ESA Agency Report

WGISS#43, 3-6 April 2017, Annapolis (USA)

ESA Ministerial Council 2016 (*December 2016, Lucerne, Switzerland)*

<u>For Earth Observation:</u>

Optional programmes:

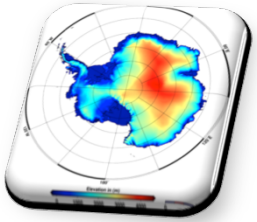
- ✓ New period of ***Earth Observation Envelope Programme (EOEP-5)***
- ✓ New elements of Earth Watch Programme (**GMECV+**, **InCubed**, **Altius**)

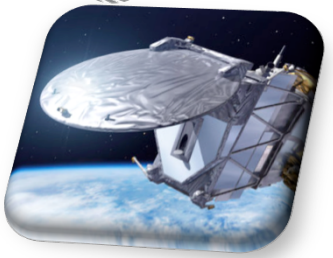
→ ***1371 M€, 83 % funded***

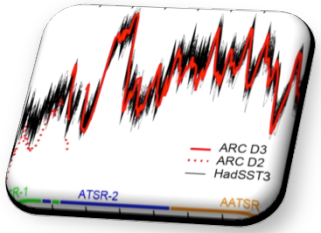
Within General Budget:

- ✓ LTDP+ (“**Heritage Data Programme**”, new period of existing programmatic line)
- ✓ **Earthnet** (new period of existing programmatic line)

Earth Observation Envelope Programme – 5th period
(EOEP-5: 2017-2021)



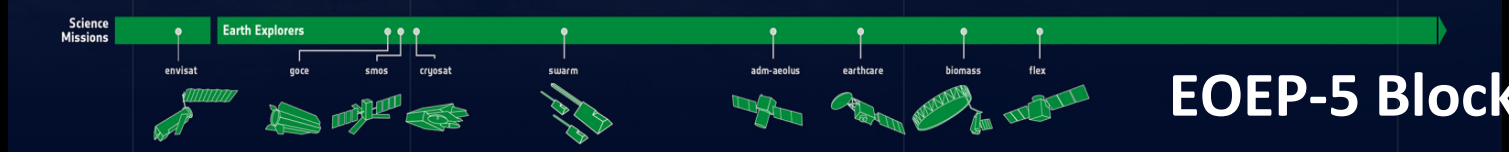




EO backbone programme to implement ESA's Space 4.0

- ✓ Addresses societal challenges (climate, water, SDG, etc.)
- ✓ Enhances competitiveness of European space, ground and services industry
- ✓ From pre-development to exploitation
- ✓ Prepares all future missions
- ✓ Drives scientific excellence and innovation
- ✓ Improved, user-ready data access
- ✓ Brings EO to all levels of society

EOEP-5 secures the continuation of the programme, with however significantly new content and methods.



EOEP-5 Block 3

08 09 10 11 12 13 14 15 16 17 18 19 20 21

Funded by EOEP-3 MOM (5 years)

Funded by EOEP-4 MOM (5 years)

Funded by EOEP-5 MDM (4 years)

smos — SMOS

cryosat — CryoSat

swarm — Swarm

adm-aeolus — ADM-Aeolus

earthcare — EarthCARE

SAOCOM-CS

goce — GOCE

ers — ERS-1/-2

1991

envisat — Envisat

2002

2012

Data management

Funded by Heritage Data Programme (LTDP+)

Data preservation and valorisation

Data management

Data preservation and valorisation

Data management

Data preservation and valorisation

smos
cryosat
swarm
adm-aeolus
earthcare
biomass
flex
goce
ers
envisat

EOEP-5 Block 3

Earth Explorer Missions Management

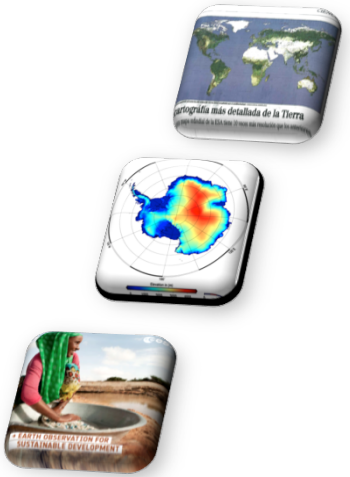
+

Level 2 products
for all Earth Explorers
in development
& in exploitation

EOEP-5: EO Science for Society - Block 4

1. Scientific data exploitation
2. EO Exploitation Platforms → ***support to EO-Innovation Europe concept***
3. EO for Sustainable Development

- → Community engagement, science/development projects, toolbox development
- → Open science, EO social networking
- → Develop data access/platform technology
- → Business incubation
- → Cooperation with intl. funding institutions



Two key EO elements in the ESA General Budget 2017-2021

"Heritage Data" (a.k.a. LTDP+)

"Data are central in science and in economy and are the only remaining assets once the mission is ended"

- ✓ Heritage Data programme not only care for data preservation of the data, but also for their accessibility / usability e.g. for long-term climate studies.
- ✓ Implemented as a common programme across ESA (4 directorates)

heritage data programme
ltdp+

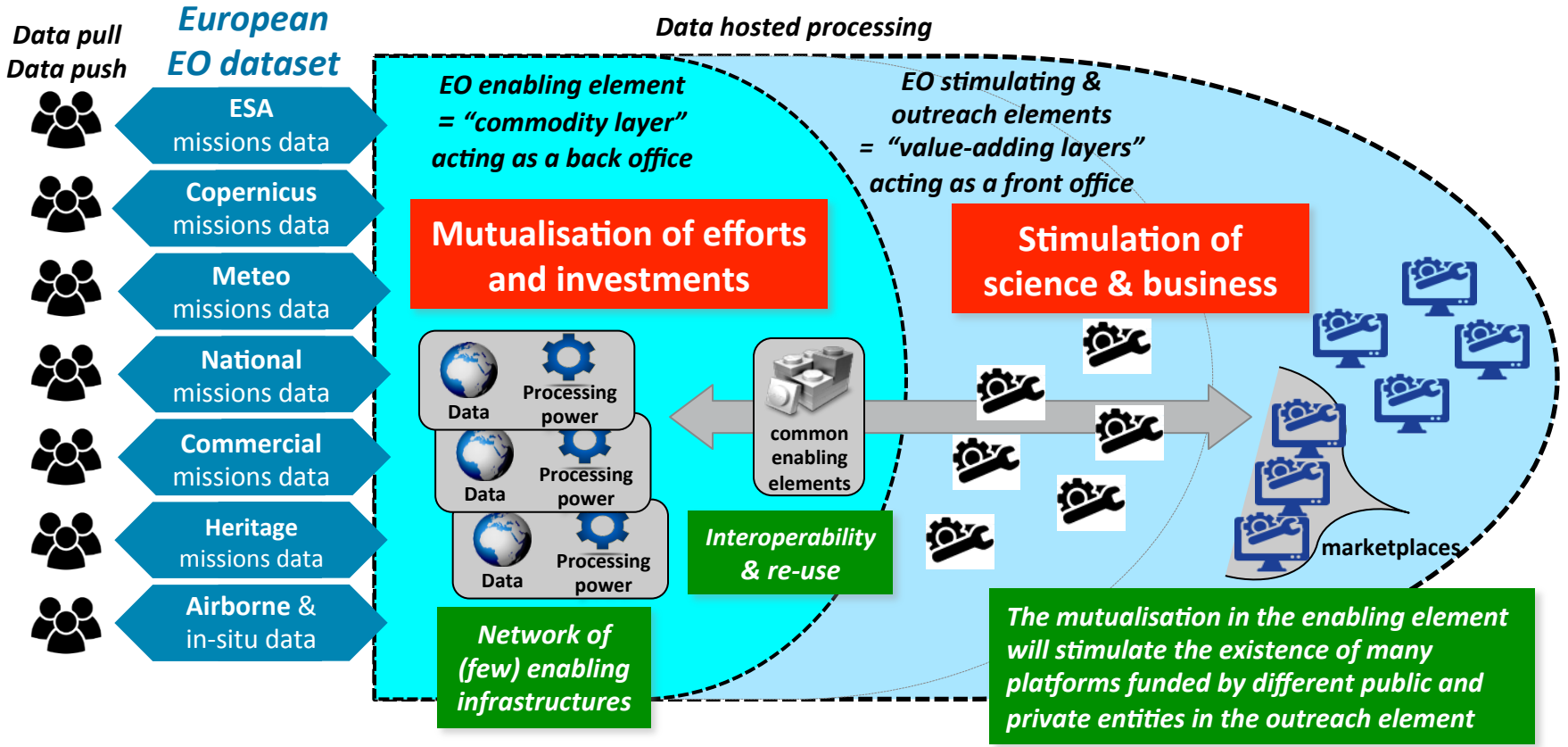
"Earthnet"

