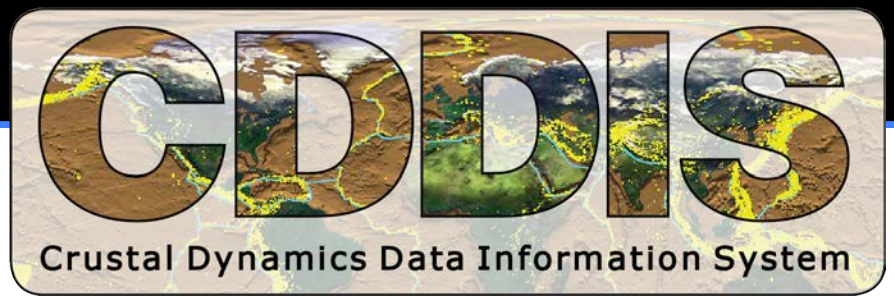

Distributing Real-Time GNSS Data and Derived Products at the CDDIS

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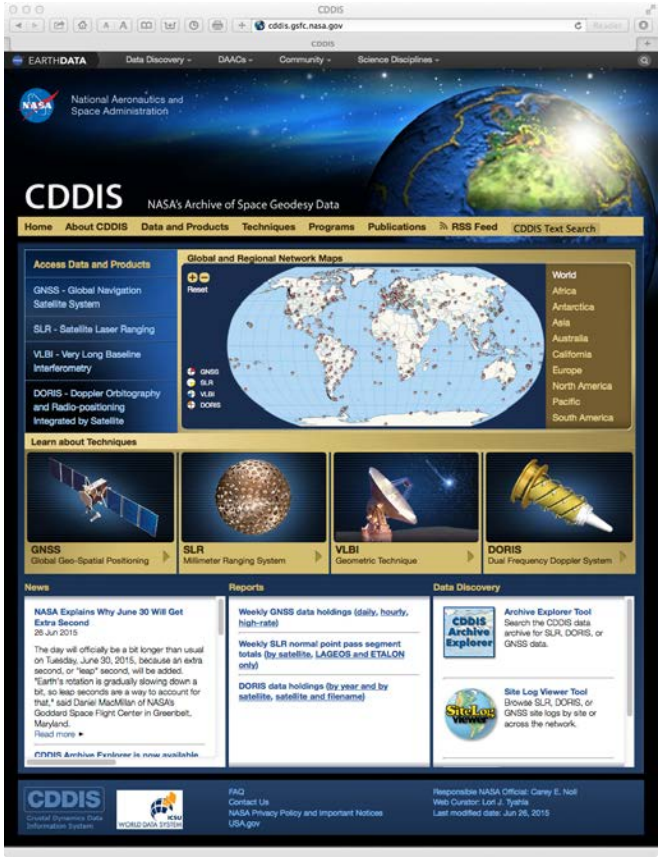
July 22, 2015

Webinar Overview

- Introduction and background
- GNSS: Global Navigation Satellite System
- International GNSS Service
- Real-time GNSS
- User community
- User registering and login
- CDDIS real-time caster and protocol
- Application demo
- Future plans

