European Data Relay System Achievements and Capabilities

2019 Conference on Big Data from Space (BiDS'19)
Munich

Dr. Harald Hauschildt
ESA - Telecom & Integrated Applications Directorate

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EDRS is a Public-Private-Partnership: ESA and Airbus Defence and Space (DE)

EDRS is **NOT** a typical ESA **Technology Development** Programme…

BUT

… is implemented as a **Service Development** Programme in a Public-Private-Partnership between ESA and Airbus Defence and Space, Germany.

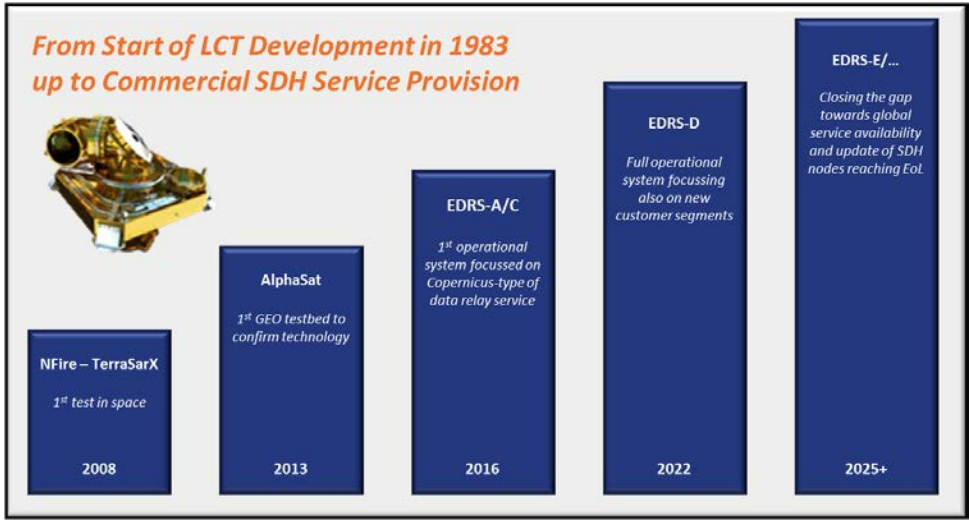
Airbus branding for the service: **SpaceDataHighway**

European Space Agency

EDRS: Europe's unique and world first laser communication network in space !

Why Optical Communication?

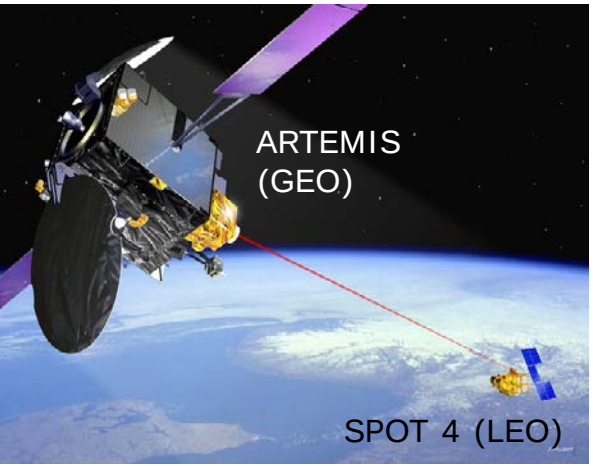
- ✓ The **demand for broadband solutions is insatiable** and continuously growing with more performant sensors available
- ✓ Free-space optical comms is now a mature technology, evolving towards **customization & broadband applications**
- ✓ Only **finite amount of radio spectrum** available for high bandwidth applications; congestion is inevitable
- ✓ Overcrowded RF spectrum also prone to **interference, interception and jamming** (compared to optical ISL)



Optical Communication Technology is one of the next revolutions in the Space Sector!

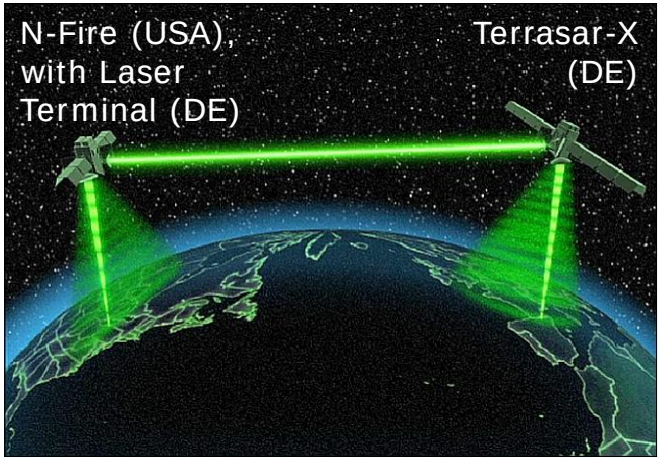
Optical Communication Technology has gone a long way from Testing …

36000km GEO-LEO
50Mbit/s, 200kg Terminal



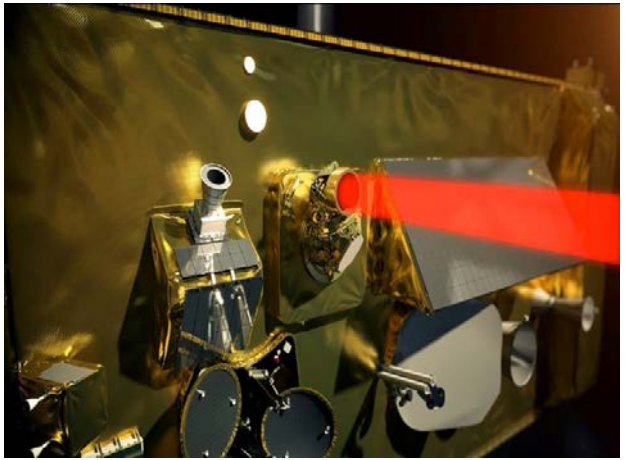
ESA's Artemis and SPOT 4 communicating via the SILEX system (2001)

8000km LEO-LEO
5.6 Gbit/s, 50kg Terminal



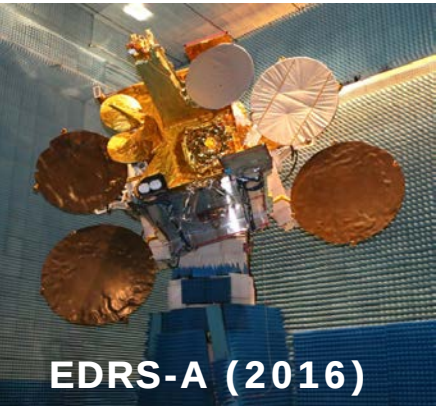
N-FIRE-Terrasar X US-German Laser Cross Link Experiment (2008)

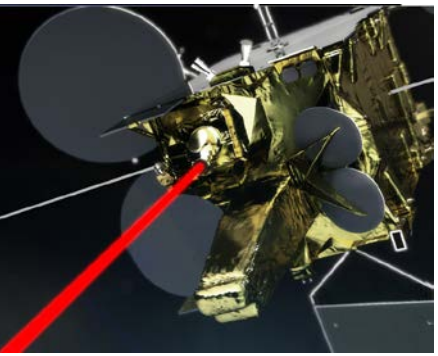
36000km GEO-LEO
1.8 Gbit/s, 50kg Terminal

