



WE LIGHT UP SPACE

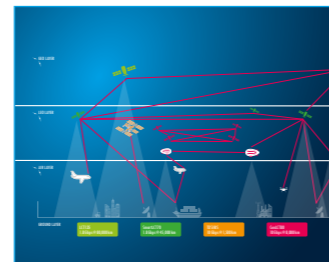
STRONGEST LASERCOMM PORTFOLIO WORLDWIDE



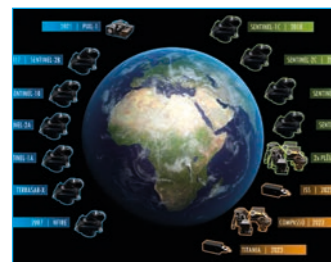
About TESAT



Lasercomm Milestones



Lasercomm Solutions



Lasercomm Programs



LCT Family



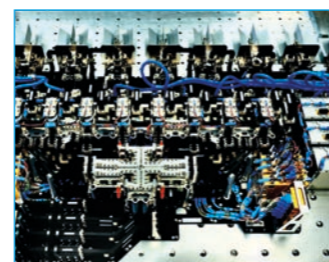
LCT In-Orbit Services



What else?!



Services



Product Highlights

A QUICK OVERVIEW – VERIFIED, SECURE & RELIABLE

TESAT is the world's only provider of a space-proven and in-orbit verified portfolio of Laser Communication Terminals (LCT) for a vast variety of different use cases. With already ten terminals in space and the experience of more than 55,000 established optical satellite links, TESAT provides an unmatched heritage and expertise in manufacturing and operating laser communication.

As different fields of application and different orbits demand different approaches, TESAT is able to provide the perfect LCT for every demand. The LCT135 is our heritage terminal and flying since 2007. Integrated on the geostationary satellites of the European Data Relay Satellite System (EDRS) as well as the Earth observation satellites of the European Copernicus programme, it enables near real-time data and image transmission of high-resolution Earth images by today.

The SmartLCT70 is the consequent further development of the LCT135 and found its place on future LEO satellites, as in the next generation of the ISR mission Pléiades Neo. Its modular

design fits best the demand for space saving and effective placement as well as the enhanced requirement for lower footprints.

Following the approach of smaller footprints and compactness, the ConLCT80 is specifically designed for the use in upcoming satellite (mega) constellations with high data rate service. The product design is particular aligned to match the requirements of series production, while at the same time following the demand for best performance. As TESAT already has broad experience in space-based series production in unmanned and automated production lines, we are already prepared to deliver highest quantities in short time frames.

With both, the CubeLCT and the TOSIRIS, TESAT offers even smaller laser communication solutions to be integrated on even smaller spacecrafts. But "small" is not mandatory essential, as the TOSIRIS will find its way onto the international space station ISS soon, and thus bringing the gigabit era to humanity's threshold in space. The CubeLCT however had its maiden flight

in the beginning of 2021 on TESAT's own PIXL-1 mission, demonstrating that even terminals with an edge length of less than 10cm and a weight of less than 400g can deliver high data rates.

Resumed, from geostationary payloads with ranges of up to 80,000km up to terminals fitting your trousers pocket, TESAT offers space-proven and in-orbit verified laser communication products of highest quality.

Above all and what all mentioned have in common, all our laser communication terminals are already prepared for the next generation of data encryption: quantum key distribution (QKD). With QKD, information is encoded with the physical properties of a quantum, thus achieving a level of encryption that is – even from a purely computational point of view – hard to crack. Without the quantum used for encryption, the information on the receiving end is useless. QKD is due to its technical requirements reserved for light-based transmission technologies and so significantly increases the already high (cyber) security of laser communication once more.



ABOUT TESAT

FACTS & FIGURES

KEY FACTS

• Location	Backnang, Germany
• Core business	Communication payloads Equipment & Subsystems
• Employees	1,000
• Turnover	approx. 300 million Euro
• Total area	60,000 m ²
• Clean room area	12,000 m ²

KEY PARAMETERS

- Telecommunications
e.g. Heinrich Hertz, Eutelsat, EDRS
- Navigation
e.g. Galileo, GPS
- Earth Observation
e.g. European Commission's Copernicus
- Science
e.g. ISS, Juno, Mars Rover, Perseverance, Juice

FEATURES

- Unique provider of in-orbit verified & operating laser communication technology (approx. 55,000 OSs executed)
- Leading manufacturer of high power amplifiers & passive assemblies for navigation payloads
- High capacity qualified production lines
- World leading parts agency for EEE parts
- Founding member of the German industrial association for quantum security (DIVQSec) as commercial partner for the manufacturing of quantum key distribution technology

PORTFOLIO

- Active Products
e.g. MPMs, SSPA, EPCs, LCAMPs, TWTAs & MPAs
- Passive Products
e.g. IMUXes, OMUXes, Waveguide Switches, Coax Filter, Assemblies
- Datalink Products
e.g. Modulators, Downlink Transmitters & TT&C Transponders
- Laser Products
CubeLCT, ConLCT80, TOSIRIS, SmartLCT70, LCT135 & Airborne LCT
- Services
Manufacturing, Testing, Engineering & In-Orbit Commissioning, EEE Parts Agency

CLIENT BASE

- Space agencies, governments, industries and commercial service providers all over the world
e.g. Thales, SDA, NASA, Maxar, JPL, JAXA, ISRO, Intelsat, Inmarsat, Eutelsat, ESA, CAST, Boeing, Airbus, ...

