

→ THE ESA EARTH OBSERVATION Φ -WEEK

EO Open Science and FutureEO

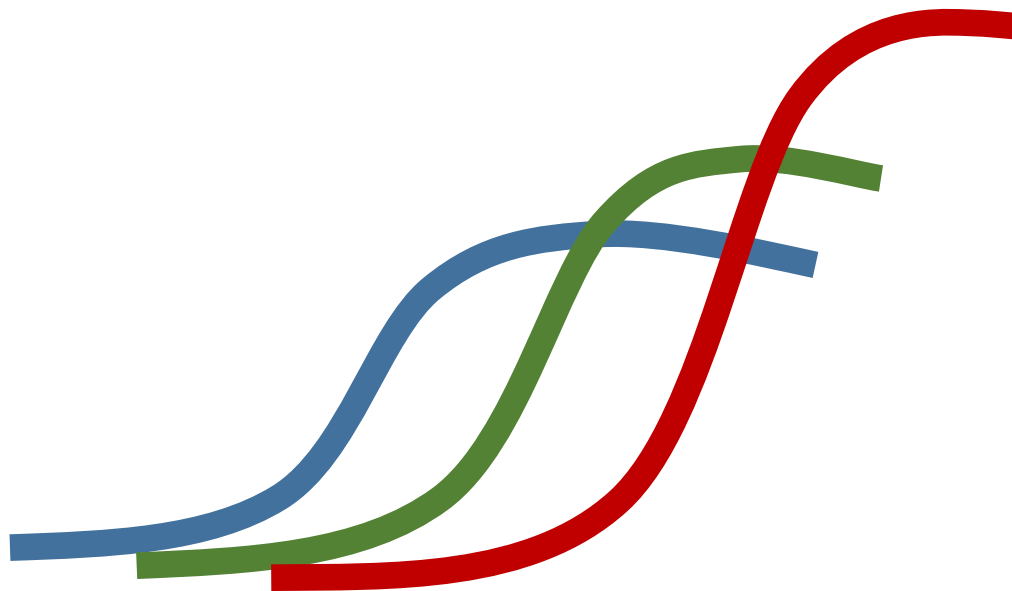
12–16 November 2018 | ESA–ESRIN | Frascati (Rome), Italy

The boosting factors of the SpaceStream Paradigm

Cristoforo Abbattista; Daniela Drimaco; Leonardo Amoruso

15/11/2018

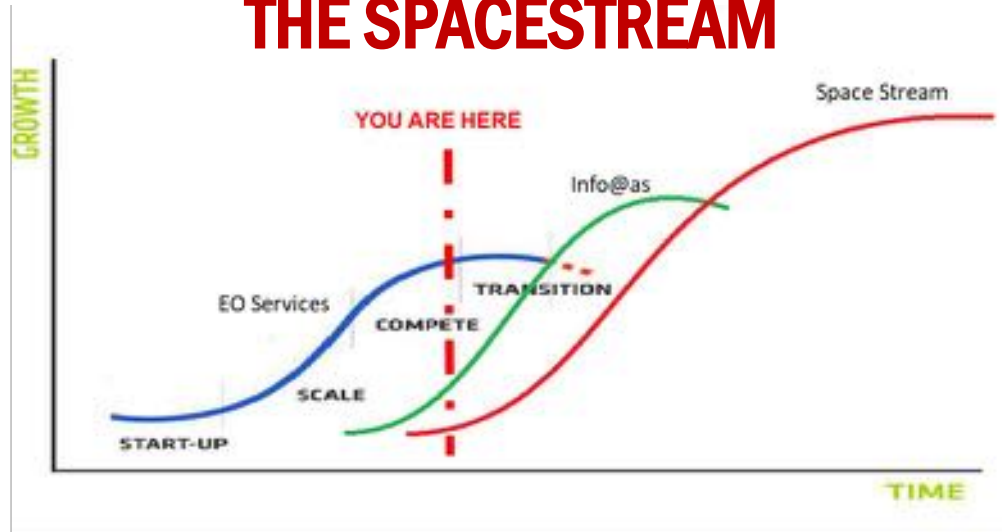
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SPACESTREAM

THE RIGHT INFORMATION AT THE RIGHT TIME IN THE RIGHT PLACE

THE SPACESTREAM



Traditional EO Service:

- High recurring costs
- Generic Coverage Information
- Low Automation
- High Geographic Dependence

