PROPOSAL COVER PAGE

(Date : Nov 11, 2002)

REASON-0156-0039

Name of Submitting Institution: Jet Propulsion Laboratory **Congressional District:** 27

Certification of Compliance with Applicable Executive Orders and U.S. Code

By submitting the proposal identified in this Cover Sheet/Proposal Summary in response to this Research Announcement, the Authorizing Official of the proposing institution (or the individual proposer if there is no proposing institution) as identified below:
· certifies that the statements made in this proposal are true and complete to the best of his/her knowledge;
· agrees to accept the obligations to comply with NASA award terms and conditions if an award is made as a result of this proposal; and
· confirms compliance with all provisions, rules, and stipulations set forth in the two Certifications contained in this NRA [namely, (i) Assurance of Compliance with the NASA Regulations Pursuant to Nondiscrimination in Federally Assisted Programs, and (ii) Certifications, Disclosures, And Assurances Regarding Lobbying and Debarment & Suspension]. Willful provision of false information in this proposal and/or its supporting documents, or in reports required under an ensuing award, is a criminal offense (U.S. Code, Title 18, Section 1001).

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[3] ... Proposal Title (Short and/or Full)

Short Title:	GPS Data Products for Solid Earth Science
Full Title:	GPS Data Products for Solid Earth Science Research and Applications

[4] ... Proposed Start/End Date

Start Date:	02/01/2003

End Date:	09/30/2007

[5] ... Science Areas

Applications/Type I
Research

[6] ... Summary

Over the past decade, regional and global networks of continuously operating Global Positioning System (GPS) ground stations have been developed and deployed around the globe that support NASA Solid Earth Science priorities and ESE flight projects. The primary objective of many of these networks is for understanding the deformations of the solid earth in tectonically and volcanically active regions. The networks provide raw GPS observables that are then used by a relatively small community of power users capable of analyzing the raw data for geophysically meaningful signals. In order to expand the utility of these GPS networks, we propose to provide data and higher level data products to scientists, local governments, and surveyors from the GPS networks in western North America.

The focus of the project will be on the Southern California Integrated GPS Network (SCIGN), a multiagency project that was jointly sponsored by NASA, NSF, USGS, and the WM Keck Foundation for the study of earthquake hazards in southern California. Over the next five years, SCIGN will transition from a standalone project to an integral part of the multi-agency and multi-disiplenary NSF-lead Plate Boundary Observatory (PBO), a distributed observatory of high-precision geodetic instruments covering western North America, scheduled for installation beginning in 2003. PBO is part of the NSF EarthScope initiative and will serve a broader comunity of scientists, government agencies, and surveyors than SCIGN does now.

To deliver these data products to the different user communities that these networks serve, this project will build on current capabilities within SCIGN for analysis, verification, validation, and information systems, and disseminate the following data products: geodetic time series, deformation velocity fields, strain rate maps, fault models, near-real-time earthquake response information, surveying support and reference systems, and aquifer recharge monitoring. As SCIGN transitions into PBO towards the end of the proposed 5-year CA, these products will be transistioned and integrated into the PBO data system.

The specifications of the data products will be developed through existing contacts with the following organizations: PBO/UNAVCO, SCEC, CSRC, TriNet, and the SCIGN Science Advisory Council, and through participation in the SEEDS Technology Infusion working group. All the products will be archived and made publicly available via a SEEDS compliant data system and web interface.

[7] ... Budget

Continue

Edit Proposal Information

GPS Data Products for Solid Earth Science

NASA Cooperative Agreement (CAN)

CAN-02-OES-01

Earth Science Research, Education and Applications Solutions Network (REASoN)

Notices of Intent Due: November 1, 2002

Proposals Due: November 26, 2002

Transmittal Letter

Note to Proposers: You do not need to prepare a transmittal letter. When your final proposal has been submitted to Karen Piggee (x4-9154), Karen will prepare this letter.

PROPOSAL COVER PAGE

TWO proposal cover pages are required as part of the proposal.

The first is a **hard copy** (see the CAN for instructions on how to acquire the proposal hardcopy from the online system) which must be signed by the Principal Investigator and an official by title of the investigator's organization who is authorized to commit the organization. This authorizing signature also certifies that the proposing institution has read and is in compliance with the required certifications printed in full, therefore, these certifications do not need to be submitted separately. This page will not be counted against the page limit of the proposal.

The second proposal cover page must be submitted **electronically** to the SYS-EYFUS Web site located at **http://proposals.hq.nasa.gov/**. If the respondent has submitted an electronic Notice of Intent (Appendix E) to SYS-EYFUS, the same user UserID and password can be used to complete the electronic proposal cover page. If the respondent obtained a User ID and password in the process of submitting a proposal for a previous research opportunity announcement, the same user UserID and password can be used to complete the electronic proposal cover page in response to this research opportunity announcement. Be sure to click on "Edit Personal Information" if any of your correspondence information in SYS-EYFUS is not current.

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- Click the hyperlink for **new user, which** will take you to the Personal Information Search Page.
- Enter your first and last name. SYS-EYFUS will **search** for your record information in the SYS-EYFUS database.
- Confirm your personal information by **choosing** the record displayed.
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Respondents without access to the Web or who experience difficulty in using this site may contact the Help Desk at proposals@hq.nasa.gov (or call 202.479.9376) for assistance. After you have submitted your notice of intent or proposal cover page electronically, if you are unsure if it has been successfully submitted, do not re-submit. Please call the Help Desk. They will be able to promptly tell you if your submission has been received. Please note that submission of the electronic cover page does not satisfy the deadline for proposal submission.

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1.0 ABSTRACT

Over the past decade, regional and global networks of continuously operating Global Positioning System (GPS) ground stations have been developed and deployed around the globe that support NASA Solid Earth Science priorities and ESE flight projects. The primary objective of many of these networks is for understanding the deformations of the solid earth in tectonically and volcanically active regions. The networks provide raw GPS observables that are then used by a relatively small community of power users capable of analyzing the raw data for geophysically meaningful signals. In order to expand the utility of these GPS networks, we propose to provide data and higher level data products to scientists, local governments, and surveyors from the GPS networks in western North America.

The focus of the project will be on the Southern California Integrated GPS Network (SCIGN), a multi-agency project that was jointly sponsored by NASA, NSF, USGS, and the WM Keck Foundation for the study of earthquake hazards in southern California. Over the next five years, SCIGN will transition from a standalone project to an integral part of the multi-agency and multi-disciplinary NSF-lead Plate Boundary Observatory (PBO), a distributed observatory of high-precision geodetic instruments covering western North America, scheduled for installation beginning in 2003. PBO is part of the NSF EarthScope initiative and will serve a broader community of scientists, government agencies, and surveyors than SCIGN does now.

