ASCEND | Las Vegas, NV 16–18 November 2020

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Defining the Space Economy

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Recent analysis suggest that a fully developed space-based economy is poised to dwarf the current economic activities on Earth. Realizing the full promise and possibility of that growth—a forecasted $1 trillion globally by 2040—demands bringing together business leaders, academics, innovators, investors, technical experts, government stakeholders and decision-makers to envision, design, and build the future of space commerce, together.

One of the primary goals of ASCEND is to facilitate that collaboration by expanding the opportunity for participation and, ultimately, the collection of industries that are included in the definition of the space economy. The commercial space ecosystem must transcend the aerospace and defense industries to include a much broader range of adjacent interests, such as agriculture, construction, IT, telecommunications, hospitality and tourism, food and beverage, fashion, and more.

To achieve this expansion, there is an immediate need for new ideas, investment in promising ideas, and support for critical infrastructure and capabilities. ASCEND will be the platform, working with other national and international professional organizations, to engage relevant stakeholders and interested parties in this discussion.

An increased emphasis will be placed on interdisciplinary submissions that incorporate education, public outreach, policy and law, manufacturing, operations, economic factors, supply chain management, international partnerships, public-private partnerships and technical standards.

Technical Papers | Topics of interest include, but are not limited to:

- Adjacent Industry Applications, such as Agriculture, Construction, Entertainment, Food and Beverage, Hospitality, Mining, Pharmaceuticals, and Retail
- Commercial Space Stations
- Economic and Business Case Analysis
- In-Space Infrastructures
- In-Space Manufacturing & Assembly
- Insurance and Risk Management
- Investment and Financing
- LEO Constellations
- Licensing and Oversight Regimes
- Market Stimulation and Incentivization
- Multisector Partnerships
- National and International Advocacy, Cooperation, and Outreach
- On-orbit Servicing
- Realizing Societal Benefits
- Space Laws and Legal Structure Supporting Economic Expansion
- Space Tourism
- Supply Chain Management
- Sustainable New Space Enterprises
- Technology Transfer
- Utilization of Commercial Flight Vehicles for Maturation of Space Technologies

Entrepreneurial Development Activities

Individuals, organizations and subject matter experts are encouraged to propose case studies, workshops, and tutorial sessions on space-related commercial stimulation initiatives, such as SBIR/STTR programs, technology incubators and accelerators, business plan and pitch development, and technology transfer programs.

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Education, Outreach, & Workforce Development

For questions, email:
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Potential types of activities include:

- Component Fabrication
- Design Competition
- Guided Exercise
- Hackathon
- Space Mission Simulation

Activities should promote or engage one or more of the following skills areas:

- 3D Printing
- Art
- CAD
- Chemistry
- Computer Programming
- Math
- Music
- Physics

Education, Outreach, and Workforce Development is an expansive zone of ASCEND that includes technical papers, case studies, professional development activities, and outreach opportunities. ASCEND will extend the knowledge exchange inherent in conferences and workshops to the aerospace workforce to enhance their abilities and skill sets for the future. This will help to create an engineering workforce pipeline of information to solve real aerospace challenges.

Technical Papers & Case Studies

Initiatives and programs come and go, often without any documented analysis to verify their effectiveness. Examples of successful activities, in-depth analyses of educational programs, outreach initiatives, and workforce development programs will help to identify what is and is not working. AIAA sections, external organizations, conference organizers, and others who have conducted education, outreach, and workforce development activities are strongly encouraged to document their experiences and results.

Topics of interest include, but are not limited to:

- Case Studies, Metrics, and Reporting on Outreach Initiatives
- Best Practices for Education and Outreach Activities
- Educational or Workforce Analysis
- Outreach or Public Engagement Analysis

Tutorials & Professional Development Activities

Software vendors, university faculty, and subject matter experts are encouraged to propose to provide training and/or certification courses on space-related topics, in areas such as computer aided design (CAD), computational fluid dynamics (CFD), computer aided engineering (CAE), requirements management, ITAR/EAR compliance, thermal/structural analysis, trajectory analysis, numerical computing tools, programming languages, cloud computing, and applications of machine learning and data science. Consideration will also be given to tutorials on non-technical skills, such public speaking, leadership, or project management.

