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COSMIC

CONSORTIUM FOR SPACE MOBILITY AND IN-SPACE SERVICING, ASSEMBLY AND MANUFACTURING (ISAM) CAPABILITIES

2024 COSMIC CAPSTONE CHALLENGE INFORMATION PACKET

Design a payload, to be hosted about the BCT X-Sat Venus Class bus, that will demonstrate a chain of three or more operations that provide an on-orbit, autonomous ISAM capability.

REVISION AND HISTORY PAGE

Revision No.	Description	Release Date
Baseline	Initial Baseline	7/10/2024
B	Updated schedule, links and design guidance	01/28/2025

Contents

1. Executive Summary: The 2024-25 COSMIC Capstone Challenge

Design a payload, to be hosted about the BCT X-Sat Venus Class bus, that will demonstrate a chain of 3 or more **operations** that provide an on-orbit, autonomous ISAM **capability**.

2. Description

The Consortium for Space Mobility and ISAM Capabilities (COSMIC) was established in 2023 by NASA in response to the Office of the President's call for a national strategy for in-space servicing, assembly, and manufacturing (ISAM). One COSMIC focus area is Workforce Development, which includes inspiring the next generation of engineers, artists, and visionaries to contribute to ISAM. The COSMIC Capstone Challenge (C3) is a design competition taking place over the course of an academic year for students of US-based educational institutions and can be adapted for a variety of in-class and out-of-class options.

The competition is open to teams of students from any **US-based educational institution**. Many of the entrants will be seniors as part of their senior design class, often known as Capstone. The project can also be pursued by students pursuing independent study, as a team of students in a lab, or a student club. Teams can also be formed across universities, and it is open to high school students.

The challenge is to design a payload, to be hosted about the BCT X-Sat Venus Class bus, that will demonstrate a chain of three or more operations that provide an on-orbit, autonomous ISAM capability. The goal is to engage in **the early design work necessary for a complex ISAM mission** that could be ready for launch by the end of the decade. It is explicitly a Conceptual Design challenge, distinguishing it from competitions that focus on building a product for demonstration or creating detailed design work sufficient to begin manufacturing. These concepts are the starting point for ambitious satellite missions. Some of these concepts may be continued post-competition, either by the entrants themselves or other entities (academic, industrial, or government) to fund further development. Mentors, judges, speakers, and other COSMIC members will provide guidance on how to further extend their work.

The C3 competition begins in July, when universities are encouraged to register their interest. Teams are encouraged to sign-up early as **registration closes October 14**. After registering, teams will be assigned a mentor from industry, government, or a nonprofit research institution engaged with ISAM. Mentors will provide guidance to the students through weekly meetings, identifying problems and guiding students toward solutions. While recommended milestones are listed the only required deliverable is the final outbrief in mid-April at the C3 Final Showcase accompanied by a technical paper. The judge's scores will be based almost entirely on the 25-minute out brief (with 5 minutes reserved for questions), so crispness of presentation is essential. The presentations will be mostly virtual with in-person options at The Aerospace Corporation in El Segundo, California and possibly other sponsor locations.

The 2024-25 challenge was developed in response to the **national ISAM strategy calling for development orbital manufacturing capabilities** across the country and promoting **workforce**

development. Engineers have worked to identify and advance technologies important for orbital manufacturing. Many technologies have been demonstrated terrestrially and on-orbit, with more in the works. These technology advances pave the way for larger, more complex payloads which are in the early stages of development as follow-on work. Conceptually designing those payloads is the 2024-25 C3 topic. This project does not stand alone. The hope is that some of these projects develop into funded missions, and the successful missions help pave the way for the future of manufacturing in space. For more information, visit: https://COSMICSpace.org/C3 or contact C3-COSMIC@aero.org.

3. Request for Proposal

Create a conceptual design for a payload, to be hosted about the BCT X-Sat Venus Class bus, which will demonstrate a chain of three or more operations that provide an on-orbit, autonomous ISAM capability.

