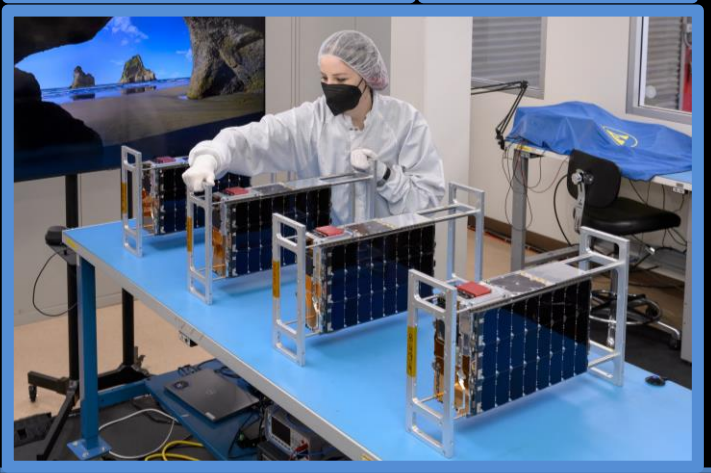




Development and Implementation of a Small Satellite Systems Engineering Webinar Series: A Collaboration Between the United Nations Office for Outer Space Affairs and the National Aeronautics and Space Administration

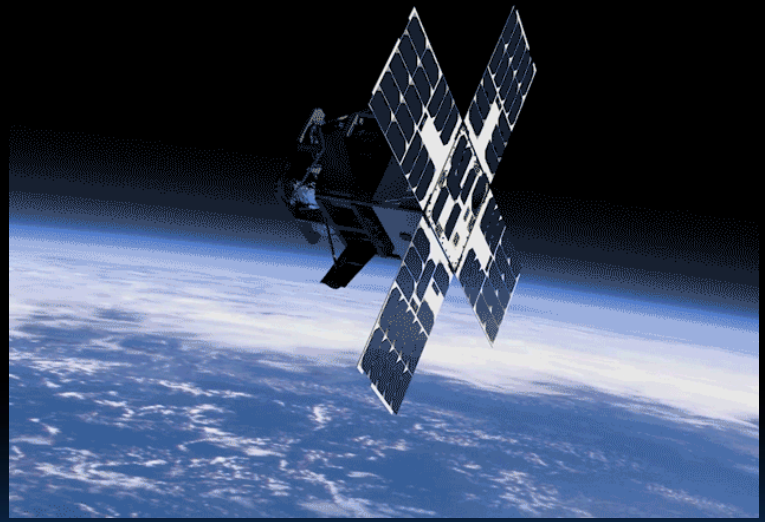
Craig D. Burkhard, Ph.D.
Deputy Director,
NASA Small Spacecraft Systems Virtual Institute

