National Aeronautics and Space Administration

SPACE COMMUNICATIONS AND NAVIGATION INTERN PROJECT

LOOKBOOK

GODDARD SPACE FLIGHT CENTER

SUMMER 2020

DISCOVERY
LEADERSHIP
OPPORTUNITY

SCaN Internship Project

Summer 2020 Look Book

Program Overview

The Space Communications and Navigation (SCaN) program at NASA Headquarters in Washington oversees much of NASA's communications and navigation infrastructure and technology development portfolio. Additionally, they take responsibility for developing the future NASA workforce. The crown jewel of that effort is the SCaN Internship Project (SIP), which connects students with NASA mentors to perform work of real benefit to the agency.

In addition to the standard intern experience, SIP offers students supplementary events and programming to enhance their summer. In addition to building their resumes by assisting them in completing their project, SIP provides professional development workshops, valuable networking opportunities, and events that foster friendship and fellowship among interns.

To. Ensure their safety during the COVID-19 pandemic, this summer's SIP students had to work virtually to ensure their safety. SIP met this challenge by adjusting programming for the virtual environment, creating opportunities for connection in spite of the pandemic. Though SIP looked different this year, interns still had opportunities for in-person engagement and interpersonal growth.

In this "Intern Look Book," you'll learn about SIP participants supporting SCaN for the Summer 2020 semester through the Exploration and Space Communications (ESC) projects division. ESC realizes SCaN's vision at Goddard Space Flight Center in Greenbelt, Maryland, as well as two other Goddard-managed facilities: Wallops Flight Facility on Wallops Island, Virginia, and the White Sands Complex in Las Cruces, New Mexico.

All of these interns have risen to the challenge of the virtual summer, delivering powerful innovations that support SCaN's strategic goals. With their mentors, they have made meaningful contributions to agency initiatives across a wide variety of disciplines.

Messages from SCaN Leadership

Badri Younes

**Deputy Associate Administrator for SCaN,
NASA Headquarters**

Thank you all for being part of our family. We believe that you all have the potential to move NASA forward into the future. As you continue to define yourselves academically, professionally and even personally, please maintain focus and let your passion be your guide. Always move forward, and if you fall, get back on your feet and continue your journey. The future is yours to define and shape for the better. Make it worthwhile and enjoy the journey. Best of luck on your future endeavors and hopefully I will see you back at NASA.

Barbara Adde

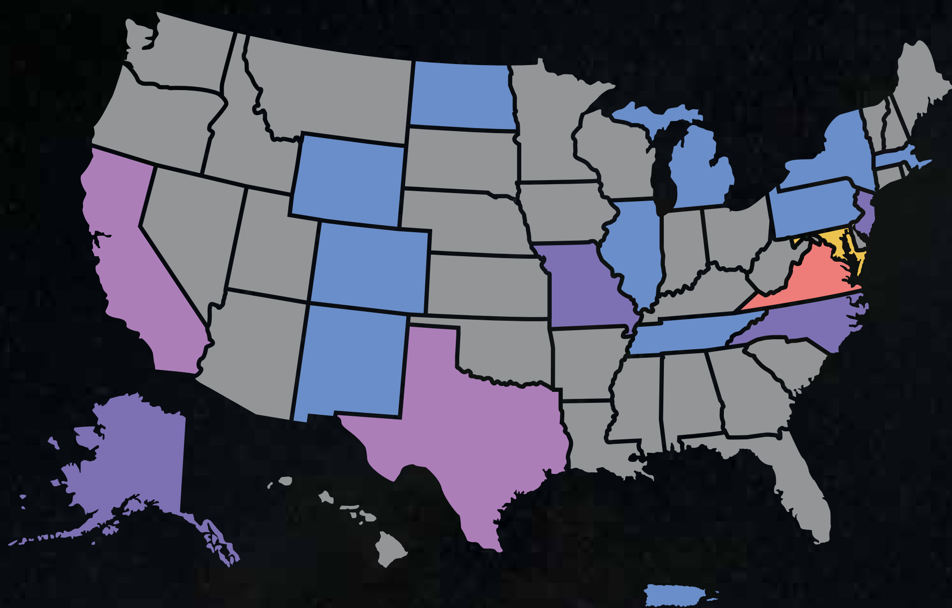
**SCaN Policy and Strategic Communications Director,
NASA Headquarters**

Summer has become our favorite season at SCaN, when the interns join us for 10 weeks and spread enthusiasm and energy throughout the program. SIP is designed so that everyone benefits — NASA, SCaN, the mentors, and each of you — creating a synergy that's always exciting. Interacting virtually instead of in person due to the quarantine has led to creative ways to build relationships, and I hope that you will continue to reach out to each other and to those of us on the NASA team — SIP leaders, mentors, and SCaN staff — as you progress in your collegiate and professional careers. Thank you for sharing your summer with us. We hope you can visit us in the future. The best days are ahead.

Summer 2020 Interns By The Numbers

The interns participating in the summer session of SIP 2020 hail from towns across the nation, each with diverse backgrounds. Below are some key metrics about our students — where they live, what they study, and which facility they called home base this summer.

41 TOTAL INTERNS



INTERN HOME STATES & TERRITORIES

- 1
- 2
- 3
- 4
- 12

INTERNS BY LOCATION

Goddard Space Flight Center	90%	37
Wallops Flight Facility	5%	2
White Sands Complex	5%	2

SEASONS WITH SIP

First Season	54%	22
Second Season	17%	7
Third Season	17%	7
Fourth Season	10%	4
Fifth Season	2%	1

INTERNS BY ACADEMIC LEVEL

High School	7%	3
Undergraduate	71%	29
Graduate	15%	6
Doctoral	7%	3

INTERNS BY GENDER

Male Identified	30	73%
Female Identified	11	27%

*Percentages have been rounded for clarity.

INTERNS BY PROJECT DISCIPLINE

Software Engineering	16	39%
Cybersecurity	4	10%
Systems Engineering	4	10%
Telecommunications	4	10%
Data Modeling	3	7%
Optical Communications	3	7%
Quantum Communications	2	5%
Electrical Engineering	2	5%
Education and Outreach	2	5%
Navigation	1	2%

Intern Projects and Biographies

MENTOR: Ryan Turner

Hands Off: Elevating the NEN Remote Status Server into the Cloud

MCKADE SORENSEN, SHAWN MCGRAW,
STEFANY ALICEA, ISSHIN KUROKAWA

Hardware can be expensive and difficult to maintain. The Near Earth Network (NEN) Now web application, which visualizes communications through the NEN, currently relies on a Remote Status Server (RSS) using NASA hardware. Replacing the RSS with software systems like a Cloud Status Server (CSS) would drive down costs and decrease the amount of code needed to update the server. McKade Sorenson, Shawn McGraw, Stefany Alicea, and Isshin Kurokawa created a proof-of-concept that demonstrates a potential CSS architecture for NEN Now.

The CSS will have the ability to store and retrieve NEN antenna status data using an Amazon Web Services (AWS) repository. By using AWS, NASA can maintain the flexibility, scalability and accessibility of modern cloud architecture without the challenges associated with hardware.
The team established an AWS sandbox development area to build the CSS architecture. In this space, they could use AWS tools as building blocks to meet developer needs. The team created an outline of AWS tools to visualize data pulled from the AWS repository for the developers.

Next, they developed an adaptor for the NEN Now server, which forwards status data to the AWS repository. The team then created a Graphical User Interface (GUI) display to allow users to access and visualize status data in a manageable format. The GUI will revamp the existing RSS interface for an easy transition between software products.

The CSS will have the ability to generate report summaries and detail upcoming events, provide real-time notifications of failed communication between satellites and antennas, and share other mission-specific details. The CSS will enhance the current capabilities of NEN Now while reducing operating costs and improving efficiencies.

STEFANY ALICEA

HOMETOWN: College Park, MD

Stefany Alicea recently graduated from Smith College with a bachelor's degree in computer science and a minor in chemistry. This is her third summer participating in SIP on the SCaN Now team. She is interested in careers in the biotechnology industry, where she can leverage her programming skills and healthcare-related interests. In her free time, she enjoys biking, gardening, painting, and comedy specials.

ISSHIN KUROKAWA

HOMETOWN: Silver Spring, MD

Isshin Kurokawa recently graduated from The Heights School in Potomac, Maryland. In the fall, he will attend the University of Pittsburgh. He plans to pursue his bachelor's degree in computer science. This is his second internship at Goddard as part of the SCaN Now team. In his spare time, he enjoys strumming the ukulele, playing video games, and spending time with his friends.

SHAWN MCGRAW

HOMETOWN: Davidsonville, MD

Shawn McGraw is a recent graduate of the University of Maryland, College Park, where he earned his bachelor's degree in computer science. Previously, McGraw worked for three years on the mission operations team for the Joint Polar Satellite System (JPSS), a constellation of weather satellites. While with JPSS, McGraw wrote software applications to streamline engineers' work. He was also given the opportunity to sit in the launch control room during the launch of JPSS-1.

MCKADE SORENSEN

HOMETOWN: North Pole, AK

McKade Sorensen is a senior at the University of Alaska Fairbanks studying computer science. He hopes to enroll in a master's program in computer science upon finishing his bachelor's degree. Last summer, he interned at the Alaska Satellite Facility. In his free time, Sorensen participates in several outdoor activities including hiking, biking, and kayaking.

MENTOR: Wes Eddy

Operation and Visualization Tool for the Solar System Internet

REEMA AMHAZ

Network infrastructure has always been a vital component of NASA's mission to learn more about the universe. As the agency ventures further into space with the Artemis mission, engineers will need a tool that offers insight into network performance by visualizing communications between users, relay satellites, and ground stations.

Reema Amhaz spent her summer working on a Delay/Disruption Tolerant Networking (DTN) visualization tool. The graphic interface will receive and display network performance metrics for data transmission over NASA's DTN network, which uses Bundle Protocols to expand internet-like network performance into space. The visualization tool will inform the network architecture of future human and robotic missions to the Moon and Mars.

Amhaz built an infrastructure that automates simulations, data storage, and visualizations in an interface for network architects and engineers. She also built a transport mechanism for the transmission of the data output into relational databases, constructed the database schema, developed a way for users to query the database, and designed dashboards that visualize key data. In addition, Amhaz constructed various simulation input scenarios, improved existing source code, parsed the files, built an interface and database to store the results, and created custom graphics to represent simulations.

The completion of this tool will foster a better understanding of network organization. Ultimately, Amhaz's work will improve performance of NASA's DTN network, an innovation that will be key to future deep space missions.

REEMA AMHAZ

HOMETOWN: Brooklyn, NY

Reema Amhaz is a rising senior at New York University studying computer science and data science with an interest in astrophysics. Her research is focused on applications of machine learning in interstellar space travel and stellar orbits. This summer, she will design and test networks between spacecraft and ground stations. Amhaz hopes to become a software engineer in the space sector. She also enjoys reading, yoga, traveling, and going to the beach.

MENTOR: Guadalupe Hernandez

Streamlining Asset and Configuration Management

ALAN BALDERAS

Enterprise Asset Management (EAM) monitors the lifecycle of NASA hardware and software configuration items, maximizing their lifetime and reducing costs. The EAM process improves the quality, health, and environmental safety of NASA assets. This summer Alan Balderas monitored several EAM systems at NASA's White Sands Complex, identifying ways to make the EAM process more efficient. He worked to install, deploy, and maintain a centralized database system for multiple active and legacy projects.

