

Satellite Communications System

This is a generic model for analyzing the performance of a satellite-based communications system. The number and location of earth station and the satellite constellation can be configured. The model also accommodate mobile nodes that can connect to the ground stations.

This version of the model shows two ground stations, located in Berlin and San Francisco, linked by a constellation of communications satellites. The top level view of the model is shown in Figure 1 below.

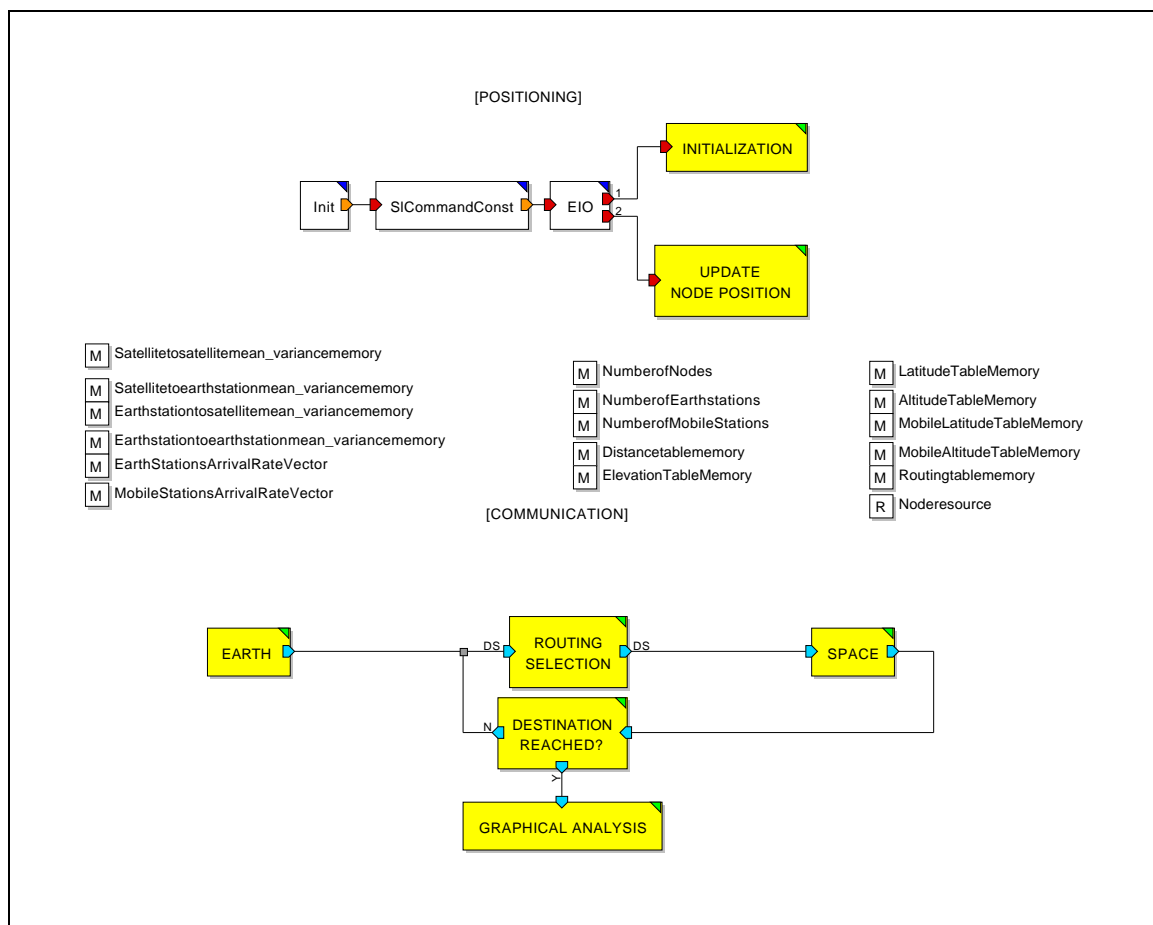


Figure 1: SatCom top level model

The model is comprised of seven major modules: Implementation, Update Node position Earth (transmitter) Space (Communication in Progress), Route Selection, Destination Reached? And Graphical Analysis (receiver and statistics.) Each of these modules is briefly described below.

