Integration of Missions, Programs and Core Technologies (IMPaCT)

Overview

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Topics

- Purpose of presentation
- IMPaCT Overview
- IMPaCT Architecture
- Relationship to OCT TechPort
- IMPaCT Capabilities
- Application Security and Access Control
- Future Versions
- Summary
Purpose of Presentation

- To provide an overview of IMPaCT, its architecture and capabilities
- To describe the key drivers for the development of IMPaCT
- To outline capabilities that IMPaCT offers to the NASA’s Planetary Science Division and planetary mission developers and technologists
- To describe the relationship between IMPaCT and the OCT’s Technology Portfolio Management tool, TechPort
- To outline future capabilities that are being developed for IMPaCT including technology assessment and advanced portfolio analysis
**IMPaCT Overview**

- **Description:** IMPaCT is a web-based database tool designed to support NASA's Planetary Science Division in defining its mission and technology portfolios within resources and operating constraints. Allows portfolios of technologies to be constructed and monitored. The architecture also enables users outside of the PSD to input data and develop portfolios.

- **Scope:** Will contain comprehensive information on
  - Current planetary missions and possible future missions, including studies
  - Current technology development activities
  - Potential technology development activities related to planetary science
  - Selected State of the Practice technologies

- **Purpose:** To provide the user, particularly PSD, the capability to analyze their portfolios and future needs. It will also provide an assessment of the status of technologies and their infusion paths.

- **Status:** The current version of IMPaCT contains missions, studies and partial technology data sets of interest to PSD. Security and access controls that have now been implemented to allow extending use to other NASA Centers.
Current Drivers for the Development of IMPaCT

• The Decadal Survey recommended in March 2011 “the development of a freely available technology database”
  – customized with the information required by new proposals
  – populated by technologies that have been pre-screened by NASA to ensure that they can be infused with manageable risk.

• The Planetary Science Technology Review Panel recommended in July 2011, the development of a comprehensive technology database that would
  – ensure proper documentation and availability of technology data and development progress.
  – ensure that scientists, technologists, and mission planners have understandable and easily accessible information
  – ensure that technology developments are directly traceable to PSD science goals
Related Activities

- NASA’s Office of the Chief Technologist is developing a Technology Portfolio Management system called TechPort
  - TechPort is an online system that provides high level information about NASA funded technology projects
- The IMPaCT team worked on the TechPort development effort through FY12, when the initial TechPort version was released within NASA.
- The IMPaCT team continues to support the TechPort development by participating in the NASA Center Rep working group.
- IMPaCT leverages the data collected in TechPort by
  - Adding data important to PSD mission and technology programs
  - Providing analysis capabilities not available in TechPort
  - Showing the linkages between technologies and missions
IMPaCT Architecture

Mission Sets

Mission
- Approved
- Concept

Is a member of
Mission - Mission Interdependencies

Selected missions

Technology Sets

Technology Element
- Capability
- Development
- Roadmap

Is a member of
Mission - Technology Interdependencies

Required technologies

- Technology - Technology Interdependencies

Portfolio selected by analyst

Apply funding profile or wedge

Missions enabled and enhanced by technology

Adjust launch dates and mission costs

Portfolio “Sand” Chart
Mission Time Line
Dependency Violations
IMPaCT Home Page and Login

Welcome to IMPaCT

Integration of Missions, Programs and Core Technologies (IMPaCT) is a web-based database tool designed to support NASA’s Planetary Science Division in optimizing its mission and technology programs. IMPaCT contains information on current missions and possible future missions. It also contains information on current technology development activities as well as potential technology development activities. IMPaCT enables portfolios of missions and the needed technologies to be constructed and evaluated against resource constraints.

