



SKA project

Large systems – from engineering to integration and maintenance

16/10/2017

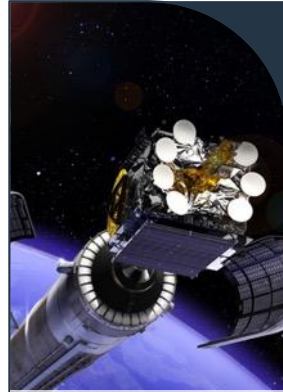
ThalesAlenia
a Thales / Leonardo company **Space**



Thales has a recognized expertise and experience in the fields of complex systems' projects management, engineering, architecting and IVV



AEROSPACE



SPACE



GROUND
TRANSPORTATION



DEFENCE



SECURITY

**EACH OF THE MARKETS
THAT THALES SERVES
PLAYS A VITAL ROLE
IN SOCIETY**

Thales operates as a **single organisation**, drawing on the talent and technologies of the entire Group to act as prime contractor, systems integrator, equipment supplier and value-added service provider on both civil and military programmes



Thales Alenia Space has developed its own system capacities taking benefit of the Thales experience, tools and projects feedback



Telecommunications

Civil, military, dual-use

Geostationary Orbit Spacebus satellites:

Yamal 401 & 402, Arabsat 5C & 6B
Eutelsat W3C, W6A, W3D, Apstar 7,
Athena-Fidus, Sicral 2

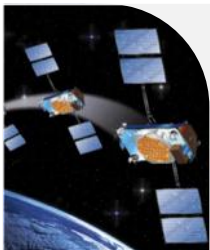
Payloads:

Telkom3, Redsar, Arsat-1



Orbital infrastructure

Supply 50% of the pressurised volume
of the International Space Station



Telecommunications

Prime contractor

for telecommunication satellite

Constellations Iridium Next, Globalstar, O3b



Science

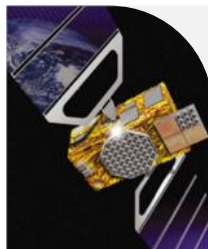
Prime contractor for ExoMars, Europe's first
mission to land on Mars



Earth observation

Civil, military, dual-use

Meteosat 1st, 2nd & 3rd generations,
French national programmes, Pleiades, Cosmo
SkyMed, Sentinels



Navigation

Prime contractor for Galileo Ground Mission
Segment and EGNOS



SKA-project available system engineering capacities

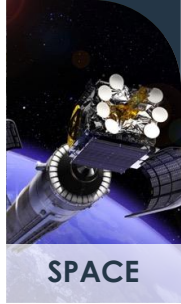
A unique and unrivaled experience through the lead of major systems

Galileo: Responsible for System design and Ground Mission Segment (GMS). Ground infrastructure deployed on 16 sites worldwide ; real-time algorithms with nanosecond timing synchronization, taking into account relativist effects.

Syracuse 3 & 4 - French military communication systems: Responsible for design and development of the entire system. Syracuse 3 is operated since 2005. Syracuse 4 is under development.

Iridium Next - worldwide mobile communications: Provision of 81 satellites ; Responsible for design, integration and verification of the entire system ; On-board processing and routing throughout the constellation with inter-satellite links. To date 30 satellites launched, service opened 2 months after the 1st launch.

Atacama large Millimeter Array (ALMA): Provision of 25 giant antennas for the most complex and powerful ground-based astronomical observatory ever built. Design, manufacture, transport and on-site integration of the 12-meter antennas in the Atacama desert



How to deal with a very large operational system ?

Strong processes and heritage - Successfully applied on critical large systems



Involvement of end-user: “Voice of customer” to share the understanding of value for end-user

Methodology : Modeling to cope with the complexity of the system (out of human capacity)

Requirements management : Full traceability of requirements at every level, from design to validation

Engineering : Unique way to commit on consistency and completeness of complex systems

Integration, Verification, Validation : Envisage lifecycle (incl. evolution) of system and operations jointly as a whole to ease operational capacity increment

Operations, maintenance, life-time support : Anticipated in system engineering is key to master total cost of ownership : from design, development, manufacturing to operation and disposal /removal

Cyber security : Take into account early in system engineering to avoid rework at the end

Suppliers management, partnerships : Management of industrial organization is key factor