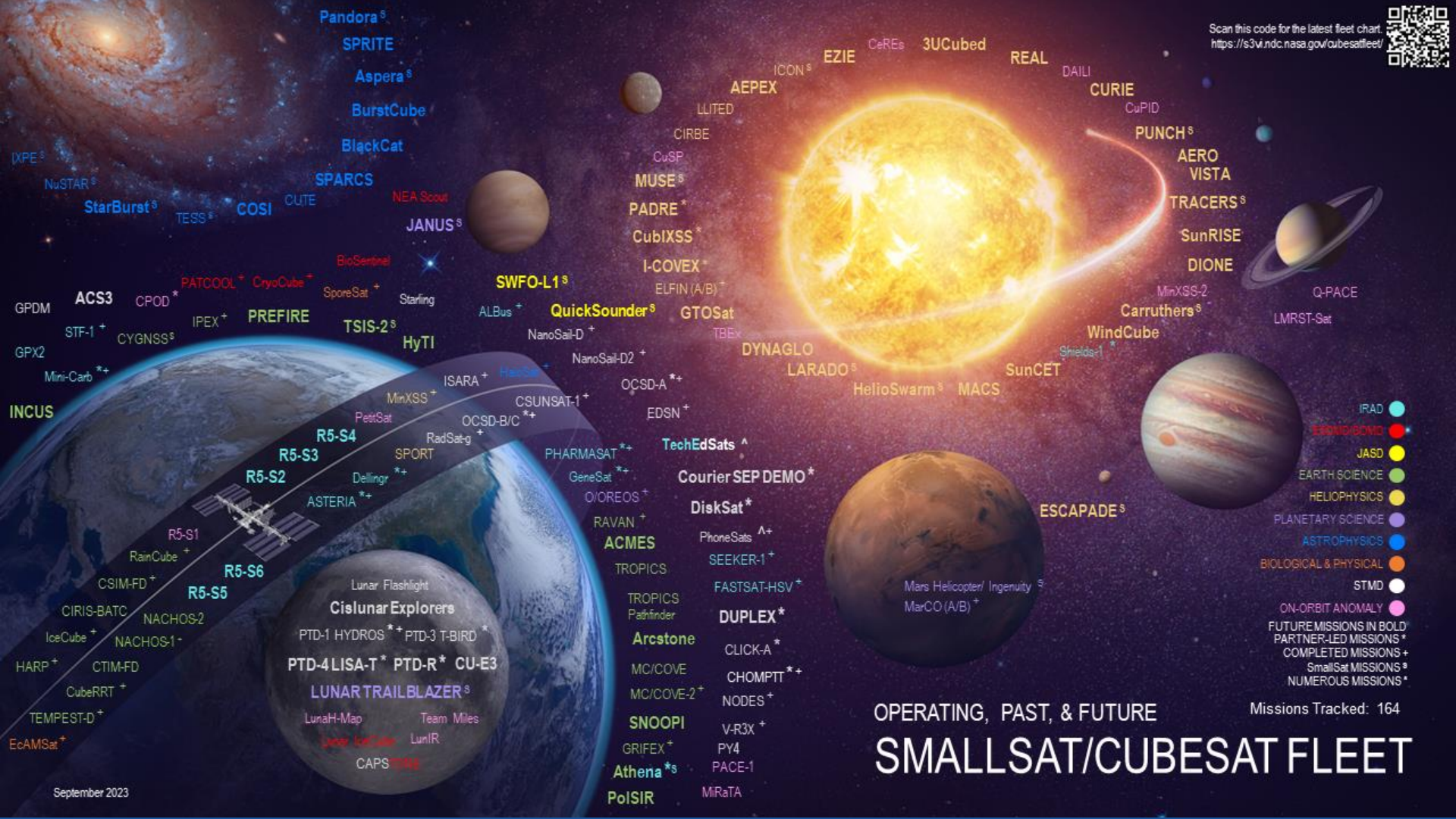
2024 4S Symposium
Palma de Mallorca, Spain, 27 May 2024

Presentation Overview

This presentation will focus on the following:

- Small Spacecraft Systems Virtual Institute (S3VI) Products and Activities
- Systems Engineering Webinar Series
  - Background
  - Registration Process
  - Content
  - Survey Responses
  - Archived Content
- Other Recent NASA Contributions to UNOOSA
- Future NASA/UNOOSA Webinars
- Acknowledgements




