

## 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.

### Motivation

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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.

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## Overview of SMC

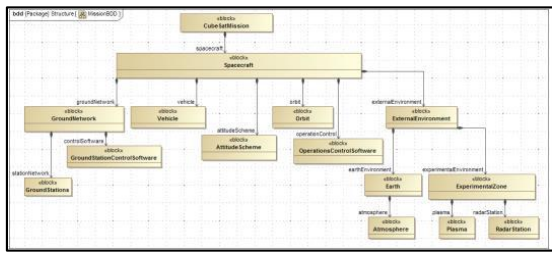
## Modeling

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## Simulation

- Interaction between components
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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.

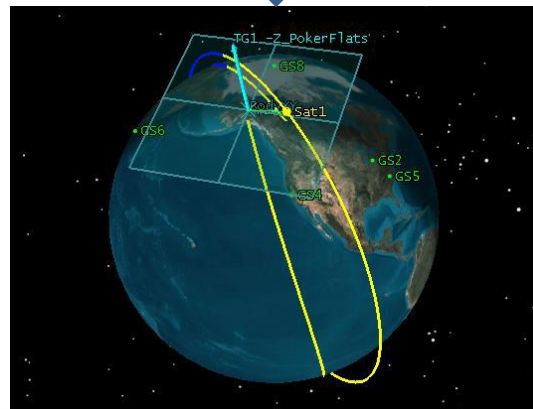
## SMC Task Objectives:

- 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.



## 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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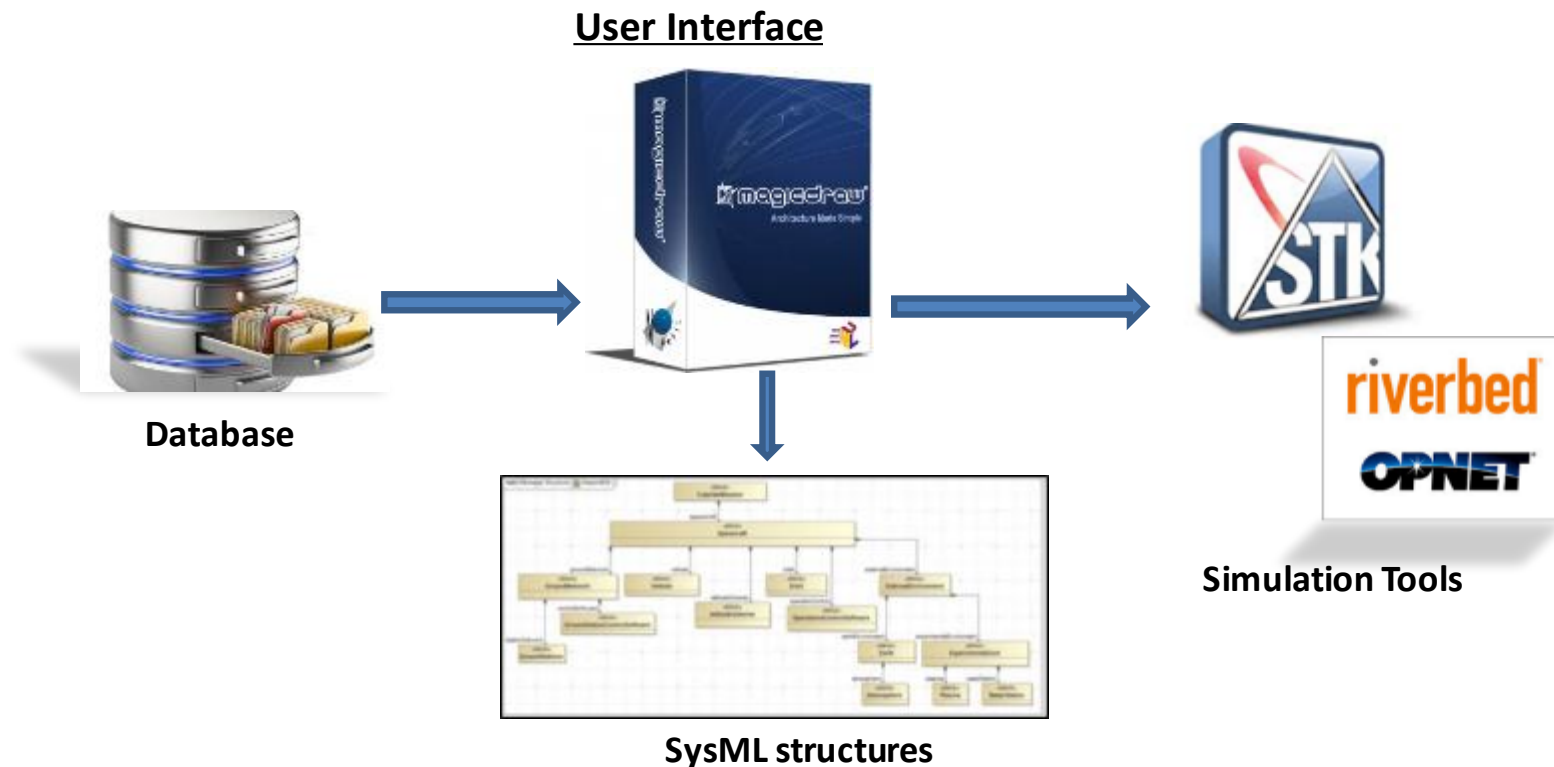
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Selected MBSE tool: MagicDraw by No Magic Inc.

