National Aeronautics and Space Administration

SIGNAL

THE SCAN INTERNSHIP PROJECT JOURNAL

GODDARD SPACE FLIGHT CENTER

SUMMER 2023

SIGNAL

THE SCAN INTERNSHIP PROJECT JOURNAL

SUMMER 2023

GODDARD SPACE FLIGHT CENTER

EDITORIAL, ART, & INTERN TEAM

EDITORS IN CHIEF: Korine Powers, Mariah Pulver
EDITORIAL TEAM: Kendall Murphy, Katherine Schauer
WRITERS: Emma Friedman, Korine Powers, Mariah Pulver
ART DIRECTOR: David Ryan
GRAPHIC DESIGNERS: Kasey Dillahay, David Ryan
INTERN PROGRAM COORDINATORS: Jimmy Acevedo, Korine Powers

SIP Overview

NASA's Space Communications and Navigation program, or SCaN, is the backbone of the agency's space missions. Science, robotic, and human spaceflight missions rely on SCaN's networks to send and receive critical exploration data that inspire people across the globe to be curious about Earth and the universe. SCaN also recognizes an obligation to turn that curiosity into a passion that will carry NASA into a new era of innovation for communications and navigation technologies.

The SCaN Internship Project (SIP) is a testament to the program's dedication to NASA's future workforce. SIP connects talented, passionate students with NASA mentors to design, build, document, and promote the missions and technologies that define the agency's long-term vision for the future of aerospace. In only ten weeks, this summer's interns completed foundational experiments in quantum communications, performed complicated mathematics that will bolster the future of the Near Space Network, and documented the Nancy Grace Roman Space Telescope's telecommunication systems' development — and these achievements describe only three of the nearly 30 projects that SCaN interns completed at NASA's Goddard Space Flight Center this summer.

In addition to providing guidance on their main projects, SIP supports the professional development of its interns through workshops, meet-and-greets, trainings, field trips, and one-on-one meetings focused on the interns' academic and professional goals. SIP coordinators work hard to provide the logistical and programmatic support interns and mentors need to complete meaningful work for the agency and build lasting relationships with each other and the wider NASA community.

At Goddard, SCaN's mission and vision is executed by the Exploration and Space Communications (ESC) projects division, which hosted 40 SIP students this summer. The interns included in this journal are from 17 different states, over 30 different schools, and nearly 20 different majors. Each student was paired with a dedicated mentor, whose specialties capture the full expanse of space communications and navigation technologies. Altogether, SIP students and their mentors contribute to the broader Near Space Network, which provides critical communications and navigation services to missions within two million kilometers of Earth.

Some of the interns included in these pages are familiar faces. Many are joining us for the first time. A mix of both will be joining us this autumn as they continue in the SIP program or become civil servants, contractors, and Pathways students. Others will apply what they've learned with us to work with commercial partners, academic institutions, or entirely different industries. Wherever they are in their journey, their achievements contributed to SCaN's essential role in NASA's exploration endeavors.

Table of Contents

Farewell from Badri Younes

Former Deputy Associate Administrator for SCaN
NASA Headquarters — Washington, D.C.

Throughout my time leading SCaN, supporting the next generation of students has been one of my top priorities. I firmly believe in developing the future leaders of NASA - sharing our knowledge, providing opportunities for growth, and welcoming new perspectives. The SCaN Internship Project (SIP) is crucial in that effort. Our interns complete meaningful and important projects to support SCaN's goals.

To the interns: Your work enhances communicatons and navigation services and technologies, which are critical as NASA explores further than ever before - to the Moon, Mars, and beyond.

I am so proud of our SIP interns. Each year, you impress me with your passion, focus, and curiosity. Please maintain that as you move through your academic and professional journey – it will take you far! Although I am retiring, we are all now part of the NASA family and I can't wait to see what you do in the future.

Farewell,

Badri A. Younes

Message from Jeff Volosin

Acting Deputy Associate Administrator for SCaN
NASA Headquarters – Washington, D.C.

Congratulations to the SCaN Internship Project (SIP) class! Together we joined or returned to SCaN this summer; and I am proud to come back alongside a class of passionate, motivated, innovative, and impressive students.

STEM engagement is a core focus for NASA and interns are a big part of that. The agency aims to inspire, engage, educate, and employ the next generation of explorers. I applaud you for taking on the challenge of solving real-world problems, researching new technologies, and supporting mission critical services as a SIP intern this summer.

But learning is a life-long process – I continue to be inspired and engaged every day at NASA. I hope that through your time here you have taken opportunities to network, ask questions, and gain knowledge. That has certainly been my process in every role I've held and that's my biggest advice to you. Wherever you are in your educational, professional, or personal journey, continue learning and be open to new opportunities.

Many thanks,

Jeff Volosin

Message from Barbara Adde

SCaN Policy and Strategic Communications Director
NASA Headquarters — Washington, D.C.

Each summer, we look forward to welcoming students as part of the SCaN Internship Project (SIP). As interns, you bring new excitement with your ideas, energy, and creativity. You inspire us by confidently accepting the challenge to complete impactful work to support space communications and navigation efforts.

Our hope is that working at NASA inspires your future career! Through SIP, interns can apply knowledge from their schoolwork, gain valuable work experience, and network across the agency. Whether you spent the summer researching new technologies, supporting network services, conducting communications and outreach, or enhancing our cybersecurity, you have made a profound difference. You all have extremely bright futures ahead and we cannot wait to see what you do.

It was great to get to know you this summer. Please keep in touch, and we hope to see you in the future.

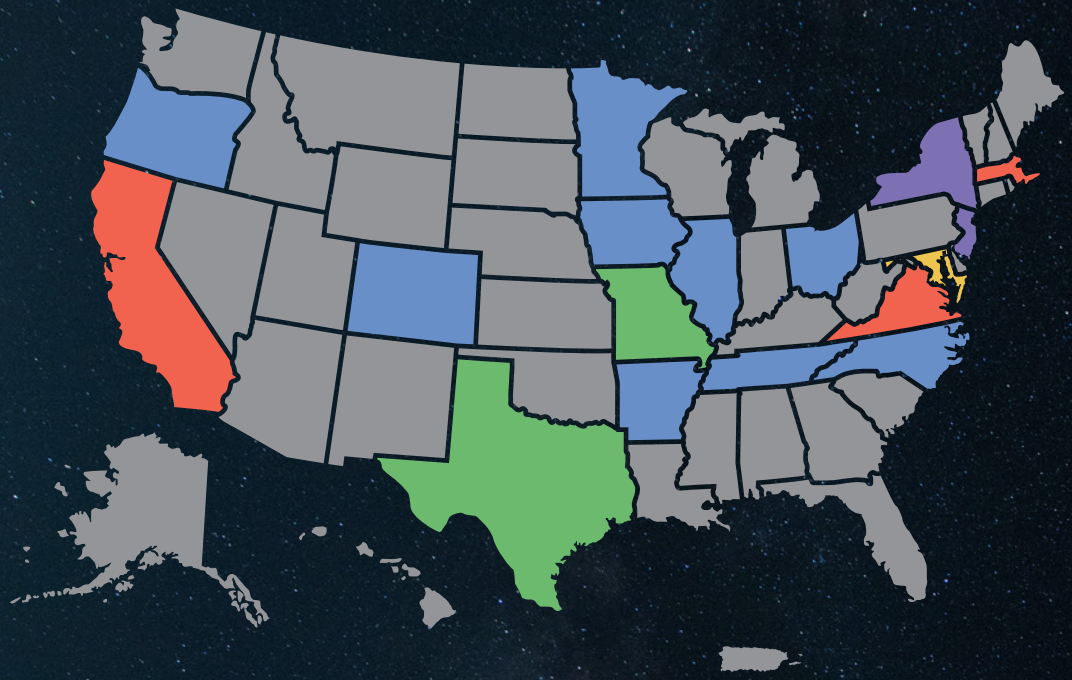
All the best,

Barbara LB Adde

2023 Intern Demographics

The SIP 2023 interns represent interests and abilities stemming from a wide variety of backgrounds and experiences. Much of what makes these interns so special is impossible to chart, but the metrics below provide a picture of the schools, disciplines, and geographies that helped shape our cohort. Their unique imaginations, to paraphrase Carl Sagan, will carry us to new worlds and possibilities.

40 TOTAL INTERNS



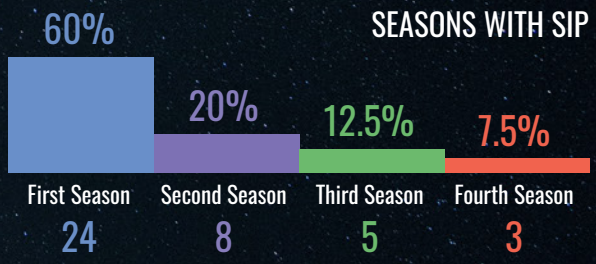
INTERN HOME STATES & TERRITORIES

- 1
- 2
- 3
- 4
- 9

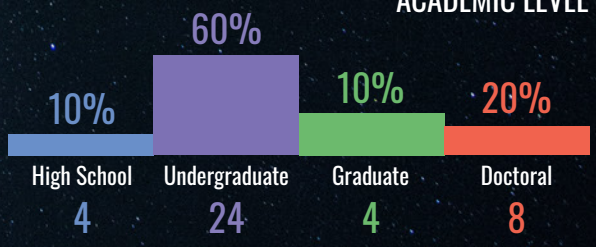
INTERNS BY DISCIPLINE

Communications & Marketing	3	7.5%
Data & Analytics	5	12.5%
Education	2	5%
Laser Communications	4	10%
Mechanical Engineering	1	2.5%
Navigation	1	2.5%
Network Engineering	8	20%
Quantum Communications	6	15%
Radio Frequency Engineering	4	10%
Software Engineering	6	15%

SEASONS WITH SIP



INTERNS BY ACADEMIC LEVEL



*Percentages rounded for clarity.

