MIT Industrial Liaison Program Faculty Knowledgebase Report

Space Tech @MIT

April 20, 2021 10:00 am - 12:00 pm

10:00 AM

Welcome and Introduction
Ron Spangler
Director, MIT Corporate Relations

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Ron Spangler serves as the Director of Corporate Relations, managing a diverse portfolio of companies in the mining, energy, aerospace, and defense sectors. Before joining MIT Corporate Relations, Ron dedicated two decades to an industry career, primarily focusing on various MIT-connected startup companies. In 1994, he earned his doctorate in Aeronautics and Astronautics from MIT, and his extensive contributions include numerous publications and patents. Notably, Ron is also an FAA-licensed pilot with a glider rating.

10:05 AM

Bold Technologies Enabled by Small Satellites
Kerri Cahoy
Associate Professor of Aeronautics and Astronautics
Co-Director, Small Satellite Center
Bisplinghoff Faculty Fellow

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Kerri Cahoy is an Associate Professor of AeroAstro at MIT. Cahoy received a B.S. in electrical engineering from Cornell University, Ithaca, NY, USA, in 2000, and M.S. and Ph.D. degrees in electrical engineering from Stanford University, Stanford, CA, USA, in 2002 and 2008, respectively. Cahoy currently is the Co-Director of the Small Satellite Center, and leads the Space Telecommunications, Astronomy, and Radiation (STAR) Laboratory. Cahoy's research focuses include nanosatellite atmospheric sensing, optical communications, and exoplanet technology demonstration missions.

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We can use small satellites to test how well new ideas and cutting-edge technologies perform on-orbit within months, not decades, at a cost low enough that risks can be tolerated. The small satellites themselves often take a starring role in these dynamic demonstrations, with their coordinated actions among multiple agents. Current projects are inspired by optical communication, imaging, actuation, and on-orbit assembly. Innovative beam steering approaches are compared, using MEMS, liquid lenses, and shape memory alloy actuators. On-orbit laser beam steering can even help large ground telescopes see dimmer objects, opening up the possibility of finding new exoplanet worlds, or pressing further back in time to understand the evolution of our Universe. And now that we are sold on the promise of small satellites, why not use robots to precisely assemble them on orbit and skip the expensive traditional ground-based build-and-test process?

10:20 AM

Enabling a New Age in Spaceflight and Space Exploration Through Space Traffic Management and Autonomous Space Systems
Richard Linares

Rockwell International Career Development Professor
Associate Professor of Aeronautics and Astronautics, MIT AeroAstro

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Richard Linares joined the Department of Aeronautics and Astronautics as an assistant professor last July. Before joining MIT, he was an assistant professor at the University of Minnesota's aerospace engineering and mechanics department. Linares received his BS, MS, and PhD degrees in aerospace engineering from the State University of New York at Buffalo. He was a Director's Postdoctoral Fellow at Los Alamos National Laboratory and also held a postdoc appointment at the United States Naval Observatory. His research areas are astrodynamics, estimation and controls, satellite guidance and navigation, space situational awareness, and space-traffic management.

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Space flight is entering a period of a renaissance with considerable change in the perception of what humanity's role in space will be. Recently, SpaceX and OneWeb have proposed mega satellite constellations of up to 4,425 satellites in Low Earth Orbit (LEO), which will more than double the number of satellites currently in LEO. These constellations have the potential to revolutionize the telecommunication industry by providing complete global internet coverage. The economic gains of completely connecting rural areas and developing nations cannot be understated, however, the current space infrastructure is not capable of handling such a dramatic increase in the number of active satellites. Therefore, there is a critical need for new solutions to the problem of Space Traffic Management (STM) and Space Situational Awareness (SSA).

Conversely, the technologies that are revolutionizing near-Earth spaceflight will provide new opportunities for deep space exploration. Future science-driven interplanetary missions and/or missions to Lagrangian points and asteroids will require advanced guidance and navigation algorithms that are able to adapt to more demanding mission requirements. For example, future missions to asteroids and comets will require that the spacecraft be able to autonomously navigate in uncertain dynamical environments by executing a precise sequence of maneuvers (e.g. hovering, landing, touch-and-go) based on information collected during the close-proximity operations. These missions will require approaches for landing at selected locations with pinpoint accuracy while autonomously flying fuel-efficient trajectories.