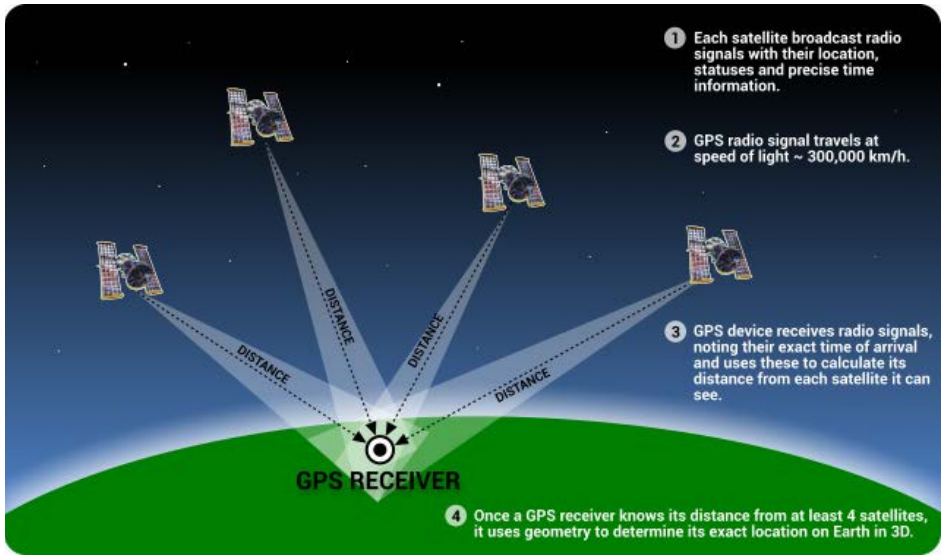


Background

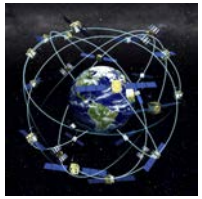
- CDDIS: NASA's active archive of space geodesy data, products, and information
  - GNSS: Global Navigation Satellite System
  - SLR and LLR: Satellite and Lunar Laser Ranging
  - VLBI: Very Long Baseline Interferometry
  - DORIS: Doppler Orbitography and Radio-positioning Integrated by Satellite
- Operations since 1982
- Located at NASA Goddard Space Flight Center
- In October 2007, support for the CDDIS was reorganized at NASA HQ and it became the 12th EOSDIS DAAC
- CDDIS is central to the data management component for NASA's Space Geodesy Project (SGP)
- CDDIS is a regular member of the International Council for Science (ICSU) World Data System (WDS)

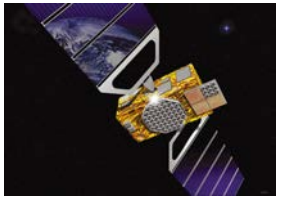
GNSS

- Global Navigation Satellite System
- Space Segment:
  - Satellites equipped with precise clocks transmitting messages to ground (and space-based) receivers
  - GPS (U.S.), GLONASS (Russia), Galileo (Europe), Beidou (China), QZSS (Japan), IRNSS (India)
- Ground Segment:
  - Multi-frequency GNSS receiver and antenna
  - 500+ stations (at CDDIS); 1000's worldwide
- Observable:
  - Station to satellite pseudorange, phase delay
- Characteristics:
  - Comprehensive global network
  - Navigation, surveying, atmospheric and space weather