International Charter Space & Major Disasters
Charte Internationale Espace et Catastrophes Majeures

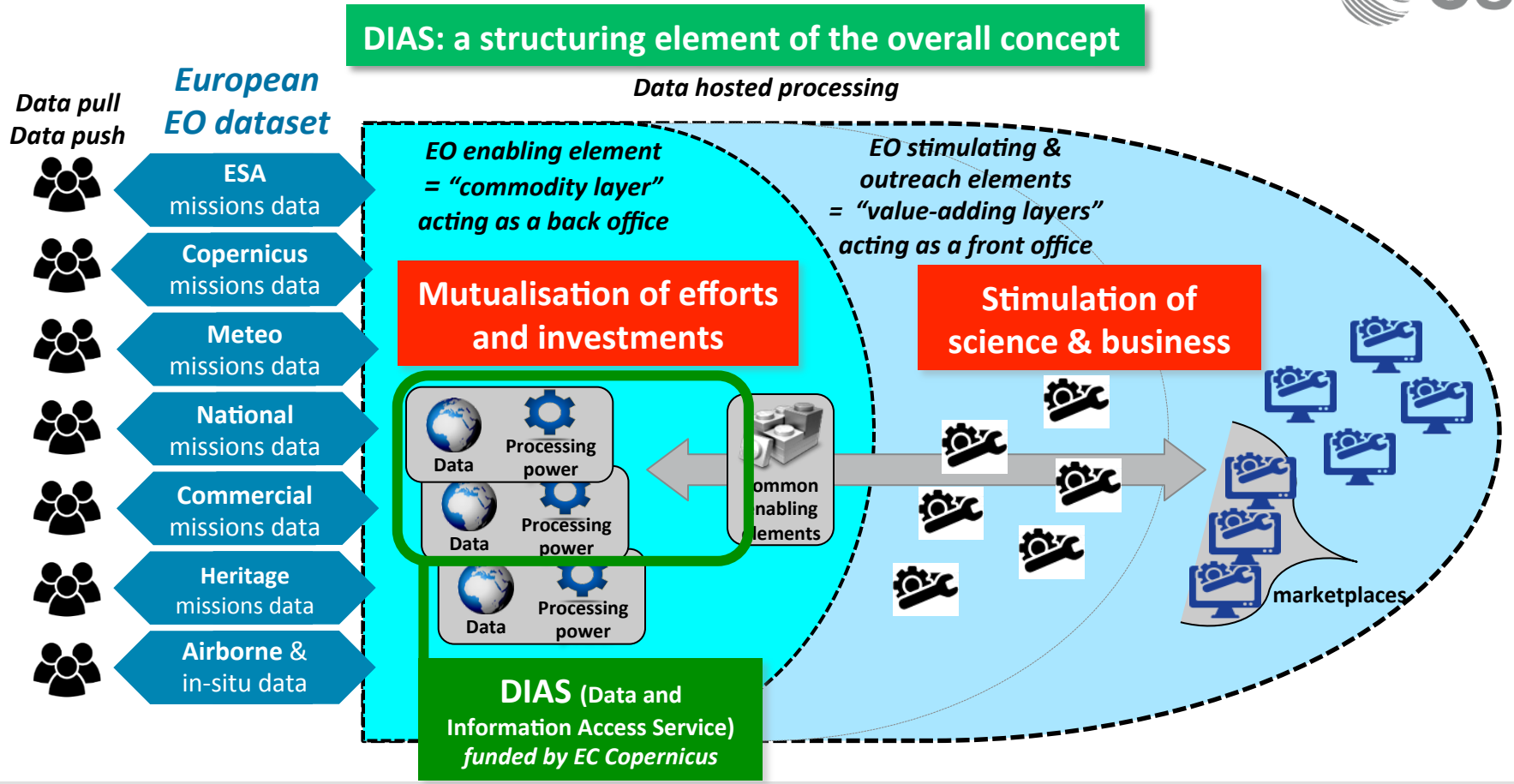
"European international gateway for Earth Observation"

- ✓ Equal & persistent MS access to Third Party Mission (including historical SPOT series, Jason-3, Landsat series, …)
- ✓ 24/7 coordination of the International Charter on Space and Major Disasters,
- ✓ Presence in organisations and committees (e.g. UN, GEO, CEOS) and in initiatives for promoting the international use of EO data (e.g. in Africa, China)

EO Innovation Europe → *an architectural framework*



EO Innovation Europe → *an important step forward: DIAS*



European EO data ecosystem

→ *Partnership and aligned programming between DG-GROW and ESA*

DG-GROW Copernicus Data Access and Information Service (DIAS) platforms are *primarily* addressing **data** & **ICT layers** and associated components:

- Procurement of online data storage, performance computing resources & network bandwidth
- ICT resources made available to EO Community e.g. Copernicus Services, ESA, Participating States, R&D and commercial users on commercial terms to be defined

- Copernicus services, user uptake and research (H2020) measures to build on DIAS
- Future support of scientific computing through e-infrastructure services (e.g. DG-CONNECT)
- Future strong synergies between European GEOSS infrastructure and Copernicus ecosystem (e.g. DG-RTD)

ESA EOEP-5 (Block 4 'EO Science for Society') will build on the Copernicus resources put in place by DG-GROW and *primarily* focus on:

- Development of **common enabling and EO data tool** components
- Implementation of **middleware, data analytics and community (value-adding) layers**

ESA's EO programme components (EOEP, InCubed, Earthnet, LTDP +, Earth Watch CCI) would build on the Copernicus resources put in place by DG-GROW and *primarily* focus on:

- Availability of curated historic data and long time series
- Availability of complementary data from ESA missions and Third Party Missions alongside Copernicus data & information

It is foreseen that ESA focuses its R&D efforts on the Commission-supported Copernicus ecosystem

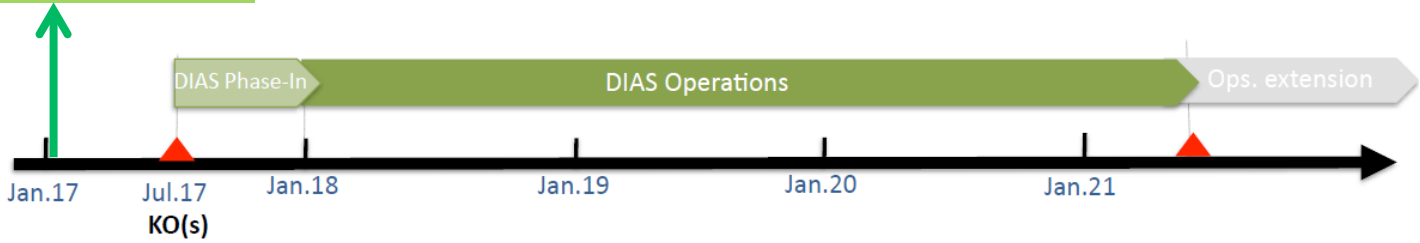
DIAS (Data and Information Access Service)
funded by EC Copernicus

DIAS ITT Industry Information Day (21 December 2016)

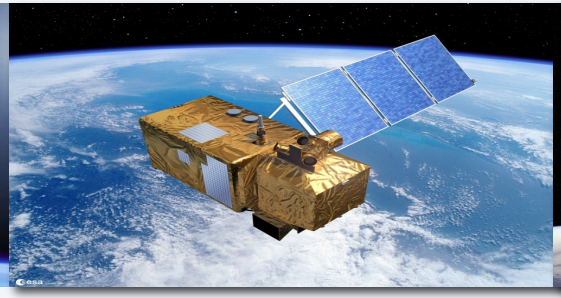
→ ***200+ participants*** filling the ESRIN Big Hall, making it one of the largest industry days at ESRIN

→ representatives from large system integrators, major European ICT providers, numerous SMEs + delegates from national space agencies, EUMETSAT, JRC, etc.

