

CDDIS DATA CENTER: AN UPDATE

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Abstract

The Crustal Dynamics Data Information System (CDDIS) supports data archiving and distribution activities for the space geodesy and geodynamics community. The archive consists of Satellite Laser Ranging (SLR), Global Navigation Satellite System (GNSS), Very Long Baseline Interferometry (VLBI), and Doppler Orbitography and Radio-positioning Integrated by Satellite (DORIS) data sets and products derived from these data. The CDDIS data system is a key component in several of the operational services within the International Association of Geodesy (IAG) and the Global Geodetic Observing System (GGOS), including the ILRS, the International GNSS Service (IGS), the International VLBI Service for Geodesy and Astrometry (IVS), and the International DORIS Service (IDS), as well as the International Earth Rotation and Reference Systems Service (IERS).

With the influence of space geodesy data and their derived products in scientific studies over the last decade, CDDIS has seen its ingest volume explode to over 30 million files per year or more than one file per second from over hundreds of simultaneous data providers. In order to accommodate this increase and to streamline operations, CDDIS has recently performed a significant computer system upgrade requiring updates to the data upload and distribution architecture. The poster and summary paper provides background information about the system and its user communities, archive contents, and information about these updates and enhancements to the CDDIS.

CDDIS Overview

The Crustal Dynamics Data Information System (CDDIS) is NASA's active archive of space geodesy data, products, and information (GNSS, laser ranging, VLBI, and DORIS). The CDDIS is one of twelve NASA Earth Observation System Data Information System (EOSDIS) Distributed Active Archive Centers (DAACs). The CDDIS is viewed as a key component of the International Association of Geodesy (IAG); this community accounts for the majority of users of the CDDIS. The CDDIS serves as one of the primary data centers and core components for the geometric services established under the IAG, an organization that promotes scientific cooperation and research in geodesy on a global scale. The CDDIS has extensive partnerships through the IAG serving as one of the primary data centers for the geometric services:

- International GNSS Service (IGS)
- International Laser Ranging Service (ILRS)
- International VLBI Service for Geodesy and Astrometry (IVS)
- International DORIS Service (IDS)

The CDDIS also supports the IAG's observing system, GGOS (Global Geodetic Observing System).

In 2013, the CDDIS became a regular member of the International Council for Science (ICSU) World Data System (WDS), an international organization that strives to enable open and long-term access to multidisciplinary scientific data, data services, products and information.

The ILRS Data Center at the CDDIS is responsible for archiving and providing access to laser ranging data from the ILRS network as well as the products derived from the analyses of these data. The CDDIS archive is approximately 17.5 Tbytes in size (over 190 million files) of which 16.5 Tbytes (95%) is devoted to GNSS data (15.4 Tbytes), products (1.1 Tbytes), and ancillary information (see Figure 1a). All data and products are accessible through subdirectories of <ftp://cddis.nasa.gov/slr>. Nearly 1.8 billion files (nearly 260 Tbytes) were downloaded from the CDDIS in 2016, with an average of nearly 80 million files per month; as shown in Figure 1b, the majority of users download GNSS data and derived products.

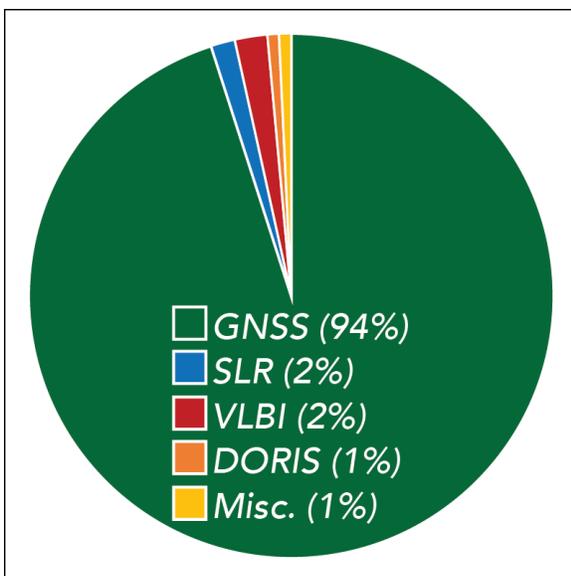


Figure 1a. CDDIS archive size (by data type); GNSS data and derived products account for more than 95% of the contents of the CDDIS archive.