From www.geneko.rs

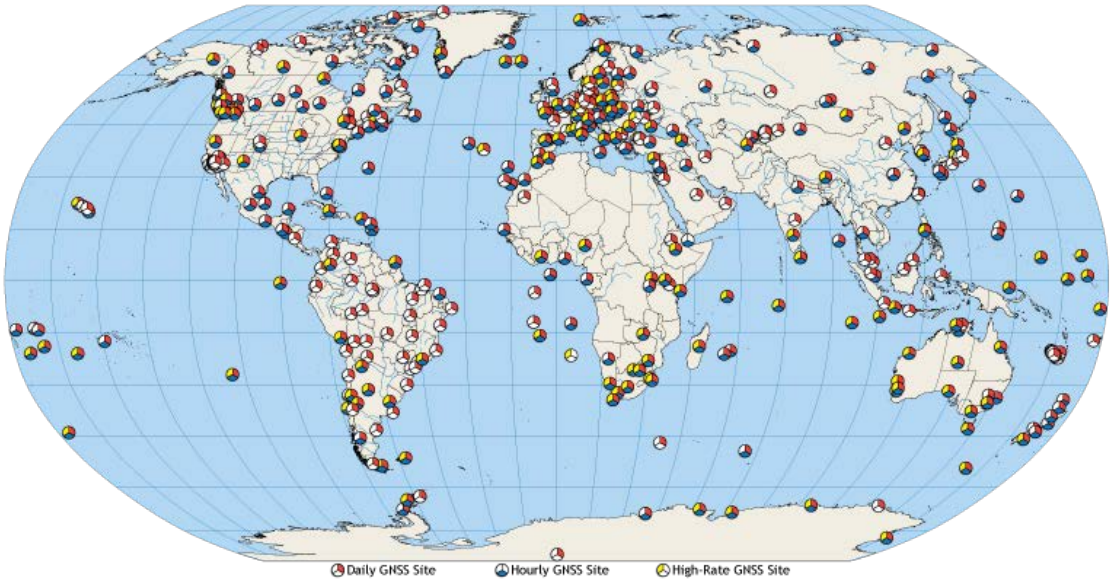





GNSS at the CDDIS

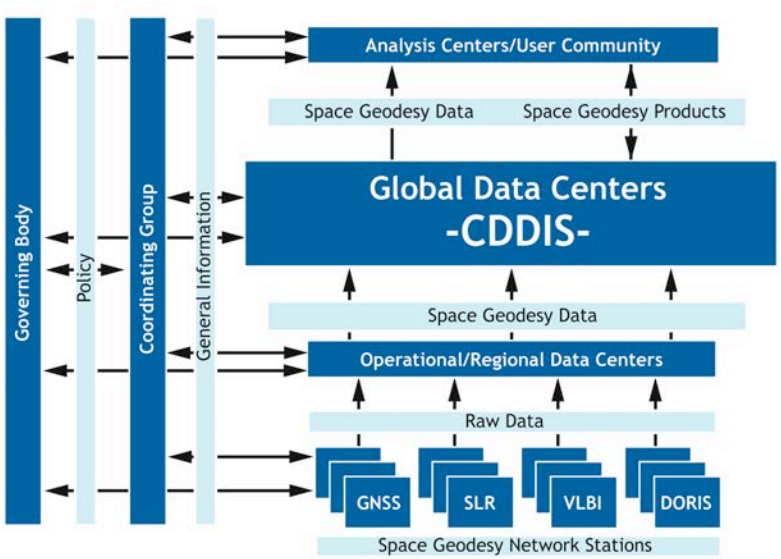
- GNSS data archive:
  - Daily
    - ~500 receivers
    - 30-second sampling rate
  - Hourly
    - ~330 receivers
    - 30-second sampling rate
  - Sub-hourly
    - ~185 receivers
    - 1-second sampling rate
  - Real-time
    - ~150 receivers
    - 1-second sampling

- GNSS product archive:
  - Precise orbits
    - Weekly, daily, sub-daily
  - Station positions/velocities
    - Weekly, daily
  - Troposphere ZPD
    - Daily
  - Ionosphere TEC
    - Daily



International Services and the IGS

- The International Association of Geodesy (IAG) established “services” to facilitate international cooperation
- The International GNSS Service (IGS) has ensured the availability of open access, high-quality GNSS data products since 1994
- Products enable access to a global reference frame for scientific, educational, and commercial applications
- A voluntary federation of over 200 self-funding agencies, universities, and research institutions in more than 100 countries
- Providing access to tracking data from over 450 worldwide reference stations
- Working for the continuous development of new applications and products through Working Groups and Pilot Projects



IGS

IGS Real-Time Service (RTS)

- IGS is driven by a strong rationale to support public-benefit applications
- IGS Real-time Service (RTS) extends the its capability to support applications requiring real-time access to IGS products
- RTS is a GNSS orbit and clock correction service that enables precise point positioning (PPP) and related applications, such as time synchronization and disaster monitoring, at global scales for scientific and hazard detection applications
- RTS based on the existing IGS global infrastructure of network stations, data centers, and analysis centers that provide world standard high-precision GNSS data products
- Real-time stations disseminate differential correction data or other kinds of GNSS streaming data to stationary or mobile users over the Internet
- Users capture data streams for applications requiring real-time corrections and for generation of real-time products
- Users obtain corrections/data from reference stations in real-time to improve positioning

