The Copernicus Ground Segment

Behind the scenes of the ESA Sentinel operations

for an ever-increasing sustainability, flexibility and transparency

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#LPS22

ESA Copernicus Sentinels Operations

> 200,000 satellite orbits
> 15 Million min of satellite observations
> 50 Million products published
> 400 PB of data downloaded by users
> 550,000 registered users
> ....

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Plan the satellite observations

Acquire the satellite data on ground

Process all satellite data into user products

Maintain access to all relevant information for user data exploitation

Preserve acquired mission data for future access

Ensure access to new and past Sentinel data

Ensure and monitor the data quality

Operate, monitor and control the satellites

Operational resources are not infinite….

…and data volumes & user scenario are a constant challenge

…their strategic management is constantly pursued by ESA to…

Ensure the long-term sustainability of the present and future Copernicus operations

Enhance the data exploitation with improved data quality, evolved products, data access interfaces…

Maximize the operations performance within the available resources

Maximize the operations transparency

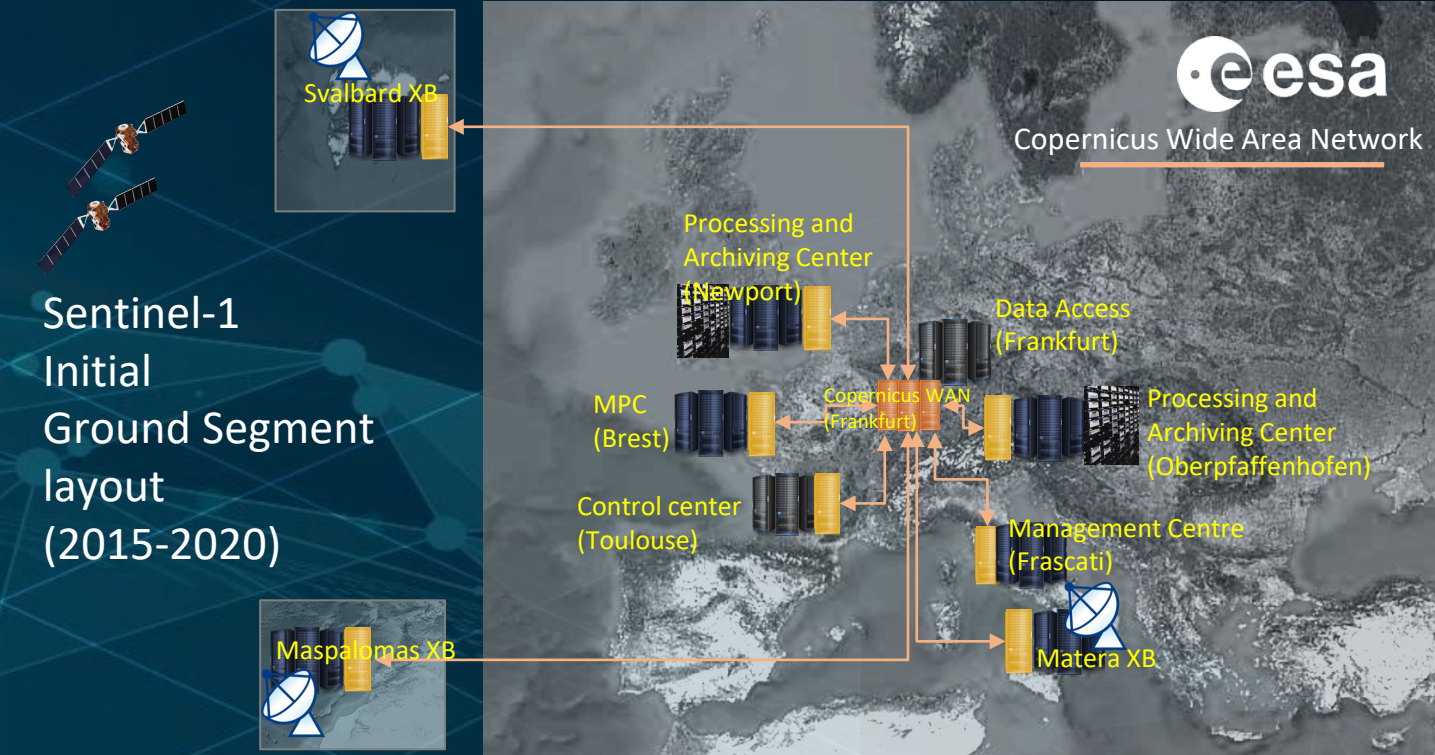
The ESA Copernicus Ground Segment has been drastically transformed with a gradual and user-transparent evolution over the last 2 years….