Info@as:

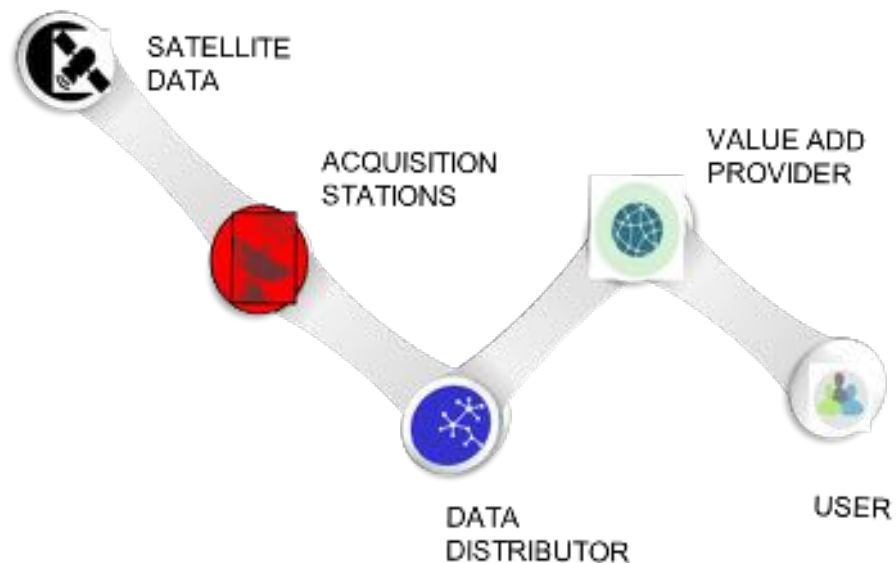
- Subscription Services
- Analytical Vertical Information
- Big Data Integration
- Globally Scalable (Auto) Services

SpaceStream:

- Satellite to User services
- Synthetic Sensors (virtual sensors)
- In Space processing of data
- Globally Scalable Services

The traditional EO Value Chain

A sharp separation between Up Stream and Down Stream activities.



EO Services will sell **Wisdom**

Networks of “*heterogeneous, distributed Ground Segments*”

Swarms of “*cooperative and competitive Space Agents*”

*UpStream and DownStream mixed in the FOG
of the **Continuous SpaceStream***

A shared Vision



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European Space Agency

EO data is a commodity

- We can get data at different time by different providers
- We have even complete background EO missions/constellations like Sentinel or Landsat

We can ask for more than data

- Responsiveness: *Normal Mode*
- Reactivity: *Emergency Mode*
- Low Latency: *Less Data more Services*

Marine



- Phytoplankton bloom
- Oil spill
- Plastic island
- Thermal anomalies
- River Plume anomalies

Security



- Non collaborative Ships
- Accidents: Airplanes, Ships
- Situation Awareness
- Border Security
- cross border activities
- Critical Infrastructure

Land



- Flooding
- Fires
- Heat Islands
- Thermal anomaly
- Cryosphere events

Smart Sensor

- Different operational modes
- New Sensing capabilities
 - Compressive Sensing
 - Quantum Imaging

Smart Platform

- High Performance Processing
- Innovative Comm. Protocols
- High speed memory
- Attitude knowledge
- Pointing capabilities
- Self Awareness