3.1 Definitions

- An **operation** is defined as an action or set of actions performed by a single device. Examples of operations are listed below.
  - Polymer extrusion
  - Moving a part
  - Generating or receiving a diagnostic signal
  - Cutting, bending, grabbing, and dispensing
  - Determining minimum distance between two satellites in proximity
- A **capability** is a chain of operations that, when performed together, perform a useful function. Examples of capabilities are listed below.
  - Extruding polymer, moving the nozzle on a gantry, and removing finished part from a build plate
  - Generating an ultrasound signal without contact, listening for the signal after it passes by an inspection target, and interpreting that signal to evaluate the target part
  - Determining minimum distance between two satellites, producing movement so they are in near contact, and establishing physical contact without affecting attitude
  - More broadly, operations could be inspections, manufacturing, assembly, refueling, debris removal, and other servicing operations
- The **BCT X-Sat Venus Bus**
  - Available volume: 20.5” x 16.4” x 27.0” (single solar array) or 17.0” x 16.4” x 27” (dual solar array)
  - Payload mass capability: 70kg
  - Solar array power: 222W (single array) or 444W (dual array)
  - Energy storage: 10.2 Ah
- Autonomous means it should operate on its own with limited remote commands
  - Since the phrase “limited remote commands” is subject to interpretation, teams should describe and justify their expected level of remote interaction. Initiating a sequence, confirming alignment before operation, interrupting an operation or proceeding to the next step are clear examples of “limited remote commands.”

3.2 Deliverables

Categories, prizes, and the overall classification structure will be announced in Spring 2025

1. Judging will be based upon a 25-minute briefing that comprises 95% of the score at the C3 Final Showcase
2. A 10–20-page technical paper will account for 5% of the final score
3. There is an optional category for the best functional prototype which does not count toward the final score, and the top prototype entry will be recognized

3.3 Elements of the Conceptual Design

- The payload should be designed for the BCT X-Sat Venus Class bus.
- It needs to demonstrate three or more operations to demonstrate an orbital ISAM capability.
- The payload should be designed to autonomously with limited remote commands
- Key design elements
  - The payload design should consider the entire mission lifecycle, from launch to deorbit.
  - Consideration should be given to known loads and environmental factors; this includes operating in vacuum, operating in microgravity, how it will be operated, and designing to survive launch loads.
  - The team should describe the expected operating duration.
  - The design should be captured using CAD software that can display essential views required to explain the process and concept of operations for this design.
  - A rough bill of goods required to build and integrate the payload should be included in the C3 Final Showcase presentation.
  - Analysis is required to sufficiently determine if a design is feasible, can survive launch, can operate successfully in a LEO environment, and can meet the BCT X-Sat Venus Class bus specifications.

The following describes the judging rubric.

1. The presentation must describe in sufficient detail the design to understand the following:
    1. Technical impact of demonstrated capability.
    2. Feasibility of Prototype mission.
    3. Innovativeness of the payload design.
    4. Adherence to the design requirements.
    5. Identification and mitigation of risks associated with the design.
    6. The recommended path to proceed to a Preliminary Design Review (PDR).
    7. Summary of trade studies that help illustrate the design development.
2. Describe the Concept of Operations from launch to deorbit:
    1. Create a storyboard of the complete operation.
    2. Animate one or more key operating sequences.
    3. Generate a high-level overview of data handling and ground communications
    4. Document achievement of key milestones
3. List key lessons learned during the project:
    1. Three innovate ideas that were shared, even if not pursued.
    2. Three technologies most important to develop for this demo or other ISAM activities.
    3. Three biggest challenges encountered, even if avoided.
4. The work should be well defined and clearly described
    1. Make a professional, concise, understandable presentation at the C3 Final Showcase
    2. Write a 10–20-page technical paper that would be appropriate for at least an engineering conference, journal, engineering magazine, etc. The deadline for submitting an extended abstract to AIAA SciTech is typically in late May. While optional, it accounts for 5% of the score and builds good experience.

Opt. There is an **optional** category for the Best Functional Prototype. This is not required and will not be considered in judging the winners, except as a tool to illustrate the Conceptual Design. The team with the best functional prototype will be recognized with a distinct recognition.

4. Timeline

4.1 Key dates for universities & other educational institutions

- July 1, 2024: C3 University/ team registration opens
- August 5, 2024: Preferred registration deadline (to enable C3 organizers to match mentors and teams)
- September 30, 2024: Late registration deadline

4.2 Key Dates for Students (week of)

- September 9, 2024: Live on-boarding session for teams and mentors (recorded for later viewing)
- October 14, 2024: Deadline to register your team for the COSMIC Capstone Challenge
- December 9, 2024: **Midpoint showcase** and announcement of divisions and possible prizes
- April 14, 2025: **Presentation and judging** at C3 Final Showcase (winners announced the following week)
- Post-event survey must be completed for award eligibility

