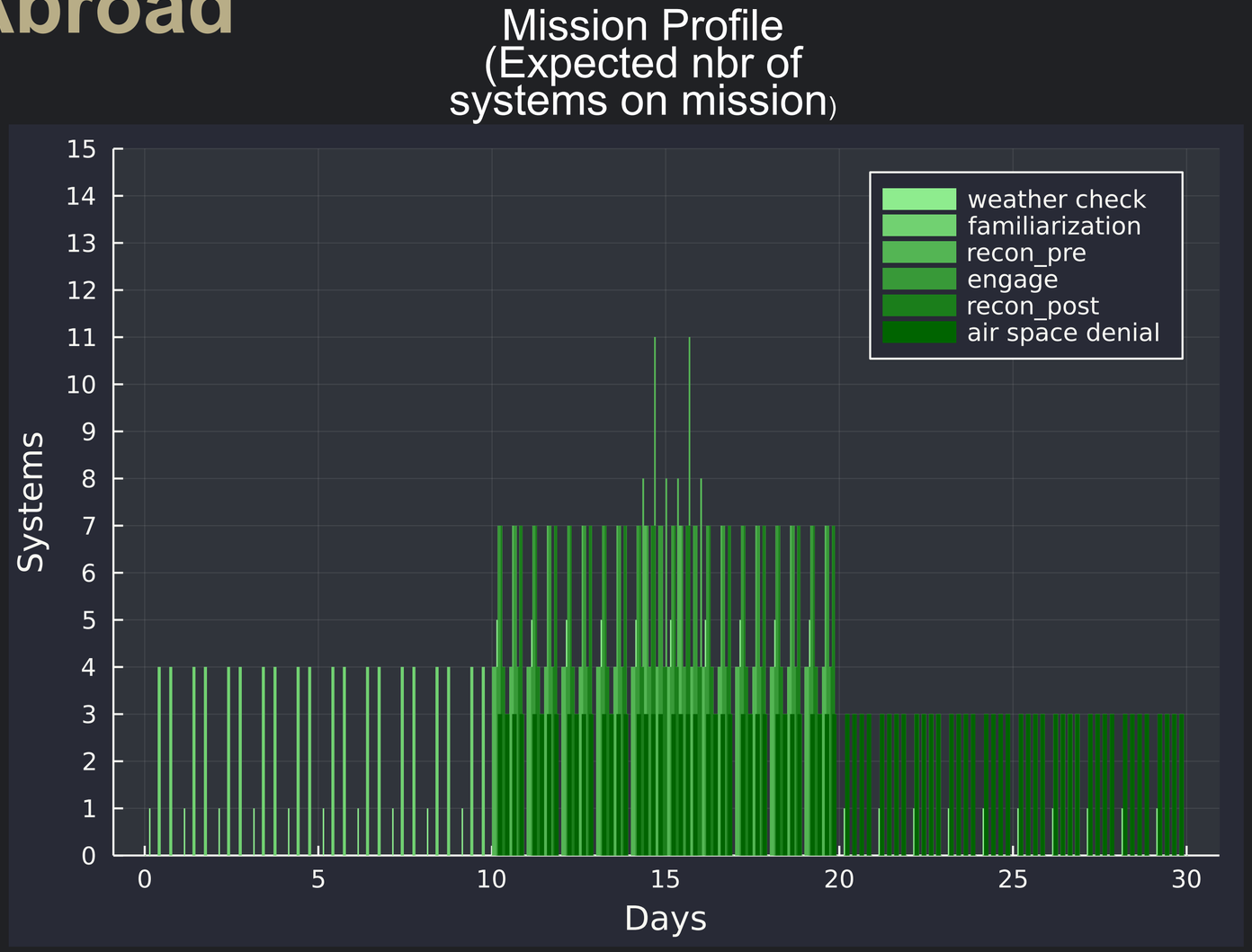
Request for Deployment Abroad

- **Combined warfare with two system types**
  - Manned
  - Unmanned

- **30-day scenario with differing utilization**
  - Different system requirements for each mission

- **Three Phases (six different missions)**
  - **Low**
    - Familiarization
  - **High**
    - Pre recon
    - Engagement
    - Post recon
    - Airspace denial
  - **Medium**
    - Airspace denial
  - Weather check each day

  - No Resupply from home bases



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Dimensioning a deployment kit

- **Dimension the deployment kit**
  - Number of systems (both manned and unmanned)
  - Spares assortment
  - Maintenance resources
- **Given a limit**
  - Max weight
  - Max volume
  - A budget (cost)
- **We want to maximize mission success**
  - Prioritize the engagement phase

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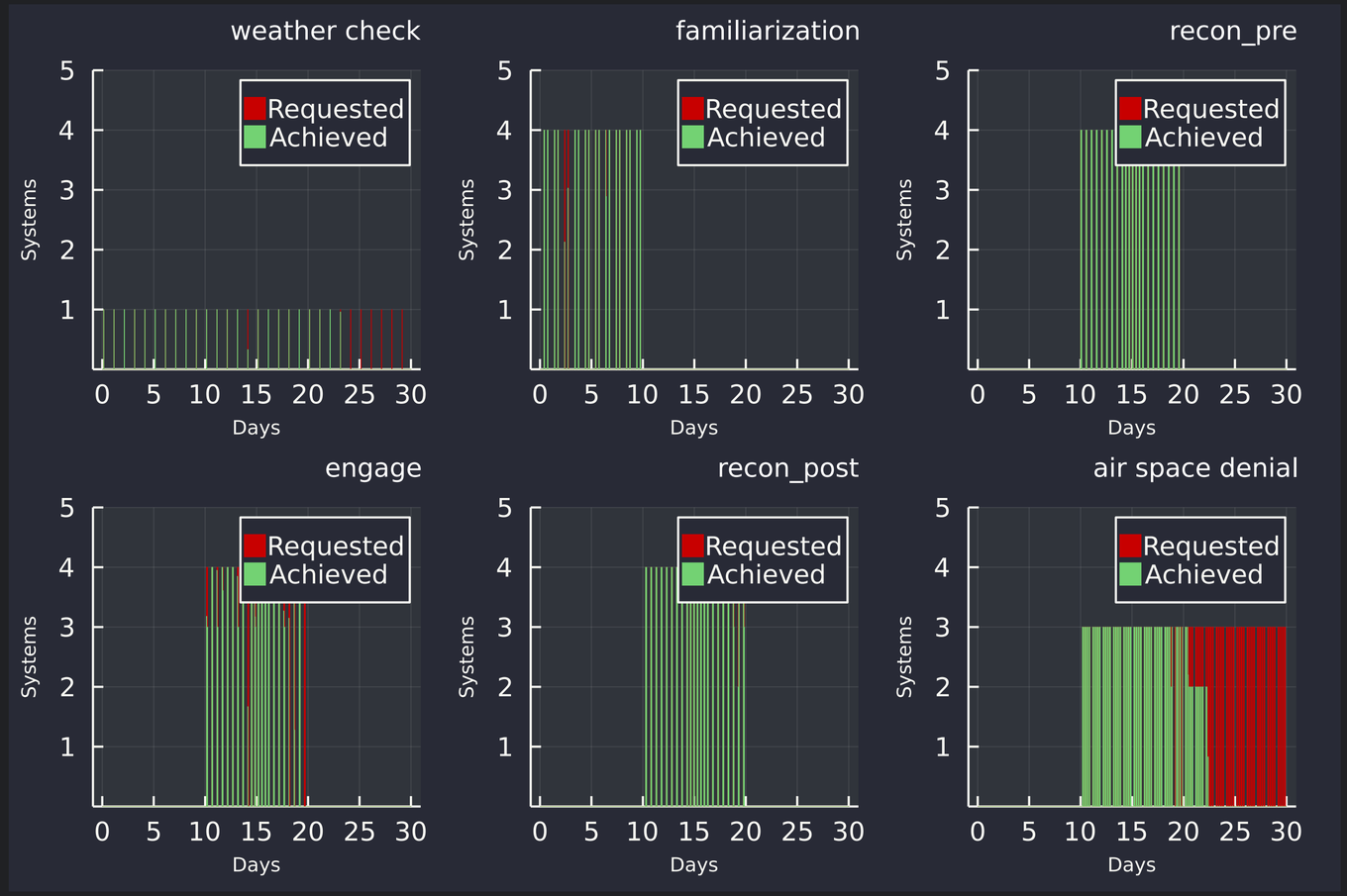
Moving from Readiness to Mission Success

