Interoperability Plenary

Meeting of IOP-5 at

London, United Kingdom

20 – 22 June 2023

COMMUNIQUÉ

Background

The first international Interoperability Plenary (IOP-1) was convened in June 1999 at the Headquarters of the European Space Agency (ESA) in Paris, France. As a result of that meeting, the Interagency Operations Advisory Group (IOAG) was established to achieve cross-support across the international space community and to expand the enabling levels of space communications and navigation interoperability.

The National Aeronautics and Space Administration (NASA) hosted the second IOP (IOP-2) in December 2008 in Geneva, Switzerland, at which the governmental space agencies engaged in space communications interoperability and reviewed the progress made by the IOAG on issues related to cross support and interoperability. A communiqué was issued providing resolutions for guiding the future direction of the IOAG and its related activities, in preparation for a third IOP, to be held in the next 4-5 years. This included the creation of a draft Solar System Internetwork (SSI) Operations Concept and a mature architectural proposal for review and endorsement at the third Interoperability Plenary meeting.

The third IOP (IOP-3) was hosted by the Centre National d'Etudes Spatiales (CNES) in June 2013 in Toulouse, France, at which the governmental space agencies engaged in space communication interoperability reviewed the progress made by the IOAG on issues related to cross support and interoperability since IOP-2. The report comprised the progress related to the interaction between the IOAG and various international bodies and the progress to some key technology items (26 GHz frequency band for LEO missions, mission operations services, optical link communications, space internetworking, spacecraft emergency cross support, etc.) that led to the creation of a Mission Operations Systems Strategy Group charged with producing a service catalog to be submitted and adopted at IOP-4.

The fourth IOP (IOP-4) was hosted by Deutsches Zentrum für Luft- und Raumfahrt (DLR) in December 2018 in Munich, Germany to receive the progress report of the IOAG regarding the recommendations made during IOP-3. On this occasion, the IOP recommended the creation of a Sustainability of Operations in Space Group, encouraged the expansion of the IOAG membership, and promoted a closer interaction with commercial providers.

The fifth IOP (IOP-5) was hosted by the United Kingdom Space Agency (UKSA) in June 2023 in London, United Kingdom, to receive the progress report of the IOAG regarding the recommendations made during IOP-4 and to provide guidance for future IOAG endeavors, as summarized in the sections below.

IOP-5 Meeting Summary

The IOP-5 meeting was attended by participants from CNES (France), CSA (Canada), DLR (Germany), ESA (Europe), JAXA (Japan), KARI (Republic of Korea), NASA (United States), and UKSA (United Kingdom). In addition, the representative from ASI (Italy), although unable to attend in person, provided significant contribution to the IOP-5 preparation.

Delegates received reports on the IOAG's accomplishments to date and deliberated on the future course that the IOAG should take through consideration of activities and proposals from the IOAG's working groups and liaisons. The delegates acknowledged the good work performed by the IOAG and the importance of new technologies for future communications and navigation scenarios. The delegates endorsed the role of the IOAG as a focal point for communications and navigation-related issues that concern the various participating agencies and provided various recommendations that are documented in a set of IOP-5 resolutions.

As a consequence of the reports/presentations provided and the subsequent deliberations of the IOP-5 delegates during the meeting, the IOP-5 unanimously adopted the following resolutions.

IOP-5 RESOLUTIONS

On 22 June 2023, the IOP-5 meeting in London, United Kingdom, unanimously adopted the following acknowledgements and resolutions:

Resolutions related to the proposed evolution of the Interagency Operations Advisory Group (IOAG):

The IOP acknowledges:

- the good work of the IOAG in the past years and its achievements, for example in the area of lunar communications architecture and the consolidation of service catalogs;

- the expertise that is in the IOAG and the usefulness of the IOAG as a forum to exchange communications and navigation-related information that involves the participating space agencies.

Therefore, the IOP resolves that:

1. participating agencies provide continued support to IOAG activities consistent with IOP resolutions;

2. the IOAG continue to pursue efforts to achieve cross support across the international space community and to expand the extent of space communications, navigation, and mission

operations interoperability. Particular attention shall be devoted to promoting interoperability in the context of Lunar communication and position, navigation, and timing (PNT);

3. the IOAG continue efforts to expand membership and participation to include additional national space agencies.