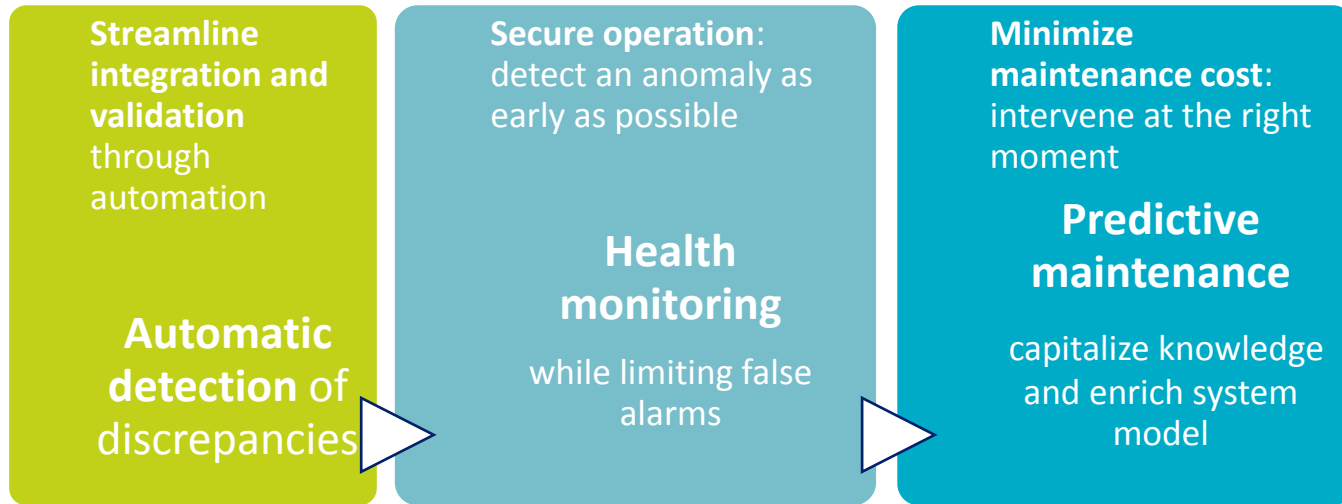
Application 1 – Artificial Intelligence for telemetry analysis



Artificial Intelligence for large systems

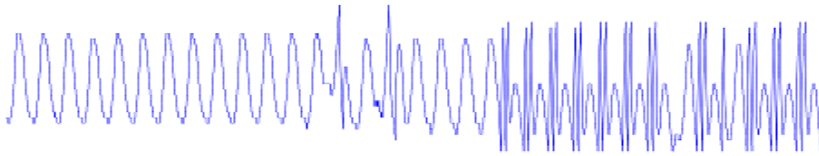
Very large volumes of telemetries are generated by large systems
Need to **extract the relevant information**

The life cycle :

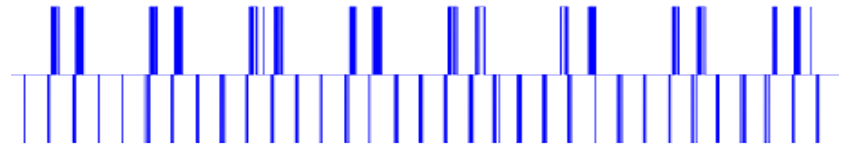


Experience for telemetry analysis

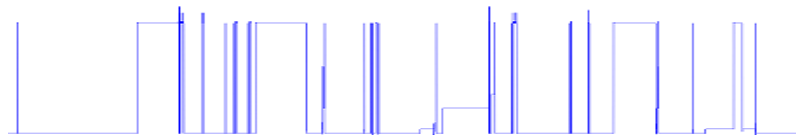
- TAS is the world leader of **in-orbit satellite constellations** (Iridium-next, Globalstar, O3b)
- Experience in integration, validation and operational experience
 - **Constant monitoring of thousands of telemetries**
- Experience with **very heterogeneous data** coming from many systems and sub-systems.



