



PROGRAMME OF THE
EUROPEAN UNION



Sentinel-1 Next Generation

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Copernicus SAR Timeline



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Next Generation Objectives



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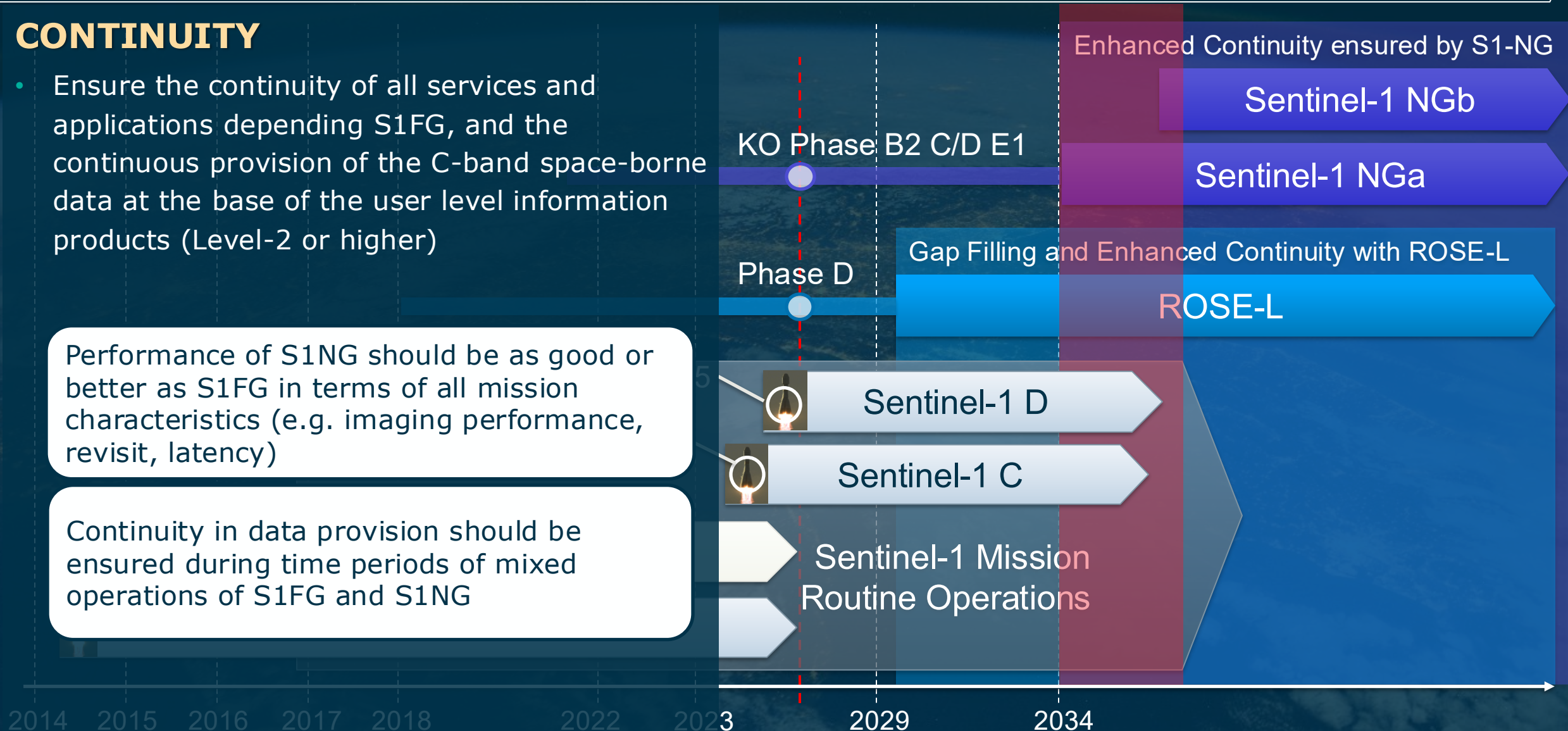