- What is the expected outcome?
  - We decide on 12 systems each
  - Select some of the most failing items as spares
  - Simulate and reach 90%
- **From a long-term perspective, maximizing readiness is a good objective**
- **In the short-term, readiness does not necessarily correspond to mission success**

- **90% Readiness. What does it mean in practice?**
  - Is it good enough?
  - The deployment commander wants to know the risk of a failed mission (due to logistics) rather than average availability
- **If only there was a way to optimize mission success…**



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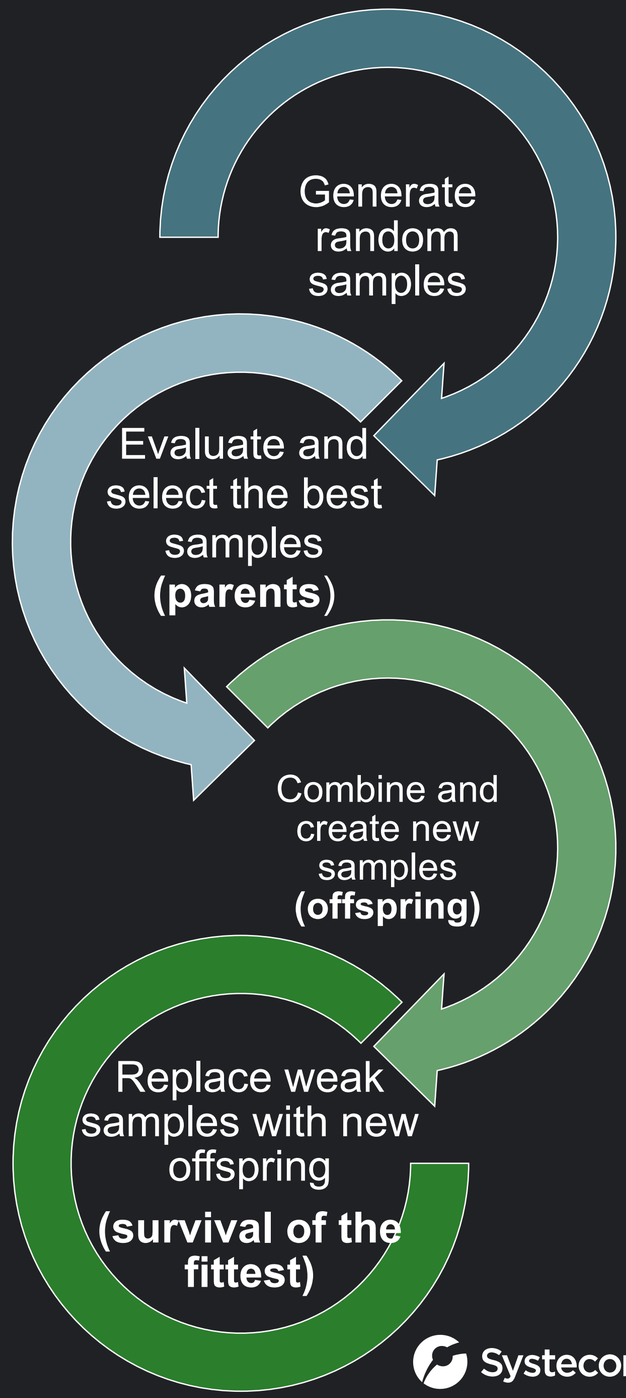
Opus Evo

Heuristics: Evolutionary Algorithms

- **General (robust) optimization algorithms**
  - Evolution based iterative approaches
- **Used in a range of applications**
  - Cancer treatment
  - Scheduling
  - Logistics
- **Multi-processor & multi-core friendly**
  - Scales (almost) linearly
- **Black-box optimization**
  - Uninhibited by mathematical constraints
  - Optimize any parameter..
  - …any objective
  - *If you can evaluate, you can optimize*



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Example: Evaluation

$$\boldsymbol{minimize}\ \boldsymbol{f}(\boldsymbol{x_i})$$

Where $\boldsymbol{x_i}$ are the variables and $\boldsymbol{f}(\boldsymbol{x_i})$ the objective function.

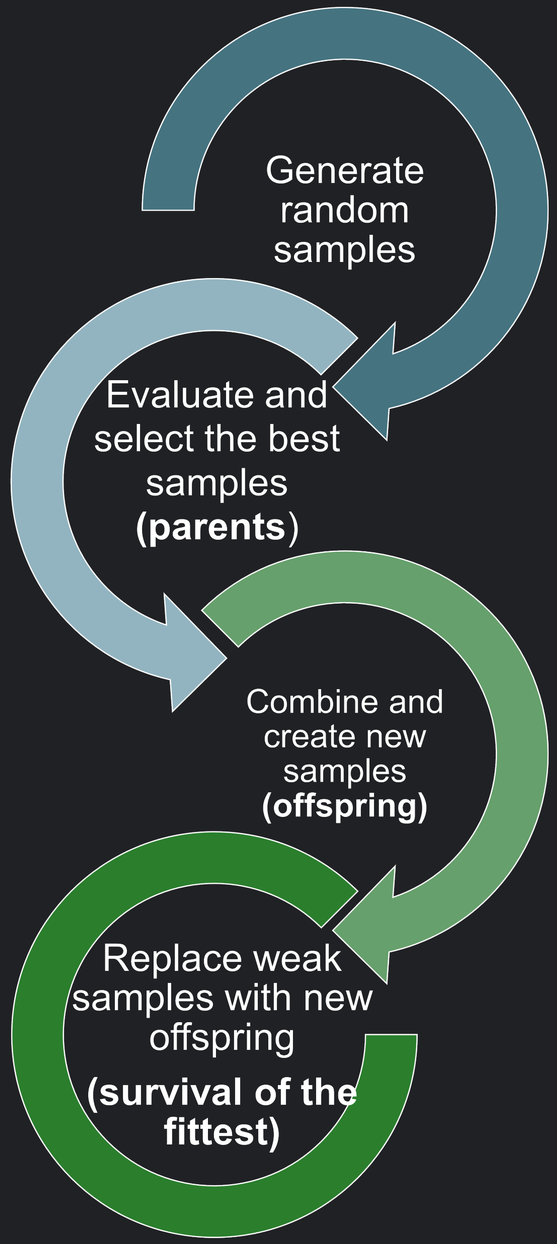
This could be a mathematical function, e.g.