To deliver these data products to the different user communities that these networks serve, this project will build on current capabilities within SCIGN for analysis, verification, validation, and information systems, and disseminate the following data products: geodetic time series, deformation velocity fields, strain rate maps, fault models, near-real-time earthquake response information, surveying support and reference systems, and aquifer recharge monitoring. As SCIGN transitions into PBO towards the end of the proposed 5-year CA, these products will be transitioned and integrated into the PBO data system.

The specifications of the data products will be developed through existing contacts with the following organizations: PBO/UNAVCO, SCEC, CSRC, TriNet, and the SCIGN Science Advisory Council, and through participation in the SEEDS Technology Infusion working group. All the products will be archived and made publicly available via a SEEDS compliant data system and web interface.

2.0 PROJECT DESCRIPTION

The utility and justification for continuously operating GPS networks has been well documented in numerous recommendations and reports, and through community use of the data, science advancement, and the growth in scientific, civil, and commercial applications, around these networks [e. g., refs for SESWG, SCEC reports, PBO White Paper, GeoNET].

A cornerstone of this growth has been the Southern California Integrated GPS Network (SCIGN), a 250-station network of continuously operating GPS receivers (Fig. of SCIGN). SCIGN is jointly sponsored by NASA, NSF, USGS, and WM Keck Foundation and operates under the auspices of the Southern California Earthquake Center (SCEC). It is governed by a multi-agency and multi-organization coordinating board (Fig. of SCIGN Org) consisting of project members, universities, local, state, and federal government officials, and scientific community members. An independent science Advisory Council (AC) provides critical input on its operations, goals, and responsiveness to the community. A website is maintained that documents the project, including annual reports, and project status and Level-0 GPS data are provided to users via the SCIGN archive.

When SCIGN was first proposed, there was only a 3-station GPS network in southern California that was dedicated to monitoring crustal strain. Following the valuable contribution from these stations to both the 1992 Landers and 1994 Northridge earthquakes, SCIGN was proposed as a 7-year experiment into both the utility of applying GPS network technology to studying the earth and the understanding of the processes driving tectonics in southern California.

One of the primary concerns at that time was the ability of the community to retrieve, distribute, and process the observations from such a large network. Since its inception, SCIGN has demonstrated that these obstacles can be overcome, resulting in the development of other regional GPS networks and the initiation of the biggest integrated strain network in history, the Plate Boundary Observatory (PBO) (Fig or other networks and PBO). The PBO, which SCIGN will become an integral part of, enjoys wide community support and is progressing as through the National Science Foundation as part of the EarthScope initiative. PBO, together with the other systems that compose EarthScope (Fig) is certain to result in quantum changes in the way we view earthquakes, volcanoes and the evolution of the Earth.

Since its installation, SCIGN has been able to meet the needs of the then perceived users of the network. Over the last 7 years, as the utility of this type of monitoring has been realized, the requirements of the users have also grown. SCIGN was originally conceived as an observatory, providing Level-0 data products from the networks to users who would then process them for geophysical parameters. The value of the observations has been recognized by the community in a number of ways such as through publications and new projects and feedback from the SCIGN science Advisory Council (AC). Growth in community interest in the information contained in the data from SCIGN has lead the AC to recommend to SCIGN that we provide higher level data products and that these data products be provided with lower latency. This is a testament to the success of the project and represents a new phase of operations and an unsupported requirement on the network to increase the value of the data.

We propose to provide high level data products to the community of geophysicts studying earthquake processes, crustal evolution, and magmatic systems. These data products will be at the level just below interpretation. In addition we will also provide rapid geophysical parameters in response to earthquakes and volcanic events within the GPS networks that will give emergency managers, policy makers, and service provides key information to response to such events.

The specific products and target user communities are summarized in Figure 1.

Currently, SCIGN produces Level-0 data from the GPS receivers in the network and preliminary Level-1 which is a by product of the verification and validation of the network health. The proposed data products in Figure 1 are new products that have been requested by the community of science users through the AC and the local government users through their participation on the SCIGN Coordinating Board and through the California Spatial Reference Center (CSRC). We plan for these data products to be derived from the SCIGN network initially, and as SCIGN transitions to the multi-agency EarthScope project as the next few years, the scope and basis of data products will be derived from the larger Plate Boundary Observatory (PBO).

The data products are targeted at both research users and government officials and agencies which provide services and emergency management support. The target research community is the Solid Earth science community and the target products and service for them are derived from NASA's ESE strategic plan, SESWG report, NSF recommendations, and other community input to the SCIGN project via the EarthScope initiative, and the SCIGN Advisory Council.

This project will leverage its existing depth in the science and commercial community in developing standards for GPS networks, data formats, metadata, and archiving to apply principles from the Strategy for the Evolution of ESE Data Systems (SEEDS. With this depth, this project will support ongoing SEEDS efforts through participation in Working Groups for Standards and Interfaces, Technology Infusion Working Group, and Metrics Planning and Reporting.

The USGS has substantial depth and contact with emergency mangers and support systems through its congressionally mandated lead role to respond to earthquake and volcano emergencies. As a project member, this role will be employed to integrate the high-level data products in the existing emergency response system which is currently dominated by seismic data.

The leveraging of NASA's investment in GPS network technology into EarthScope has been a recommendation of NASA's Solid Earth Science Working Group (SESWG) and is a key NASA contribution to EarthScope.

2.1 Relevance of Data or Services

The primary data products to be produced by the project, their relevance, users, and how they relate to the existing efforts are shown in the operational concept in Figure 2 and summarized in Table 1.

The SCIGN Advisory Council (AC) which represents the solid earth science community has recommended that SCIGN provide high-level data products and low latency data products from that network that will allow geophysical users make use of the network without the need to process the raw data.

We will follow and expand the AC recommendations and those of NASA's Solid Earth Science Working Group (SESWG) by generating these high level data products though an integrated effort within the project in which estimates from the processing groups within SCIGN are compared and then combined to provide the following official SCIGN products: Daily time series; Daily positions and velocities; Differential strain and strain-rate maps; Fault slip rates; Aquifer discharge and recharge rates; and an event-driven rapid post-seismic deformation. The products will be archived and made available to the scientific community via a web interface.

Level 1-2 Products: Time Series and Velocity Fields

The main motivation for providing official SCIGN geodetic time series and velocity maps is to provide scientists with the most basic scientifically useful data set, while relieving them of the need for tedious, costly and redundant data processing. Generating weeks, months, and years of GPS geodetic time series requires a substantial, time-consuming and delicate data processing effort.

