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# SATELLITE AND SPACE COMMUNICATIONS

<http://committees.comsoc.org/ssc/>



IEEE  
COMMUNICATIONS  
SOCIETY



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SSC Newsletter

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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).

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# SATELLITE & SPACE

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## - JOIN US -

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

### ONLINE MEETING URL:

<https://zoom.us/j/91842398316?pwd=RXc3VlIjUD-FEUIh0RWVHTFoyQT09>

**Time:** Friday, Dec 18, 2020  
07:30 AM - 9:00 AM EST (NEW YORK)

## GLOBECOM 2020 SSC Committee Activities: Symposium on Selected Areas in Communications:

**SAC-SSC1** *Wednesday, December 9, 11:00 - 12:30 Taipei, Taiwan Time Zone*

**SAC-SSC2** *Wednesday, December 9, 14:00 - 15:30 Taipei, Taiwan Time Zone*

**SAC-SSC3** *Wednesday, December 9, 16:00 - 17:30 Taipei, Taiwan Time Zone*

**SAC-SSC4** *Thursday, December 10, 11:00 - 12:30 Taipei, Taiwan Time Zone*

**SAC-SSC5** *Thursday, December 10, 14:00 - 15:30 Taipei, Taiwan Time Zone*

## Future SSC Meetings

June 2021, Montreal, Canada  
December 2021, Madrid, Spain

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## HOW TO JOIN SSC COMMITTEE AND MAILING LIST

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**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>.

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## SSC COMMITTEE OFFICERS

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## MESSAGE FROM THE CHAIR

*Dr. Song Guo*

I am thrilled to have been appointed as Chair of the Satellite and Space Communications (SSC) and would like to express my best gratitude and heartfelt thanks to the SSC TC Officers Selection and Nomination Committee as well as all members, who have given their full trust and confidence to me for this privileged position. I will definitely devote myself to continued development of SSC TC.

I'd like to take this opportunity to especially appreciate the outstanding services from our former Chair, Prof. Tomaso de Col, who have served the TC chair for two terms and have promoted important initiatives, enhanced high visibility levels as well as improved quality of effect. Without his diligent works, we cannot have the fruitful achievements so far.

Prof. Pascal Lorenz and Prof. Mianxiong Dong will serve as Vice Chair and Secretary of SSC for the next term respectively. We are excited and honored to enroll in service and looking forward to your help and advices to continue improve our TC as well as our members' professional career.

It is worth noting that there is a growing trend in the number of attendees in the TC meetings, showing that the interest in our TC activities is increasing and are attracting potential new members. The management approach of SSC has been improved to attract even more audience to further increase the visibility. In addition, we have extended our cooperation to both industries, academia and standardization organizations. We are also witnessing a rapidly growing in the subscription to our website and mailing list. SSC also actively proposing special issues, conference tracks, as well as standardization activities. Special thanks to my predecessors and congratulation to all

contributors who have made such great achievements, cheers!

There are many new initiatives being considered and will be planned afterward. In the big data era, more topics will be explored to embrace the power of artificial intelligence across extended geographical areas. Topics of interests are listed but not limited to:

- Air-space-ground integrated networks
- Edge for satellite
- Full virtualization
- Inventions in physical layer such as intelligent reflecting surface, full-duplex communication, etc.
- Integration with 6G ecosystem
- Distributed learning system over satellite and space communication

There is a lot we can reverie and implement to carry out the importance role of satellite and space communication in next years. And related research and disseminations will for sure appear in the next ICC and Globecom conferences.

I am keen to hear from you via numerous ways to participate with SSC, to help boost our TC to higher levels. As we all agree, this is surely a reciprocal and rewarding endeavor and I sincerely hope you will join us in a series of affairs. We are always looking for more volunteers to actively engage in various aspects of the TC. It is truly a privilege to Chair SSC with glorious traditions, experts and partners. I will actively explore and keep creating chances for both virtual and real modes to supporting our members in being professional success and toward a promising satellite communication community.

*Dr. Song Guo*

*Satellite and Space Communications TC*

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**SCANNING THE WORLD**

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*Pascal Lorenz*

The Starlink satellite broadband Internet access project proposed by SpaceX will soon compete with Amazon's Kuiper constellation.

