Zero Debris Operations Workshop - Wrap-up

27/06/2023

Multifaceted Approach to Space Debris

Awareness

- Paramount importance of ESA's space debris office efforts.

International Rules and Guidelines

- The critical role of IADC, UN COPUOS and other international conferences.
- Engagements in the slow but necessary process of implementing rules.
- Not enough by itself; a more proactive approach is necessary.

Achieving Zero Space Debris

More Stringent and Pragmatic Rules

- Role of working sessions in defining pragmatic rules.
- ESA's plan for new applicable standards by the end of the year.

Technical Evolutions

- Necessity of innovative technical development.
- Industry's commitment to implement changes cost-effectively.
- Investors' support for these developments.
- Public sector's role in covering qualification costs and mastering recurrent costs.
- ESA's roadmap for technical developments to achieve Zero Debris.

In conclusion, saving space is a shared responsibility and requires the concerted efforts of all stakeholders. Our commitment to a Zero Debris approach underlines our dedication to ensuring a sustainable future for space activities.

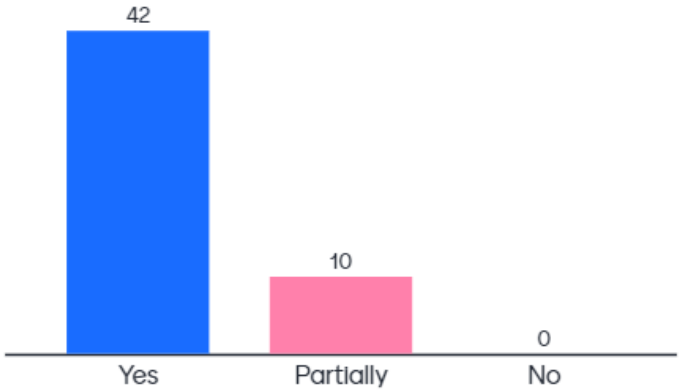
Thank you all for your participations

60 ENTITIES

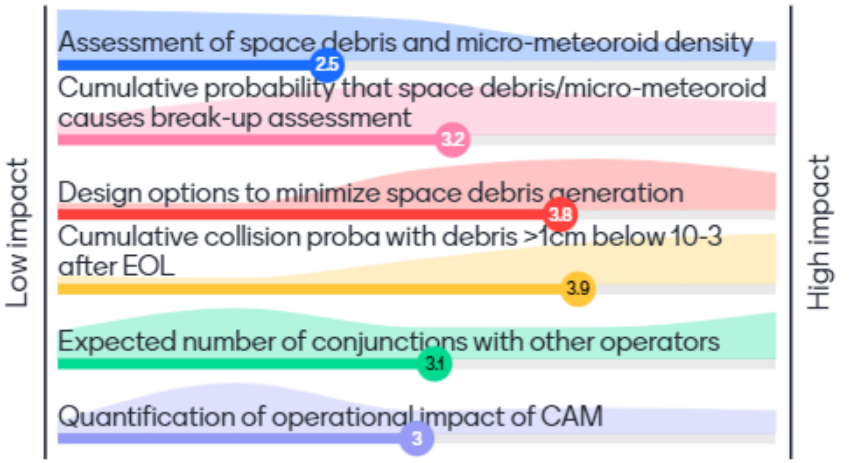
100 DELEGATES

1.1. Collision Risk Assessment and minimization (part

Do you agree with the need and rationale of these requirements?



Which of the requirements is most impactful (design, operations, cost…)?