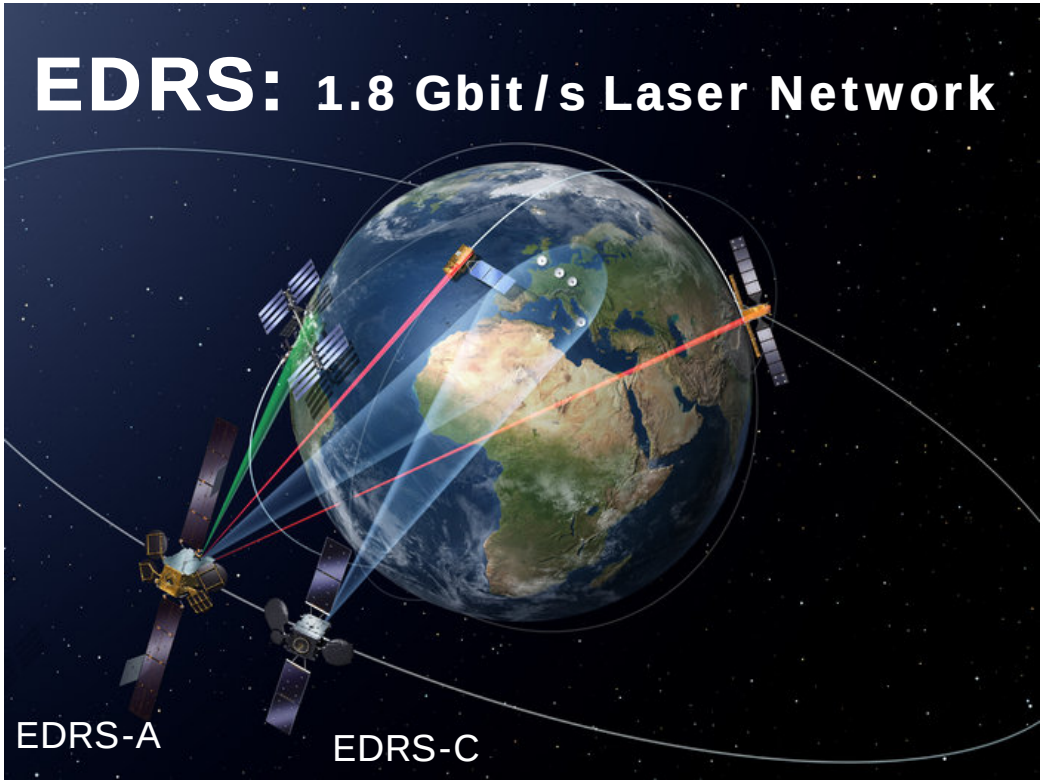


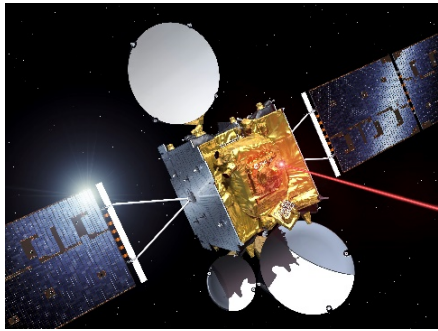
ESA Alphasat – Sentinel 1A links (2014)

...to the world first operational Laser Communication Network in Space - EDRS



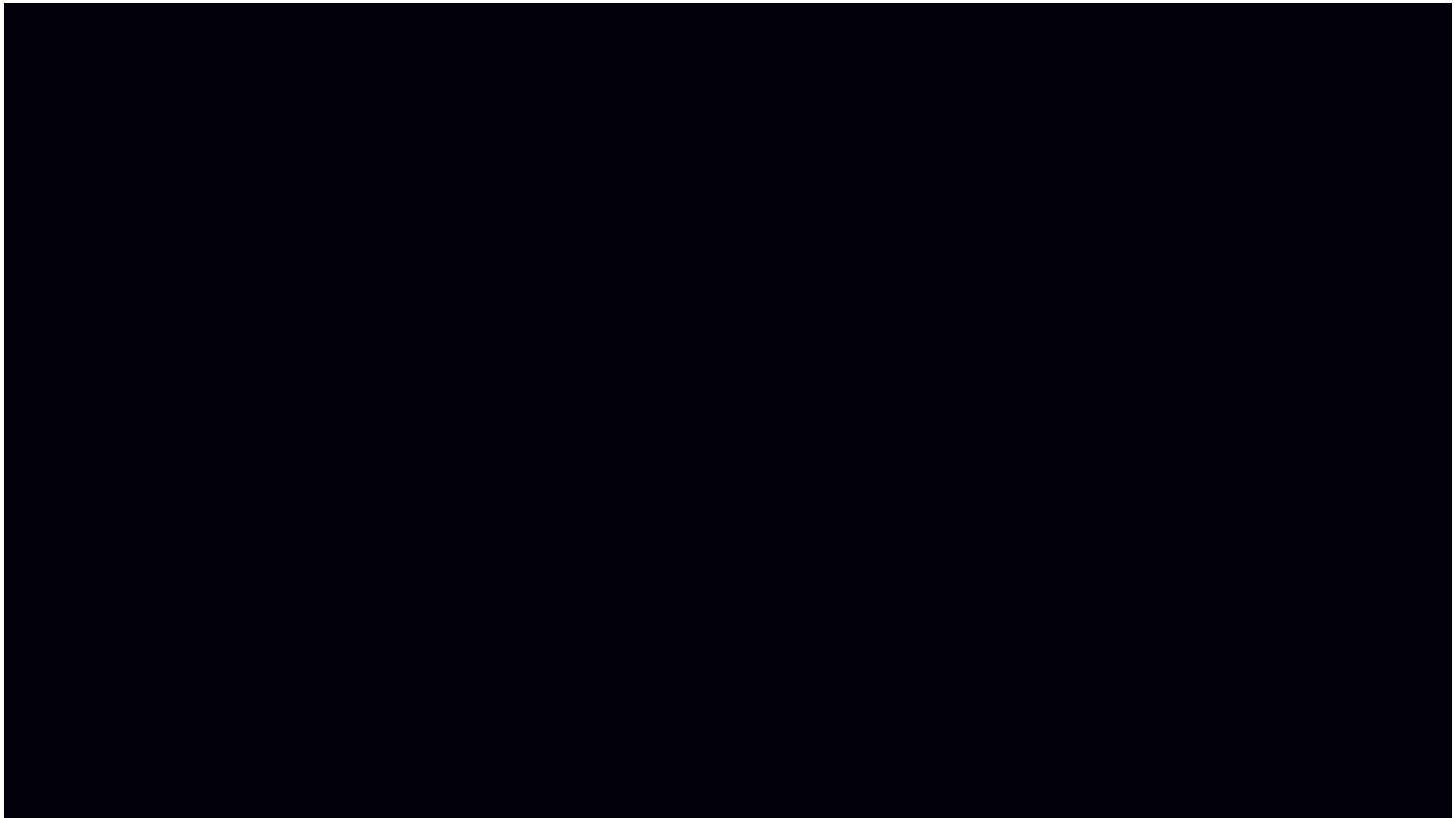






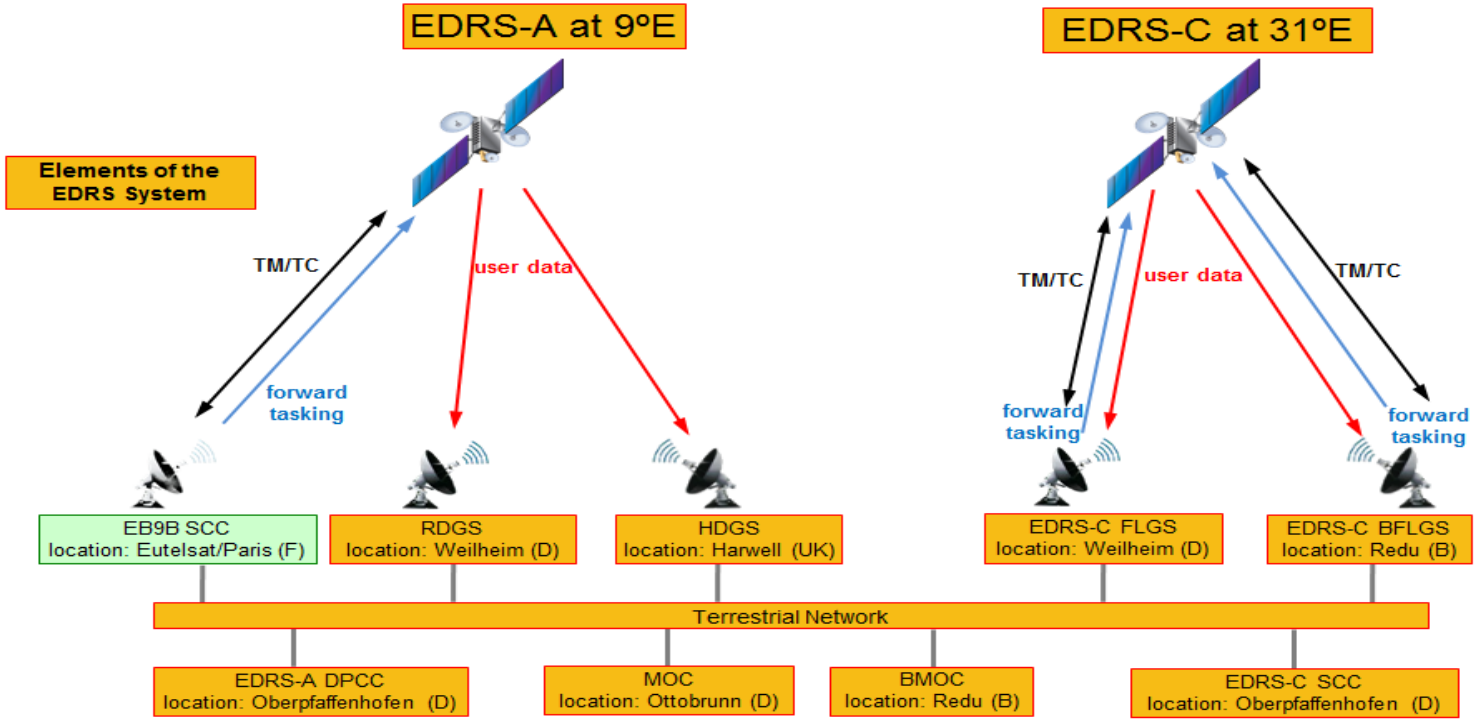
EDRS-C (2019)

