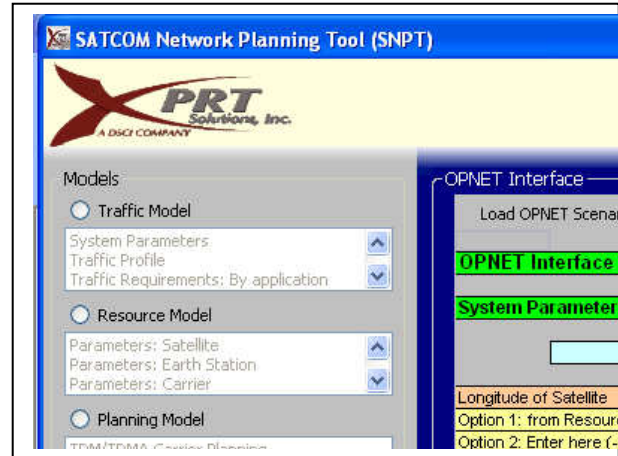


High Fidelity Modeling and Simulation of Commercial SATCOM Capability for the Planning and Decision Making Process

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PROBLEM STATEMENT

Deployment of SATCOM systems for modern warfighting missions and campaigns raises various problems in the systems design and planning. Navy needs to examine the performance of a broad range of deployment options with respect to maximum achievable data rates for a given set of SATCOM terminals. The effects of the SATCOM systems need to be examined in the context of a warfighting scenario. The following are the major challenges for establishing a high fidelity SATCOM performance analysis model to aid commercial SATCOM system design in support of the planning and decision making processes:

- Versatility of the warfighting model
Each warfighting mission needs to support a variety of communications connectivity, traffic pattern, and applications supportability parameters. For example, the required connectivity can be point-to-point, point-to-multipoint, or dynamically changing among the locations. Traffic can be equally distributed among different locations or concentrated on a hub location. Applications can include voice, video, file transfer, email, Internet access etc. Furthermore, the communications requirements may change over time during a mission. The SATCOM model must accommodate communications capabilities supporting such versatile mission requirements.
- Versatility of commercial SATCOM products
DoD procurement strategy includes use of Commercial Off The Shelf (COTS) products. The characteristics of SATCOM equipments supplied from various vendors can be very different. Sometimes even the basic design approaches may differ from various products. The SATCOM model should support features and characteristics of

various SATCOM products. To facilitate the supportability, the model needs to be linked to, and capable of maintaining a commercial database of applicable SATCOM products.

- Complexity of performance analysis for high fidelity model

Accurate, high fidelity SATCOM model will require complicated formulas and problem solving techniques to analyze signal transmission impairments such as inter-modulation due to satellite transponder nonlinearity, polarization distortion, signal attenuation due to rain, and interference from any adjacent satellites. These techniques cannot be developed in a short period of time. The model should use prior state-of-the-art techniques from ITU and other research communities involved with SATCOM.

- Terminal simulation in the context of a warfighting scenario, i.e. network modeling

Terminal simulation in terms of the capability as a communications networking element can provide a lot of necessary information to aid the decision making process. This, however, will help only one part of the problem. Another dimension of the problem is the network simulation part or putting the SATCOM terminal information in the context of the warfighting scenario. A specialized simulation tool is needed to assess each SATCOM terminal in terms of bandwidth performance, power amplifier, antenna, modem parameters, etc. In addition, the warfighting scenario needs to be modeled using a discrete event simulation tool such as OPNET with a rich library of SATCOM terminal capabilities that need to be evaluated in a warfighting network stressed under an actual scenario.

WHO CAN BENEFIT?

Commercial wide-band SATCOM systems have been extensively used by the Department Of Navy (DON) and the Department Of Defense (DOD) in general. Navy's Advanced Digital Network System (ADNS) is a technical thrust for integrating the communications assets including shore and ship SATCOM terminals. The toolset will be instrumental to planning the network and evaluate the performances. In particular, the toolset enables configuring an integrated simulation scenario combining existing models with the SATCOM network model.