Migrating the operations to **public clouds**

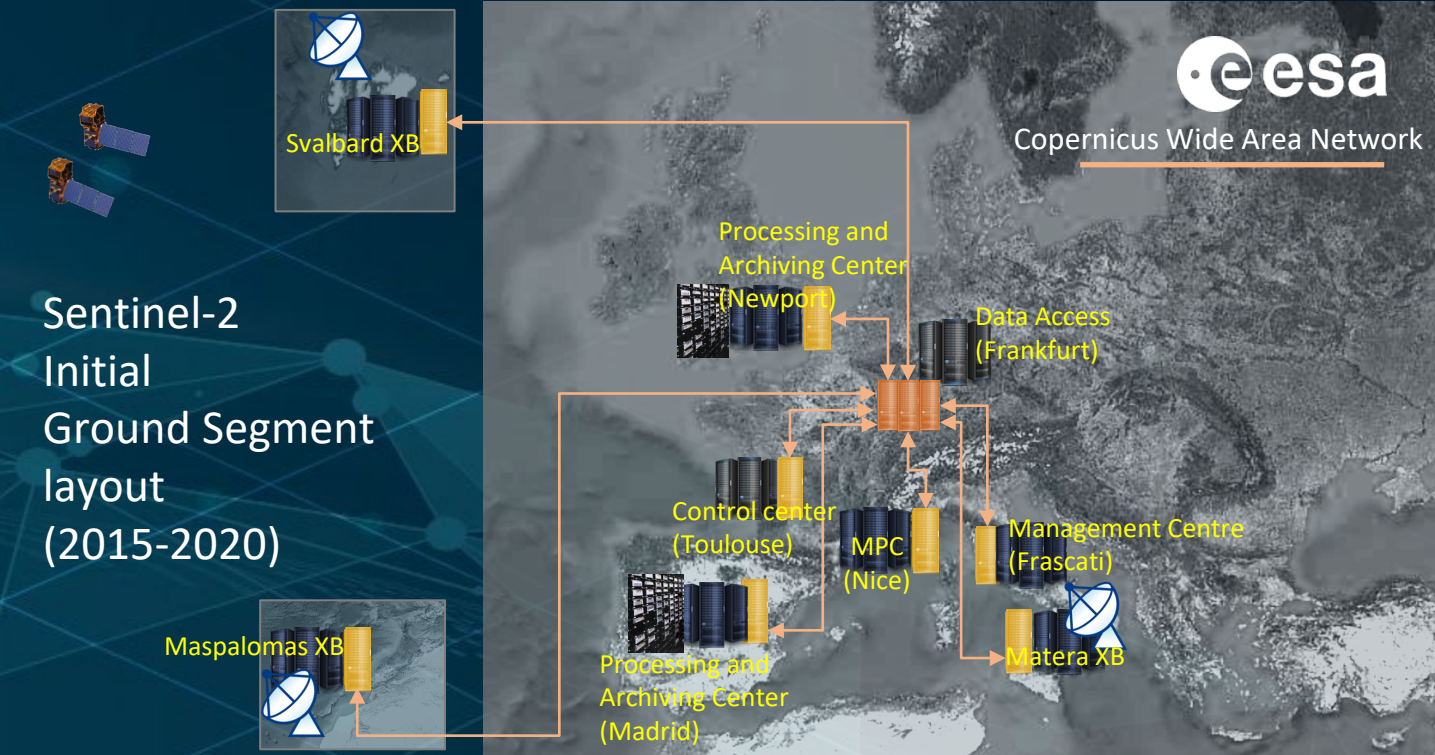
Strengthening the **industrial service** approach

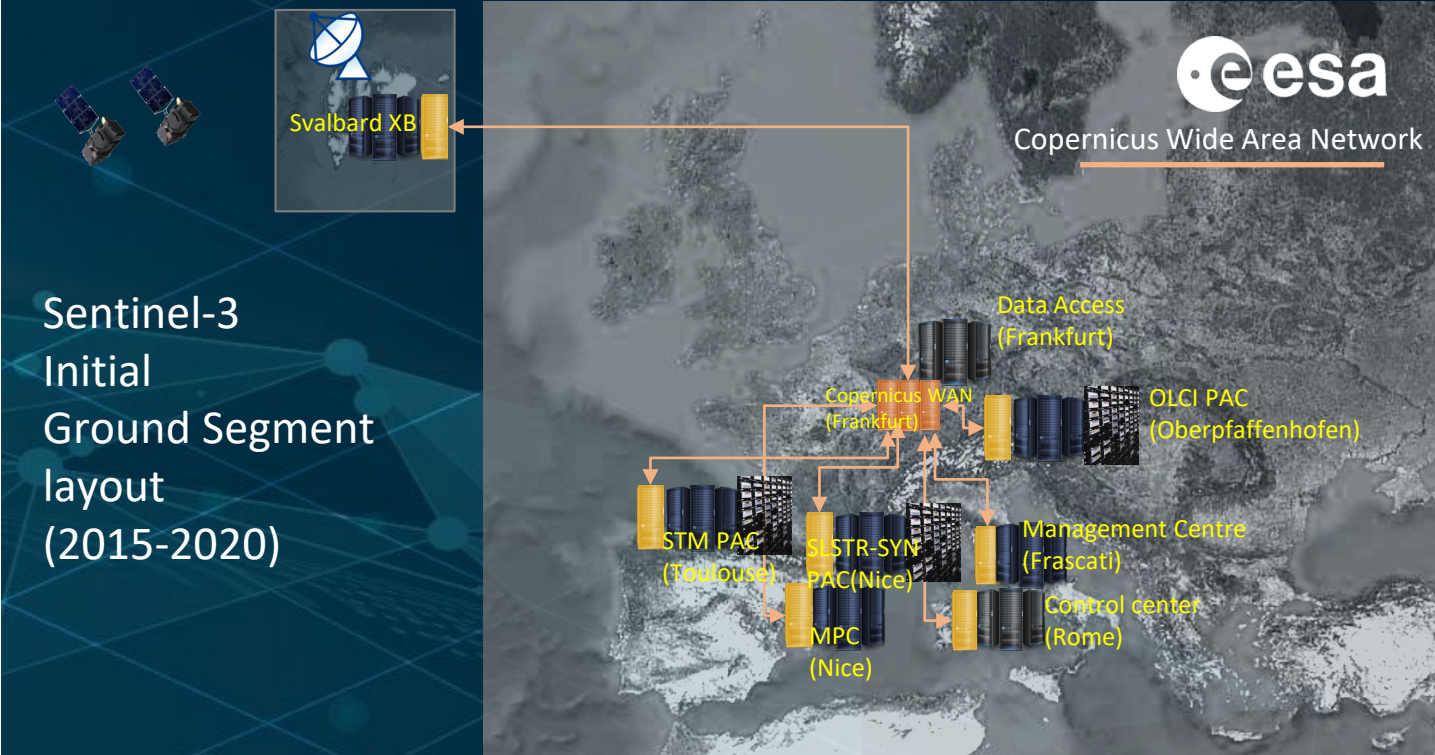
Increasing **competitiveness** of operational services provision