Introduction Videos to EDRS

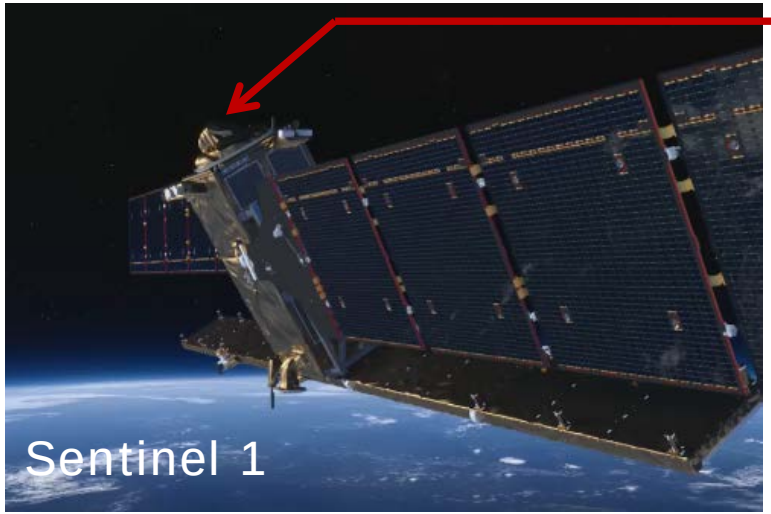


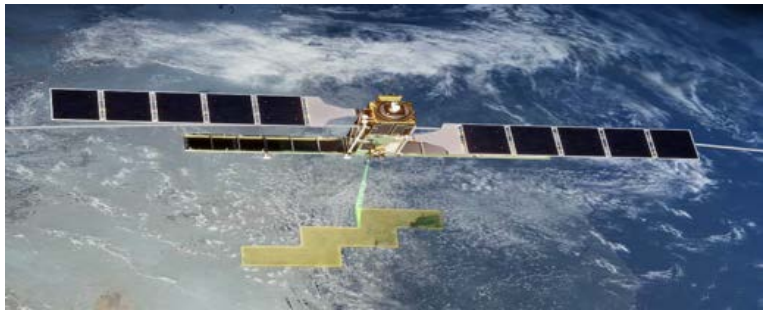
Introduction Videos to EDRS

EDRS Infrastructure 2019



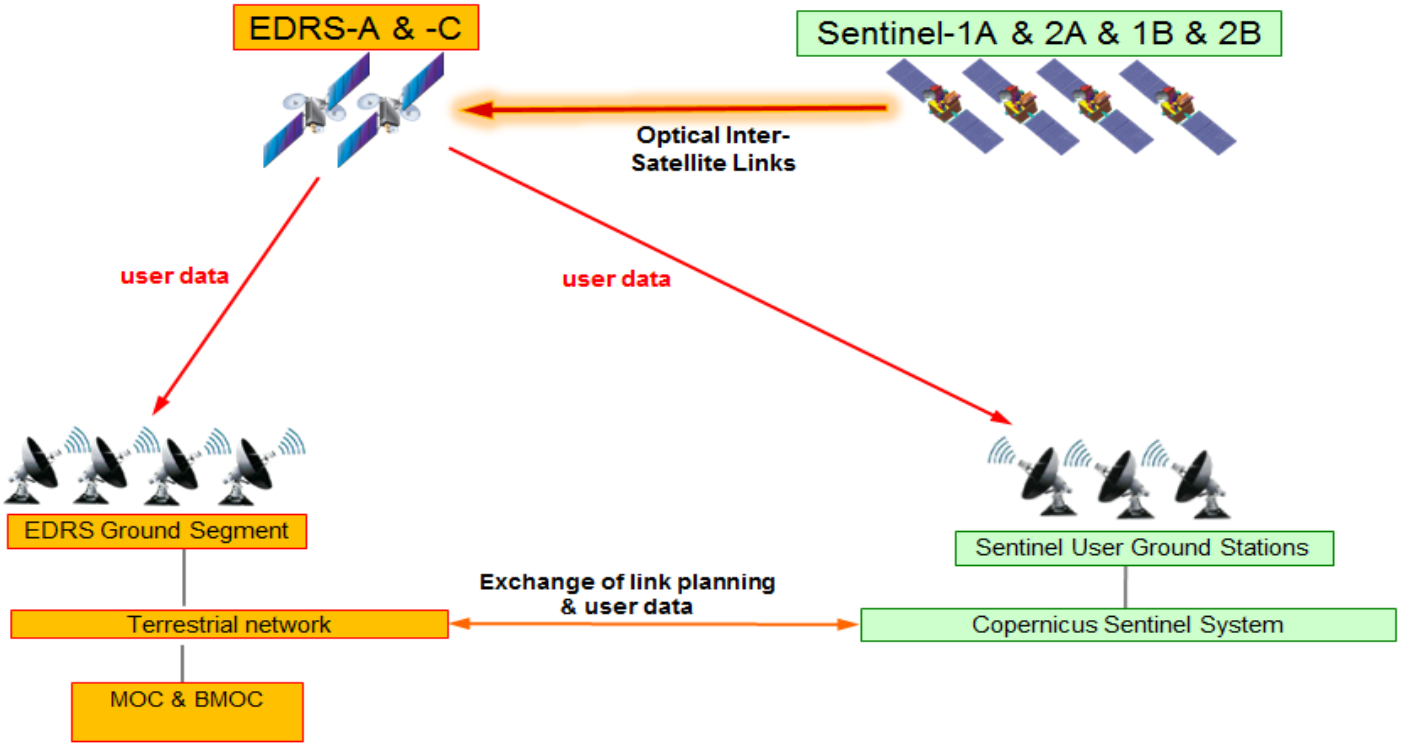
Laser Terminals @Sentinel 1 and 2



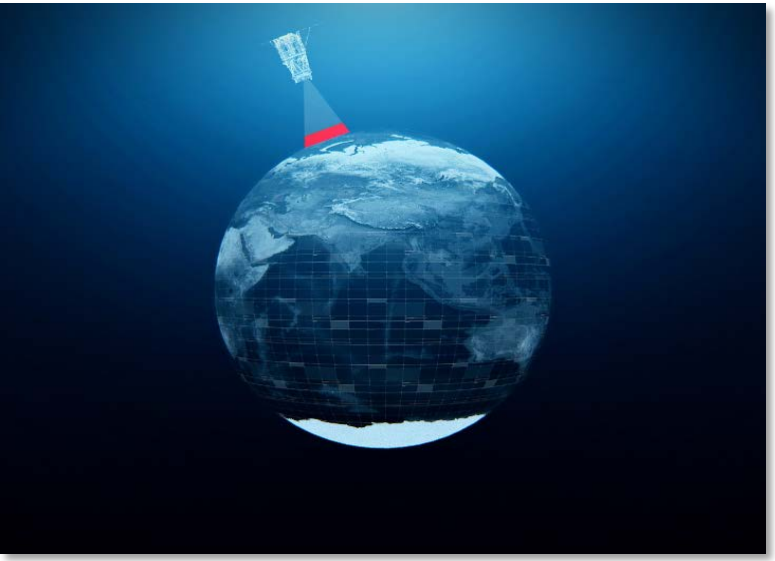


Laser Communication Terminal locations

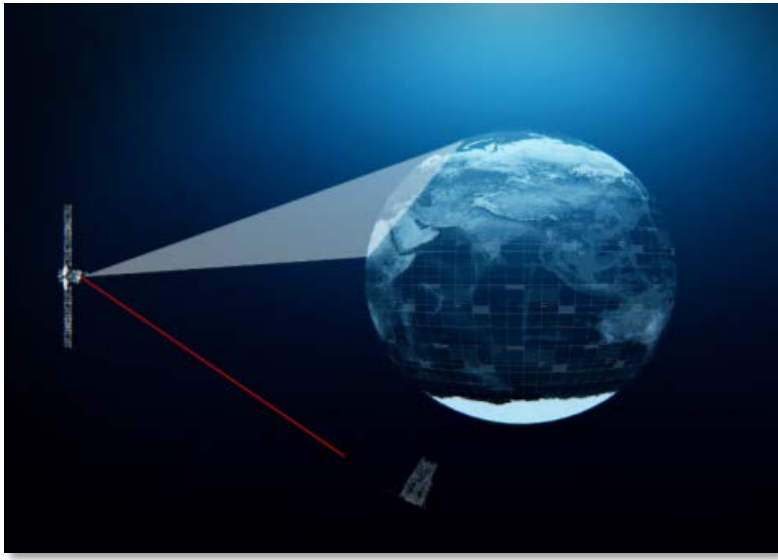
EDRS – Sentinel Specific Use Case



EDRS Always-On ‘Virtual Ground Station’

