

**Interim Report of the UNAVCO Facility Standing Committee
Delivered to the UNAVCO Board of Directors**

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Members of the Facility Standing Committee

Tim Dixon (Chair)

Tim Ahern

Glen Mattioli

Simon McClusky

Carol Raymond

Jeanne Sauber

Charge to the Committee: The formal charge to the committee can be viewed at <http://www.UNAVCO.org/community/governance/committees/Fac-Stand-Comm-Charge.html>. Briefly, the Facilities Standing Committee (FSC) is charged with reviewing all aspects of UNAVCO's infrastructure, including its physical plant, hardware, software, personnel, and budget, to insure that UNAVCO can meet the current and future scientific needs of its members in the general area of high precision geodesy.

Format of this Report: The FSC was asked to address a series of issues and specific questions relative to each of the major groups at UNAVCO, as well as some general questions. These questions came both from personnel at UNAVCO as well as the community. In the future, we need to give the community more opportunities for this kind of input, perhaps by an email survey. The questions or issues are listed below, followed by our response.

Data Group Issues

Is UNAVCO's data archive facility meeting the needs of the community?

UNAVCO has long maintained an archive of campaign-based, episodic GPS data (EGPS) from around the world, and is recognized in the space geodesy community as one of the world's primary archives for such data. With the initiation of Earthscope, UNAVCO will play an increasing role in the archiving of continuous GPS (CGPS) data, as well as other types of geodetic data. Other groups operating GPS data archives in the US include NASA (CDDIS), archiving global CGPS data; NOAA (CORS), archiving domestic CGPS data; and the Scripps Orbit and Permanent Array Center (SOPAC) archiving both domestic and global CGPS data. No facility currently archives all available EGPS and CGPS data.

In 2004, UNAVCO was selected by NSF and Earthscope as the primary archive for PBO geodetic data. UNAVCO also directly manages a backup up archiving and distribution system physically located at the IRIS Data Management Center in Seattle in order to provide a fully functional offsite backup facility. The FSC was asked to evaluate not

only UNAVCO's ability to provide for the archival needs of the PBO community, but also the broader needs of its members, who conduct global research, and hence require access to global data. PBO also benefits from access to global data, as it is important for orbit and reference frame refinement. For example, the geodetic reference frame for Earthscope (SNARF) depends on availability of data across North America, some of which are not currently archived at UNAVCO.

The primary function of an archive is to insure the long-term availability of data. While it is difficult to plan for all contingencies, it is reasonable to require that an archive commit to assuring the availability and integrity of its data for many decades. In this regard, consortia-style institutions like UNAVCO and IRIS are better suited to archiving than are universities or individual investigators. University priorities can change, and individuals may retire or move on to other projects.

It is instructive to recall that the seismological community went through a transition two decades ago, with the initiation of IRIS as the primary archiving institution for global network data, regional network data, and PI-driven "campaign" seismic data, largely replacing individual PI and university archives. There is a strong analogy here for UNAVCO, which we believe will play an increasing role in archiving all types of geodetic data, not just GPS, as discussed in more detail below.

Thus, the FSC believes that Earthscope's decision to make UNAVCO the primary archive for PBO GPS data with a UNAVCO managed back-up at IRIS is reasonable. However, we note that UNAVCO will have to upgrade some aspects of its archiving functions if it is to achieve the level of performance the community requires for analysis of large networks of CGPS stations. This includes provision for rapid dissemination of large volumes of data to users in an automated manner. A robust, high bandwidth, near real time data delivery system at UNAVCO will require some development. The committee recommends that UNAVCO devote the resources needed to manage global geodetic data of all types, including EGPS and CGPS, as well as other types of geodetic data.

Summary recommendation: The FSC recommends that UNAVCO make it a top priority to expand its archiving capability. The long term goal should be to provide a "full service" archive, to hold all available CGPS and EGPS data from anywhere in the world, other geodetic data and metadata as appropriate, and to make these data available on line in near-real time to any investigator.

This is our highest priority recommendation. We recognize that this may take additional resources, and therefore recommend that these resources be requested in the next Facility proposal, and also from the Earthscope project.