1st

CubeLCT LAUNCHED IN 2021

70

SYSTEM & AIT ENGINEERS

+55K

OPTICAL SATELLITE LINKS

1

SITE WITH INTEGRATED
R&D & MANUFACTURING

1st

LEO CONSTELLATION LCT
LAUNCHED IN 2008

+30

YEARS OF IN ORBIT OPERATION

99.9%

SUCCESS RATE IN PERFORMING
INTER-SATELLITE LINKS (ISLs)

80

ConLCTs / MONTH
PRODUCTION CAPABILITY

1064^{NM}
1550^{NM}

MODULATION FROM SIMPLE OOK TO
COMPLEX COHERENT BPSK

10

LCTs IN ORBIT

LASERCOMM MILESTONES



GEO LAYER

LEO LAYER

AIR LAYER

GROUND LAYER



LCT135
1.8 Gbps @ 80,000 km



SmartLCT70
1.8 Gbps @ 45,000 km



TOSIRIS
10 Gbps @ 1,500 km

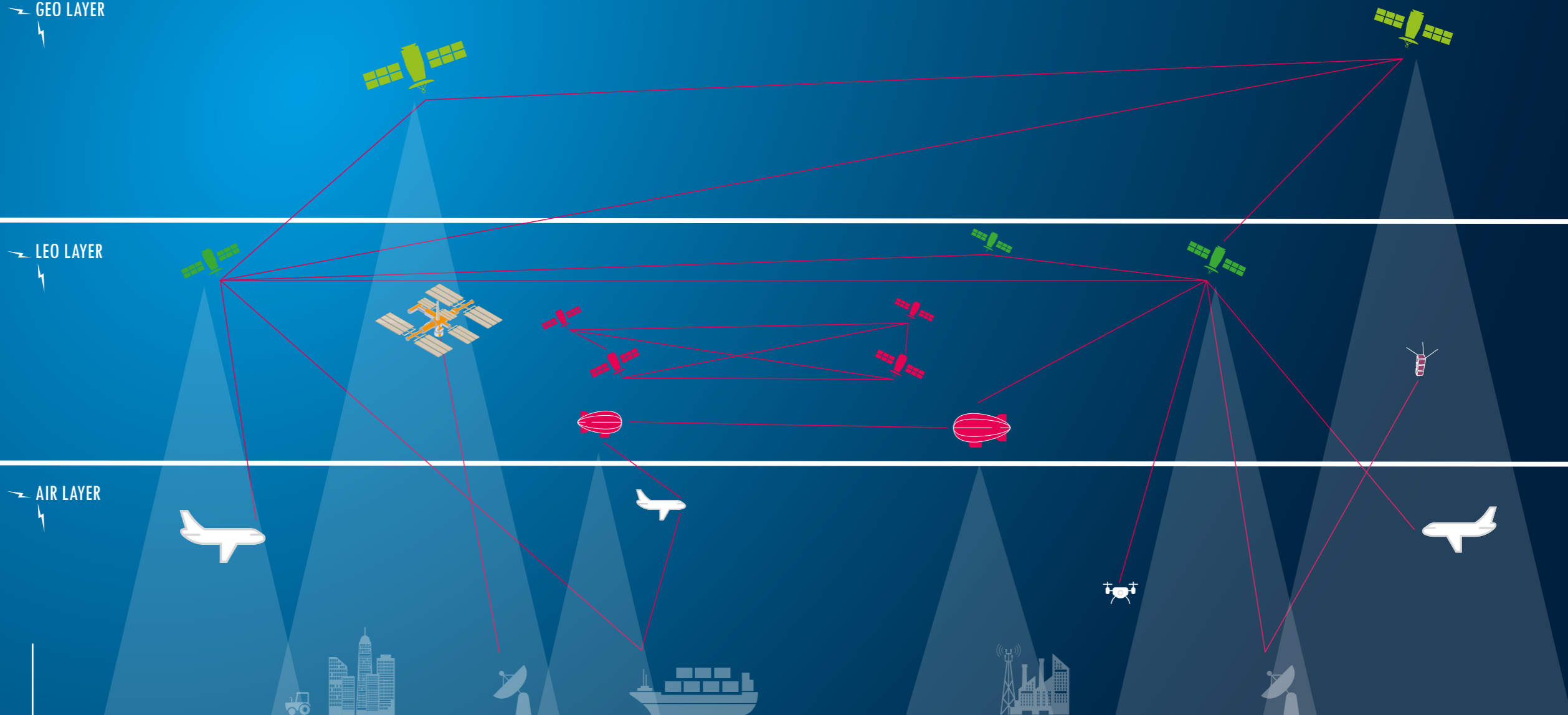


ConLCT80
10 Gbps @ 8,000 km



CubeLCT
100 Mbps @ 1,500 km

SOLUTIONS BY TESAT



2019 | EDRS-C



2021 | PIXL-1



SENTINEL-1C | 2018



IN ORBIT | 10

DELIVERED | 6

IN PRODUCTION | 57

2016 | EDRS-A



2017 | SENTINEL-2B



SENTINEL-2C | 2019



73 LCTs
Under Contract

2013 | ALPHASAT



2016 | SENTINEL-1B



SENTINEL-1D | 2020



2015 | SENTINEL-2A



SENTINEL-2D | 2021



2014 | SENTINEL-1A



