

# → THE ESA EARTH OBSERVATION $\Phi$ -WEEK

## EO Open Science and FutureEO

12–16 November 2018 | ESA–ESRIN | Frascati (Rome), Italy

**From Research & Innovation to Operations:  
Implementing a Set of Space and Security services**

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13/11/2018

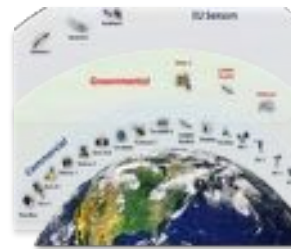
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Agency of the EU



HQ near Madrid (ES)



User of EO Satellite Data



Service Provider

To support the decision making and actions of the EU in the field of the CFSP by providing products and services resulting from the exploitation of relevant space assets and collateral data



DIRECTOR

Capability Development

Operations

IT

Admin

Finance



The *Research, Technology Development and Innovation* Unit is implementing new operational solutions looking at the whole EO and collateral data lifecycle:

- Cooperation (e.g. H2020 Projects, ESA, GEO)
- New Data Acquisition Systems (e.g. HAPS, Small Satellites)
- Alternative Data Sources (e.g. Mobile Networks)
- Innovative Technologies (e.g. Big Data, Artificial Intelligence)
- EO Based Applications (e.g. SAR Change Detection)



New solutions

should enable effective exploitation of  
increasing data volumes

(foreseeing a major contribution of open data)

through automatic tools

covering the whole data life-cycle

## CLASSICAL APPROACH

### Data Access

- Decentralized
- Distributed
- Duplicated
- Different formats
- Metadata
- Need for data preparation

### Data Processing

- Different tools for different tasks
- Different tools for different formats
- One task at a time
- Manual tuning

### Data Analysis

- Visual interpretation
- Based on human intelligence
- Limited number of discoverable patterns
- Discarded information outside visible spectrum
- Analysis time grows with area scale

Data Access



Data Processing



Data Analysis

## AUTOMATIC APPROACH

### Data Access

- Single point of access
- Easy search, discovery and retrieval
- Standardized catalogues
- Analysis-ready data

### Data Processing

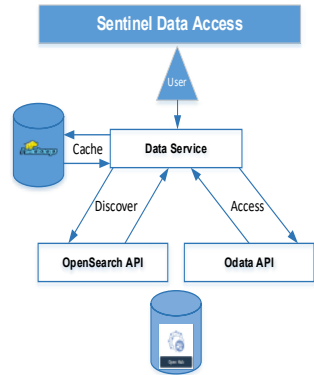
- Processing As a Service
- Format agnostic
- Scalable (multiple tasks at a time)
- Proactive large area handling (e.g. change detection)

### Data Analysis

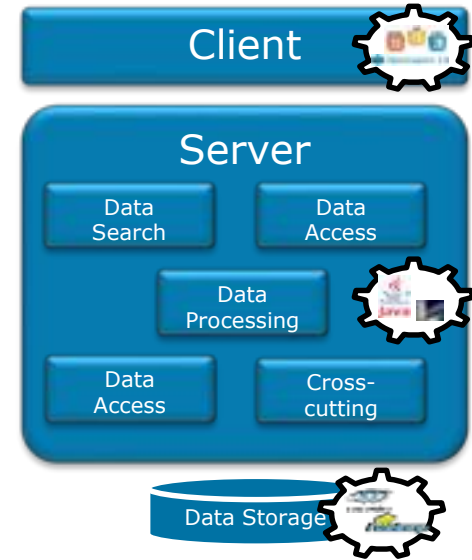
- Discover patterns not visible to the human eye
- Increased accuracy
- Focus human intelligence on deeper analytics
- Scalable
- Proactive analysis (e.g. object detection, anomaly detection)

- Data Access Services
  - Sentinel Data Access
- Data Processing Services
  - Sentinel-1 Pre-Processing
  - Sentinel-1 ACD
  - Sentinel-1 MTC
- Data Analysis Services
  - ML Object Detection





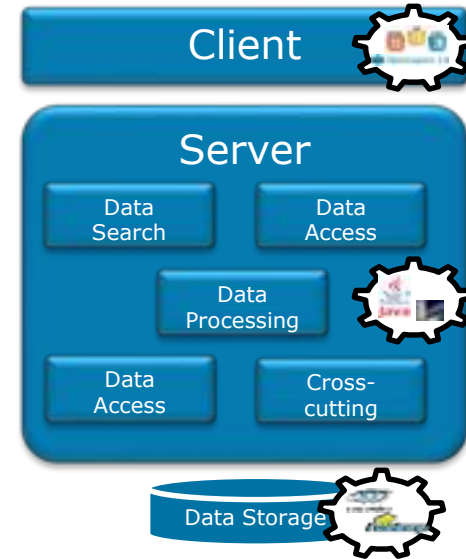
- Data Discovery
- Data Access
- Data Caching





