

IAF SPACE COMMUNICATIONS AND NAVIGATION COMMITTEE (SCAN)

1. Introduction

The IAF Space Communications and Navigation Committee deals with all aspects of space-based systems, services, applications, and technologies for communication and navigation. This includes fixed, broadcast, high-throughput, mobile, optical, and quantum communication, and position, velocity, and time determination and tracking for navigation.

2. Latest Developments

Satellite constellations are being built over the world. SpaceX continues to deploy its Starlink constellation with over 3800 operational satellites in the first quarter of 2023. OneWeb completed its initial satellite constellation with 618 satellites, the last group of satellites being launched in India.

Telesat's Lightspeed LEO broadband constellation is expected to employ 188 satellites in a combination of polar and inclined orbits, providing complete global coverage for high-speed low latency digital service. At the end of 2022, the Israel-based company Spacecom successfully completed data transmission-related testing with data rates over 50 Mbps and average latency below 30 millisecond on the phase 1 Lightspeed demonstration satellite. Pandemic related manufacturing delays and other issues will likely postpone the start of Lightspeed service to 2026.

NASA's Deep Space Optical communications (DSOC) technology demonstration will be integrated in the Psyche project to be launched in October this year. DSOC aims to test high-data-rate laser communications and demonstrate its feasibility to replace radio communications for high throughput applications.

Quantum communications continues to be a major area of research. Chinese research institutes in cooperation

with the Chinese National Space Science Center (NSSC) are working to develop a medium-high orbit satellite to allow for the development of a new quantum communication network through the combination of high and low orbit satellites in the future. Advances in satellite quantum technology are also pursued in other regions such as in Europe and Canada. The building of European Quantum Communication Infrastructure (EuroQCI) started in January 2023 with deployment of national quantum key distribution networks. EuroQCI will have a strong space segment. Regarding this space segment, the EU announced at the end of 2022 a €6 billion EU project for satellite communications called Infrastructure for Resilience, Interconnection and Security by Satellites (IRIS2). Moreover, ESA plans to demonstrate and validate quantum key distribution technologies from Low Earth Orbit to the ground through the Eagle-1 mission to be launched in 2024 as well as promoting the TeQuantS project to develop quantum technologies for future quantum information networks and cybersecurity applications with the first ground stations built in 2026. In parallel, the Canadian Quantum Encryption and Science Satellite

(QEYSSat) is aimed to be launched in 2024-25 and will demonstrate quantum key distribution (QKD) in space.

Indian Space Research Organisation (ISRO) is planning to introduce L1 band signal in the upcoming Navigation using Indian Constellation (NavIC) satellites to enhance the interoperability of the constellation with GNSS. The Interface Control Document for this new signal has been published recently. This new SPS signal will use Synthesized Binary Offset Carrier (SBOC) modulation scheme and is interoperable with other L1C services.

Galileo, EU's GNSS has started the delivery of its High Accuracy Service (HAS) on the 24 January 2023. Galileo is now the first GNSS providing free-of-charge, high accuracy Precise Point Positioning corrections

worldwide both through the Galileo signal in space (E6-B) and via the internet. HAS expected to support development of innovative applications – from farming to drone navigation and autonomous driving.

In anticipation of increased user demands of navigation services ESA is planning to explore LEO satellites for Position, Navigation and Timing (PNT) services. These satellites will be significantly smaller than the MEO-based counterparts. It is expected that the proposed LEO-PNT will complement the existing GNSS services and provide faster position fixes and resilient PNT services.

3. Breakthroughs

LEO satellite mega constellations to provide Internet services are getting larger. Starlink and OneWeb are currently leading the way in this field with successful launches and deployment of hundreds of small satellites into orbit. Starlink is the most extensive constellation up to the present time with more than 3,800 satellites in orbit. OneWeb has reached the threshold for global coverage in March this year, with more than 600 satellites in orbit.

Artificial Intelligence is increasingly becoming a part of people's lives. This is also reflected in satellite

communications and navigation projects where the applicability of AI techniques is being analyzed. As an example, the Hera mission to be launched in 2024 to perform a detailed post-impact survey of the Dimorphos asteroid after the successful NASA's DART mission in September 2022, will use AI to steer itself through space. As time goes on, it can be expected that more and more space missions integrate AI- powered components.

4. Action plan for the year

During the 2023 Spring Meetings in Paris, the committee reviewed the small overlap of topics with the B6 Small Sats symposium. The discussions of holding a joint session on communication and navigation in Small Sats is on-going with B6. This idea will be pursued, potentially for IAC 2024 or later.

The committee discussed various opportunities for activities beyond IAC symposium sponsorship. In particular, plans were made to create a playlist of SCAN-related Youtube videos to be posted on the IAF site. In addition, plans were made for SCAN member to create individual 5-minute introduction videos, which will be posted on IAF site. Progress will be reported at the IAC 2023.