CGMS-53-WGI-WP-04
18 March 2025

Prepared by: EUMETSAT
Agenda Item 3.1
Discussed at WG-I

Subject	**Report from CGMS WGI Task Group on Space Environment Sustainability**
In response to CGMS action/recommendation	WGI/A50.07: Deliver a Best Practice document on Space Environment Sustainability, with supporting presentation to CGMS WGI, for recommendation for endorsement in CGMS-52. WGI/A50.08: All CGMS Members involved in spacecraft operations are strongly encouraged to nominate participants for the CGMS WGI Task Group. SWCG/A51.02: Review current usage of space weather data for spacecraft operations and goals for improvement. SWCG/A51.11: Produce a report of space weather observation requirements for improved STC services and space sustainability
HLPP reference	2.5 Operational issues related to space weather 2.6 Space traffic coordination 2.7 Space Sustainability
Executive Summary	This document reports on the background, content of the Terms of Reference and progress achieved for the CGMS WGI Task Group on Space Environment Sustainability, relevant to CGMS member current and planned missions. The members of the Coordinated Group for Meteorological Satellites (CGMS) rely on the sustainability of the space environment to ensure their satellite missions remain able to deliver meteorological and space weather data to global forecasting services. In this regard, safety on Earth is very much intertwined with safety in space. CGMS has therefore established a Task Group on Space Environment Sustainability which shall address all aspects of operations in the space environment where CGMS member coordination can help improve the safety and sustainability of space operations for all space actors. The objectives include establishing best practices covering Space traffic coordination, lifetime extensions, end-of-life disposal and

	space weather mitigation of risks and effects. It is foreseen that a proposal on acceptable space traffic coordination practices can be submitted for consideration by UN COPUOS.
Action/Recommendation proposed	Set WGI/A50.07 Due date for CGMS-53 Plenary. WGI/A50.08: Membership has increased, but more members being sought – and in particular experts. **Close and add new reworded action**: All CGMS Members involved in spacecraft operations are strongly encouraged to nominate participants for the CGMS WGI Task Group and subject matter experts for supporting analyses. SWCG/A51.02: Was transferred from SWCG at CGMS-52 – requires a WGI action identifier. Keep Open SWCG/A51.11: Was transferred from SWCG at CGMS-52 – requires a WGI action identifier. Keep Open **New actions proposed:** ➢ *Action WGI/A53.XX: Define the requirement for supplying owner/operator orbit and manoeuvre information to TraCCS and identify steps for implementation.* ➢ *Action WGI/A53.XX: Identify steps to coordinate modelling of thermospheric density impacts and perform inter-comparison of model results.*

1 INTRODUCTION

1.1 Purpose

This document reports on the background, content of the Terms of Reference and progress achieved for the CGMS WGI Task Group on Space Environment Sustainability, relevant to CGMS member current and planned missions.

The status of Task Group membership and call for additional members and subject matter experts to support analyses is also highlighted.

Reporting on outreach activities and plan for future meetings are also provided.

1.2 Scope

This report describes the on-going activities and provides the Terms of Reference in its entirety in the Annex and its relation to the CGMS Future Directions Theme on Space Situational Awareness.

An abridged version of Terms of reference to highlight the main objectives and deliverables is provided in the body of this document.

1.3 Applicable Documents

There are no applicable documents identified.

1.4 Reference Documents

	Document Title	Reference
RD-1	Discussion on future CGMS WGI efforts on Space Debris and Collision Avoidance	CGMS-51-WGI-WP-07, PPT
RD-2	CGMS future direction 2022+ *Position paper theme: Space Situational Awareness*	CGMS-51-CGMS-WP-19
RD-3	CGMS future direction 2022+ Task Team - Terms of Reference (for information)	CGMS-51-CGMS-WP-07
RD-4	UN General Assembly: COPUOS Special report of the Inter-Agency Meeting on Outer Space Activities on developments within the United Nations system related to space debris	A/AC.105/1317

2 BACKGROUND TO THE TASK GROUP

This Task Group builds upon the preliminary work initiated by its predecessor, the Space Debris and Collision Avoidance Task Group established in 2019, but having lapsed activities since 2022 [RD-1]. Note that activities conducted were limited to bilateral interactions between NOAA and EUMETSAT. The RD-1 provides the references to the reports issued, including the Terms of Reference.