Increasing operational **flexibility**

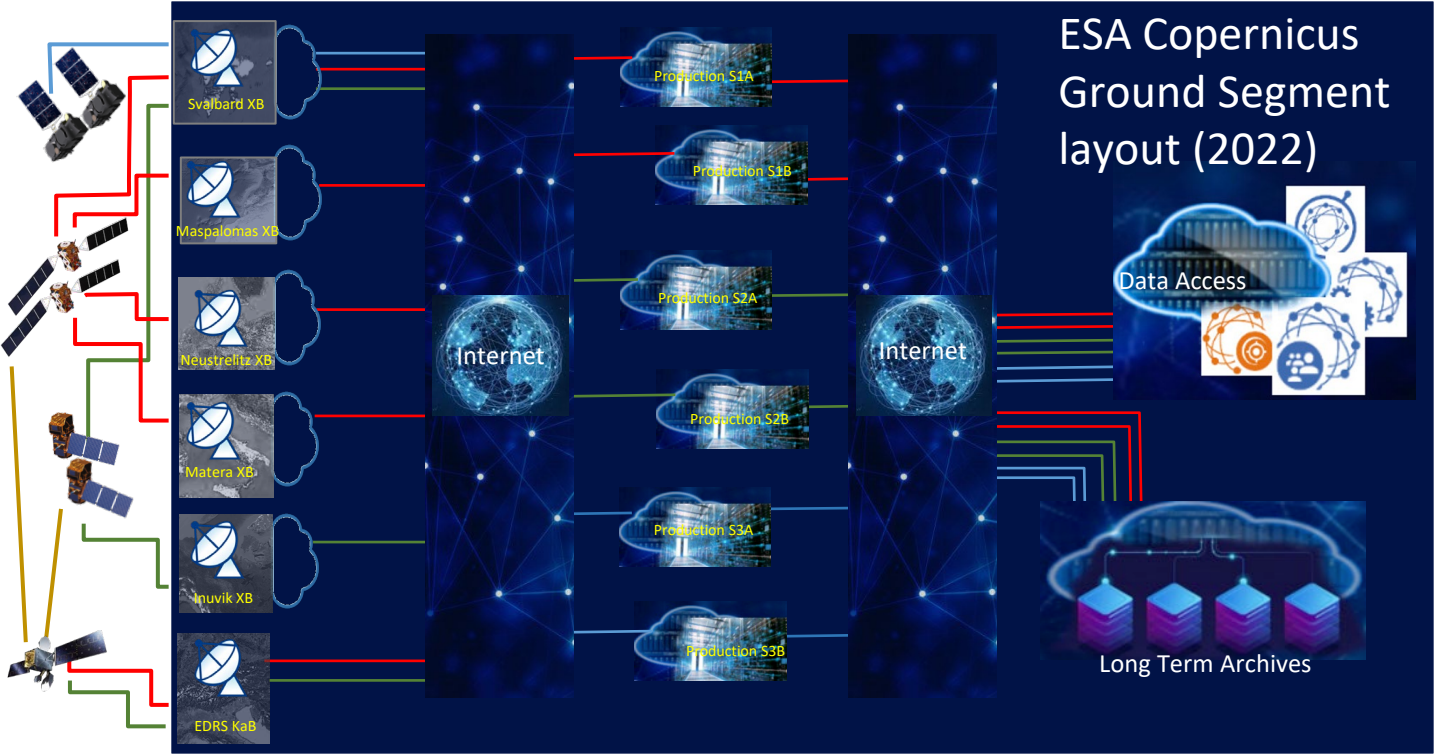


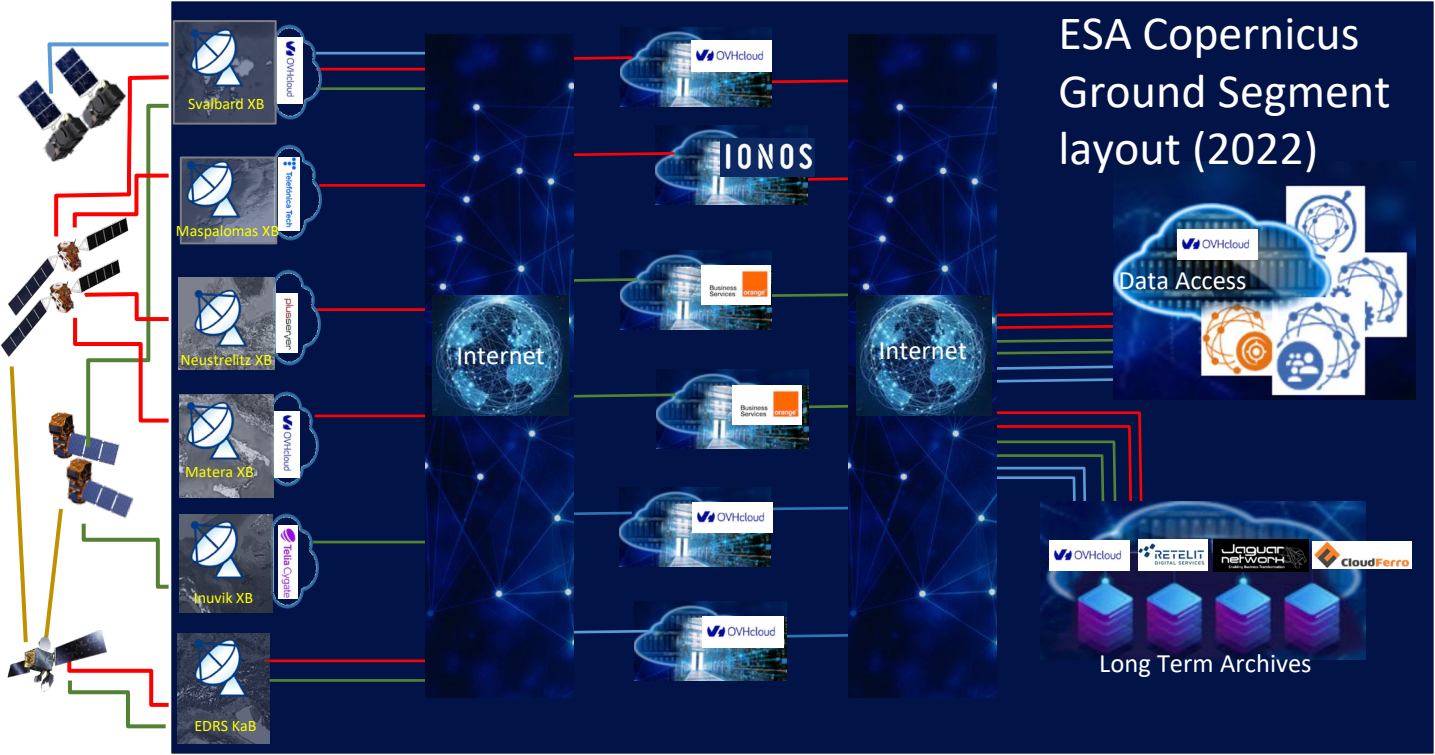
Sentinel-1 Initial Ground Segment layout (2015-2020)