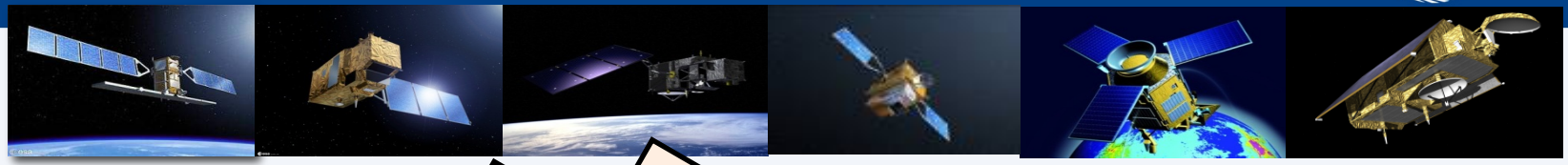
DIAS ITT issued on 27 January 2017



Copernicus Space Component Operations and Data Access


Copernicus Space Component: Dedicated Missions



- Radar Mission
- High Resolution Optical Mi
- Medium Resolution Imaging and Altimetry Missio
- Geostationary Atmospheric Chemistry Mission
- **P:** Low Earth Orbit Atmospheric Chemistry Precursor Mission
- Low Earth Orbit Atmospheric Chemistry Mission
- **(Jason-CS):** Altimetry Mission

A-LAUNCHED 3.04.2014

B-LAUNCHED 25.04.2016

A-LAUNCHED 23.06.2015

B-LAUNCHED 7 MARCH 2017

A-LAUNCHED 16.02.2016

B-LAUNCH Q4-2017

LAUNCH Q3-2017

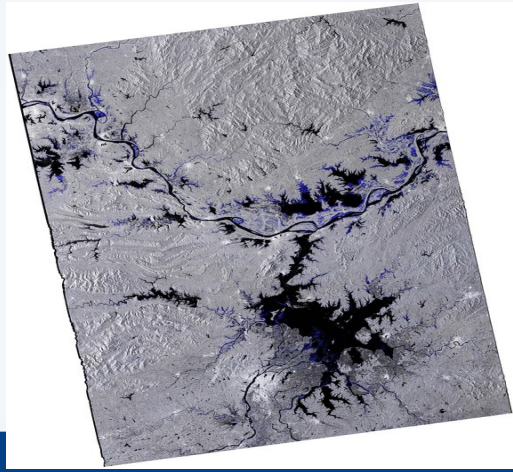
Sentinel-1: mission status

➢ 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 generates now 8 TB of products daily** (against a formal specification of 3 TB)

- Expected to be further increased with EDRS and 4th core X-band station capabilities



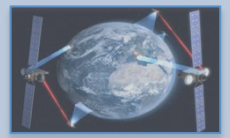
Sentinel-1 mission capacity increase

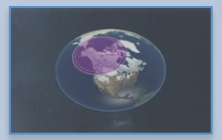
SENTINEL-1A
- ✓ Launched 3 Apr 2014
- ✓ Fully operational

SENTINEL-1B
- ✓ Launched 25 Apr 2016
- ➢ + 100% observation capacity

GROUND SEGMENT:
- ✓ 3 X-band stations

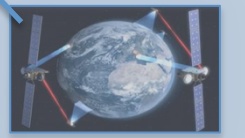
EDRS-A:
- ✓ Launch: 29 Jan 2016
- ✓ In Commissioning
- ✓ Service commissioning with S1A started in May 2016
- ✓ Routine service start: Nov 2016
- ➢ + additional downlink flexibility





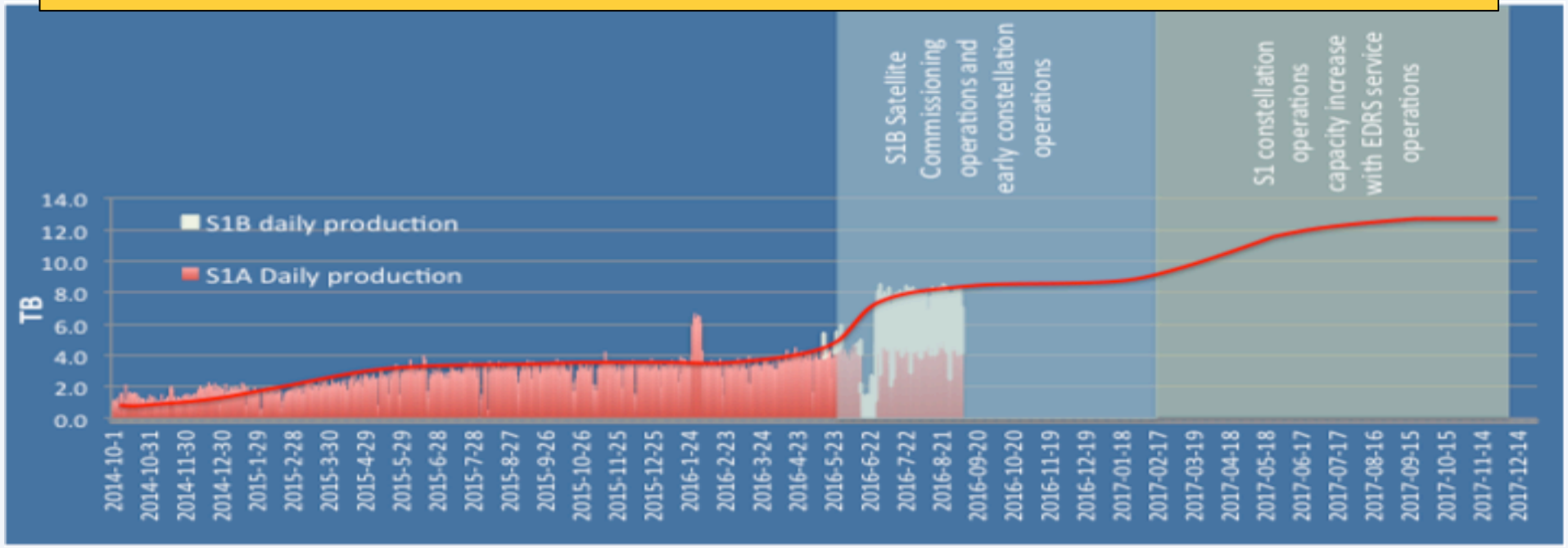
GROUND SEGMENT:
- ➢ 4th X-band station
- ➢ additional downlink capacity and flexibility

EDRS-C:
- ➢ Launch: 2017



Sentinel-1 mission capacity evolution - 2017

The Sentinel-1 mission total daily production will further increase in coming months. A **conservative forecast** projects the daily mission production to reach **~12 TB per day** by end 2017 (**~ 4.4 PB/y**)



Sentinel-2: mission status

➢ **S-2A nominal routine operations continue**

- Systematic coverage of Europe, Greenland and Africa every 10 days (at equator). Rest of the World alternating in 10 days and 20 days.
- **S-2B successfully launched on 7 March 2017: now in commissioning phase.**

➢ **Upcoming Milestones**

- Release of sample Level-2A products (surface reflectance) as part of feasibility study, and pre-operational Level-2A production over Europe.

