# Improving Data Collection for Real-Time Casualty Assessment (RTCA) in Operational Tests

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# Outline

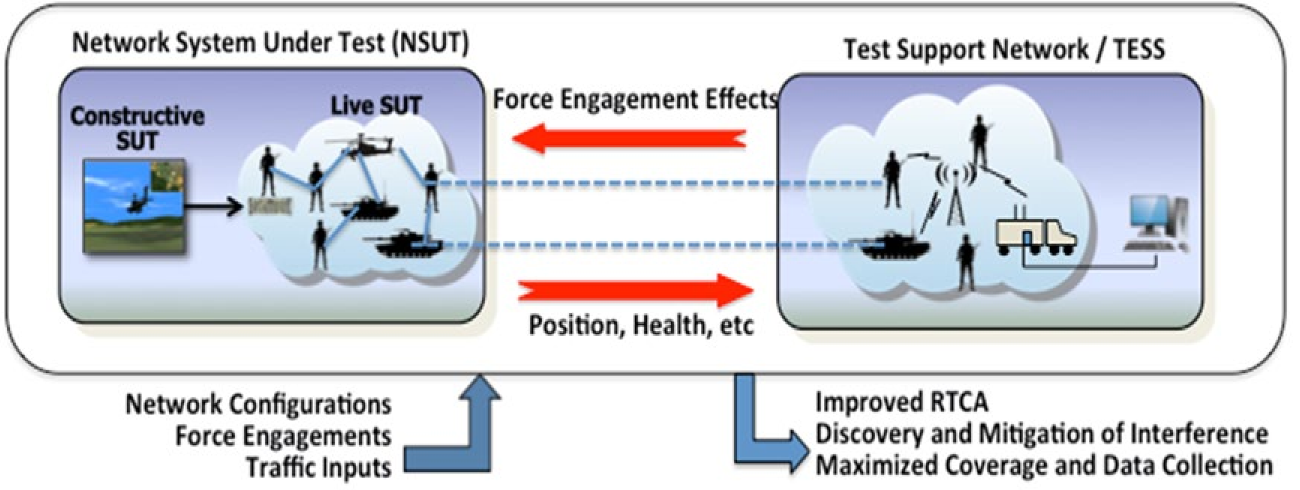
- Motivation
- Technology Overview
- Semi-automated TSN Layout Generation
- Semi-automated Operational Traffic Generation
- Results and Summary

# Motivation

- **An Operational Test (OT) for network-enabled technology involves fielding multiple networks simultaneously:**
  - One or more Networked Systems Under Test (NSUT)
  - One or more Test Support Networks (TSN) which are responsible for data collection test control and range instrumentation
  - One or more Tactical Engagement Networks (TEN) which initiate the force-on-force interactions and provides Real-Time Casualty Assessment (RTCA) data during the live test

- **Critical gap exists with current test planning tools**
  - Planners cannot ascertain ahead of time if the deployed TSN provide adequate bandwidth to support timely collection of Real-Time Casualty Assessment (RTCA) data

# Technology Overview



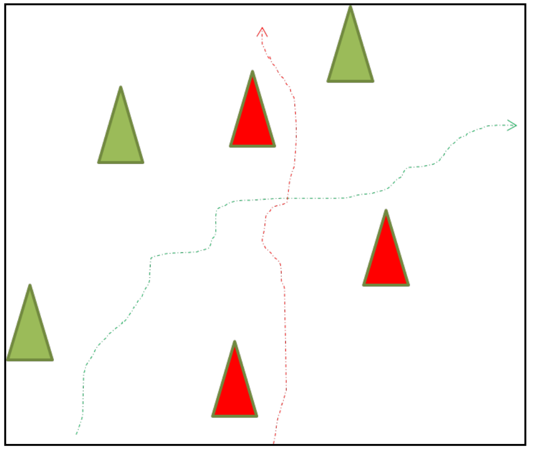

- **Integration of planning of tactical, test support, and tactical engagement networks is an important goal of simulation-based planning systems.**
- **Two major features of test-based planning are:**
  - **Semi-automated TSN Layout:** Create a best-effort feasible TSN layout that meets the operational test (OT) requirements for TSN network coverage and bandwidth
  - **Predict bandwidth needs for RTCA applications:** Planning tool requires a semi-automated Operational Test Traffic Generation tool to generate realistic traffic to predict test conditions

