

the IRIS Consortium Structure and Governance

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IRIS Overview

For 25 years IRIS—the Incorporated Research Institutions for Seismology—has been supported by the National Science Foundation and governed by its Consortium members to manage the key infrastructure resources to support academic research in seismology. IRIS, operating as a not-for-profit consortium of 114 U.S. universities and research institutions across the country, has facilitated and embraced a commitment to high-quality instrumentation, data access and sharing, and data services that now underlie much of the research in seismology and solid Earth sciences in the United States and many parts of the world. IRIS activities comprise distributed core facility programs and projects managed by IRIS staff for the community. IRIS has revolutionized how the technical and organizational aspects of seismology are practiced in the United States and worldwide. The concept of shared resources, and especially data sharing, is gradually being adopted globally in large part due to the IRIS philosophy of open data and data sharing for multiple purposes. Never is the access to data more obvious than immediately following major earthquakes such as the recent events in Sichuan, Haiti, Chile and Japan.

As a consortium that from the outset comprised all of the “major players” in U.S. academic seismology, IRIS has engaged a much broader governance community than is typical for the oversight of facilities developed for specific projects or experiments. Rather than focusing on the development of the technical resources for a single experiment or research institution, IRIS facilities are inherently multi-user and multi-use, and directed by a community with a wide range of research interests. This governance model served seismology well in the early days, when it provided a forum for defining the science goals and developing the initial technical specification for instrumentation and data management. The model has continued to be effective as the incubator for new initiatives such as USArray and EarthScope. Seismology instrumentation is intrinsically distributed and one of the major goals of IRIS is to coordinate data and instrumentation with often-complex histories. This inclusive model was and remains important for establishing community ownership of instrumentation resources and data.

The IRIS Mission

- Facilitate and conduct geophysical investigations of seismic sources and Earth properties using seismic and other geophysical methods.
- Promote exchange of geophysical data and knowledge, through use of standards for network operations, data formats, and exchange protocols, and through pursuing policies of free and unrestricted data access.
- Foster cooperation among IRIS members, affiliates, and other organizations in order to advance geophysical research and convey benefits from geophysical progress to all of humanity.

NSF Facilitate Collaborate Educate IRIS

Important changes over time include the progressive increase in sophistication of the facilities and the growth of the Consortium to include virtually every U.S. university with even a modest research program in seismology. IRIS has adapted to these changes by modifying both the staffing and the governance structure of the not-for-profit corporation. The community governance model — including the core program Standing Committees reporting to a Board of Directors that is both elected by and comprised of academic members — has provided a framework for the academic seismological community to participate in decision making and has preserved community oversight of the facilities to ensure that they continue to serve the evolving research needs. In parallel, a combination of contracting and hiring key technical staff with skills that complement those of research seismologists has enabled the facilities to take full advantage of new technologies and make the facilities ever more efficient.

The continued broad participation in IRIS governance has ensured that access to portable instruments and services as well as access to data continue to benefit a widening circle of investigators. Alternatives, such as separate governance of each facility by individual institutions or small groups, would put both the integration and the widespread benefits at risk. The benefits of consortium governance and joint management will accrue as long as the underlying technologies of seismic data acquisition and archival continue to evolve and the research community continues to apply these data in innovative ways.

Consortium governance also provides natural opportunities to integrate early-career investigators into the decision-making process. Continuous rotation of membership on the standing committees has engaged many universities in IRIS governance at high level, and has brought in younger researchers as first-generation leaders have moved on. Many of those who now

make use of IRIS resources and serve in advisory roles on IRIS committees have enjoyed the support of IRIS throughout their entire academic careers. This changing demographic was especially evident during the 25th anniversary celebration in 2010. Almost half of the participants were students, postdocs, and early-career scientists, and an award was presented to a Harvard graduate student who *birth date* was three months after the incorporation date for IRIS in 1984.

The consortium, by virtue of its broad representation of the U.S. academic seismological community, also has proven very successful in its interagency and international collaborations with, for example, the U.S. Geological Survey. IRIS has fostered successful international collaborations with many countries hosting GSN equipment, and with groups like the International Monitoring System for the CTBT whose data-collection activities help offset many telemetry costs for the GSN. These partnerships are greatly facilitated by the academic stature and multilateral relationships of the IRIS Consortium membership.

