Temasek Defence Systems Institute

# Systems Engineering Approach to Ground Combat Vehicle Survivability in Urban Operations


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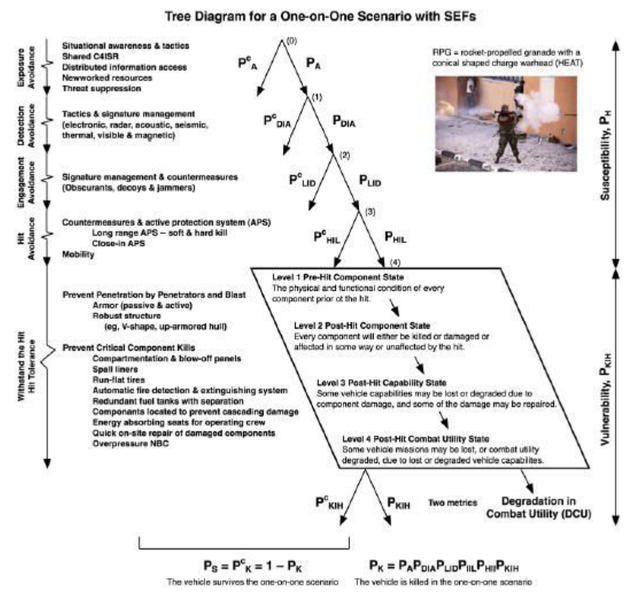
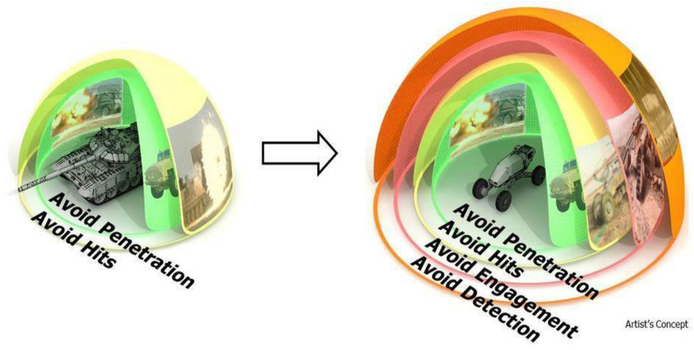
- Objectives
  - Assess adequacy of traditional survivability concept
  - Assess alternative survivability concepts for GCVs in urban operations
  - Develop a model to engineer cost-effective survivability capability in urban operations
    - Close range, single missile attack against a GCV

- Research Results
  - Need to move from armour-based protection (vulnerability reduction) to minimizing the probability of being hit by a threat (susceptibility reduction)
  - Use probabilities to quantify vulnerability and susceptibility reduction technologies
  - Using Design of Experiment (DOE) techniques, the developed model can be used to determine different combinations of probabilities to fulfil the same P(survival) requirement
  - Each survivability architecture has its own unique trade-offs. MADM methodology can be used to facilitate decision-making on the most cost-effective survivability architecture
  - Hard-kill Active Protection is a critical survivability technology

- Applications
  - Current survivability models focus primarily on vulnerability reduction
  - Proposed model allows engineers to determine the survivability characteristics of a GCV taking into account both vulnerability and susceptibility reduction
  - There are many mature and upcoming susceptibility reduction technologies that engineers can consider to integrate on GCVs

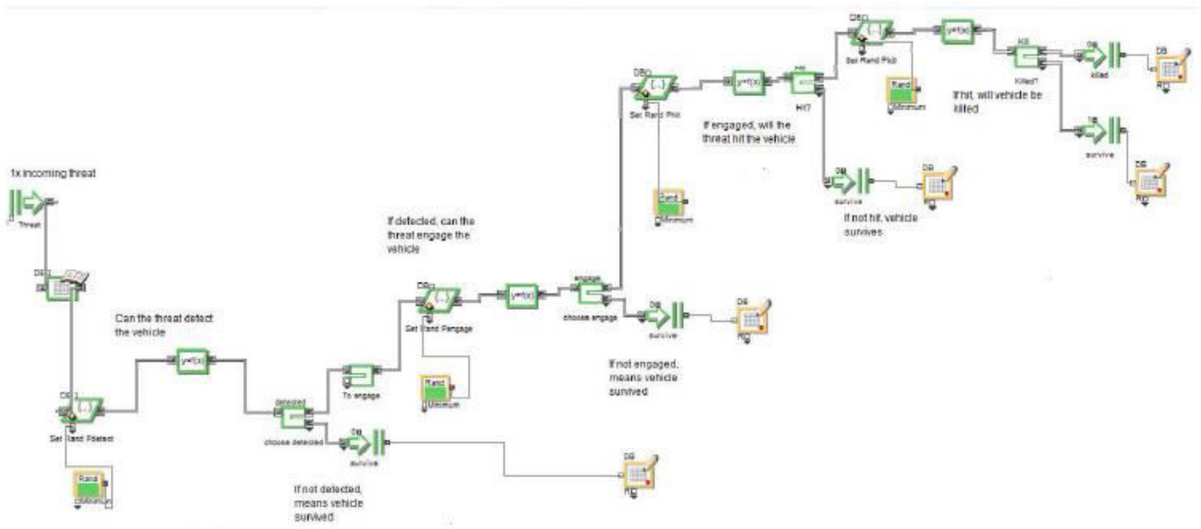
- Future Work
  - Revise model to analyze alternative threat scenarios
  - Adapt model to analyze non ballistic threats such as mines and IEDs




