DISTRIBUTED MULTISPECTRAL SPACEBORNE SENSOR SOLUTIONS FOR RECONNAISSANCE AND EARTH OBSERVATION

AUTHORS

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  is working at OHB Digital Connect GmbH in Bremen, Germany, and has a scientific background in mechanical engineering with focus on material modelling and statistical analysis. He is involved in research and development projects, also together with scientific partners, in different fields for years and gains experience especially in systems engineering, product development, proposal preparation and project management. Currently he manages research and development projects in the area of remote sensing applications and supports future project and product developments.

- **Dr. Felix Wenk**
  is a computer scientist with the Sensors and Image Analysis Team of the Communication and Sensing Solutions department of OHB Digital Connect in Bremen, Germany. His background is state estimation from noisy measurements (“sensor fusion”) in general and from inertial sensor data in particular.

- **Irmgard Runkel**
  is the managing director of GEOSYSTEMS GmbH, an GEO-IT solution provider and Hexagon partner. She comes with a geoinformatics background and has about 30-years experience in remote sensing applications with a domain expertise in environmental applications. Additionally to regular employments she worked as short-time expert for various organizations like United Nations.

DISTRIBUTED MULTISPECTRAL SPACEBORNE SENSOR SOLUTIONS

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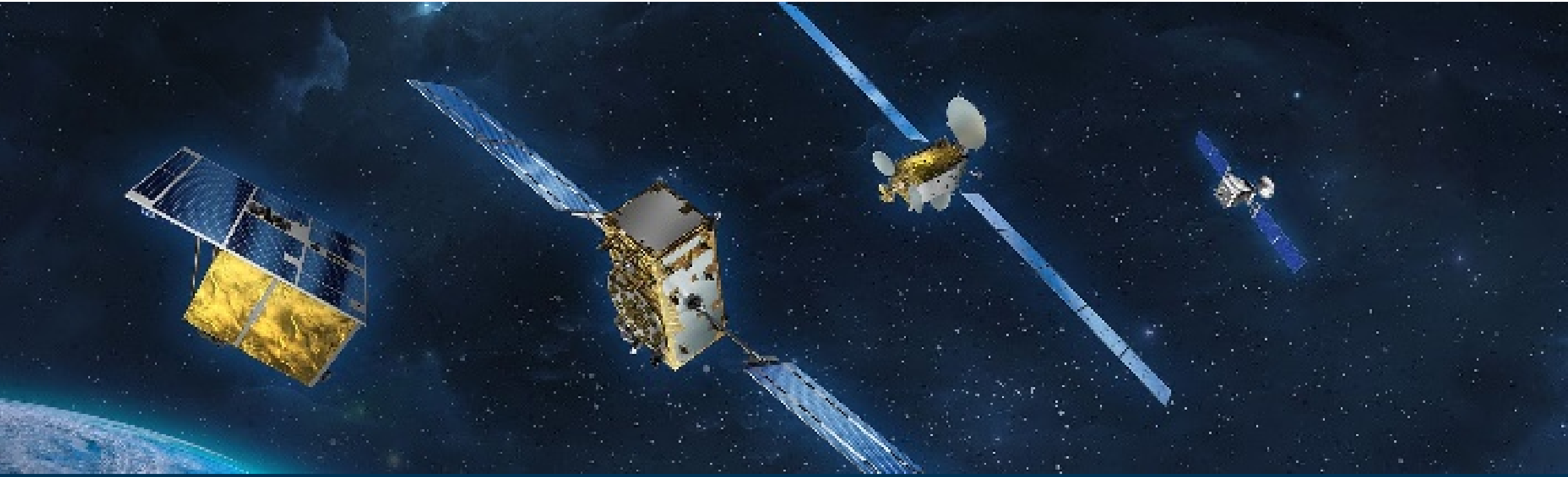
PHIL DARO KRUMMRICH, FELIX WENK, IRMGARD RUNKEL, MAY 24, 2022
OHB DIGITAL CONNECT GMBH / GEOSYSTEMS GMBH

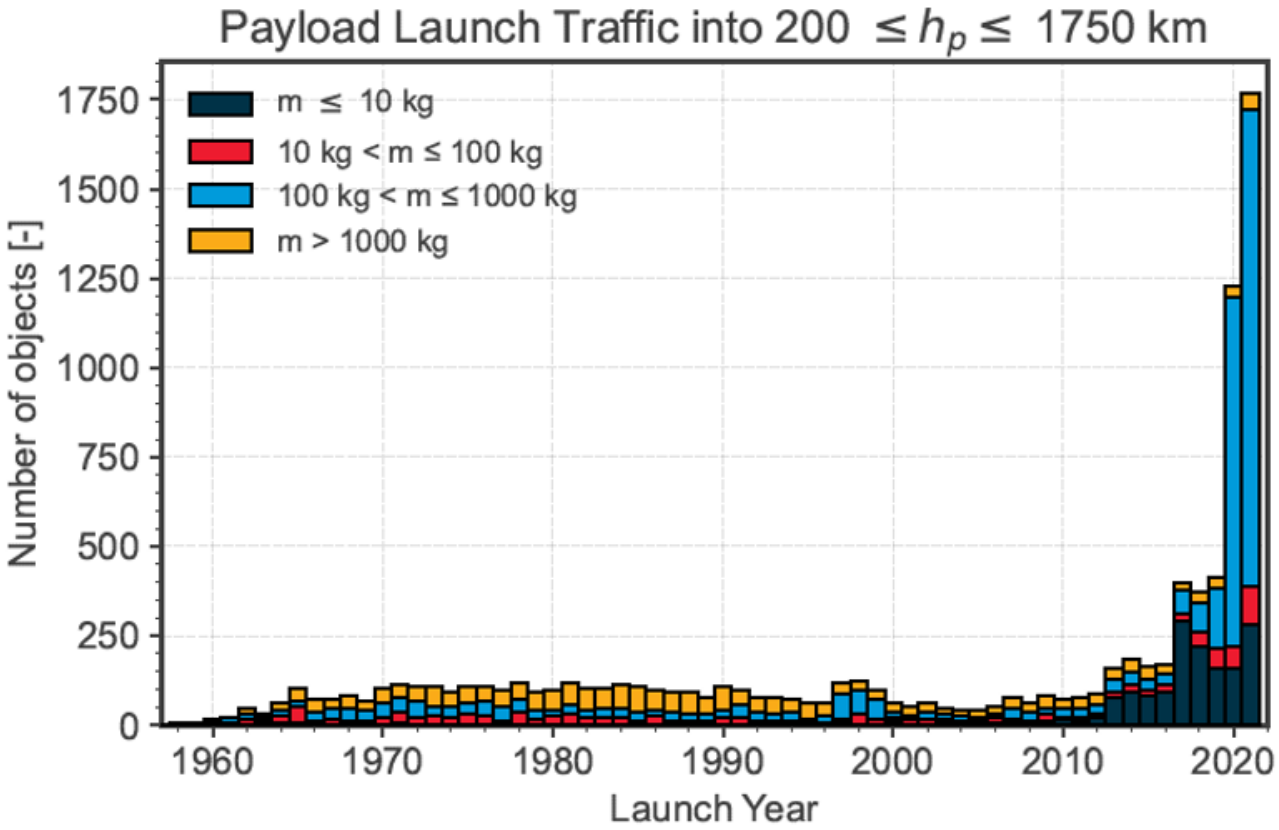
„SMALL BUT SMART:
WE WANTED -AGAINST THE TREND- TO MAKE SPACE SYSTEMS SMALLER AND MORE COST-EFFECTIVE.“