IMPaCT is also a powerful information resource providing information at varying levels of detail on current and potential mission and for ongoing technology developments and roadmaps. IMPaCT can display this information interactively or it can also be downloaded using reporting routines to standard formats such as Adobe .pdf files, MS Excel or MS Word. IMPaCT has been developed at JPL under NASA’s Planetary Science Program Support task for supporting questions raised by NASA about future mission and program scenarios.
Missions/Concepts – Screen Shots

Highlights

• Mission Sets
• Mission/Concept – Listing
• Mission/Concept – Overview
• Mission/Concept – Technical Description
• Mission/Concept – Cost
• Mission/Concept – Dependencies
### Mission Sets

Showing 1 to 15 of 15 sets (filtered from 19 total sets)

<table>
<thead>
<tr>
<th>Mission Set</th>
<th>Description</th>
<th>Agency</th>
<th>Directorate</th>
<th>Division</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discovery (Disc)</td>
<td>The Discovery Program goal is to achieve outstanding results by launching many smaller missions using fewer resources and shorter development times. The main objective is to enhance our understanding of the solar system by exploring the planets, their moons, and small bodies such as comets and asteroids. The program also seeks to improve performance through the use of new technology and broaden university and industry participation in NASA missions.</td>
<td>NASA</td>
<td>Science Missions</td>
<td>Planetary Science</td>
</tr>
<tr>
<td>Discovery Missions of Opportunity</td>
<td>NASA Missions of Opportunity give the U.S. scientific community the chance to participate in non-NASA missions by providing funding for a science instrument or hardware components of an instrument. They also offer the possibility to use an existing NASA spacecraft for a new science investigation. Five Discovery Program Missions of Opportunity have been selected.</td>
<td>NASA</td>
<td>Science Mission Directorate</td>
<td>Planetary Science</td>
</tr>
<tr>
<td>Europa Study 2012</td>
<td>Missions directed toward the study of one of Jupiter's moons, Europa, which may hold the potential for life in deep underground oceans.</td>
<td>NASA</td>
<td>Science Missions</td>
<td>Planetary Science</td>
</tr>
<tr>
<td>In-Space Propulsion Technology (ISPT)</td>
<td>The In-Space Propulsion Program work being performed at the Glenn Research Center develops primary propulsion technologies that can benefit near and mid-term science missions by reducing cost, mass and/or travel times. The In-Space Program is working to develop next generation electric propulsion technologies, including ion and Hall thrusters. Solar Sails, which are a form of propellantless propulsion, are also being developed. Solar Sails rely on the naturally occurring sunlight for the propulsion energy. Other propulsion technologies being developed include advanced chemical propulsion and aerocapture.</td>
<td>NASA</td>
<td>Science Missions</td>
<td>Planetary Science</td>
</tr>
<tr>
<td>Mars Exploration Program</td>
<td>The Mars Exploration Program is a science-driven program that seeks to understand whether Mars was, is, or can be, a habitable world. To find out, we need to understand how geologic, climatic, and other processes have worked to shape Mars and its environment over time, as well as how they interact today. Includes past, current and possible future Mars Exploration missions. Does not include Discovery missions or Mars Scouts (which are now part of the Discovery Program).</td>
<td>NASA</td>
<td>Science Missions</td>
<td>Planetary Science</td>
</tr>
</tbody>
</table>
### Missions/Concepts - Listing