Data Product	Product Level	Format	Data Product Description	Accessibility	Relevance of Data Services & Primary Users	Production
GPS Observables	*0*	*RINEX*	*RINEX files organized by station*	*GSAC and SCIGN Archive at ftp://lox.ucsd.edu http://sopac.ucsd.edu/dataArchive*	*Raw GPS observable used by scientists, surveyors, and others for calculating geodetic coordinates and their time history*	*Funded through SCIGN project*
Geodetic Time Series	1C	XML based format under development by SCIGN	Automated daily update of time series from each SCIGN/PBO site based on the combined solutions from the analysis centers.	SCIGN web-site at http://www.scign.org/ as machine readable observations and graphical displays	Forms the basis for any high-level data product. A lower latency and SCIGN combined product has been recommended by the science community through the SCIGN Advisory Council (AC)	Independent processing using GIPSY and GAMIT, followed by verification, validation, and combination into an official SCIGN time series
Velocity Field	2	TBD through negotiations with user communities	Automated daily update of the velocity filed of SCIGN	SCIGN web-site at http://www.scign.org/ as machine readable observations and graphical displays	Long-term, high-resolution monitoring of changes in the Earth's surface addressing ESE goals in Solid Earth Science. Recommended by SCIGN AC and SESWG.	Existing software for strain estimation will be extended to produce automated velocity maps from the SCIGN time series.
Strain and Strain Rate Field	3	TBD	Automated daily update of strain and strain rate fields	SCIGN web-site at http://www.scign.org/ as machine readable	Directly called for and addresses recommendations of SESWG, EarthScope, and NASA ES research strategy goals in surface stress and deformation, with special focus on active earthquake and volcanic regions. .	Existing software for strain estimation will be extended to strain differentials and rates, fault slip rates, aquifer undulation, and pre-, co- and post-seismic fault slip rates using the methodology of an spatial-temporal (S-T) filter
Aquifer undulations	3	TBD	Aquifer discharge and recharge rates provided for water resource management with	SCIGN web-site at http://www.scign.org/ as machine readable observations and		
Earthquake Fault Parameters	3	TBD	Fault slip rates derived from the SCIGN velocity maps will be provided on a long term, and event	SCIGN web-site at http://www.scign.org/ as machine readable observations		
Co-seismic Deformation	3	TBD	Co-seismic and rapid post-seismic displacements within 1 hour of an event	SCIGN web-site at http://www.scign.org/ as machine readable observations and graphical displays and Co-seismic	Office of emergency services, local authorities, utilities, transportation and media outlets will be the primary users of this	Independent near real time analysis systems will be implemented.
Surveying	SIO	SIO	SIO	SIO	SIO	

Table 1. Data products

Reference frame consistency as well as other important issues concerning antenna height offsets, editing of outliers, the number of position breaks due to co-seismic displacement or undocumented equipment changes, ambiguity resolution , tropospheric modeling, regional filtering, and non-linear effects such as seasonal aquifer variations and post-seismic relaxation, all have to be taken into account. [REFERENCES] SCIGN (and PBO)'s provision of these products will facilitate Earth scientists ability to focus their limited resources on science, rather than on data processing. At the same time, in accordance with SCIGN philosophy, interested parties will still find the raw GPS observables in the SCIGN public archive.

Level 3 Products: Strain, Fault Slips, Aquifer Undulation, Co-seismic & Post-Seismic Deformations

Strain rates and fault slip rates are the most robust measurable physical parameters related to earthquake generation on inter-seismic time scales [REFERENCES] (Figure ???). Strain differentials and rates, fault slip rates, aquifer undulation, and co-seismic and post-seismic fault slip rates will be calculated using the methodology of a spatial-temporal (S-T) filter [REFERENCES] through the calculation mechanism of the JPL developed Quasi-Observation Combination Analysis software (QOCA) [Dong et al., 1998; http://gipsy.jpl.nasa.gov/qoca]. QOCA is an open structure software which can assimilate a variety of measurements (SAR, EDM, VLBI, SLR) with the GPS station position estimates. QOCA is used all over the world for strain and deformation analysis [REFERENCES], and is the tool of choice of the USGS.

The S-T filter is an extension of QOCA software. It estimates the amplitudes of various Green's functions directly, and as a result performs time-dependent inversion directly. Currently, a basic protocol of the S-T filter has been established that implements the 4-D (time-space) Kalman filtering and dynamic memory allocation, and can easily combine more than 1500 sites simultaneously, which will be necessary for PBO implementation. In addition, the flexibility of the S-T filter approach enables user-defined requests for a deformation map in a specified region for co-seismic or post seismic displacement field.

Once a SCIGN velocity map is obtained, calculation of strain rates is a straightforward process. Strain rate maps with and without cyclic signals (aquifers) will be derived from the SCIGN combined velocity maps. SCIGN strain analysis will integrate direct strain measurements from the SCIGN laser strainmeter, and the USGS borehole strainmeters within the array. The integration of regional strain inference from GPS measurements with pin-pointed precise direct strain measurement is at the core of PBO.

2.2 Approaches for Data Production, Distribution, and User Support

Summary

From its inception, SCIGN has operated two independent analysis centers to provide consistent, validated, high accuracy geodetic solutions: one at the Jet Propulsion Laboratory (JPL) and one at the Scripps Institute of Oceanography (SIO). Each center uses the same input data but different processing software and analysis strategies. The Gps Inferred Positioning SYstem (GIPSY) software is used by JPL while the Gps At MIT (GAMIT) software is used by SIO. The SCIGN official SCIGN product is Level 0 daily GPS observation files (Rinex files).

An unofficial byproduct of monitoring the network health, both centers compute time series and velocity estimates based on data from approximately 250 SCIGN network receivers and make results available via internet every six months. These results can be obtained at: http://sideshow.jpl.nasa.gov/mbh/series.html and at http://sopac.ucsd.edu/cgi-bin/dbShowArraySitesMap.cgi?array=SCIGN

Under the CA SCIGN will produce the high-level research and application data products listed in Table 1. The data production scheme is outlined in Figure 1.

Figure 1 : Project Flow

Data Comparison, Verification and Validation

SCIGN data processing philosophy - dual independent analysis centers. The IGS model of competing independent analysis centers has been adopted by SCIGN to allow comparison and validation of results [SCIGN Analysis Committee Report, 2000, 2001, 2002]. The SCIGN Executive Committee has concluded in 2002 that the independent SIO and JPL solutions agree to satisfactory levels. The comparison and validation process will be automated.

After the data has been gathered, archived, and processed by the two SCIGN analysis center it will be delivered to a SCIGN Solution Center (SSC), to be funded under the REASoN CAN. The scientific community representative within SCIGN, the Science Advisory Council, will be periodically consulted during the development and implementation stages of the final products.

The SSC will perform the following tasks:

Data combination and SCIGN product generation:

Once the two independent GPS solutions received from JPL and SIO, it will combine the overlapping solutions into a single SCIGN time series. Quality control will detect outliers and ensure that both centers use the same offsets. A long term (years) and short term (weeks-months) velocity fields will be calculated from the time series. Derivatives of the time series will be combined to produce corresponding dilatation and shear-strain maps. An archive of the evolving strain field will be kept. These products will be made publicly via web interface as soon as they are completed.

Assimilation with other products and generation of science-level products:

An added layer of validation will be provided by comparison and assimilation with other data sets. The SSC will model the velocity field data to fault motions along known faults first using elastic dislocation models, and next using viscoelastic models. In an event of a large earthquake the residual deformation field will be compared to a deformation model generated independently by fault plane solutions (moment tensor solutions) from CISN.