The Initialization module establishes communication with SatLab and initiates a configuration script that defines the earth stations and the satellite constellation and the date and time for the simulation so SatLab can start the satellites in the correct orbital positions. MLDesigner also initiates the SatLab simulation so it can respond to MLDesigner commands.

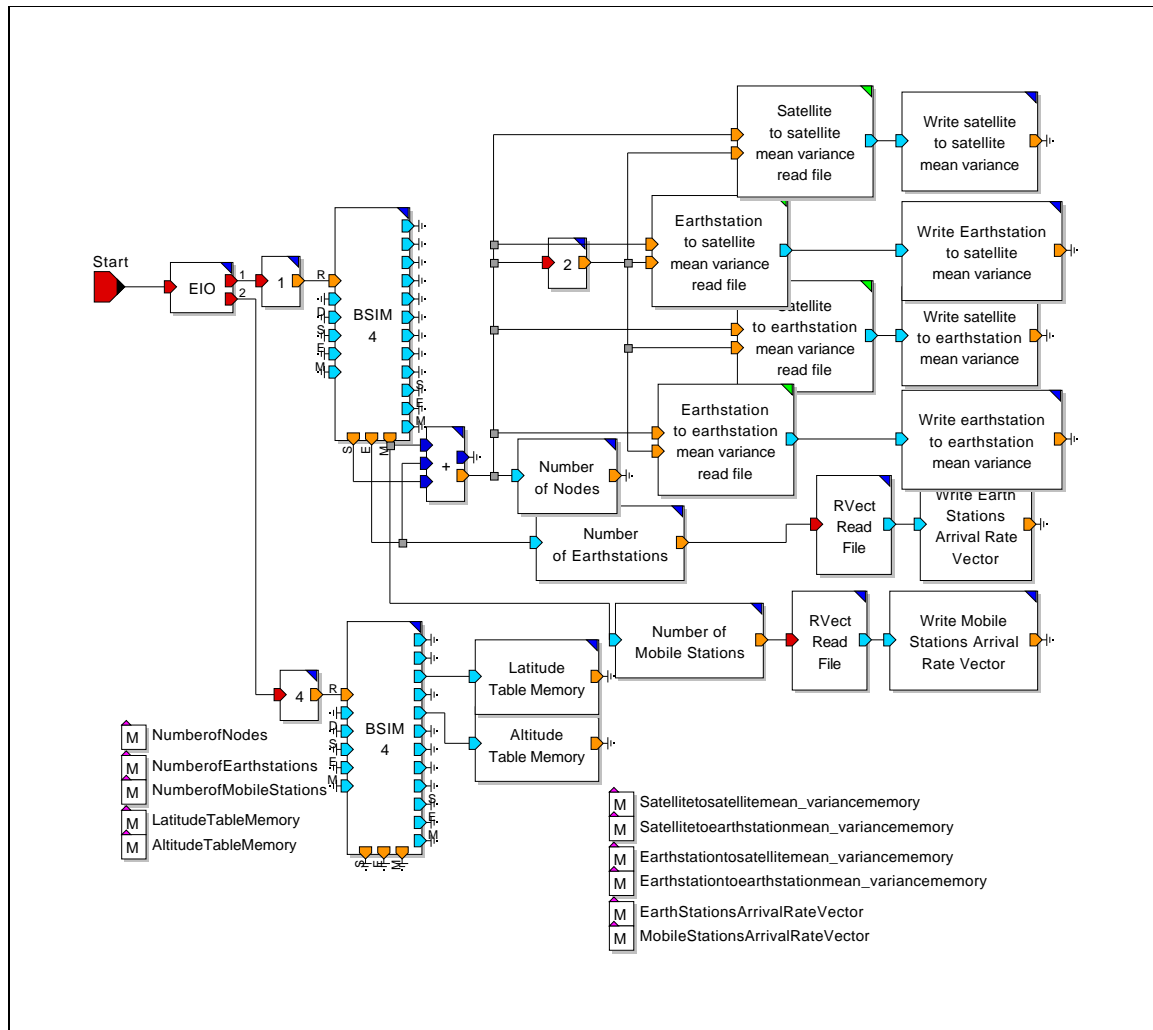


Figure 2: Initialization module

The Update Node Position module calculates position data to update MLDesigner and passes information between MLDesigner and SatLab. MLDesigner send requests for position update information to SatLab at intervals specified by a parameter, SatLab calculates and returns the relative position and velocity of all nodes and updates the shortest path routing table.

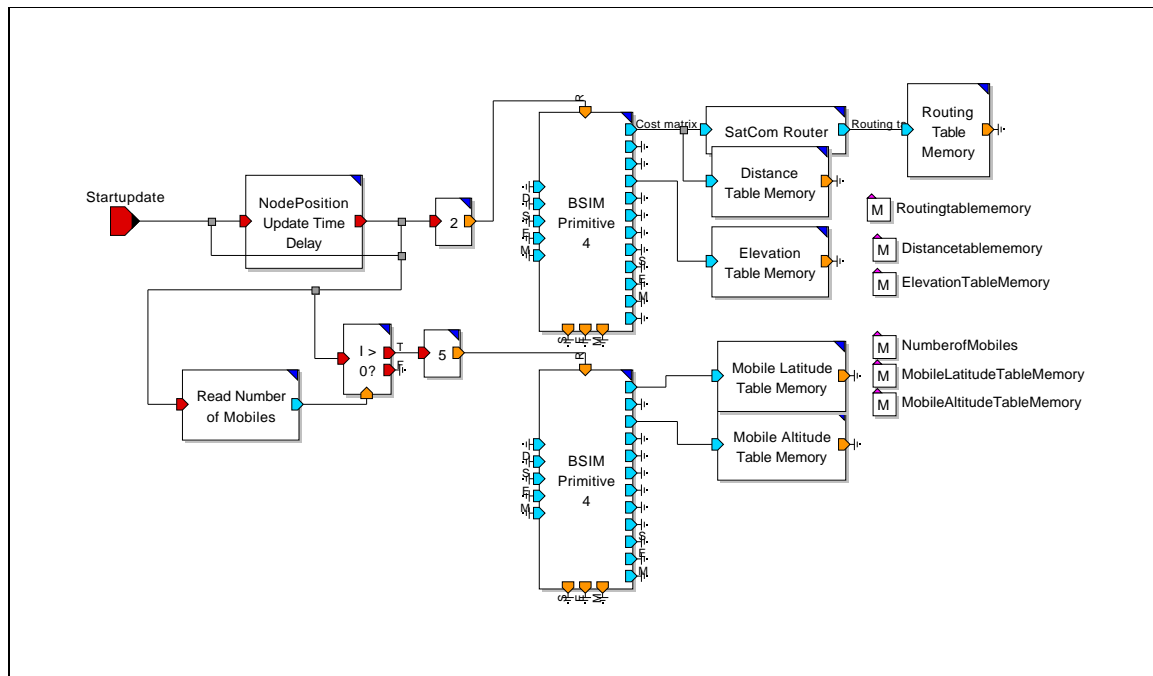


Figure 3: Update Node Position module

The Earth/Transmitter module represents all terrestrial node transmitters. It generates packets (data structures) from earth nodes located at each ground station location, inserts a source address, a destination address, a message length and a time stamp, and to the routing selection module for transmission to the appropriate satellite.