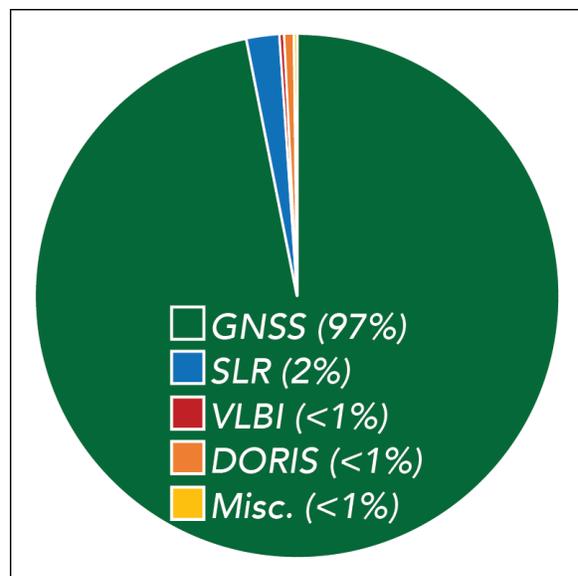


Figure 1b. CDDIS distribution statistics (by data type); the majority of CDDIS users download GNSS data and derived products.

CDDIS Support of the ILRS

The CDDIS is one of two data centers supporting the archive and distribution of laser ranging data, ILRS products, and ILRS information. The diagram shown in Figure 2 illustrates the flow of data from the ILRS network stations to these data centers and the user community. Stations in the ILRS network transmit data in a timely fashion (ideally hourly) to operations centers (OCs) at NASA and EDC. These operations centers interface to the stations and perform data quality control and conversion of incoming data into ILRS standard formats (e.g., CPF). The OCs then submit data on an hourly and daily basis to the ILRS data centers (DCs) at CDDIS and EDC. These DCs receive, archive, and distribute station data from operations centers and derived products from ILRS analysis centers (ACs) and combination centers (CCs). The ACs generate derived products (e.g., station coordinates, precise satellite orbits, etc.) and the CCs retrieve the products in order to generate the official ILRS products which are then transmitted to the ILRS

DCs for archive and distribution. Overseeing the day-to-day operations of the ILRS is the Central Bureau which manages the service, coordinates activities at all levels, facilitates communication, and responds to user inquiries. Finally, the ILRS Governing Board provides general oversight of the service and determines future direction and activities.

