NSF Budget and Management Review
IRIS Proposal for Support of
Seismological Facilities for the Advancement of Geoscience and EarthScope (SAGE)

Executive Summary

A ten-person panel with expertise in seismology, geodesy, information technology, cyberinfrastructure, data management, project management, scientific and user-facilities operation, and budgeting met at the National Science Foundation (NSF) from January 9-11, 2013 to review the management and budget aspects of a pair of large-facilities proposals for the operation of SAGE (IRIS) and GAGE (UNAVCO). The panel had received and reviewed in advance the two-volume proposals for each project, along with the report of a "Special Emphasis Panel" review, which NSF had convened in October 2012 to assess the intellectual merit and broader impacts of the proposals. At the January review, in separate sessions without representatives of the other proposal present, IRIS and UNAVCO each made a presentation about their respective proposal and answered detailed questions from the panel. A list of additional written questions was provided to each team at the end of the first day, with written answers due and submitted by noon the following day. A final, brief and separate telephone interview was held with each proposal team to follow up on the responses. Separate reports were prepared by the panel for the GAGE and SAGE proposals. This report applies to the SAGE proposal.

<u>Strengths</u>

1. The SAGE proposal builds on IRIS' extraordinary record of success in providing national and worldwide seismological monitoring and the full range of data services from collection to curation.
2. The connection to the seismological community and mechanism for working with this community is strong and highly effective.
3. IRIS (SAGE) is also well connected to the larger scientific and geosciences data sciences community and it is clearly leveraging opportunities and advances in these areas.
4. IRIS has a formal and inclusive structure to engage consortium members in interactions to inform and guide the direction the organization takes to meets it goals and accomplish its mission. The panel agrees with the IRIS Board of Directors that an opportunity exists to streamline the governance structure in ways that enhance cross-program integration, promote inclusion, and reduce the effort and costs involved in governance.
5. The Instrumentation Services (IS) component represents over 70% of the budget, and it has implemented best practices in project management and system engineering to manage and engineer their activities effectively. IRIS' track record in IS demonstrates consistent success in achieving the scope within the assigned budgets and schedules.
6. The Panel applauds IRIS for its foresight in designating resources to invest in and develop innovative new technologies. Such work is vital for the long-range value of SAGE and seismological research.
7. IRIS overall plan for the operation of data services (~20% of the budget) is appropriate and adequate for the data services needs of SAGE. The plan is well developed in terms of the services to be provided and the manpower resources to be deployed.
8. Attention to data quality, support for data services, and the development of necessary quality assurance tools, like the MUSTANG toolset, is commendable.

9. IRIS is engaged in a well conceived migration to a service-oriented architecture, using web services to access all data.
10. IRIS' selection process for and successful track record of overseeing and managing subawardees bodes well for SAGE, as 47% of the proposed budget is expected to be spent through subawards.

Weaknesses

- The budget as presented was not very transparent, making it quite difficult for the panel to understand what the particular activities and the proposed expenditure amounts were for. Three examples follow:
  - Travel needs to be better justified throughout the proposal. Both the number of trips and their purposes need explanation.
  - There are large amounts of funding in the "other" category, which are not clearly described or explained.
  - The purpose of the high publications budget is not apparent, and it is not well justified.
- Presentation of formal risk-management approach was inadequate, and IRIS should ensure that a focus on risk management, including very importantly safety, is present at all levels of the organization and in all WBS elements of SAGE.

Recommendations

1. Polar activities have high public visibility and support important science, with the potential for greater output with more extensive collaboration with the climate science community and the potential for efficiencies and cost savings through increased collaboration with UNAVCO.
2. Deeper engagement between GAGE and SAGE should be planned for as a specific activity in the data services WBS element. This may position both organizations to take better advantage of new disruptive technologies and community investments, like Earth Cube.
3. This review panel concurs with the October review panel regarding the importance of IRIS incorporating within the EPO effort initiatives that can broaden the impact of SAGE to the professional community beyond traditional seismology.
4. The panel recommends that IRIS and NSF consider some reprioritizing within the total budget estimate for EPO, such that the recommendations from the October panel could be included, along with an external evaluator to provide systematic evaluation of the K-12 and teacher-oriented EPO activities.
5. For Community Activities, if budget savings might be needed, it would be worth considering reductions in costly print publication/dissemination, in favor of lower cost web or CD/DVD publication, along with using distance technologies for some symposia, workshops, and other meetings.
6. International Development Seismology (IDS) is an ambitious and worthwhile activity that should be pursued. Since this program is just getting started, IRIS should develop specific goals and milestones together with appropriate metrics for evaluating success.
7. The panel suggests that more clarity be included in the budget and recommends that NSF seek more detailed explanation of the activities covered in IDS.

A. Introduction

IRIS is a university consortium that has operated an extensive network of national and global seismic stations for the benefit of the earth science community and society, primarily sponsored by NSF and other federal agencies. For EarthScope, IRIS was responsible for the USArray component. In response to a request by NSF, IRIS submitted the proposal for support of "Seismological Facilities for the Advancement of Geoscience and EarthScope" (SAGE). NSF

specifically requested that IRIS develop a plan to integrate and operate its core seismological resources along with the USArray component of EarthScope, seeking synergies and cost-savings. Additional synergies were to be developed in collaboration with UNAVCO, which was requested to present a plan for operating a network of geodesy stations through a facility called "Geodesy Advancing Geosciences and EarthScope: the GAGE facility." NSF provided budget guidance and allowed annual increase amounts, and requested an integrated proposal for 5-years of operation (FY2014 through FY2018). The resulting proposal has a 5-year budget of $152.4 million, of which $5.7 million relates to the polar regions and would be funded by NSF's Division of Polar Programs (DPP) rather than NSF-EAR. IRIS engaged its governance committees and the seismological research community extensively in developing the proposal it submitted.

