

Synthetic Aperture Radars: Current status and future Developments

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ThalesAlenia
Space
a Thales / Leonardo company

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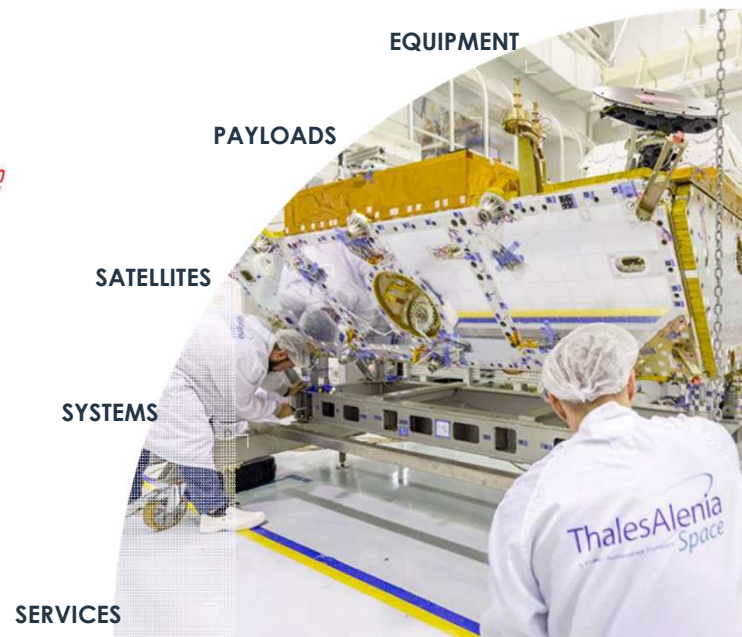
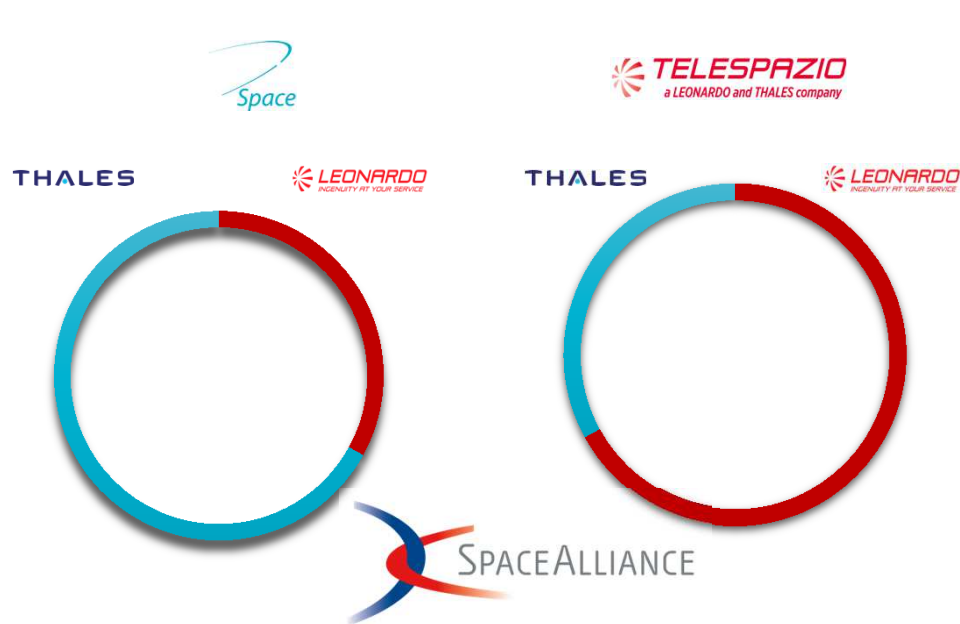


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THALES ALENIA SPACE INTERNAL

