High Channel Count Time-to-Digital Converter and Lasercom Processor, Phase II Project

SBIR/STTR Programs | Space Technology Mission Directorate (STMD)

ABSTRACT

High-channel-count, high-precision, and high-throughput time-to-digital converters (TDC) are needed to support detector arrays used in deep-space optical communications (DSOC) link receivers being developed between Earth and deep-space solar-system exploration platforms for human and robotic activities in 2020 and beyond. Compared to current radio-frequency (RF) space communications, DSOC will provide 10- to 100-times more data returns for future advanced instruments, live high-definition video, telepresence, and human exploration beyond cislunar space. To be accepted operationally, the optical link must provide substantially greater data rates/data-return volumes than equivalent mass and power RF systems�and at lower cost per bit. Therefore, to prepare for these deep-space missions, substantial enhancement of the current NASA telecom-link capacity is needed. To satisfy NASA�s DSOC needs, a scalable high-precision (≤ 100 ps), high-throughput (> 100 Gbps) high-channel-count (≥ 256) time-to-digital advanced processor (HiTAP) architecture will be developed for use in single-photon-counting free-space optical communications systems and test beds. In Phase II, two fully functional systems integrating custom hardware, firmware, and software will be designed, fabricated, tested, and delivered to NASA.

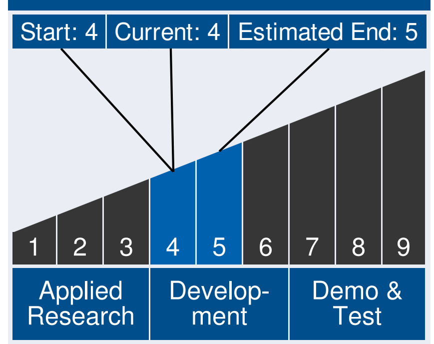
ANTICIPATED BENEFITS

To NASA funded missions:

Potential NASA Commercial Applications: HiTAP will enable deep-space optical communications. NASA�s Space Communications and Navigation program office identified optical communications as an important technology for NASA missions, enabling enhanced volume and quality of data to be returned from the farthest reaches of space in preparation for future human deep-space exploration missions. Although several missions have validated optical communications from low-Earth and geostationary orbit, the unique challenges of deep-space

Table of Contents

Technology Maturity



Management Team

Program Executives:
- Joseph Grant
- Laguduva Kubendran

Program Manager:
- Carlos Torrez

Continued on following page.

optical links still require separate risk-retiring technology demonstrations before implementing inner-orbit communication. Many other NASA applications benefit from the innovation, such as reading out individual pixels of APD arrays, including single-photon avalanche-photodiode detectors and sensor signal-processing nodes. This makes it useful to NASA in systems for applications like LADAR autonomous navigation, docking and landing, space-based laser altimetry for studying the surface height of Earth and other planets from orbit, LIDAR instruments for atmospheric sciences, large-scale surveying / surveillance, bathymetry, and forestry.

To the commercial space industry:

Potential Non-NASA Commercial Applications: This innovation satisfies the general need for multichannel data processors supporting wideband (GBPS-class) free-space optical-link FPAs and instruments requiring high-throughput time-of-flight instruments. The proposed innovation also has applications in these fields: free-space optical communications; 3D time-of-flight LADAR and LIDAR mapping systems; positron-emission tomography (PET) imaging in nuclear medicine; single-photon-emission computed tomography (SPECT) imaging in nuclear medicine; time-correlated single-photon-counting and fluorescence lifetime imaging microscopy in life sciences; collision avoidance, imaging, and adaptive cruise control in automotive applications; and data centers for high-throughput real-time data transfer and processing.