Streamlining & Automating Report Generation for Modem Testing

BROOKE BALLHAUS, TARUN NARAHARI
MENTORS: DAVID SCHUCHMAN & ZAC SMITH

The Advanced Communications Capabilities for Exploration and Science Systems (ACCESS) project is a critical service provider for the Near Space Network, operating and maintaining government-owned, contractor-operated ground- and flight-based systems. This summer, Brooke Ballhaus and Tarun Narahari developed an automatic-generation test reporting functionality for ACCESS ground-based modems. In order to develop their front- and back-end software, Ballhaus and Narahari started by researching Python coding strategies and packages capable of supporting dynamic report modification. In addition to the creation of templates and functions necessary for these test reports, Ballhaus and Narahari ensured that the templates were modifiable and capable of autogenerating graphs and tables from test data. When the back-end software was complete, the team built a graphical user interface (GUI) that allows ACCESS engineers to easily understand and make use of the ACCESS Modem Test Suite's (AMTS) capabilities. The AMTS allows NASA engineers to conduct high-fidelity performance testing of any ACCESS ground-based modems, and the team's GUI supports user functionalities that allow for easy and efficient test report creation and modification. Ballhaus and Narahari's software standardizes the process of generating modem test reports, which in turn ensures that the ACCESS modem team has an easy means of observing the operational health and behavior of their systems. Their work allows NASA to optimize the decisions engineers make surrounding their modems.

BROOKE BALLHAUS

HOMETOWN: The Plains, Virginia

Brooke Ballhaus is a class of 2026 Stanford student pursuing a degree in computer science. In addition to her coursework in Python, Java, and C++, Ballhaus has experience with coding, machine learning models, and cybersecurity through her previous internships. This is her first NASA internship. Ballhaus is also proud of her outreach and leadership work, supporting several organizations to encourage women to join STEM fields.

TARUN NARAHARI

HOMETOWN: Portland, Oregon

Tarun Narahari is a junior at the University of Maryland at College Park studying computer science. His hobbies include playing basketball, watching sports, traveling, and exploring the outdoors. Narahari considers himself extroverted and loves to engage in conversation. This summer was his first time interning for NASA and he's excited to keep learning.

Ground Station Model-Based Systems Engineering

HOMETOWN: Baltimore, Maryland

Khalil Bethea is a senior at Morgan State University (MSU) majoring in electrical engineering. At Morgan State, Bethea uses his skills in computer-aided design to create intricate models for rocket parts on behalf of the MSU Rocket Team. He is a first-time NASA intern. Outside of work, Bethea enjoys video games, sports, and listening to music.

KHALIL BETHEA

MENTOR: ANDREW BAKKE

Khalil Bethea spent his summer contributing to NASA as a ground station systems engineer. In the past, engineers logged complex system specifications and requirements in a series of digital and paper documents built from multiple sources, stored across various locations, and dependent on individual calculations. Model-based systems engineering (MBSE) replaces static, multi-source documentation with a digital model that organizes, documents, and displays system requirements in a standard, accessible, and easily alterable format. Bethea compiled information drawn from a ground station, system activity, and sequence diagrams to build an accurate ground station model. Then, he bookmarked key elements within the diagram to ensure users unfamiliar with MBSE could find and more easily understand key system information. Bethea's work gives NASA's ground station systems engineers a flexible and standardized "single source of truth" when evaluating system requirements and upgrades going forward. The model he created makes it easier to identify potential issues and enhancements to NASA ground stations, protecting the agency's telecommunications for present and future missions.

Automation of Low-Cost Optical Terminal System Configuration

HOMETOWN: San Ramon, California

Tejas Bhartiya is a rising junior at the University of California, Merced studying computer science and engineering. This is their first internship with NASA, though not their first in DevOps and cloud engineering. Outside of work, Bhartiya enjoys reading, biking, photography, and more!

TEJAS BHARTIYA

MENTOR: VICKY WU

In order to create a cost-effective global network for optical communications, NASA Goddard is building low-cost optical terminals (LCOT) that use commercially available components that can be quickly reconfigured to support optical communications missions with minimal modifications or custom-built equipment. Tejas Bhartiya contributed to this effort by automating key elements of LCOT system configuration, supporting efficient configuration management and future replicability to LCOT. Bhartiya created Ansible Playbooks, an efficient blueprint of repeatable actions within the system that automate IT setup including package installs and environment configuration. Bhartiya investigated user requirements, implemented Ansible playbooks for key LCOT submodules, and created corresponding documentation for the playbooks. In addition, Bhartiya implemented an Ansible playbook for installation of initial key packages to support development and future test containerization efforts. Using Ansible for automation enables configuration management of an environment setup and reduces the need for time intensive manual system configuration, greatly increasing the overall ease of replicability. These contributions ensure that LCOT's role in NASA's future optical communications network can be deployed in a more cost-effective and efficient way.

Spacecraft Constellation Guidance and Control

DEREK BOURABAH

MENTOR: WAYNE YU

A Distributed Systems Mission (DSM) involves multiple spacecraft working together to rapidly detect, prioritize, and observe transient science events. Derek Bourabah implemented autonomous guidance, navigation, and control (GNC) on individual satellites within a DSM constellation. Satellite GNC allows each spacecraft in the larger system to optimize its orbit within a constellation, even when presented with uncertain or incomplete data about the location of other satellites. Bourabah was responsible for designing the optimization algorithm a satellite uses to best position itself for rapid response science missions. Bourabah first researched possible optimization algorithms and determined which one to implement. Then he simulated the motion of a full satellite constellation to determine if satellites employing the algorithm achieved mission goals and how the process compared to current response times and success rates. In improving satellite performance within the simulation, Bourabah's optimization algorithm provides the framework for equipping NASA spacecraft with the capability to autonomously navigate, guide, and control a satellite constellation for the purpose of rapidly observing transient science phenomena.

HOMETOWN: Brooklyn, New York

Derek Bourabah is a Ph.D. candidate at the University at Buffalo studying tethered satellite systems under Dr. Eleonora Botta. In his undergraduate career, he participated in projects like the Air Force Research Laboratory's University Nanosatellite Program. During his graduate studies, he presented at numerous conferences, more recently on work focused on space debris removal via tethered systems. This is his first year as a NASA intern. Beyond aerospace, Bourabah enjoys playing Dungeons & Dragons and hiking.

Network Commercialization: Multimedia and Outreach

RICKY CHANG

MENTORS: MARIAH PULVER & ERIN ROBERTS

The Commercialization, Innovation, and Synergies (CIS) office fosters relationships between NASA, private industry, other government agencies, and international partners to enhance Exploration and Space Communications (ESC) capabilities for the Near Space Network. Ricky Chang spent this summer building a marketing campaign to raise awareness of CIS and ESC commercialization efforts and services. Chang began his marketing efforts by building a roadmap to success to focus and organize campaign priorities. After building the campaign roadmap, he researched and developed actions and metrics of success. Chang then applied his research to writing marketing content, raising awareness with social media and email, and employing collaborative marketing strategies that pair CIS efforts with offices and companies that share an interest in building the innovative technologies that enable scientific discovery on Earth and in space. In addition to modeling the CIS office's commitment to partnership, Chang's marketing and outreach efforts showcased the benefits of merging public and private interests in space exploration to a wider audience of potential collaborators. His work allows NASA to better serve and grow the widening market of commercial aerospace.

HOMETOWN: Manassas, Virginia

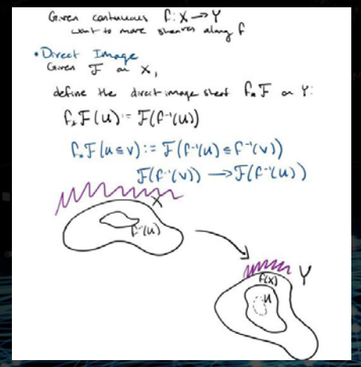
Ricky Chang is a recent George Mason University graduate with a bachelor's degree in communications with a focus on media production and criticism. While this is his first internship with the agency, Chang has been a huge fan of NASA and interested in the cosmos for as long as he can remember. On Earth, Chang loves all things comedy and stand-up—he's even performed a few sets himself. As a firm believer that laughter is the gateway to connecting with people, Chang can't help but try and make you crack a smile during conversation.

The Mathematics of Space Communications

OLIVER CHIRIAC, JI HUN HWANG, MIGUEL LOPEZ, BRENDAN MALLERY, TATUM RASK, MARK RONNENBERG

MENTOR: ALAN HYLTON

Oliver Chiriac, Ji Hun "Jimmy" Hwang, Miguel Lopez, Brendan Mallery, Tatum Rask, and Mark Ronnenberg used higher-level mathematics to extend the foundations of time-varying delay-tolerant networks to solve issues facing space communications architectures. They began by expanding on a theory developed last summer. Then, they used algebraic topology to detect clusters in time-varying delay-tolerant networks and describe how a network's structure can change with time. In addition, they investigated geometric methods for characterizing information flow in time-evolving networks using a notion of curvature. Lastly, the team studied the problem of maintaining computer clock synchronization across a distributed network that can stretch the distance between two planets while preserving network integrity in instances where a piece of the network is sharing potentially corrupted or compromised data.

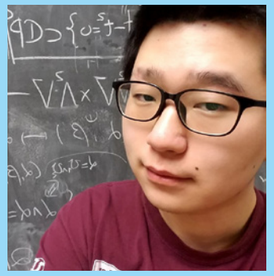


They concluded their research by testing their methods and potential frameworks using data gathered from simulated satellite networks. Their research contributes to the development of delay-tolerant routing in large-scale satellite networks that are efficient, autonomous, and scalable. Beyond their contributions to the Near Space Network, their work lays the foundation for future algorithms, standards, and policies that will inform the creation of a solar system internet.

OLIVER CHIRIAC

HOMETOWN: Plainsboro, New Jersey

Oliver Chiriac is a master's student in mathematics at the University of Oxford studying geometry and topology. He received his bachelor's in mathematics from the University of Toronto, where he specialized in topics ranging from symplectic geometry and quantum field theory to K-theory and C*-algebras. He is a first-time NASA intern. Outside the realm of mathematics, Chiriac devotes his time to competitive sports, music, art, travel, and technology.



