# Space Sustainability, a multidisciplinary approach- ENG- 587

*Introduction to the Space Sustainability Rating (SSR)*

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# *OUR MISSION*

Encouraging space actors to **design & implement sustainable & responsible space missions** for the long-term **sustainability of the space environment**

# *A GLOBALLY SHARED RESOURCE UNDER PRESSURE*

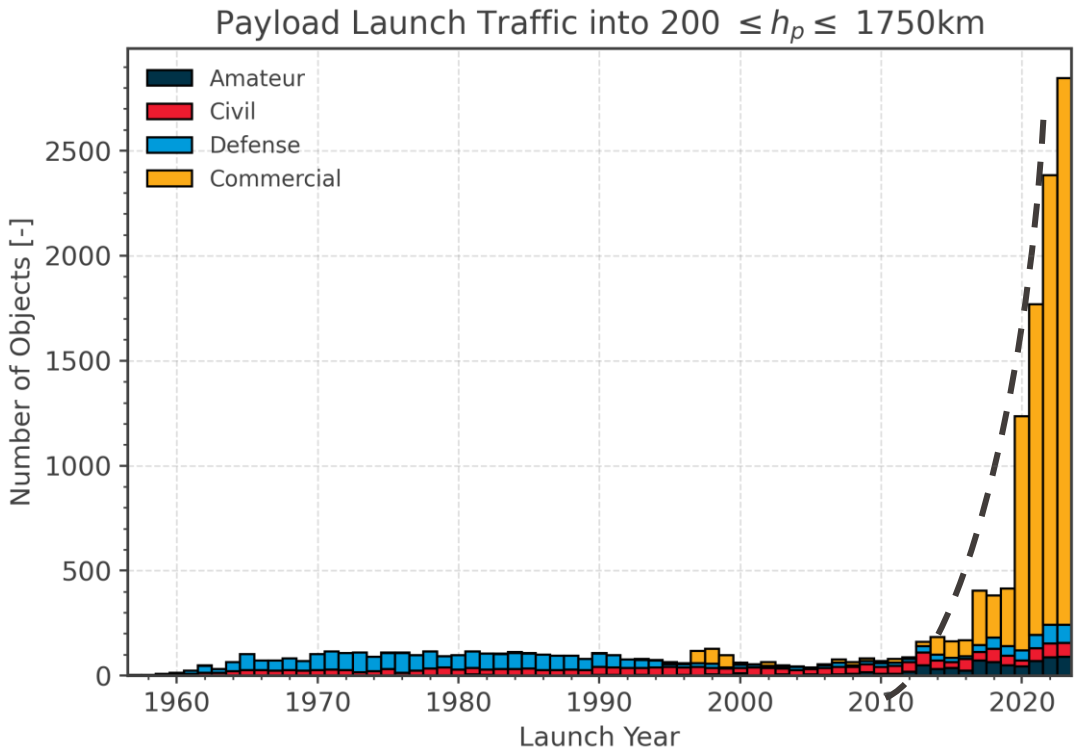
Space infrastructure & services are essential to **life on Earth**

A growing number of objects are **orbiting around earth**

Increasing awareness on the challenges raised by **space debris & unsustainable space operations**

A number of existing **international guidelines** are not enforced

# AN INCREASINGLY CROWDED SPACE ENVIRONMENT…




Source: ESA, Space Environment Statistics

***Launch traffic, 1960-2022***

**x10**

*In the last decade*

***Launch traffic forecast, 2022-2031***

**24,500**

*Satellites to be launched in the coming decade*

**+327%**

*Of active satellites the next decade*

Source: Euroconsult Satellites to be Built & Launched, 25th edition

# … THREATENING OPERATIONAL SAFETY

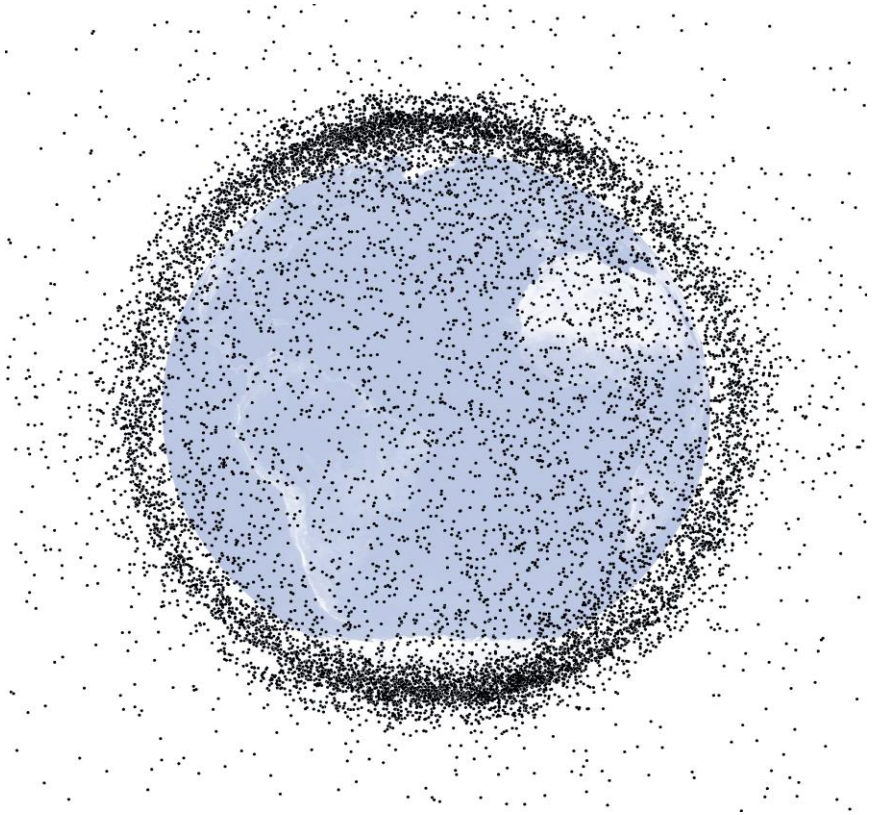
**40,500**

***Debris greater than 10 cm in size in 2024*** *(1)*

**1,100,000**

***Debris greater than 1 cm in size in 2024*** *(1)*

Source: ESA, Space Environment Statistics



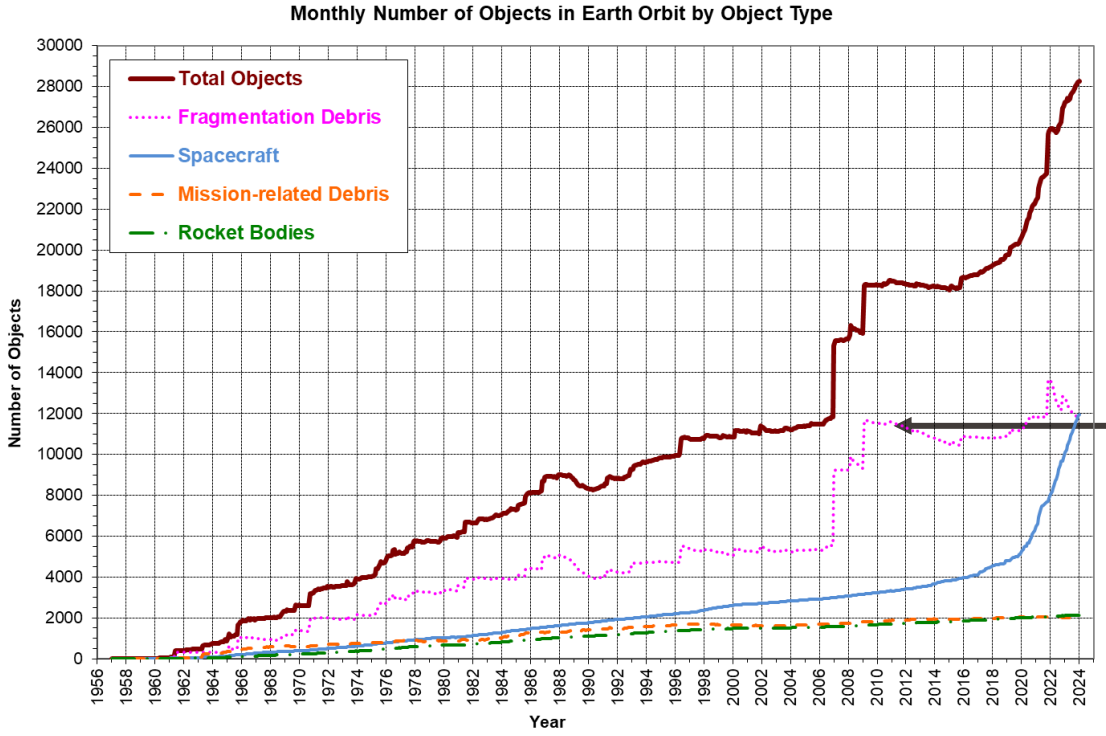
Source: NASA Orbital Debris Program Office, image based on models (debris size not to scale), 25 August 2009

**1 cm ≈**

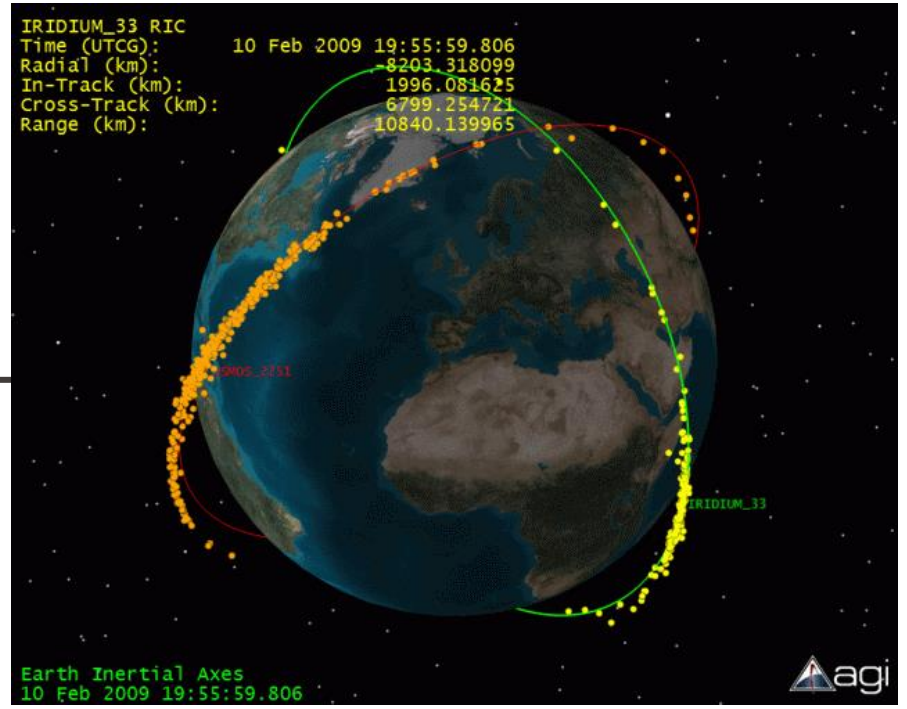
Source: ESA, effects of hypervelocity impacts