Scan this code for the latest fleet chart
https://s3vi.ndc.nasa.gov/cubesatfleet/
Pandora $
SPRITE
Aspera $
BurstCube
BlackCat
SPARCS
IXPE $
NuSTAR $
StarBurst $
TESS $
COSI
CUTE
NEA Scout
JANUS $
BioSentinel
SWFO-L1 $
EZIE
CeREs
3UCubed
REAL
ICON $
AEPEX
DAILI
CURIE
LLITED
CuPID
CIRBE
PUNCH $
CuSP
AERO
MUSE $
VISTA
PADRE *
TRACERS $
CubIXSS *
SunRISE
I-COVEX *
DIONE
ELFIN (A/B) +
MinXSS-2
Q-PACE
GPDM
ACS3
CPOD *
PATCOOL +
CryoCube +
SporeSat +
Starling
ALBus +
QuickSounder $
GTOSat
Carruthers $ *
LMRST-Sat
STF-1 +
IPEX +
PREFIRE
TSIS-2 $
NanoSail-D +
WindCube
CYGNSS $
HyTI
TBEx
GPX2
NanoSail-D2 +
DYNAGLO
Shields-1 *
Mini-Carb *+
OCSD-A *+
LARADO $
SunCET
ISARA +
HaloSat +
HelioSwarm $
MACS
MinXSS +
CSUNSAT-1 +
INCUS
PetitSat
OCSD-B/C *+
EDSN +
R5-S4
RadSat-g +
R5-S3
SPORT
TechEdSats ^
PHARMASAT *+
R5-S2
Dellingr *+
GeneSat *+
Courier SEP DEMO *
ASTERIA *+
O/OREOS +
DiskSat *
RAVAN +
R5-S1
PhoneSats ^+
ACMES
RainCube +
SEEKER-1 +
R5-S6
TROPICS
FASTSAT-HSV +
CSIM-FD +
R5-S5
TROPICS Pathfinder
DUPLEX *
CIRIS-BATC
NACHOS-2
Lunar Flashlight
Cislunar Explorers
Arcstone
IceCube +
NACHOS-1 +
PTD-1 HYDROS *+
PTD-3 T-BIRD *
CLICK-A *
HARP +
CTIM-FD
PTD-4 LISA-T *
PTD-R *
CU-E3
MC/COVE
CHOMPTT *+
CubeRRT +
LUNAR TRAILBLAZER $
MC/COVE-2 +
NODES +
TEMPEST-D +
LunaH-Map
Team Miles
SNOOPI
V-R3X +
EcAMSat +
Lunar IceCube
LunIR
GRIFEX +
PY4
CAPSTONE
Athena *$
PACE-1
PolSIR
MiRaTA
ESCAPADE $
Mars Helicopter/ Ingenuity $
MarCO (A/B) +
IRAD
ESSNO/BOMD
JASD
EARTH SCIENCE
HELIOPHYSICS
PLANETARY SCIENCE
ASTROPHYSICS
BIOLOGICAL & PHYSICAL
STMD
ON-ORBIT ANOMALY
FUTURE MISSIONS IN BOLD
PARTNER-LED MISSIONS *
COMPLETED MISSIONS +
SmallSat MISSIONS $
NUMEROUS MISSIONS ^
OPERATING, PAST, & FUTURE
Missions Tracked: 164
SMALLSAT/CUBESAT FLEET
September 2023

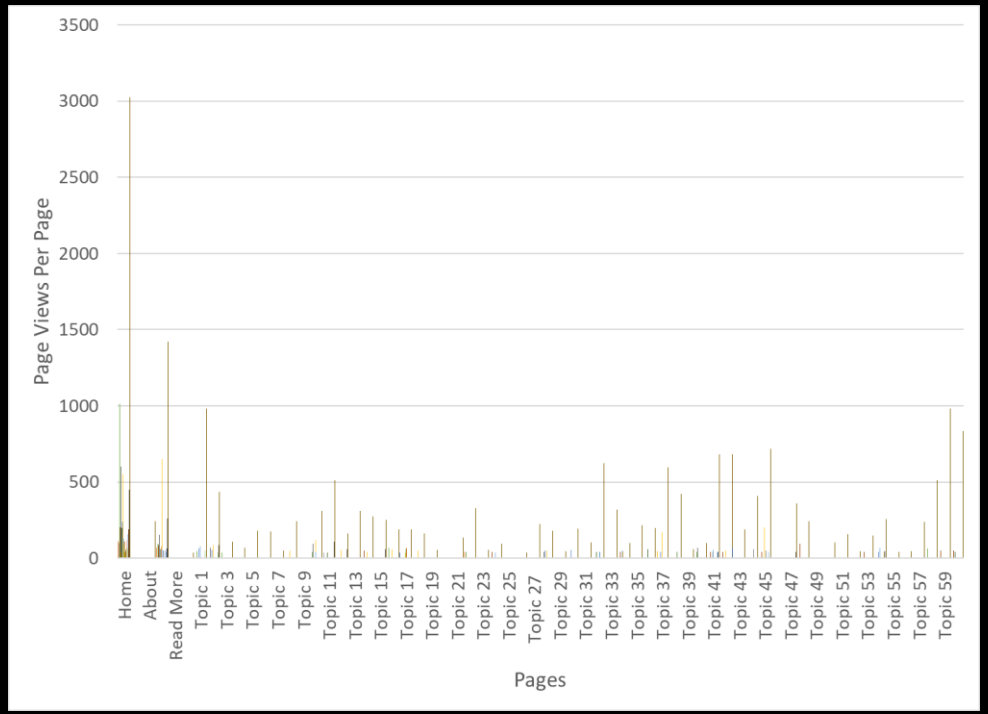
Small Spacecraft Systems Virtual Institute Products & Activities