A JOINT VENTURE BETWEEN TWO LEADERS

A UNIQUE COMBINATION OF EXPERTISE
COVERING THE FULL VALUE CHAIN



Key Figures

STRONG INDUSTRIAL PRESENCE IN EUROPE. COMMERCIAL REPRESENTATION IN MULTIPLE COUNTRIES

**7 500 EMPLOYEES
15 SITES IN 8 COUNTRIES**



A GLOBAL OFFER

WE DESIGN, BUILD AND DELIVER END-TO-END SPACE SYSTEMS FOR

EXPLORATION

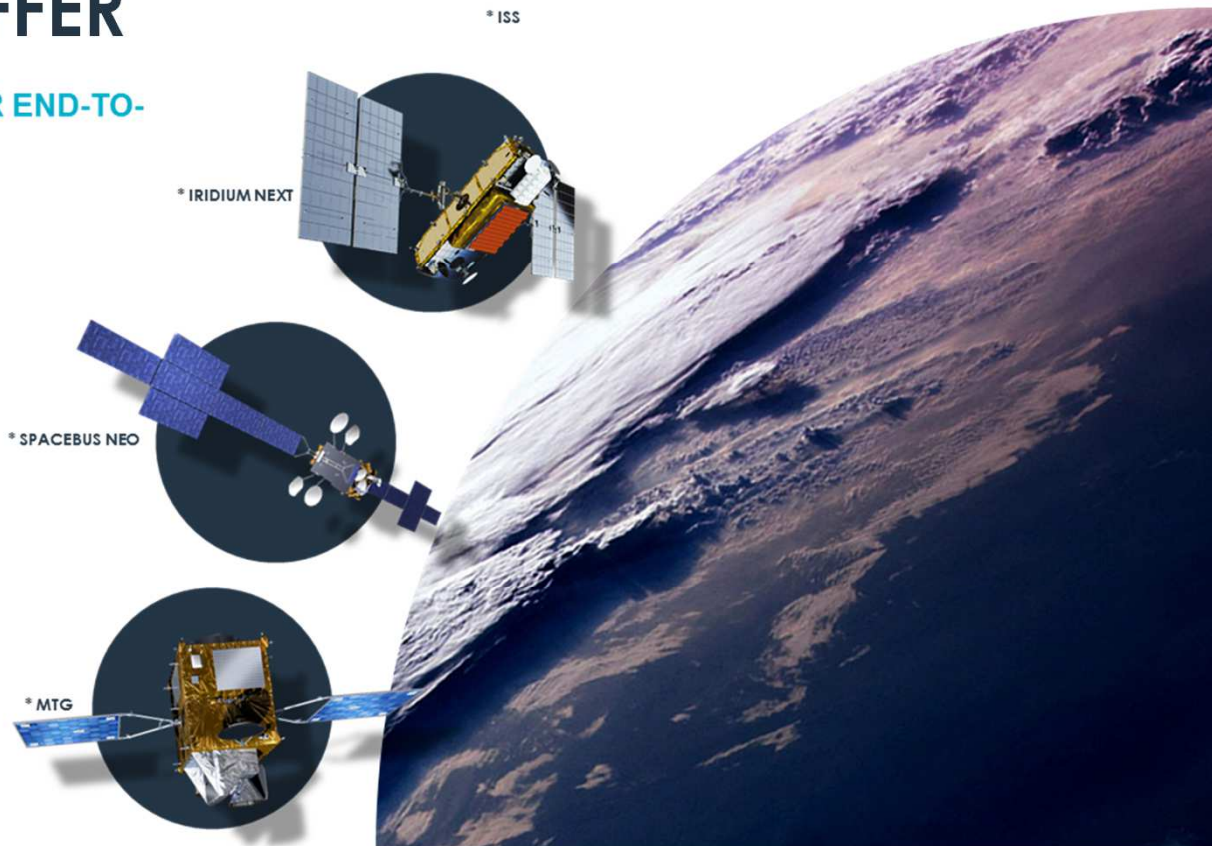
NAVIGATION

SCIENCE

OBSERVATION

TELECOMMUNICATIONS

A GLOBAL OFFER
FROM EQUIPMENT
TO END-TO-END
SPACE SYSTEMS

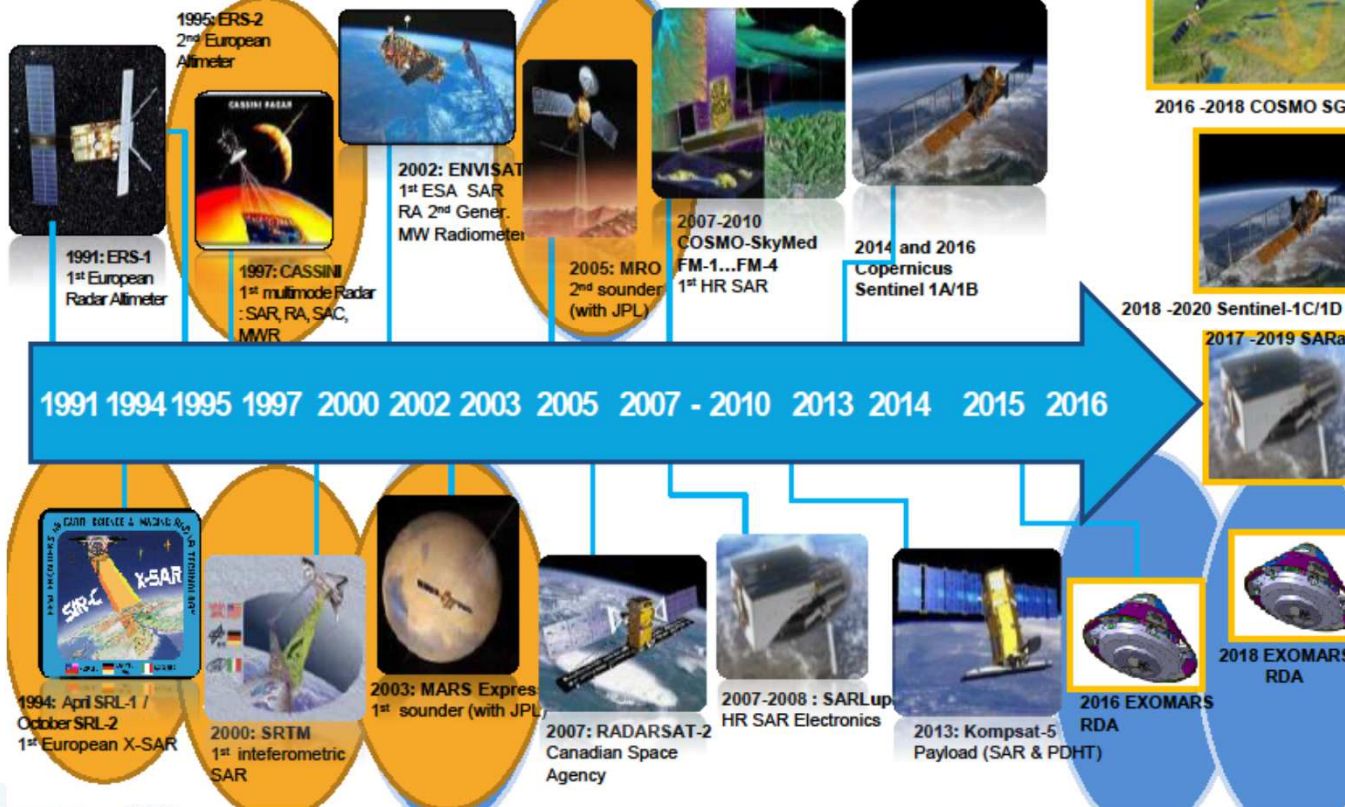


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Thales Alenia Space in worldwide Radar Missions

35+ years success record



Key drivers for Thales Alenia Space strategy:

- *push on competitiveness through product differentiation and insertion of new technologies*
- *maximize synergies between institutional programs and commercial market*
- *maximize synergies also outside of the Earth Observation domain*
- *explore capabilities of constellations*

SAR: key alternatives on frequency bands

X-band:

- High GSD (Ground Sampling Distance) resolution is a key driver.
- Consolidated flight heritage: COSMO-SKYMED, TERRASAR, SAR LUPE, TECSAR,...
- On-going developments: CSG, TERRASAR NG, SARAH,...

C-band:

- Medium GSD resolution, well suited for LAND and MARITIME monitoring
- Flight heritage: SENTINEL1 A/B, RADARDSAT 2, RISAT 1, GAOFEN 3, ...
- On-going developments: SENTINEL 1 C/D, RADARSAT CONSTELLATION, ...