JI HUN HWANG

HOMETOWN: Amherst, Massachusetts

Ji Hun "Jimmy" Hwang is a second-year Ph.D. student in computer science at Purdue University specializing in cryptography and information theory. Hwang earned his master's in computer science and bachelor's in mathematics from the University of Massachusetts Amherst. Outside of his research, Hwang can be found jogging, watching documentaries, and solving puzzles.

MIGUEL LOPEZ

HOMETOWN: Boston, Massachusetts

Miguel Lopez received his bachelor's degree in mathematics at Boston University and is currently a fourth-year Ph.D. student in applied math at the University of Pennsylvania. Under the supervision of Robert Ghrist, he is studying how algebraic topology can inform network science and machine learning algorithms.

BRENDAN MALLERY

HOMETOWN: Somerville, Massachusetts

Brendan Mallery is a third-year Ph.D. student studying mathematics at Tufts University. He is returning for his fourth internship at NASA to continue developing mathematical foundations for the study of time-evolving networks. He is interested in mathematical approaches involving a mix of metric geometry, probability, and dynamics. When not performing research, Mallery enjoys running, painting, and playing music.

TATUM RASK

HOMETOWN: Littleton, Colorado

Tatum Rask is a third-year Ph.D. student at Colorado State University studying mathematics. She earned her bachelor's degree in mathematics from Pepperdine University. Her research is in applied topology, specifically using tools from combinatorics and category theory to study persistent homology. Outside of work, Rask enjoys trail running and reading. In fact, she just competed in a mountain trail race!

MARK RONNENBERG

HOMETOWN: Cedar Rapids, Iowa

Mark Ronnenberg defended his dissertation and graduated with a Ph.D. in mathematics from Indiana University this summer. This fall, he will be an assistant professor of math at Anne Arundel Community College. This is his second internship with NASA and a continuation of his previous work on applying mathematics to space communication networks. When not doing math, Ronnenberg enjoys hanging out with his wife and cats, playing guitar, and going for runs.

Mission Visualization Toolkit 3.0: One LATTE to Go

ADITYA DUTT, AMAN GARG, ARYA KAZEMNIA, LEO WANG
MENTORS: GEORGE BUSSEY & ELANA RESNICK

Scheduling systems enable the success and timeliness of NASA science missions by connecting them to a ground station or relay satellite. Additionally, these systems analyze mission timetables to maximize connection times, account for overlaps in satellite communication windows, and understand data size and priority. Aditya Dutt, Aman Garg, Arya Kazemnia, and Leo Wang continued development on a novel web-based tool for generating representative schedules to aid in Near Space Network mission design and planning. The Loading Analysis Tool for Telecommunications Engineers (LATTE) utilizes the Unity engine and WebGL interactive graphics to allow users to visualize custom scheduling scenarios in an interactive three-dimensional space, while providing a dynamic analysis of the multi-satellite scheduling challenge. LATTE improves upon time-consuming and expensive methodologies.

Wang and Garg designed the terrain system, which can generate up to sub-arcsecond displays of various missions' interests and draw from a variety of sources to produce accurate topographical geography. Kazemnia used the generated terrain in conjunction with Unity's built-in physics functions and custom algorithms to determine spacecraft visibility and connection windows. Dutt designed a modified depth-first search style algorithm that schedules the connectivity windows with constraints such as frequency bands and communication priorities to optimize for the longest service period usage for each mission interest. LATTE is the product of three summers of intern development, and provides a cost-effective, accessible, efficient, and engaging solution to scheduling challenges.

ADITYA DUTT

HOMETOWN: East Brunswick, New Jersey

Aditya Dutt is a high school senior at the Edison Academy Magnet School and a second-year NASA intern. He will be pursuing a computer science major at the Georgia Institute of Technology this autumn. Outside of school and work, Dutt enjoys playing the violin, acting on stage, and spending time with his two pet parakeets.

AMAN GARG

HOMETOWN: Baltimore, Maryland

Aman Garg is a rising high school senior at the Gilman School and a third-year NASA intern. He and his team competed as finalists during the NASA App Development Challenge, and his ultimate goal is to pursue a career in software engineering and quantitative finance. Beyond his work and research, Garg enjoys cycling, skating, and swimming.

ARYA KAZEMNIA

HOMETOWN: Baltimore, Maryland

Arya Kazemnia is a rising senior at the Gilman School. Upon graduation, he plans to pursue a career in biomedical engineering. This is Kazemnia's third internship with SCaN on the Mission Visualization Toolkit. Outside of research, his hobbies include ice dancing, working in the Gilman greenhouse, playing jazz, sewing clothing, and learning languages and cultures.

LEO WANG

HOMETOWN: Baltimore, Maryland

Leo Wang is a rising high school senior at the Gilman School. He enjoys coding simulations, especially modelling physical terrain. His goal this year is to learn how to efficiently offload central processing unit tasks to the graphics processing unit. Outside of academics, Wang enjoys competitive gaming.

Better Together

SMALL INTERN GROUPS STRENGTHEN OUR BONDS

Encouraging interns to build relationships with one another is a key part of SIP's commitment to preparing young professionals with the skills, experience, and connections they need to thrive in the modern workplace. This summer, interns were divided into small cohorts based on shared project areas, majors, interests, and time zones. These cohorts — named after Apollo-era astronauts — met on a weekly basis to share their successes and challenges with like-minded members of the SIP community.

Cohort A: ARMSTRONG
Khalil Bethea
Thomas Francois
Jonas Kolker
Austin McInnis
Maximilian Telman
Albert Walters III
Theodore Xie

Cohort B: BORMAN
Derek Bourabah
Ricky Chang
Emma Friedman
Bryce Lanese
Sruthi Sankararaman

Cohort C: CONRAD
Collin Frink
Wade Lamberson
Cord Mazzetti
Connor Riahin
Nick Sebasco

Cohort D: DUKE
Oliver Chiriac
Jimmy Hwang
Miguel Lopez
Brendan Mallery
Tatum Rask
Mark Ronnenberg

Cohort E: EVANS
Aditya Dutt
Aman Garg
Arya Kazemnia
Leo Wang

Cohort G: GRISSOM
Brooke Ballhaus
Tejas Bhartiya
Carter T. Edmond
Nicholas Jara
David Martinez
Tarun Narahari

Cohort H: HAISE
Jacob P. Krell
Aditya Kumar
Dedelolia Olungwe
Lauren Saloio
Beck Saunders
Kat Sharonin
Andrew Wilder

LunaNet Messaging Service Prototype

CARTER T. EDMOND

MENTOR: DAVE ISRAEL

LunaNet is an innovative, extensible framework that aims to create a lunar infrastructure to enable NASA's long-term presence on the Moon with robust communications, navigation, and networking capabilities. This summer Carter T. Edmond prototyped the LunaNet messaging service, a core component of its interoperability and international standards. This service is a focal point of Edmond's Lunar Relay Operational Network Demonstration (LROND), which he began formulating last summer. Edmond began prototyping the messaging service by meeting with stakeholders to understand their envisioned use of the messaging system. He then outlined a scenario to simulate the arrangements and functionality of nodes and connections within the network. After building the simulation, Edmond collaborated with NASA's Glenn Research Center to access a networking testbed for constructing the prototype of the messaging service application and message structure. Finally, he ran the messaging prototype on the simulated network and logged its health metrics for future analysis. The messaging service prototype offers a functional example of a core component of LunaNet's communication services, further advancing the development of its network architecture.

HOMETOWN: San Jose, California

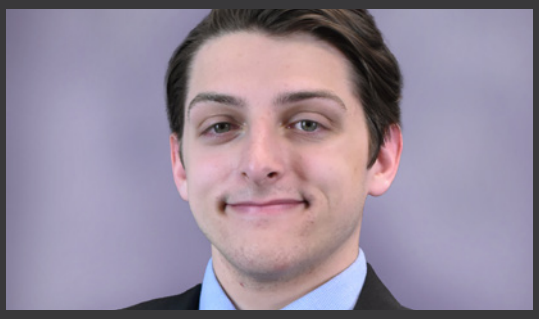
Carter T. Edmond is a senior at San Jose State University (SJSU) majoring in computer science and minoring in physics. He plans to pursue a master's degree in artificial intelligence after he graduates this December. This is his fourth SIP season and his third working on the Lunar Relay Operational Network Demonstration. At SJSU, Edmond works as a student researcher studying emergent combinatorial gravity and acts a mentor in the CubeSat club. Outside of school, Edmond enjoys cooking, watching movies, and photography.

Optimization of Radio Frequency Compatibility Testing

THOMAS FRANCOIS

MENTORS: JAKE BARNES, PAUL SEGARS, & TYLER WILLIAMS

For three SIP seasons, Thomas Francois has worked with Goddard's radio frequency (RF) Compatibility Test Area (CTA) to integrate OpenC3 COSMOS command and monitoring software into RF compatibility testing. COSMOS is an open-source operations and test environment that can service everything from small circuit boards to full satellites. OpenC3 COSMOS is cost-effective and customizable, and can control, log, and analyze equipment data on one dashboard. Francois' work on device integration improves the efficiency of compatibility tests and has been utilized in several NASA compatibility test campaigns, including the Plankton, Aerosol, Cloud, ocean Ecosystem (PACE) satellite and the Orion capsules for the Artemis missions. In addition, Francois shared his knowledge and experience with new SIP interns; his project contributions and peer mentorship improve the efficiency, documentation, and skillsets within the CTA. This summer, Francois also worked with NASA Goddard's Search and Rescue (SAR) office to develop a functional lunar search and rescue beacon prototype. He designed schematics, drew circuits, and developed printed circuit boards for the project. This beacon will aid SAR's efforts to protect Artemis astronauts in the event of an emergency.



HOMETOWN: Wildwood, Missouri

Thomas Francois completed his bachelor's degree in electrical engineering at the Missouri University of Science and Technology (S&T). This is his third NASA internship and his first through the Pathways program. Francois plans to return to Missouri S&T to complete his master's degree. Francois is also an amateur radio extra-class operator - call sign KX0STL - and a fan of tinkering with radios and antennas. In his free time, he lends his radio frequency expertise to Missouri S&T student-led design teams and prepares students for the amateur radio license exam.

