Active Project (2012 - 2017)

Deep Space Optical Communications (DSOC) Project

Game Changing Development Program | Space Technology Mission Directorate (STMD)

ANTICIPATED BENEFITS

To NASA funded missions:

The GCD Program funded DSOC Project will accelerate a near term Technology Demonstration Mission (TDM) that will retire the risk of infusing optical communications into future NASA missions. A successful TDM will serve as a precursor toward an operational capability. Eventually use of optical technology from deep-space will address the ever increasing demand on link capacity for NASA's future deep-space science and human exploration missions. Furthermore, the benefits can be realized without additional mass or power burden. Large volumes of uncompressed data can be returned to earth while utilizing shorter contacts, thereby allowing missions to spend more time gathering science and exploration data. Immediate enabling features will be the ability to stream multiple channels of high-definition imagery from deep-space. Longer term benefits will include high precision ranging for navigation and science, as well as, novel light science applications.

To the nation:

As the technology matures the capability to perform light-science will be advanced. Just as RF telecom system are used to perform radio science investigations, optical communication will introduce new and exciting light-science applications such as occultation studies of planetary atmospheres, high precision ranging for science and navigation, probing of high magnetic fields for laser polarization state changes and other science investigations.

DETAILED DESCRIPTION

Develop and integrate technologies for demonstrating optical communication from deep-space thereby retiring the risk for achieving at least ten times the data return capacity for future NASA missions

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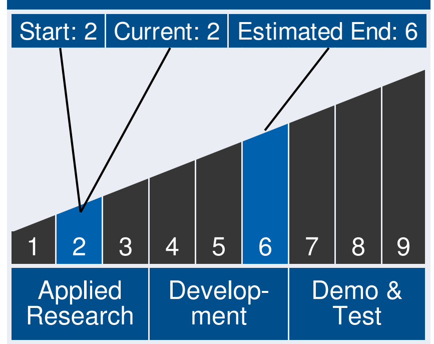
Technology Maturity



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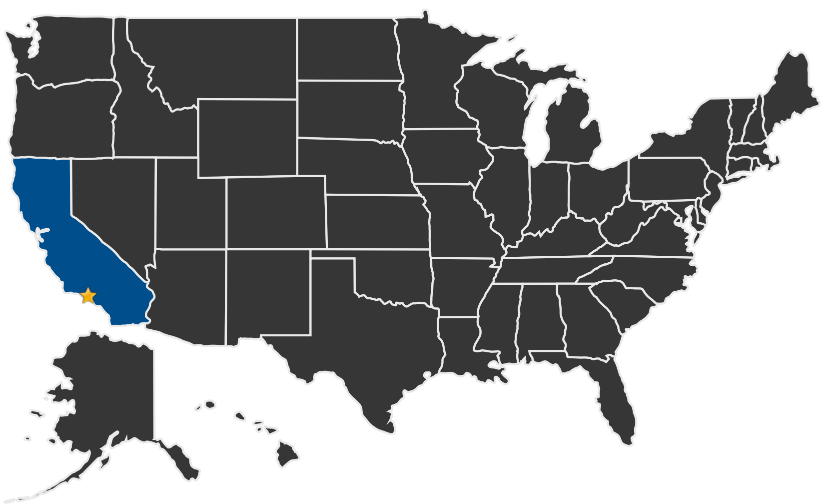
U.S. WORK LOCATIONS AND KEY PARTNERS



U.S. States With Work

Lead Center:
Jet Propulsion Laboratory

Other Organizations Performing Work:

- Amplification Technologies, Inc. (Paramus, NJ)
- aPeak, Inc. (Newton, MA)
- Controlled Dynamics, Inc. (Huntington Beach, CA)
- Fibertek, Inc. (Herndon, VA)
- Human Exploration and Operations Mission Directorate
- L3-SSG Integrated Optical Systems
- Massachusetts Institute of Technology Lincoln Laboratory
- NIST Boulder
- Princeton Lightwave, Inc. (Cranbury, NJ)
- Science Mission Directorate

LATEST SUCCESS STORY

2015-08-05_DSOC

Realized Benefits

1 Success Story

Management Team

Program Executive:
- Lanetra Tate

Program Manager:
- Mary Wusk

Project Manager:
- Abhijit Biswas

Principal Investigator:
- Denise Podolski

Technology Areas

Primary Technology Area:
Communications, Navigation, and Orbital Debris Tracking and Characterization Systems (TA 5)
└─ Optical Communications and Navigation (TA 5.1)
  └─ Acquisition and Tracking (TA 5.1.4)
    └─ Disturbance-Free Platform (TA 5.1.4.1)

Continued on following page.

