EOS Data and Operations System (EDOS) "EDOS High-Rate Data Capture and Delivery of Low-Latency HyspIRI Level-Zero Data"



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EDOS is NASA's high-rate, multi-mission science data system that:

- Autonomously captures science data at remote ground stations
 - EDOS capture systems are located at 6 sites serving 16 antennas
 - Front-end processing includes demodulation, frame synchronization, and decoding, as needed
- Transfers science data to GSFC over NASA's closed high-rate network or high-rate open (Internet) networks with increased bandwidth, where available
- Performs initial level zero science data processing
- Currently delivers more than 1/2 Terabyte of level-zero products worldwide (20 external customers) in a variety of formats and protocols on a daily basis
- Can transfer data directly to level 1 science customers (or HyspIRI Cloud storage) from station gateway via open (Internet) networks, where available







- Data-driven system (no schedules or pre-pass setup required)
- Routinely supports spacecraft downlink rates from 150 Mbps to 300 Mbps (capable of 500 Mbps and extendable to higher rates in the future)
- Prioritized data delivery to insure latency requirements are met
- Fully automated system; operation intervention only needed to resolve ground system anomalies
- Experienced 24x7 multi-mission operations and engineering support team
- Modular design permits level zero processing and delivery to be performed at ground station or central site, as needed
- Worldwide customer access to web-based displays providing real-time monitoring of mission data quality
- Evolutionary design enables cost effective support for new missions by leveraging existing NASA infrastructure







- In addition to the current and future missions planned, EDOS previously supported ICESat, OCO, and ALOS missions
- Additional infrastructure capacity exists to add new missions
- Ground station support at:
 - SvalSat, Norway
 - Poker Flat, Gilmore Creek and ASF, Alaska
 - White Sands, New Mexico
 - Wallops Island, Virginia
 - TrollSat and McMurdo (via TDRSS), Antarctica
- Data-driven high-rate capture systems switchable between antennas
- Designed to support any mission that is CCSDS compliant
- Delivers selected products with various latencies to MOC or Level 0 science user:
 - real-time products < 5 seconds
 - near real-time products < 1 hour
 - non-real-time products < 24 hours
- Produces time-based products from multiple antenna contact sessions
- Upon request can archive all products for life of mission
- Highly stable system with complete backup level-zero processing facility





Centralized Model

- All data captured at the remote site are transferred to the LZPF at GSFC
- The data is transferred via high rate NASA networks or open networks from the stations to GSFC
- EDOS LZPF performs level zero processing and generates and delivers all products from GSFC to science customers worldwide
- Supports time-based products from multiple ground stations



Diagram illustrating the Centralized Model





Remote Site Decentralized Model

- This EDOS architectural model offers the capability of capturing, processing, and delivering level zero data directly to the endusers from the ground site
- This model is useful for high-rate missions and is the model that was used for ALOS
- The EDOS modular design permits level zero processing to be performed at the central or at remote sites as required



Diagram illustrating the Decentralized Model



EDOS Hybrid Architecture Overview









- EDOS strives to keep pace with technology and network advances in order to deliver Level 0 data to the science community as soon as possible
- The major focus for EDOS latency enhancements is to maximize WAN throughput from the ground stations
 - 1. Enhancements to use the existing network bandwidth more efficiently:
 - Use of "Jumbo Frames" to enhance TCP performance on closed network
 - Prioritized data delivery including prioritized queuing and "Real-time" streaming
 - Lossless data compression to increase network throughput
 - Removal of encoding bits at ground station after forward error correction
 - Replace TCP-based WAN protocol with open-source UDP-based WAN accelerator protocol to overcome long round trip delays
 - 2. Architectural enhancements to increase the network bandwidth:
 - Use of higher rate open network connections in Hybrid architecture
 - Ongoing effort to add new open network connections with higher bandwidth
- For high rate missions, the EDOS default minimum latency requirement is the time needed to transfer all data received during a contact (with margin) before the next contact.

EDOS Goal: Continuously improve WAN transfer rate to keep up with spacecraft downlink rate.





- 24x7 operations support monitoring all station contacts and product deliveries for all missions and customers
- Additional EDOS capture systems can be easily added at existing (or new) ground stations worldwide as part of a modular, scalable architecture
- No schedule interface is required due to data-driven design assuring 24x7 data capture for any EDOS mission
- Existing integrated high-rate networks provide reduced product latencies
- Proven interface to EOSDIS Distributed Active Archive Centers for product distribution extendable to the HyspIRI Cloud Storage
- High-rate data delivery from remote site or centralized LZPF
- Additional spare capacity exists in existing system. More can be added!
- Reduced project risk to use an existing system for HyspIRI at a fraction of the cost of developing a new system

EDOS is a cost-effective solution for HyspIRI high rate data capture, level zero processing, and low-latency delivery