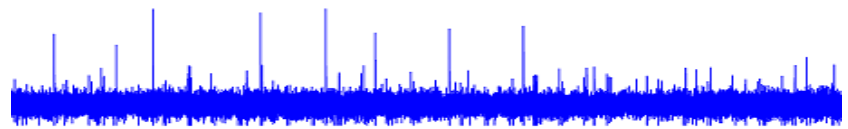
Temperature



Voltage



Categorical state



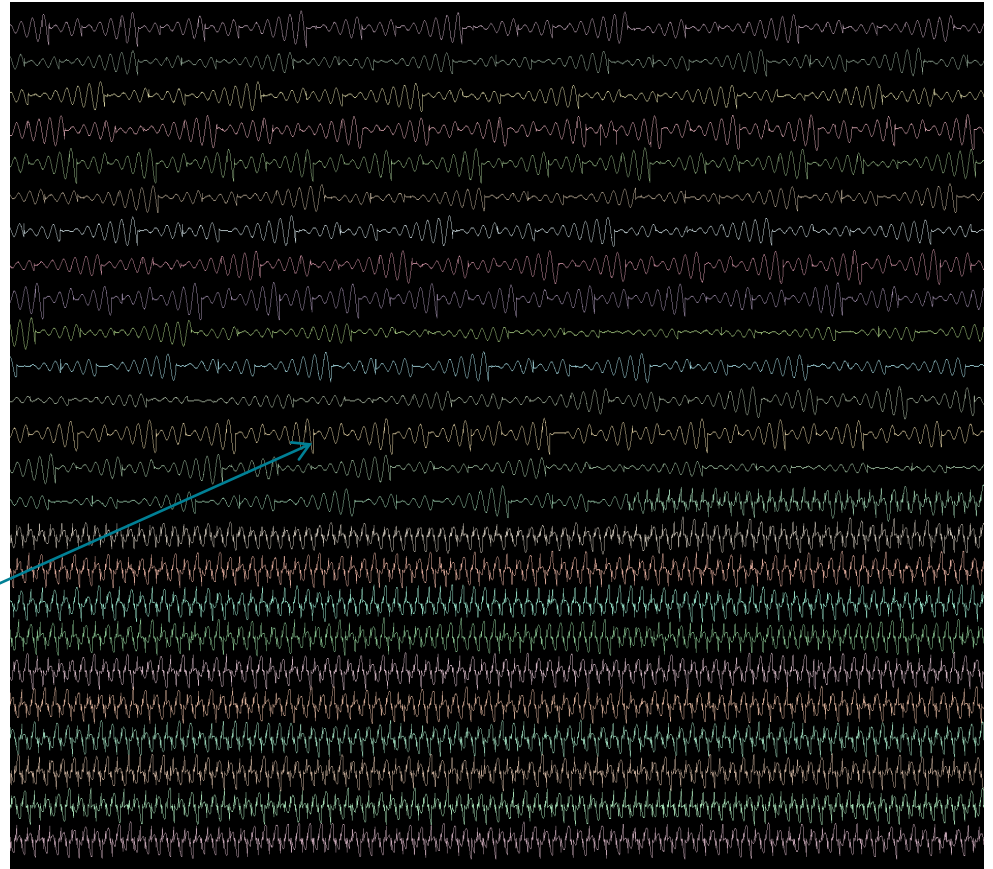
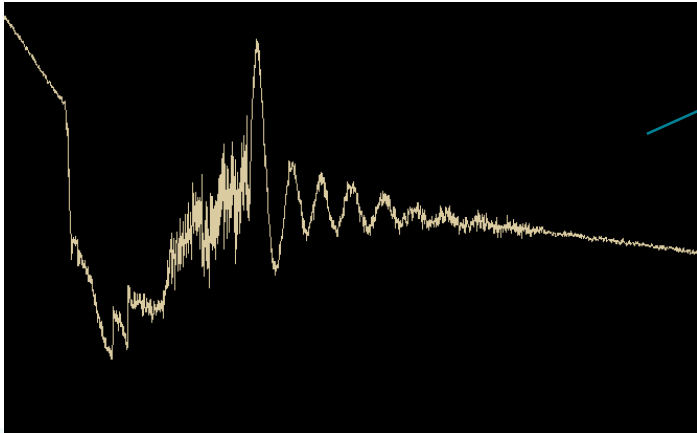
Current

