



SPACE COMMUNICATIONS AND NAVIGATION

SMC: SCENIC MODEL CONTROL

Presented by Priyanka Srivastava and Jeff Kraus
Summer Intern Mentor: Robert Murawski, Ph.D.
NASA Glenn Research Center Project Manager: Bertsel Golden, Jr.





Introduction-Synergy of Students



SCENIC MODEL CONTROL





Presentation Agenda



- Motivation
 - SCaN
 - SCENIC
 - Model Based Systems Engineering
- Overview of Project SMC
- Modeling
 - About MagicDraw
 - Structural Diagram
 - Functionality
 - Internal Architectural Diagram
- Simulation
 - Interaction between components
 - User Interface inside MagicDraw



Space Communication and Navigation (SCaN)



SCaN manages and directs:

- The ground-based facilities and user services provided by the **Near Earth Network (NEN)** and **Deep Space Network (DSN)**;
- The ground- and space-based facilities and user services provided by the **TDRSS Space Network (SN)**



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Space Communications and Navigation (SCaN) (continued)



SCaN future objectives:

- Integration of existing NASA SCaN assets, building a single NASA-wide space communications and navigation network;
- Implementation of data communication protocols for Space Exploration missions that are internationally interoperable.
- Meets the future needs and commitments to provide space communications and navigation services to missions.

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Strategic Center for Education, Networks, Integration and Communications (SCENIC) Lab



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SCENIC Mission Statement: Provide a strategic center for education, networks, integration, and communications to collaboratively define and address the needs of future NASA communications.

Modeling and Analysis Goals

- Development of current SCaN Network models that are expandable, verifying proposed future architectures;
- Capacity Modeling of the existing and future SCaN Networks;
- Simulation of the network communication and navigation infrastructure space and ground networks.



Why Model-Based Systems Engineering?



Motivation

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Overview of SMC

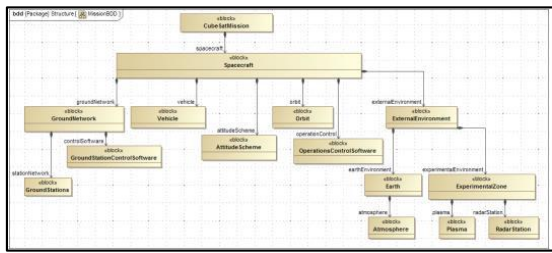
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- Enables system-level model capture
 - Formal, accurate, authoritative single source
 - Contains elements, relationships, interactions
 - Multiple compatible views, e.g. physical/functional
 - Requirements verification and traceability
- Enables integration of models and simulations
 - Connect system-level model to analytical tools (STK, OPNET, MATLAB etc.)
 - Execute dynamic simulation of end-to-end mission
 - Identify failure to satisfy requirements
 - Accommodates re-evaluation when design changes occur



SysML Model of a System



Analytical Tools



SCENIC Model Control (SMC)



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Project Mission:

To develop a SCaN network model with its architectural elements in an evolutionary and expandable format. SMC is a framework utilizing a modular approach with MagicDraw as the primary User Interface Software.

SMC Task Objectives:

- Model SCaN ground networks and desired user missions in SysML
- Perform capacity modeling and coverage analysis of SCaN Network assets based on SCaN Mission Loading.
- Integrate the developed tools and wrappers thru a custom MagicDraw User Interface.
- Development of a Control Module which facilitates transfer of model information and generated reports via custom XML communication schema.

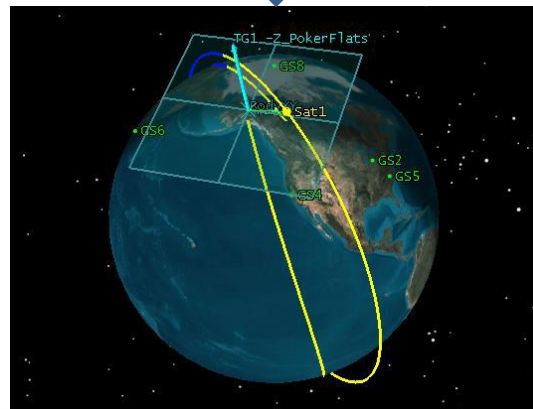


SMC Capacity Modeling Tools



End Products of SMC:

- Optimized User Mission Schedule for modeled mission set generated by STK Scheduler
- Link Budget Reports between satellites and a Ground Stations using STK
- Network performance reports between Satellites and Mission Operation Centers (MOC) using OPNET



Coverage Access, Link Budget Reports, Scheduler Reports



MOC Statistics Reports, Data Package Exchange Reports

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Modeling SMC



SIP Project questions:

- How does one integrate the NEN and SN ground station information within a single database?
- How does one seamlessly integrate simulation tools for the purpose of performing future capacity modeling?
- How do changes in the configuration of SCaN networks and spacecraft missions impact future system performance and requirements?

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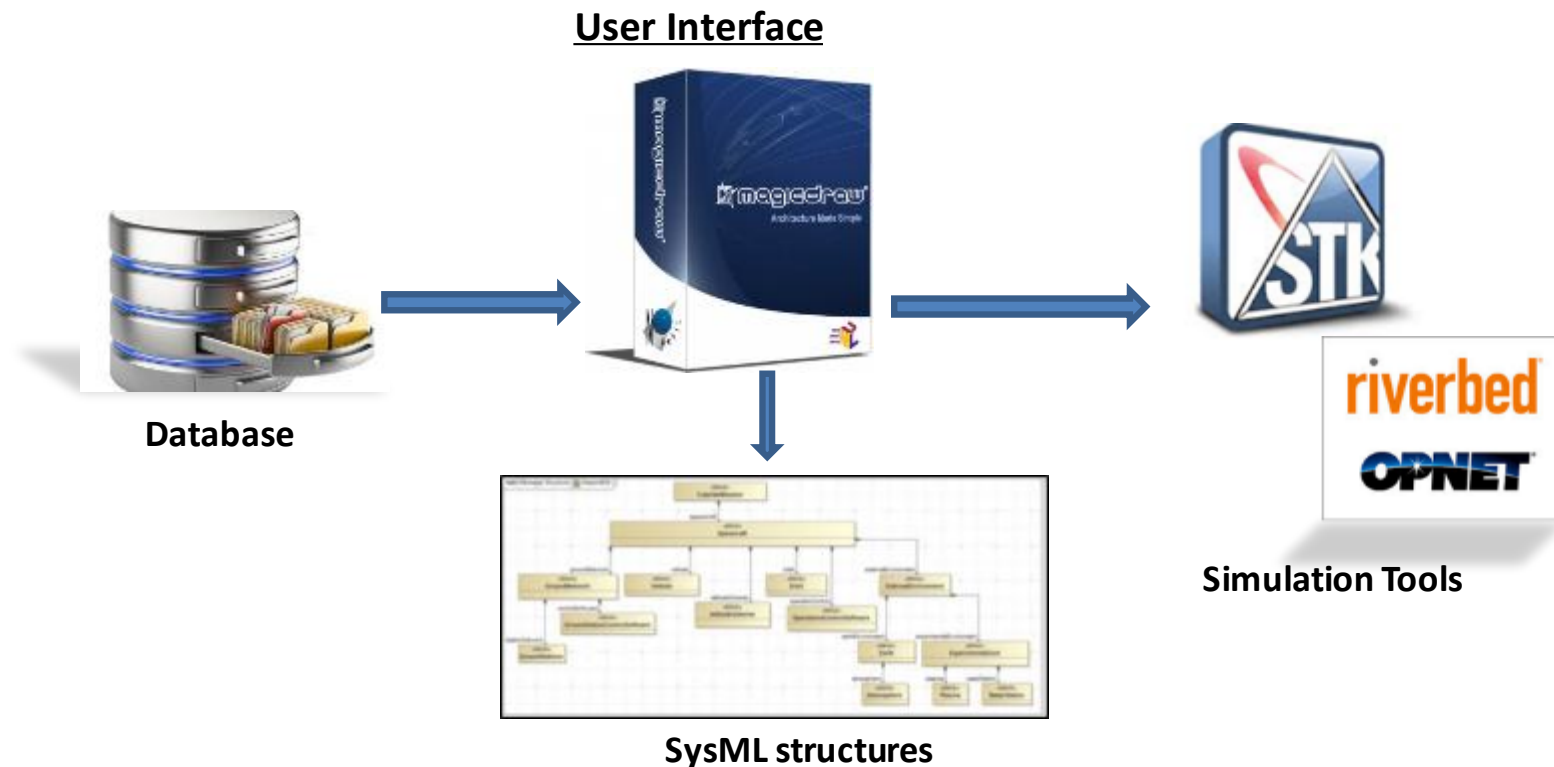
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Selected MBSE tool: MagicDraw by No Magic Inc.