1.1. Collision Risk Assessment and minimization (part

Main feedback

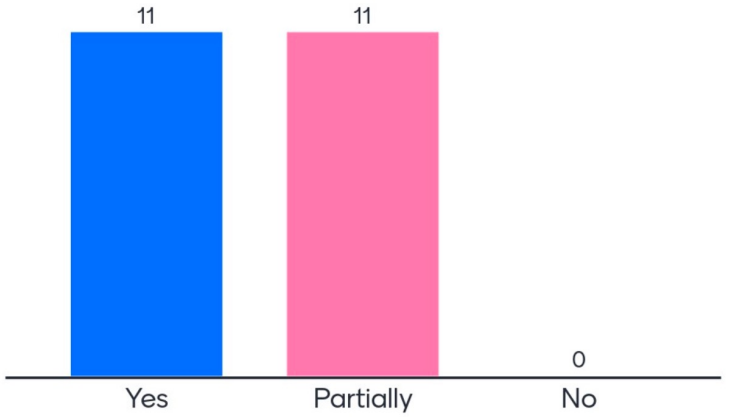
- Need for more extensive explanation of the rationale behind the **10-3 and 1cm**.
- Applicability to **MEO** and **GEO** (especially linked to the 1cm threshold)
- Specify the methodology to assess and verify the 10-3 threshold with debris >1cm.
- **Probability** of collision currently achievable versus **consequences** of collision which is the true objective

Way forward:

- Engage with further outreach on linking requirements to the state of the environment
- Specify verification methodology
- Address lack of data for impact risk

1.2. Improved Disposal strategy

Do you agree with the need and rationale of these requirements?



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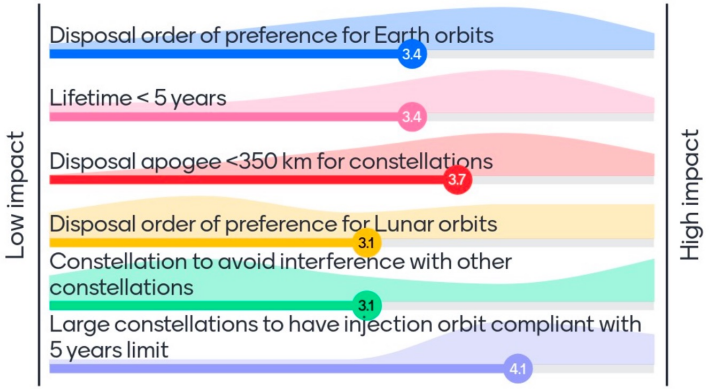


1.2. Improved Disposal strategy

Main feedback

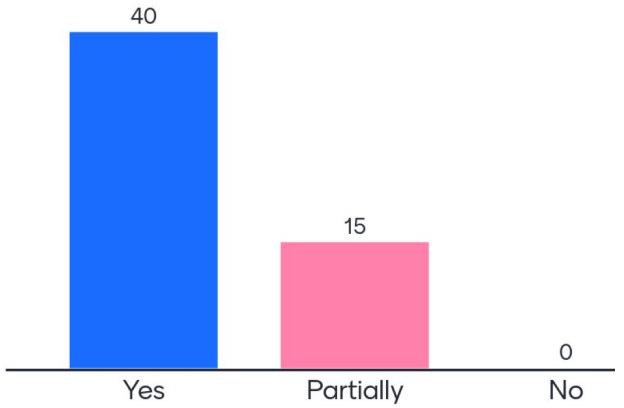
- Need unified methodology to calculate the cumulative probability of collision, and to discuss and try to coordinate with other entities using e.g. different statistical models
- Need to better define what some terms mean, e.g. “known constellations” or “average solar activity”
- Further discussion is needed about the 350km figure (disposal apogee for large constellations) to assess the impact of this figure with respect to possible alternatives (375 or 400 km)

Way forward:

- Consolidation of the requirements to be proposed following feedback
  - In particular, regarding the uncertainties and methodology for calculating the threshold of 10-3 for debris >1 cm debris CPC risk
- Engage with partners to propose a methodology to quantify the CPC risk and define the deorbit strategy that can be harmonized and used outside of ESA
- Promote technology roadmap regarding services development to support the monitoring and quantification of small debris

2.1. Collision Risk Assessment and minimization (part

Do you agree with the need and rationale of these requirements?



Which of the requirements is most impactful (design, operations, cost...)?