- 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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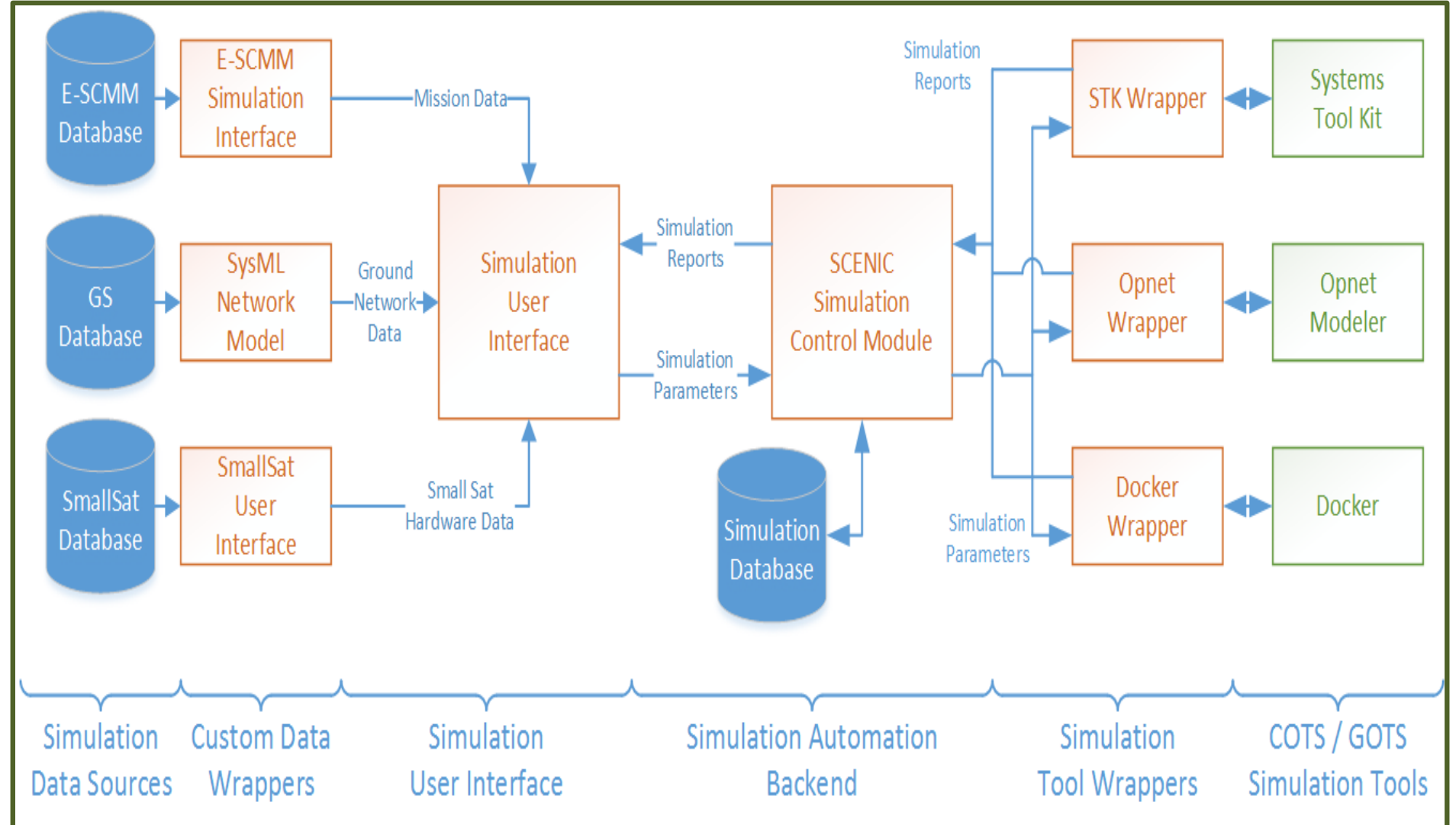
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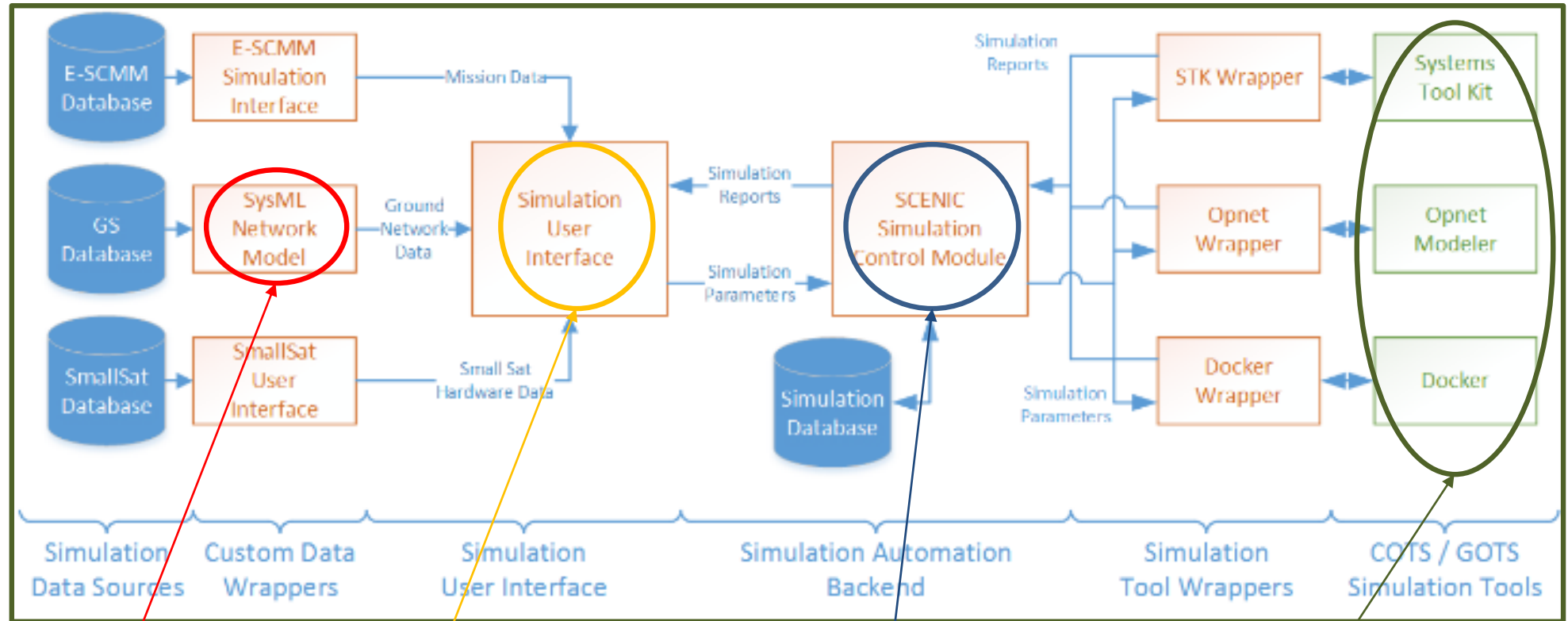




