Ref. Ares(2026)6641444 - 02/07/2026



Enhancing Copernicus Security Services –
EU governmental crisis management hub for forced population displacement

Delivery of the tailored Very-High-Resolution Earth Observation and Space-based Video Data Tools, D6.1

Formerly: D6.1 “Delivery of the tailored Very-High-Resolution Earth Observation tools” and D6.2 “Very-High-Resolution (VHR) and Thermal imaging and low-visibility sensing”.

WP6 – Very-High-Resolution Earth Observation

Funded by the European Union

This project has received funding from the European Union’s Horizon Europe research and innovation programme under GA 101190051. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union. Neither the European Union nor the granting authority can be held responsible for them.

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Due Date	**28.02.2026**
Delivery Date	**23.02.2026**
Type	**R - report**
Dissemination Level	**PU - public**
Keywords	**EU VHR asset analysis, video-capable missions**

Document History

Version	Date	Description	Comments	Edited by
0.1	13.10.2025	Outline		OHB DS
0.2	16.12.2025	First draft	Initial draft of the contents.	OHB DS, SPACE-SI
0.3	27.01.2026	First internal version	For request for partners' input.	OHB DS, SPACE-SI
0.4	13.02.2026	Internally revised version	For review by partner LuxSpace.	OHB DS SPACE-SI GSH SATCEN
0.5	20.02.2026	Reviewed version	Final check by partner LuxSpace.	OHB DS SPACE-SI LXS
1.0	23.02.2026	Final version	Screened and cleared by the SAB.	OHB-DS
1.1	18.06.2026	Updated final version	Inclusion of Interim Technical Review comments regarding mission selection, acquisition cost, and SAR video.	OHB-DS SPACE-SI

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ANNEX I - EU VHR EO mission data.

Executive Summary

The current deliverable, D6.1 “Delivery of the tailored Very-High-Resolution Earth Observation and Space-based Video Data Tools”, corresponds to task T6.1 – “EU-independence and space data diversity including Very-High-Resolution (VHR) and Thermal imaging and low-visibility sensing (i.e. SAR)”, led by OHB-DS, and task T6.2 – “Space-based video, Satellite-Based Multi-Payload Data Acquisition and Processing for Land, Coastal, and Marine Applications”, led by SPACE-SI under WP6 – “Very-High-Resolution (VHR) Earth Observation (EO)”, led by OHB-DS.

Deliverable D6.1 is the consolidated report of T6.1 and T6.2. It provides THEIA with an evidence-based assessment of VHR optical, thermal and Synthetic Aperture Radar (SAR) imaging capabilities, together with space-based video acquisition options available from current and near-term EU, EU-national and Copernicus Contributing Missions (CCMs).

This document follows the suitability criteria set in the Grant Agreement (GA) as well as the results of WP5, which defines the THEIA use cases in deliverable D5.3. These criteria are applied in a rigorous screening of candidate missions. It presents side-by-side evaluations of representative sample datasets to map satellite imaging capability to the THEIA use cases. The deliverable demonstrates how video-capable microsatellites (notably NEMO-HD) can complement established Earth Observation (EO) sensors. The findings in this deliverable will directly feed into task T6.3 (mission selection and optimization methodology) and will provide inputs for downstream integration into THEIA.

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List of Acronyms / Abbreviations

Table 1. - List of Acronyms/Abbreviations

Acronym / Abbreviation	Explanation
VHR	Very-High Resolution
OHB-DS	OHB Digital Services GmbH
CCM	Copernicus Contributing Mission
EO	Earth Observation
SAR	Synthetic Aperture Radar
API	Application Programming Interface
CSK	COSMO-SkyMed First Generation
CSG	COSMO-SkyMed Second Generation
EDRS	European Data Relay System
GSD	Ground Sampling Distance
SIIS	Satrec Initiative Imaging Services
GeoAI	Geospatial Artificial Intelligence
SatCen	The European Union Satellite Centre
ASI	Agenzia Spaziale Italiana
EU	European Union
UK	United Kingdom
CA	Consotium Agreement
HD	High Definition
HR	High Resolution
LR	Low Resolution
MS	Multi Spectral
NIR	Near Infrared
VNIR	Visible and Near Infrared
SWIR	Short-Wave Infrared
MWIR	Mid-Wave Infrared
LWIR	Long-Wave Infrared
TIR	Thermal Infrared

1 Introduction

Addressing critical challenges such as population displacement due to conflicts, exacerbated by factors like climate change, extreme weather events, food shortages, and poverty, remains paramount. The implementation of THEIA, integrating data fusion, processing, and analysis, particularly leveraging Geospatial Artificial Intelligence (GeoAI) and Machine Learning, is poised to enhance the efficacy of existing services significantly. Through the amalgamation of multi-temporal data and diverse datasets, THEIA empowers better decision-making and adapts to evolving policy and user needs. This technological advancement, bolstered by GeoAI, augments detection capabilities and ensures timely access to crucial information, bridging the gap between capabilities and stringent security demands.

By integrating non-space data and end-user intelligence, THEIA's supply chains add value not only at the operational level but also at regional and local levels, facilitating improved coordination. Furthermore, THEIA catalyses fostering EU-independent capabilities and technologies, thereby bolstering the European space ecosystem's consolidation and ensuring the sustainable coexistence of legacy and New-Space solutions. Its services cater to a wide array of end-users, including EU agencies such as SATCEN and FRONTEX, which are Copernicus-entrusted entities for security services, Member State Ministries of Défense, Intelligence Agencies, Police Forces, NATO, and potentially Extra-EU National and Supranational Entities such as the United Nations.

This document is an output of work package 6 (WP6), which consists of the following tasks:

- Task 6.1: "EU-independence and space data diversity including Very-High-Resolution (VHR) and Thermal imaging and low-visibility sensing (i.e. SAR)" [M2-M15]
- Task 6.2: "Space-based video, Satellite-Based Multi-Payload Data Acquisition and Processing for Land, Coastal, and Marine Applications" [M2-M15]
- Task 6.3: "Selection and optimisation of the methodology of appropriate space data for each use case" [M13-M22]

This report comprises the output of **Task T6.1 and Task T6.2.** It presents the overall approach, scope, and principal findings of these tasks, including the analysis of EU space data sources (VHR optical, thermal, and SAR), the assessment of satellite video and multi-payload acquisition capabilities. The mission assessments produced here will feed into Task T6.3 (Selection and optimisation of the methodology of appropriate space data for each use case) and the subsequent Deliverable D6.2, which will define the mission selection methodology to be used by THEIA.

1.1 Purpose and scope of the deliverable

The purpose of the deliverable is to record and deliver the results of Tasks T6.1 and T6.2: a systematic analysis of EU space data acquisition capabilities, comprising VHR optical, thermal and SAR imaging, as well as space based video capabilities. The mission assessments are based on technical and operational criteria and yields a selected subset of space assets suitable for THEIA. These outputs will provide actionable guidance for THEIA end users.

The report covers:

- A systematic inventory of current and near-term EU space assets comprising VHR optical, thermal, SAR, selected hyperspectral and video missions from EU nations and CCMs.
- The definition and application of THEIA suitability criteria (spatial/temporal performance, acquisition-to-access timelines, metadata requirements, tasking constraints, product analysis suitability), yielding a subset of candidate missions.
- A representative mission product comparison using sample datasets.
- A focused analysis of space-based video concepts.

1.2 Structure of the deliverable

This document consists of the following chapters:

- The executive summary of the deliverable.
- **Chapter 1** which includes a short description of THEIA objectives, and the purpose, scope and structure of deliverable D6.1.
- **Chapter 2** which introduces the relevant aspects of the involved EO technologies.
- **Chapter 3** which presents the main results of the EU VHR EO asset analysis.
- **Chapter 4** which shows sample images for THEIA use cases.
- **Chapter 5** which draws a conclusion.
- **Annex I**: EU VHR EO mission data.

1.3 References

- Project Grant Agreement (GA) with No. 101190051
- THEIA Partners Consortium Agreement (CA)
- D5.3 “Use Case Definition Report”
- D7.1 (draft version)

2 EO in THEIA - Technical overview

Here, a brief overview of the involved remote sensing technologies (optical and infrared reflectance; mid-infrared emission; and radio wave scattering) is given. The purpose is to provide the reader with the necessary understanding of the involved technologies to choose the optimal sensor type for their respective use cases.

Further, a hands-on description of EO image and video acquisition procedures is given here, exemplified with NEMO-HD. The purpose is to fathom the readers understanding of intrinsic restrictions arising e.g. from orbital constraints, target pointing limitations, and downlink limits.

2.1 Optical, Thermal, and Radar Imaging

Optical (VNIR and SWIR) imaging

Passive systems that record reflected sunlight in the visible, near-infrared, and short-wave infrared domains (0.4–2.5 µm). The measured signal is surface reflectance, which depends on material composition, vegetation, moisture, and texture. Typically, panchromatic channels deliver the highest spatial detail, while multispectral and hyperspectral bands enable spectral discrimination of surface features.

Thermal infrared imaging (MWIR and LWIR)

Passive measurement of emitted thermal radiation (3–14 µm). The signal is dominated by the temperature and emissivity of the observed surface. Thermal sensors reveal heat signatures independently of solar illumination, making them capable of night-time operations, and detection of thermal anomalies (fires, industrial activity, hidden infrastructure, …)

Synthetic Aperture Radar (SAR) imaging

Active microwave systems (typical bands: X: ~3 cm, C ~5 cm, S: ~12 cm, L: ~24 cm) that transmit radio waves and record the backscattered echo. The signal strength and phase depend on surface roughness, geometry, dielectric properties, and structure (vegetation, buildings, etc.). SAR is weather-independent and day and night capable, penetrates clouds and low-density vegetation.

Table 2 - EO Sensor types relevant for THEIA and their properties.

Sensor	**Illumination**	**Weather penetration**	**Night capability**	**Information provided**	**Main limitations**
Optical	Sunlight	No	No	Material spectral differentiation, change	Daylight only, cloud-sensitive
Thermal	Not required	Partial	Yes	Heat sources, activity monitoring	Lower native spatial resolution, emissivity ambiguity
SAR	Active sounder	Yes	Yes	Structure, roughness, deformation	Speckle, layover/shadowing

2.2 Satellite video

Satellite video is a form of Earth observation that captures continuous motion imagery from space, rather than single still images. Unlike traditional satellite photos, which provide snapshots of the Earth at a moment in time, satellite video allows analysts to observe movement, behaviour, and change over seconds or minutes.

Over the past decade, advances in sensors, onboard processing, and satellite miniaturization have transformed satellite video from an experimental capability into a commercially viable and operational technology.

Most satellite video systems operate from Low Earth Orbit (LEO), typically 450–650 km above the Earth. This altitude balances high spatial resolution, manageable revisit times, and sufficient ground coverage during a single pass. Earth observation satellites often follow sun-synchronous orbits, ensuring consistent lighting conditions.

Video satellites use optical sensors like those used for still imagery but optimized for rapid frame capture (multiple frames per second) and short exposure times to reduce motion blur. Video length is typically 10–120 seconds, framerate 1–30 frames per seconds. Video satellites must have attitude determination and control system capable of stable pointing and tracking.

Because satellites move at ~7–8 km/s relative to Earth, video capture requires high-precision attitude control systems that enables continuous target tracking during overpass.