$$\boldsymbol{f}(\boldsymbol{x_i}) = \boldsymbol{x_1^2} + \boldsymbol{x_2^2}$$

Given any value for $\boldsymbol{x_1}$ and $\boldsymbol{x_2}$, $\boldsymbol{f}(\boldsymbol{x_i})$ can be evaluated

$\boldsymbol{x_1}$ = 1 & $\boldsymbol{x_2}$ = 1 gives $\boldsymbol{f}(\boldsymbol{x_i})$ = 2

$\boldsymbol{x_1}$ = 0 & $\boldsymbol{x_2}$ = 0 gives $\boldsymbol{f}(\boldsymbol{x_i})$ = 0



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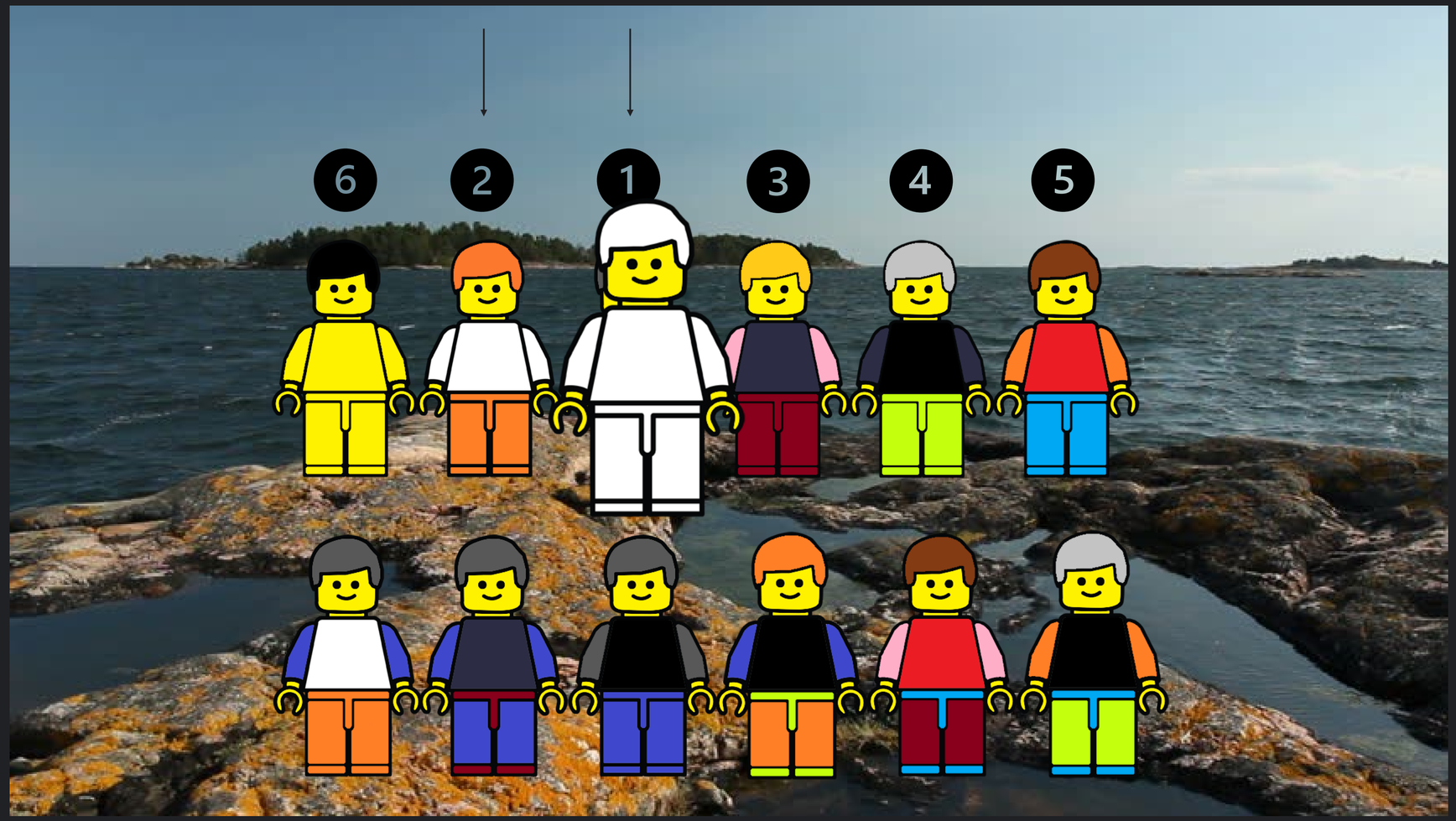
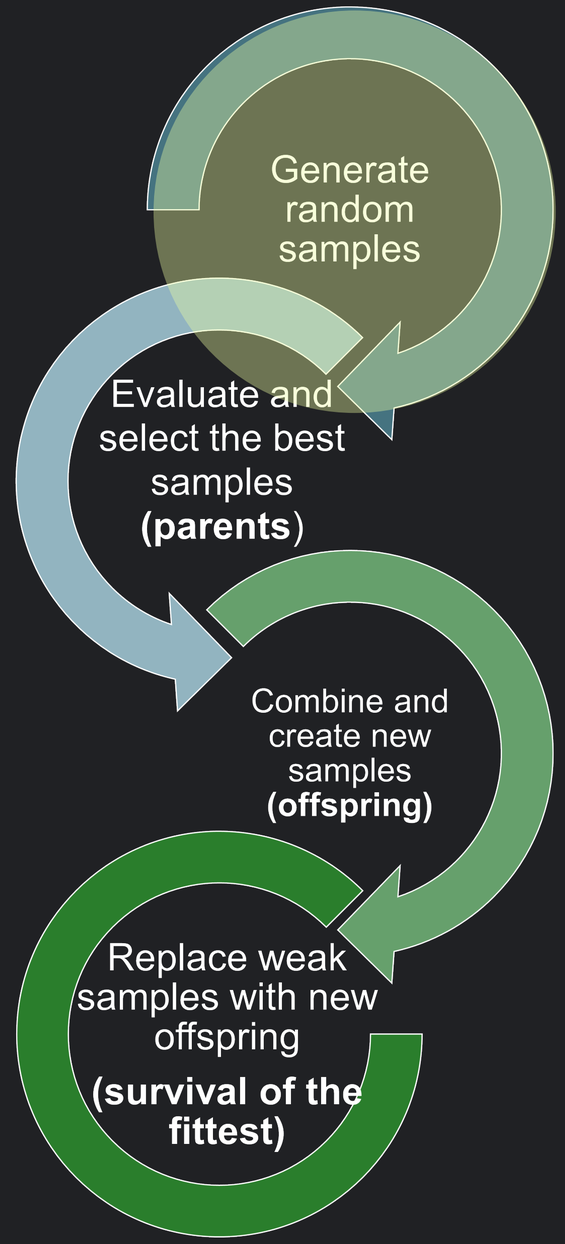
Example: Create a camouflage



x_1 = Hair, x_2 = Arms, x_3 = Torso, x_4 = Legs, x_5 = Shoes

$f(x_i)$ = How easily am I spotted?