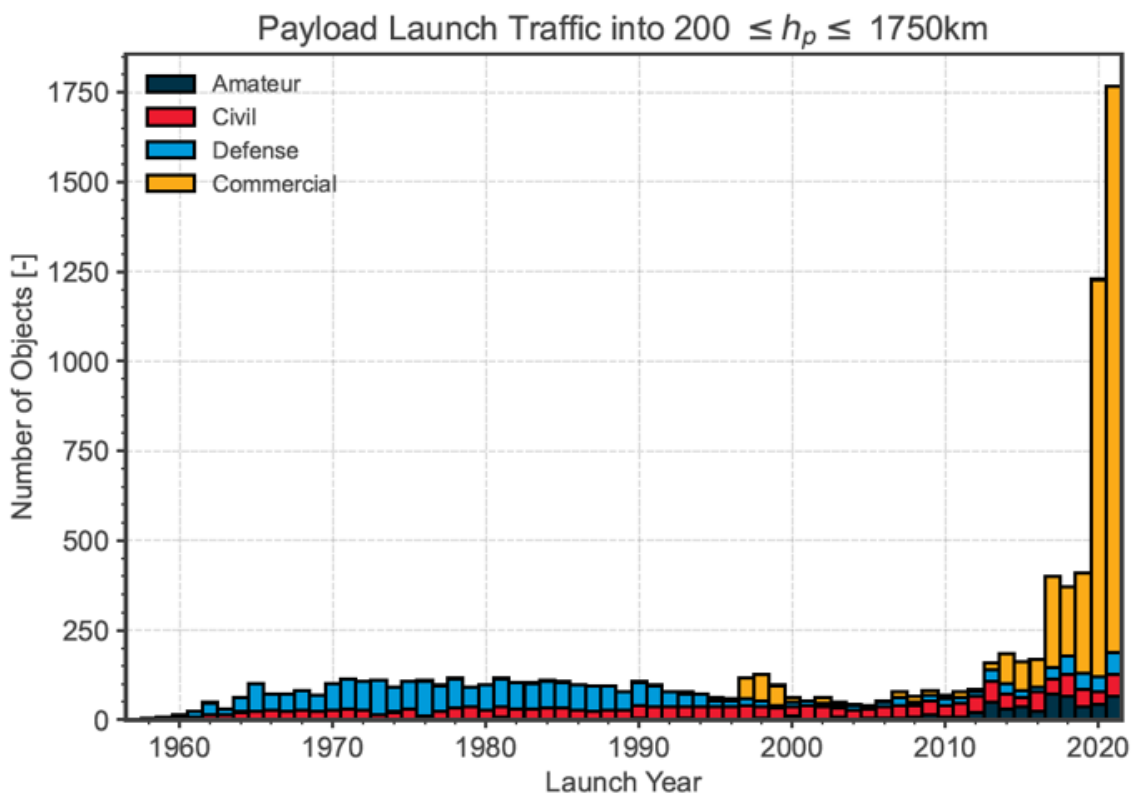
PROF. DOTT.-ING. H.C. MANFRED FUCHS (1938-2014), FOUNDER OF OHB



ONGOING TRANSFORMATION

THE USE OF SMALL SATELLITES INCREASES STRONGLY





[Image:ESA Space Environment Report]

