Overview of Presentation

- Coordinate Systems
  - Types of coordinate systems currently used.
  - How these coordinate systems relate to a planetary object.
  - What values are used to describe position within each type.
- Matrix Transformations
  - History of these types of calculations.
  - How to transform between different coordinate systems.
- Global Positioning System
  - What the system does.
  - How it is used for position determination.
  - How the system may be used in the future.

Coordinate Matrix Transformation Process

- The transformation process requires solving three simultaneous equations through a matrix calculation.
- The transformation of coordinate systems is required between spacecraft (S/C) and ground-based coordinate systems outside of the spacecraft orbit.
- The transformation of coordinate systems is required to position the S/C to a particular orbit in space.
- The transformation of coordinate systems is used to address an offset of change of position on the S/C of an instrument for field of view.

How Global Positioning System (GPS) Works

- GPS consists of three components: a space segment of GPS satellites, a control segment that monitors and operates those satellites, and a user segment that receives signals from the satellites.
- GPS uses a system of satellites to provide a global navigation service.
- GPS satellites emit signals that are received by GPS receivers on the ground, which then use the signals to calculate their position and time.

The Impact to the IV&V analysis efforts

- Validation of the Requirements for Pointing Accuracy.
  - E.g. Attitude Correction Systems (ACS).
  - E.g. Inertial Measurement Unit (IMU).
- Validation of the Requirements for Attitude Accuracy.
  - E.g. Attitude Correction Systems (ACS).
  - E.g. Optical Navigation (ON).

GPM & MMS use GPS for Spacecraft Navigation

- The Global Precipitation Measurement Mission (GPM) and the Magnetospheric Multiscale Mission (MMS) utilize the same GPS system.
- The spacecraft uses GPS signals to determine its position and orientation.

Conclusions

- The transformation understanding allowed the NASA IV&V to clearly understand the complete understanding of external navigation.
- The GPM Navigation is utilized for both the GPM and MMS spacecraft, providing a robust and accurate navigation solution that is used for both spacecraft.
- The improved data sets and processing tools used for GPM have been successfully applied to other spacecraft missions.

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