

Modeling and Simulation of Large-Scale Networks

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MITRE Sponsored Research



Problem

Complexity Factors

- **Heterogeneous networks**
 - “Wired” & “Wireless”
- **Multiple platform types**
 - Ground-based, air-based, and space-based platforms
- **Multiple radio device types**
 - E.g., WNW and SRW radios with KaSAT terminals
- **Diverse traffic types**
 - Data, voice, video, multi-media
- **Mobile Ad-Hoc Network (MANET) operations**

Result In

Large-Scale M&S

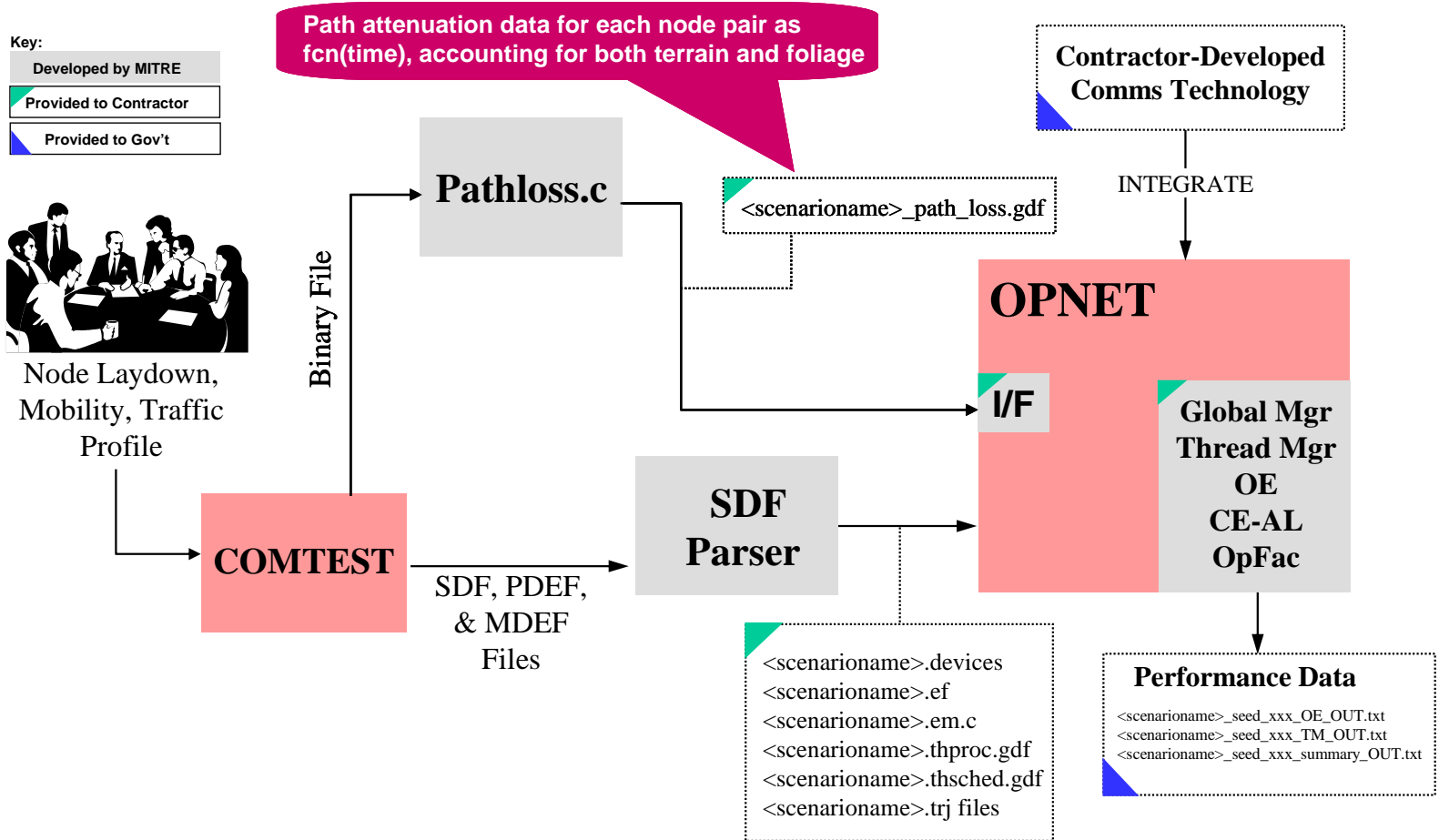
- From an M&S standpoint
 - The term “large scale” is best considered in terms of “# of events” versus “# of nodes”
- The “# of events” in a simulation is a function of # of nodes **PLUS.....**
 - Traffic profile
 - Offered load (insertion rate)
 - Traffic type (mix of voice, video, and data)
 - Delivery mechanism (unicast or multi-cast)
 - Degree of “wireless” ops
 - Fidelity of the protocol models
 - Amount of mobility
 - Other factors

