PS05

Foundation CORS – The Backbone of the U.S. National Spatial Reference System

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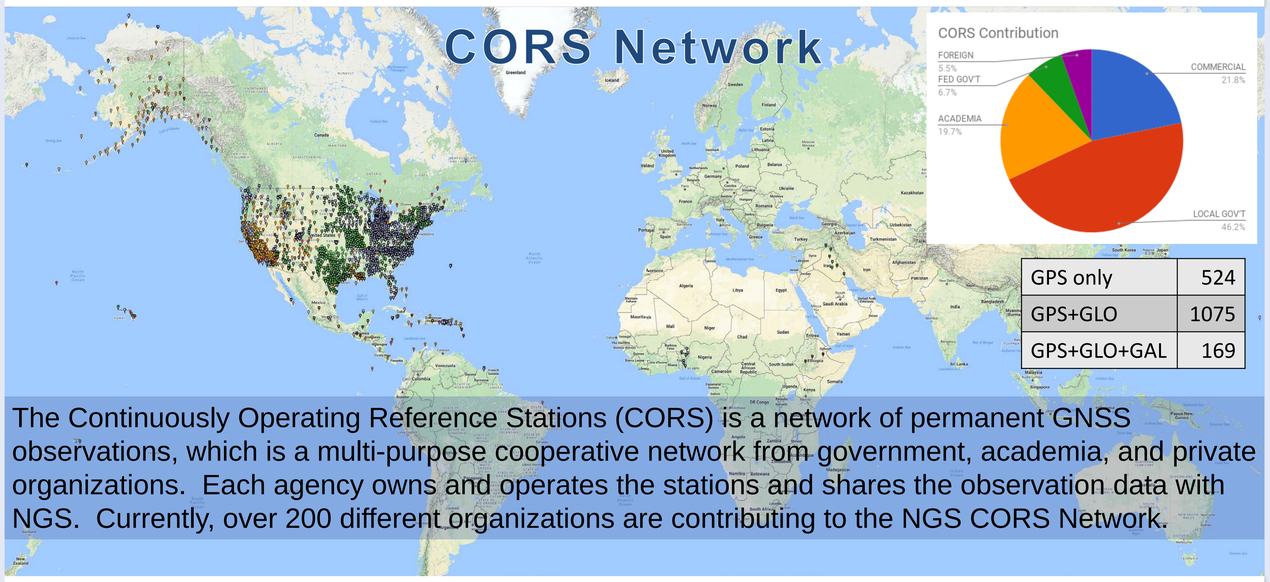
Background

Since 1994 NGS has fostered a collaborative network of permanently installed geodetic-grade GPS reference stations, known as Continuously Operating Reference Stations (CORS). The CORS is a multi-purpose cooperative network of GNSS observations collected from over 200 of government, academic, and private organizations. The primary objective of the CORS program is to enable GPS users to provide precise positioning relative to the NSRS. Each CORS shares its data with NGS, and NGS in turn analyzes and distributes the data to the general public free of charge.

Despite the large number of partner agencies and stations, the global reference frame stations in the US are limited due to density considerations and quality issues. In order to keep the long-term consistency with the ITRF and International GNSS Service (IGS) frames, it is desirable to maintain the reference frame sites with the highest standard.



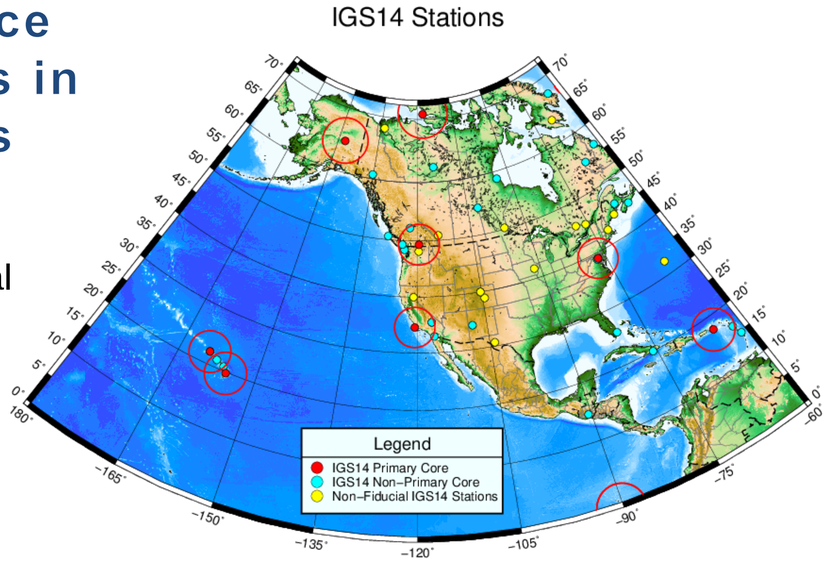
GPS only	524
GPS+GLO	1075
GPS+GLO+GAL	169

