FRAMEWORK FOR THE SPACE SUSTAINABILITY RATING

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ABSTRACT

In 2018, the Word Economic Forum issued a call for proposal to develop a so-called *Space Sustainability Rating*, a score representing a mission's sustainability as it relates to debris mitigation and alignment with international guidelines. Following this call, the European Space Agency, MIT, University of Texas at Austin, and Bryce Space and Technology have formed a consortium to design a rating able to encourage behaviours that are more responsible by promoting mission designs and operational concepts that are compatible with a stable evolution of the environment.

The approach adopted for this initiative is to combine, in a composite indicator, different modules that capture different aspect of sustainability in space, considering both the impact on other operators and on the environment globally, looking both at short-term and long-term effects. In particular, the identified modules include a metric of the fragmentation risk associated to an object in orbit, an evaluation of the collision avoidance process adopted by a mission operator, the steps to ease the detectability, identification, and tracking of the mission, the level of data sharing implemented, the adoption of international standards related to debris mitigation measures, and the readiness of a mission with respect to on-orbit servicing.

The paper will give a brief overview of the modelling approach adopted by the two modules based on physics (i.e. the fragmentation risk metric and the detectability, identification, and tracking score), and the scoring criteria adopted for the other modules, which is based on the evaluation of the inputs provided by the applicants through a questionnaire. The normalisation and weighting approach used to combine the modules into a single indicator will also be presented.

Keywords: sustainability; debris mitigation; impact assessment.

1. INTRODUCTION

The objective of the Space Sustainability Rating (SSR) is to create an incentive for operators to design missions compatible with sustainable operations and operate their missions considering not only their objectives, but also the potential impact on other operators and on the debris environment more in general. The rating does not want to create a new set of guidelines, but rather to recognise positive behaviours such as compliance with mitigation guidelines and efforts that go even beyond those recommendations.

One of the first challenges in designing the rating has been the selection of which elements to capture in the formulation. Table 1 provide a (non-exhaustive) list of the elements analysed in the initial phase of the rating definition. Some elements were discarded because considered too complex (e.g. *Material selection*), especially for what concerns their technical analysis by the future agency that will be issue the rating. Similarly, some elements (e.g. *Shielding*) may require the disclosure of proprietary information that could create a barrier for operators to participate into the rating. Other elements may be perceived as controversial: an example is the case of the *Mission Objectives*, whose evaluation is likely to be considered subjective. Finally, some categories were discarded (e.g. *Re-entry*, *Spectrum*, *Economic aspects*) because the intent for the first version of the rating is to focus specifically on the issue of space debris, and in particular on the collision risk. Nevertheless, the SSR itself is envisaged as a regularly revised scoring system, to adapt to the evolutions in the space environment as well as best practices and standards. For the first version of the rating, six main modules were selected:

- Mission Index (or space traffic footprint),
- Detectability, Identification, and Tracking (DIT),
- Collision Avoidance Capabilities,
- Data Sharing,
- Standards,
- External Services.

Table 1. List of potential elements affecting the sustainability of a mission.

Physical parameters
Spacecraft size and mass
Material selection
Bus selection
Shielding
Orbital parameters
Concept of operations
Mission objectives
Collision avoidance capabilities
Duration of operational lifetime
End-of-life strategy
End-of-life passivation
Mission related object generation
Launcher provider selection
Operational availability
External services
Space Situational Awareness
Identification
Trackability
Data sharing
Re-entry
Casualty risk
Oxone depletion
Land/water contamination
Spectrum
Spectrum use
Frequency interference
Processes
Registration
Standards
Verified mitigation plan
Economic aspects
Orbit value
Financial resources
Insurability

The first two modules are based on simulations, whereas the other four will be evaluated based on the answers to a questionnaire. The single modules will be described in 2. A seventh element, the *Data Verification*, is applied across all the modules, as it will be explained in Section 3.