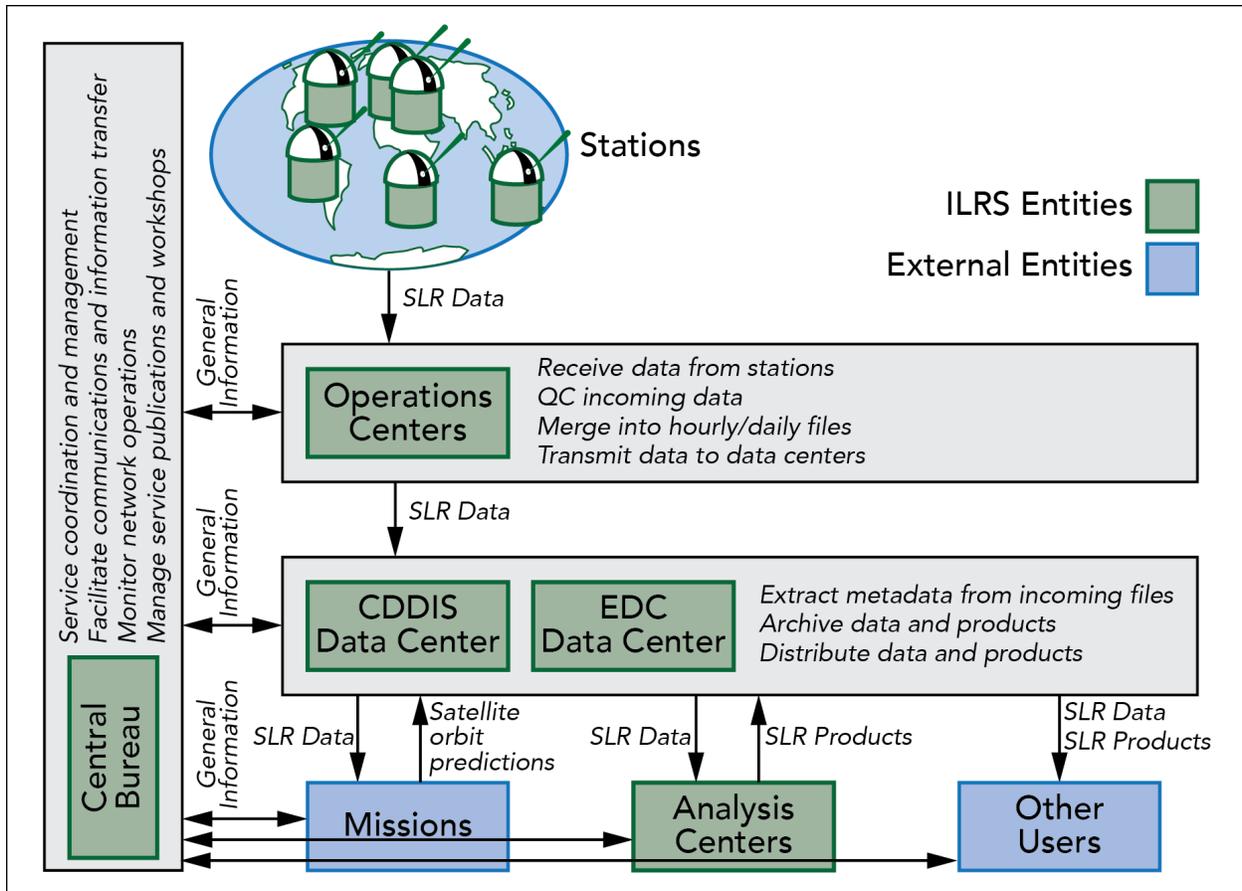


Figure 2. Flow of data and information, from station to user, utilized by the ILRS to support scientific research.

Recent Developments

System Facilities/Architecture Improvements: Over the past seven years, the CDDIS has experienced double-digit growth. By the end of 2016, nearly 1.8 billion files totaling over 260 Tbytes were distributed to a global user community. Approximately 3.5 Tbytes (over 30 million files) were added to the archive. In order to meet future requirements, the CDDIS procured a new hardware infrastructure in 2015; installation was completed in early 2016. This system was installed in a new location on the NASA Goddard Space Flight Center (GSFC) campus that provides better infrastructure, particularly in power and network connectivity. The system was designed for high availability with multiple redundant 40Gb networks directly connected to the Internet. The new system was implemented with virtual machine architecture for reliability and expandability. Both production and disaster recovery (DR) systems have been installed and are located in different buildings at GSFC. A 100 Tbyte unified storage has been configured across both the production and DR systems. A high-level diagram of the new system architecture is shown in Figure 3.