L-band:

- Low GSD resolution, but best suited for specific application (i.e.: agriculture, forestry, hydrology, oceanography,)
- Flight heritage: ALOS 2-PALSAR ,....
- On-going developments: ALOS 3, NISAR (NASA+ISRO), SAOCOM, TERRASAR L,

Other bands:

- S-band (HJ-1-C, NOVASAR)
- P-band (BIOMASS)

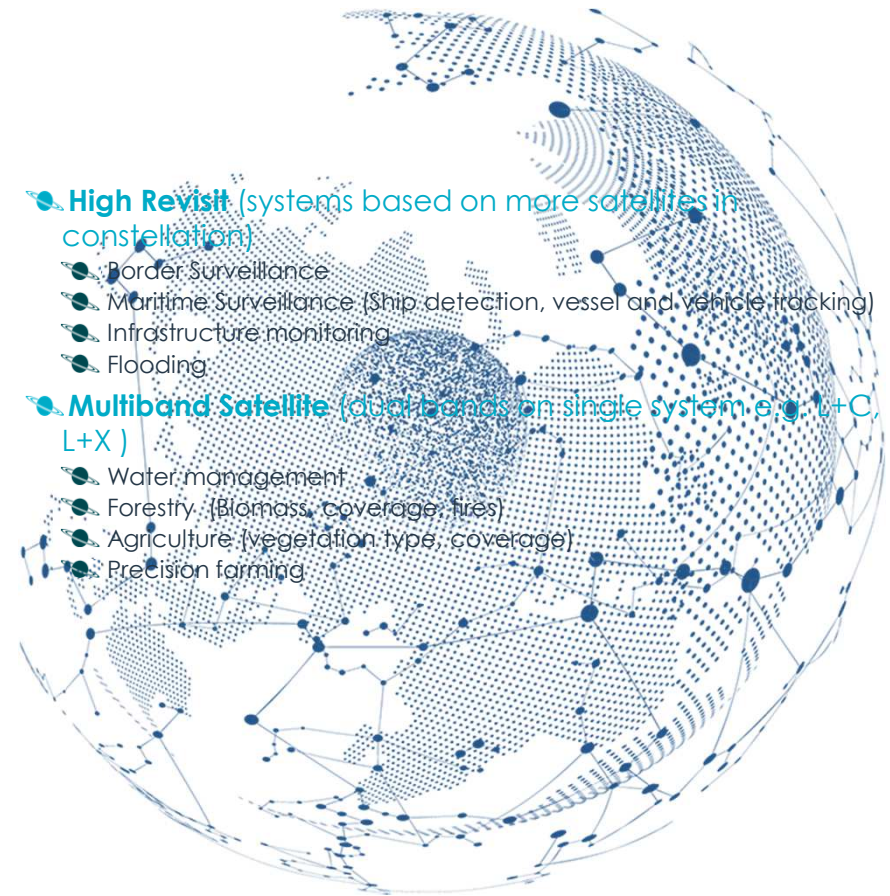
Increasing interest for multichannel/multiband SAR (i.e. URTHECAST, planned hybrid constellation on X/L bands and optical)