2x PLÉIADES NEO | 2021



2007 | TERRASAR-X



ISS | 2022



2007 | NFIRE



COMPASSO | 2023



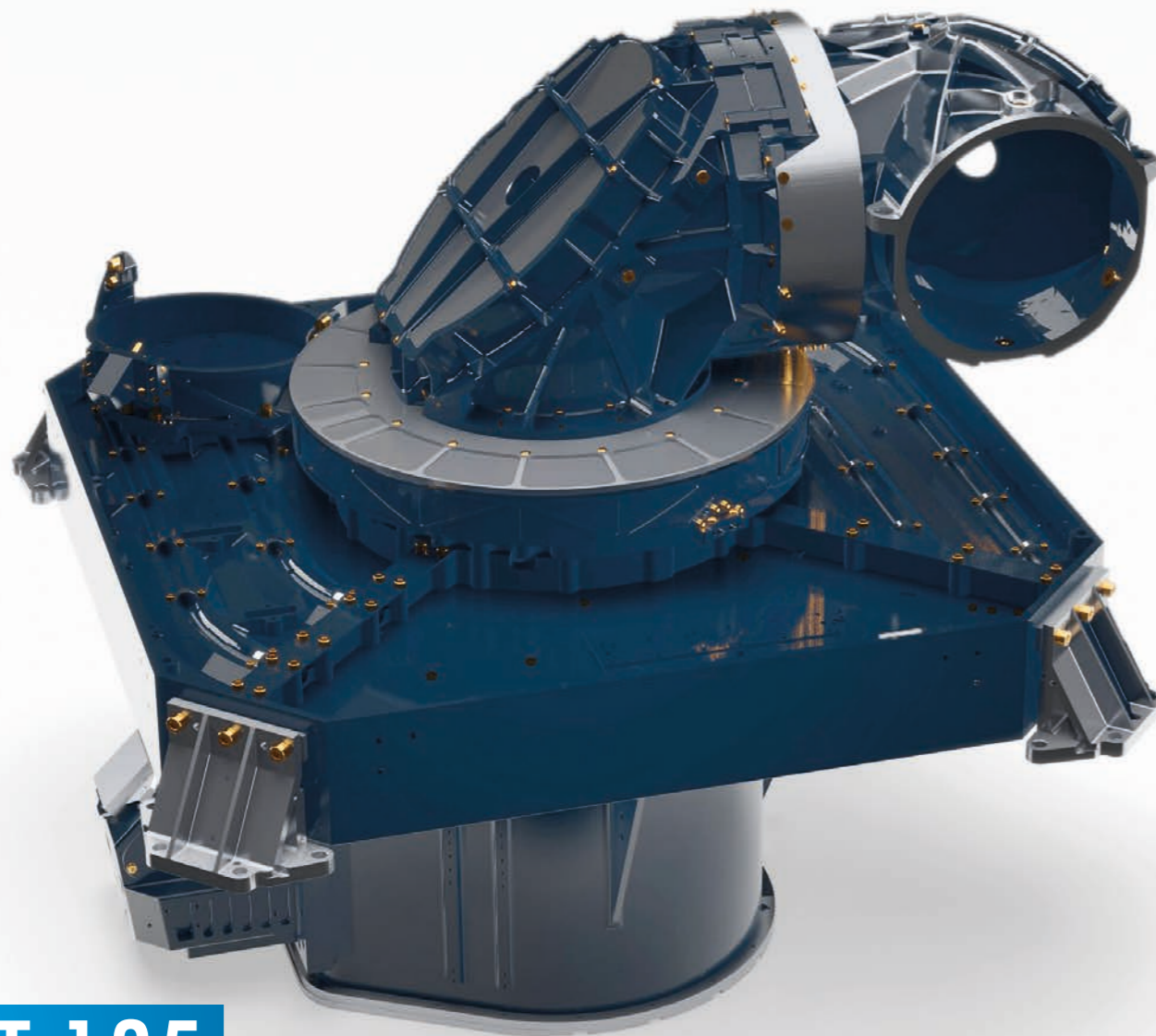
PROGRAMS OVERVIEW

TITANIA | 2023



54 ConLCTs
US LEO CONSTELLATION | 2021





LCT 135

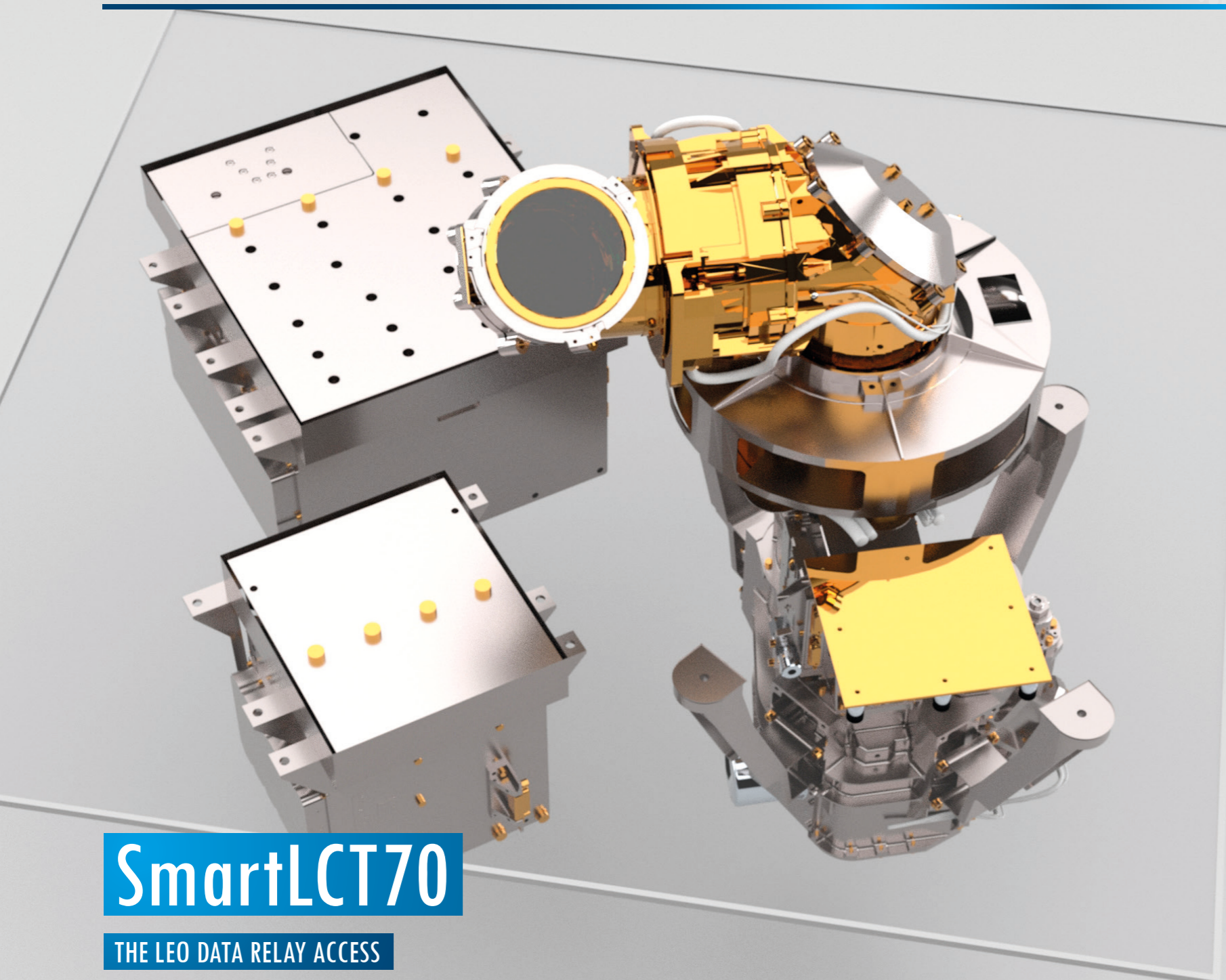
THE GEO BACKBONE

KEY PARAMETERS

- **Application**
Gigabit Inter-Satellite Link (ISL) for Data Relay on GEO S/C working as reliable backbone; core element of the operational service for the European Data Relay Satellite System (EDRS); 14 flight models delivered / in production
- **Range**
Up to 80,000 km; GEO to GEO, GEO to LEO, GEO to Airborne, GEO to Ground
- **Technical Features**
TESAT LCT in space with coherent, space qualified 1064 nm laser source, using homodyne BPSK modulation; most efficient design for long range, high data rate transmissions with resiliency to sunlight and jamming. Next generation features: 2 Mbps forward channel (tasking); 3.6 Gbps data rate increase; dual wavelength (1064 nm + 1550 nm) for interoperability options.

