Temasek Defence Systems Institute

Asset Pre-positioning and Post-Attack Sequential Network Reconstitution in a Contested Road Network

Author: CPT Chang Hong Yu
Thesis advisor: Emily M. Craparo
Co-advisors: W. Matthew Carlyle

Background/ Objectives: Combat engineer operations planning is often tedious and reliant on intelligence reports, which can quickly become outdated due to the dynamic nature of enemy tactics. Traditional planning methods are reactive, focusing on overcoming known obstacles, which limits the flexibility and effectiveness of the planning process. This research proposes the use of optimization tools to enhance combat engineer planning. We develop a sequential network reconstitution model to optimize engineering asset employment, and we use it as a sub-problem in an algorithm to optimize pre-positioning of engineering assets. By employing mixed-integer linear programming (MILP) and Bender's decomposition, our model generates optimal plans considering possible enemy actions. Our model effectively solves small-scale scenarios providing insights into pre-positioning for sequential network reconstitution.

Model: A sample road network based on the Normandy beach landing illustrates the model, where the Allied logistics convoy aims to reach Caen as quickly as possible. Allied combat engineers work offensively to clear obstacles, while enemy forces deploy obstacles defensively to delay progress. The attacker-operator model represents this interaction: enemy forces, as attackers of the network, aim to disrupt the network, while Allied forces, as operators of the network, work to minimize delays. The model's objective function is time-based, with enemy forces trying to maximize delay and Allies minimizing it by optimally clearing obstacles. Key decision variables include the placement and type of obstacles by the enemy and the allocation of limited engineering assets by the Allies, whose success depends on matching asset types to obstacles. This framework helps evaluate the impact of strategic deployment choices on convoy progress.

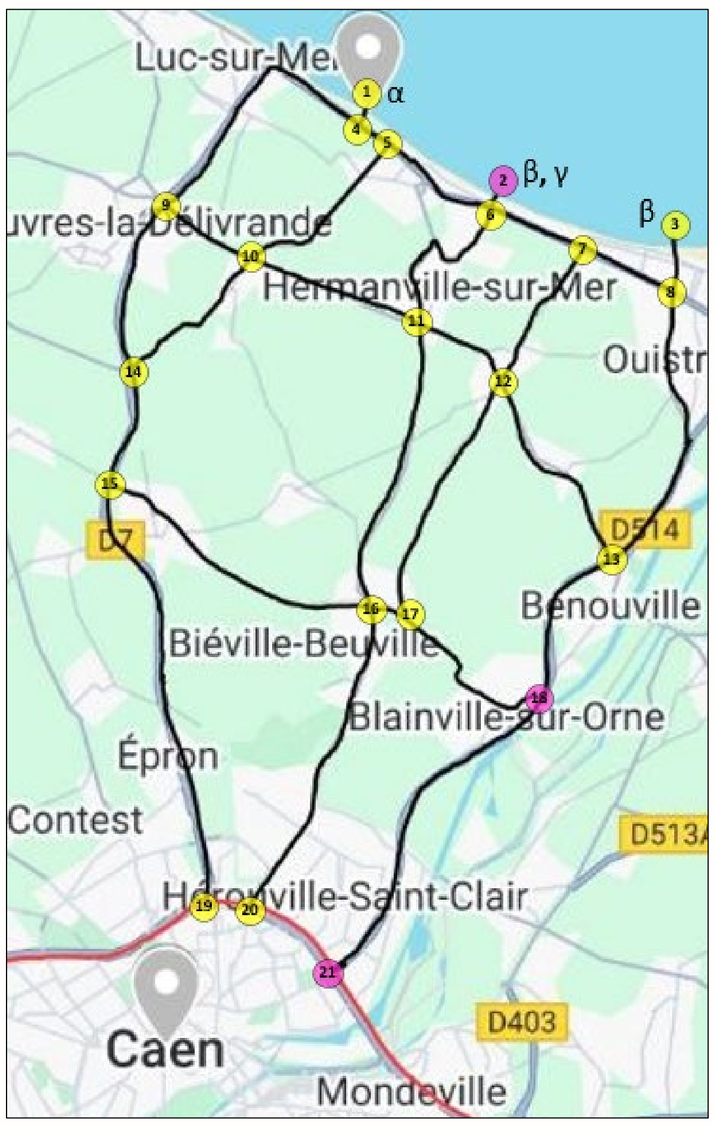

Figure 1. Sample road network with obstacles and pre-positioned assets

Benefits/ Potential applications: The model serves as a decision support tool to make combat engineer planning less tedious by automating calculations that are traditionally done manually. By providing a road network and making reasonable assumptions about enemy capabilities, the tool can simulate the worst-case scenarios of obstacle deployment, allowing planners to anticipate challenges. It also offers a framework to test various pre-positioning strategies for engineering assets, helping military forces optimize their allocation based on available resources and network information. Additionally, the model quantifies the required amount of engineering assets for a given battlefield, informing resource planning and deployment decisions.

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NUS National University of Singapore