08/03/2017



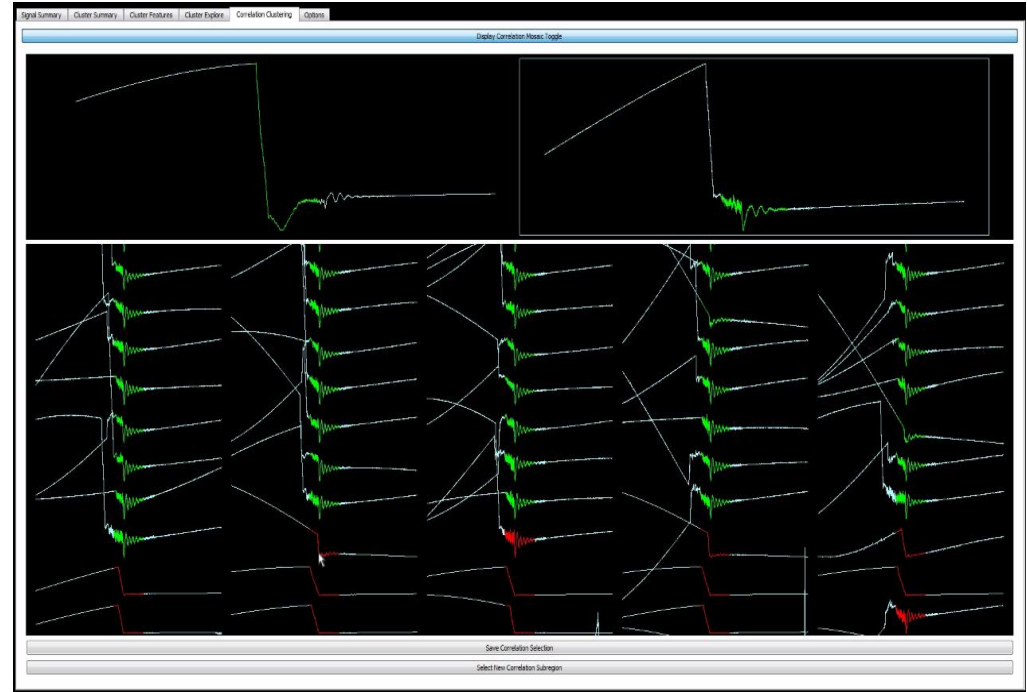
Know-how and tools

- **Interactive data exploration**
 - Hundreds of millions of samples
 - Many scales of interest



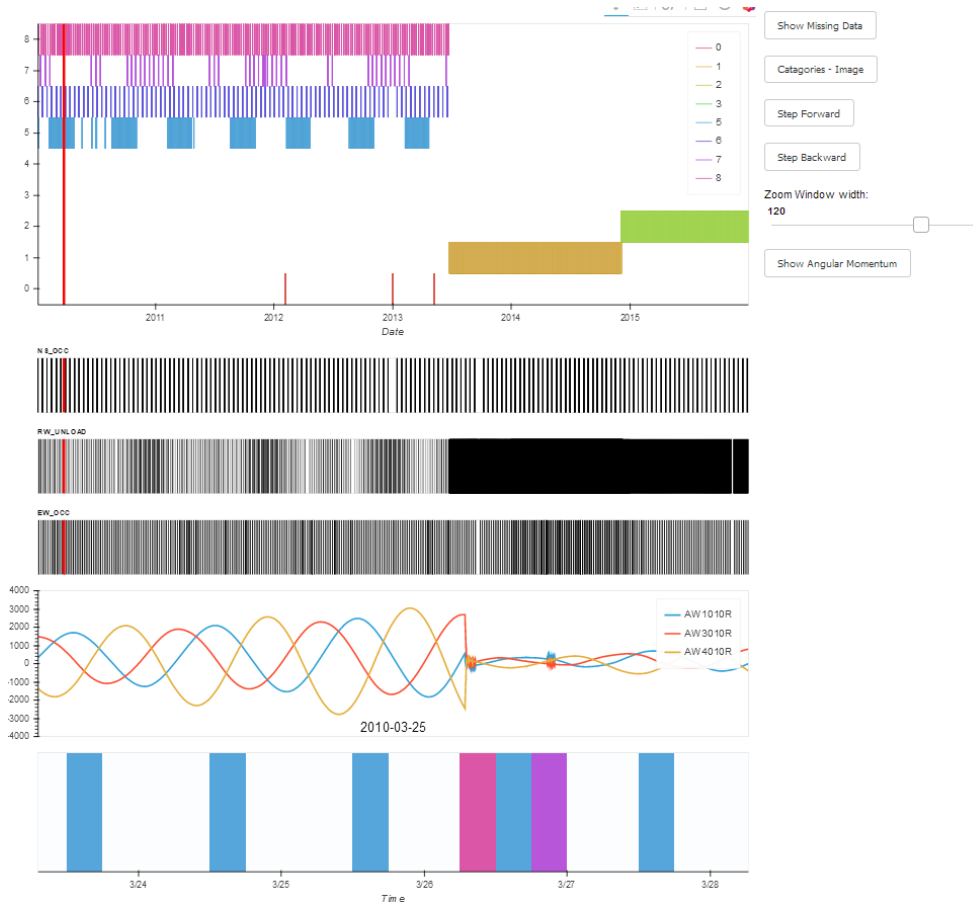
Know-how and tools

- **AI-enabled search engine** for similar behaviors
- **Automatic anomaly detection**



