

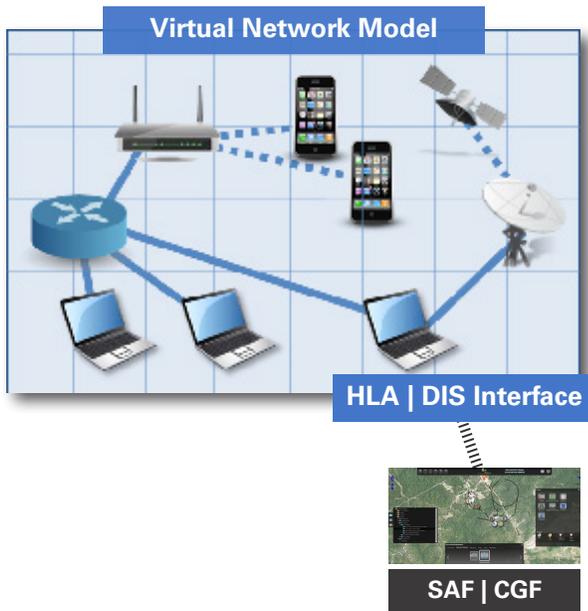
QualNet®

Network modeling software for: Development Analysis

QualNet® software (QualNet) is a tool for scientists, engineers and network planners to create virtual models of all types of data, voice and video networks. The models are comprised of **nodes** representing the network elements and endpoints (routers, switches, access points, ground stations, satellites, mobile phones, radios, sensors, PCs, servers, firewalls and other security equipment) and the **links** that interconnect the nodes (LAN segments, internet circuits, radio transmissions, Wi-Fi signals, LTE connections, etc.).

The virtual network models are used by QualNet to **simulate the behavior of the network** under a wide variety of user-defined operating scenarios and application traffic patterns at **faster-than-real-time speeds**. Simulations can be federated with other simulation tools via HLA, DIS and socket interfaces.

QualNet virtual network models deliver **real-world fidelity, accuracy and precision**. A comprehensive **statistics database** is generated by each simulation for post-processing, analysis and reporting.



QualNet Key Capabilities

- Scalability to thousands of nodes enables more sophisticated design and analysis
- Faster-than-real-time simulation optimizes productivity
- High-fidelity models deliver more accurate results
- Cost-effective “lab-based risk reduction” network simulation technology provides solutions to mission-critical, business-critical problems

The QualNet® Network Modeling Platform is used for:

- Research on protocol and waveform technology
- Network design and architecture optimization
- Capacity prediction
- RF interference and propagation modeling
- Mission planning
- Early-stage device design comparisons
- Applications performance analysis
- Disaster response preparation
- Hardware and software development
- Communications problem identification

Highly-realistic “virtual” models of all types of data, voice and video networks are utilized by the high-performance simulator to answer a wide range of “what if” operational planning and problem solving scenarios, such as:

- Will the network design provide the necessary performance and application response time?
- What happens if key links get congested?
- Why are mobile systems losing connectivity in the rear of the warehouse?
- Can this radio configuration provide sufficient coverage in the expected terrain?

QualNet supports scientists and engineers who need to Make Networks Work.

QualNet® Overview

QualNet® software (QualNet) is a “platform” used to design and analyze networks, networked systems and distributed applications behavior. Virtual models of all types of network architectures and information flows are built on the platform using libraries of pre-defined and user-developed component models.

There are two versions of the platform:

QualNet Developer

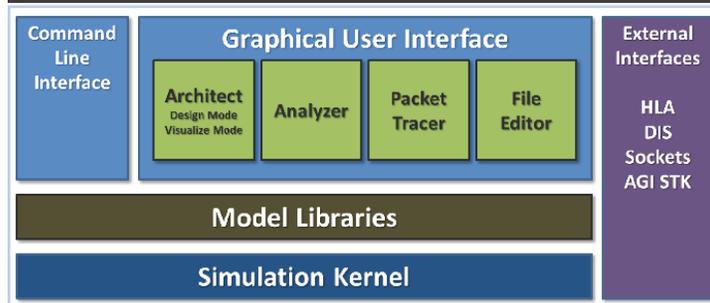
- **Design Mode:** Create virtual network models (and create new protocol and waveform component models)
- **Visualize Mode:** Define and execute operational scenarios in simulation
- **Analyzer:** Process results and generate reports

QualNet Run-Time

- **Visualize Mode:** Define and execute operational scenarios in simulation
- **Analyzer:** Process results and generate reports

Virtual network models created by network engineers with the QualNet Developer platform can be leveraged by users of the Run-Time platform for ongoing analysis and experimentation.

QualNet Platform Architecture



Virtual network models and simulation scenarios are created and executed primarily via a feature-rich visual development environment lets users quickly quickly set up models, code protocols if necessary, and then run scenarios that present real-time statistics and helpful packet-level debugging insight. There is also a command line interface for multi-run experimentation control.