This presentation will discuss new methods for enabling STM and autonomous space systems. In particular, this presentation will discuss a new method for assessment of confidence in position knowledge through improved satellite drag modeling, which is critical for STM. This presentation will also discuss novel methods for accurate upper atmospheric density estimation and uncertainty quantification. Furthermore, autonomous space systems and robotic systems can offer new ways of exploring our solar system. Current research on autonomous space systems will also be discussed. Finally, this presentation will provide a vision for the basic research that is needed to enable the future of spaceflight and space exploration.

10:35 AM

MIT Space Exploration Initiative: Democratizing Access to Space
Ariel Ekblaw
Director, MIT Space Exploration Initiative

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Ariel Ekblaw is the founder and Director of the MIT Space Exploration Initiative, a team of over 50 graduate students, staff, and faculty actively prototyping the artifacts of our sci-fi space future. Founded in 2016, the Initiative includes a portfolio of 40+ research projects focused on life in space, and supports an accelerator-like R&D program for payload development and flight testing across MIT. For the Initiative, Ariel drives space-related research across science, engineering, art, and design, and charters an annually recurring cadence of parabolic flights, sub-orbital, and orbital launch opportunities. Ariel graduated with a B.S. in Physics, Mathematics and Philosophy from Yale University and defended her MIT PhD in autonomously self-assembling space architecture for future habitats and space stations in orbit around the Earth, Moon, and Mars. Ariel's work has been featured in *WIRED* (March 2020 cover story), *MIT Technology Review*, *Harvard Business Review*, the *Wall Street Journal*, the BBC, CNN, NPR, IEEE and AIAA proceedings, and more. Humanity stands on the cusp of interplanetary civilization and space is our next, grand frontier. This opportunity to design our interplanetary lives beckons to us—Ariel strives to bring our space exploration future to life.

This talk will present the current portfolio of the MIT Space Exploration Initiative, including a sneak-peek of our Q4 2021 ISS mission and highlights on our emerging lunar surface exploration activities and policy development.

10:50 AM

MIT Startup Exchange Lightning Talk

Analytical Space: Building the in-orbit communication infrastructure for real-time knowledge on the surface of our planet

Weston Marlow
CTO
Analytical Space

MIT Startup Exchange Lightning Talk

Accion Systems: Building in-space propulsion solutions for the future of exploration and commercialization

Natalya Bailey
CTO & Founder
Accion Systems

MIT Startup Exchange Lightning Talk

Tomorrow.io: Transforming The Weather Industry From Space: Take Control of Tomorrow, Today

Rei Goffer
Co-Founder and CSO
Tomorrow.io

MIT Startup Exchange Lightning Talk

Lunar Station: Refining raw data into actionable intelligence for lunar missions

Blair DeWitt
CEO & Founder
Lunar Station

11:10 AM

The Future of Satellite Communications
Bruce Cameron
Director, MIT System Architecture Lab

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Bruce Cameron is the Director of the System Architecture Group at MIT. His research interests include technology strategy, system architecture, and the management of product platforms. Previously, Dr. Cameron ran the MIT Commonality study, a 30-firm investigation of platforming returns, which concluded that firms face systemic downward pressure on commonality, partially resulting from challenges capturing the costs of variety. Dr. Cameron has supervised over 50 graduate students and has directed research projects for Amazon, BP, Sikorsky, Nokia, Caterpillar, AMGEN, Verizon, and NASA. Current research efforts include:

- Platform management in large R&D organizations
- System architecture of complex systems
- Switching costs and retention incentives in ride-hailing firms
- Satellite mega-constellations in Lower Earth Orbit

Dr. Cameron is a co-founder of Technology Strategy Partners, a consultancy created to help firms to restructure product development organizations, build systems engineering functions, and identify new architectures. Dr. Cameron has led projects in Fortune 500 firms in high tech, medical devices, transportation, and consumer goods.