CONTINUITY

- Ensure the continuity of all services and applications depending S1FG, and the continuous provision of the C-band space-borne data at the base of the user level information products (Level-2 or higher)

Performance of S1NG should be as good or better as S1FG in terms of all mission characteristics (e.g. imaging performance, revisit, latency)

Continuity in data provision should be ensured during time periods of mixed operations of S1FG and S1NG



Next Generation Objectives



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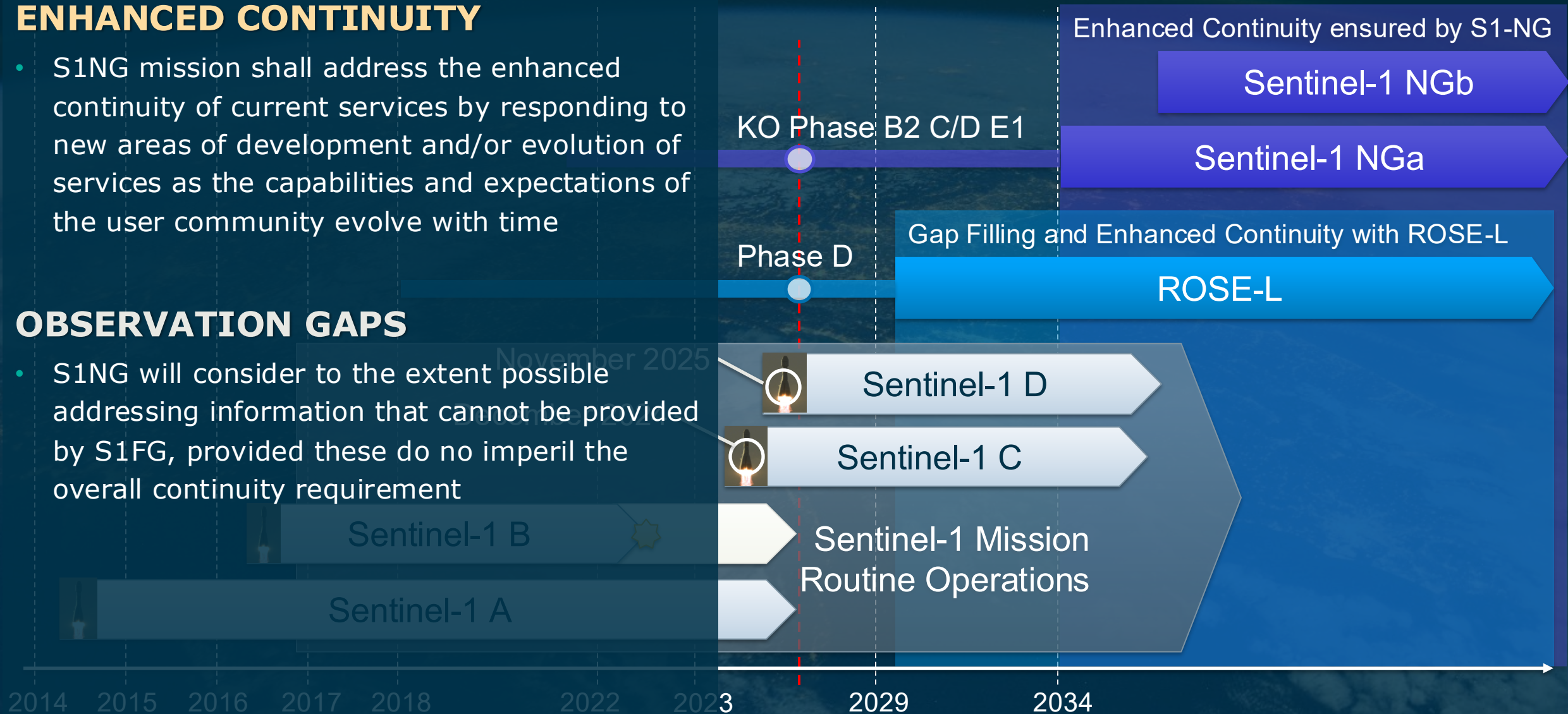


