

**CGMS-52-WGI-WP-05**  
**10 April 2024**

*Prepared by: EUMETSAT*  
*Agenda Item 6.1*  
*Discussed at WG-I*

<b>Subject</b>	<b>Report from CGMS WGI Task Group on Space Environment Sustainability</b>
<b>In response to CGMS action/recommendation</b>	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.
<b>HLPP reference</b>	2.5 Operational issues related to space weather 2.6 Space traffic coordination 2.7 Space Sustainability
<b>Executive Summary</b>	<p>This document reports on the background and content of the Terms of Reference for the newly formed CGMS WGI Task Group on Space Environment Sustainability, relevant to CGMS member current and planned missions.</p> <p>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.</p>
<b>Action/Recommendation proposed</b>	Set WGI/A50.07 Due date for CGMS-53. CGMS Members to nominate participants of the Space Environment Sustainability Task Group.



## 1 INTRODUCTION

### 1.1 Purpose

This document reports on the background and content of the Terms of Reference for the newly formed 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 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, <a href="#">PPT</a>
RD-2	CGMS future direction 2022+ <i>Position paper theme: Space Situational Awareness</i>	<a href="#">CGMS-51-CGMS-WP-19</a>
RD-3	CGMS future direction 2022+ Task Team - Terms of Reference (for information)	<a href="#">CGMS-51-CGMS-WP-07</a>

## 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 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].

### **3 SCOPE OF THE TASK GROUP TERMS OF REFERENCE**

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. The full scope of CGMS Future Directions Themes is summarised in [RD-3].

### **4 HIGHLIGHTS OF TASK GROUP ROLE AND OBJECTIVES**

The following description of the role and set of abridged objectives has been provided via WMO to the United Nations Office for Outer Space Affairs (UNOOSA) acting as Secretariat to UN-Space (the Inter-Agency Meeting on Outer Space Activities) who are preparing a Special Report on Space Debris to be presented for consideration by the Committee on the Peaceful Uses of Outer Space at its sixty-seventh session, to be held in June 2024 in Vienna.

The members of the Coordinated 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 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.

### **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

A call for members was sent to the CGMS List Server and WGI members on 19 February 2024, inviting representatives from all CGMS members actively involved in space operations or supporting SSA / Space Weather data provision to spacecraft operators to join this effort.

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

ISES Membership is also invited in order to support the objectives on space weather service utilisation by spacecraft operators and a presentation to ISES on this TG (and the spacecraft anomaly TG of SWCG) was made on 22 February 2024.

Identification of experts to enable deeper understanding of issues between agencies is also foreseen.

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 <a href="mailto:Andrew.Monham@eumetsat.int">Andrew.Monham@eumetsat.int</a>
Co-Chair	ESA	Head of Space Weather CGMS Future Project SSA lead	Juha-Pekka Luntama <a href="mailto:Juha-Pekka.Luntama@esa.int">Juha-Pekka.Luntama@esa.int</a>
Secretary	TBC		
Member	CMA		Cong HUANG <a href="mailto:huangc@cma.gov.cn">huangc@cma.gov.cn</a>
Member	CNES		
Member	CNSA		
Member	IMD		
Member	ISRO		
Member	JAXA		
Member	JMA		
Member	KASI	Chief Manager / Principal Researcher Space Hazards Program Office Center for Space Situational Awareness	Dr. Eun-Jung Choi <a href="mailto:eunjung@kasi.re.kr">eunjung@kasi.re.kr</a>
Member	KMA	Senior Researcher of Satellite Operation Divison	Jaeyoung Byon <a href="mailto:jybyon@korea.kr">jybyon@korea.kr</a>