# Semi-Automated TSN Layout Creation

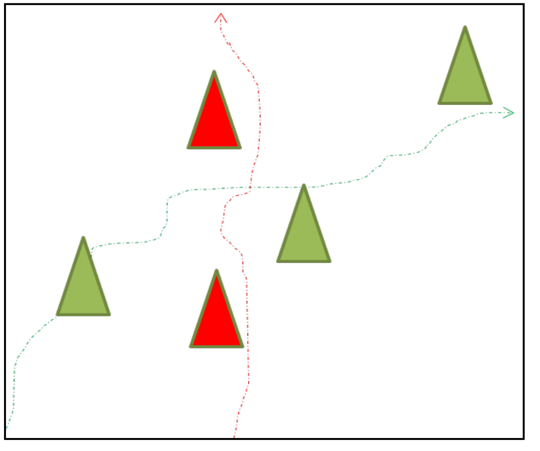
# Layout Overview

- **Goal: Given N number of towers with fixed TX power T, create a TSN layout where towers are placed to best meet OT requirements for TSN network coverage and bandwidth**

- **Process:**
  1. Start with an initial TSN layout, can be created by test planner or generated automatically
  2. Improve TSN layout by running Push-Pull Layout Optimization Algorithm
  3. Simulate improved TSN layout to determine TSN performance
  4. Test planner determines if TSN performance meets OT requirements, repeat step 2 as necessary

