Test & Evaluation/Science & Technology Program
C4I & Software Intensive Systems Test (C4T)
Test Technology Area

Integrated Planning of Tactical, Test Support, and Tactical Engagement Networks (IPT3N)

International Test and Evaluation Symposium

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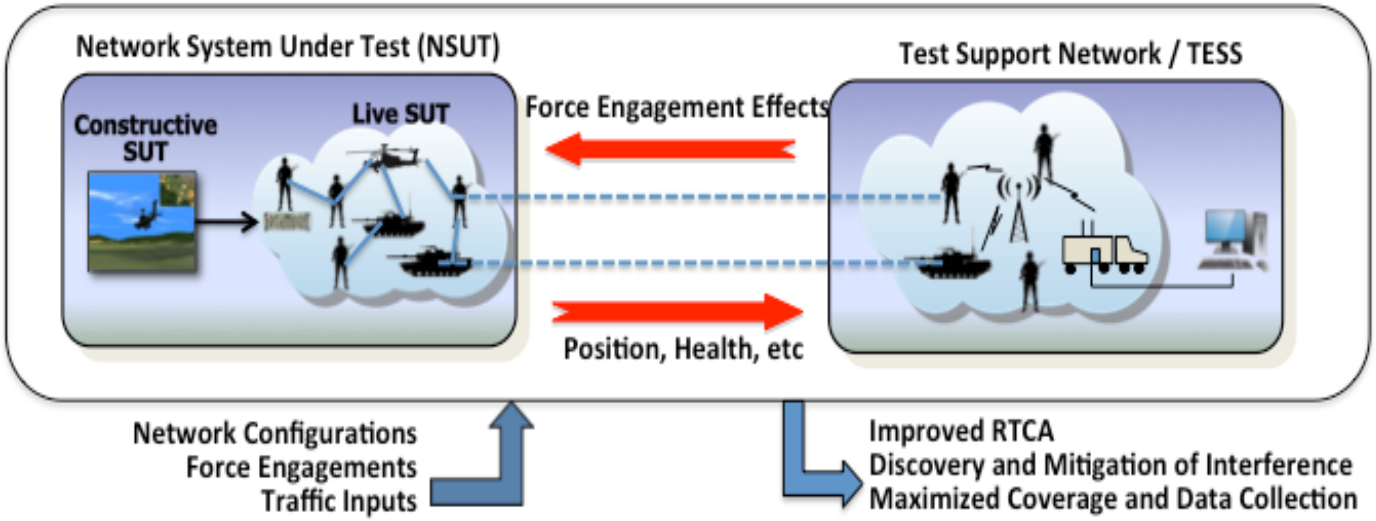
SCALABLE NETWORK TECHNOLOGIES

S&T Challenges

- **Efficient, preferably real-time, computation of interference among simultaneously active, independent, networks (SAIN)**
  - Interference must be calculated across heterogeneous radio waveforms across the various nets and environmental sources
  - Must be low complexity in transmitter count for large heterogeneous nets
  - Parallelism issues – decomposability and information transfer – very important
- **Optimize TSN deployment given dynamic force maneuvers, resource availability, and placement constraints**
  - Automate the selection of the most suitable TSN technology or technologies for a given NSUT
  - Optimize the deployment ahead of the live test based on assumed traffic and mobility
  - Support for dynamic re-deployment of TSN assets *during the live test*
- **Determine coverage for RTCA data collection for a given TSN deployment and force maneuver accounting for live and constructive entities and threats**
  - Accurate planning estimates for TSN traffic necessary to mitigate potential congestion
  - Traffic trace files and stochastic traffic generators have limited utility