Outreach Activities - STEAM Pilot Program

ASCEND seeks to engage the next generation…today! AIAA will partner with student organizations, youth-serving organizations, schools, community organizations, individuals, and others to use the platform of ASCEND as a means to engage both local and remote youth in space-focused activity. Providers should propose to conduct activities at ASCEND that are hands-on and engage youth in a manner that transfers aerospace education, creates excitement, and promotes STEAM-based space career paths. Activities should be appropriate for being conducted inside a typical conference exhibit hall or conference room and should target specific numbers and age-ranges of students. Youth-serving organizations should propose to bring a specific number and age range of students interested in being exposed to space-related opportunities. AIAA is especially interested in partnering with youth-serving organizations that impact underrepresented student populations.

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Information Systems & Software

For questions, email:
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Information Systems Group

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» **Michael Rubin**
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» **Daniel Selva**
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» **Rick Tuggle**
PeopleTec
» **John Valasek**
Texas A&M University

The scope of the Information Systems and Software track broadly includes all aspects of architecture, design, development, operations and maintenance of information systems for space applications. Specific areas of interest include commercial offerings that provide communications and PNT for cislunar space; replacement for the Deep Space Network (DSN); computing platforms that enable large networks of autonomous systems to inter-operate; transition of commercial power (batteries, fuel cells) and electronics to space applications; and applications of AI, Machine Learning and Data Science to spacecraft operations.

Topics of interest include, but are not limited to:

» Communications Systems: Design, development and operation of communications systems for space applications, and associated architectures and technologies, including small, lightweight, low power, and COTS technologies for smallsat applications; software-defined radio and software-defined networking technologies; quantum communication advancements; RF, optical and combined component technologies to realize higher bandwidths; and security improvements from the physical to application layers. [Subtopic POCs: Peter Garland and Thomas Butash]

» Computer Systems: Theoretical and practical considerations involving the applications of computers and information processing techniques to space systems, including embedded and energy efficient (low power) computing systems; High-Performance Computing (HPC); parallel, GPU, and multicore processing; and hardened, secure, and fault-tolerant processor architectures. [Subtopic POCs: Mahyar Malekpour and Rick Tuggle]

» Cybersecurity: Application of cyber defense and security system technologies and methods to space systems, including cyber-security frameworks and architectures, cyber risk modeling and analysis for space assets, preemptive threat vector identification, security event management, cyber-security assurance using techniques like blockchain, security intelligence with data-driven analytics, and real-time security defenses with online anomaly detection. [Subtopic POCs: Sam Adhikari and James Paunicka]

» Digital Avionics: Design, development and operation of digital avionics systems and technology for space applications, including avionics technologies for safe and efficient space vehicle operation; flight critical avionics architectures; and safety and security impacts of complex electronic hardware. [Subtopic POCs: Douglas Abernathy and Denise Ponchak]

» Information and Command and Control Systems: Integrated application of data acquisition, data assessment, and data dissemination functions required for timely and efficient command and control of space systems, including unmanned satellites for both military and civilian applications, manned spacecraft, and integrated space, air, ground, and cyber systems. [Subtopic POC: Jimmie McEver]

» Intelligent Systems: Application of Intelligent System (IS) technologies and methods to space systems, and development, verification and validation, and operations of these systems – including automated planning and scheduling, fault/health management, model-based reasoning, machine learning, adaptive and intelligent control systems, and other technologies enabling effective, reliable and highly autonomous operation of complex space systems or sub-systems; and applications of IS to more effective, lower cost development of space systems. [Subtopic POCs: John Valasek and Daniel Selva]

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Information Systems & Software

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» Human-Machine Teaming: Design, development, verification, validation, certification, and deployment of human-machine systems where the “functions of humans and machines are integrated” – ranging from systems with machines designed to automate a finite set of tasks using predetermined rules to systems of self-governing machines that are able to both make decisions and operate independently of human supervision. [Subtopic POC: John-Paul Clarke]

