



ITT Industries

Engineered for life

GPS IIR On-Orbit Analysis

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Agenda



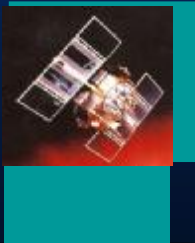
- ITT's history with GPS
- Mission Support using STK
- On-Orbit Data Analysis
- Analysis Animation
- Conclusion



History of ITT's Contribution to the Advanced Development for GPS



GPS Block II/IIA



Developed Advanced Block IIR Payload with

- AUTONAV
- CROSSLINK
- TKS
- On-Orbit Reprogrammability

GPS Block IIR (1997)



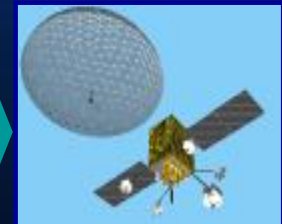
GPS Block IIRM (2003)



GPS Modernization

- Flexible Signal Structure
- Enhanced Signal Security
- Adjustable Signal Power

Future GPS



Generated the GPS Signal For

- Block I
- Block II
- Block IIA

Feasibility Study

- Smart Payload
- Networking
- High Speed Uplink/Downlink
- Signal-On-Demand
- High Speed Crosslink

GPS Block I



Generated GPS Signal Since Inception



ITT GPS Operations Support



- Support Pre Launch Test & Checkout to Ensure that the Total Navigation Payload (TNP) Portion of the GPS Block IIR SV is flight worthy.
- Support On Orbit Test, Operation, & Anomaly Resolution Activities to Ensure the TNP Portion of the GPS Block IIR SV is always operating at Optimal Levels
- Investigate Iterative Enhancements, Study Topics, etc that Continuously Improve the Signal-In-Space Accuracy & Maintainability of the GPS Block IIR TNP



ITT Mission Support using STK



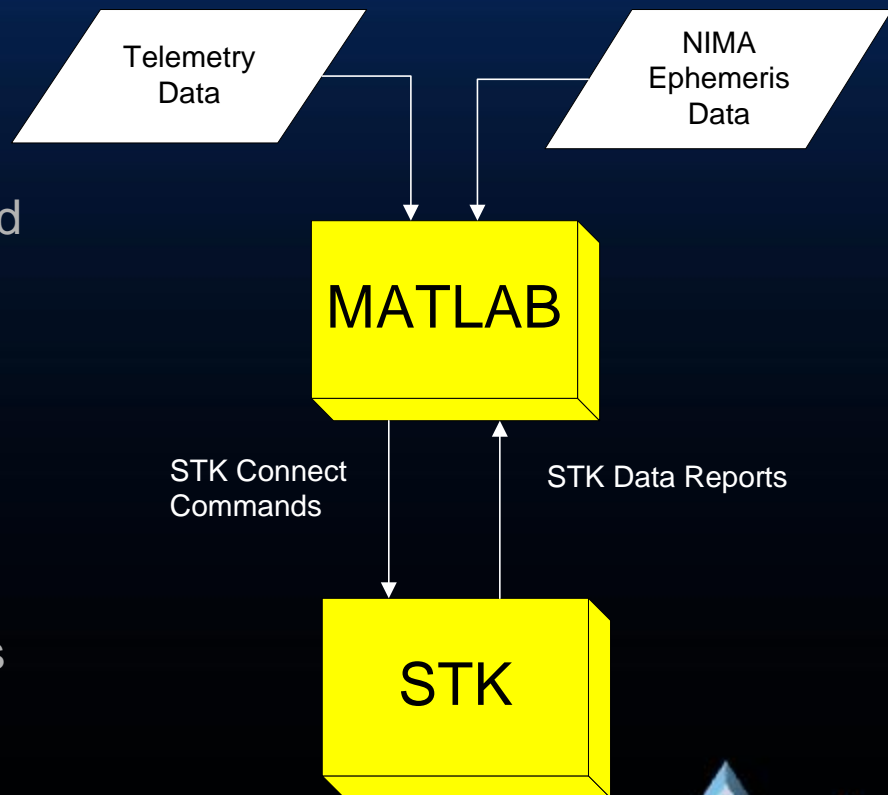
- ITT uses Matlab and STK as a powerful tool to quickly analyze, visualize, solve and make recommendations to the customer
- Analysis Example demonstrates use of the following STK modules:
 - STK/Comm
 - STK/PRO
 - STK/VO
 - STK/Connect
 - STK/MATLAB