<table>
<thead>
<tr>
<th>Mission Set</th>
<th>Opportunity</th>
<th>Mission/Concept</th>
<th>Target Body</th>
<th>Nominal Launch</th>
<th>Latest Study</th>
<th>CML</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decadal Survey Mission and Technology Studies 2010</td>
<td>Discovery or New Frontiers</td>
<td>Mars Polar Climate Mission</td>
<td>Mars</td>
<td>2010</td>
<td>CML 2</td>
<td></td>
</tr>
<tr>
<td>Discovery</td>
<td>Discovery 6</td>
<td>Comet Nucleus Tour (CONTOUR)</td>
<td>Mission to fly by three comet nuclei</td>
<td>2007</td>
<td>2006</td>
<td>CML 9</td>
</tr>
<tr>
<td>Discovery</td>
<td>Discovery 9</td>
<td>Dawn</td>
<td>Asteroids - Vesta and Ceres</td>
<td>2001</td>
<td>2006</td>
<td>CML 9</td>
</tr>
<tr>
<td>Discovery</td>
<td>Discovery 8</td>
<td>Deep Impact</td>
<td>Comet Temple 1</td>
<td>2001</td>
<td>2006</td>
<td>CML 9</td>
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<tr>
<td>Discovery</td>
<td>Discovery 5</td>
<td>Genesis</td>
<td></td>
<td>2001</td>
<td>2006</td>
<td>CML 9</td>
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<tr>
<td>Discovery</td>
<td>Discovery 11</td>
<td>Gravity Recovery and Interior Laboratory (GRAIL)</td>
<td>Moon</td>
<td>2011</td>
<td>2011</td>
<td>CML 9</td>
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<tr>
<td>Discovery</td>
<td>Discovery 12</td>
<td>Insight</td>
<td>Mars</td>
<td>2011</td>
<td>2011</td>
<td>CML 9</td>
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<tr>
<td>Discovery</td>
<td>Discovery 10</td>
<td>Kepler</td>
<td>Extra-Solar Earth-Like Planets</td>
<td>2009</td>
<td>2009</td>
<td>CML 9</td>
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<td>Discovery</td>
<td>Discovery 3</td>
<td>Lunar Prospector</td>
<td>Earth's Moon</td>
<td>2009</td>
<td>2009</td>
<td>CML 9</td>
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<tr>
<td>Discovery</td>
<td>Discovery 2</td>
<td>Mars Space Environment, Astrobiology, Geophysics, and Resources (MAG)</td>
<td></td>
<td>2013</td>
<td>2013</td>
<td>CML 9</td>
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<tr>
<td>Discovery</td>
<td>Discovery 7</td>
<td>Mars Pathfinder</td>
<td>Mars</td>
<td>2013</td>
<td>2013</td>
<td>CML 9</td>
</tr>
<tr>
<td>Discovery</td>
<td>Discovery 1</td>
<td>Near Earth Asteroid Rendezvous</td>
<td>Asteroid 433 Eros</td>
<td>2009</td>
<td>2009</td>
<td>CML 9</td>
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<tr>
<td>Discovery</td>
<td>Discovery 2</td>
<td>Phoenix Lander</td>
<td>Mars</td>
<td>2009</td>
<td>2009</td>
<td>CML 9</td>
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<td>Discovery</td>
<td>Discovery 4</td>
<td>Stardust</td>
<td>Comet Wild 2</td>
<td>1999</td>
<td>1999</td>
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<td>Discovery Missions of Opportunity</td>
<td>Missions of Opportunity</td>
<td>EPOXI</td>
<td>Hartley 2</td>
<td>2013</td>
<td>2013</td>
<td>CML 9</td>
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<td>Missions of Opportunity</td>
<td>Stardust NEXT</td>
<td>Tempel 1</td>
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<td>2013</td>
<td>CML 9</td>
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<tr>
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<td>Strofo</td>
<td>Mercury</td>
<td>2013</td>
<td>2013</td>
<td>CML 9</td>
</tr>
</tbody>
</table>
The proposed Mars 2018 MAX-C caching rover mission would launch NASA's MAX-C and ESA's ExoMars rovers and land them together on a pallet using the "Sky Crane" concept developed for MSL. The strawsman instrument set includes a panoramic camera, a near-infrared (NIR) spectrometer, a microscopic imager, an Alpha Particle X-Ray Spectrometer (APXS), and a dual wavelength Raman spectrometer. These instruments would locate, study, and select samples for possible return to Earth. These samples would be acquired and encapsulated by MAX-C's sampling handling system and deposited in a cache or a backup cache. The caches would be placed on the surface of Mars to await retrieval by a fetch rover from the proposed future Mars Sample Return mission.

The proposed MAX-C rover 2018 mission would be launched in May 2018 on a NASA-supplied Atlas V 531-class launch vehicle on a Type 1 trajectory and would arrive approximately 8 months later in January 2019, at the tail end of the martian dust storm season. The rovers would land in a region of Mars between latitudes 25°N and 15°S.