Promoting Artemis II's Optical Communications System

HOMETOWN: Chicago, Illinois

Emma Friedman is a rising senior at the University of Maryland. She is earning her degree in English with a minor in astronomy in the spring. Friedman is considering a career in space law, focusing on the legislation and regulation of lunar resources. In her free time, she enjoys playing the guitar, solving crossword puzzles, perusing flea markets, and rock collecting. This is her first NASA internship.

EMMA FRIEDMAN

MENTOR: KATHERINE SCHAUER

This summer Emma Friedman created engaging content to excite audiences about the inclusion of a laser communications terminal on the upcoming Artemis II Moon mission. The Orion Artemis II Optical Communications System (O2O) will allow NASA to demonstrate laser communications — and share beautiful Moon imagery with the world. Friedman raised awareness of O2O's groundbreaking technology by writing content for social media posts, NASA web articles, launch campaign proposals, educational activities, and more. To capture the importance of O2O on the future of space communications, Friedman researched how lasers communications terminals work and interviewed many project leaders and engineers. This resulted in understandable, jargon-free content designed for a general public audience. Her work highlighted the concepts and ideas at the heart of laser communications, the engineers who made O2O possible, and the possibilities terminals like O2O offer to future space missions. Her work brings the theoretical possibilities of laser communications "down to Earth," allowing people to imagine the photos, videos, and voices traveling by invisible light from the Moon to Earth.

Benchmarking Algorithms for Quantum Compressive Sensing

HOMETOWN: Shoreview, Minnesota

Collin Frink is a recent graduate of the University of Wisconsin - Madison where he double majored in applied math, engineering, physics (AMEP), and computer science. This is his second internship with NASA focusing on expanding quantum compressive sensing. He is currently considering graduate programs and career paths in quantum computer science and physics. Outside of work, Frink enjoys going to the gym, rock climbing, ping pong, video games, and spending time with friends.

COLLIN FRINK

MENTORS: ERIKA JONES & HARRY SHAW

This summer Collin Frink implemented, tested, and benchmarked algorithms for quantum compressive sensing (QCS) on the quantum cloud service Amazon Braket. Building upon his research from last year in utilizations of quantum algorithms, Frink implemented quantum compressive sensing protocols that were previously developed in Goddard's quantum communications lab. Compressive sensing is a signal processing protocol that optimizes large-signal reconstruction, or interpolation, via learned structures and the sparsity of the signal. QCS is an adaptation of this protocol that leverages the computational advantages of quantum hardware and aligns with NASA's long-term quantum communications efforts. Frink first used Qiskit, the IBM software development kit, to implement the QCS protocols. He then adapted and benchmarked these protocols on the lab's newly acquired quantum computing service Amazon Braket. Establishing benchmarking procedures for the QCS algorithms on Amazon Braket's quantum computing service supports the quantum communications lab's future development and implementation of more sophisticated quantum algorithms. Also, Frink's work with QCS may prove beneficial to NASA's long-term efforts in quantum communications.


LIGHT THE WAY FOR
NASA'S NEXT GENERATION
The SCaN Internship Project
is looking for community members to mentor students.
Mentoring is a valuable opportunity to:
Gain new perspectives on your project
Share your knowledge
Develop leadership skills
Learn more by emailing us at
gsfc-sip-intern@mail.nasa.gov

Full-Stack Development of the White Sands Health & Safety Website

HOMETOWN: El Paso, Texas

Nicholas Jara is a senior at the University of Texas at El Paso (UTEP) studying computer science. He will be an officer at UTEP's Coding Interview Club next semester and works on a small machine learning project in his free time. This is his third internship at the NASA White Sands Test Facility. Outside of work, Jara loves photographing special moments and boxing to relieve stress.

NICHOLAS JARA

MENTORS: CARMEN CHAVEZ & ROBERT OGNAN

The Environmental Health and Safety Project Review (EHSPR) website is meant to replace the forms currently used to determine necessary safety requirements for new projects at the White Sands Test Facility. Nicholas Jara oversaw the front- and back-end development of the EHSPR website to ensure it is easy to use, holistic in its project and safety questions, and easily editable to accommodate protocol changes. Jara began by studying front-end (user-facing) and back-end (data tracking) development, and evaluating which web frameworks could accommodate fast, secure, scalable, and user-friendly design. For the backend, he used the Python-based Django for its clean organization and fast, cost-effective design, and TypeScript-based Angular to assist with building an attractive and easily understandable front-end design. Jara connected the two frameworks to create a seamless interaction between a user setting up or taking a survey and the database scanning and storing both pieces of information. The EHSPR website simplifies tracking and organizing project safety requirements, making it easier to identify safety needs early in a project's development. Jara's work will be keeping White Sands employees and equipment safe for many years to come.

Exploring Novel Benchmarking Approaches for Quantum Computing

HOMETOWN: Irvington, New York

Jonas Kolker is a senior at Columbia University majoring in applied physics and researching the optical properties of quantum materials. Before pursuing his master's degree, he hopes to spend the year following graduation promoting student interest in physics as part of Teach for America. Kolker spends his free time watching so-bad-they're-good horror movies with friends and scrolling through the news.

JONAS KOLKER

MENTOR: ERIKA JONES

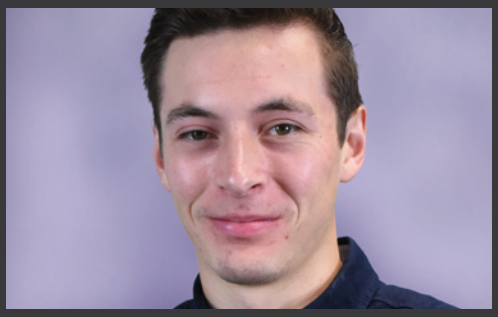
As quantum computing technology develops, so too does the need for effective, all-encompassing performance metrics. Quantum benchmarking involves the development of algorithms, or a series of operations a processor runs through, to demonstrate its computing capabilities and limitations. Jonas Kolker examined novel performance measurement processes for quantum processors and explored IBM's open-source software development kit Qiskit for its use in simulations for quantum computing benchmarking. Kolker first familiarized himself with the emerging literature on benchmarking. He then ran algorithms on Qiskit to demonstrate the software's potential for simulating more complicated algorithmic approaches to run on Amazon Braket, the lab's recently acquired cloud-based quantum-computing service. After compiling results from the algorithms, Kolker presented his findings to the Goddard quantum lab team and provided recommendations for future benchmarking. His work contributes to SCaN's understanding of the foremost quantum benchmarking techniques and the systems with which to run them, allowing NASA to make well-informed and cost-effective decisions as it moves forward in quantum communications research.

Digital Twin: Ground-to-Space Optical Communications Terminal

JACOB KRELL

MENTOR: PATRICK L. THOMPSON

NASA is designing, demonstrating, and publicly documenting the designs and results for a Low-Cost Optical Terminal (LCOT), an infrared communications ground terminal constructed primarily from commercial off-the-shelf parts. The terminal is part of an effort to augment NASA's Near Space Network radio frequency capabilities with optical communications. To aid in the adoption of optical communications, Jacob Krell further developed LCOT's "digital twin," a three-dimensional (3D) computer-aided design (CAD) model of the terminal. Krell's model shows every aspect of the terminal down to the exact screws, washers, and bolts used in its construction. While some LCOT components were already modeled, Krell consulted LCOT's technicians to document any unaccounted-for changes. After logging these changes, he researched part numbers and materials for new hardware, the dimensions and materials of custom-made parts, and the specific arrangement of optical mounts as technicians updated their placement to accommodate new test results. Krell used this information to update the 3D CAD models to form a more complete digital twin. LCOT and its digital twin may become essential tools in expanding NASA's space communications systems to include the much higher data rates made possible by optical communications.



HOMETOWN: Ellicott City, Maryland

Jacob Krell is a native Marylander but joined NASA Goddard this summer with funding from the West Virginia Space Grant Consortium. Krell is a senior aerospace engineering student at WVU and hopes to pursue a master's degree related to opto-mechanical engineering at the University of Arizona next year. His hobbies include hiking, climbing, music, and science. He also enjoys playing jazz piano, experimenting with synthesizers, and programming audio plugins to better understand signal processing and the mathematics of waves.

Behind the Scenes of the Science & Planetary Operations Control Center

ADITYA KUMAR

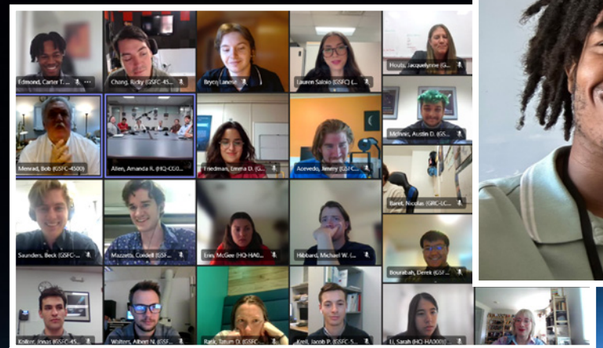
MENTORS: MAHIMA KAUSHIK & JENNIFER SAGER

This summer Aditya Kumar split his time between software and data management in the Science and Planetary Operations Control Center (SPOCC) and modeling advanced visualizations of NASA's Integrated LCRD Low-Earth Orbit User Modem and Amplifier Terminal (ILLUMA-T) payload. For SPOCC, Kumar performed software enhancements, including configuring the center's Lightweight File Management tool by building Python-based scripts that run every time a JavaScript Object Notation rule is executed. Kumar compared Red Hat Enterprise Linux (RHEL) 7 and RHEL 8 operating systems, noted their major differences, and gave recommendations on how to approach the operating system migration. Kumar also mapped articulation points on a model of ILLUMA-T and converted the model's file formatting. He then integrated the model into a visualization scenario to plot object positions, track object orientation, and model key spacecraft data. His work on ILLUMA-T explores the observational capabilities and servicing information 3D modeling can bring to spacecraft monitoring and control.