2.3 Earth System Science User Support

1. *Earth system science user support -- the proposal shall outline the approach taken to support users. The respondent shall identify the specific user community(ies) targeted. The proposal must also address the distribution and availability of data products for the greater Earth system research, applications, and education community.*

2.4 SEEDS Guiding Principles

This project will leverage its existing depth in the science and commercial community in developing standards for GPS networks, data formats, metadata, and archiving to apply principles from SEEDS. The project members have a long history of engaging the community in defining products and services for GPS geodesy through their participation in the leadership and governance of the major GPS geodesy organizations: International GPS Service (IGS), University Navistar Consortium (UNAVCO), GPS Seamless Archive (GSAC), California Spatial Reference Center (CSRC), Southern California Earth Quake Center (SCEC), SCIGN, and PBO.

Through these organizations, we have developed and implemented solutions for storage, access, distribution, and long term archive of GPS data and defined and implemented standard interfaces and data formats for exchanging data with other GPS archives, in particular NASA's CDDIS and the community based GSAC.

With this depth, this project will support ongoing SEEDS efforts through participation in Working Groups for Standards and Interfaces and Metrics Planning and Reporting.

2.5 Level of Participation in SEEDS Working Group

The project will participate on the SEEDS Standard and Interfaces Work Group. Given our depth in developing standards and interfaces for the community as discussed in the preceding section, SIO through its archive activities at SOPAC (http://sopac.ucsd.edu) will lead the SEEDS participation.

The SCIGN archive at SOPAC currently participates as an archive for the IGS, SCIGN, and GSAC. SOPAC maintains an Oracle RDBMS that unifies collection, archive, analysis and dissemination of Level-0 data and metadata on GPS stations. The higher level data products generated under this project will be added to the database for access by users.

Currently, automatic access to the RDBMS is through ftp and web-based applications that allow users to the information.GIS functionality that adds spatial awareness to the products. Level-0 data is also available through the GPS Seamless Archive (GSAC). This archive allows users to access several data archives with common interface. SOPAC is a lead organization in the establishment and development of the GPS Seamless Archive (GSAC). Access is primarily through http://sopac.ucsd.edu and the database tools there, such as the Site Information Manager (http://sopac.ucsd.edu/scripts/SIMpl_launch.cgi). The experience from these programs and the community driven development of the standards and interfaces will be valuable contributions to the SEEDS.

The project members, lead by SOPAC, have been involved in the UNAVCO community for over five years now in the development and implementation of the Seamless Archive, designed to permit user-friendly, single-point access to GPS data in a common format from multiple GPS data centers. Basic capability went into in place in early 2002 with implementation of a retail interface tool that provides a simple graphical interface to the combined archive holdings, along with a data request mechanism.

One of the most important steps in the development of the seamless archive architecture was the definition of the Data Holding Records (DHR) which are designed to describe not only data holdings in the form of GPS standard Receiver Independent Exchange (RINEX) format and raw GPS data files but also data products such as the Solution Independent Exchange format (SINEX) files that contain results from the analysis of the GPS data. The definition of the DHR's is sufficiently flexible to allow other types of information from GPS networks to be incorporated in the future.

Several GPS data archives have been designated as retail and/or wholesale data centers, depending on whether they provide data community-wide holdings or just holdings to other data centers that serve as retailers. The Seamless Archive project forms a foundation for the more capable network and data management system envisioned for this project based on the data formats, data access tools, and institutional synergies developed over the period of the project.

The data management system for this project will not only include handling, dissemination and archiving of the data collected for PBO but will also cover the dissemination of the analysis results. SIO (http://sopac.ucsd.edu) and JPL (http://mihouse.jpl.nasa.gov) provide access to GPS position time series and velocity results. For this project, these product centers will be coordinated with the aim of generating results that can be directly interpreted and used in further analyses to build geophysical models the deformation process in the plate boundary. These developments will also include near-real-time production of results that can be used for geophysical studies and emergency response.

2.5.1 Data Format and Content

a) *Data format and content. Describe the proposed data format and content, basis for selection, and community involvement in the selection process.*

2.5.2 Interface Standards

b) *Interface standards. Describe external interfaces, basis for selection, and use of existing standards in defining those interfaces.*

2.5.3 Software Reuse

c) *Software Reuse - Describe reuse options that were considered and the basis for selection. Describe any software that is available for reuse*

2.5.4 Evolution

d) *Evolution – Describe steps taken to enable evolution of system capability/capacity.*

2.5.5 Technology Utilization

e) *Technology Utilization - Describe proposed utilization of advanced technologies in the production/delivery of proposed product/service to minimize barriers to access and use of Earth Science information. Note that directions for technology development are listed below (Section 3.5).*

2.5.6 Levels of Service

f) *Levels of Service – Describe proposed levels of service to enable discovery, identification, selection, translation/subsetting, ordering, and delivery of products and services. Describe any partnering arrangement to support these levels of service.*

2.5.7 Metrics

g) *Metrics – Propose metrics to measure the quality, capability, and value of the proposed products and services, and the progress towards those goals. REASoN projects shall provide all NASA-required metrics to the existing Federation (see Section 3.7).*

2.5.8 Non-proprietary Data for the ESE Data Systems Cost Model

h) *Provide non-proprietary data for the ESE Data Systems Cost Model currently under development (see the SEEDS homepage Cost Estimation link for information on the model).*

2.5.9 Participation of the Project Investigators and Staff on SEEDS Working Groups

i) *The proposal will discuss the participation of the project investigators and staff on SEEDS Working Groups. Discuss special expertise the project collaborators can contribute to SEEDS study activities (Appendix J). At a minimum, NASA expects the projects to participate in at least one Working Group at a level of .25 FTE. The proposal should discuss the contributions the project will make to its preferred and, at least, one other alternate working group.*

j) *Projects can optionally propose to develop an Open-Source Prototype/testbed for the Architecture and Reuse Working Group. Projects proposing to develop an open-source prototype should discuss their technical approach for completing the prototype in detail and should specifically address contributions they will make to the SEEDS Architecture and Reuse study goals.*

2.6 *Compliance with REASoN Project Requirements*

The project will maintain a WWW-compliant presence at www.scign.org. This web site will be enhanced over its current capabilities to provide high level data and information to the users via the Internet. It will contain descriptions of all products and services. These descriptions will be provided to the NASA GCMD. In addition, the products will contain and be searchable via FGDC compliant metadata. The SCIGN EC is currently moving forward with applying for membership to the existing Federation.

2.7 *Additional Research REASoN Project Elements*

SCIGN has pioneered and championed the adoption of an open data policy for GPS and other geodetic data. Under this project, we will continue this policy and extend it to include the higher level data products. The policy can be found at http://www.scign.org/DataPolicy.html.