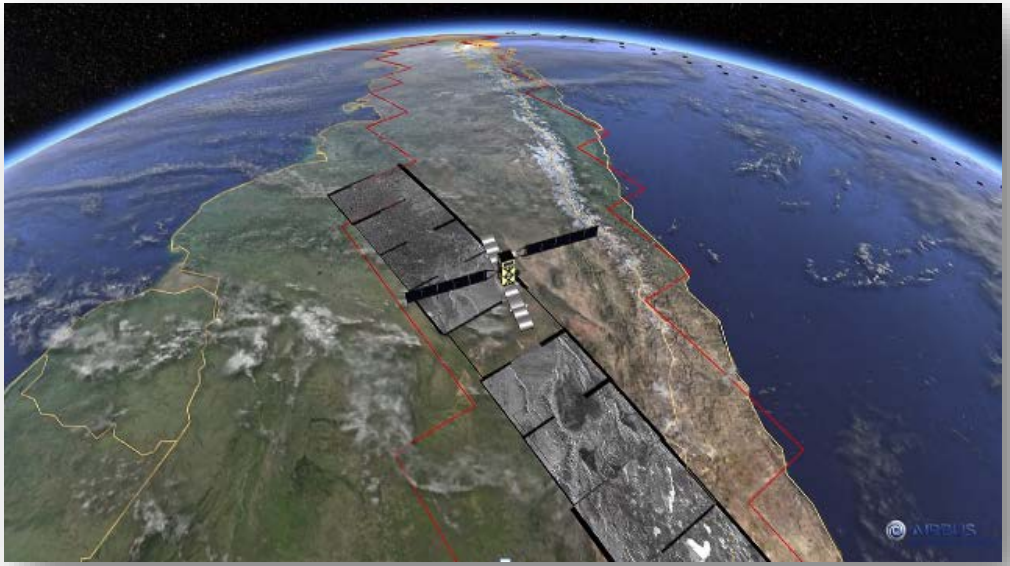


WITH GROUND STATIONS ONLY
UP TO 90MIN DELAY &
MAX 10 MIN VISIBILITY

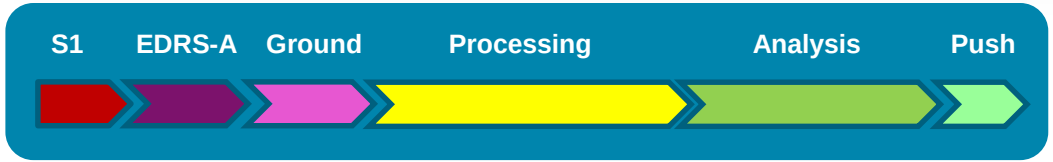


WITH EDRS
QRT DATA ACCESS &
UP TO 45MIN OF VISIBILITY

Objective: Receive Actionable Information from a Satellite



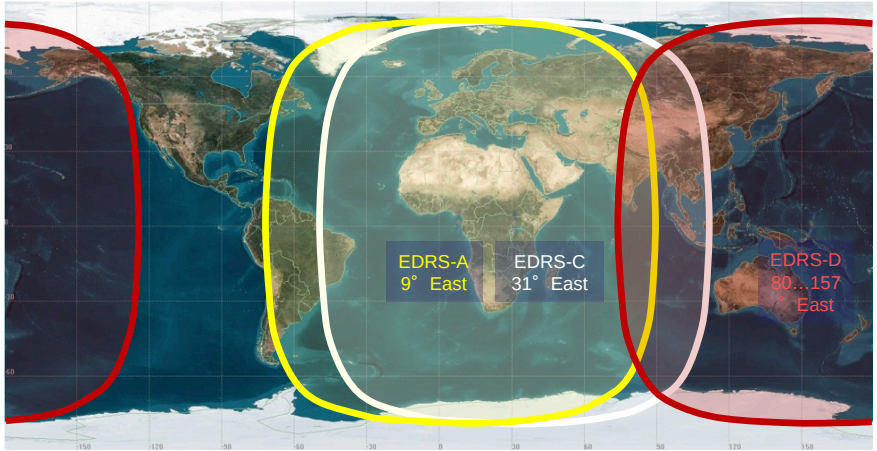
- **Space Latency** can be up to 100 minutes of satellite traveling towards next ground contact
- SpaceDataHighway can **minimize** the Space Latency even beyond line of sight to direct receiving stations



Information Latency < 15 Minutes can be required

The Service

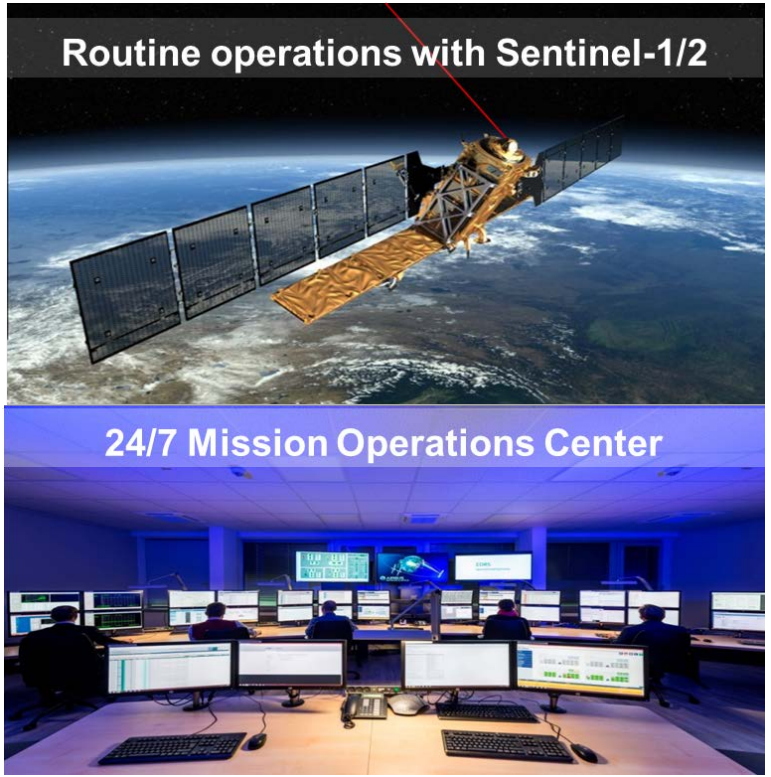
- has been successfully delivered since **November 2016** to the Sentinel-1/2 satellite missions of European Copernicus program
- **regular data backhaul** from the Sentinel satellites mainly while they are orbiting beyond line of sight of the European ground station network
- is managed from the **24/7 Mission Operations** Center (MOC) in Munich
- is initially delivered via the geostationary (GEO) relay node EDRS-A, to be complemented in 2019 by EDRS-C