4.3 Key milestones & recommended completion dates for student teams

- Dates based upon 2 semesters spanning 9/3/2024 – 5/2/2025, and may be adjusted for other timeframes
- September 16, 2024: Identify who on the team will serve as program manager
- October 14, 2024: Select operations to form the foundation of the target capability
- November 15, 2024: Present Systems Requirements Review (SRR) to peers, mentor & advisor
- January 13, 2025: Complete trade studies
- March 3, 2025: Present Conceptual Design Review to peers, mentor & advisor
- April 1, 2025: Develop a plan to reach Preliminary Design Review
- Late May 2025: Submit paper to technical conferences (such as AIAA SciTech Abstracts)

4.4 Key dates for organizers, mentors, judges, and sponsors

- July 1, 2024: Mentor registration opens
- July 2024: Socializing C3 at COSMIC meetings, at ISSRDC, and through university & high school networks
- August 5, 2024: Preferred mentor registration deadline (enable C3 organizers to match mentors & teams)
- Week of September 9, 2024: Live on-boarding session for teams and mentors
- September 30, 2024: Late mentor registration deadline
- October 1, 2024: Judge registration opens
- November 1, 2024: Deadline for sponsors to offer prizes
- Week of December 9, 2024: Midpoint showcase and announcement of categories and any prizes
- February 2025: Send Out Schedule Survey (to begin planning C3 Final Showcase agenda)
- March 2025: Judge registration closes
- March 2025: Establish agenda for presentations & judging assignments
- March-April 2025: Judge orientation/on-boarding

- April 14, 2025: Presentation and judging at C3 Final Showcase (winners announced the following week)
- April 14, 2025: Send out post-event survey to judges, mentors, advisors, and students

4.5 Recurring events

- COSMIC will host weekly office hours for ask questions & guidance beginning week of August 19
- Meet with industry mentors on weekly or biweekly basis
- COSMIC-hosted monthly ISAM seminars

5. Expectations

5.1 Expectations for students

- Contact mentor to set up weekly or biweekly meetings & act professionally in those interactions
- Read through this entire C3 Information packet at start of project
- Review reference documents
- Reach out to mentors, academic advisors, and C3 committee as appropriate with questions
- Complete all required classwork, even if it is not required for C3
- Address & document key milestones from Timeline page
- Eligibility: all members enrolled at a US-based college or high school
- Complete post-event survey

5.2 Expectations for professors & other academic advisors (or team lead for clubs, etc.)

- Sign up for C3 on website by August 5 (preferred) and no later than September 30
- Direct students to contact mentor
- Reach out to C3 committee with questions about the program
- Help students form teams as: part of a class, for a student club, or as independent study
- For design classes, grades based upon the school's own criteria
- Do not use C3 scores as a proxy for grades

5.3 Expectations for mentors

- Meet 2-4 hours monthly with students (at least biweekly)
- Serve as the ISAM expert for the students, and direct them to appropriate resources
- Contact C3 committee if there are team issues and with other questions
- Treat the students as junior engineers; encourage them to be innovative
- Do not share export-controlled or proprietary information with teams
- Support, encourage and advise students
- Are not responsible for evaluating individual students or the team
- Complete post-event survey

5.4 Expectations for C3 committee

- Provide clear guidelines to all stakeholders
- Be available on a daily basis for email & weekly basis for verbal communications from July 1 onward
- Maintain a compelling program throughout the academic year & incorporate feedback from stakeholders

5.5 Expectations for judges

- Attend judging onboarding brief, which includes overview of ISAM and objective of C3
- Spend 1 or more days listening to presentations & scoring entries
- Do not mentor any of the teams
- Review the C3 Information Packet & score sheets before the C3 Final Showcase

6. Reference Documents

About ISAM & related technologies

- COSMIC ISAM 101
- NASA ISAM overview

Technology assessment and development roadmaps – required reading

- "In-Space Servicing, Assembly and Manufacturing Strategy," National Science & Technology Council. April 2022
- "In-space Servicing, Assembly, and Manufacturing (ISAM) State of Play," Dr. Dale Arney, John Mulvaney, Christina Williams (NASA Langley Research Center), Dr. Richard Sutherland, Christopher Stockdale (Analytical Mechanics Associates, Inc.)
- "Technology Roadmap for the Development of an Orbital Smallsat Factory," Matthew B. Obenchain, Jacob Rome, Chris Hartney, Kelvin Chen, Alejandro Trujillo, Arianna Villegas, Vinay Goyal, Jon Strizzi and Deneen Taylor. AIAA 2024-1274. AIAA SCITECH 2024 Forum. January 2024. https://doi.org/10.2514/6.2024-1274