# *CATASTROPHIC COLLISIONS*

cause **significant financial losses**, create **thousands of new debris objects** and **endanger the long-term use of orbits**

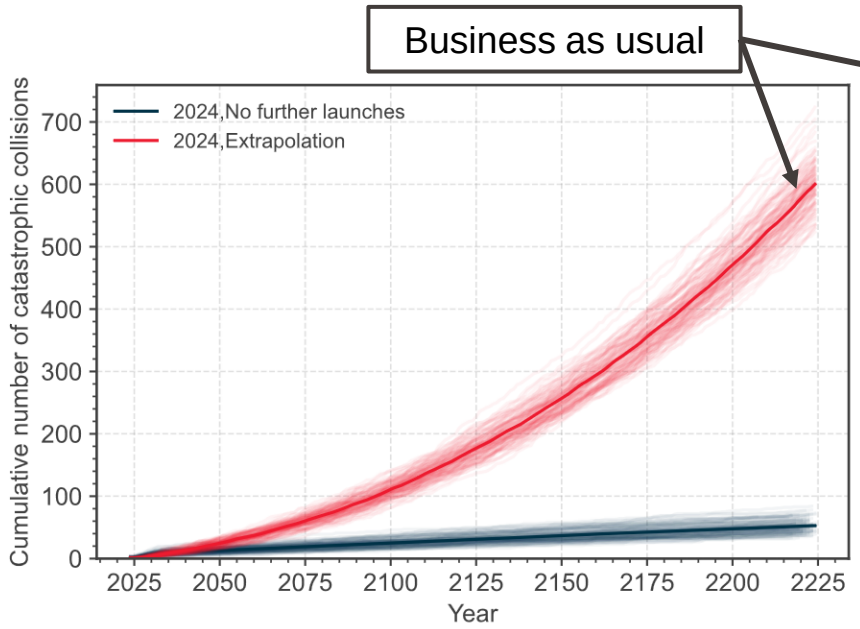


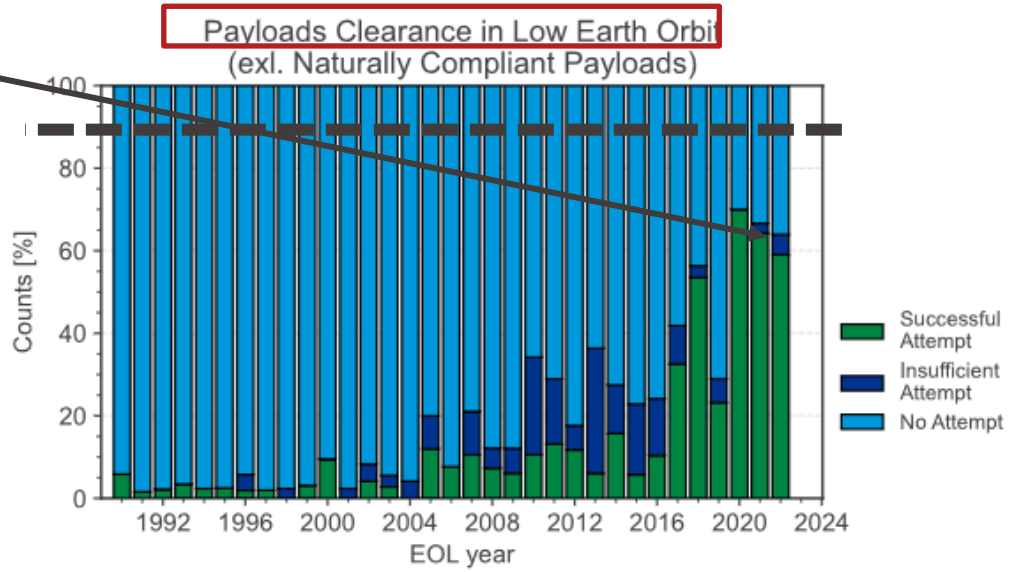

Source: NASA Orbital Debris Charts, April 2024




Source: AGI 2009 Iridium-Cosmos Satellite Collision

# *BUSINESS AS USUAL IS RECKLESS*




(a) Relative clearance of $LEO_{IADC}$ by payloads.

Figure 7: Number of cumulative collisions in $LEO_{IADC}$ in the simulated scenarios of long-term evolution of environment.

**Low level of compliance**

*To mitigation measures for spacecraft disposal in the LEO region*

Source: ESA'S ANNUAL SPACE ENVIRONMENT REPORT

# *BRACE FOR CHANGE*

Anticipate a more **stringent regulatory landscape**

SPACENEWS

FCC approves new orbital debris rule

Jeff Foust September 29, 2022

ESA seeks global adoption of "zero debris" policy

Jeff Foust January 20, 2023

Updated space safety document outlines rules of the road for avoiding collisions

Jeff Foust April 5, 2023



Growing importance of **public perception** & **protect reputation**

# *IMPLEMENTING A FUTURE-PROOF VISION*

## Take an active role in making space safer & more sustainable, for all

**Design** missions compatible with **responsible** operations

**Operate** missions minimizing **impact on the orbital environment** & **other operators**

**Communicate** on **space sustainability** & **debris mitigation efforts**

# *REWARDING RESPONSIBLE BEHAVIOR IN SPACE*

A **rating system** informed by **transparent, data-based assessments** of the level of sustainability of space missions

**Practical guidance** on how to **improve** sustainability performance & practices

A **platform for action-focused collaboration** centered on the rating system to support research and leverage best practices

# *SUPPORTING SPACE ACTOR'S SUSTAINABILITY JOURNEY*

Assess current **sustainability performance**

→

Identify **opportunities for improvement**

→

Implement **change** & drive **positive impact**

→

**Champion sustainability** & **take the lead**

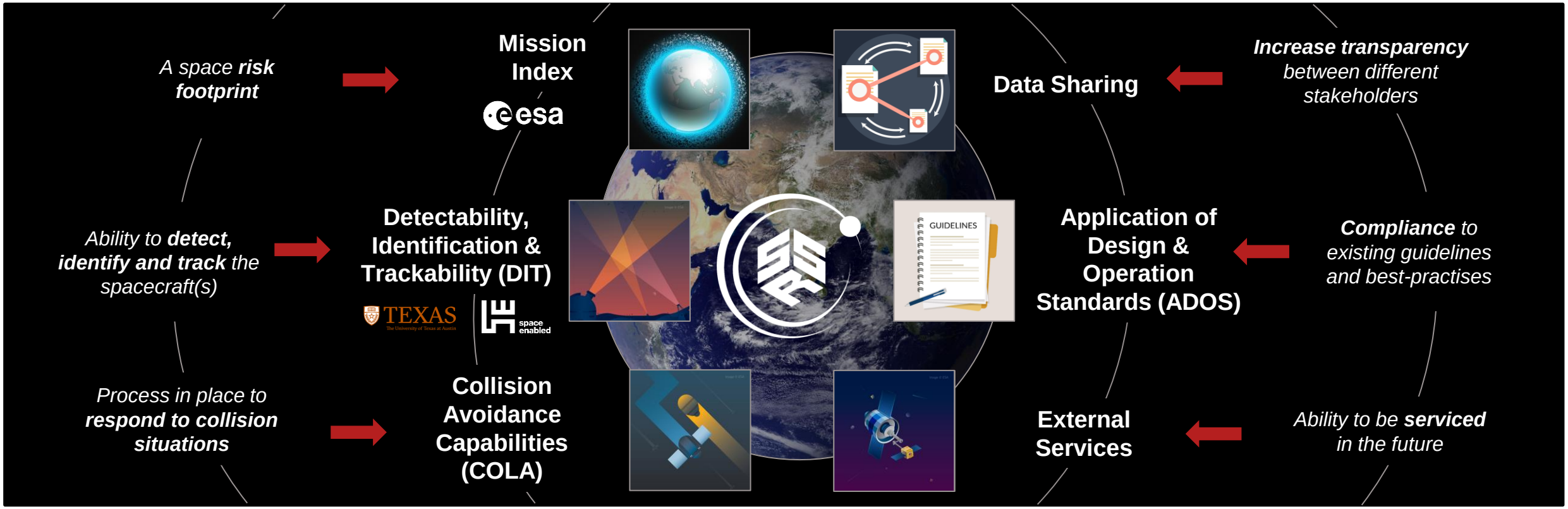
# *A SINGLE SCORE TO MEASURE SPACE SUSTAINABILITY*

SPACE SUSTAINABILITY RATING

# *RATING SCOPE*

- **Satellite** missions in **near earth orbits**
- A mission can consist of a **single satellite**, a **satellite and launch vehicle**, or **larger combinations of these elements**, e.g. several satellites and launch vehicles
- A rating is valid for **12 months**, upon its finalization (regular reassessments are needed to ensure the rating trustworthiness)
- A rating can be performed at **any mission phase**, including in preliminary design and in orbit phases

# *A MODULAR RATING*



# *IN A NUTSHELL*

- **Collision probability** over the entire mission lifetime
- **Risk reduction** thanks to collision avoidance strategy
- **Post mission disposal** efficiency and reliability
- **Collision avoidance** capabilities (processes)
- **Transparency** when it comes to spaceflight safety data sharing
- **Compliance with existing design and operation standards** for debris mitigation (i.e., guidelines, best-practises)
- Ability of spacecraft to be **detected, tracked**
- Readiness to be **removed or serviced**

