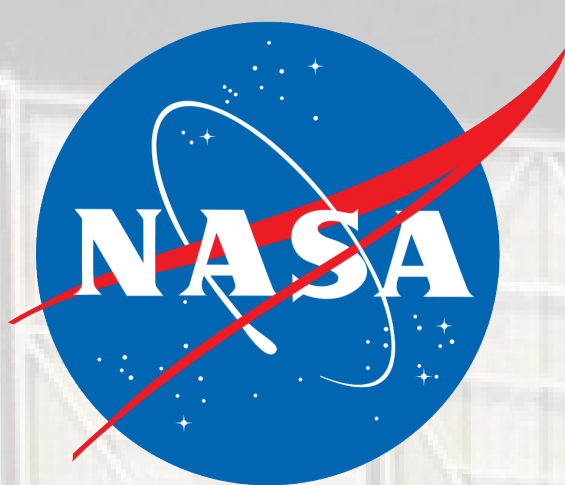# Creating an Interactive Mission Model for NASA Communication Network Analysis

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Background

My project involved working with my mentor, George Bussey, to support NASA space communication capabilities. NASA operates three space communications networks for sending and receiving data to and from satellites. These networks are the Near Earth Network (NEN), which provides periodic contact with unmanned satellites in Low Earth Orbit; the Space Network (SN), which provides constant contact with manned missions in LEO like the Space Station; and the Deep Space Network (DSN), which provides periodic contact with interplanetary missions. These networks must support a constantly changing array of missions. Because it takes time to upgrade these networks, network engineers at NASA need to accurately predict network usage many years out. They accomplish this by using mission models that detail current and planned future missions and the types of support these missions will require. Current mission models rely on multiple data sources that contain inconsistent and incomplete information. These mission models also must be manually constructed from the parent databases. A new, standardized model needs to be developed that constructs the most complete set of data available for all missions

Satellite dishes supporting the Near Earth Network in NASA's Alaska Satellite Facility in Fairbanks, AK.
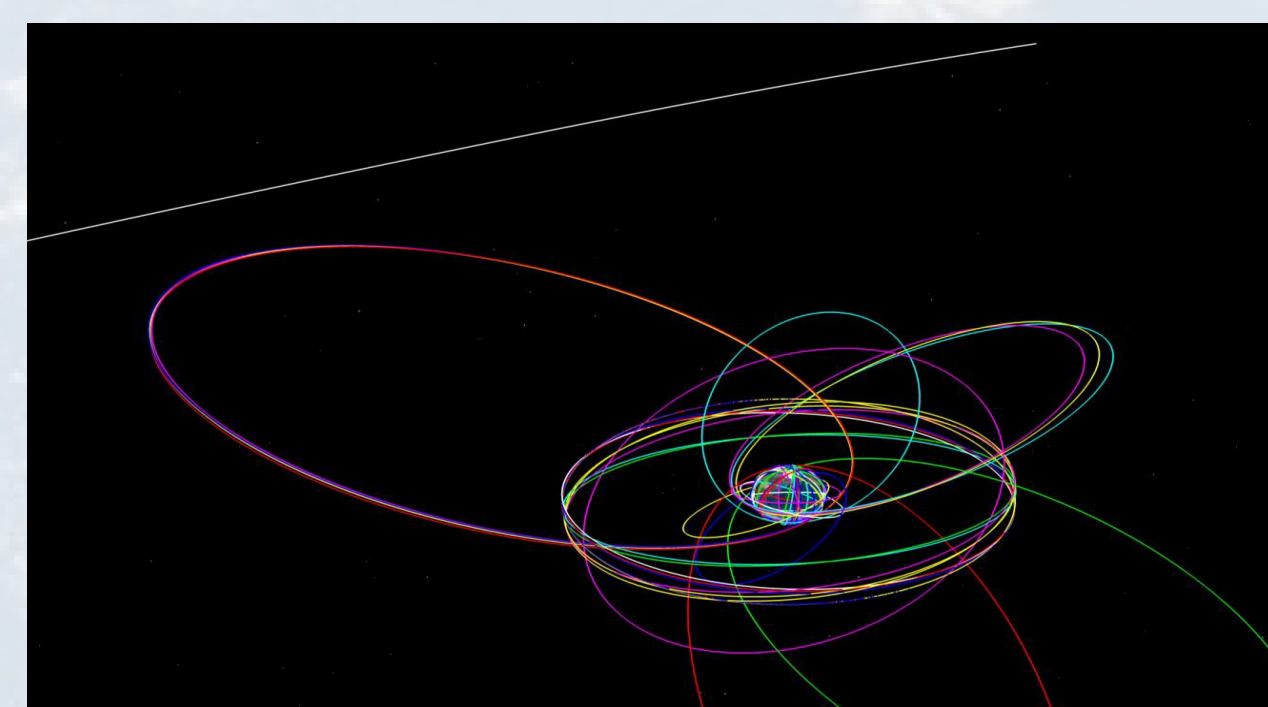
Constructing a Database