KEY FACTS

• Data Rate	1.8 Gbps, bidirectional
• Mass	53 kg
• Size	60 x 60 x 70 cm ³
• Power Consumption	max. 150 W in acquisition mode, 120 W in communication mode
• Field of Regard	Full hemispherical with Coarse Pointing Assembly (CPA)
• Lifetime	15 years in GEO orbit
• Data Interface	LVDS / Wizard Link
• TRL	TRL9



SmartLCT70

THE LEO DATA RELAY ACCESS

KEY PARAMETERS

- Application
Earth observation LEO satellites connected to GEOs in data relay scheme
- Range
Up to 45,000 km in connection to the LCT135
- Technical Features
Space proven 1064 nm technology; autonomous link acquisitions: algorithms verified 10,000 fold in space; derived from TESAT's LCT135 space heritage.

KEY FACTS

• Data Rate	1.8 Gbps., unidirectional LEO to GEO
• Mass	30 kg
• Size	4 subunits (< 35 x 35 x 20 cm ³ per subunit)
• Power Consumption	max. 110 W in communication mode
• Field of Regard	Full hemispherical
• Lifetime	10 years in LEO orbit
• Data Interface	Wizard Link
• Available	FM 2020
• TRL	TRL7



TOSIRIS

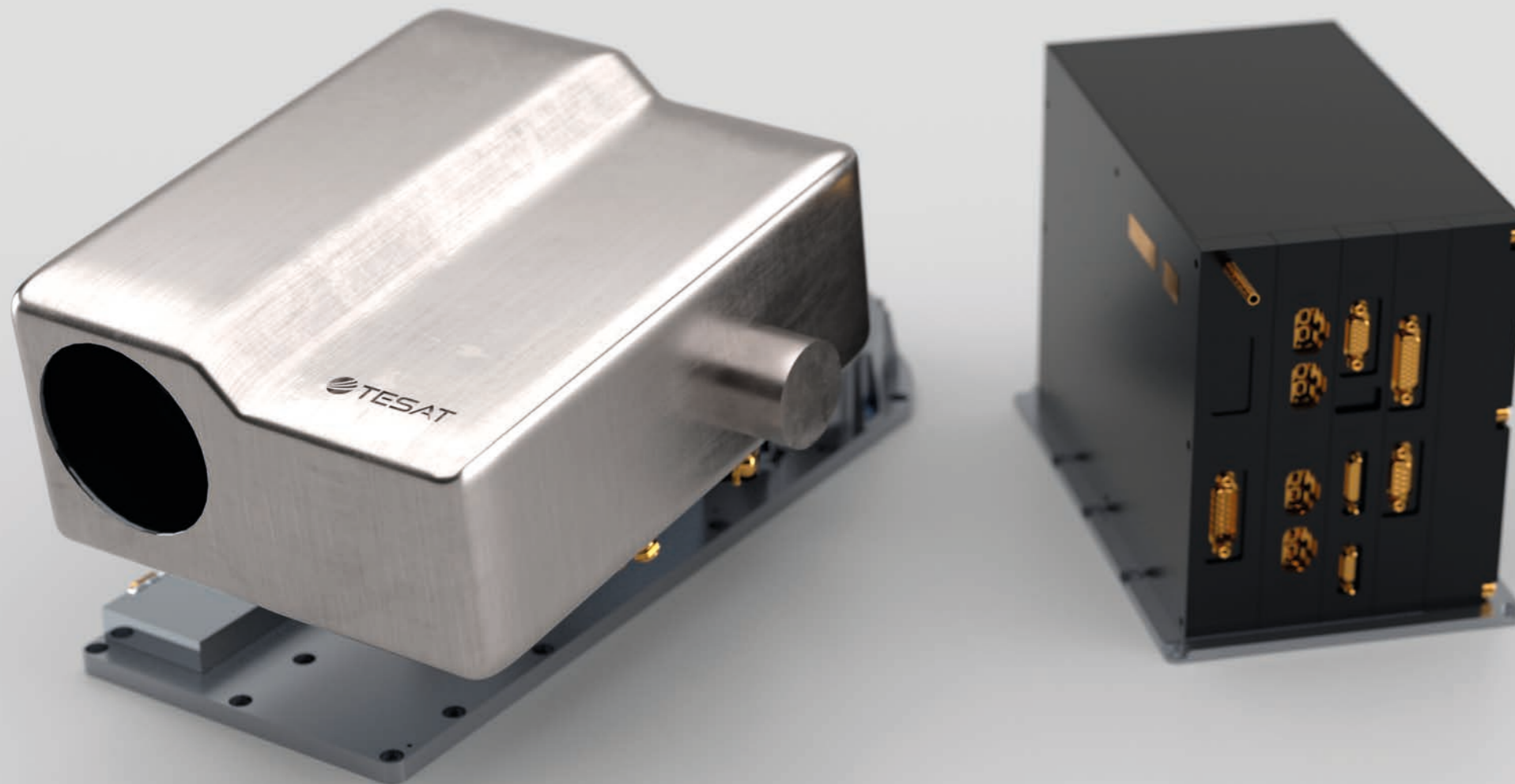
10 GBPS SPACE TO GROUND

KEY PARAMETERS

- **Application**
Smallsat LEO to ground laser communication solution based on TESAT's longterm industrial experience and DLR Institute of Communications and Navigation's research knowledge.
- **Range**
LEO to Ground
- **Technical Features**
LCT optimized for 60cm aperture optical ground station with uplink beacon, 1550nm IM DD technology, 10 min. communication time / ground station pass. Integrated terminal controller for autonomous terminal operation; integrated mass memory; uplink TC channel from optical ground station. Reference implementation for CCSDS O3K standard.