HOMETOWN: Potomac, Maryland

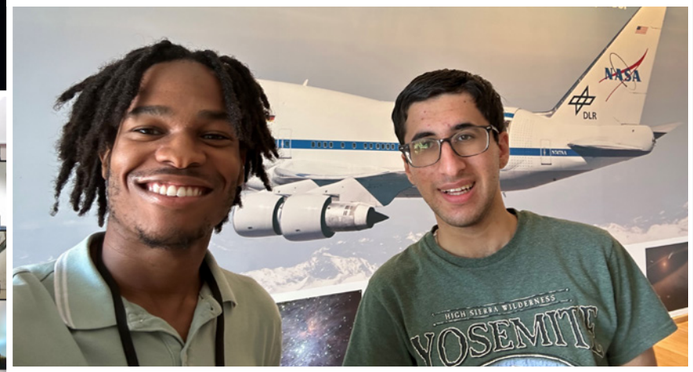
Aditya Kumar is a rising sophomore at Virginia Tech studying computer science and computational modeling and data analytics. This is his first year interning at NASA and he is excited to gain real world computer science experience. Outside of work, Kumar loves tennis and watching Formula 1 racing.

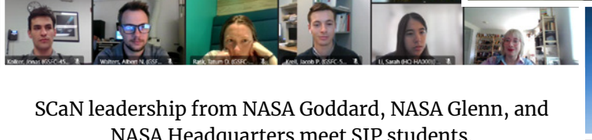
Interns at Work

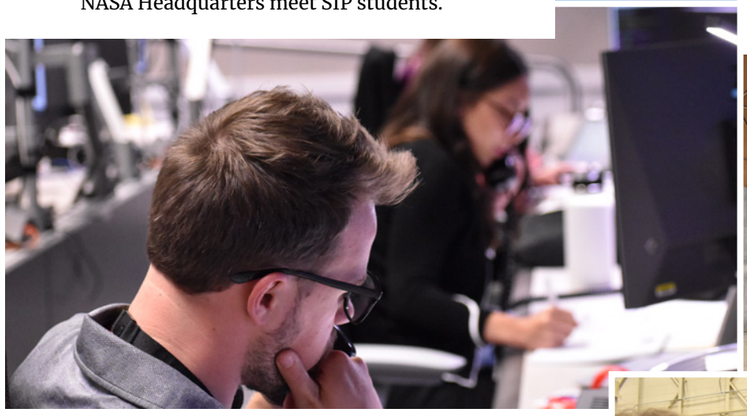


SCaN leadership from NASA Goddard, NASA Glenn, and NASA Headquarters meet SIP students.

West coast students Carter Edmond and Tejas Bhartiya at NASA's Ames Research Center in California.





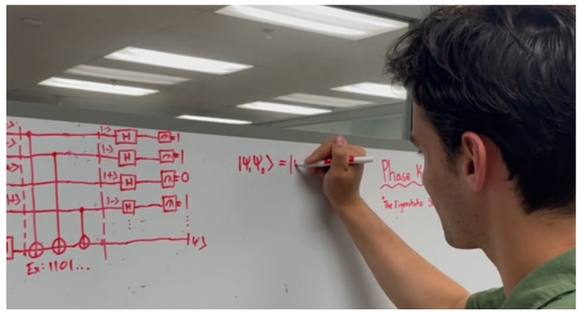


Albert Walters and Lauren Saloio practice communications and problem-solving during a flight operations simulation at the Near Space Operations Control Center.

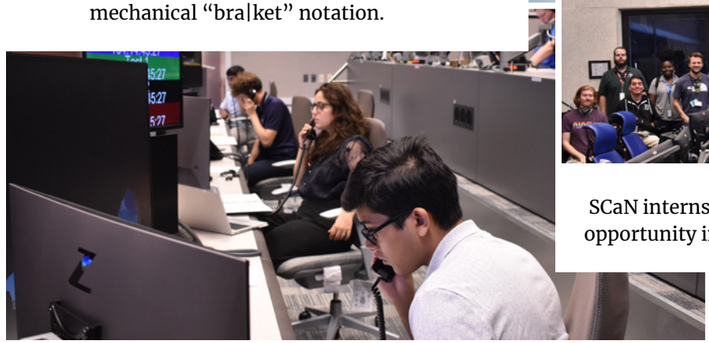
Extra-class amateur radio operator Beck Saunders, KT0E, examines the hardware inside the radome of the new Wallops Ground antenna 5.

Interns touring NASA's Wallops Flight Facility get an up-close look at rocket fabrication capabilities in the machine shop.

Interns sit on-console to listen to a briefing by the Wallops Director of Launch and Flight Operations.



Jonas Kolker demonstrates the basics of quantum mechanical "bra|ket" notation.



Aman Garg, Arya Kazemnia, Emma Friedman, and Aditya Kumar participate in a flight operations simulation in the Near Space Operations Control Center at NASA Goddard.

In-person interns at the summer kickoff event.

SCaN interns and NASA employees pause for a photo opportunity inside the Wallops Range Control Center.

Cloud-Based Quantum Computer Architecture Analysis

HOMETOWN: Russellville, Arkansas

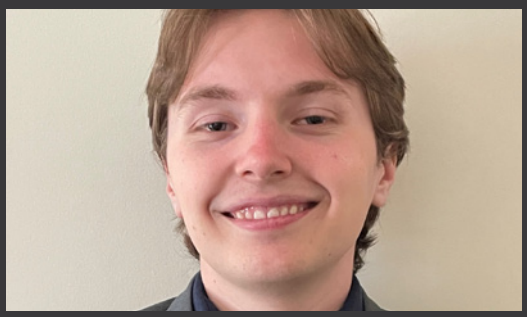
Wade Lamberson is a Space Grant recipient collaborating with the Washington Metropolitan Quantum Network Research Consortium (DC-QNet) team at NASA Goddard. He graduated from Harding University where he majored in physics, mathematics, software development, and electrical engineering. Lamberson will attend Texas A&M this fall to pursue a Ph.D. in physics and continue working in quantum computing. Lamberson finds solace in the outdoors and reading. He also participates in outreach programs to educate and inspire the next generation of scientists and engineers.

WADE LAMBERSON

MENTORS: ALEJANDRO RODRIGUEZ PEREZ & HARRY SHAW

As a member of the Quantum Space Telecommunications and Algorithms Research (Q-STAR) lab, Wade Lamberson performed benchmarking tests on the newly acquired cloud-based quantum computing service Amazon Braket. Lamberson analyzed benchmarking across different quantum computer architectures accessible via Amazon Braket, such as ion trap and superconducting. In writing his code to interact with quantum simulators and quantum hardware, Lamberson used IBM Qiskit, an open-source software development kit designed for working with quantum computers at the base level of pulses, circuits, and application modules. Additionally, Lamberson gained hands-on experience with quantum equipment and practices, including generating a key following the BB84 quantum key distribution protocol, interferometry, and entangled-photon sources. Lamberson's project supports SCaN's commitment to investigating the capabilities of quantum technologies and its novel applications to aerospace communications.

Prototyping Educational Activities for Amateur Radio on the International Space Station



HOMETOWN: Willoughby, Ohio

Bryce Lanese is a senior at Cleveland State University majoring in electrical engineering and minoring in mathematics. Next year, he plans on entering a master's program in nano-bio technologies and eventually pursuing a Ph.D. in mathematics. Outside of work, Lanese enjoys boxing, watching basketball, and working as a math tutor for Cleveland State's student support services program.

BRYCE LANESE

MENTORS: RANDY BERGER & FRANK BAUER

Bryce Lanese worked on multiple projects designed to excite students' interest in amateur radio by connecting them with astronauts aboard the International Space Station. First, Lanese connected Raspberry Pi Zeros to build nanosatellites called CubeSatSim Lites, which are used as satellite emulators for classroom demonstrations. Lanese analyzed their transmissions for five modes of telemetry data using a software-defined radio, Fox Telemetry Decoder, MMSSTV decoder, and SDR# (SDRSharp). Second, Lanese performed comparative analysis on various AI programs by asking them to build a ground station capable of establishing contact with amateur radio operators at the Moon. He then compared the results with his own calculations to determine accuracy. Finally, Lanese used data from the European Space Agency to build antenna pattern gain measurements from L- and S-band antennas in MATLAB. The data from these plots will be used by NASA and the Amateur Radio on the International Space Station (ARISS) team for analyzing link margins. Lanese's projects help the ARISS program develop new materials that increase students' interest in STEM and amateur radio.

Upgrading the Guam Data Interface System Switch Stack

DAVID MARTINEZ, JR.

MENTORS: MICHAEL ALVILLAR & MICHAEL KRAJEWSKI

This summer, David Martinez upgraded the network switch stack within the Guam Data Information System network, allowing engineers to monitor and maintain the operational system more effectively. A system switch stack is a series of physical network switches cabled together so that they operate as a single logical device. Martinez prepared for the switch stack upgrade by researching the network and identifying potential problems and remediation strategies. Then, Martinez "hardened" the new switches by implementing a series of cybersecurity techniques that reduced their vulnerability to attack or unauthorized access and scanned for IT security approval. Next, he tested in a development environment to ensure the switch stack operated as expected. Following successful network tests, Martinez documented all aspects of the upgrade. Martinez's testing and documentation prepares his team for the next step: scheduling a window to safely install the switches into the operational network with minimal interruption. His work will ensure that network engineers at NASA's White Sands Complex have access to network management resources and the tools they need to efficiently monitor and maintain the Guam Data Information System.

HOMETOWN: El Paso, Texas

David Martinez is a senior at the University of Texas at El Paso pursuing his bachelor's degree in electrical engineering. This is his fourth SIP season working at the White Sands Complex. After spending the last year working with the network engineering team, his knowledge of the site's network configuration has allowed him to take part in ensuring its successful operation. In his free time, Martinez enjoys playing video games, watching movies, and going bowling.