2.1. Collision Risk Assessment and minimization (part 2)

Main feedback

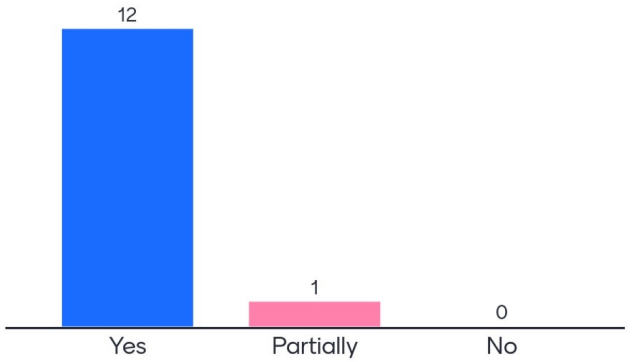
- Mostly agreement behind the need and relevance of all requirements, especially need for **better coordination** and **data sharing**
- Rationale behind the **1 day** identification works for large operators, but difficulty to comply with this requirement for **smallsats**
- Controversy about **feasibility to achieve the given positional accuracy**, depending on the methodology used.
    - **Verification method** for the positional accuracy unclear
    - Agreement that a threshold is needed, with the goal to quantify uncertainty at TCA
- Need for '**rules of the road**' at international level, which lever to be used for coordination?
- Agreement to have transparent procedures

Way forward:

- Re-evaluation of the thresholds presented
- Engage with operators and surveillance community on objectives for 2026 and 2030
- Continue engagement with international standardisation
- Investment in space surveillance system for improving the accuracy of the data

2.2. Dark and Quiet Skies

Do you agree with the need and rationale of these requirements?



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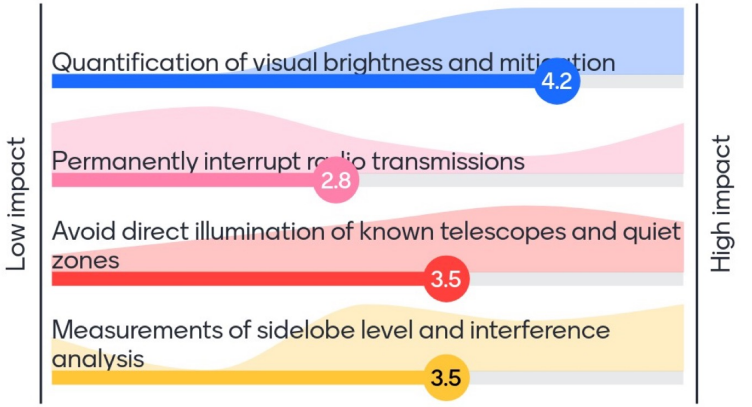


2.2. Dark and Quiet Skies

Main feedback

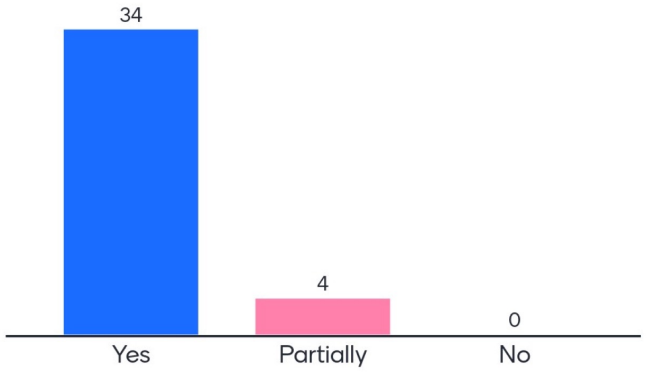
- Keep in mind other stakeholders than professional astronomers (e.g., general public or amateur astronomers)
- Possibility to complement the visual brightness requirement with others e.g. about operational solutions, as well as more details about the assessment that should be performed
- Reflect on the idea of a maximum capacity metric to safeguard astronomy
- Clarify where to find the list of active telescopes and quiet zones
- Complement current requirements asking for assessment with a request for mitigation strategy

Way forward:

- Engage with Astronomer community to consolidate user needs and discuss effectiveness of mitigation solutions (particularly for constellation design)
- Gain experience through application for soft requirement and establish the verification methodology
- Prepare technology roadmap to mitigate impacts on visual and radio astronomy and citizens

3.1. Improved Collision Avoidance process

Do you agree with the need and rationale of these requirements?