Resolutions related to the Leadership Forum themes

The IOP discussed the following themes: Interoperability in a Changing Space Landscape, Commercialization and Cooperation, Future Trends in Communication and Navigation, and Safety and Sustainability in Space Operations.

The IOP acknowledges:

- the benefits of a closer interaction with commercial providers and operators for the promotion of interoperable services;

- that agencies have a role in the pursuit of interoperability within the broad community and in particular with commercial providers—a role that relies on sound leadership as well as the establishment of partnerships;

- that timely availability of internationally recognized standards represents an essential step for achieving interoperability and an enabler of new commercial services, provided these standards lead to efficient implementation;

- the benefit of developing and implementing optical communications, PNT technology, and Delay/Disruption Tolerant Networking (DTN);

- the steady increase observed in the number of conjunction events requiring avoidance maneuvers, in particular in low Earth orbit.

Therefore, the IOP resolves that:

1. the IOAG continue in its role to assess promising space operations technologies and to provide recommendations for their development, standardization, and utilization answering the needs of the agencies' programs and projects;

2. the IOAG continue to pursue the establishment of mechanisms to engage with relevant commercial providers;

3. the agencies share technical and operational experience and collaborate in their development, demonstration, and subsequent infusion into missions;

4. The IOAG study the challenges associated with conjunction avoidance maneuvers for operators.

Resolutions related to the liaisons with other international organizations

In regard to its relationship with the Consultative Committee for Space Data Systems (CCSDS):

The IOP acknowledges:

- the improved processes and the important technical accomplishments that have been achieved by the CCSDS agencies;

- the CCSDS work to develop critical standards to enable the development of strategic interoperable mission-enabling capabilities;

- that a healthy discourse enhances the products of both IOAG and CCSDS.

Therefore, the IOP resolves that:

1. for the topics that are under the cognizance of the IOAG, the IOP encourages further cooperation between the two organizations;

2. the CCSDS is encouraged pursue a timely process for the production of new standards in response to the priorities identified by IOAG.

In regard to its relationship with the International Committee on Global Navigation Satellite Systems (ICG):

The IOP acknowledges:

- that the success of many international space missions, from LEO into cislunar space, is dependent on Global Navigation Satellite Systems (GNSS) capabilities for positioning, navigation, and timing;

- the developing importance of GNSS as a contributor to robust PNT in the cislunar environment and the need for coordination between lunar PNT providers and GNSS providers to ensure interoperability, compatibility, and availability of PNT for cislunar users;

- the benefits to the IOAG observer member status to the ICG and endorses its role as the provider of the database of IOAG missions utilizing GNSS.

Therefore, the IOP resolves that:

1. the IOAG continue the liaison with the ICG and to build on the coordination it enables, including developing additional collaboration opportunities such as interoperability workshops;

2. the IOAG and ICG collaborate on the use of GNSS and future interoperable lunar PNT systems, including identification of required standards;

3. the IOAG organize a multilateral workshop with the International Committee on GNSS (ICG) to provide an international coordination venue for GNSS providers and lunar communications and navigation providers.

In regard to its relationship with the International Space Exploration Coordination Group (ISECG):

The IOP acknowledges:

- the role of the IOAG as the forum for identifying common needs across multiple international agencies for coordinating space communications and navigation architecture, high-level procedures, technical interfaces, and other matters related to interoperability and cross-support;

- the progress made by the IOAG in the establishment of a positive relationship with the ISECG and recommends ensuring compatible mission plans;

- the advancement of the reference communications and navigation architecture for lunar missions as a good example of this cooperation.

Therefore, the IOP resolves that:

1. IOAG and ISECG continue strengthening this relationship through activities such as collaboration on ISECG products that align future exploration visions with expected capabilities;

2. the liaison continues between the two organizations to ensure future space exploration missions are efficiently supported, e.g., to prepare a communications and navigation architecture for future Mars exploration scenarios.

In regard to its relationship with the Space Frequency Coordination Group (SFCG):

The IOP acknowledges:

- the important accomplishments that have been achieved by the SFCG in cooperation with IOAG;

- the role played by SFCG in the assignment of relevant frequency bands and in the frequency coordination for lunar and Martian missions.