Major commercial satellite video providers today are Chang Guang Satellite Technology from China with their Jilin-1 constellation and Planet from United States of America who operates SkySat satellites. In addition to large providers there are few small satellites capable of video acquisition from space, like Slovenian NEMO-HD by Space-SI and Spanish-Portuguese Garai satellite, precursor of Atlantic Constellation by Iberian Space Partnership. Several video constellations were planned (Vivid-I by Earth-I (SSTL), UK, and EarthTV by SEN, UK), but except for the predecessor satellites (not operational anymore), the constellations were not launched.

The key **applications of satellite video** are:

- **Disaster response** – video helps responders understand how situations change over time, not just where damage exists.
  - Flood dynamics and affected areas
  - Wildfire spread
  - Earthquake damage evolution
- **Transportation and traffic monitoring** – satellite video enables macroscopic traffic analysis over large areas.
  - Highway congestion patterns
  - Port activity and ship movement

Airport ground operations

Maritime and Ocean Monitoring – motion analysis.

Vessel tracking (non-AIS dependent)

Illegal fishing detection

Port congestion and offshore activity

Defence and security – here, behaviour and patterns matter more than static imagery.

Monitoring vehicle movement

Observing activity changes at facilities

Border and maritime surveillance

Infrastructure and construction – video reveals operational intensity and timelines

Tracking construction progress

Monitoring mining operations

Observing energy infrastructure activity

Scientific Research and AI – satellite video is valuable for machine learning applications.

Training datasets for object tracking

Change detection research

Urban dynamics and mobility studies

The main constrains of satellite video are short recording duration per pass, smaller area coverage compared to imagery, sensitivity to clouds and lighting (as any other optical sensors), high cost and limited open data access (mostly on demand acquisitions). Another very important limitation is the latency of the video, which is rarely accessible in (near) real time but with a delay of several hours. Some satellites (e.g. NEMO-HD) have the capability to stream video to the ground station in real time, but this feature is limited to the ground station's footprint. As a result, satellite video is typically used alongside, not instead of, traditional imagery. Satellite usability grows with larger constellations with better revisit rates, AI-driven (onboard) processing, integration with still imagery, SAR, and ground data and with expanded commercial and research access.

Satellite video represents a significant evolution in Earth observation. By capturing motion from space, it enables insights that static images cannot provide. While still a niche compared to traditional imagery, satellite video is increasingly important for disaster response, security, transportation, and scientific research.

As technology and access continue to improve, satellite video will play a growing role in how we observe and understand our changing planet.

3 EU VHR EO asset analysis

This chapter presents the main results of the analysis of EU EO assets conducted under Tasks T6.1 and T6.2.

The primary objective is to conduct a comprehensive assessment of EU EO assets suitable for THEIA. To identify the most relevant subset of space assets, we apply a selection process driven by the project's foundational requirements. In accordance with the Grant Agreement (GA), the scope is restricted to "current and short-term upcoming" capabilities sourced exclusively from "EU-based" entities. This includes Copernicus missions, Copernicus Contributing Missions (CCMs) [1], and EU national constellations. The GA further mandates a focus on VHR assets. We further apply the technical specifications defined in deliverable D5.3 to narrow this down to assets that meet specific operational needs. This involves prioritizing platforms that support optical, thermal, or radar (SAR) image and video techniques that align with the VHR1/VHR2 resolution classes with GSD below 4m [2]. Further details on the suitability evaluation can be found in Chapter 4. This process ensures the final list of assets is clearly defined and ready for THEIA's operational framework.

This evaluation draws on a wide variety of sources, including mission-specific documentation from the mission providers, ESA-curated databases and partner expertise. Following the GA, the analysis also considered additional national and specialized missions, including those originally developed for military purposes, although these were found not to provide relevant input for THEIA needs here. Similarly, the detection and fusion services offered by the providers not investigated further here, because THEIA will develop these capabilities in WP10. Generally, the investigated missions were found to provide rich metadata for their products, where applicable. The analysis was conducted during the year 2025 and was finalized in November 2025. The findings will inform mission selection in Task T6.3 and support the integration of diverse EO data into THEIA's operational framework.

3.1 Overview and comparison of mission parameter

This subchapter provides the reader with excerpts from the full database in ANNEX I. The contained metadata are groups be subject and sorted either alphabetically or by the most relevant indicators spatial resolution and readiness. The intention is readability; please refer to ANNEX I for the full list.

Sources

[1] https://www.esa.int/Applications/Observing_the_Earth/Copernicus/Copernicus_Contributing_Missions

[2] https://mapping.emergency.copernicus.eu/about/using-of-earth-observation-data/

3.1.1 Basic information

Table 3 - Alphabetical list of all missions in scope of D6.1. Red highlights non-EU or non-CCM missions. Gray gighlights missions with unclear or deprecated CCM status.

Mission	Owner	Country	CCM
Axis 1.2*	Greece (GOV)	Greece	unclear
Axis 2*	Greece (GOV)	Greece	unclear
Balkan-1*	Endurosat	Bulgaria	unclear
CO3D	Airbus DS	France	unclear
COSMO-SKyMed	Italy (GOV)	Italy	Yes
COSMO-SkyMed 2nd Gen.	Italy (GOV)	Italy	Yes
GARAI	GEOSAT	Portugal	No
GEISAT Precursor*	Satlantis	Spain	Yes
GeoEye-1	Vantor	U.S	Yes
Geosat 2	GEOSAT	Portugal	Yes
HotSat	SatVu	Great Britain	Yes
Hydra	Aistech	Spain	Yes
ICEYE*	Iceye Oy	Finland	Yes
IKONOS-2	Vantor	U.S	Yes
KOMPSAT 3	South Korea (GOV)	South Korea	Yes
KOMPSAT 3A	South Korea (GOV)	South Korea	Yes
KOMPSAT 5	South Korea (GOV)	South Korea	Yes
NAOS	Luxembourg (GOV)	Luxembourg	unclear
NEMO HD	SPACE-SI	Slovenia	No
OPTSAT-3000	Italy (GOV)	Italy	No
PAZ	Spain (GOV)	Spain	Yes
Planetscope*	Planet Labs	U.S	Yes
Pleiades	Airbus DS	France	Yes
Pleiades Neo	Airbus DS	France	Yes
ProtoMéthée-1*	Promethee	France	Yes
Quickbird-2	Vantor	U.S	Yes
RADARSAT-2	MDA Space	Canada	until 2014
SkySat	Planet Labs	U.S	Yes
SPOT-6	Airbus DS	France	Yes
Terra-SAR X / TanDEM-X	Germany (GOV)	Germany	Yes
Vision-1	Airbus DS	France	Yes
WorldView Legion	Vantor	U.S	Yes
WorldView-1	Vantor	U.S	Yes
WorldView-2	Vantor	U.S	Yes
WorldView-3	Vantor	U.S	Yes
WorldView-4	Vantor	U.S	Yes

* These smallsat missions are included here for completeness, but are detailed in Deliverable D7.1.

3.1.2 Technical specifications

Table 4 - Main technical parameters sorted by maximum achievable spatial resolution (GSD at nadir).

Mission	Sensor type	Maximum spatial resolution at nadir in m
PAZ	SAR X	0,25
Terra-SAR X / TanDEM-X	SAR X	0,25
Pleiades Neo	VNIR MS	0,3
WorldView-4	VNIR MS	0,31
WorldView Legion	VNIR MS	0,34
WorldView-3	VNIR MS	0,34
GeoEye-1	VNIR MS	0,41
WorldView-2	VNIR MS	0,46
CO3D	VNIR MS	0,5
ICEYE*	SAR X	0,5
NAOS	VNIR MS	0,5
OPTSAT-3000	VNIR MS	0,5
Pleiades	VNIR MS	0,5
WorldView-1	PAN	0,5
KOMPSAT 3A	VNIR MS	0,55
SkySat	VNIR MS + video	0,57
Quickbird-2	VNIR MS	0,61
KOMPSAT 3	VNIR MS	0,7
Geosat 2	VNIR MS	0,75
COSMO-SkyMed 2nd gen	SAR X	0,8
GARAI	VNIR+SWIR MS + video	0,8
Vision-1	VNIR MS	0,87
Axis 1.2*	SAR X	1
Axis 2*	V+NIR+SWIR MS	1
COSMO-SkyMed	SAR X	1
IKONOS-2	VNIR MS	1
KOMPSAT 5	SAR X	1
Balkan-1*	VNIR MS	1,5
ProtoMéthée-1*	VNIR MS	1,5
SPOT-6	VNIR MS	1,5
GEISAT Precursor*	VNIR+SWIR MS	1,65
NEMO HD	VNIR MS + video	2,8
RADARSAT-2	SAR C	3
HotSat	TIR	3,5
Planetscope*	VNIR MS	3,7

* These smallsat missions are included here for completeness, but are detailed in Deliverable D7.1.

3.1.3 Readiness of the constellation

Table 5 - Readiness of the constellation sorted by the deployment status

Mission	Deployment Status	planned launch dates
Axis 1.2*	1 - Definition Phase	2026 - ?
Axis 2*	1 - Definition Phase	2026 - ?
HotSat	1 - Definition Phase	2026 - ?
CO3D	2 - Commissioning	2025
WorldView Legion	2 - Commissioning	2024 - ?
NAOS	2 - Commissioning	2025
GARAI	2 - Commissioning	2025 - 2026
Balkan-1*	2 - Commissioning	2025 - ?
ProtoMéthée-1*	2 - Commissioning	2023 - ?
GEISAT Precursor*	3 - Fully Operational	
PAZ	3 - Fully Operational	
Terra-SAR X / TanDEM-X	3 - Fully Operational	
Pleiades Neo	3 - Fully Operational	
WorldView-3	3 - Fully Operational	
GeoEye-1	3 - Fully Operational	
WorldView-2	3 - Fully Operational	
ICEYE*	3 - Fully Operational	
OPTSAT-3000	3 - Fully Operational	
Pleiades	3 - Fully Operational	
WorldView-1	3 - Fully Operational	
KOMPSAT 3A	3 - Fully Operational	
SkySat	3 - Fully Operational	
KOMPSAT 3	3 - Fully Operational	
Geosat 2	3 - Fully Operational	
COSMO-SkyMed 2nd gen	3 - Fully Operational	
Vision-1	3 - Fully Operational	
COSMO-SkyMed	3 - Fully Operational	
KOMPSAT 5	3 - Fully Operational	
SPOT-6	3 - Fully Operational	
NEMO HD	3 - Fully Operational	
RADARSAT-2	3 - Fully Operational	
Planetscope*	3 - Fully Operational	
WorldView-4	4 - Decommissioned	
Quickbird-2	4 - Decommissioned	
IKONOS-2	4 - Decommissioned	

* These smallsat missions are included here for completeness, but are detailed in Deliverable D7.1.

3.2 Optical missions in detail

3.2.1 CO3D

CO3D is a French-led optical constellation focused on generating a global high-precision 3D Digital Surface Model (DSM), setting it apart through its emphasis on stereoscopic acquisitions for topographic mapping – potentially useful for applications like crisis terrain modelling, hydrology, and infrastructure assessment in civil security contexts. It provides VNIR multispectral stereo imagery with onboard AI enabling real-time object detection and low-light urban imaging.

Owner / operator:

- CNES (French National Centre for Space Studies): Primary owner/operator, mission lead and funding.
- Airbus Defence and Space: Manufacturing, ground segment operations, and commercial data distribution.