The outcome of the assessment is a rating with different tiers (e.g. silver, gold, platinum). An applicant can apply to the rating before launch and the rating is periodically updated based on actual operator performance during the on-orbit part of the mission. This captures the notion that only once a mission is truly over, is its impact on the space environment known. In other words, if not differently specified, it is assumed that the evaluation in the different modules is routinely repeated along the mission life cycle.

In addition to the tier rating, various questions count towards bonus scores. Bonuses are reported separately and do not contribute to the baseline rating of a requesting entity. Due to the novelty of some of the bonus categories, bonus items are often less defined and rely more heavily on operator self-assessment versus verification of a particular well-defined behaviour.

2. MODULE DESCRIPTION

2.1. Mission index

The mission index is a metric that quantifies the fragmentation risk associated to a mission, which is the likelihood that an object is involved in a fragmentation and the severity of this potential fragmentation measured through the impact on operational satellites [1]. As such, this metric is connected with several aspects of a mission as, for example, the size of the spacecraft, and the orbit where it is operating. It is important to notice that we refer to the index of a *mission*, intending with this a functional unit of spacecraft, launch vehicle, and mission related objects aimed at providing a specific service, by means of design and operations, for which they need to access and use part of the space environment. This means that a mission can consist of a single satellite, a satellite and launch vehicle, or larger combinations of these elements, and the risk metric is computed considering the contribution from all the objects.

The input required for the assessment are the following (for each object in the mission):

- mass,
- cross-sectional area,
- operational mean altitude,
- operational inclination,
- target disposal trajectory (apogee, perigee),
- expected disposal success rate,
- mitigated collision risk.

The value of this metric is computed along the whole mission lifetime to capture the risk reduction associated with the implementation of disposal strategies, as shown in Figure 1 for a representative spacecraft. The dark blue curve represents the risk evolution in the case of a successful disposal, whereas the red curve indicates the case where the spacecraft is abandoned in its operational orbit.

In addition, for the rating, we also compare the risk associated with the selected disposal and the one corresponding to the recommended disposal action in the corresponding orbital region (e.g. the 25-year rule in LEO). This case is shown in light blue in Figure 1: in this case, the mission adopts a more string disposal (e.g. 10 years), then the computed risk reduction also contributes to the scoring. In particular, two separate scores are compute for a mission: the *absolute* index of the mission (I), intended as the simple evaluation of the risk metric for the mission, and the *relative* value, intended as the ratio between the absolute index I and the one corresponding to the reference mitigation scenario (I_{ref}).

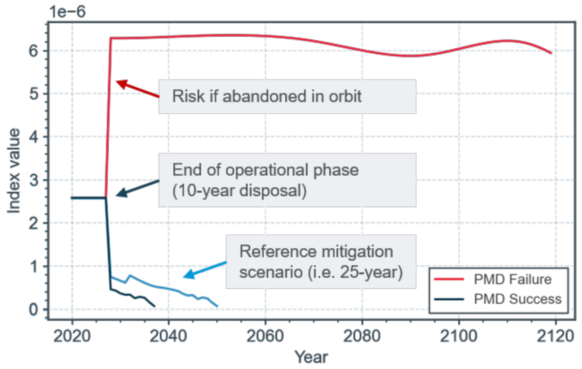

Figure 1. Index evolution in three mitigation scenarios.

For what concerns the index evaluation with respect to the mission life cycle, it is considered that the environment parameters related to the computation (e.g. the background debris population) are fixed at a defined project milestone and kept constant in the subsequent evaluation. This is done to avoid that, in case of a fragmentation, the operator is penalised by events outside their control. In case of a request for a mission extension, then the environment parameters are re-updated to the current status of the environment to reflect that any consideration related to the extension should take into consideration if major changes to the environment have occurred.

2.2. Detectability, Tracking, and Identification

Another aspect captured by the rating is the quantification of how easy is to detect, identify, and track a space object, and in a previous work we have specifically explored the strong link between the proposed rating and related needs in terms of Space Situational Awareness (SSA) [2]. With *detectability* we indicate the likelihood of observing an object without prior information. Different metrics are defined for optical (e.g. object brightness) and radar sensors (e.g. signal-to-noise ratio), and details about the simulation approach can be found in [3].