Exemplar ISAM missions

- NASA OSAM-1
- DARPA Orbital Express
- Northrop Grumman Mission Extension Vehicle

Partial selection of technologies that would benefit on-orbit demonstration

- Low SWaP Robotics.
  - "Very Low SWaP-C Robotics Using Autodynamic Flexible Circuits," Fuller.
- Ultrasound for non-contact NDE
  - "Laser ultrasonics for nondestructive testing of composite materials and structures: A review," Alireza Zarei, Srikanth Pilla, Ultrasonics, 136, 2024, 107163, https://doi.org/10.1016/j.ultras.2023.107163.
- Thermography for non-contact NDE
  - "Application of NDT thermographic imaging of aerospace structures," Shakeb Deane, Nicolas P. Avdelidis, Clemente Ibarra-Castanedo, Hai Zhang, Hamed Yazdani Nezhad, Alex A. Williamson, Tim Mackley, Maxwell J. Davis, Xavier Maldague, Antonios Tsourdos, Infrared Physics & Technology, Volume 97, 2019, 456-466, https://doi.org/10.1016/j.infrared.2019.02.002
- Snap-fit connectors for permanent or temporary structural joining techniques
  - "Design Guidelines for Additive Manufactured Snap-Fit Joints," Procedia CIRP, Volume 50, 2016, Pages 264-269 https://doi.org/10.1016/j.procir.2016.04.130
- Electro-permanent magnets
  - "Safe, Failure-Tolerant CubeSat Docking Using Passive Magnetic Mechanisms," Kyle P. Doyle* and Mason A. Peck. AIAA SciTech Forum 10.2514/6.2017-0614 9 - 13 January 2017. https://arc.aiaa.org/doi/pdf/10.2514/6.2017-0614.
- Wire embedding in a polymer matrix

- "Ultrasonically Embedded Wires in Multi-Material Parts Produced by Hybrid Additive Manufacturing," David A. Sepulveda-Navarrete, Patrick S. Gutierrez, Amit Lopes, Jacob I. Rome, Vinay K. Goyal, David Espalin, Additive Manufacturing, Volume 73, 2023, 103662, https://doi.org/10.1016/j.addma.2023.103662.

About the COSMIC Capstone Challenge

- "Overview of the ISAM Design Challenge and Competition," Jacob Rome and Vinay Goyal. AIAA 2024-0628. AIAA SCITECH 2024 Forum. January 2024. https://doi.org/10.2514/6.2024-0628.
- "Orbital Manufacturing Initiative," Rome (SSDM).
- LinkedIn Group.

Example projects

- University of California San Diego: Autonomous Rail Transportation Network for Spacecraft Servicing and Inspection.
- Kennesaw St.: "Conceptual Development Design Challenge of On-Orbit Autonomous Manufacturing Payloads," Goyal (contact C3-COSMIC@aero.org to request a copy).

Design review templates

The first reference listed is **required reading**. The others are provided for students as guidelines for conducting reviews and planning the work. They are meant to be descriptive not prescriptive.

- "Introduction to Conceptual Design," Lee
- "NASA System Requirements Review Template," Benedict
- "NASA System Concept Review Template," Benedict
- "EML2322L – Design Report Template," University of Florida

Program Management

- NASA Research and Technology Program and Project Management Requirements (Revalidated w/change 5) NPR 7120.8A
- NASA Systems Engineering Processes and Requirements Updated w/Change 2. NPR 7123.1D
- Videos and classes:
- Project Planning for Beginners: https://youtu.be/ZWmXi3TW1yA?si=toydKiVnwEZH572Z
- Project Management Fundamentals from Coursera

Host Vehicle

This vehicle was chosen to provide all teams with a common starting point. Other companies offer similar host capabilities, either as a satellite bus or a persistent platform.

- About Blue Canyon Technology satellite buses
- BCT Venus-class bus datasheet

Other Design Competitions

Links are provided to other competitions to spark ideas amongst students as they pursue their design projects. While most of the competitions focus on building prototypes, many have solid university-appropriate guidelines on how to progress through the design process.

- AIAA Design/ Build/ Fly
- Formula SAE
- 3D Printed Aircraft Competition
- American Solar Challenge
- Revolutionary Aerospace Systems Concept Academic Linkage (RASC-AL)
- Intelligent Ground Vehicle Competition
- NASA Student Launch Initiative

7. Vision For the Future of the COSMIC Capstone Challenge

The genesis of C3 was the ISAM Design Challenge starting in Fall 2022, a senior design project developed by Aerospace to harness the creativity of college students while introducing them to the emerging ISAM field. It evolved during the past two years, and with the creation of C3, the structure has become better defined and formalized. The design challenge has been crafted with input from industry mentors, government customers, capstone professors, competition organizers and student participants. During the first year of C3, the focus is running the program well for the participants and getting it off the ground successfully so it can be sustained and grow in the future.