On-Orbit Data Analysis: Overview



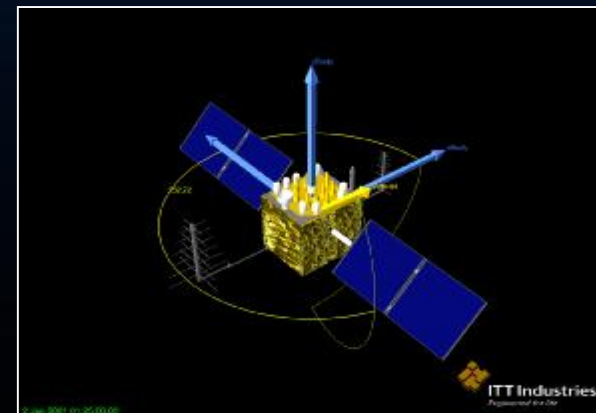
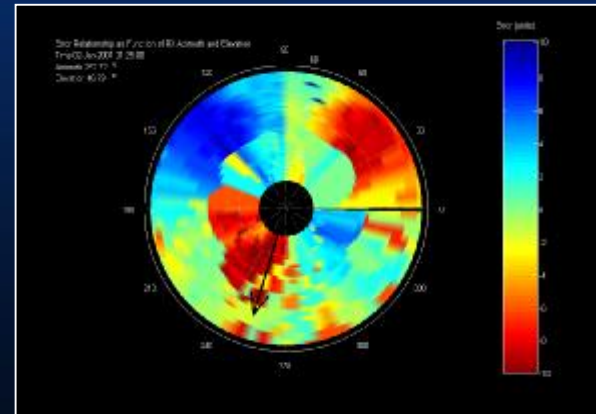
- The analysis example demonstrates how STK may be used in a TNP anomaly resolution study
 - Satellite telemetry data is correlated with vehicle attitude, orbit position, etc.
 - STK provides computation and visualization of satellite link geometry and vehicle attitude relationships
 - Matlab provides numerical analysis and plotting capability



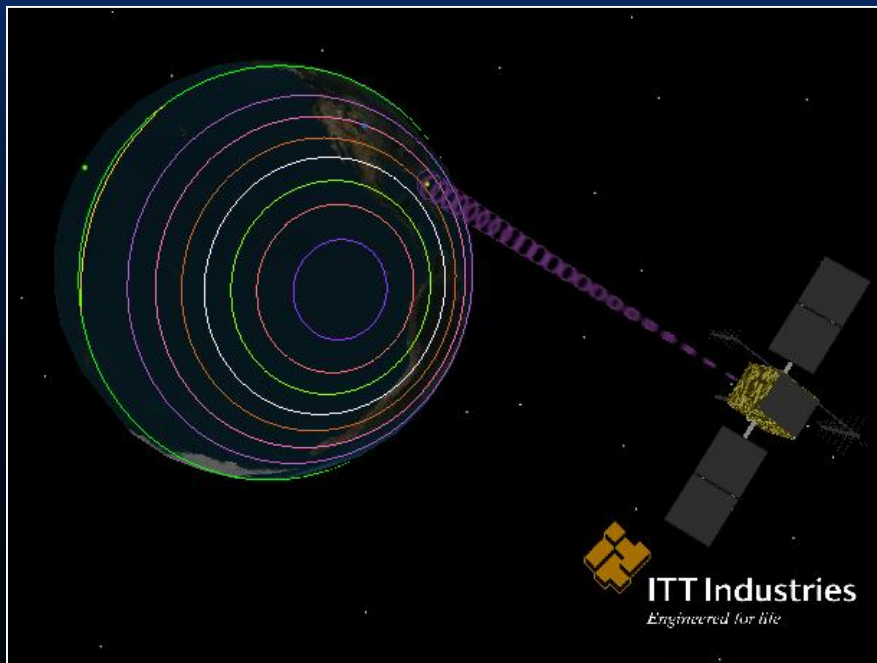
On-Orbit Data Analysis: Attitude Correlation



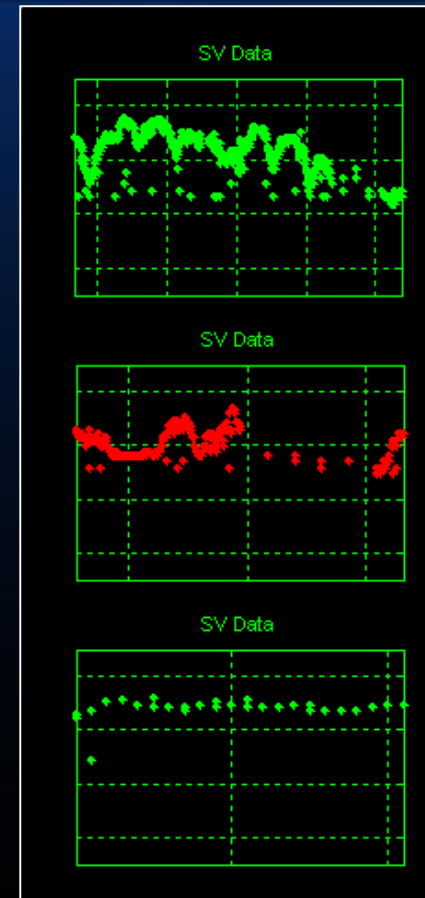
- Access
 - Determine inter-satellite range and create a position vector to transmitting satellite
- Vector Geometry Tool
 - Define new local x-axis vector
 - Define new angle between x-axis vector and position vector of access satellite
- STK/MATLAB
 - Request AER report and custom Angle report, use Matlab for data correlation



