

Paving an Integrated Approach for Space's Traffic Jam Problem

March 30, 2022

Traffic etiquette, once learned, can seem intuitive: a driver stops their car at a red light, understanding that cross traffic will have a green light and the right-of-way. Coordinating these simple signals has enabled a vast transportation system that continuously accommodates over 275 million motor vehicles across the United States. Before traffic signals existed, thoroughfares were congested with cars, horses, and people which led to avoidable accidents.



The historic ad hoc traffic flow regime is analogous to today's space environment, but just like how air, ground, and maritime transportation systems have developed traffic flow standards, space traffic coordination needs to evolve with standards and best practices to operate safely and efficiently.

The Aerospace Corporation is supporting the space enterprise and the broader space community to address these challenges, such as fostering discussions on best practice frameworks and advancing the technical capabilities that demonstrate the art of the possible.

In support of the Office of Space Commerce (OSC) within the National Oceanic and Atmospheric Administration (NOAA), Aerospace's experts have contributed to a cloud-based prototype system that will

allow for ingesting vast amounts of space object orbital data, creating an essential digital repository that enables the level of space situational awareness data sharing and processing needed for the space domain to thrive.

"The expected exponential increase in space activity in the coming years will be driven by commercial activities," said Uma Bruegman, Assistant General Manager in Aerospace's Civil Systems Operations. "Aerospace has a deep history collaborating with defense, civil and commercial space to advance the nation's space enterprise. Supporting government missions and working with all stakeholders to address the need for effective space traffic coordination schemes is a natural extension of our inherent space expertise."



The current space environment is experiencing an unprecedented boom, also elevating concerns of considerable congestion of low Earth orbit.

Enabling Broader Data Sharing for Safe Space Operations

The ongoing transition of the Space Situational Awareness (SSA) on-orbit safety mission for the commercial satellite owner/operators from the Department of Defense (DoD) to NOAA marks a shift in the responsibility for the mission of communicating and coordinating civil and commercial SSA data. This effort will entail collaboration with non-government and international partners to shape best practices through transparency and establish an integrated approach to data and information sharing.



In accordance with Space Policy Directive-3, and at the request of the U.S. Congress, NOAA recently provided a demonstration of the cloud-based prototype system to support space traffic awareness data sharing efforts. The cloud-based system known as the SSA Open Architecture Data Repository, or OADR, included support from federally funded research and development centers (FFRDCs), including MIT Lincoln Labs, MITRE and Aerospace in developing and demonstrating NOAA's transformative prototype.

Read the full article on Aerospace.org.

Sci-Fi Fact or Fiction: How Would Satellites Battle in Space?

March 24, 2022

Is a Star Wars-like dogfight merely fictional or the future of military engagement? What would an actual battle in space look like?

Aerospace's Dr. Rebecca Reesman, Senior Project Engineer and author of the Center for Space Policy and Strategy paper, <u>The Physics of Space</u> <u>War</u>, recently answered some of sci-fi most popular questions on Aerospace's <u>Medium channel</u>, dispelling what's fact and what's fiction when it comes to space warfighting.



Let's talk about starcruisers. How realistic are popular sci-fi depictions of military space operations?

Sci-fi depictions, while fun to watch on the big screen, are not representative of what is possible in Earth's orbit. The starcruiser concept is an extension of what combat can look like in the air domain, but it is not possible in space. All spacecraft or satellites are constantly moving, orbiting earth in an elliptical shape, not moving in straight lines as shown in movies. The concept of a spacecraft chasing another spacecraft would be more like a slow dance in space.

What are the limiting factors for in-space warfighting?

Orbital dynamics, which dictates how things move in space, is very different from what we know and experience on Earth. These physics realities can feel like constraints — predictable orbit paths, speed being tied to altitude, slow maneuvers. The biggest constraint in space is probably the limitation on energy, which equates to changes in velocity (delta-v).

