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# **Space Traffic Management**

## **The IAF initiative**

### **Status of Working Group #4.2**

**Technical regulations  
(New activities)**

**Special Session @ IAC 2021**  
Wednesday 27 October, 2021



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# Membership

WG - #:4.2

| Name           | First name     | Country  | GMT relative | Role   |
|----------------|----------------|----------|--------------|--|
| Anz-Meador     | Phillip        | USA      | -6           | coordinator, Mars extension                          |
| Singh          | Balbir         | India    | 5.5          | Coordinator, ADR                                     |
| Fu             | Yulei          | China    | 8            | subtask lead, In-Orbit Servicing (IOS)               |
| Kato           | Akira          | Japan    | 9            | subtask lead, Lunar extension                        |
| Lefevre        | Fleur          | France   | 1            | subtask lead, Spaceports                             |
| Lin            | Shen           | China    | 8            | subtask lead, Active Debris Removal (ADR)            |
| Maclay         | Tim            | USA      | -5           | subtask lead, Large Debris Traffic Management (LDTM) |
| Nassisi        | Annamaria      | Italy    | 1            | subtask lead, Space Tugs                             |
| <i>Samanga</i> | <i>Ruvimbo</i> | Zimbabwe | 2            | <i>Space Generation Young Professional</i>           |
| Santoro        | Francesco      | Italy    | 1            | subtask lead, suborbital activities                  |
| Unfried        | Christian      | Austria  | 1            | subtask lead, Just-in-Time Collision Avoidance (JCA) |

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# TC26 Task 4.2/WG7 Topics

- 4. TECHNICAL REGULATIONS
- But new activities required
  - Shall include elements related to Space Tugs, IOS, ADR, JCA, LD TM
  - Shall include sub-orbital
  - **Can** include criteria for risk based evaluations, and acceptance, of certain operations
  - May include Spaceports
  - Open to extension of the domain to Moon and Mars



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# TC26 Task 4.2/WG7 Activity Plan

Outcomes **MUST BE** REALISTIC AND ACTIONABLE

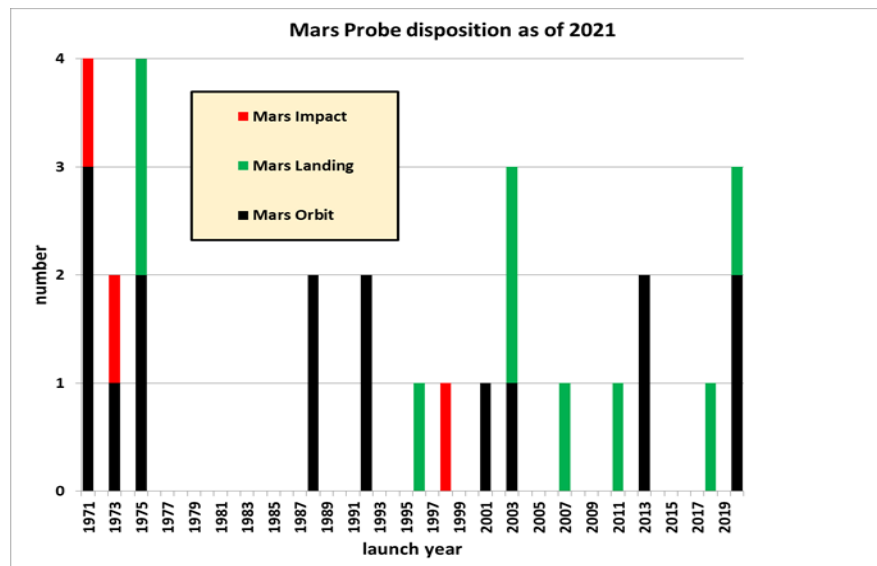
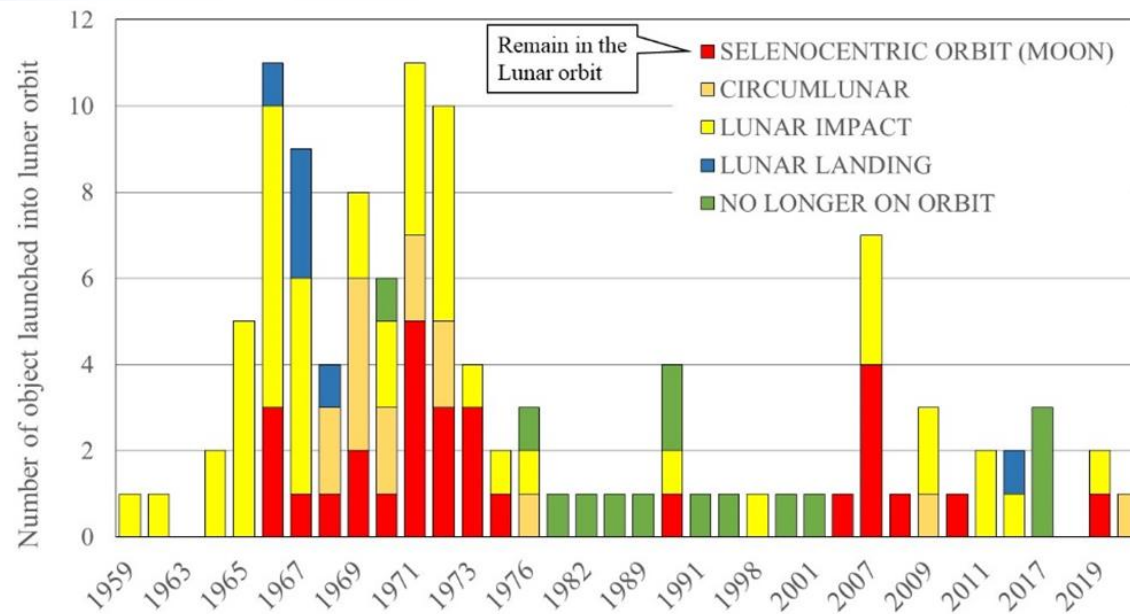
- (1) Review existing technical regulations (BASELINE for evaluation) for ADR, IOS, LDTM, *etc.*, including spaceports/suborbital/lunar (minimum)/lunar and Mars operations (maximum): *may be national, supranational/NGO, international/IGO*
- (2) Identify specific technical regulations relevant to ADR, IOS, *etc.*
- (3) Identify gaps, given known and easily anticipated technology and operational scenarios
- (4) Identify possible extension of existing technical regulations (the “old regulations”) and new regulations to address the gaps; note that these may leverage existing maritime (**IMO**) and air traffic (**ICAO**) rules, from the technical (running lights => equivalent in radar/laser, optical/IR, RF) to the organizational (call signs/International Maritime Organization registry number => call signs/registry number; Satellite-AIS, *etc.*) using available tools, including relevant visualization tools (e.g. marinetraffic.com).