Therefore, the IOP resolves that:

1. IOAG members continue pursuing SFCG goals for International Telecommunication Union (ITU) World Radiocommunication Conference 2023 (WRC-23) and beyond by ensuring that the positions of their national frequency management authorities are aligned with the SFCG position;

2. the liaison continue between IOAG and SFCG, with a focus on the cooperation related to lunar and martian missions and encourages further cooperation between the two organizations.

Resolutions related to the IOAG working groups

In regard to the work of the Committee to Study LunaNet Governance (CSLG):

The IOP acknowledges:

- the decision by the IOAG member agencies to establish LunaNet as the international lunar Internet having a publicly available (open) architecture to provide communications, position, navigation, and timing (CPNT) services to cislunar users based on international standards;

- that LunaNet will be implemented as a network-of-networks accessible by all cislunar users, independent of the terrestrial Internet, with international contributions from governmental, commercial, and other stakeholders that, consequently, requires international coordination and collaboration for planning and operation;

- the Committee may make recommendations that involve changes to the IOAG's scope and operation.

Therefore, the IOP resolves that:

- the IOAG-led Committee to Study LunaNet Governance (CSLG) shall provide a final report that will define and recommend how to establish, operate, and sustain the governance of LunaNet, while meeting the objectives of the study in accordance with the architectural and process guiding principles defined in the CSLG Terms of Reference;

- CSLG shall consult with subject-matter experts from stakeholder organizations and partner with other organizations including academic institutions, non-governmental organizations, and commercial associations and companies as required.

In regard to the work of the Internet-of-Things Working Group (IoTWG):

The IOP acknowledges:

- the interest of and benefit to the agencies and industry of a simple and cost-effective Internet-of-Things (IoT) near-permanent connectivity solution;

- that the above connectivity solution is a viable method to improve the timeliness, operations, and interoperability between all involved parties;

- the need for the identification of required space and ground technologies and the operations approach to support the above items;

- the need for enhanced coordination of frequency assignments and licensing in the context of IoT.

Therefore, the IOP resolves that:

1. the delegates will encourage their national frequency coordination and licensing agencies to coordinate the relevant regulatory processes.

2. the IoTWG develop high-Level ConOps and architectures for IoT communication between LEO Spacecraft and ground communication and relay systems, including the identification of relevant standards, technology development and security needs.

In regard to the work of the Security Working Group (SWG):

The IOP acknowledges:

- the importance of secure interoperability, and the interoperability of security services, in the space environment where multiple government and commercial providers simultaneously operate and provide services;

- that government and commercial providers must simultaneously provide for secure operations of their own assets, while offering interoperable and secure space communications, PNT, and networking services to other users who are granted access to the provided resources.

Therefore, the IOP resolves that:

1. the Security Working Group shall be established to collaborate across multiple space agencies and ensure that secure interoperability and adherence to agreed-upon standards become a high

priority for all organizations and countries embarking on lunar or deep space missions and/or providing internetworking or ground network support for such missions;

2. the Security Working Group include IOAG Agency technical representatives, representatives of Agency security offices, and representatives from target missions and other internetworking or ground network communities of interest.

In regard to the work of the Lunar Communications & Navigation Working Group (LCNWG):

The IOP acknowledges:

- the importance of interoperability in the cislunar environment where multiple government and commercial providers are expected to simultaneously operate;

- that LunaNet will provide a framework for communications and PNT services based on associated interoperability standards and specifications.

Therefore, the IOP resolves that:

1. the IOAG Lunar Communications and Navigation Working Group shall provide independent review and guidance to ensure that the goals of LunaNet interoperability and adherence to documented standards are maintained as a high priority while multiple commercial and government service providers are established for operation in cislunar space.

In regard to the work of the Mars and Beyond Communications Architecture Working Group (MBCAWG):

The IOP acknowledges:

- the importance of interoperability for deep space communications and navigation so that multiple ground and space networks expand the available combined capacity to respond to the needs of deep space missions, due to the time, effort and cost required to build and operate these large deep space apertures, which are in relatively short supply.