Currently, satellites are launched with all the fuel they will ever have. That is like never being able to refuel your car, airplane, or ship, which limits the number of maneuvers you can do. While there have been advancements in energy sources and discussions of on-orbit fuel depots — which would greatly help — it's important to remember that space is very big. Even with improved efficiency of energy sources and increased number and location of possible refueling depots, the vastness of space would still impose limitations.



What physical and technological challenges would have to be overcome for a sci-fi version of a space battle to be possible?

If you want to "defy" orbital dynamics to force a spacecraft to move in a straight line, you'll need tens of thousands, or even millions, of meters per second of delta-v. This is orders of magnitude beyond what is currently possible. If we did have that kind of energy available today, the forces generated by acceleration would break apart the spacecraft.

Any space power strategy should work with — not against — those realities. Policymakers and defense strategists must continue to have a realistic understanding of what is possible and practical. A strategy that works in air, land, or maritime domains won't necessarily work in the space domain.

Read the full interview on Aerospace's Medium channel.

Take a Virtual Tour of Aerospace's Guidance and Control Labs

March 23, 2022

The <u>Aerospace Virtual Tours</u> allow you to digitally navigate through some of our world-class labs to learn more about the innovative and complex work our experts do every day to advance space capabilities. Be sure to check out what other virtual tours are available on Aerospace.org.

Aerospace's Guidance and Control Subdivision is the home to three labs dedicated to the research, study, testing and demonstration of guidance, navigation, and control systems, both hardware and software components, high-fidelity simulations, including hardware-in-the-loop, and autonomous systems. The three labs are:



Embedded Systems Application Center (ESAC)

ESAC hosts Hardware-in-the-Loop (HIL) simulation systems that provide a real-time platform with flightequivalent avionics components and simulated vehicle dynamics used to validate embedded software in flight-equivalent avionics and software environments. Activities include flight computer hardware/software integration and testing, and avionics performance, timing, and redundancy validation and verification.

The Embedded Systems lab provides an environment for embedded systems development and integration for the AeroCube and Slingshot CubeSat programs, and any other program that requires embedded systems. Research is done to develop innovative solutions in flight software design, hardware and software integration, and testing. The lab also houses CubeSat HIL simulations for rapid integration, prototyping of solutions, and test-like-you-fly capability.

Collaborative & Autonomous Vehicle Ecosystem (CAVE)

CAVE provides an environment and ecosystem for research, development, integration and testing of autonomous sub-systems and systems using Vicon motion capture cameras, robotic arms, rovers and drones, to explore how increased autonomy and collaborative robotics will make autonomous space systems manageable.

Mechatronics Research Lab (MRL)

Though not included on this tour, the MRL is Aerospace's premier facility for testing and evaluating control system hardware, including electromechanical, electro-optical, and optomechanical devices. The MRL's extensive experience enables rapid response in engineering testing, including system design evaluation, analytical model validation, and anomaly resolution. The laboratory can also design new capabilities to meet emerging needs.

Explore the **<u>Guidance and Control Subdivision labs</u>** to learn more.

Spaceflight Safety Takes Center Stage With Aerospace's New Actors in Space Workshop

March 14, 2022

The "space club" is experiencing immense growth, the rate of which has rapidly transformed space access from novelty to trend. The presence of more actors, driven by the commoditization of space technology, lower barriers to participation and other factors, has the potential to exacerbate threats to the long-term sustainability of space activities if it remains uncoordinated.

Fortunately, new space actors are only operating within a literal



vacuum, not a figurative one. The collective knowledge developed by the space enterprise over decades can provide guidance and solace to new companies and countries rising to meet the multitude of challenges that accompany space activities.

To help educate space newcomers on the importance of space safety, The Aerospace Corporation's <u>Space</u> <u>Safety Institute</u> partnered with Secure World Foundation to produce an interactive, two-day New Actors in Space Workshop. The event convened expert discussions intended to distill fundamental insights that inform new actors on how to best leverage and benefit from the collective technical, policy and operational safety knowledge acuity at Aerospace, which has been derived from over seven decades of space activity across the space enterprise. "The Space Safety Institute promotes space activities that are safe, supports economic and scientific development and fosters the long-term sustainable use of outer space through innovation, independent analysis, advocacy, training and education," said Uma Bruegman, Assistant General Manager of Aerospace's Strategic Assessments, Studies and Projects Division and co-lead of the Space Safety Institute. "Our vision is to serve as an objective center of space safety expertise and capabilities at this pivotal time of change."