The FSC also suggests that UNAVCO should:

- 1) develop improved data discovery tools, recognizing that major changes may require resources that are not currently available. A high priority should be

- improved search tools for the UNAVCO web site, e.g., to find and download data by 4-char ID, by region, by data type, or by epoch.
- 2) archive InSAR data, and foster the use of InSAR data, e.g., by providing courses in the use of InSAR.
 - 3) archive tilt and strainmeter data, and foster the use of these data, e.g., by providing courses in their use. This should be coordinated with existing EarthScope strainmeter data archiving at IRIS and NCEDC. The formats to store and export these data and associated metadata are currently under discussion. UNAVCO is encouraged to take the lead at developing and publishing these standards, as well as the tools for converting data from commonly deployed instruments into such a device independent format, analogous to the TEQC approach for GPS data.

Given the likelihood of limited resources, prioritizing these tasks is important (the above list is not prioritized). This could be done by a sub-committee appointed by the Board, or be designated as a future task for the FSC.

Should UNAVCO provide processing capability or solutions?

The committee felt that UNAVCO should not provide GPS processing solutions at this time, as it duplicates activities that are already done (and done reasonably well) at universities. However, a processing service for campaign data might be beneficial for certain users who elect not to be involved in the details of GPS data processing. This could be included in the next facility proposal, for peer-review evaluation.

One related contribution that UNAVCO could make is to provide courses in GPS and InSAR processing software and techniques. For InSAR, UNAVCO could collaborate with JPL by making the Boulder facility available for courses in the publicly available ROI_PAC software. The committee notes that despite the public availability of several software packages for analysis of GPS and INSAR, the complexity of these packages and the lack of support for their implementation on certain computing platforms can make their use difficult and time consuming, especially for new users. UNAVCO could play an important role as a clearing house for these issues, providing technical support for analysis much as it does for GPS hardware. A poll of member representatives or a larger community might be useful to assess the need for such services.

How should UNAVCO proceed with GSAC (GPS Seamless Archive Center)?

GSAC was meant to be a software package that would allow a user logging into UNAVCO's archive to seamlessly acquire data, no matter where that data was physically located. GSAC was conceived in the mid-1990's when a number of institutions maintained partial archives of GPS data. GSAC has both data discovery and data retrieval functions.

Development of the software has been funded by NSF and NASA at the level of roughly \$100K per year for most of the last decade. At the present time more than \$600K has

been spent in-house and on external contracts on the development of this software package. We polled a number of GPS users, and found that very few currently use GSAC. This may reflect the fact that many users have automated processing scripts that can reliably retrieve data from one or two archives, but may have trouble with the GSAC approach to data retrieval. The data discovery aspect of GSAC remains a useful tool.

One philosophical problem with GSAC is that it assumes a long-term commitment from the various “players” towards the archiving activity. However, even government agencies may lose funding for certain activities or change missions or priorities. For example, NASA may in the future reduce its commitment to Earth Sciences, as funding is re-directed towards sending humans to Mars. This could impact its long term viability as a GSAC node. It is particularly challenging to insure that international groups agree to maintain the necessary long term commitments, not only to the basic idea of archive-sharing, but also such practical things as formats, access protocols, etc.

For these reasons, the committee did not endorse further efforts to promote the data retrieval aspects of GSAC (the data discovery aspect of GSAC should be further considered). Resources should be re-directed to in-house archiving and development of data discovery/distribution tools (the data discovery aspect of GSAC could probably be folded into this activity). This is the best way that the UNAVCO community can insure long-term data integrity and reliable data access.

Should UNAVCO routinely archive high-rate (1 Hz) GPS data?

The committee did not endorse an effort to routinely archive high-rate data at this time. While we recognize the potential importance of these data, we are concerned with the high cost of archiving this volume of data, and note that the scientific applications of these data are still being developed. The Facility could consider providing a large ring buffer to store data for a period long enough that decisions about archiving specific subsets of data could be made (at the present time the major application of these data relate to strong ground motion after major earthquakes). The UNAVCO Board should consider appointing a sub-committee to further consider the cost versus benefits of near-line versus offline storage of high rate data and data buffering. Since the seismological community may be major users of 1 Hz data, this sub-committee should include at least one strong-ground motion expert. In addition, this sub-committee should consider development of linkages between UNAVCO and IRIS to better exploit 1 Hz data, to assess cost-effective strategies for its use and archiving, and to manage large volume datasets.

Future Tasks for the FSC:

Assist UNAVCO in obtaining the resources to expand its overall archiving capability. Assist UNAVCO in obtaining access to data by contacting data providers as needed and encouraging their cooperation. “Problem providers” may need to be “nudged”, first by the committee, next by NSF or other program managers. For US investigators, NSF program managers can remind investigators that a condition of their original funding was that all GPS data acquired as a result of their research would be archived at UNAVCO.

