SENTINEL-1 Mission Status

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Sentinel-1: Mission Profile

Copernicus radar imaging mission for ocean, land, emergency

- Part of the Copernicus Programme led by the European Union
- Mission based on 2 identical satellite units (S1A & S1B) and a highly performing ground segment
- Main satellites characteristics:
  - C-band Radar instrument
  - Instrument duty cycle of 25min/orbit in HBR modes and 75min/orbit in LBR
  - Sun-synchronous orbit at 693 km altitude
  - Inclination: 98.18°
  - 7 years lifetime; Consumables for 12 years
  - Mean LST: 18:00h at ascending node
  - 12-day repeat cycle at Equator (6 days with 2 satellites)
- Instrument operations based on a predefined observation scenario
- Systematic data processing with open & free data access
- Gradual increase of the mission operational capacity from the S1A launch up to the mission constellation routine operations
S1B Data flow opened to all users worldwide on 26 September 2016

S1B satellite commissioning phase completed on 14 September 2016

S1B launched on 25 April 2016 on Soyuz from Kourou

Start of operational S1A data delivery to Copernicus Marine service

S1A Data flow opened to all users worldwide on 3rd October 2014

S1A Nominal orbit reached on 7 August 2014

S1A satellite commissioning phase completed on 23 September 2014

S1A operational qualification

1st S1A-EDRS link and 1st S1A EDRS products on 31 May 2016

S1 Mission Operations Qualification

S1 Mission Routine Operations

Start of EDRS use with S1A on 23 Nov 2016

1st S1A
ROR
9 June 2015

S1B
 Products
operationally
qualified

S1A Launch
3 April
2014

S1A IOCR
Sep
2014

1st S1A
ROR
9 June
2015

S1B
 Launch
25 April
2016

S1 B
 IOCR
Sep
2016

S1B Products operationally qualified

S1B Space Segment Commissioning

S1 Mission Routine Operations

S1 Mission ROR ~ Q2 2017

14 Mar 2017
Sentinel-1 mission status

- **Sentinel-1 nominal routine operations continue**
  - Sentinel-1B core products distributed to all users since end September 2016
  - Data routinely provided to Copernicus Services
  - On-going support to various activations from the Copernicus Emergency Management Service and International Charter Space and Major Disasters
  - EDRS-A start of services to Sentinel-1A on 23 November 2016, focusing on end-to-end operational service validation. Use of EDRS service being progressively increased as part of routine operations

- **Sentinel-1 constellation currently generates nearly 10 TB of products daily** (against a formal specification of 3 TB)
  - Expected to be further increased with the use of EDRS for Sentinel-1B and the 4th core X-band station

- **Upcoming Milestones**
  - Start of gradual increase of Quasi Real Time observations
  - Sentinel-1 Constellation Mission Operations Review: May 2017
Sentinel-1 observation scenario
Main components & thematic domains

- Agriculture
- European coverage
- Forestry
- Calibration/validation
- Maritime surveillance
- Global land mapping
- Emergency
- Tectonic active areas and volcanoes / landslides and subsidence
- Security
- Sea state
- Sea-ice, icebergs, lake-ice
- Ice sheets, glaciers, permafrost and snow
- PR actions (infrequent)
Sentinel-1 observation scenario main objective is to establish a predefined stable conflict free observation plan.

### Sentinel-1 SAR Operational Modes

<table>
<thead>
<tr>
<th>Operational Modes</th>
<th>GRD Level 1 product resolution</th>
<th>Swath Width</th>
<th>Polarisation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>50m (3 ENL)</td>
<td>&gt; 400 km</td>
<td>HH+HV or VV+VH</td>
</tr>
<tr>
<td></td>
<td>20m (5 ENL)</td>
<td>&gt; 250 km</td>
<td>HH+HV or VV+VH</td>
</tr>
<tr>
<td></td>
<td>9m (4 ENL)</td>
<td>&gt; 80 km</td>
<td>HH+HV or VV+VH</td>
</tr>
<tr>
<td></td>
<td>50m (140 ENL)</td>
<td>20 x 20 km² at 100 km spacing</td>
<td>HH or VV</td>
</tr>
</tbody>
</table>

Main mode over land and coastal areas.
The use of Sentinel-1B, similarly to Sentinel-1A, allows to increase the observations volume by a factor 2 overall.