# Functionality of SMC



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**MagicDraw Plugin**  
(developed using Java And Eclipse IDE)

Web hub to interface application tools

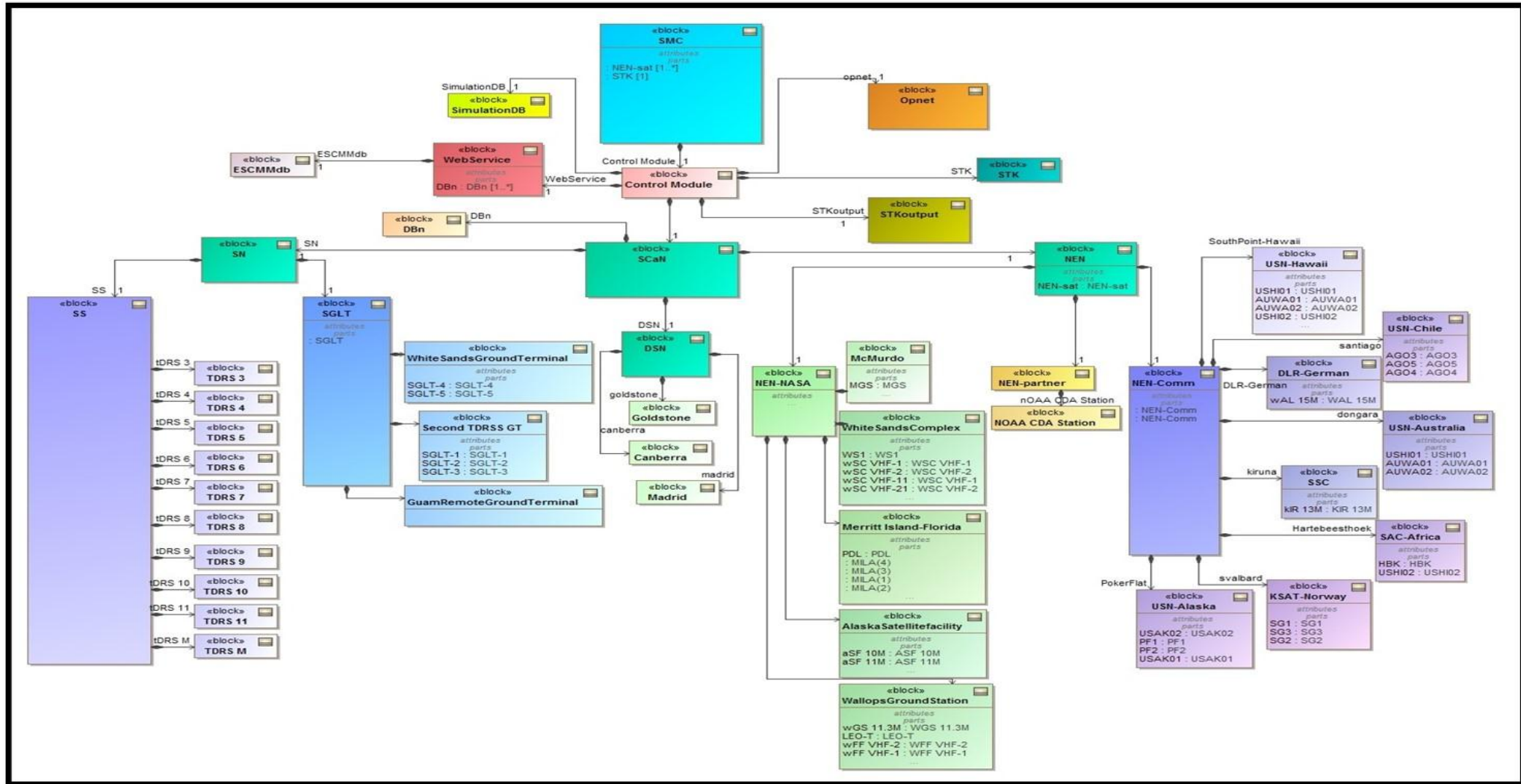
Simulation tools



# Block Definition Diagram