Geo-referenced

Ortho-rectified



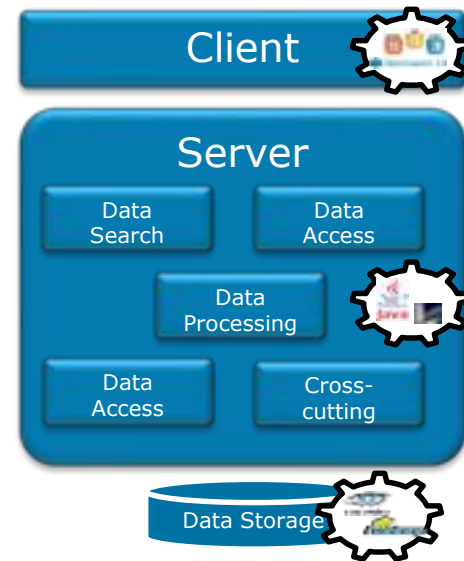


# Sentinel-1 Amplitude Change Detection

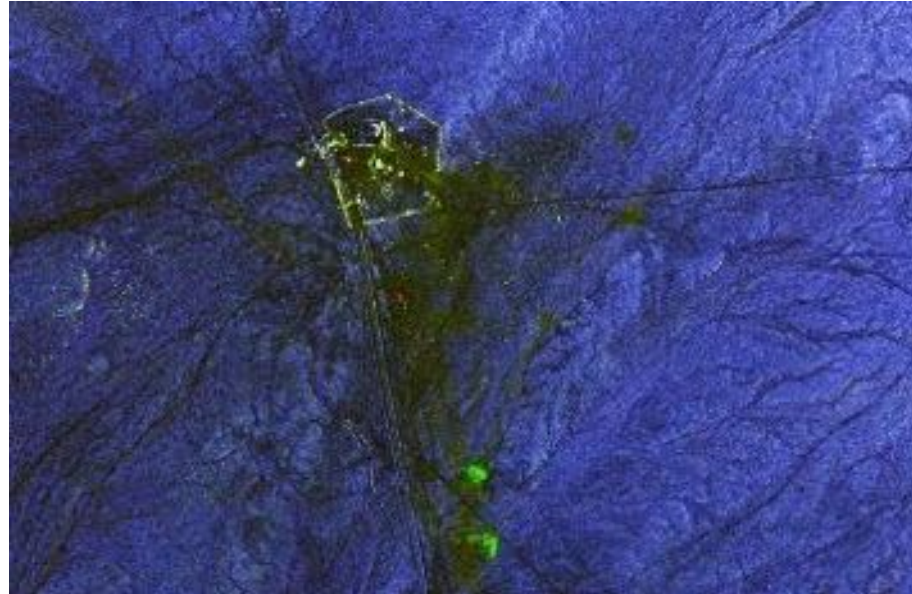
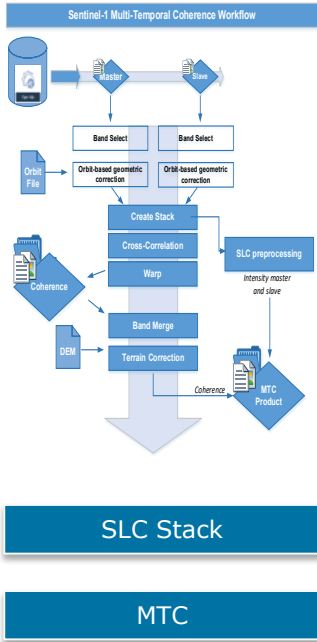