The S3VI provides the SmallSat research community with access to mission enabling information and maintains engagement with small spacecraft stakeholders in industry, government and academia. The S3VI resources listed below are available to all at: https://www.nasa.gov/smallsat-institute/

- Community of Practice Webinar Series
- Small Spacecraft Reliability Initiative Knowledge Base Tool
- LaunchPortal
- Small Spacecraft Guidebooks
- United Nations Office of Outer Space (UNOOSA) Systems Engineering Webinar Series
- NASA Small Spacecraft State of the Art Report
- S3VI WebPortal
- Quarterly S3VI Newsletter
- Small Spacecraft Information Search
- Space Mission Design Tool Catalog

S3VI is sponsored by NASA's Space Technology Mission Directorate

Small Satellite Reliability Initiative (SSRI) KB Tool Page Views



- 31,100 pageviews from May 1, 2023 to April 30, 2024
- Top five viewed topic pages - United States: Mission Architecture Design, Thermal Vacuum, Bake Out, Thermal Cycling, and Shock Testing
- Top five viewed topic pages - International: Thermal Cycling, Mission Simulation and Analysis, Mission Architecture Design, Orbit Design and Analysis, and EMI/EMC Testing

Mission Architecture Design – 1
Mission Simulation and Analysis – 2
Planning for Mission Success – 3
Assembling a Team – 4
Scheduling – 5
Cost Estimating – 6
Reporting and Documentation – 7
Licensing and Regulations – 8
Orbit Design and Analysis – 10
ConOps Planning and Autonomy – 11
Mechanical and Thermal Design – 12
Material Selection – 13
Structural Analysis – 14
Thermal Analysis – 15
Mechanical Fault Tree Analysis – 16
Circuit Design – 17
Board Layout – 18
Part Selection – 19
Circuit Analysis – 20
Radiation Analysis – 21
Numerical Reliability Analysis – 22
Development – 23
Testing – 24
Timing Analysis – 25
Testing – 26
Development – 27
Attitude Determination and Control – 28
Propulsion – 29
Electrical Power – 30
Communications – 31
Command and Data Handling – 32
Electronics Manufacturing – 33
Mechanical Assembly – 34
Integration – 35
Day-in-the-Life Testing – 36
EMI/EMC Testing – 37
Accelerated Life Testing – 38
Electronics Functional Testing – 39
Single Event Effects Testing – 40
Total Ionizing Dose Testing – 41
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2023 Small Spacecraft State of the Art Report



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Country information from S3VI webportal usage data as obtained from Google Analytics May 1, 2023 to April 30, 2024

The Institute Reaches Individuals in Roughly 170 Countries

Small Satellite Systems Engineering Webinar Series Background

The National Aeronautics and Space Administration (NASA) and the United Nations (UN) have worked together since NASA's inception in 1958, most actively with the United Nations Office for Outer Space Affairs (UNOOSA) and the UN Committee on the Peaceful Uses of Outer Space.

This has been a productive partnership that has allowed NASA to expand its global reach and encourage countries to behave responsibly and practice peaceful use in the exploration of outer space.

The Small Satellite Systems Engineering Webinar Series is one of many examples of this enhanced cooperation between the two organizations. After reviewing an extensive list of areas for possible collaboration, the topic of systems engineering was determined to be an ideal initial theme as it would fill an existing knowledge gap for many teams from developing countries while addressing a topic of mutual interest between NASA and UNOOSA.