Engineering and Equipment Group Issues

Facility Pool Issues:

What is the best use of ~\$100K for new pool equipment in 2005?

What is the best use of 43 older generation receivers that are still in the equipment pool (4000 series Trimbles)?

What is the appropriate size for a dedicated emergency equipment pool? What are the ground rules for deployment of such a pool?

What is the appropriate number of kinematic or RTK units for the pool?

The FSC was satisfied that existing plans developed by UNAVCO personnel reflect a good use of these resources, and preferred not to “micromanage” these issues.

Agent Agreement Issue:

The UNAVCO Agent Agreement that accompanies the use of UNAVCO Pool Equipment is currently under revision. A concern had been raised about “unbounded” commitment to PI’s that will hopefully be addressed by this new agreement.

The FSC suggested looking at the IRIS policy for similar language. This has been done and a revised Agent Agreement is available for review.

Community Equipment Purchase Issues:

Centralized vs. distributed equipment pool – have price reductions changed the basic paradigm (centralized pool at UNAVCO)?

What is the appropriate level of technical support and maintenance for receivers purchased by community members?

How does UNAVCO decide what configurations are supported?

The committee recognized that given recent price reductions for GPS equipment, more and more members are purchasing their own receivers, augmenting what is available from the community pool. UNAVCO support for this community equipment constitutes a very important service to the community. At the same time, UNAVCO cannot be expected to maintain expertise in all possible equipment types and configurations. We recommend that UNAVCO maintain expertise and provide technical support for a reasonable number of the most common receiver types and configurations, and state clearly what these are, so that member purchases can be guided accordingly.

The support and maintenance of a distributed receiver pool will increase the importance and visibility of the UNAVCO technical support group, and is a good way for UNAVCO to “get the message out.” We recommend that additional resources be allocated here as appropriate. UNAVCO has internal review mechanisms in place for on-going assessment of these and related issues.

General Issues Related to Support and Planning

EAR University PI Projects Issues:

UNAVCO has limited visibility into future projects, which makes long term planning difficult. What can be done about this?

The FSC does not have a good answer to this, beyond noting that short lead times are typical for many small, PI-driven scientific projects. Maintaining visibility at national meetings and maintaining informal contacts with potential PI's (which UNAVCO already does quite well) are probably the best that can be done. More draconian measures, e.g., requiring pre-proposals for all GPS-related projects, would probably be counter-productive, as they severely limit projects of opportunity and could limit innovative research; the FSC would not support such measures.

The IRIS example may be instructive. Panels make their funding decisions for funding individual experiments based on the science and then contact PASSCAL to determine when IRIS can provide the required number of instruments. The FSC will recommend to NSF that they involve UNAVCO personnel more closely in the proposal process, notifying UNAVCO shortly after proposals have been selected, to facilitate appropriate planning. Notification any earlier in the process would probably not be productive, with the possible exception of very large projects which would have a large impact on UNAVCO resources.

We also recommend that a statement regarding UNAVCO resources and capabilities be included in all relevant NSF and NASA Research Announcements. UNAVCO will draft such a statement, and the FSC will ask EAR and OPP program managers to include it in their program solicitations.

The committee recognizes the problem of highly variable levels of effort required by UNAVCO personnel because of non-uniform project initiation and implementation. The committee suggests that enhanced flexibility to deal with this issue could be obtained by having some UNAVCO personnel trained in several areas (e.g., archiving and technical support). These personnel could then be assigned appropriately as the situation demands. UNAVCO already has some of this flexibility, and we endorse further efforts in this area.

There is often pressure from sponsors to justify UNAVCO funding on project-by-project basis. This puts excessive administrative burden on personnel. What is the appropriate response?

The FSC recognizes that there is significant value in having resources available to the community regardless of specific funding sources (within certain limits). This is an excellent way to encourage young investigators, who may not have large resources available to them at the early stages of a project, and will help develop a larger community of users.

The FSC believes it is counterproductive to attempt to justify UNAVCO's funding level on a project by project basis. This would constitute an inappropriate level of micro-management, and if fully implemented, would require a large increase in paperwork and non-productive activity, taking UNAVCO personnel away from more important tasks. Critical UNAVCO activities such as archiving clearly cannot be accounted for on a project-by-project basis.

Should UNAVCO be concerned that some PIs work independent of UNAVCO despite available resources?

No. There is a large range of abilities and expectations in the scientific community, and some PI's will always prefer to "go it alone". UNAVCO only needs to verify that a copy of the resulting data is sent to its archive.