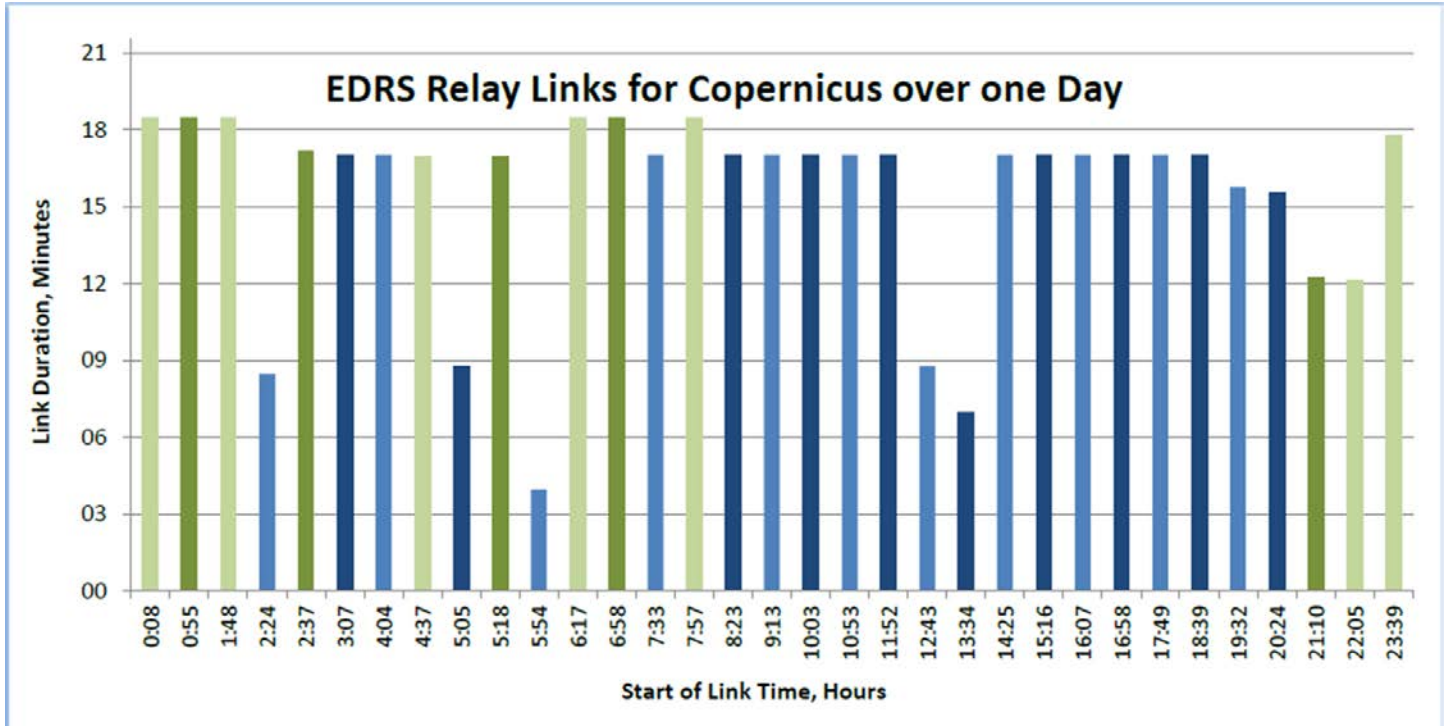
Benefits for Copernicus and Achieved Performance

- By end 2017 regular data backhaul from four Sentinel satellites
  - ✓ increasing data collection capacity by 50%
  - ✓ improving data collection flexibility
  - ✓ Quasi-Real-Time data transmission capability
- Link times of 10-20 minutes per satellite and orbit

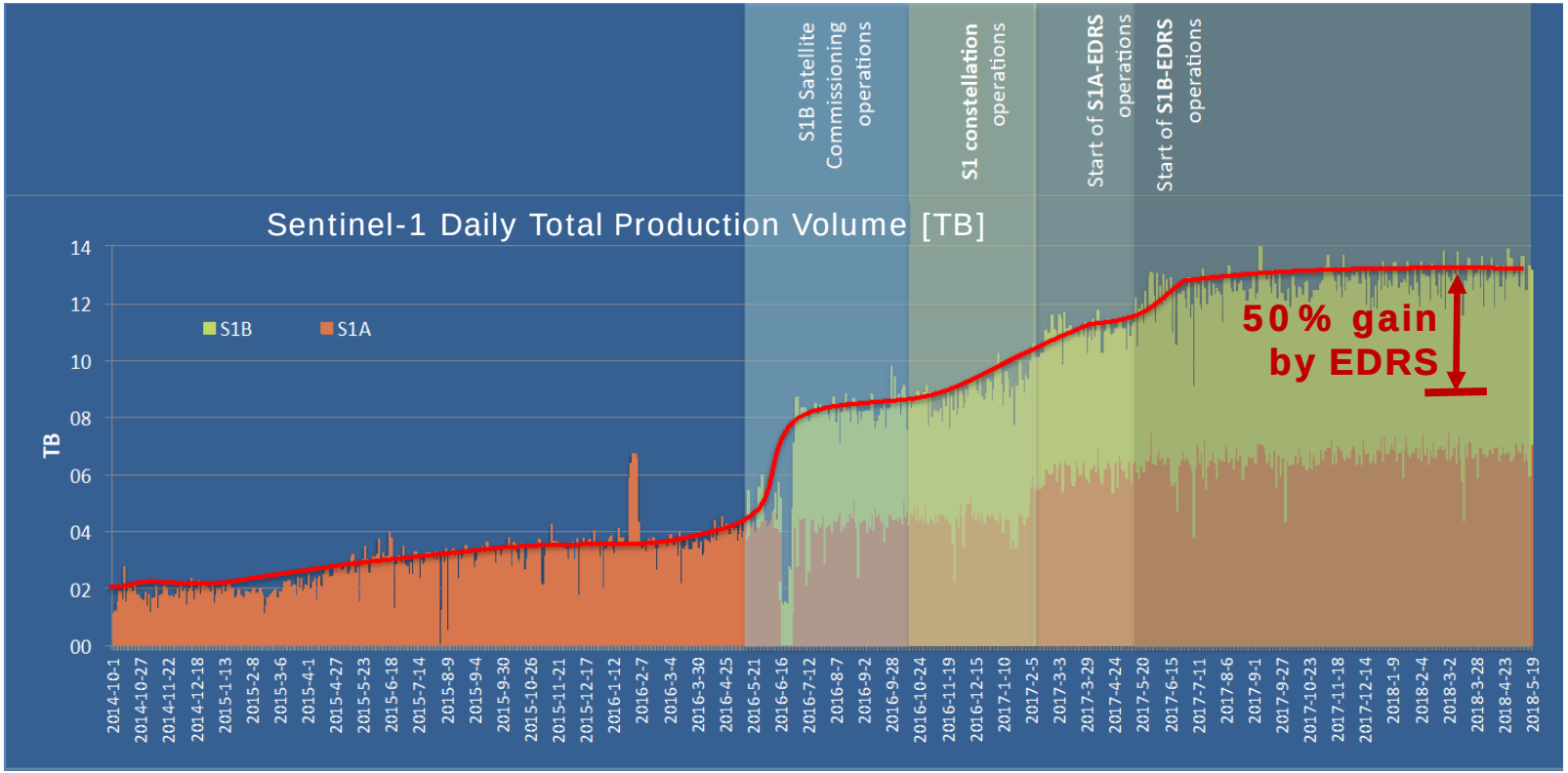
- since Nov 2016
  - ✓ > 18000 successful Laser links
  - ✓ > 99.5% availability



A Day of EDRS Service to Copernicus

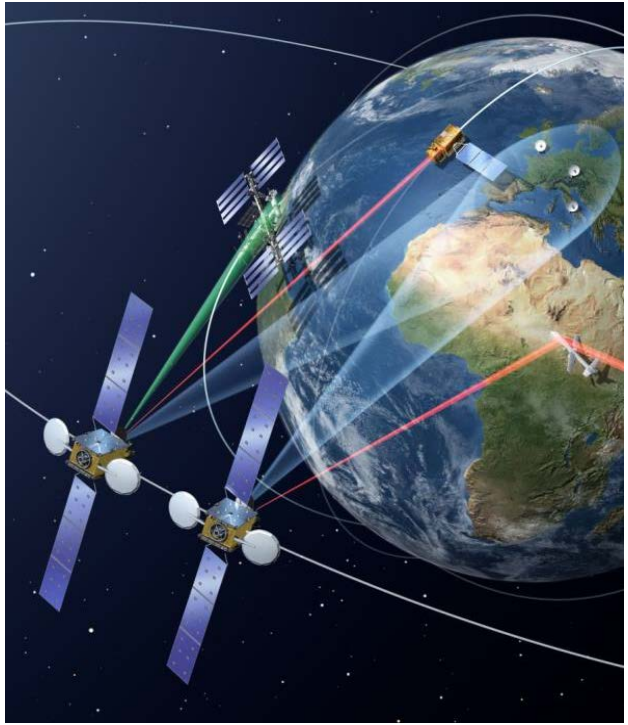


Sentinel-1 daily production volume evolution



Complementary Services

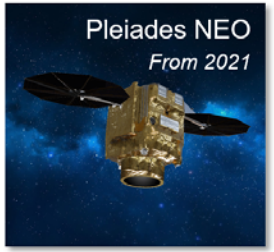
- bi-directional relay service in **Ka-band**
- first operational case for a dedicated communications capability between Columbus Module of the **International Space Station** (ISS) and ground control in 2019
- further application: **tasking of LEO satellites**, helping to improve imaging efficiency, and cross-cueing between satellites
- Ka-band receiver for LEO satellites goes into service in 2021