ENHANCED CONTINUITY

- S1NG mission shall address the enhanced continuity of current services by responding to new areas of development and/or evolution of services as the capabilities and expectations of the user community evolve with time

OBSERVATION GAPS

- S1NG will consider to the extent possible addressing information that cannot be provided by S1FG, provided these do not imperil the overall continuity requirement



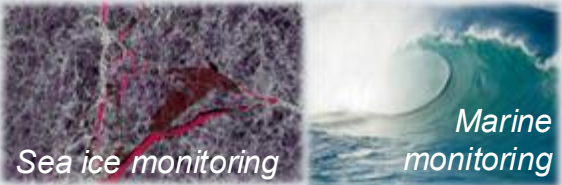
SAR Missions and Copernicus Services



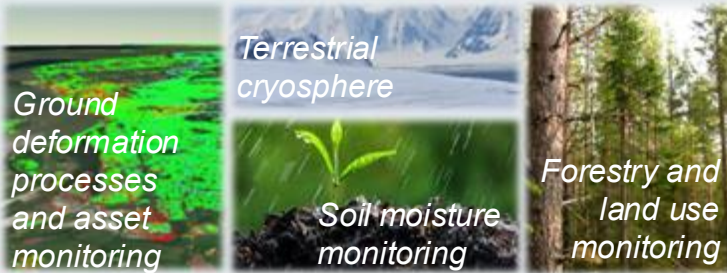
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Sea ice type, concentration and motion
Ice sheets & glaciers velocity
Grounding line
Snow water
Ice sheet melt/freeze extent
Permafrost thawing and extent



Sea ice type, concentration and motion
Iceberg location, size and drift
Ocean surface wind vectors
Swell properties
Ocean surface currents



Land use and land use change, including
agriculture and forestry
Soil moisture
Forest biomass and structure
Snow water
Wet snow extent
Ground movement



Flooded area
Ground movement
Soil moisture
Abrupt surface elevation changes



Iceberg location, size and drift
Vessel location, size and velocity
Oil spill location and morphology

