PROJECT POLARIS: A STATUS REPORT

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ABSTRACT

Under project Polaris, NOAA's National Ocean Survey/National Geodetic Survey (NOS/NGS), in close cooperation with the National Aeronautics and Space Administration (NASA), is establishing a network of three observatories that will utilize interferometric observations of extragalactic radio sources to regularly monitor polar motion and UT1.

The sites will be: The Harvard Radio Astronomy Station (HRAS), near Ft. Davis, Texas; the Westford Observatory, near Boston, Massachusetts; and the U.S. Naval Observatory Time Service substation, near Richmond, Florida. Present activities are focused primarily on the upgrading and equipping of the HRAS facilities, which are expected to be in limited operation by the end of 1979. Present planning is for the Polaris network to become fully operational about 1983.

INTRODUCTION

Polaris is an acronym formed from POLar-motion Analysis by Radio Interferometric Surveying. Under project Polaris, the National Ocean Survey/National Geodetic Survey (NOS/NGS), in close cooperation with the National Aeronautics and Space Administration (NASA), is establishing a network of three observatories that will utilize radio interferometric observations of extragalactic radio sources to regularly monitor polar motion and UT1.

The project was proposed by the author in 1977 to meet the newly developing demands for higher resolution and accuracy polar motion and Earth rotation data to support modern geodynamic studies. The basis for the selection of radio interferometry, rather than lunar or artificial satellite laser ranging or Doppler satellite tracking, has been reviewed in Carter and Strange (1979) and Carter (1979).

As NOS/NGS developed the Polaris project plan more fully and began to explore various options for its implementation, it became apparent that close cooperation between NOS/NGS and NASA would be beneficial to both agencies. The NASA mission to develop and demonstrate applications of space-related technology and to transfer that technology to operational agencies for application to their mission meshed well with the NOS/NGS Polaris plans. A joint work group was formed. The membership quickly increased to include six organizations: the National Oceanic and Atmospheric Administration (NOAA), NASA, U.S. Naval Observatory, Defense Mapping Agency, National Science Foundation, and the U.S. Geological Survey. They produced a document entitled "Interagency Coordination Plan for Development and Applications of Astronomic Radio Interferometry for Geophysical Sciences" (1978). This document sets out the roles, missions, and plans of the participating agencies.