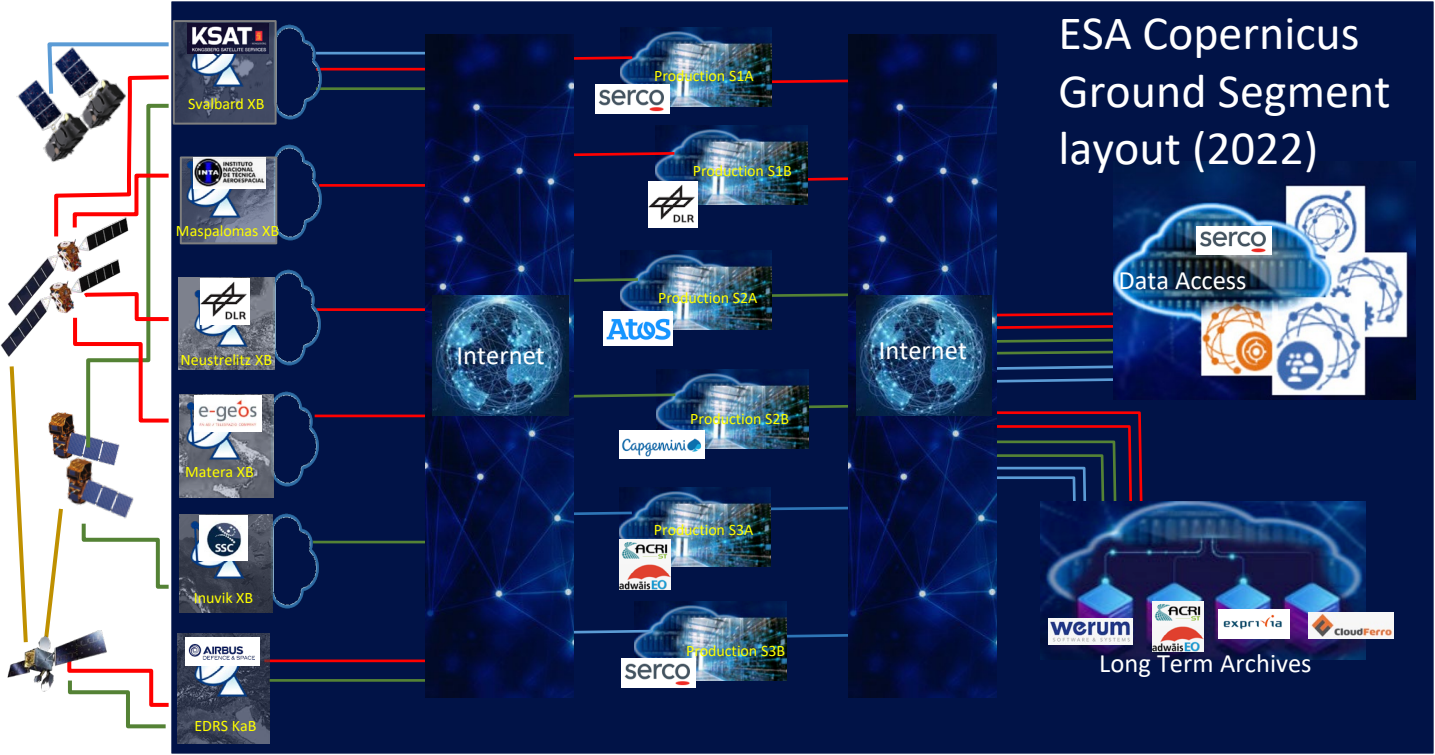

Copernicus Wide Area Network
Sentinel-2
Initial
Ground Segment
layout
(2015-2020)
Svalbard XB
Processing and
Archiving Center
(Newport)
Data Access
(Frankfurt)
Control center
(Toulouse)
MPC
(Nice)
Management Centre
(Frascati)
Maspalomas XB
Processing and
Archiving Center
(Madrid)
Matera XB



Sentinel-3 Initial Ground Segment layout (2015-2020)


ESA Copernicus Ground Segment layout (2022)
Svalbard XB
Maspalomas XB
Neustrelitz XB
Matera XB
Inuvik XB
EDRS KaB
Internet
Internet
Production S1A
Production S1B
Production S2A
Production S2B
Production S3A
Production S3B
Data Access
Long Term Archives


ESA Copernicus Ground Segment layout (2022)
Svalbard XB
Maspalomas XB
Neustrelitz XB
Matera XB
Inuvik XB
EDRS KaB
OVHcloud
IONOS
Business Services orange
Internet
Internet
Data Access
RETELIT DIGITAL SERVICES
Jaguar network
CloudFerro
Long Term Archives


ESA Copernicus Ground Segment layout (2022)
KSAT
Svalbard XB
INTA
Maspalomas XB
DLR
Neustrelitz XB
e-geos
Matera XB
SSC
Inuvik XB
AIRBUS
EDRS KaB
Internet
Internet
Production S1A
serco
Production S1B
DLR
Production S2A
Atos
Production S2B
