Presentation for the GSAW 2007 Conference

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The Critical Link Between Space and Earth

• A properly designed ground system is critical to mission success.
  ➢ Provides mission controllers and data users with necessary access to spacecraft
  ➢ Smart design leverages existing standards, capabilities, and infrastructure and keeps costs down.

• Cardinal rule: keep it simple.

*Things should be made as simple as possible, but not any simpler.*
- Albert Einstein
Mission Development Time vs. Operations Time

- Ops time exceeds development time on average
- Begin using ground systems capability around time of I&T

<table>
<thead>
<tr>
<th>Mission</th>
<th>Development Time (years)</th>
<th>Operations Time (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Terra</td>
<td>6</td>
<td>7 (ongoing)</td>
</tr>
<tr>
<td>MER</td>
<td>3</td>
<td>3 (ongoing)</td>
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<tr>
<td>MGS</td>
<td>3</td>
<td>10</td>
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<tr>
<td>Mars Odyssey</td>
<td>4</td>
<td>6 (ongoing)</td>
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<tr>
<td>TOMS-EP</td>
<td>5</td>
<td>10 (ongoing)</td>
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<tr>
<td>Landsat 4</td>
<td>3</td>
<td>18.5</td>
</tr>
<tr>
<td>Landsat 5</td>
<td>3</td>
<td>27 (ongoing)</td>
</tr>
<tr>
<td>POES**</td>
<td>3</td>
<td>15</td>
</tr>
<tr>
<td>UARS</td>
<td>4*</td>
<td>14</td>
</tr>
<tr>
<td>TIMED</td>
<td>4</td>
<td>5 (ongoing)</td>
</tr>
<tr>
<td>Swift</td>
<td>4</td>
<td>2 (ongoing)</td>
</tr>
<tr>
<td>GRO</td>
<td>4*</td>
<td>9 years</td>
</tr>
<tr>
<td>HESSI</td>
<td>4</td>
<td>5 (ongoing)</td>
</tr>
<tr>
<td>AVERAGE</td>
<td>~3.8</td>
<td>~10.1</td>
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</tbody>
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* Development time does not include Challenger-related delays
** Average development and operations times
Built to Last

Ten Years and Three Billion Miles...

2007-2014
For most of the eight-year task from Jupiter to Pluto, the spacecraft will spend nearly a year of "hibernation," according to a team of experts at "sleeping peacefully." But for about 90 days, it will be awakened to conduct an intensive set of observations and science observations.

2014

January-March 2014
If the spacecraft encounters during the first three weeks of its launch window, it may fly by Jupiter and swing up to three years at right angles to the spacecraft's gravity center provided by the giant planet. The heliocentric view of this figure shows a spacecraft entering a launch window during the first 17 days of the launch window.

July 2014
During the fly-by of Pluto, the spacecraft will be observed at least once from Earth. This fly-by will occur approximately 45 days after the launch window.

Fall 2014
Regular monitoring begins about 90 days before the spacecraft's closest approach to Pluto.

2015-2016
With Pluto's closest approach, the spacecraft will be observed more than once from Earth. This fly-by will occur approximately 24 hours after the launch window.

2016-2017
With the closest approach to Pluto, the spacecraft will be observed more than once from Earth. This fly-by will occur approximately 45 days after the launch window.

2017-2020
With the closest approach to Pluto, the spacecraft will be observed more than once from Earth. This fly-by will occur approximately 24 hours after the launch window.

2020-2021
With the closest approach to Pluto, the spacecraft will be observed more than once from Earth. This fly-by will occur approximately 45 days after the launch window.

2021-2023
With the closest approach to Pluto, the spacecraft will be observed more than once from Earth. This fly-by will occur approximately 24 hours after the launch window.

2023-2025
With the closest approach to Pluto, the spacecraft will be observed more than once from Earth. This fly-by will occur approximately 45 days after the launch window.

2025-2027
With the closest approach to Pluto, the spacecraft will be observed more than once from Earth. This fly-by will occur approximately 24 hours after the launch window.

2027-2030
With the closest approach to Pluto, the spacecraft will be observed more than once from Earth. This fly-by will occur approximately 45 days after the launch window.

2031-2035
With the closest approach to Pluto, the spacecraft will be observed more than once from Earth. This fly-by will occur approximately 24 hours after the launch window.
Technical Challenges

• **Interoperability**
  - Multiple vehicles and systems demand common protocols and standards that leverage commercial approaches
  - Standardized interfaces

• **Software** – key driver as hardware becomes more common and COTS-oriented

• **Scalability** – Suitable for both large- and small-scale use

• **Flexibility** – Easy to service and upgrade technology

• **Cost Effectiveness** – Components, equipment, standards, development time
Agency Requirements for Ground Systems

NPR 7120.5D applies to all current and future NASA space flight programs and projects (including spacecraft, launch vehicles, instruments developed for space flight programs and projects, research and technology developments funded by and to be incorporated into space flight programs and projects, critical technical facilities specifically developed or significantly modified for space flight systems, and ground systems that are in direct support of space flight operations).

Applicable program/project reviews include:

- Critical Design Review (CDR)
- Production Readiness Review (PRR)
- Operations Readiness Review (ORR)
- Flight Readiness Review (FRR)

Other product lines will be addressed by:

- **NPR 7120.7** – NASA Institutional Infrastructure and Information Technology Program and Project Management Requirements
- **NPR 7120.8** – NASA Research and Technology Program and Project Management Requirements
Ground Systems: The Center of the Architecture

from integration…

…to operations