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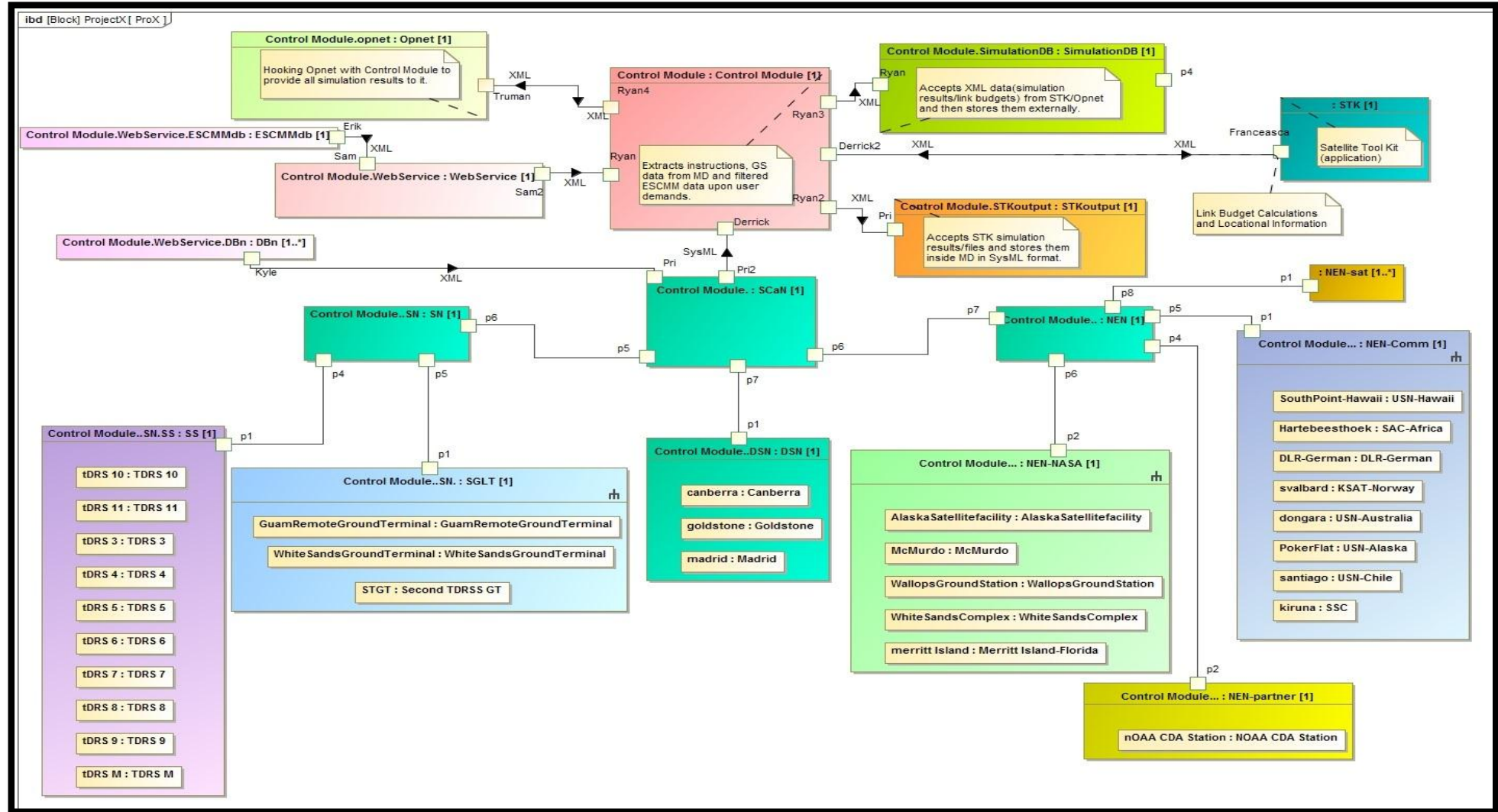
SMC Block Diagram as viewed by the SMC project user



# Internal Block Diagram



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IBD captures the structure, behaviors and interactions between the elements