Success of IRIS in achieving past goals

The 1984 founding proposal for IRIS identified a 10-year program to implement four national facilities for seismology, including a Global Digital Seismic Array with real-time satellite telemetry from 100 observatories, a 1000-unit portable digital seismograph Mobile Array, Central Data Management and Distribution Facilities to provide rapid and convenient access to data for the entire research community, and a Major Computational Facility capable of supporting analyses of the new data. Today, the Global Seismographic Network (GSN) is a 153+ station, globally distributed, state-of-the-art digital seismographic network sustained by close partnership between NSF and the U.S. Geological Survey and many international partners. The Program for Seismic Array Studies of the Continental Lithosphere (PASSCAL) and the USArray Flexible Array includes more than 800 dataloggers, 2000 three-component sensors (broadband, intermediate period, short-period, high-frequency, and accelerometers), and 7000 single channel instruments that are loaned to NSF-funded researchers for use in experiments worldwide. The Data Management System (DMS) is comprised of eight nodes of data collection centers and a Data Management Center (DMC) that provides open and easy access to all IRIS data holdings and data products along with even larger quantities of other seismological data and virtual pathways to international data archives.

Today, in the wake of a large global earthquake, a few clicks on a web page can provide any seismological researcher anywhere in the world full waveform in real time for over 1000 seismic

stations around the world. There are approximately 150 terabytes of data archived in the DMS and more than 160 terabytes will be shipped to researchers in 2011.

IRIS programs have articulated new goals with each succeeding five-year proposal, many of them in support of training and outreach objectives. The DMS has supported international workshops on data formats and digital network functions. PASSCAL provides extensive training to ensure the adoption of best practices in field experiments and data collection. The Education and Outreach Program has become one of the most successful of NSF's solid Earth science outreach efforts, supporting museum displays, teacher training, seismographs in schools, summer internships, distinguished lecture series, and educational poster distributions. These activities have been regularly reviewed and adapted by the Consortium, and are now intrinsic strengths of the core IRIS programs.

The ultimate success of IRIS must be gauged by the scientific impact of the facilities, and the hundreds of research papers published each year in peer-reviewed journals based on the use of IRIS facilities provides strong testimony to the importance of IRIS resources in enabling U.S. academic Earth science research. The evolution of the discipline of seismology since 1985 has been extraordinary: over 600 PASSCAL experiments with more than 5000 portable stations have been deployed to study plate boundaries, cratons, orogenic systems, rifts, faults, magmatic systems, glaciers, icebergs, and structural responses in the built environment. Thousands of earthquakes around the world have been studied using GSN data to define tectonic motions, stress distributions, and exotic sources such as impacts, ring faults, and volcanic plumbing. Local, regional and global tomography have leapt forward capitalizing on improved spatial coverage and resolution using GSN and PASSCAL datasets, imaging previously unknown structures from the inner core to the surface. Synergies with geodynamics, mineral physics, volcanology, and even climatology have emerged that were unprecedented prior to the availability of IRIS datasets. IRIS-recorded ground motions, spanning from Earth's continuous hum, to non-volcanic tremor, to violent shaking from numerous great earthquakes around the world, have been used in thousands of research studies, revealing the fundamental nature of lithospheric deformations and ocean-atmosphere-solid Earth interactions. The large number of U.S. university programs with seismological research programs is largely a response to the open access provided to IRIS data, enfranchising research programs at all levels to pursue innovative research. This open-data policy has had great international impact on seismological data access, and establishing a precedent for sharing all varieties of scientific data between nations.

Sustaining Investments and Preparing For the Future

The ongoing support of any facility program requires a delicate balance between operating, maintaining, and refurbishing existing facilities, and investing in both technological innovation and new initiatives that advance the science. A central organizational and financial commitment of IRIS is to continue to support and maintain those core facilities and resources that form the essential underpinning for a broad sector of research support in seismology for the U.S. academic community. At the same time, we seek to provide the infrastructure and facilities to support the research community in new and interdisciplinary lines of research in the Earth sciences.

