European Data Relay System – one year to go!

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***Abstract*— The service provided by the European Data Relay System (EDRS) is planned to start after in-orbit commissioning of its first node EDRS-A, to be launched in the first quarter of 2015. The programme, run in a Public-Private-Partnership between ESA and Airbus Defense and Space (formerly Astrium Services) (Germany), consists of two geostationary nodes (EDRS-A and EDRS-C) which will provide data relay services via a laser-optical link as well as in Ka-Band. The first customer for the optical service, based on the Laser Communication Terminal manufactured by TESAT Spacecom, is the Copernicus (formerly GMES) Sentinel constellation.**

This paper will provide an overview of the EDRS status and its future plans, less than one year from the launch of its first node.

Keywords—EDRS, European Data Relay System, LCT

I. INTRODUCTION AND OVERVIEW

The European Data Relay System (EDRS) is designed to provide data relay and data forward services. It consists of two geostationary nodes. The first node, called EDRS-A, is embarked as a hosted payload onboard the Eutelsat EB9B satellite. The second node, called EDRS-C, is a dedicated satellite also hosting a 3rd party mission. The two nodes – to be launched in 2015 and 2016 respectively - are the data relay backbone, equipped with high and medium speed inter-satellite communication terminals (Optical and Ka-Band inter-satellite links) as well as with a high speed Ka-Band feeder link to ground. The data will be received either at dedicated EDRS Ground Stations or - upon the user's request - at User Ground Stations to achieve direct delivery of the data to the user premises. The EDRS ground coverage area, within the Ground Stations have to be located, is Europe.

The system capacity will be scheduled from ground to serve multiple users with dedicated service requirements and with dedicated user requested time slots.

The commercial service will be offered by Airbus Defense and Space (Germany – formerly Astrium Services), who is ESA's partner in this Public-Private-Partnership programme [6].

II. SPACE SEGMENT

The first node, EDRS-A, is hosted on Eutelsat's EB9B satellite. The satellite prime is Airbus Defense and Space (formerly Astrium) (France) and the platform is based on the Eurostar 3000 telecom satellite product family.

The second node, EDRS-C, is designed as a dedicated satellite, based on the SGEO telecom satellite product family by OHB (Germany). This node will also host a 3rd party payload called HYLAS 3 built by MDA Corporation (Canada) for Avanti Communications (United Kingdom).

The prime contractor for the complete EDRS payload on both nodes is TESAT Spacecom GmbH (Germany) [5], who is also providing the Laser Communication Terminal (LCT), on which the optical service is based. Even if embarked on different platforms, the relay payloads on both nodes have the same capacity for the optical inter-satellite service providing a data rate of up to 1.8 Gbit/s and the same data rate for the Ka-Band feeder link down to ground. The EDRS system therefore is fully redundant for the optical inter-satellite service.

The EDRS-A node is, in addition, equipped with a microwave (Ka-Band) inter-satellite link terminal (Ka-ISL) providing over 400 MHz of relay capacity (typical user data rates will be at around 300 Mbit/s).

Both services (Optical and Ka-Band inter-satellite links) are transparent to the data routed via the system. No data will be stored on-board, however an additional encryption service is available on the downlink from the geo-stationary payloads to the ground, on request by the user.

The different types of EDRS services are described below, while a detailed overview on the payload architecture is presented in [5].

The first node, EDRS-A, is currently under manufacturing and test. It is scheduled for completion late in December 2014 and is planned to be launched in spring 2015. Start of the EDRS service is expected mid 2015 after in-orbit commissioning of the spacecraft, the EDRS payload and the service commissioning with the Copernicus/Sentinel-1 system.. The orbital position will be 9 degrees East.

The second node, EDRS-C, is undergoing its Critical Design Review (CDR) and planned to be launched mid 2016. The orbital position will be 31 degrees East.

The lifetime for both nodes is 15 years.

III. INTER SATELLITE LINKS

The heart of the EDRS system is the optical inter-satellite link based on the Optical Laser Communication Terminal (LCT), complemented by the Microwave Ka-ISL Terminal.

Both terminals are bi-directional and will be used to receive data from, and transmit command sequences or data to the user satellite.