Capgemini
Production S3A
ACRI ST
adwaisEO
Production S3B
serco
serco
Data Access
werum
ACRI ST
adwaisEO
exprivia
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Long Term Archives

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Maximize the operations performance within the available resources

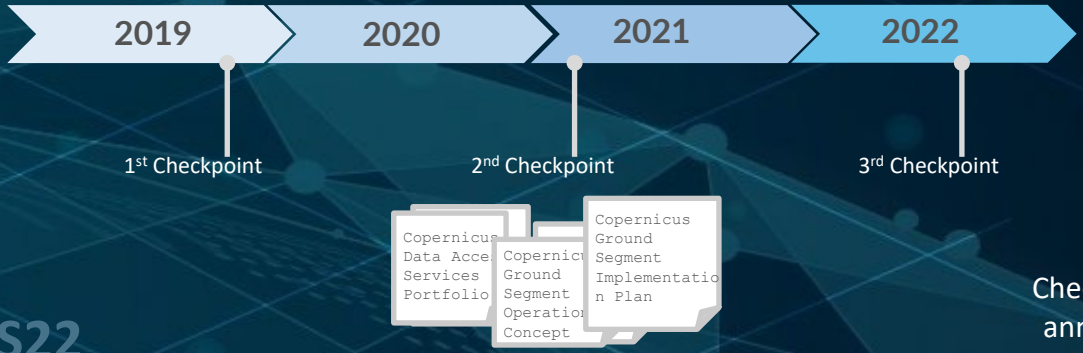
Maximize the operations transparency

Enhance the data exploitation with improved data quality, evolved products, data access interfaces…

Copernicus Operations Checkpoints

The Copernicus Ground Segment technical baseline and evolution roadmap are publicly presented at a yearly Checkpoint

Documentation baseline is made publicly available to registered participants



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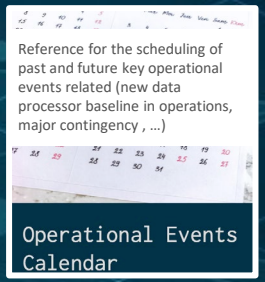
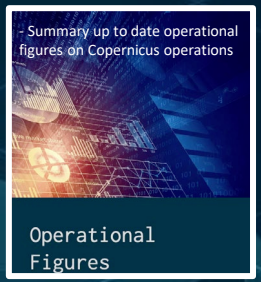
Checkpoints are announced on ESA EMITS

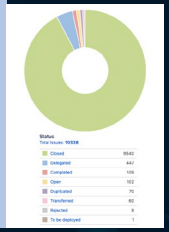
Public Copernicus Operations Dashboard

A public interactive interface providing users and stakeholders up-to-date information on the Copernicus operations
from satellite level to data take level!