Optimization of Radio Frequency Compatibility Testing: Integration & Data Management

AUSTIN MCINNIS

MENTORS: JAKE BARNES & TYLER WILLIAMS

This summer Austin McInnis worked on integrating the monitor and control software platform COSMOS with radio frequency (RF) compatibility test set equipment to improve the efficiency and fidelity of compatibility testing data collection. McInnis began by familiarizing himself with foundational RF knowledge, OpenC3's COSMOS software, and the compatibility test set equipment. He then determined which test instruments could most easily integrate COSMOS. He began by automating all direct-to-Earth RF communication send and receive commands from the Compatibility Test Area's (CTA) Jersey Microwave frequency converter. After successful integration, McInnis began the process of building a data management tool for all CTA equipment currently running COSMOS. Finally, McInnis combined the automation processes he used on the CTA frequency converter with the instrument data he compiled on his management tool to create a single source for full compatibility testing. By using COSMOS to automate and consolidate the CTA's RF compatibility testing instruments, McInnis has streamlined the testing process. Additionally, his work in COSMOS implementation allows users to collect and manage large data sets as part of the RF compatibility testing process. These system automations increase the speed and scope of prelaunch testing for future missions using NASA's Near Space Network.

HOMETOWN: Charlotte, North Carolina

Austin McInnis is senior at the University of North Carolina - Charlotte studying computer science with a concentration in software engineering. This is his first internship with NASA. Outside of work and school, McInnis enjoys fishing, reading, and talking to anyone who will have a conversation.

Testimonials

"SIP is such an excellent introduction to the work field. I've had the opportunity to network with some of the most interesting people at NASA and participate in workshops and discussions that will have real benefits to my career. I also have to mention the "Down to the Wire" activity, which was possibly the coolest thing I've ever done and something I'll never stop talking about. All in all, I can't recommend SIP enough!"

BROOKE BALLHAUS

"I've been really impressed with the number of events and activities available to SIP interns. I've also felt very supported by the people around me, and I get the sense that everyone here wants to give interns valuable, hands-on experience whenever possible."

JONAS KOLKER

"Going into this internship, I knew next to nothing about telecommunications systems or how crucial they are to the success of NASA's missions. Since I've started, I've learned so much about the complex designs of these systems and the irreplaceable role that they play in communicating between a spacecraft and Earth."

LAUREN SALOIO

Investigating Quantum Clock Synchronization Efficacy

CORD MAZZETTI, NICHOLAS SEBASCO
MENTORS: VIRGINIA AYRES (MICHIGAN STATE UNIVERSITY) & HARRY SHAW

Cord Mazzetti and Nick Sebasco investigated methods for performing the synchronization of clocks using quantum entanglement to construct a measurable simulation of its theoretical operation and function. Mazzetti and Sebasco began their investigation by thoroughly reviewing quantum clock synchronization (QCS) protocols and their respective requirements to determine which protocol would optimize the accuracy, error rate, and stability of the system. They then constructed an operational concept for the architecture that would implement their chosen QCS protocol. After finishing the conceptional or notional design for its implementation at the block diagram level, Mazzetti and Sebasco simulated the protocol to gauge its performance. Lastly, they combined their findings to pursue further research. There is a direct relationship between timing accuracy and precision in the measurement of gravitational waves, the Global Positioning System (GPS), data transfer networks, and telecommunications systems. Reliable, incorruptible time synchronization across vast distances is a critical resource for space navigation that only grows more important as NASA continues to expand its exploration efforts.

CORD MAZZETTI

HOMETOWN: Austin, Texas

Cord Mazzetti is a senior at the University of Texas at Austin studying electrical and computer engineering and quantum information science. He intends to pursue further study of quantum information and computer science upon his graduation in May 2024. Beyond his studies and internship, Mazzetti enjoys writing and playing music, exercising, running a Pathfinder Roleplaying Game, and programming at multiple startups.

NICHOLAS SEBASCO

HOMETOWN: Memphis, Tennessee

Nick Sebasco is a Ph.D. student at Michigan State University studying electrical and computer engineering. During his previous summer internship, he researched Spontaneous Parametric Down-Conversion-generated qubits and set up Goddard's Franson interferometer. In his free time, Sebasco loves programming and playing sports.

Exploring Interoperability in Delay-Tolerant Networking Implementations

HOMETOWN: Randallstown, Maryland

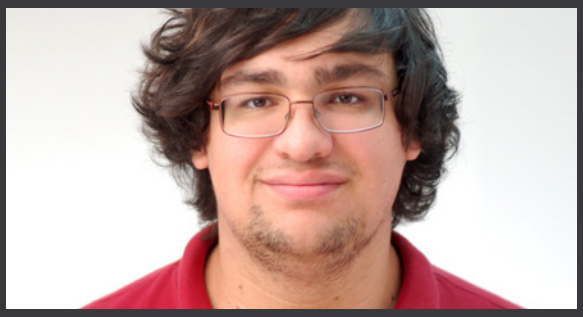
Dedelolia Olungwe is a first-year master's student at George Mason University studying data analytics engineering. She has a bachelor's degree in biomedical engineering from Virginia Commonwealth University. This is Olungwe's second SIP semester and a continuation of her work in DTN. She has worked on many NASA projects, including AI/machine learning, digital twin research, and user interface design. Outside of research, Olungwe enjoys visiting museums and art galleries.

DEDELOLIA OLUNGWE

MENTORS: BEN ANDERSON, BRAD HILL, & KENDALL MAULDIN

Delay-tolerant networking (DTN) is a communications paradigm designed to facilitate data transfer in scenarios where end-to-end connectivity is intermittent, unpredictable, or nonexistent. Dedelolia Olungwe tested different DTN implementations in challenging and intermittent connectivity environments. Olungwe's implementation experiments included the Bundle Protocol Library, Interplanetary Overlay Network, High-Rate DTN, and DTN Marshall Enterprise. She designed and executed a series of trials intended to evaluate potential performance, interoperability, and reliability under various network conditions. The gathered data was then analyzed, compared, and interpreted to chart the strengths and weaknesses of each DTN implementation. Olungwe's research provides insights on the most effective methods for maintaining reliable communication between spacecraft, ground stations, and other mission-critical nodes using real NASA networks. Her work allows NASA to further optimize data exchange and satellite coordination in future space exploration missions.

Quantum Dot Synthesis & Characterization



HOMETOWN: Catonsville, Maryland

Connor Riahin is a sixth-year graduate student at the University of Maryland at Baltimore County working toward a Ph.D. in chemistry. His work on semiconducting polymer nanoparticles has been published in two papers and he plans to defend his thesis this summer. This is his first internship with NASA. Outside of work, Riahin enjoys playing video games and fighting with his cat.

CONNOR RIAHIN

MENTOR: HARRY SHAW

Connor Riahin worked on the synthesis and characterization of quantum dots for use in an absorption spectrometer. Quantum dots are semiconductor particles with the diameter of 10-50 atoms. Riahin synthesized his cadmium selenide quantum dots via a hot-injection, where a cadmium precursor and trioctylphosphine oxide are heated to 320 °C to form a clear solution. He then injected a selenium precursor into the solution and allowed the reaction to continue until the quantum dots reached the desired size. The dots were then characterized by transmission electron microscopy, absorption, and fluorescence spectroscopy. Finally, Riahin printed the dots onto silicon wafers to make quantum dot pixels, wherein a quantum dot's ability to emit different colored light based on their size can be used to form a digital display. Unlike traditional spectrometers, a quantum dot spectrometer can fit in one's hand. Riahin's work in quantum dot synthesis will further the creation of lighter, smaller, and reduced-cost high resolution spectrometers. As weight and mass are at a premium aboard a spacecraft, the ability to perform compound identification with very little equipment is an invaluable asset to future NASA missions.

Back in Orbit

RECOGNIZING THE STELLAR CONTRIBUTIONS OF OUR RETURNING INTERNS

All SIP interns, regardless of age, experience, or expertise, contribute to NASA's mission from their very first day with us, but our returning interns have come to define our summer cohort. Whether they are starting a fresh project or building on their previous work, returning interns take on the additional role of guiding our newer interns. They advise new students on completing key assignments, share tips on networking, and use skills drawn from their own lessons learned to equip their peers for success.

This year's returnees include rising high school seniors we first met as freshmen, students who have turned their previous SCaN projects into conference papers, and newly minted doctors sharing their skills with us before moving on to teaching or research positions. Their commitment and contributions to SIP have been invaluable to NASA's collective success:

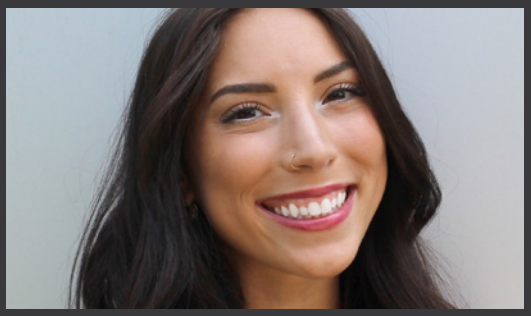
Aditya Dutt
Carter T. Edmond
Thomas Francois
Collin Frink

Aman Garg
Jimmy Hwang
Nicholas Jara
Arya Kazemnia

Brendan Mallery
David Martinez
Dedelolia Olungwe
Mark Ronnenberg

Nick Sebasco
Leo Wang
Andrew Wilder
Theodore Xie

Drafting Documentation for the Roman Space Telescope & PACE Missions



HOMETOWN: Ludlow, Massachusetts

Lauren Saloio is a recent graduate from the University of Massachusetts Amherst where she received a bachelor's degree in English and a certificate of Professional Writing and Technical Communication. After this summer, she is looking to begin a career in technical writing. This is her first internship with NASA and her second technical writing internship. Outside of work, Saloio enjoys reading, movie nights, and going to the beach, park, or coffee shops.

LAUREN SALOIO

MENTOR: JUSTIN LONG

Lauren Saloio wrote technical reports documenting the telecommunications systems of the Nancy Grace Roman Space Telescope and Plankton, Aerosol, Cloud, ocean Ecosystem (PACE) spacecraft. Saloio familiarized herself with the field by researching telecommunications systems and interviewing the engineers who designed them. She then collected and reviewed supporting documents from the engineering staff, visited the facilities where the spacecraft systems were being developed and tested, and consulted with experts as she reviewed the technical information. Saloio began drafting the reports during the research process, dividing the work into sections that could be independently edited and reviewed by subject matter experts so she could write and revise accordingly. The resulting documentation Saloio produced compiles technical documentation, details about spacecraft telecommunications design and testing, and a diverse knowledge base. These reports will later be published as scientific papers and presented at engineering conferences to share this information with the public. Her work provides valuable insight on the communications systems aboard two important NASA spacecraft and suggests opportunities for future design reuse.