Army launched an ambitious fielding of Joint Network Node (JNN) that responded to a 2004 urgent needs statement from U.S. Central Command to provide communications capabilities better than the current Mobile Subscriber Equipment in Army units then. The JNN takes advantage of satellite access and up-to-date commercial Internet technology to increase bandwidth throughout the division and improve the reliability and agility of the communications network. The communications bandwidth and connectivity requirements are met with commercial-off-the-shelf-based SATCOM equipment. The modeling and simulation toolset developed by XPRT Solutions can support the needs to evaluate the performances of such a SATCOM network for various deployment scenarios.

Marine has WIN-X program, which uses commercial SATCOM system, in line with the JNN operational concept. The toolset can support planning and evaluating the network.

For commercial SATCOM, the toolset enables to assess the bandwidth performance of given sets of SATCOM terminals, or terminal fielding plans, within different SATCOM resource allocation scenarios. It also enables to simulate the performance of a variety of SATCOM terminals and satellite transponders under a number of different constraints.

BASELINE TECHNOLOGY

Navy's communications engineering might have worked with a range of satellite operators and SATCOM product manufactures to investigate the performance of various SATCOM network deployment options. Navy might have developed discrete event simulation models to represent such SATCOM networks and evaluate the network performances. In general, such a technical effort requires a lot of time and engineering resource in order to achieve the fidelity and accuracy to support the objective. Multiple simulation models would need to be developed in order to represent and evaluate different network architectures as well as different SATCOM access and resource management schemes. The toolset developed by XPRT will enable significant saving of engineering resources while it will provide high fidelity and accurate results in a considerably short period of time.

TECHNOLOGY DESCRIPTION

As depicted in Figure A, the toolset includes SATCOM Network Planning Tool (SNPT) and OPNET Simulation Model applicable to various SATCOM networks. SNPT is a Windows® Applications Software Package consisting of models representing and analyzing SATCOM traffic, resource, and the plan. The OPNET Models consist of node process models representing SATCOM networking components including terminals, resource management, traffic generator, TDMA slot allocation, etc.

The following are the list of the major toolset features and the associated impact:

- Accurate SATCOM planning and analysis models
 - SNPT supports a degree of technical rigor comparable to typical commercial SATCOM planning & operations engineering to be given by satellite operators and SATCOM product
 - For users with moderate knowledge on SATCOM, SNPT enables to accurately evaluate various deployment options and SATCOM products selections based on the technical details.
- Capability to automatically generate a high-fidelity discrete event simulation scenario in accordance with SATCOM system planned by the SNPT
 - OPNET model building and configuration typically needs a lot of time and effort. SNPT enables easily configuring and automatically generating OPNET scenarios for a wide range of SATCOM networks. This automation of scenario also reduces the possibility of introducing human errors while configuring the OPNET model parameters.
 - The toolset is applicable to a wide range of tactical and commercial SATCOM planning & operation. It is applicable to representing SATCOM products including SCPC, TDM, TDMA, and Joint IP Modem (JIPM).