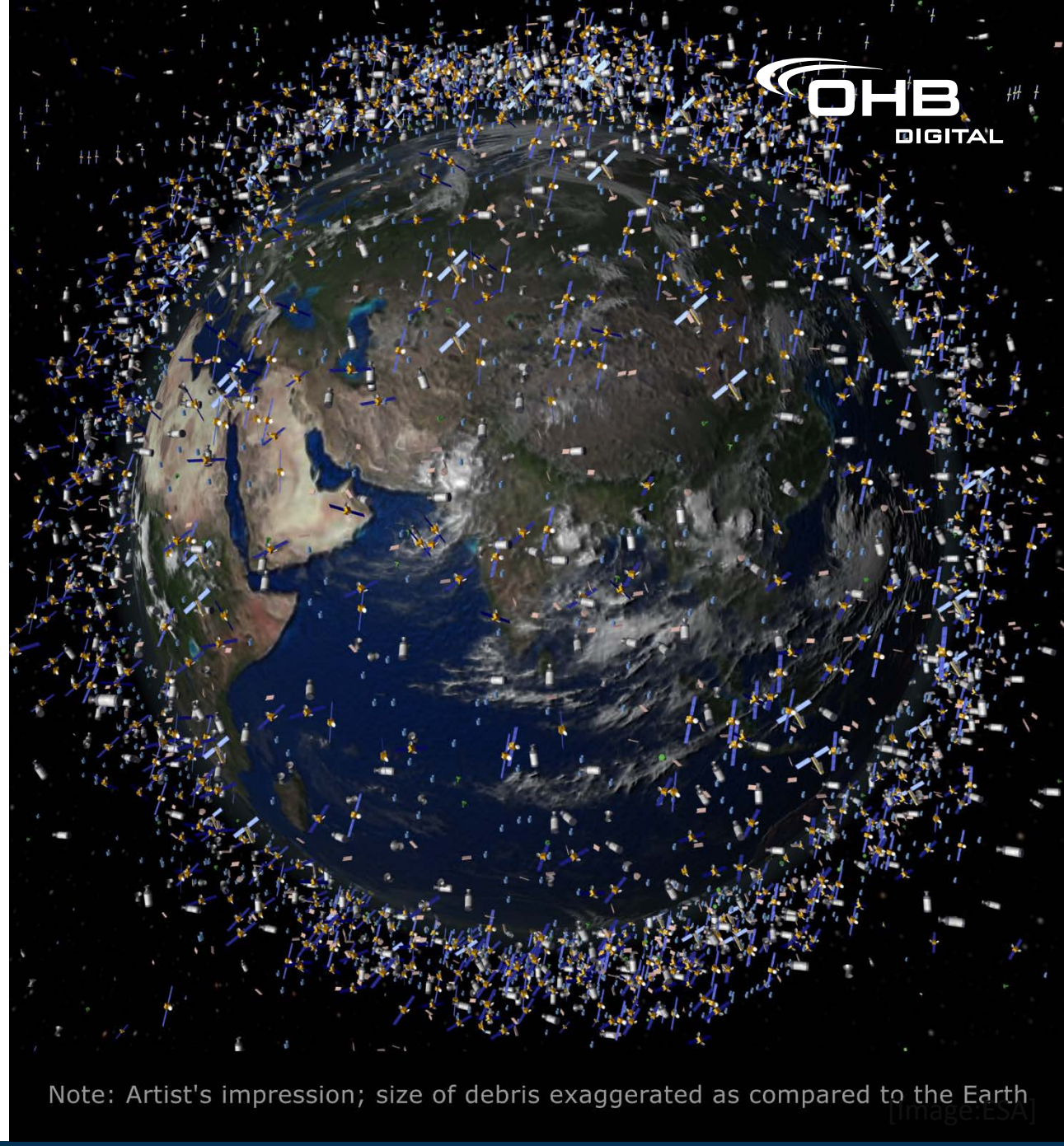
NEW SPACE SINCE 1980S

NEW SPACE. NEW PARADIGMS. NEW CHALLENGES.

„Vision of high-performance, low-earth or geostationary mostly private small satellites in modular design."

- **Trends:**
  - Miniaturized satellites
    - Space traffic
  - Advanced space manufacturing
    - Transportation management
      - Smart Propulsion

[Image:ESA]



Note: Artist's impression; size of debris exaggerated as compared to the Earth

[Image:ESA]

NEW SPACE EARTH OBSERVATION

DISTRIBUTED MULTIPLE SENSORS

"Novel and high-performance Earth Observation Systems combine ground resolutions well below 50 cm with video-like temporal resolutions and allow for response times below one hour, thus promising real-time applications in the near future."

[Image:ESA]