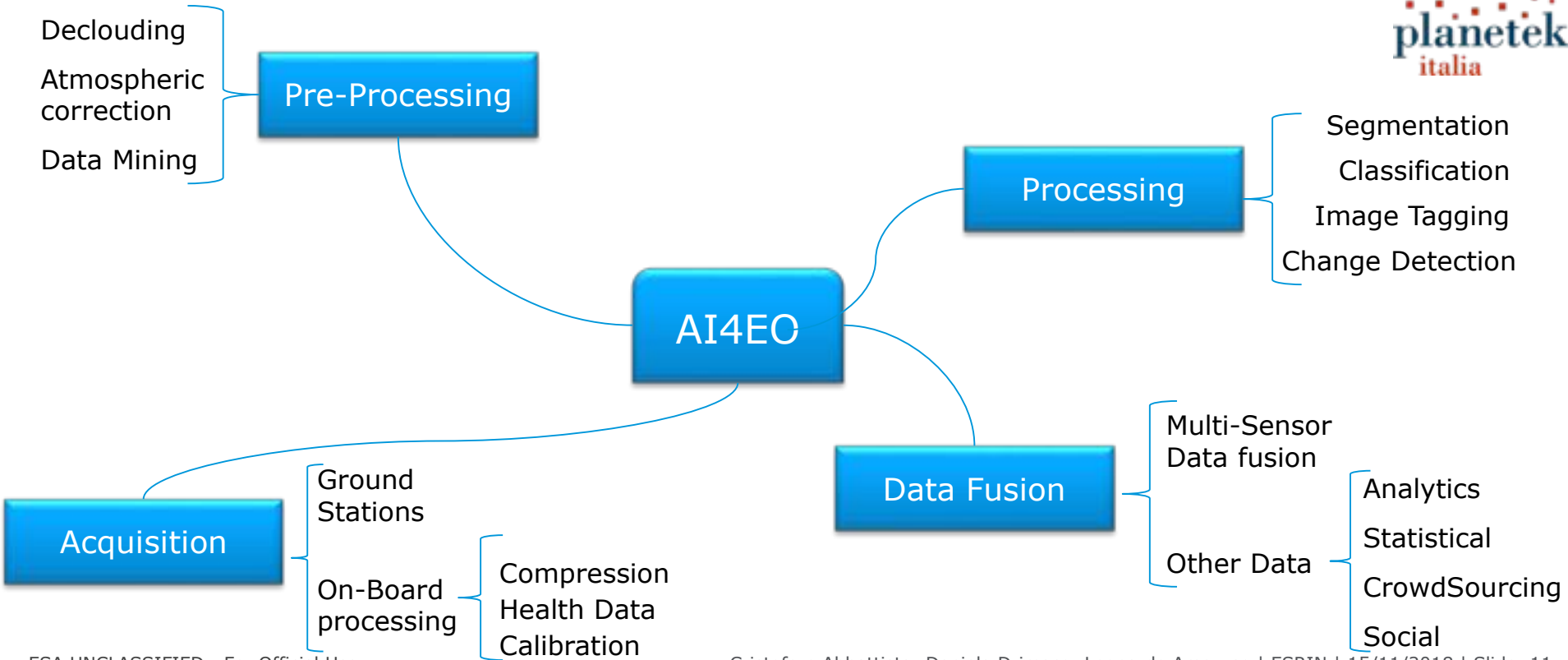
Smart Software

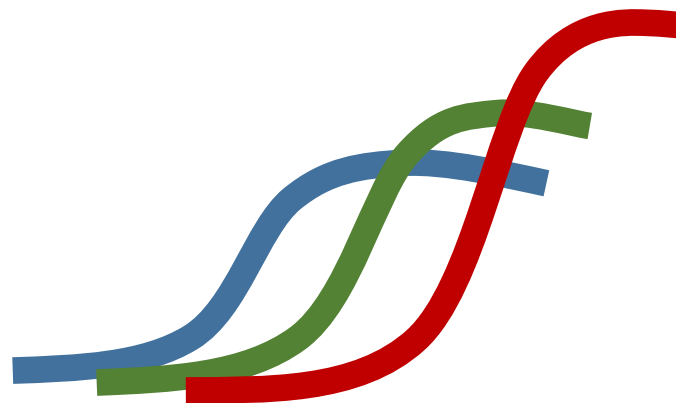
- GeoAnalytics
- On demand processing
- AI Processing
- On Board Payload data processing
- Autonomous Tasking
- CyberSecurity
- BlockChain

Smart Ground

- Peer to peer architectures
- Health Monitoring
- Knowledge Based Tasking
- Tasking 4 Processing