Achieving the IRIS goals has involved diversifying funding bases, collaboratively working with other agencies besides NSF to develop and sustain the facilities, and working with hundreds of international partners to provide the global coverage and communications facilities that underlie the facilities. NSF can legitimately view its investment in IRIS facilities as being heavily leveraged to the benefit of the scientific undertakings of the seismological research community.

Forward-looking activities provide the basis and motivation for the refinement and support of IRIS services and the facilities. The Board of Directors, the Program Standing Committees, and other IRIS governing bodies all comprise active researchers who themselves carry out and publish cutting-edge research and participate in dozens of scientific conferences, workshops, and review panels in the United States and around the world. The strength and validity of the Consortium depends on sustaining and adapting facilities to enhance these research opportunities, and relies on the continuous input of this research community.

IRIS Governance and Management

The IRIS governance and management structure is an interface between the scientific community, funding agencies and the programs of IRIS. The structure is designed to ensure close involvement of the research community in the development of IRIS facilities, to focus scientific talent on common objectives, to encourage broad participation, and to effectively manage IRIS programs. Community involvement in the governance and management of IRIS has been a key to the success of the Consortium. Each year, over 80 scientists from more than 50 research institutions participate in the management of IRIS through its ten regular committees, plus *ad hoc* advisory groups. These scientists work with a professional staff led by the President, Director of Planning, Director of Program Support

and Special Projects, Director of USArray, Director of Finance and Administration, and four Program Managers to administer IRIS programs.

As a **consortium of research universities**, IRIS looks to its members to provide advice and direction on IRIS activities. Through on-going interactions with scientists at member institutions and through formal structures such as workshops, annual meetings, symposia and newsletters, the research community interacts with IRIS and, through the Consortium, expresses its evolving needs to funding agencies. From the enthusiasm and experience of its members, IRIS derives excitement and vision to guide the role that IRIS can play in supporting Earth science and encouraging forefront research.

As a **major facilities program** for NSF, IRIS works closely with the NSF Division of Earth Sciences to develop a program focused on the support of facilities on which NSF-funded seismological research is based. Through a series of Cooperative Agreements, NSF has provided funding with which IRIS, on behalf of the research community, operates and manages GSN, PASSCAL, DMS, E&O and USArray. Since many operational aspects of the IRIS programs are closely integrated with activities at the US Geological Survey and other federal and international programs, joint IRIS/NSF coordination with these activities is also essential to maintaining an effective program.

As a **corporation**, IRIS provides the legal and fiscal structure through which NSF can interact with IRIS for the stable operation of its facilities, and a mechanism for developing programs and bringing the wishes of its members to fruition. Through its professional staff, committees and sub-awardees, IRIS provides continuity in institutional and personnel resources for operational and developmental activities.

Consortium Membership

IRIS is a 501 (c) (3) not-for-profit corporation, incorporated under the laws of the State of Delaware in 1984. As specified in the IRIS By-Laws, educational and not-for-profit institutions chartered in the U.S., with a major commitment to research in seismology and related fields, may become Members of IRIS. Two and four-year colleges and universities with a commitment to teaching undergraduate Earth science, including seismology, may become Educational Affiliates. Research institutions and other not-for-profit organizations both inside and outside the US engaged in seismological research and development, which do not otherwise qualify for IRIS membership, may be elected Affiliates or Foreign Affiliates. The IRIS by-laws were modified by the membership in June 2004 to transition from a structure in which all member institutions held seats on the Board of Directors to one in which the executive powers of the corporation are undertaken

by a nine-member Board of Directors elected by representatives of the Member Institutions. Under this new structure, the Member Institutions retain significant powers, including revisions to the by-laws, election of the Board and calling of special meetings. The Board of Directors meets in-person three times per year, and holds frequent conference calls, to receive reports of programmatic activities, guide the development of on-going programs and new activities, approve annual program plans and budgets, appoint members to supporting committees, monitor the fiscal state of the corporation, participate in the development and review of new proposals and transact other activities that require Board action. The Annual Meeting of the full Membership takes place in December during the American Geophysical Meeting in San Francisco. Consortium activities also take place at the IRIS Biennial Workshop, usually held in June, where scientific sessions, technical training and small group discussions provide an opportunity for the seismological community to learn of IRIS activities and resources and provide input to the development of future plans.