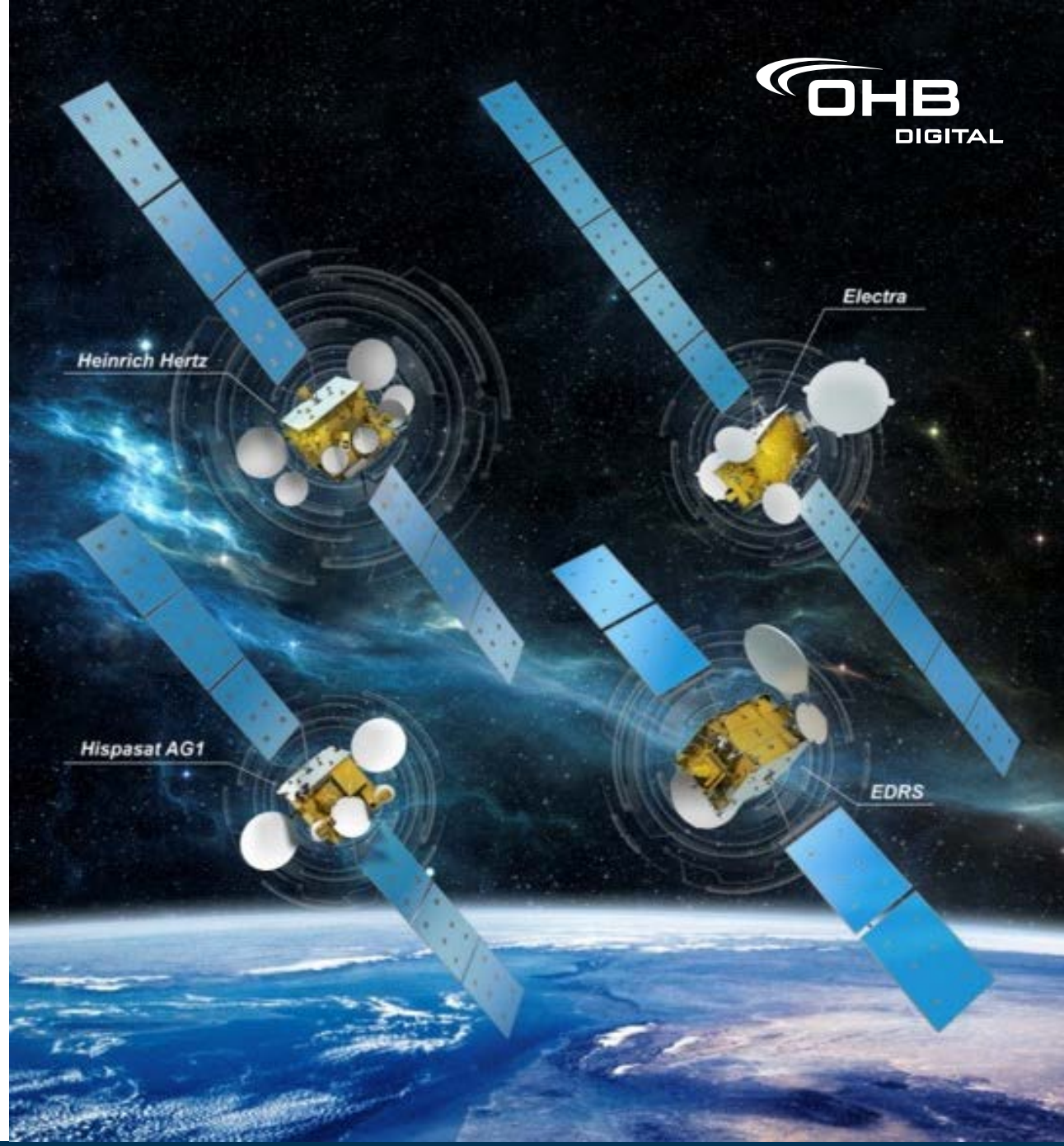
1

PLATFORMS

OHB SMALLGEO

GEO-STATIONARY “NEW SPACE” SATELLITE

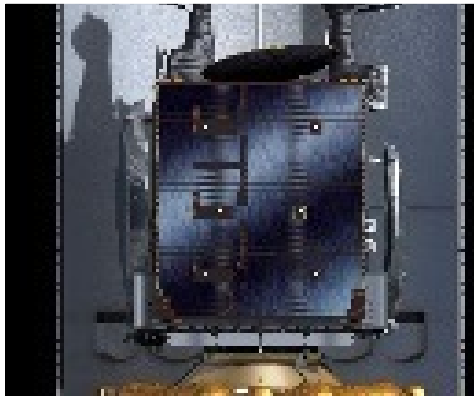
- Telecommunication Satellite *Product Line*
- Modular Design for customer-specific communication concepts:
  - Broadcast / Direct
  - Machine to Machine
- Targets institutional/governmental customers and private customers.
- Launch Mass Category: 3 tons
- Payload:
  - Weight: 800 kg
  - Power: 10 kW

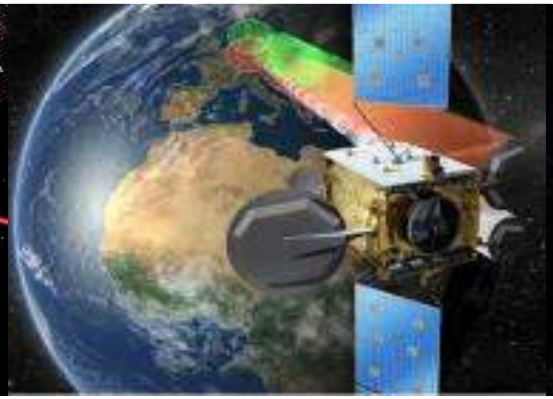


OHB SMALLGEO

PRODUCTS OF THE LINE

H36W-1	EDRS-C	Heinrich Hertz	Electra
Hispasat S.A.	European Commission	German Aerospace Center (DLR)	PPP of ESA, SES S.A. and OHB System AG
Pioneering Mission	**Laser Communications**	**Technology Innovation**	**First Evolution**
ESA ARTES-11 Programme Ku- and Ka-Band for TV-Broadcast and Data Transmission	ESA ARTES-7-Program: European Data Relay to serve EU Copernicus Sentinel Earth Observation Satellites	Scientific and technological Verification in Space and Ground and Additional Capacity for German Armed Forces	ESA ARTES-33 Programme Optimized Payload Capacity (enabled by full electric propulsion)






2

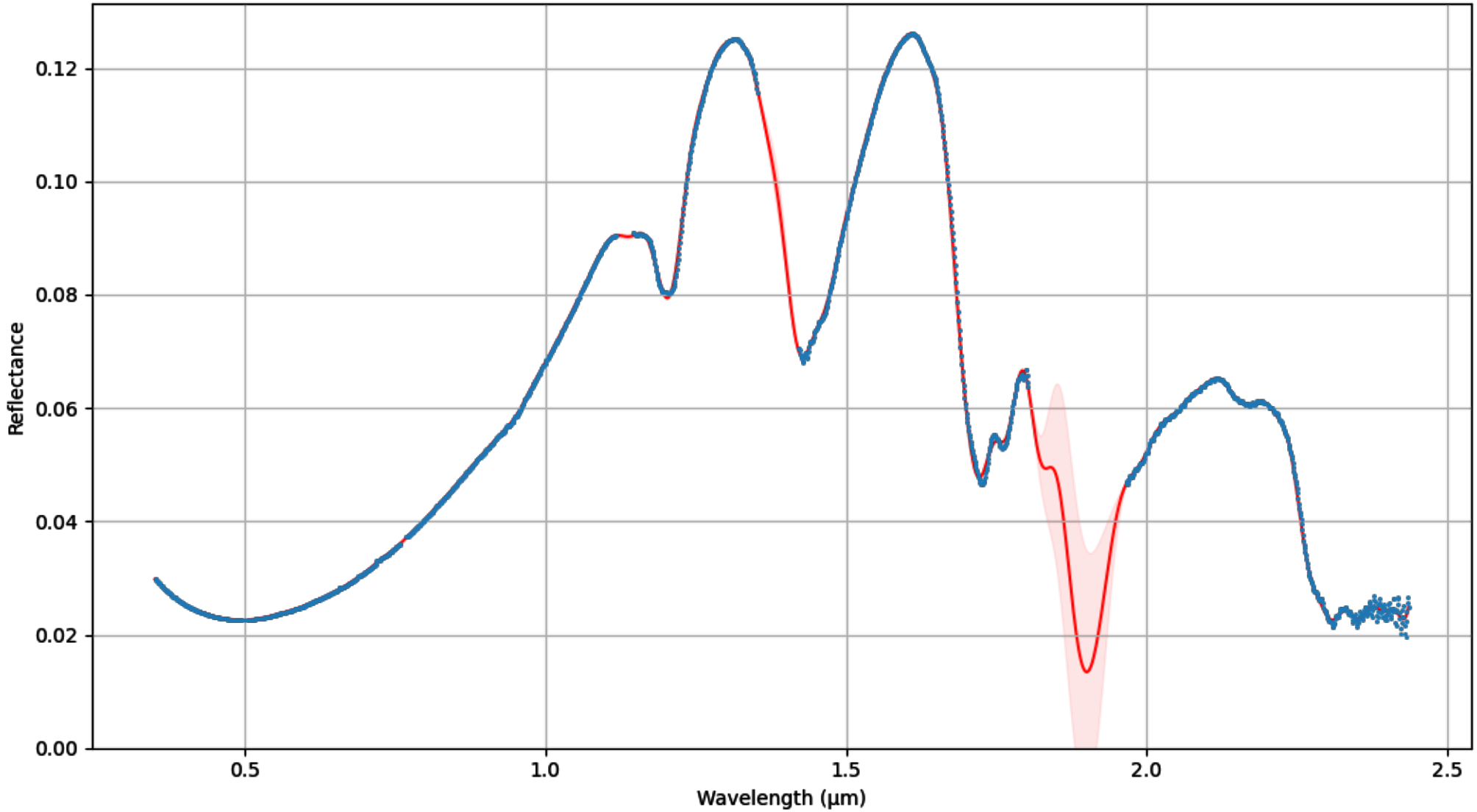
INSTRUMENT & SENSING

MULTI – HYPER – SUPER?