Problem: Excessive run-time and memory footprint

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Background: M&S Environment



- **Single** network (e.g., JTRS)
- **Single** radio device type (e.g., WNW)
- **100+** nodes
- **High run-times and memory footprint**

Objective

- Develop & evaluate methods to **improve run-time and memory footprint performance** for “complex, large-scale” networks
 - 1000s of nodes
 - Heterogeneous (wired and wireless)
 - Diverse traffic profile (Data, voice, video, multi-media)
 - Mobile Ad-Hoc Network (MANET) operations
- **Quantify** achievable **results** using the **MSE** and **EMAST** capabilities

Activities

Develop/quantify the baseline performance

- Develop **baseline scenario** to investigate
 - Based on 114-node “Balkan” scenario generated in support of earlier efforts
- Develop **baseline node model** to apply
 - 802.11, OLSR, PIM-SM
- Generate **baseline performance data**
 - Use MSE
 - Quantify run time and memory footprint data
 - Determine sensitivity of these to various scenario parameters such as traffic load and mobility

Activities (Concluded)

Evaluate low-risk/moderate payoff techniques

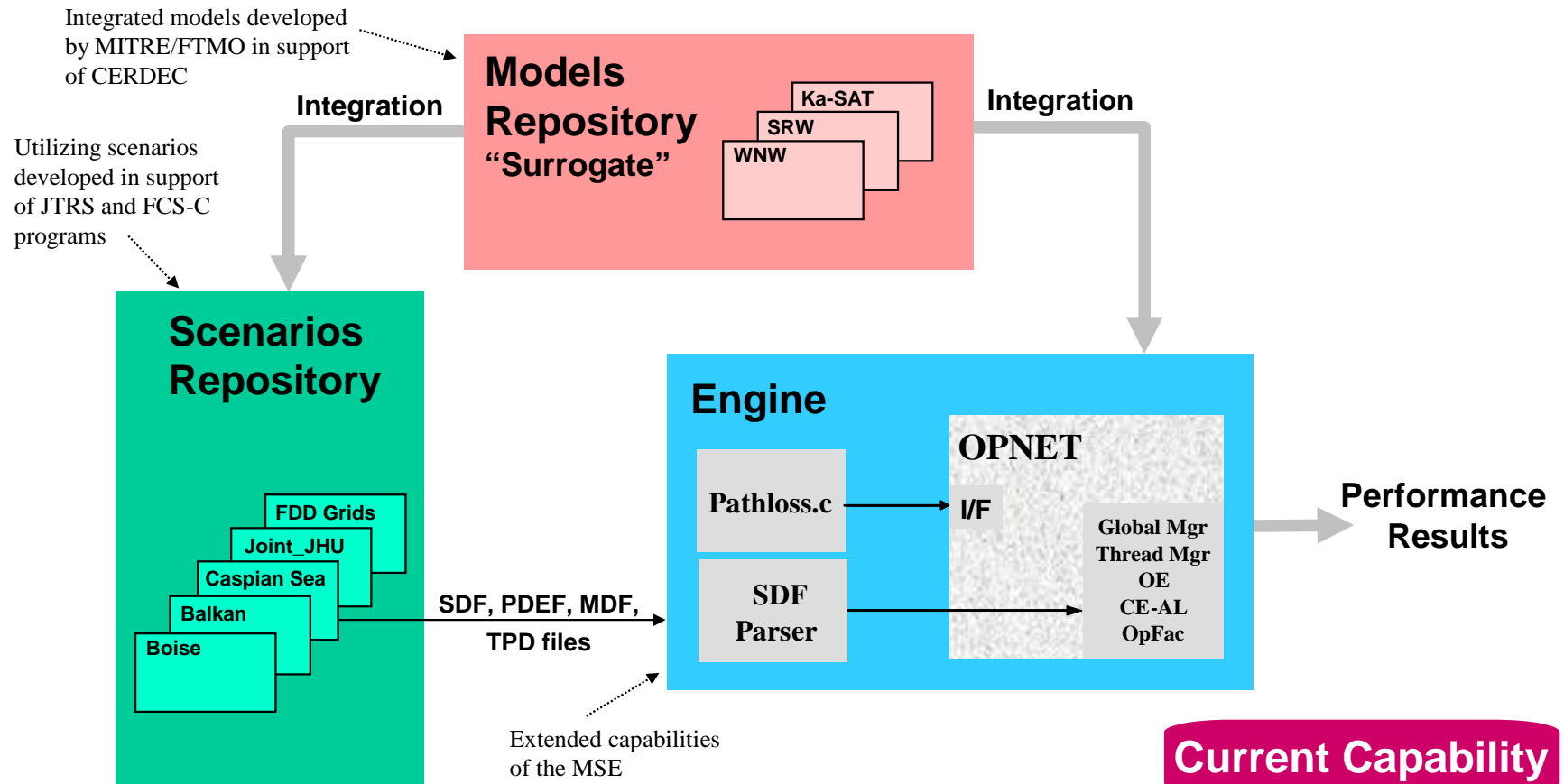
- Identify/quantify the impact of process improvements
 - Similar to off-line calculation of path loss matrix
- Make more efficient use of existing techniques already supported by OPNET