KEY FACTS

- **Channel Data Rate** 10 / 5 / 2.5 / 1.25 Gbps LEO to ground; 1 Mbps TC Channel ground to LEO
- **Mass** 9 kg
- **Size (CPA & Terminal)** 15 x 20 x 55 cm³
Size (CPA) 165 mm length, 125 mm diameter
- **Power Consumption** 90 W (typical), 130 W (peak)
- **Field of Regard** Full hemispherical, coarse beam pointing mechanism included
- **Lifetime** 5 years in LEO orbit
- **Data Interface** Baseline: Ethernet; Option: SpaceFibre according to ECSS-E-ST-50-11C
- **Available** FM available Q2 / 2022, 1st flight missions: TITANIA (UK) and Airbus' Bartolomeo platform on the ISS



ConLCT80

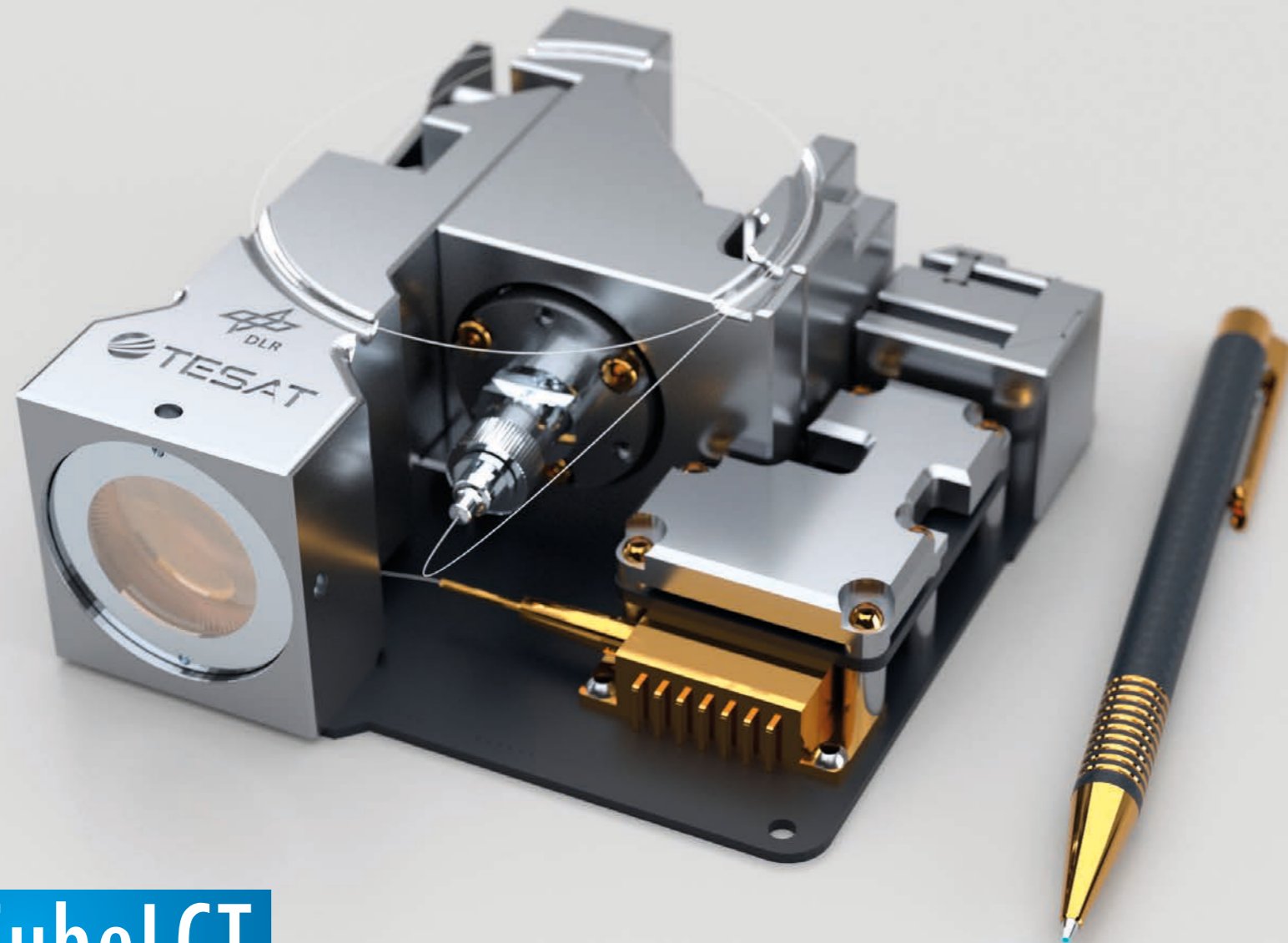
FOR BROADBAND CONSTELLATION

KEY PARAMETERS

- Application
LEO Broadband Constellation
- Range
8,000 km
- Technical Features
Using TESAT's LCT heritage; fast & reliable; beaconless pointing acquisition and tracking; higher integrated; designed for mass production of 1,000's of units per year; different data rates to up to 10Gbps; evolution towards 100Gbps; SDA compliant.

KEY FACTS

• Channel Data Rate	10 Gbps, bidirectional
• Mass	15 kg
• Size (Optical Head)	50 x 18 x 26 cm ³
• Size (LCT Electronics)	26 x 11 x 17.5 cm ³
• Power Consumption	60-80 W, depending on data rate
• Lifetime	5 years
• Data Interface	Ethernet
• Available	FM 2021



CubeLCT

THE SMALLEST LASERCOMM SOLUTION IN SPACE

KEY PARAMETERS

- **Application**
CubeSat LEO to ground laser communication solution based on TESAT's longterm industrial experience and DLR Institute of Communications and Navigation's research knowledge
- **Range**
LEO to Ground; 1,500 km
- **Technical Features**
Laser communication terminal for lowest size, weight and power consumption; optimized for 60 cm aperture optical ground station with uplink & beacon; IM/DD technology; CCSDS O3K implementation; Expandable for 1 Gbps Optical Downlink, 100 Mbps Optical Inter-Satellite Links & Air2Air.