# *HOW IS A MISSION RATED?*

**1.** **Data collection and verification**

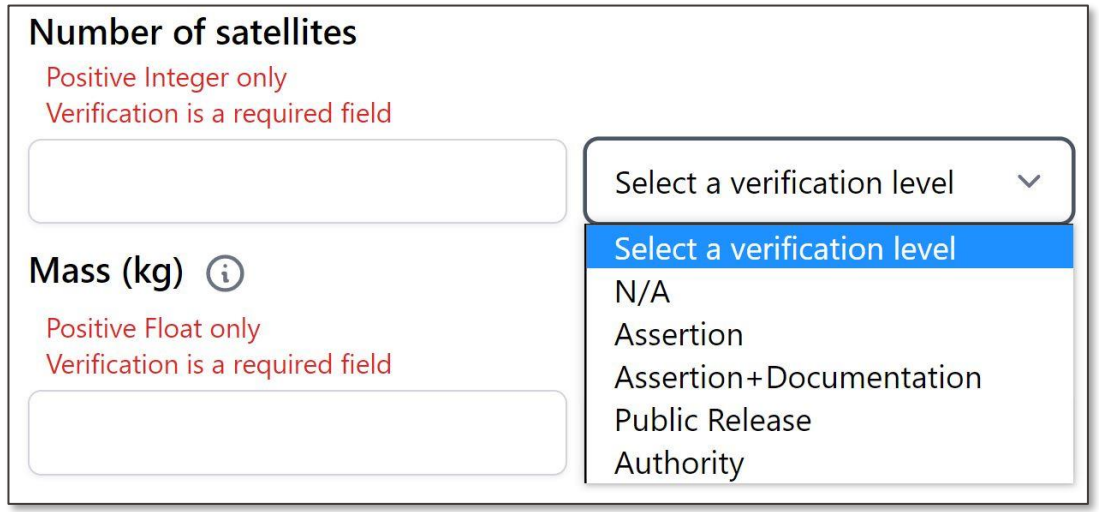





# *THE SSR DATA VERIFICATION ASSESSMENT*

| Level of verification | Factor |
|---|---|
| **Assertion**<br>Affirmative statement by the applicant is provided, without supporting documentation | **0.5** |
| **Technical documentation supporting the assertion**<br>Supporting technical documentation on the mission design is disclosed to the SSR entity | **0.6** |
| **Public release of the technical documentation**<br>Supporting technical documentation is submitted to a government or non-profit available for public review | **0.8** |
| **Authority – independent technical review**<br>An independent technical review or confirmation of compliance by a third-party technical expert is provided | **1** |

**Each** information provided shall be associated with a confidence level



# *HOW IS A MISSION RATED?*

**1.** **Data collection and verification**

**2.** **Module evaluation**

**3.** **Weighting**


*High* *Medium* *Low* *Bonus*


*81 – 100 %*


*71 – 80 %*


*56 – 70 %*


*40 – 55 %*

SPACE
SUSTAINABILITY
RATING

[Operator's logo]

# SPACE SUSTAINABILITY RATING

## CERTIFICATE

[Company and Mission Name],
completed a rating and achieved a **Gold Rating** with **Two Bonus Stars**.

Scope of certificate: [Mission Phase]

GOLD

Date of issue

**[Date]**

[Signature]

**Prof. Jean-Paul Kneib**
**Academic Director**
**eSpace - EPFL Space Center**

This document is not an official certification and is valid during the [Mission Phase] of the assessed mission.
This rating can be re-evaluated upon request of the applicant, or if it is deemed necessary by the issuer. This certificate is the property of Space Sustainability Rating.

# *COMMUNICATE YOUR SUCCESS*

- There are three possible ways of communicating your rating:

1. The SSR announces collaboration with your company, but no rating performed nor results shared

2. The SSR announces collaboration with your company, and that it has been rated

3. The SSR announces collaboration with your company, that it has been rated and the final score

# *EXAMPLE OF A RATING PROCESS TIMELINE*

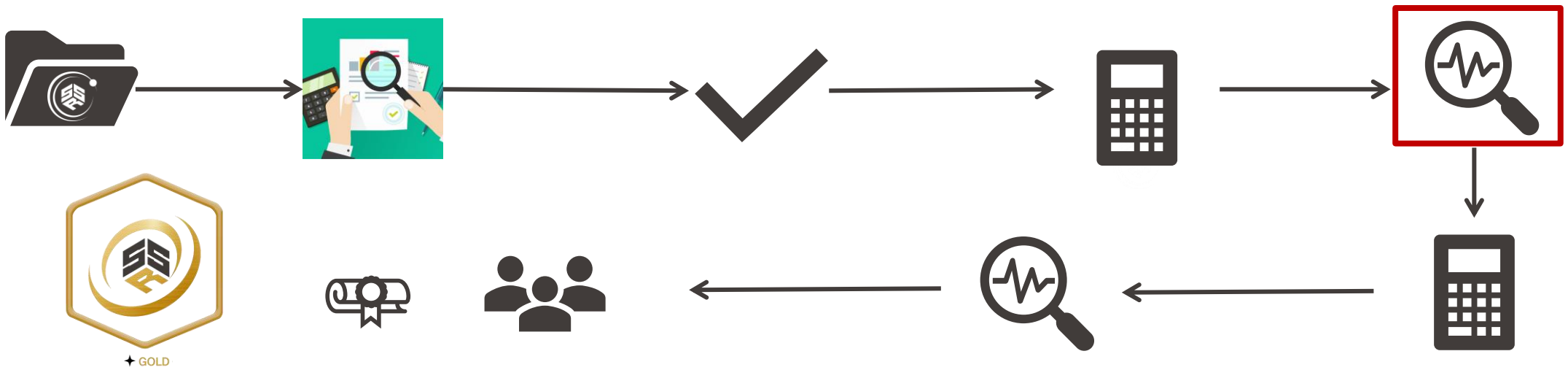
WD0: Documentation is provided

WD+6: Input list provided by applicant

WD+ 19: Inputs validation by the SSR issuer after clarifications

WD+31: First score computation

WD+35: Score analysis and decision to justify further the inputs to increase the score




WD+48: Second score computation

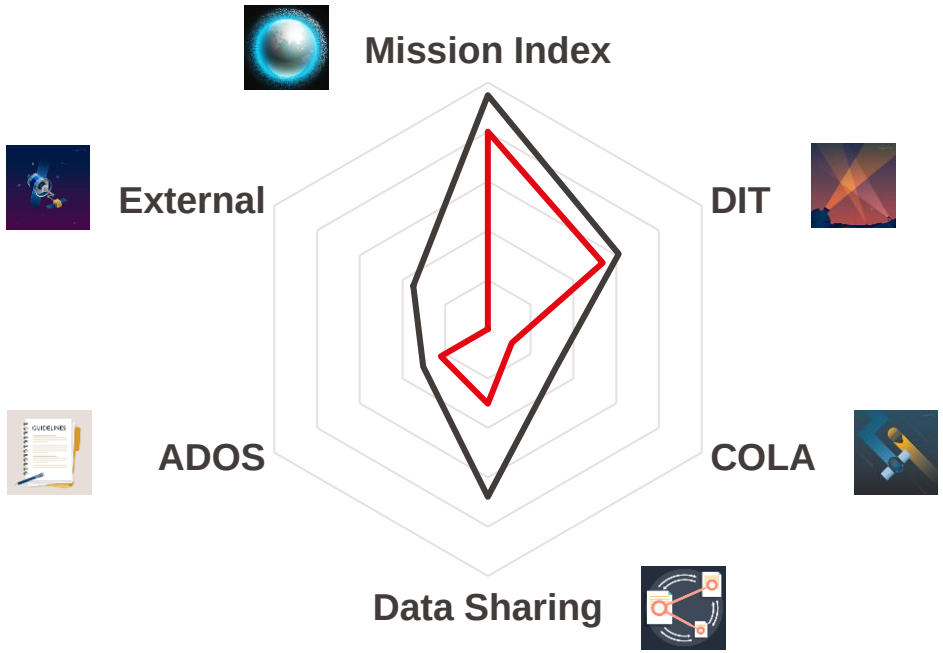
WD+51: Technical report issued

WD+60: Closure meeting, technical presentation on score outcome, certificate issuing, feedback

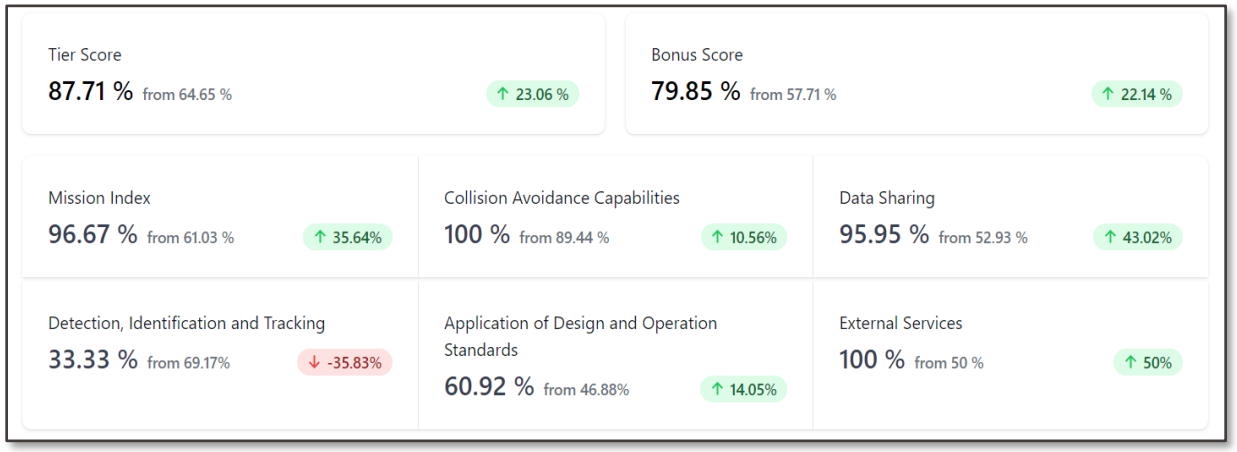
# *FEEDBACK LOOP*

- After first computation, the score is communicated, with an **analysis** including the identification of the main **mission strengths and weaknesses** (score-wise)
- A feedback is provided under the form of **written recommendations** and the projected score including the recommendations is computed
- An operator can implement the recommendations and ask for **one score recomputation**

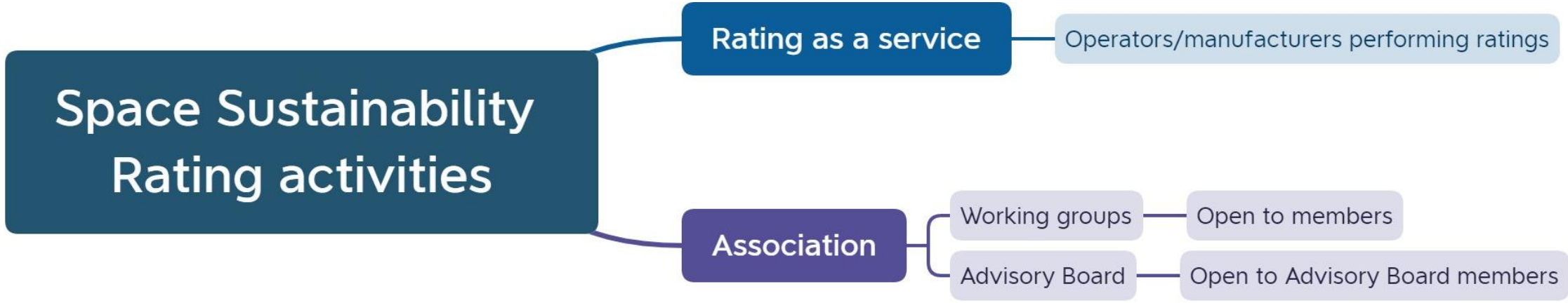
# INCREASE YOUR SUSTAINABILITY PERFORMANCE


| Reco. * | Description | Score increase (module) | Score increase (Tier) |
|---|---|---|---|
| MI_1 | Comment | +3.5% | +1.75% |
| DS_1 | Comment | +4% | +0.66% |
| COLA_1 | Comment | +12% | +1.98% |
| DIT_1 | Comment | +5% | +0.6% |
| … | … | … | … |
| **Total SSR Score increase** | | | **+8.29%** |
| **New tier** | | | **Gold** |



# *THE SSR ACTIVITIES*




**Rating as a service**

Engage with satellite operators or manufacturers to perform ratings.


