program or resource can be expanded through a well-defined enhancement, NSF, NASA, USGS, and NOAA collaborations may augment core-funded program activities. Under its Cooperative Agreements, UNAVCO programs are first and foremost accountable to NSF’s Earth Sciences Division. Additional activities are sometimes funded through independent awards that are carefully coordinated with the cognizant NSF program officer to best serve the needs of the UNAVCO community and to optimize resources on behalf of the sponsor. For example, the PBO O&M Cooperative Agreement was augmented in 2009 to upgrade an additional 250 GPS sites in Cascadia to high-rate, low-latency capability with NSF-ARRA funding, thus leveraging the initial NSF investment in PBO. The plan also guides the GAGE Facility proposal in its goal of using resources freed by recently realized and planned efficiencies to respond to new initiatives. UNAVCO’s six Strategy and Actions, outlined in the Strategic Plan, are woven throughout sections 2, 3 of the Project Description and the Budget Plan of this document.

1.4 THE GAGE FACILITY

Until early 2012, guided by its two principal Cooperative Agreements, UNAVCO community research was supported by two UNAVCO programs that reflected our primary sponsors within NSF–EAR: the Plate Boundary Observatory and the UNAVCO Facility, funded by the EarthScope and Instrumentation & Facilities programs respectively. Under the PBO Cooperative Agreement, UNAVCO also accepted management responsibilities to sustain the San Andreas Fault Observatory at Depth (SAFOD) until NSF identifies a new organizational home. NSF–OPP Antarctic and Arctic Programs, and NASA also support the UNAVCO Facility Cooperative Agreement.

In anticipation of a single award for 2013 – 2018, UNAVCO undertook an internal reorganization to integrate activities that had been previously done in parallel, and to strategically and efficiently refine its community support and advisory committees (Figures 1-3, 1-4). The three new UNAVCO programs focus on: (1) the integration of observing systems and networks across techniques (Geodetic Infrastructure); (2) network data operations, enhanced community data products and cyberinfrastructure for data security, discovery and accessibility (Geodetic Data Services); and (3) education and outreach strategies, both within Education and Community Engagement, and integrated across the organization. Since 2008, UNAVCO’s mission statement has articulated its commitment to the full integration of research support and education, which will be fully realized in the synergies among related activities under a single GAGE Facility plan. As of mid-2012, the staffing and organizational stage of program reorganization is now complete, with minor ongoing refinements to ensure efficacy, and new plans to achieve realignment of community governance (i.e. our advisory committees) by 2013. Through its management strategies and practices, UNAVCO has built a reputation for responsive and innovative stewardship of public resources in support of community and sponsor priorities.

The GAGE Facility advances a broad geodesy community agenda, which includes:

- supporting EarthScope science as data sets mature with ongoing O&M and upgrades to the PBO Facility;
- improving data access and analysis with web services and cyberinfrastructure;
- meeting demand of burgeoning scientific applications for TLS technology and advancing community interests in LiDAR and InSAR data acquisition;
- expanding the use of autonomous integrated geodetic networks to new scientific targets, new geographic settings, and new science disciplines;
- influencing geodetic monument design and construction as well as open data protocols as GPS networks continue to proliferate around the world;
- broadening access to real-time GPS and ancillary data streams from core geodetic networks;
- bringing emerging data sets and technologies to the attention of investigators in research areas such as atmospheric science and hydrology; and
- focusing attention and resources on education and community engagement to link these initiatives to the broader public, to educators who are teaching the next generation of scientists and citizenry, and to groups that are historically underrepresented in the Earth sciences.

UNAVCO management and governance aspire to operate GAGE as a model for next-generation science facility support: enabling the science community to advance research and its broad impact, strategically, effectively, and efficiently, while exploiting the full range of innovation and

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1. The “Global Positioning System” (GPS), used throughout, relies on the US NAVSTAR satellite constellation for precise positioning applications. We restrict use of the more general term for all such constellations, “Global Navigation Satellite System” (GNSS) to specific activities (SpaceCC, Development and Testing) that are making early use of signals from other satellite constellations.
cyberinfrastructure solutions for investigator and community science.

This proposal identifies the infrastructure support needed to sustain the scientific inquiry of a diverse, vibrant, and growing community of investigators who use GPS, geodetic imaging, strain, and other geodesy technologies to study the solid Earth and its fluid envelopes (Table 1).

### 1.5 THE GEODESY TOOLBOX

For more than twenty years, the observation and understanding of Earth’s time-varying shape, gravity field, and rotation has benefitted from rapid technological advances that provide scientists with an unprecedented suite of tools to investigate these changes. The results include a wealth of applications for cutting-edge research in related scientific fields as well as many transformational applications in geophysics. These applications have far-reaching impact on advancing fields of knowledge such as earthquake physics, volcanology, geodynamics, oceanography, atmospheric and climate science, hydrology, glaciology, geomorphology, ecosystem science, physics, and astronomy. In addition to these research applications, geodesy is used to study natural hazards and is systematically building a foundation for rapid detection of earthquakes, tsunamis, landslides, volcanic eruptions, and severe storms. The UNAVCO Community Toolbox in the accompanying textbox highlights the technology used to advance our understanding of Earth processes with benefits for research, education, and society.

#### 1.6 STRATEGIC PARTNERSHIPS

UNAVCO’s mission and capabilities are unique, yet highly collaborative; all activities, sponsors, and many international partnerships. Given this breadth, there are many lenses that one could use to categorize UNAVCO partnerships. Fundamentally, as NSF’s Earth Science National Geodetic Facility, GAGE will sustain the coordinated presence for the geodesy community in its interactions both at home and abroad with shared and overlapping geoscience research and education goals (Figure 1-5).

At one end of the spectrum are some very practical and transactional relationships and peer to peer interactions that advance projects that are mission-critical and of mutual interest, either nearby or halfway around the world (e.g. executing international memoranda to sustain long-running geodetic instruments at specific sites, rebooting a telecommunications device at a GPS field station, or ensuring correct metadata for GPS and other observations). Activities such as these are critical to all aspects of geodesy, because the collection and stewardship of long-term geodetic observations is essential to nearly all studies of global change. At the other end of the spectrum and equally critical, lie intricate multi-national activities, which include geodesists at universities, agencies, and projects around the world, who collaborate under the umbrella of the International GNSS Service (IGS) to develop

![Figure 1-5. UNAVCO Partnerships](image-url)