KEY FACTS

• Channel Data Rate	100 Mbps LEO to ground; 1 Mbps TC Channel ground to LEO
• Mass	397 g
• Size	9 x 9.5 x 3.5 cm ³
• Power Consumption	10 W (Peak)
• Field of Regard	+/- 1° integrated Fine Steering Mirror capability (requires S/C body pointing)
• Lifetime	3 years in LEO orbit
• Data Interface	LVDS (for data); UART (for TM/TC)
• Wavelength	According to CCSDS (Telecom C-Band)
• Available	TRL9; 1 st flight on PIXL-1 mission January 2021



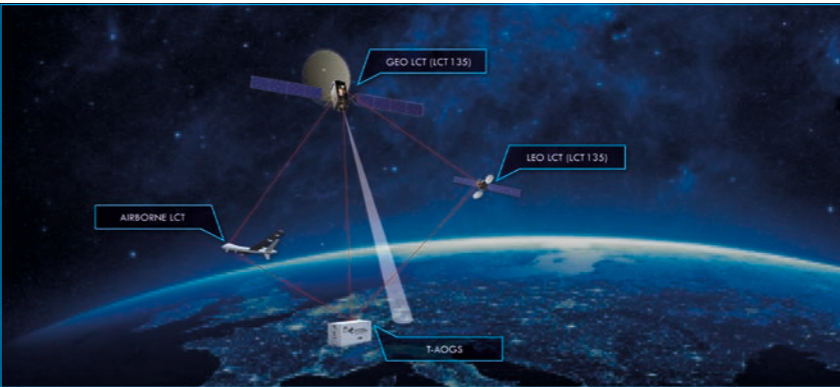
STRATEGIC SKILLS

- Enabler of the optical communication market support
- Providing customer support in the transient to optical communication
- Perform maintenances for LCTs in-orbit

LCT IN-ORBIT SERVICES

COMMISSIONING & OPERATION FOR OUR CUSTOMERS

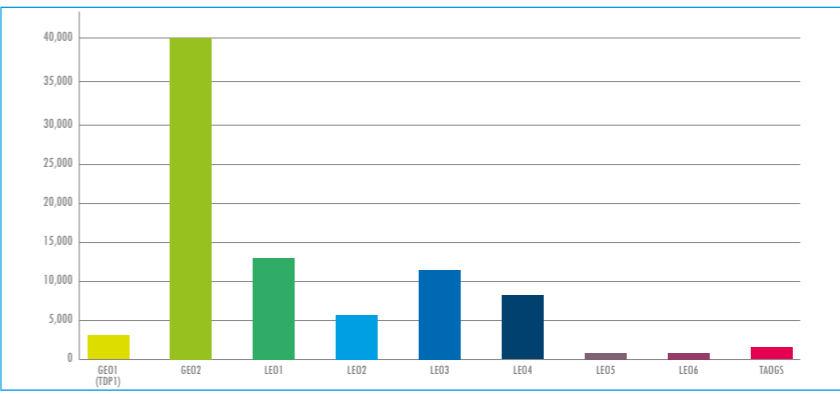
TECHNOLOGY DEMONSTRATOR PAYLOAD-1 TEST BED (END-TO-END INFRACTURE)



TRANSPORTABLE OGS



INTER-SATELLITE & SPACE-GROUND LINK HERITAGE



TESAT Laser Communication Terminals performed more than 55,000 successful optical links due to August 2021. The LCTs have an average of about 1,000 links per month – increasing continuously.

Today, optical communication is commercially and successfully applied for high capacity data transmission between satellites. In consequence, there is also high interest for optical data transmission from and towards ground. Applications range from feeder links (ground to GEO), over links from LEO direct-to-Earth (DTE) and links between ground and airborne platforms (High Altitude Platforms (HAPs), UAVs) up to quantum key distribution from space to ground.

PRODUCTS & SERVICES

- E2E test bed for 1064 & 1550nm
- Professional engineering help desk
- Performance & trend analyses
- DTE mission planning

DEVELOPMENT TOOLS

- MATLAB & Origin (TM Analysis)
- Python & C (TM Handling)
- MOIS
- IBM Rational DOORS



WHAT ELSE?!

YOUR ONE-STOP-SHOP FOR COMPONENTS & SERVICES



FACILITIES & SKILLS

- 200 years accumulated experience in hybrid microwave manufacturing
- Production experience of 80,000 complex LTCC modules
- Magazine loader
- Plasma cleaner
- Epoxy dispenser
- Pick & placer

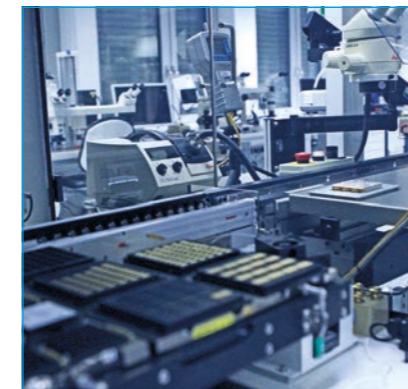
AUTOMATED HYBRID FACTORY

HIGHEST QUANTITY IN SHORTEST TIMEFRAME

ASSEMBLY LINES, WIRE-BONDING LINE, FINAL ASSEMBLY & ELECTRICAL TEST



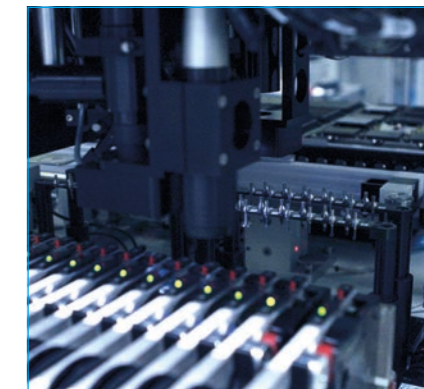
ASSEMBLY LINE



WIRE-BONDING LINE



AuSn STATION



- The facility covers a clean room area of 400m² (ISO class 8)
- Man-less ghost-shift capability
- Capacity more than 15,000 hybrids / month
- ESA-qualified hybrid line according to ESCC 2566000



PARTS AGENCY

EFFICIENT PROCUREMENT AND ENGINEERING OF EEE PARTS



Today's space industry needs to step up its efforts to industrialize the production processes to reduce costs and lead-times. Thereby, an efficient procurement and engineering of EEE Parts plays a significant role.

A major challenge on the way to cost-effective production of space equipment are supply bottlenecks, quality problems as well as the general dependency on component availability.