The workshop adapted material directly from Secure World Foundation's <u>Handbook for New Space Actors</u>, first published in 2017.

"The impetus for this Handbook came from our observation that there are many new actors that are eager to join the space club, and there should be a resource for these new space actors that outlines the obligations and responsibilities of being a member of the space club," said Dr. Peter Martinez, Executive Director of Secure World Foundation. "We are very excited to be working with Aerospace to present the content of the handbook in this format."



The New Actors in Space Workshop adapted material directly from Secure World Foundation's Handbook of the same name first published in 2017.

For more on The New Actors of Space Workshop, read the full article on Aerospace.org.

Women's History Month: Aerospace Employees Discuss Power of Mentorship and Networking

March 10, 2022

In honor of Women's History Month, the Aerospace Women's Committee (AWC) hosted a virtual panel last week on "<u>Generations of Women in Space</u>." The discussions explored the changes the panelists have seen throughout their careers with regard to women in the industry, as well as how mentors have made an impact and helped them find their place in the space industry.

Started in 1909 as Women's History Day, Women's History Month is now commemorated each year in March to celebrate the valuable contributions of women to events in history and contemporary society.

The AWC panel consisted of Aerospace's:

• Niabelle Thelemaque, Member of the Technical Staff in the Communications Payload Command and Telemetry Department



AWC panelists shared their journeys as women in STEM and finding support and solidarity through mentorships and groups like AWC.

- **Terita Norton**, Systems Director at the GEOINT Development Office in the Systems Engineering Department
- Gretchen Lindsay, General Manager of CTED
- Malina Hills, recently retired Senior Vice President of the Space Systems Group
- Liz Young, retired U.S. Navy Rear Admiral and Aerospace consultant who formerly served as the Director of the Systems Engineering Directorate for the Intelligence Community

The panel was moderated by **Tammy Choy**, Vice President and Chief Information Officer, who invited panelists to share experiences about their journeys and how they started in the industry. While many described a variety of challenges breaking into the industry, they all felt a strong desire to work hard to overcome obstacles so they could continue to explore their passions in the aerospace field.



Pictured clockwise: Panelists Tammy Choi, Dr. Malina Hills, Manzar Chaudhry, Liz Young and Niabelle Thelemaque were among the participants who shared their experiences and inspirations as professionals in the space industry. (Click image to watch video)

Norton, who grew up seeing the space shuttle in Florida, fell in love with trying to figure out electronics by taking apart household appliances. She got her start as an intern at Aerospace and has since seen a lot of

changes over her more than 24 years working at the company.

"I've seen a lot of growth in diversity of thought and experiences. When I first started out as an intern and I was going into meetings, or even when I came on full-time, I could walk into a technical meeting and be the only female or be the only person of color or both. And now, things are progressing where numbers are starting to increase," said Norton. "I can now walk into a meeting and see a woman leading the meeting, leading that technical discussion. I can see the advances in leadership. Although there still needs to be more, I can see the progression. I'm not the only one in the room. I'm not the only one sitting at the table and having that awareness and having that growth. I think we still have a long way to go but seeing that progression has been great."

Young, who spent 30 years in the Navy and was the only woman chemistry major in her Naval Academy class and only woman in the physics and space operations programs in her graduate program, spoke on some of the challenges she faced in a male-dominated field.

"Getting to the Naval Academy was the first time I had gotten on a plane-the first time I had ridden on a bus. Then I ran out of money, so I walked the rest of the way to the Naval Academy," said Young. "I finished pretty high in class rank, but I was in one of the first classes that had women and there weren't really many opportunities. I thought I would fly a plane or sail a boat, but we were prohibited by law."