EDRS Service Summary (Feb. 2019)

- ✓ The operational service started in end of 2016 with Sentinel 1A (radar satellite)
- ✓ As of January 2018 **all 4 Sentinel satellites** are commissioned and served

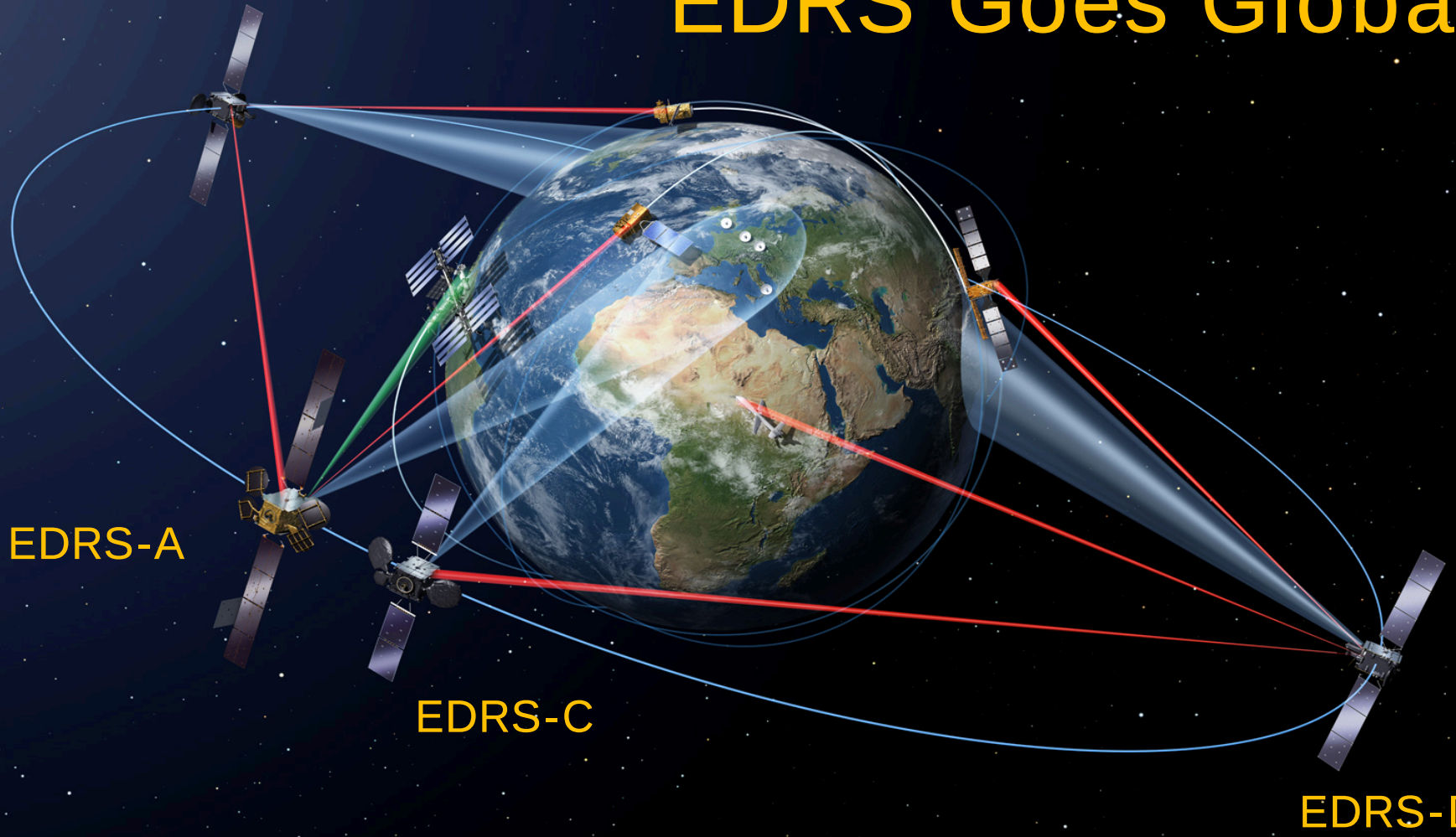
- ✓ Data collection **capacity/day increased by up to 50%** (Sentinel-1)
- ✓ Improved data collection flexibility by clearing on-board storage before crossing Europe
- ✓ Sentinel-2 world mapping revisit in 5 days (instead of 10 days w/o SDH/EDRS)
- ✓ European Users aiming for **QRT pass-through links** via SDH/EDRS



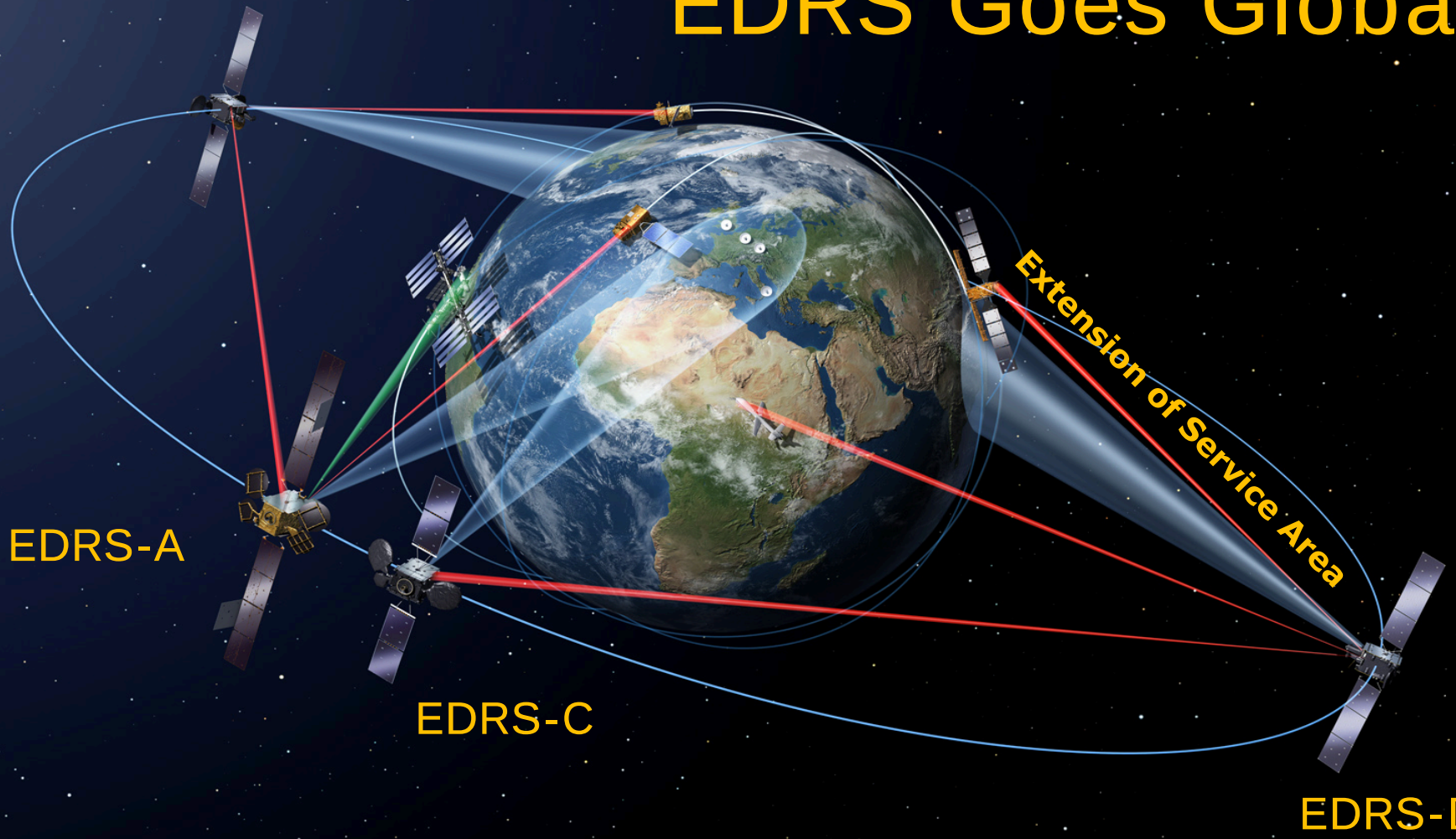
- ✓ >1 Petabyte transferred until today
- ✓ up to 39 operational links/day
- ✓ up to 18.5 minutes/link @600Mbit/s
- ✓ **~14 minutes per communication session**