The rovers would be enclosed in an aeroshell inside the cruise stage for the duration of cruise. Prior to atmospheric entry, the

Source: Planetary Science Decadal Survey (2011)
Mission Concept: Mars Astrobiology Explorer-Cacher

Technical Description

Technical Summary:

Needed Technology Developments:
This mission concept would require the development of several capabilities prior to the mission preliminary design review (PDR). The technology challenges are described below.

Sample Acquisition and Propagation:
NASA has limited experience in planetary sample acquisition. On Mars, the experience is limited to Viking and Phoenix scoops for sampling regolith. The proposed MAX-C rover would acquire rock cores.

Launch Vehicle:
Atlas V 551 – class vehicle (baseline)

Durations (number of months)

Cruise(s): 8
Operations: 24

Architectural Trades

Key Trades:
The MAX-C team has already addressed a number of key trades, some of which strongly benefited from the MSL extensive review and similar trades during its design. Many of these trades focus on the landing system. For both MSL and the proposed 2018 mission, extensive reviews of the airbag architecture (Mars Pathfinder, MER) versus the Sky Crane architecture (MSL) versus the legsged lander (Viking, Phoenix) have been conducted. In addition, the capability of landing on a pallet versus landing on wheels has been newly explored for 2018. In order to accommodate the two rovers, the team also reviewed the implications of staying with an aeroshell size of 4.5 m or increasing the aeroshell to a diameter of 4.7 m. The team also studied the shape of the

Technology Trades

Source: Planetary Science Decadal Survey (2011)
IMPaCT Overview of Capabilities 
May 15, 2013
### Mission Concept: Mars Astrobiology Explorer-Cacher (MAX-C)

#### Mission Funding Profile

**Funding Base Year**: 
- **Real Year**
- **Start Year**: 
  - Year (Relative)
  - Year (Fiscal) 2011
- **Funding Period Definition**: 10 Year(s)

**Use Generic Funding Profile**

#### Funding Profile Based on "Discovery Generic Mission Funding Profile"

<table>
<thead>
<tr>
<th>Year (Fiscal)</th>
<th>Cost in $</th>
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<tr>
<td>2011</td>
<td>980</td>
</tr>
<tr>
<td>2012</td>
<td>2830</td>
</tr>
<tr>
<td>2013</td>
<td>5830</td>
</tr>
<tr>
<td>2014</td>
<td>20030</td>
</tr>
<tr>
<td>2015</td>
<td>45830</td>
</tr>
<tr>
<td>2016</td>
<td>47020</td>
</tr>
<tr>
<td>2017</td>
<td>45240</td>
</tr>
<tr>
<td>2018</td>
<td>36950</td>
</tr>
<tr>
<td>2019</td>
<td>5850</td>
</tr>
<tr>
<td>2020</td>
<td>4920</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>2225.60</strong></td>
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</tbody>
</table>

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**Source**: Planetary Science Decadal Survey (2011)

IMPaCT Overview of Capabilities

May 15, 2013
### Mars Astrobiology Explorer-Cacher

#### Technology Dependencies

<table>
<thead>
<tr>
<th>Dependent</th>
<th>Would Depend Upon</th>
<th>Priority</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mission Concept</td>
<td>Mars Astrobiology Explorer-Cacher</td>
<td>Max-C Specific Technologies</td>
<td>1</td>
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<tr>
<td>Mission Concept</td>
<td>Mars Astrobiology Explorer-Cacher</td>
<td>Instrument Technology Funding Total</td>
<td>3</td>
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</table>

Both the Raman and NIR spectrometers are being developed under the NASA Planetary Instrument Definition and Development Program.