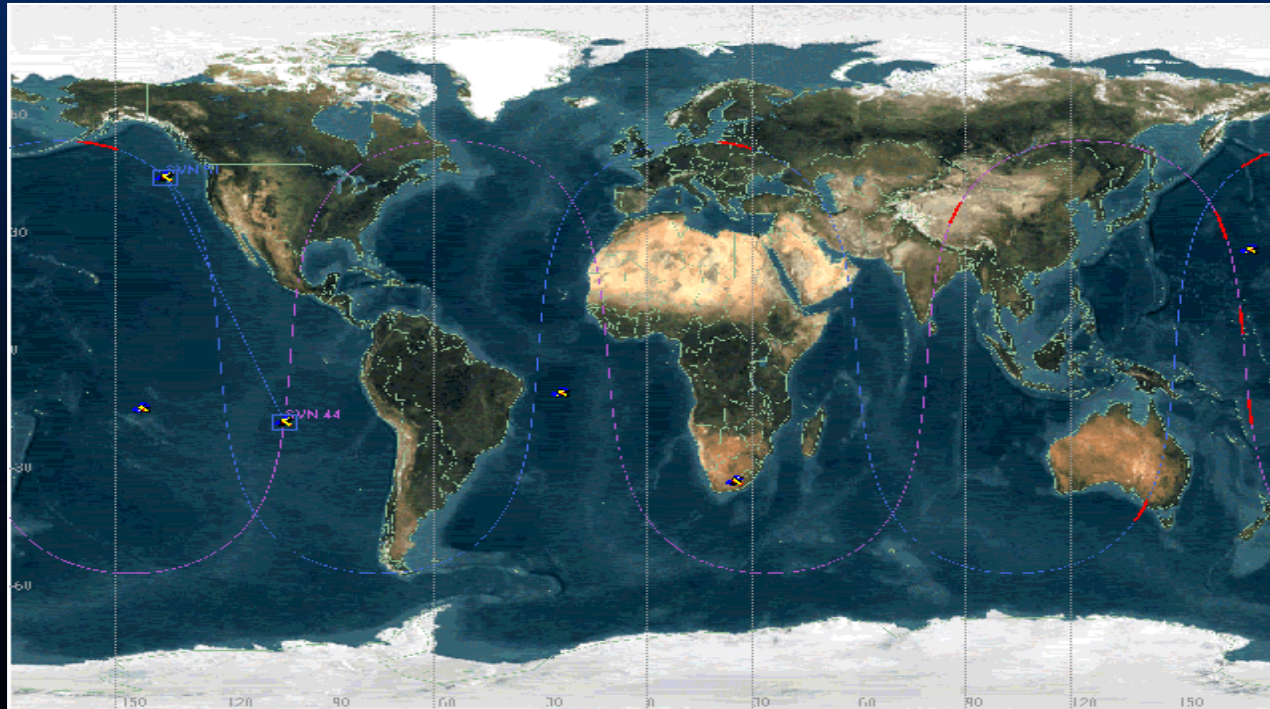
On-Orbit Data Analysis: Orbital Position Correlation



- Use STK external sensors to view angles from a satellite offset (Matlab Controlled)
- STK/Matlab Interface used to correlate and plot satellite data