**Armor-Based Protection**

**Envisioned GXV-T Protection**




| | factor name | MDD | P(detect) | P(engage) | P(Hit) | P(kill) | APSP(hit) | Results |
|---|---|---|---|---|---|---|---|---|
| 5 | 1 | **200** | **0.73** | **0.61** | **0.43** | **0.95** | **0.75** | 0.16 |
| 6 | 2 | **182** | **1** | **0.39** | **0.56** | **0.79** | **0.58** | **0.22** |
| 7 | 3 | **176** | **0.83** | **0.93** | **0.41** | **0.61** | **0.74** | **0.22** |
| 8 | 4 | **117** | **0.96** | **1** | **0.58** | **0.98** | **0.56** | **0.585** |
| 9 | 5 | 188 | 0.71 | 0.63 | 0.45 | 0.88 | 0.79 | 0.13 |
| 10 | 6 | 194 | 0.98 | 0.52 | 0.5 | 0.78 | 0.59 | 0.23 |
| 11 | 7 | 141 | 0.84 | 0.98 | 0.48 | 0.6 | 0.76 | 0.245 |
| 12 | 8 | 111 | 0.91 | 0.96 | 0.54 | 0.96 | 0.6 | 0.4 |
| 13 | 9 | 135 | 0.78 | 0.45 | 0.67 | 0.89 | 0.63 | 0.205 |
| 14 | 10 | 153 | 0.9 | 0.5 | 0.78 | 0.69 | 0.71 | 0.205 |
| 15 | 11 | 147 | 0.77 | 0.83 | 0.98 | 0.74 | 0.53 | 0.475 |
| 16 | 12 | 158 | 0.92 | 0.76 | 0.96 | 0.9 | 0.89 | 0.595 |
| 17 | 13 | 123 | 0.75 | 0.43 | 0.69 | 0.84 | 0.55 | 0.18 |
| 18 | 14 | 170 | 0.88 | 0.56 | 0.91 | 0.66 | 0.73 | 0.285 |
| 19 | 15 | 129 | 0.76 | 0.89 | 0.93 | 0.75 | 0.5 | 0.46 |
| 20 | 16 | 164 | 0.89 | 0.72 | 1 | 0.93 | 0.86 | 0.645 |
| 21 | 17 | 105 | 0.85 | 0.65 | 0.65 | 0.8 | 0.7 | 0.27 |
| 22 | 18 | 10 | 0.97 | 0.69 | 0.87 | 0.65 | 0.65 | 0.134 |
| 23 | 19 | 28 | 0.7 | 0.91 | 0.74 | 0.81 | 0.83 | 0.061 |
| 24 | 20 | 34 | 0.87 | 0.37 | 0.89 | 0.99 | 0.66 | 0.0997 |
| 25 | 21 | 93 | 0.74 | 0.3 | 0.72 | 0.63 | 0.84 | 0.013 |
| 26 | 22 | 22 | 0.99 | 0.67 | 0.85 | 0.73 | 0.61 | 0.153 |
| 27 | 23 | 16 | 0.72 | 0.78 | 0.8 | 0.83 | 0.81 | 0.0673 |
| 28 | 24 | 69 | 0.86 | 0.32 | 0.83 | 1 | 0.64 | 0.0793 |
| 29 | 25 | 99 | 0.79 | 0.34 | 0.76 | 0.64 | 0.8 | 0.0253 |
| 30 | 26 | 75 | 0.93 | 0.85 | 0.63 | 0.71 | 0.78 | 0.07 |
| 31 | 27 | 58 | 0.8 | 0.8 | 0.52 | 0.91 | 0.69 | 0.09 |
| 32 | 28 | 63 | 0.93 | 0.48 | 0.32 | 0.86 | 0.88 | 0.0143 |
| 33 | 29 | 52 | 0.78 | 0.54 | 0.34 | 0.7 | 0.51 | 0.044 |
| 34 | 30 | 87 | 0.95 | 0.87 | 0.61 | 0.76 | 0.85 | 0.06 |
| 35 | 31 | 40 | 0.82 | 0.74 | 0.39 | 0.94 | 0.68 | 0.073 |
| 36 | 32 | 81 | 0.94 | 0.41 | 0.37 | 0.85 | 0.9 | 0.00967 |
| 37 | 33 | 46 | 0.81 | 0.58 | 0.3 | 0.68 | 0.54 | 0.04 |

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