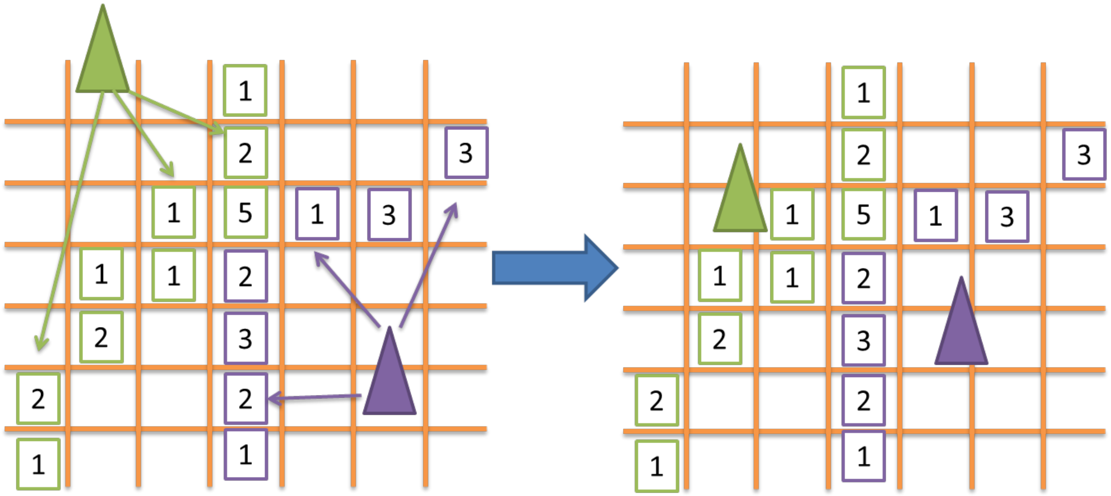


**Original TSN Layout (coverage = 85%, throughput = 100kbps)**



**Improved TSN Layout (coverage = 95%, throughput = 250kbps)**

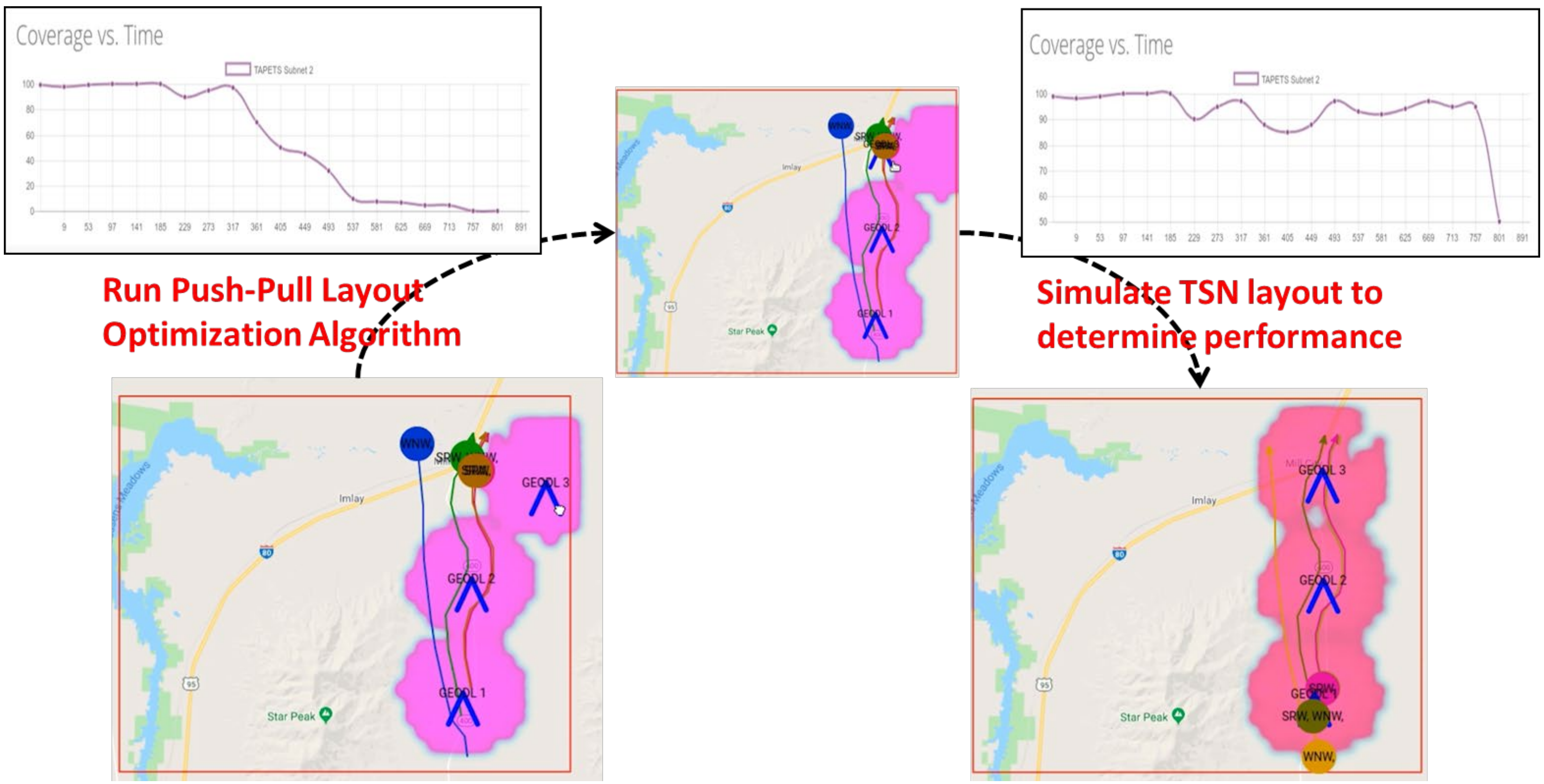
# Push-Pull Layout Algorithm




**Move tower to an equilibrium position by push-pull force vectors**

1. For K colored possible towers with K initial centers $C_i$
2. Associate grids to the relevant $C_i$
3. A grid can have multiple weight values, one for each optimization domain (coverage, traffic, etc.), weights can be adjusted based on performance of previous layouts
4. For each grid associated with $C_i$, create a force vector based on the relevant weight values and distance between the grid and $C_i$
5. Positive weight values will pull $C_i$ closer and push it away if it is negative
6. Sum the pulling and pushing vectors and move $C_i$ by the corresponding sum
7. Repeat step 2-6 until net movement vector is < threshold