The name of this revived Task Group was changed in recognition of the broader scope of activities, dealing not only with debris but also with safe operations in increasingly congested orbits and additionally taking into account potential impacts from space weather.

Furthermore, the objectives and actions from the CGMS Future Directions Project SSA theme were considered in the scope of this Task Group [RD-2].

3 SCOPE OF THE TASK GROUP TERMS OF REFERENCE

The Terms of Reference were approved at CGMS-52 and have remained stable.

The Terms of Reference is addressed to all CGMS participants and is relevant for all management, engineering and legal functions responsible for ensuring the definition, implementation and operation of CGMS agency space-based systems is compatible with the space environment and its sustainability.

The Task Group objectives and activities defined by the Terms of Reference are therefore applicable across all satellite-based programmes in all mission phases.

The Terms of Reference intends to cover all space sustainability issues of relevance to CGMS missions without exclusion. In particular, this ToR includes all SSA aspects associated with the Short-, Medium- and Long-term Goals for CGMS, as defined in [RD-2] and split into the following categories:

- Space Traffic Coordination
- Space Weather
- Space Sustainability

It should be noted that there is potential relevance to other CGMS Future Directions Themes and any such cases identified during discussion should be highlighted. However, no specific case was identified during discussions since CGMS-52. The full scope of CGMS Future Directions Themes is summarised in [RD-3].

4 HIGHLIGHTS OF TASK GROUP ROLE AND OBJECTIVES

The United Nations Office for Outer Space Affairs (UNOOSA) acting as Secretariat to UN-Space (the Inter-Agency Meeting on Outer Space Activities) reference the CGMS activity in the Special Report on Space Debris presented for consideration by the Committee on the Peaceful Uses of Outer Space at its sixty-seventh session, in June 2024 (RD-4). The extract is reproduced below.

> **N. Meteorology**
>
> 86. The members of the Coordination Group for Meteorological Satellites (CGMS), of which WMO is one, rely on the sustainability of the space environment to ensure their satellite missions remain able to deliver meteorological and space weather data to global forecasting services. In this regard, safety on Earth is very much intertwined with safety in space. CGMS has therefore established a Task Group on Space Environment Sustainability which shall address all aspects of operations in the space environment where CGMS member coordination can help improve the safety and sustainability of space operations for all space actors. The objectives include establishing best practices covering space traffic coordination, lifetime extensions, end-of-life disposal and mitigation of space weather risks and effects. It is foreseen that a proposal on acceptable space traffic coordination practices may be submitted for consideration by the Committee on the Peaceful Uses of Outer Space.

Highlights of Objectives and Deliverables (abridged from the full Terms of Reference in the Annex).

Task Group Overall Objective

This Task Group address all aspects of operations in the space environment where CGMS member coordination can help improve the safety and sustainability of space operations for all space actors.

Membership: CGMS member organisations. Outreach to interested external space actors is planned.

Detailed key objectives and deliverables

1. **Objective:** Stay abreast on the status, current events and foreseen evolutions of the space environment, together with related regulations, guidelines, approaches, tools and services with the potential to constrain or inform in-orbit and planned CGMS mission services.
    - **Deliverable:** Accessible Resource database.

2. **Objective:** Establish a Best Practice on Space Environment Sustainability aspects for CGMS member's missions covering:
    i. Space Traffic Coordination
    ii. Lifetime extensions and end-of-life disposal

iii. Break-up and atmospheric re-entry notification process
iv. Space weather forecast usage and mitigation of risks and effects.

- **Deliverable:**
  a) A best practice document on Space Environment Sustainability based primarily on existing practices, but also with a view to emerging technologies and concepts for long-term, system lifecycle sustainability
  b) A gap analysis on global Space Traffic Coordination capabilities and alignment
  c) Updated proposal for best practices based on outputs from (a), (b), targeting approval by CGMS for submission to UN COPUOS, with focus on Space Traffic Coordination.

3. **Objective:** Identify and act upon risks to sustained operations.
   - **Deliverable:** A space environment sustainability SWOT analysis, with identified actions.

5 CALL FOR MEMBERS

Membership of the Task Group has gradually increased since CGMS-52 which allows a meaningful exchange to take place. In particular membership with responsibility for space debris mitigation and situational awareness which has been underrepresented is starting to increase, but would still benefit from additional nominations.