To that end, C3 has been developed to ease its adoption within the construct of a **2-semester senior engineering design class**, often referred to as a Capstone project. However, **it is not restricted to that category**. Instead, it is being opened wider, so that student clubs could enter the challenge, as could groups of students, undergraduate, graduate or even high school, pursuing independent or directed study. The best outcome of these projects will be an excited core of students that want to continue the project past the conceptual design phase to detailed design work or even prototyping.

There is a strategic component to casting it as a judged competition with mentoring. To be precise, the judges and mentors will often be drawn from elements of the government and industry that are interested in pursuing these projects. **The successful version of this program would connect student teams with funding sources to continue the work towards an eventual mission,** executed either by a successor team at the university or by contractor capable of executing the designated mission. This is an element that could play well with student clubs, which typically have carryover from year-to-year. It is possible that a future iteration of C3 will be to bring a promising Conceptual Designs to the Preliminary Design phase, in which case student clubs would be able to leverage that continuity to continue.

For the coming academic year, the competition is focused on the engineering part of the problem. In future iterations, the **scope may be widened to encourage non-engineering students with an interest in ISAM to participate**. This could be done through the problem statement, through the judging rubric, or via additional categories. For example, up to 10 points could be awarded for developing a business plan to identify how the project would go from Conceptual Design through launch by identifying funding sources, launch opportunities, and long-term project management. A similar approach could take place for artwork. Or there could be a separate award for the team that creates the best 1-page marketing pitch to potential sponsors.

C3 is very much a work in progress. The development of the program in the future will be guided by mentors, judges, other members of the COSMIC community, students, professors, and supporters. The community will develop Future C3 Information Packets, and it is the intent of COSMIC to appeal to a broad swath of students as we work to advance ISAM while exposing students to the possibilities of ISAM.

8. Administrative Items

- COSMIC has no rights to any intellectual property (IP) generated during this project, with a limited permission to share the final products as described in the next bullet.
- Entrants grant the COSMIC Capstone Challenge (C3) organizers a non-exclusive right to:
  - Post online the outbriefs from the competition online to share them with the COSMIC membership and (past, current, and future) participants in the COSMIC Capstone Challenge
  - To allow C3 organizers to incorporate elements into written publications, briefings and marketing materials that would be available to the public.
- There is no guarantee of monetary prizes being awarded. If there are any prizes awarded by C3 sponsors, the prize is the sole responsibility of the sponsors.
- All C3 judges and mentors must be authorized participants from a COSMIC member organization; COSMIC is no cost to join, and open to any US organization.
- Any authorized participants from a COSMIC member organization may serve as a mentor or a judge but cannot serve as both a mentor and a judge. Mentors may serve that role for multiple teams. C3 organizers may fulfill either judge or mentor roles if required, but no organizer will serve in both roles.
- If C3 is used as a Capstone, scoring criteria used in this solicitation is not required to grade students. It is up to the discretion of the professor to select class grading material. Likewise, mentor feedback should not have direct impact on student grades.
- There is a strict no-harassment policy.
- All participants (entrants, judges, and mentors) must abide by ITAR rules. Mentors must not provide any information to any team that is ITAR controlled, and student entries must not include any ITAR restricted materials.
- While entrants must be enrolled at a US-based educational institution, there is no citizenship requirement for any student members of participating teams or their advisors.
- COSMIC membership is not required for teams or their associated educational institutions to enter.

9. COSMIC Capstone Challenge 2024

Design a payload, to be hosted about the BCT X-Sat Venus Class bus, which will demonstrate a chain of 3 or more operations that provide an on-orbit, autonomous ISAM capability.