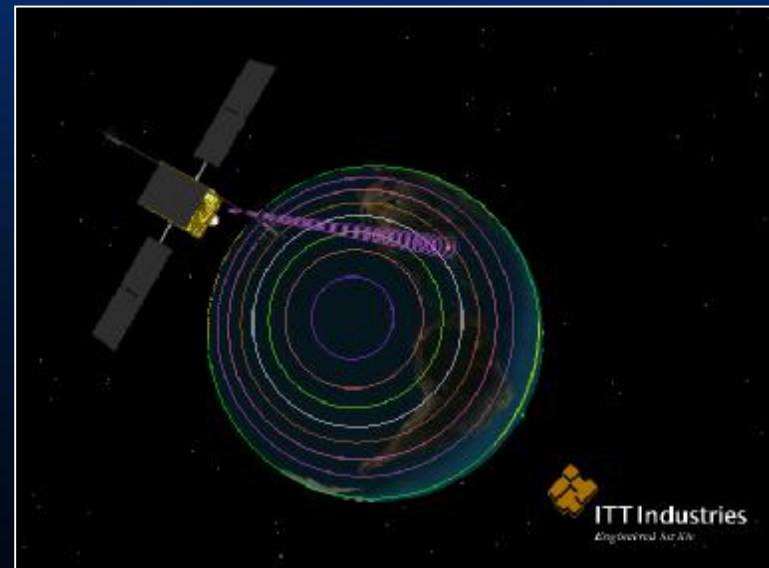


On-Orbit Data Analysis: Orbital Position Correlation



- Matlab is used to automate custom intervals (red) in STK
- Red interval period on ground track indicates missing data

On-Orbit Data Analysis: Crosslink Simulation and Visualization

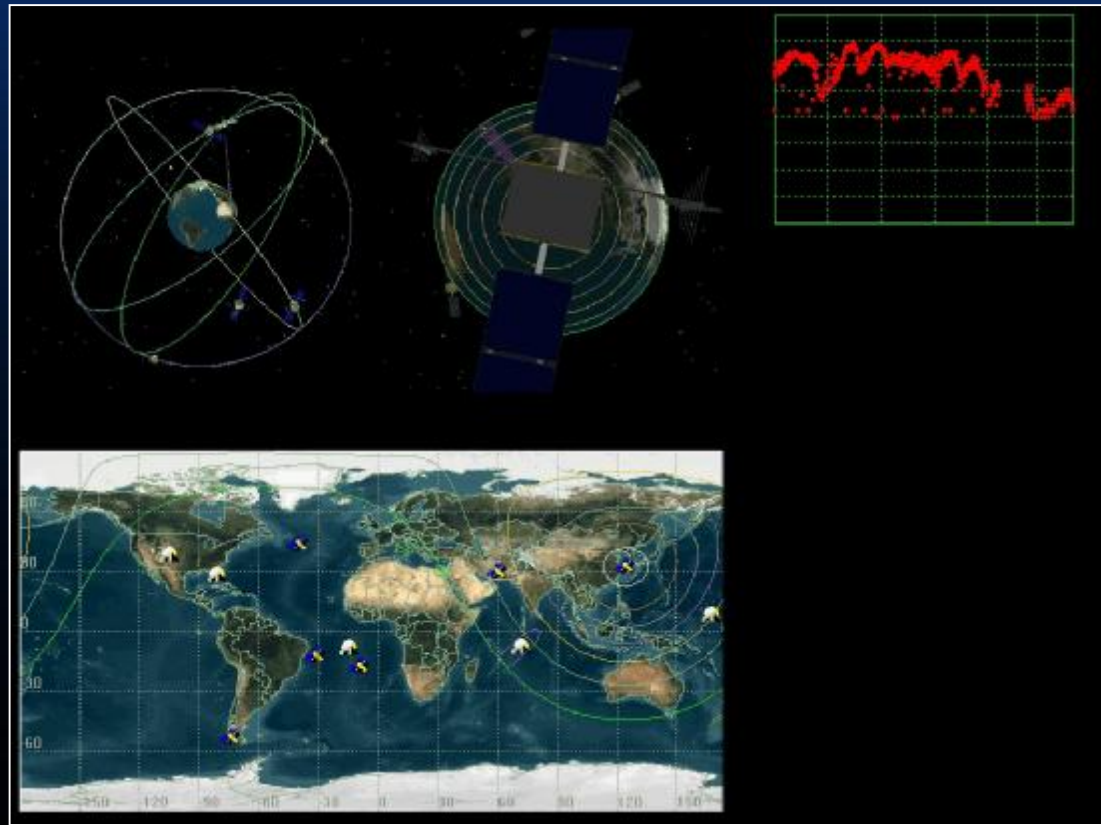


- GPS crosslink simulated using sensors and intervals for display
- STK/Matlab Interface used to generate and input display intervals from telemetry

- Simulated S-Band contact using sensor and display intervals periods from Matlab
- External antenna file used to produce contour lines

On-Orbit Data Analysis: Animation II

- **Use STK Matlab/Connect to drive simulation**
 - Actual satellite data used for simulation
 - Simulated S-Band and crosslink sensors
 - STK Animation commands
- **View patterns from different perspectives**
 - 2D Map
 - 3D Earth-Centered View (View of entire constellation)
 - 3D Custom View (Zoomed in view of satellite)
- **Use STK external sensors to view angles from a satellite offset**



Conclusion



- ITT has used STK as a powerful tool for both analysis and visualization
- Using these COTS technology tools reduces software development and related maintenance costs
- STK modules allow for many different tools to aid in analysis
- Results in a quick turnaround time to report analysis results to the customer

