



National Aeronautics and
Space Administration



EXPLORE LEARN

LEARNIng from Experiences, Achievements, and Resolution Navigation

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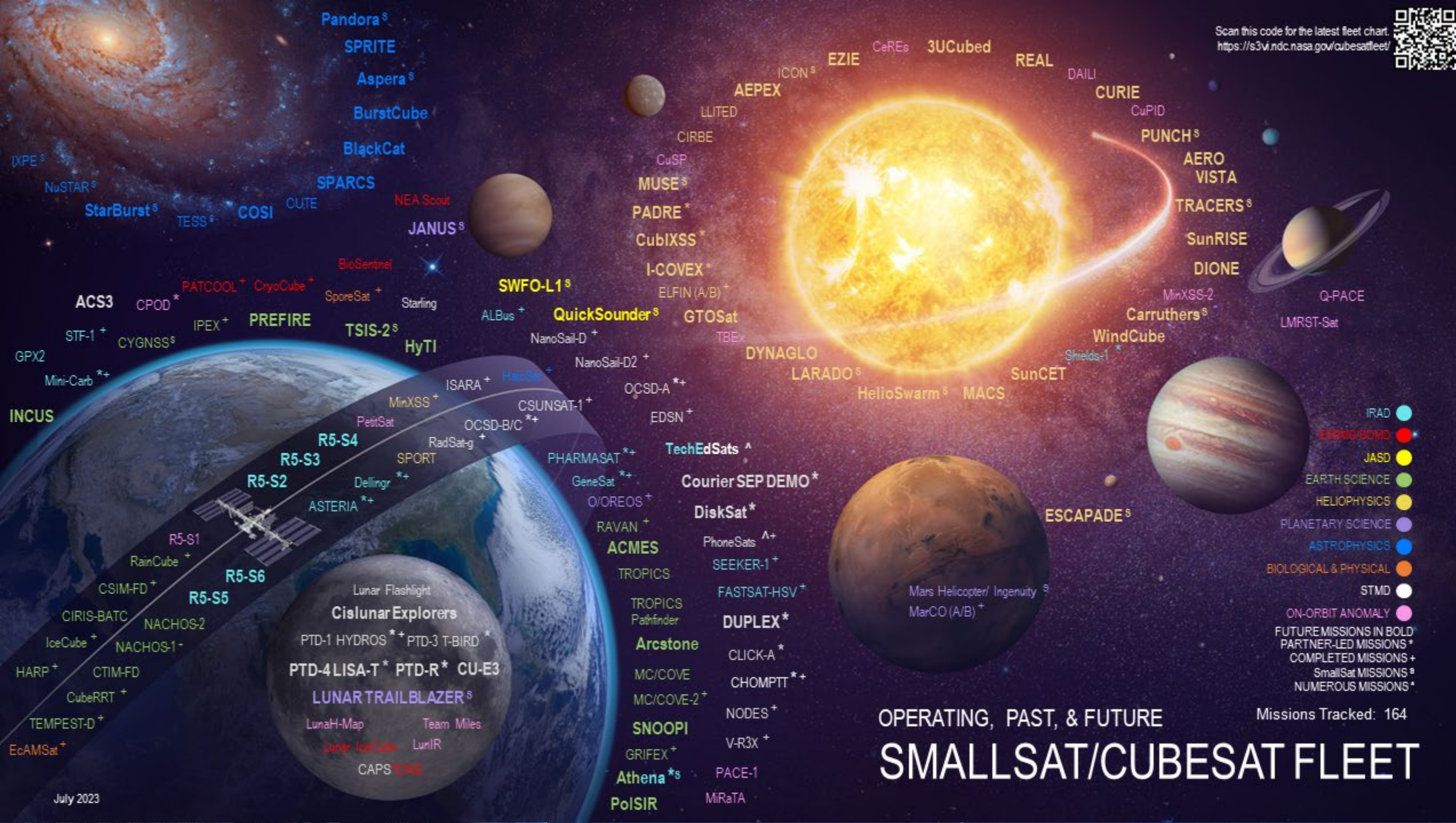
Science Mission Directorate