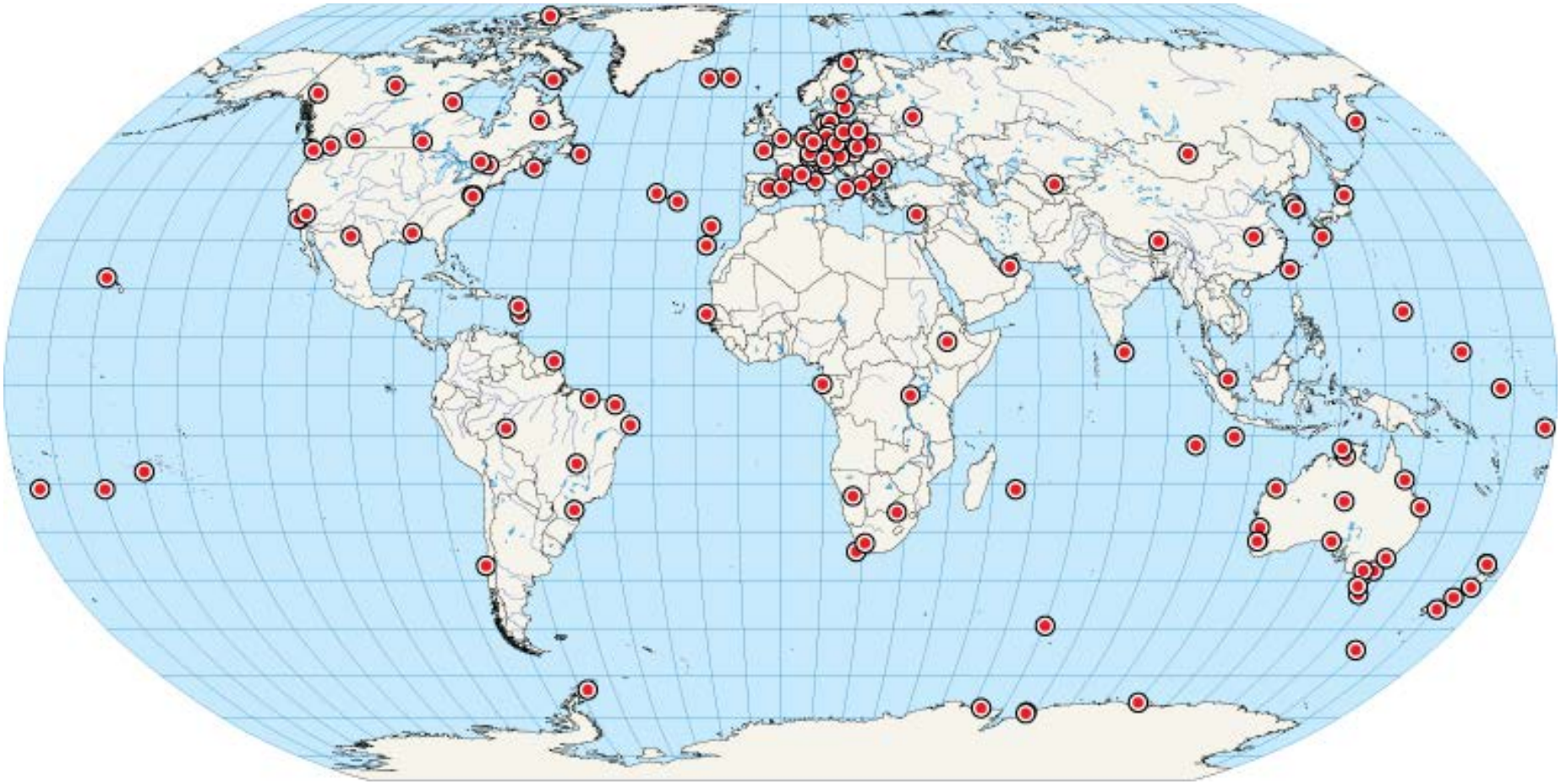
IGS RTS

- IGS real-time products:
  - data streams from a global network of high-quality GNSS receivers
  - real-time combined orbits
  - accurate satellite clock solutions
  - real-time ionosphere information (vertical total electron content)
- Products enable real-time precise point positioning (PPP) at global scales for scientific and hazard detection applications
- Products have potential application for quality assessment of multi- constellation satellite performance and monitoring inter-system biases between the different GNSS
- Principal user applications:
  - geophysical hazard detection and warning systems
  - time synchronization
  - conventional weather forecasting
  - space weather forecasting
  - GNSS performance monitoring and quality assessment
  - monitoring inter-system biases between GNSS

CDDIS Support of IGS RTS

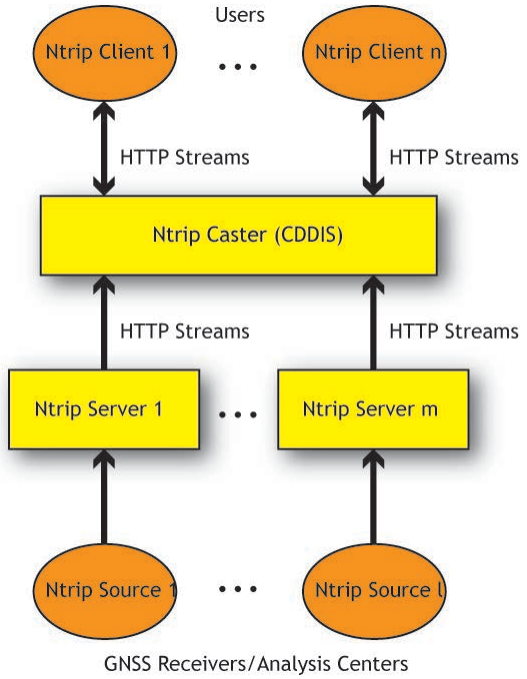
- In 2014, the CDDIS installed a real-time server, called a caster
- Caster is a dedicated server for receiving and serving (broadcasting) real-time GNSS data and product streams
- CDDIS is one of three primary casters supporting the IGS RTS
- Uses NTRIP (Networked Transport of RTCM via Internet Protocol) software
- CDDIS currently pushing 156 real-time data streams and 37 product streams
- Available streams
  - GNSS data
    - 1-second
  - GNSS orbit corrections
    - 5 or 60-seconds
  - GNSS clock corrections
    - 5 seconds
  - Ionosphere VTEC (vertical total electron content)

IGS Real-Time Network: CDDIS



What is NTRIP?