#### Mission Dependencies

<table>
<thead>
<tr>
<th>Dependent</th>
<th>Would Depend Upon</th>
<th>Priority</th>
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</thead>
<tbody>
<tr>
<td>Mission Concept</td>
<td>Mars 2018 Sky Crane</td>
<td>1</td>
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</table>

#### Dependents

<table>
<thead>
<tr>
<th>Dependent</th>
<th>Would Depend Upon</th>
<th>Priority</th>
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</thead>
<tbody>
<tr>
<td>Mission Concept</td>
<td>Mars Sample Return Orbiter</td>
<td>1</td>
</tr>
<tr>
<td>Mission Concept</td>
<td>Mars Sample Return Lander</td>
<td>1</td>
</tr>
</tbody>
</table>

The Mars Astrobiology Explorer Cacher must successfully cache a core sample before the Mars Sample Return Lander mission is initiated.
Technology – Screen Shots

Highlights

• Technology Sets
• Technology Element – Overview
• Technology Element – Performance
• Technology Element – Milestones
# Technology Sets

<table>
<thead>
<tr>
<th>Category</th>
<th>Technology Set Name</th>
<th>Description</th>
<th>Agency</th>
<th>Directorate</th>
<th>Division</th>
<th>Roadmap</th>
</tr>
</thead>
<tbody>
<tr>
<td>Funded Development</td>
<td>Advanced Radioisotope Power Systems Program</td>
<td>Currently funded technology developments for Radioisotope Power Systems, including MARITUG and the Stellar RPS.</td>
<td>NASA</td>
<td>Science Missions</td>
<td>Planetary Science</td>
<td>Edit</td>
</tr>
<tr>
<td>Funded Development</td>
<td>Center Innovation Funds: GSFC</td>
<td>The purpose of the Center Innovation Fund is to stimulate and encourage creativity and innovation within the NASA Centers in addressing the technology needs of NASA and the nation. Funds will be distributed to each NASA Center to support emerging technologies and creative initiatives that leverage Center talent and capabilities. NASA scientists and engineers will lead projects but partnerships among Centers and with other agencies, academic laboratories, academic and private industry are encouraged. The individual Centers will have full discretion on the use of the funds and the Center Chief Technologists will coordinate a competitive process at their Center for the selection of projects. Centers will report on progress periodically and the program office at NASA Headquarters will evaluate the Center efforts on an annual basis.</td>
<td>NASA</td>
<td>Space Technology Mission Directorate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Funded Development</td>
<td>Center Innovation Funds: JPL</td>
<td>The purpose of the Center Innovation Fund is to stimulate and encourage creativity and innovation within the NASA Centers in addressing the technology needs of NASA and the nation. Funds will be distributed to each NASA Center to support emerging technologies and creative initiatives that leverage Center talent and capabilities. NASA scientists and engineers will lead projects but partnerships among Centers and with other agencies, academic laboratories, academic and private industry are encouraged. The individual Centers will have full discretion on the use of the funds and the Center Chief Technologists will coordinate a competitive process at their Center for the selection of projects. Centers will report on progress periodically and the program office at NASA Headquarters will evaluate the Center efforts on an annual basis.</td>
<td>NASA</td>
<td>Space Technology Mission Directorate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Funded Development</td>
<td>DSN Technology Planning and AMMOS Program</td>
<td>Support upgrades and improvements to the Deep Space Network (DSN) and the Advanced Multimission Operating System (AMMOS)</td>
<td>NASA</td>
<td>Science Missions</td>
<td></td>
<td>Edit</td>
</tr>
<tr>
<td>Funded Development</td>
<td>Flight Opportunities Program</td>
<td>NASA depends on advances in technology, and yet, space-based and space-based applications of promising technologies remain one of the most difficult of all NASA missions. High costs and risk of flight demonstration to incorporate advanced technologies into future missions have been a great challenge to NASA. Selecting payoffs on commercial parabolic and satellite vehicles will bridge the fast &quot;valley of death&quot; and help move technologies rapidly to maturity. The technology elements included in the technology set are those relevant to planetary science missions. See the URL for the full set of OCT flight opportunity program technologies.</td>
<td>NASA</td>
<td>Office of the Chief Technologist</td>
<td></td>
<td>Edit</td>
</tr>
<tr>
<td>Funded Development</td>
<td>Game Changing Technologies</td>
<td>The Game Changing Development Program seeks to identify and rapidly mature innovative and impactful capabilities and technologies for infusion in a broad array of future NASA missions. Multiple performing teams using varied approaches will attempt to achieve selected high impact challenge goals. Performing teams are held accountable for ensuring that discoveries move rapidly from the laboratory to application. The Game Changing Development Program portfolio will produce both autonomous and advanced technologies that will produce transformative and impactful technologies for future space systems in preparation for flight demonstration.</td>
<td>NASA</td>
<td>Office of the Chief Technologist</td>
<td></td>
<td>Edit</td>
</tr>
<tr>
<td>Funded Development</td>
<td>In-Space Propulsion Technology Program</td>
<td>The In-Space Propulsion Program managed by the Glenn Research Center develops new generation electric propulsion technologies that can benefit near and end-of-life science missions by reducing mass and travel times. The In-Space Propulsion Program is working to develop next-generation electric propulsion technologies, including high power solar electric propulsion (SEP), Hall thruster hybrid thruster, and hybrid electrothermal thruster technologies, in preparation for flight demonstration.</td>
<td>NASA</td>
<td>Science Missions</td>
<td>Planetary Science</td>
<td>Edit</td>
</tr>
</tbody>
</table>
Technology Element – Overview: UltraFlex SOP