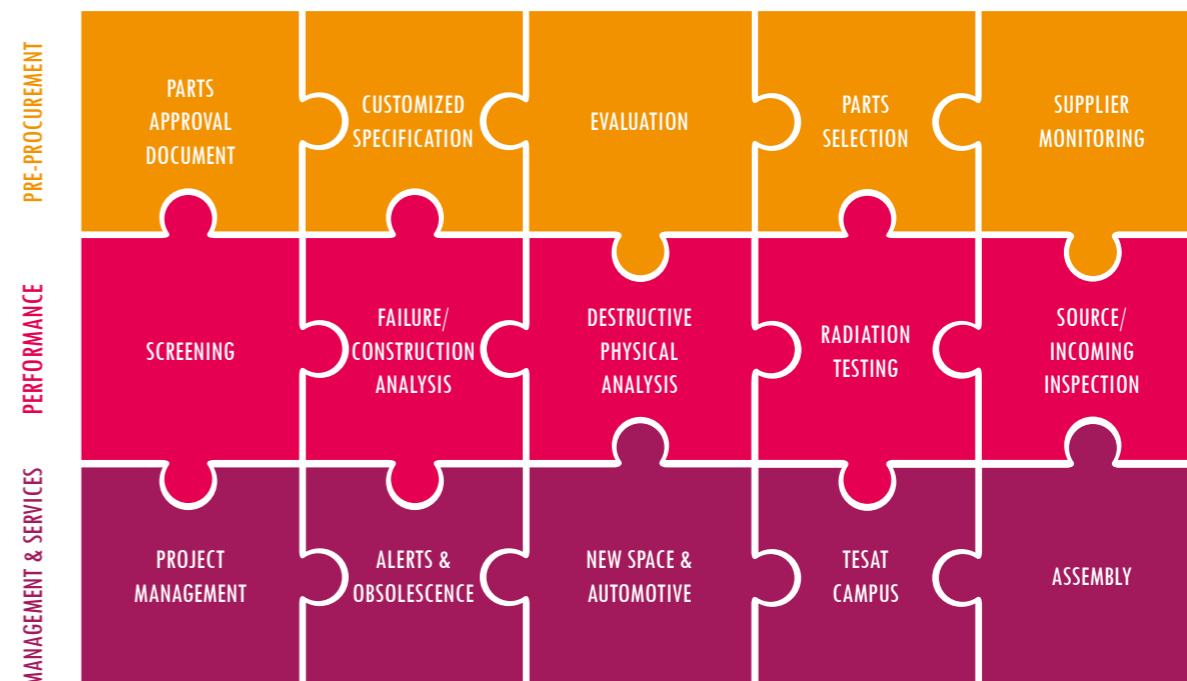
The TESAT Parts Agency and EEE Centre offer innovative procurement approaches and efficient EEE Parts engineering to massively reduce costs

and project risks. Our services – managed by project managers with long-term expertise in space programs – are constantly extended to add new market trends as e.g. innovative upscreening, testing and volume approaches for the New Space industry.

In all phases of the EEE service projects, the customers of the Parts Agency benefit from TESAT's outstan-

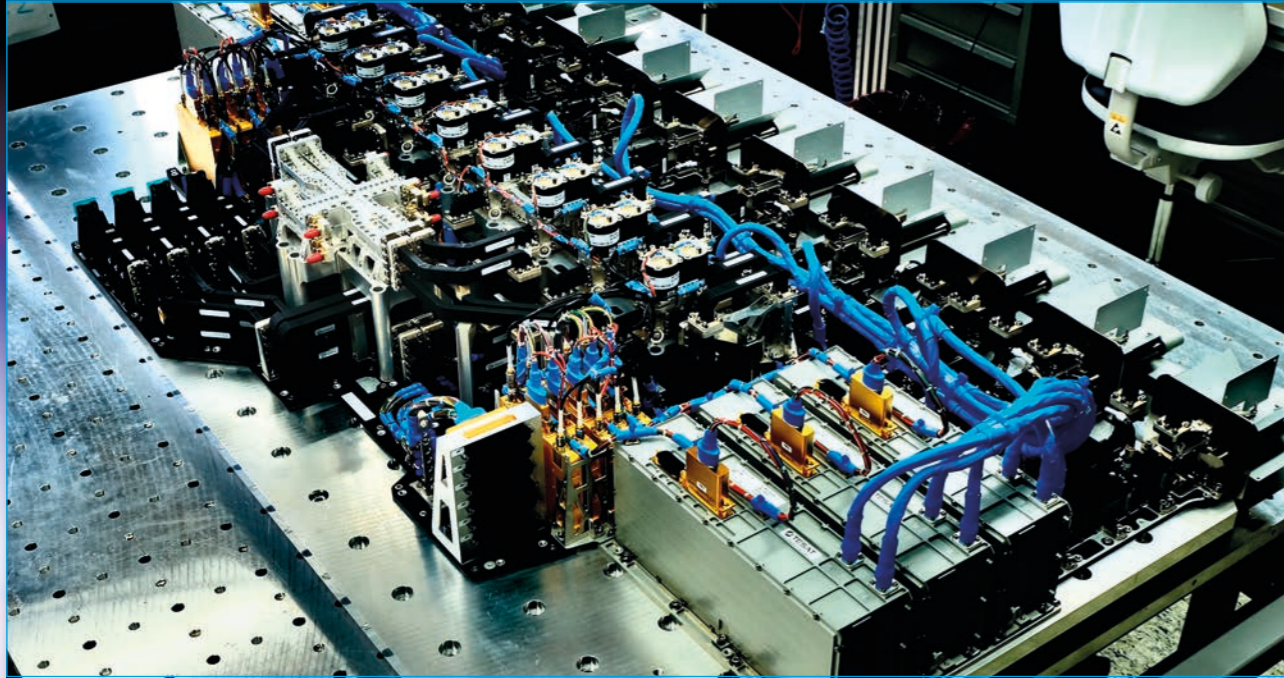
ding experience as a manufacturer of space equipment and PCBs – also from the large EEE parts stock that often allows managing unexpected part shortages.

Broaden your knowledge and get yourself updated by booking [TESAT Campus](#) trainings with state-of-the-art EEE expert knowledge. More infos at parts.tesat.de.