Balderas provided EAM support to STPSat-6 Antenna and Ground Equipment (SAGE), Space Network, Space Network Ground Segment Sustainment (SGSS), and the Laser Communications Relay Demonstration (LCRD) projects. His work included transitioning Space Network discrepancy reports from a legacy system over to the EAM, and his system will soon help the Near Earth Network make the same transition.

Balderas also managed the overall enterprise asset configuration of hardware and software, documenting the data using IBM's cloud management tool Maximo. He optimized the baseline of over 50,000 configuration items with Control Desk, another tool developed by IBM. Balderas' knowledge of systems engineering proved invaluable as the logistics and facilities departments at White Sands Complex migrated inventory counts, work orders, preventive maintenance, and job plans to the Amazon Web Services Government Cloud (GovCloud), a long-term hosting solution.

HOMETOWN: El Paso, TX

ALAN BALDERAS

Alan Balderas is a graduate student studying software engineering at the University of Texas at El Paso, where he also earned a bachelor's degree in computer science. Balderas has interned at White Sands since 2019, working on an enterprise asset management project. He is a member of the Computer Alliance of Hispanic Serving Institutions and the Future Business Leaders of America. Balderas also enjoys traveling, cooking, and going to the gym.

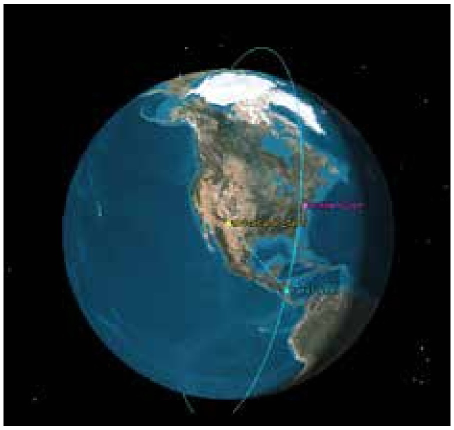
MENTOR: Obadiah Kegege

Optical Communication for Low Earth Orbit SmallSats

DANA BARKER, REGGIE GESICHO

Currently, NASA's Near Earth Network provides communications and navigation services using radio frequencies. However, as missions generate more data and the radio portion of the electromagnetic spectrum becomes increasingly congested, the Near Earth Network will incorporate infrared optical communications into the suite of services it provides. Optical communications offers higher bandwidths that enable unprecedented volumes of data return at greater speeds. Additionally, optical communications systems are smaller, lighter, and require less power than comparable radio systems.

For their summer project, Dana Barker and Reggie Gesicho modeled optical communications downlink scenarios. Barker and Gesicho used



MATLAB, a computing environment developed by MathWorks, to discern optimum system performance for the transmitter and ground receiver terminals while analyzing the communications coverage for a small satellite.
While developing their model, Barker and Gesicho gained a deeper understanding of the fundamentals of space communications and spaceflight. Barker and Gesicho's analysis of the modeling shows future challenges or risks that need to be mitigated in order to incorporate optical communications into low-Earth orbit SmallSat missions.

Using his analysis, the Near Earth Network can take the first step towards enhancing the way we communicate with satellites. Barker and Gesicho's models will play a pivotal role in developing Direct-to-Earth (DTE) optical communications services for low-Earth orbit users, thereby helping the network embrace this revolutionary communications technology.

DANA BARKER

HOMETOWN: Columbia, MD

Dana Barker is a senior at Long Reach High School in Columbia, Maryland. Her interests include math, engineering, computer science, and robotics. Barker also participates in competitive speech, ethical debate, and a Christian youth group. She has future plans to study aerospace engineering and foreign languages. In her free time, Barker is learning Spanish and German, creating traditional and digital art, composing written and spoken word poetry, biking with friends, and engaging in philosophical discussion with anyone willing to listen.

REGGIE GESICHO

HOMETOWN: East Stroudsburg, PA

Reggie Gesicho is a sophomore at Penn State pursuing a bachelor's degree in computer science with a minor in engineering leadership development. This is his first year as an intern at Goddard. He is passionate about computers and participates in Penn State's annual hackathon, HackPSU. Apart from academics, Gesicho enjoys playing soccer, tennis, basketball, and watching anime.

MENTOR: George Bussey

Evaluating Localization Capabilities for Lunar Exploration

DAWSON BEATTY

As part of the Artemis missions, NASA will establish a sustainable presence on the lunar surface, returning humanity to the Moon — this time to stay. Artemis astronauts will need robust navigation capabilities, relying on several Earth- and space-based measurements to determine their location.

Dawson Beatty spent his summer developing a lunar navigation tool that will be used to determine the capability of ground and satellite architectures in supporting the localization of astronauts on the lunar surface. This tool will evaluate mission scenarios and sensor capabilities, allowing mission designers to conduct trade studies that evaluate the effect that the changing quantity of visible ground stations, different satellite configurations, and sensor capabilities will have on lunar surface navigation.

In the first application of this iteration of the tool, Beatty will determine whether a single lunar relay satellite is sufficient to localize users on the Moon. Future development will include more complicated dynamics to prepare for expected uncertainty. Future work might also include additional measurements, such as inertial measurements from the ground or the use of a lunar lander as a fixed reference position.

Interns like Dawson Beatty are ensuring the success of the Artemis missions through their diligence and expertise. Beatty's navigation tool will grant astronauts peace of mind as they traverse the Moon's rocky plains.

HOMETOWN: Boulder, CO

DAWSON BEATTY

Dawson Beatty is completing his master's degree in astrodynamics and satellite navigation at the University of Colorado Boulder. In 2019, he received his Bachelor of Science in aerospace engineering and applied mathematics. His master's research is focused on incorporating time-of-flight measurements with imperfect clocks into distributed state estimation. This is his third internship in the aerospace industry. This summer he is spending his free time reading and training for a marathon.

MENTORS: Armen Caroglanian, Steven Stochaj

Low-Cost Atmospheric Monitoring System for Optical Ground Stations

VINCENT BIA, JR.

High-data-rate optical communications over infrared lasers will be a staple of space-to-ground communications in the near future. Given the significant impact of water vapor in the form of clouds and atmospheric turbulence on the effectiveness of infrared transmissions, accurate weather prediction at ground terminals will be paramount to the success of optical communications.

The New Mexico State University capstone project completed initial research into the development a low-cost cloud imager and weather station during the 2019-2020 academic year. Vincent Bia Jr. participated in SIP this summer to maintain project continuity between academic years and continue progress on the station.

Measurements of atmospheric data at optical ground stations normally requires expensive weather monitoring equipment. Bia's weather station, which records atmospheric data via an infrared camera, will be a far more cost-effective solution.

Over the course of his internship, Bia integrated the weather station sensors into a datalogger, deployed the weather station on the roof of New Mexico State University's Thomas and Brown Hall, and set up data acquisition via a Wi-Fi link. For the cloud imager, Bia investigated reflector materials and interfaced the camera with a computer to process and record data.

Low-cost cloud imagers and dataloggers like those at the New Mexico State University weather station will allow NASA to better optimize and schedule optical communications links. Bia's project sets the stage for NASA to better analyze inclement weather there and at other optical ground stations where this weather station is implemented.

VINCENT BIA, JR.

HOMETOWN: Las Cruces, NM

Vincent Bia Jr. is a junior at New Mexico State University in the engineering physics program with an electrical concentration. He selected his major because of its all-encompassing approach to physics, and he enjoys studying the intersection of physics with cars and computers. After graduating, Bia hopes to become an engineer at NASA specializing in optics. In his free time, Bia enjoys playing sports, cooking, and hanging out with friends and family.

MENTOR: Harry Shaw

Chaotic Quantum Key Distribution Applications in Space Communications

NOAH COWPER

Secure data transmission is a challenge that the agency must overcome to ensure the security of mission-critical data and the safety of astronauts venturing into deep space. NASA is researching new ways to communicate and encrypt data in order to meet these challenges. Among the communications and encryption options, quantum key distribution (QKD) promises a truly un-hackable future, where NASA can be sure that information sent over quantum networks remains secure.

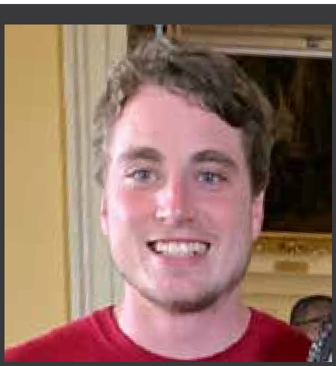
This summer, Noah Cowper developed a tool that evaluates the practical limitations of quantum networks that rely on QKD. Cowper explored a novel application of QKD and synchronized chaos to mask a transmitted message. While other QKD schemes relying on single-photon emission can be vulnerable to number splitting attacks, Cowper discovered this new transmission scheme is free of the usual limitations inherent to single-photon emission.

Usually, when attenuated laser radiation is the source of quantum states, quantum cryptography can be susceptible to eavesdroppers who may obtain pieces of key information. Cowper observed a simulated eavesdropper gaining the maximum amount of information during key setup and key reconciliation on his transmission scheme, and concluded that the limited information the eavesdropper gains would be insufficient to decode the message.

Cowper's work will benefit the quantum communications team by providing insight into the capabilities of different QKD schema. As SCaN engineers create NASA's first quantum networks, Cowper's research will ensure that those networks are as secure as possible.

HOMETOWN: Laramie, WY

NOAH COWPER



Noah Cowper is entering his third year of graduate school at the University of Wyoming, where he also completed his undergraduate degree and will continue on to pursue his doctorate. He studies physics and has been recognized as an outstanding student by the university's College of Arts and Sciences. Cowper is currently researching quantum communication and its implementation. In his spare time, Cowper enjoys learning history and exploring the outdoors.

MENTOR: Ben Ashman

Evaluating a Lunar Navigation Architecture

KYLE CRAFT

With NASA's Artemis missions to the Moon, astronauts will return to the lunar surface for the first time since Apollo. While the challenges of navigating crewed missions in lunar space remain largely the same as they were 50 years ago, new computer capabilities and technologies will improve the positioning, navigation and timing capabilities of Artemis missions. Kyle Craft spent his summer analyzing how these new innovations can be incorporated into lunar mission navigation architectures.

For Apollo, ground-based tracking networks were the cornerstones of communications and navigation. For the Artemis missions, which will see NASA establish a sustained presence on the Moon, the agency will need a more robust method for real-time navigation. By using Global Navigation Satellite System (GNSS) signals like GPS in tandem with traditional ground-based tracking, NASA can provide astronauts with the powerful navigation capabilities they need. NASA has already proven the viability of high-altitude GNSS at distances halfway to the Moon and simulations show they will work in lunar orbit as well.

This summer, Craft investigated lunar navigation architectures that incorporate innovations like high altitude GNSS. His team tested many different navigation schemes for different mission profiles, identifying the merits and drawbacks for each.

Craft's evaluations were conducted using Goddard's Orbit Determination Toolbox (ODTBX). Simulation fidelity was confirmed using flight data from NASA's Magnetospheric Multiscale (MMS), Geostationary Operational Environmental Satellite-16 (GOES-16), and Exploration Flight Test-1 (EFT-1) missions.

Craft's research will empower the Artemis missions to use new technologies that improve the accuracy and safety of navigation systems. Though the challenges of landing a crewed spacecraft on the Moon remain similar to those faced by Apollo engineers, Craft's team will provide NASA with more tools to meet these challenges than ever before.

KYLE CRAFT

HOMETOWN: Jefferson City, MO

Kyle Craft received a Bachelor of Science in aerospace engineering from Missouri University of Science and Technology in May. He will begin working on his doctorate in aerospace engineering at Texas A&M University in the fall. His research focuses on spacecraft navigation algorithms and techniques. His personal interests include hiking, tennis, and climbing. This summer, he is hiking a new trail each week in the state of Missouri.

