International Conference on Space Optics—ICSO 2018

Chania, Greece

9–12 October 2018

Edited by Zoran Sodnik, Nikos Karafolas, and Bruno Cugny

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International Conference on Space Optics — ICSO 2018, edited by Zoran Sodnik, Nikos Karafolas, Bruno Cugny, Proc. of SPIE Vol. 11180, 111800X · © 2018 ESA and CNES · CCC code: 0277-786X/18/$18 · doi: 10.1117/12.2535952

Global Quasi-Real-Time-Services back to Europe: EDRS Global

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***Abstract*— The Public-Private-Partnership between ESA and Airbus Defense and Space (Germany) has created the European Data Relay System (EDRS), which is operational since 2016.**

The joint teams are running the Phase B of the globalisation of the European Data Relay System (EDRS) with an addition to the programme called EDRS Global (former GlobeNet).

EDRS Global is planning to increase the capacity of EDRS by adding a geostationary data relay payload, called EDRS-D, over the Asia-Pacific region – in cooperation with Airbus DS partner JSAT (Japan). The heart of the system will be multiple laser terminals, based on TESATs upgraded design, featuring also a dual wavelength capability (1064 nm and 1550 nm) to serve more customers at the same time. The 1550 nm capabilities will be implemented in a cooperation between Airbus and TESAT (Germany), and NEC (Japan).

The evolution of the service will also aim for security sensitive user missions, including RPAS missions. The Laser Communication Technology on-board EDRS-D will be the starting point for the world's first global laser based network in space, providing Global Secure Quasi-Real-Time-Services at Gigabit per second speed back to Europe by connecting its EDRS GEO nodes (EDRS-A/-C and EDRS-D) over 80,000 km distance by the means of optical communication.

The paper will provide details of the project and information about the latest status.

Key Words:
EDRS, European Data Relay System; GlobeNet, ScyLight Laser Communication Terminal; LCT; TESAT; Global Laser Network; Sentinel; Copernicus; Columbus; ISS, Quasi-Real-Time, QRT, Data Relay, Security

I. OVERVIEW : EDRS

The European Data Relay System (EDRS) started in 2008 as a public-private-partnership programme between ESA and Airbus Defense and Space (Germany). It is designed to provide Quasi-Real-Time data relay services and data forward services based on both, optical and RF/Ka Intersatellite Link (ISL) terminals ([1], [2], [3], [4]). The current system consists of two geostationary nodes.

The first EDRS node, EDRS-A, hosted on-board the Eutelsat-9B satellite has been launched on 29 January 2016.

The second node, EDRS-C (Figure 1), is designed as a dedicated satellite, based on the SGEO telecom satellite product family by OHB (Germany) to be launched in 2019.

Figure 1: EDRS-C at the test center at IABG, Germany (Airbus Defence and Space 2018). The white cover is protecting the TESAT LCT.

The heart of EDRS is the Laser Communication Terminals (LCT) developed and manufactured by TESAT Spacecom (Germany), complemented by the Microwave Ka-ISL Terminal.

The features of both EDRS payloads/satellites and the details on the EDRS service types are described in [2], [3] and [7].

II. Operations and Service Concept

EDRS-A is fully operational and provides routine data relay services to the Copernicus Sentinel 1 A&B and 2 A&B satellites - the EDRS initial user platforms including encryption of downlink for specific ground stations and users were required..

All service details are defined on a purely commercial basis governed by Service Level Agreements (SLA), defining the Key Performance Indicators to measure the quality of the provided services achieving a service availability of 99.7% Between January 2017 to August 2018 EDRS transferred 787.9 TB

It shall be noted that the commercial service is offered by Airbus under its own brand “SpaceDataHighway”.

About 15,000 links have been executed by EDRS and about 1,000 optical links per month are performed as Optical ISL return service at a data rate of 600 Mbit/s for the first 4 Sentinels, and - at a later stage, for the 4 Sentinel C/D models. Other customers may use data rates of up to 1,800 Mbit/s. Figure 2 shows the link numbers and their duration over one typical day. Between January 2017 to August 2018 EDRS transferred 787.9 TB as complement to the Sentinels X-band downlink.

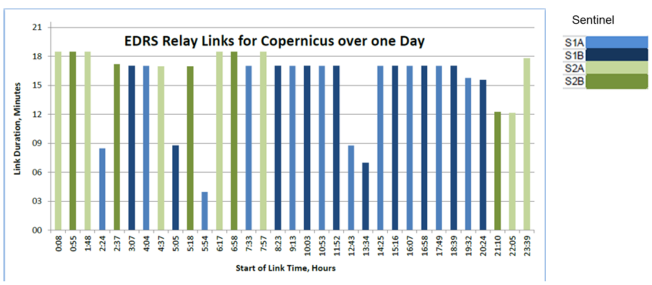

Figure 2: EDRS Relay Links for Copernicus Sentinel 1A, 1B, 2A and 2B over one typical day. Typical Link durations are around 15-19 Minutes as per operational requirements by the user.