Following the authorization granted by the U.S. Federal Communications Commission (FCC), this latter has announced an investment of 10 billion dollars to build its Kuiper satellite network, which should consist of a network of 3,236 satellites. The Kuiper satellite network would benefit mobile network operators for the deployment of 5G and other services.

The Starlink constellation, which has already 500 satellites in orbit, plans a network of 42,000 satellites for a total cost of 10 billion dollars. SpaceX also received this year the authorization from the International Telecommunication Union (ITU) to equip its network of 12,000 satellites. To counter the problem of light pollution, Elon Musk proposes to equip its satellites with sunshades.

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**FORTHCOMING  
GLOBECOM AND  
ICC CONFERENCES**

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**COSPONSORING / RELATED  
CONFERENCES AND WORKSHOPS**

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**GLOBECOM 2021**

*December 7-11, 2021, Madrid, Spain*

<http://globecom2020.ieee-globecom.org/>

IEEE GLOBECOM 2020 - 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. Each year, more than 2,900 scientific researchers and their management submit proposals for program sessions to be held at the annual conference. 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.

**ICC 2021**

*June 14-18, 2021, Montreal, Canada*

<http://icc2021.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, the conference being finally attended by 1500 - 2000 professionals from all around the world. 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 2021 - Featuring the latest developments in telecommunications from a technical perspective.

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**CONFERENCES CALENDAR**


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CONFERENCE	DATE & LOCATION	INFORMATION
<b>SPECTS 2021</b> International Symposium on Performance Evaluation of Computer and Telecommunication Systems	TBD	<a href="http://atc.udg.edu/SPECTS2021/">http://atc.udg.edu/SPECTS2021/</a>
<b>ITC 2021</b> 33 <sup>rd</sup> International Teletraffic Congress	Aug. 31st - Sep. 3rd 2021, Avignon, France	<a href="http://itc33.org/">http://itc33.org/</a>
<b>CITS 2021</b> International Conference on Computer, Information and Telecommunication Systems	July 29-31, 2021, Istanbul, Turkey	<a href="http://atc.udg.edu/CITS2021/">http://atc.udg.edu/CITS2021/</a>
<b>ICL-GNSS 2021</b> International Conference on Localization and GNSS	1-3 June 2021, Tampere, Finland	<a href="https://events.tuni.fi/icl-gnss2021/">https://events.tuni.fi/icl-gnss2021/</a>
<b>PIMRC 2021</b> IEEE International Symposium on Personal, Indoor and Mobile Radio Communications	13-16 September 2021, Helsinki, Finland	<a href="http://pimrc2021.ieee-pimrc.org/">http://pimrc2021.ieee-pimrc.org/</a>
<b>Ka-Band/ICSSC 2021</b> The 26th Ka and Broadband Communications Conference and the 38th International Communications Satellite Systems Conference (ICSSC)	September 27 -30, 2021, Arlington, USA	<a href="http://www.kaconf.org/">http://www.kaconf.org/</a>
<b>VTC-Spring 2021</b> 2021 IEEE Vehicular Technology Conference (VTC-Spring)	25 - 28 April 2021, Helsinki, Finland,	<a href="https://events.vtsociety.org/vtc2021-spring/">https://events.vtsociety.org/vtc2021-spring/</a>

**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/>.

## Standards for Optical Space Communication

Dr. D. Giggenbach, German Aerospace Center (DLR)

The interest in optical inter-satellite communication and optical data links from satellites or space probes to the ground has increased significantly in recent years. The focus here is on point-to-point connections, which are typical for data repatriation and bidirectional communication, i.e. Earth observation missions as well as connections in satellite networks ("mega-constellations"), or their connection to the terrestrial Internet. The advantages of increasing the carrier frequency from the radio spectrum to the optical or infrared range around 1  $\mu\text{m}$  wavelength lie primarily in the extreme bundling of the transmitted beam power. This leads to several advantages such as very high data rates, and an increase in power efficiency which in turn reduces the required transmission power and mass or volume of communication terminals. Secondary effects are the greater security against eavesdropping by the small footprint of the signal (spot size on the ground is only a few meters in diameter at distances from low-earth orbit - LEO), or the applicability of photonic effects such as secure quantum key transmission. In the case of connections through the Earth's atmosphere (i.e. down or up links), its disruptive influence must be taken into account, i.e. cloudiness, attenuation, and index-of-refraction turbulence [1].