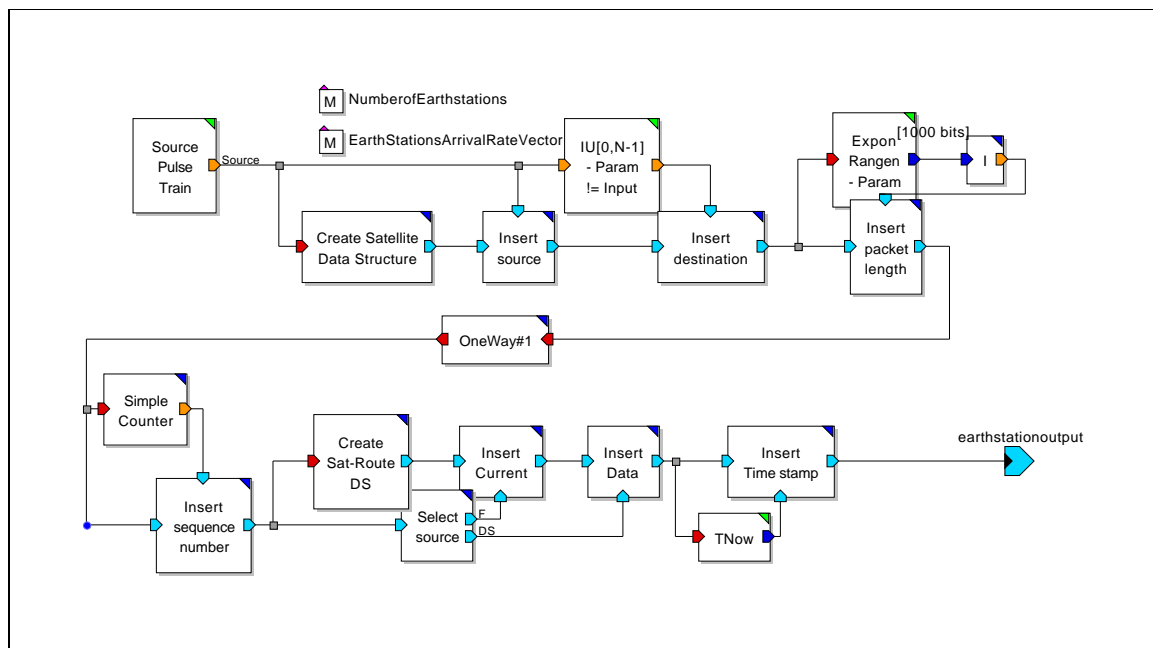


Figure 4: Earth station (transmitter) module

The routing selection module finds the next hop of a packet from the Routing Table and inserts this information in the Next field of the Sat Route DS. The Routing Selection module abstracts the operations of all terrestrial and satellite routers.

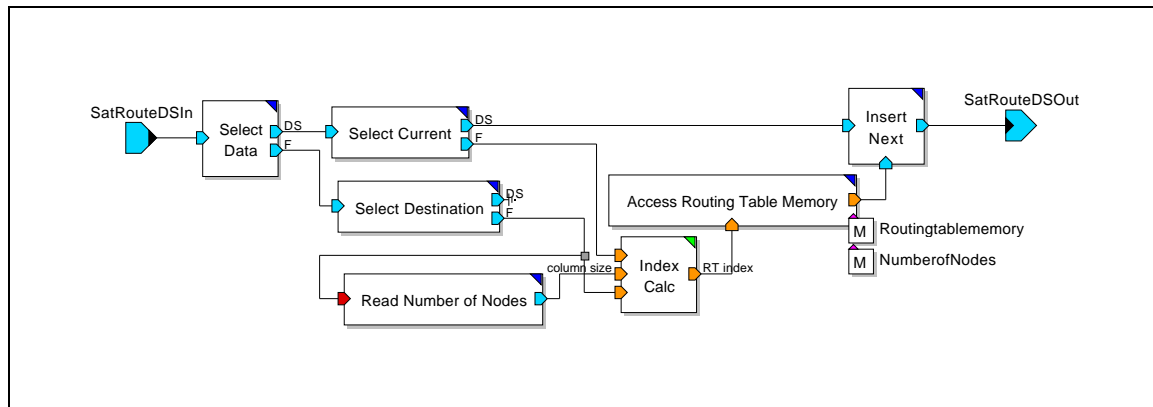


Figure 5: Routing Selection module

The Space (Communication in Progress) module receives the packet data structure from the Routing Selection module and passes it to the appropriate transmission channel (Earth to Earth, Earth to Satellite, Satellite to Earth, Satellite to Satellite) which sends it to the “Destination Reached” module.