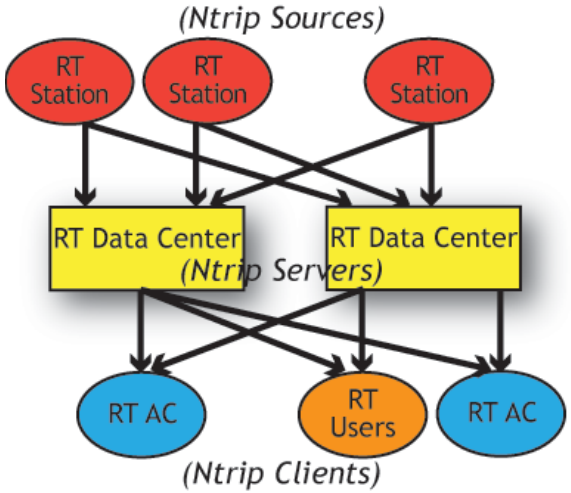
- Network Transport of RTCM by Internet Protocol
- Standard in RTCM
- System for collecting and distributing GNSS information in real-time
- Open, non-proprietary
- HTTP server (caster)
- HTTP clients
  - NtripClient
  - NtripServer
- Based on HTTP streaming standard



- NtripSource: generates data streams at a specific location
- NtripServer: transfers the data streams from a source to the NtripCaster
- NtripCaster: collects streams from sources and serves streams to clients
- NtripClient: accesses data streams of desired NtripSources on the NtripCaster

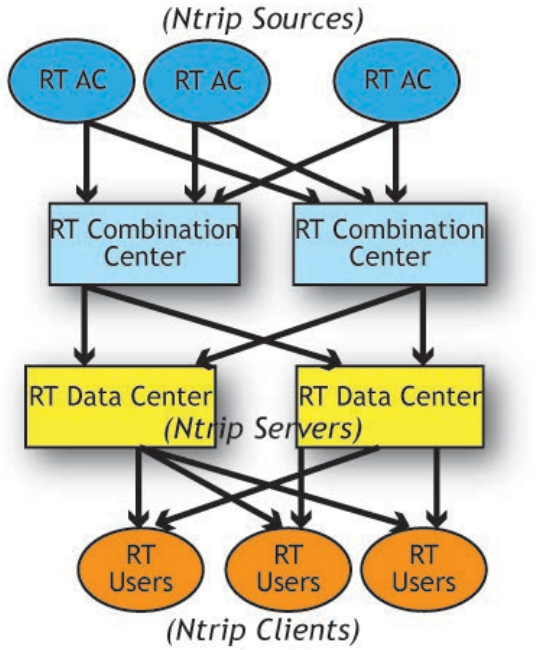
Real-Time GNSS Data Flow

Real-time GNSS station data flow to data center



- Latency of less than 3 seconds
- Data center to real-time analysis center/user

Real-time analysis center product flow to combination center



- 5 second delay to accumulate streams at DC; 5 seconds to produce orbits and clocks
- Ideal delay of 10 seconds to CCs
- Products delivered every 5 seconds