MENTOR: Bob Wiegand

Rapid Start-ups: Consolidating Dependencies for Delay/Disruption Tolerant Networking

RYAN DAUGHERTY

NASA is implementing Delay/Disruption Tolerant Networking (DTN) across the agency's networks to ensure reliable data transference as missions venture further into deep space. This summer, Ryan Daugherty worked on a Bundle Protocol Node-Ground (BPN-Ground), which will help comprise the ground component of the Interplanetary Overlay Network (ION), NASA's DTN network.

Daugherty cataloged the required installation dependencies of users, clients, and developers into a single distributed version-control system for tracking changes in source code called a git repository. This repository will ameliorate the complicated process of replicating the BPN-Ground program installation by placing everything in a single location. Daugherty's comprehensive documentation will further assist in installing the BPN-Ground node and futureproofing the process should future upgrades and modifications to the directory be made.

Daugherty attempted multiple builds of BPN-Ground over the course of the summer. He repeatedly tested the network dependencies to assure that new instantiations of BPN-Ground could be easily implemented. Individual tests of each BPN-Ground build were conducted to ensure all installations were working correctly.

Daugherty's work will make the infusion of DTN into new NASA missions simple and efficient. Following Daugherty's instructions, new users can easily implement their own BPN-Ground, expanding ION to more ground stations and encouraging users to embrace DTN.

HOMETOWN: Raleigh, NC

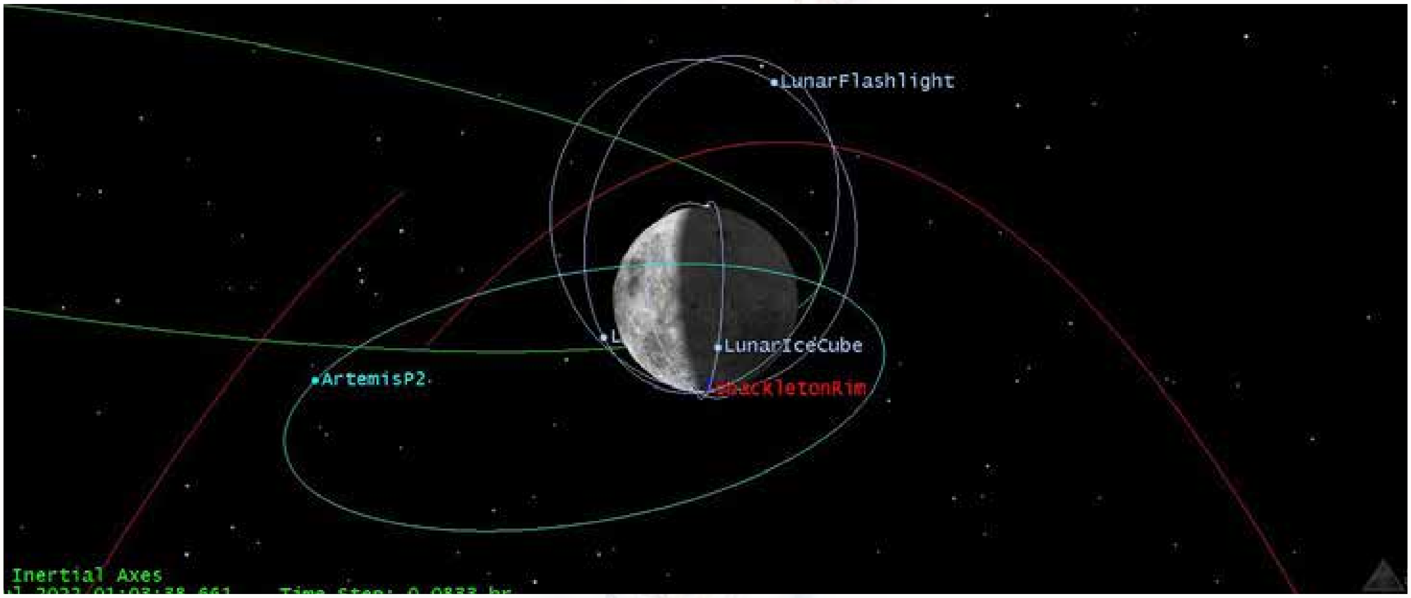
RYAN DAUGHERTY

Ryan Daugherty is a senior at North Carolina State University studying computer engineering. Before working at NASA, he completed a co-op for Engineering with Oracle, a cloud computing company. After graduating, he hopes to work in either digital logic design or software engineering. Daugherty's hobbies include board games, video games, and playing Dungeons and Dragons.

MENTOR: George Bussey

Optimizing Generational Machine Learning for Lunar Communications

GEORGE DOWNEY



NASA's communications networks are the essential link between Earth and satellites. These critical networks allow NASA to monitor, control, and receive data from spacecraft near and far. However, NASA engineers must analyze these networks' ground and space-based infrastructure to ensure their ongoing ability to support the communications needs of both current and future missions.

This summer, George Downey developed predictive models using machine learning that will help NASA understand current and future mission requirements. These models were developed by processing and formatting comprehensive satellite data for maximum compatibility with the machine learning algorithm. That satellite data was then used to train the predictive models, which were then tested on new data to determine their predictive accuracy.

The results of Downey's models indicate that missions using the same network have correlating spacecraft requirements. With this information, NASA can predict design requirements for upcoming missions based on the mission's use of a given network. The application of the model will significantly enhance SCaN's understanding of future network requirements, allowing the agency to better plan the science and exploration missions of tomorrow.

GEORGE DOWNEY

HOMETOWN: Annapolis, MD

George Downey is a senior at the University of Maryland, College Park studying electrical engineering. Last summer, he interned as a CubeSat development engineer for the U.S. Naval Academy Satellite Lab, developing the communications systems using amateur radio frequencies. Downey is fascinated by circuit design for spaceflight communications and the future of optical communications. He also enjoys building and tinkering with electric guitars and amplifiers.

Visualizing the Invisible: Bringing Optical Communications to SCaN Now

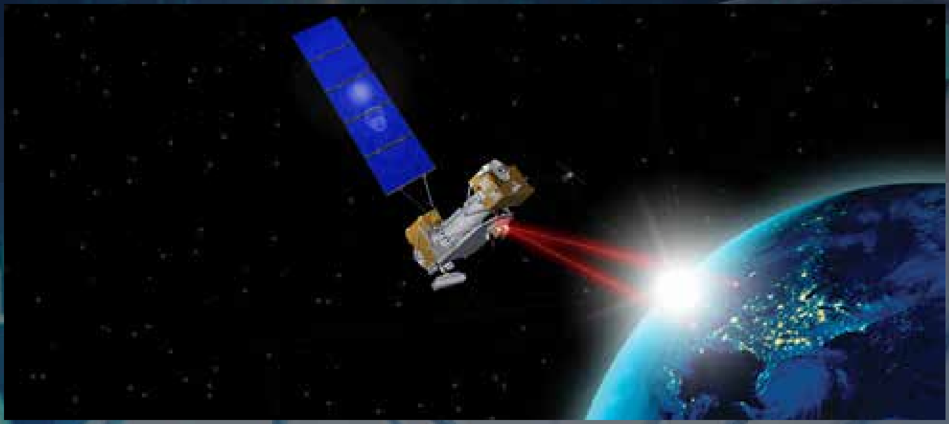
RYAN DAUGHERTY

Laser-based optical communications will revolutionize NASA's networks, providing space missions with the bandwidth needed to support the downlink of high resolution science data. Brandon Ginn and Elizabeth Smith communicated the powerful benefits of optical to the public by beginning to incorporate optical communications into SCaN Now, a web application that shows the live status of NASA's communications networks.

Ginn and Smith built a prototype of Optical Communications Now (OpComm Now) by creating a status file that feeds data from optical ground stations (OGS) and space payloads into the web application. The status file will provide real time information from OGS1 in California, OGS2 in Hawaii, and the Laser Communications Relay Demonstration (LCRD), which will launch into geosynchronous orbit in 2021.

The OpComm Now prototype uses 3D geospatial technology to present the current locations of ground stations, the LCRD spacecraft, and spacecraft communicating with LCRD. In addition to discovering locations via address and landmark input, the end-user will have the capability to interact with the 3D display by panning, zooming, and rotating the globe.

Smith, a Pathways intern, authored the use cases and concept of operations documents for the prototype with assistance from Ginn. This document will provide a clear record and guidelines for future work on OpComm Now, and ensure the successful completion of the project.



HOMETOWN: Edgewater, MD

BRANDON GINN

Brandon Ginn is a senior at South River High School in Edgewater, Maryland. This is his second summer internship at NASA, developing the SCaN Now web application. In college, Ginn hopes to pursue a degree in computer science with the intention of becoming a software developer at a major company. Apart from coding, Ginn enjoys playing soccer, golf, and video games in his free time.

ELIZABETH SMITH

HOMETOWN: Greenbelt, MD

Elizabeth Smith is a junior at the University of Maryland Global Campus pursuing a bachelor's degree in computer science. Upon graduation, she aspires to become a NASA civil servant and to pursue a master's degree in cybersecurity. Prior to joining NASA, she interned at the National Institutes of Health. She enjoys board games, outdoor activities, and exercising her love of learning.

MENTOR: Tyler Williams, Jacob Barnes

Test-set Automation and Integration of Laboratory Oriented Resources (TAILOR)

DIANA GODJA, JAMARIUS REID, MICHAEL YU

Current radio compatibility testing systems are expensive, time-consuming, and labor-intensive. These testing processes take about three to eight weeks on average to plan, process, and report. That timeframe can increase based on mission requirements and the number of spacecraft that will undergo testing.

Michael Yu, Diana Godja, and Jamarius Reid helped establish a radio compatibility testing system that lowers test cost, improves test efficiency, and increases repeatability. The Test-set Automation and Integration of Laboratory Oriented Resources (TAILOR) will automate radio frequency compatibility testing for spacecraft. This automation will allow engineers to allocate more time to designing tests instead of compiling reports on test data.

Each member of the intern team managed a different piece of TAILOR’s assembly. Yu created a web-based user interface that presents test information to the user. Godja developed the application programming interface (API), which manages the interactions between the hardware and software systems. Reid administered the database for the TAILOR application, which can store and retrieve mission configurations and established mission data as parameters.

The TAILOR project will allow engineers to establish, store, test, and replicate radio configurations across spacecraft platforms. Automating these processes will allow easy retrieval of testing reports and configurations, which significantly reduces the time spent on compatibility testing. TAILOR will also enhance efficiency and accuracy when multiple tests and configurations must be performed for missions.

DIANA GODJA

HOMETOWN: Centreville, VA

Diana Godja is a senior at George Mason University studying computer science. In the past year, she has worked as an undergraduate teaching assistant and as a front-end developer on mobile applications. She has also assisted with machine learning research on the application of deep learning in artificial echolocation and image reconstruction. Upon graduation, she plans to work in full stack development. Godja enjoys running, playing the piano, reading, and watching documentaries.

JAMARIUS REID

HOMETOWN: Clarksville, TN

Jamarius Reid will earn his master's degree in unmanned systems with a concentration in space operations from Embry-Riddle Aeronautical University this December. Reid also holds a bachelor's degree in computer science from Austin Peay State University. Upon receiving his master's degree, he hopes to pursue a doctorate in aviation and eventually become a NASA astronaut. Reid currently serves in the U.S. Army Reserves as a signal support systems specialist for the 332nd Medical Brigade Nashville, TN. Reid is also an active member of the Space Generation Advisory Council (SGAC).