## Example WG Activities

|            |                          | NEW ACTIVITIES       |                       |                                  |                                 |
|------------|--------------------------|----------------------|-----------------------|----------------------------------|---------------------------------|
|            |                          | End of Life Disposal | Active Debris Removal | Just-in-time Collision Avoidance | Large Debris Traffic Management |
| TECHNIQUES | Space Tugs               |                      |                       |                                  |                                 |
|            | Orbital Transportation   |                      |                       |                                  |                                 |
|            | Laser Ablation           |                      |                       |                                  |                                 |
|            | Laser Radiation Pressure |                      |                       |                                  |                                 |
|            | Non Destructive Impact   |                      |                       |                                  |                                 |
|            | Cloud of Particles       |                      |                       |                                  |                                 |

- New activities described using typical, historical, or logical “use cases”
- Many new activities are *cross-cutting*, enabling common technique development across multiple new activities
- Also influences regulatory compliance

# Example WG Activities



- Several new activities are more “*vertically oriented*”, including spaceport and suborbital activities and STM expansion to cislunar and Martian orbital spaces
- Suborbital activities coordinates with ICAO, IATA and other aeronautical domain authorities
- Latter extensions provide opportunity to define and optimize required **local** STM structure





# Example WG Activities

Regulation (“hard”/”soft law”)

