SATELLITE AND SPACE COMMUNICATIONS **SSC**
http://committees.comsoc.org/ssc/

IEEE COMMUNICATIONS SOCIETY

SSC Newsletter **Vol. 34, No. 1, June 2024**

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The Satellite and Space Communications (SSC) Committee is a volunteer group actively involved in advancing satellite and space communication technologies within the IEEE. This committee is approved by the IEEE Communications Society and is governed by the constitution and bylaws of the IEEE as well as the other twenty-three Technical Committees in the Society. The committee belongs to the Technical Committee Clusters of Communication/Signal Processing (C/SP).

SATELLITE & SPACE

- JOIN US -

All conference attendees are welcome to join us in the SSC Committee meeting.

HYBRID MEETING URL:
https://zoom.us/j/92711443139?pwd=cHdnOXhTV3BZVnBTVnYzVC90bUhDQT09

Time: Thursday, June 12, 2024
7:30am - 9:00am MDT
(Denver, USA)

Future SSC Meeting:
December 2024, Cape Town, South Africa

ICC 2024 SSC Committee Activities:

Symposium on Selected Areas in Communications:
Monday, June 10

- **11:30 - 13:00**: SSC-IS: Topics in SSC (Interactive)
- **16:30 - 18:00**: SSC-1: Communications I

Tuesday, June 11

- **11:30 - 13:00**: SSC-4: Low Earth Orbit II
- **14:30 - 16:00**: SSC-2: Low Earth Orbit I
- **16:30 - 18:00**: SSC-3: AI for Satellite Communication

Wednesday, June 12

- **11:30 - 13:00**: SSC-4: Low Earth Orbit II
- **14:30 - 16:00**: SSC-5: Communications II
- **16:30 - 18:00**: SSC-6: Platform and Performance Evaluation

HOW TO JOIN SSC COMMITTEE AND MAILING LIST

If you like to join SSC Technical Committee: Please send your name and e-mail address to the SSC Secretary, optionally include your mail address, telephone and fax numbers.
If you like to join SSC Mailing List: Instructions on how to subscribe/unsubscribe are available at https://comsoc-listserv.ieee.org/cgi-bin/wa?A0=ssc.

SSC COMMITTEE OFFICERS

MESSAGE FROM THE CHAIR

Gunes Karabulut Kurt

Dear SSC Colleagues,

It gives me immense pleasure to announce the appointment of our new board for the upcoming year, where I will serve as the chair, Prof. Giovanni Giambene will serve as the vice-chair, and Prof. Peng Hu will serve as the secretary. Our team is also supported by Advisor Prof. Halim Yanikomeroglu and TC Standard Liaison Prof. Wael Jaafar; our committee is set to shape the future of space communication technologies in this era of pioneering advancements in New Space!

We will serve for one year, concluding with the next election cycle planned for the fall of 2024. We are aiming that our tenure will bring fresh perspectives and visionary leadership to our committee's efforts in advancing the frontiers of satellite and space communications. We are fully aware that our roles are crucial in steering our strategic direction, organizing impactful conferences, and workshops, and engaging our community in meaningful ways.As we embark on this new chapter, your support and collaboration will be invaluable as we work together to achieve our goals and continue making significant strides in our field. I am confident that with our combined efforts and the dynamic leadership of our new board, the SSC TC will reach new heights of achievement.

Overall, we are looking forward to a year filled with progress, innovation, and community building.

Thank you for your ongoing commitment to the SSC TC.

SCANNING THE WORLD

Giovanni Giambene

During 2024, satellite systems continued their expansion and development, offering global connectivity via large constellations. Recent news reports that Starlink (with 5800 operational satellites as of May 2024) expects to provide a mean latency below 20 ms to compete with terrestrial networks even if current measurements are above this expected latency. Many other mega-LEO satellite systems are in the design and development phase, such as Amazon Kupier (3232 planned satellites), Telesat Lightspeed (198 planned satellites), the Chinese G60 system (1296 satellites in the first phase), and the new GuoWang (SatNet) project to name a few. Systems mergers, such as SES with Intelsat, are also in progress.

Early experiments carried out in September 2023 with AST SpaceMobile BlueWalker3 LEO satellite (single satellite mission for experiments at an altitude from 375 to 425 km) proved the feasibility of a direct call using an unmodified smartphone on the ground. This satellite was equipped with a large 10 m x 10 m phased array antenna to achieve a high gain.