» Model-Based Systems Engineering: Applications of Model-Based Systems Engineering (MBSE) to support system requirements, design, analysis, verification and validation activities, including innovative space-related applications, methodologies, tools, and analysis techniques. [Subtopic POC: Michel Ingham]

» Sensor Systems and Information Fusion: All aspects of space sensor systems and distributed sensor networks, including detection, collection, fusion, processing, storage, retrieval, distribution, and reception of information at the local sensing node and at the distributed sensor network level; space situational awareness; multi-sensor field/flight experiments; novel sensors for space applications. [Subtopic POC: Kent Engebretson]

» Software: Innovative software architectures and software engineering methodologies and tools for complex space systems, across the software engineering lifecycle, including requirements, design, code, test, verification and validation, evaluation, operation and maintenance. [Subtopic POC: Michael Rubin]

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National Science Priorities

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Throughout human history, we have pondered the great mysteries, such as the formation of the universe and our solar system, the existence of life on other planets, and how we can better understand the complex systems of the Earth. Within the past century, however, advances in space technology have allowed us to make great leaps in our understanding of these and other scientific frontiers.

As we seek to further accelerate the growth of the space economy and make strides toward our off-world future, it is imperative that we leverage the resultant new technologies and capabilities to continue to address the most crucial scientific questions that remain unanswered. This topic seeks to focus attention on these questions, as prioritized by the scientific community in publications such as the U.S. decadal surveys, and to identify opportunities and challenges that can be addressed through increased activities and human presence in space.

Topics of interest include, but are not limited to:

- Addressing Global Climate Change
- Decadal Survey Mission Concepts
- Exoplanets and Astrobiology
- Hosted Payloads
- Instrument Design and Development
- Mission to Planet Earth
- Planetary Protection
- Science Enabled by Human Exploration
- Sensor Design/Development
- Space Weather
- Technology Gaps for Planned Science Missions
- Remote Sensing
- Weather Observation and Prediction

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National Security Space

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ASCEND seeks dialogue-generating content and papers to foster outcomes shaping the future utilization and protection of space. Since space fuels the American way of life, the overlap between efforts to produce value in space, efforts to manage the increasingly crowded space domain and efforts to protect our ability to operate freely in space form a nexus for the space community. We wish to form sessions around space-based capabilities, sensor and system technologies, space traffic management, space domain awareness, and the protection of space assets. Proposed proliferated systems, space user visions and space domain awareness drive the conversation around space traffic management. Content covering cislunar ventures provides insights into the growth beyond the traditional earth orbit focus. Additionally, experiences in commercialization partnerships and private public partnerships inform the evolution and approaches to providing the systems necessary to protect, defend and enable the continued open use of space for the benefit of all humankind in an environment in that is becoming increasingly crowded, dangerous, and essential.

Topics of interest include, but are not limited to:

- Cybersecurity
- Defense Acquisition
- Distributed Architectures
- Funding and Investment Opportunities
- International Law
- International Strategic Space
- Near Peer Analysis and Comparison
- Sensor Layer Technology
- Space Asset Protection
- Space Command
- Space Conflict
- Space Force
- Space Domain Awareness: Architectures and Applications
- Technology Accelerators and Incubators
- Technology Gaps for Planned Missions
- Technology Transfer
- The Role of Private Industry in Space Security

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Propulsion

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» **Mitchell Walker**
Georgia Tech

Affordable, efficient, and innovative propulsion systems are an essential factor for growing the space economy and enabling exploration. Exploiting new designs, fuels, materials, and manufacturing technologies will allow for novel mission architectures, spacecraft concepts, and system level improvements. Papers are solicited that relate to all aspects of propulsion systems, including component and system-level design, material development/selection, manufacturing, testing, ballistic prediction methodologies, performance evaluation, and state-of-the art technology advancements.

Additional areas of interest include overviews of historical propulsion systems, lessons learned from development, testing and flight experience, and current status of upcoming systems/programs.