Management Team *(cont.)*

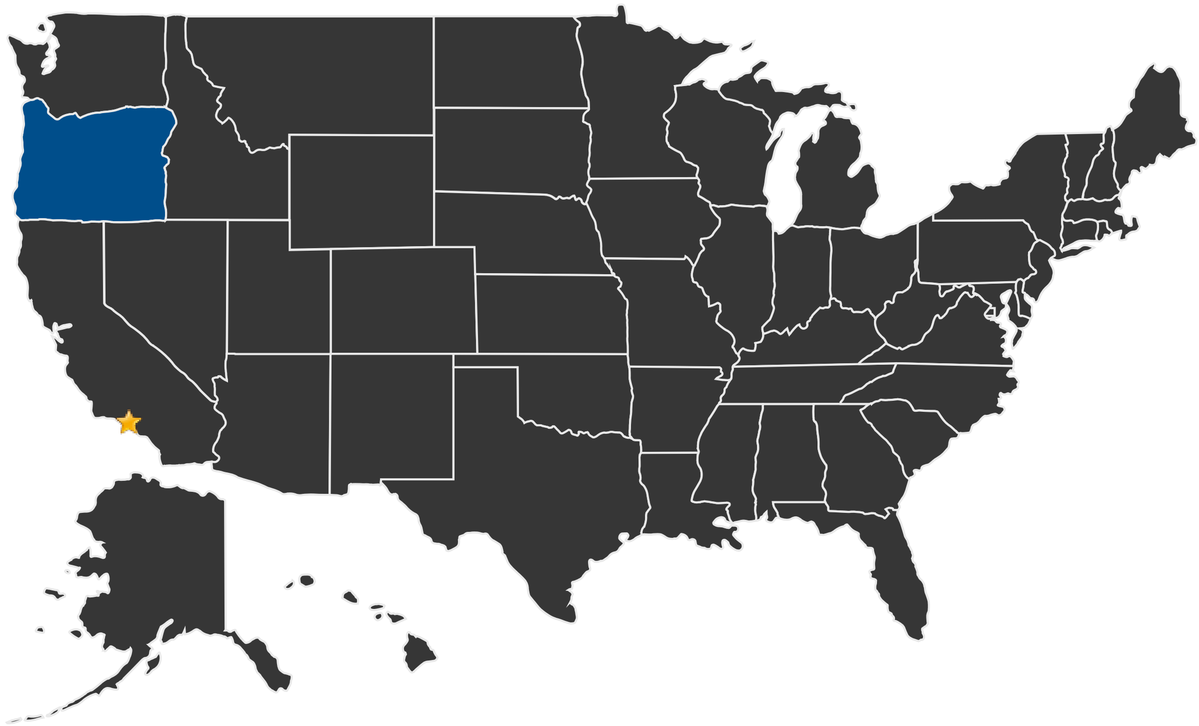
Principal Investigator:

- Vinit Dhulla

Technology Areas

Primary Technology Area:
Communications, Navigation, and Orbital Debris Tracking and Characterization Systems (TA 5)
└ Optical Communications and Navigation (TA 5.1)
  └ Optical Tracking (TA 5.1.6)

U.S. WORK LOCATIONS AND KEY PARTNERS



U.S. States With Work

Lead Center:
Jet Propulsion Laboratory

Other Organizations Performing Work:

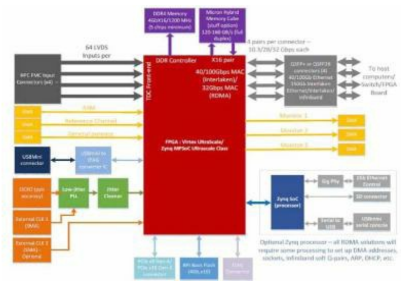
- Voxtel, Inc. (Beaverton, OR)

PROJECT LIBRARY

Presentations

- Briefing Chart
  - (http://techport.nasa.gov:80/file/23329)

IMAGE GALLERY



High Channel Count Time-to-Digital Converter and Lasercom Processor, Phase II

DETAILS FOR TECHNOLOGY 1

Technology Title

High Channel Count Time-to-Digital Converter and Lasercom Processor, Phase II

Potential Applications

HiTAP will enable deep-space optical communications. NASA�s Space Communications and Navigation program office identified optical communications as an important technology for NASA missions, enabling enhanced volume and quality of data to be returned from the farthest reaches of space in preparation for future human deep-space exploration missions. Although several missions have validated optical communications from low-Earth and geostationary orbit, the unique challenges of deep-space optical links still require separate risk-retiring technology demonstrations before implementing inner-orbit communication. Many other NASA applications benefit from the innovation, such as reading out individual pixels of APD arrays, including single-photon avalanche-photodiode detectors and sensor signal-processing nodes. This makes it useful to NASA in systems for applications like LADAR autonomous navigation, docking and landing, space-based laser altimetry for studying the surface height of Earth and other planets from orbit, LIDAR instruments for atmospheric sciences, large-scale surveying / surveillance, bathymetry, and forestry.