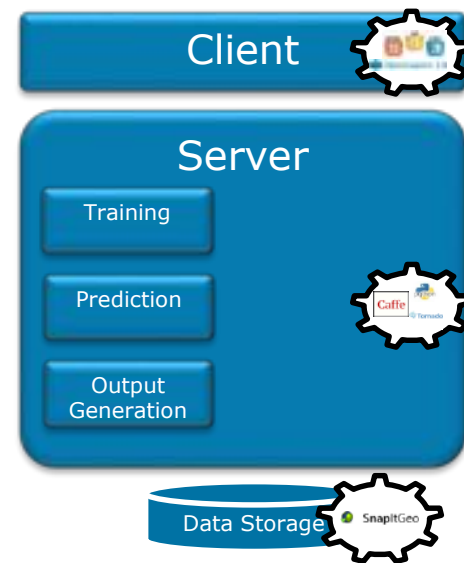
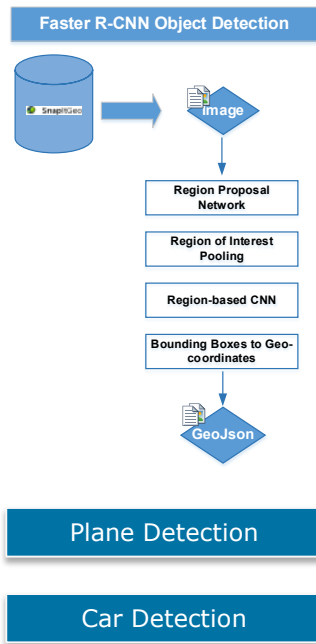
Change Detection

Continuous Monitoring

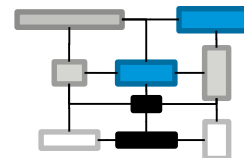


# Sentinel-1 Multi Temporal Coherence





# Moving to a New Concept



Several Interfaces

Vertical Scalability

Scales at once

Single Technology

Interoperability more Complex

Slow – Less Agile Iterations

Evolution: Domino Effect?

Monolith Applications

Single Interface

Horizontal Scalability

Per Service Scalability

Different Technologies

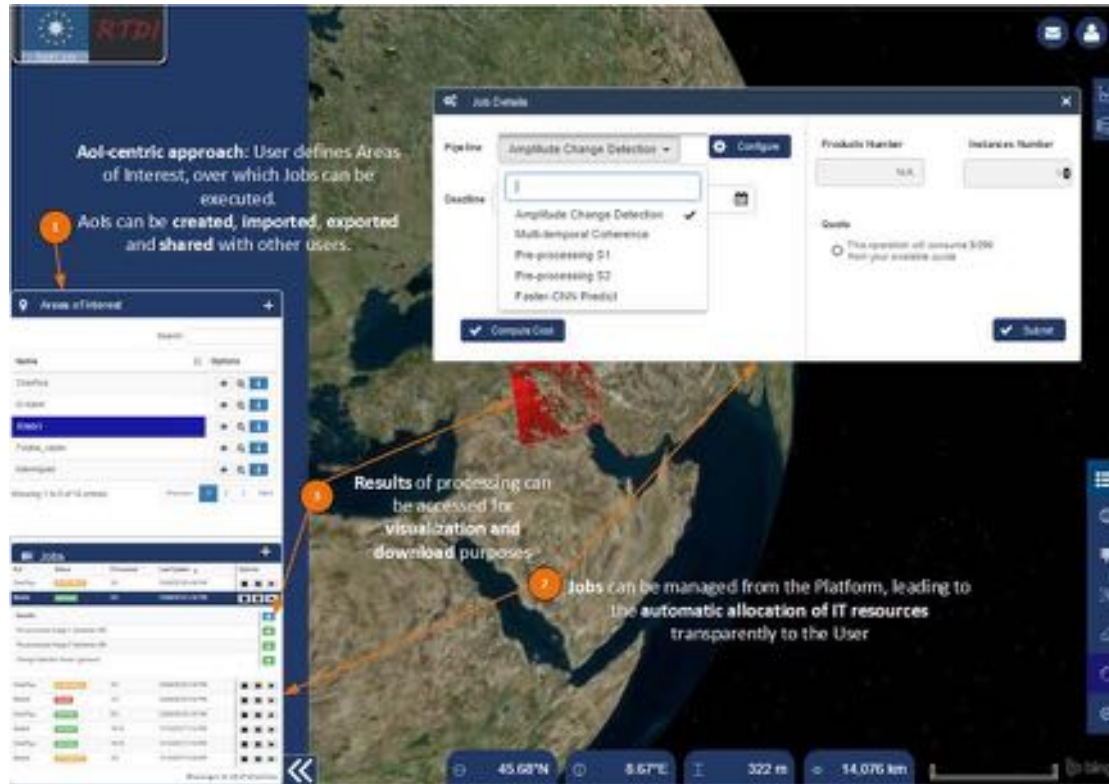
Interoperability by Design

Faster – More Agile Iterations

De-coupled Services

Pipelines

Moving from a standalone monolithic architecture to a SoA composed of loosely coupled elements



**Aoi-centric approach:** User defines Areas of Interest, over which Jobs can be executed.  
Aois can be created, imported, exported and shared with other users.