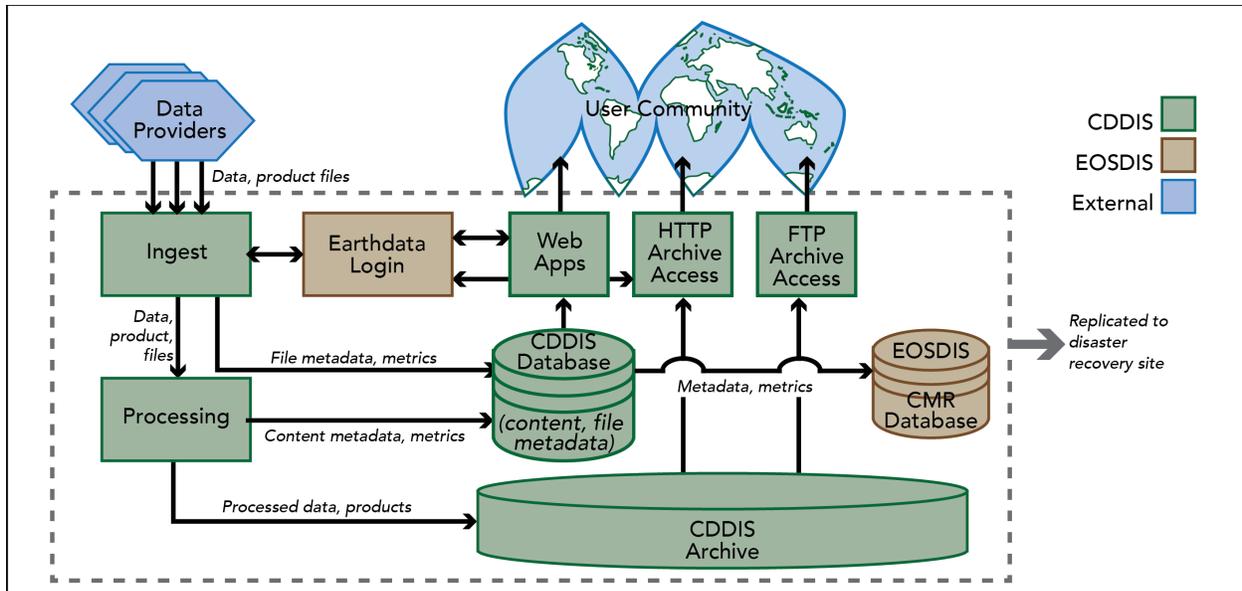


Figure 3. The new CDDIS system architecture, implemented in late 2016, provides more reliable support of the user community.

New File Upload Procedure: Before the new system became operational in December 2016, the CDDIS utilized an ftp-based file upload system. Because of NASA security restrictions, CDDIS could no longer use non-secure FTP for file submissions from data providers. Therefore a new system was designed to use the HTTPS protocol for file upload. CDDIS staff implemented the new system with both web and command line interfaces. The new upload system utilizes the EOSDIS Earthdata login utility (Figure 4a) for user registration and authentication. So new file suppliers must first register with the EOSDIS Earthdata login to obtain a user ID for access to the upload system. The web-based interface allows for simple, interactive uploads; an example is shown in Figure 4b. The command interface can be used for bulk uploads and scripting. This method allowed users to make simple modifications to existing scripts for uploads to the new system. The cURL tool is the supported program for command line access but any program that can perform an HTTP GET and POST can be used to upload files to CDDIS; Figure 5 shows an example of a cURL command for uploading files. The CDDIS staff has provided sample code examples in Java and bash for bulk uploading and scripting. More information on the CDDIS upload system is available at:

https://cddis.nasa.gov/Data_and_Derived_Products/CDDIS_File_Upload_Documentation.html

Real-Time GNSS Distribution: The CDDIS now operationally streams real-time GNSS data and derived products in support of the IGS Real-Time Service (RTS). CDDIS is one of three IGS real-time “casters” distributing data from over 250 global sites as well as thirty real-time derived product streams. The CDDIS actively adds additional streams as new IGS real-time stations come online. The real-time system also utilizes the EOSDIS Earthdata login application for access to the real-time server. Users must first register with EOSDIS to obtain a user ID for access to CDDIS GNSS caster.

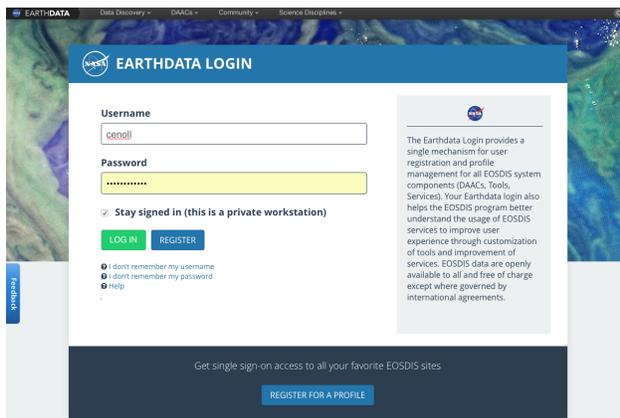


Figure 4a. Earthdata login interface: Used to register and access file upload application (as well as CDDIS real-time GNSS streaming system).