The fundamental tenants of the policy are that data from all SCIGN stations are available on-line as soon as they can be physically moved from the site to the archive. In SCIGN's current operational mode, that occurs usually within a few hours. Additionally, higher level data products such as daily coordinate solutions, periodic velocity solutions, and plots of resulting positions or position differences are available promptly to the scientific community. SCIGN requires that users of these data products acknowledge SCIGN and its sponsoring organizations, (W.M. Keck Foundation, NASA, NSF, USGS, SCEC) as the source of the data and that other permanent networks cooperating with SCIGN and receiving benefits from SCIGN (hardware, software, logistic support, etc.) are required to adhere to the same data distribution policy.

Under this project, we will continue this policy and extend it to include all data products produced and have budgeted for the resources necessary to accomplish.

2.8 *Additional Application REASoN Project Elements*

2.8.1 Description of Application

The USGS Earthquake Hazards Program is charged with a task of national importance. USGS is responsible for scientific earthquake response and for communicating results to researchers, the media, and emergency responders; this is a Type 1 application using NASA data products to support decisions made for Disaster Management (National Application #7, Appendix 7). USGS provides reliable information about earthquake location, magnitude, rupture zone, shaking intensity, and co-seismic deformation. Precise geodetic data products are co-seismic and post-seismic displacement, strain, and tilt, and estimates of the stress change on nearby faults. Combined geodetic and seismological data provide high-quality earthquake fault parameters. These data products will be developed as a dynamically updated interactive Web service.

These earthquake response data products differ from those produced by the SCIGN Solution Center (SSC). To verify and validate the small deformations (a few mm/yr at each station) that occur during the inter-seismic period, the SSC will use two independent solutions from JPL and SIO, a sophisticated reference frame adjustment, and the most precise orbit available. For earthquake response, the near-field displacements are on the order to 10 cm to several meters. Therefore some precision may be sacrificed in order to produce fast results. The earthquake response application uses rapid or predicted orbits to produce one solution in a nominal ITRF2000 reference frame. Comparison of USGS fast results to more precise JPL and SIO co-seismic displacements for the M 7.1 1999 Hector Mine earthquake showed discrepancies of a few mm.

2.8.2 Utilization of NASA Data, and/or Science Results, and/or Technology Products in the Project/Application

The role of NASA data and technology investment includes: A key sponsor of SCIGN responsible for the implementation and construction of the network; sponsor of the development and maintenance of GIPSY; a contributing sponsor for Real-Time GIPSY (RTG) for sub-daily analysis; sponsor of applications research into the integration of GPS and seismic data; sponsor of the technology, development, and maintenance of the Global GPS Network which supports the generation of precise GPS orbits and clocks.

2.8.3 Current State of the Application

USGS processes data daily to be ready for earthquake response. Each day USGS downloads the data from the previous day and processes it with the ultra-rapid orbit from the International GPS Service (IGS). This preliminary result is sufficient for timely response to an earthquake, should one occur. Better solutions are produced 12 days later using the highest quality precise orbits.

The USGS Web page at http://pasadena.wr.usgs.gov/scign/Analysis/ (which can be reached from http://www.scign.org/) provides several interactive tools. MapSurfer, developed at

USGS, shows SCIGN stations on a map of California. Users can zoom in and out, obtain basic information about stations, and choose whether to display recent earthquakes, major faults, and geographical and cultural features. Co-seismic displacements are available, in both digital and mapped vector form, for the M 7.1 Hector Mine earthquake of October 1999. Automatically generated displacement vectors between the last two daily solutions can be displayed; these are usually used for quality control, but are estimates of co-seismic deformation when an earthquake of M 6 or larger occurs. Interactive time series tools allow users to plot or download time series.

2.8.3.1 Expected End State of the Application

The anticipated end state of the application is the operation of a demonstration system at the USGS that will use sub-daily and real-time solutions and high quality orbits in near real-time to automatically generate strain and tilt fields. These fields will then be integrated with seismic solutions and used to automatically generate estimates of stress changes on nearby faults. The results will be provided on the web and to the USGS.

2.8.4 End Users of the Application

As the primary end user and as a Project Member, the USGS is committed to incorporate these products into its emergency response to earthquakes in Southern California. Currently, following a significant earthquake, the USGS responds via its Southern California Earthquake Hazards Program Web page at http://pasadena.wr.usgs.gov/ providing information on the location, size, and magnitude of the event. If the event results in significant effects, the USGS conducts briefings with state and local governments and the media. The products developed under this project will allow the USGS to provide timely data to the public on the effects of an earthquake (Table 1). The secondary end users are the scientific community, the media, and agencies involved in earthquake response (FEMA, the California Office of Emergency Services, the California Department of Transportation, local governments, and operators of lifeline services).

2.8.5 Milestones to Evaluate the Application's Readiness

See section 5.3 and Table 3 for a description of each milestone and success criteria.

2.8.6 Post-Cooperative Agreement Intent/plan

The project intends to continue the applications activities pending successful demonstration of the application to the USGS and the availability of funds to operate the system. If the application is successful, SCIGN will seek through its USGS partner funds from the CISN, USGS, OES, and/or SCEC to continue the operation of the rapid earthquake response part of the project.

	Roles and Responsibilities		
Task	***JPL***	***SIO***	***USGS***
Project Management	**Leads Project**	Leads SIO activities	Leads USGS activities
Data Retrieval		Backup data retrieval	**Primary data retrieval ***

		Roles and Responsibilities		
Daily Data Processing		**Process network data with GIPSY ***	**Process network data with GAMIT ***	
Near Real Time Data Processing		**Process network data with RTG**	**Process network data with RTD**	
Verification and Validation		Participation on SCIGN Analysis Committee	Participation on SCIGN Analysis Committee	**Lead SCIGN Analysis Committee ***
Solution Combination		Participation on SCIGN Analysis Committee	Participation on SCIGN Analysis Committee	**Lead SCIGN Solution Combination effort ***
Product Generation	Time Series	Generation of GIPSY time series	Generation of GAMIT time series	**Generation of combined time series from combined solution ***
	Velocity Field	Support generation of combined velocity field	Support generation of combined velocity field	**Generation of combined velocity field (SCIGN Velocity map) ***
	Strain and Strain Rate Field	**Modify existing software for spatial and temporal filtering**	Consult on spatial and temporal filtering strategies	Consult on spatial and temporal filtering strategies
	Fault Models	**Implementation of faults parameter estimation into existing software ***	Support modeling efforts	**Calculation of fault slip rates + assimilation with seismic data ***
	Aquifer Models	**Implementation of aquifer parameter estimation into existing software**	**Generalization of Orange County work to other aquifers***	
	Earthquake Response	**Implementation Near Real Time deformation field and strain rate calculation**	**Support Near Real Time Data retrieval**	**Assimilation of deformation measurement with seismic data + interface with authorities / utilities/ media ***

	Roles and Responsibilities		
SEEDS	Support project participation in SEEDS	**Participation in SEEDS Technology Infusion Work Group ***	Support project participation in SEEDS
Archive		**Maintenance and Development of SEEDS compliant SCIGN archive ***	
Product Delivery / WWW	Product support	**Development and maintenance of www.scign.org ***	**Interact and implement feedback from scientific community ***

3.0 PREFERENCES FOR PARTICIPATION IN THE FEDERATION AND SEEDS WORKING GROUP(S)

This project will leverage its existing depth in the science and commercial community in developing standards for GPS networks, data formats, metadata, and archiving to apply principles from SEEDS. The project members have a long history of engaging the community in defining products and services for GPS geodesy through their participation in the leadership and governance of the major GPS geodesy organizations: International GPS Service (IGS), University Navistar Consortium (UNAVCO), GPS Seamless Archive (GSAC), California Spatial Reference Center (CSRC), Southern California Earth Quake Center (SCEC), SCIGN, and PBO.