With *identification* we indicate the likelihood that an object can be uniquely distinguished (without coordination with the operator): the metrics for this are still under development, so it won't be included in the first issue of the rating.

Finally, with *trackability* we indicate the feasibility of predicting the trajectory evolution (for an agent different from the operator); also in this case, several metrics (i.e. pass duration, orbital coverage, interval duration) for the characterisation of an object have been defined [3].

The inputs required by the analysis are

- (Required) Geometric approximation and dimensions (rectangular prism, cylinder, or sphere);
- (Requested) Simplified CAD model (Basic size and geometry);
- (Requested) Detailed CAD model (Complex faceted model, i.e. >1000 faces, with material details);
- Operational Orbit Parameters;
- Nominal requirements for satellite Attitude/Pointing during primary mission;
- The number of satellites in the mission and the deployment process from the launch vehicle;
- A qualitative description of the early operational stages to reach the operational orbit.

In addition, a part of the score is attributed from a series of questions on tracking operations (e.g. time required to reach full custody of a space asset) and on the photometric/radiometric characterisation of the spacecraft

2.3. Collision Avoidance Capabilities

While the aspect of risk-reduction (e.g. threshold selection) related to collision avoidance is captured in the mission index, this module focusses on the operational aspects of collision avoidance i.e. the operators capabilities to identify, respond to, and mitigate collisions. The questions asked to operators are related to three specific aspects:

- Orbital state knowledge, with levels based on state accuracy, update frequency, covariance characterisation;
- Availability to coordinate, with levels based on personnel availability;
- Capability to coordinate, with levels based on the presence of established procedures to handle conjunctions alerts.

For each of these elements, four different levels are defined, which are associated to different scores: 0 for the minimum, 2 for Low, 3 for Medium, and 4 for High. The scoring is attributed including all the lower levels i.e. if an operator matches all the conditions up to the highest level, they would get in total 9 points for the entry.

For example, for the evaluation of the availability to coordinate, the questionnaire asks operators to select among the following statements:

None (0 points) Not able to coordinate;

Low (2 points) Able to coordinate in response to emergencies (but not necessarily on a routine basis);

Medium (3 points) Able to coordinate during set hours per day;

High (4 points) Has a system for routine conjunction assessment and capability to respond to concerns 24 hours per day via human or computer system capable of supporting near-immediate coordination and reaction for urgent issues.

The three elements previously listed all contribute to the *tier* component of the rating. In addition, bonus scores can be gained if the operator maintains orbital state knowledge after the end of normal operations.

2.4. Data sharing

This module evaluates which data an operator is willing to share and with whom. A matrix approach is adopted for the evaluation here, with different points attributed depending on how the shared information contributes to space flight safety. Three main categories of data have been identified:

- Collision avoidance coordination information, e.g. contact information, hours of operations;
- Satellite metric information, e.g. ephemeris, covariance, launch sequence;
- Satellite characterisation information, e.g. mass, operational status, manoeuvre capability.

To achieve credit for sharing a specific type of data with a certain audience category, the SSR applicant should generally make the specific form of data available to entities in that particular category on a reasonable and non-discriminatory basis. The following audience types have been identified:

SSA Provider(s) Many entities operate SSA databases for use by third parties or provide SSA data products or services to others. Some of these entities are governmental, others are operated as non-profits or in academia, and some are for profit entities.

Other operators upon request for coordination Another operator may make a request for coordination to an SSR applicant in response to a high interest event or other specific planned or emergent event. Operators may be willing to share information with other entities with a credible need to know in response to such an event.

Voluntary network of operators/stakeholders Various organizations, including the Space Data Association[1], exist as venues to share safety of flight information, with some providing additional data verification and validation and/or legal and technical restrictions on the use of shared information. Informal networks also exist for various spacecraft operators with overlapping orbits, where data sharing happens on ad-hoc bases and to serve specific needs of operators.

Public In order to earn credit for sharing with the public, the operator must maintain and provide the relevant source of information.