Topics of interest include, but are not limited to:

- Boost and Upper Stage Propulsion
- Combustion
- Cryogenic Fuel Storage and Management
- Electric Propulsion
- Entry, Descent, and Landing
- Experiment and Test Facilities
- Field Effects Research
- Freight Transportation
- Green Propellants
- Hypersonic Flight
- Liquid, Solid and Hybrid Propulsion
- Magnetic and Pulsating Fields
- Nuclear Propulsion
- On-orbit Propulsion
- Propellant Depots and Storage
- Propulsion Architectures
- Reusable vs Expendable Launch
- Space Planes and SSTO
- Subsystems
- Theoretical Analysis

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Space Exploration Architectures & Enabling Infrastructures

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Made in Space

The exploration of the solar system and the eventual permanent human settlement on another space body are all topics of interest that will impact human life for generations to come. AIAA and the sponsoring technical committees welcome specific and interdisciplinary technical papers, presentations, and discussions on all aspects of space exploration architecture, enabling technologies, and infrastructures to be presented at ASCEND.

To facilitate this, there is an immediate need for in-space infrastructure to be planned, funded, and implemented in order to facilitate broader, efficient, and easy access to cis-lunar space for all interested stakeholders and participants. This section is concerned with the architectures and infrastructures associated with both near- and long-term human space activity. As the world looks back and celebrates the 50th anniversary of the Apollo program, ASCEND will be the platform to look ahead and propose the possibilities of the next 50 years and beyond.

Primary focus should be Low Earth Orbit, Cislunar Space, the surface of the Moon, and the surface of Mars. However, architectures and infrastructure associated with other destinations are welcome. What are the likely infrastructures to be developed in the inner solar system? What human space flight destinations are reasonable? What is the role of robotic systems in the arena of human space flight?

Of particular interest are the related issues of affordability and sustainability. Hundreds of space architectures have been proposed in federal and commercial sectors across the decades of human spaceflight, but few have resulted in actual programs. Most of the few that did become programs were targeted for cancellation in order to free up the funds used to sustain them. There is a high interest in papers that not only present new and unique architectures, but also contextualize them in an implementable framework that holds potential to become part of a long-term exploration strategy.

Topics of interest include, but are not limited to:

» Artificial Intelligence Applications
» Autonomous Systems
» Cislunar Architectures
» Deep Space Transportation
» Enabling Technology Development
» Entry, Descent, & Landing
» Funding and self-sustaining space economy
» Guidance, Navigation, Control, and Timing
» Human Exploration Support and Systems Integration
» In-Space Logistics (infrastructure) and Resupply
» Logistics and Spares Standards
» Lunar Infrastructures Enabling Deep Space Exploration
» On-Earth Spaceports and Launch Systems
» On-orbit Servicing, Assembly, and Manufacturing
» Programmatic Considerations: Risk, Cost, Schedule
» Robotic Precursor Missions
» Space Electronics & Manufacturing
» Space Exploration Architectures and Concepts of Operation
» Space Flight Analogs and Simulations
» Space Resource Utilization
» Space Systems Operation
» Sustainability and Reusability
» Technical Standards Development
» Technology Gaps in Planned Missions
» Traditional/Alternative Systems Engineering Techniques

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Space Life Sciences & Systems

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Economical, human exploration of deep space will demand robust space systems with effective solutions for mitigating human health risks. Cost-effective and integrated solutions for space systems could evolve from technologies and capabilities that currently support terrestrial markets and may leverage lessons learned from closed biomes. These advanced and robust systems need to be reliable, resilient and recoverable, and can include habitats, ECLSS, communications, medical/behavioral health accommodations, gravity simulation and more (see the topic list below). ASCEND seeks to bring together space researchers, habitat architects, and designers with visionary engineers and scientists addressing UN sustainability goals to advance the state of the art in service of space and terrestrial applications.