- Present a high level architectural framework of the system components
- Act as the User Interface to initiate processes inside the system
- Integrate databases and software such as STK and OPNET via a custom developed plugin.





SMC Structure



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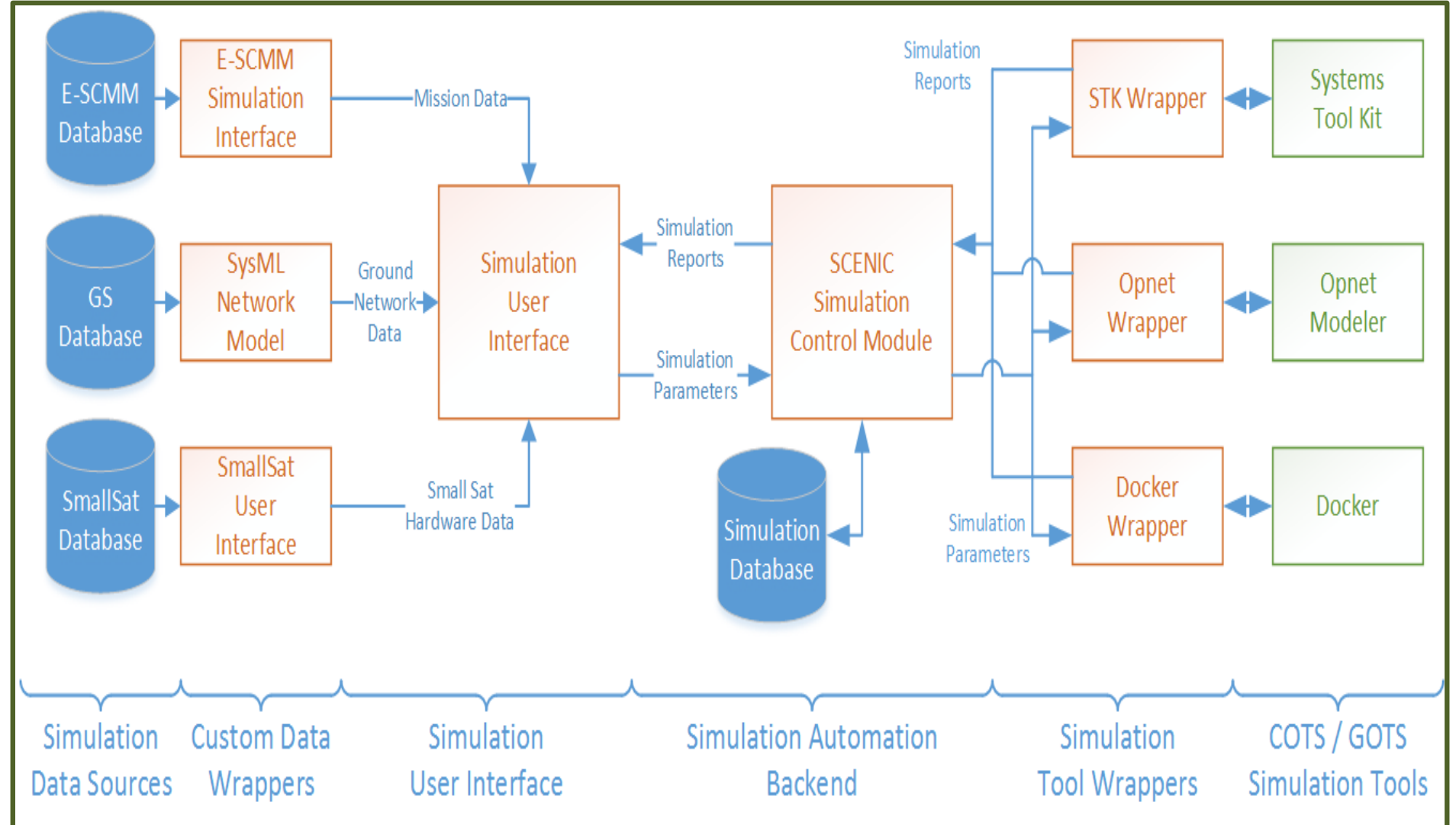
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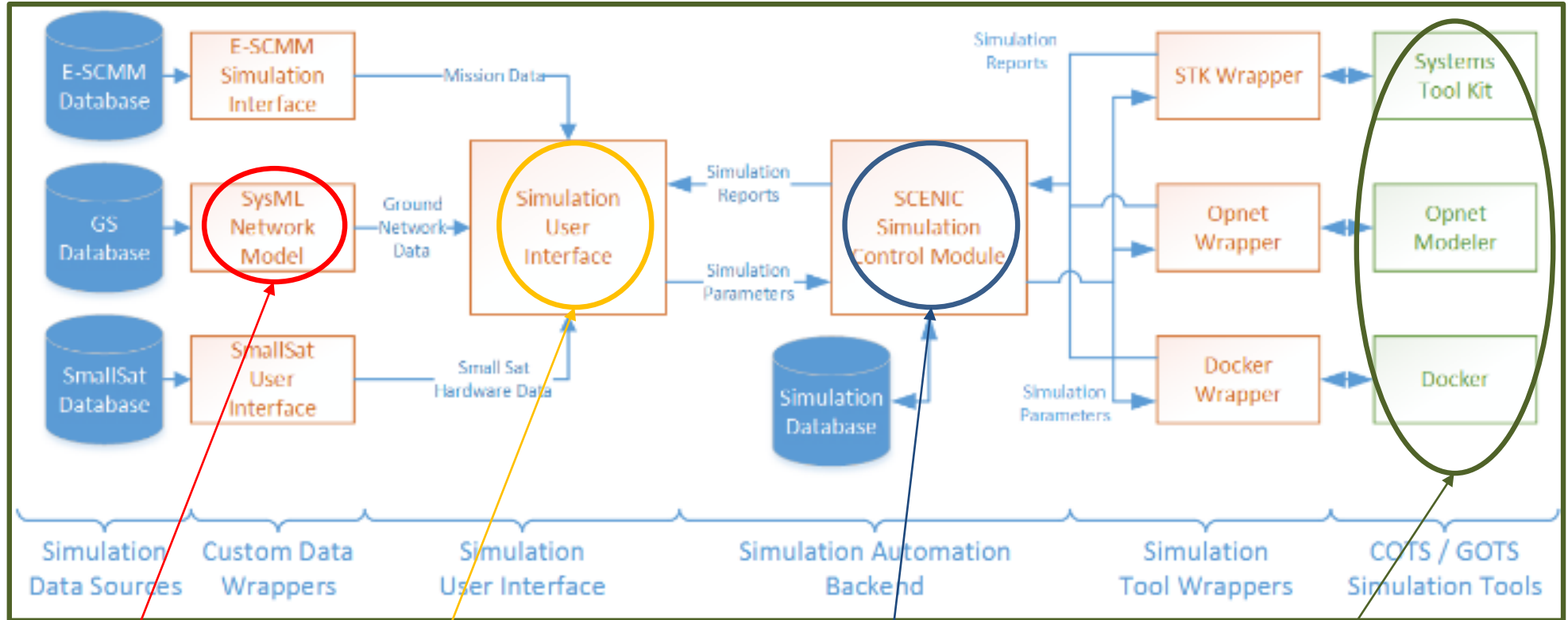




Functionality of SMC



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MagicDraw Plugin
(developed using Java And Eclipse IDE)