NSF convened a ten-person panel (Appendix I) with expertise in seismology, geodesy, information technology, cyberinfrastructure, data management, project management, scientific and user-facilities operation, and budgeting to review the management and budget aspects of a pair of large-facilities proposals for the operation of SAGE (IRIS) and GAGE (UNAVCO) (Appendix II). The panel met at the National Science Foundation (NSF) from January 9-11, 2013, with two members participating via WebEx. The panel had received and reviewed in advance the two-volume proposals for each project, along with the report of a "Special Emphasis Panel" review, which NSF had convened in October 2012 to assess the intellectual merit and broader impacts of the proposals.

At the January review, in separate sessions without representatives of the other proposal team present, IRIS and UNAVCO each made a presentation about their respective proposal and answered detailed questions from the panel. A list of additional written questions (Appendix III) was provided to each team at the end of the first day, with written answers due and submitted by noon the following day. A final, brief and separate telephone interview was held with each proposal team to follow up on the responses. Separate panel reports were prepared for the GAGE and SAGE proposals. This report applies to the SAGE proposal.

B. IRIS Overall Management and Governance (WBS 3.1.1, 3.1.2, 3.2.1, 3.2.2, 3.3.1, 3.3.2)

1. Community Governance Structure and Composition

IRIS is a consortium of 117 university members and 143 affiliate members, including 117 foreign affiliates. It is governed by a nine-member Board of Directors, which has fiduciary responsibility for the IRIS consortium and the IRIS non-profit corporation. Directors are elected by the membership. Candidates for the board are primarily drawn from the Member Institution Representatives, although recently two board members serve from outside the consortium. Election slates are assembled by a Nominating Committee. Typically, six to eight candidates are nominated for three positions.

Several standing programmatic committees composed of IRIS stakeholders report to the Board of Directors and provide advice on the community's needs and priorities. In addition, ad hoc working groups study and report on specific issues. In total these bodies comprise some 80 individual members of the IRIS community, the majority of whom are active researchers. Individual participants are expected to act in the best interest of the consortium when serving in governance capacity, and a conflict of interest policy is in place to minimize the risk of board members acting differently.

An effort is made to encourage balanced representation in terms of individual scientific credentials, discipline, institution, geographic distribution, gender, ethnicity, and career stage. In 2012, 83 individuals were involved in IRIS governance (67 from universities, two from research institutes, one from a 2-year college, one from industry and eight from government/national laboratories). Individuals are drawn from 28 distinct states, eight of which represent EPSCoR jurisdictions. Women represented 31% of the 2012 governance participants, and this is a number that has increased over time. Early-career governance participation (pre-tenure or very close to tenure) is about half of each of the primary standing committees—PASSCAL, DMS, GSN and EPO. The panel feels that IRIS should continue to focus attention increasing diversity to broaden participation at all levels in governance processes.

We note that a prior panel reviewing this proposal called for additional effort to engage early career scientists in governance. This panel agrees that engagement of early career scientist is important and acknowledges the steps IRIS is taking to promote inclusion of early career scientists in governance. For instance, IRIS provides modest support for an Early Career Investigator group, which meets at AGU meetings, participates in the bi-annual Workshop, and interacts with NSF and international organizations. If nurtured, the group can increase the visibility of early-career scientists and their research and promote mentoring and collaboration between junior and senior scientists.

Summary: IRIS has a formal and inclusive structure to engage consortium members in interactions to inform and guide the direction the organization take to meet its goals and accomplish its mission. The panel agrees with the IRIS Board of Directors that an opportunity exists to streamline the governance structure in ways that enhance cross program integration, promote inclusion, and reduce the effort and costs involved in governance. The frequency of governance meetings is not considered to be inordinate; the Board meets three times each year and standing committees meet two times each year.

2. Corporate Management Structure

Based on a long history of successfully advancing seismology research, presentations to the panel, and a review of the biographical information, the IRIS senior management team appears to be highly professional and accomplished.

The IRIS corporate management structure was recently reorganized in anticipation of the unification of NSF funding under the proposal under evaluation. In the current structure, which is envisioned to be carried forward into a new award period, the office of the President includes cross-organizational planning and support and business and administrative function. It is funded through the indirect cost pool. Four main program areas report to the President: Instrumentation Services, Data Services, Education and Public Outreach, and International Development Seismology. Activities in these areas would be funded primarily as direct costs under the SAGE award as well as from other smaller extramurally funded sources. Evolution of the IRIS management structure included establishing a Business Services Organization in response to a formal NSF Business Systems Review. The panel suggests that the initiation of SAGE offers IRIS an opportunity to develop a project management plan that explicitly describes the duties and responsibilities of the officers and the various committees as well as how the decision-making process works. It could well be a codification of the current structure. Such a document would be valuable in the future, particularly if conflicts arise.

IRIS program areas correspond to the standing committees, and IRIS staff-level Program Directors have strong interfaces with the corresponding committees and, presumably,

committee chairs. This structure creates the key interfaces between the community and the facility staff.

Significant portions of the work scope are performed by subawardees. Major subawards are requested for New Mexico Tech, UC San Diego, and Honeywell Technology Solutions. These proposed subawardees have been working with IRIS for many years, capably providing similar support as is planned for SAGE.

The work proposed under the New Mexico Tech award would continue to be carried out in a facility dedicated to IRIS activities. The Portable Instrumentation Program Manager, an IRIS employee, works out of that facility. The GSN Program Manager has responsibility for managing the GSN portion of the UC San Diego subaward. Honeywell Technology Solutions provides field installation services for the Transportable Array. The Transportable Array Manager is responsible for oversight of the Honeywell subaward. This award is long-standing, and the size has allowed a strong relationship to form between IRIS personnel and a dedicated cadre of specific Honeywell engineers.

Subawards introduce risk into all projects and the risks in this case are amplified because proposed subawards constitute nearly half of the total proposed budget. IRIS has a well-thought out rationale and management and control structure in place for subaward monitoring. For instance, several awards were originally competed or there is a clear sole-source justification, and the proposed performers have excellent track records in the areas they are planned to participate. The New Mexico Tech subaward leverages significant institutional support in the form of a dedicated facility. IRIS has a formal written subaward policy. Finally, IRIS demonstrated mechanisms for active engagement of the day-to-day management of the work being performed by subawardees. Nevertheless, subaward monitoring should remain a management priority.