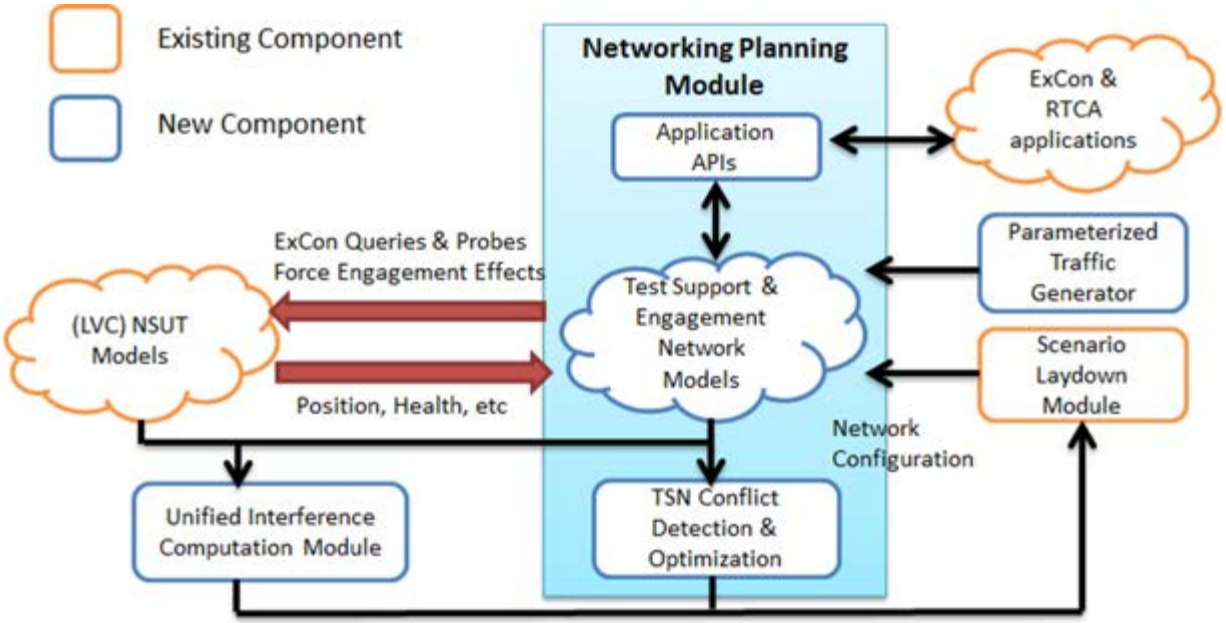
Program Objective



IPT3N will provide the test planner an integrated simulation-based planning framework, with a set of semi-automated tools to significantly reduce the complexity of TSN planning

Provide accurate Real Time Casualty Assessments (RTCA)
Reduce overall cost of planning the Operational Test (OT)
Improve level of confidence in test data collected during OT
Shape battlefield effects so that OTs are more realistic

Project Scope



- **Single unified simulation framework, with three primary modules: unified interference computation, network planning and optimization, and parameterized traffic generator**
- **Well-defined APIs to support integration with existing network simulators such as JNE**
- **Leverages multi-core architecture for scalability to plan OT for unified network with 1000+ nodes, that incorporates terrain and environmental effects on communications**
- **Application APIs to integrate existing high fidelity models of tactical networks, as well as appropriate RTCA and ExCon applications**
- **Use models of specific TSN technologies to demonstrate relevance**