Constellation:

- Planned: 4 satellites (potential expansion to 20).
- Launched: 4 satellites (July 2025).
- Upcoming: None.
- Revisit time: Daily global coverage.
- Status: Initial operational capability (commissioning phase).

Satellite(s) technical characteristics:

- Mass: ~300 kg.
- Swath width: 7 km at nadir.
- Acquisition modes: Step-and-stare for stereo; diamond geometry.

Band name	Resolution @ nadir [m]
Blue	0.5
Green	0.5
Red	0.5
NIR	1

Platform & Archive:

- Ground segment: Airbus Geo-Digital Systems (GDS).
- Archive: Airbus (commercial) or CNES (scientific); products include Level 2A (geometric), 2B (elevation), Level 3 DSM. No public API yet.

Tasking capabilities:

- Flexible multi-angle stereo (synchronized).
- Delivery timeline: standard <24 h.

Sources
https://space.skyrocket.de/doc_sdat/co3d.htm
https://newsroom.arianespace.com/arianespace-startet-erfolgreich-co3d-und-microcarb-satelliten
https://www.eoportal.org/satellite-missions/co3d-constellation

3.2.2 GeoEye-1

GeoEye-1 is a commercial VHR optical satellite providing panchromatic and multispectral imagery, setting itself apart through its high geolocation accuracy and large daily collection capacity for detailed mapping and analysis applications.

Owner / operator:

- Vantor (formerly Maxar Technologies, U.S.) – owner and operator.

Constellation:

- Planned: 1 satellite.
- Launched: 1 satellite (September 2008).
- Upcoming: None.
- Revisit time: 48 hours.
- Status: Full operational capability.

Satellite(s) technical characteristics:

- Mass: 1955 kg.
- Swath width: 15.2 km at nadir.
- Stereo capable.

Bands:

Band name	Wavelength (nm)	Resolution (m)
Panchromatic	450–800	0.41
Blue	450–510	1.64
Green	510–580	1.64
Red	655–690	1.64
Near Infrared	780–920	1.64

Platform & Archive:

- API access via Vantor (formerly Maxar) API.

Tasking capabilities:

- Left/right looking, off-nadir up to 60°.
- Delivery timeline: Standard <24 h.

Sources:
https://earth.esa.int/eogateway/missions/geoeye-1
https://www.satimagingcorp.com/satellite-sensors/geoeye-1/

3.2.3 GEOSAT-2

GEOSAT-2 is a very-high-resolution optical mission providing VHR imagery for global Earth observation. It has a daily collection capacity of over 150,000 km² and rapid response capabilities. The mission stands out as the first European fully-private satellite offering sub-metric multispectral imagery, facilitating cost-effective access to high-quality data for diverse users.
Innovations include AI-based super-resolution for enhanced products (up to 0.40 m panchromatic), machine learning for change detection, stereo imaging for 3D models, and atmospheric correction for accurate radiance values.

Owner / operator:

- GEOSAT (Spain): owner and operator responsible for mission control, data acquisition, processing, and distribution.

Constellation:

- Number of satellites: 1 (GEOSAT-2, following GEOSAT-1).
- Number of satellites launched: 1 (June 2014).
- Next launch: None.
- Revisit time: 2 days worldwide, 1 day at mid-latitudes.

Satellite(s) technical characteristics:

- Swath width: 12 km standard (24 km with tessellation).
- Off-nadir up to 45°; strip length up to 1,400 km.
- Weight: 500 kg.

Band name	Wavelength (nm)	Resolution (m)
Panchromatic	560-900	1
Blue	466-525	4
Green	532-599	4
Red	640-697	4
Near Infrared	770-892	4

Platform, Archive:

- Platform: Web interface and API.
- Archive: 8+ years global coverage.

Tasking capabilities:

- Delivery timeline: Standard during working hours; 24/7 rush for emergencies.

Sources:
https://geosat.space/wp-content/uploads/2024/02/GEOSAT-2-PS-guide_comp.pdf
https://earth.esa.int/eogateway/missions/geosat-2
https://satsearch.co/suppliers/geosat

3.2.4 KOMPSAT 3

KOMPSAT 3 is a high-resolution optical Earth observation mission providing panchromatic and multispectral imagery for GIS, agriculture, environment, oceanography, and disaster monitoring. The mission sets itself apart as a standalone satellite with agile pointing for event monitoring and stereo observations, enabling detailed analysis options.
Innovations include a stabilized Korsch-type telescope and focus mechanism for optimized imaging.

Owner / operator:

- Korea Aerospace Research Institute (KARI): Governmental agency, primary owner/operator, funded by Ministry of Education, Science and Technology.

Constellation:

- Planned: 1 satellite.
- Launched: 1 satellite (May 2012).
- Upcoming: None.
- Revisit time: 1.4 days.
- Status: Fully operational.

Satellite(s) technical characteristics:

- Mass: ~980 kg.
- Swath width: 15 km at nadir.
- Acquisition modes: Strip imaging; tilt roll ±45°, pitch ±30°; stereo capable.

Band name	Wavelength [nm]	Resolution @ nadir [m]
Panchromatic	450–900	0.7
Blue	450–520	2.8
Green	520–600	2.8
Red	630–690	2.8
Near Infrared	760–900	2.8

Platform & Archive:

- Ground segment: Mission Control Element (MCE), Image Reception and Processing Element (IRPE).
- No public API. Access via Satrec Initiative Imaging Services (SIIS).

Tasking capabilities:

- Tasking possible via SIIS.

Sources:
https://eos.com/find-satellite/kompsat-3-3a
https://www.eoportal.org/satellite-missions/kompsat-3

3.2.5 KOMPSAT 3A

KOMPSAT 3A is a high-resolution optical Earth observation mission providing panchromatic, multispectral, and infrared imagery for GIS, agriculture, environment, oceanography, and disaster monitoring.

The mission sets itself apart as a standalone satellite with agile pointing for event monitoring and stereo observations, enabling night-time imaging and fire detection.

Innovations include a stabilized Korsch-type telescope and focus mechanism for optimized imaging, plus IR sensor for thermal applications.

Owner / operator:

- Korea Aerospace Research Institute (KARI): Governmental agency, primary owner/operator, funded by Ministry of Science, ICT and Future Planning.

Constellation:

- Planned: 1 satellite.
- Launched: 1 satellite (March 2015).
- Upcoming: None.
- Revisit time: 1.4 days.
- Status: Fully operational.

Satellite(s) technical characteristics:

- Mass: ~980 kg.
- Swath width: 12 km at nadir.
- Acquisition modes: Strip imaging; tilt roll ±45°, pitch ±30°; stereo capable.

Band name

Band name	Wavelength [nm]	Resolution @ nadir [m]
Panchromatic	450–900	0.55
Blue	450–520	2.2
Green	520–600	2.2
Red	630–690	2.2
Near Infrared	760–900	2.2
Mid Infrared	~3000-5000	5.5

Platform & Archive:

- Ground segment: Mission Control Element (MCE), Image Reception and Processing Element (IRPE).
- No public API. Access via SI Imaging Services.

Tasking capabilities:

- Tasking possible via SIIS.

Sources:
https://www.eoportal.org/satellite-missions/kompsat-3a
https://www.satimagingcorp.com/satellite-sensors/kompsat-3a

3.2.6 NAOS

NAOS is Luxembourg's first Earth observation satellite, is planned to provide very high-resolution optical imagery for applications like defence, security, and crisis management, supporting applications in border surveillance, arms control verification, humanitarian aid, natural disaster relief, and climate monitoring. The mission is set to provide global daily coverage capability, enabling rapid image acquisition.

Owner / operator:

- Luxembourg Directorate of Defence: Primary governmental owner.
- LUXEOps (consortium of RHEA System Luxembourg, LUXSPACE, OHB Digital Connect, RHEA System): Operator for system maintenance and data handling.

Constellation:

- Planned: 1 satellite (may change).
- Launched: 1 satellite (August 2025).
- Upcoming: None.
- 15 orbits per day (global coverage with >100 images/day).
- Status: Initial operational capability.

Satellite(s) technical characteristics:

- Mass: 645-800 kg.
- Swath width: Not specified.
- Acquisition modes: Not specified yet.

Bands: Optical bands expected to reach ~0.5m ground resolution.

Platform, Archive, Tasking: Not specified yet.

Sources:
https://news.satnews.com/2025/08/26/spacex-launches-naos-an-eo-spacecraft-for-luxembourg-smallsats-from-sunny-california/
https://space.skyrocket.de/doc_sdat/naos.htm

3.2.7 OPTSAT-3000

OPTSAT-3000 is an Italian high-resolution optical reconnaissance satellite, providing global imagery for defence users, government agencies, and international partners. It supports security and crisis management through detailed Earth observation. The mission sets itself apart as a standalone satellite with high autonomy and reliability, enabling integrated use with radar systems like COSMO-SkyMed for enhanced operativity.

Owner / operator:

- Italian Ministry of Defence: Primary owner.
- Telespazio: Prime contractor for ground segment, operations, and logistics.

Constellation:

- Planned: 1 satellite.
- Launched: 1 satellite (August 2017).
- Upcoming: None.
- Status: Fully operational.

Satellite(s) technical characteristics:

- Mass: 368 kg.
- Spatial resolution: 0.5 m panchromatic, 2 m multispectral
- Swath width: Not specified.
- Acquisition modes: Not specified.

Band name	Resolution @ nadir [m]
Pan	0.5
Blue	2
Green	2
Red	2
NIR	2

Platform & Archive:

- Ground segment: Fucino Space Centre, CITS in Pratica di Mare, CIGC in Vigna di Valle.
- No public API.

Tasking capabilities:

- Not specified.

Sources:
https://www.telespazio.com/en/business/space-programmes/optsat-3000
https://space.skyrocket.de/doc_sdat/optsat-3000.htm

3.2.8 Pléiades

Pléiades is a VHR optical imaging constellation, supporting applications in cartography, agriculture, forestry, hydrology, geological prospecting, dynamic geology, risk management, and defence. It offers global daily access to any point on Earth, enabling detailed land cover, topography, and crisis response analysis. The mission sets itself apart as a two-satellite system with high agility for minimizing programming conflicts and rapid acquisitions. Innovations include sensitive detectors for reduced exposure time, autonomous orbit determination with DORIS, and gyro-stellar attitude control. Calibration methods like AMETHIST and lunar observations ensure radiometric accuracy.

Owner / operator:

- CNES (France): Primary owner and mission lead.
- Airbus Defence and Space: Operator for civil distribution and satellite mastery.

Constellation:

- Number of satellites: 2 (Pléiades-1A and 1B).
- Number of satellites launched: 2. (December 2011 and December 2012)
- Next launch: None.
- Revisit time: 24 hours.

Satellite(s) technical characteristics:

- Swath width: 20 km at nadir.
- Characteristics: Off-nadir up to 60°.
- Weight: ~970 kg.

Band name	Wavelength (nm)	Resolution (m)
Panchromatic	480-820	0.7 (resampled to 0.5)
Blue	450-530	2.8 (resampled to 2)
Green	510-590	2.8 (resampled to 2)
Red	620-700	2.8 (resampled to 2)
Near Infrared	775-915	2.8 (resampled to 2)

Platform, Archive:

- Platform: User centres in Creil (defence), Toulouse (civil).
- API access: via Airbus OneAtlas API (contract-based).