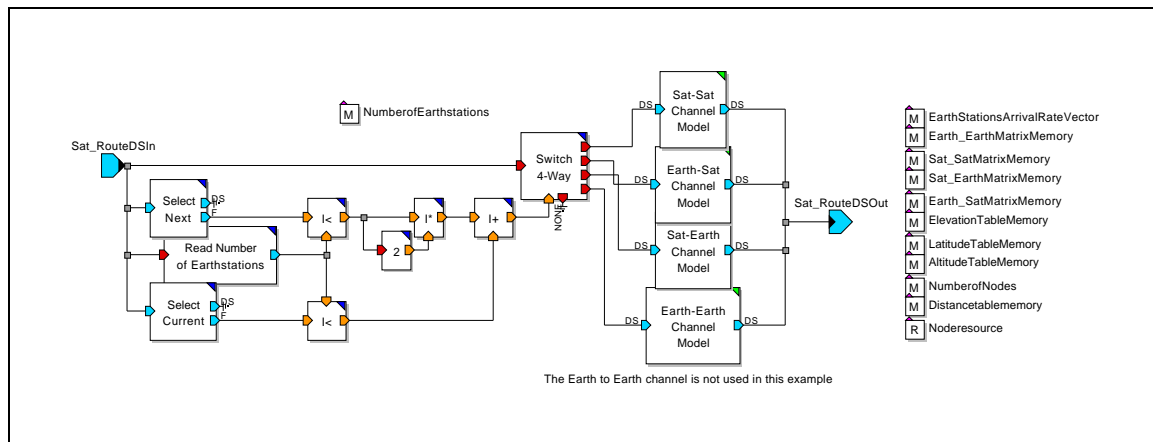


Figure 6: Satellite module

The details of the Earth-to-Satellite communication channel is shown below. The other channel models are similar.