The Ka-ISL Terminal is capable of receiving user data from a User/LEO satellite across a bandwidth of 400 MHz (typical user data rates will be at around 300 Mbit/s) and transmits user data to a LEO satellite across a 2 MHz bandwidth (typical user data rates will be at around 1 Mbit/s) to task/command the user satellite independently from any contact to its own Ground Station. The first Ka-ISL counter terminal will be embarked on-board the International Space Station providing data download and real time services via EDRS.

The most innovative part of the inter-satellite service is the Laser Communication Terminal (LCT). The LCT technology has been developed by TESAT Spacecom GmbH (Germany) under contract with the German Aerospace Center (DLR, Bonn, Germany). The first generation of the technology has been validated in orbit on-board the German Terrasar-X satellite and on-board the US NFIRE satellite. The first optical inter-satellite links between these two satellites were performed on 21st February 2008 and successfully demonstrated 5.6 Gbit/s data rate transmission over distances up to 5 000km [3].

Based on the results of the in-orbit demonstration a 2nd generation of the LCT has been developed, capable to transmit 2.8 Gbit/s (1.8 GBit/s user data) over a distance of up to 45000km. The terminals used by EDRS – as well as by its anchor customer Sentinel 1A, 2A, 1B, 2B (LEO) - are based on this 2nd generation LCT, validated in orbit on-board the AlphaSat Satellite (launched July 2013) [3], [4].

IV. GROUND SEGMENT

In order to provide a commercial service based on two different geo-stationary satellites, multiple ground station locations and (multiple) user interfaces, the EDRS Ground Segment is defined as a complex distributed system.

The central part is the Mission Operation Center (MOC, location Ottobrunn, Germany and Back-up MOC, Redu, Belgium) which is processing the service requests by the users. The planning details may vary from user to user, but will contain information on the orbital position of the counter terminal/user satellite at the time of service requested, the planed duration of the link and the handling of the data on-ground. Such information, together with the planning constraints of the EDRS and the user satellite are defining the overall service schedule.

Based on the information described above, the MOC will task the corresponding ground segment elements – either the one related to EDRS-A or the one related to EDRS-C (see figure 1).

The EDRS-A related Ground Segment consists of the Devolved Payload Control Center (DPCC), which is preparing the commands for the EDRS payload hosted on Eutelsat's EB9B satellite. The command files are send to Eutelsat's Satellite Control Center and finally uplinked to the satellite. The user data are downloaded to the data receiving Ground Stations (RDGS, Weilheim, Germany and HDGS, Harwell, United Kingdom).

The EDRS-C related Ground Segment consists of two ground stations which serve as spacecraft control and data receiving station at the same time (FLGS, Weilheim, Germany and BFLGS, Redu, Belgium).

Especially due to the high data rate requirement for the downlink of 1.8 Gbit/s, the Ka-Band frequency used for the European feeder link and the high link availability required for the EDRS system (99.6 %), the system is equipped with a data consolidation network.

In addition to the EDRS data receiving stations, the user has the option to receive the data at his own ground stations to ensure direct access to the required data at the desired location.

V. SERVICE CONCEPT

The European Data Relay System will establish data transmission in broadband quality in near-real-time. This makes it ideal for relaying time-critical and sensitive information, required e.g. for Maritime surveillance or Government/Security services.

Emergency response teams and security services can use EDRS to gain much faster access to Earth observation satellite data – even while in the field - when time is of the essence.

EDRS will provide 4 different services, 2 based on the Optical ISL and 2 based on the microwave Ka-ISL. They are listed in table 1

- The data relay RETURN service provides data gathered by the LEO satellite, via Inter-Satellite Links to the geostationary node and from there via Ka-Band Feeder link down to ground.
- The FORWARD service will be mainly used to task and command the LEO satellite in near real time if the LEO has no direct line-of-sight with its own ground segment. The optical forward service is routed via TM/TC channels from the ground to either EDRS-A or EDRS-C and from there to the LEO user satellite.