DEEPWATER HORIZON OIL SPILL

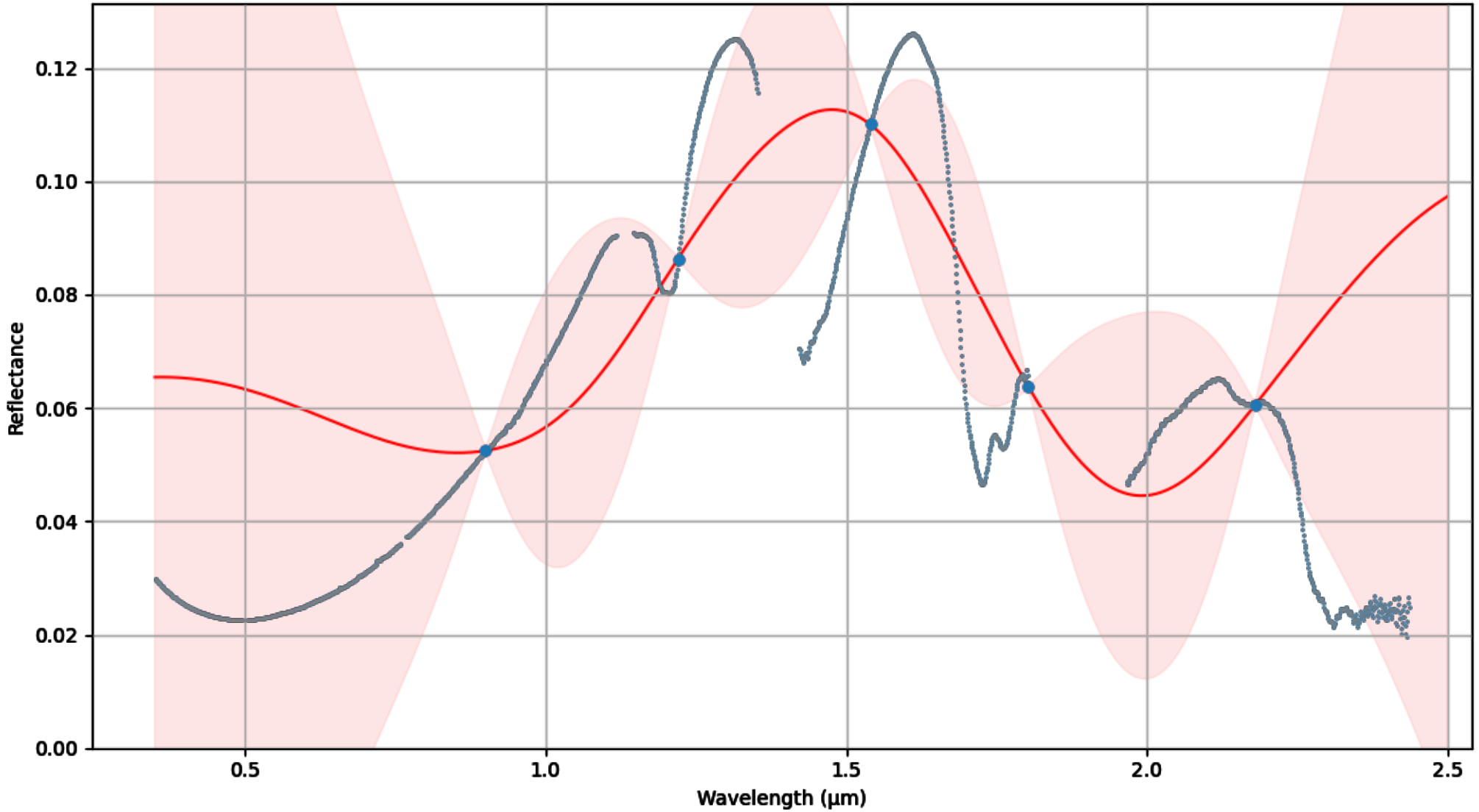
MULTI – *HYPER* – SUPER?

REFLECTANCE OF “BEACH” AFTER DEEPWATER HORIZON OIL SPILL



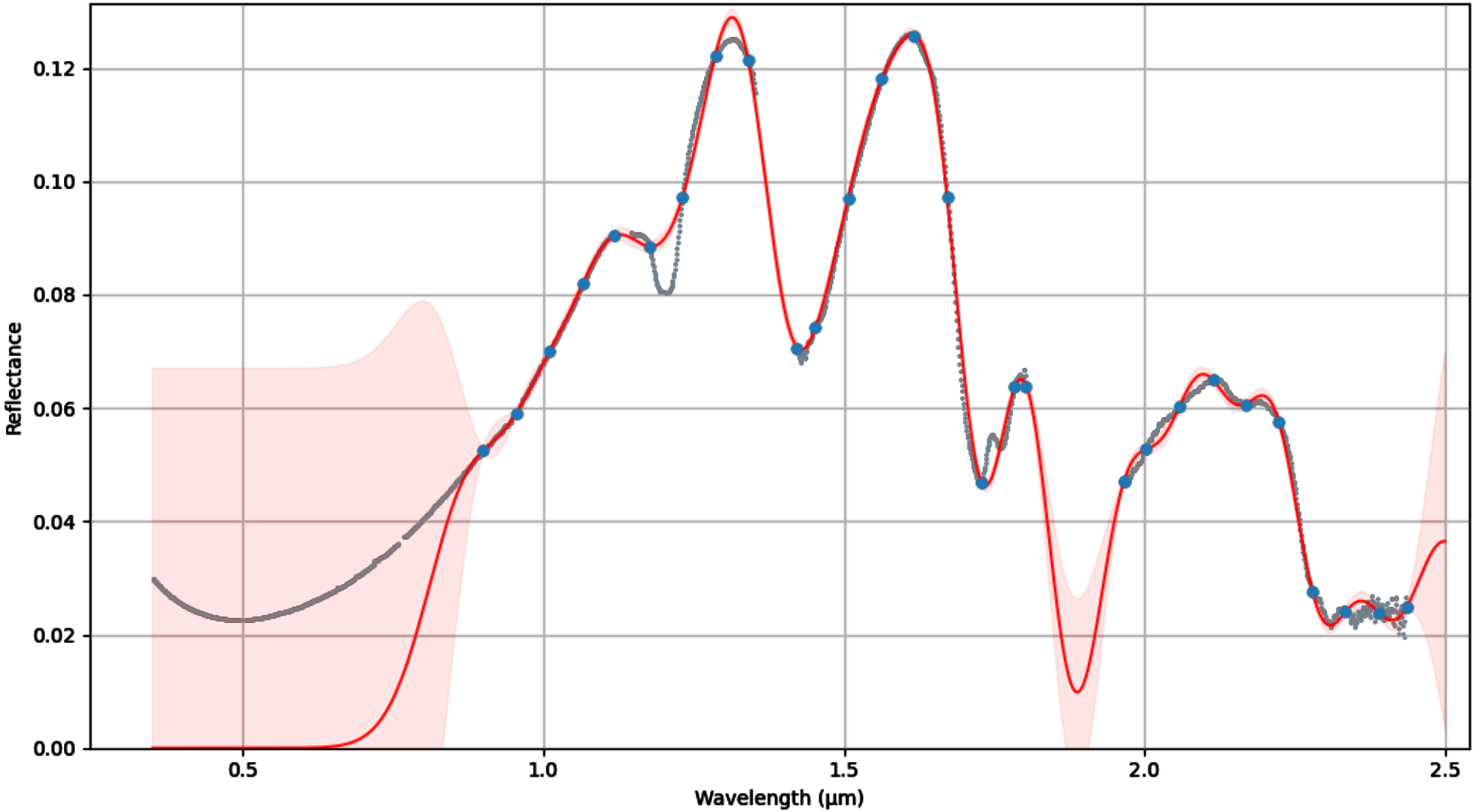
MULTI – HYPER – SUPER?

