GNSS Real-Time Data and Product Streams at NASA's CDDIS: User Applications and Caster Performance Improvements

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Introduction

- CDDIS is one of NASA's 12 Distributed Active Archive Centers (DAACs)

- CDDIS is NASA's premier Space Geodesy archive

- The Crustal Dynamics Data Information System (CDDIS) is operated at the NASA Goddard Space Flight Center (GSFC) in Greenbelt, Maryland (Figure 1).

- The CDDIS supports the International Global Navigation Satellite System (GNSS) Service (IGS) and is a contributing member of the IGS Real-Time Service Working Group.

IGS INTERNATIONAL GNSS SERVICE

Figure 1 (above): NASA GSFC Aerial view 2010 facing south. Photo owned by government license and published on Flickr. (Wikipedia)

Figure 2 (above): CDDIS is located at Building 34 at NASA GSFC. (Earthdata CDDIS Fact Sheet)

Figure 3 (below): GNSS receiver at NASA's Goddard Geophysical and Astronomical Observatory (GGAO)

CDDIS Caster

Operational since 2012, CDDIS broadcasts GNSS data and derived products in real-time via the Networked Transport of RTCM via Internet Protocol (NTRIP).

- GNSS data and derived products disseminated in real-time (1Hz)
- Multi-GNSS pseudo-range and carrier phase observations, and high-accuracy satellite orbit and clock corrections
- ~ 360 Data streams
- ~ 35 Data-derived product streams
- Relayed from 15 different countries
- CDDIS collects latency, completeness and other stream performance metrics in a relational database

Figure 4 (below, left): The CDDIS caster homepage that contains the GNSS real-time GNSS data and derived product streams relayed, registration instructions, and configuration help for accessing stream with BKG's BNC.

Figure 5 (left): QR Code that you can scan with your smart phone and directly access the CDDIS caster homepage!