Sentinel-1 constellation observation scenario considered already very stable.

Allows the user community to define own activities with stable observation patterns.
- Increase of revisiting frequency for operational monitoring services, in particular Copernicus marine environment service and maritime surveillance services

- **European coverage increase by a factor 2**, ie 6-day cycle in both ascending and descending, in IW dual-polarisation VV+VH

- **Interferometry every 6 days for relevant areas** and applications, for instance:
  - for fast moving glaciers (Greenland margins and “supersites” in Antarctica)
  - areas subject to large subsidence

- **Increase of global land mapping frequency** for land cover applications in particular, that require short revisit time
  ➔ **Full mapping of global land areas every 12 days at least** (except Antarctica and Greenland, subject to specific campaigns), with a combined use of S1A and S1B
Sentinel-1 Constellation Observation Scenario:
Mode - Polarisation - Observation Geometry

POLARISATION SCHEMA
- HH or HH-HV
- VV or VV-VH
- HH or HH-HV

MODE / POLARISATION
- IW mode / dual polarisation
- IW mode / single polarisation
- EW mode / dual polarisation
- EW mode / single polarisation

PASS
- ASCENDING
- DESCENDING

SM mode / dual-polarisation
SM mode / single-polarisation

Calibration Site
(locally different modes or polarisations possible)
KML files providing detailed information on the planned acquisitions regularly published on Sentinel Online

https://sentinels.copernicus.eu/web/sentinel/missions/sentinel-1/observation-scenario/acquisition-segments
All Sentinels acquired data are systematically downlinked and processed to generate the core products within 24 hours from sensing:
- L0 products
- L1 GRD
- L1 SLC (initially over selected regional areas, since July 2015 over all land masses)
64,700 self-registered unique users
(status 23 February 2017)

ESA missions data users

Sentinels missions data users
Welcome to the Copernicus Open Access Hub

The Copernicus Open Access Hub (previously known as Sentinels Scientific Data Hub) provides complete, free and open access to Sentinel-1, Sentinel-2 and Sentinel-3 user products, starting from the In-Orbit Commissioning Review (IOCR).

- Open Hub
- API Hub
- S-3 PreOpsHub
- User Guide
- Roadmap
The Copernicus Sentinel data policy ensures **open and free on-line access to Sentinel-1 products**, stimulating SAR based applications in the operational and scientific domains, providing equal opportunities to all users and facilitating the undertaking of new value-added activities.

- Access through self-registration
- Automated download scripting capability and dedicated API-Hub
- Restriction on concurrent downloads

Today, more than 1 Million Sentinel-1 products are available on-line for download, representing more than 1 PB of data.

The complete mission archive has been downloaded more than 7 times.
Sentinel-1 related documentation and technical notes are available.
Weekly Mission Status Reports published online
(145 reports issued since S1A launch)

https://sentinel.esa.int/web/sentinel/missions/sentinel-1/mission-status

Mission Status Report 1
Reference Period: 3 April - 7 April 2014

Mission Status
- Sentinel-1A was successfully launched from Kourou on 3 April 2014, 21:02 UTC.
- The Launch and Early Orbit Phase (LEOP) was successfully performed according to the planned timeline and declared closed on 6 April at 10:00 UTC.
- The commissioning phase has started.

Satellite
The LEOP covered the main following key activities:
- Deployments of the solar panels (including, rotation) and of the Synthetic Aperture Radar (SAR) antenna.
- Achievement of the S1A Nominal Mode and ACCS Nominal Pointing Mode.
- Switch on and initial checks of the spacecraft sub-systems.
- First operations of the X-band Transmitter and the SAR instrument (3 min of X-band mode).

In addition, a collision avoidance manoeuvre was performed on 5 April.

Ground Segment
- The Flight Operations Segment performed nominal during the complete 3 days of LEOP.
- First X-band data acquisition took place at the Matora ground station on 5 April, early morning.
- First SAR instrument data acquisition was performed on 6 April. The related measurement was successfully processed at UK-PAC.
- The FCOS and the POCIS were declared ready to support the commissioning phase.

Outlook
- Start of platform and payload commissioning activities.
- First SAR acquisitions driven by the operational POCIS mission planning system are planned to start on 9 April, as part of the initial verification and calibration activities.
- Start of orbit manoeuvres sequence to acquire the target reference orbit.