MRD

NG

Copernicus Sentinel-1 Next Generation
Mission Requirements Document

User Needs

- Polar Expert Group
- REDD+
- UNFCCC
-

MRD

Copernicus L-band SAR Mission
Requirements Document

Next Generation Imaging

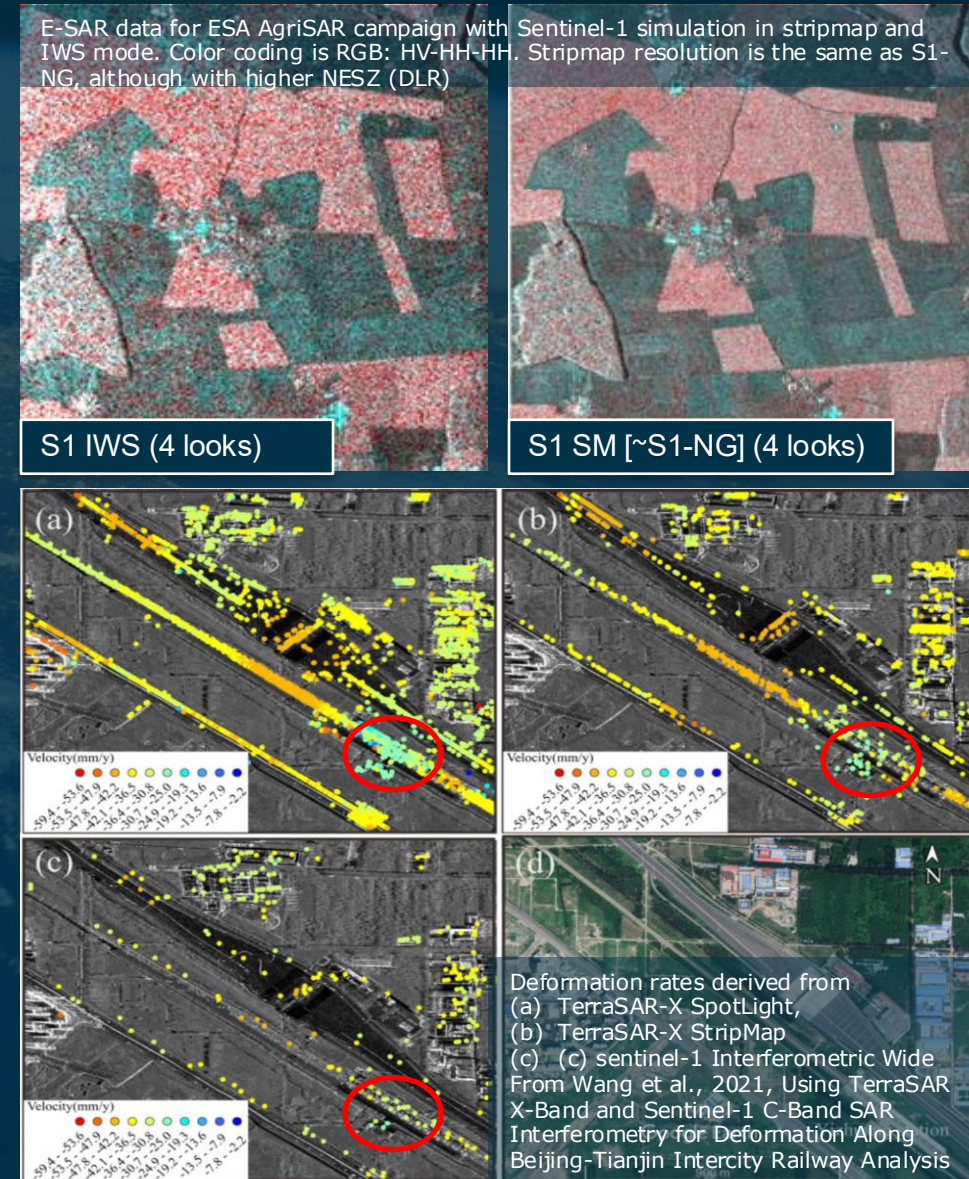


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ENHANCED SPATIAL RESOLUTION

- Provide **information for smaller parcels** especially within Europe (e.g. 0.5 Ha parcel mentioned in EC working document)
- Improve **detection of flooded areas**
- Provide **better offset tracking for land ice monitoring** and ENL for snow monitoring resulting in better product accuracy
- Lead to **increased number of detected PS/DS** per unit area and improved information
- Higher resolution with respect to S1FG (EW) to **improve sea ice ridge detection** which represents important information **for tactical navigation**
- **Detect smaller vessels and infrastructure** (speed boats, trafficking and smuggling, piracy, fisheries control)
- Improve **oil spill and iceberg detection**