Know-how and tools

- **Semantic** analysis & visualization in terms of behaviors
- Interactive **tools** for **causality** exploration



Artificial Intelligence for SKA

SKA is an extremely complex system which generates a lot of heterogeneous monitoring data

This has many similarities with satellite constellations

SKA faces many challenges common with satellite industry

Streamline integration and validation through automation

Ensure nominal behavior of the system

Minimize maintenance cost in harsh environment

Our methodology is adapted to SKA because it is data-driven (not domain-driven), and shares the objective to limit the maintenance costs

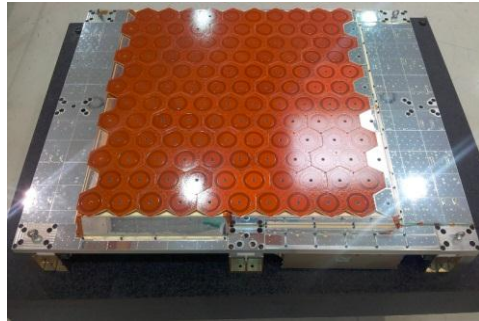


Application 2 – Active arrays of antennas & ground antennas

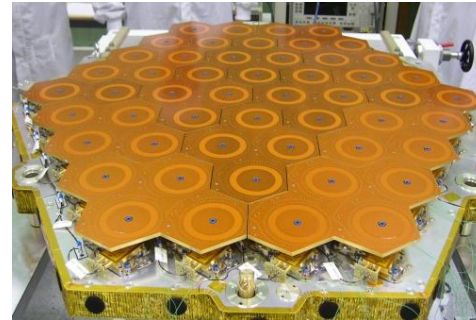
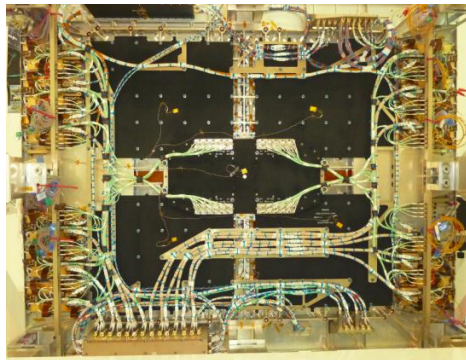


Active antenna array : heritage and R&D

- **Active Antennas** for mobile communications by constellations - linked with system design
- **Anti-jammed Antenna** for telecommunications satellite - linked with system design
- **Active Antenna with Digital Beam Forming Network (D-BFN)** under development, large bandwidth



IRIDIUM-Next main mission receive antenna



GLOBALSTAR-2 receive antenna



Thales Alenia Space experience in system and complex antenna design could bring an important technical added-value to the SKA project

Ground antennas

Ground station & antenna

HERITAGE

• PRODUCT

- ✓ From C to EHF (45 GHz) band
- ✓ QV band on board heritage



9m30

• DIAMETER

- ✓ From 1m80 to 42 m

• FEEDS

- ✓ Large and multibandwidth
- ✓ Monopulse in all conf.



13m

• ELECTRONICS

- ✓ LNA
- ✓ TRK system
- ✓ SERVO



UNDER DEVELOPMENT

• PRODUCT CONFIGURATION :

- *Multi band up to 50 GHz*
- *High efficiency on V band required*

• STIFF REFLECTOR

- ✓ Generic oversized hub, with RF Tx-Rx chains
- ✓ Generic oversized antenna pedestal
- ✓ antenna, station & Energy racks

• OPTIMIZED INTEGRATION

• DESIGN to AIT APPROACH

- ✓ Increase factory IVV
- ✓ Minimize On site test & lead time



13m

2200 Aa

Gain : 74 dBi

0.3dB = 0.03 deg

Tracking error ± 0.08 deg



ADDED VALUE FOR SKA

- High heritage on engineering, expertise, manufacturing and qualification of ground antenna
- Multiple In-house softwares dedicated to high efficiency, low side lobes antenna
- The highest competence in France for feed design...up to qualification in the hardest and severe conditions
 - Temperature range
 - High power handling