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Satellite communications is undergoing more change in the next couple years than in the previous couple decades, driven by two key trends : changing services to smaller city-sized beams, and market entry of LEO constellations. We will explore what opportunities and challenges these new services present from an operator perspective, focused on the key of how to manage services dynamically. Additionally, we'll provide a brief overview of the market landscape in LEO with the latest MIT analysis on SpaceX Starlink, OneWeb, Telesat, and Amazon Kuiper.

11:25 AM

Sustainability in Space and on Earth: Research Initiatives of the Space Enabled Research Group
Danielle Wood
Director of the Space Enabled Research Group, Media Lab
Assistant Professor of Media Arts & Sciences and Aeronautics & Astronautics

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Professor Danielle Wood serves as an Assistant Professor in Media Arts & Sciences and holds a joint appointment in the Department of Aeronautics & Astronautics at the Massachusetts Institute of Technology. Within the MIT Media Lab, Prof. Wood leads the Space Enabled Research Group which seeks to advance justice in Earth's complex systems using designs enabled by space. Prof. Wood is a scholar of societal development with a background that includes satellite design, earth science applications, systems engineering, and technology policy. In her research, Prof. Wood applies these skills to design innovative systems that harness space technology to address development challenges around the world. Prior to serving as faculty at MIT, Professor Wood held positions at NASA Headquarters, NASA Goddard Space Flight Center, Aerospace Corporation, Johns Hopkins University, and the United Nations Office of Outer Space Affairs. Prof. Wood studied at the Massachusetts Institute of Technology, where she earned a PhD in engineering systems, SM in aeronautics and astronautics, SM in technology policy, and SB in aerospace engineering.

View full bio

The presentation will present the work of the Space Enabled Research Group at the MIT Media Lab. The mission of the Space Enabled Research Group is to advance justice in Earth’s complex systems using designs enabled by space. Our message is that six types of space technology are supporting societal needs, as defined by the United Nations Sustainable Development Goals. These six technologies include satellite earth observation, satellite communication, satellite positioning, microgravity research, technology transfer, and the infrastructure related to space research and education. While much good work has been done, barriers remain that limit the application of space technology as a tool for sustainable development. The Space Enabled Research Group works to increase the opportunities to apply space technology in support of the Sustainable Development Goals and to support space sustainability. Our research applies six methods, including design thinking, art, social science, complex systems, satellite engineering and data science. We pursue our work by collaborating with development leaders who represent multilateral organizations, national and local governments, non-profits and entrepreneurial firms to identify opportunities to apply space technology in their work. We strive to enable a more just future in which every community can easily and affordably apply space technology. The work toward our mission covers three themes: 1) Research to apply existing space technology to support the United Nations Sustainable Development Goals; 2) Research to design space systems that are accessible and sustainable; and 3) Research to study the relationship between technology design and justice. The presentation will give examples of research projects within each of these themes.

11:40 AM

Laser Communications for Past and Future Space Missions
Farzana Khatri
Senior Staff Member in the Optical Communication Technology group, MIT Lincoln Laboratory

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Dr. Farzana Khatri is a Senior Staff Member in the Optical Communication Technology group at MIT Lincoln Laboratory in Lexington, MA. She is currently the Lead System Engineer and Operations Lead for the lasercom links for NASA's Laser Enhanced Mission Communications and Navigation Operational Service (LEMNOS) program. She was a key player in the Lunar Laser Communication Demonstration (LLCD) project, a first-of-its-kind, record-breaking Moon to Earth free space laser communication system demo. Her roles in the LLCD project have included system engineering, test bed design, system /subsystem /spacecraft I&T, and operations. Before coming to Lincoln in 2002, Farzana worked at AT&T/Tyco Submarine Systems and at Sycamore Networks. She received the S.B., S.M., and Ph.D. degrees in Electrical Engineering and Computer Science from MIT in 1990, 1992, and 1996.

MIT Lincoln Laboratory has been working on space-based laser communications research for over two decades. Traditionally, communications between the Earth and space has relied on radio frequency (rf) systems, which have been in use since the Apollo era when the Internet did not exist. As humans venture deeper into space, laser communications will be a key enabler to support high bandwidth bi-directional communications links required for space habitats. This talk will describe past and upcoming lasercom missions.

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11:55 AM

Closing Remarks