CDDIS Caster Statistics

- ~ 150+ new users registered per year (in 2021 and 2022)
- CDDIS caster users span 67 countries world-wide
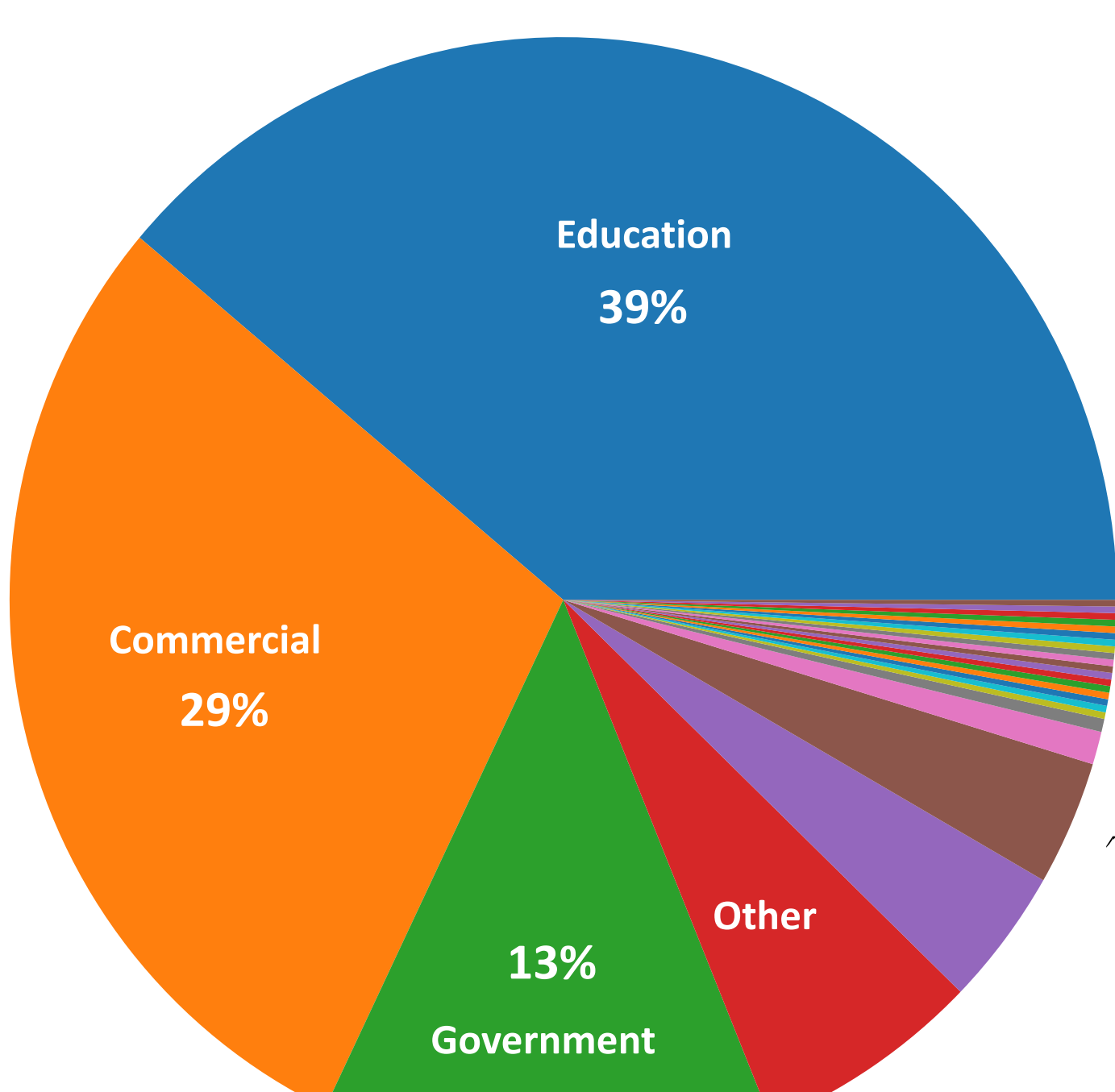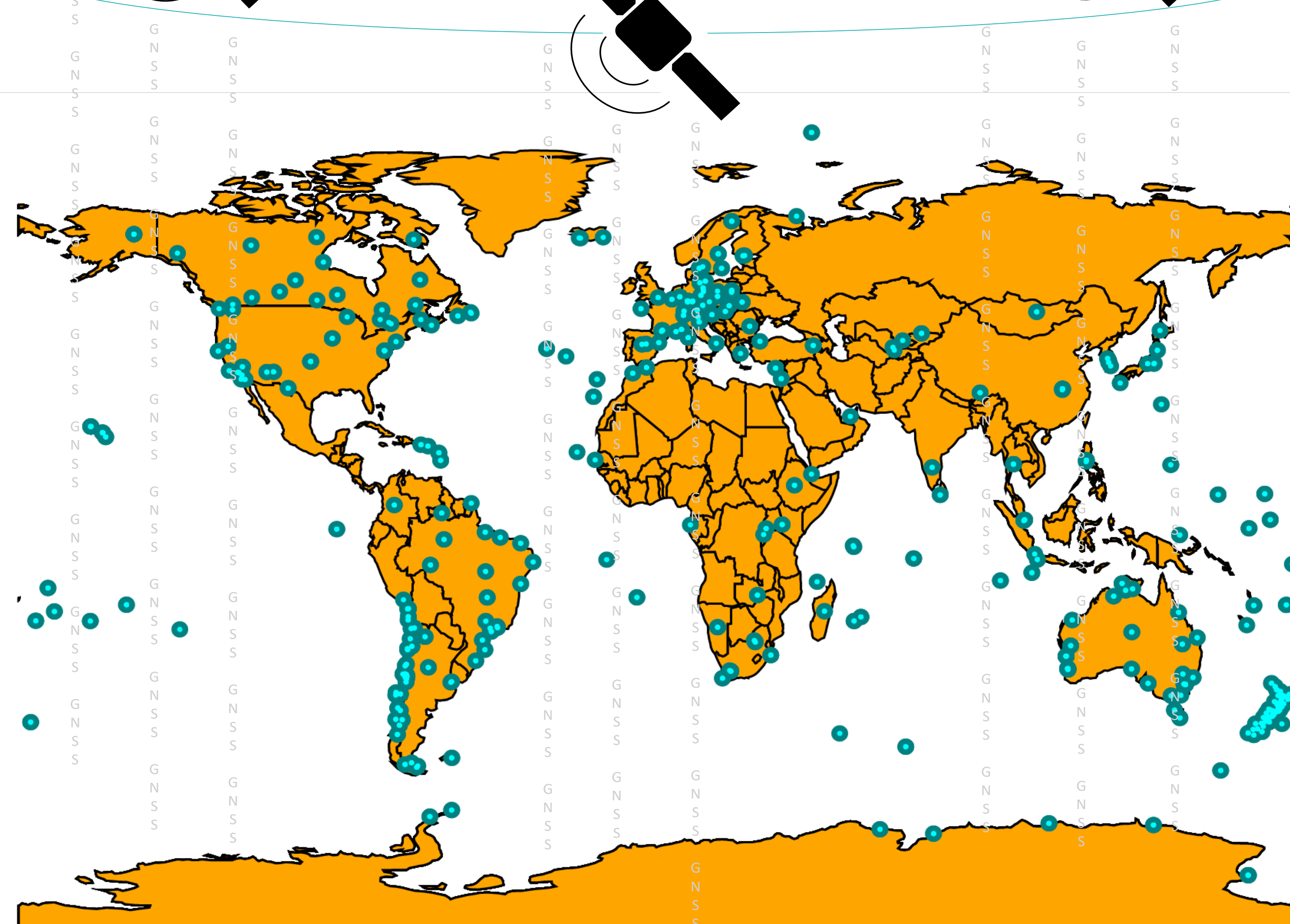