State of the Practice: “UltraFlex”

UltraFlex is an accordion-fold, flexible-blanket solar array comprising interconnected, triangular, ultra-lightweight substrates (gores). During deployment, the gores unfold and the array is tensioned to form a shallow umbrella-shaped membrane structure.

UltraFlex is compatible with all solar-cell technologies, including the ultra-lightweight TMM cells anticipated to be ready for flight within the near future.

Successfully flown on Phoenix Mars Lander.
## Technology Elements – Performance: UltraFlex SOP

### State of the Practice

#### UltraFlex

**Performance**

**Application**

Solar power generation for LEO, GEO, interplanetary, and landed spacecraft. Refer to attached graph for scalability.

**Performance Specification**

<table>
<thead>
<tr>
<th>Type</th>
<th>Reference Cell Type</th>
<th>Reference Cell Efficiency</th>
<th>W/kg (BOL)</th>
<th>Stowage Volume (kw/m³)</th>
<th>Wing Diameter (m)</th>
<th>Max. Power per panel (W)</th>
<th>Voltage Capability</th>
<th>Min. Deployment Frequency (First Mode, Hz)</th>
<th>Temp Range (°C)</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>UltraFlex ST8 NGU-S</td>
<td>Std. Thickness Multijunction Photovoltaics</td>
<td>0.28</td>
<td>175</td>
<td>33</td>
<td>5.5</td>
<td>7000</td>
<td>Up to 100V</td>
<td>0.3</td>
<td>100/-90</td>
<td>New Millenium ST8 Program</td>
</tr>
<tr>
<td>UltraFlex ST8 NGU-LW</td>
<td>Lightweight (100 micron thick) Multijunction Photovoltaics</td>
<td>0.275</td>
<td>220</td>
<td>33</td>
<td>5.5</td>
<td>7000</td>
<td>Up to 100V</td>
<td>0.3</td>
<td>100/-90</td>
<td>New Millenium ST8 Program</td>
</tr>
<tr>
<td>UltraFlex - Mars Phoenix Lander</td>
<td>Triple Junction Photovoltaics</td>
<td>0.24</td>
<td>&gt;103</td>
<td>/</td>
<td>2.1</td>
<td>/</td>
<td>/</td>
<td>/</td>
<td>/</td>
<td>As flown on Phoenix</td>
</tr>
<tr>
<td>UltraFlex - Mars 01 Lander</td>
<td>High Efficiency Silicon</td>
<td>0.17</td>
<td>/</td>
<td>/</td>
<td>2.1</td>
<td>/</td>
<td>/</td>
<td>/</td>
<td>/</td>
<td>Flight hardware built, qualified and delivered</td>
</tr>
</tbody>
</table>

#### Planetary Environment Capability

- **Launch**
- **In Space**
  - Option to withstand v3g’s deployed (e.g. landing, docking, or transfer orbit power). Not proven.
- **Entry/Landing**
- **Planetary**
  - Successfully flown on Phoenix Mars Lander (2008)
Technology Elements – Performance: UltraFlex SOP (cont’d)

**Maturity & Availability**

<table>
<thead>
<tr>
<th>Current TRL</th>
<th>9</th>
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</thead>
</table>

**Availability:**

- 2.1m arrays proven on planetary landers. Scaled-up versions under development for Orion MPCV and future planetary mission concepts.

