Temasek Defence Systems Institute

# Model-Based UAS-UGS IED Clearance Mission Engineering

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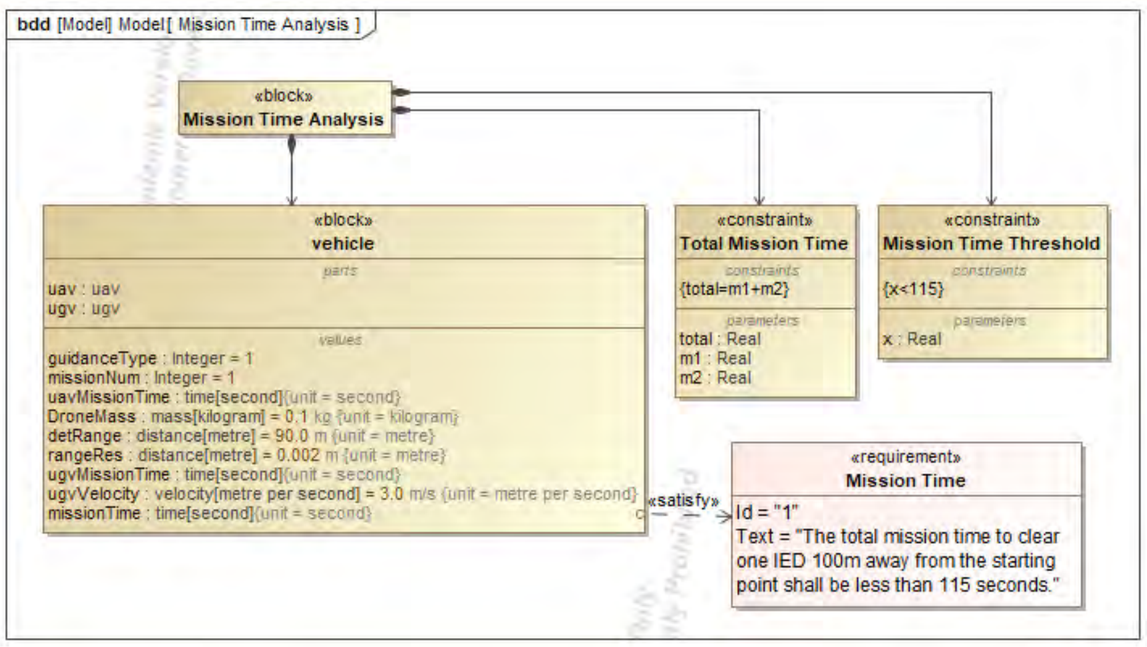
## Objective

This thesis explores the possibility of using model-based systems engineering (MBSE) environment to architect and explore unmanned aerial system (UAS) and unmanned ground system (UGS) teaming in improvised explosive device (IED) clearance while using high-fidelity models developed in MATLAB/Simulink development environment.

## Main Research Ideas

Cameo – a powerful MBSE tool – was used to develop executable system model for the UAS-UGS IED clearance mission, integrating it with the high-fidelity Simulink models of UAS and UGS missions, and executing multiple simulations seamlessly to analyse the function and performance of the system. The mission context begins when the UAS confirms the presence of the IED by taking off, navigating across the varying levels of buildings, and landing on the target. Sequentially, the UGS navigates to the detected IED and detonate it. The measure of performance (MOP) was the time taken for each mission starting from the launch of the UAS until the UGS reaches the target.