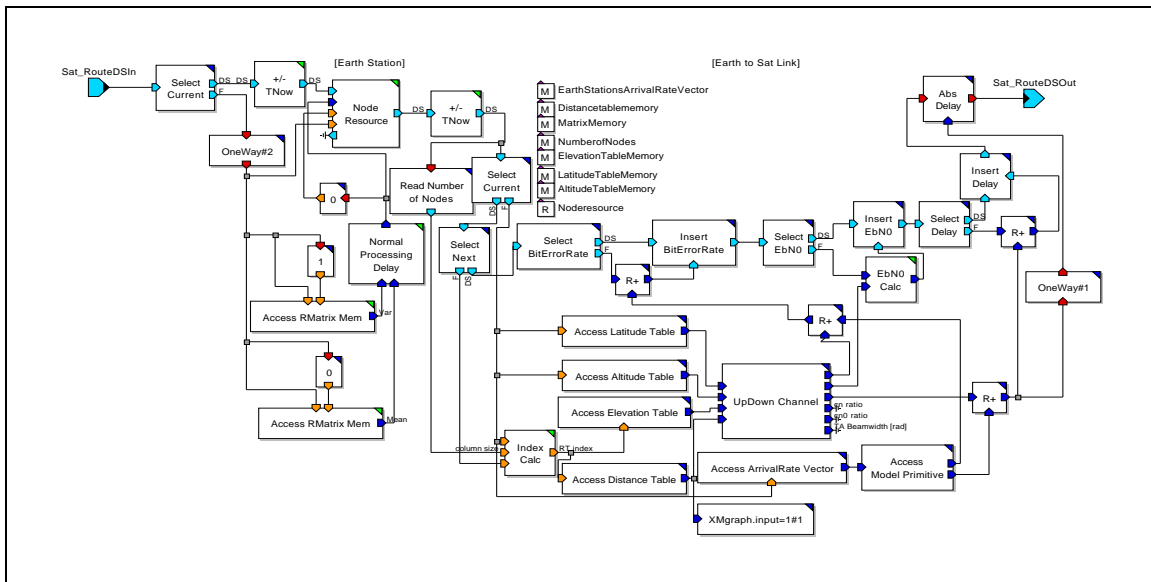


Figure 7: Earth to Satellite Channel module

The Destination Reached module checks to see if the destination is an earth station; if so, the packet is passed to the Graphical Analysis module, which serves as the earth station receiver. If not, the packet is passed to the Routing Selection module for transmission to the next satellite.