Table 2 shows an example of the matrix evolution approach applied to satellite metrics, where one can observe how more relative importance is given to sharing ephemerides with respect of the covariance characterisation as the former is considered more relevant to the objective of increased space safety. Similarly, for the satellite characterisation category, sharing information on the manoeuvrability status of a spacecraft will give more points than sharing its mass.

In addition to the previous data categories, bonus scores are attributed if the operator shares radio-frequency information, spacecraft anomaly data, and datasets to support academic and governmental research.

2.5. Application of Design & Operation Standards

This module is introduced in recognition of how guidelines and technical standards are essential to ensure a common understanding of mitigation actions across operators. The questionnaire distinguishes between mandatory and voluntary adoption, with the latter contributing to the bonus score. This approach tries to strike a balance between discouraging the selection of looser regulatory regimes and recognising beyond-than-required behaviours.

In particular, the following guidelines and standards are considered:

- Space debris mitigation guidelines (e.g. IADC);
- Long-Term Sustainability guidelines;
- Space debris mitigation standards or verifiable laws (e.g. ISO, FSOA);
- Standardised operational products (e.g. CCSDS);
- In case of close proximity or rendezvous operations: relevant safety standard (e.g. CONFERS).

Any tailoring of the guidelines and standard should be detailed to allow for an appropriate score correction.

Table 2. Example of data sharing evaluation on satellite metric information.

Parameter	SSA Provider	Upon request	Network	Public
Predicted ephemerides	12	8	15	15
Covariance values	6	5	6	6
Covariance validation	1	2	3	3
Launch timing	3	1	1	2

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[1] https://www.space-data.org/sda/

2.6. External Services

The last module accounts for the adoption of external services for life extension or removal, with the score contributing to the bonus component of the rating. The module considers a range of activities and identifies classes of actions that satellite operators can take to make their mission more amenable to receive external services (or On-Orbit Service, OOS) such as fixing, improving, and reviving satellites and refers to any work to refuel, repair, replace, or augment a satellite in space, and removing it.

In particular, the following four categories of actions are defined:

OOS features Actions during the design and pre-launch phase to make it easier for operators to have their mission serviced in the future. These actions can range from compiling a detailed documentation of the platform design up to adopting design features to facilitate relative navigation and servicing;

Standardised OOS features Utilising standard design features to facilitate OOS;

Life extension service Commitment to use or demonstration of use of On Orbit Servicing;

Active removal Use of active removal as a backup plan (or in addition) to traditional disposal strategies.

For what concerns OOS features, it is important to notice that organisations such as NASA's Satellite Servicing Projects Division (SSPD) and ESAs Clean Space Office have begun independent assessment, verification and validation of OOS features through their own testing, particularly design choices, e.g. grapple fixtures. Taking advantage of these studies and verification tools could be used as a baseline in the attribution of this component of the score.

3. SINGLE SCORE AGGREGATION

Once that all the modules have been briefly described, they need to be combined together into a single score. The first step is to ensure that all the module produce a score between 0 and 1, with 1 indicating the best achievable value. For the modules based on the questionnaire, this is simply done by normalising the score with the maximum achievable point total. For the two modules based on simulations, some reference performance need to be estabilished.

3.1. Normalisation

Mission index For the *absolute* part of the mission index, the normalisation is performed by introducing the concept of environment capacity, that is the number and the type of missions that are compatible with a stable evolution of the environment [4]. This approach is more complex than normalising with a reference mission, but it is also more robust and can capture the evolution of the environment. For example, if more and more missions are abandoned in orbit without disposal, the available capacity will decrease and a future mission will need a lower fragmentation risk to get the same score of one launched when the available capacity was higher.

The approach for the estimation of the available capacity is detailed in [1] and it is based on two steps:

- compute the risk metric described in Section 2.1 to all the intact objects in orbit to obtain a total value representative of the whole environment,
- compare this value with the value obtained in long-term simulation of the environment, under the assumption of a good adherence to mitigation guidelines.