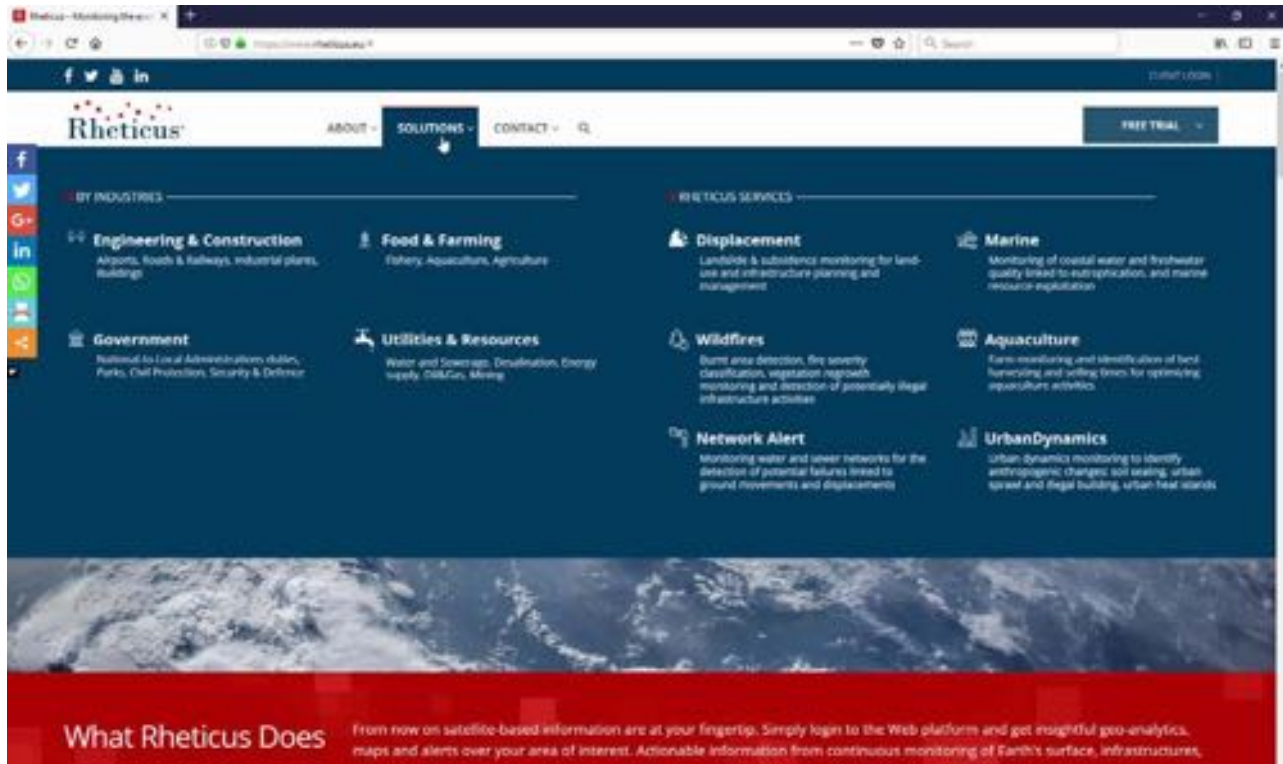
Artificial Intelligence Role





SPACESTREAM

The future of EO



The screenshot shows the Rheticus website interface. At the top, there are navigation links for 'ABOUT', 'SOLUTIONS', and 'CONTACT', along with a search bar and a 'FREE TRIAL' button. The main content is organized into two columns under the heading 'BY INDUSTRIES'. The left column lists 'Engineering & Construction' (Airports, roads & railways, industrial plants, buildings) and 'Government' (National & Local Administrations, cities, Parks, Civil Protection, Security & Defence). The right column lists 'Food & Farming' (Fishery, Aquaculture, Agriculture), 'Utilities & Resources' (Water and Sewerage, Demolition, Energy supply, Oil&Gas, Mining), 'Displacement' (Landslide & subsidence monitoring for land-use and infrastructure planning and management), 'Wildfires' (Burnt area detection, fire severity classification, vegetation regrowth monitoring and detection of potentially illegal infrastructure activities), 'Network Alert' (Monitoring water and sewer networks for the detection of potential failures linked to ground movements and displacements), 'Marine' (Monitoring of coastal water and freshwater quality linked to eutrophication, and marine resource regulation), 'Aquaculture' (Farm monitoring and identification of local harvesting and selling times for optimizing aquaculture activities), and 'UrbanDynamics' (Urban dynamics monitoring to identify anthropogenic changes: soil sealing, urban sprawl and illegal building, urban heat islands). Below the services, there is a satellite image of a coastal area. At the bottom, a red banner contains the text 'What Rheticus Does' followed by a description: 'From now on satellite-based information are at your fingertip. Simply login to the Web platform and get insightful geo-analytics, maps and alerts over your area of interest. Actionable information from continuous monitoring of Earth's surface, infrastructures,'.