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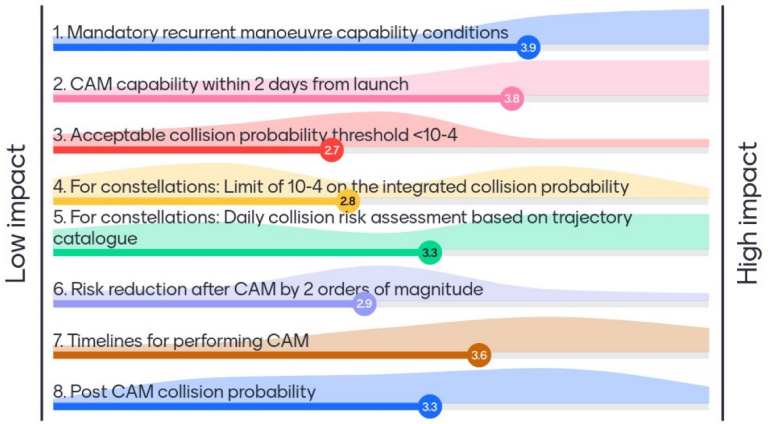

3.1. Improved Collision Avoidance process

Main feedback

- Lots of diversity in how the operators compute the PoC and act upon it, depending on the orbital regime
- Some requirements need a review of numerical threshold but having a target is the clear objective
- Need of coordination on how PoC is computed
- Importance of sharing and coordination
- “No bikes on the highway”: avoid sats with no propulsion in crowded orbits
- Diluted cases with large uncertainties should be tackled more specifically
- Need for requirements for orbit raising and its sharing of data

Way forward:

- Standardisation of collision risk assessment
- Fine-tuning of threshold as a function of orbital environment
- Foster procedures for engagement
- Target to automate in the denser orbits in the future

3.2. Probability of Successful Disposal

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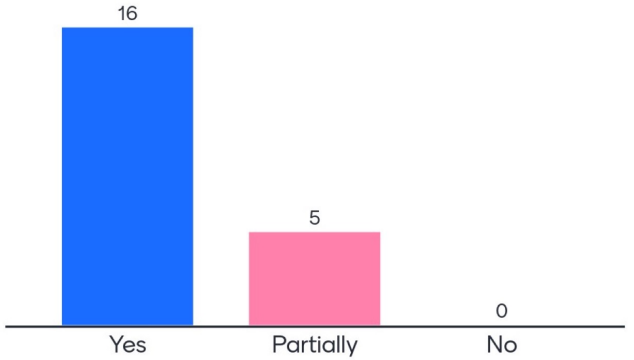

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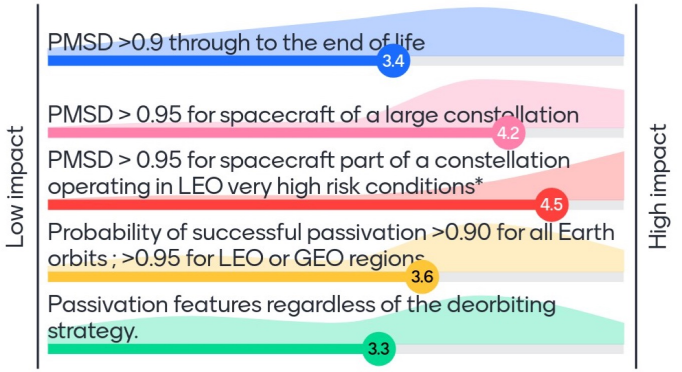