Let's indicate with C the available capacity and with $\hat{I}$ the normalised mission with respect to it ($\hat{I} = I/C$). The score S is obtained from

$$S_a = 0.5 - \frac{1}{\alpha}\log_{10}(\hat{I}) - \frac{\hat{I}-1}{\beta}, \tag{1}$$

where the logarithmic component is introduced to highlight the differences in order of magnitude in the risk metric, whereas the linear part penalises cases above the available capacity threshold. The functional dependence in Equation 1 was preferred to definition of tiers to keep more granularity in the assessment of different missions.

The two parameters α and β in Equation 1 are set respectively to 10 and 50, where the values were selected by analysing the score distribution across the current population of active objects and its dependence on the mission mass. With these values, any mission below the available capacity threshold will have a score $\geq$ 0.5 and the maximum score can be achieved only by small and medium missions (with mass <1000 kg).

Also the *relative* component of the mission index (I_r) requires normalisation. In Section 2.1, I_r was defined as I/I_{ref}, and this value is translated into a score with the following expression

$$S_r = 1 - I_r^{\gamma}, \tag{2}$$

where γ was set equal to 3 after a calibration phase based on the analysis of some reference missions with different disposal approaches. It is important to notice that using Equation 2, S_r can be ¡ 0, if $I > I_{\text{ref}}$ i.e. if the mitigation measures are less effective than the reference mitigation scenario. While the weighting (w) between the two index component will be discussed later in Section 3.3, it can be already anticipated that the following formualtion

$$S_i = \max(w_a S_a + w_r S_r, 0) \tag{3}$$

is adopted to limit the score within the acceptable interval between 0 and 1.

DIT For the Detectability and Tracking score, the normalisation is carried out by defining performance tiers for each of the metric used in the assessment. The cut-off values for each metric are reported in Table 3, where the number in brackets indicate the points attributed to the tier. The tiers were defined based on the analysis of literature and of the distribution of these metrics across the current population of objects in orbit [3].

For the score on detectability (D), the maximum score between the evaluation with the optical and with the radar sensors is selected. For the tracking score (T), the value is obtained giving the same weight to the three metrics. Finally, the overall DIT score is also obtained giving the same weight to D, T, and Q, where Q is the evaluation coming from the questionnaire and where all the three components are defined between 0 and 1.

3.2. Data validation

In parallel to the normalisation process, for each of the modules it is assessed how verifiable is the data provided for the rating computation. The rationale behind the approach proposed here is that an SSR application will not involve an in-depth review of the mission design on behalf of the SSR issuer. Rather, the SSR issuer will evaluate the level of verifiability of the data provided and leverage on already existing verifications provided by technical authorities. Four different levels are defined:

Assertion by Applicant (0.5) Affirmative statement by the applicant is provided, without supporting documentation;

Assertion with Technical Documentation (0.6) Supporting technical documentation on the mission design is disclosed to the SSR issuer;

Public Release of Technical Documentation (0.8) Supporting technical documentation is submitted to a government or non-profit available for public review;

Authority (1.0) An independent technical review or the confirmation of the compliance by a third-party technical expert is provided.

The number between bracket indicate the corrective factor corresponding to each level. For the modules based on the questionnaire, the corrective factors are applied individually to each entry in the questionnaire; for the modules based on simulations, an aggregated corrective factor is computed considering the different inputs (and their verifiability) used in the assessment.

3.3. Weighting

Finally, all the scores are combined together by using weighting factors. The approach used here is to define three levels (high, medium, low) and associate each module to one of the levels. It is important to mention that the SSR is still in its testing phase and the specific values of the weights may be revise depending on the feedback from the test users. Nevertheless, the association currently adopted is the following:

High (50%) mission index;

Medium (15%) DIT, collision avoidance capabilities, data sharing;

Low (5%) standard application (and external services),

where *external services* is indicated between brackets as a reminder that it contributes only to the bonus score and not to the tier component. For the mission index, the 50% has to be distributed between the *absolute* and the *relative* component as indicated in Equation 3. In particular, it was found that setting $w_a = 4w_r$ provide the desired balance between recognising the differences in the absolute risk assessment and rewarding operators for implementing more stringent disposal measures as quantified by the relative component I_r.