Chair, Small Spacecraft Coordination Group

NASA Headquarters

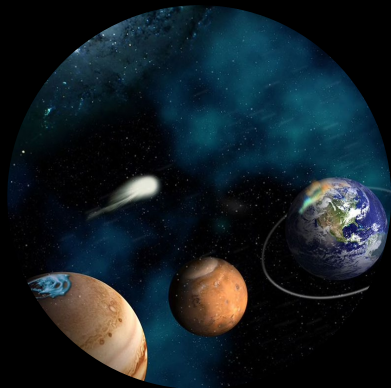
Apr 16, 2024

Scan this code for the latest fleet chart.
<https://s3vi.ndc.nasa.gov/cubesat/fleet/>



Focus Areas of Strategic Emphasis

Fundamental to Enabling NASA's Overall Vision for Small Mission Activities



1 - Strategy and Implementation



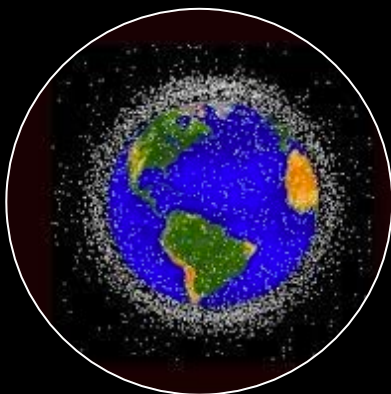
2 - S&MA, Reliability, and Technical Excellence



3 - Launch Accommodation and Rideshare



4 - Services and Infrastructure



5 - Conjunction Assessment and Mitigation



6 - Cybersecurity and Enterprise Protection



7 - Commercial Partnerships and New Space



8 - International Relationships and Outreach



Goals of LEARN Forum

LEARNIng from Experiences, Achievements, and Resolution Navigation

- Interact and network to build a NASA **Smarter** SmallSat Community
- **LEARN** from each other
- Provide **feedback**

The LEARN forum facilitates knowledge sharing within SmallSat community through the exchange and collection of experiences across NASA mission areas.

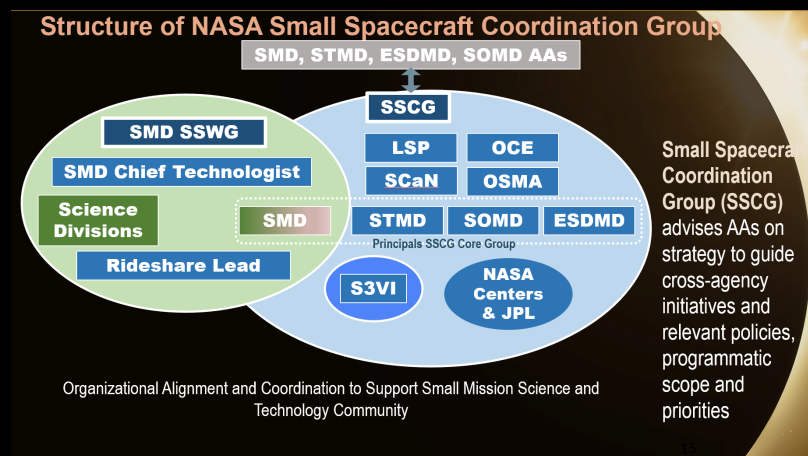
Our forums are designed to inspire frank and open discussions, technical knowledge sharing, establish and refresh best practices, identify common challenges and possible solutions, provide policy updates and required actions, and promote continual improvement, and success and connect the community.