**Association activities**

Enable involvement of various stakeholders through active participation (Working Groups) or consultation (Advisory Board)




# *RATING AS A SERVICE*

- Assess the mission's level of sustainability based on third party assessment, without disclosure of sensitive mission data
- Demonstrate compliance to international policies and standards for space debris mitigation
- Publicly communicate around effort implemented for improving space sustainability
- Improve current practises based on recommendations issued from an SSR assessment

ENDUROSAT

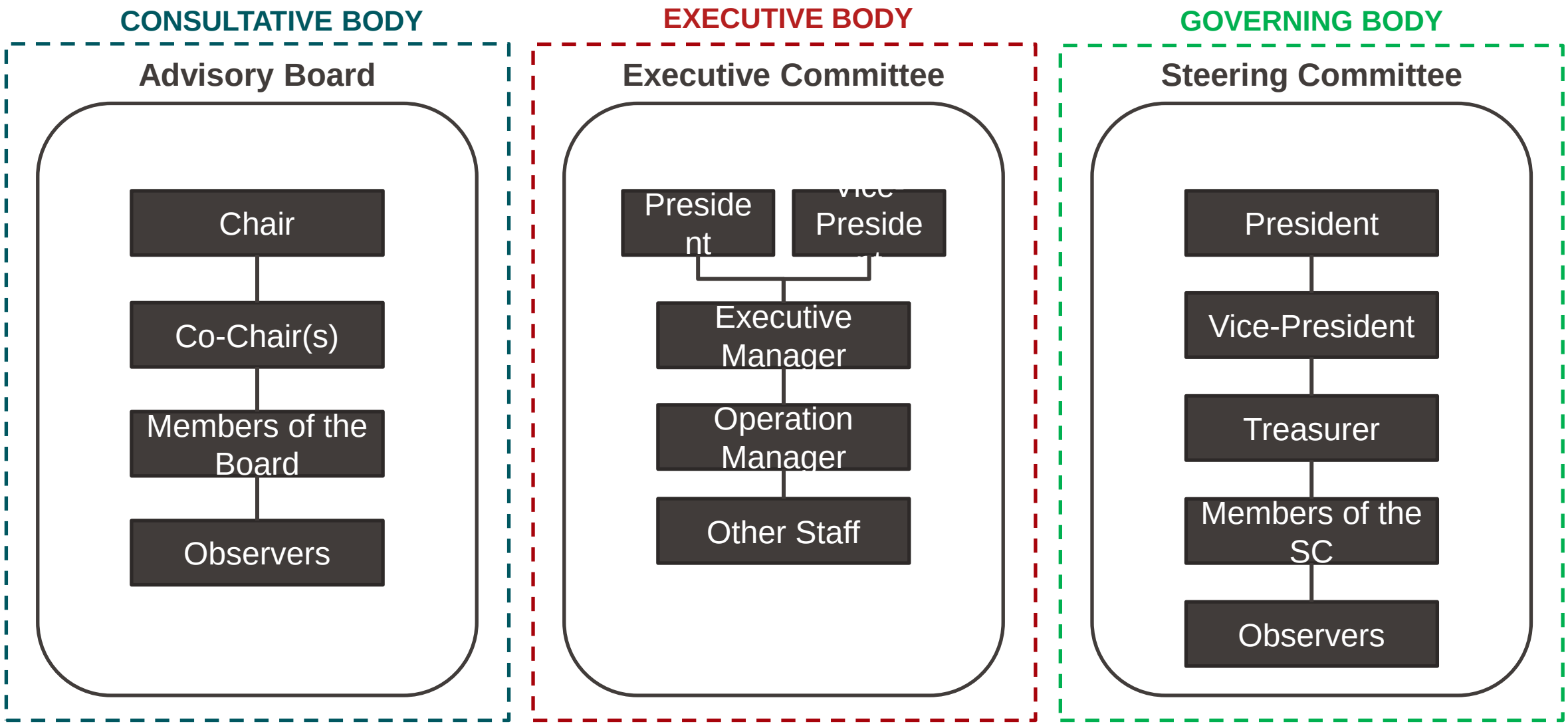
Interested in knowing more from a rated entity ? Read IAC-23,A6,8-E9.1* on general perspective from a rated entity: EnduroSat



* Pre-selected for the peer review process of Acta Astronautica following 74th IAC.

# *SSR ASSOCIATION BODIES*





# *SSR ASSOCIATION: MEMBERS*

- Participate in working groups of the SSR association
- Be actively involved in future evolution of the rating
- Support the establishment of the rating as an internationally recognized system
- Support the development of the rating certification scheme
- Be visible as an SSR member (SSR website, communications…)
- Global networking with organizations and individuals who are internationally recognized experts on space sustainability

# *RATING-USERS*

**Official ratings***

stellar

TU Delft

ENDUROSAT

+3 finalized

**Computation partner**

esa

mit media lab

POLITECNICO MILANO 1863

**Beta-testing**

AIRBUS

astrocast

AXELSPACE

EPFL SPACECRAFT TEAM

OneWeb

planet.

STARLINK

THE UNIVERSITY OF MELBOURNE

*Additional ratings are currently underway and will be announced later this year.

# *MORE THAN 20 MISSIONS RATED (08/12/2023)*

**6**

**OFFICIAL**
**Ratings**

Rating as a service including score analysis and recommendations

**8**

**BETA**
**Tests**

Streamlining the rating process with satellite operators and manufacturers

**7**

**ALPHA**
**Tests**

Rating computation methodology fine tuning using publicly available data

SPACE SUSTAINABILITY RATING

+1 rating being performed (contract signed)
+2 rating prospects (strong interest, no contractual commitment)

# *SSR MEMBERS: A GROWING COMMUNITY*

ALTER TECHNOLOGY GROUP

Ansys

ENDUROSAT

CONFERS
FOSTERING THE SATELLITE SERVICING INDUSTRY

DEBRIS-X
德博睿

infomaniak

LULEÅ UNIVERSITY OF TECHNOLOGY

自主創造
日本大学
NIHON UNIVERSITY

neuraspace

PRIVATEER

SECURE WORLD FOUNDATION

SLINGSHOT AEROSPACE



Reminder: SSR members are paying an annual fee and benefit from participation in the Working groups and visibility on the website

**FOR SATELLITE MANUFACTURERS & OPERATORS**

# GET A RATING

1

**GET A RATING**

Flat fee of **CHF 20,000.- per rating**

**Benefits:**

- **Individualized and continuous support** from the SSR team, focusing at maximizing value, providing:
  - Up to two computations (i.e. one initial rating, one feedback and re-computation loop before final submission)


SPACE SUSTAINABILITY RATING

[Operator's logo]

SPACE SUSTAINABILITY RATING

CERTIFICATE

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Scope of certificate: [Mission Phase]

Date of issue
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***FOR SPACE AGENCIES, INSTITUTIONS, LARGE INTEGRATORS***

# *GET A RATING*

1

**GET RATINGS**

- Customized package for multiple ratings

**Benefits:**

- **Multiple missions** being rated.
- **Customized agreement** based on the needs.
- Possibility to set up more than two computations per rating (enabling using SSR for **sustainability trade-offs** during a design phase for instance)

# *BECOME A MEMBER*

2

**BECOME A MEMBER**

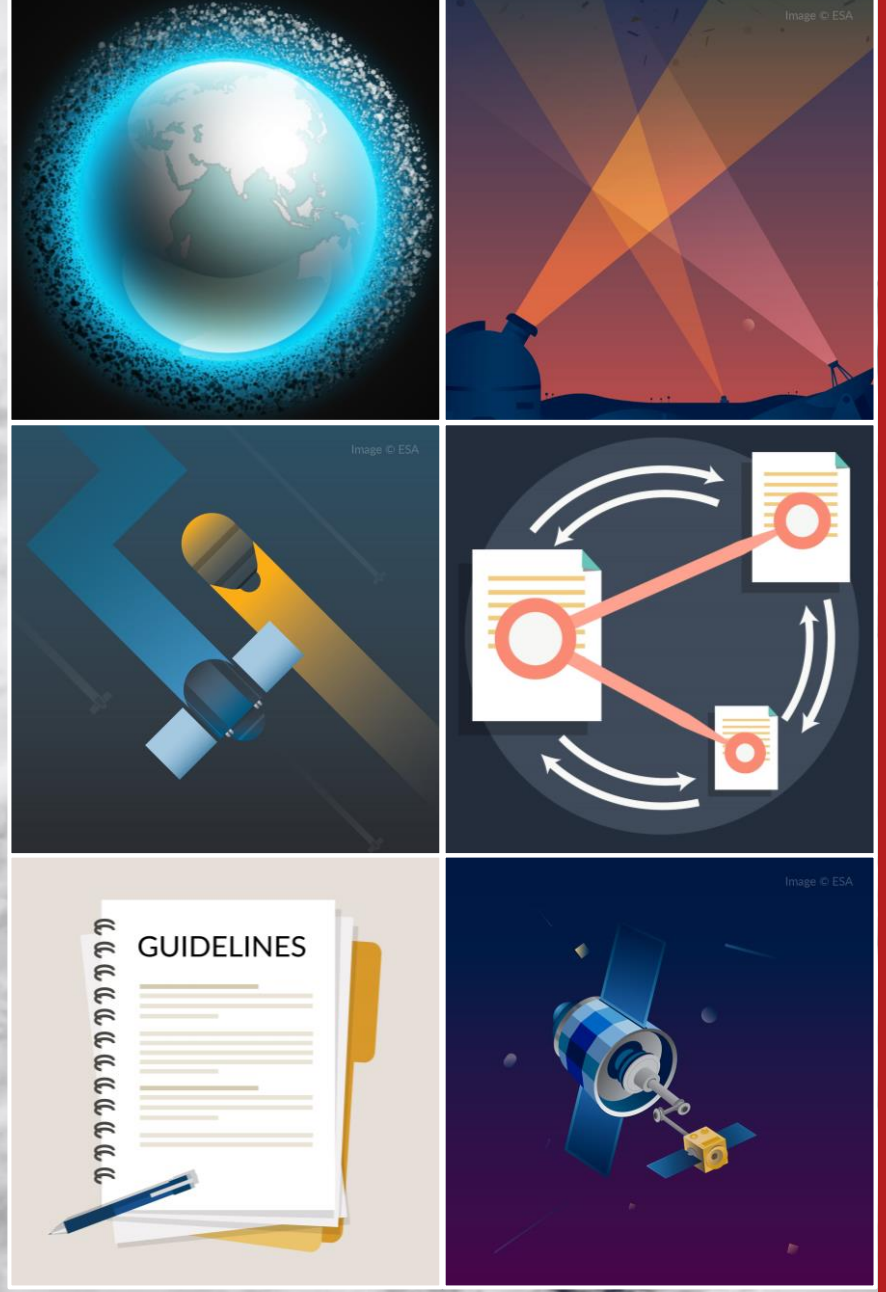
**Membership fees:**

- **CHF 5,000.-**
- **Valid one year upon joining**

SSR Association provide the following benefits:

