

Inter-Agency Space Debris Coordination Committee



Minutes of Meeting

IADC Working Group 1 Meeting, 12-15 June 2023, ESOC Darmstadt, Germany

List of Participants (present: 25 delegates from 11 delegations)

Agency	Name
ASI	Fabrizio Piergentili, Lorenzo Mariani, Marco Felice Monteroni, Alessandra di Cecco, Germano Bianchi, Pierluigi di Lizia, Mauro Massari,
CNES	Pascal Richard
CNSA	Rongyu Sun
CSA	Viqar Abassi
DLR	Hauke Fiedler
ESA	Tim Flohrer, Thomas Schildknecht, Jan Siminski, Delphine Cerruti-Maori
ISRO	-
JAXA	Toshi Yanagisawa, Hideaki Hinagawa
KARI	Saehan Song
NASA	Tim Payne, Heather Cowardin
ROSCOSMOS	-
SSAU	Oleksandr Kozhukov
UKSA	Adam White, Andrew Hammett, Emma Kerr

Agenda

- 1) Finalisation of Agenda
- 2) Agency status Reports
- 3) AI and IT Review
- 4) WG1/WG2 joint session
- 5) Presentations on research reports
- 6) AI/IT discussions, preparation of new AI/IT
- 7) AoB

1. Finalisation of Agenda

Finalised Agenda 20230612 version rev. 1 approved by all – see attached file

(NB: the minutes from the 40th IADC Meeting in Jeju, Korea, had already been approved in a previous teleconference (2022-10-13_IADC40_WG1_minutes_final.pdf at <https://iadc-home.org/wg1-minutes-of-meetings/view/id/243#u>)

2. Status reports

Presentations have been provided by ASI, CNES, CNSA, CSA, DLR, ESA, JAXA, KARI, NASA, SSAU, UKSA

- ASI: see attached presentation
- CNES see attached presentation
- CNSA see attached presentation
- CSA see attached presentation
- DLR see attached presentation
- ESA see attached presentation
- JAXA see attached presentations (2)
- KARI see attached presentation
- NASA see attached presentation
- SSAU see attached presentation
- UKSA see attached presentation

3. AI and IT Review

a) AI38.2 Attitude motion characterization of LEO upper stages using different observation techniques

- AI38.2 status presentation (Fabrizio Piergentili, ASI and Toshifumi Yanagisawa, JAXA)
 - See attached report
 - WG discussed on what shall we do with this data now, recollecting the original task was to collect data (achieved) and to bring WG2 and WG4 to understand behavior in orbit. WG noted the wide participation from many agencies as an achievement. The discussed question was (1) on how will WG1 continue and (2) on how data can be shared with other WGs.
 - The WG found that the AI did not provide justification to continue with further modelling, so an IT might cover this in preparation for a potential later new AI. The WG agreed to inform WG2 on the results and to discuss next steps, and to inform SG with the request to close the AI by presenting the final draft at end of the IADC meeting (**action WG chair and deputy chair**). NB: After receiving positive feedback from the SG after the meeting the WG already finalised AI38.2 for publication by the SG.
- ESA presented the efforts in support of the AI (Thomas Schildknecht, ESA)
 - See attached presentation
- ESA presented on attitude motion characterization of LEO upper stages using different observation techniques (Delphine Cerutti-Maori, ESA)
 - See attached presentation

- WG discussed the possibility to apply the method beyond radar to optical measurements, and for multi-static setups.
- The further discussion of next steps with WG2 should cover the following options that WG1 considers interesting
 - (1) Review of current data reduction and processing capabilities and (2) Common data processing exercise to exploit the completed deep survey data set /slow and fast rotators
 - Priority topic for: ASI, ESA, JAXA, SSAU (TBC), (UKSA)
 - (3) Collection of requirements from ADR / IOS and modelling
 - Priority topic for: UKSA, ASI, ESA
 - (4) Data acquisition with new facilities and labs and observations / simulation concepts
 - Priority topic for: ASI, DLR, (ESA [Radar]), JAXA, CNSA
- The WG agreed to postpone the decision to create an IT41.2 “Exploitation of data acquired in AI38.2” for priority points (1)&(2) to the next telecon (**action: WG chair and deputy chair**), and also possibly for (3) subject to further internal discussions in ASI, ESA, UKSA. The WG noted that (4) can be addressed partly in (1) for validation.

b) IT 34.1 Feasibility options to study Molniya population of space debris.