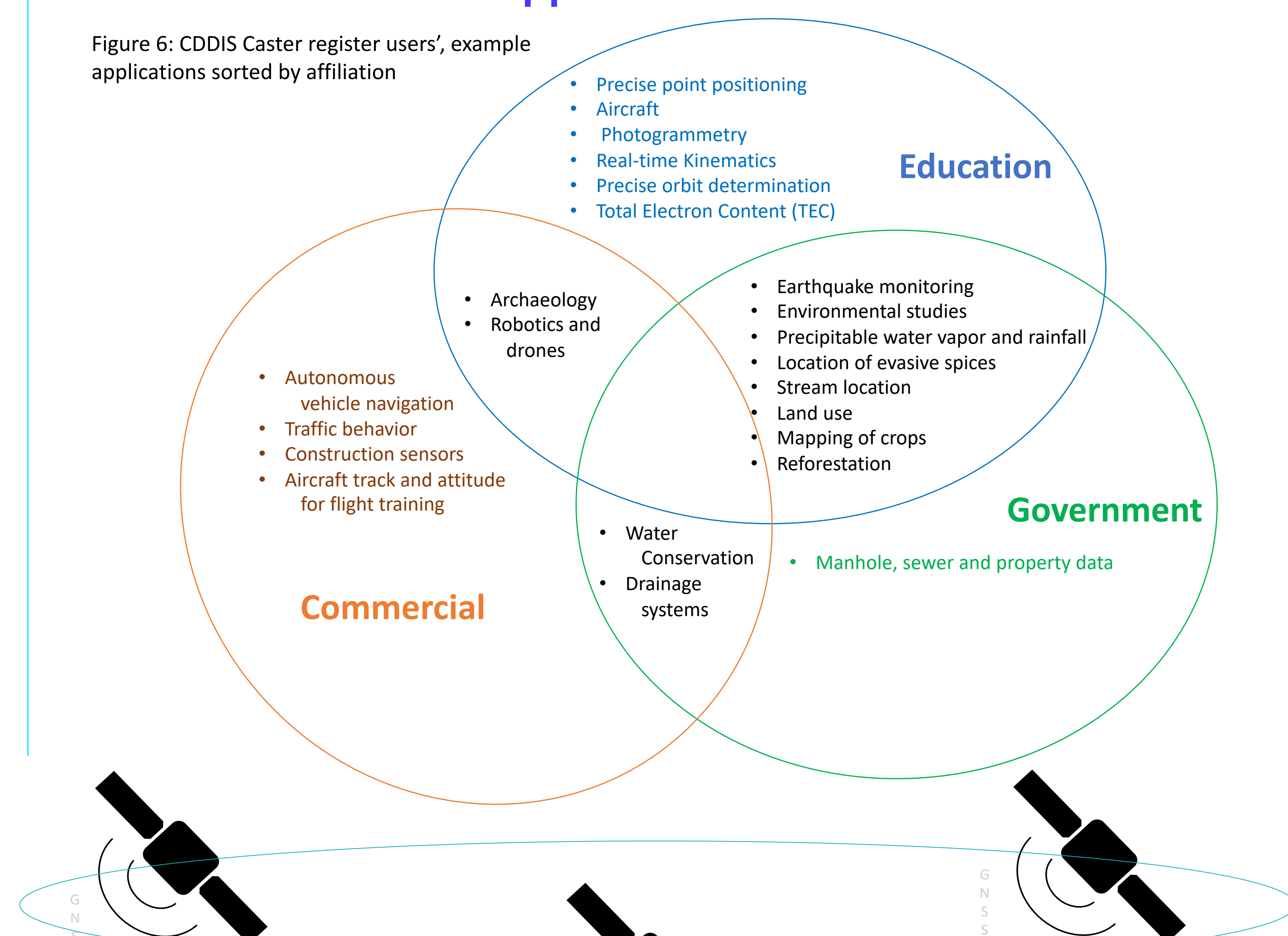- ~ Half of registered Caster users from USA and China