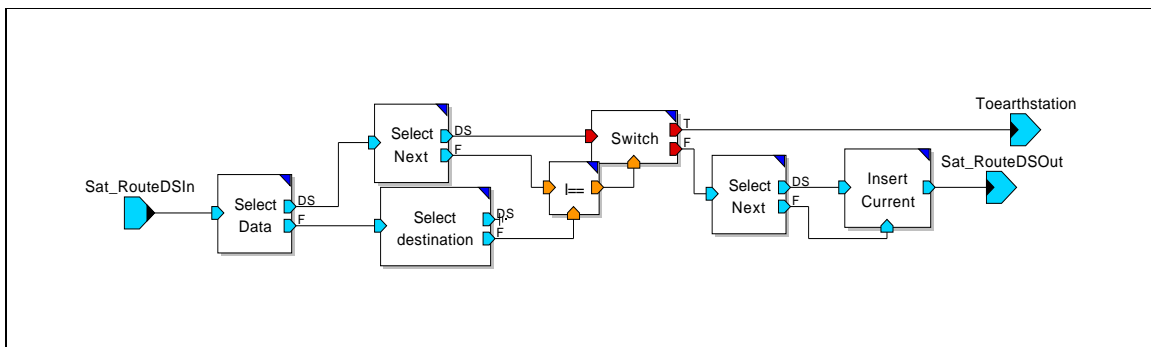
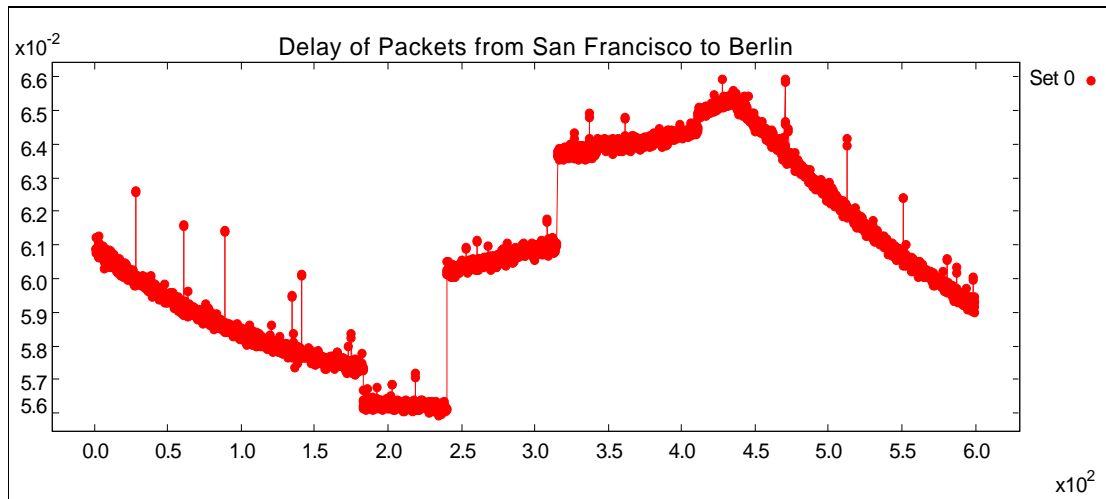
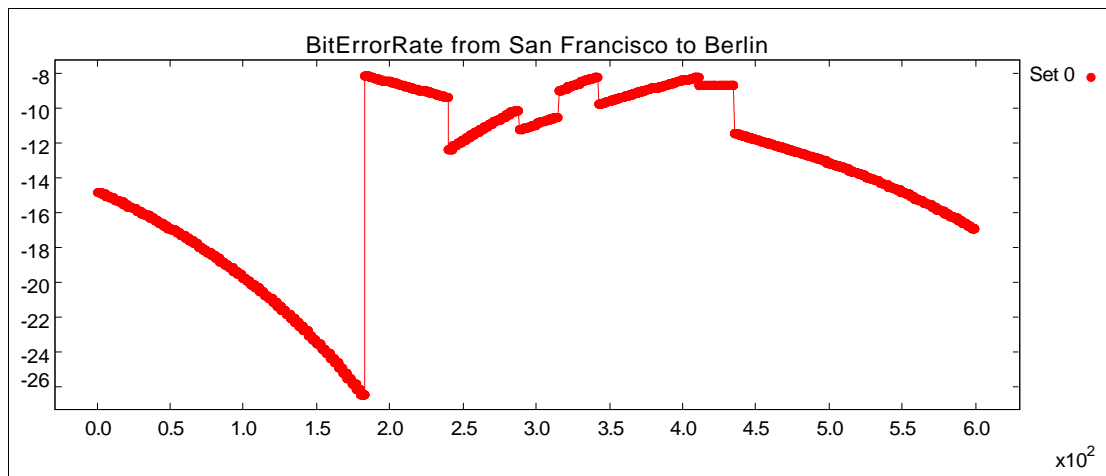