4. EXAMPLE OF ASSESSMENT

A set of representative missions was defined to test the current formulation and the results are shown in Figure 2.

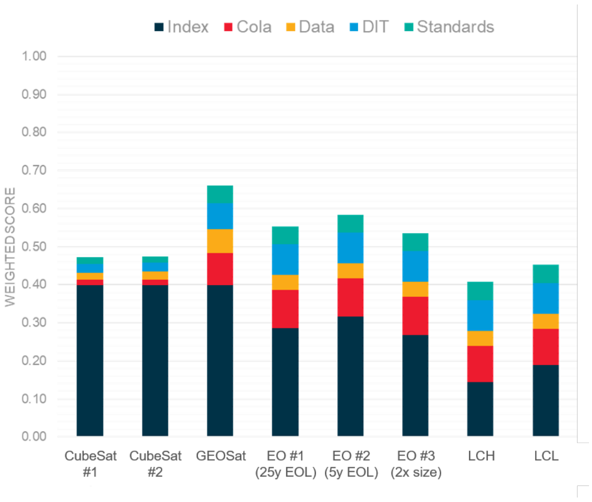

Figure 2. Rating assessment (and module contribution) for a set of representative missions. EO indicates an Earth Observation mission in a Sun-synchronous orbit, LCH indicates a Large Constellation in LEO at High altitude, LCL one at Low altitude.

One can observe how CubeSat missions have low associated risk, but are penalised by the lack of collision avoidance capabilities.

Table 3. Performance tiers for the DIT metrics. The number in brackets indicate the points attributed to the tier.

Sub-module	Metric	Tiers			
Detectability	Visual magnitude	<15	>15 (1)		
	Probability of detection	<50%	50-75% (0.5)	≥75% (1)	
Tracking	Visual magnitude	<120”	120-180” (0.25)	180-400” (0.5)	≥400” (1)
	Orbital coverage	<10%	10-25% (0.25)	25-60% (0.5)	≥60% (1)
	Interval duration	>12h	12-6h (0.5)	<6h (1)	

GEO missions benefit from reduced risk metric with respect to LEO missions and, in the simulation, it was also reflected the fact that GEO operators do usually share ephemerides and other data to facilitate coordination.

EO indicates an Earth Observation mission in a Sun-synchronous orbit, in a non-naturally compliant altitude, so that a manoeuvre is required to meet the 25-year rule at the End-of-Life (EOL). Two variations with respect to the baseline mission were considered. In one case (EO#2), the disposal phase was reduced from 25 to 5 years, so that the mission gets an improved assessment for what concerns the mission index. On the other hand, in the other case (EO#3), the size of the spacecraft is doubled, which results in a higher associated fragmentation risk and a penalisation in the mission index.

Finally, the case of large constellation (LC) in LEO was considered. LCH refers to a large constellation operating at altitude high enough that the spacecraft are not naturally compliant with the 25-year rule, but the expected success rate is equal to 95% (instead of the baseline 90%); LCL refers instead to a case at lower altitude, where satellites are naturally compliant. Large constellations have a lower score from the mission index because of the higher intrinsic risk level. This can be (partially) compensated through the other modules or by adopting more stringent disposal strategies.

5. CONCLUSIONS

The paper has presented the proposed framework for the Space Sustainability Rating, whose objectives are to promote the importance of space sustainability, with a focus on the problems with orbital debris, and to act as an incentive for positive behaviours.

The rating is based on six main modules plus the evaluation of the verifiability of the data provided by the applicant to the SSR issuer. The selection of which modules to include has been based on considerations such as the relevance to the debris issue, and the use of data that operators are willing to share.

The process of normalisation and weighting required to combine the modules into a single score has been carried out by analysing the performance across existing missions and it is currently in the process of being reviewed together with the beta testers of the rating.

APPENDIX

The full scoring criteria applied for the *Collision Avoidance Capability* module and for the *Data sharing* one are reported respectively in Table 4 and Table 5.

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Table 4. Scoring Rubric for Collision Avoidance Capability. Please note that the scores may be revised as the SSR Design is matured.