Rheticus AQUACULTURE

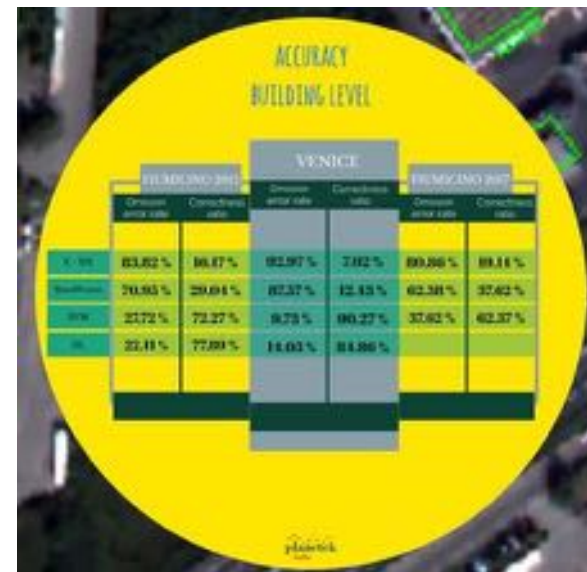
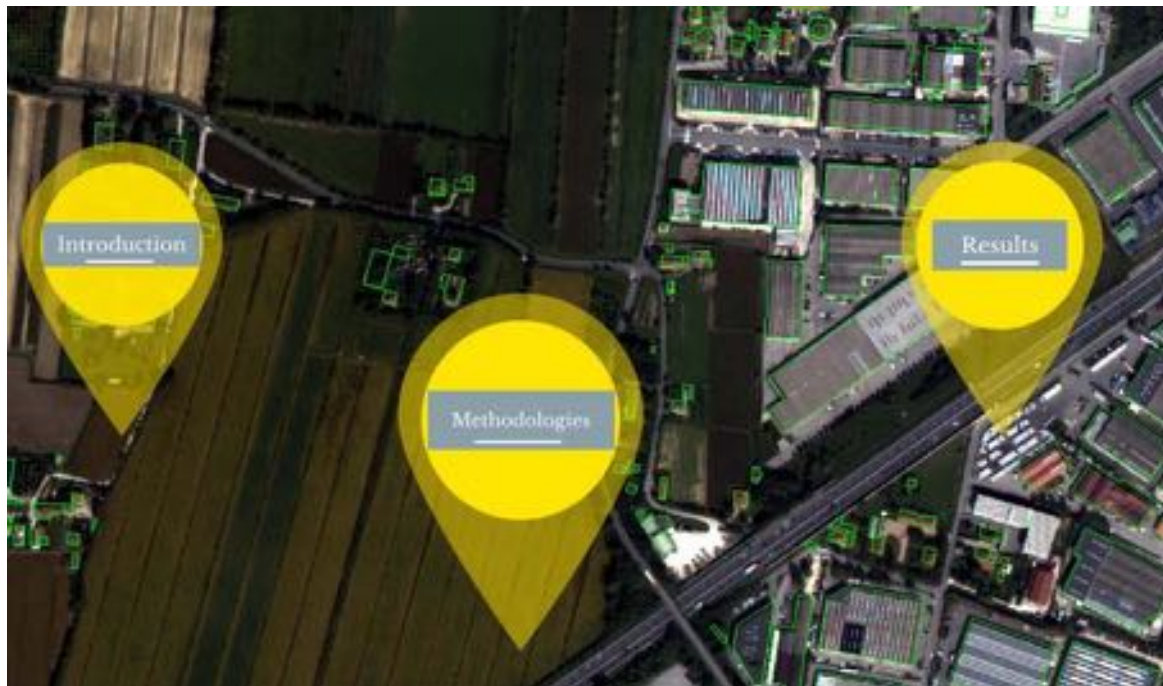
Satellite Support for Smart Aquaculture

Parameter	Acronym	Value	Units	State
1-year average Chlorophyll-a concentration	Chl-a	0.14	mg/m ³	●
1-year average Water Transparency	WT	10.00	m	●
1-year average Sea Surface Temperature	SST	20	°C	●
1-year average Dissolved Oxygen	O ₂	8.40	mg/l	●
1-year average Salinity	S	34.00	PSU ‰	●
1-year average Sea Surface Waves	SSW	0.20	m	●
1-year average Current Velocity	UV	0.05	m/s	●

