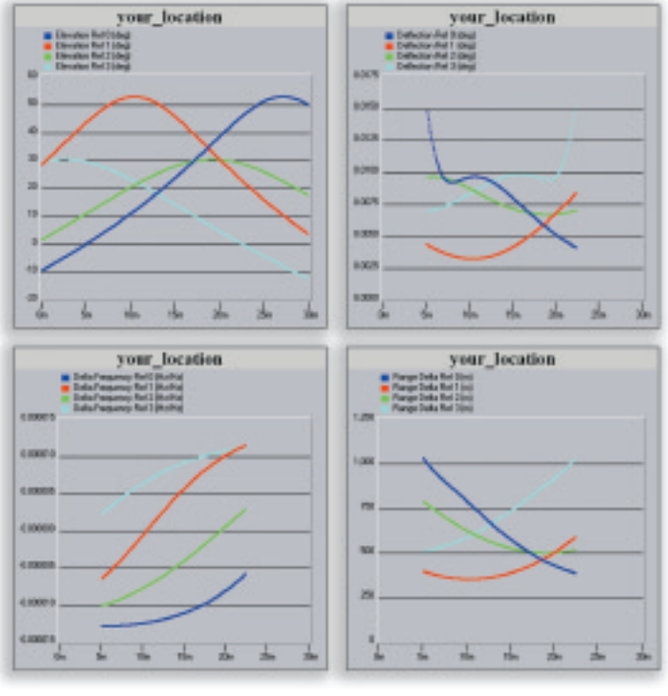
MODEL OUTPUT STATISTICS

The GLM produces the following statistical measurements each time the process is invoked:

- Position (computed)
- Expected Position Error (3-D ellipse)
- Velocity (computed)
- Expected Velocity Error
- Position Dilution of Precision (PDOP)
- Range/pseudorange data (for TOA technique)
- Timing Data (for TDOA technique)
- Geometric Data (for AOA technique)

Additionally, an optional log file may be generated that provides details associated with changing node positions, iterative position refinements, intermediate matrix algebra values, and specific geometry warnings.



PRICING

Individual GLM licenses.....$9,000
Additional simultaneous purchases.....$6,000

GLM licenses include 90 days maintenance and support. Evaluation versions do not include source code.

Customized training, model development, and consulting support are also available.

CONTACT INFORMATION

To purchase or evaluate the GLM, please contact:

Highland Systems, Inc.

679 E. 2nd Ave. • Suite 10 • Durango, CO 81301
Phone: 888.385.0482 • FAX: 888.385.0483
E-mail: info@HighSys.com
Web: www.HighSys.com

INTELLECTUAL PROPERTY

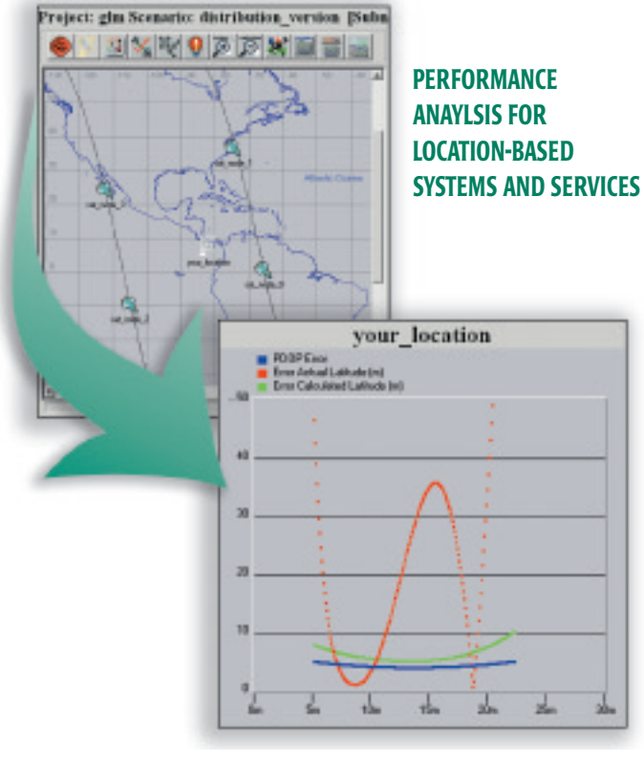
Portions of the GLM have been developed in collaboration with:

eta ergon technology associates

Some implementations of GLM-based techniques may be subject to intellectual property licensing requirements. For details, please contact Dr. Neil C. Schoen at: ncschoen@ergoncorp.com

Highland Systems, Inc.