Web hub to interface application tools

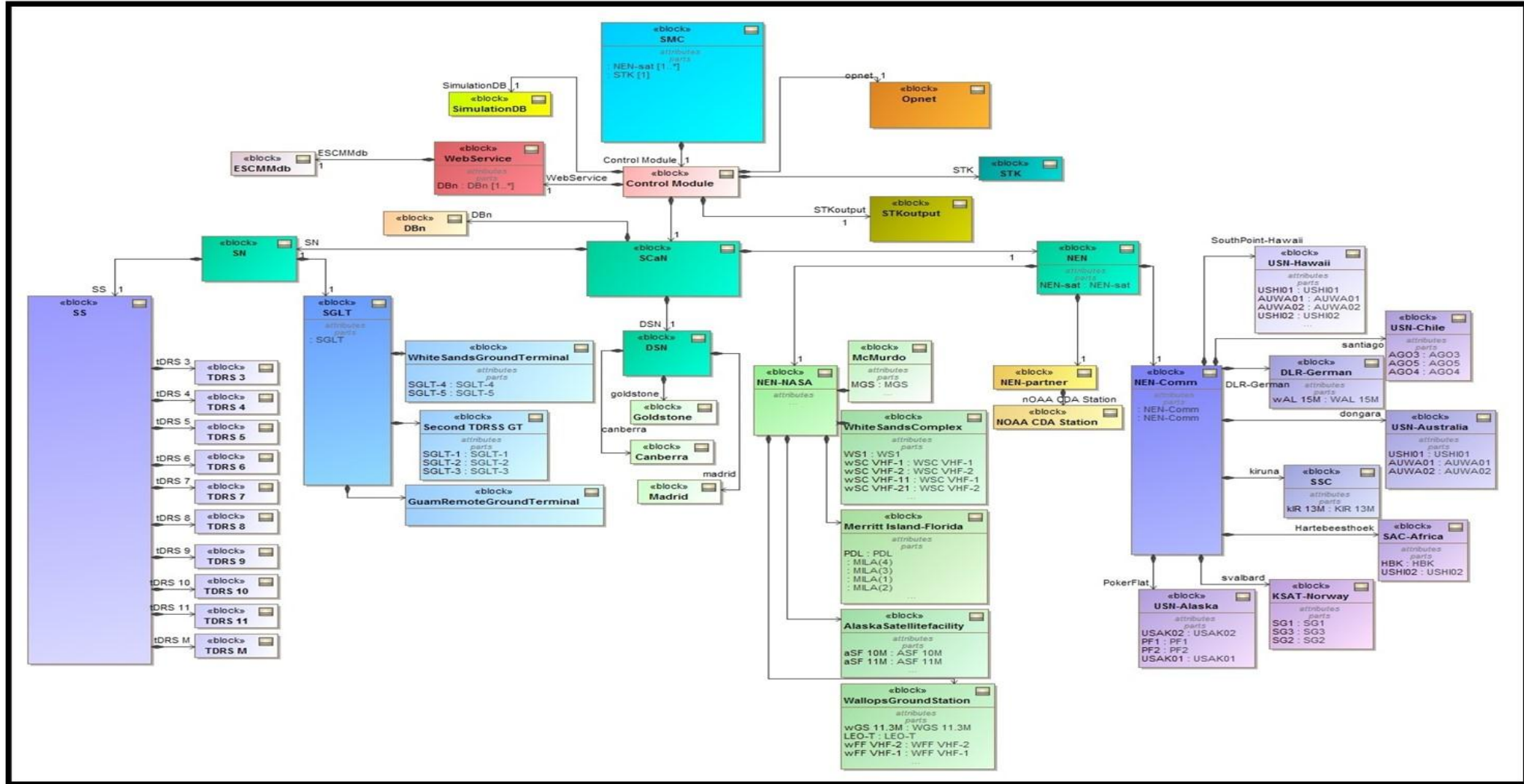
Simulation tools



Block Definition Diagram



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SMC Block Diagram as viewed by the SMC project user