NASA SmallSat LEARN Forum



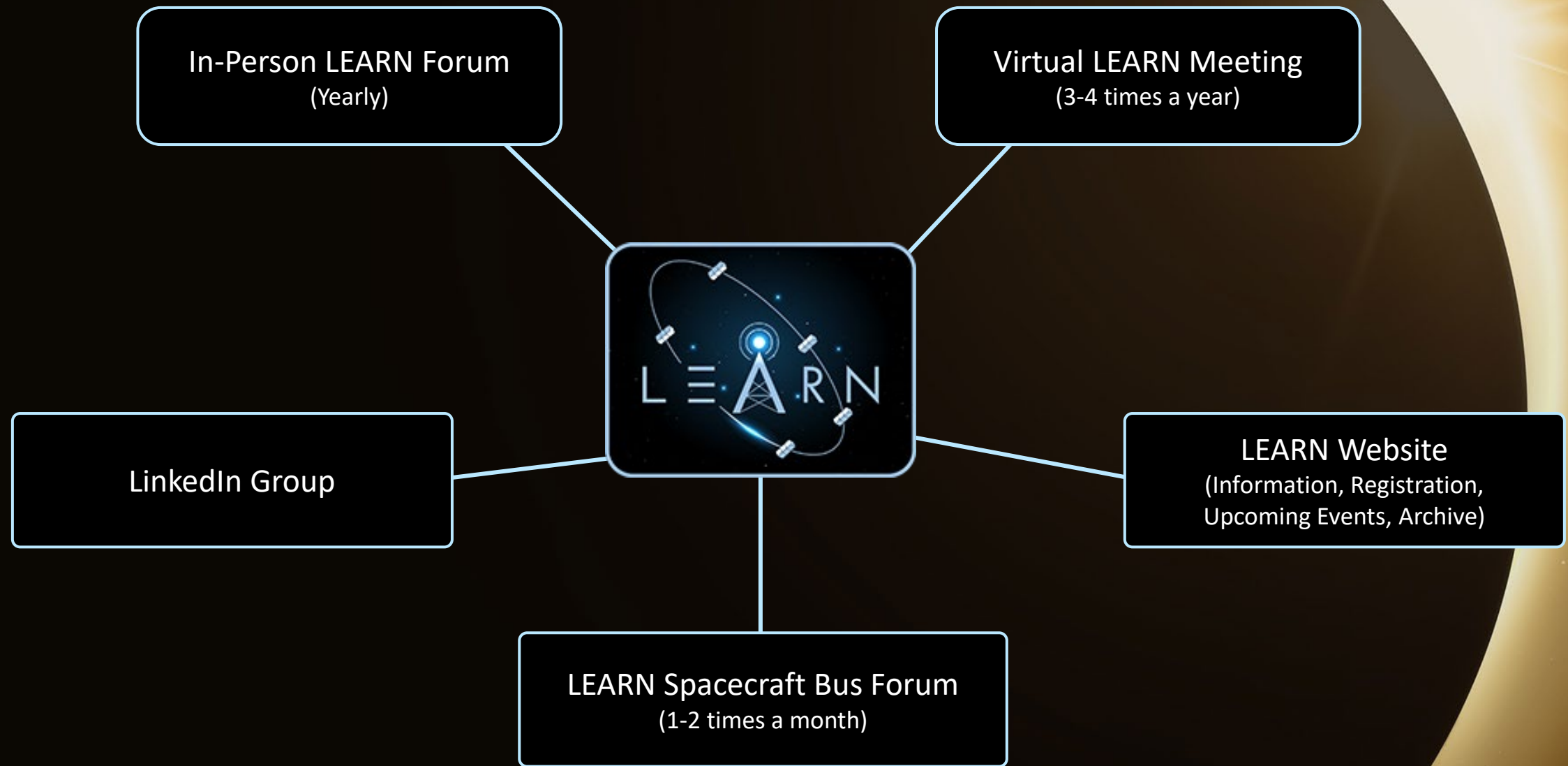
SSRI Knowledge Base Tool - Enhancements included: Application Programming Interface (API) and Best Practices and Lessons Learned 58 topic pages and 533 Unique Resources released 2/2022	2021 State of the Art Report - Major chapter updates: In-space Propulsion, SmallSat Avionics, Complete SmallSat Platforms, Power, Structures, Materials, and Mechanisms, Communications - Released November 2021	2022 Small Spacecraft LEARN Forum - Facilitate community learning through sharing, and exchange of experiences - Hosted bi-monthly with one annual in-person - Online platform planned
Industry Days - Monthly series to continue interaction with industry 11 webinars hosted 6/2021 – 5/2022 - Recordings and presentations hosted on NEN / CoP Small Spacecraft	Anomaly Alert / Reporting System - Alert system for near real-time information on flight HW & SW anomalies to the NASA community - Hosted via JARVIS³	Community of Practice Webinars - New series to capture & celebrate small spacecraft missions that have successfully completed, or exceeded, their mission goals 11 total webinars were held, 5 were "Mission Accomplished"
Information Search – New Databases Three new databases added or migrated 6/2021 – 5/2022 to include: SPOON database, SBIR/STTR, and SmallSat Presentation Database	2022 SmallSat Technology Partnerships Virtual Technology Exposition - Sharing for infusion & commercialization of STP-funded tech - Nine 2020 STP and 1 STP 2018 projects participated - Held June 8; 50+ attendees	Mission Design Tools - Open-source software from NASA or the smallsat community for smallsat mission design - Eight design tools were added 7/2021 – 5/2022 (PyCubed, cFS, NOS3, R-GENTIC, CRÉME, TAT-C, VCE, and F Prime)