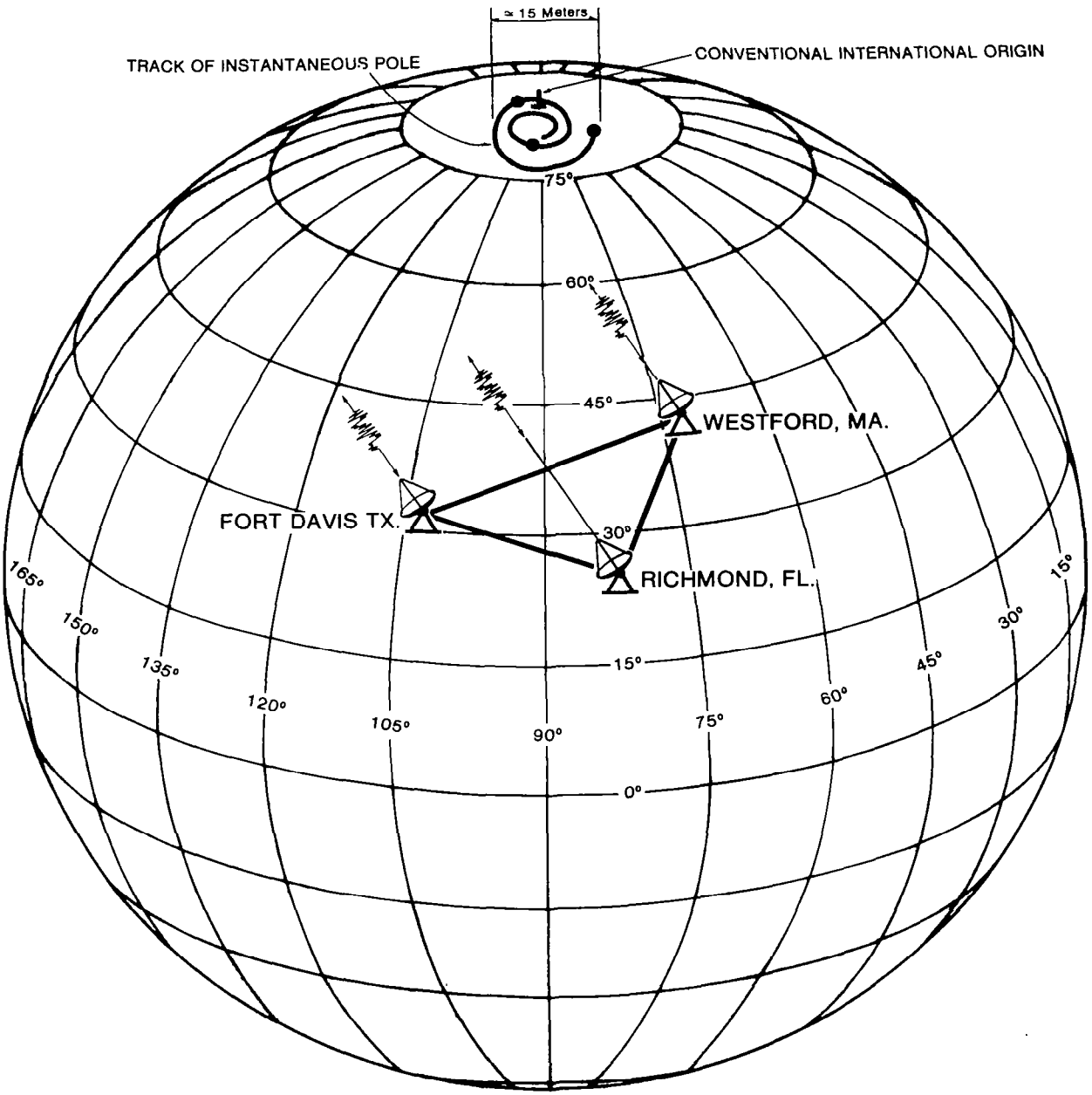
THE NETWORK

A minimum of three stations is required to monitor both components of polar motion and UT1 by radio interferometry. Network design criteria include: costs of establishing and operating the network; geometrical strength and stability of candidate networks; potential for multiple users of the facilities; bureaucratic and political appeal.

The sites selected for the Polaris network are (see figure 1):

1. The Harvard Radio Astronomy Station (HRAS) located near Ft. Davis, Texas.
2. The Westford Observatory located in the Haystack Radio Observatory complex near Boston, Massachusetts.
3. The U.S. Naval Observatory Time Service Substation at Richmond, Florida.

The cost of establishing the network will be kept relatively low by using the existing facilities at HRAS and Westford. These facilities can be upgraded to meet the Polaris performance specifications without the necessity of establishing new sites. The cost of maintaining and operating the



POLARIS

POLar-motion Analysis by Radio Interferometric Surveying

Figure 1.

network will be minimized by "time sharing" the facilities and the operating personnel. Costly duplication of facilities to meet the overlapping requirements of multiple agencies will be eliminated.

According to computer simulations the HRAS-Westford-Richmond network will be capable of determining both components of polar motion to ±10 cm and UT1 to ±0.1 millisecond in an observational period of about 8 hours. Better geometrical configurations can be postulated, but the predicted advantages in performance are offset by increased costs and a greater likelihood of degradation resulting from local, regional, and plate instabilities. The three selected sites are all located in reasonably quiet seismic zones away from the edges of the North American Plate.

NASA already had plans to use HRAS in their research activities. One of the important missions of the U.S. Naval Observatory is the determination and transfer of time. That work will benefit from the development of the Richmond Polaris facility.

PRESENT STATUS OF EACH STATION

The NOS/NGS has negotiated a long term user agreement with Harvard University to use the HRAS facilities. NOS/NGS, NASA, and Harvard Observatory have jointly formulated plans to upgrade the 27-meter prime focus, equatorially mounted telescope to meet the Polaris performance specifications. Engineers from the three organizations are cooperating in this effort. A Mark III very long base line interferometry (VLBI) Data Acquisition System is under construction. Initial test observations at HRAS are scheduled for the last quarter of 1979 into early 1980.

