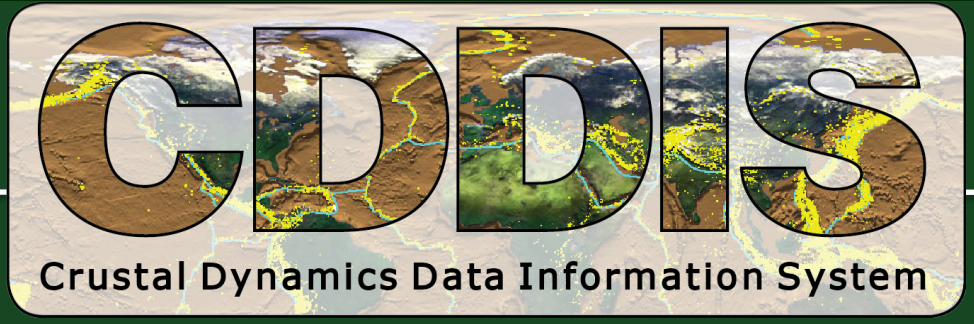


The CDDIS and the International Space Geodetic Services

Carey Noll/Code 690.1
CDDIS Manager

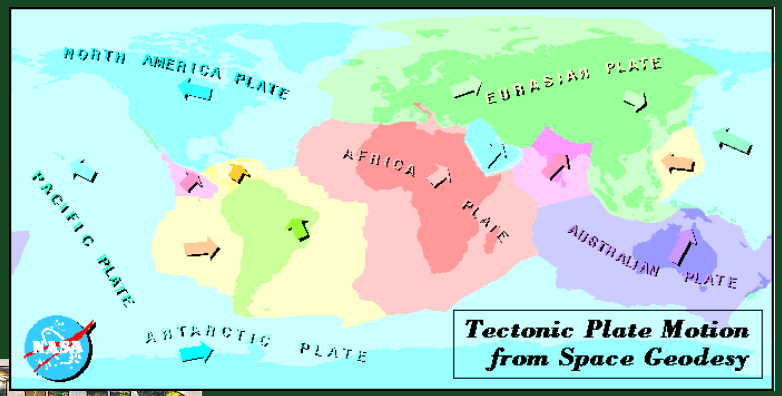
- Background
- System and service development
- User community
- Future Plans

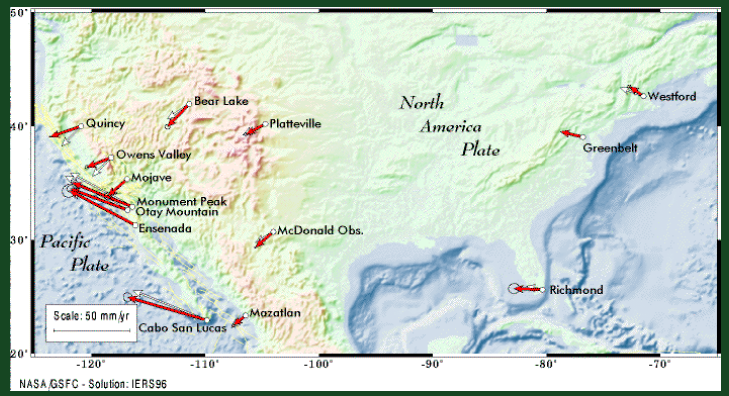
CDDIS Overview

- Crustal Dynamics Data Information System, NASA's active archive of space geodesy data, products, and information
- Established in 1982 as a dedicated data bank to archive and distribute all Crustal Dynamics Project-acquired data and information about these data
- Continues to serve as an archive and distribution center for space geodesy data, particularly GNSS, laser ranging, VLBI, and DORIS data
- Has extensive partnerships through the International Association of Geodesy (IAG) serving as one of the primary data centers for the IAG services and its observing system GGOS (Global Geodetic Observing System)

Historical Perspective (1/2)

- CDDIS began operations as the data system supporting NASA's Crustal Dynamics Project in 1982
- The CDP used space geodesy to monitor plate motion and the rotational dynamics of the Earth with unprecedented accuracy
- Authorized CDP investigators obtained data from the CDDIS (tapes!) and provided their scientific results to the CDDIS
- The CDP paved the way for cooperative investigation using space geodesy
- Cost high, global coverage low (with SLR and VLBI)