PROJECT LIBRARY

Success Stories

- 2015-08-05_DSOC
  - (http://techport.nasa.gov:80/file/16843)

Technology Areas *(cont.)*

Secondary Technology Area:
Communications, Navigation, and Orbital Debris Tracking and Characterization Systems (TA 5)
└─ Optical Communications and Navigation (TA 5.1)
  └─ Detector Development (TA 5.1.1)

Additional Technology Areas:
Communications, Navigation, and Orbital Debris Tracking and Characterization Systems (TA 5)
└─ Optical Communications and Navigation (TA 5.1)
  └─ Large Apertures (TA 5.1.2)
  └─ Lasers (TA 5.1.3)
  └─ Acquisition and Tracking (TA 5.1.4)
  └─ Atmospheric Mitigation (TA 5.1.5)
  └─ Optical Tracking (TA 5.1.6)
    └─ Embedded Optical Tracking for Spacecraft Navigation (TA 5.1.6.1)
  └─ Integrated Photonics (TA 5.1.7)
└─ Integrated Technologies (TA 5.5)
  └─ Radio Frequency and Optical Hybrid Technology (TA 5.5.6)
    └─ Large Aperture Combined Radio Frequency (RF)/Optical Apertures (TA 5.5.6.1)

DETAILS FOR TECHNOLOGY 1

Technology Title

Deep Space Optical Communication (DSOC)

Technology Description

This technology is categorized as a hardware assembly for unmanned flight

The GCD Program funded DSOC Project is targeting at least 10x higher instantaneous downlink data-rate while utilizing the equivalent mass and power of a state-of-art deep-space RF telecommunication system. This is achieved by having:

- Sub-microradian pointing control to enable transmitting microradian beam-width lasers from deep-space spaceraft
- Power-efficient direct-detection modulation and coding signaling that operate to within 1-2 dB of theoretical channel capacity
- High peak-to-average power ratio (~ 160) laser transmitters that support the modulation schemes
- Sensitive photon-counting detectors on both the space and ground ends of the link sensitive to irradiance levels of a few pW/m^2

The game changing aspect of this technology is to design mass and power efficient systems that can operate with the long round-trip light times, large point-ahead angles encountered by deep-space spacecraft. These technology challenges and risks coupled with the diverse link and atmospheric conditions cannot be addressed and retired by near-earth optical communication demonstrations. In order to migrate to an operational capability with optical technology a network of large aperture (10-12m diameter) dedicated ground telescopes are needed. These currently do not exist. However, existing large aperture diameter (> 5m) astronomical telescopes can be adopted to support technology demonstrations that will validate the flight transceiver functions and performance. It is expected that after a successful Technology Demonstration Mission (TDM) of optical communication from deep-space justification for the development of ground infrastructure will be established with an eye to eventually migrating deep-space optical receivers to earth orbit with future advancements in deploying large aperture telescopes in space.

The optical technology also supports high rate uplink data transmission capability and eventually can be matured to provide high precision ranging for future science and navigation.

Capabilities Provided

Deep space optical communications will provide 10X to 100X increased data returns over present radio frequency (RF) space communications, for future advanced instruments, live high definition (HD) video, tele-presence, and human exploration beyond cis-lunar space.

Potential Applications

Deep space optical communications will enable a 10X to 100X improvement in return data volume for space missions. Increased data volume will permit increased science data returns with 10X higher resolution imaging and mapping, real-time streaming of high-definition video during asteroid or planet flybys, and multispectral imaging of dynamic processes such as clouds on gas giants, dust storms on Mars, and active volcanoes on giant moons.   “Virtual presence” and public engagement in NASA space operations will also be enhanced by the increased data rates to be provided by optical communications.