Temasek Defence Systems Institute

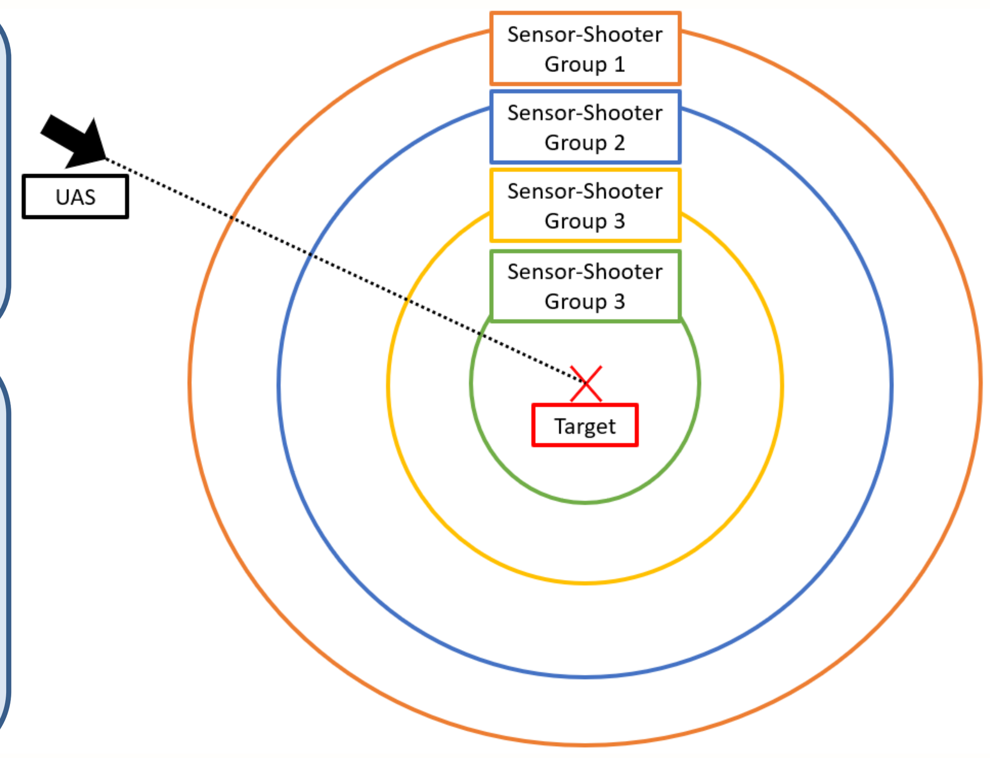
ANALYSIS OF A MULTI-LAYER SYSTEM OF SYSTEMS TO COUNTER UNMANNED AERIAL SYSTEMS

Author: MAJ Aaron Seow
Thesis advisor: Douglas L. Van Bossuyt
Co-advisor: Britta Hale