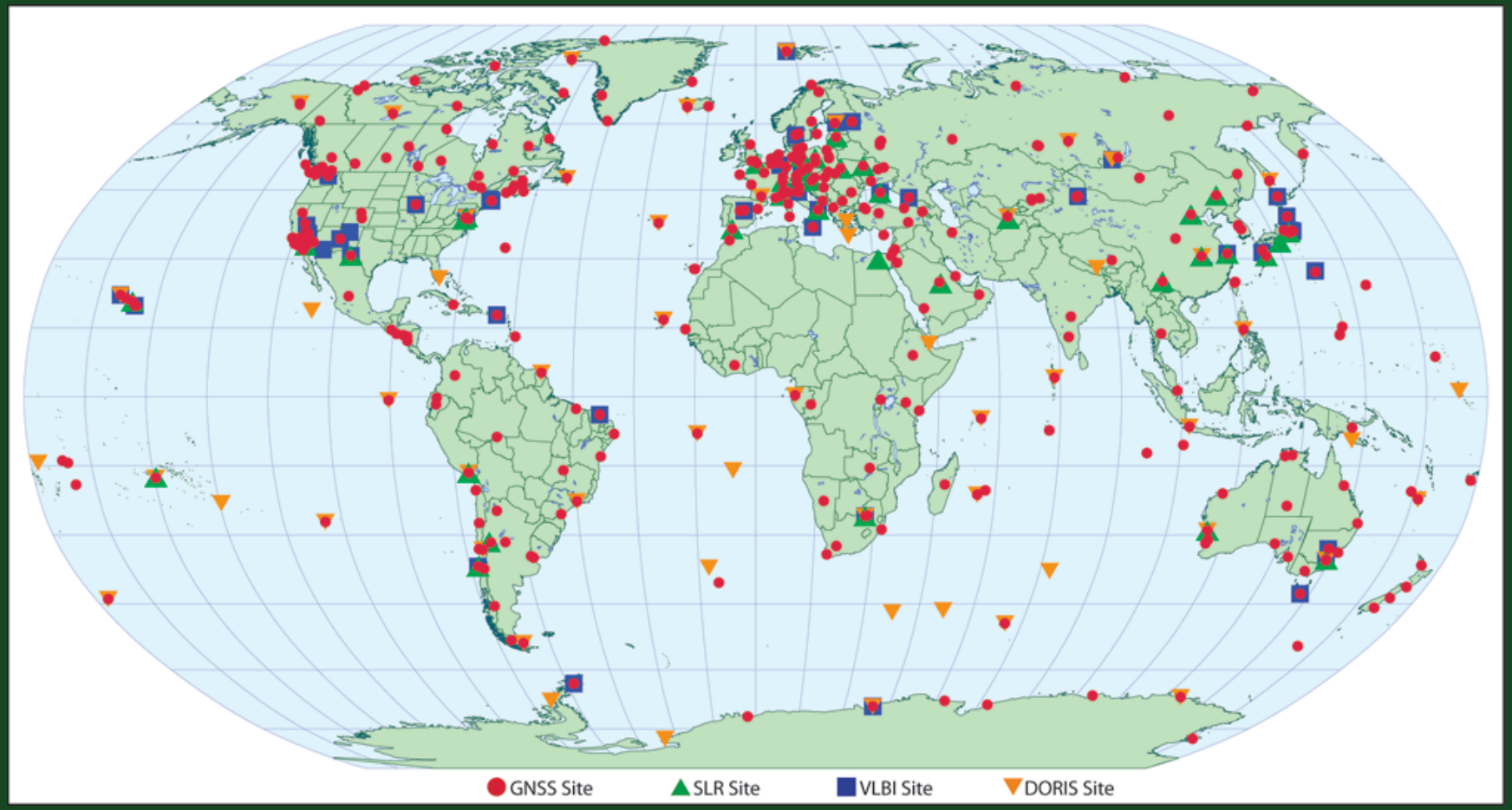
Historical Perspective (2/2)

- By late 1980's, government agencies, universities, etc. began deploying GPS receivers in permanent configurations for scientific study
- Goal: millimeter-level positioning
- Problem: No single government/agency/group could do the job on a global scale
- Solution: international, cooperative partnerships to facilitate research
- Multi-level cooperation: networks, data centers, analysis groups
- The International Association of Geodesy (IAG) began planning for the IGS – The International GPS Service
- IGS has provided precise GNSS observations and products for over 20 years
- Today, the International GNSS Service is a voluntary organization of over 200 agencies in over 90 countries