CDDIS Real-Time and URS

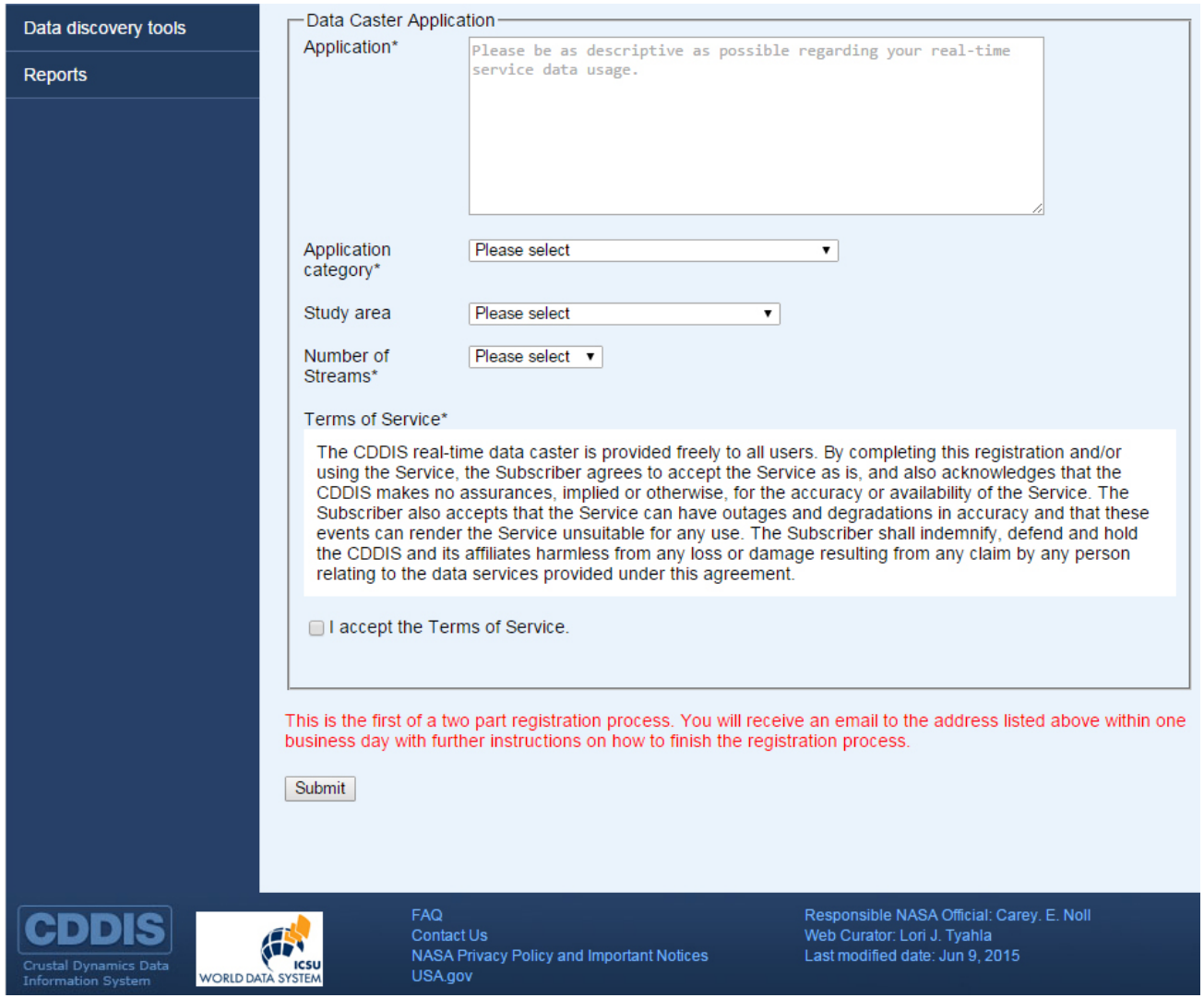
- CDDIS archive available through anonymous ftp and web
- IGS RTS established user registration policy
- Users register with CDDIS for access to real-time data and products (“streams”)
- User registration provides authentication required for RTS
- Worked with ESDIS to implement registration through URS
- Multi-step process to register
- User also accepts Terms of Service
- User client configured for routine access

RT Registration Process

- Data Caster Home page: https://cddis-casterreg.gsfc.nasa.gov/
  - Explains the purpose of the CDDIS Data Caster.
  - Contains links to information on connecting to the Data Caster, the streams that we carry, client configuration, and the registration form.
- Registration is a two-step process (an example is given in the following slides).
  1. Submit the form on the Data Caster website to register with our colleagues at EOSDIS (Earthdata).
     - If you already have an EOSDIS user ID, do not complete the registration form. Contact the help email address (cddis-help-ntrip@lists.nasa.gov) for assistance in using your existing ID.
     - Submitting the form does NOT give you access to the data streams; you must also complete step 2.
     - You will receive an email response from us within one business day.
  2. Respond to the email we will send you that provides information on completing the registration process.
     - Your response will include the list of streams to which you would like access.
     - Based on your response, our staff will provide you with access to your streams and send you an email within one business day of receiving your stream list, stating that you can access the streams. You will not have access until you receive this second email from us.
- Registration form:
  - https://cddis-casterreg.gsfc.nasa.gov/DataCasterRegistrationForm.html

RT Registration Process/Example

RT Registration Process/Example



RT Registration Process/Example

Registration results page

RT Registration Process/Example

You will receive an e-mail from us with instructions on how to complete the registration process. You will not be able to use the Data Caster until you respond to this email.