Scoring Sheet of Competition Judging

Team Name: _____

Team Organization: _____

Team Members: _____

_____

_____

Judge's Name: _____

Date: _____

Category 1: Conceptual Design			
Subcategory	Description	Score Range	Score (½ OK)
1.1 Technical Impact of Demonstrated Capability	If the prototype is successfully demonstrated, how much impact would those capabilities have for future space missions? Consider the following 3 questions: Would it enable new or improved types of spacecrafts? Could it be used to augment or repair existing satellites? Would other technology developments be required for this capability to be useful?	0-9	
1.2 Feasibility of Prototype Mission	How likely is it that this prototype (if funded) could be designed & built by the end of the decade? Evaluation of these items should be considered when scoring this category: the bill of materials, current CAD drawings, plans to develop technology as needed, approach for manufacturing and testing the prototype.	0-8	
1.3 Innovation	Is the design original in an inventive, pertinent way? Scoring considerations for this category: Has this ever been demonstrated in space before? Has it ever been proposed? Has it been executed in a similar fashion? Is it uniquely useful for on-orbit operations?	0-8	
1.4 Completion of Required Elements	Is there analysis to show that the design conforms to requirements & perform per requirements? Five elements to consider: Will it fit within the assigned volume, staying within mass and power requirements? Will the proposed bus support the operations; if not has the team identified potential solutions? Does the design consider the launch environment? Does the design demonstrate a useful capability by combining/ sequencing 3+ technologies? Is the appropriate type of analysis performed?	0-10	
1.5 Identify & mitigate risks	Has the team identified likely points of failure and identified potential solutions?	0-5	
1.6 Path to PDR	Has the team identified the next steps in the design process & created a sequenced outline to advance to Preliminary Design Review?	0-5	
1.7 Trade Studies	Has the team highlighted trade studies to illustrate the design development & selection process?	0-5	
Category Total	Conceptual Design	0-50	

For the Concept of Operations and Lessons Learned categories, teams should clearly identify within their briefings where these elements are included. For example, the subcategory name could be the title of the slide, with the requested item(s) below. These slides should remain on display long enough for judges to comprehend and evaluate.

Category 2: Concept of Operations			
Subcategory	Description	Score Range	Score (½ OK)
2.1 Animate key operating sequence	Utilizing CAD designs, a prototype, or other tools, develop an animation or video to show step by step processes required to execute concept design.	0-8	
2.2 Storyboard of complete operation	At each phase of a mission (from launch until deorbit), illustrate and describe the varying configurations and operations the concept will progress through over the mission's duration.	0-8	
2.3 Data handling & comms	Develop a high-level overview/flowchart of data management and ground communications needs	0-4	
2.4 Systems Engineering Milestones	Did the team provide evidence that they hit the key milestones: Selecting a program manager, selecting operations, presenting SRR, completing trade studies, presenting CoDR, develop path to PDR?	0-6	
Category Total	Concept of Operations	0-26	

Category 3: Lessons Learned			
Subcategory	Description	Score Range	Score (½ OK)
3.1 Innovative concepts	What are the three most innovative ideas you had? Even if they weren't pursued.	0-3	
3.2 Tech. gap assessment	Identify 3 technologies as most important to develop for this effort.	0-3	
3.3 Biggest challenges	The three biggest challenges with the design process, even if you avoided them.	0-3	
Category Total	Lessons Learned	0-9	

Category 4: Presentation and Paper			
Subcategory	Description	Score Range	Score (½ OK)
4.1 Presentation	Clarity, professionalism, and persuasiveness of the presentation, including visual aids and verbal communication. Consider these 5 key elements: Chart construction, verbal explanations, cohesiveness, proper use of white space, handling of questions.	0-10	
4.2 Paper	A paper ten-to-twenty pages long which would be suitable for inclusion in a technical conference. Consider elements such as length, organization, technical content, writing, and bibliography	0-5	
Category Total	Presentation and Paper	0-15	

Summary			
Category	Description	Score Range	Score (½ OK)
1.	Conceptual Design	0-50	
2.	Concept of Operations	0-26	
3.	Lessons Learned	0-9	
4.	Presentation and Paper	0-15	
Grand Total	COSMIC Capstone Challenge	0-100	
Opt. Prototype	If the team opted to create a functional prototype, provide a score based upon its function and performance	0-10	

Team Name: _____

Judge's Name: _____

Total Score: _____

10. Frequently Asked Questions & Updates

1. What has changed from the original C3 Information Packet?
    a. The C3 Information Packet has been effectively frozen as of July 8, 2024. The only section that will be changed is this FAQ. Important updates will be addressed in the FAQ & on the C3 website.
    b. The document format was updated to match COSMIC products on July 10, 2024.
    c. Minor updates were made to the Deliverables section to remove ambiguity in February 2025.
    d. Changes were made to the judges' scoresheet. Subcategory 2.3 was eliminated and the points distributed to other Concept of Operations subcategories. Other minor wording changes were made to be more precise and accurate. These changes were made in February 2025.