In early 2024, a new satellite industry alliance was created to provide Direct-to-Device (D2D) connectivity using frequencies set aside by regulators for mobile satellite services. This is the Mobile Satellite Services Association (MSSA), aimed to accelerate the rollout of D2D connectivity for smartphones and other devices. The members are Viasat, TerreStar Solutions, OmniSpace, Ligado Networks, Omnispace, and Yahsat.

In this period, 3GPP has been very active in the standardization of Non-Terrestrial Networks (NTN), including satellite systems, High Altitude Platforms (HAPs), and Unmanned Aerial Vehicles (UAV) as part of the 5G/6G eco-system. Release 17 and the recently frozen Release 18 have made significant progress in integrating NTN with terrestrial systems, focusing on coverage enhancement, mobility enhancements, and NTN operating bands above 10 GHz.

FORTHCOMING GLOBECOM AND ICC CONFERENCES

GLOBECOM 2024

December 2024 // Cape Town, South Africa

https://globecom2024.ieee-globecom.org

IEEE Global Communications Conference (GLOBECOM) is one of the IEEE Communications Society's two flagship conferences dedicated to driving innovation in nearly every aspect of communications. After extensive peer review, the best of the proposals are selected for the conference program, which includes technical papers, tutorials, workshops and industry sessions designed specifically to advance technologies, systems and infrastructure that are continuing to reshape the world and provide all users with access to an unprecedented spectrum of high-speed, seamless and cost-effective global telecommunications services.

COSPONSORING / RELATED CONFERENCES AND WORKSHOPS

ICC 2025

June 2025 // Montreal, QC, Canada

http://icc2025.ieee-icc.org/

The International Conference on Communications (ICC) is one of the two flagship conferences of the IEEE Communications Society, together with IEEE GLOBECOM. Each year the ICC conference attracts about 2-3000 submitted scientific papers, a technical program committee involving about 1500 experts provides more than 10000 reviews. IEEE ICC is therefore one of the most significant scientific events of the networking and communications community, a must-attend forum for both industrials and academics working in this area. IEEE ICC 2025 - Featuring the latest developments in telecommunications from a technical perspective.

CONFERENCES CALENDAR

CONFERENCE	DATE & LOCATION	INFORMATION
ICCSPA 202 35th International Teletraffic Congress The 6th International Conference on Communications, Signal Processing, and their Applications	8 - 11 July, 2024 Istanbul, Turkiye	https://2024.iccspa.org/
VTC-Fall 2024 2024 IEEE Vehicular Technology Conference (VTC-Fall)	7-10 October 2024- Washington DC, USA	https://events.vtsociety.org/vtc2024-fall/

To all SSC members: If your postal address, telephone or fax numbers have changed, please update them with the committee secretary. You can review our current records on our web page at http://committees.comsoc.org/ssc/.

LEO Satellites and Systems Space Environment Workshop

Organized by: Peng Hu,

University of Manitoba,

Canada

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Overview

It is our pleasure to present the IEEE LEO Satellites and Systems Space Environment Workshop associated with the IEEE Future Directions – LEO Satellites and Systems (SatS) initiative on May 2nd, 2024.

LEO satellites have many advantages over other satellite systems, such as higher data rates, lower latency, better global coverage, and scalability, compared to other solutions. With these compelling benefits, there has been significant growth in the number of LEO satellites, with an even greater future growth forecast. This raises questions about how the regions of outer space used by LEO satellites will be affected by this growth and how space sustainability can be achieved with the addition of tens of thousands or more LEO satellites.

We would like to thank the IEEE Future Directions and LEO SatS team for their help with organizing the workshop and publishing content. The workshop recordings are available at :
https://leosats.ieee.org/workshops/space-environment-workshop

Stresses on the Earth-Space System from LEO Satellite Systems" by Dr. Aaron Boley

Abstract: Humanity's rapid and accelerating expansion into outer space, including the proliferation of satellites in LEO, presents many opportunities for society. Indeed, satellites already play vital roles in weather forecasting, food production, forest fire detection, climate science, communications, navigation, search and rescue, disaster relief, military operations, and arms control verification. However, there are also negative consequences, from the loss of dark and radio-quiet skies, to space debris and collision risks on orbit, casualty risks from reentering rocket bodies and satellites, and changes to the atmosphere from both launches and reentries.

These negative consequences arise because space is generally not regarded as an environment in need of protecting, nor is it seen as being closely connected to Earth's environment. In reality, the two are so closely related that we need to speak of the Earth-Space system. This talk highlights several of the interconnected challenges associated with humanity's growing use of outer space. By understanding and confronting our impact on the Earth-Space system, we can better develop sustainable paths forward, ensuring not just the preservation of the Earth-Space environment, but long-term access and use of Earth orbits.