Welcome to the CDDIS caster for GNSS data and products supporting the IGS Real-Time Service (RTS). We thank you for registering with us. In order to finish activating your account, you will need to provide us with those streams that you would like access to. Please see our source table (https://cddis-caster.gsfc.nasa.gov) for a quick synopsis of what streams we currently carry. For more in depth information on each stream please see
(http://cddis.gsfc.nasa.gov/Data_and_Derived_Products/Data_caster_streams.html)
– which defines all the information that is displayed in the source table. Please peruse this resource to ensure the streams you requested access to are the ones that you truly need.

NTRIP client configuration details can be found at
(http://cddis.gsfc.nasa.gov/Data_and_Derived_Products/Caster_client_config.html)
– which should help you in setting up your client to work with the CDDIS Caster. Please note that the CDDIS caster ONLY provides streams over secure sockets layer (SSL), i.e. https and it is therefore critical that you follow the instructions on the configuration page to ensure that you have properly configured your client.

Once you have reviewed all the information above please forward this email along with your list of streams to cddis-help-ntrip@lists.nasa.gov. Please ensure you state the five or seven digit codes that uniquely identify each stream you are requesting access to. For example say you want access to Christchurch, New Zealand that would be MQZG0 or you wanted access to the IGS product stream number 1 – that would be IGS01.

Typical turnaround time from the time we receive your list of streams to activation on the CDDIS caster is less than 24 hours. You will receive an additional email once this process is completed letting you know that access to the requested streams is complete. In the future, if you have problems or would like access to other streams please send an email to cddis-help-ntrip@lists.nasa.gov in order to modify your access.

The CDDIS Team

RT Registration Process/Example

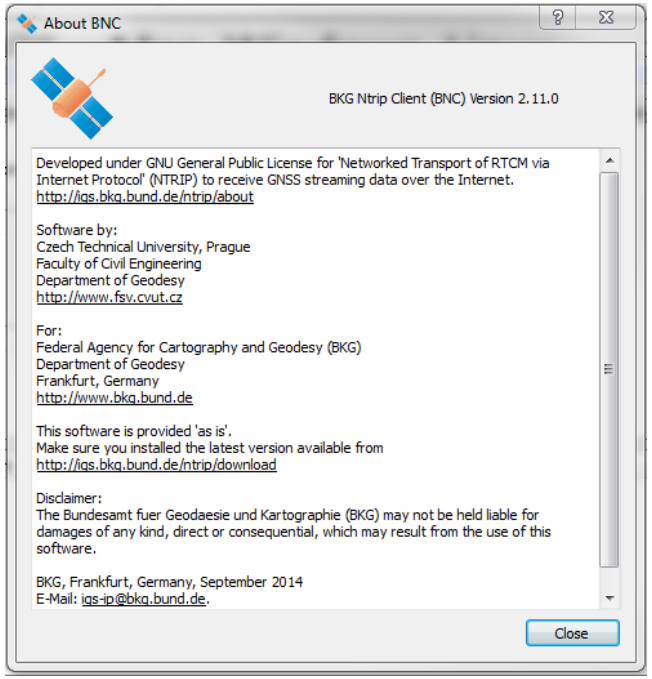
http://cddis.gsfc.nasa.gov/Data_and_Derived_Products/Data_caster_streams.html

No.	Country	Identifier	Closest City	System	Network	Carrier	Latitude	Longitude	Solution Type	Generator	Format	Format Details
												4087(10)
154	ZAF	CTWN0	CapeTown	GPS+GLO	MISC	2	-33.95	18.47	0	TRIMBLE NETR5	RTCM 3.0	1004(1), 1005(5), 1007(5), 1012(1), 1019, 1033(5), 4094(5)
155	USA	DS131	Goldstone	GPS+GLO	IGS	2	35.25	-116.79	0	TRIMBLE NETR9	RAW	RT27
156	USA	DS132	Goldstone DSS-13	GPS+GLO	IGS	2	35.25	-116.79	0	TRIMBLE NETR9	RTCM 3.0	1004(1), 1012(1)