Summary: The recently reorganized IRIS management structure is clearly defined and should facilitate cross program integration and operational and administrative efficiency. Well defined interfaces exist between the IRIS governing committees and the senior program staff. Subaward monitoring and proactive management is strong—as it must be—given that almost half of the budget request is allocated to subawards.

3. Governance and Management Processes

Community engagement. IRIS has a clear organizational mission and strong community-based planning and assessment process. The IRIS community appears to be significantly involved in IRIS planning and review activities. For example, the annual budget process involved (1) developing high level guidance at the President/Board level, (2) engagement by program managers and the standing committees, (3) review by the Program Coordinating Committee, and (4) final approval by the Board of Directors. The development of the SAGE proposal followed a similar process of community input and vetting. Goals and priorities followed from several community-developed planning documents, and the proposal was reviewed at the annual IRIS workshop.

To understand more specifically how the community's assessments are used, the panel elicited from IRIS representatives concrete examples of how priorities have been determined and difficult choices made. In one case, a choice was made to maintain the current size of the pool of portable instruments, despite it being oversubscribed, and to direct significant resources into

next generation technology, new deployments, and facility initiatives. The community-mediated process that led to this resource allocation included deliberation and recommendations in the PASSCAL standing committee, discussion at a community workshop, and ultimately approval by the Board of Directors.

In another case, the IRIS Board of Directors issued budget guidance (based on NSF guidance) that did not provide enough funding to implement the original US Array plan in Alaska. A set of choices was presented to participants in a half-day dialog at a community workshop in Austin in May 2012, which resulted in a plan that reduced the number of Transportable Array stations by 25%, increased the station spacing, and eliminated stations located well out on the Aleutian chain. The revised plan was presented to and approved by the USArray Advisory Committee and a new project budget was built up under the revised scope.

No trade-off pleases everyone but a sound community-based process creates a strong basis for making difficult decisions.

Management systems and practices. The IRIS Business Services Organization handles financial services and sponsored projects, which include accounting and financial controls, contracts and awards, procurement, inventory, insurance, management policies and procedures, proposal submission and reporting. It appears to be amply staffed to support the organization's business functions generously, including administrative monitoring of IRIS subawards.

IRIS tracks a number of performance metrics across the organization. IRIS representatives explained how different metrics are presented to and used by technical staff and management, governing bodies, the IRIS membership, and NSF to review the organization's performance and make day-to-day and long term decisions.

Risk management is one important management function that seemed under-emphasized in the proposal and in interactions with the panel. IRIS staff recognized that risks are embedded in the assumptions made in the WBS and are typically resolved through schedule and scope adjustments. Aside from data backups, no serious mention was made of risk mitigation to prevent risks from being realized, forcing schedule and/or scope compromises. For instance, given the heavy field-based nature of many elements of the proposed activity, the panel expected to hear more about how IRIS manages safety risks across the project. In response to a prior panel recommendation, IRIS indicated that the Board maintains a succession plan for senior leadership. These are important and admirable risk management approaches, however, an organization as large and complex as IRIS should have systematic understanding of the risk environment across all parts of the organization to enable a comprehensive risk management strategy at the upper management level.

Ongoing management issues that should receive continued attention include: inclusive community engagement, ensuring a good balance between maintenance of existing facilities and investing in innovative new directions, and ensuring long-term sustainability of programs.

Summary: IRIS has an authentic process for integrating community-based governance with facility management. Examples explored by the panel have demonstrated how difficult choices and trade-offs were made with input of the community. IRIS has a strong management process that includes business and administrative functions and controls, performance monitoring, succession planning. Presentation of formal risk management was inadequate, and IRIS should

ensure that a focus on risk management, including safety, is present at multiple levels of the organization.

4. Budget Considerations

In this section, the Panel evaluates general budgetary assumptions and principles and provides comments that apply to the overall proposal and to the budget requested for management and governance activities. The overall budget was developed using appropriate guidance from sponsors, historical costs and escalation considerations. Budgets were segregated by sponsor and program, so that the panel could see which specific scope would be funded by DPP. The budget and work plans were organized in a work breakdown structure (WBS), which covers the entire scope of SAGE. Descriptions of the different WBS elements and information regarding the basis of estimate are found in the WBS Dictionary. Subaward costs were documented through the budget detail provided by the proposed subawardee. Detailed budgetary analysis of the other components of SAGE is addressed in subsequent sections of this report.

The costs of governance and management are carried in clearly identified elements of the WBS and in the indirect cost pool. The total cost (direct + indirect) of management and governance for the identified WBS elements is just under 15% of the budget. The indirect costs budgeted to IRIS, which also partially support management and governance, is about 12% of the budget. (Additional indirect costs are allocated to subawardee institutions.)

The level of managerial staff seems ample. Some panel members indicated a sense that the organization may be somewhat top heavy and that IRIS should have been able to document a reduction of more than a few FTEs in the reorganization. Other panel members accepted that the efficiencies were realized incrementally within individual positions in the organization (as opposed to identifying redundant positions), which permitted a redistribution of job duties to allow more or less the same number of individuals to accomplish additional scope of work as represented by the new initiatives such as Large N and GABBA. In any case, it appears that IRIS is managing to increase scope within a budget, which is allowed to increase by only 3% per year. The panel notes that the projected annual funding for 2013-2018 coupled with likely inflationary cost increases will require IRIS to develop and implement innovative process improvements and cost-reduction initiatives in order to maintain the quality of service being provided to users.

At the highest level, IRIS has used a sound approach to developing the budget and the costs are traceable to specific WBS elements, which are comprehensive in defining the scope of work over the next five years. Some relatively minor concerns were raised about the budget in general.

Several panelists felt that the IRIS budget was difficult to follow and lacked adequate budget transparency and clearly formulated budget assumptions. For example, what competitive pressures exist that risk the retention of key personnel, and were these risks considered in the general assumptions for labor costs? There are also a number of cases in which costs identified in the WBS dictionary are not well justified. For instance, there are cases (e.g. education and outreach) where there is inadequate justification of assumptions related to the number and purpose of trips estimated for various staff members. And, we found the budget for publication costs to be high and the recognition of the benefits of emphasizing electronic dissemination and collaboration mechanisms in a time of downward pressure on federal budgets to be low.