The Continuously Operating Reference Stations (CORS) is a network of permanent GNSS observations, which is a multi-purpose cooperative network from government, academia, and private organizations. Each agency owns and operates the stations and shares the observation data with NGS. Currently, over 200 different organizations are contributing to the NGS CORS Network.

CORS Socio-Economic Benefit

NGS Estimates of CORS Benefits, 2008 vs. 2017							
	2008			2017			
Service	Value per Download (2008)	CORS Data Downloads (2008) (thousands)	Total Value (billions of dollars)	Value per Download (2017)	CORS Data Downloads (2017) (thousands)	Total Value (billions of dollars)	
OPUS-RS	$ 500	72.2	0.04	$ 569	155.0	0.09	
OPUS-S	$ 500	182.1	0.09	$ 569	381.8	0.22	
UFCORS	$ 133	1,042.7	0.14	$ 151	1,303.6	0.20	
CORS FTP	$ 30	9,391.0	0.28	$ 34	59,262.3	2.02	
	Value per Upload	Database Uploads	Total Value	Value per Upload	Database Uploads	Total Value	
OPUS-Share	400	0.0	0.00	455.35	2.4	1.09	
TOTAL			0.55			2.53	

IGS14 Reference Frame Stations in U.S. Territories



To support international activities such as Global Geodetic Observing System (GGOS), ITRF, and IGS, as well as to ensure access to the National Spatial Reference System (NSRS), NGS has planned for the construction and/or adoption of a number of ultra-stable GNSS reference stations.

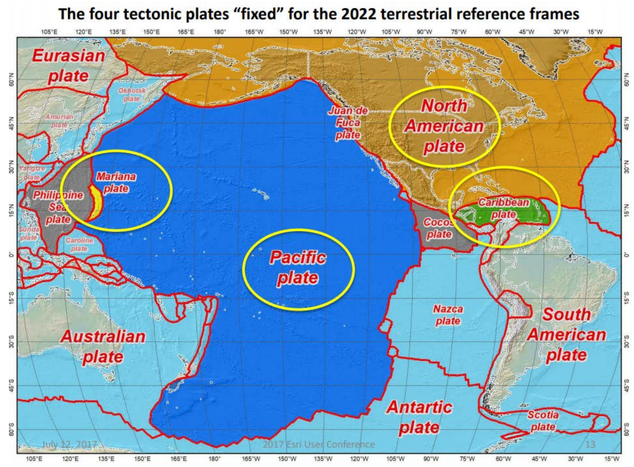
This subset of CORS stations will be called Foundation CORS and will become the **"Backbone of the NSRS."** These stations will contribute to densify ITRF stations in the U.S. Territories.

New National Spatial Reference System

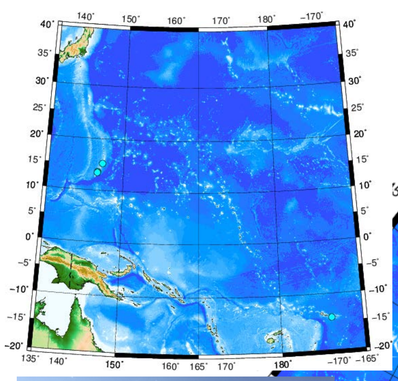
- Establish a backbone for the NGS CORS Program using an ultra-stable sub-network
- By 2022, the National Spatial Reference System (NSRS) will be modernized with CORS becoming a more foundational component.

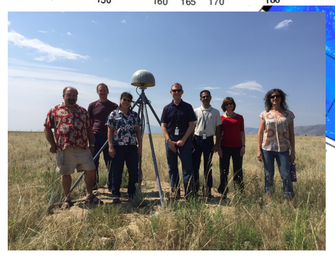
- NGS will continue to support the ITRF and GGOS activities through IGS reference sites.
- The NSRS will continue to be defined in relation to the ITRF (GGRF).