From 2019 onwards the Ka-ISL service anchor user will be the ESA’s Columbus laboratory, which is part of the International Space Station (ISS) [3][4]. Further EDRS capacity has been reserved and can be made available by ESA in support to ESA and ESA partner missions.

Future missions may also benefit from EDRS last minute tasking of optical satellite systems using latest weather forecast represents a major new capability allowing to increase the efficiency significantly with reference to cloud coverage (imaging efficiency). In current commercial optical satellite (e.g. WorldView/Pléiades/Spot) operations the upload of tasking plans occurs 3 to 6 times per day ensuring typically 50% of cloud free imagery. By using reactive tasking through EDRS this can be improved to 80-90% and above. A higher level of cloud free imagery is of great economic value. Airbus will therefore implement in the Pleiades Neo program the combination of direct Ka-band ISL tasking and near real time image retrieval via Optical ISL using both capabilities of EDRS [8].

III. Global Quasi-Real-Time-Services back to Europe

In December 2016 the ESA Member States confirmed their vision of the World’s first global laser based network in space and started the EDRS Global Programme (initially called “GlobeNet”) at their council meeting at Ministerial level in Lucern (CH).

The aim of EDRS Global is to bring additional service capabilities by means of an additional geostationary node called EDRS-D, but more importantly the capabilities to get sensitive data in quasi-real-time (QRT) back to Europe without any ground station on non-European territory, thanks to the GEO-GEO optical communications capabilities.

The current planning of the implementation is based on a hosted payload concept, with the EDRS-D payload to be embarked on a commercial satellite located somewhere between 120-155 degrees east.

In summary EDRS Global will add the following features to EDRS:

- capacity to serve more customers around different orbits and geographical areas beyond Europe;
- capability to route data back to Europe improving European non-dependence and minimizing latency (LEO-GEO-GEO-Ground links);
- high capacity feeder links to serve specific user needs simultaneously;
- enhanced security means and services (e.g. data relay for UAVs/RPAS);
- end-to-end security functions.

With its GEO-GEO laser terminal capability EDRS-D will enable Global Quasi-Real-Time services for the benefit of European users. As depicted in Figure 3 and 4, user data gathered over e.g. the Pacific Ocean will be transmitted optically from the user platform to EDRS-D, re-routed via a up to 80,000 km laser link to EDRS-A or EDRS-C and downloaded directly within the EDRS European footprint, without touching any ground station on non-European territory. The laser communication technology on-board EDRS-D will be the starting point for the world’s first global laser based network in space.

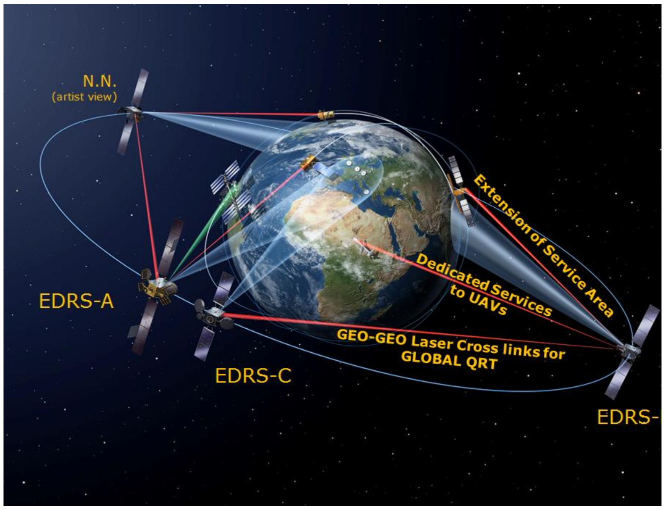

Figure 3: EDRS System and location of EDRS-A (9 degrees east) , EDRS-C (31 degrees east) and the new geostationary node EDRS-D (120-155 degrees east). Quasi-Real-Time service via the GEO-GEO laser network and the services to LEO and UAVs are depicted.

IV. Multi-User Capability

EDRS-D will be the first EDRS node and the first satellite worldwide featuring a farm of laser terminals to serve multiple customers at the same time.

The farm of laser terminals will consist of 3 laser communication terminals providing user data rates up to 3.6 Gbps routed via high capacity Ka-band feeder down links (at least 3.6 Gbps) to the EDRS-D ground stations in e.g. Japan and Australia.