Identification of experts from member organisations who can support offline analyses of the Task Group is key to progressing on the objectives of the Task Group and this remains to be achieved.

Due to the scope of the Task Group, a secretarial function supporting the Co-Chairs would be welcomed.

The current status of membership is provided below (extracted from Terms of Reference in Annex).

Role	Organisation	Function	Names
Co-Chair	EUMETSAT	SES / LEO Satellite Operations	Andrew Monham Andrew.Monham@eumetsat.int
Co-Chair	ESA	Head of Space Weather CGMS Future Project SSA lead	Juha-Pekka Luntama Juha-Pekka.Luntama@esa.int
Secretary	TBC		
Member	CMA		Cong HUANG

Role	Organisation	Function	Names
			huangc@cma.gov.cn
Member	CNES		
Member	CNSA		
Member	IMD		
Member	ISRO		
Member	JAXA	JAXA STCC (Satellite Tracking and Communications Center	Shinichi Nakamaru
Member	JMA		
Member	KASA	Head of Space Weather	Kichang Yoon
Member	KASI	Chief Manager / Principal Researcher Space Hazards Program Office Center for Space Situational Awareness	Dr. Eun-Jung Choi eunjung@kasi.re.kr
Member	KMA	Senior Researcher of Satellite Operation Divison	Jaeyoung Byon jybyon@korea.kr
Member	NASA	Head of Space Weather Space Comms & Navigation	Jamie Favors james.e.favors@nasa.gov John Hudiburg john.j.hudiburg@nasa.gov
Member	NICT	Executive Researcher Space Environment Laboratory	Tsutomu Nagatsuma tnagatsu@nict.go.jp
Member	NOAA	Deputy Director of NOAA Satellite Operations	Scott Leonard scott.leonard@noaa.gov
Member	ROSCOSMOS		
Member	ROSHYDRO MET		
Member	WMO		Heikki Pohjola hpohjola@wmo.int

Role	Organisation	Function	Names
Member	ISES	Deputy Director of ISES (http://www.spaceweather.org/)	Sergio Dasso sergio.dasso@gmail.com
Expert	ESA	Space Debris Office	Klaus Merz
Expert	EUMETSAT	Flight Dynamics	Pier Luigi Righetti
Expert	EUMETSAT	Mission Analysis	Jose Maria de Juana Gamo
Expert	EUMETSAT	Programme Development	Remy Chalex
Expert	EUMETSAT	Legal Affairs	Rachelle Antal-Wokes
Expert	NASA	LEO	Paul Apostolopoulos
Expert	NASA	GEO	Ian Ross
Observers	SANSA	Space Weather	Mpho Tshisaphungo Rendani Nndanganeni

6 TASK GROUP PRIORITIES

a) Top priority is to produce best / acceptable practices for Space Traffic Coordination (collision avoidance, active on active satellite coordination practices).
b) 2nd priority is the CGMS action : Produce a report of space weather observation requirements for improved STC services and space sustainability
c) 3rd priority is the action : Review current usage of space weather data for spacecraft operations and goals for improvement.

7 TASK GROUP ACHIEVEMENTS

7.1 Space Traffic Coordination

The Task Group is compiling a matrix of currently used practices in the different domains of space traffic coordination and debris mitigation. This covers various orbital domains used to support the activities of the CGMS members: LEO, GEO, HEO, ExtraTerrestrial. Annex II provides an example of the LEO matrix.

Inputs have been received from CMA, ESA, EUMETSAT, JAXA, NASA and NOAA.

The next task is to perform a detailed review of these practices, to identify commonalities, deviations and identify any recommendations for improvements. An offline analysis with the support of member agency experts is requested for this.

Furthermore, the Task Group has also proposed a listing of contact points to handle active-on-active satellite conjunctions, together with additional information on the formats of data etc. In addition, it is requested to identify if the named contact for a given member can be used as an intermediary to distribute information concerning such conjunctions to national or regional third-party operators who may otherwise not be contactable. Discussion is on-going as to the use of this vs. the SpaceTrack listings.

7.2 Space Weather Requirements Supporting Space Traffic Coordination and Safe Spacecraft Operations

This refers to the 2nd and 3rd priority areas listed above which follow-up on the CGMS actions

Space weather information is split on two matrices separating the Space Traffic Coordination needs from the "safety of space operation" related information. The matrices are addressing explicitly the operations on Earth orbits for now. concentrating on LEO, GEO. So far, only inputs from ESA have been provided and further inputs are requested. An example of the Space weather needs for STC is provided in Annex III.