Tasking capabilities:

- Modes: Stereo (up to 350 km x 20 km), mosaic (120 km x 120 km), corridor.
- Left/right looking, off-nadir up to 60° (slew in 25 s).
- Delivery timeline: Standard; emergency 2-hour average via Direct Tasking.

Sources:
https://pleiades.cnes.fr/en/PLEIADES/index.htm
https://earth.esa.int/eogateway/documents/20142/37627/Pleiades-Imagery-User-Guide.pdf/
https://www.eoportal.org/satellite-missions/pleiades

3.2.9 Pléiades Neo

Pléiades Neo is a commercial VHR optical constellation from Airbus, delivering 30 cm panchromatic resolution for enhanced detail. Pleiades Neo provides daytime multispectral VNIR imagery, e.g. for border mapping and environmental impact assessment. Its innovation lies in laser-based near-real-time data relay via the European Data Relay System (EDRS), reducing latency from days to minutes for time-critical crisis response.

Owner / operator:

- Airbus Defence and Space: Primary owner, manufacturer, and operator.

Constellation:

- Planned: 4 satellites.
- Launched successfully: 2 satellites. (April and August 2021)
- Failed launch: 2 satellites (in 2022).
- Revisit time: 12 hours (with off-nadir angles up to ±46°).
- Status: Fully operational (2 satellites).

Satellite(s) technical characteristics:

- Mass: ~920 kg.
- Swath: 14 km at nadir
- Acquisition modes: Mono, Stereo, Tri-stereo.

Bands:

Band name	Wavelength [nm]	Resolution @ nadir [m]
Panchromatic	450–750	0.30
Deep Blue	400–450	1.2
Blue	450–520	1.2
Green	530–590	1.2
Red	620–690	1.2
Red Edge	700–750	1.2
Near Infrared	770–890	1.2

Platform & Archive:

- Ground segment: Airbus OneAtlas platform for streaming, analytics, and multi-mission fusion; EDRS laser relay for rapid downlink.
- API access via Airbus OneAtlas REST API.

Tasking capabilities:

- Left/right looking, off-nadir angles up to ±52°.
- Delivery timeline: Standard <24 h; near-real-time (<15 min) via EDRS for emergencies.

Sources:
https://earth.esa.int/eogateway/missions/pleiades-neo#
https://space.skyrocket.de/doc_sdat/pleiades-neo.htm
https://www.eoportal.org/ftp/satellite-missions/p/PleiadesNeo_171221/PleiadesNeo.html

3.2.10 Spot-6

SPOT-6 is an optical EO mission providing panchromatic and multispectral imagery for applications in land-use management, cartography, national security, climatology, oceanography, and monitoring human activities and natural phenomena. It sets itself apart through its wide-swath imaging capability for efficient coverage of large areas, enabling rapid acquisition of homogeneous data sets. Innovations include an advanced pushbroom imager with dual instruments for simultaneous or individual acquisitions, and enhanced manoeuvrability for stereo and tri-stereo imaging.

Owner / operator:

- Airbus Defence and Space (France): Primary owner and operator.

Constellation:

- Planned: 1 satellite.
- Launched: 1 satellite (September 2012).
- Upcoming: None.
- Revisit time: Between 1 and 3 days.
- Status: Fully operational (extended).

Satellite technical characteristics:

- Mass: ~714 kg.
- Swath width: 60 km at nadir (120 km with single-pass mosaic).
- Acquisition modes: single-pass stereo and tri-stereo; mosaics up to 5 contiguous strips; multiple acquisitions over target areas.

Bands:

Band name	Wavelength (µm)	Resolution @ nadir (m)
Panchromatic	0.45-0.75	1.5
Blue	0.45-0.52	6
Green	0.53-0.60	6
Red	0.62-0.69	6
Near Infrared	0.76-0.89	6

Platform & Archive:

- Ground segment: Operator Centre in Toulouse (France); network of Direct Receiving Stations.
- API access available. Archive and tasking (requires contract).

Tasking capabilities:

- Off-nadir ±30° tilting for event monitoring.
- Delivery timeline: Standard within hours; emergency near real-time (average 2 hours after acquisition) via 24/7 service.

Sources:
https://intelligence.airbus.com/imagery/our-optical-and-radar-satellite-imagery/spot/
https://earth.esa.int/eogateway/missions/spot-6
https://www.eoportal.org/satellite-missions/spot-6-7

3.2.11 Vision-1

Vision-1 provides panchromatic and multispectral imagery for applications in urban planning, agricultural monitoring, land classification, natural resource management, disaster monitoring, defence, security, maritime, and agriculture. The mission sets itself apart through its ability to capture multiple targets in one pass using spot, strip, and mosaic imaging modes with 45° off-pointing agility. Innovations include stereo and area modes for enhanced 3D modelling and coverage, along with high-precision location accuracy and dynamic range for optimized image quality.

Owner / operator:

- Airbus Defence and Space (France): Primary owner and operator.

Constellation:

- Planned: 1 satellite.
- Launched: 1 satellite (September 2018).
- Upcoming: None.
- Revisit time: 1 to 8 days, depending on latitude.
- Status: Fully operational.

Satellite technical characteristics:

- Mass: ~440 kg.
- Swath width: 20.8 km at nadir.
- Acquisition modes: Strip, area, stereo (two co-incident scenes at opposing pitch angles of ±30° along-track).

Mode	Resolution (range × azimuth)	Scene / Swath size
Staring Spotlight (ST)	≤0.25 m	4 km × 3.7 km
High Resolution Spotlight (HS)	≤1 m	5-10 km × 5 km
Spotlight (SL)	≤2 m	10 km × 10 km
StripMap (SM)	≤3 m	30 km × 50 km
ScanSAR (SC)	≤18 m	100 km × 150 km
Wide ScanSAR (WS)	≤40 m	270 km × 200 km

Platform & Archive:

- Ground segment: Integrated in Airbus systems.
- API access via Airbus.

Tasking capabilities:

- Viewing angle ±30° in roll for standard mode, ±45° for extended mode; pointing agility roll/pitch 60°. Multiple targets in one pass.
- Delivery timeline: Not specified.

Sources :
https://www.eoportal.org/satellite-missions/vision-1
https://earth.esa.int/eogateway/missions/vision-1/description

3.2.12 WorldView-1

WorldView-1 provides VHR panchromatic (monochrome) imagery. It supports applications in defence, intelligence, commercial sectors, and environment monitoring. The mission sets itself apart as the world's first half-meter resolution commercial satellite. Innovations include control moment gyroscopes for agile and rapid retargeting, high-capacity onboard storage, and selectable time delay integration levels for optimized imaging.

Owner / operator:

- Vantor (U.S., formerly Maxar Technologies) – owner and operator .

Constellation:

- Planned: 1 satellite.
- Launched: 1 satellite (September 2007).
- Upcoming: None.
- Revisit time: 1.7 days at 1 m GSD or less; 5.9 days at 20° off-nadir (0.5 m GSD).
- Status: Fully operational .

Satellite(s) technical characteristics:

- Mass: ~2500 kg.
- Swath width: 17.6 km at nadir.
- Acquisition modes: Pushbroom scanning; stereo capable; agile pointing with ±40° off-nadir.

Band: Panchromatic (450-900 nm) up to 0.5m GSD.

Platform & Archive:

- Ground segment: distributed receiving stations.
- API access via MGP Developer Portal for archive and tasking.

Tasking capabilities:

- Modes: Supports stereo imaging and rapid retargeting.
- Delivery timeline: Standard <24 h.

Sources:
https://earth.esa.int/eogateway/missions/worldview-1
https://www.eoportal.org/satellite-missions/worldview-1

3.2.13 WorldView-2

WorldView-2 is a commercial VHR mission providing panchromatic and multispectral optical and NIR imagery. It supports applications in defence, intelligence, commercial sectors, environment monitoring, plant species identification, vegetation stress mapping, crop types, benthic habitats, wetlands, coastal water quality, and bathymetry. The mission sets itself apart as the first commercial satellite to carry a VHR 8-band multispectral sensor, enabling enhanced multispectral analysis. Innovations include advanced control moment gyroscopes for rapid retargeting, and time delay integration with selectable levels for optimized imaging.

Owner / operator:

- Vantor (U.S., formerly Maxar Technologies) – owner and operator.

Constellation:

- Planned: 1 satellite.
- Launched: 1 satellite (October 2009).
- Upcoming: None.
- Revisit time: 1.1 days at ~1 m GSD; 3.7 days at ~0.5 m GSD (max. 20° off-nadir).
- Status: Fully operational.

Satellite(s) technical characteristics:

- Mass: ~2800 kg.
- Swath width: 16.4 km at nadir.
- Acquisition modes: Pushbroom scanning; mono and stereo capable.

Band name	Wavelength (nm)	Resolution @ nadir (m)
Panchromatic	450-800	0.46
Coastal	400-450	1.8
Blue	450-510	1.8
Green	510-580	1.8
Yellow	585-625	1.8
Red	630-690	1.8
Red Edge	705-745	1.8
Near Infrared 1	770-895	1.8
Near Infrared 2	860-1040	1.8

Platform & Archive:

- Ground segment: distributed receiving stations.
- API access via MGP Developer Portal for archive and tasking.

Tasking capabilities:

- Agile pointing with ±40° off-nadir.
- Delivery timeline: Standard <24 h.

Sources:
https://earth.esa.int/eogateway/missions/worldview-2
https://www.eoportal.org/satellite-missions/worldview-2

3.2.14 WorldView-3

WorldView-3 is a commercial optical VHR Earth observation mission providing panchromatic, multispectral, SWIR, and CAVIS imagery for precise mapping, environmental monitoring, change detection, and in-depth image analysis. It supports applications in defence, intelligence, commercial sectors, agriculture, forestry, and disaster response. The mission sets itself apart as the first commercial satellite with super-spectral capabilities across 29 bands, enabling enhanced atmospheric correction (using CAVIS bands) and material identification through haze, smoke, or dust. Innovations include SWIR bands for spectral analysis, CAVIS for consistent imagery correction, and high-agility control moment gyroscopes for rapid retargeting.

Owner / operator:

- Vantor (U.S., formerly Maxar Technologies).

Constellation:

- Planned: 1 satellite
- Launched: 1 satellite (August 2014).
- Upcoming: None.
- Revisit time: <1 day at 1 m GSD or less; 4.5 days at 20° off-nadir (<0.34 m GSD).
- Status: Fully operational.

Satellite(s) technical characteristics:

- Mass: ~2800 kg.
- Swath width: 13.1 km at nadir.

Band name	Wavelength (nm)	Resolution @ nadir (m)
Panchromatic	450-800	0.31
Coastal	400-450	1.24
Blue	450-510	1.24
Green	510-580	1.24
Yellow	585-625	1.24
Red	630-690	1.24
Red Edge	705-745	1.24
Near Infrared 1	770-895	1.24
Near Infrared 2	860-1040	1.24
SWIR (8 bands)	1195-2365 (each band 30 to 90 nm wide)	3,7
CAVIS (12 bands)	405-2245	30

Platform & Archive:

- Ground segment: X-band downlink at 800-1200 Mbit/s; distributed receiving stations.
- API access via MGP Developer Portal.

Tasking capabilities:

- Modes: Supports mono, stereo, and multiple swath imaging.
- Rapid retargeting with ±40° off-nadir.
- Delivery timeline: Standard <24 h.