- Be part of the SSR Association
- Participate in the General Assembly
- Visibility: be featured on the SSR Website, presentations & other communications
- Get involved in the Working Groups (2025)

1. **Outreach & Policy**
   - Write a white paper on the rating benefits

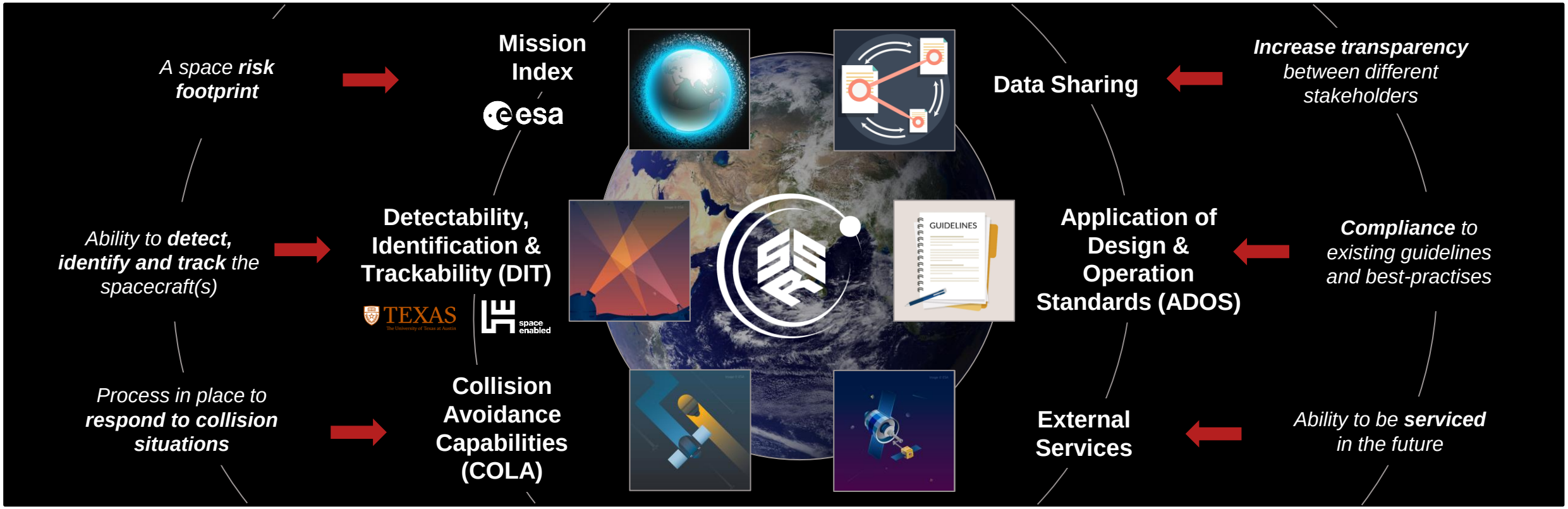



# What’s inside?

A deep-dive into the SSR Modules

SPACE
SUSTAINABILITY
RATING

# *A MODULAR RATING*

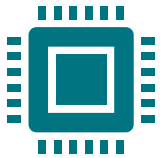


# *THE SSR MODULES*

Modular evaluation based on a set of different criteria (modules)

| Modules | Weight | Type |
|---|---|---|
| Mission Index | 50% | **Quantitative** |
| Collision Avoidance Capabilities | 16.5% | Qualitative |
| Data Sharing | 16.5% | Qualitative |
| Detectability, Identification and Trackability | 12% | **Quantitative** |
| Application of Design and Operation Standards | 5% | Qualitative |
| External Services | Bonus | Qualitative |

**Qualitative:**
Compliance based



**Quantitative:**
Model based

*Model based* *50%*



# *MISSION INDEX*

## *A space risk footprint*

- Quantifies the **collision risk** using an index metric;
- Evaluates the risk contribution of a mission to the debris environment **compared to a capacity target;**
- Uses **high level parameters** that can be obtained early in the mission development;

**Satellite & mission design**

- Number of satellites
- Spacecraft mass
- Cross-sectional area
- Operational lifetime
- Deployment duration

**Orbital parameters (at deployment epoch)**

- Semi-major axis
- Eccentricity
- Inclination

**Collision avoidance strategy**

- Accepted collision probability level
- Lead time

**Disposal strategy**

- Success rate
- Target apogee and perigee
- Description

*Model based* *50%*

# *MISSION INDEX - FORMULATION*

## Index formulation for one object, at a given epoch

Probability of collision $p_c$

$$I = p_c \cdot e_c$$

Severity of collision $e_c$

High $I$ ⇔ High risk ⇔ Low Score

$I$ depends on orbital parameters and spacecraft physical properties

## Environment simulated with

MASTER

Cumulative collision probability

$$p_c = 1 - e^{-\rho \cdot \Delta V \cdot A \cdot \Delta t}$$

- $\rho$ the density of object large enough to trigger a catastrophic collision (1)
- $\Delta V$ the relative impact velocity
- $A$ the cross-sectional area
- $\Delta t$ the timestep increment value

## Collision severity (2)

- Synthetic fragmentation triggered and modelled (reformulated NASA breakup model)
- Propagation of the debris cloud (phase space density)
- Quantification of the **increased probability of collision for a set of representative objects**

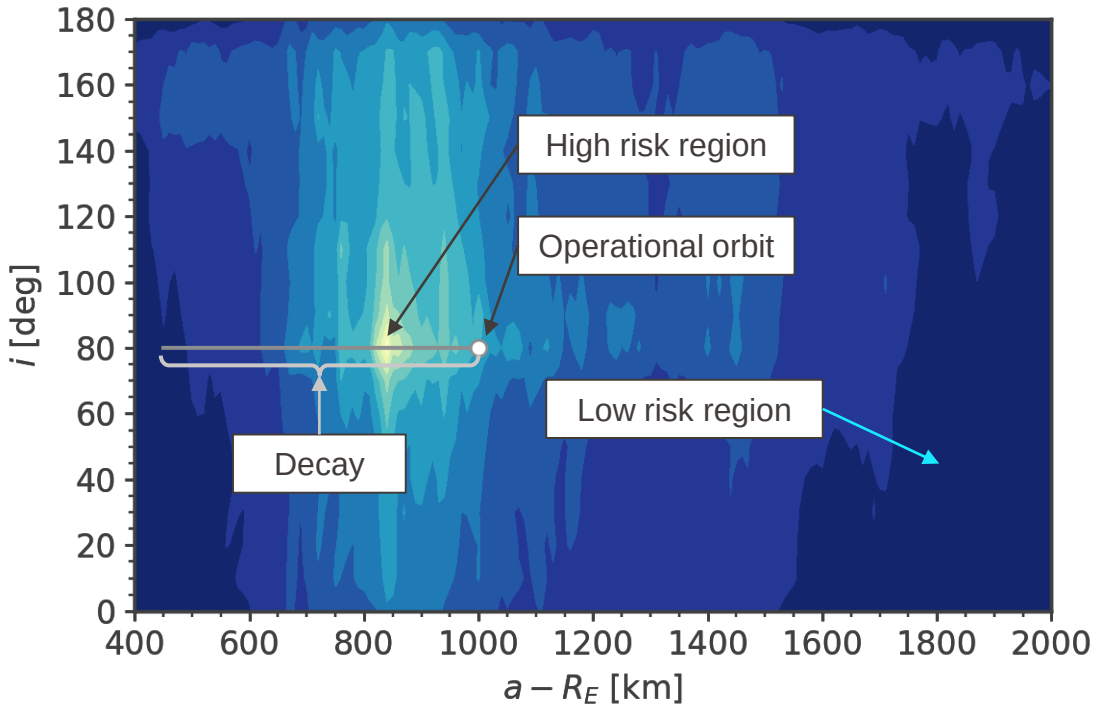
(1) collisions with an energy-to-mass ratio above the 40 J/g thresehold

(2) Colombo et al. *Tracking the health of the space debris environment with THEMIS, section 2.1*

*Model based* *50%*

# *MISSION INDEX – INDEX MAPS*

*Index value heatmap (LEO region)*

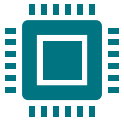



***The index value is discretized, and integrated over the object's lifetime***

$$I = \int_{t_0}^{t_f} (p_c \cdot e_c)\, dt$$

Discretized index allows to account for the spacecraft trajectory evolution (e.g. orbit raising, disposal manoeuvres, orbital decay)