MICHAEL YU

HOMETOWN: Irvine, CA

Michael Yu is a rising sophomore studying computer science at UCLA. He is interested in building robust and scalable software systems. He has previous experience researching data transfer protocols at the University of California, Irvine, and building web applications at SketchyMedical, a tech startup providing learning resources for medical school students. In his free time, Yu enjoys playing basketball and working on his road bike.

MENTOR: Diana Nevarez

Continuous Diagnostics and Mitigation Advancement

ETHAN HARDIN

The Department of Homeland Security's Continuous Diagnostics and Mitigation (CDM) program is leading the effort to reduce cybersecurity risks and increase awareness across the federal government. The CDM program equips federal agencies with the tools and resources to monitor and manage the threat of cybersecurity vulnerabilities. Keeping data secure is critical to the success of NASA missions, and ensuring compliance with CDM guidance is key to improving the agency's security posture and preventing attacks..

This summer, Ethan Hardin took on the challenging task of applying the continuous diagnostics component of CDM to multiple complex systems within NASA's Space Network. Hardin automated portions of the continuous diagnostic by creating security control scripts. Rather than running independently as a separate process, these scripts can be integrated with existing systems management infrastructure to increase overall system efficiency.

The Space Network provides continuous communications support to missions in low-Earth orbit. Hardin's automated continuous diagnostics tool has saved significant amounts of time for Space Network IT security and system administrators, and will protect the Space Network from unauthorized attacks and other cybersecurity weaknesses.

ETHAN HARDIN

HOMETOWN: El Paso, TX

Ethan Hardin recently earned his bachelor's degree in computer science from the University of Texas at El Paso. He will receive his master's degree in software engineering with a concentration in secure cyber systems this December. Last year, Hardin interned with the IT security team at the White Sands Complex, where he learned about cybersecurity in mission environments. Hardin enjoys hiking with his dogs, watching movies, and hanging out with family.

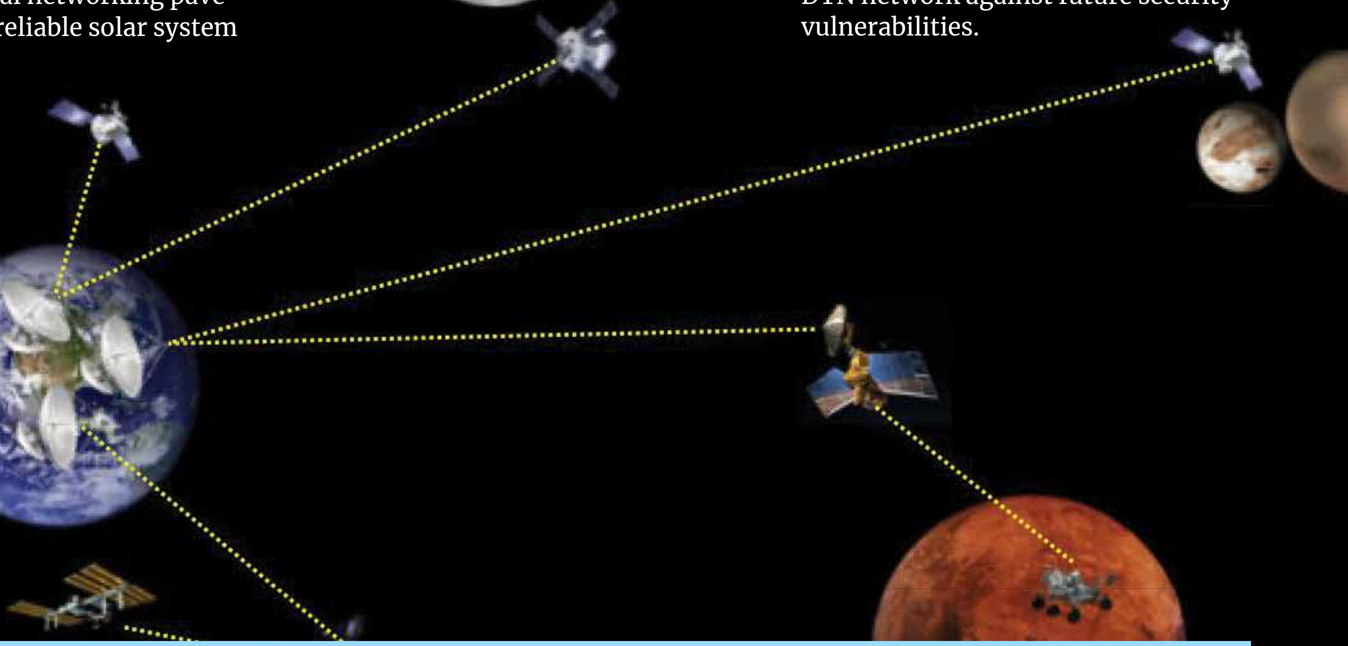
MENTOR: Jon Verville

Proactively Securing the Solar System Internet with Ethical Hacking

SHANE HITCH

The vast distances traversed by spacecraft present challenges to conventional networking technologies. Transport Control Protocol/Internet Protocol (TCP/IP), the governing communication standard of the terrestrial internet, requires an uninterrupted connection between network users that is not possible in deep space. Delay/Disruption Tolerant Networking (DTN) Bundle Protocol (BP) will mitigate the inherent to communicating with deep space missions. DTN's solutions to the errors and complications of conventional networking pave the way for a reliable solar system internet.

For his summer project, Shane Hitch tested the cybersecurity aspects of DTN, playing the role of ethical hacker to test the security of NASA's planned DTN network. Due to the nature of wireless communications, an attacker within range of a network signal could intercept DTN communications and send false or manipulated BP data between nodes. These attacks could result in a loss of irreplaceable science data or endanger NASA missions and astronauts.



Hitch researched potential security vulnerabilities within NASA's DTN network. He designed a simulated network and created custom custody transfer packets. He then tested the feasibility of injecting malicious false data packets intended to spoof the custody transfer packets into the network. Hitch thoroughly documented his test methods and findings, making recommendations on how to protect NASA's expanding DTN network against future security vulnerabilities.

HOMETOWN: West Fargo, ND

SHANE HITCH

Shane Hitch is a junior at Valley City State University in North Dakota studying software engineering. He is a 2019 SANS Technology Institute Cyber FastTrack scholarship recipient studying applied cybersecurity and ethical hacking. Upon graduation, he hopes to enter the cybersecurity industry and research security vulnerabilities. In his free time, Hitch enjoys programming, building drones, and playing guitar.

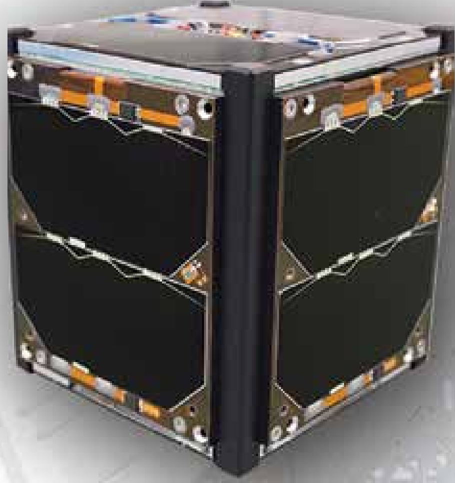
MENTORS: Garry Jocham, Dave Hamilton

CubeSat Test Platforms for Orbital Ka-band Signal Source Testing

BRANDEN JOHNSON, ANTWAAN THOMAS

Antenna testing can be an expensive and time-consuming process. Specifically, Ka-band antennas in the 11-meter class require long antenna ranges to test at the distances where antenna patterns fully coalesce. This requires a sizeable investment in facilities and real estate.

This summer, Branden Johnson and Antwaan Thomas began formulating a CubeSat constellation capable of testing antennas anywhere in the world. Developing this constellation would eliminate the need for expensive infrastructure at ground stations and integration sites.



There are currently minimal opportunities for testing Ka-band antennas with in-orbit resources. Tracking tests require a signal source in the far-field moving in a manner that results in antenna slew rates that mimic tracking an orbiting spacecraft. A drone-based solution would require a high-altitude drone to stay in the antenna's far field and flying at supersonic speeds. This approach would challenge the limits of military drone technology and cost NASA an exorbitant amount of money.

Instead, Thomas and Johnson investigated using one or more CubeSats in various orbits as Ka-band signal sources for antenna testing. Pursuing this option provides plentiful opportunities for in-orbit antenna testing. Additionally, the platform's modular nature means that test equipment can be mounted alongside science instruments on individual CubeSats to provide synergistic research opportunities.

BRANDEN JOHNSON

HOMETOWN: Greenbelt, MD

Branden Johnson returns to SIP for his third internship with SCaN. He is currently a senior at Morgan State University studying electrical engineering. Johnson is considering a master's degree in systems engineering after developing an interest in the field during his previous internships. He also hopes to start an engineering-focused mentorship program for children in impoverished communities. Johnson enjoys traveling, binge-watching TV shows, amusement parks, music, and spending time with his loved ones.

ETHAN HARDIN

HOMETOWN: Largo, MD

Antwaan Thomas is a senior studying computer engineering at Morgan State University and a returning SCaN intern. Upon graduation, Thomas will pursue his master's degree in cybersecurity engineering. After earning his master's, Thomas aspires to build a technology park in Baltimore's Collegetown area and inspire more African American children to pursue STEM careers. In his free time, Thomas enjoys working out, gardening, Netflix, and building personal engineering projects.

MENTOR: Paul Austin

From the Ground Up: Learning Operations at the Alaska Satellite Facility

DANIEL MANLEY

The Alaska Satellite Facility (ASF) operates a ground station for NASA's Near Earth Network (NEN), which provides direct-to-Earth communications services to NASA missions. The ASF-operated NEN ground station transmits mission-critical commands and data to and from a diverse array of spacecraft.

Robust communications would not be possible without a team of thoroughly trained engineers providing hands-on maintenance and system upgrades. These engineers have experience and specialized knowledge of the antennas and systems at the facility. This summer, Daniel Manley's primary task was to gain engineering knowledge specific to the ASF ground station, learning about installation, routine maintenance, and upgrading the antennas.

Manley integrated himself within the team of ground station engineers as they performed maintenance, system upgrades, and the installation of the NEN's newest 11-meter antenna at ASF. He also spent a week in the operations room to better understand the process used by the operators during satellite passes, learning how to relay critical information to a spacecraft and communicate with various customers.

Manley gained a deep knowledge of the antenna systems and their key features. By studying historic issues in timely maintenance execution, he was able to aid in diagnosing the causes of unpredictable problems and offer possible solutions. He also improved his problem-solving skills by participating in daily group meetings where ground station engineers discussed problems encountered and solutions implemented.

After this SIP experience, Manley has gained some of the expertise necessary to operate and maintain NASA ground network assets. He will continue his apprenticeship with ground network engineers as he moves into his junior year at the University of Alaska Fairbanks, which oversees ASF.

HOMETOWN: Fairbanks, AK

DANIEL MANLEY

Daniel Manley is a rising junior at the University of Alaska Fairbanks, where he studies electrical engineering with a concentration in power and control systems. This is his second SCaN internship at Goddard and he hopes to join the Goddard workforce one day, ideally in the Power Systems Branch. Manley enjoys a variety of seasonal activities: hiking, kayaking, and camping in summer months, and downhill skiing and indoor rock climbing during winter months.

MENTOR: George Bussey

Modular Wireless Channel Simulations for Lunar Missions

THOMAS MONTANO

The Artemis missions will return NASA astronauts to the Moon in just a few short years. In order to achieve a safe, sustainable presence on the Moon, NASA needs a more robust lunar communication system that ensures Artemis astronauts have consistent contact with mission control.