The TG noted that currently good propagation products using space weather inputs come from US 18th Squadron. However, their starting point (knowledge of operator orbit) is based on their own measurements, rather than operator supplied orbit. If the owner/operator orbit and future manoeuvres could be supplied, then the propagation may be more accurate. TG members are requested to consider the requirement for this and steps for implementation. Recommended to follow up with TraCSS (US DoC).

Action proposed: SES TG to define the requirement for supplying owner/operator orbit and manoeuvre information to TraCCS and identify steps for implementation.

Action proposed: Identify steps to coordinate modelling of thermospheric density impacts and perform inter-comparison of model results.

8 MEETINGS HELD / PLANNED

Since CGMS-52, the following 4 TG meetings have taken place.

19 September 2024, 3 December 2024, 28 January 2025, 12 March 2025

An additional TG meeting prior to the CGMS-53 plenary is proposed for 7 May 2025.

Proposed CGMS-53-54 TG Meetings (all virtual, starting 12:00 UTC)

- 2 July 2025
- 16 Sept 2025
- 25 Nov 2025
- 21 Jan 2026
- 10 Mar 2026

Opportunities for face-to-face discussions as side meeting in other conferences shall also be considered.

9 CONCLUSION

WGI is invited to take note of the progress of the Task Group on Space Environment Sustainability and support the call for membership and subject matter expertise from each CGMS member organisation in order to help ensure the objectives can be met.

Action WGI/A50.07 to remain open for delivery of first Best Practices document at CGMS-54.

Action WGI/A50.08: Close in favour of the following new action:

- All CGMS Members involved in spacecraft operations are strongly encouraged to nominate participants for the CGMS WGI Task Group and subject matter experts for supporting analyses
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Action SWCG/A51.02: Review current usage of space weather data for spacecraft operations and goals for improvement.

- Was transferred at CGMS-52 to WGI – requires new ID and remains open.

Action SWCG/A51.11: Produce a report of space weather observation requirements for improved STC services and space sustainability.

- Was transferred at CGMS-52 to WGI – requires new ID and remains open.

Action proposed: SES TG to define the requirement for supplying owner/operator orbit and manoeuvre information to TraCCS and identify steps for implementation.

Action proposed: Identify steps to coordinate modelling of thermospheric density impacts and perform inter-comparison of model results.

ANNEX I: TERMS OF REFERENCE

1. INTRODUCTION

1.1 Purpose

This document provides the Terms of Reference for the CGMS WGI Task Group on Space Environment Sustainability, relevant to CGMS member current and planned missions.

Once established, the relevance and accuracy of this Terms of Reference shall be reviewed and maintained on a regular basis.

It should be noted that this Task Group will build on the preliminary work initiated by its predecessor, the Space Debris and Collision Avoidance Task Group established in 2019, but having lapsed activities since 2022 [RD-1]. Note that activities conducted were limited to bilateral interactions between NOAA and EUMETSAT. The RD-1 provides the references to the reports issued, including the Terms of Reference.

The name of this revived Task Group has been changed in recognition of the broader scope of activities, dealing not only with debris but also with safe operations in increasingly congested orbits and additionally taking into account potential impacts from space weather.

Furthermore, the objectives and actions from the CGMS Future Directions Project SSA theme are to be considered [RD-2].

1.2 Scope

This Terms of Reference is addressed to all CGMS participants and is relevant for all management, engineering and legal functions responsible for ensuring the definition, implementation and operation of CGMS agency space-based systems is compatible with the space environment and its sustainability.

The Task Group objectives and activities defined by this Terms of Reference are therefore applicable across all satellite-based programmes in all mission phases.

The Terms of Reference intends to cover all space sustainability issues of relevance to CGMS missions without exclusion. In particular, this ToR includes all SSA aspects associated with the Short-, Medium- and Long-term Goals for CGMS, as defined in [RD-2] and split into the following categories:

- Space Traffic Coordination
- Space Weather
- Space Sustainability

It should be noted that there is potential relevance to other CGMS Future Directions Themes and any such cases identified during discussion should be highlighted. The full scope of CGMS Future Directions Themes is summarised in [RD-3].