Role	Organisation	Function	Names
Member	NASA		
Member	NICT	Executive Researcher Space Environment Laboratory	Tsutomu Nagatsuma <a href="mailto:tnagatsu@nict.go.jp">tnagatsu@nict.go.jp</a>
Member	NOAA		Scott Leonard <a href="mailto:scott.leonard@noaa.gov">scott.leonard@noaa.gov</a>
Member	ROSCOSMOS		
Member	ROSHYDROM ET		
Member	WMO		Heikki Pohjola <a href="mailto:hpohjola@wmo.int">hpohjola@wmo.int</a>
Member	ISES	Representatives of Space Weather Services	

## 6 MEETINGS HELD / PLANNED

The first Task Group meeting open to all interested CGMS members was held on 6 March 2024 with attendance of CGMS Secretariat, CMA, ESA, EUMETSAT, KASI, KMA, NICT, WMO.

Proposed CGMS-52-53 TG Meetings (all virtual, starting 12:00 UTC)

- 27 June 2024
- 19 September 2024
- 28 November 2024
- 29 January 2025 12 March 2025

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

## 7 CONCLUSION

WGI is invited to take note of the establishment of the Task Group on Space Environment Sustainability and support the call for membership 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-53.





## **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
RD-1	Discussion on future CGMS WGI efforts on Space Debris and Collision Avoidance	CGMS-51-WGI-WP-07, <a href="#">PPT</a>
RD-2	CGMS future direction 2022+ <i>Position paper theme: Space Situational Awareness</i>	<a href="#">CGMS-51-CGMS-WP-19</a>
RD-3	CGMS future direction 2022+ Task Team - Terms of Reference (for information)	<a href="#">CGMS-51-CGMS-WP-07</a>
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<sup>1</sup>: 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 3<sup>rd</sup> 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.

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<sup>1</sup> 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-maneuvrable 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 SCHEDULE

22 April 2024: CGMS-52 WG1 @ EUMETSAT, Darmstadt, Germany

3-7 June 2024: CGMS-52 Plenary @ NOAA, location TBC

Proposed CGMS-52-53 TG Meetings (all virtual, starting 12:00 UTC)

- 27 June 2024
- 19 September 2024
- 28 November 2024
- 29 January 2025
- 12 March 2025

WG1 Intersessional meetings attended by Chairs.

CGMS-53 WG1 Meeting April 2025 TBC

## 6 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 <a href="mailto:Andrew.Monham@eumetsat.int">Andrew.Monham@eumetsat.int</a>
Co-Chair	ESA	Head of Space Weather CGMS Future Project SSA lead	Juha-Pekka Luntama <a href="mailto:Juha-Pekka.Luntama@esa.int">Juha-Pekka.Luntama@esa.int</a>
Secretary	TBC		
Member	CMA		Cong HUANG <a href="mailto:huange@cma.gov.cn">huange@cma.gov.cn</a>
Member	CNES		
Member	CNSA		
Member	IMD		

Role	Organisation	Function	Names
Member	ISRO		
Member	JAXA		
Member	JMA		
Member	KASI	Chief Manager / Principal Researcher Space Hazards Program Office Center for Space Situational Awareness	Dr. Eun-Jung Choi <a href="mailto:eunjung@kasi.re.kr">eunjung@kasi.re.kr</a>
Member	KMA	Senior Researcher of Satellite Operation Divison	Jaeyoung Byon <a href="mailto:jybyon@korea.kr">jybyon@korea.kr</a>
Member	NASA		
Member	NICT	Executive Researcher Space Environment Laboratory	Tsutomu Nagatsuma <a href="mailto:tnagatsu@nict.go.jp">tnagatsu@nict.go.jp</a>
Member	NOAA		Scott Leonard <a href="mailto:scott.leonard@noaa.gov">scott.leonard@noaa.gov</a>
Member	ROSCOSMOS		
Member	ROSHYDROM ET		
Member	WMO		Heikki Pohjola <a href="mailto:hpohjola@wmo.int">hpohjola@wmo.int</a>
Member	ISES	Representatives of Space Weather Services	
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	TBD		
Observers	Other space agencies TBC CEOS agencies		

**Table 1: Space Environment Sustainability Task Group Membership**