Figure 5: CDDIS Caster register users' professional affiliations

Education 39%
Commercial 29%
Government 13%
Other

CDDIS Caster User Applications

Figure 6: CDDIS Caster register users', example applications sorted by affiliation

Education
- Precise point positioning
- Aircraft
- Photogrammetry
- Real-time Kinematics
- Precise orbit determination
- Total Electron Content (TEC)

- Archaeology
- Robotics and drones

Commercial
- Autonomous vehicle navigation
- Traffic behavior
- Construction sensors
- Aircraft track and attitude for flight training

- Water Conservation
- Drainage systems

Government
- Earthquake monitoring
- Environmental studies
- Precipitable water vapor and rainfall
- Location of evasive spices
- Stream location
- Land use
- Mapping of crops
- Reforestation

- Manhole, sewer and property data

NASA's Space Geodesy Archive

Crustal Dynamics Data Information System
ESTABLISHED 1982

Figure 7 (above): Blue circles mark locations of mountpoints broadcasting real-time data and derived products relayed via the CDDIS Caster
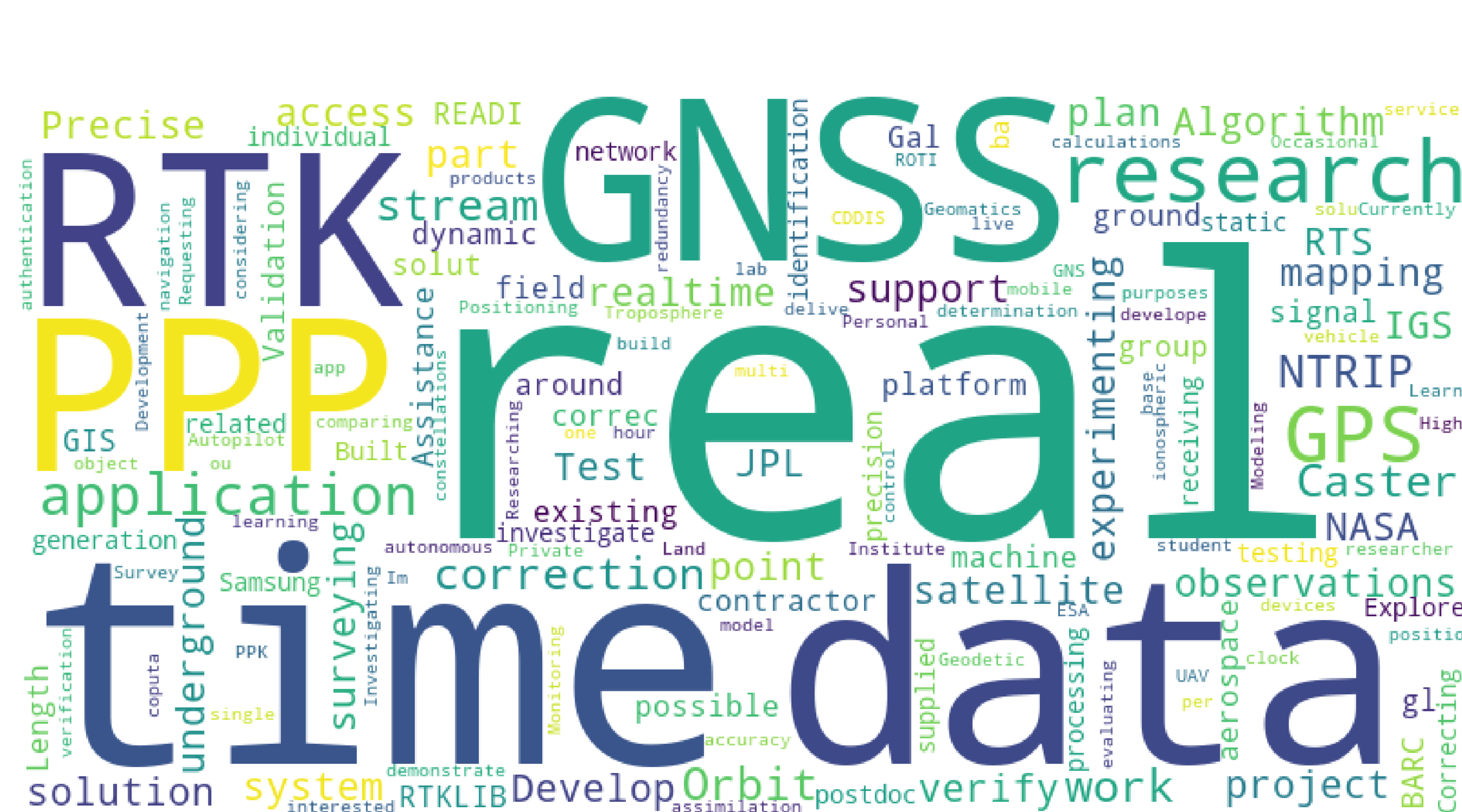

Figure 8 (above): CDDIS Caster register users' applications word cloud

GNSS Real-Time Applications & Societal Benefits

Real-time GNSS data and derived products offer a wide variety of applications with scientific and societal benefits.

- Space weather research and applications
- Autonomous vehicle navigation
- Agriculture
- Robotics
- Telecommunications
- Aviation
- Earthquake and disaster monitoring
- Environment and conservation
- Archaeology
- And more!

Figure 9 (above): Search and rescue (General Dynamics)

Figure 10 (below): Examples of disasters and extreme weather (NOAA, @NOAA/Twitter)

Figure 11 (above): Earthquake aftermath (CDC)