1.1 Applicable Documents

There are no applicable documents identified.

1.2 Reference Documents

	Document Title	Reference
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RD-3	CGMS future direction 2022+ Task Team - Terms of Reference (for information)	CGMS-51-CGMS-WP-07
RD-4		

1.3 Implementation Documents

No relevant implementation documents at this issue.

1.4 Terminology

Acronyms and Abbreviations

Acronym/Abbr.	Explanation
CGMS	Coordinated Group for Meteorological Satellites
SES	Space Environment Sustainability
SSA	Space Situational Awareness
STC	Space Traffic Coordination
SWOT	Strengths-Weaknesses-Opportunities-Threats
TG	Task Group
UN COPUOS STSC	United Nations Committee for the Peaceful Usage of Outer Space Science and Technical Sub-Committee.

Definitions

Definition/Term	Explanation

2 TASK GROUP OBJECTIVES

The Task Group objectives are as follows:

1. Stay abreast on the status, current events and foreseen evolutions of the space environment, together with related regulations, guidelines, approaches, tools and services with the potential to constrain or inform in-orbit and planned CGMS mission services, including *inter alia*:
    - The space debris environment
    - Space debris mitigation standards and guidelines
    - International and regional policy measures for the sustainability of the space environment
    - Operational space traffic affecting CGMS space system orbits
    - Space Traffic Coordination[1]: approaches, regulations and guidelines
    - Space debris tracking capabilities and services
    - Collision avoidance capabilities and services
    - Debris removal capabilities and services
    - Lifetime extension criteria, capabilities and services
    - Spacecraft design for sustainability: e.g. autonomous manoeuvrability, passivation methods, de-orbiting systems, preparedness for 3rd party removal, robustness against debris impact and space weather effects
    - Forecasting of space weather events and mitigation technologies/methods
    - Potential improvements to space situational awareness analysis (Use of AI, environmental modelling, collection of data to improve environment modelling, identification of micro-collisions from spacecraft telemetry)
    - Defunct space object information exchanges: Break-up notification process, atmospheric re-entry notification process, information on orbit and attitude of passivated satellites
    - Link to terrestrial sustainability issues with possible impact on space sustainability approaches, including carbon footprint, impact of material re-entry on atmosphere, etc.

    In this respect establish links to other international groups on space sustainability related activities and iterate on approaches and best practices.

[1] Also referred to as Space Traffic Management, encompassing awareness of active satellite trajectories and "rules of the road".

2. Establish and update as relevant a Best Practice on Space Environment Sustainability aspects for CGMS member's missions with objective of submitting a CGMS agreed proposal for consideration by UN COPUOS Science and Technical Subcommittee (STSC), with particular emphasis on global space traffic coordination.
3. Define and manage related risks and opportunities, including identification of actions and formulation of a corresponding SWOT analysis.
4. Report status, risks, opportunities and recommended actions to the CGMS WGI, including recommendations for interactions with CGMS Plenary.
5. Coordinate interactions amongst the CGMS members' expert teams taking ownership of agreed actions and responsible for the implementation of the space environment sustainability approach, including *inter alia*:
    - Satellite operations and mission analysis teams for management of in-orbit conjunctions, lifetime extension, and end-of-life planning and operations
    - Programme development authorities for all missions under definition and development, addressing the applicable regulations, guidelines, approaches and tools to ensure mission concepts and designs are consistent with space environment sustainability objectives
    - Legal affairs for identification of applicable regulations, guidelines and assessment of compliance and related liabilities.
6. Encourage space environment sustainability issues to be addressed in CGMS members' organisations, e.g. in satellite and system level reviews in every phase of a mission lifecycle, with a nominated space environment sustainability representative in every relevant review.
7. Ensure the continued relevance and accuracy of the TG objectives, activities and membership through regular review of this Terms of Reference and associated best practices.

