Proposal for a CEOS Synthetic Aperture Radar Virtual Constellation (SAR-VC)

Prepared by the International Coordination Group for Spaceborne SAR (ICGS-SAR)

Background

Over the last two decades, there has been a significant increase in the number of civilian free flying spaceborne SAR missions launched by CEOS Agencies and commercial operators. In the next decade, more than a dozen missions are expected to operate simultaneously, with each mainly driven by the needs of its agency.

The International Coordination Group for Spaceborne SAR (ICGS-SAR) was formed in 2018 in response to these needs, with three workshops held in 2018, 2022 and 2024.

The main purposes of these activities have been to foster information exchange and to facilitate coordination and collaboration among agencies, stakeholders, users, researchers, and other community members, with the vision that a fully optimised and coordinated international SAR constellation based on existing and planned missions among the space agencies would bring substantial enhanced science and societal benefit that would not be possible from a single Agency. To achieve this, the community must address several issues, including:

- improving the discovery of existing data through uniformly discoverable metadata and common metadata formats
- fostering an open, full and free data policy by inviting all space agencies to follow that policy whenever possible
- coordinating observation requirements for future SAR missions during the planning/formulation phase
- fostering R&D for Earth sciences studies and the development of new applications
- promoting the use of SAR data for operational applications
- exploiting synergies and cooperation potential in the scope of new SAR missions leading to enhanced information benefiting science and applications

The Need for Coordination

Recommendations from the first, second and third ICGS-SAR Workshops[1,2], highlight the need for further coordination. These include:

- Provide archived, present and future data in an easily and electronically accessible manner, with a **standard and common format**, at little or no cost.
- Take an **optimized systems approach** to the overall constellation of planned and proposed missions to explore the possible mutual benefit of the total constellation coverage and capabilities.
- Coordinate and share common test sites and sites for **calibration and validation**.
- Foster international coordination of **observation requirements** for future missions.
- Encourage multilateral information exchange on **mission formulation** such as anticipated architectures, collection strategies, and modes, to help foster future partnership and mission coordination.
- Establishing cross-Agency **automated disaster monitoring** tasking and data sharing on Web GIS systems and coordinating with existing international frameworks such as the International Disaster Charter (International Charter Space and Major Disasters) and Sentinel Asia.
- Establishing cross-Agency **interoperability** of cloud systems by using APIs, standard metadata (STAC, YAML, etc.) and data formats, such that multi-mission data analysis is streamlined.
- Coordinating observations of the **polar regions** (Greenland, Arctic sea ice, and Antarctica)
- Coordinating the use of **companion satellites**, passive or active, in future systems, such as Harmony for Sentinel-1, to enhance dynamic topography and 3D deformation mapping.
- **Cross-validating agency mission planning tools** to ensure optimal mission plans
- Establishing an activity similar to the CEOS LSI-VC POLINSAR task for **3D-InSAR** to coordinate imaging geometry diversity at regional sites worldwide.
- Expanding the complementarity of **Commercial VHR X-band SAR missions to** public medium-resolution SAR missions through their capacity for targeted observations at high spatial and temporal resolution.
- Redoubling efforts to advocate to their national frequency authorities for **protection of the radar band** (X-, C-, S-, L-, P-band) allocations for use for Earth observation.

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[1] https://intl-sar-coord-group.space/wp-content/uploads/2025/04/ICGS-SAR-WS3_-Recommendations-v1.1.pdf

[2] https://intl-sar-coord-group.space/

Furthermore, an article published in *Earth and Space Science* in May 2026 titled *Observation and coordination needs for current, near-future, and next generation Earth-observing SAR systems*[3] summarizes how coordination of Earth-observing SAR missions among the world's space agencies could advance toward game-changing scientific discoveries and fully realizing SAR's practical capability to address many issues facing society.

The Role of CEOS

It is clear that the most effective means of creating action from the workshop recommendations, many of which are for CEOS Agencies to consider, is through an agency-level process that formalizes recommendations and has the authority to take action. While the informal structure of ICGS-SAR provided the flexibility needed to adapt to a rapidly evolving sector, the industry has matured to a point where a more formalized coordination model will best accelerate progress on these recommendations.

CEOS' heritage as the international coordination body for all civil space-based Earth observation makes it the natural home for coordination of SAR missions. Furthermore, bringing SAR coordination under the CEOS umbrella allows for coordination with other CEOS groups, including the Working Group on Calibration and Validation SAR Subgroup (WGCV SAR Subgroup), Working Group on Disasters and CEOS-ARD Oversight Group.

The CEOS Virtual Constellation (VC) construct is considered ideal to allow for the necessary coordination of SAR missions. While not originally designed for technology-based constellations, the tasks typically undertaken by a VC align well with the tasks required for SAR coordination. While some overlap with certain CEOS groups is recognised (most notably, the Land Surface Imaging VC), a separate VC is considered required as the expertise between SAR and optical land imaging differs significantly. Coordination with other CEOS groups will be maintained. Full details on the tasks and coordination aspects can be found in the Terms of Reference and Implementation Plan.

SAR as a Unique Capability

The SAR remote sensing community - hardware designers, algorithm developers, data analysts, science users and others - has flourished largely in parallel to the electro-optical community. The wavelength regimes of SAR and optical imagers - centimeters on the one hand and microns on the other - lead to fundamentally different interactions with matter and require different skill sets, and descriptive languages. SAR is sensitive to electrical and roughness properties of objects and surfaces. EO is sensitive to chemical and textural properties. SAR has speckle, optical systems for the most part do not. From the optical imager perspective, SAR is often considered the last

[3] https://doi.org/10.1029/2025EA004868

resort for remote sensing when it is dark or cloudy, and it had better be of sufficient resolution that despeckling of the image can result in an “optical-like” image.

There is rapid and exponential growth of SAR systems and available data, and an ever-growing realization that SAR’s reliability as an all-weather, day-night observing system is an enormous advantage for science and operational applications. The unique capability of interferometric SAR to provide geodetic information is also working its way into standard scientific and operational use. In this context, SAR now serves an important and ubiquitous role in the international remote sensing ecosystem, with its own issues to address that are unique to SAR.

Thus, it is natural and fitting that CEOS contain an entity such as the SAR-VC where practitioners can coordinate within the SAR community, with linkages to other CEOS entities where common topics exist and where coordination is warranted.

The 41st Strategic Implementation Team meeting (SIT-41; April 2026; Irvine, California, USA) confirmed the initial proposal for a Synthetic Aperture Radar Virtual Constellation (SAR-VC) [DECISION 04], and tasked ICGS-SAR and the SIT Chair Team to develop a full proposal for presentation to the 40th CEOS Plenary (November, 2026; Hobart, Australia) [ACTION SIT-41-10].