3.2. Probability of Successful Disposal

Main feedback

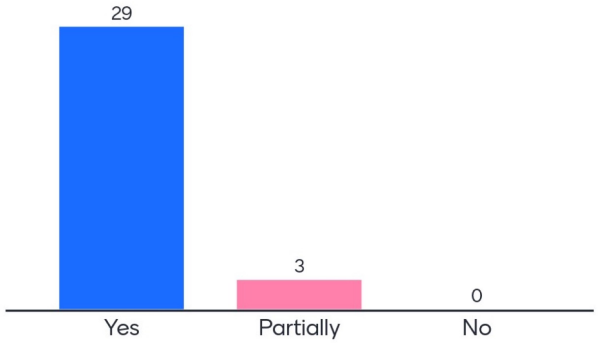
- Methodologies and standardization
- Need for higher probability of successful disposal
- Threshold for constellation: number and methodology (per satellite or aggregated)
- Need for passivation achieved either by depletion/deactivation or with passive ways

Way forward

- Update and standardize assessment methodology for reliability and debris/meteoroids impact (“common ground”, possibly exportable internationally)
- Adopting functional redundancy could be useful approach.
- “0.95 disposal” could be challenging to demonstrate through use of COTS, but data sharing, recurrent operations / return of experience, and graduality (including also penalty criteria for not meeting goals) could pave a way.
- Reliable debris removal services could compensate for unrecoverable failures.

4.1. Close Proximity Operations

Do you agree with the need and rationale of these requirements?



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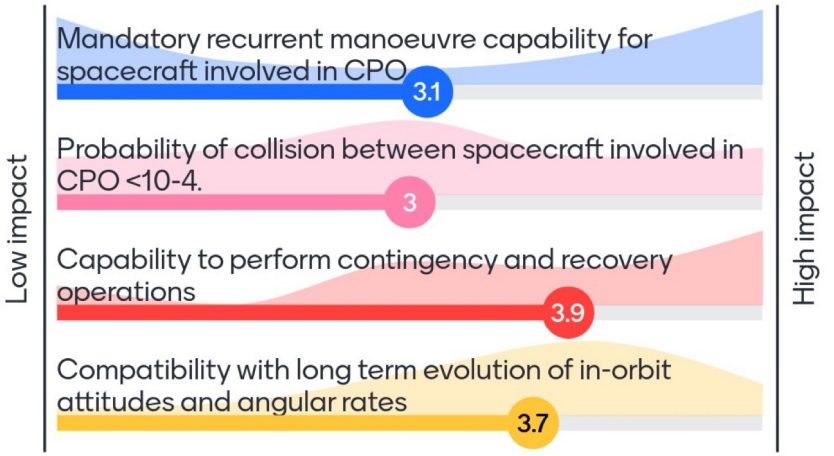

4.1. Close Proximity Operations

Main feedback

- CPO involved servicer must have recurrent manouvre capability
- "Probability of Collision" does not reflect the intention in case of missions where active engagement is foreseen →Diversify nomenclature and metric
- Idea of having different thresholds for collision risk or debris generation risk depending on the environmental benefit the mission is bringing
- Need to differentiate between cooperative and non-cooperative scenarios
- To prepare for servicing, the involvement of the prime is key and procedures should be put in place

Way forward:

- Address that CPO is a novel operation type and this to be reflected in the requirements
- Consider the maturation of the CPO guidelines into requirements
- Return on experience from current servicing missions in preparation

4.2. Health Monitoring and Mission Plan re-evaluation

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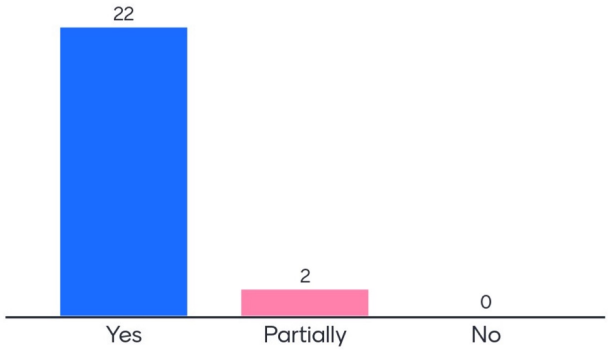