Committee Structure

It is the nine-member **Board of Directors of IRIS**, acting on behalf of the Member Institutions, that serves as the major decision-making forum for IRIS. It sets goals and policies, reviews and approves program plans and budgets, appoints members to advisory committees and directs the activities of the President and staff. The Board of Directors has created three sub-committees drawn from its membership—Budget and Finance, Membership and Legal Affairs—that are responsible for coordination of key Board functions. The Board also appoints membership to the Nominations Committee to prepare a slate for the annual election. The Board appoints and receives information and advice from four Program Standing Committees, a USArray Advisory Committee, a Planning Committee and a Program Coordination Committee. The **Planning Committee** develops new initiatives and coordinates IRIS activities with related programs in fields such as earthquake hazard mitigation and nuclear monitoring. The **Program Coordination Committee** integrates activities that crosscut the individual programs and is charged with developing a coordinated program budget each year for presentation to the Board. A special **Instrumentation Committee** was recently created to report to the Coordination Committee on pan-IRIS instrumentation issues. Five separate **Standing Committees** provide detailed oversight of the four core programs: the Global Seismographic Network (GSN), the Program for Array Seismic Studies of the Continental Lithosphere (PASSCAL), the Data Management

System (DMS), the Education and Outreach Program (E&O) and the recently initiated activities in **International Development Seismology**. A **USArray Advisory Committee** provides oversight of USArray activities. The Chairs of all Standing committees, the USArray Advisory Committee and other Board level committees participate in Board meetings on a non-voting basis. In addition, the President and the Board of Directors can appoint special advisory committees and ad hoc working groups for specific tasks. It is the role of all appointed committees to develop recommendations for the Board, which in turn, evaluates and acts upon such recommendations on behalf of the Member Institutions.

The Board of Directors meets at least three times per year to review the status of IRIS programs, to approve annual budgets and to develop long-term program directions. Each of the four Standing Committees and the USArray Advisory Committee meets twice per year to review program-specific activities and makes recommendations for improvements and future developments. The Coordination Committee meets prior to the Board's spring budget meeting to coordinate presentation of the next year's plan and budgets for approval by the Board of Directors. IRIS committee meetings are often combined with site review visits to the various program facilities, specifically: the Data Management Center in Seattle, Washington; the PASSCAL Instrument Center in Socorro, New Mexico; the GSN facility at the University of California, San Diego; the USGS partnership facility at the USGS Albuquerque Seismological Laboratory in Albuquerque, NM; and the IRIS headquarters office in Washington, DC.

One of the greatest strengths of IRIS continues to be the strong engagement of a broad sector of the scientific community in the governance and management of the Consortium and facilities. Membership on the Board of Directors is restricted to individuals from Consortium Member Institutions, but the Standing Committees, other committees and working groups can draw from any institution and a number of scientists from government agencies and labs participate, enriching the input to the committees and enhancing interagency collaboration. More than 250 individuals have served on IRIS committees since 1984, with more than 80 engaged in active, pro bono service each year. While a number of committed individuals have been exemplary in their dedication through continued service over the years, often on multiple committees, there has also been an explicit effort to engage new committee members, especially younger scientists. Most members of the Board of Directors are elected after initial participation on one of the Program Standing Committees, providing them with an in-depth knowledge of the way in which the facilities are operated. The constant feedback and advice from a community of active scientists has been

essential to the success and evolution of the programs and facilities operated by IRIS.