- Four Tectonic Plates to monitor:
  - NATRF2022 - North America
  - PATRF2022 - Pacific
  - CATRF2022 - Caribbean
  - MATRF2022 - Mariana

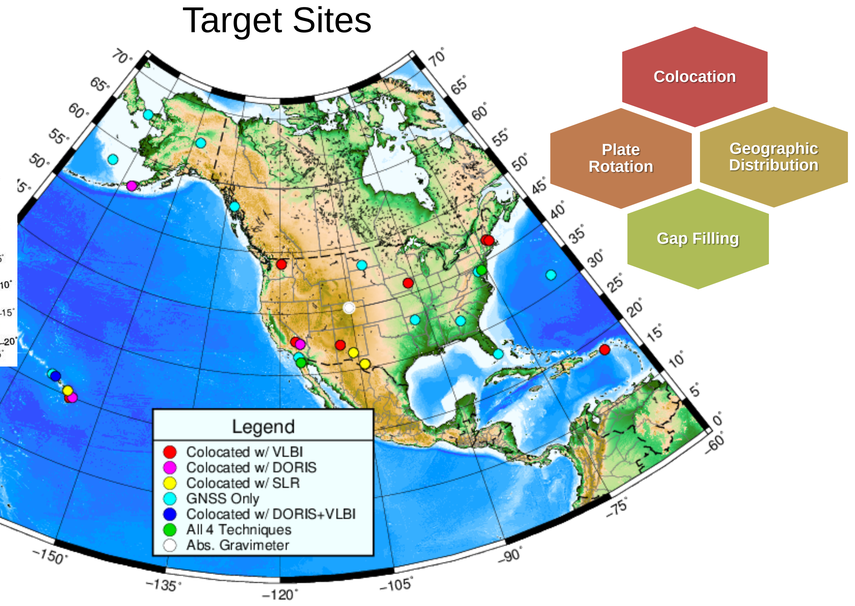


Foundation CORS Plan and Goals





Target Sites



# Sites	Status/Description
7	Current NGS Foundation CORS
8	New NGS Foundation CORS to build
1	Partner Foundation CORS to renovate (NASA- NLIB)
12	NASA-Operated Foundation CORS
6	NSF-Operated Foundation CORS
2	Other, non-federal partners
36	**Target Foundation CORS count**

OPERATIONAL GOALS

- Formal agreements signed with NASA and NSF for project support.
- All NGS-owned Foundation CORS are submitted to the IGS.
- Targeted Up-time:
  - → Network availability > 90 % at all times.
  - → Individual Station down time < 14 days
- Stations provide definitional support for the international frame and plate rotation model with densified ITRF stations.
- IERS site surveys are repeated on a 5-year cycle.

U.S. Federal Partners	Site ID	Location
National Science Foundation (NSF)	AB09	Wales, AK
	P777	Dennard, AR
Existing Sites	P804	Georgia
	AB51	Petersburg, AK
	ATQK	Atqasuk, AK
Program: Network of the Americas (NOTA)	P043	Wyoming
National Aeronautics and Space Administration (NASA)	CRO1	Saint Croix, VI*
	BREW	Brewster, WA*
	FAIR or GCGO	Fairbanks, AK
Existing Sites	GODE	Greenbelt, MD*
	GOL2	Goldstone, CA*
	MDO1	McDonald Observatory, Texas*
	MONP	Mount Laguna, CA*
Program: Global GNSS Network (GGN), operated by Jet Propulsion Laboratory	NLIB	North Liberty, IA*
	PIE1	Pie Town, NM*
	GUAM	GUAM
	KOKB	Kauai, HI*
	MKEA	Mauna Kea, HI*
	HAL1	Haleakala, HI*
NOAA- National Geodetic Survey (NGS)	ASPA	American Samoa
	CNMR	Saipan, TQ
	GUUG	GUAM*
Existing and New Sites	BRSG	Bermuda
	FLF1	Richmond, FL*
	WES2	Westford, MA*
	TMG2	Boulder, CO
	NEW	Apache Point, NM*
Program: Continuously Operating Reference Stations (CORS)	NEW	Fort Davis, TX*
	NEW	Fort Irwin, CA*
	NEW	Hancock, NH*
	NEW	Los Alamos, NM*
	NEW	Kitt Peak, AZ*
	NEW	Owens Valley, CA*
	NEW	Cold Bay, AK*
TBD	TBD	Existing location
	TBD	Existing location