Three data sources are used to compile the database: the SCMM, ESCMM, and SCENIC. A MATLAB table is used as the data format as it is easy to manipulate. A set of identifiers unique to each user—SCMM IDs, NORAD IDs, and HORIZONS IDs—are used to cross-reference between the data sources. For each mission, information from all data sources are compared based on a source hierarchy and the data that is deemed most accurate is stored in the database, and the name of the data source is stored in a reference table. This database combines and augments the three parent databases to construct the most accurate det of data available
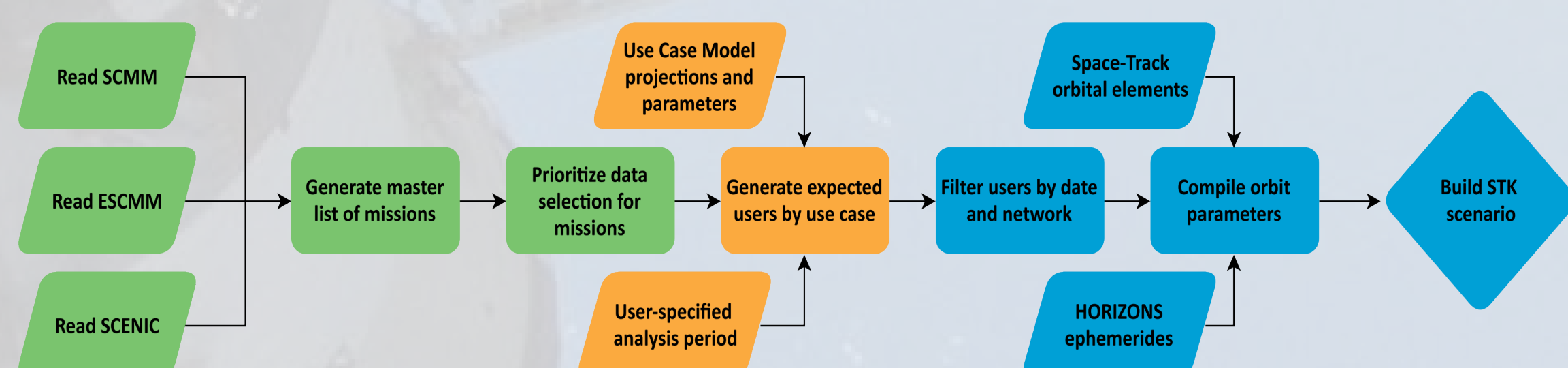
This flowchart shows the major operations of the final code structure.

Building an Interactive Model

Once this central database was constructed, additional supporting scripts were developed to import sets of missions into an analysis environment. As the industry standard, Systems ToolKit (STK) was chosen for this environment. A Graphic User Interface (GUI) was added to our program that allowed the user to choose any 30-day period to analyze. From this input, the script ran through the entire database and assembled a list of missions active in that time frame. Using MATLAB's interfacing abilities, these missions were passed to STK, where they are automatically plotted on their appropriate orbits. The interactive mission model created in STK from this set of missions could be used by network engineers to run many different studies to analyze all three networks, the NEN, the SN, and the DSN.

An STK scenario created for a 30-day period in 2020 showing satellite orbits

Results

The final MATLAB program and supporting scripts can automatically generate a completed STK scenario for a specified time period. They are also capable of combining and augmenting most available data into a central database without additional operator input. This database is then used to create adaptable STK instances that can be used to analyse the networks. Besides the direct capabilities of the program, several additions were proposed and accepted to the two databases managed by SCaN. These included adding NORAD IDs to all current missions and specifying if a mission was a secondary payload on a different satellite. These modifications make cross referencing with other databases far easier for software and human operators alike.

Conclusion

The central database and mission model created by our team of interns will be a valuable prototype towards the development of a more robust, adaptable, and capable system constructed by NASA network and database engineers. It adequately shows the advanced capabilities that will be provided by a system of this type. A mission ready version of this program would allow network engineers to easily perform network analyses and quickly vary the starting parameters to test many different scenarios. With enough development, human maintenance of the parent databases could be phased out in favor of an automated system where each NASA program is responsible for adding and updating their missions. A fully developed, central database of NASA missions would be an invaluable asset to countless centers and well worth the time and effort to construct and maintain.