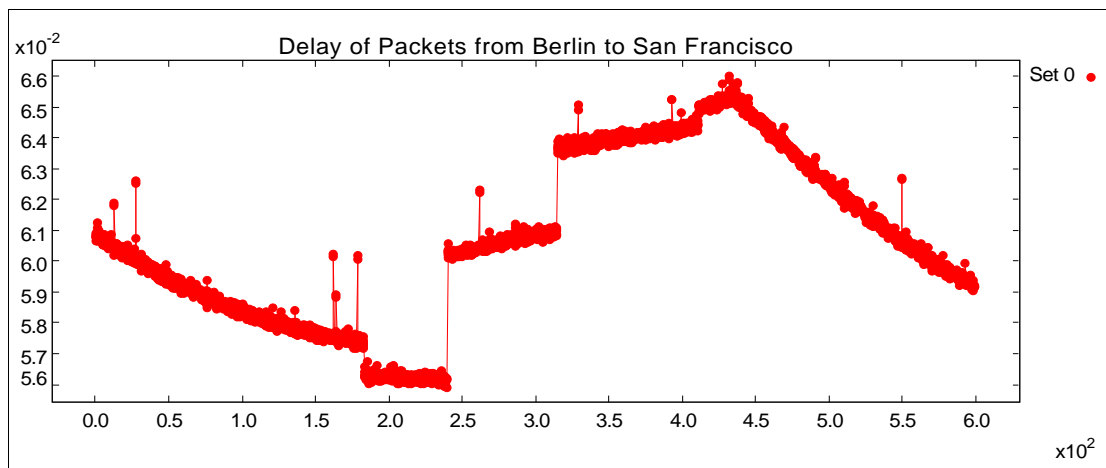
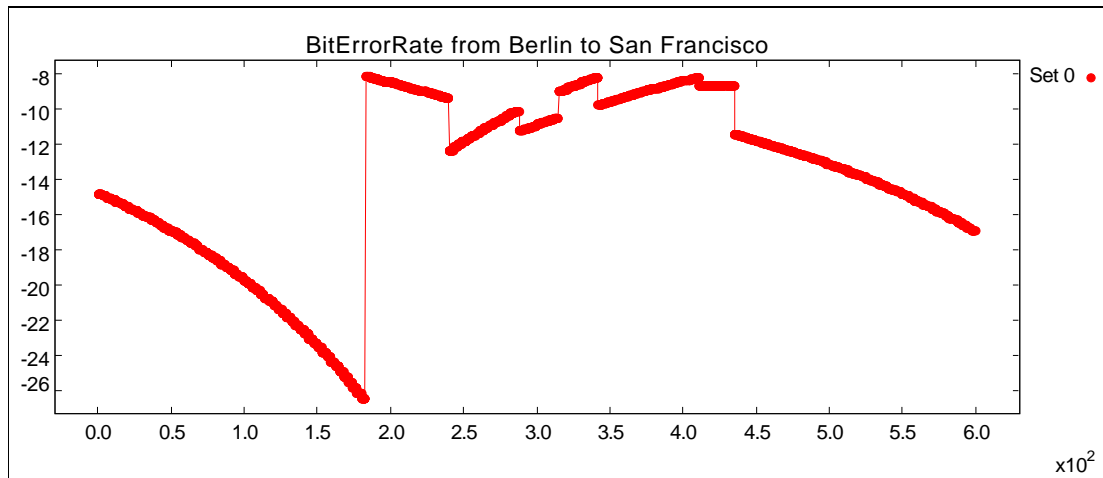


