QualNet® & EXata® Integration with Systems Tool Kit

Add Sophisticated Mobility and Radio Antenna Behavior to Virtual Network Models

Systems Tool Kit (STK) from Analytical Graphics, Inc. (AGI) is a modeling environment used to simulate complex systems (such as aircraft, satellites, ground vehicles and their sensors) and evaluate their performance using a **time-dynamic, physics-based geometry engine**.

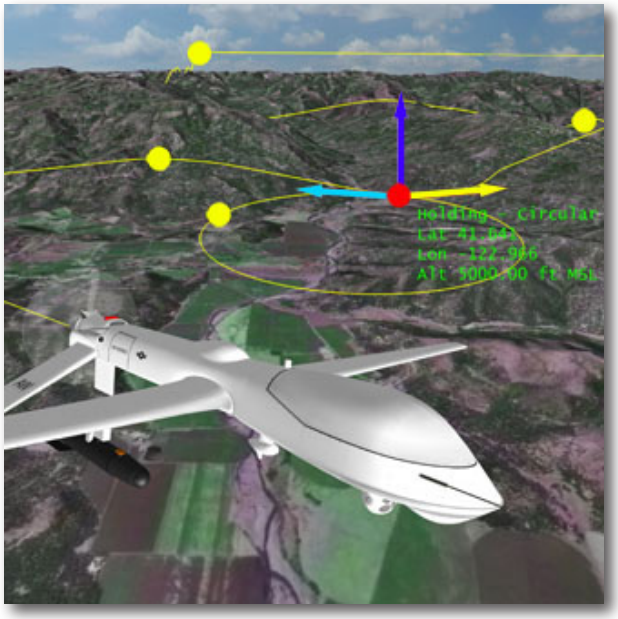
STK software addresses dynamic analysis problems, including:

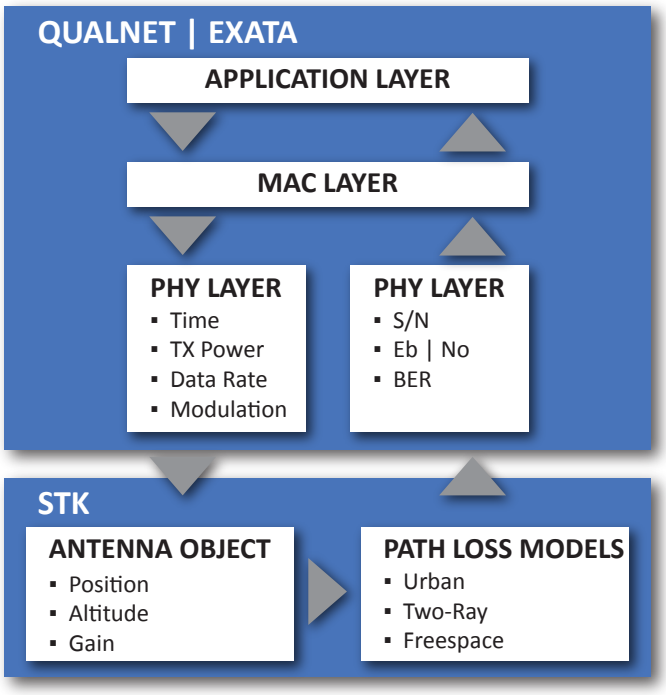
- Where are assets and how are they oriented?
- What can the assets "see" and what can "see" them?

Integrating STK with the QualNet® or EXata® network simulation platforms extends virtual network models to include:

- **Complex mobility of nodes in 3D space**
- **High fidelity modelling of radio signal propagation and path loss due to antenna orientation and movement**

The geo-environmental capabilities of STK allow for highly realistic advanced mission scenarios.