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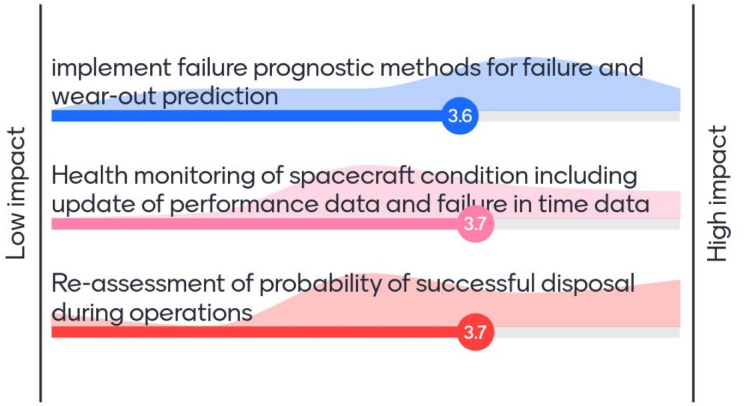


4.2. Health Monitoring and Mission Plan re-evaluation

Main feedback

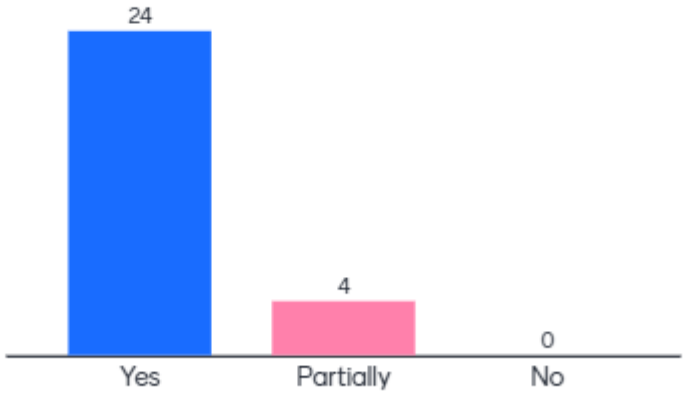
- Operators needs to systematically involve the manufacturers to understand the failure root cause (“after sale contract” needed for long-period, until disposal)
- On-ground simulations are to be representative enough
- Minimum list of key parameters needs to be exhaustively extended
- Adapt the operations to real-time environmental changes (e.g. radiation, space debris events)

Way forward:

- Improve on-board implementation (sensors) and correlation to derive trends
- Take on-orbit lessons learnt (e.g. FDIR SW update)
- Knowledge transfer to keep continuity and continuous improvement
- Machine learning / AI as opportunity

5.1. Preparation for Removal

Do you agree with the need and rationale of these requirements?



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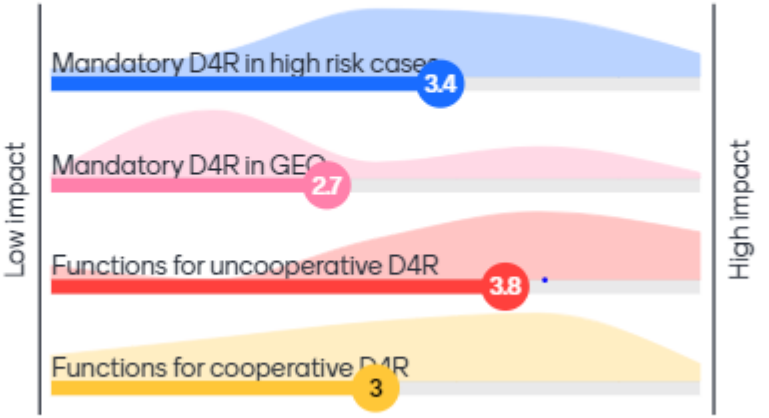