**UltraFlex Development Programs**

<table>
<thead>
<tr>
<th>Program</th>
<th>Wing Dia. (m)</th>
<th>Maturity Achieved</th>
</tr>
</thead>
<tbody>
<tr>
<td>Qualification UltraFlex solar array wing</td>
<td>3.1</td>
<td>Successfully completed full wing level qualification tests</td>
</tr>
<tr>
<td>Wake Shield 04</td>
<td>3.2</td>
<td>Completed PDR &amp; 90% of design</td>
</tr>
<tr>
<td>BallABLE INSIDE Jupiter Qual-Board</td>
<td>4.5</td>
<td>Deep Space Coupon qualification</td>
</tr>
<tr>
<td>Mars 01-Lander</td>
<td>2.1</td>
<td>Flight hardware delivered</td>
</tr>
<tr>
<td>Mars Phoenix Lander</td>
<td>2.1</td>
<td>100% Flight success</td>
</tr>
<tr>
<td>NASA-Now Millenium ST8</td>
<td>5.5</td>
<td>Completed CDR; TRL6</td>
</tr>
<tr>
<td>NASA Crew Exploration Vehicle-Onion</td>
<td>6.0</td>
<td>PDR 8/2009 (ongoing)</td>
</tr>
</tbody>
</table>

**Development Plan - If applicable**

- **Start Year:** N/A
- **Initial TRL:** N/A
- **Final TRL:** N/A
- **Development time - Years:** N/A

**Technology Hurdles to get to TRL 6**

Fig. performance 1: UltraFlex Performance Scaled Performance of Derived UltraFlex Arrays

Fig. performance 2: UltraFlex Development Milestones

Fig. performance 3: UltraFlex Mass/Structural Benefits from White et al.
Technology Element – Milestones: UltraFlex SOP

State of the Practice: UltraFlex

<table>
<thead>
<tr>
<th>Milestones</th>
<th>(month/year)</th>
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<td>TRL 1</td>
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<td>TRL 9</td>
<td>May 2008</td>
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IMPaCT Overview of Capabilities

May 15, 2013
**Technology – State of Practice**

- State of the Practice technologies are being incorporated into IMPaCT with participation from JPL Team X subsystem chairs.

- **Approach is to:**
  - Identify key figures of merit (FOMs) for each subsystem (e.g. W/kg for solar arrays)
  - Map the current technology capability into the FOMs
  - Experiment with describing this information graphically for ease of understanding
  - Define interdependencies between different FOMs and different subsystems.

- The PSPS study team is working with the JPL A-team to apply information in the IMPaCT database to mission concept development studies.
Portfolio Analysis

• IMPaCT portfolio analyses are used to develop an integrated plan for missions and technologies.
  – Useful for ‘what if’ scenarios.

• Portfolios provide analysis options for:
  – Accommodating funding constraints
    • Delaying the start of mission or technology elements
    • Reducing the cost of mission or technology elements
  – Determining impact of dependencies
    • Does starting a mission earlier impact technology readiness?
    • Does a mission delay impact other missions?
Portfolios - Listing

Mars Sample Return - Decadal Survey Example
Mars Sample Return portfolio consists of the three missions that enable Mars Sample Return together with the technology they require to implement the missions:

- Mars Astrobiology Explorer-Cacher
- Mars Sample Return Lander
- Mars Sample Return Orbiter

Source: Planetary Science Decadal Survey (2011)
Portfolio Analysis Capabilities: Hypothetical Example

Funding – Wedge based on FY11 Budget

Source: Planetary Science Decadal Survey (2011)
Application Security and Access Control

• The basic IMPaCT security application requirements are covered by a general JPL IT Security Plan that describes the controls in place to meet essential security requirements for Scientific, Engineering, and Research Information.