Outlook for a Potential Aquaculture Farm: 😊

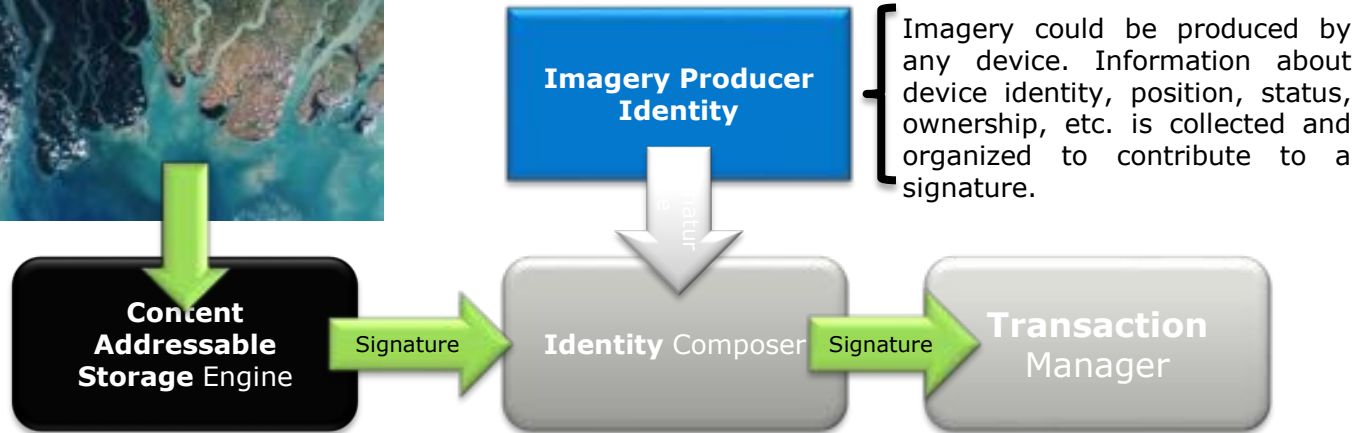


Cloud detection, Classification, Change detection, Super-resolution, Compression,





Original EO Imagery



Imagery could be produced by any device. Information about device identity, position, status, ownership, etc. is collected and organized to contribute to a signature.

Files are not identified by their names but by their signatures.

The resulting signature, which in fact contains many information about imagery and its source, is sent to the shared ledger for being stored permanently.



- **Multi OS:** MS Windows, Linux, MacOS
- **Multi Processor:** Intel, AMD, ARM, Sparc
- **Multi GPU:** Intel, AMD, NVIDIA, ARM-Mali, Imagination-PowerVR
- **Multi GPU-API:** OpenGL, OpenCL, CUDA, Vulkan
- **Multi-platform:** CPU/GRID/GPU
- **Data Oriented:** Tensor and hierarchical Tensor (HDF5, NetCDF, FITS)
- **Constrained Memory Access:** Protection from SEU (Single-Event Upset) like buffer overflow/underflow and not allowed access to memory
- **Service Locator Pattern:** to extend at run time the execution programme without recompiling

The GPU platforms



Target Hardware

- NVIDIA Jetson AGX Xavier
- CPU: 8-core ARM 64-bit CPU
- RAM: 16 GB
- GPU: 512-core Volta GPU
(with Tensor cores)



Test Hardware

- NVIDIA Jetson TX1
- CPU: Quad-Core ARM Cortex
- RAM: 4 GB
- GPU: NVIDIA Maxwell 256 core