What are the Challenges?
What are we doing?

Where and what are
some solutions?

Who are the Stakeholders?
How are we organized?



LEARN Forum

- 2024 LEARN PI Lessons Learned (Virtual)
- 2024 LEARN Industry Bus (Virtual)
- 2024 Face to Face at ARC Sept 24-25, 2024

History

- 2023 Face to face at LaRC Oct 10-11, 2023 & Virtual Sessions
- 2022 Face to Face at WFF Oct 25-26, 2022 & Virtual Sessions
- 2022 LINKEDIN LEARN group
- 2021 Virtual Forum -- 26 panels/6 weeks
- 2019 Face to face PI/PM Technical Interchange Meeting at ARC





NASA SmallSat LEARN Forum

TIME	SESSION	SPEAKER(S)
7:30-8:30 AM	REGISTRATION/CHECK-IN	
8:30-8:40 AM	WELCOME	KEVIN RIVERS
8:40-8:45 AM	LOGISTICS	CHRIS EDWARDS
8:45-9:05 AM	INTRODUCTION AND YEAR-IN REVIEW	FLORENCE TAN
9:05-9:15 AM	ANNOUNCEMENTS	BRUCE YOST
9:15-9:45 AM	LANDSCAPE OF SMALLSAT TECHNOLOGY GAPS	JUSTIN TREPTOW-MILLER
9:45-10:00 AM	BREAK	
10:00-10:30 AM	SMD HELIOPHYSICS AND ASTROPHYSICS PORTFOLIO LESSONS LEARNED	TOM JOHNSON
10:30-12:00 AM	LESSONS LEARNED PANEL DISCUSSION WITH PRINCIPAL INVESTIGATORS, PROJECT MANAGERS AND SYSTEMS ENGINEERS	MODERATOR: CATHERINE VENTURINI BRIAN FLEMMING STEVEN REISING JORDAN KARBURN LUIS LOURES CATE HENEGHAN ALAN RHODES
12:00-1:30 PM	LUNCH, LIGHTNING TALKS & NETWORKING	
1:30-2:00 PM	LAUNCH OPPORTUNITY LANDSCAPE	ALICIA MENDOZA-HILL
2:00-2:30 PM	CONSTELLATION RELIABILITY STUDY	JIM DEMPSEY
2:30-3:30 PM	BREAK & NETWORKING	
3:30-4:00 PM	COMMERCIAL GROUND COMMUNICATION LANDSCAPE	MARIE PIASECKI
4:00-5:00 PM	OPEN FORUM	MODERATOR: FLORENCE TAN



