

## IAF SPACE COMMUNICATIONS AND NAVIGATION COMMITTEE (SCAN)

### 1. Introduction

The IAF Space Communications and Navigation Committee addresses 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. Summary

Expansion of services and development of technologies in space communications and navigation is an important part of ongoing space activities, including the return to the Moon. Telecommunications satellite operators continue to grow on their current orbit or new orbits by developing new satellites and building partnerships. Optical communication has a growing role in satellite communication. More research projects are being implemented on quantum key distribution (QKD) over satellites and artificial intelligence (AI) for optimized use of communication satellite constellations. Growing number of nano-sat constellations for Internet-of-Things (IoT) creates new opportunities for emerging satellite manufacturers.

### 3. Highlights

Laser Communications Relay Demonstration (LCRD), NASA's first technology demonstration satellite for a two-way laser relay system that launched into geostationary orbit in 2021, was certified to conduct tests in May 2022. Experiments are measuring the long-term effects of the atmosphere on laser communications signals, assessing the technology's applicability for future missions, and testing on-orbit laser relay capabilities.

Among several important space communication and navigation related events during the IAC 2022 in Paris, ESA and SES signed the Eagle-1 contract. Eagle-1 will be

[the first] European quantum communication satellite with a planned launch date in 2024.

On 26 September 2022, NASA's Double Asteroid Redirection Test (DART) mission demonstrated intentional kinetic impact on an asteroid to change the trajectory of the asteroid. This final phase of the mission relied on a Small-body Manoeuvring Autonomous Real Time Navigation (SMART Nav) system, which performed autonomous vision-based navigation, guidance and control of the DART spacecraft to find Dimorphos and impact it. This mission demonstrated fully autonomous navigation capability in a deep space mission for the first time.

The European GNSS system Galileo is in the demonstration phase for two new services. The new first service is the Galileo Open Service Navigation Message Authentication (OS-NMA), which started its public observation phase in November 2021 targeting receiver manufacturers, apps developers and research organizations. The data authentication function is freely accessible to users' worldwide, making sure that the data received is indeed from Galileo and has not been modified in any way. The OS-NMA SiS is provided globally with good availability and results were presented by the receiver manufacturer u-blox at the EU Space week in Prague on the 28 September 2022. At the same event, Japanese manufacturer TOPCON presented their first results from the second new service, the Galileo High Accuracy Service (HAS). The Galileo HAS will provide free of charge high accuracy Precise Point Positioning (PPP) corrections through the Galileo signal (E6-B) and by terrestrial means (Internet) offering real-time improved positioning with accuracy less than two decimeters.

NASA and ESA are continuing the effort of establishing the Lunar Communication and Navigation Service (LCNS) through their LunaNet and Project Moonlight missions, respectively. NASA has recently published the

LunaNet architecture and interoperability document. Through simulation, ESA has demonstrated that less than 10 m of 3-sigma accuracy is achievable on the Lunar surface using LCNS. NASA and the Italian Space Agency (ASI) are working on the Lunar GNSS Receiver Experiment (LuGRE) to demonstrate GNSS-based PNT capability on Moon. LuGRE will use Software Defined Radio (SDR) receiver to acquire weak GNSS signals at Moon and utilise high-performance tracking, processing and navigation algorithm to provide a PNT solution. ESA-SSTL Lunar Pathfinder mission will use a similar GNSS receiver NAVIMOON to achieve high precision orbit determination accuracy in lunar orbit.

#### 4. Future Outlook

Integrated LCRD Low-Earth Orbit User Modem and Amplifier Terminal (ILLUMA-T) will be delivered on board of International Space Station in 2023, to bring laser communications to the orbiting laboratory and empower astronauts living and working there with enhanced data capabilities. ILLUMA-T will gather information from experiments aboard the station and send data to LCRD at 1.2 gigabits per second.

Quantum communication will have a growing importance, and different technologies and protocols will be tested in space environment. One of the most exciting resources is the entanglement, which will be used for quantum key distribution (QKD) and quantum internet as well. The importance of the field is shown not only by the growing numbers of related projects but with the Nobel Prize in Physics 2022 that was awarded to three physicists working with quantum entanglement.

With the ever-increasing number of LEO satellites, it has become essential to incorporate a robust collision avoidance mechanism in commercial satellites, which requires reliable and high-precision navigation and tracking solutions. Upcoming years will see an increase

in demand for near real-time availability of tracking data of space objects for better space traffic management (STM).

LEO constellation-based PNT solution has seen a growing interest. While Xona Space Systems and OneWeb are working towards developing new PNT system architectures with optimized design parameters for LEO-based constellations, LEO signals-of-opportunity-based approaches are also being explored.

NASA is developing Search and Rescue (SAR) capabilities for the Artemis moon missions. Based on the experience of Cospas-Sarsat, an international satellite system for distress alerting established in 1979, with nowadays SAR payloads on GNSS MEO satellites and various GEOs around the earth. Developing this kind of Lunar Search and Rescue (SAR) service is highly relevant as Lunar PNT (or Lunar GNSS) is also under development and synergies, compatibility and interoperability between this kind of systems in cislunar space are under consideration.

#### 5. Committee activities

During the Committee's IAC 2022 meeting, the Committee addressed potential content overlap with other symposia. Actions are planned to coordinate with specific symposia, with a goal to improve the abstract selection process by helping authors to properly identify location for their submissions.

The Committee is exploring the opportunity to begin several activities beyond the IAC symposium. In particular, we are pursuing the creation of SCAN-related playlist of Youtube videos, individual SCAN member introduction videos, and eventually some webinars. Progress will be reported at the IAF Spring Meetings 2023.