Courtesy: debris index frontend, ESA space debris office



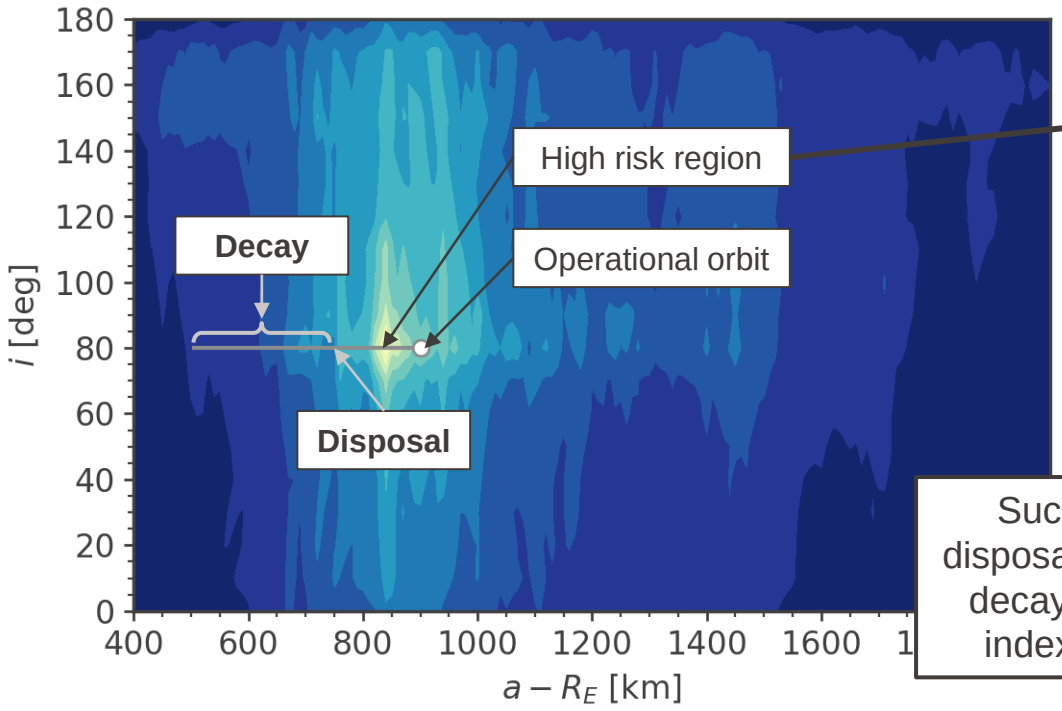
*Model based*

*50%*

# *MISSION INDEX – TRAJECTORY EVOLUTION PMD*

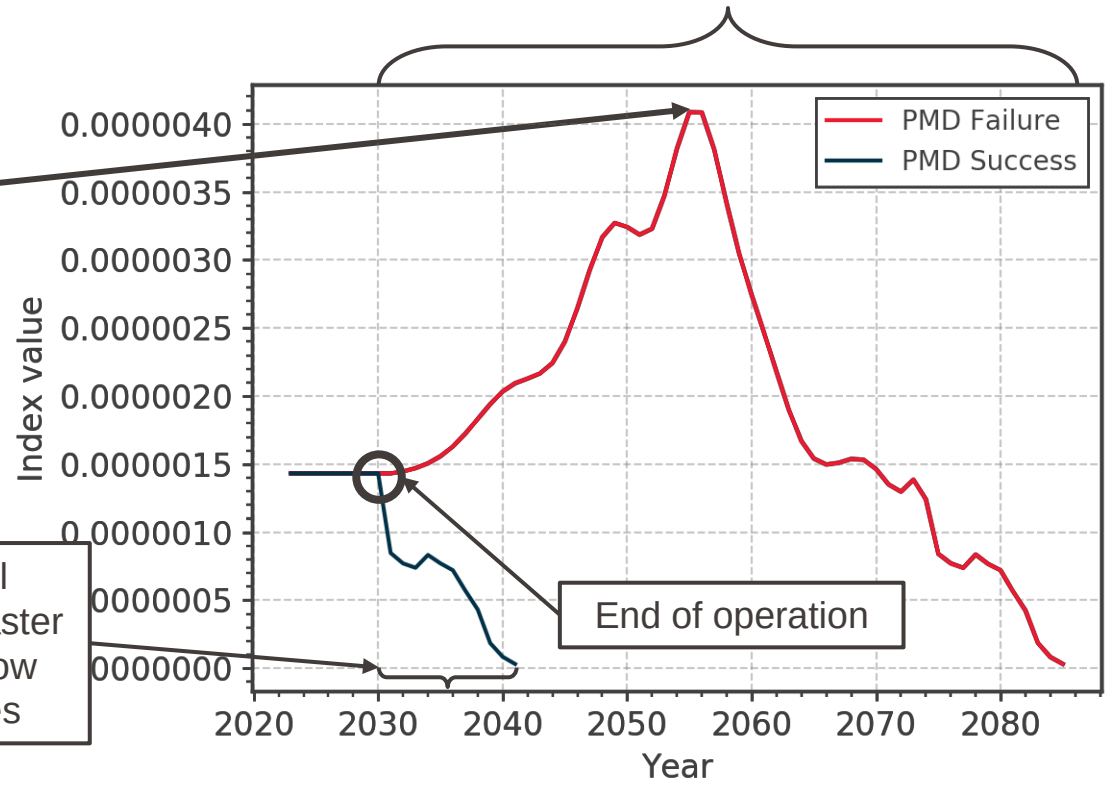
**Mock mission data:**

$A/m = 0.1$ (to highlight impact of trajectory evolution)
Initial altitude 900km
**Post mission disposal to a 750 km altitude**




Failure ⇔ Long natural decay from failure altitude and higher index values

Successful disposal ⇔ faster decay and low index values






Courtesy: debris index frontend, ESA space debris office

*Model based* *50%*



# *THE MISSION INDEX*

## Impact of the disposal strategy:

$$I_{disposal} = \underbrace{\alpha \int_{t_{EOL}}^{t_{f_D}} I_{disposal}\, dt}_{\text{PMD Success}} + \underbrace{(1-\alpha) \int_{t_{EOL}}^{t_{f_{ND}}} I_{abandonned}\, dt}_{\text{PMD Failure}}$$

**$\alpha$: Post Mission Disposal Success Rate***

Before launch:

$\alpha$ is obtained from spacecraft reliability analysis

During operation

$\alpha$ is set to 0 if a spacecraft fails
$\alpha$ is set to 1 if a spacecraft is successfully deorbited

* For a constellation, the value of $\alpha$ is aggregated for the entire fleet (i.e. weighted average)

# *MISSION INDEX – DISPOSAL RELIABILITY*

## Accounting for disposal failure scenario:

$$I_{disposal} = \underbrace{\alpha \int_{t_{EOL}}^{t_{f_D}} I_{disposal}\, dt}_{\text{PMD Success}} + \underbrace{(1-\alpha) \int_{t_{EOL}}^{t_{f_{ND}}} I_{abandonned}\, dt}_{\text{PMD Failure}}$$

**$\alpha$: Post Mission Disposal Success Rate***

Before launch:

$\alpha$ is obtained from spacecraft reliability analysis

During operation

$\alpha$ is set to 0 if a spacecraft fails
$\alpha$ is set to 1 if a spacecraft is successfully deorbited

* For a constellation, the value of $\alpha$ is aggregated for the entire fleet (i.e. weighted average)

Model based

50%

# MISSION INDEX – COLLISION AVOIDANCE

$$I_{phases\ COLA} = \int_{t_0}^{t_{EOphase}} \left[ \underbrace{(1-\gamma)\left(p_{c_{trackable}} \cdot e_c\right)} + p_{c_{non-trackable}} \cdot e_{c_{non-trackable}} \right] dt$$

**$\gamma$: Mitigated Collision Risk**

**Collisions with trackable debris can be avoided**

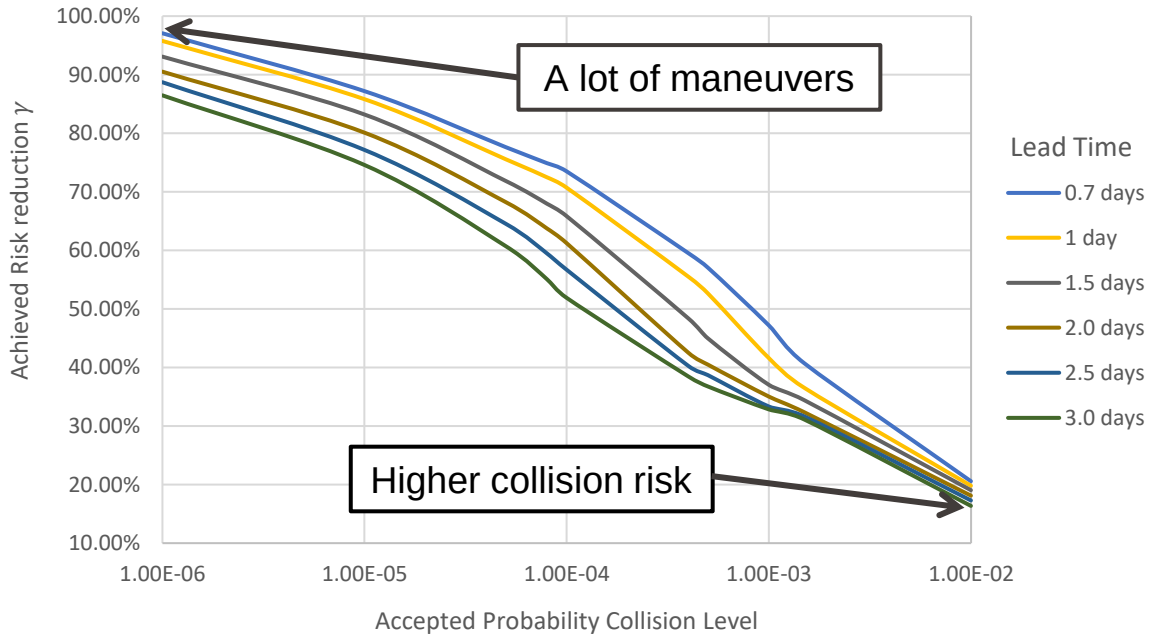
**Risk reduction** achieved by the implemented collision avoidance strategy **with respect to the case where no maneuver is performed**

mainly driven by two parameters:

**Time required to perform a maneuver**

**Accepted Collision Probability Level**

Mitigated Collision Risk vs. Accepted Collision Probability Level *




Test case used: 0.5m radius spacecraft operating at a near circular, near sun-synchronous, 400km altitude orbit

# *MISSION INDEX – NORMALIZATION*

*How to output a score?*

Mission parameters Satellite(s) physical properties

Index computation (spacecraft level)

Index at fleet level

Normalization

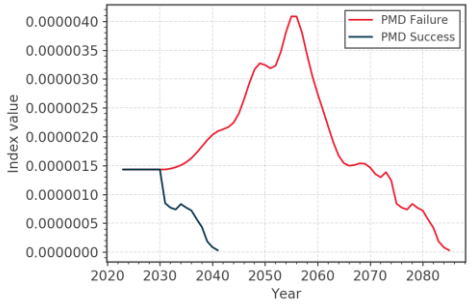
Disposal scenarios

Risk Reduction achieved through collision avoidance*

Number of satellites

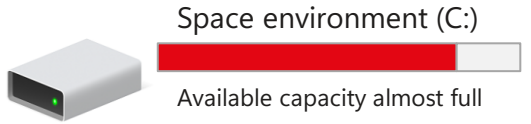
Absolute index (80%)

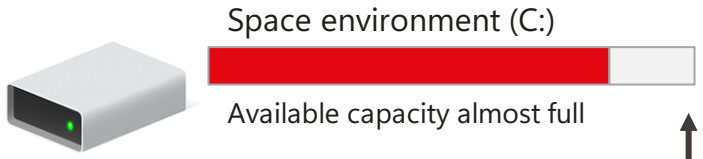
Relative index (20%)