A history of budget under-runs at the ~5% level reinforces a general sense that IRIS could implement additional cost saving, if pressed. However, the degree to which savings might be found is unclear. This might be an area for additional exploration by NSF and IRIS staff.

Summary: IRIS used a sound approach to project definition and traceable cost allocation. Some concerns related to overall budget transparency and the justification of assumptions (e.g. travel and publication budgets) were noted by the panel.

C. Instrumentation Services (WBS 3.1)

Overall, Instrumentation Services (IS) represents $108.5 million or more than 70% of the SAGE budget. The scope includes the management and activities involved with Portable Seismology, the Global Seismographic Network (GSN), Polar Support Services, deployment of the Transportable Array (TA) in Alaska, Magnetotellurics (MT), and coordinated activities. Much of the scope is accomplished through several subawards, using the same performers who have partnered successfully with IRIS previously.

1. IS Management and Governance (M&G)

This task covers the management of the complete suite of Instrumentation Services (IS) activities, such as planning, personnel management, sub-award management and preparation of annual and longer-term budgets, budget tracking, and reporting, and compliance. IS has implemented best practices in project management and system engineering to manage and engineer their projects successfully and effectively. M & G staffing levels appear to be appropriate at an average of 6.7 FTE's / year. The track record is strong and excellent for working within assigned budgets and schedules. The 5 year budget total for IS M&G is $8. Million, which is 8% of the IS budget or 5.6% of the total budget.

- IRIS management and Board of Directors are encouraged to continue looking for any efficiencies that may be gained by a more closely aligned overlay between governance and management across the entire SAGE effort.

2. Portable Seismology

The core of the Portable Seismology operations is through the portable seismology task included in the subaward to New Mexico Tech (NMT) for operation of the PASSCAL Instrument Center (PIC) and primarily covers staff support. A smaller subaward to the University of Texas El Paso (UTEP) provides support for the shared Texan instrument facility. The large NMT subaward is actively managed by an IRIS manager, who is located full time at the PASSCAL facility in New Mexico. This is a major subaward with a 5-yr budget total of $22.4 million (14.7% of the total SAGE budget or 21% of the IS budget). Although portable instruments appear to be in short supply, and it may be desirable to purchase additional units, IRIS conducted a process with its community, and the priority of investing in such units was determined to be lower than other components of SAGE. The panel respects this prioritization approach, while suggesting that IRIS, its community, and NSF could revisit this choice, if funds could be found within the budget, as additions to the portable unit inventory could be beneficial.

- Having the IRIS management person located on site in New Mexico is both prudent and appropriate.

3. Global Seismographic Network - GSN

The Global Seismographic Network task is primarily accomplished via a subaward to UC San Diego (UCSD), covering personnel and operational costs for the 41 stations in the IRIS/IDA

component of the GSN. The $15.5 million 5-year cost of this component is 10.2 percent of the total SAGE budget. A cost comparison between the 90 USGS supported stations and the 41 IRIS stations demonstrated that the IRIS costs are reasonable and compare favorably with USGS costs on a per-station basis. New equipment upgrades and replacements have increased field staff efficiencies and productivity and should continue to be exploited to minimize cost.

4. Polar Support Services

This proposal includes a request (planned to be funded by NSF's Division of Polar Programs) to utilize the staff and facilities of the Polar Support Services group at the PIC and to provide specialized cold-hardened instrumentation to support seismological projects in both polar regions. At $5.7 million, Polar Support is only 3.8% of the total SAGE budget, but it accesses very important science and has high visibility to the public and the scientific community beyond seismology. In the context of climate change, polar science is extraordinarily significant, representing something like a "canary in the climate mine." New equipment upgrades and replacements have resulted in increased field staff efficiencies and productivity. These improvements should continue to be exploited to reduce cost.

- UNAVCO's GAGE activities also include the polar regions, opening the possibility that additional collaboration in these regions between GAGE/UNAVCO and SAGE/IRIS could lead to greater efficiencies and cost savings.

5. Transportable Array (TA)

The Transportable Array is managed by a team of five IRIS employees, led by the TA Manager. The team is responsible for oversight of all procurement, permitting, siting, installation, operation, and data collection activities. SAGE includes TA deployment in Alaska, an effort likely to experience challenges different than those experienced in the Lower-48. The construction, installation, and removal of stations will be done via a subaward to Honeywell Technical Services. Inc. (HTSI), with IRIS supervisory personnel and field engineers.

Real time data return from the TA stations has been above 99% and is attributed in part to the uniformity of design, installation and construction of the TA stations. Overall the TA (WBS 3.1.6) is budgeted at $47.4 million (31% of the total SAGE budget). The Honeywell subaward is valued at ~$14.3M over the 5 years and involves ~5 FTE / yr. The panel had questions about the $1 million increase in equipment expenditures for the TA between Year 1 and Year 2. Unless this difference is for purchasing equipment to enable the full deployment of the TA in Alaska, the planned equipment budget should be investigated further.

6. Magnetotellurics

All MT activities are funded through a subaward to Oregon State University. Oversight and coordination are provided through IS Management by the Director of Instrumentation Services. The IRIS Director of IS is charged with primary oversight of the MT operations. This approach seems both adequate and appropriate. The permanent MT backbone (MT-BB) includes seven observatories deployed across the Lower 48 states. The scope also includes 21 NIMS receivers for the MT-TA stations. The budget for MT (WBS 3.1.7) is $3.7 million or 2.4% of the total budget.

7. IS Coordinated Activities – New Directions

This component of the effort emphasizes the development of innovative and advanced new technologies for possible future instruments, with development efforts emphasized in Years 1 and 2, and possible purchase and deployment of ~300 units in years 3 – 5. The budget

requested for WBS 3.1.8 is $5.3 million (3.5% of the total). A needs analysis and requirements specification are required to define user needs to guide these efforts. There is a plan to use commercial-off-the-shelf (COTS) equipment and technology, which is an appropriate approach. The desire is to obtain improved performance and energy efficiency (e.g. lower power usage) in new systems. The cost estimate for purchasing the 300 units is based on the current price of current systems, and may not be accurate for future systems.