Topics of interest include, but are not limited to:

- Autonomous Systems for Space Habitat Operations
- Design, Analyses and Modeling & Simulation
- Environmental Control & Life Support Systems (ECLSS)
- Behavioral Health / Psychological Impacts
- Clothing & Other Crew Amenities
- Command Control and Communications
- Ethics, Exploration & Eminent Domain, and Planetary Protection
- Food Production and Storage
- Human Centered Design
- Human-Machine Integration
- Integrated Power Systems
- Long-term Mission Planning & Technology Roadmap Development
- Lunar/Mars Surface Habitat Architectures
- Medical Facilities and Services for Spaceflight
- Microgravity / Reduced-Gravity Effects and Countermeasures
- Microgravity/Partial Gravity Reproduction
- Mobile Habitats
- Orbital Platform Architectures
- Radiation Protection
- Robotic Systems
- Safety and Risk Tolerance
- Science / Experiment Payloads
- Search and Rescue Operations
- Space Habitats
- Space Radiation Effects and Protection
- Spacesuits

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Space Policy & Law

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Someday soon, space colonies and deep space exploration will be a reality. There have been numerous discussions of large-scale facilities, and settlements, that in the long-term may even include terraforming a planet in order to make it more hospitable for humans to colonize. Yet, for space commerce to thrive we will need to develop Space Policy and Laws that are fair and equitable for the explorers as well as their sponsors. ASCEND participants will examine how the present and future aspects of Space Policy and Law may evolve in the years to come to enable a great expansion of human activity in outer space.

For example, it is inevitable that someday a baby will be born in a remote space colony or during a deep space mission in a space craft. Will that child be considered an international citizen with all of the applicable rights granted under the United Nations Children's Bill of Rights? Or, will that child be considered a ward of the space colony and live under a set of interplanetary laws of governance created by and enforced by a public or private space company? We are at a point in time when the human rights of any person that wants to embark into outer space may be dictated by the country or organization that is funding the space enterprise. This may also include the families who want to participate in being members of a space colony.

Topics of interest include, but are not limited to:

A Legal Framework and Code Applicable to Sustained Facilities in Space That Can Be Universally Adopted

» Basis for Sovereignty Assignment
» Enforcement Mechanisms
» Governance of Outposts/Settlements
» Historical Precedents and Analogs
» Individual and Family Bill of Rights for Outer Space
» Property Rights
» Safety Laws and Criminal Statutes
» Venues for Prompt Conflict Resolution (In-Space and International)

Formulating and Maintaining Long-term National and International Strategies

» A Sustained Rationale and Vision for Exploration
» Export Control Reform
» Incentive Programs
» Insurance and Liability

International Cooperation and Relations

» International Finance, Licensing and Regulation
» Regulations for a Safe and Sustainable Space Operations Environment (includes orbital debris limitations and mitigation)
» Rescue infrastructure and procedures
» Spectrum Allocation Reform
» System Compatibility Standards

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Space Resource Utilization

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Space Exploration Integration Committee

- **Chris Moore** NASA Headquarters
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Following many precedents in the history of human civilization, our era of exploration and short-term presence of space will be followed by the desire to increase and sustain human presence on off-Earth worlds and the expanses in between. The newest chapter of our history may unfold logically through a transition to economically feasible development of infrastructure, exploitation of resources, production means, and sustainable transportation both on planetary surfaces and in interplanetary space. This transition to economically sustainable settlements outside of Earth through the use of local resources requires a change in paradigms about the capabilities and lifecycles of space systems and the synergistic engagement of many disciplines.

ASCEND will serve as a catalytic event for professionals and students to bring forth essential questions and challenges facing the establishment of reliable in-situ resource utilization (ISRU) on the Moon and Mars as a priority. Experts from both terrestrial and space-focused industries, government agencies and academia are invited to propose content that will examine the near and long-term development and deployment of technologies and systems for space resources utilization integrated with other enabling space-based architectures. The development of this content for ASCEND will be done in collaboration with other interested technical committees to enable rich interdisciplinary discussions.

Participants are encouraged to propose content to fit various formats of presentations and discussions, including traditional technical papers.

Please consider and, where appropriate, reference the questions below, for submissions to the topics listed on the right.

Questions

- What technical and operational challenges arise to transition current space exploration architectures into the utilization of Off-Earth planetary resources?
- What concepts of reliability can be expected for ISRU operations?
- What synergies exist with terrestrial industry to enable technology development for space resource utilization?
- What economic analyses are appropriate to determine benefits of space resource utilization?
- What roles can governments and world governance play in fostering commercial development of space resources?
- What ethical principles should guide stewardship of Off-Earth resources and lands during exploitation?