REFLECTANCE OF “BEACH” AFTER DEEPWATER HORIZON OIL SPILL



MULTI – HYPER – *SUPER?*

REFLECTANCE OF “BEACH” AFTER DEEPWATER HORIZON OIL SPILL



SUPERSPECTRAL SENSOR (SUSE)

AN APPLICATION SPECIALIZED HIGH PERFORMANCE SENSOR FOR AERIAL RECONNAISSANCE

- “Superspectral”: a new category between multi- and hyperspectral, combining the advantages of both sensors.
- Superspectral Sensor SuSe:
  - Meant for size, weight and power (SWAP) sensitive applications.
  - 900 nm up to 2500 nm spectral range of the detector
  - Up to ~30 bands, each customizable between 10 nm and 200 nm
  - Tailored for specific application
  - Good signal to noise ratio (SNR) by Time Delay Integration
  - Wide swath detection (dependent of the optical system)
- First development build for the detection of camouflage
- Change of sensor dedication possible:
  - e.g. gas detection, mapping of railway tracks.

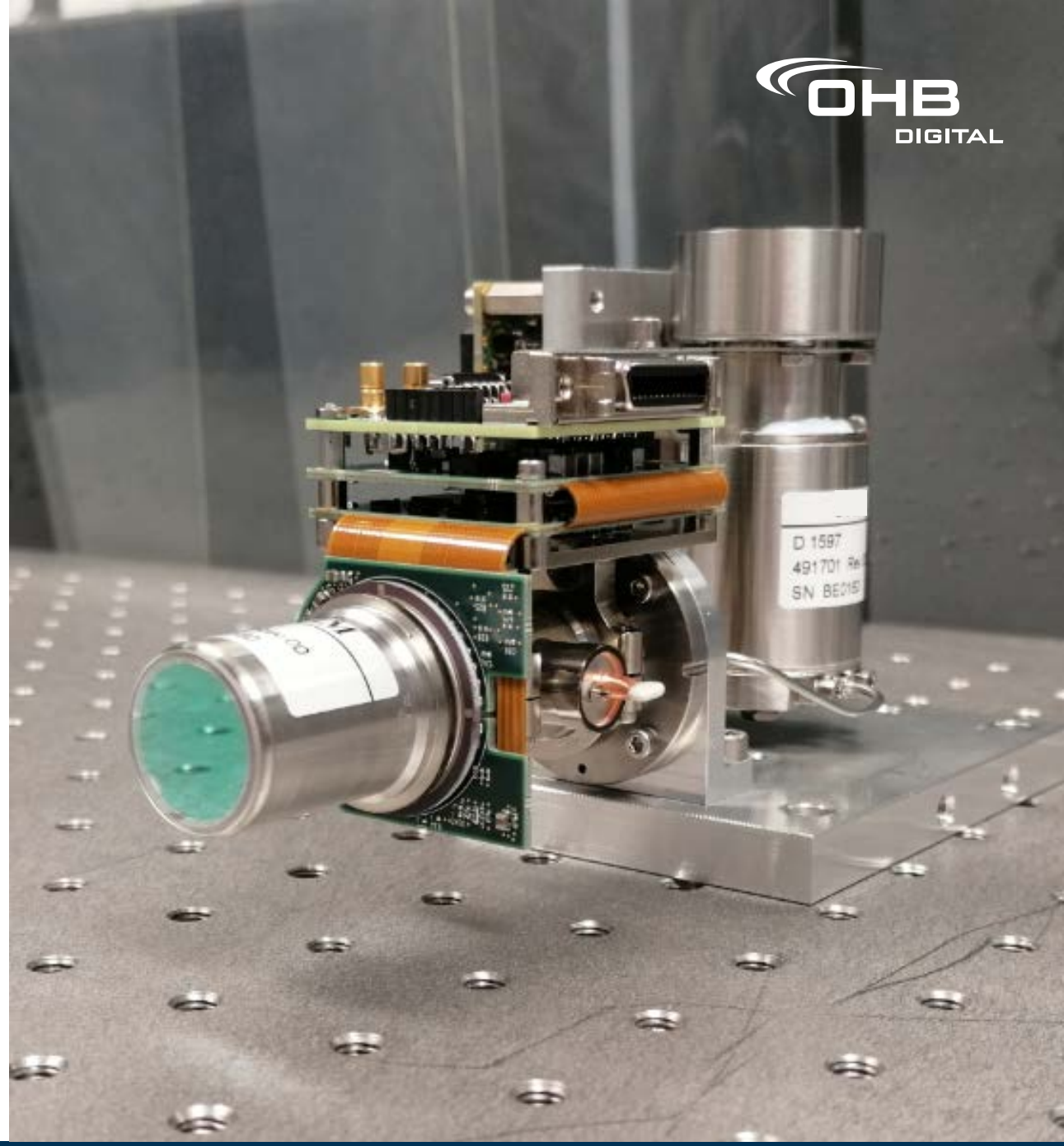
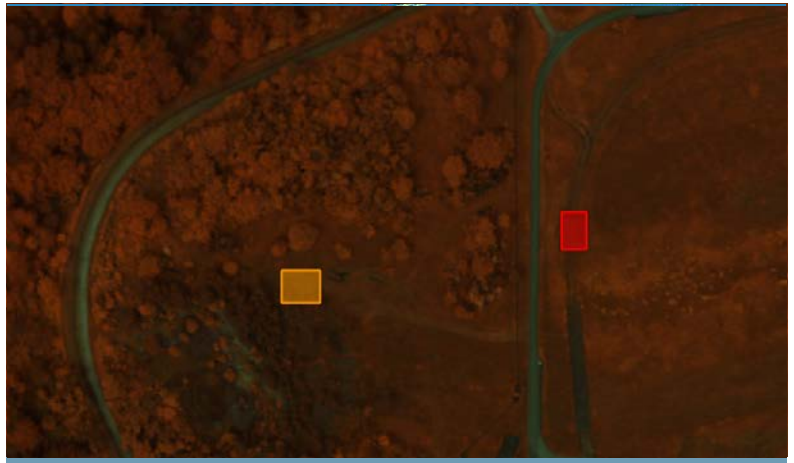