3 TASK GROUP TASKS

The SESTG will nominally meet four times per year or on request of the Chair to:

a) Review the status and foreseen evolutions of the space environment, together with related regulations, guidelines, approaches, tools and services (Objective 1).
b) Identify and establish links to related workshops, conferences, committees where CGMS representation should be considered, obtain reports from relevant proceedings and iterate on approaches and best practices (Objective 1).
c) Identify level of compliance across CGMS space mission to applicable standards and highlight current and foreseen evolutions (Objective 1).

d) Define, review and propose updates to the Best Practices on Space Environment Sustainability for CGMS missions. (Objective 2). This shall be broken down into specific aspects, inter-alia:
    i. Space Traffic Coordination: Review of approaches to identify best and minimum acceptable practices which can form the basis of an international norm, acceptable to global operators and SSA analysts. (Builds upon the NOAA-EUM CGMS-50 Papers), including:
        - Securing access to situational awareness data from object tracking and owner-operator state-vectors
        - Conjunction Analysis for LEO and GEO satellites, considering (as appropriate):
            - Asset conjunction risk assessment geometry and characteristics
            - Collision risk avoidance mitigation manoeuvre decision criteria
            - Optimal timing of manoeuvre decision and implementation
            - Minimizing impact of avoidance manoeuvre on nominal orbit maintenance
            - Acceptable background and mitigated risk analysis
            - Awareness and notification of risk for non-manoeuvrable satellites
            - How space weather inputs are being used in the trajectory assessment and identification of the space weather observation requirements
        - Inter-operator coordination and process for implementing avoidance manoeuvres for active-on-active conjunctions
    ii. Lifetime extensions and end-of-life disposal
    iii. Break-up and atmospheric re-entry notification process
    iv. Space weather forecast usage and mitigation of risks and effects. In particular:
        - The Task Group shall work with spacecraft operators and their supporting space weather services to establish best practices in the effective usage of space weather data in support of spacecraft operations. The Task Group shall:
            - review CGMS member's current practices and plans, covering:
                a. usage of space weather forecast data
                b. usage of space weather data for anomaly root cause analysis
            - invite selected external operators to present their approaches.
            - Analyse and report on current best practices and goals for improvement
    v. Long-term space systems design for sustainability, considering lifecycle sustainability issues, including emerging, enabling technologies, materials, concepts on re-use and recycling in support of a "zero-debris approach".

e) Perform a gap analysis between the needs and the available/used Space Traffic Coordination (STC) services, including identification of shortcomings. This will need to highlight deviations in regional STC service approaches and address feasibility of alignment / identification of acceptable minimum capabilities (Objective 2)
    i. Develop proposal for updated Best Practices on Conjunction Management based on agreed STC global capability alignment
    ii. Seek CGMS Plenary agreement to submit this BP proposal for consideration by UN COPUOS STSC.
f) Define, review and propose updates to a space environment SWOT analysis and identify relevant actions (Objective 3).
g) Prepare reports and presentations to WGI, comprising status, risks, opportunities and recommended actions for approval (Objective 4).
h) Define and prepare coordination exchanges between relevant CGMS member expert entities responsible for the implementation of the space environment sustainability approach, including cooperating partners as appropriate (Objective 5).
i) Discuss reported space sustainability issues arising from CGMS members' satellite and system level development reviews, operations mission lifetime reviews and identify planned reviews where space sustainability should be included in the organisational objectives, along with foreseen space sustainability representative (Objective 6).
j) Review continued relevance and accuracy of this Terms of Reference managed by the TG on an annual basis and publish updates when required (Objective 7).

4 TASK GROUP DELIVERABLES

The Task Group shall deliver:

1. An internationally accessible resource database capturing relevant information from Objective 1.
2. A best practice document on Space Environment Sustainability based primarily on existing practices, but also with a view to emerging technologies and concepts for long-term, system lifecycle sustainability. This Best Practice may be delivered in stages with increasing scope, according to a detailed work plan to be defined within the TG itself.
3. A gap analysis on global Space Traffic Coordination capabilities and alignment.
4. Updated proposal for best practices based on outputs from (2), (3), targeting approval by CGMS for submission to UN COPUOS, with focus on Space Traffic Coordination.
5. Supporting presentation to CGMS WGI for recommendation for endorsement by the CGMS Plenary.

5 TASK GROUP COMPOSITION

The Task Group composition aims to encompass all CGMS members with space assets.

Due to the wide scope of technical tasks, members may call on experts in their organisations. Members are encouraged to identify such experts here.

Since the scope of this activity extends beyond operators of meteorological satellites, observer members of the group from such agencies are encouraged to participate.

Further *ad hoc* participation in meetings or activities may be requested by the TG Chair or proposed by members.