Internal Block Diagram



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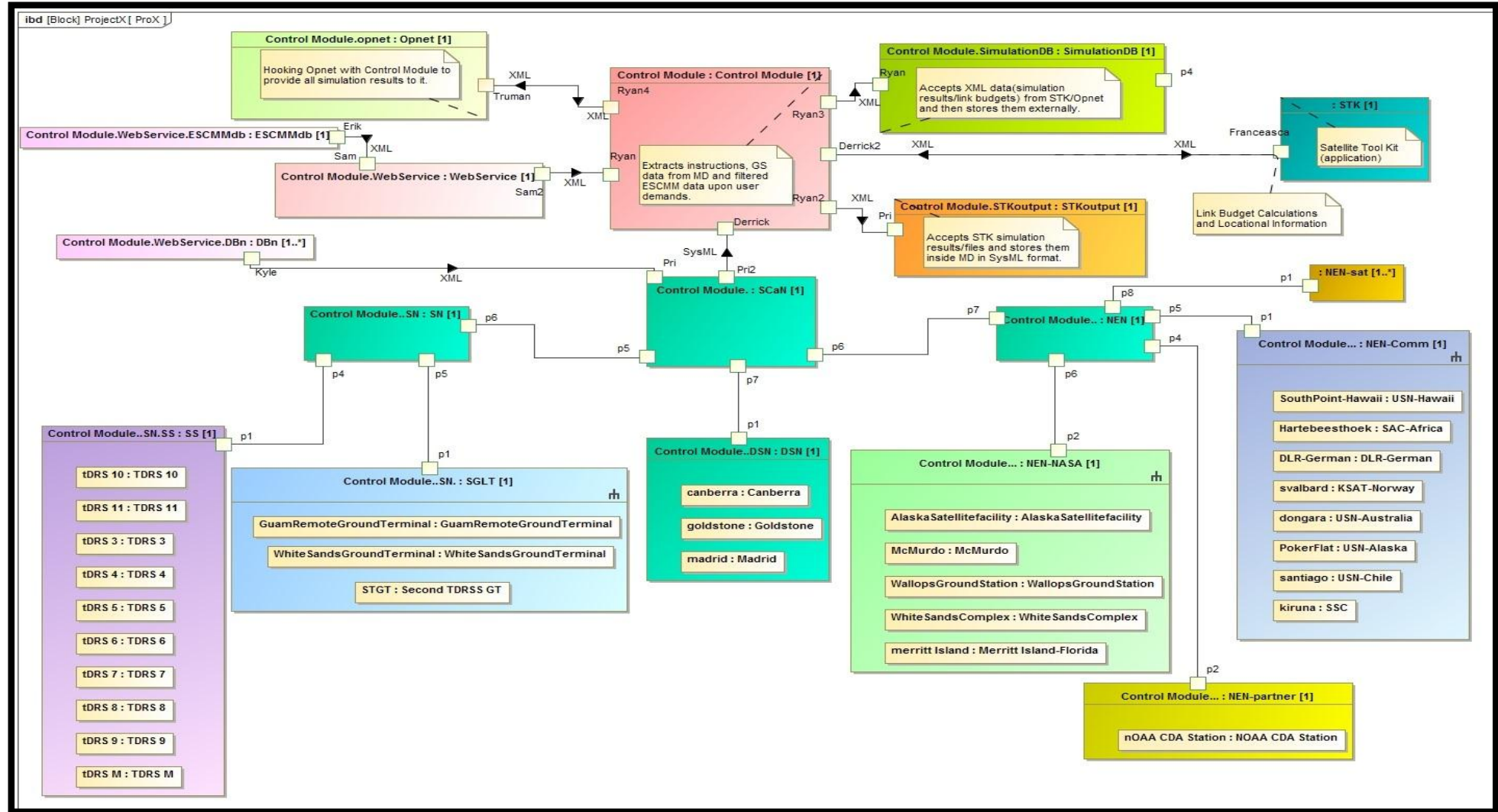
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IBD captures the structure, behaviors and interactions between the elements