International Geodetic Services

- The IGS served as a model for the creation of other services for space geodesy techniques
- Services function as cooperating federations dedicated to a particular type of data
- Provide data and products on an operational basis to geodesy analysts as well as a broader scientific community
- Examples of a successful model of community management:
  - Develop standards
  - Self-regulating
  - Monitor performance
  - Define and deliver products using pre-determined schedules
- Successful operation through cooperation of many international organizations who leverage their respective limited resources to all levels of service functionality

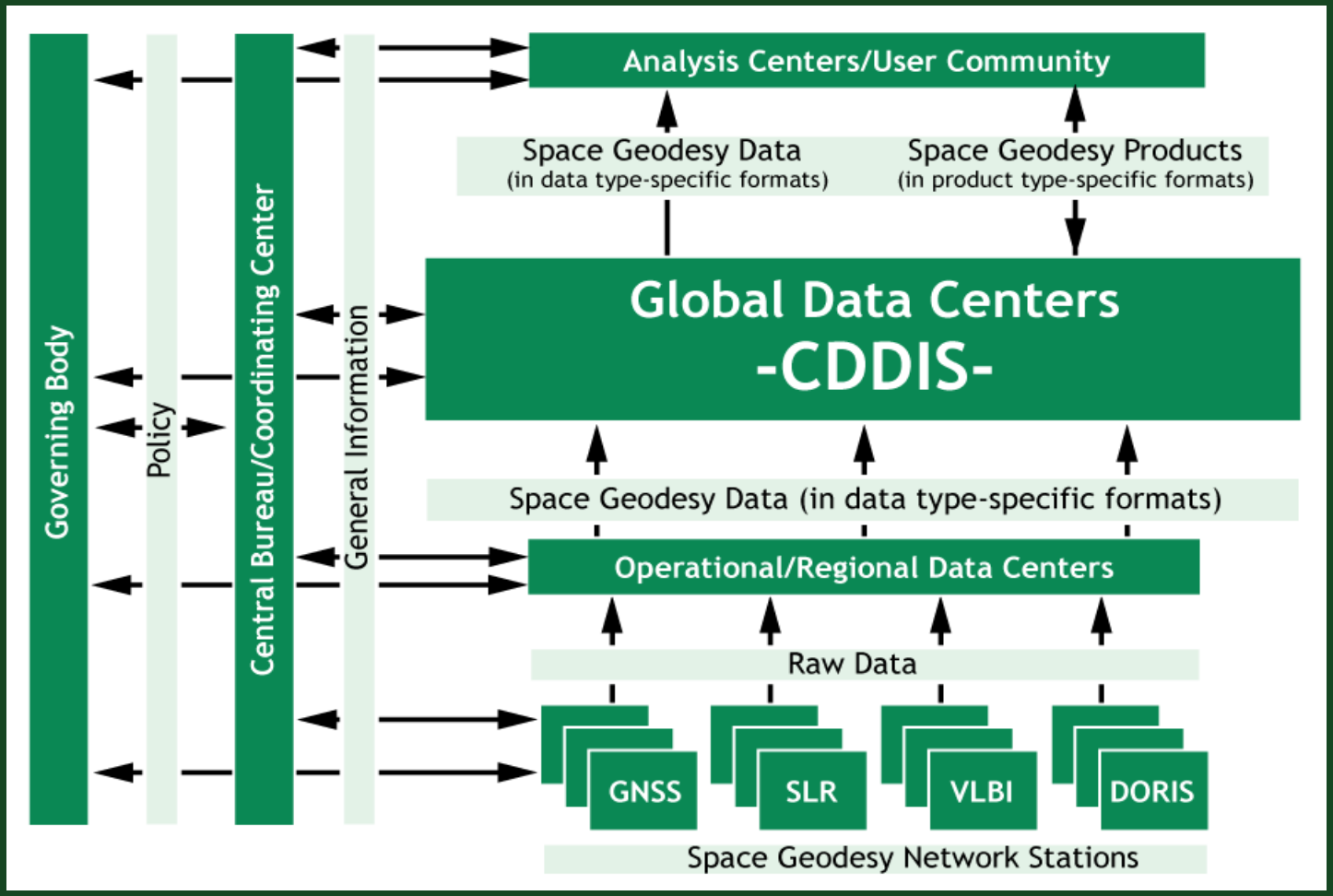
Global Networks: Input to the TRF



CDDIS Support of IAG Services

- CDDIS is the principle data center supporting services created under the International Association of Geodesy (IAG):
  - International GNSS Service (IGS)
  - International Laser Ranging Service (ILRS)
  - International VLBI Service for Geodesy and Astrometry (IVS)
  - International DORIS Service (IDS)
  - International Earth Rotation and Reference Frame Service (IERS)
- Provides infrastructure for populating CDDIS archive
- Primary user community for CDDIS archive

Data/Products: From Source to User



- CDDIS is THE principle data center supporting services created under the IAG
- Simplicity has been the key to success!