The optical *European Data Relay System (EDRS)* is currently used for Earth observation satellites that continuously send their data via LASER links to satellites in geostationary orbit (GEO), in order to be transmitted to the ground via Ka-band. This procedure has less delay and offers more data throughput than the data downlink to dedicated RF ground stations (as is common in LEO missions), which but can only take place when the satellite comes close to them. Further scenarios are currently being tested, such as the direct optical high-rate downlink from a Cube-Sat (PIXL-mission with OSIRIS4Cube as optical transmitter, launch beginning of 2021) or OSIRISv3 which is to be utilized on the International Space Station from 2022 on.

In order to ensure the global use of different optical ground stations, the transmission methods are standardized. This is currently happening in the international association of various space agencies *Consultative Committee for Space Data Systems - CCSDS*. So-called blue books are currently being created for the physical layer and for the synchronization and coding layer above. The procedure for High Photon Efficiency (HPE) is aiming at deep-space communication scenarios, while the Optical On/Off-Keying procedure (O3K) is defined for near-earth LEO downlinks. Wavelength ranges as well as data rates, modulation formats or coding methods are specified [2].

HPE requires complex technical processes both in reception (large receiving telescopes with a diameter of several meters and highly sensitive superconducting nanowire single-photon counting detectors), and in the data format (such as pulse position modulation and highly efficient error protection methods). This makes it possible to ensure a high transmission rate (e.g. up to several 100 Mbps from a Martian distance) despite the extremely demanding link budget of hundreds of millions of kilometers.

O3K, on the other hand, benefits from relatively short distances of only a few thousand kilometers from the LEO to the ground, so it can achieve several gigabit transmission rates with standard technologies - such as avalanche photo detectors and relatively small telescopes less than one meter in diameter. Forward error correction algorithms such as Reed-Solomon codes or specialized low-density parity check (LDPC) algorithms are used for error protection. Fluctuations in reception power (caused by air-turbulence) are compensated for with long interleavers [3]. In the future,



adaptive optics methods will be used to enable the received light to get directly coupled into a communication fiber on ground.

A special feature of O3K downlinks to the ground is the asymmetric link budget: low Tx antenna-gain of small transmitter telescopes in space (few centimeters) can be compensated by moderately larger receiver telescopes on the ground. In addition, the proximity of the atmospheric refractive index turbulence to the ground causes different disturbance-qualities in the down- and the up-link, which can be beneficially approached with appropriate mitigation methodologies. In an optical inter-satellite link, however, this situation does not exist. The standard "High Data Rate Links (HDR)" provided for this purpose will be used in the GEO relay over moderate distances (40 thousand to 70 thousand kilometers), or up to the moon. Recommendations for the EDRS procedure (BPSK at 1064nm wavelength), as well as for a second procedure at 1550nm wavelength, are defined in CCSDS. Communication partners of HDR are GEOs, LEOs, aircraft/UAV, and lunar satellites and stations.

These compelling developments in optical communication for space will make data transmission in future much faster and more efficient.



Laser Downlink Scenario from a miniaturized Transmitter Terminal on a CubeSat.  
Image Credits: DLR

### Acknowledgements:

Standardization work described in this text is carried out in the Consultative Committee for Space Data Systems (CCSDS)

### References:

- [1] D. Giggenbach, et al, "Optical on-off keying data links for low Earth orbit downlink applications". Satellite Communications in the 5G Era, IET TELECOMMUNICATIONS SERIES, 79. ISBN 978-1-78561-427-9.
- [2] B. Edwards, et al, "An Update on the CCSDS Optical Communications Working Group". Proceedings of ICSOS-2019. IEEE Xplore Digital Library. IEEE International Conference on Space Optical Systems and Applications, 14.-16. Oct 2019, Portland, USA.
- [3] CCSDS Blue Book "OPTICAL COMMUNICATIONS PHYSICAL LAYER RECOMMENDED STANDARD", CCSDS 141.0-B