- ASI (Lorenzo Mariani)
 - See attached presentation
- ASI, DLR, ESA (Hauke Fiedler)
 - See attached presentation
- ESA (Delphine Cerutti-Maori)
 - See attached presentation
- From the discussion, the WG collected several ideas on how to proceed with this IT:
 - Time-limited precursor to see if observations and OD is possible with sensors and limit remaining survey options
 - Tumbling motion assessment and correlation to historical data
 - Beampark for searching for unknown population features
 - Separating optical data from radar data (e. g. attitude with optical);
- The IT leads consolidated the list of options for further discussion and during this the WG agreed to start with a test on current observation capabilities to narrow the options. Participating delegations in the IT have been identified in a poll: ASI; DLR; ESA, CNES, CNSA, SSAU, JAXA, UK, CSA, NASA (TBD), ISRO (to be asked, not present). The IT leads shall define tasks and expectations, i.e. How much time is required; Definition of the “test” scope and objectives; Definition of target list: orbit regime, size of object, etc.
- After the joint session with WG2, it has been agreed that the task leaders shall organize the tests and track the progress of a Molniya test observation campaign with special focus on investigating how a search volume can be constrained efficiently. The task leader shall update the task description timely and distribute via email in the WG1 (**action ASI**) The test shall run in August/September 2023.

c) **IT 37.1 Preparation for a future beampark campaign**

- NASA (Tim Payne)
 - see attached presentation
- The WG discussed the next steps and confirmed that IT30.1 shall be taken as reference for the data exchange format. A relevant question to WG2 would be to clarify “low inclination”. ASI informed that Birales without the new transmitter might not be capable of supporting this campaign, but in 2023 the 32m dish can be used in case TIRA acts as transmitter. WG asked the IT lead to clarify with ISRO whether mechanical pointing is possible (**action IT37.1 lead**).
- From the joint session with WG2 the target a low inclination below 28.5° and everything below 1m is a preferred volume. Later WG2 informed that a classical 24-hour campaign for beam park for 800-1000km altitude, i.e. skipping low inclination would be preferred. WG1 remarked that in such a case the sensors contribution will be very limited. It was agreed that WG1 considers also the classical beampark option in the further discussions, i.e. for a decision in autumn 2023.
- The further discussion revealed that a next timeframe might be actually 2024 due to funding and due to need to define the observation strategy further.
- The WG agreed that collecting a summary on best pointing of radars, collection of time constraints, funding status, etc., is essential in order to schedule a time where most participating delegations can contribute. The IT leads will prepare a first preliminary result of pointing scenarios at autumn (**action IT37.1 leads**).

d) **IT39.1 Astrometrics and photometrics data exchange format**

- As the IT was already closed in a previous WG1 telecon, the task lead SSAU (Oleksandr Kozhukhov) just summarized the finalisation.
- The WG discussed the formalization of possible further updates on the CCSDS TDM message in future releases. As there is no official link between CCSDS and IADC the WG chair shall ask SG for advise. ESA and DLR would sponsor a presentation in the CCSDS NavWG through their delegates there.
- The SG advised that the document is adapted for public release on the IADC webpage and this document is then brought to the attention of the CCSDS NavWG (**action WG chair and IT39.1 lead**). NB: action already completed during IADC meeting and ESA and DLR delegates to CCSDS took up the presentation of the document, plus further findings for radar observations in TDM.
 - See attached documents

e) **IT39.2 Permanent IT on fragmentations**

- SSAU (Oleksandr Kozhukhov)
 - see attached presentation
- ESA (Delphine Cerrutti-Maori)
 - see attached presentation
- ASI (Fabrizio Piergentili)
 - see attached presentation
- The WG discussed on how to proceed with this IT, agreeing that it is essential to keep this IT alive. It was observed that a procedure needed on how to distribute information and data of fragmentation events efficiently and effectively. The WG

also agreed to capture the lessons via the IT lead (ASI Fabrizio) with support from ESA.