This summer, Thomas Montano developed a comprehensive model of lunar communications systems in order to better understand future mission requirements. Using MATLAB, a computing environment by MathWorks, Montano developed models that allow virtual communications channels to be completely visualized and monitored.

By developing a model of the physical transmission environment, network engineers can now perform cheap, rapid tests of new encoding and data formatting methods. These tests ensure that NASA incorporates optimal data transmission methods into future lunar missions.

Montano's models will eventually be combined with a link budget module, allowing engineers to calculate needed signal strength on the fly. These models will save network engineers time by identifying any pitfalls or issues before development of physical hardware begins.
As NASA expands its presence on the Moon, developing cost-effective solutions for rapid spacecraft development like Montano's virtual communications systems models will be key to assuring the best possible communications architectures for users.

THOMAS MONTANO

HOMETOWN: Rolla, MO

Thomas Montano is a senior at the Missouri University of Science and Technology studying electrical engineering with a focus in signal processing and communications systems. He is particularly interested in the development of communications systems for future missions to the Moon. This is his second year interning at Goddard and he aspires to work for NASA full-time once he graduates. In his spare time, Montano works as an indie video game developer.

MENTOR: Dave Israel

Mission Design Support for Lunar Architecture

SHAILESH MURALI

A sustainable human presence on the lunar surface is within NASA's reach. The Artemis missions to the Moon will require communications and navigation innovation to support the next generation of crewed, deep space exploration. The LunaNet architecture will provide the foundation for an interplanetary internet that will make future Artemis missions possible.

This summer Shailesh Murali worked with the LunaNet team to develop the lunar architecture communications requirements. The document he developed will standardize communications systems for future lunar missions, allowing engineers to easily develop designs copacetic with LunaNet.

While drafting his report, Murali reviewed documentation from prior lunar missions, focusing on an S-band radio frequency communications system. In addition, Murali performed link calculations to determine what specific hardware requirements would meet user and network needs.

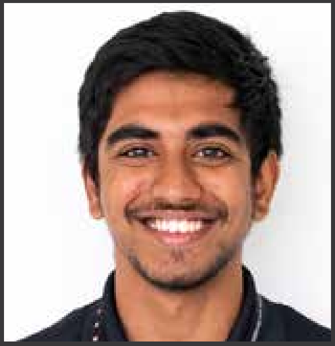
Murali's project will allow mission designers to understand what the larger LunaNet architecture means for a particular mission. While his work focused specifically on S-band communications, Murali's document can be expanded to account for different frequencies and new communications technologies.

By creating this general system design, Murali is empowering more missions to embrace the LunaNet framework. The more spacecraft incorporated into the LunaNet architecture, the stronger and more interconnected LunaNet becomes. Ultimately, this interconnectedness will create a future where lunar users enjoy the same power and connectivity as Earth's internet users.

HOMETOWN: Monmouth Junction, NJ

SHAILESH MURALI

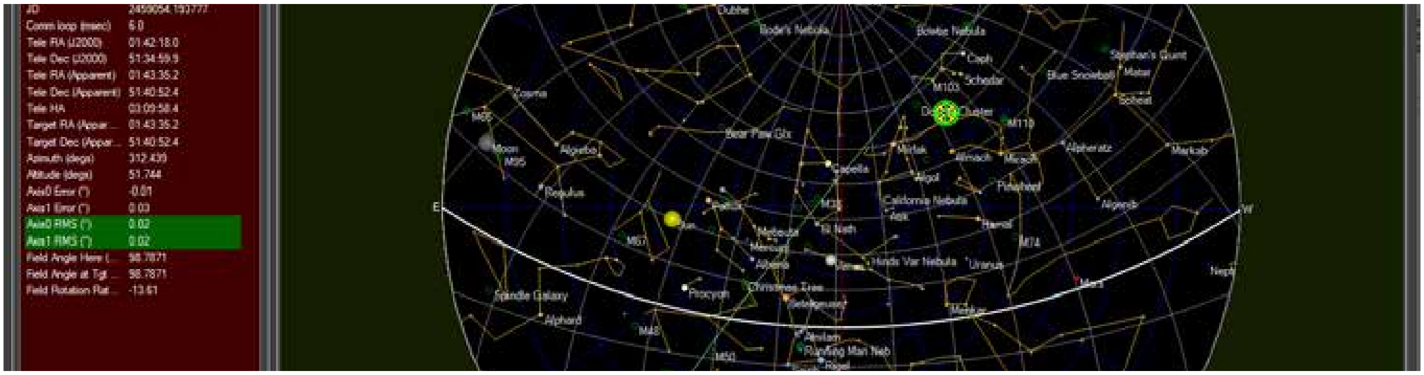
Shailesh Murali is a senior at the University of Maryland, College Park majoring in aerospace engineering with a minor in business. This is his second summer internship at Goddard. He is currently developing a communications architecture for future lunar missions. Murali is the launch director for Nearspace, the University of Maryland Balloon Payload Program. Outside of the lab, he enjoys watching football and basketball, rock climbing, and everything related to comic books.



MENTOR: Haleh Safavi

Four Years at Goddard: A Survey of New Telecommunications Methodologies

NAVEED NAIMIPOUR



Naveed Naimipour is in his fourth year with SIP, lending invaluable experience across a number of key efforts within SCaN. Throughout his tenure at NASA, Naimipour has worked on a variety of different communications innovations, allowing him to spend this summer assisting his mentor in multiple veins of inquiry.

Naimipour's projects are multitudinous. He worked on transmission error correction, using techniques like low-density parity-check (LDPC) code to transmit data in noisy environments. Naimipour also investigated the viability of polar codes — another method of error correction — for optical communications with Consultative Committee for Space Data Systems (CCDS) standards.

In addition, Naimipour used machine learning algorithms to analyze anomalies in Tracking and Data Relay Satellite (TDRS) battery performance and perform error correction. For TDRS, he used Hidden Markov models, a statistical method for inferring the hidden state of a system over time by observing its output.

Naimipour also worked on a trade study for Laser Communications Relay Demonstration (LCRD) hardware and designed a tool to verify the performance of LCRD hardware. Working on LCRD, he got his first experience with field-programmable gate arrays (FPGAs), reprogrammable integrated circuits.

In 2019, Naimipour took on his most ambitious project yet: leading a team of interns as principal investigator for the Quantum Entangled Stratospheric Telecommunications (QuEST) project. The project involved designing a balloon-based quantum entanglement experiment from scratch, leveraging Naimipour's experience in both optical and quantum communications.

This year, Naimipour documented his NASA experiences thus far with a look towards his own future. As a part of NASA's Pathways program, Naimipour's doctoral research has become increasingly intertwined with his work at NASA. Once he completes his thesis, Naimipour hopes to further formalize that relationship, joining NASA as a civil servant.

NAVEED NAIMIPOUR

HOMETOWN: Chicago, IL

Naveed Naimipour is pursuing a doctorate in electrical engineering at the University of Illinois at Chicago, where he received his bachelor's degree in electrical engineering in 2015. A returning intern, Naimipour researches signal processing and communications with a focus on machine learning, specifically clustering and deep learning. He enjoys watching sports, cooking, baking, and playing video games with friends.

MENTOR: Jonathan Wilmot

Next Steps: Laying the Groundwork for Bundle Protocol v7

ROWAN PARKER

Delay/Disruption Tolerant Networking (DTN) will revolutionize the way NASA conducts space communications. Leveraging a suite of communications protocols — particularly Bundle Protocol (BP) — DTN will create a solar system internet, enabling networking similar to the terrestrial internet. LunaNet, the current communications and navigation architecture planned for the Moon, is a DTN-based network architecture that is extensible from NASA's journey to the Moon to Mars and beyond.

Goddard's Plankton, Aerosol, Cloud and ocean Ecosystem (PACE) mission, launching in 2022, will be the first science spacecraft to use DTN for operations. Goddard engineers are continuously advancing DTN capabilities and developing new versions of the BP, like the recent BP version 7 (BPv7).

Rowan Parker joins the Goddard intern cohort after completing an internship at NASA's Armstrong Flight Research Center. There, she worked as a software engineer intern developing real-time data capture and display software for an innovative meteorological instrumentation suite. This summer, Parker joined the Goddard DTN team to determine operational use cases for BPv7. In the course of her research, Parker identified different ways that the BPv7 standard could be used by future users. She then developed requirements for further implementation and wrote a living document of her findings.

Parker's work aids in PACE's transition from BPv6 to BPv7, and supports the technological readiness of the DTN architecture to one day handle both critical communications with mission control and everyday use cases like streaming high definition video. In addition, her documentation will help future staff and interns more readily orient themselves within the project and DTN's language and protocols. Parker will continue her SIP work on DTN BPv7 through the end of September.

HOMETOWN: Arcata, CA

ROWAN PARKER

Rowan Parker studies applied mathematics and software engineering at the Oregon Institute of Technology. She previously interned at NASA's Armstrong Flight Research Center in Edwards, California, where she developed a software suite for a novel meteorological instrument. Prior to her NASA internships, Parker interned at Everi Holdings Inc.'s Top Shelf Game Studio, where she created memory management protocols. In her free time, Parker builds high-powered hobby rockets, obsesses over brewing the perfect pour-over coffee, and watches cooking shows.

SIP and the Humanities: Intern Programming and Writing Support

KORINE POWERS

The future of NASA's workforce stems from the agency's interns. They provide invaluable support to their teams over the course of the summer while simultaneously building their professional development skills.

Korine Powers polished interns' writing and communications skills, enabling them to document their NASA experience and promote their professional work effectively. She pushed interns beyond the scope of their formal training to ensure they have the ability to deliver effective conference presentations, communicate respectfully with leadership and their peers, record their process and projects, and share their work with both internal and external audiences.

One of Powers' key objectives was to help interns communicate their interests and accomplishments to diverse audiences. Powers helped interns produce high-quality content that details their projects' contributions to the agency's mission.

To accomplish this goal, Powers developed workshops, templates, and various programming focused

on intern deliverables. Powers also provided one-on-one writing support, where individual interns could develop their resumes, conference presentations, professional emails, and job applications.

In addition, Powers served as an editor on external-facing content developed within SIP, namely the intern video and the "Intern Look Book." These materials promote the relevancy and importance of the interns' summer projects to future and ongoing NASA missions, as well as enhance the visibility of interns hoping to gain employment at NASA and elsewhere.

KORINE POWERS

HOMETOWN: Somerville, MA

Korine Powers is a doctoral candidate in English at Boston University. She is writing her dissertation on American postwar film and fiction, and has taught undergraduate writing and English classes on everything from Disney to Dexter. Upon earning her doctorate next summer, Powers plans to pursue a career in education and community outreach. At home, Powers enjoys drawing, cooking, gaming, graphic design, and hosting movie marathons.

MENTORS: Javier Ocasio-Perez, George Bussey

Visualization of the LCRD Communications System State

CHRISTIAN RIVERA RIVERA

As the data transference needs of state-of-the-art missions grow, there is a critical call for higher bandwidth communications throughout NASA's networks. The Laser Communication Relay Demonstration (LCRD) will test and demonstrate optical communications technologies, which use infrared lasers to provide higher data rates while reducing size, weight, and power requirements for spacecraft.

For his summer project, Christian Rivera Rivera developed a system state visualization (SSV) tool that effectively displays LCRD's schedule on a robust timeline. Currently, the LCRD ground team requires three to five operators to analyze and keep track of the data transmission schedules. With the development of the SSV tool, this responsibility can be delegated to a single operator, allowing the ground team to have more operators available for other tasks and responsibilities.