# SMC Element Interaction



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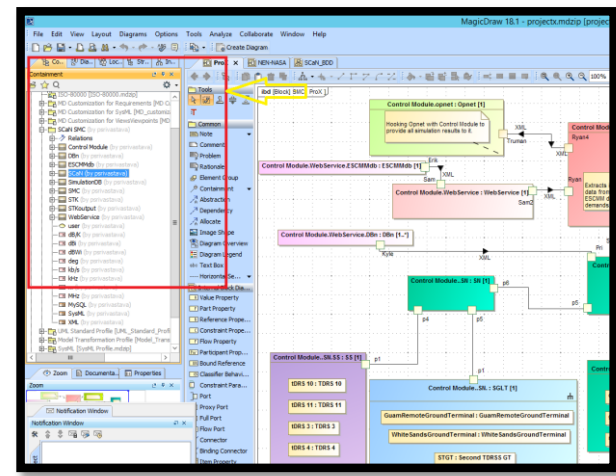
Overview of SMC

Modeling

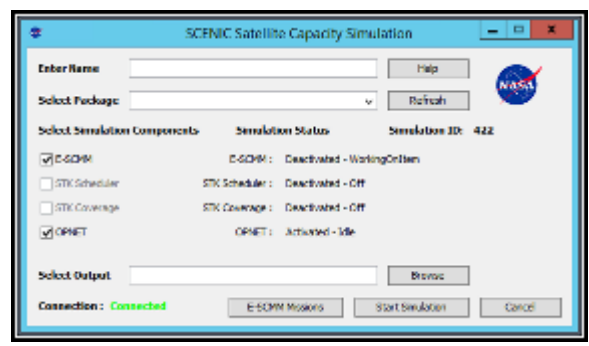
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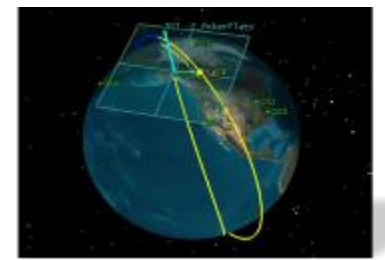


MAGICDRAW INTERFACE

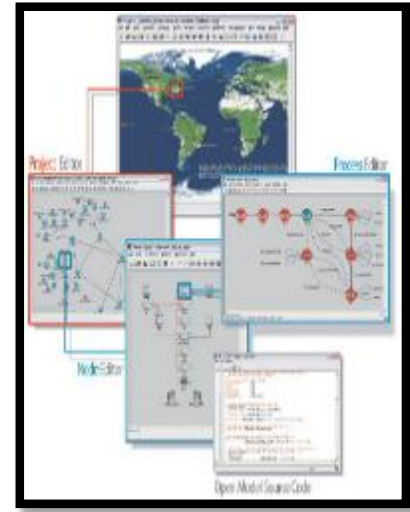


PLUGIN

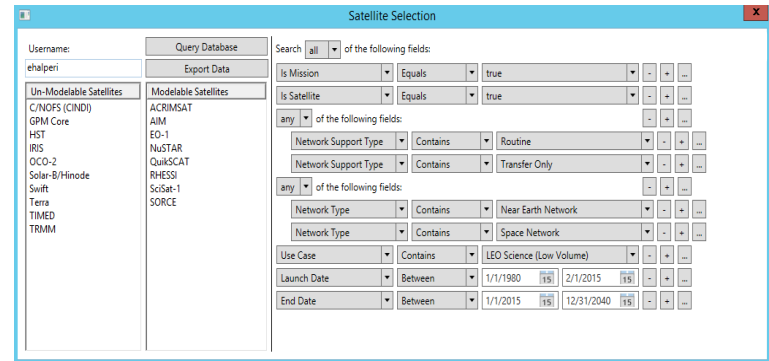
- Pulls data from model
- Presents real-time updates
- User toggled simulation components
- Receives generated reports