Therefore, the IOP resolves that:

1. the IOAG Mars and Beyond Communications Architecture Working Group shall collaborate across the multiple space agencies and commercial providers to ensure that interoperability and adherence to agreed-upon standards remain a high priority for all organizations and countries embarking on deep space missions or providing support for such missions.

In regard to the work of the Mission Operations Systems Strategy Group (MOSSG):

The IOP acknowledges:

- the interest of and benefit to the agencies in future joint missions with a high degree of interoperability between the agencies' mission operations functions;

- the IOAG/MOSSG Interoperability Demonstration effort among three (3) Agencies (CNES, ESA, and NASA), which completed a proof-of-concept demonstration of format-based and service-based approaches to interoperability per Service Catalog #3;

- that an interface gateway approach is a promising method to implement Service Catalog #3 services and data exchanges and also supports the integration of legacy systems;
- (cyber) security as a critical aspect of an interoperability environment as established by the interoperability demonstration effort conducted by IOAG/MOSSG.

Therefore, the IOP resolves that:

1. the IOAG shall pursue participation from more Agencies to take advantage of the interoperability demonstration environment created during the initial IOAG/MOSSG interoperability demonstration effort and increase the capability set of Service Catalog #3 services on the gateway;

2. an additional perspective that needs considering when discussing mission operation interoperability is the cloud environments/deployments and a future study is highly recommended;

3. the IOAG is charged to foster the infusion of mission operations interoperability services.

In regard to the work of the Service Catalog Working Group (SCWG):

The IOP acknowledges:

- the importance of the agreement on common services based on open standards to enable interagency cross support in an efficient and reliable manner;
- the recent updates to streamline Service Catalog #1 (cross support between two agencies).

Therefore, the IOP resolves that:

1. all member agencies shall work towards full implementation of all Service Catalog #1 core services;

2. the Service Catalog Working Group continue its work on updating and extending Service Catalog #2 (internetworking services), stressing the growing importance of Delay/Disruption Tolerant Networking-based services in the context of current lunar activities and the long-term vision of establishing a Solar System Internet;

3. the Service Catalog Working Group closely cooperate with the related IOAG working groups and committees, the upcoming programs for lunar communication and navigation services, and external groups.

In regard to the work of the Spacecraft Emergency Cross Support Working Group (SECSWG):

The IOP acknowledges:

- the interest of and benefit to the member agencies in establishing a standardized operating process for SECS services and in using this Standard Operating Procedure (SOP) in spacecraft emergencies;
- the importance of planning primary and backup support and of relying on SECS services only in the event of unforeseeable, potentially mission-ending circumstances.

Therefore, the IOP resolves that:

1. the IOAG members continue their work to implement SECS services;

2. the SECSWG shall continue exploring opportunities for engaging with commercial providers to utilize the IOAG SOP to implement spacecraft emergency support;

3. space agencies develop mission-unique or general agreements for the implementation of emergency cross support.

In regard to the work of the Sustainability of Operations in Space Working Group (SOSWG):

The IOP acknowledges:

- the results of the SOSWG, its report, and related public outreach;

- long-term sustainability of operations in space can only be achieved if all actors, including non-IOAG members, apply measures towards this goal.

Therefore, the IOP resolves that:

1. the recommendations of the SOSWG laid out in the domains of space debris, collision avoidance, end-of-life activities, spectrum and interference are considered within the definition of future policies, plans, and procedures that satellite builders, operators, and service providers will adopt;

2. long-term sustainability of operations in space be achieved via international collaboration and agreements leading to an internationally agreed-upon Space Traffic Management approach;

3. the IOAG work with the agencies' activities related to safety and sustainability;

4. the IOAG collaborate on safety and sustainability efforts with other entities such as Inter-Agency Space Debris Coordination Committee, the UN Committee on the Peaceful Uses of Outer Space and the UN Office of Outer Space Affairs, the SpaceOps community, industry associations and academia.

Next steps

The IOP requests the IOAG to release by mid-2025 an interim report on the progress in the implementation of the IOP-5 recommendations.

Acknowledgements

The IOP and IOAG delegates express their gratitude to the UKSA for the excellent facilities provided and the perfect arrangements made for hosting the IOP-5.