IMAGE PROCESSING APPLICATIONS

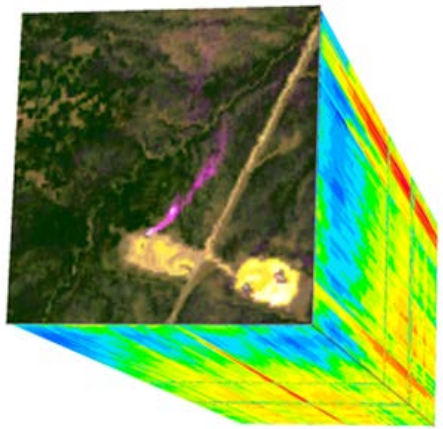
COMPLEMENTARY SENSORS: EO/IR, SAR, LIDAR



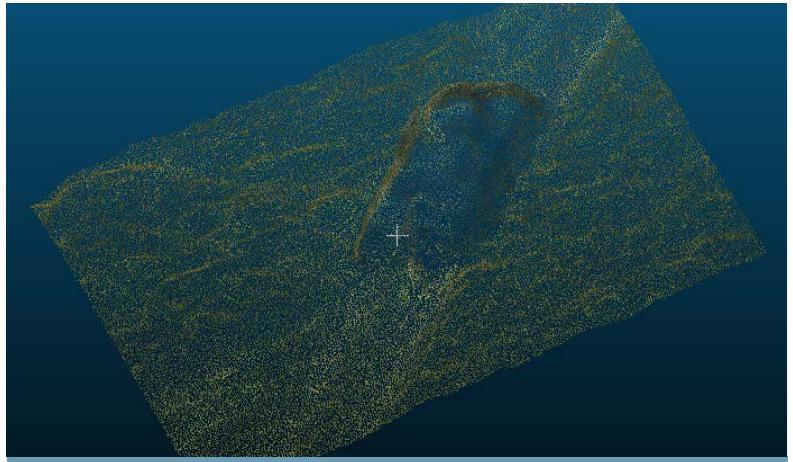
Camouflage detection with spectral data

Self localization via Data Fusion of optical/inertial data

Object Detection in SAR images



Analysis of hyperspectral data for hazardous substances

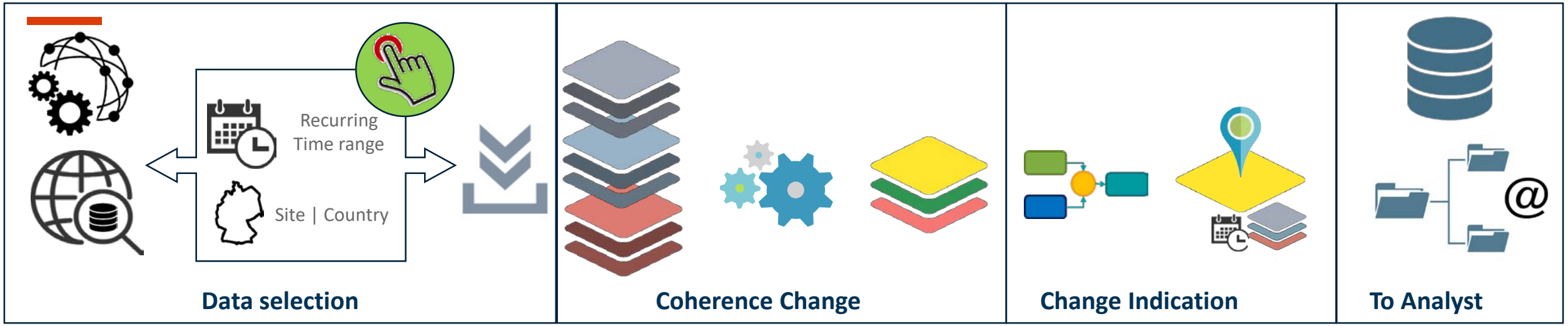


Detection of objects via shape analysis

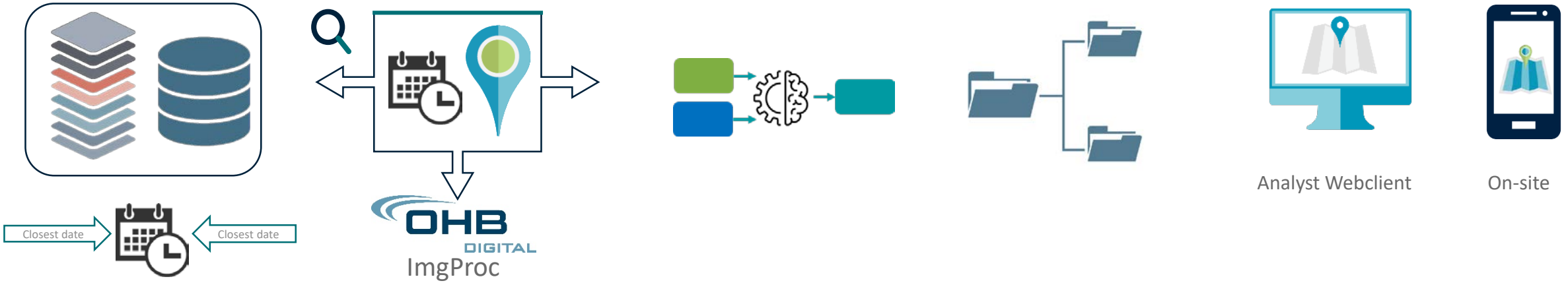
Analysis of thermal information

EXAMPLE: CHANGE DETECTION

USING SAR AND VHR IMAGES



Complete/full data control per indication



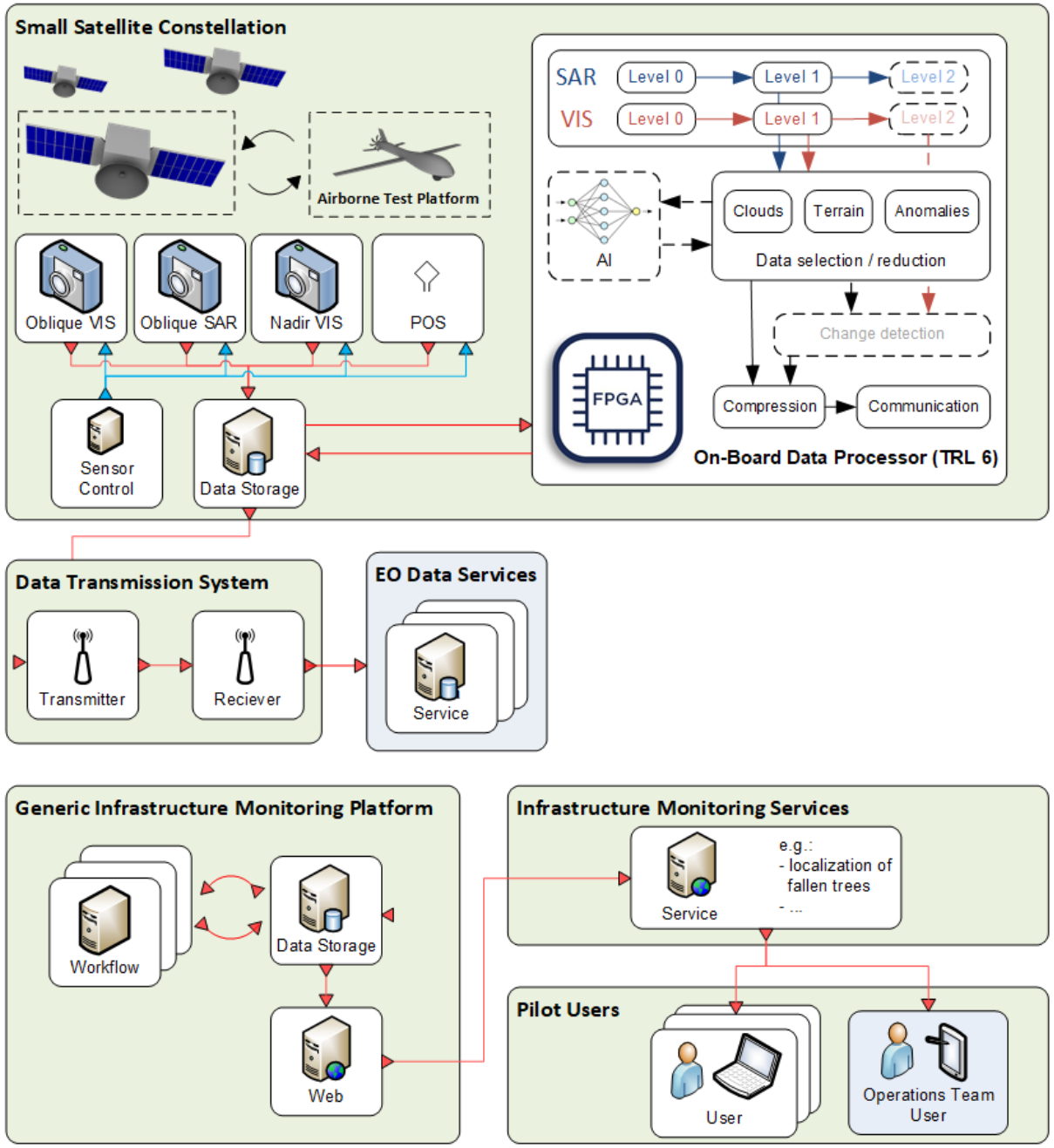
3

PROCESSING

ON-BOARD PROCESSING

WHY?

- Optical Earth Observation – Image based – from space generates huge amount and data.
- Information is supposed to be available quickly and frequently.
- Raw image data to large to transfer frequently.
- For an efficient system that is technically feasible with today`s communication technologies, the relevant data must already be selected on the satellites.
- This selection can only be made on the basis of information (level 2).
- Thus, an effective and highly specialized on-board data processing is one of the most important key technologies for continuous monitoring especially with small satellite constellations.
- The performance of the monitoring system is significantly influenced by the used algorithms.