CDDIS Archive Summary

- The CDDIS contains data and derived products from over 1500 observing sites located at about 1000 locations around the world, going back in time as far as 1975.
- The archive is updated with new data/product files on varying time scales, dependent on the data type, from a sub-daily basis to weekly basis.
- Users require continuous access to data for generation of products on pre-determined schedules.
- The majority of CDDIS user community are analysts supporting the services within the International Association of Geodesy.
- These groups produce derived products (e.g., positions of observing stations, Earth orientation parameters, precise satellite orbits, etc.) for use by a broader scientific community.
- The average user of the CDDIS accesses the contents of the archive through anonymous ftp by means of automated scripts executed on predefined schedules (typically sub-daily).
- Analysts can use this method for data transfer because they are familiar with the structure of the online archive and thus know what files they require, their availability schedule, and where to find them within the online structure.

CDDIS Archive Contents: Space Geodesy Data and Products

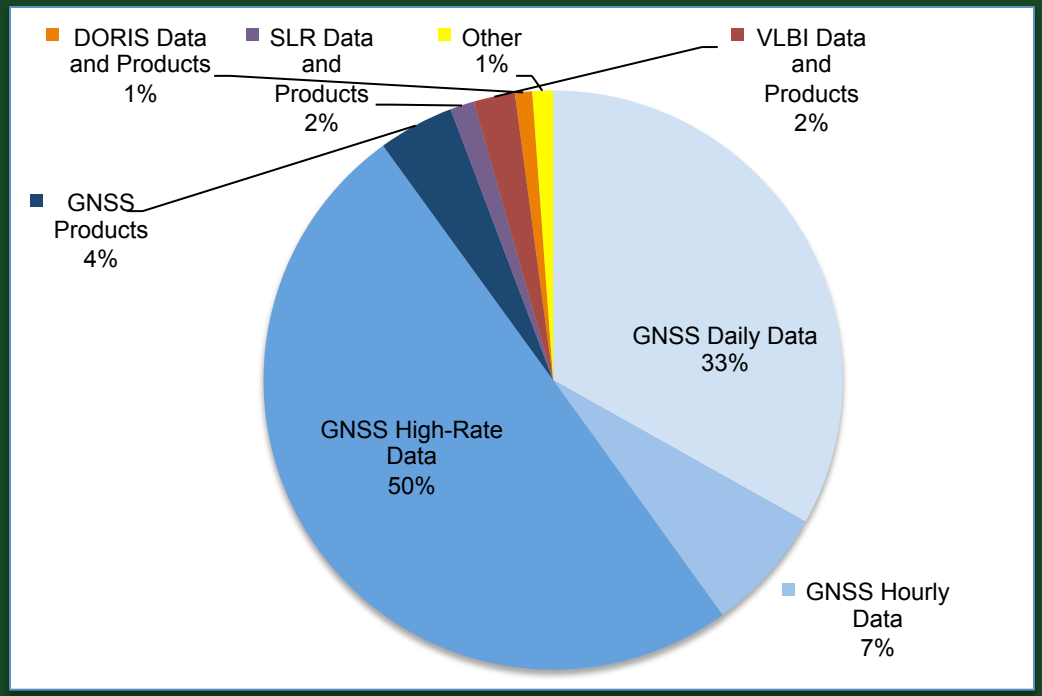
- Data:
  - Stations in the GNSS, SLR/LLR, VLBI, and DORIS networks generate point data on a multi-day, daily, hourly, and/or sub-hourly basis
  - GNSS: 450+ sites tracking GPS, GLONASS
  - Laser Ranging (SLR and LLR): 42 sites tracking 45+ satellites (including the Moon)
  - VLBI: 45 sites
  - DORIS: 58 sites tracking 7 satellites
  - Stations in the GNSS, SLR/LLR, VLBI, and DORIS networks generate point data on a multi-day, daily, hourly, and/or sub-hourly basis
- Products:
  - Precise network station positions (for ITRF)
  - Satellite orbits (for POD)
  - Station and satellite clocks (for timing)
  - Earth rotation parameters
  - Positions of celestial objects (for CRF)
  - Atmospheric parameters (Ionosphere TEC, Troposphere ZPD)
  - …
  - Products provided weekly, daily basis