- The lessons learnt have been captured and a preliminary set up of the procedure has been achieved
 - see attached slides

4. Joint Session WG1 and WG2

- The agenda for the joint session was drafted and agreed with WG2 to comprise:
 - Presentation of four key areas of common interest for WG1 & WG2 that are addressed through WG1 ITs
 - Status and conclusion of AI38.2, next steps (WG1 presentation of Status)
 - Plans for IT37.1 beam park campaigns (WG1 presentation of Status)
 - Plans for IT34.1 Molniya population of space debris (WG1 presentation of Status; WG2 presentation: Status)
 - Notification in case of fresh fragmentations IT39.2 (WG1 presentation of Status)
 - WG1 participation in the IADC re-entry test campaigns
 - Needs for data sharing means within IADC (WG1/2 discussion)
 - WG1 updates on data format
 - Protection of dark and quiet skies (WG1 and WG2 presentations)
 - New topics of potential interest
- During the joint session the WG recorded for the key areas of common interest that:
 - WG2 took note of AI38.2 status and process to close the AI. (see attached slide)
 - WG2 took note of IT 37.1 (see attached slide), WG2 provided feedback on campaign parametrization (low inclination OR high sensitivity at high elevation). For WG2 low inclination below 28.5° and everything below 1m is preference and considered helpful. WG2 will discuss and provide detailed feedback.
 - WG2 took note of IT34.1 status (see attached slide), and provided additional modelling input (See attached slide (ASI, Elisa Maria Alessi)). WG2 considers that there is a need for more and better data from fragmentation of Molniya objects. Further, attitude motion in Molniya might also be interesting. The discussion addressed the expectations of size thresholds, as radars might be limited to detect 50cm objects. It was agreed that next efforts shall start with optical survey to get a better picture from a large volume, and then shall be followed by tailored radar observations (if required). WG1 will refine the IT34.1 description.
 - WG2 took note of the IT 39.2 status (see attached slides)
- WG1 and WG2 discussed needs from a possible participation of WG1 in the IADC re-entry test campaigns, i.e. for the assessment of attitude motion.
 - WG2 expressed interest repetitive re-entries of Starlink where pattern could be derived. The new IADC re-entry web front-end allows for

- sharing more information, such as attitude data, and also supports multiple users per delegation to provide input.
- For WG1 it was important that sensors are not uniformly distributed globally, which results in limited coverages. For contribution by optical sensors the orbital characteristics are important, and the upcoming re-entries of the Cluster (4 satellites) may be a very interesting test case.
 - For WG2 even observations of the rotation state (qualitative information, excluding numerical values) would be helpful and the web front-end supports such free text.
 - WG2 informed that next re-entry test objects in 2024/2025 will be ESA's ERS2 and Cluster, as already approved by SG.
 - To support ODs in the re-entry test campaigns WG2 needs very timely data provision in the final phases of a campaign, and confirmed to WG1 that even single measurements could be helpful.
 - WG1 informed on the start of the collection of data sharing needs within IADC and will provide the identified needs to WG2 for comments.
 - WG1 update on data formats in confirming that IT30.1rev. 5 (2014) stays valid , and informed on IT39.1 results calling to update CCSDS TDM.
 - As potential new topics
 - WG1 gave an introduction to a possible support to PMD compliance assessment w. r. t. effects on upper atmosphere. ESA (Thomas) informed that this topic is brought up at UNCOUOUS and feels that IADC has to be prepared. Today, no observation is possible with traditional means, while IADC can provide estimates on the current and future flux levels. WG1 and WG2 agree that this is a topic that should be brought to SG attention, also addressing the need to estimate the mass of objects vs. number of objects and the need to understand the long-term effects.
 - WG1 presented its view on the protection of dark and quiet skies (see attached presentation) and notes that participants received requests from many organizations about prediction the prediction of space traffic and suggests that IADC shall be prepared given the combined expertise. WG2 provided a presentation on IAF STM 3.4.6 (see attached presentation), and makes reference to a recent paper by Barentine et al. <https://doi.org/10.1038/s41550-023-01904-2> , where it considers that the highlighted need for validated models should be addressed by IADC, and especially to distinguish between natural effects (small size) and fragments. WG1 and WG2 agree that SG shall be briefed on the need to support other groups with IADC expertise, i.e. for the appearance of streaks and brightness of sky background, with traffic models and space debris environmental models.
 - WG1 (Fabrizio Piergentili, ASI) provided presentation on Mega-Constellation photometry (see attached presentation)
 - After the Joint WG1/WG2 session the WG1 wrapped up and agreed to
 - proceed in closing AI38.2
 - address the findings in updating IT34.1 (see there),
 - prepare a new IT for tracking ERS-2 and Cluster (light curves and data) for further discussion in a next teleconference (**action WG chair**), ESA is asked to check the availability of satellite modelling data (**action ESA**).