Evaluate high-risk/potentially high-payoff techniques

- Investigate/quantify the improvements attainable through parallel processing
- Investigate/quantify the improvements attainable by using co-simulation techniques

Incorporate findings into MSE

Highlight: End-to-End M&S Testbed **EMAST**



- **Multiple networks** (e.g., JTRS and WIN-T)
- **Multiple radio device types** (e.g., WNW & SRW)
- **100s of nodes**
- **High run-times and memory footprint**

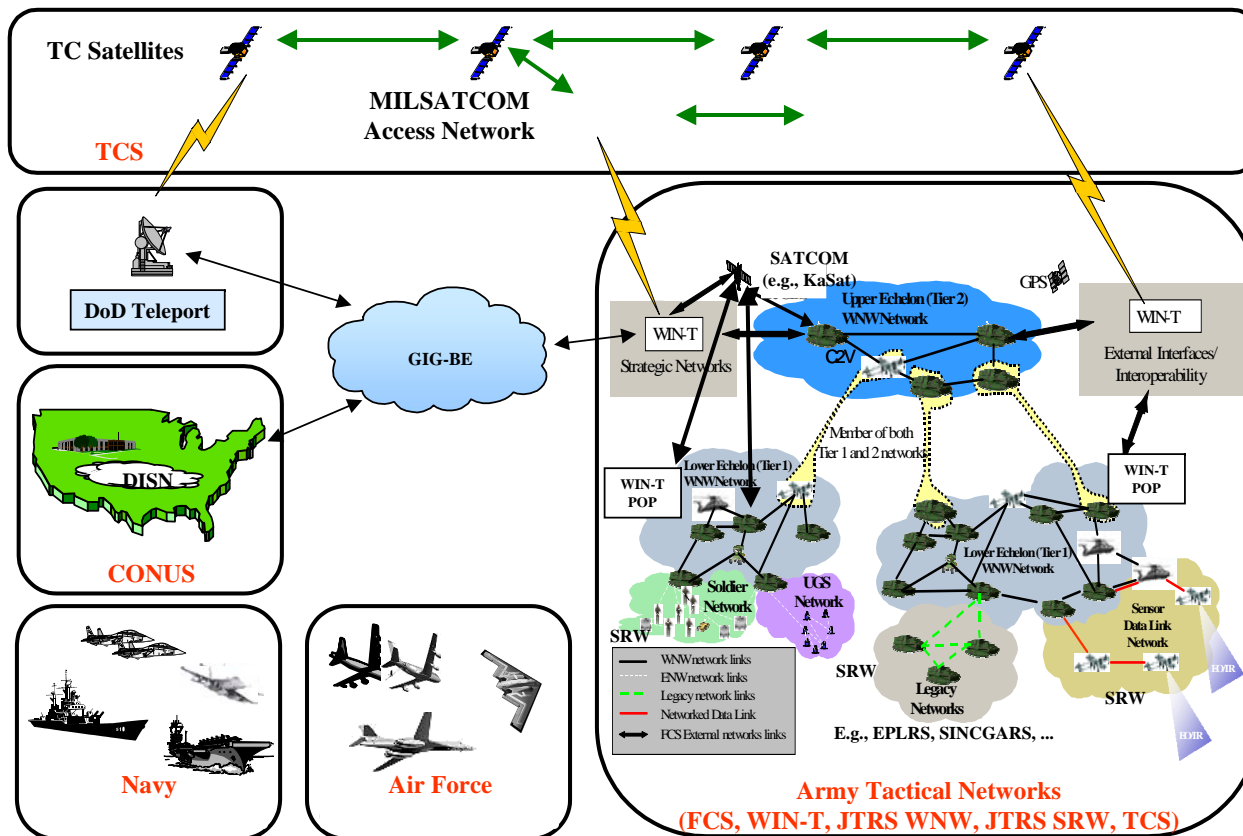
Impact

- The result of this research effort will be the **development** and **demonstration** of an M&S testbed
 - State-of-the-art (applies results of cutting-edge M&S research)
 - Unique (no one else is developing such a capability)
 - Large-scale networks (up to 1000s of nodes)
 - Detailed performance analysis (packet/IER/thread level)
 - Flexible (can address full range of questions related to DoD Transport vision)
- With this testbed, MITRE will be **the leader** in the area of **performance M&S** for DoD comms networks
 - Will allow us to help DoD design and evaluate evolving DoD network-centric architectures

This capability is needed in order for the DoD to develop a **“credible” Transport Vision.**

Future Plans

- Improve the communications network performance of large-scale networks via modeling and simulation by



incorporating the MSR findings into EMAST to support 1000s of nodes with reasonable run times and memory footprints