Program Planning and Review

The primary instrument for IRIS support has been a series of five-year cooperative agreements between IRIS and the National Science Foundation. These awards are based on proposals which review the current state of the facility and outline the goals for activities for the next five years. Separate 5-year awards are used to support the core programs (through EAR/I&F) and USArray/EarthScope, with other, smaller awards to support polar programs and part of the E&O activities. All IRIS proposals and annual program plans and budgets are approved by the Board of Directors, after development through a systematic process designed to distill the collective scientific interests and priorities of over 100 member research institutions. The mode of NSF funding for the IRIS facilities—five-year Cooperative Agreements with Annual Program Plans and Budgets—has provided a level of both stability and flexibility that has allowed the facility resources to evolve in response to changing scientific needs and technical developments.

The IRIS programs have also made on-going adjustments to respond to international developments. As hardware and data procedures established by IRIS have become de facto standards, there have been increasing opportunities for international collaboration in areas such as station installation, data exchange and field experiments. In all of these areas, decisions to adjust priorities in the evolution of the facilities have been directed by the Program Standing Committees and Board of Directors, based on consideration of their scientific and technical merits.

As a special project under the NSF Major Research Equipment and Facilities (MREFC) EarthScope program, USArray, especially during the initial 5-year construction phase, was subjected to more stringent NSF project management and budgetary constraints than had been used for oversight of the I&F awards for support of the core programs. In both the implementation and management of USArray, however, efforts have been made to ensure that maximum benefit was gained from previous IRIS experience and that close integration was achieved between USArray and all core program activities where appropriate. The structure that has evolved for USArray management and community input to its development has proven to be synergistic and successful. As USArray continues the O&M phase for EarthScope, interactions with the core programs, especially in the areas of field support, data management and product development continue and improve.

In addition to the five-year cycle of reviews carried out as part of

the NSF proposal process, the structure of IRIS management, and the organization within specific programs, have also received periodic review and evaluation by internal and external committees. For example, a review of the IRIS management structure by an ad hoc committee of former Executive Committee chairs in 1997 led to the formation of the IRIS Planning and Program Coordination Committees as a means of encouraging long-term strategic planning and interactions among programs. A competition for the IRIS Data Management Center resulted in the Center being moved from an interim location at the University of Texas to its current location at the University of Washington in 1991. A competition for the PASSCAL instrument center led to the consolidation of the previous two centers at Stanford and Lamont to a single new location in 1998 at New Mexico Institute of Mining and Technology. The DMS Standing Committee conducted a self-study to review the DMS structure and activities and presented a strategic plan to guide the development of future DMS functions. The GSN was reviewed in 1998 when the White House Office of Science and Technology Policy appointed a special panel of the National Science and Technology Council to evaluate the GSN in the context of other global networks. A special NSF-mandated external review of the GSN in 2003 resulted in improvements in GSN operations and started a process that has now evolved to networkwide standardization of GSN equipment. Similarly, a special NSF-mandated external review of PASSCAL in 2008 endorsed the excellence of that program and made recommendations for enhancement of PASSCAL. A joint IRIS/NSF review of the E&O program was carried out in 2009. Management reviews of IRIS governance and management in 2004 and 2010 strongly endorsed the consortium model and commended IRIS for the very successful management and operation of its facility programs.

Collaborations and Partnerships

IRIS has entered into partnerships with both national and international agencies and groups whose scientific goals overlap those of IRIS. These partnerships range from formal documents and MOU's to "a handshake," illustrating the flexibility with which IRIS can act in serving and furthering its scientific programs. In addition to various modes of interaction with Consortium member institutions, some of the principal organizations with which IRIS interacts in the US include: the United States Geological Survey (USGS), the Southern California Earthquake Center (SCEC), the USGS Advanced National Seismic System (and many of the associated regional networks), UNAVCO, the Network for Earthquake Engineering Simulation (NEES), GEON, Computational Infrastructure for Geodynamics (CIG), Cooperative Institute for Deep Earth Research (CIDER), the UNIDATA program center of the University Consortium for Atmospheric Research

(UCAR), the American Association of State Geologists (AASG), NASA/JPL, DOE and its labs, and AFTAC.