- The panel agrees that for the health and productivity of SAGE over the long-term, development of and investment in new technology is a requirement. However, the panel was divided over whether budgeting for a large N procurement is justified at this time, given that the equipment has not yet been identified and it is not known if the specs desired will be procurable. It could be worthwhile for IRIS and NSF to consider the benefits of the proposed approach versus a possible alternative of requesting a budget supplement if exploration and development efforts pay off.

8. Subawards

Subawards are for the most part a product of IRIS' long and successful history with their partners, and constitute 47% of the SAGE budget ($71.2 M). Some subawardees were originally selected through a competitive bid process. Others were selected via a sole source due to specialized expertise. Because the subaward volume is such a significant amount of the SAGE budget, the subawards require a high level of scrutiny and management. The selection process appears to have provided the required level of oversight and to have been a well-managed process. IRIS has an excellent track record of managing and overseeing the subawards.

University of Texas El Paso (UTEP)

UTEP was selected on the basis of a sole source, because it owns a portion of the Texan instrument pool, which is the basis for the sub-award to coordinate activities with PASSCAL. The leading expert for explosive studies and containment in the US is at UTEP – Steven Harder. The 5-Year total budget is $2.2 million.

University of California San Diego (UCSD)-IDA

UCSD was originally selected via sole source, due to its experience through Project IDA in building and operating the initial global network of seismometers and operated prior to IRIS' inception. The ANF was awarded competitively to UCSD in 2004. UCSD's proposed 5-Year total subaward budget for SAGE is $22.0 million.

University of California-Berkeley (UCB)

UCB was selected as a sole source for this small $100 K subaward, due to its role in operating the Berkeley Digital Seismic Network.

Oregon State University (ORST)

ORST is involved in magnetotellurics. It was selected through a 2006 RFP for the MT Pilot Project. The total subaward budget proposed for SAGE is $3.6 million.

Honeywell Technical Services, Inc. (HTSI)

HTSI was selected for the installation of TA stations via an RFP process, conducted in 2005. The 5-year total to continue TA deployment into Alaska is $14.3 million.

Columbia University

Columbia University is identified for a $100K subaward, based on its PI's qualifications and experience with Russian networks.

New Mexico Tech (NMT)
New Mexico Tech was selected as the location for the PASSCAL Instrument Center (PIC) via a competitive procurement process conducted in 1997. The 5-Year subaward budget totals $27.1 million.

Recommendations
- Polar activities have high public visibility and support important science, with the potential for greater output with more extensive collaboration with the climate science community and the potential for efficiencies and cost savings through increased collaboration with UNAVCO.

D. Data Services (WBS 3.2)

Data Services (DS) for SAGE is responsible for receiving, archiving, and distributing seismic data generated by the seismic stations operated by IRIS. Overall, about $30 million or 19% of the 5-year budget for SAGE, and over half of the estimated labor (120 person-years of the 234 person-years of effort) is involved in DS. The overall management and budget processes for IRIS DS are deemed appropriate and adequate for the needs of the SAGE project. IRIS provided a well-developed plan about the services to be provided and the manpower resources to be deployed. The 24 FTEs are budgeted with detailed information on the assignment of these personnel to the tasks within DS. Attention to data quality, its support in data services and the development of necessary quality assurance tools like the MUSTANG toolset is commendable. A clear, consistent, and comprehensive effort is planned to provide research ready datasets.

IRIS is well connected to the larger scientific and geosciences data sciences community and is clearly leveraging opportunities and advances in the area. Sustained efforts by IRIS, as evidenced by their participation in community activities and opportunities like the DataNet and EarthCube concept awards are noted. The success of the IRIS data team in obtaining additional competitive awards from other NSF and NASA programs to augment activities is commended. However, IRIS management should explicitly identify the impact of these other activities on staffing levels and other resources and ensure that personnel are not overcommitted.

IRIS data services team has a good track record over the years of integrating new developments in all aspects of data collection, processing, curation, and archiving. They are aware of disruptive technologies (e.g., cloud services) and their potential impacts on the data services for SAGE. It is clear that IRIS plans a systematic effort to scout and explore such technologies and bring them in. IRIS is currently engaged in a well-conceived migration to a service-oriented architecture based on web services to access all data. In fact, IRIS leads the EarthCube activity in this domain. Moreover, IRIS expertise will be used in the COOPEUS effort to deploy similar technologies at European sites.

The IRIS and UNAVCO data services operations have different data sets and different though somewhat overlapping communities. The proposal mentions synergies and efforts to exploit them. While the current level of cooperation leverages the easy complementarities (e.g. UNAVCO to send seismic data to IRIS DMC, EarthCube, COOPEUS), it is hoped that this cooperation will lead to deeper engagement and resulting efficiencies in data operations. A deeper engagement between GAGE and SAGE should be planned as a specific activity in the WBS. This approach may position both organizations to better take advantage of new disruptive

technologies and community investments like EarthCube. A detailed look at the operational aspects of DS is summarized in the following bullets.

- Management and Governance: The management and governance structure is well laid out. The model of having a standing committee and a working group augmented with topical invitees appears to be a very good model for community governance of DS.
- Data Operations: This activity includes archiving and curation. It is well supported with core staff and a mix of subawards. There appears to be a stable process for long-term data management and archiving. Hardware and software costs are in line with the storage size and access patterns expected. The University of Washington and Kazakh Data Center are subawardees contributing to this effort.
- Data Products and Services: A well defined mix of data products is proposed with staffing levels and budget appropriate to support their production and maintenance to serve the seismological community.
- Information Technology and Cyberinfrastructure: A well developed and highly qualified group is dedicated to software engineering and new technology induction.
- Quality Assurance (QA): This well organized activity includes a mix of human analyst and automated checking. The commitment to provide research-ready datasets is clear, appreciated, and vital to the success of SAGE. About 55% of the work is accomplished through the subaward to UCSD.
- Subawards totaling $3.8 million (13% of DS and 2.5% of the total SAGE cost) are planned to assist with data management and quality assurance. The University of Washington ($350 K) and the Kazakh Data Center ($165 K) are proposed to be involved in DS and DMC operations, while UC San Diego's IRIS/IDA data-center ($3.3 M) contributes to the QA effort. These subawardees are well qualified and have provided equivalent services to IRIS previously. The UCSD subaward is budgeted at 90% of their recent year amount, to account for expected efficiencies and cost reductions.