Next Generation Imaging



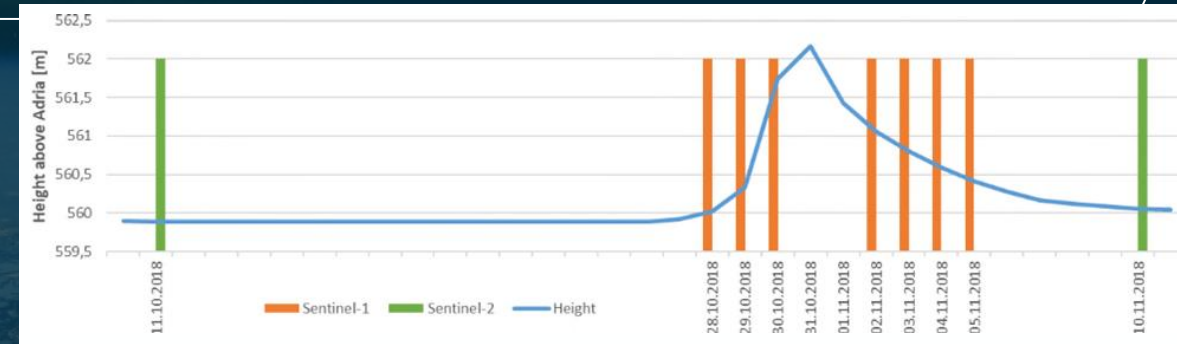
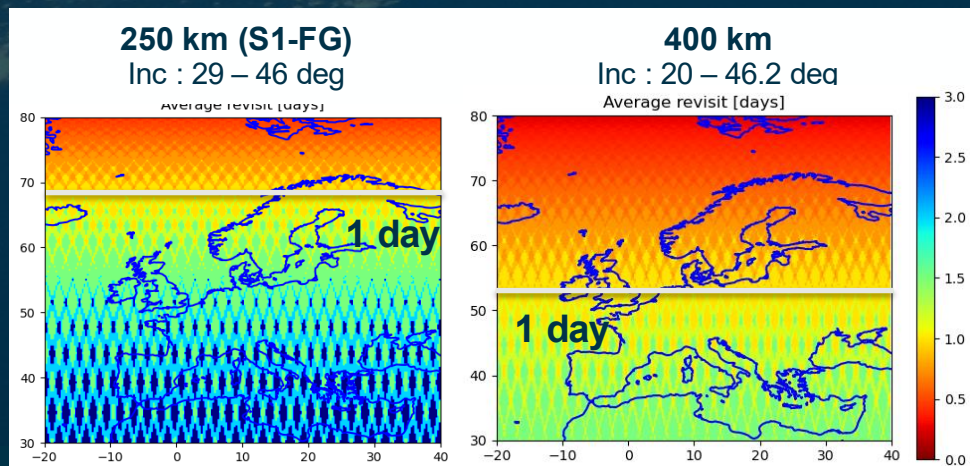
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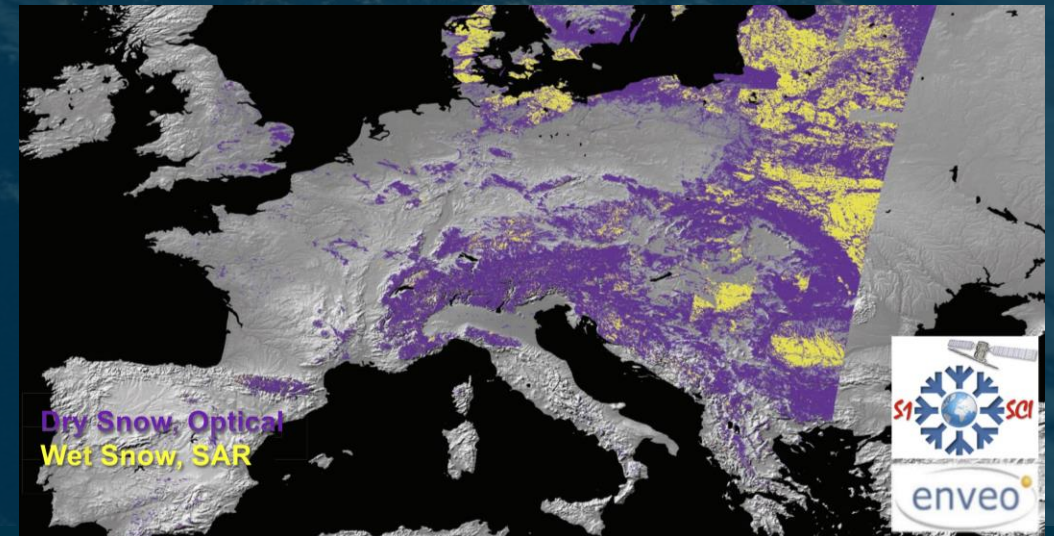
ENHANCED REVISIT

- Enhanced global revisit (3 days) to **capture large-scale flood events**
- Enhanced global revisit (3 days) for strong **impact on soil moisture** and **seasonal snow monitoring**
- Revisit of 0.5 day to 1 day for **monitoring of sea ice** in the Arctic