Rivera Rivera's tool processes relay configuration reports (RCRs) and provides a timeline of the links and services running to and from the satellite and ground stations. SSV users can view a record of all the links, and the services on those links, in chronological order. The tool also tracks active and upcoming links and services, and lists all available link and service information.

The SSV is being upgraded to meet current LCRD standards with updated timing and RCR detection. Overall, the SSV has been successful in integrating several diverse utilities into a concise tool that greatly reduces the operators necessary for analysis of LCRD schedules.

HOMETOWN: Carolina, PR

CHRISTIAN RIVERA RIVERA

Christian Rivera Rivera recently graduated from the University of Puerto Rico with a bachelor's degree in computer science. Rivera Rivera has previously interned at Goddard and NASA's Langley Research Center in Hampton, Virginia. He plans on pursuing a master's degree in computer science at the University of Maryland next year. Outside of his academic pursuits, Rivera Rivera enjoys going to the beach, watching movies, and spending time with his friends and family.

MENTOR: Paul Segars

Improving Interference Testing with Software-Defined Radio

ANDREW ROBINSON

Many innovative space communications technologies use automation to boost efficiency, save time, and reduce costs. This summer, Andrew Robinson developed a software-defined radio to automate high-fidelity interference testing processes for the Compatibility Test Area (CTA), which runs testing for spacecraft using services from the Near Earth Network and Space Network.

Currently, CTA uses a continuous wave at fixed frequencies and power levels. Implementing a software-defined radio into the CTA will also allow for customizable and complex signal generation, which will in turn permit the CTA to create more realistic test conditions. Robinson used object-oriented programming techniques to create a foundation for the software-defined radio that supports different types of modulation schemes and data sources. Using C++, Robinson generated pseudo-random binary sequences to be transmitted via the radio's open-source driver. Robinson used a spectrum analyzer and ground station hardware to verify the radio's signal output by comparing it to the output of a known signal source. Currently, Robinson's radio is capable of generating a spectrum that is similar to a known good source, and can produce multiple pseudo-random patterns in addition to supporting binary phase shift keying (BPSK) and quadrature phase shift keying (QPSK) modulation.

Robinson's work has created a foundation for CTA to perform more robust and efficient low-cost testing. Moving forward, features like additional modulation techniques and packet framing could be implemented to further increase the complexity of the software-defined radio's testing capabilities. These ever-expanding automated testing processes promise an easier, more efficient future for spacecraft compatibility testing.

ANDREW ROBINSON

HOMETOWN: Charlotte, NC

Andrew Robinson is pursuing a master's degree in computer engineering at Mercer University, where he recently earned his bachelor's degree in engineering in 2020. Robinson's previous internships have focused on signal processing, Very High Speed Integrated Circuit (VHSIC) Hardware Description Language (VHDL), and C# programming work. After graduating, he hopes to explore the fields of electronic warfare and aerospace. When he is not at the office, Robinson enjoys playing video games with his friends, programming personal projects, and spending time outdoors.

Network Management Testbed Tools for the Solar System Internet

ALEXANDER SCOTT

As a seasoned intern on the Delay/Disruption Tolerant Networking (DTN) team, Alexander Scott had a unique role this summer as a liaison for new interns working with DTN's Bundle Protocol (BP). Scott familiarized interns with DTN at Goddard and taught them how to use the Interplanetary Overlay Network (ION), NASA's implementation of DTN.

Because summer internships were shifted to a virtual environment, Scott's role was crucial in helping interns understand Goddard operations and workflows. He served as a mentor, offering experience and advice to inquiring interns. Scott scheduled informal meetings where DTN mentors and team members participated in a NASA-themed jeopardy game and played "Push the Button," an online game in which spacefarers on an imaginary vessel try to determine which of their crewmates is secretly a stowaway alien.

After acclimating new interns to the DTN team, Scott taught them how to use ION. This allowed incoming interns to begin their projects without having to learn a new program from scratch. In preparation for the ION tutorial, Scott created a slide deck detailing DTN, BP, and ION. He also created a deck that explained how to get a DTN Development Kit virtual machine running.

In addition, Scott laid the groundwork for intern projects by building two ION configurations. One served as a completed reference configuration and the other served as a template. This assisted with his explanations of DTN, BP, and ION, while simultaneously jumpstarting the interns' projects. Scott also demonstrated the construction of an ION configuration for the DTN interns via live video so that they could ask questions in real-time and record the tutorial for future reference.

HOMETOWN: Potomac, MD

ALEXANDER SCOTT

Alexander Scott is a senior at the University of Maryland, College Park studying computer science. This is his second internship at Goddard and he is working on Delay/Disruption Tolerant Networking. He will continue his relationship with NASA as a part of the Pathways program. Upon graduating, Scott hopes to either earn his master's degree or become a civil servant at NASA. In his free time, Scott enjoys playing guitar, video games, and listening to music.

MENTOR: Scott Schaire

Technoarchaeology: Documenting White Sands Legacy Hardware

DAVID SHANK

The Nancy Grace Roman Space Telescope will inform our understanding of the distant planets beyond our solar system and the universe's expansion. The mission will require additional Near Earth Network ground antennas to downlink its data. David Shank is helping NASA transfer and upgrade two 18-meter antennas to the Near Earth Network to meet these needs. In order to transfer the antennas, NASA must first secure proper documentation of the existing antenna configuration. Shank developed a comprehensive configuration documentation using the first-hand knowledge of White Sands personnel alongside piecemeal documentation from the companies and vendors initially contracted to build the antennas.

Ultimately, Shank captured the cabling configuration in painstaking detail and crafted a block diagram of the White Sands antennas being transferred to the Near Earth Network. This block diagram will help the network to upgrade the antennas to meet the requirements of the Nancy Grace Roman telescope in time for its anticipated 2025 launch date.

DAVID SHANK

HOMETOWN: Rescue, VA

David Shank is a sophomore studying electrical engineering at Thomas Nelson Community College. When he graduates in December 2020, he will continue his studies at Old Dominion University. Shank previously served in the U.S. Navy as an electrician's mate and electronics technician. Shank has previously interned with NASA's Balloon Research and Development Lab and is now interning with NASA's Near Earth Network.

Investigating Coordinate Transforms for the Low-Cost Optical Terminal (LCOT)

MEGHNA SITARAM

Laser-based optical communications allow NASA missions to dramatically increase the amount of data that can be transmitted from spacecraft to Earth. NASA is expanding the use of optical communications to lower costs and increase efficiency. The Low-Cost Optical Terminal (LCOT) telescope at Goddard Geophysical and Astronomical Observatory (GGAO) will support the growing network of optical communication satellites and serve as a testbed for innovations in optical communications.

This summer, Meghna Sitaram lent her programming expertise to the LCOT at GGAO. Optical communications requires precise satellite tracking to ensure that laser beams are centered on receiving detectors. Sitaram developed software that performs the coordinate transformations the telescope uses to track and center satellites. She created Python code that transfers coordinates in the sky onto a camera, allowing it to track and point at the location of satellites at those coordinates automatically.

The Python code extrapolates the spherical coordinates of the satellites in the sky relative to the telescope — their altitude and azimuth — from the x-y axis of the two-dimensional camera image. The script completes the coordinate transformation using matrix multiplication, which allows for additional variables like rotation of the camera and future optical components.

Sitaram's transformation script for GGAO will contribute to software development critical for LCOT development in general. This development effort supports SCaN's commitment to infusing the network with low-cost optical communications.

HOMETOWN: Chatham, NJ

MEGHNA SITARAM

Meghna Sitaram recently received her dual bachelor's degrees in astronomy and physics from the University of Maryland, College Park. She will pursue her doctorate in astronomy at Columbia University in the fall. Sitaram has previously interned at Goddard, Liverpool John Moores University, and the Joint Quantum Institute at the University of Maryland, and explored topics including quantum metrology, observations of galactic novae, and optical satellite communications. She enjoys reading, playing the violin, hiking, and running.

MENTOR: Danny Baird

Strategic Communications to Elevate and Enhance the Intern Program

CATHERINE TRESSLAR

SCaN relies on their summer internships to garner new talent to the agency. This year, Catherine Tresslar's mission was to showcase the intern summer projects and capture the unique challenges and opportunities for innovation that the digital workspace presented.

Due to the COVID-19 pandemic, SIP launched its first entirely virtual summer. Tresslar documented the unique experiences of interns working virtually while elevating the intern experience overall.

Tresslar's primary contribution was creating the "Intern Look Book." This Look Book is a yearly, magazine-style publication that introduces the interns to division and program leadership. The Look Book also provides a snapshot of the intern experience and showcases the importance of the interns' work to the agency's mission.

In addition to the "Look Book," Tresslar's project included development of public-facing web content that highlights individual interns and the program as a whole. These products help to promote intern innovation and attract more talent to SIP.

Beyond writing, Tresslar provided general support to the intern coordinator, helping him to meet the demands of a busy summer. Tresslar solicited content from the interns, hosted networking events, and promoted fellowship among the interns.

Tresslar also developed a strategic communications plan for engagement with universities. Her document outlines the goals, strategies, and desired outcomes from the campaign, while identifying target audiences and potential partnerships. It also points to specific universities with whom SCaN experts have existing relationships, identifying opportunities to enhance those partnerships in support of both the intern program and NASA objectives. This plan will further SCaN's relationships with institutions educating the future NASA workforce, draw new candidates to SIP, and encourage young talent to consider careers with SCaN.

CATHERINE TRESSLAR

HOMETOWN: Arlington, VA

Catherine Tresslar is a recent graduate of Georgetown University with a Bachelor of Arts in government. Her professional background is in nonprofit communications and digital marketing. She used her writing experience to document the SCaN Internship Project, showcasing the work of her fellow interns. She has recently returned to Washington to begin a career in national politics. In her spare time, Tresslar is a DJ and a competitive Irish dancer.

MENTOR: Jon Verville

Taking Flight: CubeSat Testbeds for the Solar System Internet

DAVID TRIMINO

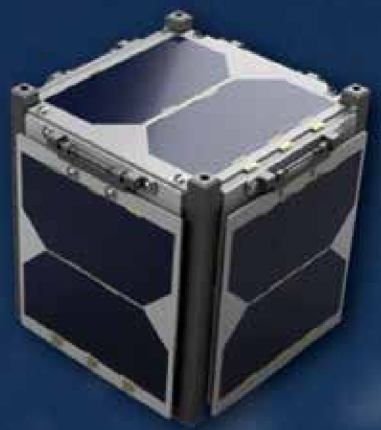
Delay/Disruption Tolerant Networking (DTN) Bundle Protocols will empower exploration deeper into space by enhancing the flexibility and robustness of NASA's networks. Missions to the Moon, Mars, and beyond will use DTN software to receive data from the far reaches of space, even without a continuous, direct link with the ground. In order to achieve this goal, DTN needs to be displayed in an operational state before NASA can expand its use.

David Trimino and his team created a test environment to showcase DTN in an operational state. They made custom operational configuration files to communicate between a DTN ground node and a CubeSat. Trimino and team also created custom telemetry pages to display data received from the satellite.

Trimino's primary contribution to this effort was initiating software testing for the testbed. He assembled and operated the DTN Bundle Protocol Node for Ground (BPN-Ground) and Integrated Test and Operations System (ITOS) software.

Trimino also kept thorough documentation of his work on the DTN ground node. His 40-page user's guide shows engineers using the node how to install and run certain tests.

Currently, DTN is being used for select applications by missions like the International Space Station and the Plankton, Aerosol, Cloud, ocean Ecosystem (PACE) mission. However, more testing is needed for future missions to rely solely on DTN. By showing DTN in an operational state, Trimino is enabling NASA to expand DTN into the backbone of the solar system internet.