While she eventually made it to the Intelligence Community, where she worked as an engineer for many years, she is thankful there is more support for women in the field today than when she started.

"The very first SCIF I worked in didn't have a women's bathroom and I had to go to a different building," said Young. "We have seen a lot of changes in the space field recently. Like all of you, I want to see the progression of the workforce and I want to see all sorts of different people. I mean this in the broadest possible sense, the organizations will do better with a diversity of views."

Young also reflected on how much has changed. Mentioning how there were no women in her departments when she first started her career and that she was thankful for two male officers who took her under their wing.

"I would just emphasize, it is a big deal [to have a network]," said Young. "Be grateful that you have these networks because it's a cold and lonely world out there when you are the only one looking for the women's bathroom."

Many on the panel also cited their mentors and how finding a group to connect with helped them along their journey.

"When I became the president of the AWC, I learned so much from the group and this network of women around me," said Hills. "I learned a lot about leadership and strategic planning because the AWC was redirecting itself. That was huge for me and having the network of women that were so supportive, having those women around me was so important. These women support you throughout your career, and networking and the AWC have been critical in my career." Thelemaque spoke about how building a strong community and network has been very helpful and kept her motivated.

"I just remember graduating in the summer and my senior design class, there were only 10 women per 30 men, and my senior design partner and I were the only two black women in electrical engineering graduating that summer," said Thelemaque. "Not seeing people who were like me can definitely affect your psyche, but when you find that community and you all lift each other up, it definitely helps you motivate each other and want to succeed with each other."

As a final call to action, Choy encouraged the audience to sign up to be mentors through Aerospace. She emphasized how critical and empowering a mentor and a community of support, like AWC, can be.

Norton shared how, particularly when she first started at Aerospace, having Dr. Wanda Austin as her general manager and unofficial mentor inspired her. She said that Austin allowed her to see good leadership and communication in action, helping her in her career to this day.

"For me, I think representation matters and that you have to see it to want to achieve it," said Norton. "Mentoring and networking are key pieces to sustaining oneself, particularly as a female in this environment."

For more on Women's History Month, the Aerospace Library has provided a collection of books that focuses on reading about women in STEM, and CorpComm has released <u>new virtual backgrounds</u> available for internal and external use.

If you'd like to learn more about Aerospace's Employee Resource Groups (ERGs) and opportunities to get involved, please visit the ERG Website.

Editor's Note: Some quotes have been edited for length and clarity.

New ISS Camera to Provide Unprecedented Nighttime Imagery

March 07, 2022

Satellite imagery has become an essential tool for many of today's technologies, such as weather nowcasting and forecasting, terrain mapping, disaster monitoring for fires, floods and storms, and space weather impacts. A challenge, however, is most space-based cameras rely primarily on the sun or moon as their light source.

Inspired by faint light emissions from the atmosphere, a team of scientists created a superior nighttime camera and flew it on the International Space Station (ISS) in 2019. It's been so successful; they've decided to do it again—with improvements.

PIANO, which is short for Phenomenology Imager & Nighttime Observer, is a 45 kg camera designed and built by The Aerospace Corporation that launched Dec. 21 on SpX-24 to support low-Earth orbit (LEO) weather and overhead persistent infrared (OPIR) augmentation missions. It was installed on the ISS on Jan. 11.

Aerospace engineers conducting nighttime tests of PIANO to ensure it is fully operational prior to its launch. [Credit: Berting]

Its name would erroneously lead you to believe it makes music, but the truth is no less creative. PIANO will rely on an unusual technique to take photos at night with stunning resolution. Day and night, chemical reactions in Earth's atmosphere emit light—known as airglow—that PIANO will harness to capture images.

"We will use the airglow layer as a flashlight to look at the ground," said Dr. Lynette Gelinas, Senior Scientist at Aerospace' Space Sciences Department and the principal investigator for this project. "PIANO can collect nighttime imagery in almost complete darkness."