Role	Organisation	Function	Names
Co-Chair	EUMETSAT	SES / LEO Satellite Operations	Andrew Monham Andrew.Monham@eumetsat.int
Co-Chair	ESA	Head of Space Weather CGMS Future Project SSA lead	Juha-Pekka Luntama Juha-Pekka.Luntama@esa.int
Secretary	TBC		
Member	CMA		Cong HUANG huangc@cma.gov.cn
Member	CNES		
Member	CNSA		
Member	IMD		
Member	ISRO		
Member	JAXA	JAXA STCC (Satellite Tracking and Communications Center	Shinichi Nakamaru
Member	JMA		
Member	KASA	Head of Space Weather	Kichang Yoon
Member	KASI	Chief Manager / Principal Researcher Space Hazards Program Office Center for Space Situational Awareness	Dr. Eun-Jung Choi eunjung@kasi.re.kr

Role	Organisation	Function	Names
Member	KMA	Senior Researcher of Satellite Operation Divison	Jaeyoung Byon jybyon@korea.kr
Member	NASA	Head of Space Weather Space Comms & Navigation	Jamie Favors james.e.favors@nasa.gov John Hudiburg john.j.hudiburg@nasa.gov
Member	NICT	Executive Researcher Space Environment Laboratory	Tsutomu Nagatsuma tnagatsu@nict.go.jp
Member	NOAA	Deputy Director of NOAA Satellite Operations	Scott Leonard scott.leonard@noaa.gov
Member	ROSCOSMOS		
Member	ROSHYDRO MET		
Member	WMO		Heikki Pohjola hpohjola@wmo.int
Member	ISES	Deputy Director of ISES (http://www.spaceweather.org/)	Sergio Dasso sergio.dasso@gmail.com
Expert	ESA	Space Debris Office	Klaus Merz
Expert	EUMETSAT	Flight Dynamics	Pier Luigi Righetti
Expert	EUMETSAT	Mission Analysis	Jose Maria de Juana Gamo
Expert	EUMETSAT	Programme Development	Remy Chalex
Expert	EUMETSAT	Legal Affairs	Rachelle Antal-Wokes
Expert	NASA	LEO	Paul Apostolopoulos
Expert	NASA	GEO	Ian Ross
Observers	SANSA	Space Weather	Mpho Tshisaphungo Rendani Nndanganeni

Table 1: Space Environment Sustainability Task Group Membership

Annex II: Space Traffic Coordination Agency Inputs (Example LEO Satellites)