The management and budget processes for IRIS DS plan of operations appear to be appropriate and adequate for the data services needs of the SAGE project. IRIS presents a well developed plan for the services to be provided and the manpower resources to be deployed. Attention to data quality, its support in data services, and the development of necessary quality assurance tools like the MUSTANG toolset are commendable. Resources are allocated to provide for this quality of service (QOS).

SAGE benefits from IRIS' excellent connections to the larger scientific and geosciences data sciences community. IRIS is clearly leveraging opportunities and advances in DS, although the impact on the personnel required for these activities is unclear. IRIS management provides a systematic effort to scout and explore new DS technologies and their adoption to benefit the user community. SAGE and GAGE are starting to exploit some synergies but there is opportunity for deeper engagement yielding further benefits and potential economies.

<u>Recommendations</u>

- IRIS management should explicitly call out the impact of external engagement (e.g. Earth Cube) activities on staffing levels and other resources planned for SAGE, so they can be understood.
- Deeper engagement between GAGE and SAGE should be planned for as a specific activity in the data services WBS element. This may position both organizations to take better advantage of new disruptive technologies and community investments, like Earth Cube.

E. Education and Public Outreach (WBS 3.3)

Education and Public Outreach (EPO, WBS 3.3) constitutes about 6.5% ($9.95 M) of the 5-year SAGE budget estimate. The scope includes the management and governance supporting EPO; curriculum, materials, software development, and professional development for K-12 students, their teachers, undergraduates, graduate students, and college faculty; web-based tools, displays, animations, mobile apps, and social networking; and outreach to the professional community. The track record of IRIS in educational and outreach activities for the public, K-12, and the seismological community has been extraordinary. The SAGE plans, however, do not include any budget for the external evaluation of the K-12 education effort.

This review panel concurs with the October review panel regarding the importance of IRIS incorporating within the EPO effort initiatives that can broaden the impact of SAGE to the professional community beyond traditional seismology. We urge IRIS to take very seriously all of the EPO recommendations made by that panel.

The management of EPO is experienced and well qualified, and the staffing and approach are both reasonable, low risk, and continuing to build on past accomplishments. There does not appear to be anything particularly new or innovative in the plans. The budget presented appears quite adequate to accomplish the described scope. However, in many cases the justification for the estimate is vague. For example, the travel budget (domestic and international) is about $375 K (about $75 K per year). This estimate is based on the director taking 13 trips per year, having each EPO staff person take about 3.5 domestic trips per year, and by supporting two trips per year for each member of the EPO Standing Committee (EPOSC). Unfortunately, no information is provided about the purpose of these trips or the reason that number proposed is the required number each year to accomplish the SAGE and EPO goals. Other estimates appear similarly generous. It is important to bring the EPOSC together, but perhaps one “in-person” meeting per year would be adequate, supplemented by one or more web or phone meetings, with the in-person meeting held at IRIS or a partner institution where space rental would be minimal to non-existent.

Projections on the number and cost of community meetings regarding the deployment of USArray in Alaska, appear to be based rather closely on the experience with these meetings for “Lower-48” deployment. The panel questions whether this extrapolation is reasonable, because the environment, distances, and communities in Alaska are so different than they are in the “Lower 48.”

Although inadequate information was provided for the panel to judge the budget for EPO thoroughly, it appears to be in the range of adequate to generous, with opportunities to economize without compromising impact. Thus, it should be possible, within the total budget estimate for EPO for IRIS to do some reprioritizing, such that the recommendations from the October panel could be included, along with an external evaluator to provide systematic evaluation of the K-12 and teacher-oriented EPO activities. This reprioritizing would maximize the effectiveness and results from EPO to the advantage of SAGE.

<u>Recommendations</u>

- This review panel concurs with the October review panel regarding the importance of IRIS incorporating within the EPO effort initiatives that can broaden the impact of SAGE to the professional community beyond traditional seismology.

- The panel recommends that IRIS and NSF consider some reprioritizing within the total budget estimate for EPO, such that the recommendations from the October panel could be included, along with an external evaluator to provide systematic evaluation of the K-12 and teacher-oriented EPO activities.

F. SAGE Community Activities (WBS 3.4)

The scope of SAGE Community Activities (WBS 3.4) is to inform and engage the seismology community along with national and international organizations and consortia in SAGE activities and planning. In addition, this WBS element includes providing general seismology and earth science information to government agencies and international organizations. Community Activities comprise 1.1% ($1.7 million) of the 5-year budget for SAGE. Primary activities include three biennial IRIS workshops, two Seismic Instrumentation Technology Symposiums (in the other two years), along with the publication of an annual report and two brochures each year, primarily intended for seismologists and other users of SAGE services. These activities continue past practice and are not particularly innovative.

Labor estimates are reasonable, and there is little doubt that the proposed budget is sufficient to accomplish the scope with minimum risk. In the future, if budget savings might be needed, it would be worth considering reductions in costly print publication/dissemination, in favor of lower cost web or CD/DVD publication, along with using distance technologies for the symposia and workshops, as many other organizations have done to reach a larger audience and engage more stakeholders at lower cost.

Recommendation

- For Community Activities, if budget savings might be needed, it would be worth considering reductions in costly print publication/dissemination, in favor of lower cost web or CD/DVD publication, along with using distance technologies for some symposia, workshops, and other meetings.

G. International Development Seismology (WBS 3.5)

The International Development Seismology (IDS) effort is a recent IRIS initiative to encourage science in general, and seismology in particular, in developing countries. At the same time IDS leverages the global reach of research programs in seismology. Partnerships with developing countries could, among other benefits, extend the Global Seismic Network, both for research and for local earthquake/tsunami hazard awareness. Overall, the IDS budget represents 1.3% of the total.

