The Next Giant Leap in Solar System Missions and Technologies

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Location: Goddard Memorial Symposium Session
Date: March 21, 2019
For over 50 years, Industry has worked alongside NASA...

- Industry has supported the scientific exploration of every planet in the solar system visited to date
- From the launch of TIROS-1 in 1960, our nation’s first weather satellite, Industry has provided satellites to monitor our weather and environment
- Industry has supported the successful landings on the Moon to Mars
- Industry has helped build and operate, alongside NASA, the great space telescopes (Hubble and Spitzer)

NASA missions are fundamentally changing our understanding of the Universe
Public-Private Partnerships Key to Success

Discovery and Mars Scout Programs

- **Stardust**
  Launched: 1998

- **Genesis**
  Launched: 2001

- **Mars Phoenix**
  Launched: 2007

- **GRAIL**
  Launched: 2011

- **MAVEN**
  Launched: 2013

- **InSight**
  Launched: 2018

Government doesn’t define mission. Teams compete to create innovative and compelling missions in a free market competition.

New Frontiers Programs

- **Juno**
  Launched: Aug 2011

- **OSIRIS-REx**
  Launched: Sep 2016

Government specifies decadal survey missions. Teams compete to define best overall mission value.

Industry Partners are a key success in working closely with NASA on Mission Execution. Discovery and New Frontiers are great Examples of Successful Public-Private Partnerships!
Science Drives Missions & Spacecraft Technology (1 of 2)

Current Decadal (2012-2022):
Mars Sample Return, Ice Giants, Small bodies (sample return & flybys), Venus in situ, Lunar Sample Return & Life Evidence missions

Capabilities include:
• Innovations in Mission Design
  • Large Delta-v (> 2000 m/sec)
  • Long duration missions (> 15 years)
• Innovations in Hardware design and fabrication
  • Power and Propulsion
  • Low SWaP Avionics
• Enabling Technologies
  • Capabilities in Sample Acquisition
  • Innovations in thermal protection systems (TPS) to support aerobraking / aerocapture & sample return
• Integrated level testing of larger and more complex systems
• Launch site & mission operations
Science Drives Missions & Spacecraft Technology (2 of 2)

Next Decadal Early Work & Studies:
Lunar Exploration including Cryo/In-Situ-Resource-Utilization (ISRU) Technologies, CubeSat/SmallSat Capabilities and Enabling Autonomous Technologies

Major Themes include:
• Lunar Landers including Cryo/ISRU Technologies
  • Robotic landers that feedforward to Human Scale
  • Maturation of larger scale cyrocooler/storage

• CubeSat/SmallSat low cost/ rapid development missions
  • SmallSat innovations (SWaP) with desire for same mission assurance as typical planetary
    – Low SWaP Avionics / Efficient RF
    – Sequencing, autonomy and fault tolerance
  • Low Cost (w/ride share) / Rapid Development

• Enabling Technologies moving forward
  • Precision Landing and hazard avoidance
  • Low SWaP sensor suites for Nav/Docking
  • Non-electric (safe) heat (RHU) - outer solar system
  • Continue to leverage heritage & reduce costs

Future Lunar and Mars mission applications (robotic and human)
Small planetary missions = small mission driven by planetary science

New Frontiers, Discovery, Lunar lander and future Gateway applications
Summary – Industry Role in Next Giant Leap

• Major Themes: Lunar exploration (robotic -> human scale), low cost/rapid development small satellite missions and enabling technologies
  • New capabilities in landers and long term surface exploration
  • Innovations and applications of CubeSat & SmallSats
  • Enabling technologies

• NASA is looking for industry to help lead the way in commercialization of landers on the moon, orbiters to Mars, landers on Mars and beyond
  • The government, US or otherwise, still remains an important source of revenue for space companies
  • Many of the commercial customers of one space company are ultimately serving a government end customer later on in the value chain.