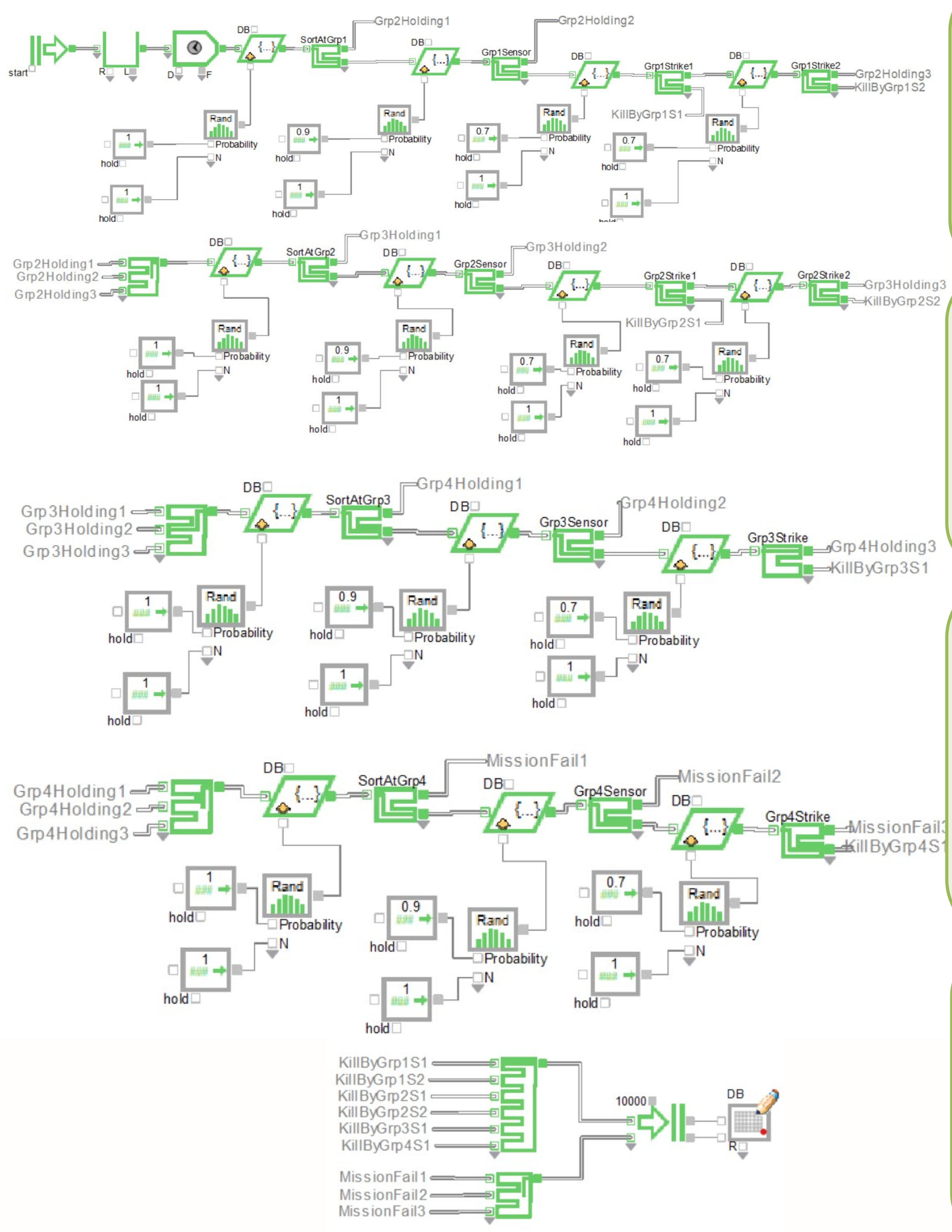
Problem Statement and Objectives

Problem Statement: The technological capabilities of Counter-Unmanned Aerial Systems (CUAS) in addressing the diverse threats posed by Unmanned Aerial Systems (UAS) have grown exponentially in recent years. There is a **need to capitalize on CUAS technologies** by developing a System-of-Systems (SoS) CUAS approach.

Objectives: (1) To **use ExtendSim**, a Model-Based Systems Engineering (MBSE) tool, to simulate the operational context when a UAS flies into a SOS CUAS' area of operations; (2) to **derive insights** after each iterations to continuously improve the model that is simulated; and (3) to **conduct cost-benefit analysis** based on the model to optimise the integrations of the various CUAS.



Modeling, Simulation and Analysis



1st Iteration – Base Model: To simplify and initiate the iterative process, a generic set of assumptions were applied based on the literature review.

Results: 99.55% success rate in neutralising the incoming UAS threats.

Analysis: A confidence level of 95% is conservative and prudent.

2nd Iteration – Varying Sensor-Shooter Groups: The number of sensor-shooter groups was varied while all else was kept constant.

Results: 50% reduction in systems used borders the 95% CI required.

Analysis: SoS can be optimized with lesser system while adjusting technological specifications.

3rd Iteration – Varying P_D and P_{Kill}: The value of P_D and P_{Kill} was varied while all else was kept constant.

Results: Different systems has different sensitivities in ensuring success.

Analysis: For the highest ROI, adjustments to system specifications should be done on the parameters with the greatest sensitivities.

4th Iteration – Improvement while Applying all 3 Insights: (1) 95% CI; (2) 50% reduction in systems; and (3) vary top 4 most sensitive inputs.

Results: From 15 permutations, 3 combinations border the 95% CI.

Analysis: From the choices, decisions can be made based on risk appetite and quantitative cost analysis to guide decision-making.

Conclusion and Recommendations

Conclusion: The ExtendSim model utilized shows potential in optimizing the integration of various CUAS to address the need for an SoS CUAS. Stakeholders can employ this model and iterate the parameters to conduct cost-benefit analysis.

Recommendations:
(1) Varying the UAS parameters and method of employment to portray a more dynamic and stochastic behaviour.
(2) Varying the system specifications of the CUAS to better represent the actual behaviour of the systems in the real-world.
(3) Integrating a central C2 system to synchronise across all sensor and shooter systems in a single command node.

NUS National University of Singapore