# Report from CGMS WGI Task Group on Space Environment Sustainability

**Presented to CGMS-53 WG-I session, agenda item 3.1**

Coordination Group for Meteorological Satellites

EUMETSAT CGMS

## Executive summary of the WP

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.

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## TASK GROUP BACKGROUND

- Started TG meetings prior to CGMS-52 to establish the Terms of Reference.
- Built upon the preliminary work initiated by its predecessor, the Space Debris and Collision Avoidance Task Group established in 2019
  - Had no activities since 2022
  - activities conducted were limited to bilateral interactions between NOAA and EUMETSAT
  - references to the documentation / reports are in the SES TG 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 are to be considered

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## 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 includes all SSA aspects associated with the Short-, Medium- and Long-term Goals for CGMS* and split into the following categories:
  - Space Traffic Coordination
  - Space Weather
  - Space Sustainability
- There has been no change of substance in the Terms of Reference since presented to CGMS-52 (abridged version in Annex)

** CGMS future direction 2022+ Position paper theme: Space Situational Awareness*

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## 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 on next slide.

# Agency proposals for new members of the TG including external agency operators.

Important to obtain wide agency membership across all domains of SSA

Colour coding:

**Participants confirmed**

Participants to be nominated

**Nomination of Experts also required**

| Role | Organisation | Function | Names |
|---|---|---|---|
| Co-Chair | EUMETSAT | SES / LEO Satellite Operations | Andrew Monham<br>Andrew.Monham@eumetsat.int |
| Co-Chair | ESA | Head of Space Weather<br>CGMS Future Project SSA lead | Juha-Pekka Luntama<br>Juha-Pekka.Luntama@esa.int |
| Secretary | TBC | | |
| Member | CMA | Space Weather | Cong HUANG<br>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<br>Space Hazards Program Office<br>Center for Space Situational Awareness | Dr. Eun-Jung Choi<br>eunjung@kasi.re.kr |
| Member | KMA | Senior Researcher of Satellite Operation Divison | Jaeyoung Byon<br>jybyon@korea.kr |

| Role | Organisation | Function | Names |
|---|---|---|---|
| Member | NASA | Head of Space Weather<br>Space Comms & Navigation | Jamie Favors<br>james.e.favors@nasa.gov<br>John Hudiburg<br>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<br>scott.leonard@noaa.gov |
| Member | ROSCOSMOS | | |
| Member | ROSHYDROMET | | |
| Member | WMO | | Heikki Pohjola<br>hpohjola@wmo.int |
| Member | ISES | Deputy Director of ISES (http://www.spaceweather.org/) | Sergio Dasso<br>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<br>Rendani Nndanganeni |

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## 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

## Task Group Achievements – Space Traffic Coordination

Matrices of capabilities in CA/STC exist for LEO, GEO, HEO, Extra-Terrestrial.

Expert, offline analysis to identify commonalities, gaps, potential for improvement.

Assessment on-going of active-on-active conjunction contact points , data formats and 3rd party operator access.

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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 (with ASA 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. New missions: ESSB-ST-U-007 Issue 1 requires 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≥1.e-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 24113 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) | |

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

Separate matrices for STC and Safety in LEO, GEO. concentrating on LEO, GEO.

Further inputs requested.

| 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 |

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

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:** 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.

## 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.

Post CGMS-52, TG meetings took place on

- 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.

## Key issues of relevance to CGMS:

- The Space Sustainability Task Group addresses the following aspects of the HLPP:
  - 2.5 Operational issues related to space weather
  - 2.6 Space traffic coordination
  - 2.7 Space Sustainability

- UN COPUOS has visibility to this Task Group Effort from the UN-Space Special Report on Space Debris presented in Vienna in June 2024

## To be considered by CGMS:

- 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**:
  - *Action WGI/A53.XX: 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*
- 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**
- 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**

- **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*

# Spare Slides – Additional Information

## Objectives / Deliverables Highlights (abridged)

Full Terms of Reference available on WGI agenda CGMS Agenda and Working Paper Tool (cgms-info.org) *CGMS-52-WGI-WP-05*

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

   **Deliverables:**
   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

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## TASK GROUP ROLE

- The following description has been included in UN-Space** Special Report on Space Debris and presented at UN-COPUOS*** in June 2024.

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.

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* *United Nations Office for Outer Space Affairs*
** *Inter-Agency Meeting on Outer Space Activities*
*** *Committee on the Peaceful Uses of Outer Space*

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