

CGMS-53-WGI-WP-09
05 March 2025

Prepared by: EUMETSAT
Agenda Item 8.1
Discussed at WGI

Subject	EUMETSAT position paper for CGMS consideration: Antenna arraying techniques for future LEO missions
In response to CGMS action/recommendation	n/a
HLPP reference	n/a
Executive Summary	<p>The purpose of this working paper is to propose to CGMS to engage a discussion on antenna arraying techniques for future missions.</p> <p>This position paper is submitted by EUMETSAT ahead of the CGMS-53 working group and plenary sessions, with the objective to trigger reactions from CGMS members and to organise a discussion on this topic firstly in the CGMS-53 WGI meeting and secondly during the CGMS-53 plenary.</p>
Action/Recommendation proposed	<ul style="list-style-type: none">i) CGMS members are invited to provide verbal or written input on this theme to the CGMS-53 WGI session on 25 March 2025.ii) CGMS members are invited to prepare for a discussion on this theme at the CGMS-53 plenary in June 2025.

1. PURPOSE OF THIS PAPER

The objective of this document is to propose to CGMS to engage a discussion on antenna arraying techniques for future missions. This position paper is submitted by EUMETSAT ahead of the CGMS-53 working group and plenary sessions, with the objective to trigger reactions from CGMS members and to organise a discussion on this topic firstly in the CGMS-53 WGI meeting and secondly during the CGMS-53 plenary.

2. TOPIC DESCRIPTION AND RATIONALE FOR CGMS ENGAGEMENT

In 1996 EUMETSAT agreed to establish its first EUMETSAT Polar System Programme (EPS). The space segment consisted of three Metop satellites accommodating the payload instruments with an expected operational lifetime of approximately 14 years (5 years of operations per satellite, with an overlap period of six months).

In 2014 the EPS-SG Programme was approved. The baseline configuration for the EPS-SG mission is a dual spacecraft configuration (Metop-SG A and Metop-SG B) with an instrument complement to be split over both Metop-SG spacecraft. Although the baseline assumption is that each spacecraft in the programme will be launched independently, both satellites of the dual configuration will be operated simultaneously in the same orbit, at defined relative phases in the orbit.

In 2025, EUMETSAT is about to embark on its first spacecraft constellation under the umbrella of the EPS-Sterna programme. The initial nominal configuration will consist of a total of six satellites in three orbital planes. The EPS-Sterna satellites will be deployed in three different sun-synchronous orbital planes, chosen to be complementary to EPS-SG, the JPSS satellites and Chinese FY-3 satellites, in order to maximise the constellation performance in terms of “time to achieve 90% global coverage”.

Most agencies involved in Earth observation activities and/or responsible for weather and climate monitoring may have had similar roadmaps in terms of spacecraft set-up.

Whilst in 1996 EUMETSAT's main focus on ground stations was finding suitable sites offering existing infrastructure, optimum coverage, simultaneous tracking and data acquisition of multiple spacecraft was only an emerging need. In fact, at that time, the proposed technical solution was to provision for dedicated antennas and acquisition chains for the morning and for the afternoon spacecraft. In other words, A backup “facility” was identified as mandatory to guarantee the security of the mission and the continuity of the service.

Today, the landscape looks somehow different. Prime and back-up ground stations cannot simply follow the logic used back in 1996.

How can CGMS help defining ground station networks in support of operational meteorological programmes so that they are sustainable and cost effective? CGMS member agencies are vital actors in establishing international collaboration whilst fostering best practices and technology advances when defining new ground stations networks.

3. Challenges/Opportunities for CGMS

Data recorded on-board the spacecraft (and constellations) throughout their orbits will be transmitted to dedicated polar ground stations in the northern and southern hemisphere. This should allow provision of calibrated data with global coverage in less than a few hours. If observations from other satellites from other agencies are combined, timeliness and quality are expected to be increased. At least two new elements have been incorporated into the discussion: Mandatory presence in the northern and southern hemisphere and (simultaneous) data acquisition from several satellites in visibility from the same site.

These new needs generate a set of challenges for the ground segment and, in particular for ground stations: expansion of the ground station infrastructure; reduction of development times; improvement of timeliness for data delivery; maximisation in the use/reuse of assets; management of interrelations with other programmes (including other agencies) and cost contention.

In view of such challenges, the current approach for the procurement of new ground segments and, in particular of new ground stations, might need to be revisited. New technologies providing responses to the emerging needs may need to be considered and further analysed. Ground stations comprising multi-beam antennas (e.g. electronically steer phased array antennas) might help reducing the number of assets at a given site whilst increasing the number of spacecraft serviced by each single antenna.

4. Impact on CGMS activities

The need to:

- consider medium- and long-term impacts on planning and implementation of new ground station networks in the frame of sustainability and costs;

- consider benefits from new antenna technologies to satellite operators in CGMS member agencies; and
- synergies with other associated themes/areas of CGMS.

5. PROPOSED Short-, medium- and long-term goals for CGMS:

Regarding the ground station network theme:

- To undertake a review of CGMS member agencies' satellite programmes requiring simultaneous or quasi-simultaneous acquisition of data from several spacecraft in field of view from the same site and assess opportunities for phase array antenna technology;
- To perform a gap analysis between the emerging needs and the currently available/used technical solutions and techniques.

Impact and proposal for activities in the framework of CGMS WGI:

CGMS Working Group I (WG I), satellite systems and operations, already exists and addresses ground segment matters, for example, to:

- provide a technical forum for CGMS agencies to address global issues and technical aspects of their satellite systems;
- address areas of mutual interest and advice agencies on topics related to frequency coordination and management;
- address technical and operational aspects of direct broadcast services (present and future) of mutual or global interest for the CGMS agencies;
- promote standards and interoperability and operational procedures to the CGMS agencies for the benefit of the user community of their direct broadcast services and the associated regional retransmission services; and
- optimise/harmonise and update the CGMS global specifications.

Potential new goals/themes within WGI would be:

Ground Stations analysis for phase array antennas

- Definition of Figures of Merit (FoM) for new ground stations;
- Services and frequency bands to be targeted;
- Growth potential and scalability of new ground stations using this technology; and
- Cost estimations

Use cases analysis for phase array antennas

- Carry out an assessment of future mission models/configurations that would benefit from such new ground stations technologies; and
- Prepare a proposal for the best practices to support optimisation and rationalisation of Ground Stations networks in response to CGMS Member Agencies' needs.

6. LEADING ENTITY

To assure these activities are addressed, CGMS members will need to nominate a leading entity to move the activity forward, and preferably as far as possible at the upcoming CGMS-53 WGI meeting in March.

7. SCHEDULE

Discussion in CGMS-53 WGI in March 2025 with agency reports on their associated activities.

Conclusions to be presented to CGMS-53 plenary in June 2025 for discussion in plenary.

8. ACTIONS/RECOMMENDATIONS

CGMS members are invited to provide verbal or written input on this theme to the CGMS-53 WGI session on 25 March 2025.

CGMS members are invited to prepare for a discussion on this theme at the CGMS-53 plenary session in June 2025.