Test Hardware

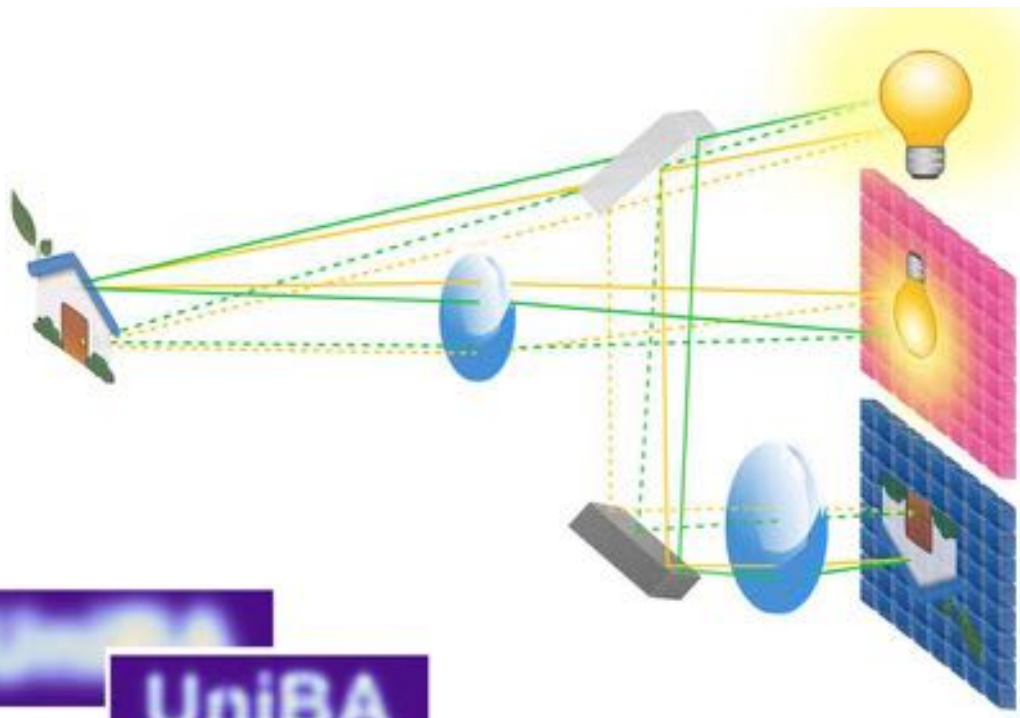
- NVIDIA Jetson TK1
- CPU: Quad-Core ARM Cortex
- RAM: 1.7 GB
- GPU: NVIDIA Kepler 192 core