Submission Topics

- Detecting/Defining/Proving Availability of Resources
- Economic Analyses involving ISRU
- Space resource / ISRU technology hardware testing and development
- Space Mining Planning/Operations Integrated within Space Architectures
- Systems Analysis of ISRU-based Surface Architectures
- Energy Production and Usage by ISRU
- Surface Energy Architecture to Meet ISRU Demand
- Production of Propellants and Other Commodities
- ISRU Product Storage and Delivery
- Public Governance and Commercial Development of Space Resources
- Ethical Stewardship in the Era of ISRU
- Other

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Space Traffic Management & Integration

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  Concepts Beyond

Vehicle traffic going into space, Earth orbit, and beyond has grown significantly in the last decade. The diversity of today's space traffic has increased dramatically over the last 50 years and now includes a variety of companies and nations with different goals, motives, and business/operating models. As growth continues, there is an increasing need to ensure access to space and safe operations from initial launch of the vehicle through mission completion. The Space Traffic Management and Integration (STMI) topic seeks to provide a collaborative forum to advance STMI issues related to technologies, operations, regulations, and standards development for commercial, governmental (civil and military), or educational applications. Papers by students are encouraged.

Topics of interest include, but are not limited to:

- Astrodynamics
- Autonomous Systems
- Catalog and Data Management
- Cost and Liability Issues
- Integration of Large Constellations
- International Coordination
- Multi-Source Information Fusion
- Launch and Re-entry Routine Airspace Integration
- Legal and Policy Frameworks
- On-orbit Rules of the Road
- Orbital Debris Management/Mitigation
- Point-to-Point Operations
- Re-entry and Return
- Rendezvous and Proximity Operations
- SSA Technologies and Data Management
- Standards Development
- Uncertainty Quantification and Representation

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Transformative Research & Technologies

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What lies beyond the technologies that we envision using over the next decades for a return to the Moon and follow-on missions to Mars? Which emerging technologies will transform space transportation as we know it? How might space materials and systems be harnessed to address our greatest challenges on Earth? We live in a time where today's research has the capacity to answer questions like these and lead to radically new technologies that revolutionize our existing models, dramatically drive down costs, and enable new opportunities.

In 1865, Jules Vern imagined a world where traveling to space was a reality. A century and a half later, we are poised to envision a future that lies beyond our current technologies and that will shift our existing paradigms in the coming centuries. Science fiction writers shape the future with their imaginations. Scientists and engineers create the future with our work. AIAA and the supporting technical committees solicit papers that emphasize transformative research of high risk and potentially high reward. Revolutionary ideas, research, breakthroughs, and discoveries that will accelerate the building of our off-world future – not just incremental growth, but order of magnitude transformations in the human experience beyond Earth.

Topics of interest include, but are not limited to:

» Advanced Materials
» Advanced Propulsion Systems and Concepts
» Advanced Surface and In-Space Power Systems
» Advanced Telecommunications
» Alternative Business Models and Revenue Streams to Fund Future Space Activity
» Artificial Intelligence
» Cloud/Edge Computing Applications
» Development of Technologies that Further Low-Cost Access to Space
» Development of Technologies that Enable Expanded Human Exploration
» Development of Technologies that support Enhanced Security of Space-based platforms
» Distant Future Visions (100-500 years)
» Factor of 10 or Greater Cost Reductions
» Integrated Long Range (e.g. 100-year) Plan for Human Space Activity
» Internet of Things and 5G Applications
» Life After Mars (human space activity after the initial Mars human missions)
» Main Belt Asteroid Human Exploration
» Mega Lift Capability (Earth launch systems with greater than 200 MT to LEO performance)
» Mercury and Venus Human Exploration
» Miniaturization
» New Manufacturing, Assembly, Integration, or Testing Processes (terrestrial and extra-terrestrial)
» Outer Planet Human Exploration
» Reformed/Revolutionary Acquisition Paradigms
» Small Size Workforce for Crewed Spacecraft Production
» Space Applications of Technologies Developed for Autonomous Vehicles, Electric Vehicles, Urban Air Mobility, Robotics, etc.
» Space Elevators
» Space Tethers