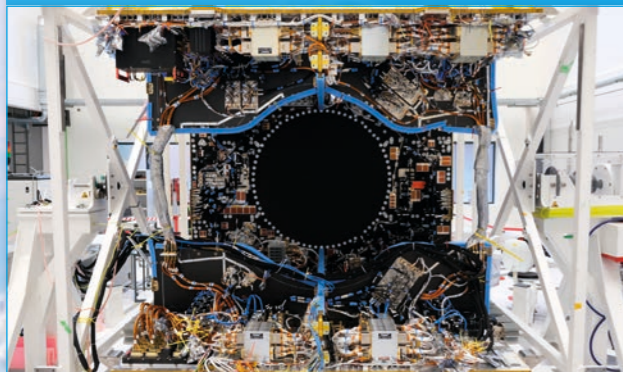


PRODUCT HIGHLIGHTS

MPA — MULTIPOINT AMPLIFIER

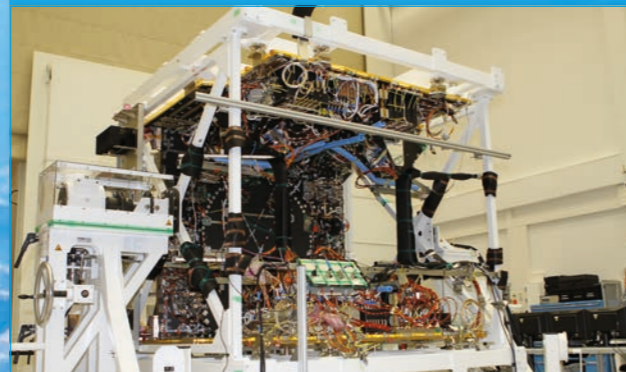


PAYLOAD



H2Sat (Heinrich Hertz)

PAYLOAD





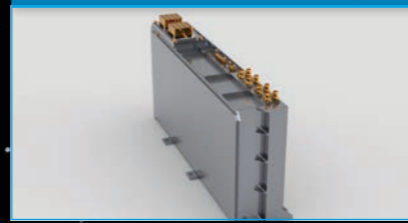
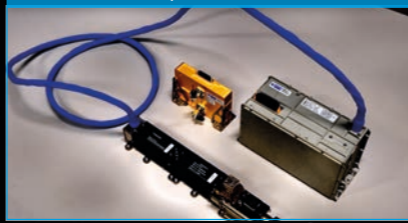
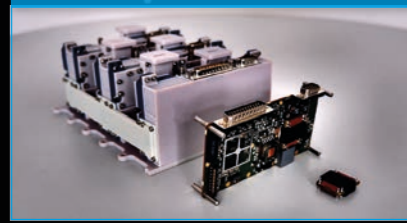



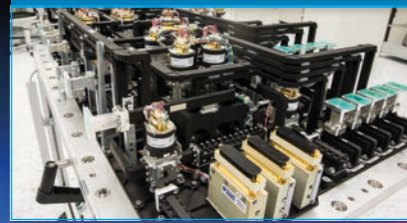
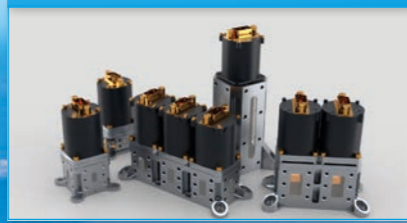



Hispasat

PAYLOADS — MANUFACTURING, INTEGRATION & TEST



Galileo 2nd Generation

PRODUCT & SERVICE HIGHLIGHTS

<p>SINGLE MPM</p> 	<p>DUAL MPM</p> 	<p>QUAD MPM</p> 	<p>SINGLE TWTA /w LCAMP</p> 	<p>SSPA</p> 	<p>HDI</p> 
<p>Microwave Power Module</p>	<p>Dual Microwave Power Module</p>	<p>Quad Microwave Power Module Electronic Power Conditioner</p>	<p>Travelling Wave Tube Amplifier with Linearized Channel Amplifier</p>	<p>Solid State Power Amplifier</p>	<p>Customer Interface Unit</p>
<p>IDT</p> 	<p>GMOD</p> 	<p>TR MODULE</p> 	<p>TT&C</p> 	<p>MODULATOR</p> 	<p>OFN</p> 
<p>Integrated RF Data Downlink Transmitter</p>	<p>Gigabit Modulator (flexible); Different Bands</p>	<p>Transmit & Receive Module (Active Antenna Systems)</p>	<p>S-Band TT&C for Galileo</p>	<p>X- & Ka-Band Downlink</p>	<p>Output Filter Network</p>
<p>IMUX</p> 	<p>TRAVELLING WAVEGUIDE SWITCHES</p> 	<p>OMUX</p> 	<p>SECURITY PRODUCTS</p> 	<p>PARTS AGENCY</p> 	<p>ONE-STOP-SHOP</p> 
<p>Coax Input Multiplexer</p>	<p>Switch family</p>	<p>Herringbone OMUX with flexible waveguides</p>	<p>Quantum Key Distribution Payloads</p>	<p>EEE components & PCB needs</p>	<p>Solutions for Primes & Space Agencies all over the world</p>

1971



Intelsat IV: First Space Project

1989



Main Contractor for Deutsche Telekom Kopernikus Satellites

1997



First Long Term Agreement for TWTAs signed

2006



SAR-Lupe: Major Supplier for first Bundeswehr Satellite

2007



NFIRE: First flight of TESAT's LCT

2013



TESAT manufactures 10,000th EPC

2019



First Inter-Satellite Link between EDRS-C and a Sentinel-2 satellite

2018



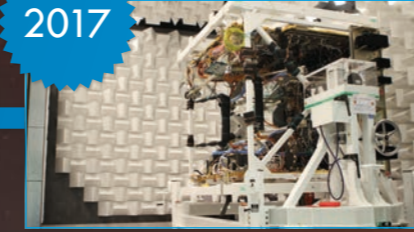
Signing of contract for Heinrich Hertz (H2Sat)

2018



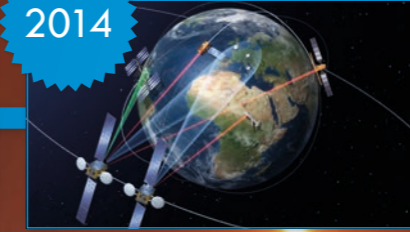
More than 10,000 established Laser links in space

2017



TESAT flexible SmallGEO Payload on Hispasat 36W-1

2014



First GEO/LEO-Optical Inter-Satellite-Link over 40,000km

2013



TESAT's first Optical Relay Payload on Alphasat

2020



TESAT's Downlink Subsystems selected for six Copernicus missions

2021



Launch of worldwide's first CubeLCT on TESAT's mission PIXL-1

2021



Mars Rover Perseverance transmits data via TESAT MPMs

2021



Completion of TESAT's first 1000 W Multiport Amplifier

2021



TESAT selected for AIT of GALILEO navigation payloads

2021



SDA ConLCTs

HISTORY & MILESTONES

1949 | AEG 1955 | Telefunken 1967 | AEG Telefunken 1983 | ANT Nachrichtentechnik 1995 | BOSCH Telecom 2000 | BOSCH Satcom 2001 | Tesat-Spacecom



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EN 9100:2018
BUREAU VERITAS
Certification



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