NASA SmallSat LEARN Forum

TIME	ROOM 112&113	ROOM 114&115	MAIN AUDITORIUM
8:30-9:30 AM	NAVAL POSTGRADUATE SCHOOL GROUND NETWORK AND CUBESAT PROGRAM <i>GIOVANNI MINELLI</i>	STATE OF THE ART AND EMERGING TRENDS IN LASER COMMUNICATIONS <i>JAN STUPL</i>	
9:30-10:30 AM	NAVIGATING NASA PROCEDURAL REQUIREMENTS: GUIDANCE ON KEY NPR	USING 3D PRINTING FOR SMALLSATS AND FLIGHT DEMONSTRATION OF GPX-2 <i>ANDREW GLENDENING</i>	
10:30-11:30 AM	7120.5 VS 7120.8 <i>TOM JOHNSON</i> CYBERSECURITY/ENCRYPTION <i>REY ANZALDUA</i> ODAR <i>MATTHEW FORSBACKA</i> RF LICENSING <i>LYNNA MCGRATH</i> ESPA RUG <i>ALICIA MENDOZA-HILL</i>	TECHNOLOGY GAPS WORKSHOP <i>LUIS SANTOS & JUSTIN TREPTOW-MILLER</i>	LANGLEY RESEARCH CENTER TOUR 1: SMALLSAT CAPABILITIES
11:30-12:30 PM	LUNCH		
1:00-2:00 PM			CONJUNCTION ASSESSMENT AND NPR 8079.1 <i>LAURI NEWMAN & JOSHUA KRAGE</i>
2:00-3:30 PM			RADIATION AND PARTS SELECTION <i>MIKE CAMPOLA & LARRY THOMSEN</i> LANGLEY RESEARCH CENTER TOUR 2: AERONAUTICS, EXPLORATION AND SCIENCE
3:30-4:30 PM			CLOSING SESSION <i>FLORENCE TAN</i>

Discussion or Action Needed from LEARN 2023

- Workshop on Guidelines for Battery passivation
- Clarity for waiver process on FCC 5 year deorbit rule
- Streamline licensing process for NTIA Spectrum applications
- CubeSat and SmallSat cost model
- “Copper rules” for CubeSats (similar to Goddard Gold Rules)
- Rideshare coordination
- Authorization to Operate Process (in work)
- Project Protection Plan (in work)
- LEARN Forum 2024 topics



Links to LEARN community

- **LEARN Forum** Jan, Mar, May, July and face-to-face
<https://www.nasa.gov/smallsat-institute/LEARN-forum>
- **NEW 2024:** Industry Spacecraft Bus Seminar starting Feb/Mar; 1-2 presentations per month
- **LinkedIn** <https://www.linkedin.com/groups/14097449/>
- **PI Launchpad Workshop**
<https://science.nasa.gov/researchers/pi-launchpad>
- **S3VI** <https://www.nasa.gov/smallsat-institute>



**NASA SmallSat LEARN
Forum**

Through the Eyes of NASA

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Summary Lessons Learned Discussions in LEARN 2023

These categorized lessons underscore the multifaceted nature of SmallSat missions and highlight the importance of careful planning, effective teamwork, and strategic decision-making throughout the project lifecycle.

Team:

- **Experienced Leadership:** Experienced project managers (PM) and systems engineers (SE) are key to guiding the team effectively.
- **Beware Burnout:** Maintain awareness of team fatigue and implement strategies to prevent burnout.
- **Flexibility and Technical Savvy:** Build a team that is adaptable, technically proficient, and knowledgeable.
- **Team Bonding and Culture:** Foster a strong team culture to keep the team cohesive and motivated.
- **Define Management Processes Clearly:** Clearly define management processes including co-location to ensure effective team coordination.

Summary Lessons Learned Discussions in LEARN 2023

Engineering Practices and Design:

- Rigorous Engineering: Maintain high standards of engineering regardless of mission size.
- Fail Gracefully Design: Design systems to fail gracefully, acknowledging that this is a challenging aspect of spacecraft design.
- Apply NPR Requirements Judiciously: Apply Procedural Requirements (NPR) requirements judiciously, especially regarding testing requirements.

Requirements:

- Understand "Make vs Buy" Choices: Make informed decisions about whether to develop in-house or procure externally, considering testing requirements.
- Designing to FFP Requirements: Design engineering and scientific objectives with firm fixed price constraints in mind.
- Key to Success: Understand the requirements thoroughly from the beginning and avoid deviating (requirements creep) from them.

Summary Lessons Learned Discussions in LEARN 2023

Testing:

- Hardware-in-the-Loop Testing: Prioritize hardware-in-the-loop testing and utilize flatsat testing as early as possible.
- Invest in Testbeds: Allocate resources for testbed development to facilitate thorough testing.
- Test Communications End-to-End: Ensure thorough testing of communication systems from start to finish.
- Work Incrementally: Begin with simpler tasks before tackling more complex challenges to maintain focus and momentum.
- Coordinate Testing Ahead: Test subsystems at all levels and coordinate testing in advance.