$\times N_{sat}$






# MISSION INDEX – NORMALIZATION

## What is “full”?

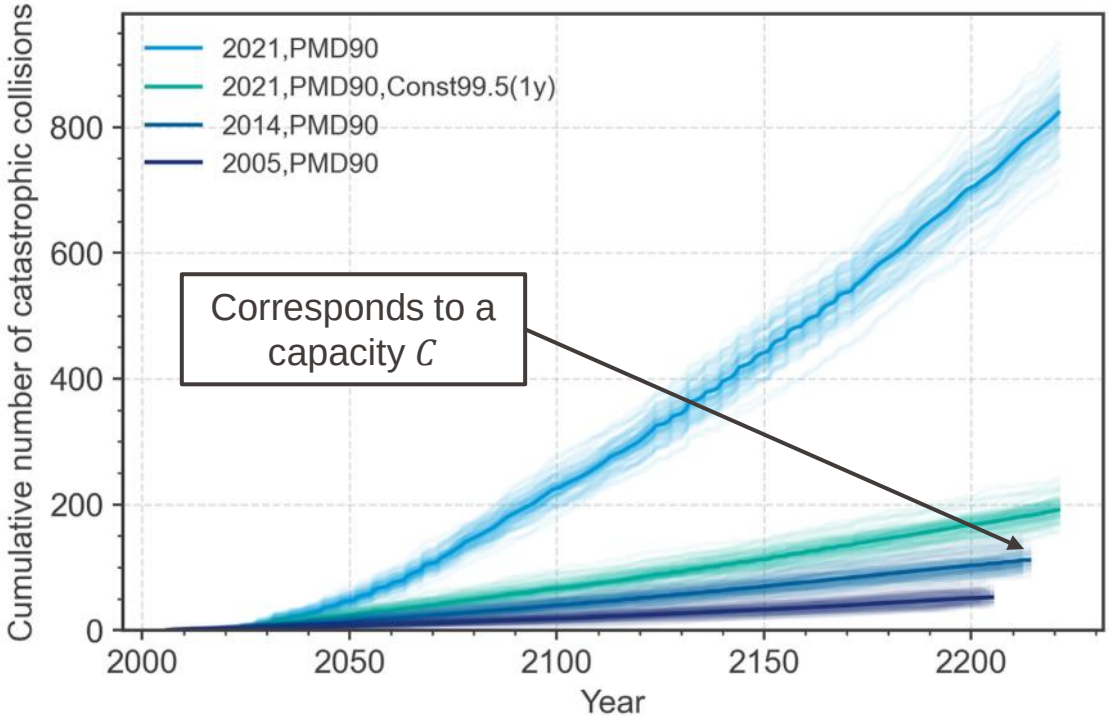
Capacity identified from long term extrapolation scenarios (the “capacity” $C$)

A normalized score is computed based on the **share of yearly available capacity** consumed by the mission

$$\hat{I} = I_{mission}/(C - I_{already\ used})$$

$$S_{abs} = 0.5 - \frac{1}{10}\log_{10}(\hat{I}) - \frac{\hat{I} - 1}{50}$$ ←

(1)




“Absolute” index score, 80% of the mission index score (2)



(1) F. Letizia et al., Assessment of orbital capacity thresholds through long-term simulations of the debris environment, Advances in Space Research, https://doi.org/10.1016/j.asr.2022.06.010
(2) Saada et al., Promoting responsible space practices: A primer on the Space Sustainability Rating

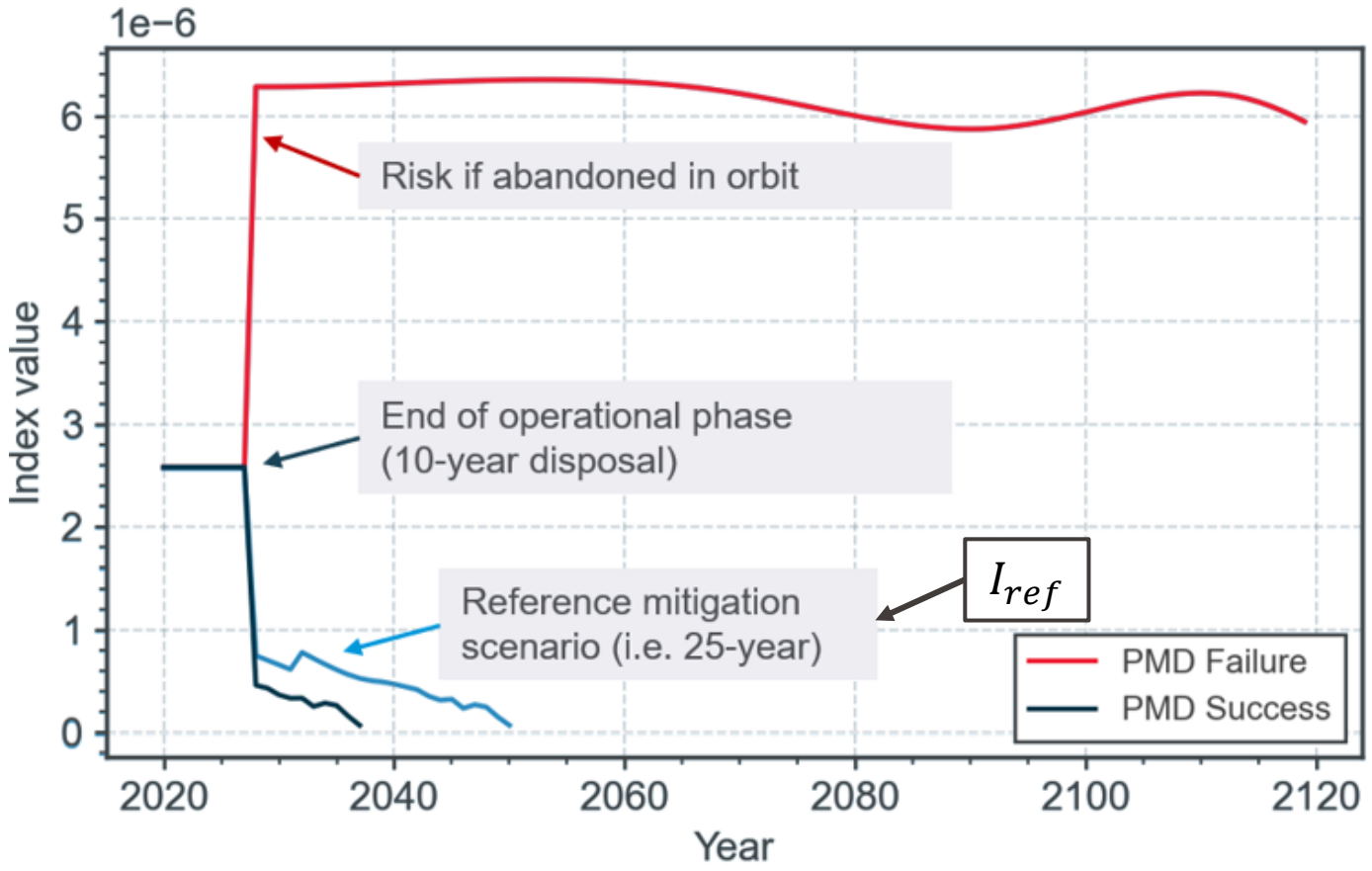
# *MISSION INDEX – NORMALIZATION*

**<u>"Relative" mission index: going beyond recommendations</u>**

- Definition of a reference case
- Comparison to the reference case

$$I_{relative} = I_{mission}/I_{ref}$$

$$S_{rel} = 1 - (I_{rel})^3$$ ⟵ "Relative" index score, 20% of the mission index score



# *MISSION INDEX – NORMALIZATION*

*How to output a score?*

Mission parameters Satellite(s) physical properties

Index computation (spacecraft level)

Index at fleet level

Normalization

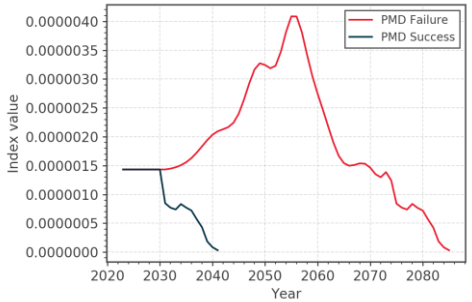
Disposal scenarios

Risk Reduction achieved through collision avoidance*

Number of satellites

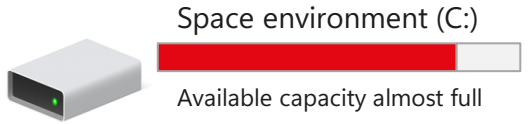
Absolute index (80%)

Relative index (20%)





$\times N_{sat}$



*Model based* *12%*

# *DETECTABILITY, IDENTIFICATION AND TRACKABILITY*

## Detectability allows traffic management

**Satellite physical properties**

- Geometric shape
- Dimensions
- Face pointing Nadir

**Orbital parameters**

- Semi-major axis
- Eccentricity
- Inclination

Simulation of a ground sensor network (optical and radar), propagation of the satellite(s), compute access periods

Likelihood that an object can be **observed** by ground surveillance systems (without prior knowledge)

Feasibility of **orbit evolution** prediction for a detected objects (for an agent different from the operator)



R. Steindl et al., Developing Detectability, Identifiability, Trackability Analyses for the Space Sustainability Rating, 2021
SSR DIT webpage

*Model based* *12%*

# *DIT Module normalization*

## Detectability Score

| Sub-components | Metrics | Scoring thresholds | | |
|---|---|---|---|---|
| | | 0 | 0.5 | 1 |
| Optical Detectability score ($S_{D_{opt}}$) | Visual Magnitude | | >15 | <15 |
| Radar Detectability score ($S_{D_{rad}}$) | Probability of Radar detection | <50% | 50-75% | >75% |

$$S_D = 0.5 \times S_{D_{opt}} + 0.5 \times S_{\mathrm{D_{rad}}}$$

## Trackability Score

| Metrics (computed for both optical and radar) | Scoring thresholds | | | |
|---|---|---|---|---|
| | 0 | 0.25 | 0.5 | 1 |
| Pass duration ($Pass_d$) | <120" | 120-180" | 180-400" | >400" |
| Orbital coverage ($O_c$) | <10% | 10-25% | 25-60% | >60% |
| Interval duration ($Int_d$) | >12h | | 12h-6h | <6h |

$$S_{T_{opt,rad}} = \frac{1}{3} Pass_{\mathrm{d}} + \frac{1}{3} O_{\mathrm{c}} + \frac{1}{3} Int_d$$

$$S_T = \max\left(S_{T_{opt}}; S_{T_{rad}}\right)$$

## DIT SCORE:

$$S_{DIT} = \frac{1}{3} S_D + \frac{1}{3} S_T + \frac{1}{3} S_{Questionnaire}$$



R. Steindl et al., Developing Detectability, Identifiability, Trackability Analyses for the Space Sustainability Rating, 2021
SSR DIT webpage