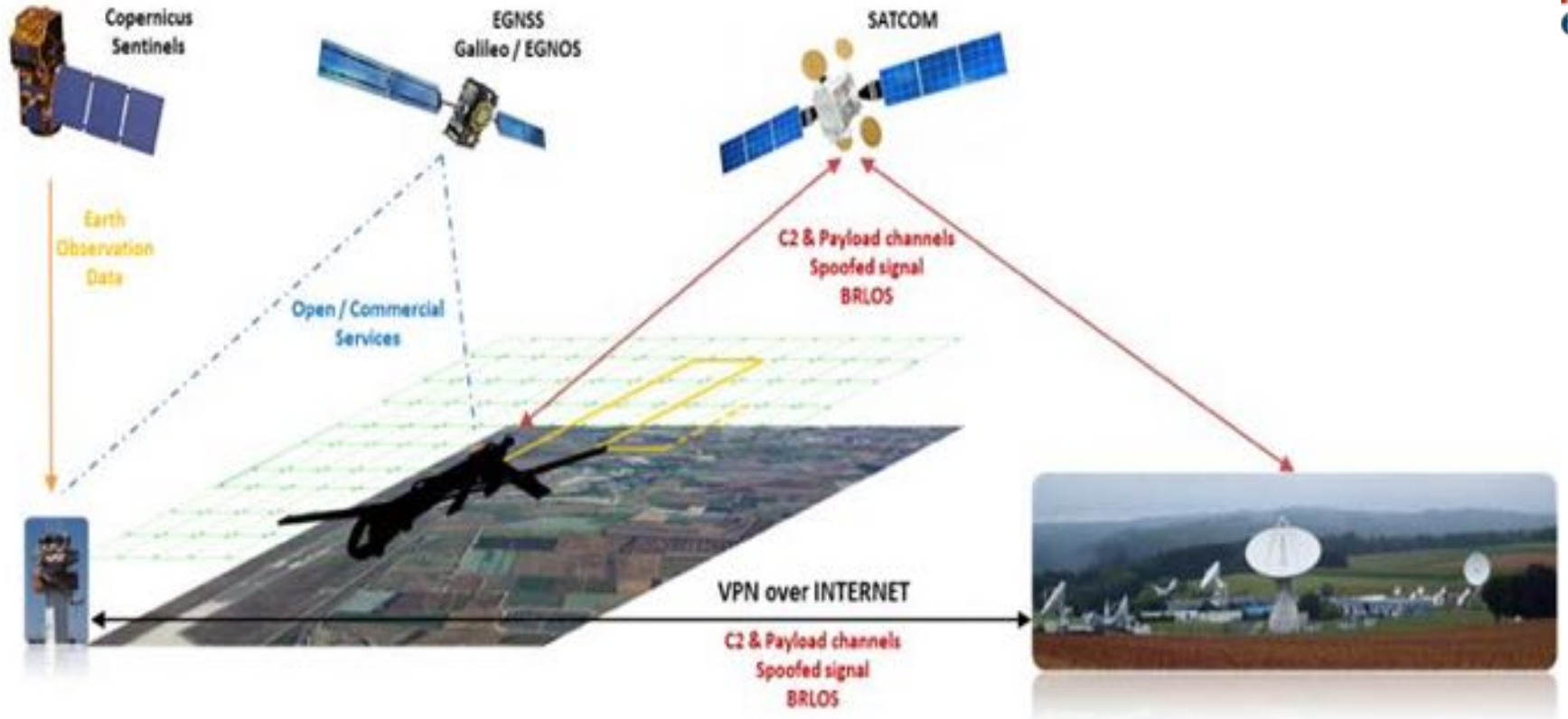
**CORRELATED
Light Source**

SENSOR 1: retrieves the
direction of light rays

SENSOR 2: retrieves the
"ghost" image of the scene



Cyber Security: CRUISE



Smart Ground Health Monitoring



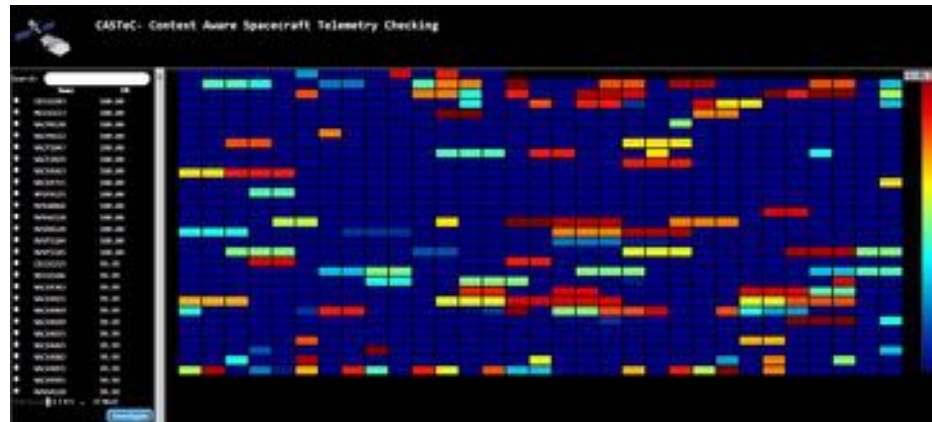
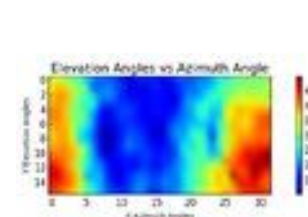
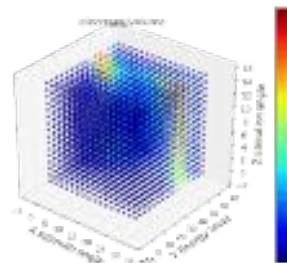
Table Commands View

ID	Type	SubType	Description
ZW0001	204	170	SMA_TC_HSI_DICR_READ
ZW0002	204	177	SMA_TC_HSI_DICR_WRITE
ZW0003	204	176	SMA_TC_HSI_HK_BHT
ZW0004	204	175	SMA_TC_HSI_MAIRO_CAL

Send Add to target ZW0004 (SMA_TC_HSI_STM_000) Done

Size (bits)	Name	Value
3	PH Reason Number	0
3	PH Type	0
4	PH Data and Test Flag	3
5	PH AND	0111
30	PH Sequence Flag	1
30	PH Sequence Count	3
13	PH Length	0
41	SPH CCDS Header Flag	0
44	SPH FLD Header	3
52	SPH ACC Flag	0
56	SPH Service Type	204
64	SPH Service Subtype	174
72	SPH Service ID	31
88	SPH START	

```
1  
2  
3 # PLANETEK MESSAGE - Python Bridge for Ex-Process  
4 # Use the MESSAGE object to interact.  
5  
6 # PLANETEK  
7  
8 # Allowed methods: log, logMinor, sendDTCPID  
9 # Allowed attributes: @pInterval, @pSubband, @ext, @ext, @p, @t  
10  
11 # Press Run button to try this.  
12 PLANETEK.sendDTCPID(174, 174, 31, 31)  
13
```



Thank you for your attention

For further information

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