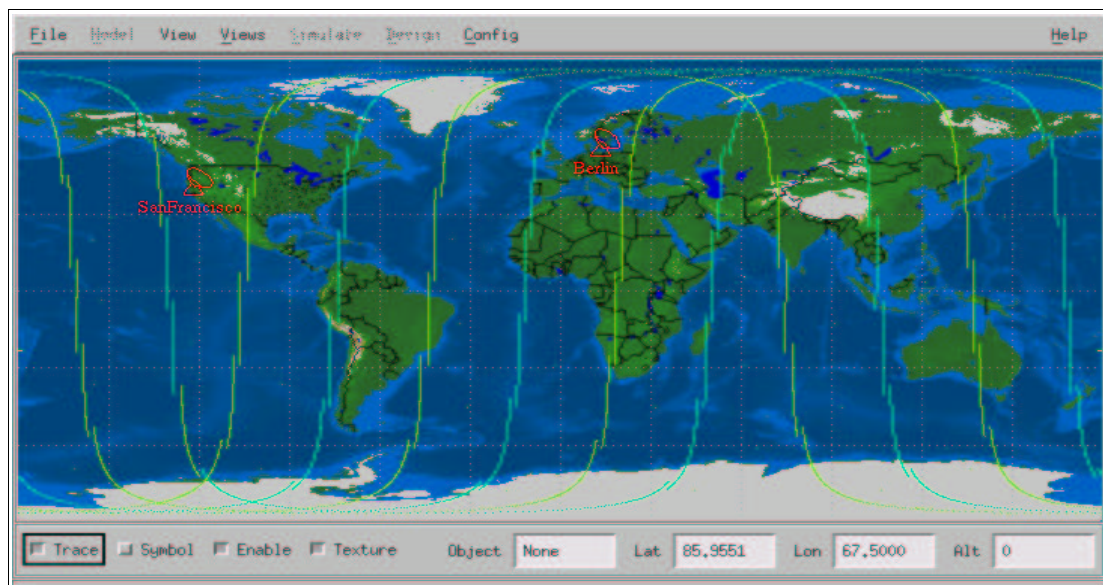
Figure 8: Destination Reached? module

The Graphical Analysis module collects information from all received packets and generates statistical reports such as those shown in Figures 9-12 below.

**Figure 9: Packet delay from San Francisco to Berlin****Figure 10: BER San Francisco to Berlin****Figure 11: Packet delay Berlin to San Francisco**

**Figure 12: BER Berlin to San Francisco**

This map from SatLab shows the position of the two ground stations and the orbits of the communications satellites.

**Figure 13: SatLab display map**