HOMETOWN: Grapevine, TX

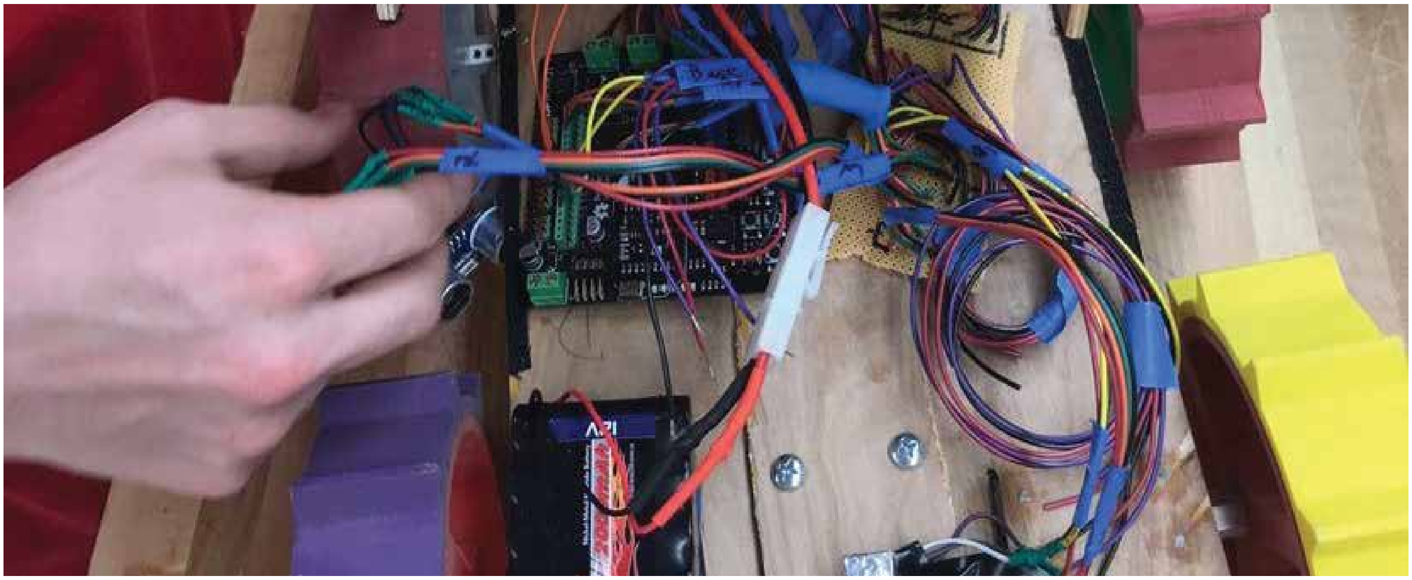
DAVID TRIMINO

David Trimino is a rising junior at the University of Texas at Arlington, pursing a bachelor's degree in computer science after having recently switched from a major in physical therapy. This summer he will be setting up Delay/Disruption Tolerant Networking software for a balloon experiment launching in August 2020. In his free time, Trimino tutors students in mathematics and encourages young people to pursue STEM disciplines.

MENTOR: David Heroux

Modem Test Bed Enhancement

LIAM VIENNEAU



The Space Network Ground Segment Sustainment (SGSS) Modem Test Bed (SMTB) is a Tracking and Data Relay Satellite (TDRS) ground test system used to characterize the performance of SGSS and other digital modems. The SMTB employs test equipment that uses a packet capture and playback (PCAP) application programming interface to capture packets from VITA 49, a digital radio interface.

Prior to Liam Vienneau's summer internship, the SMTB lacked the flexibility to efficiently evaluate the received PCAP packets. Other limitations of the SMTB's PCAP included only reading a single PCAP file format, the inability to convert older PCAP to the PCAP Next Generation format, and an inability to filter for specific data types within packets. Collectively, these limitations introduced critical inefficiencies into the SMTB's testing and results processes.

This summer, Vienneau improved the SMTB's ability to efficiently test and conduct analysis of results by increasing the tool's overall flexibility. He leveraged existing VITA 49 utilities and other SMTB engineering resources to develop new utilities, allowing for greater variability in the SMTB tool applications.

The improved SMTB now has the ability to convert PCAP files to the PCAP Next Generation file format, filter for specified packet types, and automatically identify the data type contained within a packet. Vienneau verified the SMTB's new capabilities and reported his findings in graphical representations of the two types of data contained within the SMTB's PCAP packets. Overall, Vienneau's work will streamline testing for SGSS, saving engineers valuable time.

LIAM VIENNEAU

HOMETOWN: Newburg, MD

Liam Vienneau is a senior at the University of Maryland, College Park studying aerospace engineering. He is also pursuing a minor in global engineering leadership. At the University of Maryland, Vienneau worked as both a senior lab manager for Terrapin Works in their Advanced Fabrication Lab and as a hypersonics research assistant for graduate students. In his free time, he enjoys riding his motorcycle, playing games, and kayaking.

MENTOR: Rafael Garcia

Novel Optical Demodulation Algorithm Implementation and Testing

LINDSAY WHITE

Optical communications promise higher data rates than traditional radio-based communications systems. SCaN is developing and testing optical communications technologies to support the ever-increasing amount of data gathered by NASA missions. Lindsay White worked to enable coherent digital signal processing for optical communications modem algorithms of 10 Gbps and above.

White researched and tested novel digital signal processing algorithms for optical space communications. She implemented and tested the algorithms in a hardware system comprised of several field-programmable gate arrays (FPGAs), optical transceivers, and channel emulators.

The overall goal of White's project was converting the algorithm from MATLAB, a computing environment developed by MathWorks, to Very High-Speed Integrated Circuit (VHSIC) Hardware Description Language (VHDL) code. The VHDL code drives the FPGAs, which are the heart of White's project. This conversion was accomplished by translating the algorithm from MATLAB into Simulink, a block diagram environment for model-based design. Once converted, a tool in Simulink could then convert the models into VHDL code.

This project furthers NASA's efforts to address the data link limitations of high-data-rate communications critical to newer generations of radio and optical communications. Addressing these limitations allows modems to transmit and receive more data than ever before on cheaper, more modular hardware. White's workflow in converting from MATLAB to VHDL could also be used to save time for similar efforts in future projects.

HOMETOWN: San Diego, CA

LINDSAY WHITE

Lindsay White currently attends the University of California, San Diego, where she pursues a master's degree in electrical engineering with an expected graduation date of June 2021. She previously attended San Diego State University, where she received my bachelor's degree in electrical engineering in 2018. This is her third summer interning at Goddard and she hopes to continue working in space communications after graduating in June 2021. Outside of work, White enjoys hobby projects with her amateur radio — callsign KI6LZN — and has recently started cooking and baking.

MENTORS: Julie Owens, Tara Dulaney

Communications and Cybersecurity Technology Considerations to Enable Extended Human Spaceflight

SIENNA WILLIAMS

The next generation of crewed exploration into deep space is just on the horizon. These missions, including the Artemis missions — which will establish sustained human presence of the Moon — and the journey to Mars, will present an entirely new set of challenges in space communications and cybersecurity. This summer, Sienna Williams worked to identify these challenges and propose solutions.

Williams researched communication delays, privacy, and cybersecurity in past NASA missions and applied her findings to future deep space missions. She considered how new communications technologies could fit within existing architectures, addressing issues of informational security, privacy, and autonomy.

Williams conducted her research by interviewing NASA professionals across various centers and facilities. She sourced information from network architects, communications managers, flight controllers, cybersecurity professionals, and NASA astronauts. She supplemented these interviews with a thorough review of NASA communication systems and literature about the personal experiences of astronauts during long-duration spaceflight.

Williams' report was largely tied to the astronaut experience during space travel, particularly their personal needs and privacy expectations. Williams explored how cutting-edge technology such as Delay/Disruption Tolerant Networking, optical communications, quantum networks, and artificial intelligence could protect astronaut medical and wellness data.

William's goal is to publish her research in a scientific journal.

In preparation for professional publication, she drafted a technical paper that reports her findings. Her report includes personal recommendations to overcome the unique problems encountered in crewed exploration of deep space travel, such as latency, solar blackouts, and data breaches. The paper will educate the broader community on important considerations regarding cybersecurity, astronaut psychology, and privacy concerns, while showcasing the forward-thinking technologies in SCaN's innovation pipeline.

SIENNA WILLIAMS

HOMETOWN: Clarksburg, MD

Sienna Williams is entering her second year at the Massachusetts Institute of Technology, majoring in aerospace engineering. This is her third summer interning at Goddard. She hopes to become a civil servant at NASA and eventually a NASA astronaut. Williams plays varsity basketball at MIT and is the lead drummer in the neo-soul band "Love and a Sandwich." She is also active in MIT's Black Student Union and Black Women's Alliance.

MENTOR: Scott Merritt

Monte Carlo Simulations for Determining Hybrid Laser Signal Sensitivity

JOEY YAKER

Efficient, long-distance transmission of information from space is crucial to accurately capturing mission data. Laser-based optical communications is more energy efficient than comparable radio-frequency technologies while providing superior data rates. Though there are several engineering challenges to overcome, optical communications will expand humanity's reach into deep space and provide faster, more reliable data transmissions.

This summer, Joey Yaker was tasked with evaluating the performance and sensitivity of hybrid optical communications signals. Yaker developed programs that simulated various modulation schemes, including pulse-position modulation (PPM), binary phase shift keying (BPSK), quadrature phase shift keying (QPSK), and hybrid modulation types.

In MATLAB, a computing environment developed by MathWorks, Yaker designed data models using Monte Carlo simulations, a series of computational algorithms dependent on random sampling. Yaker extracted and analyzed each model for the quality of data transference, and then compared the transmission error rates within his models to determine which hybrid optical communications signal is most effective.

Yaker's results will inform the modulation schemes used by NASA optical communications engineers in upcoming spaceflight missions. Using this research, NASA will be able to transmit clearer data through its current networks and inform the application of optical communications in future and expanded networks.

HOMETOWN: Huntington Woods, MI

JOEY YAKER

Joey Yaker is an incoming doctoral candidate in applied physics at Northwestern University. He recently graduated with a bachelor's degree in engineering from the University of Michigan, where he majored in engineering physics. He hopes to research hardware for the future implementation of quantum computing. Outside of school, Joey enjoys playing basketball and golf, and binge-watching TV shows.

MENTOR: Scott Schaire

Adapting for the Control Room: Operational Displays for SCaN Now

JOSEPH ZALAMEDA

NASA's Near Earth Network (NEN) requires an efficient user interface for network engineers relaying information through its worldwide network of ground stations. Joseph Zalameda worked on a new summary display that will visualize important NEN antenna status information, enhancing the existing graphic interface and the user experience overall.

Once implemented, this summary display will give ground station maintenance crews the ability to monitor several stations at once. Additionally, the display will provide clear and concise information about network issues should they arise, allowing NEN engineers to quickly resolve them.

To ensure proper implementation and functionality of this summary display, Zalameda developed concept of operations (ConOps) and software requirements documentation. The ConOps document details the functionality and design of the system at a conceptual level, initiating the first stages of development for the summary display.

To develop the ConOps, Zalameda interviewed potential end users of the summary display, soliciting their ideal requirements. He also researched comparable interfaces, identifying the most effective means of visualizing NEN status information.

Zalameda went through a similar process to create a software requirements document. He interviewed potential users, identifying what sorts of software would best meet their needs. He also surveyed existing technologies, ensuring that the summary display would interface well with existing systems.