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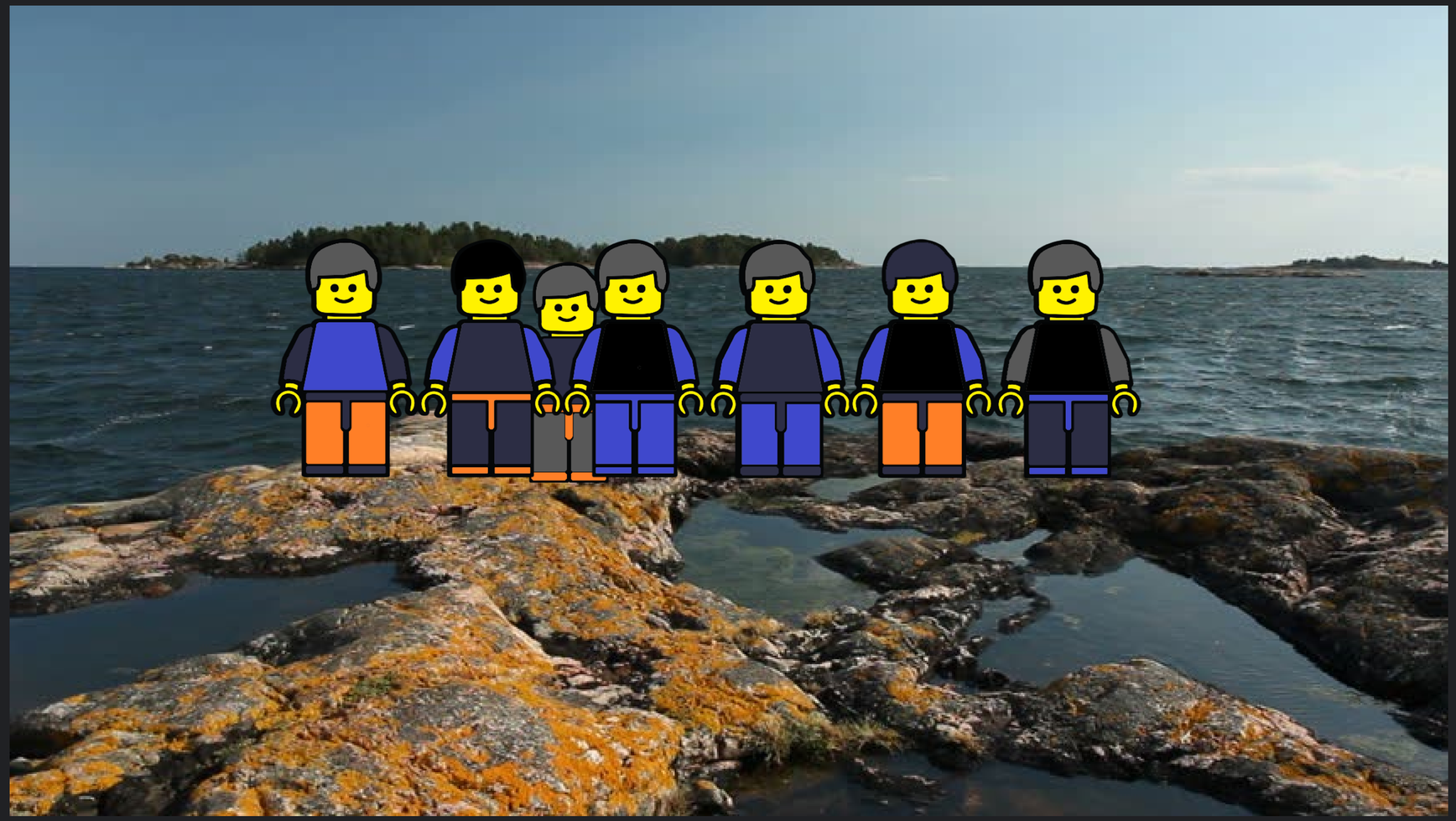

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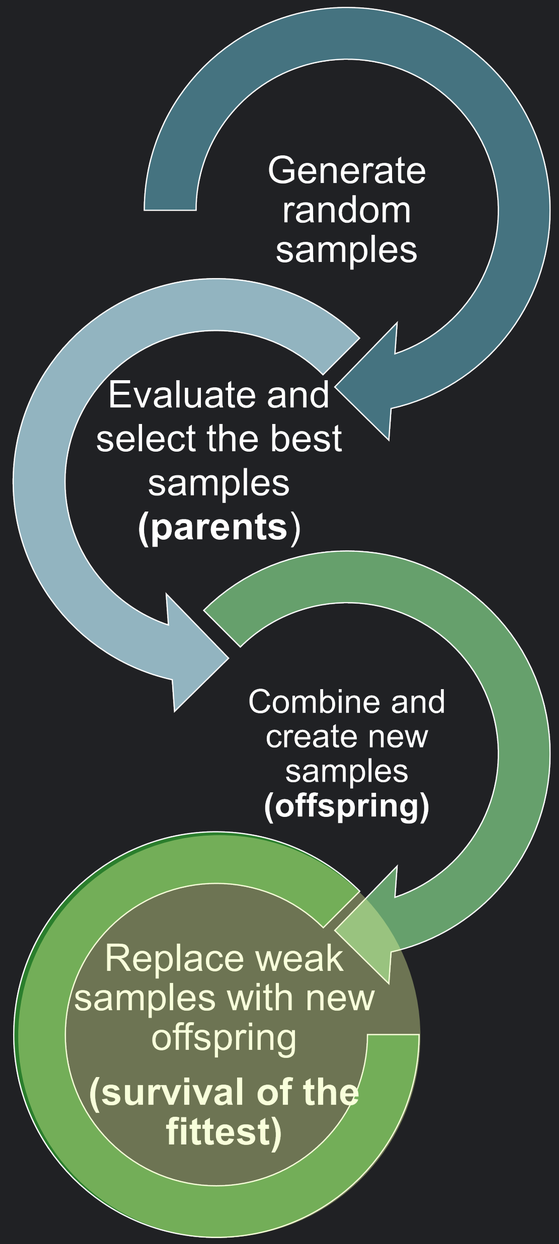

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Opus Evo: Deployed Operations Planner

Scenario: Optimal deployment kit

- **Combined warfare with two system types**
  - Manned
  - Unmanned
- **Three Phases (six different missions)…**

- **Optimize the deployment kit**
  - Decide (variables $x_1, \dots, x_n$)
    - Quantity of manned Systems
    - Quantity of unmanned Systems
    - Quantity of each spare
    - Quantity of each maintenance resource
  - Given a budget (constraint)

  - **Maximize** mission success **(objective, $f(x_i)$)**
    - Prioritize high phase (minimize risk of failing the engagement)