The EDRS initial anchor customer, Sentinel, makes use of the optical ISL return service at a data rate of 600 Mbit/s for the first 4 satellites, Sentinel 1A, 2A, 1B and 2B. The follow-on Sentinel satellites (C/D models) may consider to use higher data rates. The service details are defined in the Service Level Agreement (SLA), which also specifies the Key Performance Indicators to measure the quality of the service provided. The SLA also specifies the link duration between the Sentinel satellites and the EDRS with up to 20min per Sentinel orbit (approx. 100min). The first satellite, Sentinel 1A, was successfully launched on April 3rd 2014.

The Ka-ISL forward and return service is planned to be used by the ISS-Columbus module as the initial customers.

This service is planned to be used for the download of scientific data gathered on-board Columbus and for real time connections to ground, e.g. for remote experiments. The service take up will be in 2016.

VI. EVOLUTIONS

ESA and its private partner Airbus Defense and Space are currently planning to extend the system by adding additional geostationary nodes and by adding additional features to its service. The extension programme is called GLOBENET and will add – as a first step - one additional node, most likely as a hosted payload. The final layout will be defined in 2015/16, but will –according to the current planning- be centered around 2 Laser Communication Terminals, including the option of demonstrating GEO-to-GEO links. The launch is envisaged for 2020. The service will consider the demand for increased security requirements e.g. by enabling direct secure commanding of the payload, increased redundancy requirements and the requirements to serve UAVs. GLOBENET also contains an element in support to International Cooperation, which shall benefit from interoperability of the LCT interface, currently submitted as input to a related CCSDS standardization process.

VII. SUMMARY

Less than one year from launch the EDRS is on schedule with respect to its first geostationary node and the required ground segment including its central part, the Mission Operating Center. The launch is planned in spring 2015 and the start of the service to the Sentinels is envisaged in summer 2015. The LCT onboard Sentinel-1A has been launched successfully and provides the first user equipped LEO platform to be served. A new era for optical communication has started and further steps for the extension on EDRS towards a fully global system are underway.

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Tables and Figures

Service Type	Data Flow	Data Rate	Service available on GEO-Node
Optical ISL return service	LEO→GEO→Ground	600 Mbit/s or 1.8 Gbit/s	EDRS-A, EDRS-C
Optical ISL forward service	Ground→GEO→LEO	500 bit/s 4 kbit/s	EDRS-A EDRS-C
Ka-ISL return service	LEO→GEO→Ground	300 Mbit/s	EDRS-A
Ka-ISL forward service	Ground→GEO→LEO	1 Mbit/s	EDRS-A