The IDS program to extend seismic installations significantly in developing countries has great potential. Unfortunately, in many of these countries there are few scientists, trained technicians and resources that would allow the formation of partnerships. However, there is an opportunity to provide education and technical training and in so doing to expand local opportunities for a trained technical workforce. The availability of good jobs can help motivate talented locals to further their education, thereby helping to upgrade the quality of the workforce. Over time this investment, along with the accelerating global interconnectedness, will improve significantly the viability of seismic installations in these countries. The SAGE budget includes a full-time director and an assistant dedicated to IDS. Beyond salaries the budget included travel along with funds

to include developing-country participants in the alternating annual workshops for IRIS (about $160 K per workshop) and SITS (about $30 K per workshop).

The IDS program is just getting started and is highly ambitious. Indeed the broad scope envisaged for the program may be beyond the resources allocated. It will be important, therefore, to define specific, achievable objectives and to evaluate the efficacy of the program in reaching these objectives.

Recommendations:

- IDS is an ambitious and worthwhile activity that should be pursued. Since this program is just getting started, IRIS should develop specific goals and milestones, together with appropriate metrics for evaluating "success."
- The panel suggests that more clarity be included in the IDS budget and recommends that NSF seek more detailed explanation of the activities covered in this budget element.

H. Summary and Conclusions

On the basis of a thorough review of IRIS' management plans and budget for SAGE, the panel concludes that the proposal is overall solid, worthwhile, and well planned. The leadership and management teams are well qualified. Specific recommendations address areas where questions remain or attention is needed. In a couple cases, the panel understands and respects IRIS' process for reaching those conclusions, but suggests that IRIS and NSF together may wish to revisit the results, possibly modifying the plans, if warranted, in the best interests of SAGE and its scientific impact. The panel's concerns in this regard relate to the choices not to budget for additional portable equipment and the plan to budget for purchase of large-N future, yet-to-be-developed instrumentation.

The panel has high confidence that IRIS can and will manage SAGE effectively, and the result can be transformative for the seismic and broader earth science community.

Appendix II
Charge to the Panel

NSF Guidance and Budget/Management Review Criteria for GAGE and SAGE proposals
21 November 2012

This document summarizes guidance that the Division of Earth Sciences (EAR) at NSF provided to IRIS and UNAVCO on the GAGE and SAGE proposals, and describes the review criteria to be used in evaluating the budgetary and management aspects of each proposal.

1. General

- We requested a proposal from IRIS to operate and manage an integrated seismic Facility comprising the USArray component of the EarthScope Facility and the core seismic Facility IRIS currently manages. We requested a proposal from UNAVCO to operate and manage an integrated geodetic Facility comprising the PBO component of the EarthScope Facility and the core geodetic Facility UNAVCO currently manages. The proposals were due 1 September 2012 and were to cover the five-year period starting 1 October 2013, when current NSF/EAR support for these activities expires.

- UNAVCO and IRIS proposed the names *"Geodesy for the Advancement of Geoscience and EarthScope: the GAGE Facility*" and *"Seismological Facilities for the Advancement of Geoscience and EarthScope [SAGE]"*, which we approved.

- We are treating these proposals as "companion" proposals, but not formal collaborative proposals. We therefore directed IRIS and UNAVCO to collaborate in the preparation of these proposals to (1) develop a common high-level organization for the proposals and (2) jointly prepare the portions of the proposals that involved activities that are currently part of the EarthScope Facility.

- We provided first-year budget caps of $27.62 million for SAGE and $14.89 million for GAGE, with 3% annual inflation allowed in years 2 through 5. We also anticipated that the proposals would include total budgets that exceed those caps by including support requested from other NSF divisions/directorates or other agencies. We requested the proposals provide budget breakouts that make clear the total amounts being requested from EAR, from other NSF divisions, from all of NSF, and from other Federal sources.

- We have informed the PIs that the proposals would undergo independent mail review, followed by a joint panel review and a joint budget and management panel review. We provided review criteria (see below), and we informed the PIs that each reviewer would receive a copy of this unified document, including the review criteria.

2. Overall proposal structure and deviation from the Grant Proposal Guide

Overall, these proposals were to be prepared in accordance with the NSF Grant Proposal Guide (NSF 11-01 http://www.nsf.gov/publications/pub_summ.jsp?ods_key=gpg), but with significant deviations as described below:

- Each proposal was to be based on an underlying integrated Work Breakdown Structure (WBS), and provide a detailed "WBS Dictionary" that provides the basis of estimate for each WBS element. We specified required elements including (a) management of current continuous networks managed by each group; (b) management of the USArray or PBO

component of the EarthScope Facility, as appropriate; (c) PI support, including portable instrument pools; (d) polar programs support activities; (e) data management activities; (f) education and outreach efforts; (g) any new initiatives; and (h) project management activities. IRIS and UNAVCO provided draft WBSs, which we reviewed and approved.

- Each proposal was to be provided in three sections in two bound volumes, with contents inthe bound volumes as listed below:

- Volume 1
  - Color Cover
  - Table of contents (proposer generated)
  - NSF standard cover sheet
  - Project Summary
  - Section I
    - Project description and scientific justification (max 75 pages)
    - Budget plan and acronym glossary (max 15 pages)
    - References cited

- Volume 2
  - Color Cover
  - Table of contents (proposer generated)
  - Section II
    - IRIS or UNAVCO 1030s (5 annual + cumulative)
    - IRIS or UNAVCO Budget justifications limited to 3 pages
    - Subawardee 1030s and justifications (max 3 pages each)
  - Section III
    - Work breakdown structure dictionary and personnel table (max 30 pages)
    - Deviation authorization
    - Deviation letter
    - List of suggested reviewers or reviewers to exclude
    - Proprietary information request
    - Lobbying certification
    - FastLane-generated Table of Contents
    - Certifications
    - Biographical sketches in NSF standard format
    - Current and pending support
    - Facilities, Equipment, and Other Resources
    - Data Management Plan
    - Postdoctoral Mentoring Statement (if applicable)

Please note that the FastLane submission deviates from this structure due to the formatting requirements imposed by NSFs FastLane Proposal submission application.