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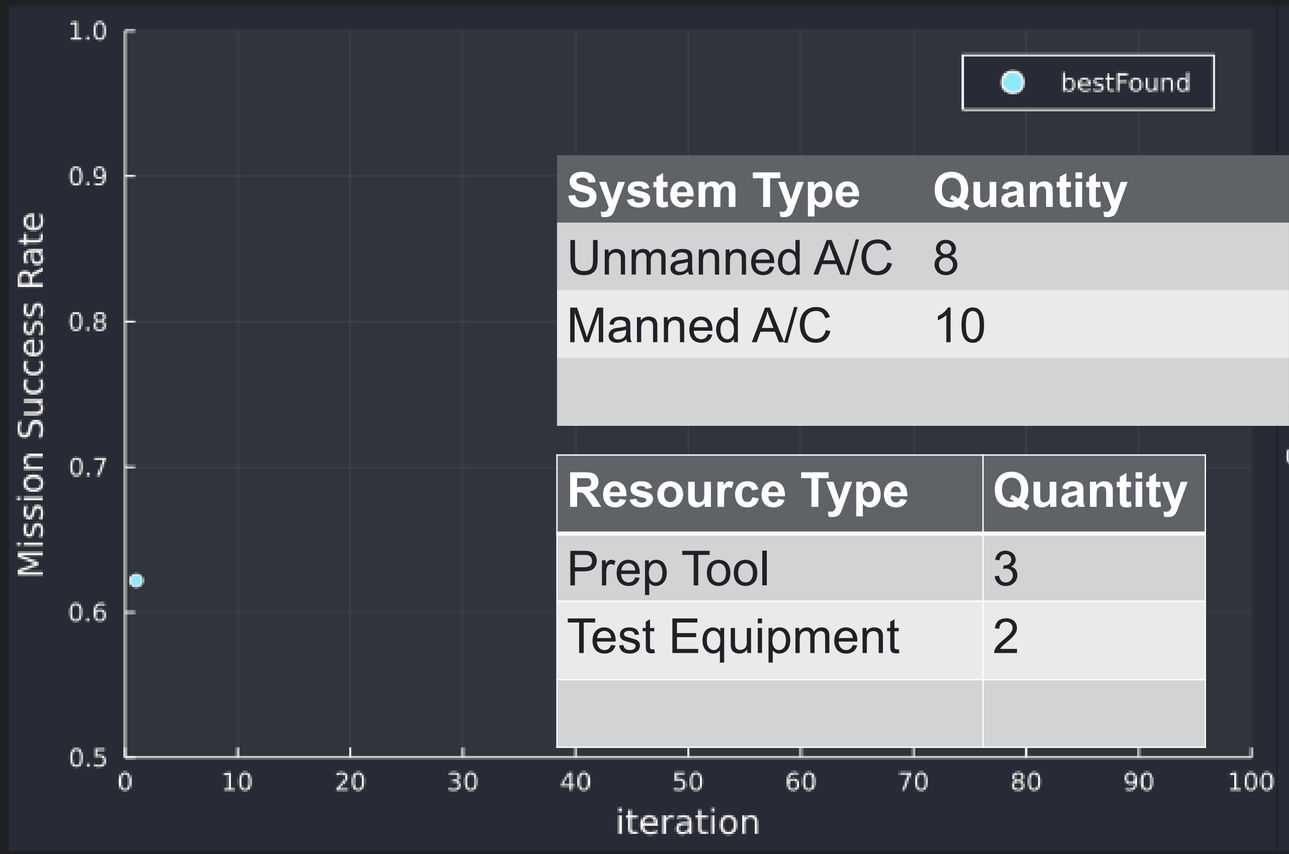
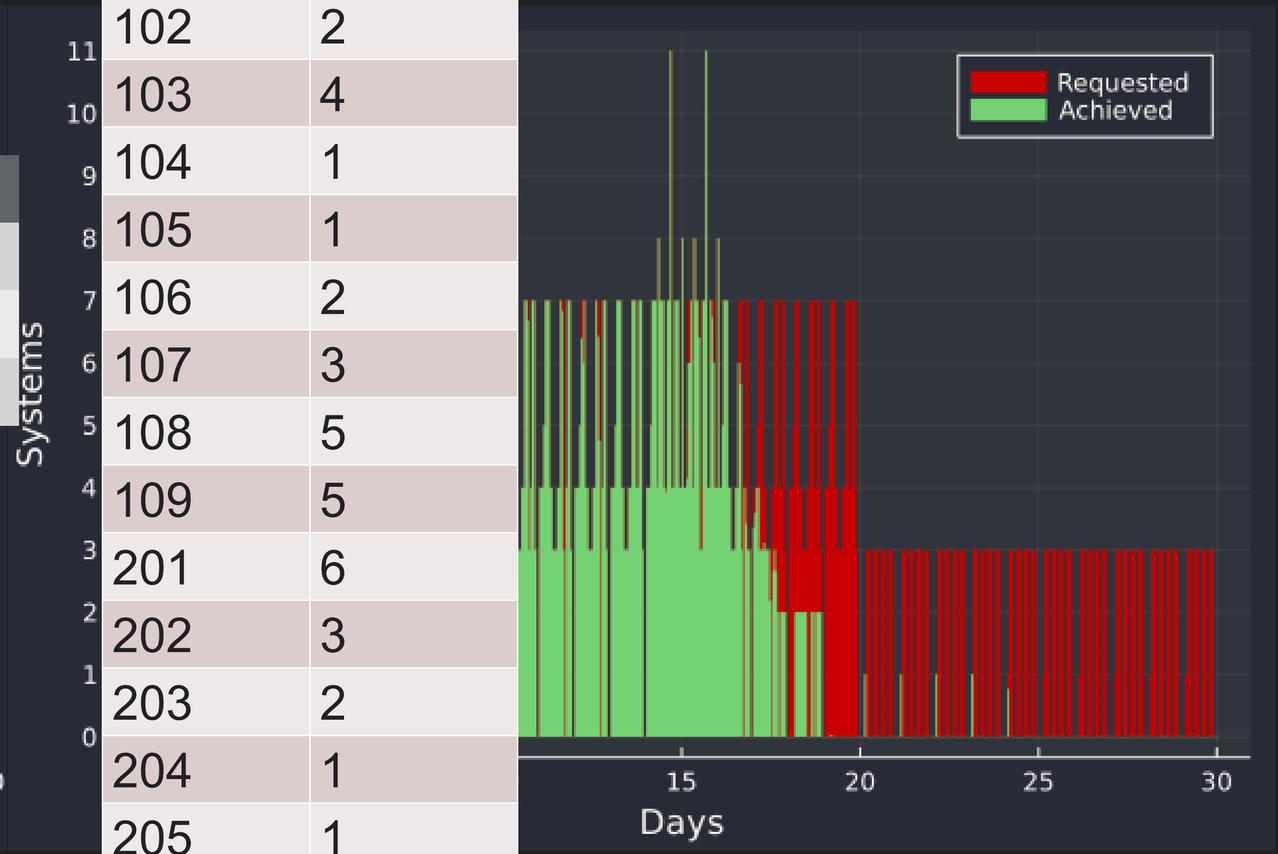
Optimizing



System Type	Quantity
Unmanned A/C	8
Manned A/C	10

Resource Type	Quantity
Prep Tool	3
Test Equipment	2

Item	Qty
101	13
102	2
103	4
104	1
105	1
106	2
107	3
108	5
109	5
201	6
202	3
203	2
204	1
205	1