Visible part of the overall operations performance monitoring and operations coordination among all teams involved in the daily operations



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Opening will be announced on Sentinels on-line web portal, planned in summer 2022

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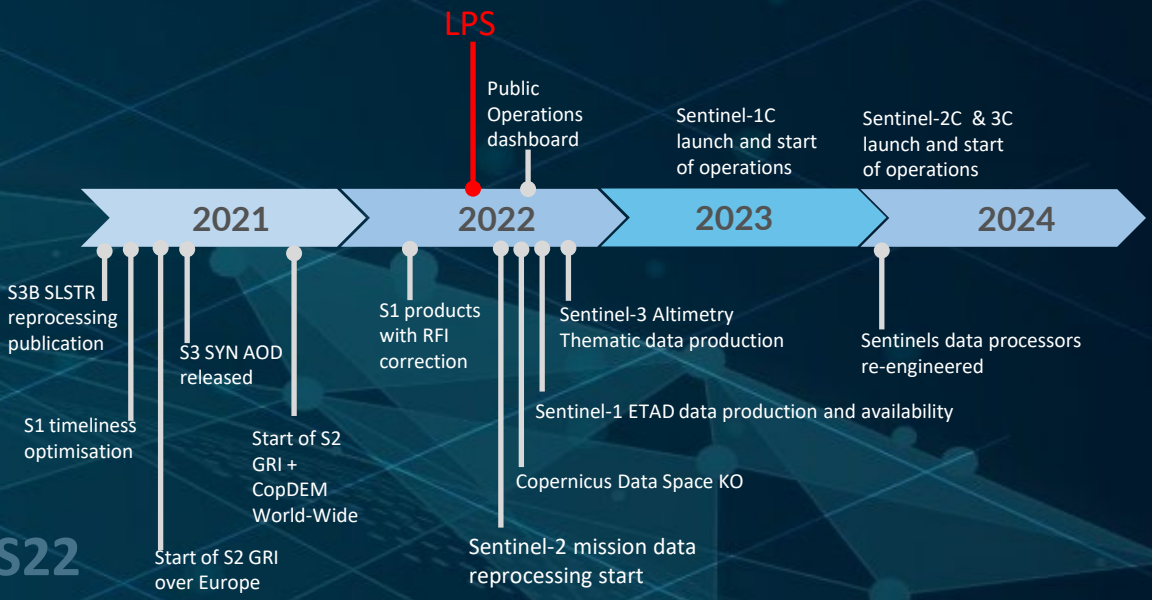
Enhance the data exploitation with improved data quality, evolved products, data access interfaces…

Enhancing and easing data exploitation



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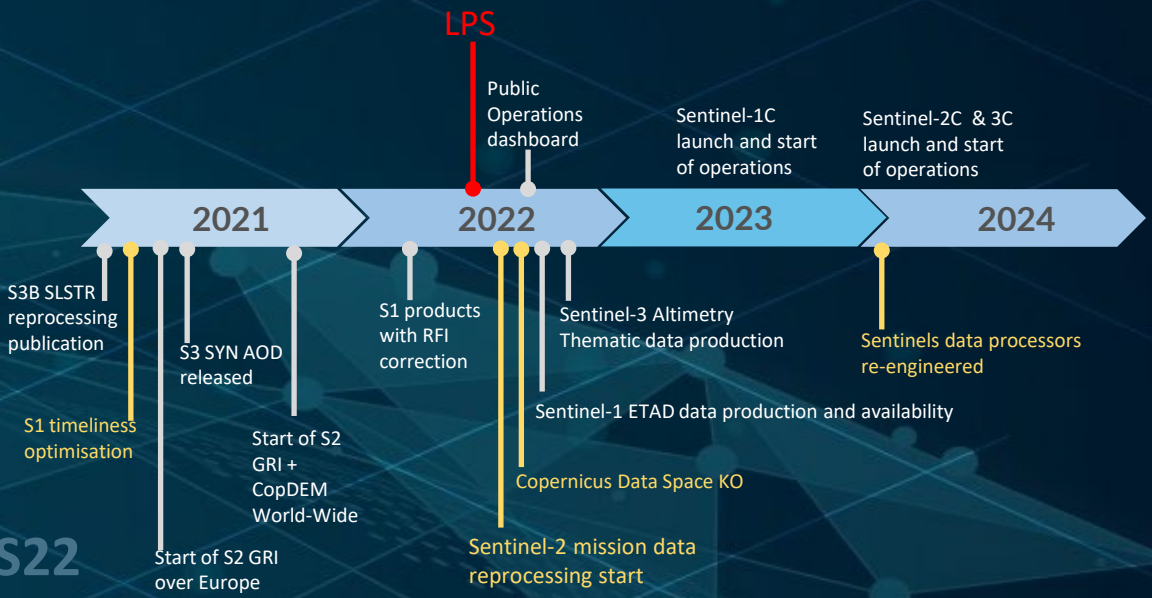
Enhancing and easing data exploitation