Sources:
https://earth.esa.int/eogateway/missions/worldview-3
https://www.eoportal.org/satellite-missions/worldview-3

3.2.15 WorldView Legion

WorldView Legion is a next-generation commercial VHR optical constellation providing panchromatic and multispectral VNIR imagery for defence, intelligence, emergency management, maritime surveillance, environmental monitoring, and resource management. It supports detailed mapping, change detection, and real-time analysis with global coverage. The mission sets itself apart through its electro-optical design delivering 29 cm resolution imagery, tri-band capacity for enhanced collection efficiency, and up to 15 times daily revisits at mid-latitudes, enabling near-real-time monitoring. Innovations include low-Earth orbit placement for rapid access and integration with existing Vantor satellites for expanded capacity.

Owner / operator:

- Vantor (U.S., formerly Maxar Technologies).

Constellation:

- Planned: 6 satellites.
- Launched: 6 satellites (first pair: May 2024; second: August 2024; third: February 2025).
- Upcoming: None.
- Revisit time: Up to 40 minutes at mid-latitudes.
- Status: Fully operational.

Satellite(s) technical characteristics:

- Mass: ~1700 kg.
- Swath width: 10 km at nadir.

Band name	Wavelength (nm)	Resolution @ nadir (m)
Panchromatic	450-800	0.29
Coastal	400-500	0.48
Blue	450-510	0.48
Green	510-580	0.48
Yellow	585-625	0.48
Red	630-690	0.48
Red Edge 1	695-715	0.48
Red Edge 2	730-750	0.48
Near IR	780-920	0.48

Platform & Archive:

- Ground segment: Integrated with Vantor systems; X-band downlink.
- Archive: Available commercially. Access via MGP Developer Portal.

Tasking capabilities:

- Acquisition modes: Pushbroom scanning; mono and stereo capable; agile pointing with off-nadir capabilities.
- Delivery timeline: Standard <24 h; near-real-time for emergencies.

Sources:
https://www.maxar.com/worldview-legion
https://www.rapidresponse.copernicus.eu/new-very-high-resolution-capabilities-available-to-copernicus-users/
https://earth.esa.int/eogateway/missions/worldview-legion
https://www.eoportal.org/satellite-missions/worldview-legion

3.3 SAR missions in detail

3.3.1 COSMO-SkyMed First Generation

COSMO-SkyMed First Generation (CSK) is a dual-use X-band SAR constellation providing data for THEIA-relevant security applications like border surveillance, maritime awareness, and crisis response for forced displacement. It supports monitoring of land/ice processes, environmental/risk management, maritime/topographic mapping, and interferometry for change detection in humanitarian aid and disasters. Innovations include multi-mode programmable SAR with single/dual polarization for flexible VHR imaging.

Owner / operator:

- Agenzia Spaziale Italiana (ASI): Primary owner/operator, conceived and funded with Italian Ministry of Education, University and Research.
- Italian Ministry of Defence (MoD): Funds dual-use/military aspects.

Constellation:

- Planned: 4 satellites.
- Launched: 4 satellites. (June 2007 to November 2010)
- Upcoming: None.
- Revisit time: 16-day cycle (up to 12 hours globally).
- Status: Fully operational.

Satellite(s) technical characteristics:

- Mass: ~1700 kg.
- Single/dual polarization options (HH, VV, HV, VH); supports interferometry.

Modalities:

Mode	Resolution	Scene / Swath size
Spotlight	≤1 m	10 km × 10 km
Stripmap HIMAGE	3 m	40 km
Stripmap PingPong	15 m	30 km
ScanSAR Wide	30 m	100 km
ScanSAR Huge	100 m	200 km

Platform & Archive:

- Ground segment: Fucino Mission Planning Centre; civil/military user centres.
- No public API. Access e.g. via ESA.

Tasking capabilities:

- Left/right looking, incidence angles ~20°–60°.
- Delivery timeline: Standard 24–48 h. Rush mode <6 h possible for emergencies.

Sources:
https://earth.esa.int/eogateway/missions/cosmo-skymed
https://www.asi.it/en/earth-science/cosmo-skymed/

3.3.2 COSMO-SkyMed Second Generation

COSMO-SkyMed Second Generation (CSG) is a dual-use X-band SAR mission following the first-generation COSMO-SkyMed, ensuring continuity with enhanced global monitoring for THEIA-relevant security applications like border surveillance, maritime awareness, and crisis response for forced displacement. It supports interferometry for change detection in humanitarian aid, environmental monitoring, and disaster management. Innovations include tripled SAR bandwidth for VHR, quad-polarization, doubled storage/downlink, and agile modes.

Owner / operator:

- Agenzia Spaziale Italiana (ASI): Primary civil owner/operator, funded with Italian Ministry of Education, Universities and Scientific Research.
- Italian Ministry of Defence: Manages dual-use/military aspects.

Constellation:

- Planned: 4 satellites.
- Launched: 2 satellites. (December 2019 and January 2022)
- Upcoming: launches planned for 2026 and 2027.
- Revisit time: 16-day cycle (up to 12 hours globally).
- Status: Fully operational.

Satellite(s) technical characteristics:

- Mass: ≤2230 kg
- Single or dual polarization options; supports interferometry.

Modalities:

Mode	Resolution (range × azimuth)	Scene / Swath size
Spotlight-2A	0.3 m × 0.5 m	3.5 km × 7 km
Spotlight-2B	0.6 m × 0.6 m	10 km × 10 km
Spotlight-2C	0.8 m × 0.8 m	5 km × 10 km
Stripmap	3 m × 3 m	40 km × 40 km (or longer)
PingPong	12 m × 5 m	40 km × 40 km
Quad-Pol	3 m × 3 m	40 km × 15 km
ScanSAR-1	20 m × 4 m	100 km × 100 km
ScanSAR-2	40 m × 6 m	200 km × 200 km

Platform & Archive:

- Ground segment: Fucino Mission Planning Centre; civil/military user centres.
- No public API. Access e.g. via ESA.

Tasking capabilities:

- Left/right looking, incidence angles 15°–60°.
- Delivery timeline: Standard <24 h; rush mode <3 h possible for emergencies.

Sources:
https://earth.esa.int/eogateway/missions/cosmo-skymed-second-generation
https://directory.eoportal.org/satellite-missions/cosmo-skymed-second-generation

3.3.3 KOMPSAT 5

KOMPSAT 5 is South Korea's first SAR Earth observation mission providing all-weather X-band imagery for GIS, oceanography, land classification, environmental monitoring, and disaster mitigation.

The mission sets itself apart as a standalone satellite with multi-mode SAR for diverse resolution and coverage needs, enabling detailed topographic and change analysis.

Innovations include an active phased array antenna for flexible beam steering and high-precision imaging.

Owner / operator:

- Korea Aerospace Research Institute (KARI): Governmental agency, primary owner/operator, funded by Ministry of Science, ICT and Future Planning.

Constellation:

- Planned: 1 satellite.
- Launched: 1 satellite (August 2013).
- Upcoming: None.
- Revisit time: 28-day cycle (up to 3 days with roll).
- Status: Fully operational.

Satellite(s) technical characteristics:

- Mass: ~1400 kg.
- Swath width: 5 km (high-res), 30 km (standard), 100 km (wide).

Mode	Resolution (range × azimuth)	Scene / Swath size
Spotlight-2A	0.3 m × 0.5 m	3.5 km × 7 km
Spotlight-2B	0.6 m × 0.6 m	10 km × 10 km
Spotlight-2C	0.8 m × 0.8 m	5 km × 10 km
Stripmap	3 m × 3 m	40 km × 40 km (or longer)
PingPong	12 m × 5 m	40 km × 40 km
Quad-Pol	3 m × 3 m	40 km × 15 km
ScanSAR-1	20 m × 4 m	100 km × 100 km
ScanSAR-2	40 m × 6 m	200 km × 200 km

Platform & Archive:

- Ground segment: Mission Control Element (MCE), Image Reception and Processing Element (IRPE).
- No public API. Access via SI Imaging Services.

Tasking capabilities:

- Tasking possible via SIIS.

Sources:
https://www.eoportal.org/satellite-missions/kompsat-5
https://space.skyrocket.de/doc_sdat/kompsat-5.htm

3.3.4 PAZ

PAZ is Spain's first X-band SAR satellite, developed as a dual-use (civil/defence) system with a primary emphasis on maritime surveillance—differentiating it from broader dual-use SAR by integrating an onboard AIS receiver for fusing radar imagery with real-time vessel tracking. It operates in tandem with Germany's TerraSAR-X and TanDEM-X (same orbit plane, ~30s separation), creating a de facto EU 3-satellite SAR constellation for sub-daily revisits.

Owner / operator:

- Hisdesat Servicios Estratégicos S.A. (Spanish Ministry of Defence and industry consortium) – Primary owner/operator.
- Airbus Defence and Space – Satellite manufacturer and technical coordinator.

Constellation:

- Planned: 1.
- Launched: 1. (Februar 2018)
- Upcoming: None.
- Revisit time: 11-day exact repeat; average ~24 h standalone.
- Status: Fully operational.

Satellite(s) technical characteristics:

- Mass: ~1400 kg.
- Single/dual polarization (HH, VV, HV, VH); on-board AIS receiver for ship detection & identification.

Modalities:

Mode	Resolution	Scene / Swath size
Staring Spotlight (ST)	≤0.25 m	4 km × 4 km
High Resolution Spotlight (HS)	≤1 m	5–10 km × 5 km
Spotlight (SL)	≤2 m	10 km × 10 km
StripMap (SM)	≤3 m	30 km × 50 km
ScanSAR (SC)	≤18 m	100 km × 150 km
Wide ScanSAR (WS)	≤40 m	270 km × 200 km

Platform & Archive:

- Ground segment: Spanish stations (Madrid, Maspalomas); fully interoperable with German TerraSAR-X ground segment.
- Full archive (2018-present) available e.g. via ESA. No public API.

Tasking capabilities:

- Left/right looking, incidence angles 15°–60°.
- High agility (phased-array beam steering, retargeting in seconds).
- Delivery timeline: Standard <24 h; rush/emergency mode <4–6 h possible.

Sources:
https://earth.esa.int/eogateway/missions/paz
https://earth.esa.int/eogateway/catalog/paz-full-archive-and-new-tasking
https://www.hisdesat.es/wp-content/uploads/2020/09/Mision.pdf
https://www.eoportal.org/satellite-missions/paz
https://www.airbus.com/en/newsroom/press-releases/2019-02-airbus-and-hisdesat-successfully-processed-the-first-terrasar-x-paz
https://earth.esa.int/eogateway/news/update-of-paz-and-terrasar-x-tandem-x-collections
https://www.dlr.de/en/latest/news/2018/1/20180222_paz-earth-observation-satellite-successfully-launched_26110
https://www.esri.com/partners/airbus-intelligence-a2T70000000TNKlEAO/radar-constellation--a2d70000000mqQnAAI

3.3.5 RADARSAT-2

RADARSAT-2 is a commercial C-band SAR mission providing imagery for applications in environmental monitoring, disaster management, maritime surveillance, resource management, and coastal security. It supports detailed analysis of ocean, land, ice, and atmospheric features, including ship detection, oil spill monitoring, and surface change detection. Innovations include fully polarimetric imaging capabilities and a wide variety of beam modes for adaptable resolution and coverage, along with left- and right-looking options to enhance revisit frequency.