- In constellation of 2 satellites, instantaneous swath driven by revisit requirement



Maximum flood extent (red line) versus Sentinel-1 observed open water two days after flood peak. Credit: TU Wien



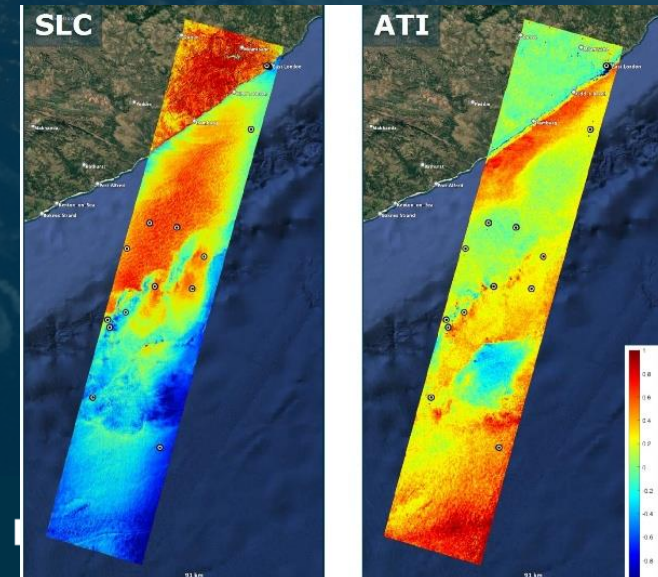
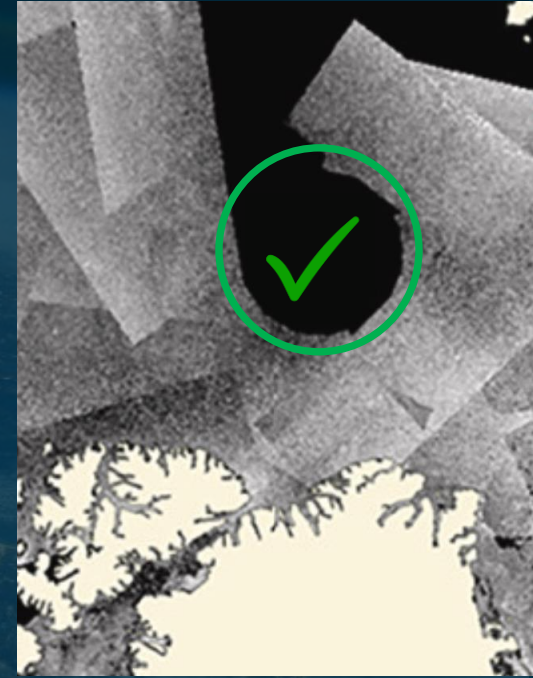
Continuity and Enhanced Continuity



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- Requirement to support systematic acquisitions → **minimisation of number of acquisitions modes** to support built-up of consistent data series
- Enhanced continuity is given by improved performance building on new technological developments while maintaining all mission elements of S1FG
 - Improved main Dual-Pol wide-swath mode
 - Quad-Pol capability in addition to the Operational Dual-Pol
 - Enhanced Wave Mode
 - A dedicated Polar Mode in answer of user needs to support monitoring of complete Arctic responding to the challenges of the “Integrated EU Arctic policy” to be used seasonally
 - Enhanced AIS payload, with capability to receive messages in the new VHF Data Exchange System (VDES) bands
- **MAPS-based antenna architecture will enable ATI** for
 - Enhanced detection of (small) vessels under challenging sea state conditions and in ice-infested waters and estimation of their velocity
 - Enhanced Ocean Surface Current Velocity estimation



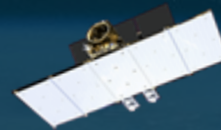
System-of-Systems in Brief



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S1FG



ROSE-L



S1NG

CONSTELLATION

- ❖ **2 Satellites** in **same sun-synchronous orbit of Sentinel-1 FG** (~700 km altitude)
- ❖ 12 days repeat cycle with 1 satellite, 6 days with 2 satellites