**Results of processing can be accessed for visualization and download purposes.**

**Jobs can be managed from the Platform, leading to the automatic allocation of IT resources transparently to the User.**

The interface shows a satellite in the top right, a map of Europe with a red Area of Interest, and several panels: 'Areas of Interest' with a table, 'Jobs' with a table, and 'Job Details' with configuration options like 'Pipe line: Amplitude Change Detector' and 'Deadline'. A 'Compute Cost' button is visible at the bottom of the Job Details panel.

- Accessing relevant **DATA & INFORMATION** in a timely manner
- Maximizing benefit from **OPEN DATA**
- Handling new data sources in a **UNITARY FRAMEWORK**
- Moving **FROM PIXEL TO INFORMATION**
- Enabling proactive analysis by **BIG DATA SOLUTIONS**
- Focusing on value added by **AUTOMATED TOOLS & AI**
- Reaching **END-USERS** in due time

# Thank You!

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## Work in progress



ML Object Detection  
*planes / cars*



Crowdsourcing  
*geotagged multimedia*



Image Processing  
*facial recognition*

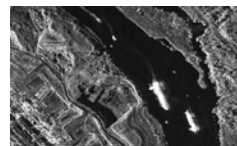


Object Detection  
*boats*

## New AI based services



Context learning



High Resolution SAR  
Object Detection



Learning Time series



Anomaly Detection

## CHALLENGES

### Data

- Definition of a common vocabulary
- Dataset preparation (accounting for data refresh cycle requirements)
- Model training

### Deployment

- Data management (security)
- Acceptance by community (Deep Learning Tools are black boxes)
- Operational constraint – training time should not exceed operation response time

### Service Provision

- Verification and Validation of AI tools and algorithms (trust and transparency issues)
- Trained workforce (i.e. analysts) to use ML/AI



The Research, Technology Development and Innovation (RTDI) Unit is conducting Research and Innovation (R&I) activities at the European Union Satellite Centre (SatCen) with the aim of providing new solutions to support the operational needs of SatCen and its stakeholders. RTDI is also in charge of fostering the cooperation with international organisations such as the European Space Agency (ESA) and the Group on Earth Observations (GEO).

To advance the management and exploitation of Earth Observation (EO) and collateral data for improved service provision to Space and Security stakeholders, RTDI is currently looking to implement a set of services using Big Data, Cloud Computing and Artificial Intelligence technologies. The typical RTDI service development lifecycle includes service design, implementation, testing, validation and integration in the operational chain.

In the pre-operational stage, the evaluation of suitable technologies and service applications is supported through the participation in several H2020 projects (e.g. BigDataEurope, EVER-EST, NextGEOSS and BETTER) and by collaborating with international organisations (e.g. ESA and GEO).

The service design is driven by requirements collected from Space and Security stakeholders (e.g. EU Member States and a number of EU entities); in particular, new technologies should enable effective exploitation of increasing data volumes (foreseeing a major contribution of open data) through automatic tools covering the whole data life-cycle. Starting from these requirements, the identified and developed services outline three main areas: Data Access, Processing and Analysis.

Data Access services aim at facilitating discovery and fetching of relevant data (e.g. geospatial data from satellites and other sources). Services are mainly set on Sentinel data: the Sentinel Data Access service currently guarantees a fast and reliable access to Sentinel-1 and Sentinel-2 data via the Copernicus Services Data Hub (ServHub). Through an optimized search the user inputs minimal query parameters to have access to rapid visualization and local download mechanism.

Data Processing services aim at providing users with image processing capabilities using processing chains customized for Space and Security applications. The Sentinel-1 Pre-Processing service allows Sentinel-1 data automatic pre-processing, providing a terrain-corrected product ready to use on the user own GIS. The Change Detection service allows the computation of Change Detection Maps, using Sentinel-1 imagery, within the user-defined interval of interest. Two SAR data processing chains are being developed: Amplitude Change Detection (ACD) and Multi-Temporal Coherence (MTC).

Data Analysis services aim at extracting value from the data. The Object Detection service is a demonstrator aiming at identifying specific objects of interest for the Space and Security community using Machine Learning techniques.

These services have different levels of maturity: the Sentinel Data Access service is deployed and operational, the Data Processing services are in the testing and validation phase, while the Object Detection service is currently under development. The final step will be the implementation of all services in a unitary framework, for a full integration within the SatCen operational workflow.