CDDIS Archive

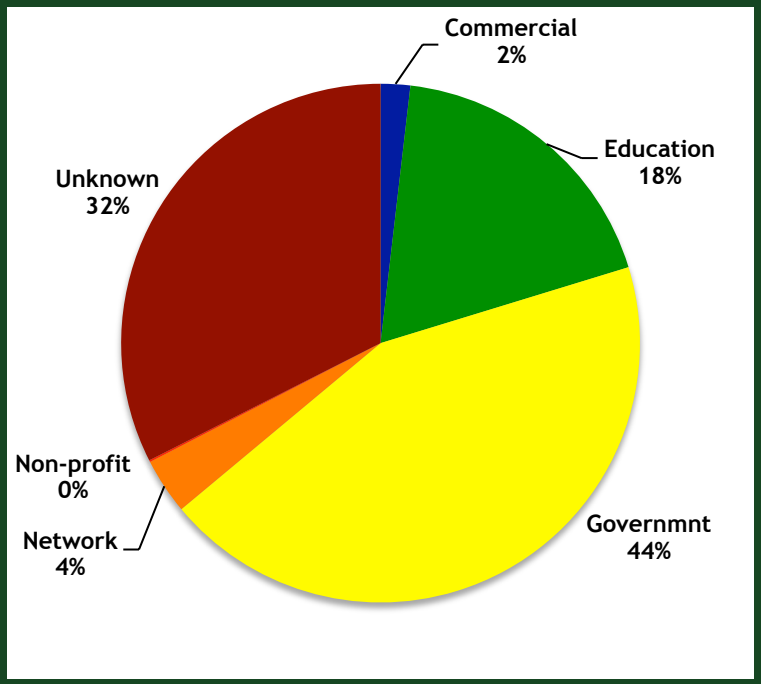
- Archive size: ~6.5 Tb
- Ingest rate: ~3 Gb/35K files per day
- Distribution rate: ~125+Gb/day, ~1.4M files/day
- File size is typically <2Mb/data “granule”, <10Mb/derived product “granule”
- Easy to add new data types/data sets
- Files:
  - Data, products derived from these data, and information about data and products
  - Multi-day, daily, hourly, sub-hourly
  - Varying latencies (minutes, hours, days)
- Metadata:
  - Non-standard, data type specific
  - Extracted from data (not all products) and loaded into relational database
  - Internal access to database

CDDIS Archive Statistics

Archive contents by data type:

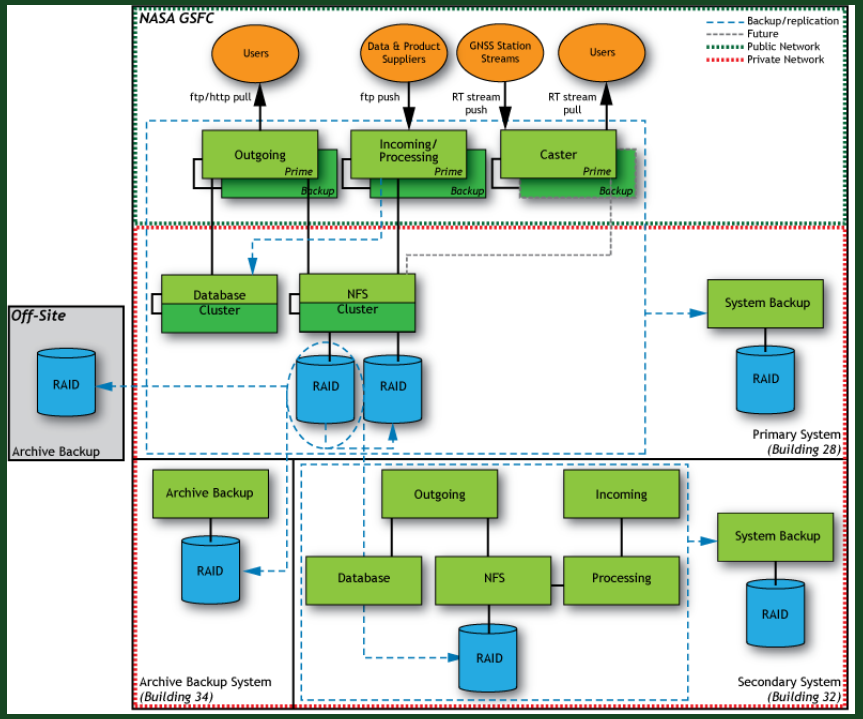


User distribution profile:



CDDIS Configuration

- The CDDIS uses a distributed server environment
  - outgoing servers: handle all web and ftp traffic
  - incoming servers: accept transfers from authorized data supplier
  - database cluster: manages MySQL database for metadata management (internal), data transfer logs (internal), data discovery (external)
  - caster servers: provide real-time streams to authorized clients
  - processing/NFS cluster: archive processing and NFS access to RAID array
- System is fully redundant (secondary/ failover system; primary and secondary systems have backup systems)
- Archive is equipped with a 32 Tbyte RAID storage system and is scaled to accommodate future growth



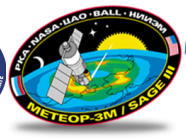
CDDIS User Community

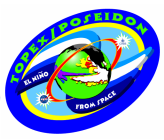
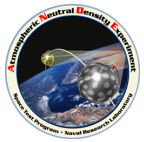
- Expert Users: scripts for automated, routine file retrieval
  - Science Teams:
    - Analysis Centers supporting IAG services, tasked with providing standard products as per service specifications
    - U.S. and international groups who produce products for use in higher level products (e.g., orbits for GRACE, Jason, etc.; ionosphere/troposphere products for weather models)
    - Require continuous access to data for generation of products on pre-determined schedules
  - Other data centers:
    - Retrieve files from CDDIS to equalize data holdings among other data centers supporting IAG services
- Novice/Occasional Users
  - Need to explore the contents of the archive by spatial, temporal, platform, or parameter specifications
  - Access archive through ftp to:
    - Pick and chose data or products
    - Grab large subsets of data on irregular basis

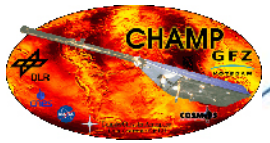
Supported Groups and Missions (a subset!)

International Services

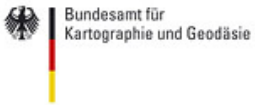
Missions





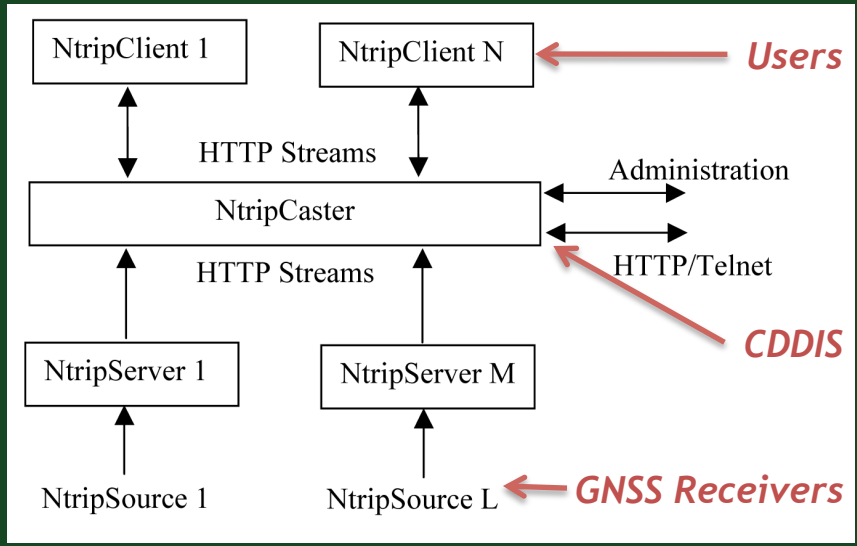
Agencies and Universities



National Resources
Canada
Ressources naturelles
Canada

Future Plans: Real-Time Data

- Networked Transport of RTCM via Internet Protocol (Ntrip)
- Disseminates differential correction data or other kinds of GNSS streaming data to stationary or mobile users over the Internet
- Mobile users obtain corrections/data from reference stations in real-time to improve positioning
- CDDIS will soon install an Ntrip broadcast relay (NtripCaster) to support the activities of the IGS Real-Time Pilot Project (RTPP) and the future Real-Time IGS Service
- Capture streams for archive



- NtripSource: generates data streams at a specific location
- NtripServer: transfers the data streams from a source to the NtripCaster
- NtripCaster: major system component
- NtripClient: accesses data streams of desired NtripSources on the NtripCaster

Future Plans: Data Discovery Application

- Completing development of new web-based application to aid users in data discovery, both within the current community and beyond
- To enable this data discovery application, the CDDIS is currently implementing modifications to the metadata extracted from incoming data and product files pushed to its archive