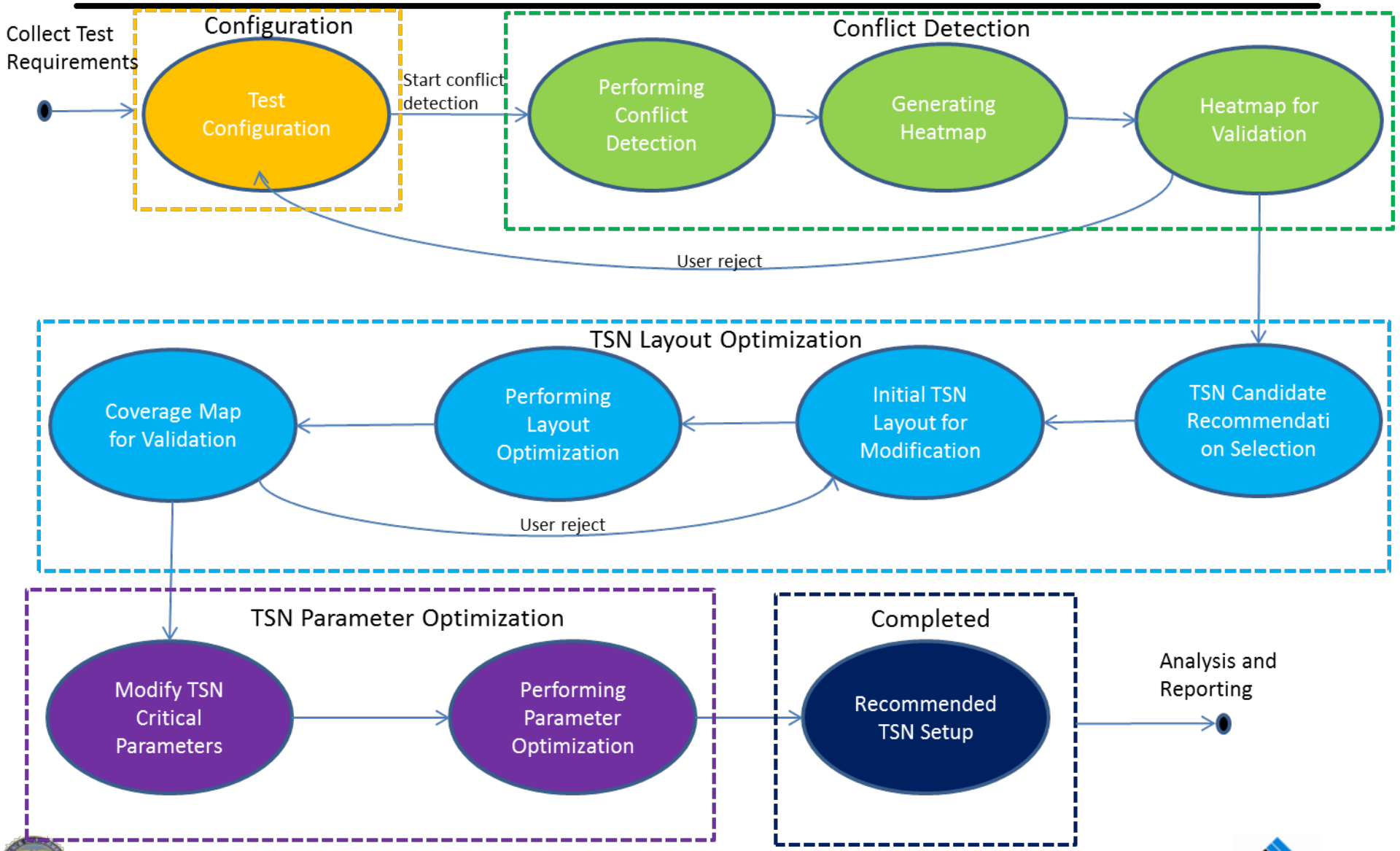
Primary IPT3N Tasks

- **Unified Interference Computation Module (UICM)**
  - Compute the interference accurately across multiple autonomous networks, and environmental sources (e.g. power lines, TV transmissions etc.)
  - Scalable to large heterogeneous networks at worst scaling linearly with total # of transmitters
  - Support for faster than real-time execution to support network planning capabilities
- **Network Planning (w/ Dynamic Re-planning)**
  - **Conflict Detection:** Automate selection of the most suitable TSN technology for a given NSUT automatically identifies resource conflicts
  - **Test Specific Optimization:** Optimize the TSN deployment ahead of the live test, based on assumed traffic and mobility patterns
  - **Dynamic Re-planning:** Dynamic re-deployment of TSN assets during the live test to suit changing conditions
- **Parameterized Traffic Generator**
  - Generate realistic test traffic for TEN deployment planning, such that the constructive traffic will not congest the TEN impacting RTCA accuracy
  - Generated traffic will be parameterized to reflect the anticipated battle rhythm and mobility patterns of the NSUT