Mission Status Report 145
Reference Period: 28 February 2017 – 6 March 2017

Mission status
- The Sentinel-1A and Sentinel-1B routine operations are on-going.
- The Sentinel-1A observation scenario supports the systematic coverage of Copernicus Services areas of interest, of European land and coastal waters, of global ice/land areas, as well as of other specific areas worldwide for various applications. The observation plan also includes a regular mapping of all land masses worldwide, with a frequency largely increased with Sentinel-1B in 'Split-Scene' processing. Starting from 26 September 2016, the Sentinel-1 observation plan is implemented with the combined use of Sentinel-1A and Sentinel-1B.
- World maps providing a high-level description of the overall Sentinel-1 constellation observation scenario, in terms of Grid nodes, polarisation, observation geometry, revisit, and coverage frequency are available at: https://sentinel.esa.int/web/sentinel/missions/sentinel-1/observation-scenario/acquisition-scenario.
- The detailed observation plan in the form of instrument acquisition segments, for both Sentinel-1A and Sentinel-1B is published at: https://sentinel.esa.int/web/sentinel/missions/sentinel-1/observation-scenario/acquisition-scenario.
- The operational use of Sentinel-1 data by the Copernicus Marine Environment Monitoring Service for sea ice and ice-edge monitoring activities is on-going.
- The European Maritime Safety Agency (EMSA) operationally uses Sentinel-1 imagery in real-time in the CleanSeaNet services; operations with EMSA service providers local stations are on-going.
- The use of the EDGERS service by Sentinel-1A is on-going as part of the routine operations, allowing to further increase the overall mission capacity.
- The Sentinel-1B optical link commissioning using Alfortsat TDP-1 is on-going.
- Both Sentinel-1A and -1B spacecraft are in a stable state, operating in Nominal Mission Mode (NMM). The Flight Operations Segment (FOS) ensuring the monitoring, control and commanding of the satellites is operating normally. Orbit control manoeuvres are performed once a week.
- X-band data acquisitions are routinely performed over Matora, Sidi Slimane and Masalma X-band over stations. The acquired data are calculated within the Payload Data Ground Segment (PDGS), systematically processed to level 0 and Level-1 products and archived.
- Wave Mode data are regularly acquired over open oceans, systematically processed to Level-2 CON products and made available. Sentinel-1 FR and SW Level-2 CON products over regional ocean areas are available on the Data Hub. The operational qualification of Level-2 CON products is on-going (geophysical validation of the Radar Surface Velocity component).
- Operations are performed regularly at the Processing and Archiving Centre (EDRAC) and UK-PAC. All other PDGS operational services (i.e. Marine Performance, Precise Orbit Determination, W-band Analysis Network) are operating normally.
- By 2 March 2017, a total of 65,526 users have self-registered on the Sentinel-1 Scientific Data Hub 720,623 product downloads have been made by users, corresponding to about 84.7 GB of data. More than 1.1 million Sentinel-1 products are available on line for download, representing 1.6 Pib of data. Statistics of last 24 hours are available in real time at the Data Hub home page: https://scihub.copernicus.eu

Outlook
- Continuation of Sentinel-1 constellation routine operations.

Report prepared by the ESA Sentinel-1 Team.
The Sentinel-1 mission total daily production will further increase in coming months.

A conservative forecast projects the daily mission production to reach \textbf{\~12 TB per day} by end 2017.
The Sentinel-1 mission operations provide:
- the technical suitability,
- the adequate revisit and global coverage,
- the long-term perspective,
- the data access conditions,

➤ to move SAR applications into the operational domain, at national/regional/continental/global scale

The unprecedented data volume generated by the Sentinel-1 mission represents today a challenge for its massive exploitation.
Winter-Spring Rice 2015/16
• March 2016: 1.4 Million ha rice
• March 2015: 1.7 Million ha rice
• 16.5% loss in rice area due to drought and salt water intrusion caused by El Nino
• 976,000 people affected, 67 Mil. $ estimated damage

• Based on unprecedented S1 timeseries
CSC Missions Management On-Line

Copernicus Programme: copernicus.eu
Sentinel Online: sentinels.copernicus.eu
CSC Data Access: spacedata.copernicus.eu
ESA Sentinel app: available for iOS and Android