REAL-TIME SIMULATION OF NETWORK CENTRIC WARFARE

CES accurately and dynamically simulates end-to-end performance of a mobile tactical wireless network in real-time. CES provides virtual and constructive simulation of battalion and brigade-sized networks.

The tactical communications infrastructure of Army Brigade Combat Team Modernization (BCTM) will be built on mobile wireless networks. The warfighter at every echelon, from brigade to squad, will be connected to sensor data and communications relays enabling battlespace situational awareness. The performance of such networks is substantially impacted by a number of factors including traffic load, waveform design, mobility, terrain, cyber warfare, and environmental effects that might cause drastic changes in link capacity, available bandwidth, latency, and packet loss rates.

Communications Effects Server (CES) for BCTM is GOTS developed under direction of the PEO Integration (PEO I), Modeling and Simulation Office. CES simulates communications of the BCTM network, and enables testing and evaluation of the network in large-scale, real-world like simulations. This reduces design errors in the early stages and enables optimization during later stages. It enables the network technology to mature from research and development to deployment much faster and at a much lower cost. CES enables users to visualize and analyze how the network will perform, in software, before depending on it. CES is used by:

Planners, Analysts and Warfighters
- Plan and visualize tactical networks
- Determine network equipment required to support missions and doctrines
- Analyze and optimize network performance
- Run "what-if" exercises under best-case to worst-case conditions
- View effectiveness of network in supporting missions
- Train warfighters on the network during testing and evaluation, before deployment

Network Experts and Engineers
- Design, simulate and optimize waveform performance and robustness
- Compare performance of multiple routing protocols for convergence time, overhead, and scalability of network size
- Tune parameters for best end-to-end QoS performance of voice, video, data
- Show effectiveness and feasibility of new technology for simulation-based acquisition (SBA)

Access to CES requires a Distribution Agreement (DA) and a government sponsor. For more information about CES contact us by email at cesinfo@scalable-networks.com.

CES performance for a 30 minute simulation of a 3000 node network with 1.2 Mbps traffic load using NCW, WNW, SINCGARS and EPLRS models on an 8 node (16 processor) Linux cluster system.

Speed and Scalability
Testing small networks, of 10-20 radios, is easy with testbeds or other simulators, but larger networks are challenging due to their complexity. CES is built on the parallel simulation engine of QualNet, and takes advantage of the latest Intel and AMD multi-core processors and Linux clusters to simulate large networks. This also enables faster execution time and more simulation runs on COTS hardware. The simulation run-time of a scenario depends on a variety of factors like number of nodes, radio type, protocols, channel conditions, mobility and traffic load.
High-Fidelity Models of Waveforms

CES simulates communications on-the-move of a BCTM network: from tactical radios and UAV relays in the field to the backbone routers. Protocols at different layers in a device are modeled in detail to provide realism of the entire simulated network. Waveforms can be modeled at high to low levels of fidelity. CES uses the QualNet simulation engine for scalability and wireless channel effects. QualNet also provides a large library of standards-based protocols. CES can also use the EXata network emulator instead of QualNet to simulate the communications effects, run real applications over the emulated network and connect with real devices.

CES: Design, Visualize & Analyze

CES GUI allows users to design the entire wireless and wired network, customize radios, set waveform parameters, set mobility and add user applications. Mobility and position updates, application traffic and other behavior can also be sent to CES during the simulation through user customizable IP socket and HLA/DIS interfaces to SAF/CGF simulators.

When a asset or platform in the battlefield simulator moves or sends a radio message to others, CES is notified. CES, in real-time, analyzes the transmitter & receiver location, computes line-of-sight (LOS) or non-line of sight (NLOS) conditions, channel environment, antenna orientation, and waveform parameters to determine whether the message is delivered or lost. CES GUI provides 2D and 3D visualization of the network that can also be reviewed later without re-running the simulation.

Users can check individual radios, or analyze waveforms to determine packet delivery ratios, connectivity maps, ad-hoc routing overhead, and other measures of performance. Post-run statistics files and databases provide more comprehensive details of the entire network's performance.

Modeling of Communications Effects

Wireless communications is seriously impacted by a variety of channel and environmental factors such as Doppler Shift, terrain, mobility, interference, pathloss, fading, non-line of sight (NLOS), and weather, among others. CES uses QualNet to model these effects dynamically and determine how they impact waveform performance, routing and applications. This improves realism of the simulation and provides predictability of the network under various battlefield conditions.

Example CES Users

- Boeing Prime for BCTM
- PEO I Modeling and Simulation Office (MSO)
- JPEO JTRS Network Enterprise Domain (NED)
- Army ATEC OTC, Ft. Hood
- Army CDID, Ft. Gordon
- Army CERDEC
- SPAWAR Atlantic
- SAIC

System Requirements

- Microsoft Windows® OR Linux® (RedHat®, CentOS, SUSE®)
- 2 GB RAM, 1 GB hard disk space
- 256 MB discrete graphics card
- Intel® or AMD® Processors
- Parallel support with
  - Dual, quad-core or multi-core processors
  - Multiprocessors and Linux clusters with Ethernet or Infiniband® backplane

CES FEATURES

- QualNet or EXata Parallel Engine
- Scalability for Large Networks
- 2D, 3D GUI for Network Design

MODELS

CES Models:
- WNW, SRW
- NCW, HNW

Radios:
- JTRS GMR, WIN-T
- HMS, EPLRS
- SINCGARS

QualNet Models:
- IPv4, TCP, UDP
- PIM: SM and DM
- OSPFv2, OSPFv3
- BGP, Ethernet
- ZigBee, Battery
- Radio Energy
- Link11, Link16
- Urban Terrain

Ces simulating communications between blue force entities separated by terrain features. A UAV flying overhead serves as a relay and provides sensor data streams.