INTEGRATION WORKFLOW

For each time increment in a scenario simulation:

- A QualNet | EXata entity passes a transmit request down the protocol stack from the Applications layer through the MAC layer to the PHY layer, handing off parameters
  - Time
  - Transmit power
  - Data rate
  - Modulation
- The STK antenna model incorporates position, altitude and gain to compute path loss, and passes parameters back to the receiver
  - Signal-to-Noise ratio
  - Eb|No (energy per bit to noise power spectral density ratio)
  - Bit error rate

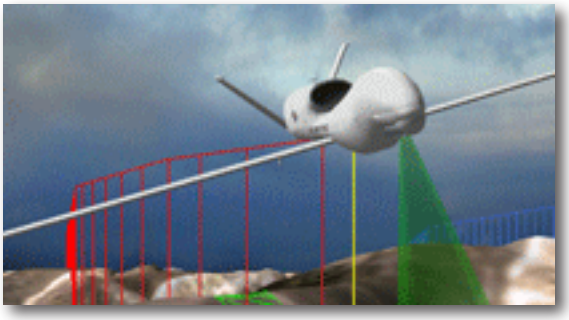
SCALABLE + AGI Integration Offers:

- Better prediction of performance in the operational environment by establishing highly realistic mission scenarios
- Increased confidence and productivity during conceptual design, requirements validation, field test planning and analysis, and operations
- Tailored design and operations of the communication system specific to the needs of each mission
- Improved levels of fidelity in the analysis of mobile communications

Functional Comparison: QualNet | EXata & STK

	QualNet / EXata	STK
Node Mobility & Orientation	▪ File ▪ Group Mobility ▪ Pedestrian ▪ Waypoint ▪ Random ▪ User Specified Orientation (Azimuth and Elevation)	High fidelity modeling of the performance and dynamics of: ▪ Aircraft ▪ Missiles ▪ Satellites ▪ Other Mobile Nodes
Antenna Model	▪ Omnidirectional ▪ Switched Beam ▪ Steerable Beam ▪ User Defined	▪ Pre-defined Models (dipole, hemi, etc.) ▪ User-defined ▪ Dynamic Pointing Coupled to Node Motion & Orientation
RF Channel Model	▪ Free Space ▪ Two-Ray ▪ ITM ▪ TIREM ▪ Statistical Urban ▪ Empirical Urban ▪ Suburban	▪ Free Space ▪ Two-Ray ▪ TIREM 3.20 ▪ Deterministic Urban ▪ 7 ITU atmospheric models ▪ Crane 1985 ▪ Custom Scripts
Network Simulation	Full Network Protocol Stack and Network Device Simulation	Physical Layer Connectivity of Wireless and Wired Networks
Communications Performance	▪ Packet Latency ▪ Drops ▪ Tracing ▪ 41 Network Statistics Sets Across Entire Protocol Stack	High Fidelity RF Link Availability and Quality ▪ Signal-to-Noise Ratio ▪ Eb/No ▪ Bit Error Rates
Mission Model	Communications only	Integrated Modeling of Communications, Vehicles, and Other Non-Communications Assets
Earth Model	Flat or Spherical	Oblate Spheroid
Celestial Modeling	-NA-	Moon, Planet, Stars
Other	▪ Radio Energy/Battery Model ▪ Network Security Models	▪ Full Motion 3D Animation ▪ Integrated Geospatial Data Visualization ▪ Photo-realistic 3D Mobile Node Models

The integration between QualNet | EXata and STK is a true co-simulation. SCALABLE and AGI have each added specific integration functionality to their respective products that ships standard "out of the box".



Application Example

Mission Plan Description

- A convoy is travelling in theatre
- Vehicles inter-communicate via radios
- One vehicle has a communications link to a UAV in the region which acts as a radio relay to a remote HQ

Issue

- **Does all data get to HQ?**

Co-simulation Solution

STK Contributions

- Mission scenario construction
- UAV platform performance
- UAV route design
- Communications link availability

QualNet Contributions

- Network protocol simulation
- Application traffic simulation
- Data latency, dropped packets, etc.