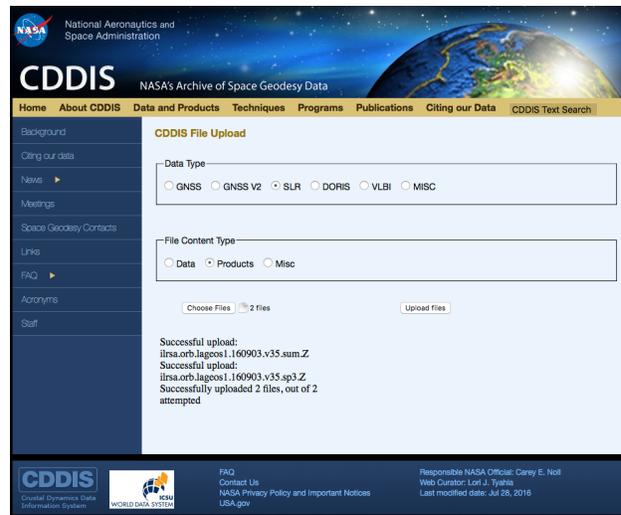


Figure 4b. File upload application example for interactive upload of files.

```
[/home/user]$ curl -c .urs_cookies -n -L
http://depot.cddis.eosdis.nasa.gov/CDDIS_FileUpload/login/
Welcome to CDDIS File Upload
[/home/user]$ curl -X POST -b .urs_cookies -F "fileType=SLR" -F
"fileContentType=products" -F "file[]=@ilrsa.eop.160901.v135.snx.Z"
http://depot.cddis.eosdis.nasa.gov/CDDIS_FileUpload/upload/
Successful upload: ilrsa.eop.160901.v135.snx.Z
Successfully uploaded 1 files, out of 1 attempted
```

Figure 5. Command line program example using cURL for scripted uploads

Future Plans

The CDDIS staff will continue to make improvements to its operational software procedures to ensure timely update of the archive for the global user community. These improvements include streamlining archive operations across all data types (SLR, GNSS, DORIS, and VLBI) and generating improved metadata for archive operations and data discovery.

As per U.S. Government policy, all web activities, including both the CDDIS and ILRS websites, transitioned to using HTTPS protocol in late fall 2016.

The CDDIS staff will implement HTTPS access to its archive by mid-2017. As global archives and users continue to move away from using FTP the CDDIS plans to implement access to its full archive through HTTPS. This access will continue to use same structure as provided through FTP. The HTTPS archive access method is as efficient as FTP transfer without the firewall/router issues of FTP. Furthermore, Earthdata login (see section above) will be used for access through HTTPS. For the near-term, access to CDDIS archive through FTP will continue but users are encouraged to explore the HTTPS capabilities when they are made available.

Staff will also make improvements to the CDDIS Site Log Viewer application (https://ilrs.gsfc.nasa.gov/network/site_information/Site_Log_Viewer/index.html). Through this web application, users can display a complete IGS, ILRS, or IDS site log, section by section, display contents of one section for all site logs, and search the contents of one section of a site

log for a specified parameter value. Thus, users can survey the entire collection of site logs for systems having particular equipment or characteristics. Planned improvements include the automated ingest to reflect site log updates as well as linking site log metadata to other applications.

More Information/Feedback

The staff welcomes feedback on the CDDIS and in particular the ideas expressed in the poster and paper; users are encouraged to contact the authors to provide feedback or obtain additional information about the CDDIS. The data and products are acquired as part of NASA's Earth Science Data Systems and archived and distributed by the Crustal Dynamics Data Information System (CDDIS). Users of the CDDIS are asked to cite the system in their publications:

C. Noll, The Crustal Dynamics Data Information System: A resource to support scientific analysis using space geodesy, *Advances in Space Research*, Volume 45, Issue 12, 15 June 2010, Pages 1421-1440, ISSN 0273-1177, DOI: 10.1016/j.asr.2010.01.018.