Owner / operator:

- MDA Space Ltd. (Canada): Primary owner and operator, responsible for development, operations, and commercial data distribution.
- Canadian Space Agency (CSA): Provides funding through a public-private partnership.

Constellation:

- Planned: 1 satellite.
- Launched: 1 satellite (December 2007).
- Upcoming: None.
- Revisit time: 24-day cycle (up to 12 days or less with left/right looking).
- Status: Fully operational.

Satellite technical characteristics:

- Mass: ~2200 kg.
- Single, dual, or quad polarization options (HH, VV, HV, VH).

Modalities:

Mode	Resolution	Scene / Swath size
Spotlight	~1 m × 3 m	18 km × 8 km
Ultra-Fine	3 m	20 km × 20 km
Multi-Look Fine	~8 m × 8 m	50 km × 50 km
Fine	~8 m	50 km
Standard	~25 m	100 km
ScanSAR Narrow	50 m	300 km
ScanSAR Wide	100 m	500 km

Platform & Archive:

- Ground segment: Mission Operations Centre (MDA, St. Hubert).
- Archive: accessible via MDA online portal. No public API.

Tasking capabilities:

- Left/right looking, incidence angles 20°–49°.
- Delivery timeline: Standard near real-time; supports emergency acquisitions.

Sources:
https://www.eoportal.org/satellite-missions/radarsat-2
https://mda.space/earth-and-space-observation
https://www.d-copernicus.de/daten/satelliten/satelliten-details/news/radarsat-2/
https://radarsat2.info/about/faq/faq_sat.aspx

3.3.6 TerraSAR-X and TanDEM-X

TerraSAR-X and TanDEM-X form a dual-use X-band SAR constellation providing VHR radar imagery applications in environmental monitoring, topographic change detection, infrastructure assessment, and geo-intelligence in civil security contexts. The mission sets itself apart as the first configurable SAR interferometer in space, utilizing twin satellites in close formation for simultaneous bistatic acquisitions. Innovations include the creation of a homogeneous global DEM with vertical accuracy better than 1-2 meters and ongoing change detection capabilities.

Owner / operator:

- German Aerospace Centre (DLR): Primary owner and operator, on behalf of the Federal Ministry for Economic Affairs and Climate Action (BMWK).
- Airbus Defence and Space: Partner in public-private collaboration for satellite manufacturing, cost-sharing, and commercial data distribution.

Constellation:

- Planned: 2 satellites.
- Launched: 2 satellites (TerraSAR-X: June 2007; TanDEM-X: June 2010).
- Revisit time: 11-day orbit repeat cycle (average ~24 hours with agility).
- Status: Fully operational.

Satellites technical characteristics:

- Mass: ~1230-1330 kg.
- Single, dual, or quad polarization options (HH, VV, HV, VH; quad in experimental mode); supports interferometry.
- Acquisition modes: Phased-array beam steering for flexible imaging; bistatic configuration for DEM generation.

Mode	Resolution (range × azimuth)	Scene / Swath size
Staring Spotlight (ST)	≤0.25 m	4 km × 3.7 km
High Resolution Spotlight (HS)	≤1 m	5-10 km × 5 km
Spotlight (SL)	≤2 m	10 km × 10 km
StripMap (SM)	≤3 m	30 km × 50 km
ScanSAR (SC)	≤18 m	100 km × 150 km
Wide ScanSAR (WS)	≤40 m	270 km × 200 km

Platform & Archive:

- Ground segment: Mission control at German Space Operations Centre (Oberpfaffenhofen).
- API access through Airbus OneAtlas. Archive and tasking.

Tasking capabilities:

- Left/right looking, incidence angles 15°–60°.
- Delivery timeline: Standard <24 hours.

Sources :
https://earth.esa.int/eogateway/missions/terrasar-x-and-tandem-x
https://www.dlr.de/de/forschung-und-transfer/projekte-und-missionen/tandem-x
https://www.eoportal.org/satellite-missions/terrasar-x
https://airbusus.com/wp-content/uploads/2020/06/r459_9_20171004_tsxx-airbusds-ma-0009_tsx-productguide_i2.01.pdf
https://tandemx-science.dlr.de/pdfs/TX-GS-DD-3302_Basic-Products-Specification-Document_V1.9.pdf
https://apollomapping.com/blog/terrasar-x-imagery-now-available-in-image-hunter

3.4 Thermal mission in detail

3.4.1 HotSat

HotSat is a thermal imaging constellation specializing in mid-wave infrared (MWIR) data to monitor heat emissions, supporting applications in disaster response, and civil security (e.g. movement tracking). Innovations include VHR MIR imaging for high-performance thermal sensing.

Owner / operator:

- SatVu (United Kingdom): Developer and operator of the thermal constellation.

Constellation:

- Number of satellites planned: up to 7.
- Launched: 1 (HotSat-1: June 2023).
- Failed: 1 ((HotSat-1: December 2023)
- Next launches: HotSat-2 and HotSat-3 expected in 2026.

Satellite(s) technical characteristics:

- MWIR thermal imager (~3-5 µm).
- Spatial resolution: 3.5 m at nadir.
- Swath width: 4.5 km.
- Weight: ~130 kg.

Band(s):

- Sensor bandwidth: 3.7-5 µm.
- Daytime bandwidth: 4.5-5 µm (filtered to reduce solar radiation noise).

Platform, Archive:

- Platform: Self-service online platform.
- Archive: Historical imagery from June to December 2023.
- Current no public API.

Tasking capabilities:

- Not specified.

Sources:
https://earth.esa.int/eogateway/missions/hotsat-1
https://www.satellitevu.com/
https://space.skyrocket.de/doc_sdat/hotsat-1.htm

3.5 Micro- and pico-satellite missions (reference to D7.1)

This Deliverable D6.1 investigates the EU VHR EO capabilities, as defined above. Another one of the THEIA deliverables, namely D7.1, is investigating micro- and pico-satellites, but with a broader scope. This results in an overlap of missions within the scope of both deliverables D6.1 and D7.1. To prevent confusion and duplication of effort for authors and readers, the overlapping missions were split between deliverables D6.1 and D7.1. The split is performed following these simple rules:

- Micro- and pico-satellites (gross weight below 130 kg) are described in detail in D7.1,
- Except if they explicitly meet the criteria of D6.1, e.g. thermal or video-capable sensors. In this case they are described in D6.1.

This means that this deliverable D6.1 describes four microsatellites, namely:

- HotSat (SatVu, UK, thermal)
- GARAI (GEOSAT, Portugal, video-capable)
- SkySat (Planet Labs, U.S., video-capable)
- NEMO-HD (SPACE-SI, Slovenia, video-capable)

For other micro-satellites, including Axis 1.2, Axis 2, Balkan-1, GEISAT Precursor, ICEYE, Plantescope, and Promethée-1, the reader is referred to deliverable D7.1.

3.6 Decommissioned satellites

Although no longer operational, decommissioned VHR CCM missions like IKONOS-2, QuickBird-2, and WorldView-4 offer extensive archives of high-quality imagery suitable for non-real-time applications such as software development, machine learning model training, algorithm testing, and project demonstrations. These datasets provide historical baselines for change detection, and simulation scenarios, with global coverage accumulated over years of operation. Archives are accessible through providers like ESA's Third Party Missions or commercial portals.

3.6.1 IKONOS-2

IKONOS-2 was a pioneering commercial VHR optical satellite delivering panchromatic and multispectral imagery for environmental monitoring, resource management, and land surface analysis. It set itself apart as the first commercial satellite to offer 1-meter resolution imagery to non-military users. Owner / operator: Vantor (U.S., formerly DigitalGlobe)
Constellation: Single satellite; launched 24 September 1999; decommissioned March 2015.
Satellite technical characteristics: Mass ~817 kg; swath width 11-13 km at nadir; acquisition modes include pushbroom scanning with ±30° off-nadir pointing, mono/stereo along-track.
Bands: Panchromatic (0.82 m resolution at nadir); Multispectral: Blue, Green, Red, NIR at 3.28 m resolution.

3.6.2 QuickBird-2

QuickBird-2 provided VHR panchromatic and multispectral optical imagery for land use analysis, agriculture, forestry, and change detection. It distinguished itself as the highest-resolution commercial satellite at launch, introducing sub-meter detail for broad civil applications. Operator: Vantor (U.S.).
Constellation: Single satellite; launched October 2001; decommissioned 27 January 2015.
Satellite technical characteristics: Mass ~950 kg; swath width 16.5 km at nadir; acquisition modes include snapshot (16.5 km x 16.5 km), stripmap (up to 225 km), area mosaics, stereo along-track; ±30° pointing.
Bands: Panchromatic (0.61 m resolution at nadir); Multispectral: Blue, Green, Red, NIR at 2.4 m resolution.

3.6.3 WorldView-4

WorldView-4 delivered VHR panchromatic and multispectral imagery for mapping, environmental monitoring, and intelligence analysis. It stood out for large-area synoptic collection. Operator: Vantor (U.S.).
Constellation: Single satellite; launched 11 November 2016; decommissioned 7 January 2019 due to gyro failure.
Satellite technical characteristics: Mass ~2087 kg; swath width 13.1 km at nadir; acquisition modes include pushbroom scanning, bi-directional, mono/stereo; agile ±40° off-nadir.
Bands: Panchromatic (0.31 m resolution at nadir); Multispectral: Blue Green, Red, NIR at 1.24 m resolution.

3.7 Video-capable missions in detail

This chapter examines technical characteristics of satellite-based video imaging through representative EU missions **NEMO-HD** and **Garai,** Copernicus contributing mission **SkySat,** and for reference also the Chinese constellation **Jilin-1.** Additional past and planned missions are mentioned in the conclusion.

3.7.1 NEMO-HD

NEMO-HD is Slovenian microsatellite mission for multispectral (VNIR) imaging and RGB video acquisition from space. It has two cameras, high and low resolution (HR, LR), that can simultaneously acquire multispectral and/or video products and provide micro-macro view of the area of interest. Acquired images and videos are tipically stored onboard and transfered to the ground station during the next contacts with the ground station. In addition, when in contact with the ground station, live videos (HR, LR) can be downstreamed in real time (not applicable for still images). With advanced guidance, navigation and control systems it can non-linear tracks on ground (imaging along rivers, roads, coastline, borderline) as well as maintain a prescribed orientation towards a selected scene on Earth for several minutes (video acquisition).
The main purpose of the multispectral images is to monitor the environmental parameters of the river basins, while the video is used primarily to capture areas of high economic activity, such as ports, marinas, airports, and mines to monitor land, sea, river and air traffic – it enables the evaluation of environmental impacts and indicators for assessing economic recovery.

Owner / operator:

- SPACE-SI (Slovenia) – owner and operator.

Constellation:

- Planned: 1 satellite.
- Launched: 1 satellite (3 September 2020).
- Upcoming: None.
- Revisit time: few days – depends on latitude and observation angle (max. 40° off-nadir).
- Status: Fully operational.

Satellite(s) technical characteristics:

- Mass: 60 kg.
- Swath width at nadir: 10 km (MS, PAN), 5 km (HR-HD), 70 km (LR-HD).
- Video frame size on ground: 3 km x 5 km at nadir (HR-HD), 40 km x 70 km (LR-HD).
- Acquisition modes: strip mode in nadir or off-nadir, area scanning mode, non-linear path tracking, target pointing/multi-angle mode.
- Payloads: HR still camera (Pan, MS), HR-HD video camera, LR-HD video camera.