5.1. Preparation for Removal

Main feedback

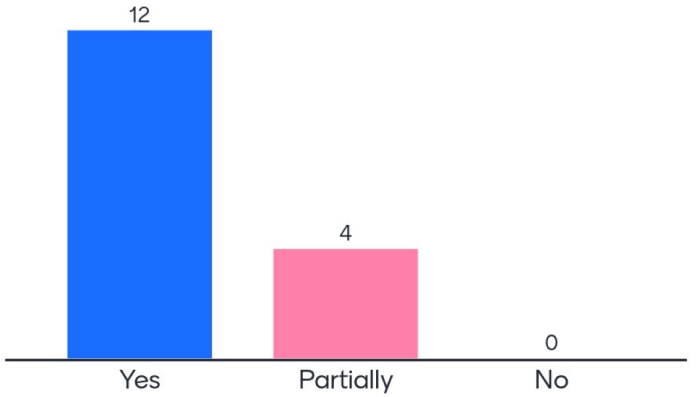
- Requirements should not be prescriptive, should define only functions
- Need to converge on interfaces in the future
- Mature attitude determination and propagation from ground, need to build know-how
- Need to incentivise detumbling functions

Way forward:

- Elaboration of the requirements with some minimum features for interfaces will be proposed
- R&D necessary to have interfaces applicable to different orbital regions
- High need to standardize and promote interoperability of the D4R interfaces
- Reconstruction of attitude on ground and detumbling technologies need to be matured and flight proven
- Engage with removal services providers to mature solutions and discuss interoperability
- Engage with removal services providers to discuss minimum information needed to be available/shared by clients

5.2. On-ground casualty risk assessment

Do you agree with the need and rationale of these requirements?



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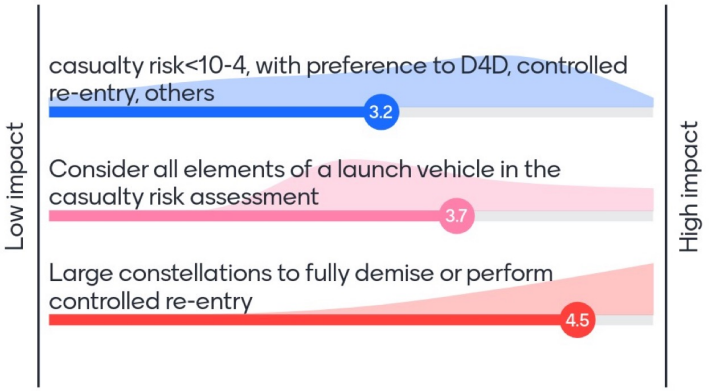

5.2. On-ground casualty risk assessment

Main feedback

- Design for demise is the preferred option over controlled re- entry
- Suggestion of assessing the impact of ablation of materials in the atmosphere
- Need of standard procedures for assessing probabilistically the expected number of casualties per re-entry
- 10-6 casualty risk on ground for large constellations: step function or progressive function based on the number of satellites?

Way forward:

- Discuss on standardised risk assessment
- Technology development for D4D
- Address open problems with atmospheric impact and air traffic safety

Take home messages

The Zero Debris is a NEED and a response to the catastrophic degradation of the Low-Earth Orbit environment.

Globally, there is **a growing need and push for stricter guidelines** (e.g. update of LOS, FCC guidelines updates, private sector best practices, etc.) **and more coordination**

These guidelines directly **influence both our present and future missions**

To maintain **competitiveness => adopt a proactive approach**

To create **platforms for data-sharing**

Objective => to engage the space sector in a collaborative effort to **consolidate the zero debris approach into a comprehensive and actionable roadmap towards 2030.**

“Embracing a zero debris approach is not an idealistic concept; it is an **absolute necessity for the future of the space industry**. ESA has taken the lead by introducing the Zero Debris approach, but we don’t simply want to lead, we want to lead by example.” ESA Director General

Next steps

- ESA will update the standard taking into account your input that will be shared with you soon

- Our objective is to build a community to craft roadmaps for the implementation of the Zero Debris approach
- This conference is the bringing together a community that should keep working together on this – this is only the beginning!

- Your participation and feedback are KEY to this process,
  - identify the necessary technologies to be developed
  - parallelly with space debris mitigation requirements.

- We’re happy to discuss the Zero Debris approach further: cleanspace@esa.int.

- Please return your badge to security! ☺

Thank you for your participation!

Let's stay in touch

#cleanspace #zerodebris #spacesafety

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