Through these organizations, we have developed and implemented solutions for storage, access, distribution, and long term archive of GPS data and defined and implemented standard interfaces and data formats for exchanging data with other GPS archives, in particular NASA's CDDIS and the community based GSAC.

As part of this project, project members will bring the knowledge and experience gained in these areas to the Federation and SEEDS efforts. In particular, we propose to be part of the SEEDS working group on Standards and Interfaces. An alternative choice where we could contribute would be on the Metrics, Planning and Reporting working group.

With this depth, this project will support ongoing SEEDS efforts through participation in Working Groups for Standards and Interfaces and Metrics Planning and Reporting.

All project data will conform to the requirements of the CAN and ESE Guidelines for internet-based data delivery systems, dynamic database update capability, support of NASA's Global Change Master Directory (GCMD) conformance to the objectives and requirements of the National Spatial Data Infrastructure (NSDI)[2], of the Federal Geographic Data Committee (FGDC) to develop and maintain on-line data and information systems consistent with the Administration's "Geo-Spatial One-Stop" (e-government) initiative.

4.0 METRICS

SCIGN is familiar with reporting metrics to NASA in accordance with the Government Performance Results Act (GPRA) and provided these to Code-Y for the installation of the SCIGN network. In addition, SCIGN currently maintains and tracks metrics that it reports at least twice a year to its sponsors including NASA, WM Keck Foundation, NSF, and SCEC. Some of these reports can be found at www.scign.org. The metrics include number of downloads of data from the archive, the number of papers and presentations published, students supported, etc. Under this project, we will provide these metrics to NASA and will work with the Federation to establish and report on these metrics.

4.1 Inputs

1) Inputs: Data, models, and other information and products used to complete and carry out the project. This includes human and physical capital and materials required for the research, applications or education process or function. It describes the cost of doing business and includes: budget, number of researchers/teams, participating users, data required, and use of other assets e.g., ancillary data.

4.2 Outputs

2) Outputs: Immediate observable products of the project. Outputs include data sets and models developed, number of presentations made, papers published, number of graduate students supported (if applicable), and other direct results of the project.

4.3 Outcome

3) Outcome: Longer term results to which the project contributes such as understanding gained, applications demonstrated, resulting programmatic decisions enabled.

4.4 Impact

4) Impact: The consequences of the program, including intended benefits and utility and socio-economic benefit to the end users/customers. Impact addresses questions such as: "Why were the results of the projects useful?" "How were they useful?" "How were the end results (i.e., applications and data products developed) used in decision-making?" "What kind of significant economic or policy consequence resulted from the project?" Most important, it answers the question, "So what?" and includes assessments such as new knowledge shared, cost saved, new applications or functions that were done that were not possible before. How did or would the results impact the public good or expanded commercialization of value-added Earth Science data?

Respondents may propose additional metrics for measuring the performance of the REASoN project and state how the project intends to provide these metrics

5.0 MANAGEMENT APPROACH

5.1 Management Approach

SCIGN is governed by a set of bylaws http://www.scign.org/bylaws.html and by a Coordinating Board that operates as a standing committee of the Southern California Earthquake Center (SCEC). The coordinating board consists of representatives from SCEC, the United States Geological Survey (USGS), the Jet Propulsion Laboratory, Scripps Institution of Oceanography of the University of California, San Diego (SIO), NASA, the National Geodetic Survey (NGS), the California Department of Transportation (Caltrans), the California Committee on Reference Stations (CORS) and the Center Director and Science Director of the Southern California Earthquake Center, who are members ex-officio. The day-to-day operations of the network are managed by an Executive Committee of the CB composed of one member from each of the three lead institutions (SIO, JPL, and USGS), plus one other member of the board. The EC and CB are chaired by a board member who is elected by the board at the annual meeting. Interagency funding issues are resolved by an interagency steering committee composed of member representatives from the NSF, USGS, and NASA.

The management of this project is modeled after the successful management of the implementation of the SCIGN network by JPL for NASA. The PI will have overall responsibility for the project and will work with the project members at the partner institutions to implement the tasks. The lead Project Members at SIO and at the USGS will be responsible for the work efforts at their institutions.

5.2 *Coordination Between Participants*

Coordination of the participants will be through the weekly EC telecons. At these telecons, the Project Members will discuss progress, resolve issues, develop plans, and coordinate work among the project members. Project Members will provide monthly financial reports to the PI and reports will be made to the sponsors as required by the sponsors and as needed. The coordinating board and the Advisory Council will convene at least twice per year. At these meetings the EC will provide to the CB status reports on progress, issues, and plans and will seek the advice and consent of the SCIGN coordinating board and the advice of the AC.

5.3 Statement of Work

The following are concise statements of work and success criteria for each major milestone shown in Table 3.

1. *System Requirements Definition and Design*

Work with users including the SCIGN CB and AC, CSRC, CISN, and PBO, to develop and document the system requirements, develop the system design, and generate a detailed project schedule. *Success criteria*: documented requirements and schedule approved by the SCIGN CB.

2. *Level 1 Product Development - Combined Geodetic Time Series*

Define input and output formats for Level-1 data products; define combination strategy and reference frame; develop and implement a software solution for combination; work with SEEDS on standard; solicit user community feedback at the SCEC annual meeting. *Success Criteria*: prototype operation of combination software.

3. *Automation of Level 1 Data Products*

Solicit user community feedback at the SCIGN and UNAVCO annual meetings; implement combined time-series production; automate daily and sub-daily data processing and develop performance metrics; enhance SCIGN web page to deliver products based on input from SEEDS Standards and Metrics working groups. *Success criteria*: Combined SCIGN time series available on the SCIGN web page.

4. *Level 2 Product Development - Velocity Field*
Define strategy for velocity field derivation from time series; define strategies for removing outliers and non-linearities; define output formats for Level-2 data product; develop and implement a software solution for velocity field derivation. Work with SEEDS on Standards; solicit user community feedback at the SCEC annual meeting. *Success Criteria*: prototype operation of velocity field derivation software.