QualNet can be federated (i.e. integrated) seamlessly with other simulation systems (such as kinetic battlefield simulators) via an optional Federation Interfaces library.

QualNet takes full advantage of the multi-threading capabilities of multi-core, multi-processor, cluster and 64-bit processor systems, **supporting models with thousands of network nodes**. The software runs on both MS Windows and Linux operating systems with single-user and server-based licensing options.

Libraries

Any network device, protocol, configuration, effect, or technology can be modeled in SCALABLE simulation, but starting from scratch can be an involved exercise. To dramatically speed up the process, SCALABLE has developed a family of libraries containing models of the typical network component building blocks. They have been engineered and verified to accurately represent specific behavior.

QualNet platforms come with a default set of libraries of component models. Licenses for optional model libraries may be added.

Each of the available libraries is also available in source code form (C/C++) in the SCALABLE Developer’s Kit. They conform to a flexible OSI architecture, allowing engineers to easily build custom protocol stacks, waveforms, devices and interfaces.

The standard “classes” of components which influence a network model (except for Images, which are for visual clarity) include:

- **Equipment:** the various hardware components
- **Human-in-the-Loop (HITL):** commands that control various elements during scenario execution
- **Images:** icons and other components that graphically depict elements and behavior
- **Interfaces:** protocols and mechanisms that enable interaction between a simulator and other simulators or external systems
- **Protocols:** the network protocols and waveforms that enable equipment to communicate
- **Terrain:** the physical terrain over which the communications takes place (DEM, DTED & Urban)
- **Weather:** descriptions of different weather behavior and its impact on communications

Examples of elements for protocols and waveforms in various libraries include Wi-Fi, sensor networks, cellular, MANET, WiMAX, and high-latency datalinks. Any of these elements can be included in your specific modeling exercise to quickly create detailed scenarios.

Affiliations



Standard and Optional Libraries

The QualNet platform has three libraries of component models included:

- Developer
- Wireless
- Multimedia and Enterprise

The libraries which are available as options include:

- Advanced Wireless
- Cellular
- Federation Interfaces
- LTE
- Military Radios [1]
- Sensor Networks
- TIREM Propagation Interface [2]
- UMTS (3G Cellular)
- Urban Propagation

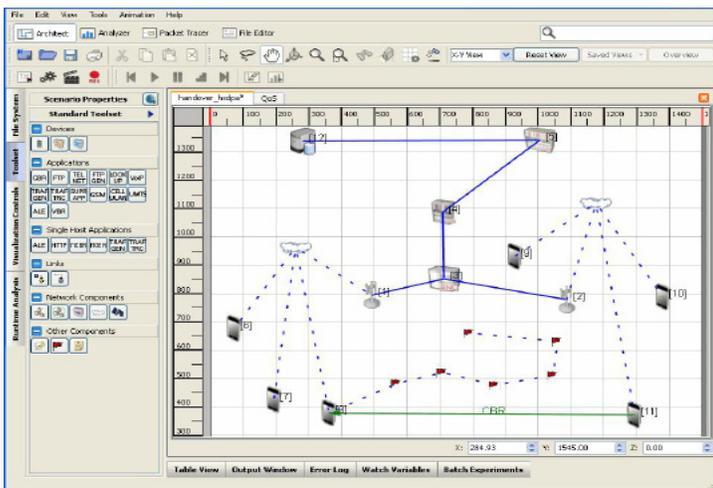
- [1] These libraries are subject to export restriction under the International Traffic in Arms Regulations (ITAR) 22 CFR 120-130. International sales of these modules require authorization from the US Department of State.
- [2] Requires the licensing of additional software from Alion Science and Technology Corporation.

Design Mode

Design Mode is used to **create virtual network models** via an intuitive point-and-click drag-and-drop graphical user interface.

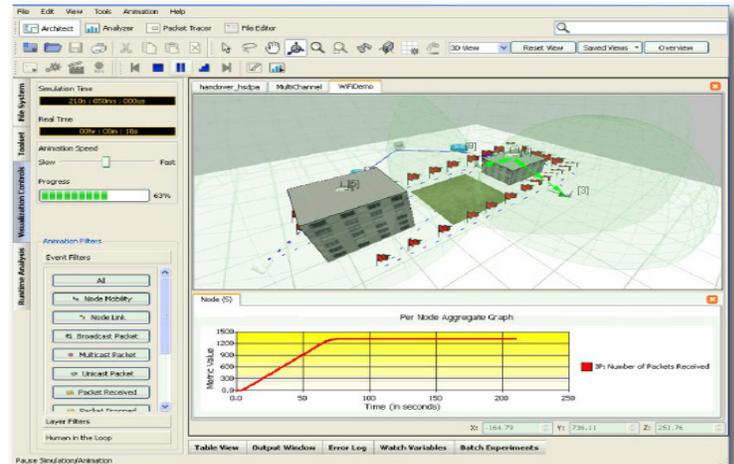
Nodes representing various types of network elements and endpoints are placed on a canvas. Each node is configured with wired or wireless network interfaces and communications characteristics. Nodes are then interconnected with the appropriate network links.