GEO-LOCATION MODULE for OPNET™



PERFORMANCE ANAYLSIS FOR LOCATION-BASED SYSTEMS AND SERVICES

GEO-LOCATION MODULE OVERVIEW

Location based systems and services represent explosive growth opportunities over the near term. Pertinent infrastructures are currently being deployed and the technologies necessary to meet the demand for consumer, civil, and military applications are becoming commercially viable.

Highland Systems Geo-location Module (GLM) has been developed for use with the OPNET™ suite of simulation tools in order to:

- Facilitate design verification.
- Quantify systems performance expectations.
- Accelerate design decisions and trade studies.
- Decrease implementation risk.
- Speed time-to-market.

TECHNIQUES & ANALYSIS

Generally, computing the location of any entity requires the solution of four equations in four unknowns: 3 spatial dimensions and time. The GLM establishes an appropriate system of equations depending on the input data available and uses an iterative least-squares approximation to solve this system of equations.

The flexible GLM procedure (implemented in an OPNET™ process model) can be used to model the behavior and performance of systems based on:

- Time of Arrival (TOA)
- Time Difference of Arrival (TDOA)
- Angle of Arrival (AOA)
- Doppler Shift

Input error perturbations can be accounted for as can phase shifts due to atmospheric and ionospheric refractive effects.

APPLICATIONS

Any system design incorporating geolocation computations may leverage GLM functionality. Specific target applications include:

Commercial

- Personal Location Services (PLS)
- Cellular Telephones (E911 Mandate)
- Materiel Management
- Location-sensitive Wireless Internet

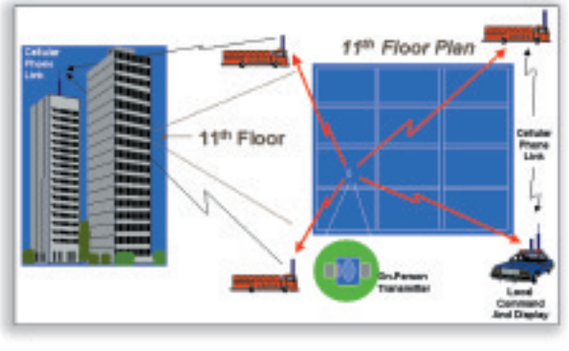
Government

- Transportation: Common Carriers
- Criminal Justice: Personnel Tracking
- Intelligent Vehicle/Highway Systems
- High-precision Emergency Location

Military

- Situational Awareness
- Remote Sensors
- Data Fusion

Because of its theoretical approach and parameterized inputs, the GLM is appropriate for terrestrial, airborne, space-based, and hybrid systems of nearly any scope.



Example: High-precision personnel location based on TOA technique with ad hoc reference points.

MODEL FEATURES

The GLM is implemented as a standard OPNET™ process model and supports:

- Model Attribute Input Parameters
- Open Source Code
- Symbolic Constants Header File
- Standard Output Statistic Probes

The primary logic is encoded in a function call library, supporting modularity and re-use.

MODEL INPUT PARAMETERS

The GLM Process model includes user input for process invocation frequency, atmospheric and ionospheric parameters, launch angle cutoff (minimum elevation angle) and iteration convergence parameters. Estimated input errors can be set for carrier frequency, transceiver clock, node position and node velocity. The actual 3-D position and velocity of the reference nodes are obtained from the standard OPNET™ model constructs.

POTENTIAL EXTENSIONS

As a modular modeling component, it is anticipated that the GLM may be extended to:

Integrate with the standard OPNET™ Transceiver Pipeline RF Model

- Explicit receiver group, channel match, link closure, received power, and dynamic noise effect models

Support Advanced Custom RF Propagation Models

- Advanced Line-of-Sight Effects
- Terrain Elevation and Morphology
- Multipath, Weather, and Relativistic Time Effects

Share Data

- Direct integration with other process models

Support Expanded Vector/Matrix Mathematics

- More than 4 reference nodes/processes