Sentinel-2: mission capacity increase

Reprocessing archive to single tiles & new format

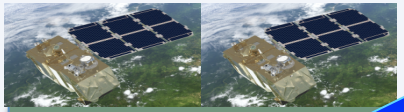
New Format (TCI, filenames)

Single tiles

Atmospheric correction 'Pilot Europe'

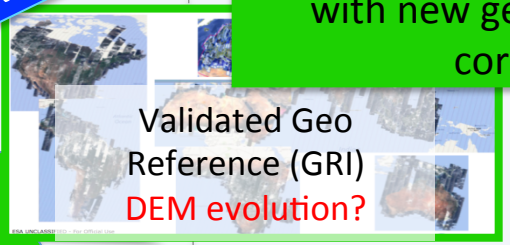
EDRS/ 4th X-band: global 10-day revisit

INCREASE OF CAPACITY, PERFORMANCE and HOMOGENEITY



perational Capacity

Large reprocessing campaign with new geometry & atm. correction ~5 PB



Atmospheric correction operational

S2A Ro

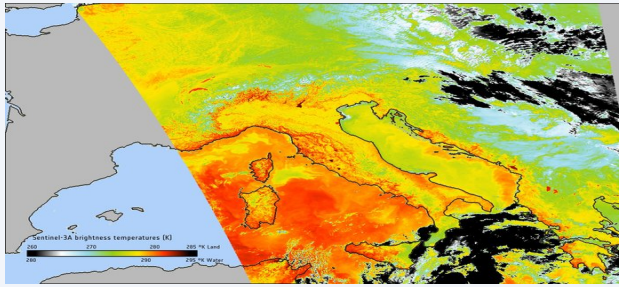
S2B Space Segment

Continue harmonisation with partner missions (e.g. GRI for Landsat-8)

S2B Launch	S2 Mission	S2 geometric
28 Feb – 8 Mar 2017	ROR ~ end 2017	Baseline 2018

Sentinel-3: mission status

- Sentinel 3A **ramp-up (operational qualification) phase progressing nominally**
- **Level 1** core products have been released to all users
- SRAL L1A and L1B-S NEW core products released in February 2017
- **Level 2** core products operational qualification on-going
  - SRAL over land and ocean released in Dec 2016
  - OLCI and SLSTR release planned in April 2017
  - SYNERGY products release planned in Q2/2017
  - AOD and FRP NEW core products release planned in Q3/2017



- **Upcoming Milestones**
- Successfully complete the Sentinel-3A ramp-up phase and transition into routine operations.
- Prepare for the Sentinel-3B launch, commissioning and ramp-up

Sentinel-5P: mission overview

- Sentinel-5 Precursor (S5P) is focusing on global observations of the atmospheric composition for **Air Quality and Climate**
- The TROPOspheric Monitoring Instrument (TROPOMI) is the payload of the S5P mission and is jointly developed by The Netherlands and ESA
- S-5P will be provide enhanced radiometric sensitivity & spatial resolution enabling sampling of small-scale variabilities specifically in the lower troposphere
- Background mission with global daily coverage
- Space and ground segment development completed
- Launch on-board Rockot (August 2017, TBC)

S-5P Data Volume:

- L1: ~35 Gbyte/orbit
- L2: ~3.5 Gbyte/orbit
- Total: ~ 640 Gbyte/ day

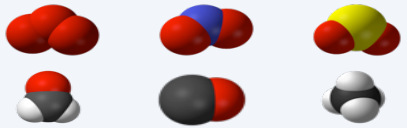
Sentinel-5P: products overview

Sentinel-5 Precursor Data Products		
Product	**Description**	**Remarks**
Level 0	**Unprocessed instrument measurement, HK & engineering data**	**internal use only**
Level 1B	**Calibrated, geo-located Earth radiance & solar irradiance spectra in all bands**	**Systematic processing**
Level 2	***Column densities/profiles for S5P primary species:*** ***UVN channel products*** **O_3** total & tropospheric columns, profiles **NO_2** total & tropospheric columns **SO_2, HCHO** total columns **aerosols** aerosol index & aerosol layer height **clouds** cloud fraction, top height, optical thickness	**Non Time Critical:** **All products** **Near Real-Time:** **All species except CH_4 & tropospheric O_3**
	SWIR channel products **CO, CH_4** total columns	

Near real-time delivery: 3 hours after sensing

Non time critical: 14 days after sensing

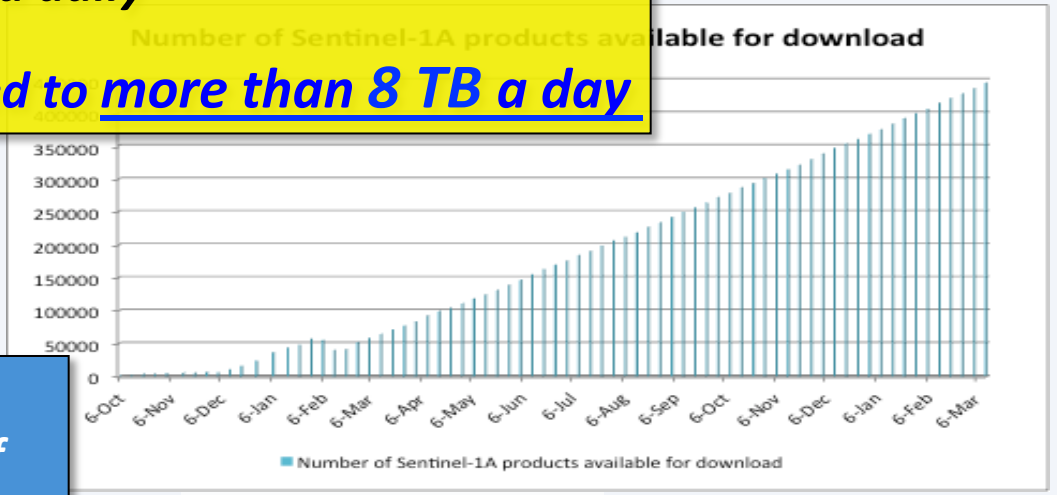
Level 1b and Level 2 will be provided to all users by ESA



Sentinel data – Systematic Production

In 2015 an average of 3 TB of core products was generated daily

By end 2016 this figure has increased to more than 8 TB a day



Full Sentinel-1 production is available online: > 1 million products (>1.4PB of data)

Full Sentinel-2A production is available online: >600,000 products (>500 TB of data)

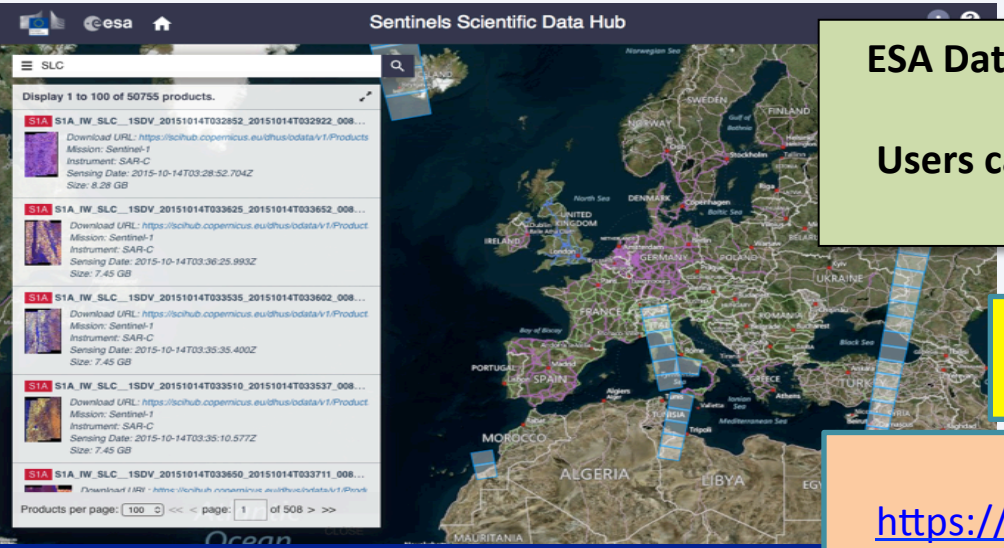
Sentinel-3A Level-1 products gradual release to all users started in Q4-2016

Statistics: 16 February 2017

Sentinel Data Access @ ESA

- ESA offers free access for all users to Sentinel products: most recent as well as complete long term archive
  - Any user can **self-register** at **sentinels.copernicus.eu**

- ESA delivers on 24/7 basis **Near Real Time** products (3 hours from sensing) as well as Non Time Critical products (24 hours from sensing)