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Key design drivers

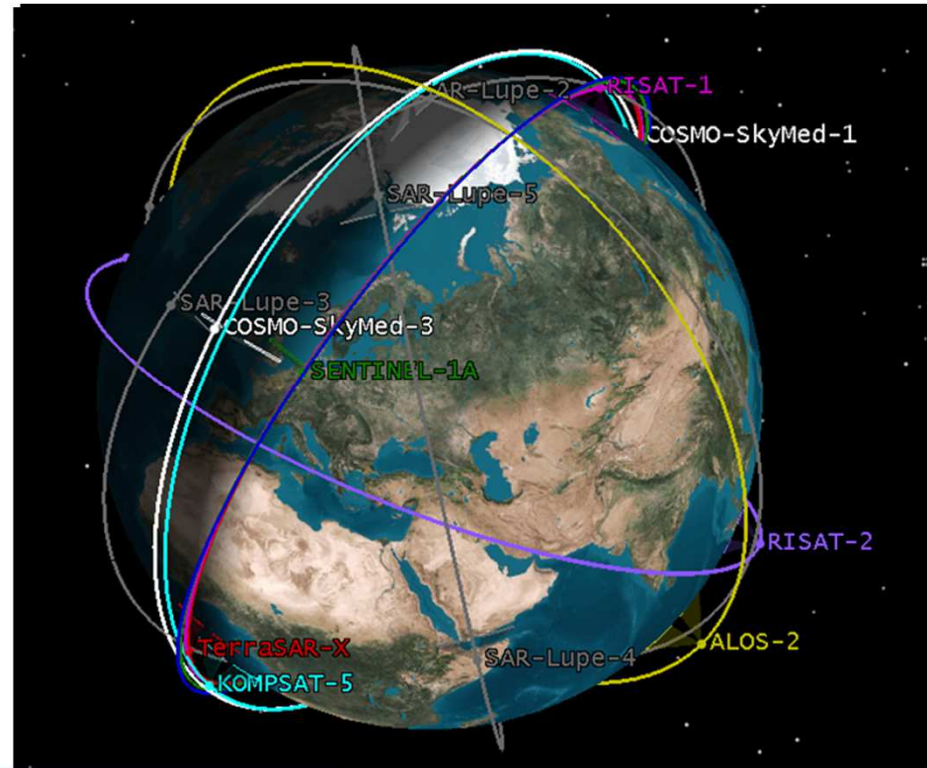
- **Large Swath High Resolution** (e.g. up to 400 km swath with 5 m resolution)
 - Maritime (shipping routes, fisheries)
 - Volcanology
 - Earthquake
 - Landslides
 - Flooding
 - Cartography
 - DEM
 - Search (deposits, identification)
- **High Resolution Strip** (tens of km & resolution <1 m)
 - Change Detection
 - Urban Development
 - Surveillance (oil spill, pipeline monitoring, leak detection)
 - Infrastructure monitoring
 - Maritime Surveillance (Ship detection, vessel and vehicle tracking)
- **Very High Resolution** (Spotlight resolution <<0.5 m)
 - Border Surveillance
 - Vehicle Identification
 - Surveillance (oil spill, pipeline monitoring, leak detection)
 - Maritime Surveillance (Ship detection, vessel and vehicle tracking)

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- **High Revisit** (systems based on more satellites in constellation)
 - Border Surveillance
 - Maritime Surveillance (Ship detection, vessel and vehicle tracking)
 - Infrastructure monitoring
 - Flooding
 - **Multiband Satellite** (dual bands on single system e.g. L+C, L+X)
 - Water management
 - Forestry (Biomass, coverage, fires)
 - Agriculture (vegetation type, coverage)
 - Precision farming



Currently operating SAR missions by TX freq

Satellite	Nation	Orbit	Band
ALOS-2	Japan	SSO	L
RADARSAT-2	Canada	SSO	C
RISAT-1	India	SSO	C
Sentinel-1	Europe	SSO	C
COSMO-SkyMed	Italy	SSO	X
KOMPSAT-5	South Korea	SSO	X
RISAT-2	India	Inc.	X
TecSAR	Israel	Inc.	X
TerraSAR-X	Germany	SSO	X
TanDEM-X	Germany	SSO	X
SAR-Lupe	Germany	SSO	X



INCUMBENT NEWCOMERS

Countries pushing on SAR technologies (sometime taking profit of technology transfer): China, India, Korea, Singapore, Russia, Ukraine, ...

Constellations:

➤ **URTHECAST** (DEIMOS acquisition, partnership with SSTL,...):

- hybrid constellation (DUAL BAND RADAR + OPTICAL) 16 high performance satellites (8+8)
- adoption of advanced technologies (GaN, DBF, ...)
- Aggressive marketing, supported by significant lobbying capability (i.e.: sponsorship/cooperation NASA, CSA, NGA,...)
- Planned launch: 2020-2021

➤ **ICEYE (Finnish start-up):**

- constellation of low cost x-band microsattellites (6) specifically conceived for arctic exploration,

➤ **CAPELLA & UMBRA LAB:**

- constellations of X-band SAR, unfurlable antenna

Other low cost solutions:

➤ **JAXA-ISAS (JAPAN):**

- MICROXSAR, low cost (10-20M\$) microsattellite FM-CW SAR (100 kg class.), based on GaN & slotted waveguides