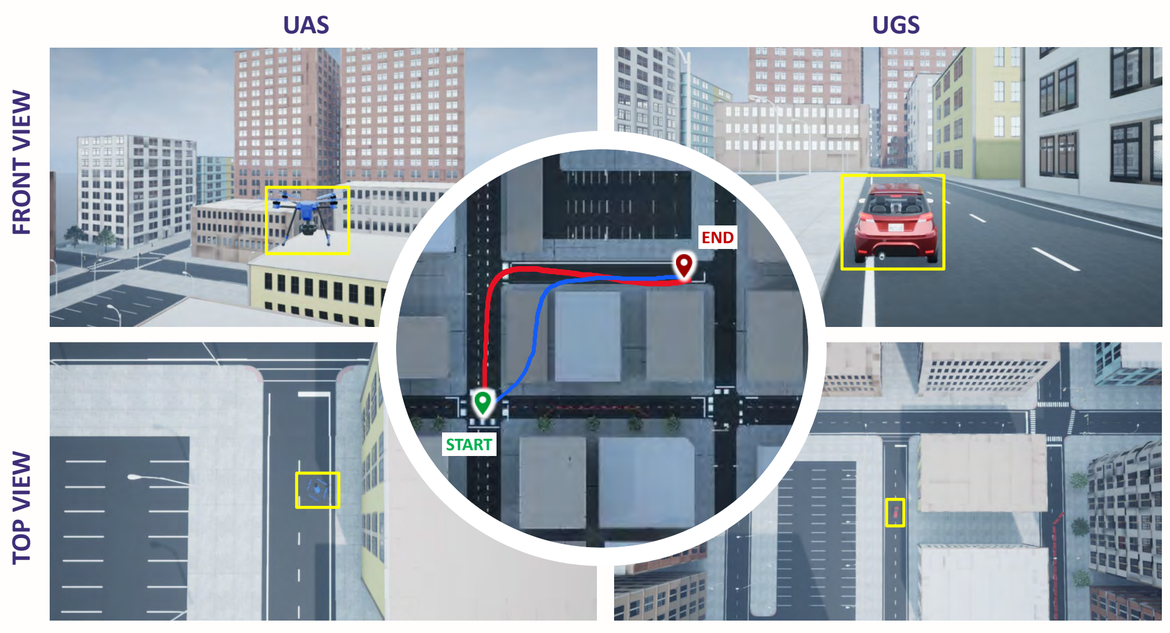

*Block Definition Diagram of Mission Time Analysis in Cameo*

## Benefits of the Research

The developed integrated model helps to analyze the advantages of employing UAS-UGS teaming in optimizing the IED clearance with lesser manpower, lower cost, and higher performance. The research also shows the methodology of how MBSE and Simulink models can be built and integrated, which can then be used to explore other machine-to-machine teaming such as unmanned underwater systems (UUS) and unmanned surface systems (USS) to accomplish a common task or mission.

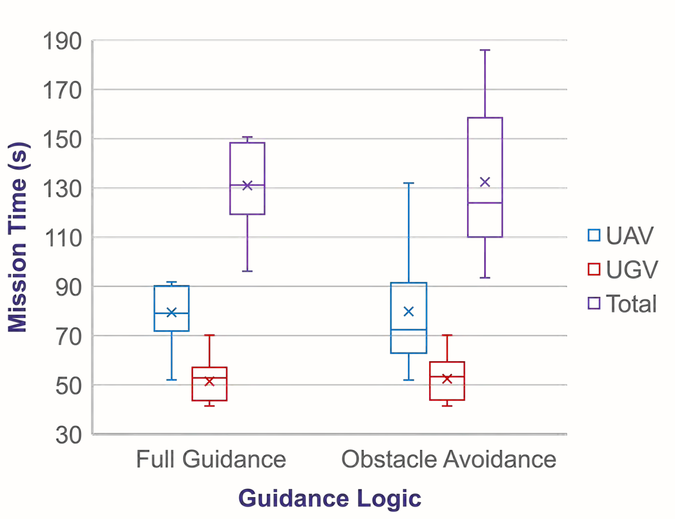
## Research Results

The integration enabled the visualization of UAS and UGS performing their respective missions in the same 3D simulation environment. This provides a medium to analyze the behaviors of the UAS and UGS before performing operational testing on actual physical systems.

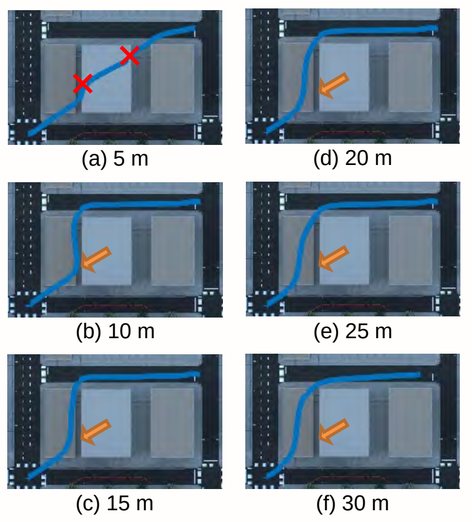



*UAS and UGS Missions in 3D Simulation Environment*

The test case design was proven to be modifiable to simulate different scenarios. External factors (e.g., obstacles and weather) and UAS and UGS system parameters can be configured to obtain the desired output (e.g., mission time) based on a specific constraint (e.g., less than 115 s).




*Effects of Guidance Logic in Mission Time*




*Effects of Detection Range in UAS Flight Path*

## Future Work

A graphical user interface (GUI) as a realistic mockup of an operator's control module may be developed to allow the user to control the UAS and UGS by manipulating the system parameters dynamically and monitor the status of the mission in real-time. Implementing the MBSE executable system models in actual small-UAS and UGS can further validate the effects of the system parameters in the mission.

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