With a successful installation onboard the ISS, preparation for PIANO to begin capturing images from space is now underway. [Credit: Berting]



PIANO, which was integrated and flown by the Department of Defense's Space Test Program, will use the airglow layer as a flashlight to look at the ground. [Credit: NASA]

This concept was proven by PIANO's predecessor, the Near Infrared Airglow Camera (NIRAC), which launched on May 4, 2019 and has served as a pathfinder since for nighttime imaging done from LEO.

"NIRAC takes some images that literally nobody else can do right now," said Dr. Jim Hecht, Senior Scientist in the Space Sciences Department. "We showed that this technique actually worked. There's no other instrument that has the equivalent resolution that NIRAC has at night with the moon down, which is where its forte is."

To learn more about PIANO, read the full article on Aerospace.org.

March 2022 Obituaries

March 01, 2022

Sincere sympathy is extended to the families of:

- Fernando Acevedo, office of technical support, hired Jan. 30, 1995, died Jan. 31, 2022
- Lynette Arrowsmith, office of technical support, hired March 19, 1979, retired April 1, 1989, died Dec. 5, 2021
- Joyce Arthur, office of technical support, hired August 7, 1964, retired Dec. 31, 1987, died Feb. 8, 2022
- Bruce Baxter, member of technical staff, hired Feb. 1, 1966, retired Oct. 1, 1993, died Feb. 4, 2022
- Gregg Bryant, member of technical staff, hired July 31, 2006, died Feb. 14, 2022
- Averil Chatfield, member of technical staff, hired April 9, 1962, retired Feb. 1, 1983, died Dec. 13, 2021
- Young-Il Choo, member of technical staff, hired July 16, 2007, retired Jan. 1, 2013, died Dec. 22, 2021
- Joy Egan, member of administrative staff, hired Nov. 6, 1961, retired August 1, 1997, died Oct. 27,

2021

- Nathaniel Feldman, member of technical staff, hired July 6, 1981, retired Nov. 1, 2010, died Nov. 24, 2021
- John Fox Jr., member of technical staff, hired July 2, 1962, retired Feb. 1, 1994, died Jan. 9, 2022
- **Stephen Gadomski,** member of technical staff, hired July 17, 1987, retired August 1, 2011, retired Jan. 22, 2022
- Robert Hallse, member of technical staff, hired March 14, 1966, retired Oct. 1, 1991, died Feb. 26, 2022
- Robert Harrison, member of technical staff, hired August 6, 1962, retired July 1, 1998, died Feb. 10, 2022
- Keith Henrie, member of technical staff, hired Jan. 23, 1964, retired Oct. 1, 1990, died Feb. 10, 2022
- Kanwar Kapur, member of technical staff, hired Sept. 7, 1965, retired Oct. 1, 2003, died Jan. 17, 2022
- Clifford Kester, office of technical support, hired June 19, 2006, retired April 1, 2016, died Nov. 27, 2021
- **Charles Klein,** member of technical staff, hired March 25, 1980, retired Oct. 1, 1996, died Feb. 25, 2022
- William Magruder, member of technical staff, hired May 29, 1961, retired May 1, 1995, died Dec. 12, 2021
- **Chester Norris,** member of technical staff, hired August 11, 1987, retired Oct. 1, 1996, died Nov. 18, 2021
- Joseph Payne, member of technical staff, hired August 21, 1967, retired July 1, 2000, died Jan. 20, 2021
- Patrick Rooney, office of technical support, hired June 19, 2006, died Jan. 27, 2022
- John Slaminski, member of technical staff, hired Jan. 12, 1987, retired Oct. 1, 2003, died Jan. 25, 2022
- Alfred Sorensen, member of technical staff, hired Sept. 18, 1978, retired Feb. 1, 2006, died Jan. 27, 2022
- Arturo Torres, office of technical support, hired August 29, 2011, died August 13, 2021
- Natalia Ulloa, member of administrative staff, hired April 12, 2021, died Feb. 9, 2022

To notify Aerospace of a death and have it included in the Orbiter, please contact People Operations at (310) 336-5107.

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