➤ **SSBV Space (Netherland):**

- PANELSAR, low cost microsattellite FM-CW SAR (interrupted to support monostatic operations), cooperation with SCS Space (South Africa) for FalconSAR and DragonSAR

➤ **STELLAR EXPLORATIONS (USA):**

- Low cost cubesat X-band SAR (lightweight unfurlable antenna)

Next generation radar enabling technologies

Novel Radar enabling technologies have to be developed to support the required capabilities:

SAR Antenna

- High efficiency active phased array supporting ultra-wide bandwidths (X band)
- High efficiency active phased array supporting high performance - low mass solutions (L band)
- Large Deployable Reflector (LDR)
-

SAR Electronics







- Digital beamforming techniques
- Multi-channel SAR receiver / Multi-channel Front-End
- Radar digital beamforming on-board processing
- High performance multi-core processors
- Photonic elements


Highly integrated SAR & Down-link Electronics, to optimize mass of satellites and costs of missions

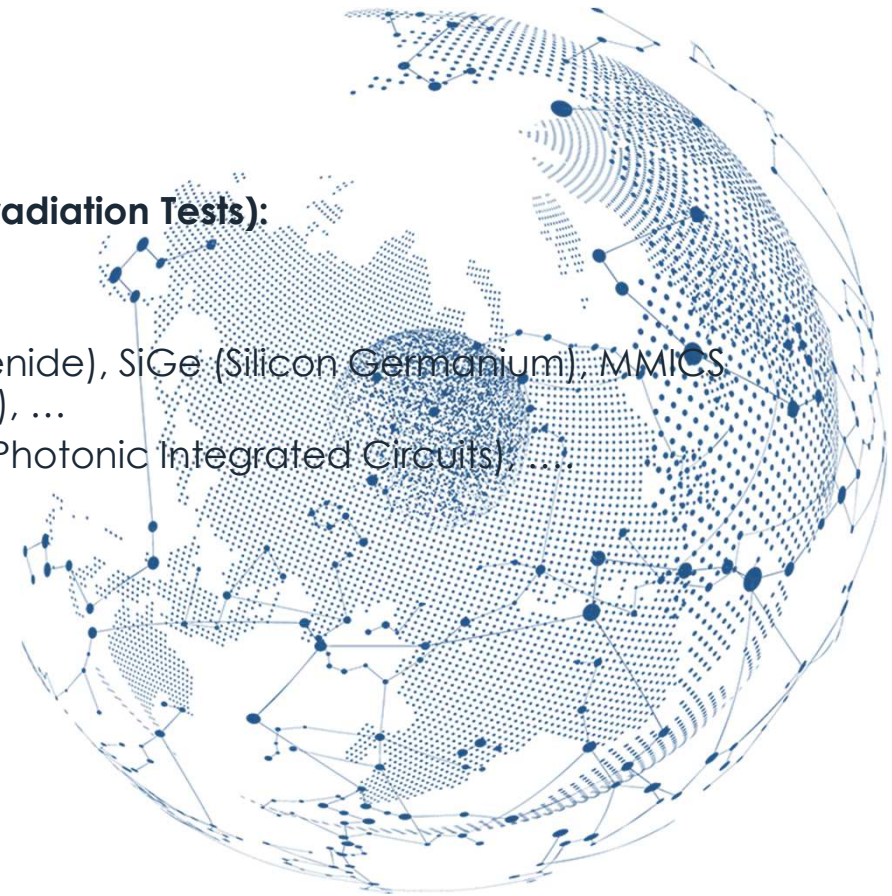


Possible areas of cooperation

- **Need for radiation effects characterization (Irradiation Tests):**

-  COTS characterization
-  New materials
-  New devices based on GaN (Gallium Arsenide), SiGe (Silicon Germanium), MMICS (Monolithics Microwave Integrated Circuits), ...
-  Optronics and Microwave Photonic (PIC, Photonic Integrated Circuits), ...
-  Additive manufacturing
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- **Big Data and Artificial Intelligence**
- **High performance computing**
- **Optical networking**
- **Innovative instruments / payloads/sensors**
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STRATOBUS: INNOVATION AT THE EARTH OF OUR BUSINESS



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