Get CSV

Ntrip Client Configuration & Demo

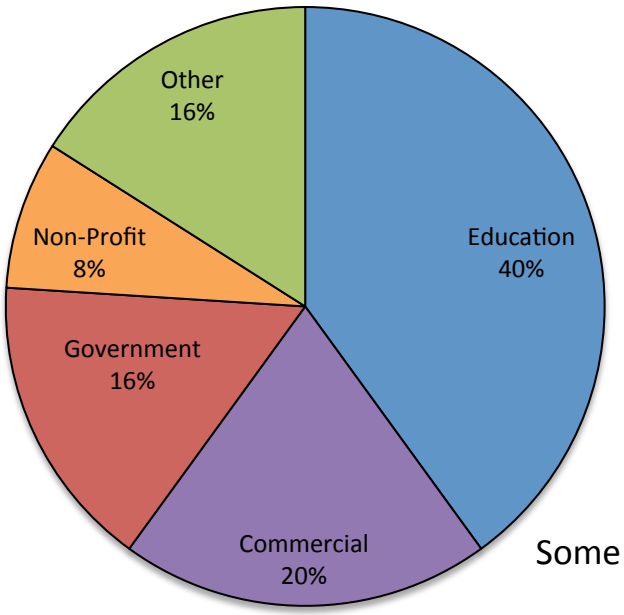
- Ntrip client (BNC)
  - Multiple OS – Mac, Windows, Linux
  - Download - http://igs.bkg.bund.de/ntrip/download
  - Documentation and Configuration
    - http://software.rtcmntrip.org/export/HEAD/ntrip/trunk/BNC/src/bnchelp.html
    - http://cddis.gsfc.nasa.gov/Data_and_Derived_Products/Caster_client_config.html
  - Secure Sockets Layer (SSL) ONLY
- Demo
  - Initial setup
  - RTCM streams to RINEX observation files
  - Precise Point Positioning (PPP) example
  - PPP with Google maps



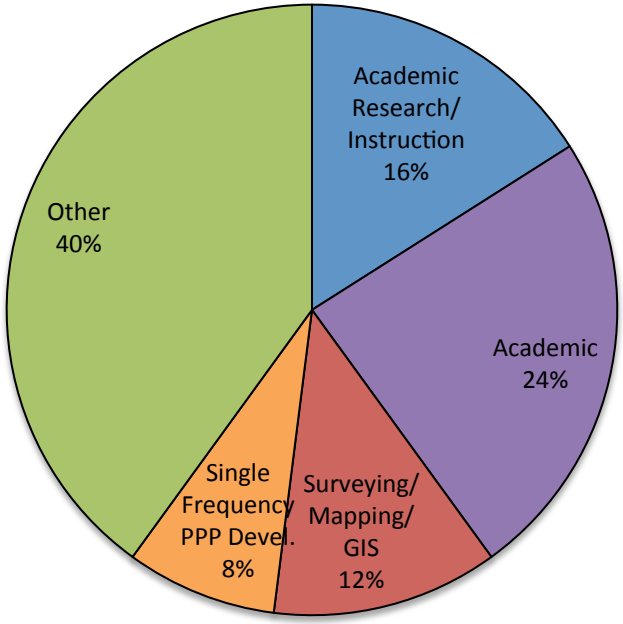
CDDIS GNSS Usage

- Since the start of the CDDIS real-time GNSS service 25 users have registered for access to CDDIS caster

User Organizations



User Applications



Some statistics (single day):

- Listeners (23):
- Number of source connects: 25225
- Number of client connects: 5429
- Average listener time: 2 hours, 52 minutes
- Average listener transfer: 5611 KBytes
- Average source connect time: 1 hours, 38 minutes
- Average source transfer: 2706 KBytes

Future Developments

- CDDIS has begun the process to capture incoming streams for generation and comparison of high-rate data files
  - High-rate files contain data sampled at 1 second
  - Generated within receiver
  - Transmitted sub-hourly with several minute delay
  - Not available from all real-time sites
- Usage monitoring/statistic capture
- Add more streams
  - Data streams from global real-time capable sites in NASA network
  - Data streams from other real-time providers
- User registration/login through URS 4

For More Information

- CDDIS website: *http://cddis.gsfc.nasa.gov*
  CDDIS real-time information: *https://cddis-casterreg.gsfc.nasa.gov/index.html*
- Noll, Carey E., 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, *http://dx.doi.org/10.1016/j.asr.2010.01.018.*
- CDDIS webinar (2014): *https://www.youtube.com/watch?v=IAVas5OMM7E&list=UUrZ-Cgk3DfiLPfHEReLzCfg&index=7*
- Contact:
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    CDDIS Deputy Manager
    Patrick.Michael@nasa.gov
  - Lori Tyahla
    User services
    Ltyahla@sgt-inc.com
- Related websites:
  - IGS Website: *http://www.igs.org*
  - IGS RTS Website: *http://rts.igs.org*
  - NTRIP Information: *http://igs.bkg.bund.de/ntrip/index*

CDDIS Staff

- Carey Noll, Manager
- Patrick Michael, Deputy Manager
- Maury Dube, Operations Lead
- Rebecca Limbacher, Operations
- Nathan Pollack, Applications Development
- Lori Tyahla, User Services, Webmaster
- Carlysle McNaught, DB and software development
- New staff member (Operations)