Mission Assurance:

- Right-Sizing Mission Assurance: Tailor mission assurance efforts based on whether the mission is primarily for technology demonstration, education, or scientific research.

Summary Lessons Learned Discussions in LEARN 2023

Vendor Relationship:

- Relationships: Foster strong relationships with vendors.
- Understanding Firm Fixed Price (FFP) Contracts: Understand the implications and expectations of firm fixed price contracts, including assigning risk and responsiveness.
- Vendor Partnership: Choose vendors carefully, akin to selecting a long-term partner.

Paperwork and Documentation:

- Paperwork Costs: Prioritize essential documentation to avoid unnecessary overhead

Others:

- Mentoring: Providing mentoring within the team fosters professional growth and ensures knowledge transfer.
- Close Coupling of Science and Engineering: Ensure close collaboration between scientific goals and engineering requirements.

Structure of NASA Small Spacecraft Coordination Group

SMD, STMD, ESDMD, SOMD AAs

SSCG

LSP

OCE

SCaN

OSMA

SMD SSWG

SMD Chief Technologist

Science
Divisions

SMD

STMD

SOMD

ESDMD

Principals SSCG Core Group

Rideshare Lead

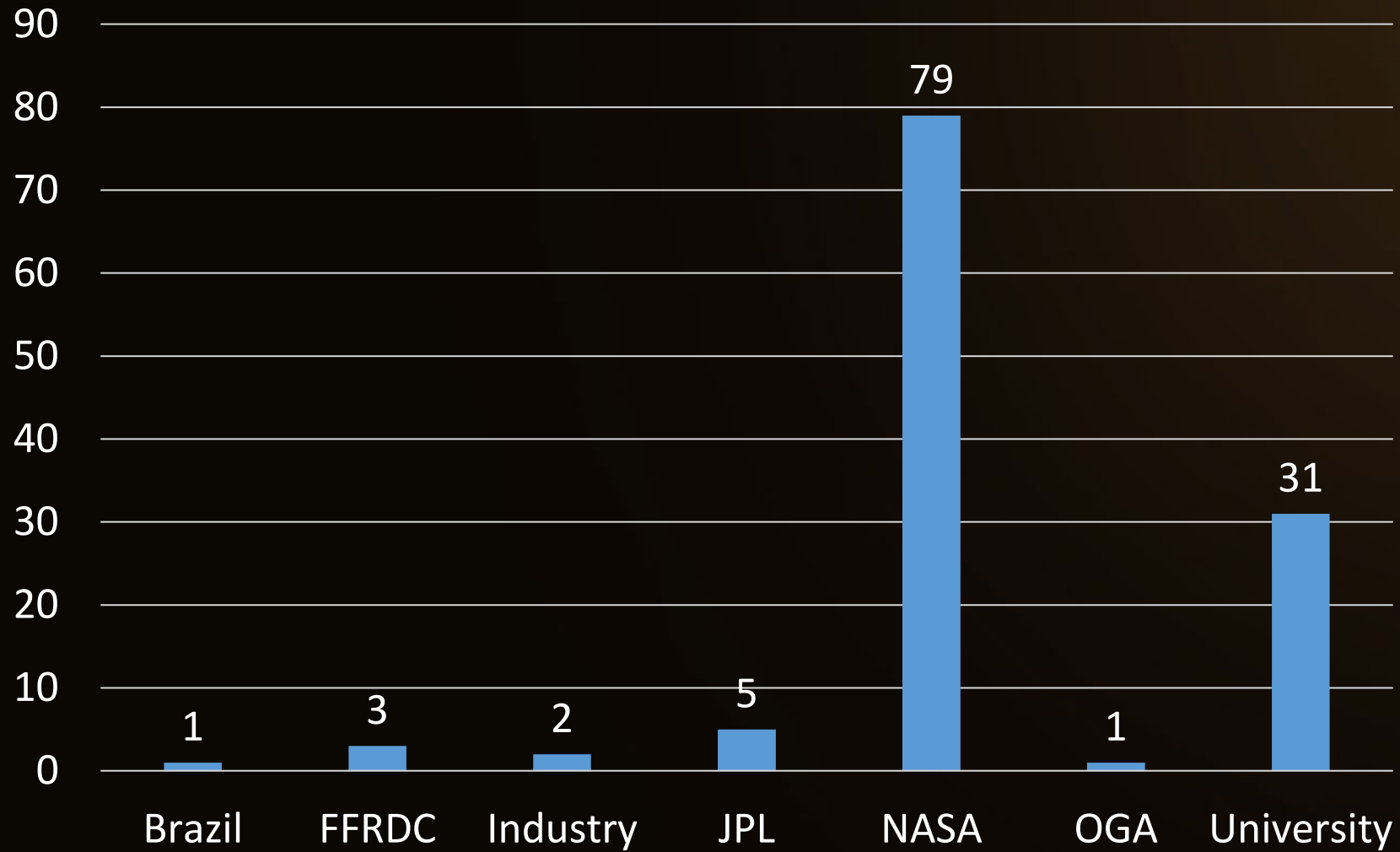
S3VI

NASA
Centers
& JPL

Small Spacecraft Coordination Group (SSCG) advises AAs on strategy to guide cross-agency initiatives and relevant policies, programmatic scope and priorities

Organizational Alignment and Coordination to Support Small Mission Science and Technology Community

LEARN Attendance Statistics 2023



Attendance and Feedback on LEARN Forum 2023

The LEARN Forum attracted over > 130 participants. These inputs are all from early career attendees. This is as much a “TEACH” forum as it is a “LEARN” forum – as participants benefit from teaching and learning with each other.

- *“The experience was exceptional and I’m going to do almost anything I have to in order to attend again next year”.*
- *“Overall, the Forum was the best use of my time I’ve had in a meeting for a long time. “*
- *“The lessons learned panel was really good. The first thing that comes to mind is that lesson learned about flatsats. We’re including the vast majority of hardware in the actual spacecraft configuration to get a 'functionally equivalent' test platform, but I’d like to revisit it and make sure we’re as close as possible. The flat form factor does us a lot of good for poking and prodding at the hardware, but a more true EDU may be worth considering again.”*