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Sentinel-2 mission data reprocessing

- Sentinel-2 data is being processed with global refinement and Copernicus DEM (90m) since Jan. 2022

A major reprocessing campaign is planned to align the Sentinel-2 past data quality with the current baseline to generate the Sentinel-2 Collection-1

- Reprocessing of the historical Sentinel mission data with global refinement and Copernicus DEM is foreseen to start in Q3 2022 => Data Processor Version 6.0
  - Reprocessing duration ~ 9 months
  - Reprocessing planned backwards (from present to past)
  - Reprocessing including L1C & L2A
  - Access to reprocessed mission data gradually available initially through the DIAS and long-term through the future Data Access Service

Sentinel-1 data access timeliness – Until March 201

On board data timeliness is minimized for Sentinel-1 observations over Europe and over some specific world-wide areas (e.g. CMEMS areas of interest) :

downlinking immediately while being acquired

or

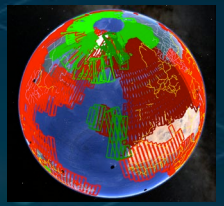
downlinking with the highest priority to minimize on-board data latency

Originally this data was processed 1st immediately after downlink (NRT version) and 2nd shortly after as soon as POD orbit information was available:

The 1st version (NRT)
- was not published on the Open Hub
- was processed without POD orbits
- slice to slice continuity was not ensured

The 2nd version (NTC)
- was published on all Hubs
- was processed with POD restituted
- slice continuity was ensured

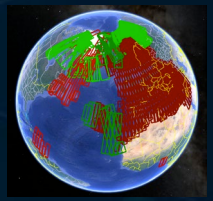
Sentinel-1 data access timeliness – Since March 201



Since March 2021:

All Sentinel-1 data is processed ONCE and same data is made available to all users with equivalent quality and slice to slice continuity.

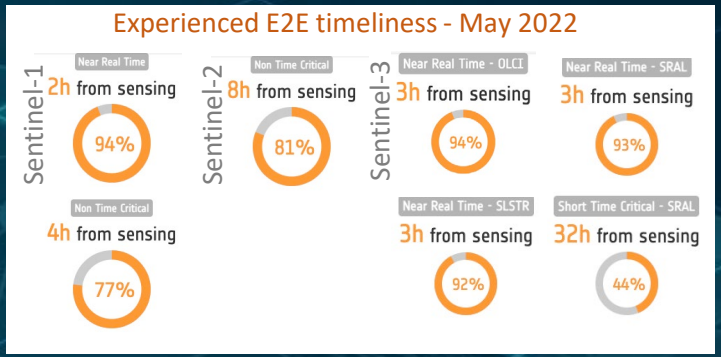
Sentinel-1 data over Europe and some specific areas, marked as “NRT” is naturally published faster as a result of shorter on-board data latency.



Sentinel-1 POD restituted and precise orbits are available on the POD Hub: https://scihub.copernicus.eu/gnss/

Sentinels data end-to-end timeliness - Experienced

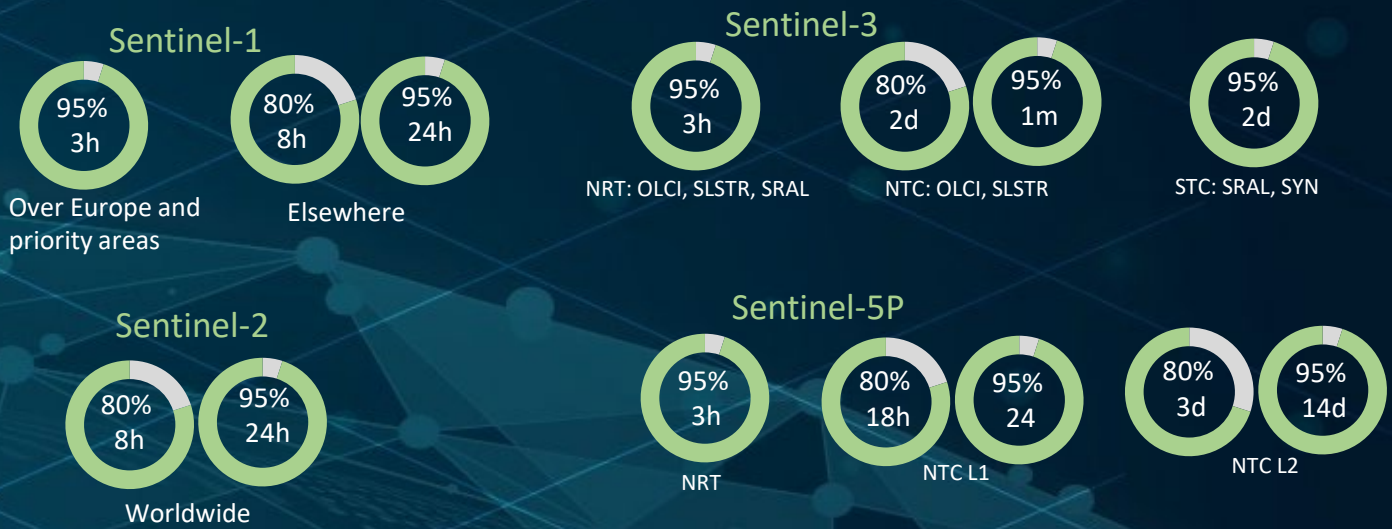
E2E timeliness ≃ [time between observation and data downlink] + [production time] + [publication time]