LEO Satellites						
Collision Avoidance / Space Traffic Coordination	**NOAA Approach**	**EUMETSAT Approach**	**ESA Approach (during operations)**	**CMA Approach**	**JAXA Approach**	**NASA**
Situational awareness data sources	Prime: CARA Sec: Commercial	Prime: CARA/18th SPCS moving to TraCCS (DoC) Sec: EUSST	18th SPCS, EUSST, commercial under test, TraCCS followed	NCSW, CMA	18th/19th SPCS, JMOD	USSF Delta 2 (w/NASA contractors onsite at
Risk assessment: LEO	CARA + Commercial Static Hard Body Radius	CARA + EUSST + Internal Dynamic Hard Body Radius	https://conference.sdo.esoc.esa.int/proceedings/sdc8/paper/296/SDC8-paper296.pdf	Static Hard Body Radius		CARA (FOD for HSF missions)
Manoeuvre decision: LEO	If Pc risk ≥ 4.4e-4 and operational concerns	If Pc risk ≥ 1.0e-4 for EPS If Pc risk ≥ 3.0e-5 for S3/6	Mission specific, usually 10-4. Non mission: ESSB-ST-U-007 Issue 1 require the acceptable collision probability threshold shall be below 10-4 per conjunction. In LEO the threshold has to reduce the annual collision probability by at least 90% with respect to not performing collision avoidance manoeuvres. For constellations the cumulative collision probability of each spacecraft of a constellation in near Earth orbit with all other spacecraft of the constellation shall be below 10-4.	If Pc risk ≥ 1e-4	A RMM is recommended If 1.0e-3>Pc≥1.0e-4. A RMM is requested if Pc≥1e-3.	If Pc risk ≥ 1e-4 for non-HSF HSF If Pc risk ≥ 1e-5 pending operational impact to mission (different thresholds needed during prox ops, EVA, ...)
Manoeuvre Timing	As late as possible	As late as possible, but anticipation considered	As late as possible, considering operational constraints.	As late as possible, but anticipation considered	As late as possible, considering operational constraints.	as late as possible given spacecraft constraints (ISS ~2.5 hrs prior to TCA)
Mitigating nominal mission impact	Optimization of satellite maneuver ops	Usage of routine maneuvers if possible	Optimisation and consideration of routine orbit control manoeuvers	Usage of routine maneuvers	Optimisation and consideration of routine orbit control	
Background risk analysis	Mitigation target: 1.0e-7	Mitigation target: 3.0e-6 Less acceptable	reduce the collision probability by at least two orders of magnitude below the threshold. Further, the collision probability with space objects shall not exceed 10-4 for 4 days after the planned avoidance manoeuvre.	Mitigation target: 1.0e-6	Mitigation target: 1.0e-6	Mitigation target of 3e-6 (HSF 1E-7)
Non-Manoeuvrable satellites	Monitoring for high risk Notification: Pc ≥ 1.0e-3	Not applicable	New: Manoeuvre capabilities are required for GEO, LEO with>5year orbital lifetime, constellations, CPOs, and when cumulative collision probability with space objects larger than 1 cm is above 10-3 through to its end of [orbital] life.	Not applicable	Monitoring for high risk Notification: Pc ≥ 1.0e-3	Monitor, report remaining risk to management at TCA-24 hours, ask for Headcount from USSF
Active on Active conjunctions	No case experienced: one to one coordination	Several cases observed: one to one coordination	mutual coordination, bilateral arrangements, coordination platforms under evaluation	No case experienced: one to one coordination	Several cases observed: one to one coordination	work with secondary operator to coordinate who will maneuver
EOL Debris Mitigation	Direct de-orbit of maneuverable satellites Passivation otherwise	Uncontrolled de-orbit except for next EPS generation (controlled)	break-up risk upper limit or 5 years for LEO; controlled re-entry for casualty risk>10-4.	Direct de-orbit of maneuverable satellites Passivation otherwise	Minimize release of objects, prevention of breakup and minimize orbital lifetime 25 years or less after disposal.	Direct de-orbit of maneuverable satellites Passivation otherwise
Applicable Space debris mitigation standards and guidelines		ISO 24413 operationally, ESA SD requirements alignment for missions to be developed in the future.	ESA Space Debris Requirements ESSB-ST-U-007 Issue 1 (goes beyond ISO24113)		Space Debris Mitigation Standard (JMR-003E) [JAXA]	NPR 8715.6, NPR 8079.1
Applicable International and regional regulations					Act on Launching of Spacecraft, etc. and Control of Spacecraft (Act No. 76 of 2016) [GOJ] *Guidelines on License Related to Control of Spacecraft *Guidelines for preventing collisions with satellites, etc.(Only Japanese)	

Annex III: Space Weather Requirements for Space Traffic Coordination

Space Weather Data, Service or Product	ESA Approach* (Mission Operations)
Observation data	
Solar activity indices used in atmospheric density models (e.g. R, F10.7, F30, S10, E10, M10, Y10,…)	ESA SWE System, NOAA SWPC (orbit prediction)
Geomagnetic activity indices used in atmospheric density models (e.g. Ap, Kp, Dst, …)	ESA SWE System, NOAA SWPC (orbit prediction)
Services and Products	
Long term (100-200 y) forecasts of solar and geomagnetic indices for long term atmospheric density forecasting	Prediction models in ESA Flight Dynamics division
Long term (100-200 y) atmospheric density forecast	Prediction models in ESA Flight Dynamics division
Atmospheric density estimate archive of at least one year	Not available yet
Atmospheric density forecast	NRLMSIS operationally, DTM being tested
Thermospheric density estimates to compute drag of spacecraft at altitudes below which drag exceeds 1% of the overall forces acting on the spacecraft	NRLMSIS operationally, DTM being tested
Near real-time monitoring of space weather events (geomagnetic storms)	Alerts and bulletins from ESA SWE System (https://swe.ssa.esa.int/)
Forecasts of space weather events (geomagnetic storms)	Alerts and bulletins from ESA SWE System (https://swe.ssa.esa.int/)
Near real-time assessment of ionospheric disturbances effecting s/c operations	Warnings based on https://swe.ssa.esa.int/tio_for