# Performance Results




**Coverage improved because in the generated TSN layout the towers are placed closer to the platform mobility path**

- **Left: Initial tower locations, does not follow mobility paths**
- **Right: Improved tower locations, modified by algorithm to follow mobility paths**

# Semi-Automated Operational Test Traffic Generation

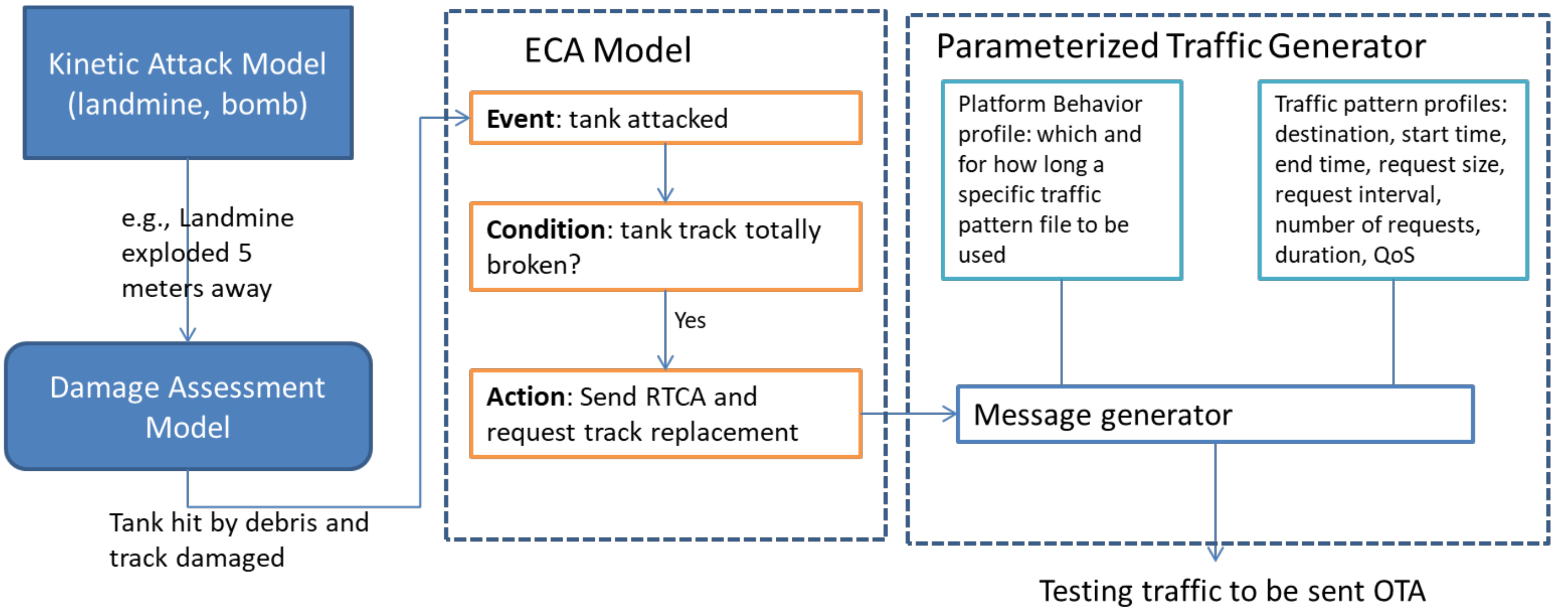
# Traffic Generation Overview

## Generate anticipated and accurate RTCA traffic based on user provided data on kinetic attack events

**User Assigned Kinetic Attack Events (IED, firefight etc.)** ⇨ **Operational Test Traffic Generation Model** ⇨ **RTCA traffic** ⇨ **TSN Simulation**