New CDDIS Caster Cluster

Due to the growing number of registered users and number of streams being relayed, the CDDIS is expanding its current GNSS real-time system architecture to a high performance, high availability cluster designed to enhance the overall performance of the CDDIS caster with minimal changes and disruptions to its active users.
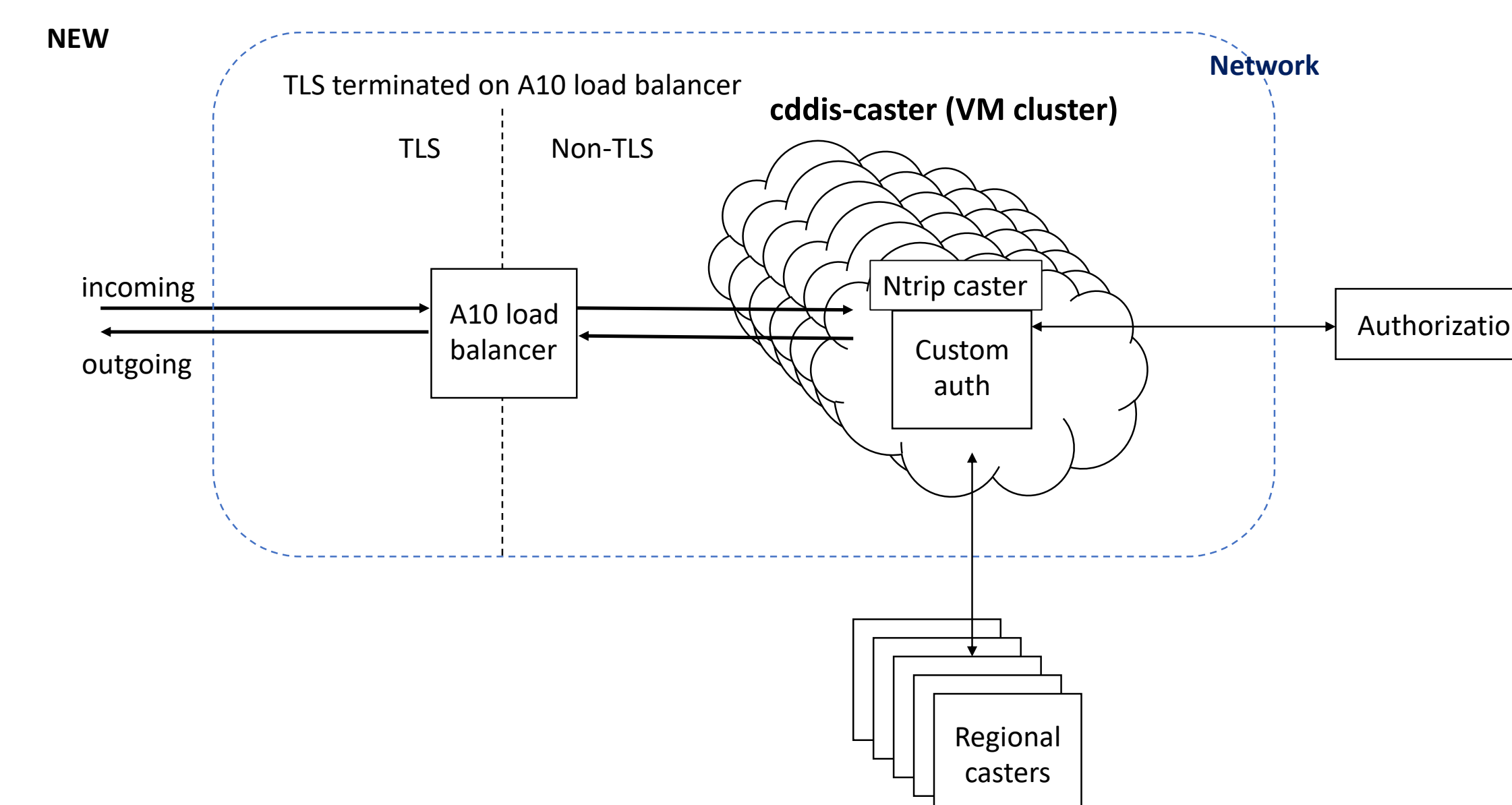

Figure 12 (above): Diagram illustrating the new system architecture for the CDDIS Caster Cluster

Resources & References

- The Crustal Dynamics Data and Information System (CDDIS):
  https://cddis.nasa.gov

- CDDIS's NASA Earthdata Webinar:
  GNSS Products at NASA's CDDIS for Disaster Monitoring, Crustal Deformation, Extreme Weather, and Other Applications

  NASA Making Earth System Data Records (ESDR) for Use in Research Environments (MEaSUREs) Extended Solid Earth Science ESDR System (ESESES) project, whose Global Navigation Satellite System (GNSS)-derived data products enable research on tectonic motion, crustal deformation, earthquakes, tsunamis, sea level rise, extreme weather, and more:
  https://www.earthdata.nasa.gov/learn/webinars-and-tutorials/webinar-cddis-gnss-2022-09-28

- CDDIS Presentations and Publications:
  https://cddis.nasa.gov/Publications/Presentations.html

- International GNSS Service Real-Time Service (IGS RTS):
  https://igs.org/rts/

- NASA Space Geodesy Project (SGP):
  https://space-geodesy.nasa.gov/index.html

- NASA SGP Goddard Geophysical and Astronomical Observatory (GGAO):
  https://space-geodesy.nasa.gov/NSGN/sites/GGAO/GGAO.html