Webinar Series Application and Selection Process

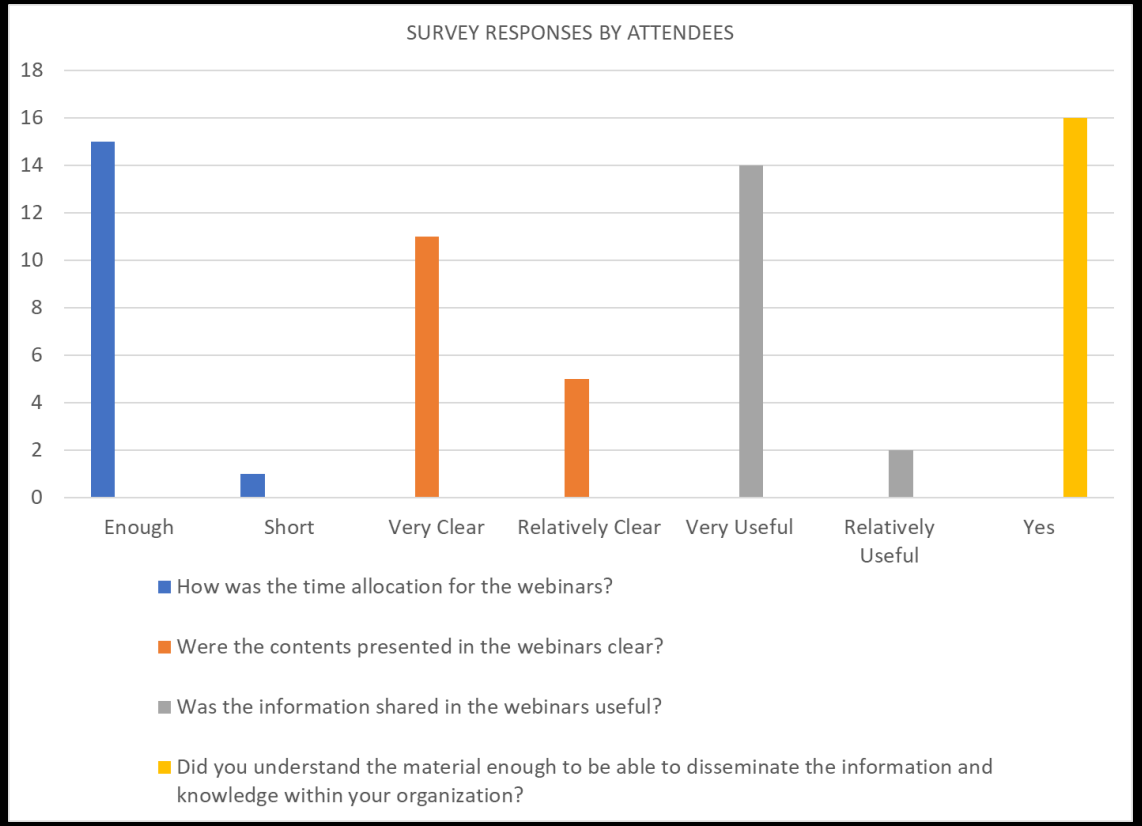
- UNOOSA advertised the webinar series via its network with the intent to create a diverse, equitable, and inclusive application pool.
- In order to facilitate an interactive classroom environment, NASA and UNOOSA aimed to select 50 to 75 applicants.
- The registration also noted that applicants would be chosen based on relevant professional or academic experience as well as information related to how they intended to use the information and knowledge obtained.
- Priority would also be given to participants from government organizations, research institutes, universities, and other public and not-for-profit organizations of developing economies and economies in transition that are Member States of the United Nations.
- UNOOSA received 888 applications from individuals around the world, with a wide variety of backgrounds ranging from undergraduate students to directors of research entities with advanced degrees in systems engineering.

Webinar Series Content

The webinar series were segmented into 90-minute webinars covering topics related to:

- The Fundamentals of Systems Engineering
  What is Systems Engineering and what does a systems engineer do? What are the elements of managing a small spacecraft project? Why does NASA use systems engineering? What are the roles and responsibilities of a systems engineer? What are the elements of a project's life cycle phases?
- Requirements and Systems Engineering
  How do you define requirements for a small spacecraft? Why are requirements important to space missions? How are trade studies used to determine parts selection and why it is important?
- Systems Assembly, Integration and Test, and Spacecraft Handling
  What are the elements of system assembly, integration and test, and spacecraft handling? What are the various steps involved for each? Why is it important to a space mission?
- Introduction to the Small Spacecraft Systems Virtual Institute (S3VI)
  This presentation provided the attendees with information and knowledge of available resources and where to find it to support the design and development of their own small satellite missions.

Webinar Series Attendee Feedback



Positive Feedback Received Based on Attendees Survey Responses

Webinar Series Attendee Feedback Summary

What did you learn through Session 1?

"The processes of mission planning, development, integration and testing were explained in a clear way that can be applied to future nanosatellite missions from South America."

What did you learn through Session 2?

"I think that it was a good talk to clarify a series of fundamental steps to make an optimal requirements definition and I will use this topic to perform new schemes of requirements in the fields of spacecraft operations."