- ✓ More than **18.000 successful relay links**
- ✓ **>99.5 % service availability**

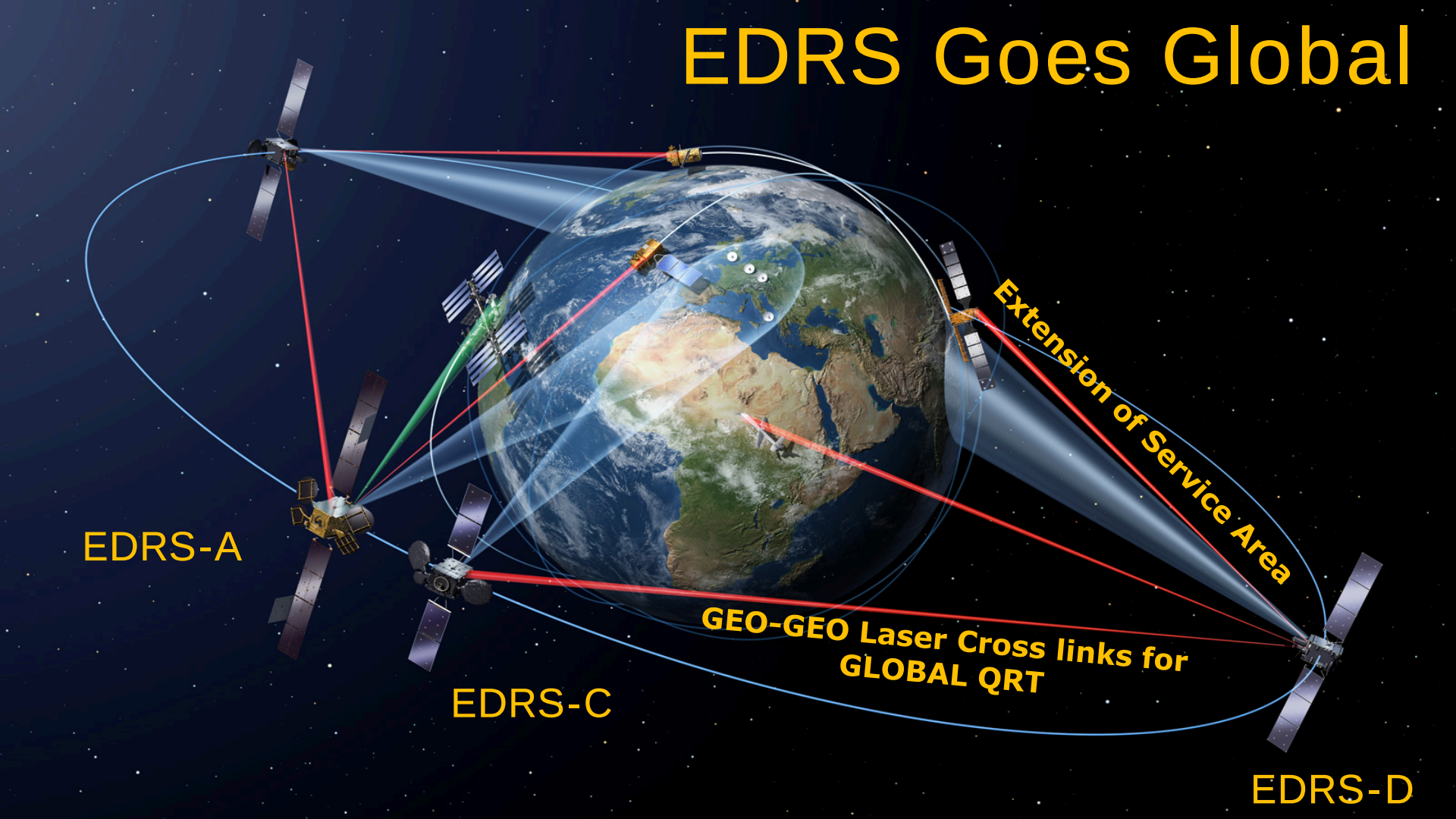
EDRS Goes Global



EDRS Goes Global



EDRS Goes Global



EDRS Goes Global

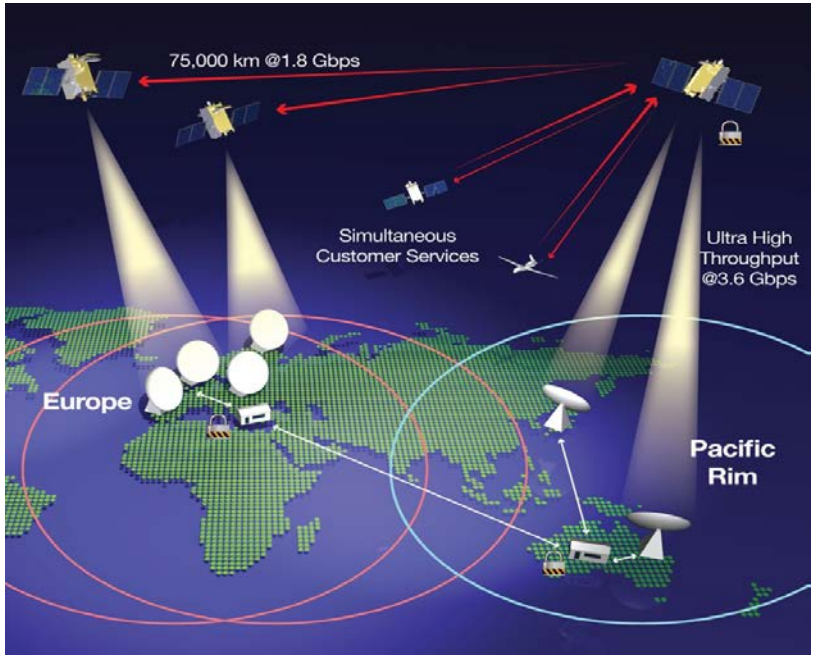
Next Generation Data Relay Node – EDRS-D

- Start of service: **2024**
- Over the **Asia / Pacific** region, equipped with **next generation GEO LCTs**
- Laser Cross link to **repatriate** user data from the Asia/Pacific region to Europe
- **Interoperability** with 1550 nm Laser

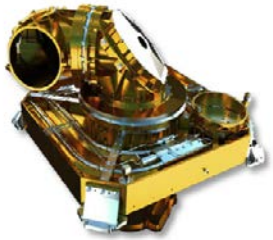
- Airbus examining business opportunities in the EDRS-D project with

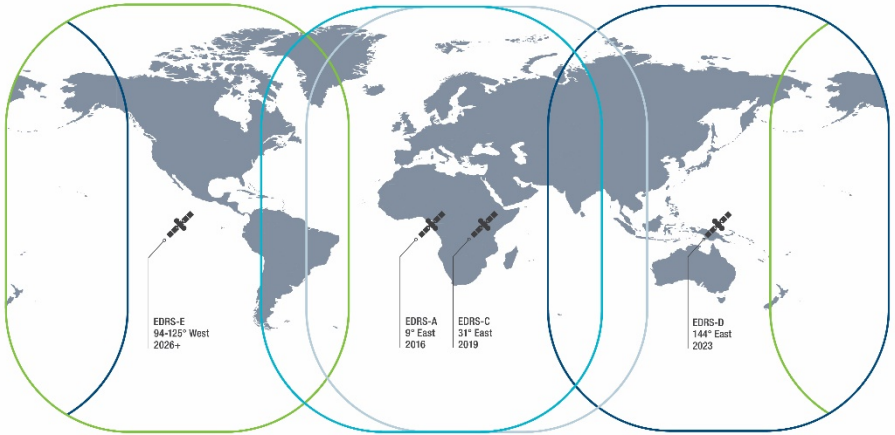
SKY Perfect JSAT Corporation

from creating a hosted payload alliance for a SpaceDataHighway collaboration



EDRS Servive is growing





Capacity Service: Supports the transmission of large data volumes from EO satellites and airborne platforms (unmanned and manned) to ground stations, thus increasing a mission's staying power and data acquisition capacity.

➔ **VOLUME [factor 2-3 more]**

Global Quasi-Real-Time Service: Facilitates QRT/NRT data delivery, minimizing latency of data collected by airborne platforms (video stream) and LEO satellites (early warning) when BLOS.

