Meeting of IOP-4 at
Oberpfaffenhofen, Germany
18 – 20 December, 2018

COMMUNIQUÉ

1. Background

The first international Inter-Operability 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 in order 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 communication interoperability 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 Inter-Operability Plenary meeting.

The third IOP (IOP-3) was hosted by le 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 the 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) That led to the creation of a Mission Operations Strategy Group charged to produce a service catalog to be submitted and adopted at IOP-4.

The fourth IOP (IOP-4) was hosted by the 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 the IOP-3 and to provide guidance for the future IOAG endeavours.

2. IOP-4 Meeting Summary

The IOP-4 meeting was attended by participants from ASI (Italy), CNES (France), CNSA (China), CSA (Canada), DLR (Germany), ESA (Europe), JAXA (Japan), KARI (Republic of Korea), NASA (United States), ROSCOSMOS (Russia), UAESA (Emirates) and UKSA (United

Kingdom). 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 subgroups and liaisons. The delegates acknowledged the good work performed by the IOAG and the importance of new technologies for the future communications scenarios. Besides the delegates endorsed the role of the IOAG as a focal point for communications related issues that concern the various participating agencies and provided various recommendations that are documented in a set of IOP-4 resolutions.

3. Resolutions

As a consequence of the reports / presentations provided and the subsequent deliberations of the IOP-4 delegates during the meeting, the IOP-4 unanimously adopted the following resolutions.

IOP-4 RESOLUTIONS

On 20 December 2018, the IOP-4 meeting in Munich, Germany, unanimously adopted the following Resolutions:

Resolutions related to the Liaisons with other International Organizations

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

1. The IOP recognizes the improved processes and the important technical accomplishments that have been achieved by the CCSDS agencies.
2. The IOP supports the CCSDS work to develop critical standards to enable the development of strategic interoperable mission enabling capabilities.
3. For the topics that are under the cognizance of the IOAG, the IOP encourages further cooperation between the two organizations, and a healthy discourse that enhances the products of both IOAG and CCSDS.

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

1. The IOP recognizes the important accomplishments that have been achieved by the SFCG in cooperation with IOAG and encourages further cooperation between the two organizations for the upcoming World Radiocommunication Conference 19 (WRC-19) and beyond.
2. The IOP resolves to urge IOAG members to continue pursuing SFCG goals by trying to ensure that the position of their national frequency management authority is aligned with the SFCG position for the International Telecommunication Union (ITU) WRC-19 in ITU and regional preparatory meetings, and to focus on:
    i. the protection of Space Research Service (SRS) and Earth Exploration-Satellite Service (EESS) stations from the International Mobile Telecommunications 2020 (IMT-2020) as per Agenda Item (AI) 1.13 via an ITU-R recommendation on proposed coordination methodology, regulatory text proposing a review of IMT-

2020 parameters during deployment, limits on IMT-2020 station emissions, and facilitating future SRS/EESS earth station deployment and licensing;

ii. the protection of SRS stations from High Altitude Platforms (HAPS) as per AI 1.14 via HAPS separation distances or Power Flux Density (PFD) masks;

iii. the protection of EESS passive sensors from adjacent band emissions of both IMT-2020 and HAPS via appropriate unwanted emission limits.

3. The IOP resolves to urge IOAG members to liaise with their national frequency management authority for inclusion of clauses on coordination areas and future developments of SRS/EESS earth stations operating in the 26, 32, 37 and 40 GHz bands in the national frequency plan depending on WRC-19 decisions on AI 1.13 and AI 1.14.

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

1. The IOP recognizes that the success of many international space missions is dependent on Global Navigation Satellite Systems (GNSS) capabilities.
2. The IOP acknowledges the benefits to the IOAG observer member status to the ICG and endorses its role as the provider of the GNSS Payload database.
3. The IOP recommends the IOAG continue the liaison with the ICG.

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

1. The IOP recognizes and endorses the role of the IOAG as the forum for identifying common needs across multiple international agencies for coordinating space communications architecture, high-level procedures, technical interfaces, and other matters related to interoperability and space communications.
2. The IOP recognizes the progress made by the IOAG in the establishment of a positive relationship with the ISECG and approves the objectives of the IOAG to avoid duplication of activities and to consolidate this relationship.
3. The IOP acknowledges the provision of the reference communications architecture for Lunar missions as a good example of this cooperation.
4. The IOP recommends that a liaison be established between the two organizations whenever this becomes appropriate, e.g. to prepare a communications architecture for the Mars mission scenario, to make use of the available skills provided by the IOAG regarding communications and operations aspects and to make sure the two organizations remain aligned on user needs and enabling standards.

<u>Resolutions related to the IOAG WGs</u>

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

1. 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.

2. The IOP reminds IOAG members of the importance of planning primary and backup support and to rely on SECS services only in the event of unforeseeable, potentially mission ending circumstances.
3. The IOP encourages the SECSWG members to continue their work to implement SECS services including investigating the current key considerations, such as RF licensing regulations and ground communications infrastructure.
4. The IOP recommends expanding the SECSWG scope to consider emergency cross support services for crewed exploration missions.
5. The IOP recommends exploring opportunities for engaging commercial providers to utilize IOAG SOP to implement spacecraft emergency support.
6. The IOP encourages space agencies to develop mission unique or general agreements for the implementation of emergency cross support.

In regard to the work of the Low Earth Orbit 26 GHz Study Group (LEO26SG):

1. The IOP recommends efficient use of the 26 GHz band by encouraging:
    a) Missions to use the expanding set of 26 GHz band ground stations for high rate data, and avoid the increasingly crowded 8 GHz band.
    b) Missions to provide received downlink power in order to characterize atmospheric propagation models for future missions and potential submission to ITU.
    c) Missions to use advanced coding and modulation schemes, in particular Variable Coding & Modulation (VCM), in order to optimize the communication system.
2. The IOP acknowledges the achievements of the study group and recommends to provide a status report at the next IOP.