The proposals must provide detailed annual and five-year cumulative budgets; a detailed table or similar structure showing the current activities, proposed integrated activities, and proposed new activities; a table providing budget information for all cross-cutting activities; and a table or similar structure that specifies the names, educational background, and organizational responsibilities for each person for whom support is sought. Every section of the proposal, and every element of the proposal budget, was to be tied clearly and directly to the WBS for that proposal.

We permitted IRIS and UNAVCO to use the following non-standard formats:

- Two-column text in the Project Description and WBS Dictionary
- 10-point font for the Project Description and WBS Dictionary
- 8-point font for figure captions
- 1" margins on top, bottom, and inside, and 0.5" margins on the outside
- Footers with section titles and pagination within the bottom margin
- Color covers for the PDF and hardcopy versions, volumes 1 and 2
- Cover page and table of contents for each Section

We permitted IRIS and UNAVCO to use URLs in the References Cited, if that was the most appropriate citation for a given external source. We also allowed IRIS and UNAVCO to use cross-links to resources elsewhere in the proposal PDFs in order to assist you as reviewers. Links were otherwise not allowed in the proposals.

3. Review Criteria

Please review the bound copy or the PDF supplied by the PIs, not the FastLane submission. The FastLane submission does not completely mimic the structure we requested from IRIS and UNAVCO and that we anticipated in the hard copies.

The proposals have undergone standard NSF merit review focused on the two primary criteria of Intellectual Merit and Broader Impacts, with both independent *ad hoc* review for each proposal and a joint proposal review panel held in October 2012. The review to date has largely focused on scientific and technical merit. The panel being convened in January 2013 is focused on budgetary and management aspects of the proposal, using the review criteria listed below.

Please note that it's not necessary to respond to all questions under each main heading if you don't feel that a given question applies specifically to the proposal, or if you don't feel qualified to judge how well the proposal meets a given sub-question. Rather, please use these points as questions to help guide your evaluation of the proposal under each broad criterion.

How well conceived is the integrated maintenance and operation plan and budget for the proposed Facility?

- Are there well-defined vision, mission, goals, and objectives for maintenance and operations of the integrated Facility to serve the Earth science community?
- Are the planned activities justified and adequate for management and operations of the integrated Facility?
- Is the rationale used to develop task descriptions, milestones, and resource requirements adequately explained in the proposal?
- Are there coherent and effective leadership, management, and organizational structures? Are the duties of each staff position clear and is the need for each position justified? Are the salaries and time commitments appropriate and well justified?
- To what degree does the proposer have the ability to provide access to a Facility intended to serve a national research community?
- Does the project have sufficient financial and audit controls? Are there adequate descriptions of the hardware and software to be maintained and operated, and the means by which this would be accomplished?
- Are the design, construction, installation, and performance history of the installed equipment adequate to insure efficient long-term maintenance and meaningful scientific data collection?

- What is the quality of the plan for risk management for the Facility? Does the risk management plan adequately address budget and other project risks?
- What is the quality of the plan for annual critical self-assessment?

Proposed Facility budget

- Is the proposed budget appropriate, clear, and well justified?
- Does the budget demonstrate cost savings for support of current functions, achieved through integrated management of the components of the proposed Facility?
- Does the proposal include specific activities associated with the work to be performed and the activity-based resource descriptions?
- Are FTE levels appropriate? Are all labor costs used in the budget appropriately and correctly identified? Are the activities and unit costs associated with the project scope clearly identified and defined in the budget?
- Are project resources effectively allocated to all personnel tasks, activities, and equipment and material and supply costs?
- Is the budget consistent with the schedule?
- Are the schedule and budget adequate for maintaining the facility?
- Are the assumptions that have been used to develop the budget, e.g., historical data, data from similar scope projects, etc., clearly identified and defined? Have all uncertainties in theproject scope and budget been identified?

Appendix III
Panel Questions for Overnight Response by SAGE/GAGE

1. Please complete the spreadsheet requested earlier with WBS financial breakdowns and demographic information. Please be sure to provide the WBS financial breakdowns across all subawards as well as the core proposal budget.

2. How did you select your specific subawardees?

3. What is the basis for the cost estimates, including previous experience and the assumptions they made for efficiencies and cost reductions?

4. How did you adjust scope and/or budget to fit NSF's target?

5. How much money (and what percent of the total) are you devoting to developing future technologies and innovation, and how did you decide on that amount/fraction? Why not more or less?

6. What is the prior cost experience on similar work? Did you tend to over-run or under-run budgets in the past?

7. If they had to reduce the budget by 10%, how would the plans change? What about an increase of 5%--how would plans change?

8. There appears to be very limited involvement of/funding for college students (grad and undergrad). Please comment on this.

9. How do you evaluate the effectiveness/success of education and outreach activities and products (both formative and summative)? What budgetary resources are identified for this work?

10. What do your President and the Chair of your Board of Directors worry about regarding the next phase?

11. How do you track science impact? How do users acknowledge use of data and infrastructure?

12. How do you leverage other NSF data/cyberinfrastructure investments such as DataNet at JHU, XSEDE, EarthCube, etc.

13. How do you track user help requests and their resolution?

14. Please elaborate on your approach to sub-recipient monitoring both in terms of financial monitoring and day-to-day management of sub-recipient personnel and scope of work. What are the management interfaces between IRIS (or UNAVCO) personnel and sub awardee management and technical staff?

15. What WBS elements are affected by each subaward?

16. What are primary activities planned to be undertaken by the External Affairs program?

17. Please describe further the community engagement and oversight processes involved in revising or adjusting Facility activities or priorities.

18. How are your metrics used to inform management and programmatic decisions? How often are the metrics evaluated and used to impact what you are doing? Can you give an example of one of your metrics, how it is monitored and how it is used to impact what you are doing?

19. Please provide more details on your staffing: total number of employees and total number of FTEs by organizational function. Please provide an organizational chart showing this information.

20. Fringe benefits appear higher than the norm for NSF proposals. Why is this? Please provide more information on what fringe benefit costs are provided by the organization vs. through employee contributions

21. What is the utilization of the Facility – number of users, geographic distribution, distribution of functions (educational institutions, US government, private sector, etc.), volume of data delivered?