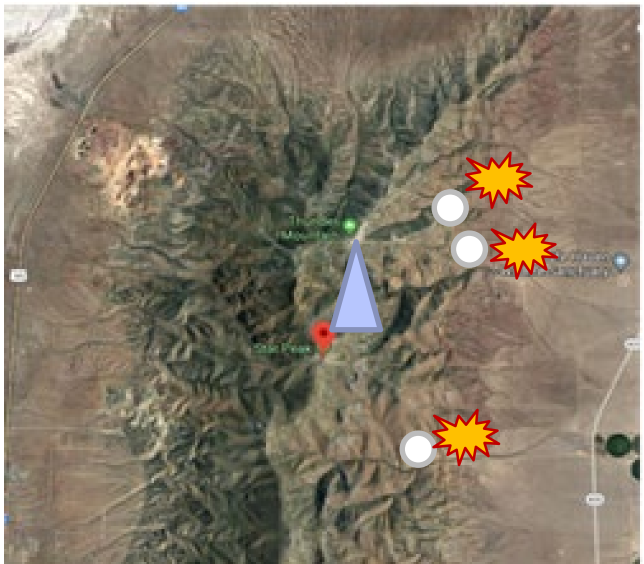
# Traffic Generation Process

**Kinetic attack information is used to predict the extent of damage on participants and the resulting traffic is generated as follows:**



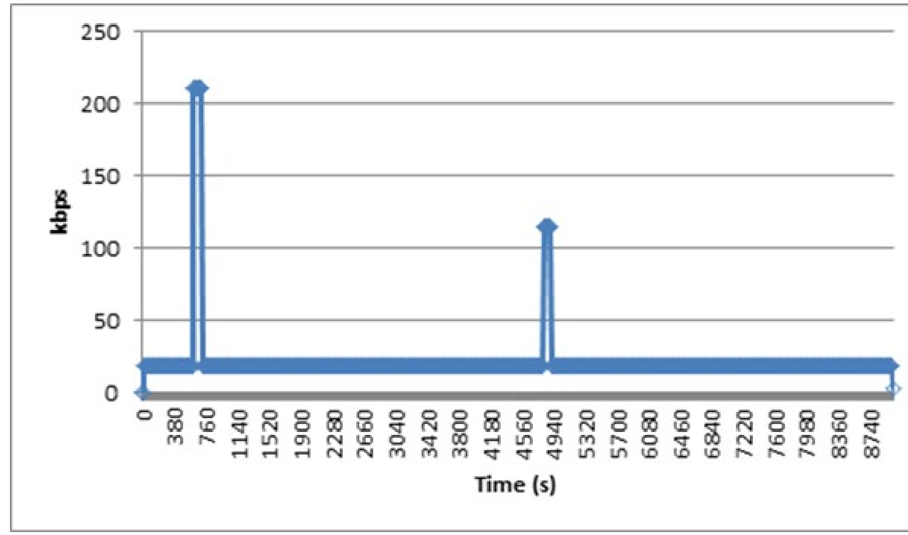

- **Kinetic Attack Model: Generates kinetic warfare attack events in the simulation**
- **Damage Assessment Model: Evaluates the damage caused by simulated kinetic attacks.**
- **Event-Condition-Action Model: Uses health thresholds-based rules to trigger actions**
- **Parameterized Traffic Generator: Generates regulated and formatted application packets**

# Traffic Generation Results



○ Platform   Kinetic Attack   TSN Tower

## TSN Traffic Load




- **In the above scenario**
  - One TSN tower and three platforms with attached TSN mobile units
  - Created RTCA traffic profiles for various damage levels
- **Three kinetic events were scheduled**
  - Two events occur at 10m, third event occurs at 80m
  - These events trigger RTCA data, spiking overall traffic load that the TSN has to handle in a timely manner
- **Semi-Automated Operational Test Traffic Generation allows test planner to predict the bandwidth needs of the TSN**

# Summary

- **Current planning tools cannot ascertain ahead of time if the deployed TSN provides adequate bandwidth to support timely collection of Real-Time Casualty Assessment (RTCA) data**
- **IPT3N provides features that can effectively mitigate the complexity of TSN planning, Semi-automated TSN Layout and Semi-automated Operational Test Traffic Generation**
- **Generated TSN layout provides improved coverage because towers are automatically placed closer to platform mobility path**
- **Operational Test Traffic Generation allows test planner to predict the bandwidth needs of the TSN**

# Q&A