5. *Automation of Level 2 Data Products*
Solicit user community feedback at the SCIGN and UNAVCO annual meetings; implement velocity field production; automate daily and sub-daily data processing and develop performance metrics; enhance SCIGN web page to deliver products based on input from SEEDS Standards and Metrics working groups. *Success criteria*: SCIGN velocity field available on the SCIGN web page.

6. *Level 3 Product Development - Geophysical Parameters*
Implement S-T filter algorithm and develop software; define input and output formats and user interface; validate strain rate, aquifer undulations and fault slip rates with independent data sets; integrate into QOCA; participation in SEEDS Standards working groups; solicit user community feedback at the SCEC annual meeting. *Success criteria*: prototype operation of S-T filter software; validated geophysical parameters.

7. *Automation of Level 3 Data Products*
Solicit user community feedback at the SCIGN and UNAVCO annual meetings; Implement geophysical parameters production; automate daily and sub-daily data processing and develop performance metrics; enhance SCIGN web page to deliver products based on input from SEEDS Standards and Metrics working groups. *Success criteria*: SCIGN strain-rates, aquifer undulation, and fault slip-rates available on the SCIGN web page.

8. *Integrate with Independent data Products*
Work with PBO community and SEEDS to develop standards and interfaces for incorporating strainmeter and seismic solutions into Level-3 product generation, and develop and implement web interface; solicit user community feedback at the SCEC annual meeting. *Success criteria*: Prototype combination demonstrated.

9. *Incorporate PBO data into products*
Incorporate PBO GPS into time series production and solution combination, and incorporate PBO strainmeter data into Level-3 product generation, and deliver products on the web. *Success criteria*: Generating and delivering combined Level-3 products.

5.4 *Key Personnel*

Dr. Frank Webb, a permanent member of the SCIGN EC and Chair of the PBO Standing Committee, is the Principal Investigator (PI) with direct responsibility to NASA for the project and within SCIGN. He is supported at JPL by Dr. Sharon Kedar, Dr. Michael Heflin, and Dr. Danan Dong. Dr. Kedar will lead the product generation at JPL and coordinate with counter parts at the USGS and SIO. He supported by Dr. Heflin who will lead the production of the Level-1 data products. Dr. Dong will lead the development implementation at JPL of the S-T filter and the geophysical model development.

Dr. Yehuda Bock is a permanent member of the SCIGN EC, the manager of the SCIGN archive, and a lead member of the CSRC. He is the SIO Project Member (PM) with direct responsibility to the project for the tasks at SIO. He also is responsible for the coordination of project activities with the surveying community represented by the CSRC.

Dr. Nancy King is a permanent member of the SCIGN EC, chair of the SCIGN Analysis Committee, and the USGS lead for operation of SCIGN. She is the USGS Project Member with direct responsibility for the implementation of USGS activities leading the coordination of the generation of project products. She is also responsible for the interface between the project's emergency response products and their users.

Table 3. Milestone schedule

	FY03		FY04		FY05		FY06		FY07	
Task	JUN	DEC	JUN2	DEC2	JUN3	DEC3	JUN4	DEC4	JUN5	DEC5
1. System Requirements Definition and Design										
2. Level 1 product Dev. - Combined Geodetic Time Series										
Input format definition										
Combination scheme development										
Reference frame definition										
Output format definition										
User community feedback - SCEC annual meeting										
SEEDS Standards WrkGrp Participation										
3. Automation of Level 1 Data Products										
User community feedback - SCIGN & UNAVCO annual meetings										
Implement combined time series production										
Daily										
Sub-daily										
Develop performance metrics										
SEEDS metrics WrkGrp Participation										
SEEDS Standards WrkGrp Participation										
Enhance web interface to deliver L1 products										
4. Level 2 Product Dev. - Velocity Field										
Velocity scheme development										
Output format definition										
User community feedback - SCEC annual meeting										
SEEDS Standards WrkGrp Participation										
5. Automation of Level 2 Data Products										
User community feedback - SCIGN & UNAVCO annual meetings										
Implement velocity field production										
Daily										
Sub-daily										
Develop performance metrics										
SEEDS metrics WrkGrp Participation										
SEEDS Standards WrkGrp Participation										
Enhance web interface to deliver L2 products										
6. Level 3 Product Dev. - Geophysical Parameters										
Model implementation										
Aquifer undulations										
Strain										
Fault slip										
S-T Filter development										
Software integration										
User community feedback - SCEC annual meeting										
SEEDS metrics WrkGrp Participation										
7. Automation of Level 3 Data Products										
User community feedback - SCIGN & UNAVCO annual meetings										
Implement geophysical parameter production										
Daily										
Sub-daily										
SEEDS metrics WrkGrp Participation										
SEEDS Standards WrkGrp Participation										
Enhance web interface to deliver L3 products										
8. Integrate with independent Data Products										
Develop interfaces for Level 3 Product Generation										
Integrate with system										
User community feedback - SCEC annual meeting										
SEEDS Standards WrkGrp Participation										
9. Incorporate PBO data into products										

6.0 PERSONNEL

For each PI or PM, submit a brief biographical sketch referencing related work, along with citations of the most relevant recent publications and any exceptional qualifications covering the past five years. The biographical sketch and publications list shall not exceed one page per PI or PM. A summary of other participants shall not exceed one page. Include qualifications for participants involved in technology development.

The Principal Investigator is responsible for direct supervision of the work and participates in the conduct of the project regardless of whether or not compensation is received under the award. Omit social security number and other personal items which do not merit consideration in evaluation of the proposal. Give similar biographical information on other senior professional personnel who will be directly associated with the project. Give the names and titles of any other scientists and technical personnel associated substantially with the project in an advisory capacity. Universities should list the approximate number of students or other assistants participating in the proposed effort, together with information as to their level of academic attainment. Any special industry-university cooperative arrangements should be described.

The biographical sketches and publication lists for the PI and each PM can be found at the end of this section.

Frank Webb: Dr. Webb is the Principal Investigator with overall responsibility for the performance of the work. He has over 12 years of experience at JPL where he has been a Senior Member of the Technical Staff, a Project Element Manager, Proposal Manager, and PI on several NASA space geodetic proposals. Currently, he is the group supervisor of the Satellite Geodesy and Geodynamics Systems Group and an intern in the Mission Architect Development Program at JPL. He received his PhD from Caltech in 1991 and has worked at JPL since 1990.

Sharon Kedar:. Dr. Kedar is a member of the technical staff at the Satellite Geodesy and Geodynamics Group at NASA's Jet Propulsion Laboratory. He received his Ph.D. in Geophysics from the California Institute of Technology in 1996, where he specialized in volcano seismology. Prior to his arrival to JPL, Dr. Kedar was involved in all aspects of volcanic data acquisition, processing, analysis and modeling at the United States Geological Survey, Volcano Hazards. He was part of several field installations in various active geothermal areas (Kilauea, Long Valley, Coso), and was part of the crisis team that monitored Long Valley Caldera during the summer of 1997 dramatic increase of activity. At Caltech Dr. Kedar lead a development and research team which built an instrument that successfully measured underwater pressure and temperature inside Old Faithful Geyser, Yellowstone [*Nature*, 1996].