Operator action	No score	Low score (1)	Medium score (3)	High score (4)
Orbital State Knowledge (during normal operations)	Rely on a third party public SSA provider for state information (e.g. space-track.org TLE)	Operator maintained orbital position state knowledge of object	Maintain orbital state knowledge of object to < 10 km in any direction. + Update orbit determination for the operated satellite when a manoeuvre or other event induces a change to its orbit that would cause the operators state estimation to be worse than the required orbital state knowledge. + Characterize and validate covariance of your orbit determination	Maintain orbital state knowledge of object to within < 1 km in any direction. + Update orbit determination for the operated satellite when a manoeuvre or other event induces a change to its orbit that would cause the operators state estimation to be worse than the required orbital state knowledge. + Characterize and validate covariance of your orbit determination
Collision Avoidance: Availability to Coordinate	Not able to coordinate	Able to coordinate in response to emergencies (but not necessarily on a routine basis).	Able to coordinate during set hours per day.	Has a system for routine conjunction assessment and capability to respond to concerns 24 hours per day via human or computer system capable of supporting near-immediate coordination and reaction for urgent issues.
Collision Avoidance: Capability to Coordinate	Operator has no dedicated process for conjunction screening, assessment, or mitigation. The operator may be unable to or chose not to ever manoeuvre in response to conjunctions	Has the capability to be contacted in case of close approach or another high-risk event + Operator regularly screens orbits and planned manoeuvres against public catalogues and/or information from SSA sharing organizations and/or third-party SSA providers	Operator is capable of interpreting conjunction data messages and other common formats, to determine risk and generate/screen mitigating manoeuvres + Operator has a system for automated routine conjunction assessment	Has documented procedures for collision screening, assessment, and mitigation + Regularly screens operational spacecraft and planned manoeuvres against SSA sharing organization catalogue
Maintaining orbital state knowledge after the end of normal operations (BONUS)		Maintain orbital state knowledge until spacecraft is placed into a graveyard orbit or is disposed of through atmospheric re-entry.	Maintain orbital state knowledge to 10 km until spacecraft is placed into a graveyard orbit or is disposed of through atmospheric re-entry.	Maintain orbital state knowledge to 1 km until spacecraft is placed into a graveyard orbit or is disposed of through atmospheric re-entry.

Table 5. Scoring Rubric for Data Sharing. Please note that the scores may be revised as the SSR Design is matured.

Data shared	SSA provider(s)	Upon request	Voluntary network	Public
Collision Avoidance Coordination Information				
Publish + update collision avoidance contact Information	10	10	12	12
Publish + update collision avoidance contact time zone/hours of operation	3	3	3	4
Publish + update COLA contact/coordination request response time guarantees	1	2	2	1
Satellite Metric Information				
Publish + update satellite ephemeris (including manoeuvres)	12	8	15	15
Publish + update covariance values	6	5	6	6
Publish + update covariance validation	1	2	3	3
Publish + update launch vehicle timing	3	1	1	2
Satellite Characterization Information				
Publish + update satellite mass	4	3	4	4
Publish + update satellite manoeuvrability (manoeuvrable/non-manoeuvrable)	5	5	6	6
Publish + update satellite manoeuvrability capability	3	2	3	3
Publish + update satellite operational status (operational/non-operational)	5	5	6	6
If the satellite uses autonomous systems (systems without a human in the loop) for satellite manoeuvring, publish + update:				
The criteria for when a manoeuvre is triggered	5	3	5	5
Where and with what frequency planned autonomous manoeuvres are reflected in shared SSA information	5	3	5	5
If emergency stop procedures exist to interrupt autonomous procedures in case of malfunction and how another operator should request an emergency stop	2	2	3	3
Other forms of data sharing (BONUS)				
Radio-frequency Information to support interference avoidance/mitigation/geolocation	1	4	3	3
Spacecraft anomaly information	1	2	3	4
Other datasets to support government/academic research	3	3	3	4
APIs or other means for automatic machine to machine access to above information	1	1	2	2