**Qualitative:** Compliance based

# QUALITATIVE MODULES SCORE COMPUTATION

| Type of data shared | Points earned for sharing with: | | | |
|---|---|---|---|---|
| | **SSA providers** | **Other operators** | **Network of operators** | **Public** |
| Publish and update collision avoidance contact information | 10 | 10 | 12 | 12 |
| Publish and update collision avoidance contact time zone/hours of operation | 3 | 3 | 3 | 4 |
| Publish and update COLA contact/coordination request response time guarantees | 1 | 2 | 2 | 1 |

| Level of verification | **Factor** |
|---|---|
| Assertion | **0.5** |
| Supporting technical documentation | **0.6** |
| Public release | **0.8** |
| Authority – independent technical review | **1** |

$$S_{module} = \frac{\sum_{j=1}^{n} p_{input_j}}{Available\ points_{module}}$$

* All modules points can be found on the SSR rating webpage, or in previous academic papers (Ref [4], [5], [6] provided at the end of the slide deck)

*Qualitative* *16.5%*

# *COLLISION AVOIDANCE CAPABILITIES*

## **Evaluation of the capabilities and processes** to follow-up orbital state and be able to prevent collisions

| Operator Action | Orbital State Knowledge | Availability to Coordinate | Capability to Coordinate | | Maneuver capabilities |
|---|---|---|---|---|---|
| **Lowest Performance** | Rely on third party public SSA provider | Not able to coordinate | Operator has no dedicated process for conjunction screening, assessment, or mitigation. | | No maneuver capabilities |
| **Highest Performance** | Maintain/update orbital state knowledge of object to within < 1km | Has a system for routine conjunction assessment and capability to respond to concerns 24 hours | Has documented procedures for collision screening, assessment, and mitigation; | Regularly screens operational spacecraft and planned manoeuvres against SSA sharing organization catalogue | Reaction (at least Δv=1 cm/s) within one orbital revolution |

*Qualitative*

*16.5%*

# *DATA SHARING*

## Increase transparency between stakeholders

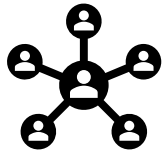
### What information are you sharing?

- **Ephemerides**
- **Covariance information**
- **Contact of person in charge for collision avoidance (and list objects by NORAD ID)**
- **Covariances**
- **Maneuvrability of the spacecraft(s)**
- **…**

### With whom?

**SSA Providers**

**Other operators upon request**



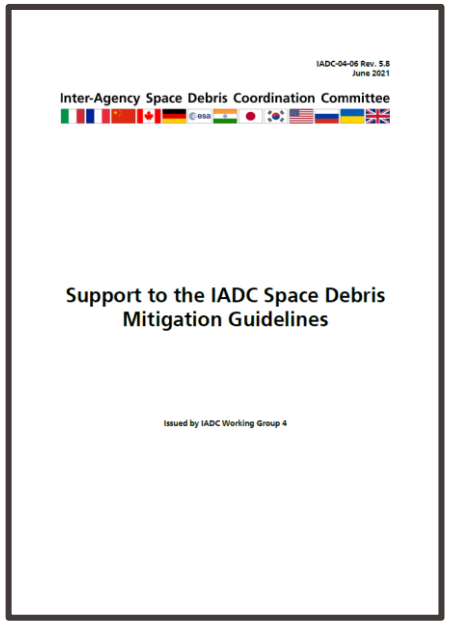
**Network of operators**

**Public**

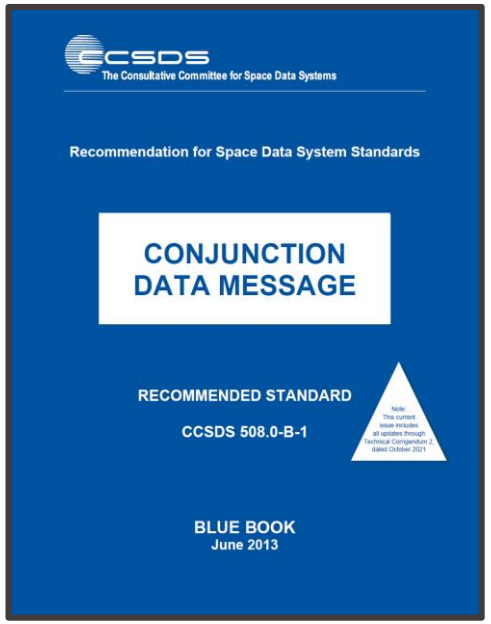
# APPLICATION OF DESIGN AND OPERATION STANDARDS

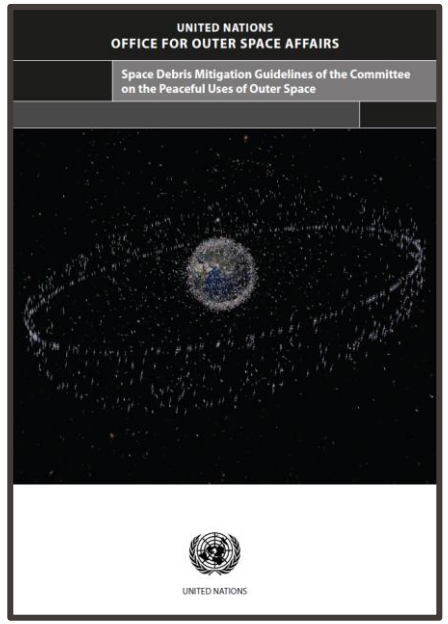

*Qualitative* *5%*

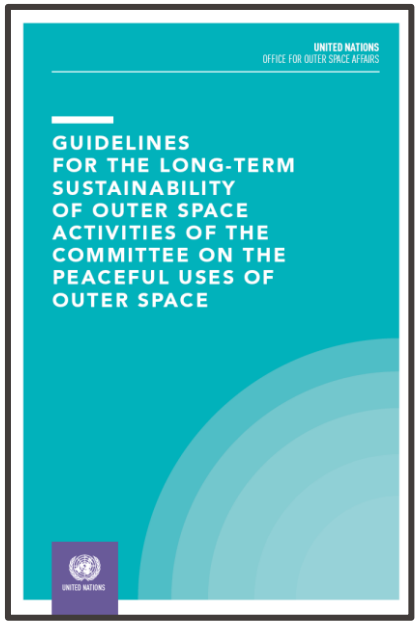
## Incentivize further adoption of well-recognized standards, norms, guidelines for sustainable practises

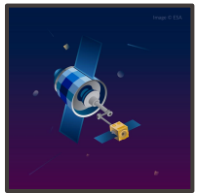








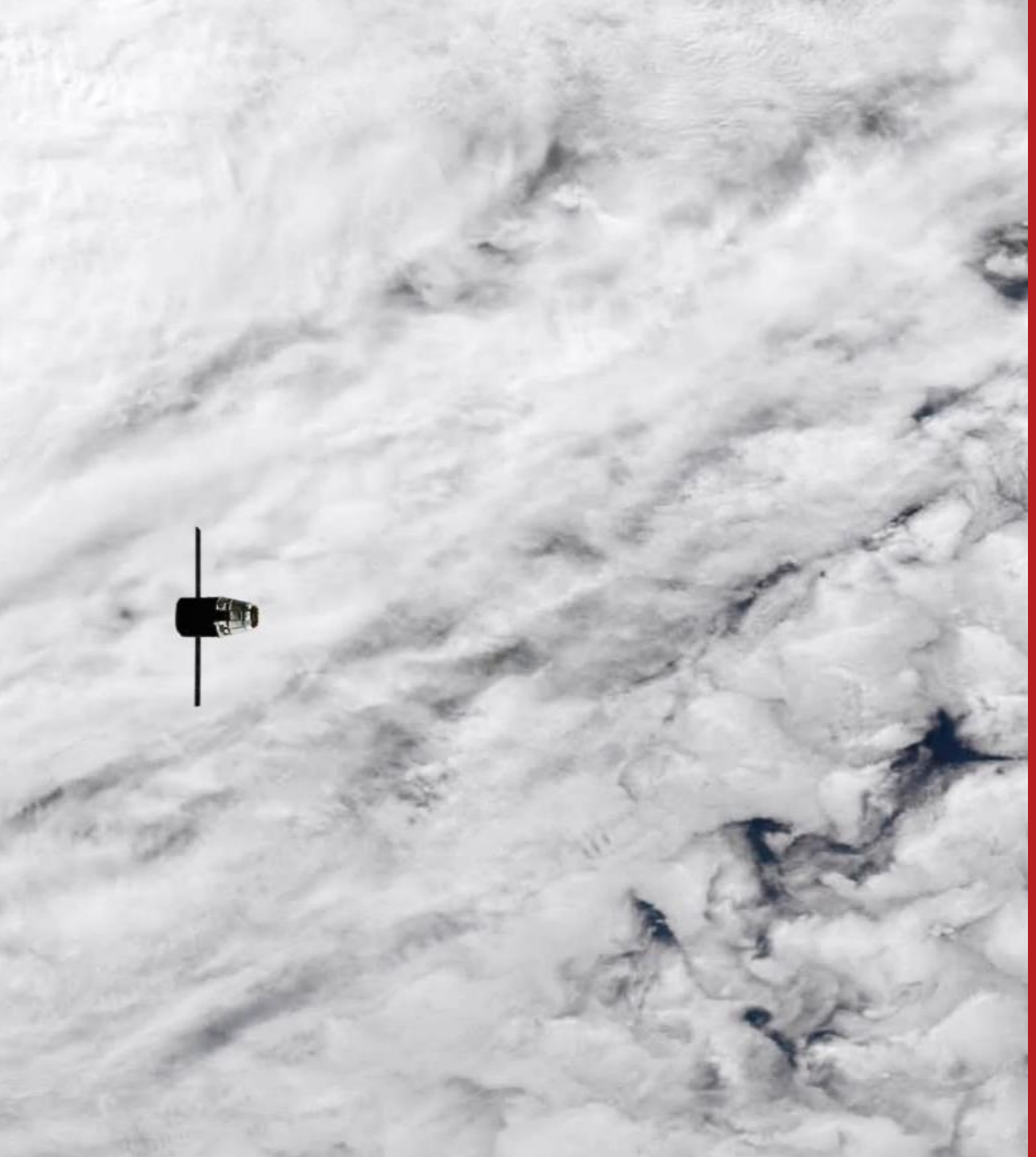
Qualitative Bonus

# *EXTERNAL SERVICES*

## Prepare for removal!


- Standardized interface for removal
- Active debris removal service in case of failure
- Visual fiducials
- Grappling fixtures

NOT INTEGRATED IN THE SCORE TODAY BECAUSE SUCH EXTERNAL SERVICES ARE NOT AVAILABLE AS OF NOW
SSR External Services Webpage



# *GET IN TOUCH*

*contact@ssr.space*


## Emmanuelle DAVID

***Vice-President***

*emmanuelle.david@ssr.space*


**spacesustainabilityrating.org**

SPACE
SUSTAINABILITY
RATING

# *Exercise*

- Primary task: Compute index values and understand risk profile for different set of scenarios to understand risks associated with
  - Operational orbit
  - CAM/No CAM scenarios
  - Disposal trajectory
  - Disposal reliability / no disposal scenarios
  - Spacecraft size