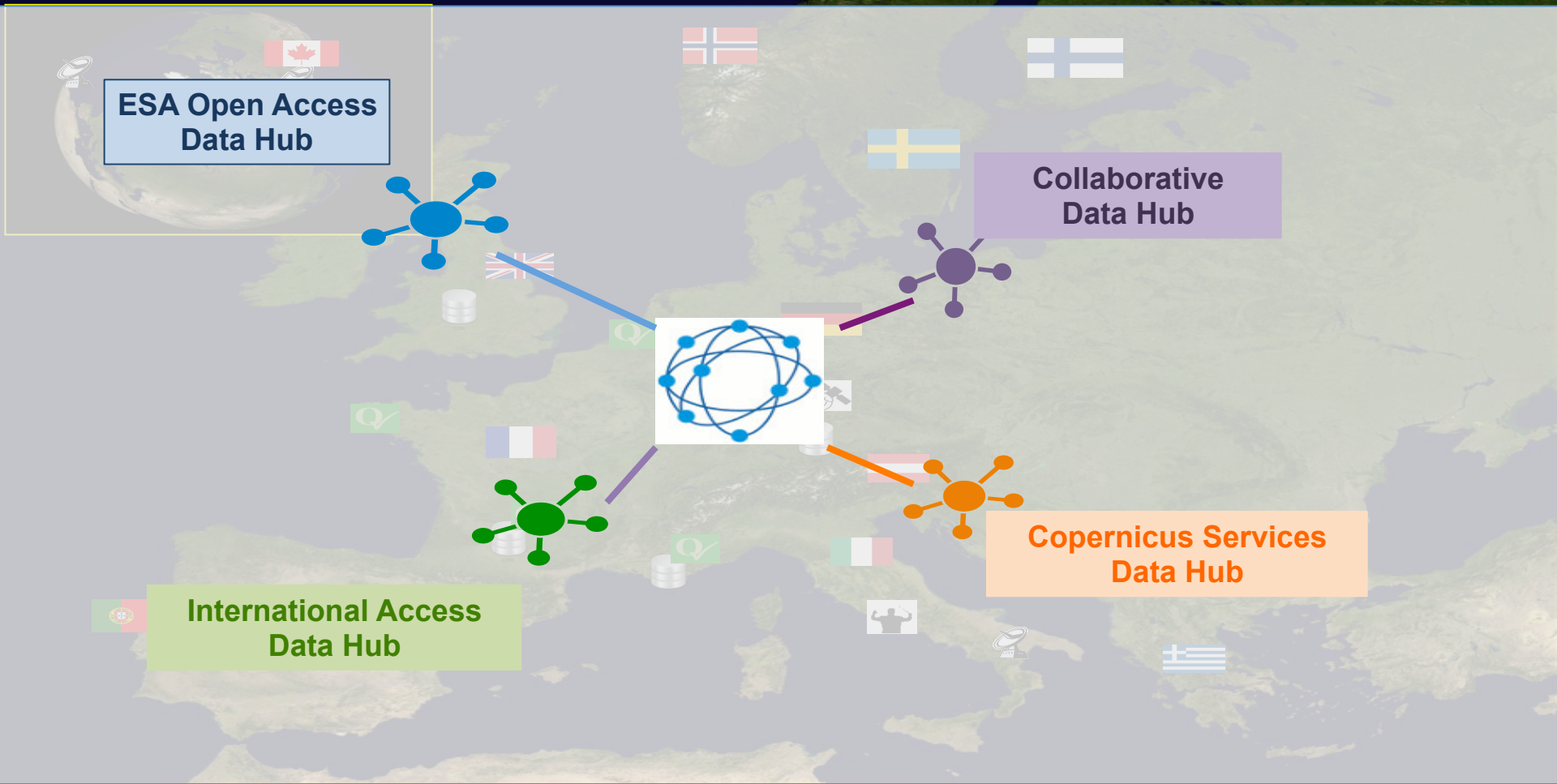
ESA Data Hub provides an OPEN SOURCE Web interface

Users can set own scripts to automatically search filter and download products

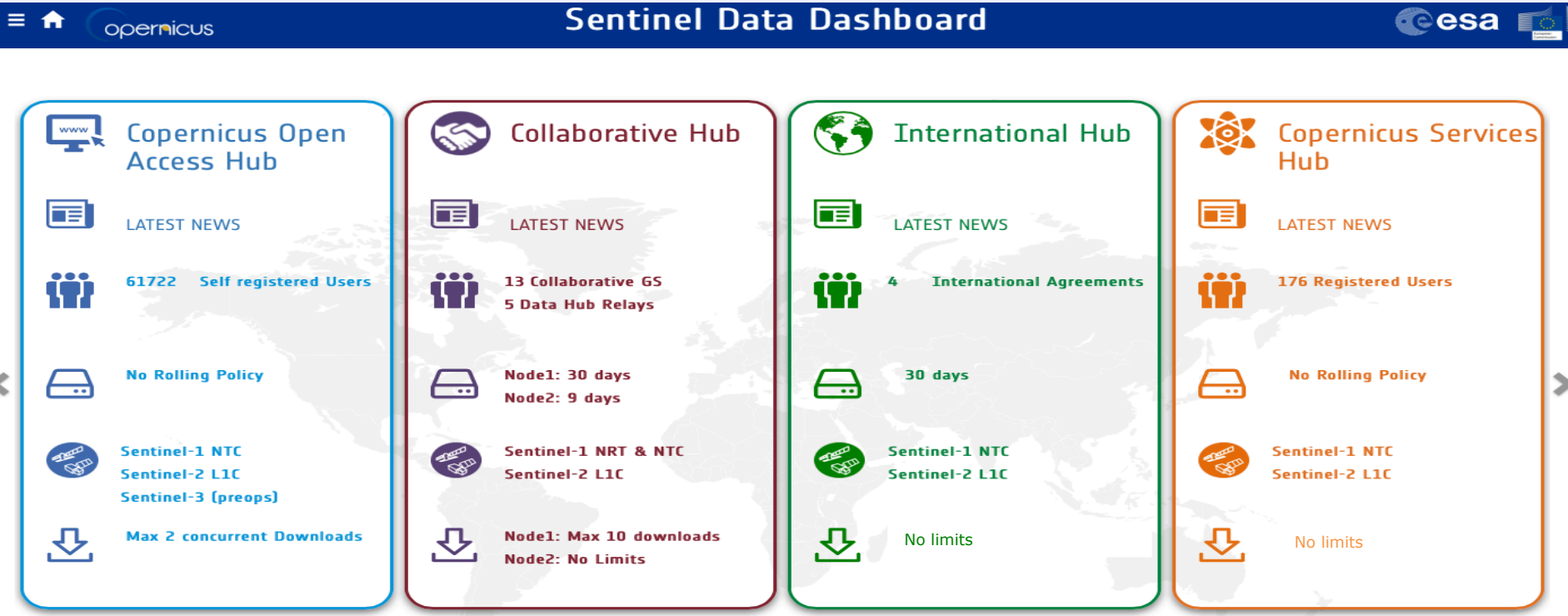
Sentinel Toolbox available as open source software https://github.com/senbox-org

Data Hub Server software available at https://github.com/SentinelDataHub/DataHubSystem