The objective of both documents was to identify patterns in feature preferences by system users and compare that data to systems with similar features. Zalameda's research will be crucial to building a practical system that meets NEN users' needs in a timely, well-executed manner.

JOSEPH ZALAMEDA

HOMETOWN: Poquoson, VA

Joseph Zalameda is a senior at Old Dominion University studying computer engineering, electrical engineering, and computer science. He is currently enrolled an accelerated degree program and plans to pursue a doctorate in computer engineering after graduating in May 2021. He has previously interned at NASA's Langley Research Center in Hampton, Virginia, and Wallops Flight Facility. Zalameda enjoys surfing, fishing, wakeboarding, and spending time near water.

Features

“Down to the Wire” Activity Turns Interns into Mission Controllers

The chance to peek inside the Network Integration Center (NIC) is one of the most exciting experiences for SIP interns at Goddard. From the NIC, network directors can oversee NASA’s vast communications infrastructure, managing communications for a wide variety of spacecraft. In fact, many launch vehicles rely on a Go/No-Go decision from a network director in the NIC moments before blasting off the pad.

While many aspects of this summer’s SIP experience had to change because of the program’s virtual nature, interns still got to experience the thrilling atmosphere of the NIC while practicing their communication skills. The new “Down to the Wire” activity turned interns into flight controllers role-playing vital mission support personnel on a simulated console.

The activity was broken into two separate phases. Phase one gave interns the opportunity to experience what it’s like for mission controllers to talk with astronauts on the International Space Station. Phase one acted as an introduction to SCaN’s role as a trusted provider of communications and navigation services, stressing the importance of these services to NASA missions.

Despite being physically away from campus, interns got a behind-the-scenes look at the NIC through a video developed by an intern just a few summers ago. Interns learned about the critical role that Goddard has played in NASA’s most famous missions: Mercury and Apollo, the Shuttle program, the Hubble Space Telescope, and the construction of the space station. Then — with new insight into mission support — the interns prepared to pay their parts.

Interns also had the opportunity to learn from Julie Owens, a member of the ESC team who previously served as a flight controller and flight controller trainer at NASA’s Marshall Space Flight Center in Huntsville, Alabama. She shared her experiences behind the console, both supporting the space station and training others to do so as well. She also led interns through activity scenarios in the role of Flight Director.

Participants gathered on Microsoft Teams, a virtual collaboration platform, to act out different scenarios that mission controllers and network personnel might encounter. Each were assigned key roles in mission support like Payload Communications Manager or Operations Controller. In each exercise, the interns followed along with a script while consulting their virtual console, practicing proper protocols and jargon to ensure clear communications with the space station’s crew.

“This exercise was probably in my top-10 most stressful moments of my life… I had a blast, and have even more respect for those who do it on actual missions,” reported one intern. Another intern described the experience as feeling “a bit like my [own] version of Space Camp.”

Phase two built off the momentum and enthusiasm garnered in phase one. Interns worked on similar collaboration and communication skills while getting more acclimated with their group members. Interns played the virtual puzzle game, “Keep Talking and Nobody Explodes,” where players must work together to defuse a virtual explosive before time runs out.

Each round, one intern could see the explosive on their computer monitor while others could only see the defusal manual. The interns used the effective communication skills they practiced in phase one to successfully deactivate the device.

“The second ‘Down to the Wire’ session was entertaining and exciting. It really made our team connect,” shared intern Vincent Bia Jr. Other SCaN interns described the experience as “a great [way] to analyze individuals in unfamiliar circumstances.”

Returning interns praised SIP for successfully recreating the campus environment from home. “Down to the Wire” left interns feeling engaged with their intern cohort and certain of the importance of space communications.

“I appreciated the structured opportunity to get to know my teammates,” said a participating intern in anonymous feedback. “In an in-person setting, it’d be much easier to strike up casual conversations and get to know people… Having activities like this — where we need to work together — helps build [camaraderie.]”

The “Down to the Wire” activity was one example of how SIP used technology to turn challenges into opportunities this summer. While interns may have felt apprehensive about entering an entirely virtual work environment, SIP programming eased those anxieties, allowing interns to still feel part of the NASA community.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Creativity, Flexibility, and Resilience: Intern Innovation in a Time of Social Distance

Many interns will remember the summer 2020 virtual SIP experience as the summer they worked from their childhood bedrooms, answered the question, "where are you calling from?" several times a day, and ended emails with phrases like "it was nice to e-meet you!"

The COVID-19 public health crisis made this summer uniquely challenging, but that did not stop SIP interns from delivering powerful results. This cohort of 41 students turned a summer of uncertainty into an opportunity for innovation and growth.

Intern coordinator Jimmy Acevedo played a critical role in the online transition, working with SIP mentors and SCaN leadership to ensure a fulfilling intern experience. Acevedo prepares year-round to ensure SIP is "the best, most instructive, and most effective experience for students," but not everything can be planned.

When NASA announced that summer internships at Goddard facilities would have to take place remotely, Acevedo and his team worked tirelessly to reimagine the summer, turning it into a virtual incubator for SIP innovation.

"There was a lot of uncertainty at first. We started building summer programming in February and would normally have solidified things by March," said Acevedo. "We had to quickly shift focus from polishing curriculum to adapting everything to a virtual workspace and ensuring a seamless transition.

"Our initial uncertainty eventually turned to excitement. There were plenty of unique benefits the virtual environment offered our students."

In many ways, the remote nature of the summer made SIP resources more accessible to many students. While interns, mentors, and SIP staff were many miles apart, meetings could be easily scheduled through Microsoft Teams, a collaboration platform.

"Finding face-to-face time with the interns has never been easier," said Acevedo. "We didn't have to run all over campus to check in on everyone's progress or provide support."

With the agency embracing virtual meetings more than ever, many interns were able to expand their NASA network beyond the confines of their specific campus. SIP intern Sienna Williams used the virtual environment to broaden her research into the impacts of communications and cybersecurity technology in long-duration crewed missions. She was able to interview NASA personnel across various centers to bring more insight to her project. She even had face time with a few astronauts.

"As someone who has always aspired to become an astronaut, it was an incredible opportunity to research the technologies that will help me (hopefully) and other astronauts in the future," said Williams. "Additionally, hearing about the experience of spaceflight firsthand through interviews has motivated me even more, and the connections I've made will be invaluable as I move forward in my career."

SIP intern Meghna Sitaram found other ways in which the virtual internship sparked opportunities for innovation. To continue developing a low-cost optical communications terminal for Goddard, Sitaram and her teammates had to create a simulation of the ground terminal. This simulation will set the effort up for success when the center reopens, streamlining future development.

"The virtual summer has us thinking about a lot of things that we need to do in the future and looking farther ahead," says Sitaram.

Offering virtual summer internships demonstrates NASA's continued commitment to the future workforce. The success of 2020 SIP students shows the Artemis generation's tenacity, the young people who will help NASA return to the Moon and journey on to Mars.

"One of the positive outcomes of these virtual internships has been teaching the interns to be flexible," said Acevedo. "Despite the oddities, difficulties, and challenges, they all practiced resilience and creativity in the face of hardship with incredible results."

Looking through the projects featured in this "Intern Look Book," it's easy to see how the interns rose to the remote internship's challenges, delivering truly powerful innovations to NASA and SCaN.


CHEAT SHEET
High School
BOWL

Interns of the Artemis Generation: SIP Empowers NASA's Journey to the Moon, Mars and Beyond

As NASA ventures to the Moon, Mars, and beyond with the Artemis missions, SCaN looks to interns for innovations that will empower exploration. The Artemis generation will see NASA place the first woman and the next man on the lunar surface, continuing a legacy of crewed expeditions beyond Earth that extends back to the Apollo missions.

Each of the 2020 SCaN interns can proudly say that they've contributed to the agency's vision for the future of exploration. Some work directly on Artemis and lend their enormous talents to the immediate challenges of communications and navigation in lunar space.

This year, SIP interns are helping to overcome some of the biggest obstacles NASA will face. Overcoming these barriers will allow humans to maintain a sustained presence on the Moon and beyond, beginning this next chapter spaceflight history.

SIP intern Kyle Craft worked alongside mentor Ben Ashman on lunar landing architectures. The project focused on the navigation technologies that missions to the Moon will require to ensure accuracy. This improved accuracy will ensure a safe landing for brave astronauts touching down on lunar regolith.

"It's pretty exciting working on this project," said Craft. "It encounters some of the most interesting and difficult engineering challenges facing navigation engineers right now."

Craft helped extend the use of Global Navigation Satellite System (GNSS) signals — like GPS signals — out to lunar distances. GNSS signal data could supplement other methods of tracking, like using ground stations or optical navigation.

While Artemis is fueling some of the most innovative technologies like high-altitude GNSS, much of Craft's project framework is still rooted in work done by NASA navigation engineers for the Apollo missions.

"The fundamental mathematics behind pretty much everything I do was all developed for the Apollo missions," said Craft. "It was all developed by mathematicians and engineers to solve the same lunar landing problem I'm addressing now."

SIP intern Shailesh Murali is helping to develop lunar networking capabilities that Apollo astronauts could only dream of. Led by mentor and ESC architect Dave Israel, Murali has lent his time and talent to LunaNet, a flexible and extensible network architecture that will enable a solar system internet.

The LunaNet architecture is based on interoperable nodes that are all connected to the same larger network. These nodes will offer various services to spacecraft at or on the Moon, ensuring seamless access to data across the network, even when a data path to Earth isn't immediately available.

Murali worked to identify the communications standards for missions using LunaNet. The document he wrote will help communications engineers for early-stage missions hoping to use LunaNet to design their communications systems. Murali has long been fascinated with crewed missions, so the opportunity to have such an impact on Artemis is a huge win.

"As someone who went and saw the space shuttle when I was younger and read lots of books about space," said Murali, "it's just exhilarating that I help contribute to the next phase of human spaceflight. It's just incredible to me."

The Artemis missions to the Moon will serve as a proving ground for the technologies needed for interplanetary travel. SCaN interns are a critical part of making these missions possible as they lead the Artemis generation further into the unknown. A SCaN intern may well be among the first humans to step foot onto Mars, leading the charge into deep space and beyond.

It Takes a Village

The SIP team extends their deepest gratitude to all the mentors who made this program happen on top of their already-packed schedules. These generous mentors went the additional mile to adapt their work for the online summer. By sharing their experiences and insights with interns, mentors cement our investment in the Artemis generation — the generation that will see NASA go to the Moon, Mars, and beyond.

Further, as the idiom goes, “It takes a village.” This challenging, wonderful summer experience would not be possible without dozens of other unsung heroes: secondary mentors, support staff, returning interns, and former interns who’ve returned to NASA as full-time employees. The success of this virtual internship experience would not have been possible without your dedication.

Thank you all.

Reflection from ESC Leadership

Bob Menrad

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

Congratulations to this year's summer intern cohort! This division takes pride in executing an intern program that both advances the vision of SCaN — a vision that includes developing the next generation of talent - and represents the standard of excellence that is Goddard Space Flight Center. We are extremely proud of the work each intern has achieved throughout this 10-week program. Each has brought their own unique skillset to this division and advanced our community's work on projects like quantum communications, Delay/Disruption Tolerant Networking, cybersecurity, and so much more. Although your work took place in a virtual setting, each and every one of you showcased outstanding adaptability, overcoming all of the challenges associated with the virtual environment. Thank you for joining us this summer and contributing to our mission. We trust that you were inspired by your mentors, learned from those you observed and have come to see your amazing capacity to meet the challenges that come with exploring the heavens. Well done!

SPACE COMMUNICATIONS AND NAVIGATION
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