What did you learn through Session 3?

"During the 3rd webinar, I learned about a small spacecraft project, subsystem components of a small spacecraft, and the systems assembly, integration, and testing with the AITS, test plan and types of tests, as well as how to use safe spacecraft handling and the different steps involved. The importance of a space mission. It was also included with experience shared from NASA's projects has big implications for my future career and project implementation."

What did you learn through Session 4?

"Gaining insights from the NASA Small Spacecraft Systems Virtual Institute introduction. I'm refining my approach. By assimilating key principles, I aim to enhance project strategies, fostering efficiency, innovation, and collaboration initiatives. Excited to apply these learnings and contribute to the advancement of small spacecraft systems through collaborations, particularly with fellow African countries."

Webinar Series Attendee Feedback Summary

What other activities and/or themes for webinars would you like to see from UNOOSA and NASA?
On-site training, practical, and hand-on experience sharing, collaborative robotics/other STEM related topics, possible practical collaborations and mentorship programs.

What did you wish to learn that was not covered in the webinar series?
"*Learning some real demo from initial design up to the launching stage, how to apply Model Based Systems Engineering (MBSE) techniques in small satellite systems engineering, and would like to know about the processes that ended with a spacecraft proposal."*

Do you have any overall comments/recommendations/observations about the webinar series?
"It was perfect, good learning opportunity; it was very interesting, wonderful, interactive and I look forward to the next upcoming webinars" and "I want to thank NASA and UNOOSA for offering this great opportunity to close the gap for developing countries that want to establish their own space programs."

Webinar Series Content - Archived

- The Small Satellite Systems Engineering Webinar Series presentations were recorded and posted as well as the presentation charts for the community to view.

- Since November 1, 2023, and as of April 30, there have been a total of 243 content views.

- The archived webinar series content is open to the public. For more information see the links below.
  - https://www.nasa.gov/smallsat-institute/systems-engineering-series/
  - https://www.unoosa.org/oosa/en/ourwork/access2space4all/NASA.html

Webinar Content is Archived and Available for Viewing

Other Recent NASA Contributions to UNOOSA, Including

Capacity Building Program:
Provides workforce development, training activities and collaborative projects for Earth observations

Summit of the Future:
Plans to highlight the importance of NASA's space-based activities and how they contribute to Sustainable Development Goals

Space4Youth:
Partners with UNOOSA and U.S. Mission to International Organizations in Vienna to provide opportunities to the winners

Pale Blue Dot:
Visualization Challenge – Competition: Collaboration with UNOOSA and U.S. Mission to the International Organizations in Vienna to promote visualization using Earth observation data that advances the UN Sustainable Development Goals of zero hunger, clean water, and climate action.

UN Space4Women:
Provides mentors to this project that encourages women and girls to pursue STEM education in the space sector

Systems Engineering Webinars:
Provides small satellite systems engineering content for developing countries to have knowledge of developing missions

Planetary Defense: NASA and UNOOSA provide experts for discovering, monitoring, and physically characterizing the potentially hazardous near-Earth objects

UN Space for Water Project:
Promotes the use of space-based technologies for increased access to water

Climate:
Provides the world with science and space-based data required to understand, mitigate, and adapt to the changing planet