Sentinel Data Hubs

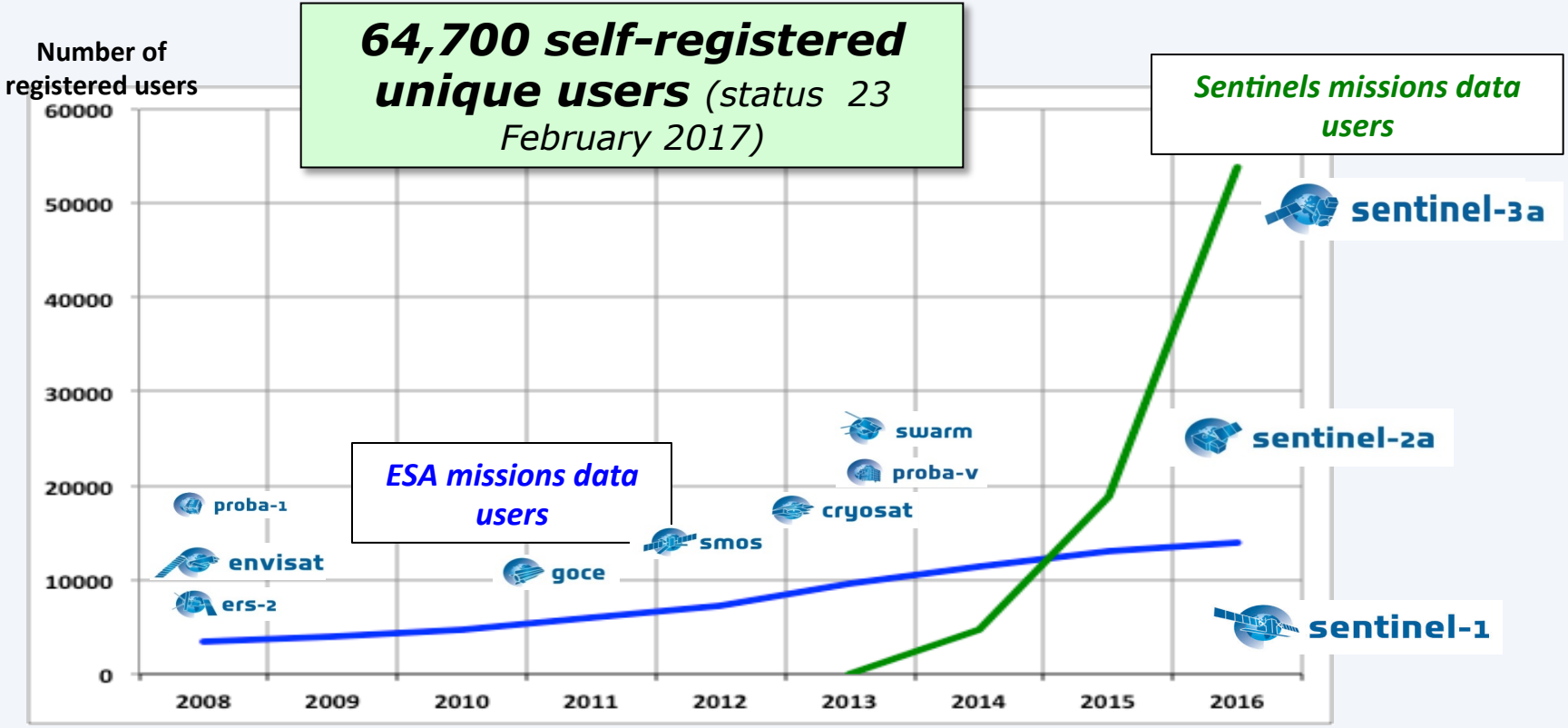


Sentinel Data Hubs – Latest Configuration

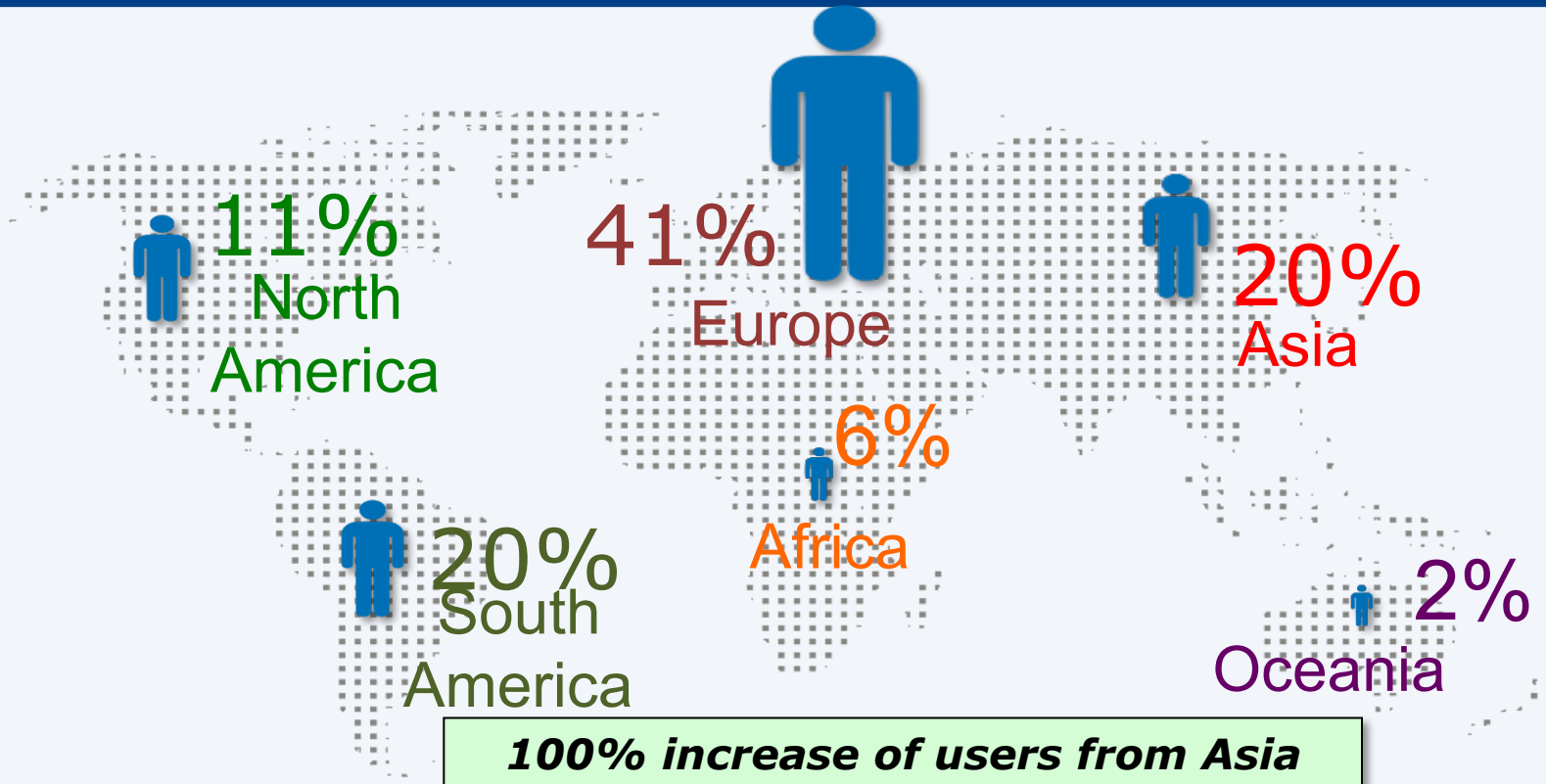


Statistics: 7 February 2017

Sentinel data - Users Registration



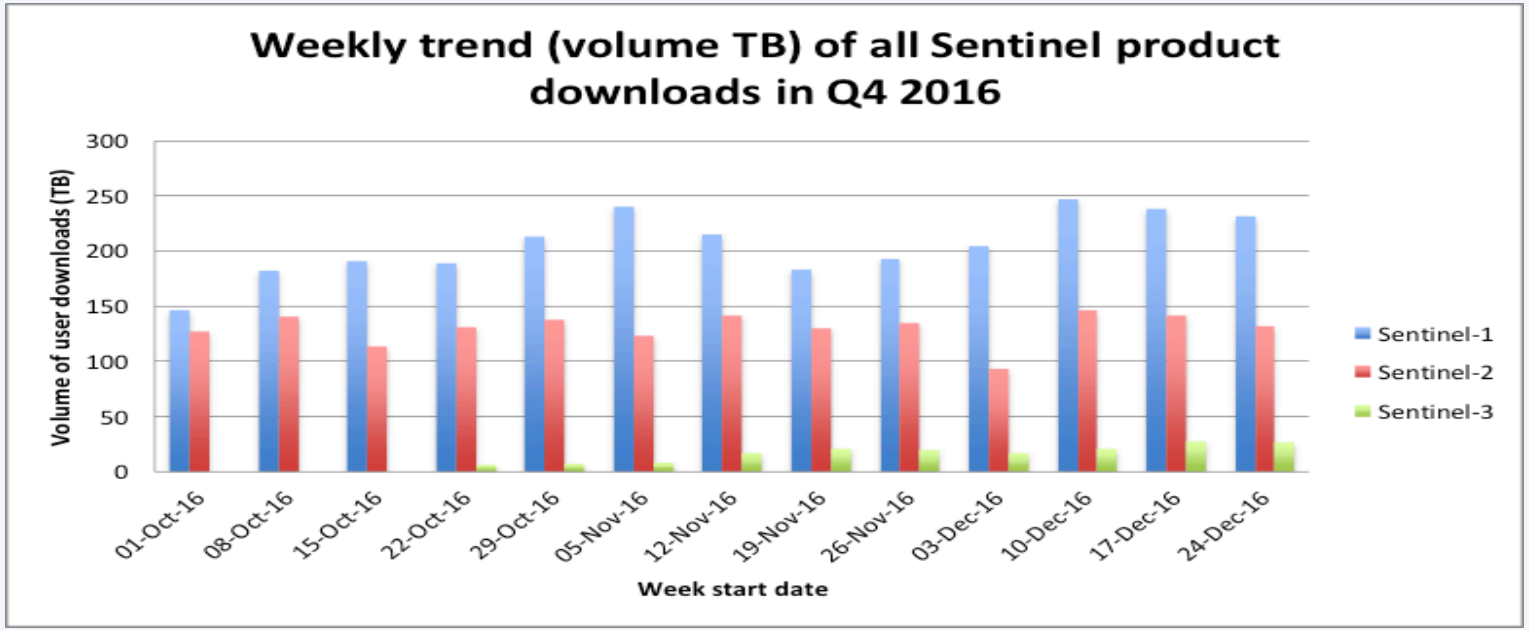
Sentinels Data Access Statistics – Global View