- Bring the topic of dark and quiet skies to the attention of the SG (**action WG chair and deputy chair**)

5. Presentations on research efforts

- ASI Elena Velutini (remote) Flyeye telescope
 - see attached presentation
- ASI Fabrizio Piergentili LEDSAT
 - see attached presentation
- ESA Thomas Schildknecht Monitoring of small sized debris
 - see attached presentation
- ASI Pierluigi di Lizia Birales
 - see attached presentation

6. AI/IT discussions, preparation of new AI/IT

a) New Ideas

- The WG discussed the need for a potential new IT “Data sharing means”, as it was found after the 40th IADC that the sharing via IADC web page is not possible. Further, ESA informed that the previously used ESAbox is not available anymore. The WG decided to collect in a brainstorming the current needs for exchange of information and data related to WG1 business:
 - Security: limited access, not shared, prevention of malicious files, respecting potential commercial interests
 - Accessibility and availability (international)
 - Exchange of large amount of data (500Mb for one file) → request for total storage of 30Gb right now (with possible increase in the future)
 - Back-up capability for data
 - Data retention policy
 - Exchange documents, folder structure
 - Editing simultaneously documents including version control
 - Provenance information
 - Delegations to have equal roles and permissions
 - Possibility of automated of synchronization with local repositories of users

The WG agreed to share this list with WG2 and (as similar needs are anticipated) to ask for related comments. SG shall be informed on the status of the reflections in both WGs (**action WG chair and deputy chair**).
- ESA (Thomas Schildknecht) proposed to discuss with WG2 in the joint session the need to address effects on the upper atmosphere as part of PMD efforts
- ASI (Fabrizio Piergentili) proposed to discuss dark skies with WG2 to obtain a IADC view on the new subject “Light Pollution from Mega-Constellation: optical measurements and laboratory facilities”
- For a new IT 41.1 “Support of re-entry test campaigns” a draft has been prepared with IT leads UKSA and DLR, and the following delegations expressed interest in the participation: ASI, CNES [TBD], CNSA[TBD], CSA to be asked, DLR, ESA, ISRO to be asked, JAXA, NASA [TBD], ROSCOSMOS to be asked, SSAU [TBD], UKSA.

- For a new IT41.2 “Exploitation of data acquired in AI38.2” a draft has been prepared with IT leads ASI and JAXA, and the following delegations expressed interest in the participation: ASI, CNSA, DLR, ESA, JAXA, SSAU(TBC), UKSA (TBD).

b) Presentation of briefing for SG

- At the end of every meeting day, the WG prepared briefings on the progress to SG, which were delivered by chair and deputy chair at the end of every day and for the closing plenary
 - see attached presentations

7. AoB

A request from WG4 on current capabilities for space debris size sampling addressing a catastrophic collision threshold has been received during the meeting. A first preliminary reply from chair and co-chair was formulated and sent. The topic shall be further discussed at the next teleconference (**action WG chair and co-chair**).

The WG thanked ESA for the hosting and the chair closed the WG sessions of the 41st IADC meeting.