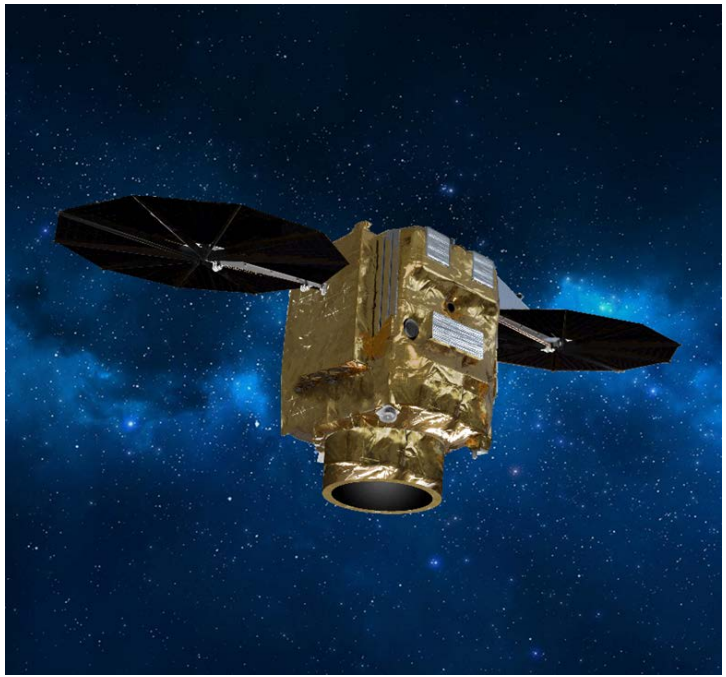
➔ **LATENCY [from hrs to sec]**

Agile Tasking Service: Improves mission flexibility and reactivity by enabling the transfer of tasking data to EO satellites or airborne platforms on short notice and BLOS communication with the command and control centre.

➔ **REACTIVITY [from hrs to min]**

Commercial Remote Sensing System Benefits from EDRS/SpaceDataHighway

- Satellites equipped with
  - latest Laser Communication Technology to transfer data at 1.8 Gbps, enabling **terabytes/day** transmitted securely in quasi-real-time to ground
  - Ka-band terminals allowing **last minute tasking** updates, even beyond ground stations' line-of-sight
- To utilize SpaceDataHighway for
  - highest system **reactivity**
  - lowest **latency**
  - high **volume** data transfer
- Benefits: increased **monitoring** capability, and optimized operational **efficiency** (natural disasters, first line response for civil and military applications)



Opening Services for Airborne Platforms

- Bi-directional link of hours/days
- Joint Aerial Layer Network support
- LPI/LPD

Development Partners

capability demo → prototyping → operational demo → certification → operational service

2017 — 2023 +

Evolution of LEO Laser Communication User Terminals

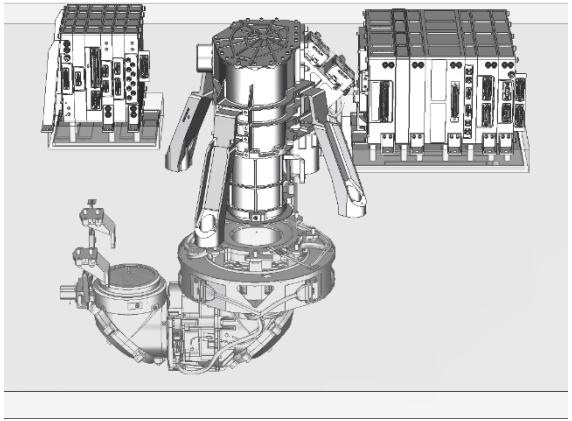
- Current **Laser Communication Terminal (LCT)** technology has proven its link **quality** and **reliability** on Sentinel satellites
- **New features** to be added
  - ✓ GEO-GEO cross link
  - ✓ 3.6 Gbps bandwidth
  - ✓ Dual Wavelength for interoperability*)
  - ✓ Airborne bi-directional

*) *in international cooperation*

Smart LCT

- Development of new **compact / light weight** user terminals to make this technology more accessible also for smaller satellites and a wider market

- New generation of terminals (**LEO SMART** LCT) available in **2020**



Range	45,000 km
Data Rate	1.8 Gbps
Transmit Power	5 W
Telescope Diam.	70 mm
Mass	30.8 kg
Power Consumption	130 W max.

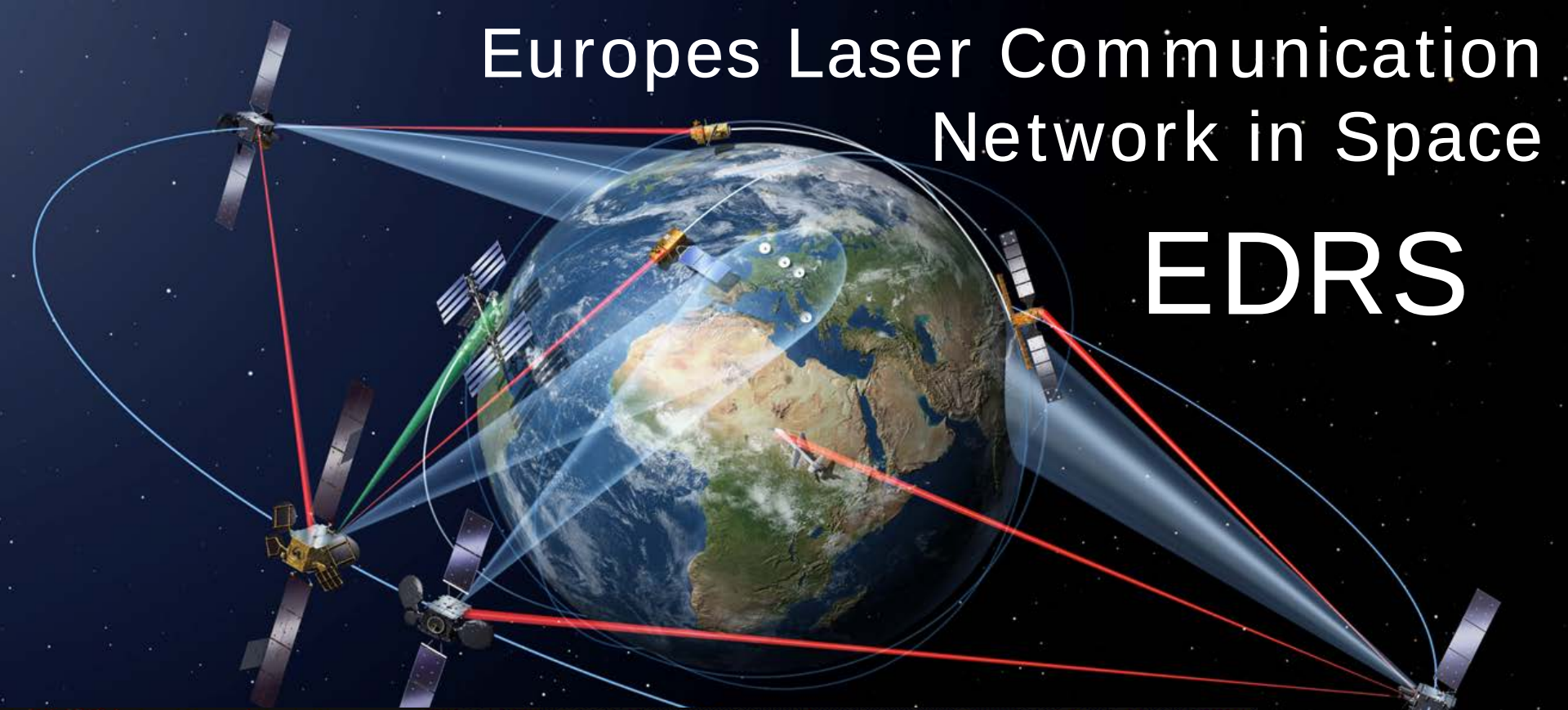
Laser Communication Technology
KEY Messages for future Mission Designers

- **RF spectrum /** RF efficiency are **not longer the bottleneck** for mission designs
- **Reduced** GEO political constraints on **Ground Stations Network**
- **Minimize**/balanced **mass memory on-board, increasing** planning **flexibilty**
- New type of services:
    - **Capacity Service**: Virtual Ground Stations in Space
    - **Global Quasi-Real-Time Service**, with GEO-GEO Link
- **Laser Communication Terminals**
    - proven, mature and reliable technologies
    - multiple sizes and data rate fit multiple type of mission architectures

Capabilities for novel mission features exist in Europe!
YOUR Creativity is keen!

Europes Laser Communication Network in Space

EDRS



Enlighting! Thanks for your attention!