Dr. Aaron Boley is an associate professor in the Department of Physics and Astronomy at the University of British Columbia. His research explores a wide range of topics, including planetary dynamics, astrophysical discs, meteoritics, space sustainability and security, and space policy. Before joining the faculty at UBC, Boley was a NASA Sagan Postdoctoral Fellow at the University of Florida and a postdoctoral researcher at the Institute for Theoretical Physics at the University of Zurich. He is the Co-Director of the Outer Space Institute and co-author of Who Owns Outer Space? International Law, Astrophysics, and the Sustainable Development of Space.

The Mean is Meaningless" by Dr. Darren McKnight

Abstract: The low Earth orbit (LEO) space object population can best be described as consisting of clusters of derelict objects, clouds for fragments, and constellations of smallsats. These constituents combine in different ways at different altitudes that result in drastically varying neighborhoods throughout LEO. The LEO population and the resulting collision risk is examined through the lens of balancing (1) risk burden posed by each of the three components of the LEO population in tandem with the (2) risk that is abated through best practices and (3) the persistence of the objects.

Dr. Darren McNight is currently Senior Technical Fellow for LeoLabs. Darren leads efforts to realize the value proposition for the growing global network of ground-based radars for space situational awareness, space safety, and space sustainability. He creates new data depictions, develops risk algorithms, and leads space incident investigations. He is focusing on creating new statistical collision risk assessment approaches to provide valuable context to the operational collision avoidance support provided by LeoLabs worldwide.

As a member of the International Academy of Astronautics' Space Debris Committee, he has been active in position paper development, selection of symposia papers, and execution of the annual International Astronautical Congress. His current focus is on developing technical solutions and encouraging global behavior that leads to sustained space operations assurance through limiting the risk of debris collision hazard to space systems in Earth orbit. Recent efforts have shown that the greatest debris-generating potential in low Earth orbit comes from the thousands of massive derelict objects deposited over the last 60 years and not from the recent proliferation of smallsat constellations. He has coauthored five books ranging from space debris and spacecraft operations to soccer coaching and innovation. Darren has authored over 120 technical papers and presented them in 21 countries including guest lectures at ten universities globally.

From Passive-Optical Observation to High-Power Laser Irradiation: DLR-TP Activities on Space Debris Detection and Mitigation" by Dr. Stefan Scharring

Abstract: With the strong increase in the number of space debris objects due to spontaneous debris-vs-debris collisions, the highly frequented orbital regime around 800 km has finally arrived at the dawn of the Kessler Syndrome. But it is not only the number of debris objects that can be expected to increase exponentially, the number of newly launched satellites raises in a similar way while, to our knowledge, not a single debris object has ever been actively de-orbited up to now. The related risks of mutual collisions are far from impacting only the orbital environment itself. In fact, the potential economic damage of large-scale satellite failures underlines the necessity of substantial efforts for sustainable operations in space.

As an adaptation to the space situation, exhaustive awareness of potential collisions is needed. While more than 35,000 debris objects are tracked and catalogued already, this only constitutes less than 4% of all potentially mission-terminating debris with a size greater than 1 cm. To counteract the large number of untracked space debris in the low Earth orbit, methods for passive-optical debris detection by sunlight reflections in twilight are developed and explored at the DLR Institute of Technical Physics (DLR-TP). With this initial information from the debris, object tracking is undertaken allowing for high-precision laser-based ranging measurements from various facilities of our institute. The recorded data is employed in our numerical models for orbit prediction and serves for conceptual work on ranging station network architectures for reliable orbital data striving to an exhaustive coverage of a multitude of small debris objects down to sizes of only a few centimeters.

While our activities on space situational awareness respond to the demand for more comprehensive capabilities in collision avoidance, related maneuvers can only be carried out if at least one of the conjunction partners can actively be maneuvered. For the initially mentioned mutual collisions among different space debris objects, this is not the case – yet. In principle, such objects might be movable remotely from ground using light-matter

interaction processes like photon pressure or laser ablation, induced remotely from a high-power/high-energy laser on ground. Conceptual studies on laser-driven collision avoidance are presented which open up the perspective to even de-orbit a multitude of debris fragments using ground-based lasers.

Whereas future high-power laser systems for space debris removal still require substantial development efforts, the potential of passive-optical observations for space sustainability should not be underestimated: Temporal intensity fluctuations of the sunlight reflected from debris can already reveal valuable information on its rotational behavior. Hence, these light curves are analyzed in order to support in-orbit capture missions – serving as well for space sustainability by active debris removal.