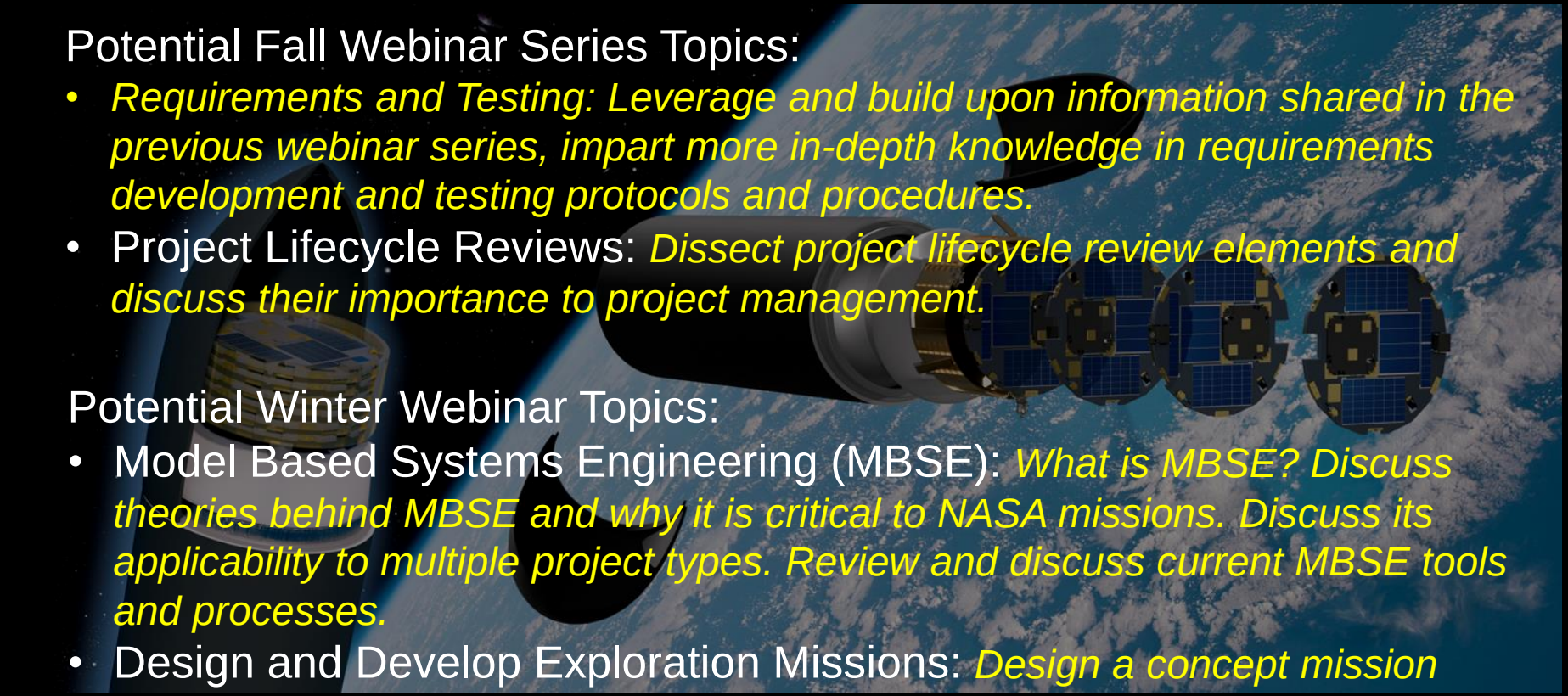
UN-SPIDER
Provides disaster management and resilience through Space-based Information for Disaster Management and Emergency Response

STEM-Focus Activities

Technology-Focus Activities

NASA Continues to Expand and Enhance Collaborations with UNOOSA

Future NASA/UNOOSA Webinar Series



Potential Fall Webinar Series Topics:

- *Requirements and Testing: Leverage and build upon information shared in the previous webinar series, impart more in-depth knowledge in requirements development and testing protocols and procedures.*
- Project Lifecycle Reviews: *Dissect project lifecycle review elements and discuss their importance to project management.*

Potential Winter Webinar Topics:

- Model Based Systems Engineering (MBSE): *What is MBSE? Discuss theories behind MBSE and why it is critical to NASA missions. Discuss its applicability to multiple project types. Review and discuss current MBSE tools and processes.*
- Design and Develop Exploration Missions: *Design a concept mission applying various processes and tools described over the course of this series.*

Acknowledgements

The authors of the paper and accompanying presentation would like to extend their sincere appreciation to the following individuals who helped to make the Small Satellite Systems Engineering Webinar Series come to fruition and become a huge success:

- UNOOSA: Hazuki Mori, Allison Areias, Nathalie Ricard and Mami Sasamura

- NASA Ames Research Center: Sonja Caldwell and Ricky Guest

Appreciation To Those Who Supported The Webinar Series

QR Codes to S3VI Products

FLEET CHART

2023 SMALLSAT STATE OF THE ART

SSRI KNOWLEDGE BASE TOOL

INFORMATION SEARCH

COMMUNITY OF PRACTICE WEBINAR SERIES

SYSTEMS ENGIEERING WEBINAR SERIES

Questions?



www.nasa.gov/smallsat-institute/

craig.d.burkhard@nasa.gov