SMC Element Interaction



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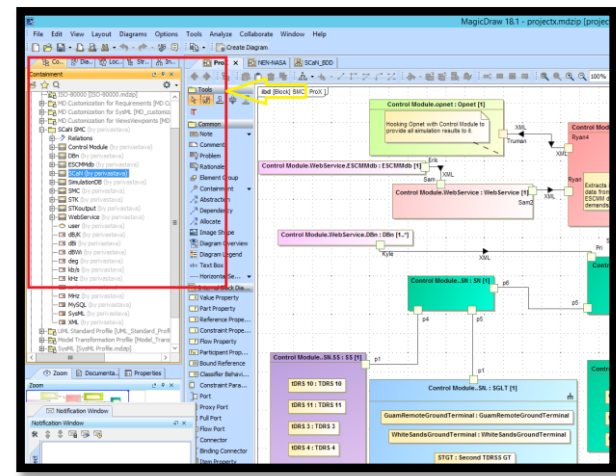
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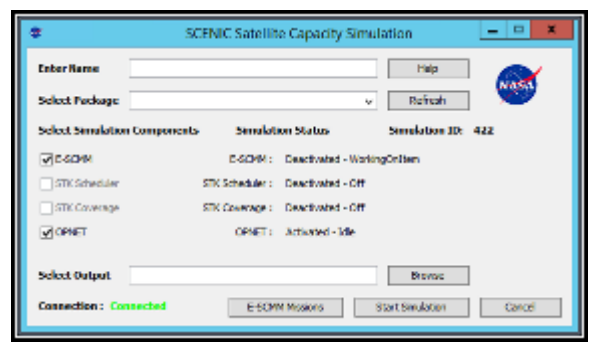
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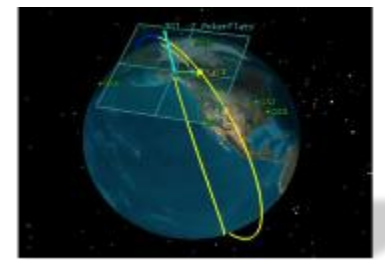


MAGICDRAW INTERFACE

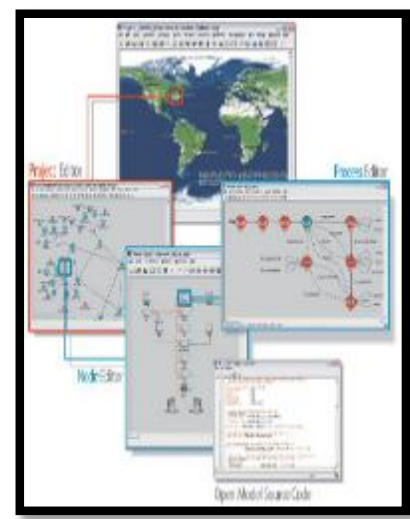


PLUGIN

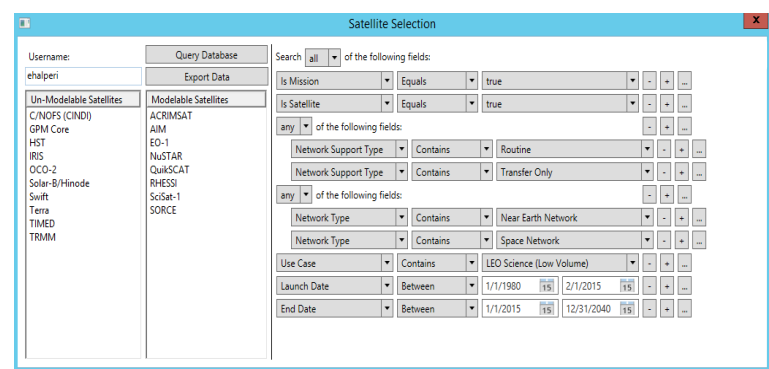
- Pulls data from model
- Presents real-time updates
- User toggled simulation components
- Receives generated reports



