



PSP GN&C, Glue, and 42 Independent Dynamics for Independent Testing



Mark Suder Systems Engineer TMC Technologies NASA's IV&V Program



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BLUF – Why?

- NASA's Independent Verification and Validation Program
 - Key: Independence



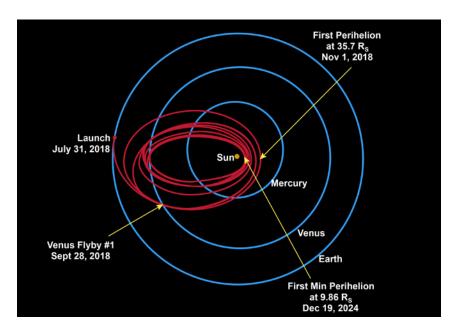
- Managerially, financially, technically
- Software within the system focus
- NASA IV&V Engineer concern:
 - Single truth/FSW GN&C Matlab/Simulink model developed by the SPP project
 - Can IV&V have an independent truth source?





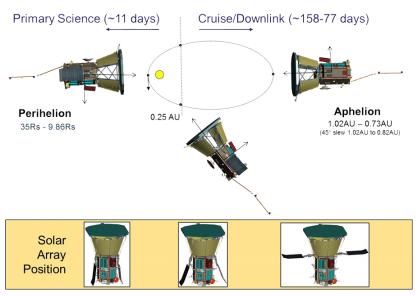


Parker Solar Probe (PSP)



- Protected by a 4.5-inch-thick carboncomposite shield
- Withstand temperatures that reach nearly 2,500 degrees Fahrenheit
- Pointing is <u>incredibly</u> important!

- Swoop closer to the Sun's surface than any spacecraft before it
- Face brutal heat and radiation conditions





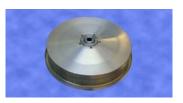




Sensors/Actuators

- Star Trackers
- Reaction Wheel Motors/Tachometers
- Solar Limb Sensors
- Digital Sun Sensors
- IMU/Gyroscopes/Accelerometers
- Thrusters
- Solar Array Motors/Potentiometers
- High Gain Antenna Motor/Potentiometers

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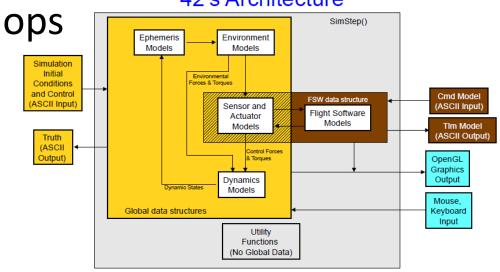


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An Independent Dynamics Source

- Developed by Eric Stoneking, GSFC
- A simulation of spacecraft attitude and orbital dynamics and control
- Intended for use from concept studies through 42's Architecture







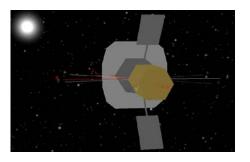




IV&V and JSTAR

- IV&V
 - Perform analysis of software artifacts for a project
 - Requirements, Design, Code, Test, etc.
- JSTAR developers
 - Experts in simulations
 - Build tools used by IV&V analysts to do their job
- Sam Brown, IV&V Analyst, started the PSP Testbed
- JSTAR developers:
 - Re-architected environment
 - Modularized environment
 - Added sensor and actuator models



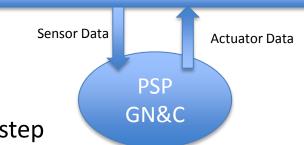






Glue

- PSP GN&C cFS app using S/W bus messages
 - Sensor data in
 - Actuator data out
- 42 architecture:
 - Allows call out to flight S/W each integration step
- JSTAR wrote the Glue Code
 - 42 dynamics data position, velocity, acceleration, attitude, sun vector, wheel speeds, joint positions
 - Convert to body/sensor frame and then to sensor signals
 - Pass in to PSP GN&C as the software bus message data structures
 - PSP GN&C actuator control messages
 - Received by glue code and converted to 42 actuator commands
 - Thruster firing, reaction wheel torques, motor movements















Inputs and Outputs

- Parameter Files
 - Ephemeris, mass props, etc.
- Command Files
 - Load ephemeris, report parameters, set control parameters
- CSV Reports

Easily plot inputs/outputs

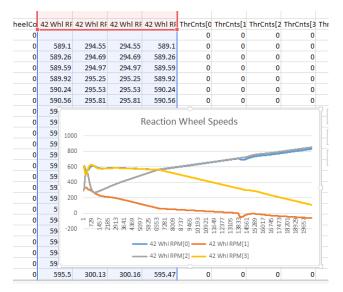
2.6484 ! Mass 0.0513 0.0518 0.0767 ! Moments

 0.0513
 0.0518
 0.0767
 ! Moments of Inertia (kg-m^2)

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 ! Products of Inertia (xy, xz, yz)

 0.0018
 0.1110
 0.1206
 ! Location of mass center, m

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0.0 SC[0] LoadEphemerisFile spp ephemeris 0p25out.txt ! %s should be the name of a file in
0.0 SC[0] GetParameter Name=GCC.SPGUID.SlopeAngOverParrays v Ds Ds Type=double Dimension=8
0.0 SC[0] GetParameter Name=GCC.SPGUID.SlopeAngOverParrays v Ds Slope Type=double Dimension=8
0.0 SC[0] GetParameter Name=GCC.SPGUID.Pwing PCPeri gain Type=double Dimension=8
0.0 SC[0] GetParameter Name=GCC.SPGUID.ElecOverThermPowerRatio Type=double Dimension=1
0.0 SC
         PlatenTemperature[0] 80 ! Set the platen temperature to the specified degrees Celcius -
0.0 SC[0] PlatenTemperature[1] 80 ! Set the platen temperature to the specified degrees Celcius
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         SAShortCircuitCurrent[1] 0.05 ! Set the solar array short circuit current
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Video





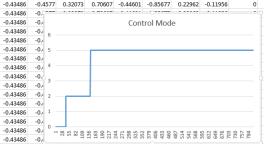






Advantages/Disadvantages

- Advantages
 - Using PSP auto generated & hand generated code
 - 42 makes it easy to call out... just set/get data at appropriate rates for PSP GN&C
 - Extensive CSV reporting of GN&C inputs, outputs, intermediate results, 42 truth data
 - Independent truth model
- Disadvantages



- Took some time / GN&C expertise to develop







IV&V Uses

- Testing
 - Ability to independently test how the software will behave under adverse conditions
- Learning how the sensors/actuators really work and interact



- A huge benefit not necessarily thought of at the beginning
- Just starting to really leverage the testbed

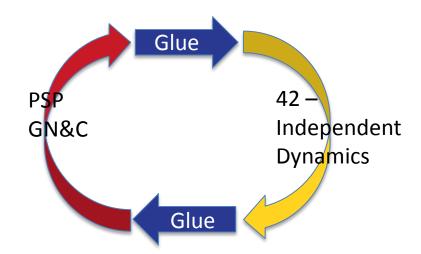






Bottom Line

- Bottom line why this is important
 - Provides independent testing capability based on IV&V identified need



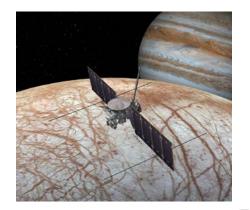






Future

- Future on SPP
 - Hope to get more IV&V analyst use as a testing and learning tool
- Future on other missions
 - Pathfinder, shows it is possible
 - We went closed loop!







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The End!

• Questions?

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