Degree of compliance

Mission lifecycle

| Compliance Matrix TaskGroup 4.2                 |  |  |  |                               |                           |                              |                  |  |            |  |   |  |             |                  |   |   |  |   |            |                           |            |            |            |
|---|--|--|--|-------------------------------|---------------------------|------------------------------|------------------|--|------------|--|---|--|-------------|------------------|---|---|--|---|------------|---------------------------|------------|------------|------------|
| 0   | could not determine or classify            |  | subtask name & general description:                              |                               |                           |                              |                  |  |            |  |   |  |             |                  |   |   |  |   |            |                           |            |            |            |
| 1   | no coverage (~ 0%)                         |  |  |                               |                           |                              |                  |  |            |  |   |  |             |                  |   |   |  |   |            |                           |            |            |            |
| 2   | minimal coverage (~25%)                    |  |  |                               |                           |                              |                  |  |            |  |   |  |             |                  |   |   |  |   |            |                           |            |            |            |
| 3   | partial coverage (~50%)                    |  | Initiation   | United Nations                |                           |                              |                  |  |            | International Standards Organization (ISO) |   |  |             | subtask specific |   |   | International Telecommunications Union (ITU) |   |            | Relevant non-space domain |            |            |            |
| 4   | coverage with limited omissions (~75%)     |  | United Nations (UN) Long Term Sustainability (LTS) Identifier(s) | 1967 Outer Space Treaty (OST) | 1972 Liability Convention | 1975 Registration Convention | 1979 Moon Treaty | 2010 Space Debris Mitigation Guidelines (COPUOS) | UN OTHER1: | UN OTHER2:                                 | 24113 Space Systems-Space debris mitigation requirement | 24330 Space Systems-Rendezvous and Proximity Operations (RPO) and On Orbit Servicing (OOS) - Programmatic principles & practices | ISO OTHER1: | ISO OTHER2:      | EXAMPLE: Aerospace Standard (AS) 6029A – “Performance Criteria for Laser Control Measures Used for Aviation Safety” | EXAMPLE: FAA Advisory Circular (AC) 70-1 “Outdoor Laser Operations” | ITU Constitution Articles (Art.) 44 & 45     | ITU Non-planned Procedures (Art. 9 & 11) & Planned Procedures (Appendices 30, 30A, 30B) | ITU OTHER: | Maritime1:                | Maritime2: | Aviation1: | Aviation2: |
| 5   | complete coverage (~100%)                  |  |  |                               |                           |                              |                  |  |            |  |   |  |             |                  |   |   |  |   |            |                           |            |            |            |
| 6   | regulation not relevant to subtask element |  |  |                               |                           |                              |                  |  |            |  |   |  |             |                  |   |   |  |   |            |                           |            |            |            |
| Subtask   |  |  |  |                               |                           |                              |                  |  |            |  |   |  |             |                  |   |   |  |   |            |                           |            |            |            |
| subtask ground element: design                  |  |  |  |                               |                           |                              |                  |  |            |  |   |  |             |                  |   |   |  |   |            |                           |            |            |            |
| subtask ground element: implementation          |  |  |  |                               |                           |                              |                  |  |            |  |   |  |             |                  |   |   |  |   |            |                           |            |            |            |
| subtask ground element: operations              |  |  |  |                               |                           |                              |                  |  |            |  |   |  |             |                  |   |   |  |   |            |                           |            |            |            |
| subtask ground element: retirement              |  |  |  |                               |                           |                              |                  |  |            |  |   |  |             |                  |   |   |  |   |            |                           |            |            |            |
| subtask orbital element: design                 |  |  |  |                               |                           |                              |                  |  |            |  |   |  |             |                  |   |   |  |   |            |                           |            |            |            |
| subtask orbital element: implementation         |  |  |  |                               |                           |                              |                  |  |            |  |   |  |             |                  |   |   |  |   |            |                           |            |            |            |
| subtask orbital element: launch                 |  |  |  |                               |                           |                              |                  |  |            |  |   |  |             |                  |   |   |  |   |            |                           |            |            |            |
| subtask orbital element: checkout               |  |  |  |                               |                           |                              |                  |  |            |  |   |  |             |                  |   |   |  |   |            |                           |            |            |            |
| subtask orbital element: operations1 (describe) |  |  |  |                               |                           |                              |                  |  |            |  |   |  |             |                  |   |   |  |   |            |                           |            |            |            |
| subtask orbital element: operations2 (describe) |  |  |  |                               |                           |                              |                  |  |            |  |   |  |             |                  |   |   |  |   |            |                           |            |            |            |
| subtask orbital element: operations3 (describe) |  |  |  |                               |                           |                              |                  |  |            |  |   |  |             |                  |   |   |  |   |            |                           |            |            |            |
| subtask orbital element: operations4 (describe) |  |  |  |                               |                           |                              |                  |  |            |  |   |  |             |                  |   |   |  |   |            |                           |            |            |            |
| subtask orbital element: operations5 (describe) |  |  |  |                               |                           |                              |                  |  |            |  |   |  |             |                  |   |   |  |   |            |                           |            |            |            |
| subtask orbital element: retirement             |  |  |  |                               |                           |                              |                  |  |            |  |   |  |             |                  |   |   |  |   |            |                           |            |            |            |
| subtask orbital element: disposal               |  |  |  |                               |                           |                              |                  |  |            |  |   |  |             |                  |   |   |  |   |            |                           |            |            |            |
| Risk  |  |  |  |                               |                           |                              |                  |  |            |  |   |  |             |                  |   |   |  |   |            |                           |            |            |            |