- **For an effective and highly specialized on-board and off-board data processing the image processing algorithms and processing units must be optimally tailored to each other.**



COTS/CLASS 3 AI & OBP

FOR MICRO- AND NANO-SATELLITES

- For LEO missions, 7 years lifetime
- Based on COTS/Automotive Parts
- Combination of FPGA/VPU and GPU/AI Accelerator
- Up to 8 TOPS,
- 8Tbit SSD M.2/2660 with own AES256 encryption module
- 1U, < 30 W
- Including SEU Middleware
- Developed in ESA contract for ARTES, but extended also to EO applications
- AI applications for
  - RFI detection, characterization and classification (incl. Fingerprint)
  - SAR on Board Processing up to Level 2
- Optional extension with Neuromorphic Processor, incl. Neuromorphic AI algorithm

OUTLOOK

GREAT INGREDIENTS

Already there:

- Modular, small-size satellites with medium-satellite-like payload capacity.
- Small size-weight-and-power super-spectral sensor.
- On-board processing capabilities.
- Satellite communication infrastructure.
- Data processing for complementary sensors.

Suggesting:

- Constellation of N satellites of same product line.
- Each of the N satellites equipped with a few of a set of complementary sensors.
- Data processing on-board.
- Communication of Information instead of Sensor data to terrestrial users: Real-Time Capability

THANK YOU!

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