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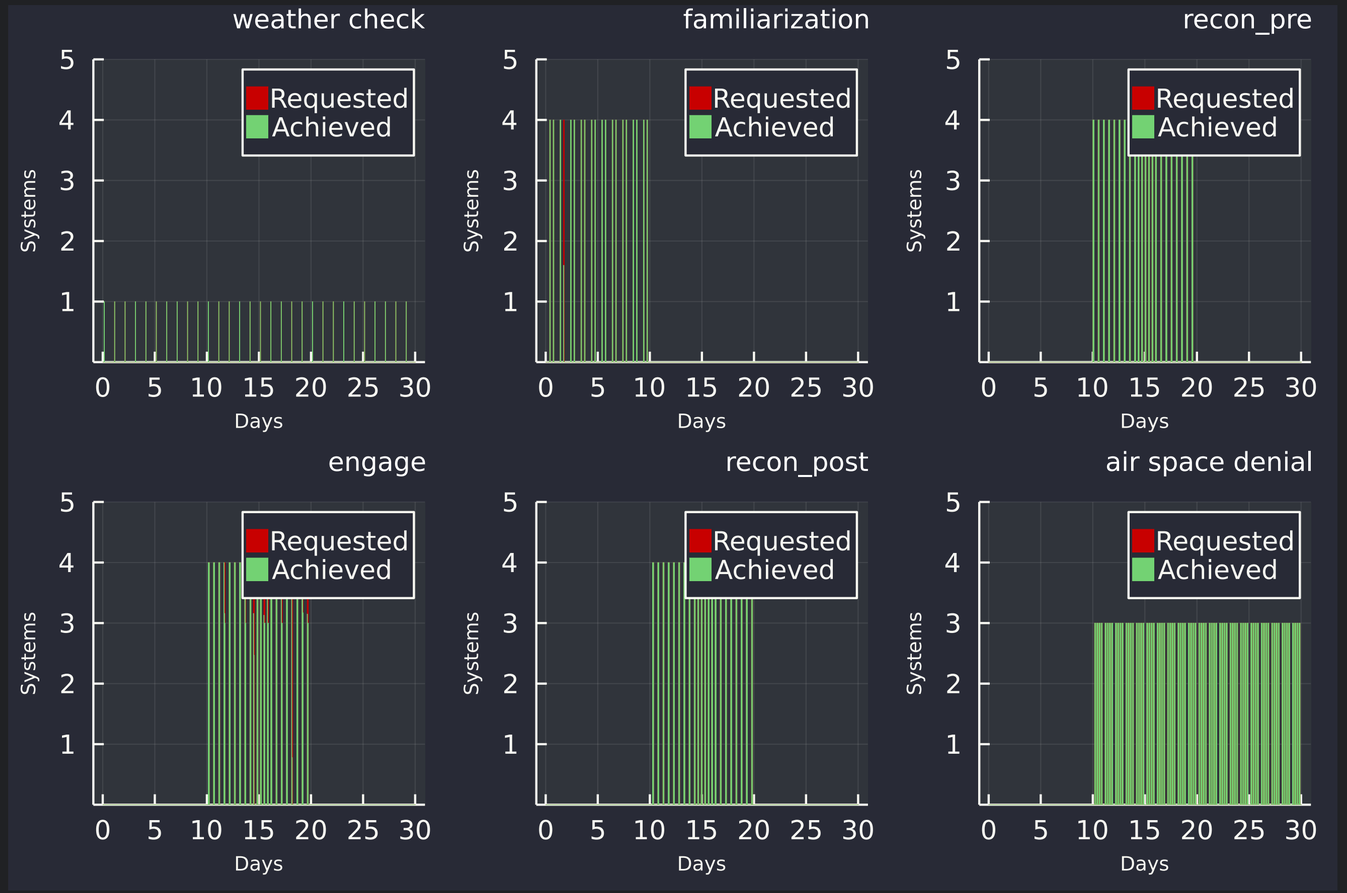
Results

- **Mission Success rate up from 90% to 98%**
  - Risk of failed mission in high phase very low

- **18 systems instead of 24 (10 manned and 8 unmanned)**
- **Optimal spares assortment**
- **30% less cost**
- **…and a satisfied deployment commander**



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The situation back home: Back to Readiness

Situation at home base (during and after deployment)

- **The systems are returned to home base after overhaul**
  - One manned and one unmanned per month
  - No spares from the deployment zone are returned

- **How to get back to similar readiness as before the deployment**

- **Additional funding for the next two years is assigned to improve System Readiness (for each mission)**

- **We need to buy new spares to improve the situation at home**

- **Unfortunately, war time**
  → High Demand
  → LONG lead times
  This needs to be considered

IF only there was a way that we could optimize this…

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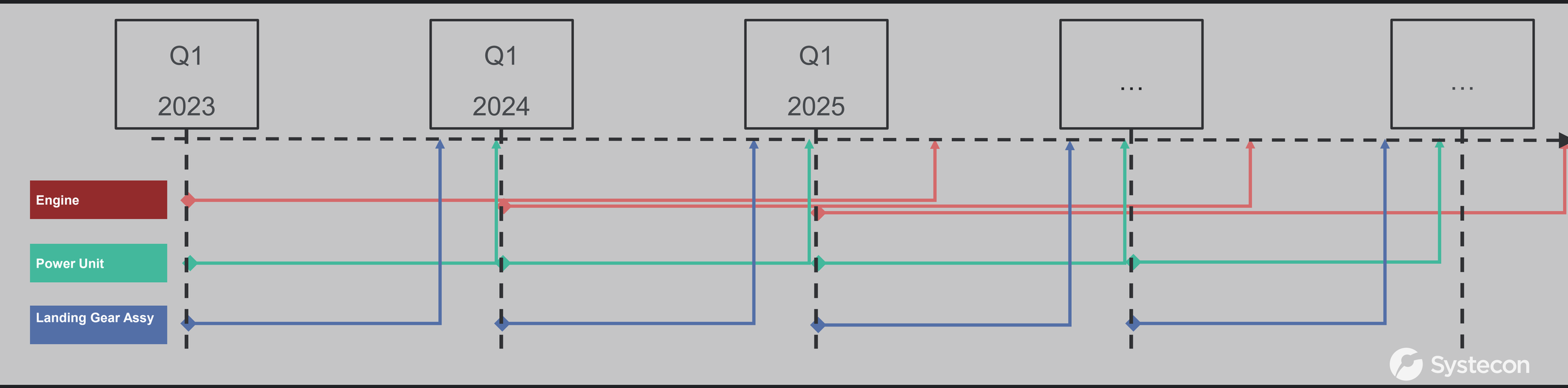
Opus Evo: Tactical Logistics Support Procurement Optimizer

Sparing: With an Annual Budget

- *” There is no overnight delivery option when you buy a jet engine!”*
- Which spares should be ordered with the next budget?
  - Different lead times for different components
- Do we have all components in stock for the upcoming overhaul?
- How do we utilize the additional funding optimally?