7.0 PROPOSED COSTS

Proposals shall contain cost and technical parts in one volume; do not use separate "confidential" salary pages. In addition to the instructions contained here, respondents are referred to Appendix H which contains a model format for a yearly Budget Summary and line-by-line instructions.

The budget section of the proposals shall include a budget breakdown by Government fiscal year (October 1 to September 30) for each year of the proposed work. Full cost accounting (FCA) is required in all proposals. For those submitted by NASA, FCA should be provided beginning in FY04 commensurate with NASA accounting methods. To assist in the selection process, proposals that include any U.S. Government costs must submit budgets that clearly indicate the costs with and without FCA.

If proposals involve collaborations with PMs who are at institutions different from that of the PI, and those PMs require funding support, the budget total of each participating institution shall be listed under category "3.a. Subcontracts" in the Proposal Budget Summary of the PI. Details of the budgets of such participating institutions shall be provided separately.

Describe available facilities and major items of equipment especially adapted or suited to the proposed project, and any additional major equipment that will be required. Identify any Government-owned facilities, industrial plant equipment, or special tooling that are proposed for use on the project. Before requesting a major item of capital equipment, the respondent should determine if sharing or loan of equipment already within the organization is a feasible alternative to purchase. Where such arrangements cannot be made, the proposal should so state. Title and disposition of equipment purchased with Government funds will be determined for each cooperative agreement depending upon the nature of the recipient (i.e., nonprofit or profit making company) and other factors.

Costs of mandatory participation in the existing Federation should be included in the costs. These costs include site implementation and maintenance of any system-wide requirements, standards and protocols, and work to be performed by the REASoN projects to interact with each other (e.g., meetings and telecons). Respondents should budget for attendance to at least four meetings per year. Existing Federation meetings are held twice per year; existing SEEDS meetings are held twice per year. It is our intention to enable any required reporting on SEEDS working group activities at either set of meetings. Meeting and working group activity should be budgeted at a target level of 0.25FTE.

Costs for metrics collection and reporting should be included in the costs. Metrics required by the Federation and other proposed metrics should be factored into these costs.

If proposals include an optional technology development component or an open source prototype demonstration, these costs will be uniquely identified and totaled by year as an identifiable cost.

7.1 *Budget Breakdown by Fiscal Year*

7.2 *Facilities and Equipment*

INSTRUCTIONS FOR BUDGET SUMMARY

1. *Direct Labor (salaries, wages, and fringe benefits): Attachments should list the number and titles of personnel, amounts of time to be devoted to the grant, and rates of pay.*

2. *Other Direct Costs:*
   a. *Subcontracts: Attachments should describe the work to be subcontracted, estimated amount, recipient (if known), and the reason for subcontracting.*
   b. *Consultants: Identify consultants to be used, why they are necessary, the time they will spend on the project, and rates of pay (not to exceed the equivalent of the daily rate for Level IV of the Executive Schedule, exclusive of expenses and indirect costs).*
   c. *Equipment: List separately. Explain the need for items costing more than $5,000. Describe basis for estimated cost. General purpose equipment is not allowable as a direct cost unless specifically approved by the NASA Grant Officer. Any equipment purchase requested to be made as a direct charge under this award must include the equipment description, how it will be used in the conduct of the basic research proposed and why it cannot be purchased with indirect funds.*
   d. *Supplies: Provide general categories of needed supplies, the method of acquisition, and the estimated cost.*
   e. *Travel: Describe the purpose of the proposed travel in relation to the grant and provide the basis of estimate, including information on destination and number of travelers where known.*
   f. *Other: Enter the total of direct costs not covered by 2a through 2e. Attach an itemized list explaining the need for each item and the basis for the estimate.*

3. *Indirect Costs**: Identify F&A cost rate(s) and base(s) as approved by the cognizant Federal agency, including the effective period of the rate. Provide the name, address, and telephone number of the Federal agency official having cognizance. If unapproved rates are used, explain why, and include the computational basis for the indirect expense pool and corresponding allocation base for each rate.*

4. *Other Applicable Costs: Enter total explaining the need for each item.*

5. *Subtotal-Estimated Costs: Enter the sum of items 1 through 4.*

6. *Less Proposed Cost Sharing (if any): Enter any amount proposed. If cost sharing is based on specific cost items, identify each item and amount in an attachment.*

7. *Total Estimated Costs: Enter the total after subtracting items 6 and 7b from item 5.*

** Facilities and Administrative (F&A) Costs*

Budget Summary						
For period from ___________ to __________						
				| NASA USE ONLY |		
			A		B		C
1.	Direct Labor (salaries, wages, and fringe benefits)					
2.	Other Direct Costs:					
	a. Subcontracts					
	b. Consultants					
	c. Equipment					
	d. Supplies					
	e. Travel					
	f. Other					
3.	Indirect Costs *					
4.	Other Applicable Costs					
5.	**SUBTOTAL—Estimated Costs**					
6.	Less Proposed Cost Sharing (if any)					
7.	**Total Estimated Costs**					XXXXXXX
8.	**APPROVED BUDGET**	XXXXXXX		XXXXXXX		

*Facilities and Administrative Costs.

8.0 COOPERATIVE AGREEMENT PAYMENT SCHEDULE

Table X shows the milestones for the project. The initial milestone is for the period February to December 2003, then on a December/ June basis for the remaining term of the cooperative agreement. Each milestones is a verifiable event in the project that is defined as the delivery of science information and/or servicesand participation in and support for the Federation and SEEDS

9.0 CURRENT AND PENDING SUPPORT

Following the budget section, the proposal shall contain a summary of current and pending Federal support of all projects with substantial involvement of the PI and each PM for whom support is requested. The information content shall include: source of support, project title with grant or contract number, award amount by Government fiscal year, and total award amount, award period, level of effort in person-months, and the location where the work is to be performed.

Person	Source of Support	Project Title (Grant or Contract #)	Award Amount by Fiscal Year	Total Award Amount	Award Period	Level of Effort	Location of Work

10.0 SPECIAL MATTERS

Include any required statements of environmental impact of the work, human subject or animal care provisions, conflict of interest, or on such other topics as may be required by the nature of the effort and current statutes, executive orders, or other current Government-wide guidelines.

Respondents should include a brief description of the organization, its facilities, and previous work experience in the field of the proposal. Identify the cognizant Government audit agency, inspection agency, and administrative contracting officer, when applicable.

All commercial awardees will be subject to terms and conditions under NASA Grant and Cooperative Agreement Handbook, Part 1274, Sections 901 through 942 unless otherwise indicated in this CAN, when Cooperative Agreements are negotiated after notification of selection. Respondents should pay careful attention to these referenced provisions and conditions and indicate in their proposal if they take exception to any of these terms and conditions.