SPARKI: Workshopping Amateur Radio Education Resources

HOMETOWN: Herndon, Virginia

Sruthi Sankararaman is a freshman at Princeton University planning to study mechanical and aerospace engineering. She is especially interested in the physics and mechanics behind aircraft and spaceflight designs. This is her first summer as a NASA intern. Outside of school, Sankararaman loves lacrosse, biking, and learning how to play the ukulele. She recently grew more interested in photography and is teaching herself how to develop film.

SRUTHI SANKARARAMAN

MENTORS: FRANK BAUER & DIANA SCHULER

Sruthi Sankararaman contributed to Amateur Radio on the International Space Station (ARISS) initiatives by creating formal and informal educational materials for teachers. Sankararaman supported ARISS's Space Pioneers Amateurs Radio Kit Initiative, or SPARKI, by assembling pieces of an educational materials kit for teachers and running an instructional workshop at the Space Port Area Conference for Educators. During the workshop, Sankararaman guided educators through SPARKI's manual, supplies, and lessons about waves, electricity, codes/ciphers, and radios. In addition to helping teachers familiarize themselves with the current materials in the SPARKI kit, Sankararaman proposed additional activities and lessons plans that utilized SPARKI supplies. Her work this summer spread awareness of ARISS's global outreach mission and SPARKI kits, helped teachers access meaningful STEM resources, and expanded those resources in service of igniting children's passion for learning.

Satellite Data Rate Optimization for Advanced Mission Planning

BECK SAUNDERS

MENTOR: JACOB BURKE

Currently, the Communications Optimization and Planning Tool is used to calculate the total data throughput of a satellite mission during the advanced mission planning phase. This summer, Beck Saunders created a tool to simulate how asynchronous variable data rates and variable coded modulation transmission techniques would improve the information transmission capacity of future missions. To automate the process of calculating the benefits of variable data rates and variable coded modulation, Saunders modeled the satellite to ground station access intervals within Systems Tool Kit. He then applied those access intervals to calculating the total data throughput of different modulation schemes for a satellite based on known mission bandwidths and spectral efficiencies. These modulation schemes allow satellites to transmit nearly twice as much data during their limited ground station pass intervals, creating an opportunity for further satellite optimization during the advanced mission planning period.

HOMETOWN: Kearney, Missouri

Beck Saunders is a recent graduate from the Missouri University of Science and Technology with a degree in electrical engineering. He plans to enter a master's program in electrical engineering next year. Saunders is heavily involved in amateur radio and his callsign is KT0E. In his free time, Saunders enjoys reading books, talking about engineering, and playing video games.

Cloud-Based Satellite Signal Attenuation Assessment from Weather & Flight Dynamics Facility Data Ingestion and Analysis

KAT SHARONIN

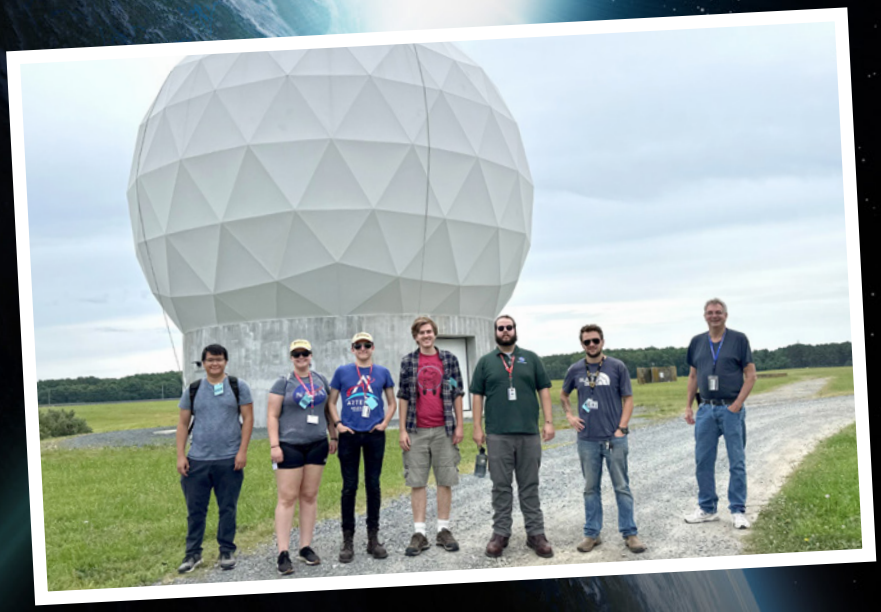
MENTOR: MICHAEL SKUBE

Kat Sharonin created a cloud-based application informing Near Space Network operators about adverse weather that may impact a downlink between a satellite and ground station. The Cloud-Based Satellite Signal Attenuation Assessment from Weather (C-SSAAW) predicts signal performance for downlinks using forecasted weather and then reports any potentials drops in performance. Sharonin designed the tool to collect scheduling requests by mission name, antenna, and downlink times. The program then pulls station-specific weather data from multiple sources. Next, it inputs the mission's signal bands, frequencies, and weather data into a model of network standards to calculate the impact of the weather on the signal properties and antenna limits. Finally, C-SSAAW sends a notification if it predicts severe downgrades in signal quality. This notification informs the network team of a potential degradation in services. As a second project, Sharonin developed Flight Dynamics Facility Data Ingestion and Analysis, a pipeline that converts weekly satellite-to-ground performance reports into a single unified database that enables a variety of analyses. She also generated interactive scripts to help analysts fetch informative statistics and visualizations. Both projects increase capabilities for NASA communications and navigation.

HOMETOWN: Belmont, California

Kat Sharonin is a rising junior at the University of California Berkeley studying electrical engineering and computer science. This is her first rotation as a Pathways intern and her fourth internship with NASA overall. Sharonin specializes in satellite technology and Earth science with an emphasis on wildfire science/ emergency services and pursued her "fiery" interest at Goddard by working on modeling fire perimeters and taking firefighter training courses.

EXPAND YOUR HORIZONS



As a SIP intern, you will embark on a journey of professional growth and assist in real NASA projects. No matter your skillset and interests, there is a place for you in SCaN!

Internships are available in a variety of disciplines such as:

- **Engineering**
- **Computer Science**
- **Finance**
- **Communications**
- ***And more!***

Apply today at

intern.nasa.gov

Search for keyword “SCaN.”

For more information, contact us at:

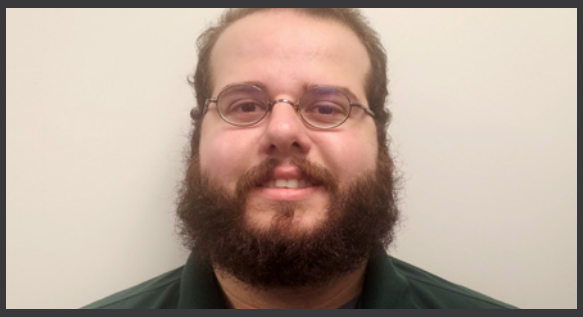
gsfc-sip-intern@mail.nasa.gov

Artemis Radio Communications Obstruction Tool

MAXIMILIAN TELMAN

MENTORS: AMY DAVIS & ROB TYE

The Artemis I mission tested every element of the Space Launch System (SLS) rocket and the Orion spacecraft, including their space communications. Maximilian Telman devoted his summer to the Artemis Radio Communications Obstruction Tool (ARCOT), which models the possible effects of environmental obstructions on radio communications for future Artemis missions. Telman used MATLAB to model the radiation pattern of the radio waves coming from a Kennedy Uplink Station (KUS) receiving antenna attached to the SLS rocket. After simulating the antenna, he modeled the buildings, ground topology, and foliage surrounding the main antenna at KUS. Telman then simulated the way the environmental factors affected radio waves as they moved around the models. The results of these simulations were recorded and notated to increase NASA's understanding of environmental factors on radio frequency communications, as well as potential opportunities to mitigate their effects. The ARCOT project protects and verifies the fidelity of Artemis launch communications by predicting possible obstructions and reducing the time needed to find environmental sources of radio interference.



HOMETOWN: Chesterfield, Missouri

Maximilian Telman is a senior studying electrical engineering at the Missouri University of Science and Technology. He is the vice president of his school's amateur radio club and works as an undergraduate research assistant at his school's microwave sensing laboratory. After graduation, he plans to pursue his master's degree in electrical engineering. This is his first internship with NASA, where he is interning out of NASA's Wallops Flight Facility.

Optimization of Radio Frequency Compatibility Testing: Integration & Data Visualization

ALBERT WALTERS III

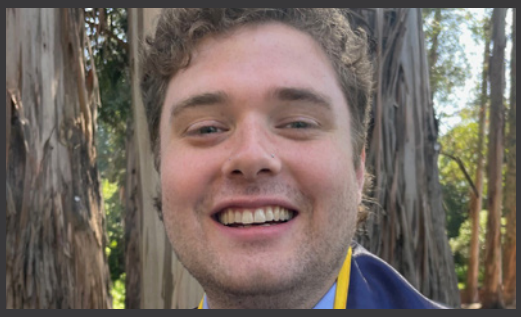
MENTORS: JAKE BARNES & TYLER WILLIAMS

Albert Walters III increased efficiency and improved the fidelity of data collection for radio frequency compatibility testing by integrating COSMOS, a monitor and control software platform, with compatibility test set equipment. Walters began the integration process by researching the problem, studying all related components, and logging known hurdles, current successes, and the tools at his disposal. First, he created a graph widget for COSMOS using JavaScript and a web-based graphing platform. Next, Walters efficiently pulled the low-bandwidth data from the Cortex machine into COSMOS. Finally, he collaborated with the Compatibility Test Area (CTA) interns to develop a Radio Frequency Compatibility Test Suite within the COSMOS software. Walters's work expanded and automated the CTA's graphing capabilities to incorporate data received from various targets, fixed Cortex machine data issues, and automated the current radio frequency compatibility process while preserving the information in a single dashboard.