• The specific application security and access control requirements are defined in a security implementation plan that ensures protection of IMPaCT information assets for:
  – Confidentiality – Applying restrictions on information access and disclosure, including means for protecting proprietary and ITAR information
  – Integrity - Guarding against improper information modification or destruction, and includes ensuring information authenticity
  – Availability - Ensuring timely and reliable access to and use of information
Application Security and Access Control

- The IMPaCT application resides outside the JPL firewall to allow access by non-JPL users
  - Access to application data is restricted to approved JPL & NASA personnel via secured login – JPL LDAP & NASA IdMAX
  - User roles and associated functions for data access and management have been defined

- The application security plan was completed January 15 and the current version of IMPaCT includes implementation of Phase I of the security plan
  - IMPaCT users are assigned User Role(s) to enable specific view and edit privileges
  - Access to data items and data functions are managed by User Roles
  - Each data item is owned by a user who can choose to keep data private (in a private work area) or make it available on a selective or general basis
  - Data configuration control is enhanced as only authorized users can make changes
Improvements Planned for Future Versions

• Technology assessment capability, including technology relevance, readiness (TRL) and infusion
• Explicit definition of environmental requirements for the technology
• Instrument developments and target mission applications
• Alternative methods of inputting data – keyboard, Excel, PDF. Goal is to make this user friendly.
• Data export capability. Goal is to provide IMPaCT data to other analysis and reporting tools.
• Printer friendly reporting
Examples of Technology Applications

- Types of assessments which the 4X Planetary Science Program Support task has been asked to conduct include:
  - Technology relevance – e.g., to PSD, Mars Program, Outer Planets Program. Changes in relevance to be tracked as the portfolio is updated
  - Technology readiness – technology readiness levels and progress in advancing readiness
  - Technology infusion – status of plans for application in ground and flight systems and monitoring progress in advancing readiness

- Technology efforts that we expect to include in the next 6 months include: STMD Game Changing Technologies, STMD Technology Demonstration Missions, ISPT, Early Stage Innovation, Center Innovation Funds and PIDDP (PICASSO/MATTISE)

- New capabilities are being added to IMPaCT as needed to augment our existing analysis tools including adding new fields and summary reports.
Examples of Technology Applications

- Very strong, broad interest in technology assessment from NASA sponsors and other communities.
  - PSD managers want to know what STMD is doing and if it will be useful for planetary science.
  - STMD managers are seeking feedback on the relevance of their technologies to future missions.
  - AGs, PIs, technologists, mission concept developers seek a clear understanding of what technologies are upcoming and how they might be applied to their area of interest.
**Summary**

- IMPaCT provides a powerful methodology to assess and develop an integrated plan for missions and technologies.
  - The functional capabilities are now in place and the mission and technology databases are being expanded
- IMPaCT provides access to broad sets of spacecraft technology data (and instruments, in the near future) for use in formulation phase studies
- IMPaCT is becoming a resource for the routine technology assessments performed for NASA’s PSD.
- Feedback is requested from users to improve the capabilities to meet needs.
References

• IMPaCT has been reported as new software in the JPL New Technology Reporting System
  – NTR #48197, July 2011
• IMPaCT featured in the January 2013 NASA TechBriefs
  – http://www.techbriefs.com/component/content/article/15485
• An OpenSource version of the IMPaCT S/W is available on SourceForge since May 2012
  – http://sourceforge.net/projects/impactportfolio/
• IMPaCT Points of Contact
  – Programmatic: Pat Beauchamp Patricia.M.Beauchamp@jpl.nasa.gov
    Chet Borden Chester.S.Borden@jpl.nasa.gov
  – Development & Application: Susan Jones Susan.K.Jones@jpl.nasa.gov