Dr. Stefan Scharring studied physics at the University of Freiburg, Germany, where he received his diploma degree in 2000. From the University of Stuttgart, Germany, he received his PhD degree in aerospace engineering in 2013 for his thesis on laser-thermal propulsion. Dr. Scharring works as a laser scientist at DLR in the field of numerical modelling. His expertise comprises numerical simulations on laser-matter interaction in the fields of laser propulsion and space debris remediation. Moreover, laser safety aspects as well as weather analysis for outdoor laser operations have been part of his expertise in recent studies.

Nanosatellite Technologies for Space Situational Awareness (SSA)" by Dr. Regina Lee

Abstract: Space systems play an important and integral role in every facet of our daily lives, including national security and resource management. Therefore, it is critical to protect our valuable assets in space through space surveillance and build resiliency in space systems. In this presentation, an overview of technology advancement in the space research, in particular, nanosatellite (smaller than 10 kg) missions for space surveillance are discussed. Most significant advancement in nanosatellite technologies came alongside the advances in microsystems technologies. It has been a focus of our research team at York University, to develop a series of nanosatellite technologies that will lead us to an advanced scientific mission in near future. Several technologies are under development including optical phased array design, sun sensor development and star trackers. In particular, our recent effort is on (1) nanosatellite attitude control system and (2) resident space object (RSO) detection and identification using a wide field of view cameras such as star trackers. Two key technologies – digital sun sensor design on IRIS mission (Geology mission on a CubeSat platform) and RSONAR mission onboard Stratos Balloon platform are presented as examples of technology development for space-borne scientific missions.

In developing a digital sun sensor (DSS), significant improvements in the design is enabled by advanced microsystems fabrication and optical sensing technologies. For the IRIS mission, we developed a simple single-slit DSS concept with improved accuracy using sub-pixel interpolation. In considering the DSS design, we focused on several characteristics of the sun sensor, including field-of-view, sensor accuracy, complexity, and computational requirements. From the simulation study, the optimal mask design was determined based on the simple geometry of the slit size, mask height and pixel width. The final demonstration from the in-orbit operation of IRIS is expected once the communication to the satellite is established. Second payload, RSONAR technology demonstration payload, Resident Space Object Near-space Astrometric Research (RSONAR) is a star tracker-like, wide FOV camera combined with commercial off-the-shelf (COTS) hardware to image RSOs from the stratosphere, overcoming the disadvantages of ground-based observations. This newly developed payload in a 2U-CubeSat form factor was flown as a space-ready payload on the CSA/CNES stratospheric balloon research platform to carry out algorithm and functionality tests in August 2022. Results and lessons learned from the campaign are described in the presentation.

Dr. Regina Lee, Professor of Space Engineering *at York University*, has led numerous projects in the area of satellite technologies including the design of micro-sensors and actuators, micro-spectrometer development, solar panel technology demonstration and attitude control design for nanosatellites. Her research focuses on the

application of micro-systems technologies in satellite design in close partnership with a number of industry and government research partners including DRDC, Honeywell, Magellan and MSCI.

Space Robotics-based ISAM to Support Space Debris Mitigation" by Dr. Angel Flores-Abad

Abstract: Thousands of space objects are orbiting the Earth, and exponential growth is expected in the following two decades. Some of those objects are spacecraft that got broken, malfunctioned or ran out of fuel. In any case, inoperational satellites are part of the hundreds of pieces of space debris that place a high risk of collision in orbit. Therefore, active methods for space e removal and mitigation are required. Space robots have been raised as an option to capture space malfunctioning space objects for repair and refueling. Not only that, but with the increasing capabilities to manufacture and assemble objects in orbit, new efforts to build tools or manufacture the broken components in orbit are also becoming an avenue to repair space assets and as a result, reduce space debris now and in the future. In this presentation, such as efforts are aligned in the context of ISAM (In-space Servicing Assembly and Manufacturing). The presentation also introduces different cases where space robots show the potential to support space debris mitigation actively.

Dr. Angel Flores-Abad is an assistant professor at the Aerospace and Mechanical Engineering Department at the University of Texas at El Paso and a researcher at the Aerospace Center at the same institution. His area of interest lies in Robotics and Autonomous systems for space, aerial, and industrial applications. He has worked to provide autonomous capabilities in the NASA asteroid robotic sampling mission, AFRL, and DLR's EPOS (European Proximity Operations System). His research has been sponsored by DOE, NSF and NASA. Dr. Flores-Abad is a member of the AIAA (Space Automation and Robotics Technical Committee).