100% increase of users from Asia and South America in last quarter

Statistics: Q4-2016 (31 December2016)

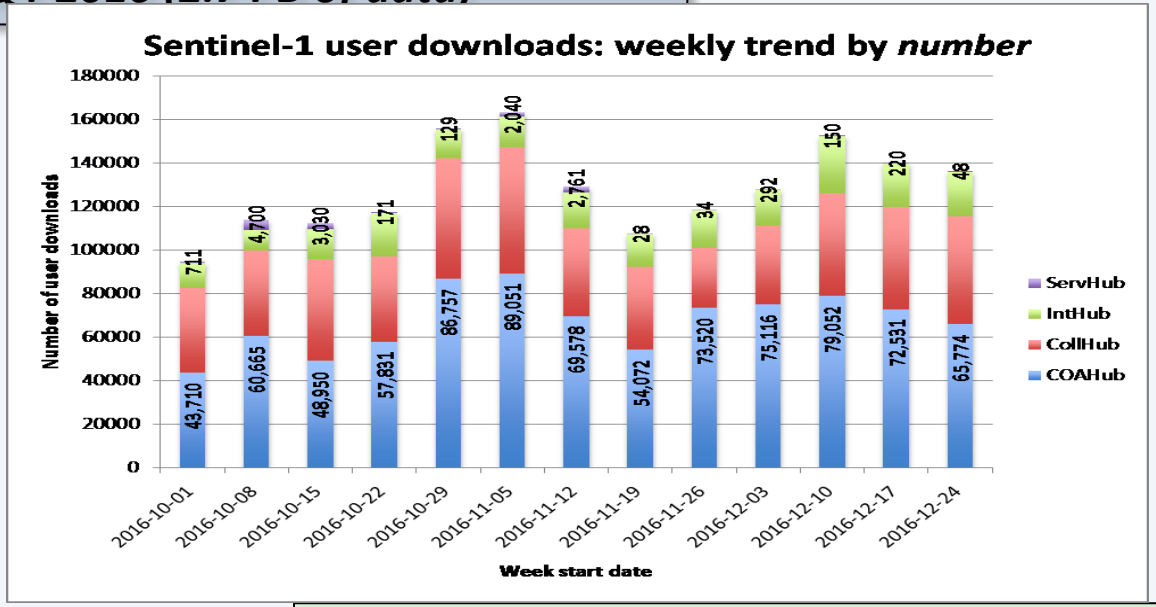
Sentinels: Data Dissemination Volumes



Approx. 4,6 MILLION products were downloaded during Q4-2016 corresponding to 4,6 PB of data

Sentinel-1: Data Dissemination Overview

Approx. 1.6 million products were downloaded during Q4-2016 (2.7 PB of data)

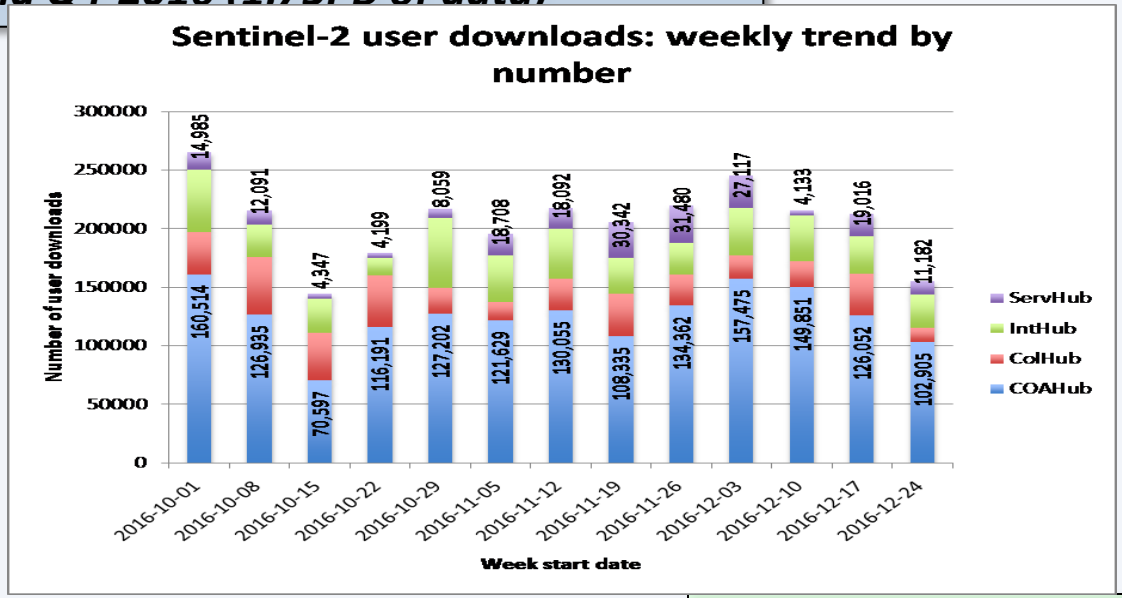


Exploitation ratio - 1:10

on average each product published has been downloaded 10 times

Sentinel-2: Data Dissemination Overview

Approx. 2,7 million products were downloaded during Q4-2016 (1.75PB of data)