- Task group developed regulatory compliance matrix (shown)
- Populated for limited number of New Technology subtasks
- Characterizes qualitative degree of compliance by regulation and New Technology mission lifecycle

# Example WG Activities

## Example of Structure/Identification of Gaps

| New Activities   | Existing Technical Guidelines Review   | Specific Technical Guidelines  | Identification of Gaps, extension, risks  |
|--|--|--|---|
| <p><b>Lunar Extension</b></p> <p><b>New Activity</b></p> <p>Clause 12 AA...same as international debris mitigation guidelines but fine study on collision probability and orbital lifetime calculation.</p> <p>NASA Document that says generation of debris be limited in Lunar, mars orbits and other specified regions</p> | <p>Moon agreement 1984 and the latest Artemis accord 2020</p> <p><b>Moon Agreement 1984<br/>Artemis Accord 2020</b></p> <ul style="list-style-type: none"> <li>• Generation of debris is limited to protection regions. What about other regions? So a detailed study is needed for criticality object density around the moon.</li> <li>• Conjunction analysis may be feasible tracked active S/C. Both active and non active tracking needs international cooperation</li> </ul> | <ul style="list-style-type: none"> <li>• The clause 12 in the Artemis accord mentions on Space Debris. It limits the generation of harmful debris released through normal operations, break-up in operational or post-mission phases, and accidents and conjunctions, as well as post-mission disposal of space structures. The concept seems as same as current international debris mitigation guidelines, but the detailed methods how to calculate the orbital lifetime or the probability of collision are left more fine study.</li> <li>• NASA-STD-8719.14B/ 4.2.1 mentions, "NPR 8715.6 requires that the generation of debris be limited in lunar orbit, in Mars orbit, and in the vicinity of Sun-Earth or Earth-Moon Lagrange Points".</li> </ul> | <ul style="list-style-type: none"> <li>• Even in the Earth orbit, the generation of debris is limited in the protection regions. Other regions are not identified to be controlled. The detail study will be needed how critical the density of orbital objects around the Moon.</li> <li>• Conjunction analysis may be feasible among the active spacecraft which are being tracked. The continuous tracking will need the co-operation with the world tracking center. Tracking the non-active debris need the support of SSA just like on the Earth, but it will take long time to facilitate such infrastructures.</li> </ul> |





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# TC26 Task 4.2/WG7 Next Steps *Highlights*

- **Key development in the near-term (1-5 years from present) include, but are not limited to:**
  - Promoting existing space debris mitigation guidelines and best practices particularly in the area of post-mission disposal;
  - Facilitating further industry standards via, e.g., the ISO, including the in-development ISO Standard 24330 “Space systems — Rendezvous and Proximity Operations (RPO) and On Orbit Servicing (OOS) — Programmatic principles and practices” and logical follow-ons.
  - Fostering the formal development of space debris remediation (ADR) guidelines, supporting documentation, analogous to the IADC Space Debris Mitigation Guidelines, and supporting Handbook.
  - Foster the continuation of best practice development but allocate resources to the establishment, within existing commercial associations equivalent to the International Air Transportation Authority (IATA), of global commercial standards and professional support to industry stakeholders;
  - Founding a UN-level mandated organization equivalent to the IMO and ICAO. This “International Spacefaring Organization” is fundamental to Space Operations Assurance (SOA) and STM



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# TC26 Task 4.2/WG7 Next Steps *Highlights*

- **Key developments over decadal time scales (10-20 years from present) are:**
  - the further development and maturation of industry and commercial associations, e.g. an IATA equivalent, and
  - a mature globally-recognized organization equivalent to the IMO and ICAO; these UN organizations have demonstrated the benefits of domain-level regulation and provide models for regulatory development and deployment.



# Outcome

- A detailed report (15 pages) on the technical regulations related to each new activity.
- Recommendations for coming 5 years and for another 10 to 20 years
- Annexures with the notable information about the old technical regulations, identified gaps, risk assessments etc.
- A editable compliance regulatory matrix based on qualitative degree of compliance by regulation and New Technology mission lifecycle.
- One page executive summary



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# Thank You

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