WIDE SWATH IMAGING

Interferometric Wide Swath Mode (IWS)

- ❖ 250 km swath
- ❖ 100 m² resolution

Extra Wide Swath Mode (EWS)

- ❖ >400 km swath
- ❖ 800 m² resolution

ROSE-L Interferometric Wide Swath Mode (RIWS)

- ❖ 260 km swath
- ❖ 50 m² resolution

ROSE-L Extra Wide Swath Mode (REWS)

- ❖ >400 km swath
- ❖ <800 m² resolution

S1NG Modes

- ❖ Supporting 400 km swath
- ❖ Supporting 25 m² resolution

Full swath overlap with Sentinel-1 IWS mode

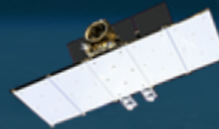
System-of-Systems in Brief



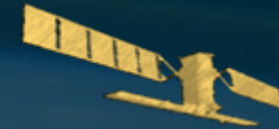
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S1FG



ROSE-L



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S1NG Modes

- ❖ Supporting **400 km** swath (*)
- ❖ Supporting **25 m2** resolution (*)

(*) not achieved at same time

REVISIT AND COVERAGE

- ❖ Up to 12d Global
- ❖ Duty cycle: 25 min/orbit

- ❖ 1d Arctic, 3d Europe, 6d Global
- ❖ Duty cycle: ~ **38 min/orbit**

- ❖ 0.5d Arctic, 3d Global
- ❖ Closing North Pole gap
- ❖ Duty cycle: ~ **43 min/orbit**

EXTRA FEATURES

- ❖ AIS (S1C and S1D)
- ❖ Imagettes over open ocean

- ❖ Imagettes over open ocean

- ❖ AIS / VDES
- ❖ Enhanced Imagettes

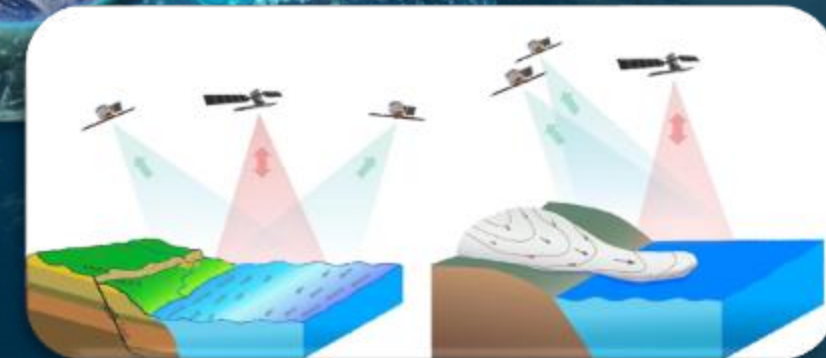
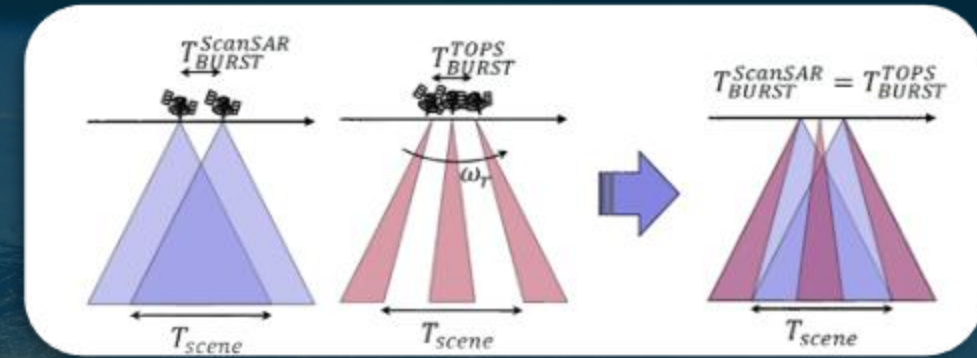
S1FG Legacy Mode