STK



OPNET



ESCMM Satellite Selection UI

CONTROL MODULE WEB INTERFACE

User Interfaces for data access

Plugins and Interfaces

Analytical Tools





OPNET Radio Transceiver Pipeline



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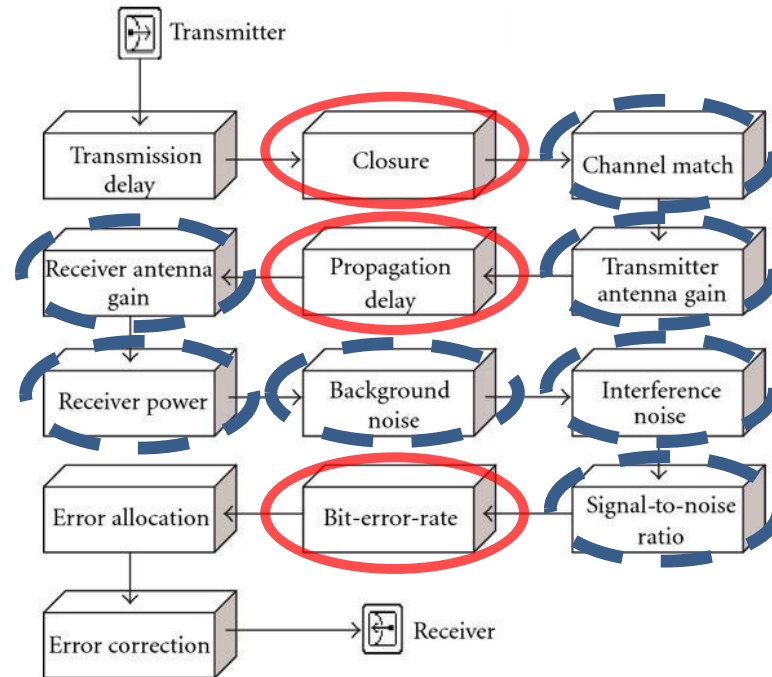
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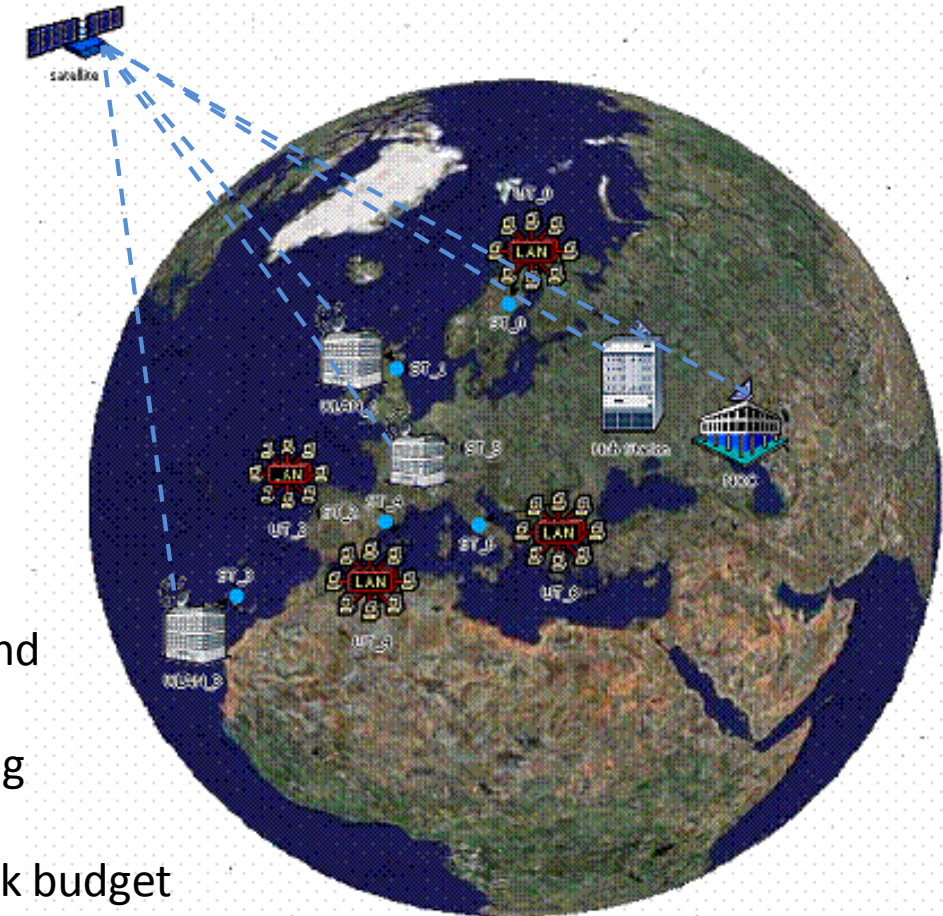
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- Builds network simulation model
- Generates network model based on ground network and mission simulation parameters
- Schedules tasks provided by STK to simulate networking between modeled objects
- Modified OPNET radio transceiver pipeline to utilize link budget reports from STK, rather than OPNET calculations, for propagation delay and bit error rate (BER) parameters





Questions / Comments / Snide Remarks?



THANK YOU IAC