PBO Nucleus Issues:

What should be the level of support for stations that are not included in the PBO Nucleus?

What is the best use of receivers being swapped out of Nucleus stations and returned to owners or to UNAVCO?

What is the best use of Zephyr geodetic antennas that came bundled with NetRS receivers, but are not being used at the Nucleus stations?

The FSC deferred to the Facility's better judgment on these issues. It was suggested that UNAVCO remain aware of who may have GPS receivers available and inform interested parties of possibilities for obtaining receivers within the community. Zephyr antennas will likely be used for many volcano monitoring applications, where they may have a high fatality rate. Having a pool of free replacement antennas would therefore be very useful to the UNAVCO community.

PBO Campaign Issues:

How do we motivate the community to propose new projects, given the limited funding available through Earthscope?

How do we ensure maximum use of available resources?

How do we minimize problems associated with use of new equipment?

The FSC recognized that these issues are important, but does not feel it has special expertise or solutions to address these problems. We therefore do not make any specific recommendation at this time.

Geo-PBO Issues:

What should UNAVCO's role be in various Geo-PBO projects, e.g., LIDAR

The LIDAR example was discussed, but no consensus was reached. We will address this at our next meeting, after soliciting members' comments.

NSF Office of Polar Programs (OPP) Issues:

OPP continues to add resources to UNAVCO. OPP currently owns 55 GPS receivers, covers 2.5 staff members, and supports technology development. With this support, UNAVCO is developing capabilities for GPS networks in remote and polar regions. Can the committee advise on any organizational or technical issues that should be addressed?

The FSC recognizes benefits and is supportive of continued involvement with OPP activities. We note that development of remote power options such as wind power for extended operation in areas where solar panels will not work would be beneficial for many users.

NASA Issues

GGN and IGS are fundamental to many scientific GPS activities. In the past these activities have been funded by NASA, NOAA, and key host countries, especially in western Europe. In the future NASA funding in particular cannot be guaranteed for operation of these facilities, which are crucial to GPS science. In addition, infrastructure upgrades will be required to maintain basic data services and to keep up with new technology.

What kind of major infrastructure upgrades will likely be needed, and who should support them? What should UNAVCO's role be in supporting global GPS tracking?

The FSC recognizes the importance of UNAVCO's continued involvement in operating this important infrastructure, and shares the concern about potential uncertainties in future NASA support for this activity.

Decisions on the nature of appropriate upgrades for global tracking stations are best left to IGS committees. However, we believe that UNAVCO should actively provide technical support for these activities, where appropriate, and should also play a pro-active role at recommending an appropriate level of financial support from the US scientific community for IGS-related activities (IGS itself has no funds, and relies on various national organizations to provide support for their stations). UNAVCO should maintain a presence on IGS committees to facilitate the necessary coordination. As NASA support for IGS declines, it will be critical to maintain a level of US funding, which presumably means that NSF will have to step in. This support could take the form of UNAVCO support for key stations in the global tracking network, in the continental US and US overseas possessions, and also in selected third world countries where local resources are insufficient. This is another example of where UNAVCO activity cannot be parsed on a project-by-project basis.

NASA currently does not support UNAVCO for individual NASA PI projects. What should be done?

The FSCC supports continued help on a best effort basis for several NASA-funded legacy projects under the umbrella of "community support". It is unlikely that individual PI GPS solid earth science projects will be funded by NASA in the future, as this agency

re-directs support to other activities, hence this kind of activity should decline in the near future. On the other hand it is possible that mission calibration/validation activities may be proposed. In the event of future new projects requiring UNAVCO support, the FSC will request the appropriate level of support for UNAVCO from NASA, after consultation with UNAVCO.

Other Short term issues (FY 05). NSF will conduct a mid-project review of UNAVCO's implementation of the Facility and Community Cooperative Agreement, tentatively scheduled for August, 2005. The FSC will participate in this review. Prior to the review, the FSC in conjunction with the UNAVCO Board will provide a mechanism for community input into the review, and coordinate UNAVCO's response to specific issues that come up during the review.

Short term issues (FY 06). UNAVCO must submit a new proposal to NSF for continued facility support in FY 06. The FSC will play a key role in preparing this proposal, including assessment of community needs, development of new strategic plans and corresponding budget, and incorporation of scientific contributions of the community that involved UNAVCO input. In particular, UNAVCO must document refereed publications related to GPS activities by NSF investigators for the FY 06 proposal. The FSC will help the facility put this list together. Graduate student training by NSF investigators would also be a useful statistics to compile.