The NOS/NGS and the U.S. Air Force have reached broad agreement on the long term use of the Westford facilities. The Northeast Radio Observatory Corporation has submitted a detailed plan to upgrade the 17-meter, Cassegrain focus, altitude-azimuth mounted telescope. Work should begin on the long-lead time items during this fiscal year. Present plans indicate that the remaining items will be completed during FY 80, and that the site will be ready for initial testing by early 1981. The site will still be heavily dependent upon joint usage of certain Haystack Observatory facilities, such as the hydrogen maser frequency standard, until additional funds can be allocated.

The Carnegie Institute of Washington has agreed to donate a 17-meter, prime focus, equatorial mounted telescope to NOS/NGS. This instrument, now located in Rockville, Maryland, will be relocated in Richmond, Florida. Dismantling of the telescope should be completed this summer, and we hope to re-erect it in Richmond during 1980. The telescope is essentially a smaller aperture version of the HRAS telescope and will require many of the same upgrades. We plan to complete the Richmond station in 1981 and begin full-scale testing of the Polaris network in 1982.

DATA PROCESSING AND ANALYSIS

During the testing and initial operational stages of the project, the Haystack Mark III correlator should have adequate capacity to handle the Polaris observational tapes with a reasonable lag time. NOS/NGS recently purchased an F model Hewlett Packard 21 MX mini-computer to replace the older slower machine that has been limiting the performance of the correlator. The new machine will allow the tapes from three stations to be processed through the correlator in about the same span of time as the observational period. Higher capacity disk storage was also added to the correlator.

NASA Goddard Space Flight Center (GSFC) has been developing a mini-computer based data processing and analyzing system for this project. The central processing unit (CPU) is a Hewlett Packard 21 MX Computer (Carter et al., 1978). NOS/NGS personnel have been assisting in developing a new software package and have used the GSFC facilities to analyze Mark I data (Robertson et al., 1978; Robertson et al., 1979). The NOS/NGS expects to have its own processing system operational at NOAA Headquarters in Rockville, Maryland, by the end of 1980.

CONCLUDING REMARKS

The predicted performance of the Polaris system represents an improvement of a full order of magnitude over our present operational systems. The goals are well within our technological capabilities. Providing that the necessary resources are obtained, as detailed in this paper, we believe that full operational status could be attained within the 1982-83 timeframe.

REFERENCES

Carter, W. E. and Strange, W. E., 1979: The National Geodetic Survey Project POLARIS. In: C. A. Whitten, R. Green, and B. K. Meade (Editors). Recent Crustal Movements 1977. Tectonophysics, 52:39–46.

Carter, W. E., 1979: Modern Methods for the Determination of Polar Motion and UT1. Proceedings of the Tenth Annual Precise Time and Time Interval (PTTI) Applications and Planning Meeting, Washington, D.C., November 1978. NASA Technical Memorandum 80250, Goddard Space Flight Center, Greenbelt, Maryland 20771.

Robertson, D. S., Carter, W. E., Corey, B. E., Cotton, W. C., Counselman, C. C., Shapiro, I. I., Whittels, J. J., Hinteregger, H. F., Knight, C. A., Rogers, A. E. E., Whitney, A. R., Ryan, J. W., Clark, T. A., Gater, R. J., Ma, C., and Moran, J. M., 1978: Recent Results of Radio Interferometric Determinations of a Transcontinental Baseline, Polar Motion and Earth Rotation. IAU Symposium No. 82, Cadiz, Spain. In: McCarthy, D. D., and J. D. H. Pilkington (Editors), Time and the Earth's Rotation.

Robertson, D. S., Clark, T. A., Coates, R. J., Ma, C., Ryan, J. W., Corey, B. E., Counselman, C. C., King, R. W., Shapiro, I. I., Hinteregger, H. F., Knight, C. A., Rogers, A. E. E., Whitney, A. R., Pigg, J. C., and Schupler, B. R., 1979: Polar Motion and UT1 Comparisons of VLBI, Lunar Laser, Satellite Laser, Satellite Doppler, and Conventional Astrometric Determinations; Presented at MIT and NEROC Haystack Observatory Conference on Radio Interferometry Techniques for Geodesy, June 18-22, 1979; Boston.