Sources :
https://www.space.si/en/microsatellite/
https://www.eoportal.org/satellite-missions/nemo-hd#nemo-hd-nanosatellite-for-earth-monitoring-and-observation--high-definition

Band name	Wavelength (nm)	Resolution @ nadir (m)
Panchromatic	400-900	2.8
Blue	420-520	5.6
Green	535-607	5.6
Red	634-686	5.6
Near Infrared	750-950	5.6
HR-HD video	RGB	2.8
LR-HD video	RGB	40.0

Platform & Archive:

- Ground segment: own ground station and mission planning centre in Slovenia.
- Data available upon request to SPACE-SI.

Tasking capabilities:

- Agile pointing with ±40° off-nadir.
- Tasking possible upon request to SPACE-SI.
- Delivery timeline: Standard <24 h (more in case of full capacities).

Sources :
https://www.space.si/en/microsatellite/
https://www.eoportal.org/satellite-missions/nemo-hd#nemo-hd-nanosatellite-for-earth-monitoring-and-observation--high-definition

3.7.2 SkySat

SkySat, operated by Planet, is a high-resolution constellation of 15 satellites, able to image revisit any location on Earth up to 10x daily (a daily collection capacity of 4,000 km^2/day). SkySat supports the Planet high resolution tasking, which allows you to choose when and where to capture SkySat imagery. SkySat produces 4-band and panchromatic imagery and is sampled at 50 centimetres per pixel when orthorectified.

Owner / operator:

- Planet Labs (USA) – owner and operator.

Constellation:

- Operational 15 satellites.
- Launched: 21 satellites (2013–2020).
- Upcoming: None.
- Revisit time: up to 10x daily.
- Status: Fully operational.

Satellite(s) technical characteristics:

- Mass: ~110 kg.
- Swath width at nadir: 8 km (SkySat-1-2), 5.9 km (SkySat-3-15), 5.5 km (SkySat-16-21).
- Video frame size on ground: 1 km x 2.5 km.
- Acquisition modes: mono collection (pushframe), triplet stereo collection (+/-27° off-nadir), target pointing.
- Payloads: HR still camera (Pan, MS), HR-HD video camera, LR-HD video camera.

Band name	Wavelength (nm)	Resolution @ nadir (m)
Panchromatic	450-900	0.5
Blue	450-515	0.7
Green	5135-595	0.7
Red	605-695	0.7
Near Infrared	740-900	0.7
Video	Panchromatic	0.9

Platform & Archive:

- API access via Planet for archive and tasking.

Tasking capabilities:

- Through Planet Account.
- Delivery timeline: 1–2 hours under normal conditions.

Sources:
https://docs.planet.com/data/imagery/skysat/
https://www.eoportal.org/satellite-missions/skysat
https://www.sciencedirect.com/science/article/pii/S0924271620303506
https://docs.planet.com/platform/get-started/access-data/task-imagery/

3.7.3 Garai

GARAI mission is formed by two EO microsatellites with submeter resolution: GARAI-A (2025) and GARAI-B (2026). This mission is a precursor for the dual use **Atlantic Constellation**.

GARAI satellites carry two dual channel instruments (iSIM) with MS, NIR and SWIR, polarimetry, and video capabilities. Main applications are oriented to fire surveillance and prevention, coastal waters pollution control, agriculture disaster monitoring.

Owner / operator:

- Iberian Space Partnership (Satlantis, Ceiia, Geosat) (Spain/Portugal.

Constellation:

- Operational: 1 satellite (GARAI-A).
- Launched: 1 satellite (2025).
- Upcoming: 1 (GARAI-B in 2026) - forerunners of Atlantic Constellation (dual use).
- Revisit time: several days.
- Status: Commissioning.

Satellite(s) technical characteristics:

- Mass: ~110 kg.
- Swath width at nadir: 7.5 km (VNIR), 13 km (SWIR).
- Video frame size on ground: 7.5 km x 5.6 km (estimated).
- Acquisition modes: strip mode in nadir and off nadir, forward motion compensation, non-linear path racking, multi-angle, target pointing (video).
- Payloads: iSIM-170 (VNIR, PAN, video), iSIM-90 (SWIR, polarimetry).

Band name	Wavelength (nm)	Resolution @ nadir (m)	Band name	Wavelength (nm)	Resolution @ nadir (m)
Panchromatic	450-900	1.0	VIS Polarimetry	450-900	3.5
VNIR-1 (Blue)	450-510	1.0	SWIR-1	1100-1300	6.5
VNIR-2 (Green)	510-580	1.0	SWIR-2	1300-1500	6.5
VNIR-3 (Red)	620-690	1.0	SWIR-3	1500-1700	6.5
VNIR-4 (Red Edge)	700-740	1.0	SWIR-4	1700-2000	9
VNIR-5 (Near IR)	760-900	1.0	SWIR-5	2000-2300	9
VNIR-6	400-450	2	Video	Panchromatic	1.0
VNIR-7	900-1000	2			

Platform & Archive:

- Tasking possible upon request to GEOSAT.

Tasking capabilities:

- Agile pointing with ±30° off-nadir.

Sources :
https://www.satlantis.com/garai-missions/
https://www.eoportal.org/satellite-missions/garai
https://digitalcommons.usu.edu/cgi/viewcontent.cgi?article=6429&context=smallsat

3.7.4 Jilin constellation (for reference)

Jilin-1 is China's first commercial remote sensing satellite system. The satellites are operated by Chang Guang Satellite Technology Corporation (CGSTL) and named after Jilin Province where the company is headquartered. The first phase of the Jilin-1 constellation project consists of 138 high-performance optical remote sensing satellites covering video, high resolution, wide band, infrared, multispectral and other series. According to CGST web site, up to now, Jilin-1 satellite constellation has 117 (72 remote sensing satellites) in orbit satellites and has built the world's largest sub meter commercial remote sensing satellite constellation. As the largest remote sensing satellite constellation in China, it can revisit any point on the globe 38-40 times a day, with the ability for global coverage six times a year and nationwide coverage once every half-month. SpaceTracks Satellite Catalog, on the other hand, contains only 43 Jilin-1 satellites, 3 of them are reported decayed in 2025.

Owner / operator:

- Chang Guang Satellite Technology Corporation (China) – owner and operator.

Constellation:

- Operational 72 remote sensing satellites (117 all together).
- Launched: 73 (or more) satellites (2015-2025).
- Upcoming: 65 (by 2030).
- Revisit time: < daily (10 min revisit time expected for complete constellation).
- Status: Fully operational.

Satellite(s) technical characteristics:

- Mass: <50 kg.
- Swath width at nadir: 17 km (different for different sensors).
- Video frame size on ground: 2 km x 4 km, 1 m GSD (up to 120s).
- Acquisition modes: different for different satellites and sensors.
- Payloads: different for different satellites.

Platform & Archive:

- Contact provider.

Tasking capabilities:

- Contact provider.
- Delivery timeline: information not found.

Sources :
https://www.jl1global.com/
https://www.eoportal.org/satellite-missions/jilin-con
https://www.jl1global.com/products/satellites-data/

3.7.5 Other video missions and outlook

The satellites presented in this chapter—**NEMO-HD, SkySat, Garai, and Jilin-1** —highlight the current state of spaceborne video imaging. By combining high-resolution optics, agile satellite platforms, and advanced onboard processing, these systems have expanded Earth observation from static snapshots to dynamic, continuous video capture. Their applications in environmental monitoring, disaster response, urban activity analysis, and maritime situational awareness underscore the growing value of real-time and near-real-time video data from orbit.

Recent industry developments point to an even broader shift in how video data is collected and delivered. **Orora Tech**'s announcement that it will stream live thermal video from satellites in the Kepler constellation signals a move toward real-time delivery of space-sourced video to end users, reducing latency and enabling near-instantaneous insights for monitoring and decision-making. Relayed by their fast optical comms network, OroraTech's thermal insights, computed on-orbit, will be provided to customers on the ground as persistent, real-time infrared data from orbit, enabling fast wildfire detections and thermal data.

An important breakthrough in satellite video capabilities is the collection of **SAR video by the ICEYE** constellation. The satellites operate in different observation modes. In dwell mode, the satellite continuously points at the same target, while the acquisition time is divided into multiple individual sub-apertures. Each discrete sub-aperture is used as a frame of a video sequence. ICEYE satellites enable the collection of approximately 25-second-long SAR video sequences over a 5 km × 5 km scene, with a ground resolution of up to 0.25 m. In addition to detecting moving objects, SAR video is also effective for identifying objects concealed in forested areas, as well as human-made objects, which often produce strong radar reflections and appear as glints when the video is played. The main advantage of SAR video compared to optical video is that it is independent of lighting and weather conditions. The ICEYE constellation is described in more detail in Deliverable D7.1, Chapter 3.2.3.2.

Complementing dedicated Earth-observation platforms, planned **HotSat** constellation by SatVu (presented in chapter 3.2.6) brings thermal-infrared video imaging into the fold for monitoring heat-based phenomena. Not VHR but worth mentioning in the context of video capable satellite missions are also **EarthTV-1** (ETV-A1) by British company Sen, that was launched in 2022 (10m GSD) and **Sen's video operations from the International Space Station**, which leverages the ISS's unique orbital trajectory to yield continuous, global perspectives. Earth-TV was planned as a constellation of 5 16U cubesats for real-time and timely video of Earth but was cancelled after the launch of the first satellite. Vivid-I is another video satellite constellation that was cancelled after the launch of the prototype satellite **Vivid-X2/Carbonate-2** in 2018 (1m GSD, decommissioned).

Taken together, these developments mark a paradigm shift in satellite imaging: from periodic image capture toward persistent, streamed video across multiple spectral bands and platforms. As video-capable satellites proliferate and data streams become more accessible, space-based observation is becoming continuously connected, context-rich, and increasingly integral to real-world applications on a global scale.

https://ororatech.com/resources/news-blog/ororatech-and-kepler-to-launch-world-s-first-thermal-livestream-of-earth
https://sar.iceye.com/5.2.7/productguide/typesofsarcollection/
https://about.sen.com/#blank
https://earthi.space/vivid-i/



Figure 3-1 NEMO-HD HR video frame of Heathrow airport in London, United Kingdom.



Figure 3-2 NEMO-HD HR video frame of Instanbul, Turkey, demonstrating the possibilities of video analytics.



Figure 3-3 NEMO-HD LR and HR video frames of Venice, Italy, demonstrating simultaneous micro-macro view of the area of interest.

Examples of videos captured by the above-mentioned missions can be seen at the following links:

Table 6 - Satellite video sample references.

NEMO-HD	https://www.space.si/mikrosatelit/nemo-hd-dosezki-v-prvem-letu-od-izstrelitve/
SkySat	https://www.youtube.com/watch?v=WSj0XFfu6Kg
Garai	Commissioning
Jilin-1	https://www.youtube.com/watch?v=1oImyDmSKG8
OroraTech	Commissioning
HotSat	https://www.youtube.com/watch?v=NedeCNIP8Ww
ICEYE SAR video	https://sar.iceye.com/5.2.7/productFormats/vid/
EarthTV	https://www.sen.com/video/110e3b0c-1e2f-43a3-8c29-486bb9ab8c28
Live stream from ISS	https://www.sen.com/video/48b728ea-3e0d-4203-84d3-0a5caa2dfdfa
Vivid-X2/Carbonate-2	https://earthi.space/vivid-i/

3.8 Mission Outlook

Here, we explore selected EO missions that extend beyond the currently intended operational framework of THEIA. For example future EU satellite assets and out-of-scope missions that could provide auxiliary data for THEIA.