Table 1: EDRS Services

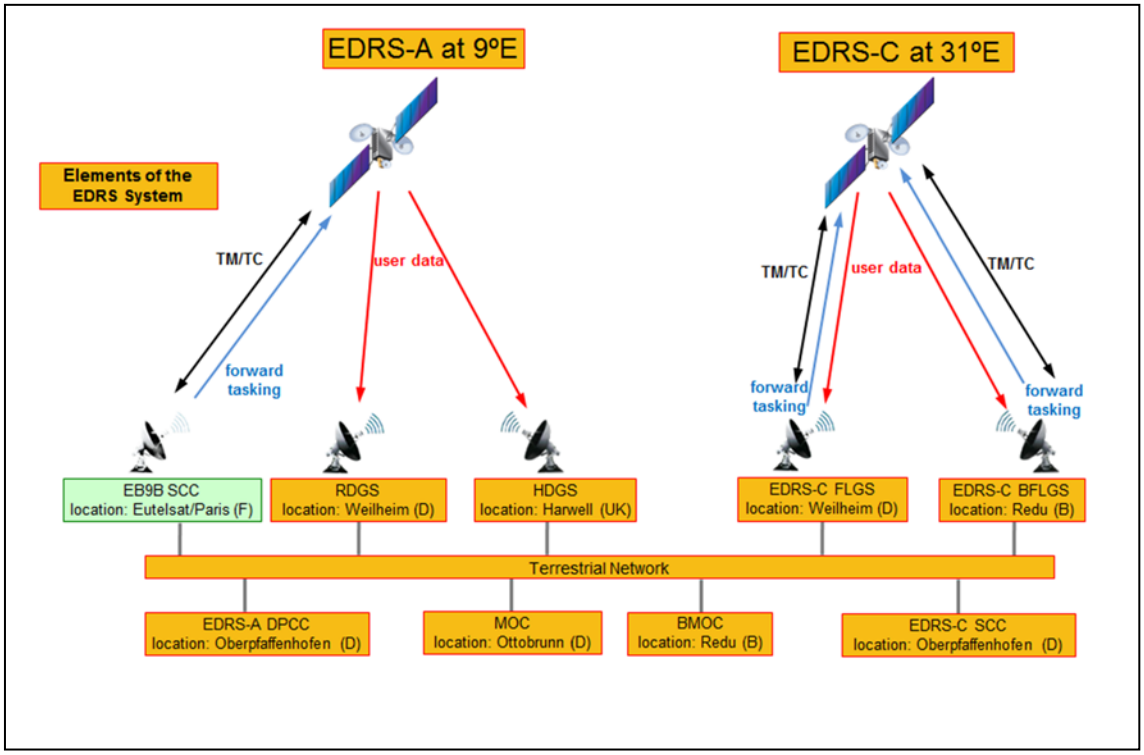

Figure 1: Overview of the EDRS System

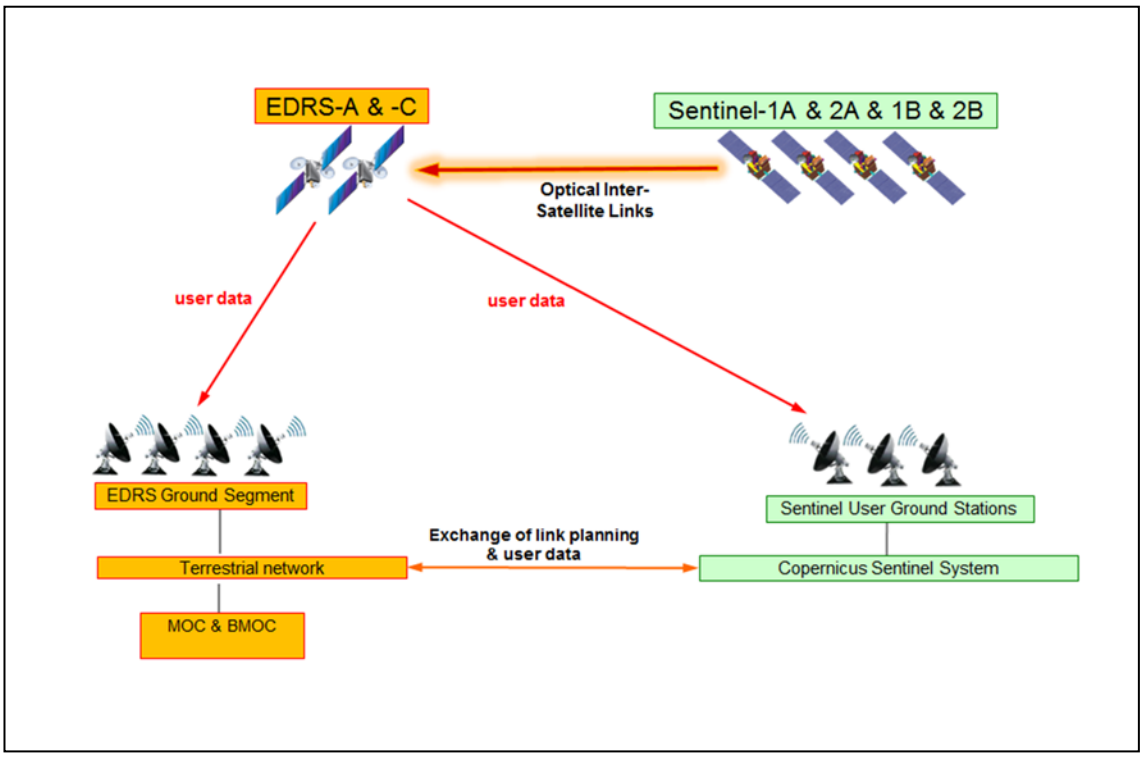

Figure 2: Service to Copernicus Sentinel Satellites