IPT3N: Primary Operations

- **Test Planning Task Management**
  - Create a new test planning task
  - Edit and view lists of test planning tasks
  - View current status of test planning tasks
- **Spectrum Conflict Detection**
  - Perform conflict detection
  - View and validate the Heat map (relative signal interference among NSUT, TSN, and environmental sources)
  - Select most appropriate TSN technology
- **TSN Optimization**
  - View initial TSN layout and TSN coverage map
  - Modify TSN layout and update TSN parameter configuration
  - View optimized TSN layout and TSN parameter configuration
- **Analysis and Report**
  - Conduct comparative analysis of alternative TSN laydown
  - Generate test planning summary report

IPT3N Work Flow



Phase 1 Goals

- **Phase 1 Objectives: Develop TRL-4 prototype to generate a feasible deployment for a specific TSN technology for a specific NSUT of no more than tens of devices over a limited geographical terrain**
  - **Architecture Design:** Develop CONOPS, APIs to integrate with existing models of the networks under test, detailed architecture IPT3N modules
  - **Interference Computation:** Design and prototype the UICM, emphasis on spectrum level conflicts
  - **TSN Modeling:** Develop abstract model of a TSN to be used for demonstration purposes
  - **Test Specific Optimization:** Develop a detailed design of the test specific optimization component
  - **Conflict Detection:** Develop conflict detection component, use a typical TSN and NSUT technology as candidates
- **Phase 1 Exit Criteria**
  - Demonstrate IPT3N prototype with UICM in a planning scenario with **TAPETS TSN** technology and **mixed WNW&SRW NSUT** for a small scale OT of 50 devices maneuvering over terrain similar to an existing range

Phase 2 Goals

- **Phase 2 Objectives: Advance the IPT3N prototype to TRL-5, expand network size, and implement TSN optimization**
  - **Network Planning & Optimization:** Develop the test specific optimization component to optimize across following metrics: Coverage, Traffic performance and Energy consumption.
  - **User Interface:** develop full-fledged test planning orientated user interface for network planning and optimization
  - **Refine UICM:** Incorporate interference computation among heterogeneous networks and expand the number of supported radio technologies
  - **Parameterized Traffic Generation** of TSN traffic
  - **Machine Learning Conflict Detection:** Leverage Phase 1 capabilities, and use machine learning to create NSUT classifiers to exploit persistent knowledge base
  - **TSN technologies**: Improve TAPETS model, and V&V of TAPETS model
  - **Scalability:** Enhance Simulation Resource Management for parallel execution and enhance Converter to support more NUST/TSN waveforms
- **Phase 2 Exit Criteria**
  - Demonstration of the integrated features using a scenario with relevant NSUT and multiple candidate TSN in an OT event involving hundreds of radios operating on a terrain similar to an existing range

Phase 3 Goals

- **Phase 3 Objectives: Advance the IPT3N prototype to TRL-6 and expand size to large-scale tests, up to thousand devices with LVC entities**
  - **UICM Scaling:** Scale up support calculations for networks with a thousand devices
  - **Mature Network Planning:** Incorporate constructive entities, heterogeneous TSN technologies, and scale of the integrated networks
  - **Dynamic Re-planning:** Develop capability that can support dynamic re-deployment of TSN assets during the live test
- **Phase 3 Exit Criteria**
  - Demo of one scenario scaled up to at least a 1000 devices, including a few hundred constructive elements
  - Demo of second scenario to illustrate the dynamic re-planning capability in which the NSUT maneuvers will diverge from those used for the initial plan