Virtual network models can include subnets, mobility patterns of wireless users, other functional parameters of network nodes, and physical characteristics such as terrain and structures. A wide array of different application layer traffic and services that run on the network can be applied.



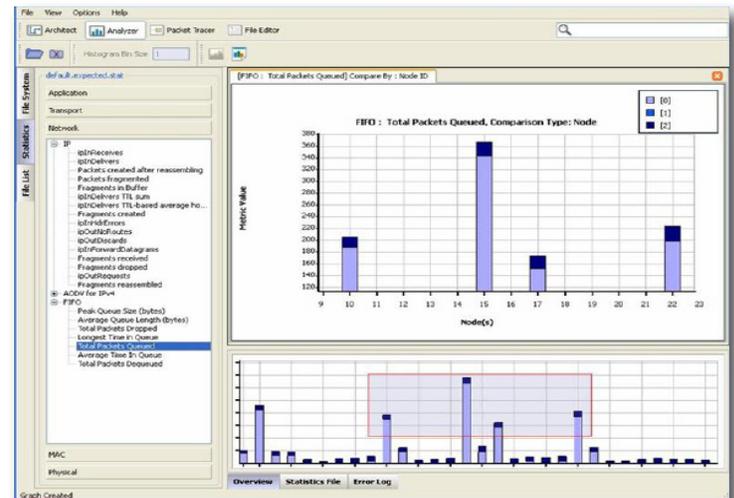
Visualize Mode

Visualize Mode gives the user opportunities to perform in-depth visualization and analysis of a network scenario created in Design Mode. As simulations are running, users can watch packets at various layers flow through the network and view dynamic graphs of critical performance metrics. Real-time statistics are also an option, where users can view dynamic graphs while a network scenario simulation is running.



Analyzer

Analyzer is a statistical graphing tool that displays hundreds of metrics. You can customize the graph display. All statistics are exportable to spreadsheets in CSV format.



Statistics Database (Stats DB)

QualNet provides for the generation of numerous statistics tables in a statistics database. These tables contain information in much finer detail than in the standard statistics file. You can specify which tables are generated and can configure the information contained in each table. QualNet supports SQLite and MySQL 5.0 for the Stats DB.

Technical Partnerships

QualNet can be integrated with a wide range of third-party simulation and analysis tools, such as:

- Analytical Graphics, Inc. (AGI) System Toolkit (STK) for advanced mobility and satellite behavior models
- VT MAK VR-Forces for interaction with computer generated forces models
- Presagis STAGE for interaction with computer generated forces models

Scenario Player Run-Time

Scenario configuration files created in QualNet are fully compatible with the optional Scenario Player Run-Time application. Player provides very high quality 3D visuals of the network elements and their interactions during a scenario. The display is suitable for presentation to senior managers who need to quickly understand scenario behavior.



Built for Speed

Real-time Simulation. Models can speed up and scale on parallel computing environments. One example: a cluster of 16 dual 2GHz Opteron systems connected by an Infiniband switch achieved real-time speed for 3,500 nodes*.

* This scenario was designed for optimum performance in terms of traffic, mobility, and partitioning.

System Requirements

CPU

- 64-bit (x86-64 compatible) processor

OPERATING SYSTEMS

Windows

- Windows 10 Home Premium and Professional 64-bit editions

Linux

- CentOS 7.6
- Red Hat Enterprise Linux 6.7
- Ubuntu 16.04 LTS and 18.0 LTS

MEMORY

- 2 GB free for LAN-size simulations with GUI
- 4 GB free for a large network (1000+ nodes)

DISK SPACE

- 2 GB free disk space (minimum)

VIDEO

- 128 MB graphics card with hardware 3D acceleration (minimum)
- 1680 x 1050 or better screen resolution

COMPILERS

If you intend to develop custom protocol, equipment or other types of element models, you will need to compile the source code into the platform using a C++ compiler.

Windows

- Microsoft Visual Studio 2017
- Microsoft Visual Studio Community 2017 for Windows Desktop

Linux

The expat development library is needed to compile QualNet on Linux systems. Install the expat development library from the Linux installation media or download site.

Distribution	glibc Version	gcc Version
CentOS 7.6	2.17	4.8
Red Hat Enterprise Linux 7.6	2.17	4.8
Ubuntu 16.04 LTS	2.23	5.0
Ubuntu 18.04 LTS	2.27	7.0