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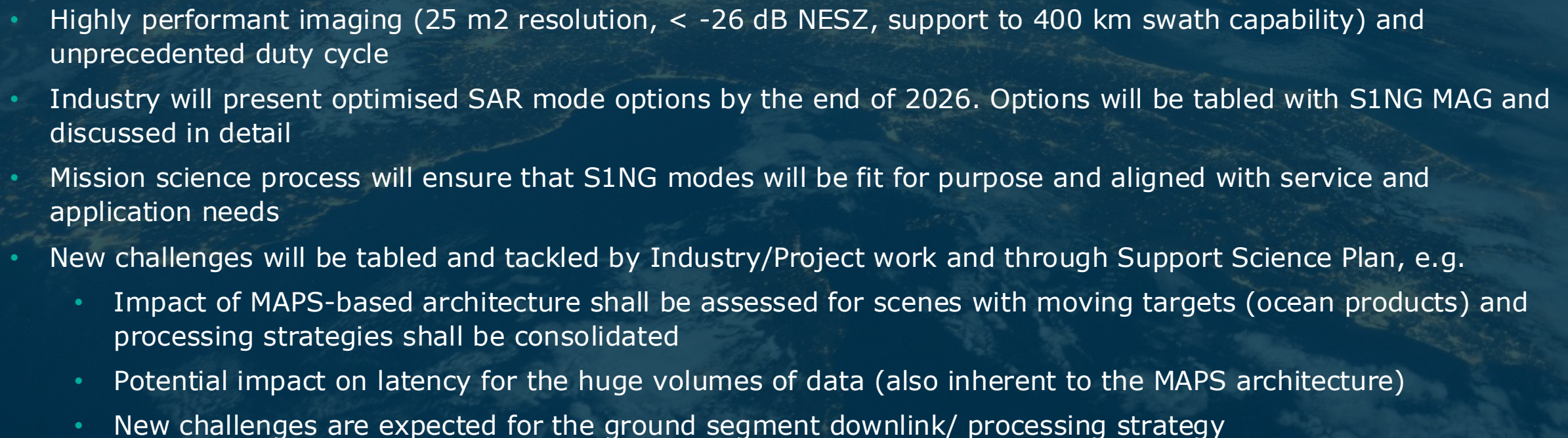
- S1FG Legacy mode option is aimed at
 - Supporting S1FG / S1NG cross-calibration and demonstration of Level-2 full continuity during S1NG Commissioning
 - Providing back-up for EE10 Harmony mission extension beyond Sentinel-1C and -1D
- Legacy Mode will be:
 - based on S1NG SAR architecture/hardware required for the Operational Modes without driving the design
 - S1FG-like **IW** TOPS or ScanSAR mode and Wave mode
- Harmony will implement compatibility with the Sentinel-1NG Legacy Mode for potential continuity of the mission
- As collateral benefit, Harmony can be used to support the demonstration of potential new applications based on bi-static SAR to enhance and expand Copernicus Services



ESA, industry and the EC are preparing the Copernicus SAR missions evolution

- Sentinel-1 NG to ensure continuity of services relying on Sentinel-1, enhance existing applications, and enable new application developments building on improved performance and observation gaps (e.g. resolution, revisit and others)

Enhanced continuity enabled by new technological developments

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- Highly performant imaging (25 m2 resolution, < -26 dB NESZ, support to 400 km swath capability) and unprecedented duty cycle
 - Industry will present optimised SAR mode options by the end of 2026. Options will be tabled with S1NG MAG and discussed in detail
 - Mission science process will ensure that S1NG modes will be fit for purpose and aligned with service and application needs
 - New challenges will be tabled and tackled by Industry/Project work and through Support Science Plan, e.g.
 - Impact of MAPS-based architecture shall be assessed for scenes with moving targets (ocean products) and processing strategies shall be consolidated
 - Potential impact on latency for the huge volumes of data (also inherent to the MAPS architecture)
 - New challenges are expected for the ground segment downlink/ processing strategy