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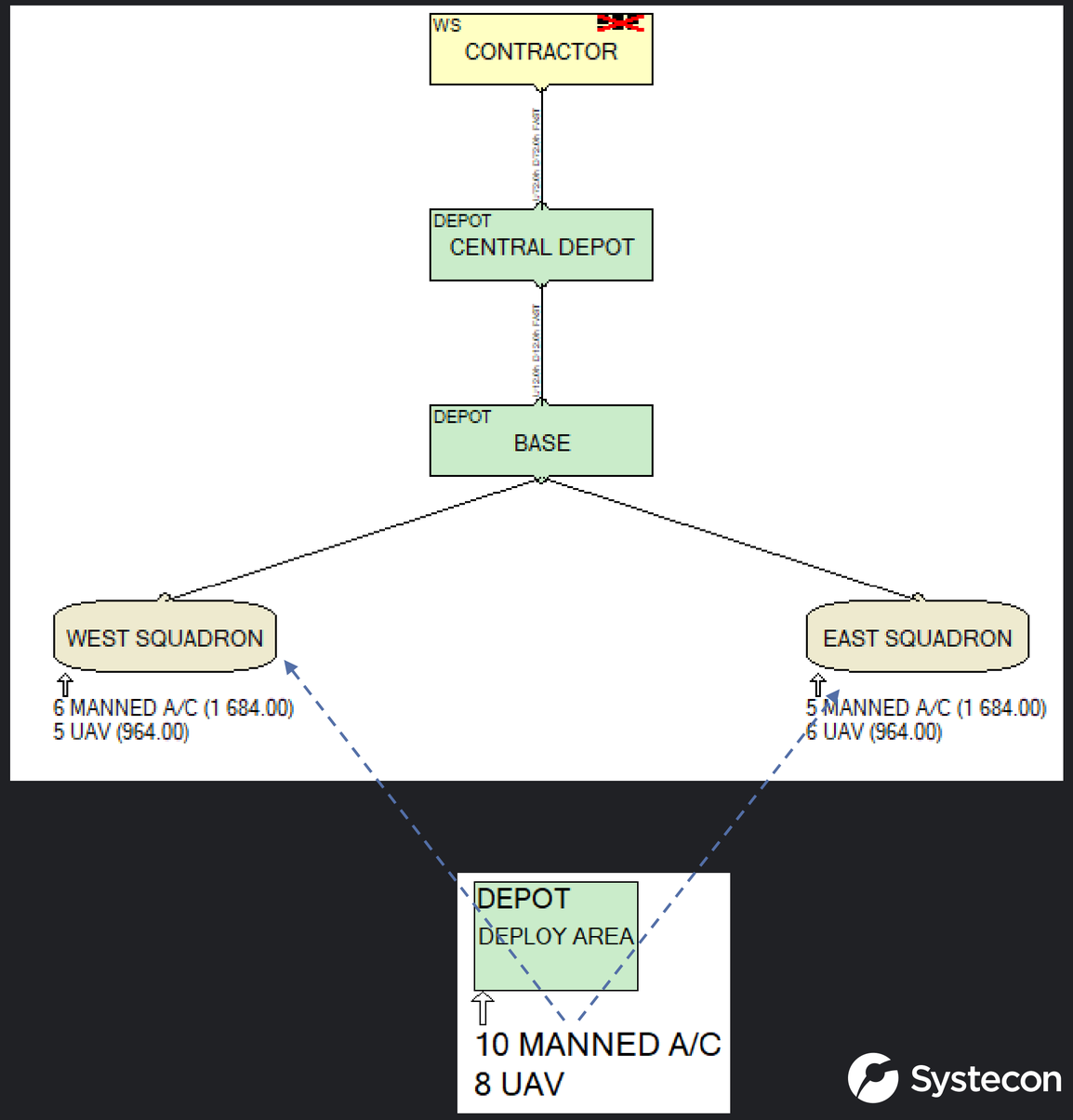
Scenario: Optimal Procurement with Lead times

- **Optimize the use of the next three budgets**

Time	Budget
Q1 2023	3 000 000
Q3 2023	2 500 000
Q1 2024	1 500 000

  - Decide (variables $x_1, \ldots, x_n$)
    - **What** spares to buy **when**
    - Lead Times between 0 and 15000 h

- **Maximize** System Time Fraction **(objective, $f(x_i)$)**



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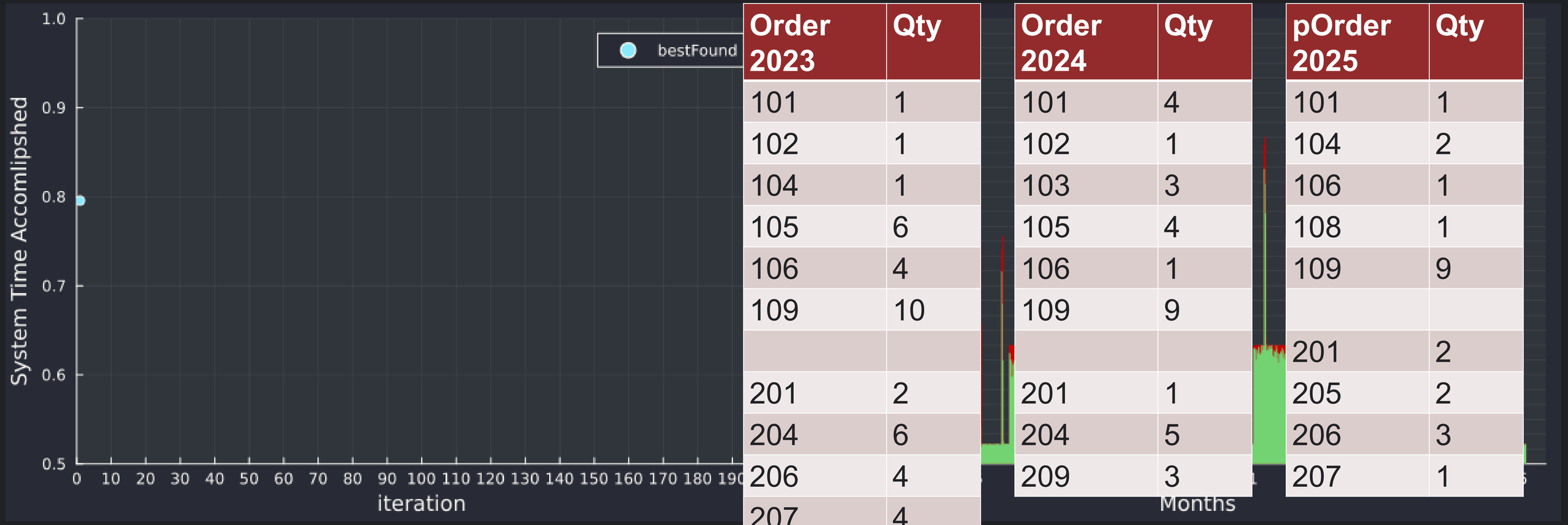
Optimizing- System Time Fraction



Order 2023	Qty
101	1
102	1
104	1
105	6
106	4
109	10
201	2
204	6
206	4
207	4
208	5
209	6

Order 2024	Qty
101	4
102	1
103	3
105	4
106	1
109	9
201	1
204	5
209	3

pOrder 2025	Qty
101	1
104	2
106	1
108	1
109	9
201	2
205	2
206	3
207	1

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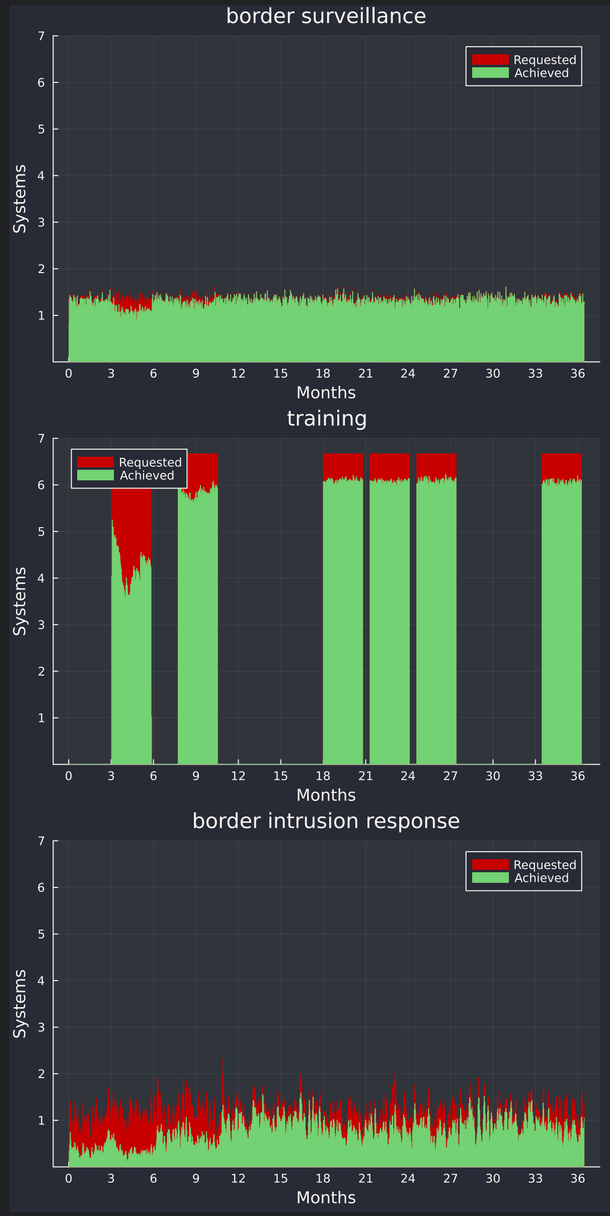
Results