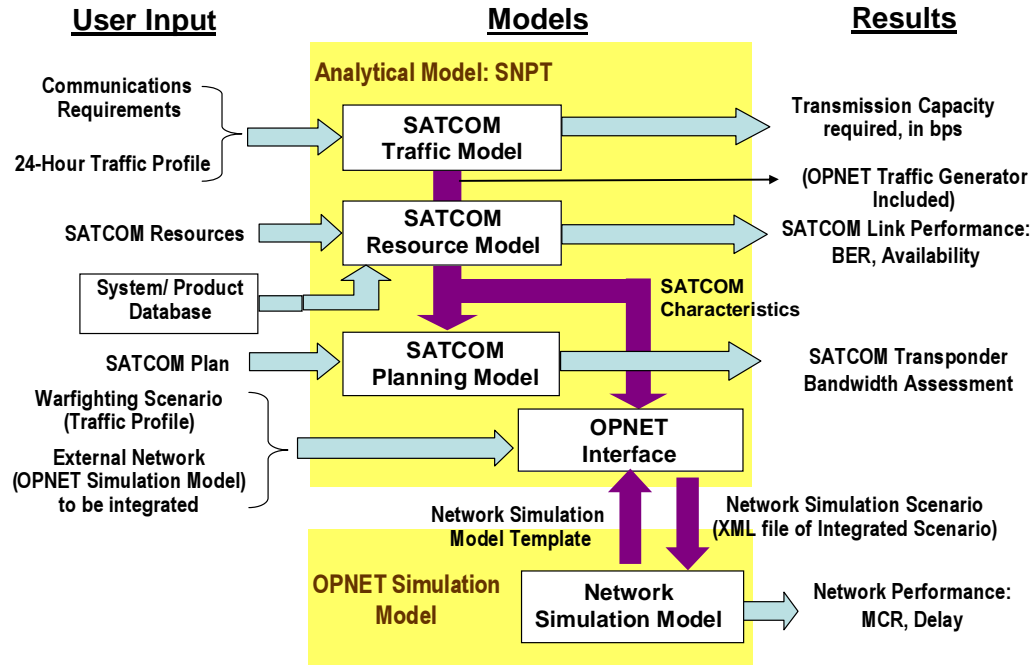


Figure A: Functional Block Diagram of SATCOM Network Planning Toolset

- Capability to integrate other OPNET network models
 - SNPT enables integrating existing OPNET network simulation models. Thus it enables to establish a scenario consisting of the SATCOM network configured by SNPT and any OPNET network model established separately.
 - This capability also enables user to establish a network component separately and add to the SATCOM network model. For example, user can integrate a SATCOM network with a traffic generator model separately established using OPNET Modeler.
- Implementing SATCOM transmission model to execute a discrete event simulation efficiently
 - OPNET pipeline stages are the standard software solutions for building a model representing radio transmission such as for SATCOM. However, such a method is inefficient as it requires a large amount of processing power to accurately represent the effect of the SATCOM transmission environment on each packet transfer event. The simulation model adopt a practical approach to model the transmission characteristics efficiently, while accurately representing SATCOM channel effects on practical system operation.
 - It enables to support simulating a network with large number of SATCOM terminals within a reasonable run-time.
- SATCOM Systems and Products database
 - SNPT consists of databases containing the characteristics of various SATCOM systems and products. It enables user to apply accurate parameter values by

- selecting the networking components including SATCOM terminals, satellite transponders, and the earth stations.
- Capability to facilitate planning a very large network by grouping remote terminals
 - SNPT has a utility to expand a set of attributes and parameters, and modify to configure a large number of remote SATCOM terminals, for example, automatically generating a range of parameters such as IP addresses.

CURRENT STATE OF DEVELOPMENT

Major features and capabilities of the SNPT and the OPNET model have been completed and under review by Navy SPAWAR staff, who will be among users of the toolset. The key functional software of the toolset is available for users. Current TRL is 4 and the level is expected to go to 5 in several months. In preparation for the readiness to Navy's operation, the following tasks have been planned:

- To get feedback from potential users and refine the toolset accordingly
- To use the toolset for Navy and Joint Forces training, exercise, operation, or war-gaming; evaluating and enhancing the features and capabilities of the toolset
- To support integration or interface with other modeling and simulation tools

REFERENCES

Jeff Monroe at (858) 792-8904, from Metron Scientific Solutions

Metron has been examining the toolset for developing interface with the Naval Simulation System (NSS).

ABOUT THE COMPANY

XPRT Solutions Inc.–A subsidiary of D&S Consultants Inc. (DSCI)–is an innovative high technology small business based in Eatontown, New Jersey. XPRT Solutions' primary business is to provide Systems Engineering (SE) and Modeling & Simulation (M&S) hardware and software products and services to various organizations in the Department of Defense (DoD). XPRT Solutions possesses extensive operational knowledge of terrestrial wireless and satellite communications systems; in-depth analytical capabilities; extensive military communications M&S experience of existing tactical waveforms such as: EPLRS, SINCGARS, UHF SATCOM, and Link 16 as well as future waveforms such as Wideband Networking Waveform (WNW) of JTRS GMR, Soldier Radio Waveform (SRW), and the Warfighter Information Network Tactical (WIN-T) including the High-band Networking Waveform (HNW) and Net-Centric Waveform (NCW).