In regard to the work of the Optical Links Study Group (OLSG):

1. The IOP recognizes the progress on the High Photon Efficiency (HPE) standard and encourages agencies to deploy deep space optical ground stations to share the high cost for initial in-orbit demonstrations and mission use cases.
2. The IOP recognizes the proposal for Lunar direct-to-Earth (DTE) and intersatellite link communication to use the HPE standard, and encourages the Lunar Orbital Platform-Gateway (LOP-G) project to consider this proposal for inclusion in the communication interface control document (ICD).
3. The IOP acknowledges the difficulties in establishing the Optical On/Off Keying (O3K) standard for Low Earth Orbit (LEO) DTE communication and urges the agencies to reach consensus.
4. The IOP takes note of the preparation of different High Data Rate (HDR) Experimental Specifications covering different wavelengths and signaling formats; however, it also acknowledges the ESA GlobeNet effort to accommodate a 1550 nm wavelength option, in addition to the existing 1064 nm, to facilitate a potential future convergence. The IOP recommends continuing in this direction to eventually facilitate data relay system interoperability in the long term.

5. The IOP urges agencies to share their technical and operational experience with optical communications, and to collaborate on technology developments and on-orbit demonstrations.

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

1. 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.
2. The IOP requests to complete the assessment of the Catalogue #3 and recommends to consider the implementation of Catalogue #3 services and defined data exchanges for the future missions requiring mission operations interoperability.
3. The IOP acknowledges that an interface gateway approach is a promising method to implement Catalog #3 services and data exchanges and also supports the integration of legacy systems.
4. The IOP resolves that the IOAG is charged to foster the infusion of Mission Operations Interoperability services by proof of concept demonstrations independent of missions.

In regard to the work of the Space Internetworking Study Group (SISG):

1. The IOP recognizes the value of DTN to mission scenarios (e.g., LEO) in addition to the previously identified Lunar and Mars scenarios, as evidenced by the ISS operational DTN system and plans for DTN use by upcoming LEO missions.
2. The IOP recognises the benefit to develop DTN flight implementations, including implementations that operate at the data rates of the high data rate Ka-band and optical transmission systems up to multiple Gbps.
3. The IOP emphasizes interagency demonstrations that include flight implementations and nodes at ground stations to facilitate expansion from point-to-point cross support into operational network-layer cross support.
4. The IOP recommends that Lunar and planetary relay spacecraft intended for cross support be equipped with DTN nodes to enhance future user mission operations and facilitate expansion from point-to-point services to network-layer services.

In regard to the work of the Lunar Communications Architecture Working Group (LCAWG):

1. The IOP acknowledges and endorses the Lunar communications architecture as defined by the working group and urges the working group to complete the documentation.
2. The IOP endorses the use of down-selected communication standards for enhancing the interoperability among the future Lunar missions.
3. The IOP acknowledges the need for DTN-based Space Internetworking Service, In-situ Tracking, In-situ Navigation, and Network Time to be offered by the relay assets.
4. The IOP acknowledges the IOAG's role in coordinating with the IOAG member agency's projects to leverage on the currently planned relay orbiters for providing relay services to future Lunar missions.

5. The IOP acknowledges the need for the development of required space and ground technology and the operations approach to support the above resolutions.

In regard to the proposed evolution of the Interagency Operations Advisory Group (IOAG):

1. IOAG as the operations coordinator for the future Projects such as the Exploration Program
    a. The IOP acknowledges the good work of the IOAG in the past years and its achievements, for example in the area of optical communications, including the recent development of a lunar communications and navigation architecture in coordination with the science, Earth and exploration mission community.
    b. The IOP acknowledges the expertise that is in the IOAG and supports the proposal to use the IOAG as a forum to exchange communications related information that involves the participating space agencies.
    c. The IOP urges the participating agencies to provide continued support to IOAG activities consistent with IOP recommendations.
    d. The IOP recommends that 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.
    e. The IOP recommends that the IOAG continue efforts to expand membership and participation to include other national space agencies.
    f. The IOP urges the IOAG to identify activities / WGs that can be finished before widening its scope and embarking on new topics in order to limit the effort and required resources.

2. Interaction with Commercial Providers and Operators, Academia and Emerging Space Agencies
    a. The IOP acknowledges the potential benefits of a closer interaction with commercial providers and operators of operations services.
    b. The IOP also sees potential benefits in establishing contacts to Academia and emerging Space Agencies and sees a role for the IOAG to establish and maintain these links
    c. The IOP asks the IOAG to explore options and establish mechanisms to engage with relevant commercial providers as an initial step.

3. Consideration of new technologies
    a. The IOP concurred that there is potential for substantial efficiency increase in spacecraft and ground segment operations by further automation facilitated through new technologies (e.g. artificial intelligence and cognitive networking).
    b. The IOP endorses the IOAG role to assess promising space operations technologies and to provide recommendations for their utilization.

4. Space Operations Sustainability

a. The IOP recommends that the IOAG evaluates the relevant issues and potential threats related to sustainable space operations and its implications for space traffic management initially in the vicinity of the Earth.
b. The IOP recommends that the IOAG deals with the technical and operational perspective.
c. The IOP recommends that the IOAG produces a situational report including recommendations on mitigation measures.

The IOP and IOAG delegates express their gratitude to DLR for the excellent facilities provided and the perfect arrangements made for hosting the IOP-4.