While the Laser Communication Terminals on-board the Copernicus Sentinel fleet are based on operating at 1064 nm laser wavelength, other customers target 1550 nm as the operating wavelength. A commercial data relay service like EDRS/SpaceDataHighway is aiming to serve multiple customers and is planning to provide services also to different types of user platforms (LEO and UAVs). As a logical commercial step the laser communication system on-board EDRS-D will be capable to provide 1064 nm and 1550 nm laser links.

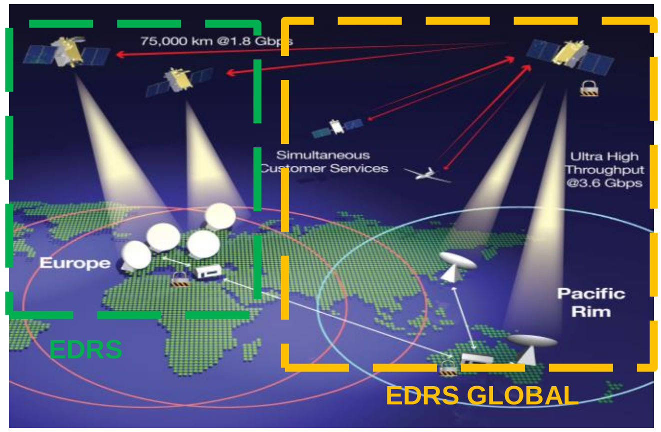

Figure 4: EDRS and EDRS Global Overview. Secured Ground Stations network in Australia and Japan planned to serve users nearly world wide.

V. Next Generation GEO Laser Communication Terminal

The evolution of TESATs LCT is currently under development within ESA's Programme on "Secure and Laser Communication Technology - ScyLight" [5] - resulting in the "Next Generation GEO Laser Communication Terminal - NGG-LCT".

The NGG-LCT unique GEO-GEO link capabilities bridging over 80,000km distance will become the first off the shelf product to be commercially available for global laser communication networks.

As mentioned above the commercial service is aiming to serve multiple customers who might use another laser wavelength like 1550 nm in their user terminal. Therefore the NGG-LCT will also foresee dual wavelength capabilities: 1064 nm and 1550 nm laser wavelength.

To cope with the ever increasing need for speed, the user data rate of the upgraded NGG-LCT will cover the range of 0.6 – 3.6Gbps (scalable up to 10Gbps) connected to a Ka-Band Feeder link System.

In addition to the GEO-GEO link capability, the 1064nm/1550nm dual wavelength compatibility and the user data rate up to 3.6Gbps, the NGG-LCT aims at reduced link acquisition time and configurable low/high data rate forward channel.

VI. Service Areas

With the addition of EDRS-D to the system, the EDRS/SpaceDataHighway service will cover the commercially most prominent service areas, as depicted in Figure 5. The service coverage zone will enable global Quasi-Real-Time services to the Copernicus Sentinel fleet and other commercial/governmental customers, bringing its data back to Europe without the need for non-European ground stations. It will also allow providing QRT data directly to European Partner Nations worldwide.

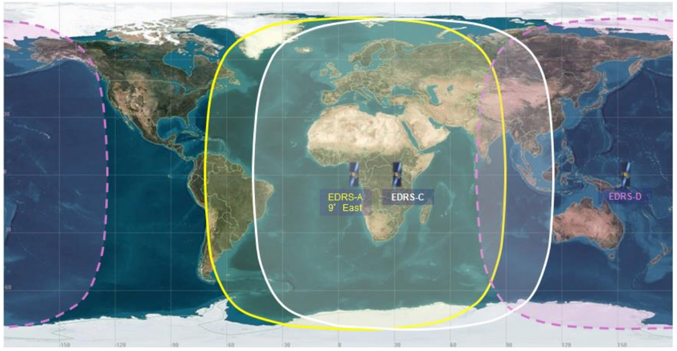

Figure 5: Service coverage zone for LEOs or UAVs to link to the EDRS System.

VII. SERVICES TO AIRBORNE PLATFORMS

Through the development of Laser Communication Terminals for airborne platforms, manned or un-manned, the SpaceDataHighway service will be made available to operators of such platforms. The benefit will occur specifically when such platforms are being operated beyond line of sight of their respective ground receiving stations.

Airborne terminals can be developed using ESA's Programme on "Secure and Laser Communication Technology - ScyLight" [5] up to proof-of-concept phase. Demonstration campaigns are planned, followed by a certification process for relevant platforms, so that operational use of EDRS/SpaceDataHighway can commence in 2023.

Figure 6: EDRS Laser Link Service to Airborne Systems.

VIII. CONCLUSIONS

Secure Global Quasi-Real-Time-Services featuring GEO-GEO laser link capabilities will bring user data directly back to Europe without the need for non-European ground stations or non-European terrestrial networks. EDRS Global will enable the first global data relay service for LEO and Airborne users. ESA and Airbus Defence and Space are preparing a unique service for its commercial and governmental customers.

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