- **Optimal procurement strategy for the next budget**
- **System Time Fraction up from 60% to 86%**
- **…and a satisfied base commander**



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US Air Force Case Study

Case Study: Spares kit for deployed operations

Scenario

- 20 days of deployed combat operations
- 24 Fighter jets - staggered deployment:
  12 A/C day 1, 6 A/C day 2, 6 A/C day 3
- Mission profile: 5 missions/day,
  4 aircrafts/mission. Totaling 20 sorties/day

Supply

- Short notice -> Deploy with what is available
- Plan for no external/continuing resupply

Requirements

- Achieve best Air Vehicle Availability (AVA) / Mission Capability (MC) for deployed aircraft

Modeling Approach

- Optimize Maintenance Significant Items (MSI). Compare Evo with USAF DSP model

Case Study: Results

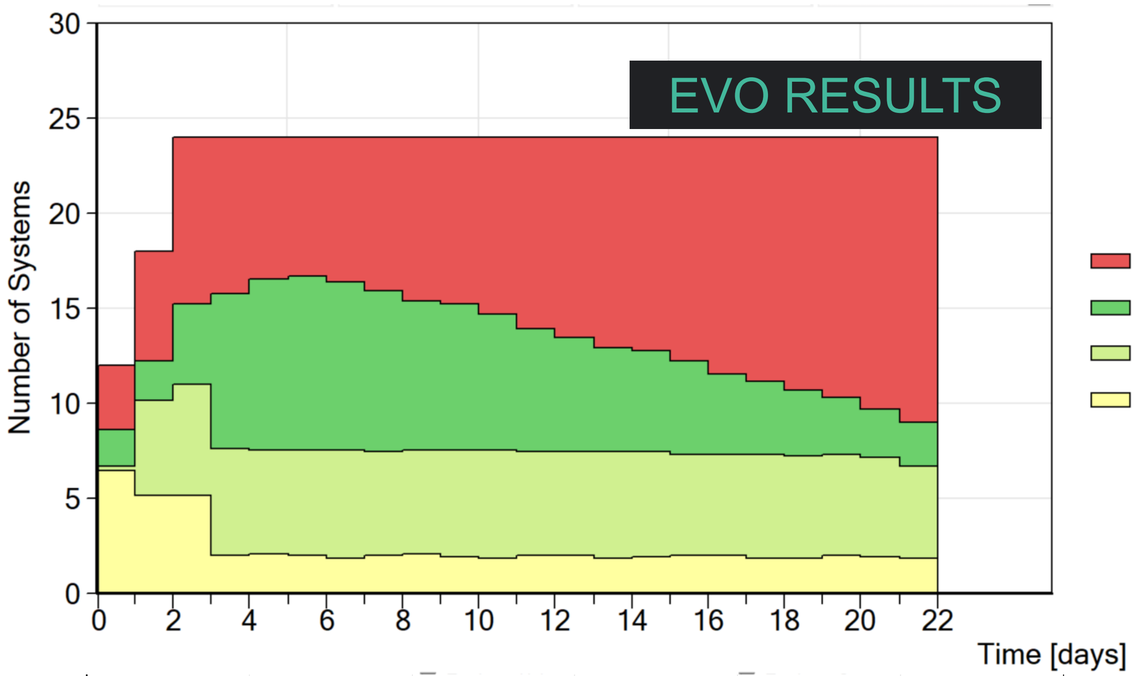
Assortment provided by Evo:
A minimum of 8 aircraft available throughout the entire 20-day tasking

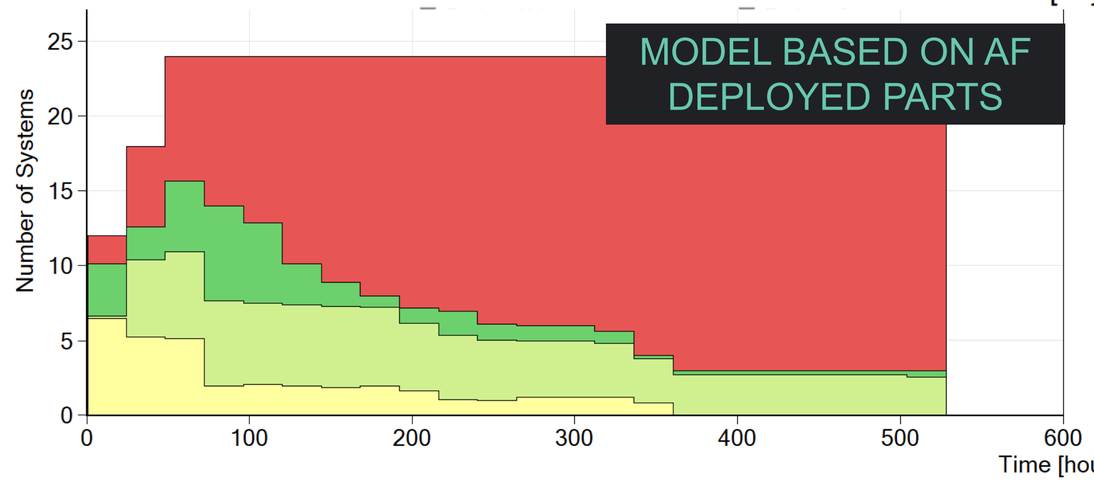
Assortment from USAF DSP model:
MC drops below the 4 A/C requirement after day 15, then limited to 3 A/C available for tasking

Evo spares kit also achieved:
- 38% reduction of total MSI parts required
- 50%+ increase in availability (AVA/MC)
- 56% costs reduction

  - DSP Model: 33.0 MUSD
  - EVO: 14.5 MUSD
  - OPUS10: 22.3 MUSD (same MC as Evo)

(OUTCOME EVALUATED IN SIMLOX)





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Opus Evo – Concluding remarks

- New approach – broad range of capabilities and applications
- Same model and data set as OPUS10 and SIMLOX
- First two products ready for delivery:
  - Deployed Operations Planner “EVO-DOP”
  - Tactical Logistics Support Procurement Optimizer “EVO-LPO”

- Learn more/Next steps:
  - Opus Evo webinar
  - Feasibility workshop: DOP / LPO
  - Other application areas and Evo-products

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Thank you.

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