Experienced timeliness ≠ Committed timeliness

E2E timeliness is associated to a given operational configuration and available operational resources

Sentinels data end-to-end timeliness - Committed



Committed timeliness targets are under consolidation:
consolidated operational objectives will be published before end 2022

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Sentinels data processors re-engineering

Sentinel-1/2/3
L0, L1, L2
Processors

Interfaces harmonisation

Maximisation Python coding & open-source

Optimisation for cloud-based operations

Increased modularity for flexible on demand processing

Sentinel-1/2/3 L0, L1, L2
Re-engineered processors
(2023/2024)

No algorithm changes

But

updated product format

(STAC metadata, zarr, json..)

New format and sample products will be published end 2022

Start of operations with new processors foreseen in 2024

Copernicus Data Access Service - Timeline

LPS

2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025 2026 2027 2028 2032

Copernicus Open Access Hub

Copernicus Data Access Service – In few numbers

7.5 years
of Data Access Service operations

560,000
Total Registered Users

>50,000,000
Published products

440 PiB
Total Volume Downloaded

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pernicus Data Access Service is under
ent, with longer time perspective

!

ace- Copernicus Data Access

6 years + Optional 4

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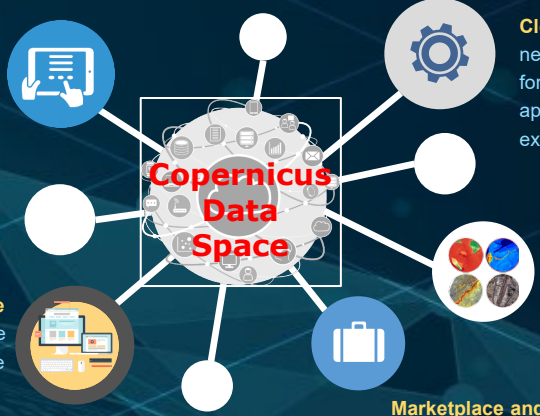
Copernicus Data Access Service - Context

CSC Data Access integrated as part of an Open **Ecosystem** on a public cloud

Unified User Management opening access to complementary services such as IaaS, PaaS or SaaS based on the same digital identity



Cloud infrastructure services (storage, network and processing resources on the cloud) for user data processing and third-party applications and services, offering users a data exploitation environment

Copernicus data availability & retrieval (Sentinels User Level Data and CCM data available for download and accessible directly using the IaaS/PaaS services)

Applications, services, documentation and software repository available for re-use by third-party users to facilitate the deployment of their own services within the Copernicus Data Space

Marketplace and support to Third-Party services

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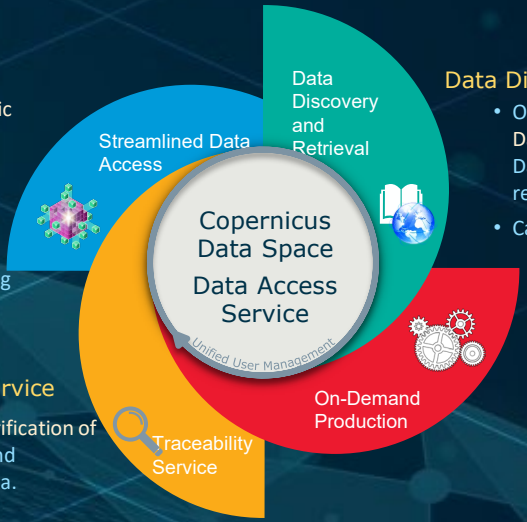
Copernicus Data Access Service - Main features

Streamlined Data Access

- Open and free Harmonised access to specific Sentinel Data collections, allowing efficient temporal and spatial access via dedicated API.
- Streamlined data representation and organisation including necessary data transformations (e.g. resampling, tiling using a common reference grid).

Traceability Service

- Allowing registration, access and verification of traces for the Copernicus Sentinel and Copernicus Contributing Mission data.



Data Discovery and Retrieval

- Open and Free Access to ALL Sentinel User Level Data and Copernicus Contributing Missions Core Data Sets for download and access using IaaS resources
- Catalogue, View, Discovery, APIs + GUI

On-Demand Production Service

- Open and free access to on-demand Sentinel-1/2/3 L1 and L2 User Level Data using ESA operational Sentinels processors.

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Copernicus Data Access Service - Data offer

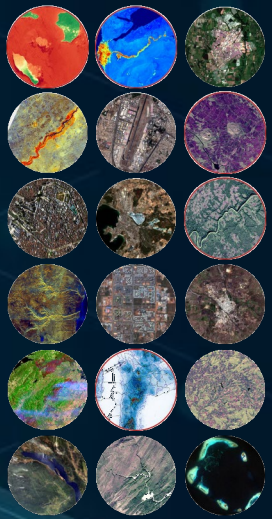
Full Free and Open access to ALL Sentinel Data
with Immediate on-line access to:

- ALL Sentinel User Level Data over Europe
- ALL Sentinel User Level Data World-Wide for at least 1 year

Copernicus Contributing Missions data:

CCM CORE Datasets (licensing conditions)

Additional data sets



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… thanks to all teams involved