HOMETOWN: Blacksburg, Virginia

Albert Walters III is a master's student at Virginia Tech studying computer science with a concentration in software development. Walters completed his undergraduate degree at Radford University where he studied geospatial science with a concentration in geoinformatics. This is Walters' first internship with NASA. When not developing software, he is working on earning his private pilot's license, hiking, hunting, snowboarding, repairing one of his vehicles, or tending to his in-law's mountain property.

Knowledge Graph of Mission and Project Relationships



HOMETOWN: Berkeley, California

Andrew Wilder is a senior data science major at University of California, Berkeley. This is his second time interning with NASA, where he previously implemented a solar flare and coronal mass ejection detection system. After his internship, he plans on pursuing a job in Earth and environmental sciences. On the weekends, Wilder enjoys playing volleyball with friends and hanging out with his dogs.

ANDREW WILDER

MENTOR: BRAD HILL

Prioritization is a key element of space communications. Limited bandwidth and connectivity windows mean that the Near Space Network is often tasked with determining what data takes precedence when communications between two or more spacecraft inevitably overlap. Andrew Wilder addressed this problem by creating a knowledge graph to determine which projects take priority in mission optimization. First, Wilder scraped and stored all available data in a non-tabular database. Then, he transferred that data into a graph database and created relationships between projects and their "nodes," such as personnel, project destination, and technological classification, in addition to employing natural language processing to generate descriptive text. That graph database then connects projects to missions that share similar auxiliary nodes. Finally, Wilder created a machine learning algorithm to find the "weight" of those nodes and their combined classifications to determine which nodes have the largest impact on a project's relevance to a mission. Wilder's knowledge graph provides an intelligent roadmap for weighing project significance and using this information to optimize Near Space Network processes.

Accessible Coding for the Low-Cost Optical Terminal

HOMETOWN: Reisterstown, Maryland

Theodore Xie is a rising senior studying computer science and applied mathematics at Johns Hopkins University. This is his second internship with NASA, as well as his second year working on optical communications at Goddard. Outside of work, Xie enjoys reading, weightlifting, and working on personal programming projects.

THEODORE XIE

MENTORS: DAN PAULSON & HALEH SAFAVI

The Low-Cost Optical Terminal (LCOT) is designed to be a generalized, multi-mission ground terminal used to interface with optical communications missions between low-Earth orbit and lunar ranges. Theodore Xie spent his summer automating an adaptive optics subassembly for the LCOT project. Xie designed a code-accessible graphical user interface (GUI) to operate LCOT's adaptive optics and narrow field-of-view tracker control systems. The control system's underlying development board and firmware is connected to the GUI by a standard workgroup — or local network — ethernet switch. Xie wrote his interface in Python, a flexible and relatively simple programming language, to ensure that users can easily understand, upgrade, and view the code. Xie's GUI successfully provides streaming status and camera frame capture to LCOT users while reflecting the LCOT project's commitment to low-cost, modular development. His work directly contributes to the future of optical communications and serves as a steppingstone for further automation of the LCOT system.

Thank You to Our Mentors!

This summer, 41 mentors bolstered SIP's 40 interns. Mentors ensured that students succeeded in their projects by aiding in logistical, technical, and professional support.

Below is a list of mentors and dedicated Pathways students whose time and talent went to inspiring this year's cohort of innovators. Thank you for your generosity in developing the next generation of NASA's workforce.

Michael Alvillar
Pouyan Amirshahi-Shirazi
Ben Anderson
Virginia Ayres
Andrew Bakke
Jake Barnes
Frank Bauer
Randy Berger
Jacob Burke
George Bussey
Abril Chavez
Amy Davis
Brad Hill
Alan Hylton
Dave Israel
Erika Jones
Mahima Kaushik
Mike Krajewski
Nancy Linton
Justin Long
Kendall Mauldin
Naveed Naimipour
Robert Ognan
Dan Paulson
Mariah Pulver
Elana Resnick
Erin Roberts
Alejandro Rodriguez Perez
Haleh Safavi
Jennifer Sager
Katherine Schauer
David Schuchman
Diana Schuler
Harry Shaw
Mike Skube
Zac Smith
Patrick L. Thompson
Rob Tye
Tyler Williams
Vicky Wu
Wayne Yu

Message from Bob Menrad

Associate Director of Flight Projects for
Exploration and Space Communications
NASA's Goddard Space Flight Center — Greenbelt, Maryland

Congratulations to this year's summer intern cohort! The Goddard Comm and Nav Community takes great pride in its interns, who produced outstanding results during their 10 weeks with us. That said, it could not have been done without the dedicated mentors who volunteered their time and expertise to guide each intern through real-world projects that advance and contribute to SCaN's mission and vision.

To the interns: thank you for joining us this summer and lending your fresh perspective to the challenges of space communications and navigation. Each of you have brought your talent and skills to solve unique problems in areas including quantum and optical communications, compatibility testing, software engineering, commercialization, and so much more.

We trust that you had a valuable experience and gained the professional skills needed to succeed in the workplace. We hope you are leaving with the new-found confidence that arises from seeing your own amazing capacity to meet the unique challenges associated with exploring space.

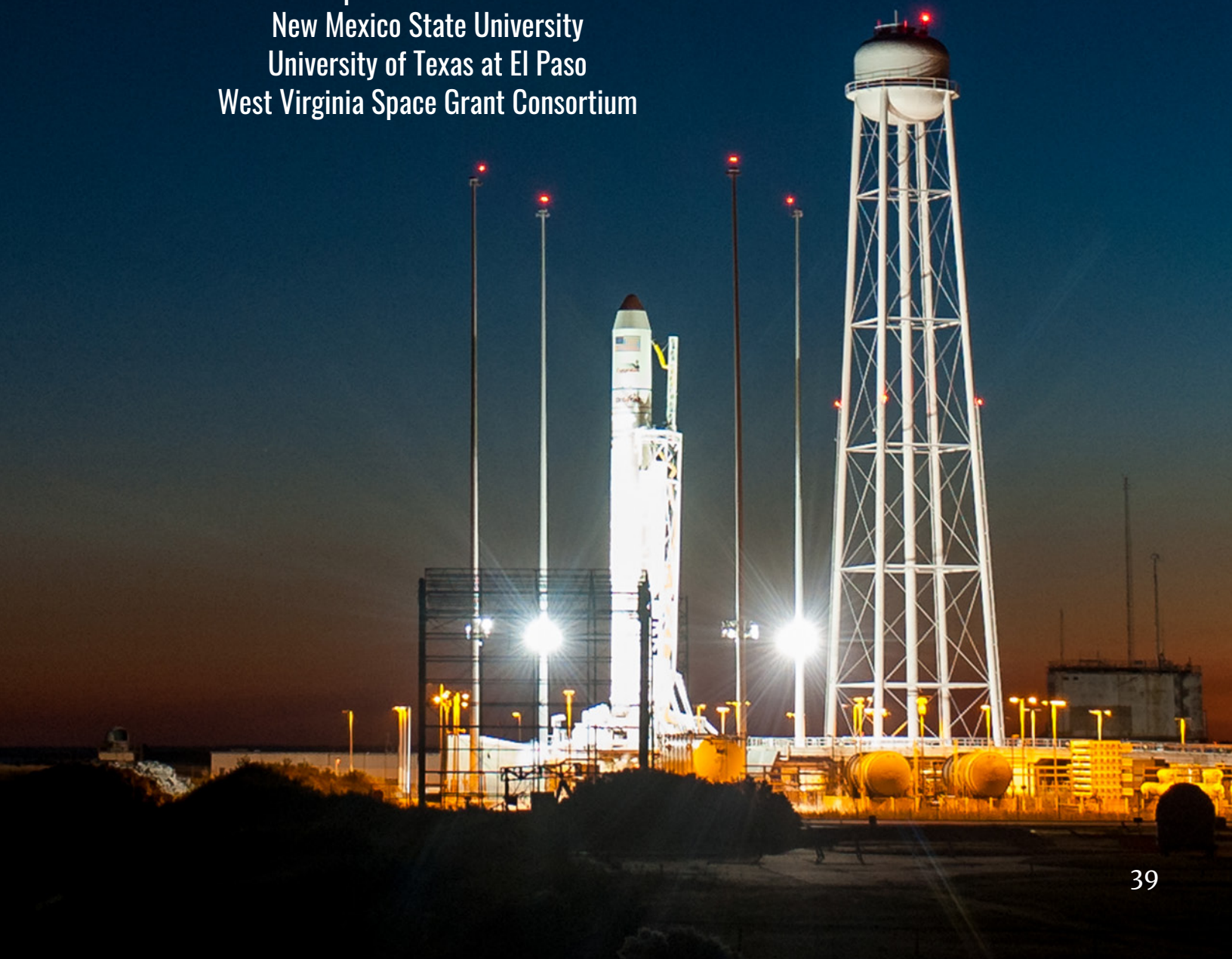
Well done!

Thank You to Our Partners!

The SCaN Internship Project would like to acknowledge the generous partners whose contributions to funding, project direction, and mentorship continue to empower our mission. Their support ensures NASA can continue to build excitement about science and technology, reach students around the country, and enable the next generation of aerospace experts.

This summer, we thank:

Amateur Radio on the International Space Station
Arkansas Space Grant Consortium
Michigan State University
National Reconnaissance Office
National Space Club and Foundation
New Mexico State University
University of Texas at El Paso
West Virginia Space Grant Consortium



SPACE COMMUNICATIONS AND NAVIGATION PROGRAM OFFICE

GODDARD SPACE FLIGHT CENTER

National Aeronautics and Space Administration

Goddard Space Flight Center
8800 Greenbelt Road
Greenbelt, MD 20771
www.nasa.gov/scan

www.nasa.gov

NP-2023-7-115-GSFC