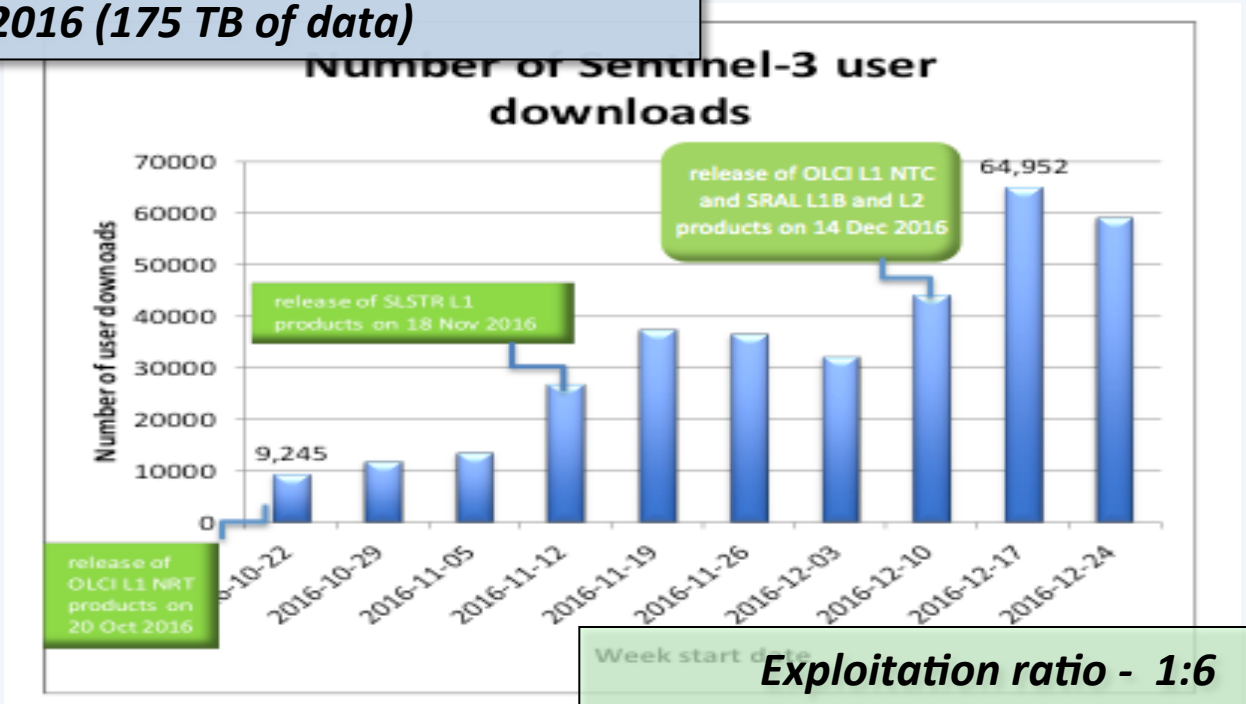


Exploitation ratio - 1:10

on average each product published has been downloaded 10 times

Sentinel-3: Data Dissemination Overview

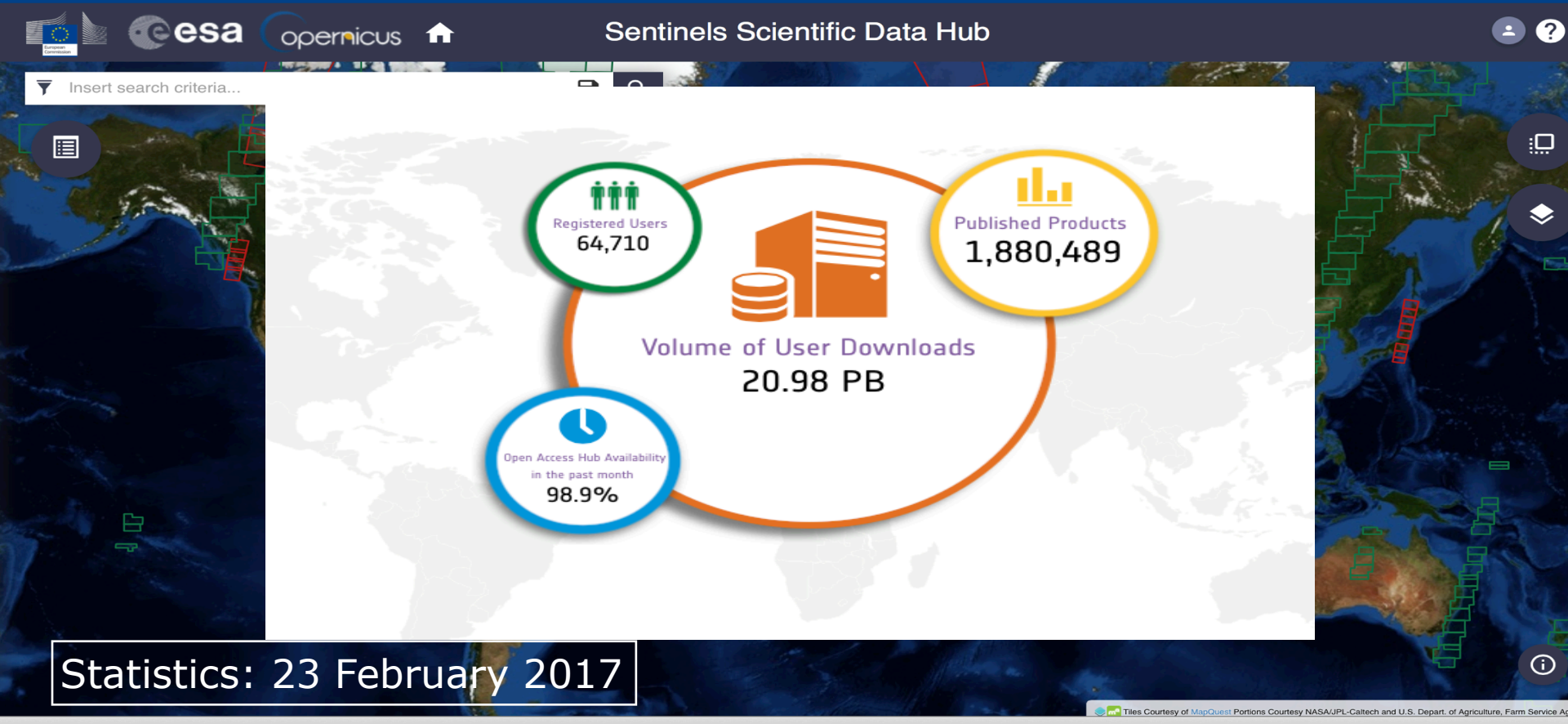
Approx. 344,000 products were downloaded during Q4-2016 (175 TB of data)



Exploitation ratio - 1:6

on average each product published has been downloaded 6 times

Sentinels Data Distribution - Overall Statistics

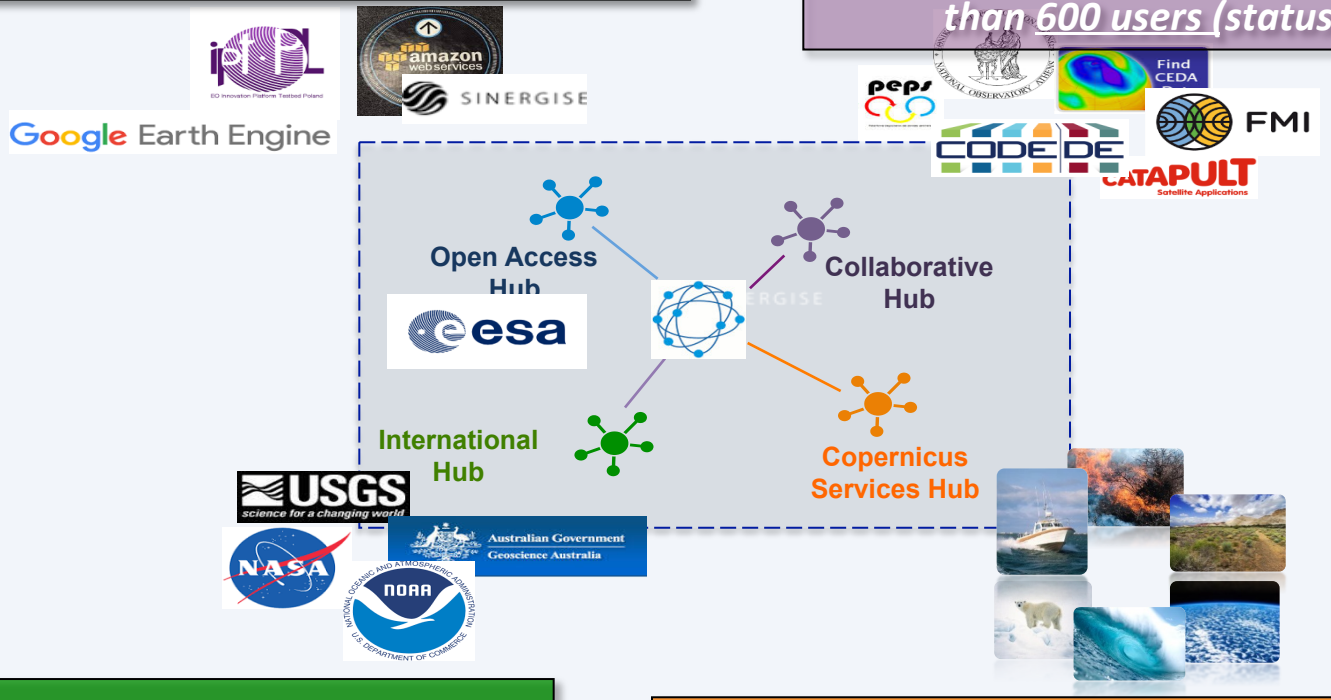


Sentinel Products - Redistribution

Many users **re-distribute the Sentinel products** downloaded from ESA's data access hubs, allowing to reach a larger community

Large and small private companies are re-distributing Sentinel products via free and pay-per-use schemes

Collaborative mirror sites directly serve more than 600 users (status end 2015)



As of spring 2016, international partners mirror sites have started disseminating towards own national communities

Copernicus Services are providing their higher level products to approx 10,000 user (status Q1-2016)