- *“... I am very thankful for the opportunity to attend this event and am thankful that I learned so much from it.”*
- *“This forum was so jam packed with information there were many things that weren't even on my radar to consider that now are after learning about them here (such as the extent of radiation damage, and the numerous different ways to help mitigate its effects).”*
- *“Overall I was really happy for the opportunity to attend the forum. I know that this will be a pivotal experience in my journey to be a great systems engineer and one day PI for my programs and I am really thankful to the team which organized this for the opportunity to participate and for all this knowledge collected over many years from knowledgeable engineers to be disseminated to all who attended.”*

Summary Posterboard Feedback in LEARN FORUM 2023

No.	Key areas of discussion	Description
1	<i>Pre Phase A</i>	Mentors will provide guidance to make smarter choices. Have reviewers for proposals to identify holes. Open source mission analysis tools are needed. Start with large margins and good systems engineering– needed because it is expensive for do-overs. Create teams to provide cybersecurity engineering and CARA requirements. Note that CARA and CyberSecurity rolled out streamlined process for CARA OCAP and ATO process. Plan a mission operation readiness training. Constellation risk assessments are available commercially. Bake in cost and schedule contingencies for the higher risk areas: payload, AI&T, software and front load development for high risks.
2	<i>Phase A, B, C</i>	Peer reviews for high risk areas good idea. Think about the things that keep you up at night. Spend time and effort at PDR and CDR – do not wait until AI&T to fix. Reimburse effort by a team to solve a problem that benefit the entire community. Small teams require experienced engineers. Small Sat teams can benefit from mentor/mentee pairing.
3	<i>Phase D</i>	Buy more lower cost options to decongest your verification and testing pipelines. Testing – must test Day in the Life and the ConOps. Review prior to performing key milestone work such as epoxy – rework is expensive! Verify Datasheets and test to your mission specifications.
4	<i>Phase E, F</i>	Start thinking about mission Ops early on in the program, and not just before launch. With respect to commercial radio vendors, regardless of documentation, SME knowledge isn't always documented and you may need to test extensively. Always test on-orbit software patches with flatsats prior to uploads. Re-test if possible any mission critical uploads.