STK



OPNET



ESCMM Satellite Selection UI

CONTROL MODULE WEB INTERFACE

User Interfaces for data access

Plugins and Interfaces

Analytical Tools









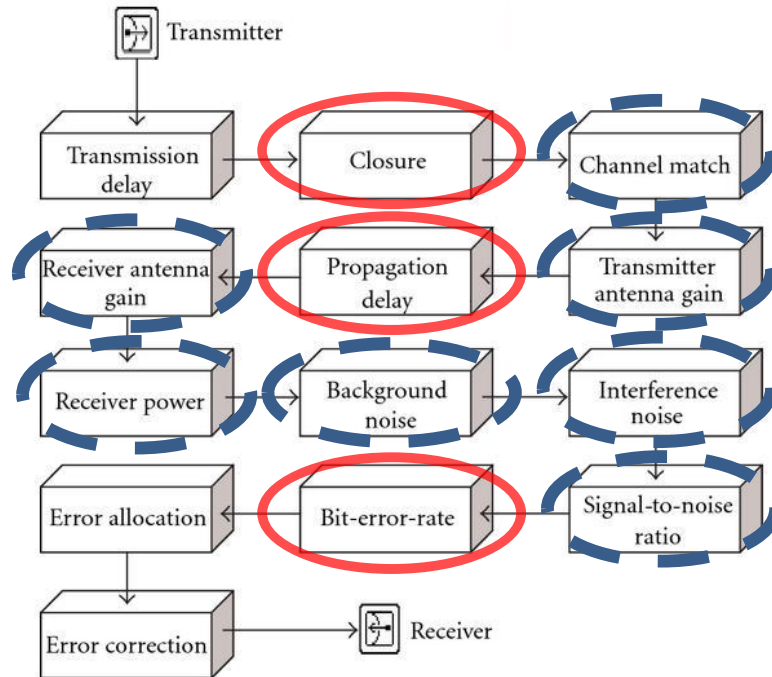
# OPNET Radio Transceiver Pipeline



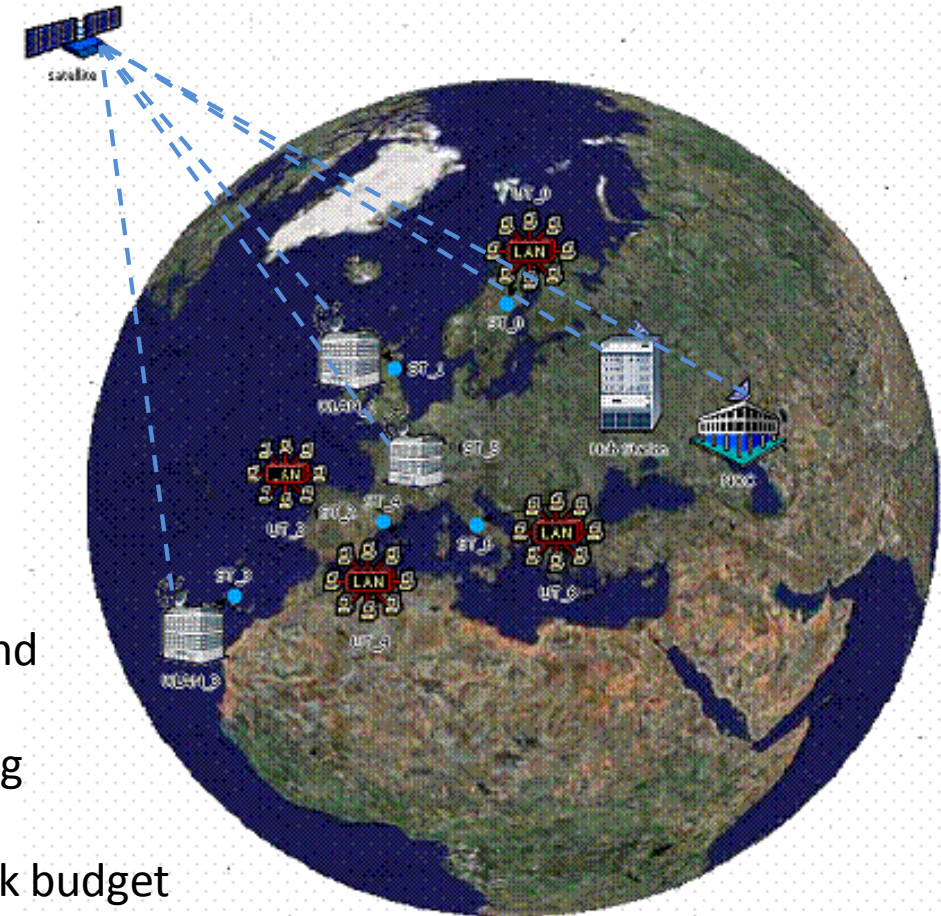
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- Builds network simulation model
- Generates network model based on ground network and mission simulation parameters
- Schedules tasks provided by STK to simulate networking between modeled objects
- Modified OPNET radio transceiver pipeline to utilize 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