3.8.1 EnMAP

EnMAP (Environmental Mapping and Analysis Program), a German hyperspectral mission, operates in the visible to shortwave infrared (VNIR-SWIR) spectrum, capturing 242 contiguous bands from 420-2450 nm with 30 m spatial resolution and a 30 km swath width.
For THEIA, EnMAP's hyperspectral data holds potential in monitoring environmental stressors in displacement zones, such as vegetation degradation or soil erosion that could exacerbate crises. It could support wildfire risk assessment through pre-fire vegetation analysis or infrastructure monitoring by identifying material changes.

3.8.2 PRISMA

PRISMA (PRecursore IperSpettrale della Missione Applicativa), an Italian hyperspectral mission captures data across 237 contiguous spectral bands in the VNIR and SWIR ranges (400-2500 nm), with a 30 m spatial resolution and 30 km swath width. This enables precise chemical-physical analysis of Earth's surface, including material composition, vegetation parameters, and environmental indicators. For THEIA, PRISMA's hyperspectral data offers potential in monitoring environmental degradation in displacement zones, such as soil contamination or vegetation stress that could signal emerging crises, supporting GeoAI for predictive analytics in humanitarian scenarios.

3.8.3 HiVe – ConstellR

ConstellR's HiVE (High-precision Versatile Ecosphere) microsatellite constellation specializes in thermal infrared (TIR) imaging, capturing long-wave infrared (LWIR) emissions to monitor land surface temperatures with a focus on global environmental and agricultural applications. It features a 30-meter spatial resolution and a 21 km swath width.
In context of THEIA, HiVE's spatial resolution is insufficient for application in e.g. object detection. However, HiVe's capabilities offer potential e.g. in detecting and tracking wildfires by identifying thermal anomalies in near-real-time, enabling rapid response to fire outbreaks in displacement-prone regions. Additionally, it supports infrastructure use monitoring by revealing operational heat patterns in critical assets, aiding security assessments during crises. Further details on HiVE can be found in deliverable D7.1.

Sources :
https://www.eoportal.org/satellite-missions/enmap
https://www.enmap.org/data/doc/Web_Flyer_EnMap_2022_10_eng.pdf
https://earthdaily.com/blog/hyperspectral-imaging-for-mining-enmap-satellite-data-versus-spectir-airborne-data
https://www.eoportal.org/satellite-missions/prisma-hyperspectral
https://www.rapidresponse.copernicus.eu/app_content/uploads/CCM_HiVE-constellation_infographic_DP.pdf
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4 Mission suitability for THEIA use cases

The primary use of VHR EO imagery in THEIA is for the detection, identification, and tracking of objects such as vessels, vehicles, and temporary settlements. The challenge to determine, which of the available VHR EO mission is most suitable for the THEIA use cases is part of task T6.3 and will therefore not be discussed in this deliverable.

However, in context of this deliverable D6.1, it appears reasonable to evaluate if the included EU VHR EO missions broadly cover the needs of THEIA. The most crucial parameter in this regard is spatial resolution. In this chapter we apply a popular "rule of thumb" known as "Johnson Criteria"*. It is commonly used to estimate which minimum spatial resolution is required to detect or identify an object of certain dimensions in an image by a human observer. Of interest here are:

- The "recognition" of an objects class (i.e. vehicle, vessel, tent, …) requires a pixel size 8±2 times smaller than the object dimensions.
- The "identification" of an objects requires a pixel size 13±3 times smaller than the object dimensions.

Below, the range of dimensions of the objects of interests in THEIA are presented. The minimum ground sampling distances (GSD) according to the Johnson criteria are stated for each. Cases in which die GSD is below the best available GSD included in this deliverable (0.25 m) are marked in red.

Table 7 - Assessing Minimum Spatial Resolution Requirements for Object Recognition and Identification in THEIA Using Johnson Criteria

Class	Example Object	Dimension Length / width [m]	Recognition min. GSD [m]		Identification min. GSD [m]	
Vessel	Small boat	10	1.3	±0.3	0.8	±0.3
		3	0.4	±0.1	0.23	±0.09
	Large trawler	40	5	±1	3	±1
		10	1.3	±0.3	0.8	±0.3
Vehicle	Small car	4	0.5	±0.1	0.3	±0.1
		2	0.25	±0.06	0.15	±0.06
	Large truck	18	2.3	±0.6	1.4	±0.5
		2.6	0.33	±0.08	0.20	±0.08
Tent	Small tent	2.5	0.31	±0.08		
		1.5	0.19	±0.05		
	Large tent	6	0.8	±0.2		
		4	0.5	±0.1		

Sources :

* https://www.osti.gov/servlets/purl/1222446

From the above table it becomes apparent, that the recognition of vessels and vehicles of all sizes intended in THEIA are covered by the missions described in this deliverable. The identification of the smallest vessels and vehicles may however be challenging due to their assumed width of 2 m (marked in yellow). The recognition of most tents should also be feasible in principle, whereas very small tents may be challenging due to their widths of only 1.5 m (marked in red). As tents are stationary, the identification task is not considered.

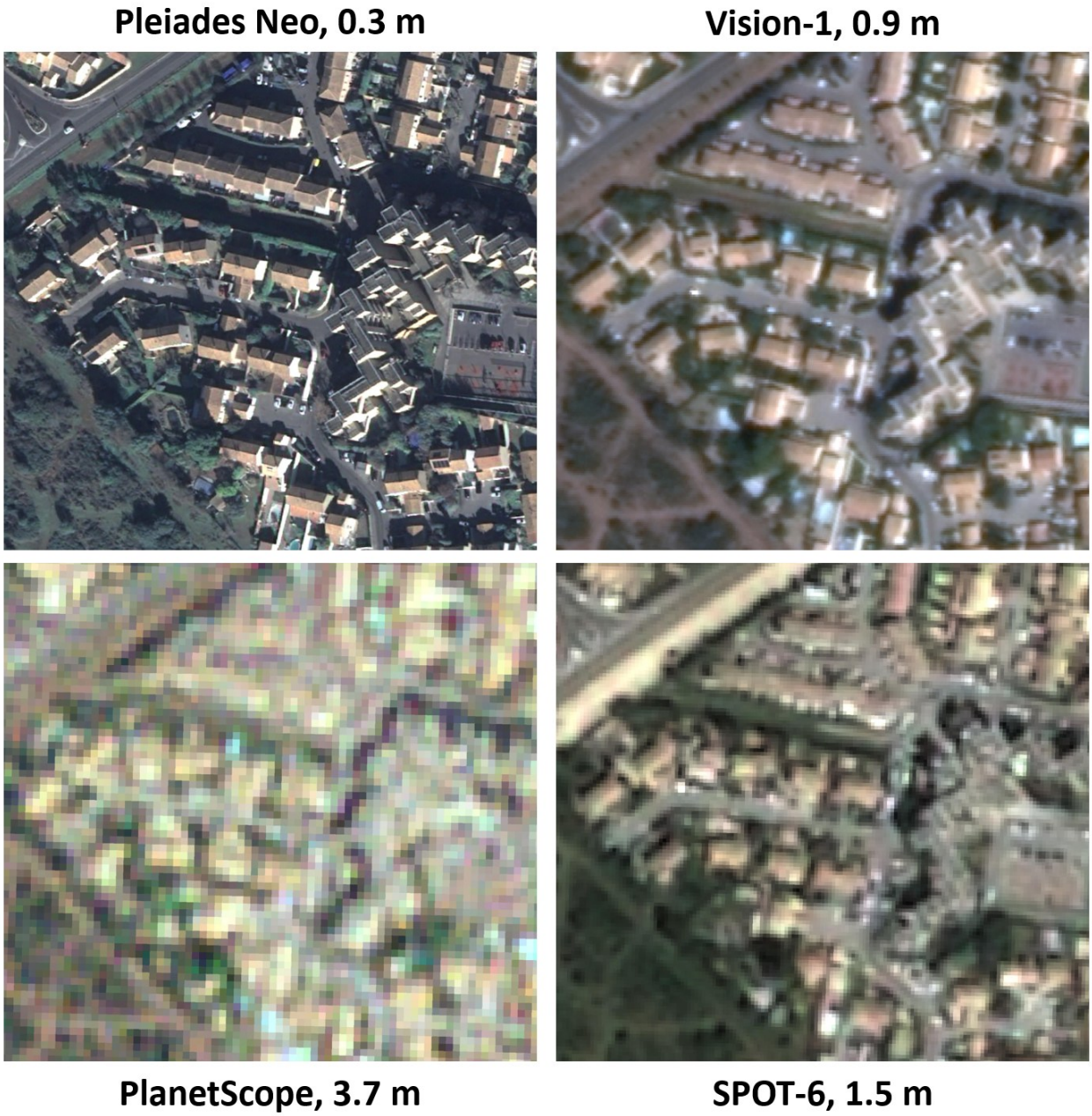


*Figure 4-1 - Comparison of VHR EO image samples of different spatial resolutions. Source: ESA**

Sources :

* https://earth.esa.int/eogateway/news/sample-data-products-from-esas-third-party-missions

Figure 1 showcases optical image samples from four EU VHR EO assets. The reader is invited to test the Johnson criteria by searching for cars in each frame. In which of the GSD levels would you feel confident to recognize cars? Would e.g. the 0.3 m GSD image allow you to identify a car so you could find it again if it changed its location?

Concluding, it can be said that the proposed resolution classes VHR!/VHR2 (<4 m,) are a very fitting choice for the applications of THEIA, because even for the recognition of the largest object of interest (a 40x10 m trawler), a GSD of 1.3±0.3 m is advisable. This falls into the resolution class VHR2 (1-4m). For the identification of a small car (4x2 m), the proposed minimum GSD of 15±6 cm (VHR1a, <50cm) is indeed not covered by current EU EO assets. This emphasizes the necessity for THEIA and similar future projects to stay open for upcoming technological advances.

Sources :

* https://earth.esa.int/eogateway/news/sample-data-products-from-esas-third-party-missions

5 Conclusion

This deliverable D6.1 has provided a comprehensive assessment of VHR EO capabilities from EU, EU-national, and CCMs, encompassing optical, thermal, SAR, and space-based video systems. By systematically inventorying current and near-term upcoming assets, defining THEIA-specific suitability criteria, it demonstrates a robust foundation for addressing crisis management challenges in forced population displacement. The analysis reveals that existing missions broadly meet THEIA's needs for object detection and tracking, with resolutions down to 0.25 m enabling recognition of key assets like vessels, vehicles, and tents. Video-capable microsatellites, such as NEMO-HD, offer complementary dynamic monitoring, enhancing real-time insights in addition to static imagery.

These findings underscore the potential of diverse EO data for GeoAI-driven decision-making with suitable timeliness and accuracy in humanitarian responses. The evaluated missions align well with THEIA's goals of EU independence and technological integration. Moving forward, the outputs will inform mission selection in Task T6.3 and support seamless incorporation into THEIA's framework, paving the way for enhanced Copernicus Security Services.

ANNEX I
See attached table.

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