Among its US partners, IRIS has formed its strongest ties with the USGS. The USGS presence and stability have proven to be of great importance throughout the IRIS programs. The USGS (through its Albuquerque Seismological Laboratory, ASL) has been a partner with IRIS in the GSN since its inception. The ASL group is responsible for operation of more than 60% of the GSN stations. Under long-standing arrangements, re-confirmed in a 2002 GSN Annex to a Memorandum of Understanding between NSF and USGS, IRIS provides the capital investment for the station instrumentation at joint stations and the USGS funds the operations and maintenance. Data collection and quality control are carried out jointly with all data from the entire GSN available through the IRIS Data Management Center. There has also been close collaboration between IRIS, EarthScope and the USGS Advanced National Seismic System (ANSS), primarily through the USGS group in Golden, CO, related to development of the ANSS Backbone (which serves as the USArray Reference Network) and data distribution. Numerous experiments involving USGS scientists, often in partnership with university PIs, have made use of PASSCAL instruments in crustal studies in the US and abroad. These have included a number of significant investigations of basin structure in urban areas in the western US related to seismic hazard evaluation. The USGS and the IRIS Education and Outreach Program have also collaborated on the development of a very successful museum display and outreach program.

EarthScope represents a significant example of the benefits of strong partnerships and collaboration in the development of a major facility program. The formation of EarthScope can be traced back to the early 1990's, when independent discussions, related to the need and opportunities for new facilities within the seismic, geodetic and fault-drilling communities, began and merged into a unified approach to NSF led by community-based organizations represented by IRIS, UNAVCO, SCEC and the San Andreas drilling team. The long road to funding, specification and implementation of EarthScope involved collaborative planning efforts between these organizations and with NSF and USGS. As with USArray and IRIS, much of the design of the Plate Boundary component of EarthScope grew from experience at UNAVCO with GPS instrumentation. The management of EarthScope construction, under the EarthScope Facility Executive Committee (EFEC), required close collaboration and sharing of technical and organizational experience between UNAVCO and IRIS and the development of the management structure of USArray was closely monitored by the IRIS Board of Directors.

In the international sphere, collaborations with many organizations have been essential to the health of the GSN as

a global observing program. The map of GSN stations and the list of GSN partners in the following section indicates the scope of these collaborations, many of them established through the international Federation of Digital Seismograph Networks. Each of the more than 100 GSN stations outside the US represents some level of formal international partnership developed by IRIS, USGS and UCSD. These range from large and complex agreements with China, Russia and many of the states of the former Soviet Union, to arrangements with national universities or Geological Surveys, to operating agreements with private organizations and individuals. A significant program with Japan has resulted in joint installation of stations at remote islands in the Pacific, including real-time satellite telemetry. Exchanges with the Central Asian republics of the former Soviet Union have also been fruitful and are currently being re-invigorated. Collaborative projects, many of them initiated by IRIS, have made it possible to install modern seismic stations and gather first-class data from regions of the world that were inaccessible to seismologists twenty five years ago. GSN stations play an important role in the International Monitoring System for the Comprehensive Test Ban Treaty Organization and arrangements for shared satellite communication with that organization are greatly improving the real-time access to some GSN stations. These and other partnerships provide an extremely cost-effective mechanism to operate a global facility like the GSN, and provide an avenue for US researchers to work in regions of the world that would be difficult to access. Many PASSCAL experiments have been able to build on contacts that have emerged through IRIS interactions with foreign institutions. Conversely, many of the IRIS Foreign Affiliates have joined as the result of interest in IRIS and its programs developed through contacts made during GSN installations or PASSCAL-supported experiments.

The IRIS Data Management System has also been a vehicle and stimulant for international collaboration, especially in the area of data exchange. Through the international Federation of Digital Seismograph Networks, many national and regional networks exchange data and contribute to the FDSN archive at the IRIS DMC. A number of national data centers have adopted IRIS-developed formats and procedures for data management, greatly facilitating data exchange. The IRIS DMS has led an effort to develop the concept of networked data centers that is being used to share resources and data among major centers in the US, Europe, Japan and China. DMS has initiated a series of Metadata Workshops, held at international venues, which provide training on data management to encourage the proper documentation of modern digital data, adherence to standards and facilitate data exchange.

While these international and domestic partnerships play a

significant role in efficient operation of the IRIS facilities, the stability and strength of these relationships is grounded in the role that IRIS plays as a university-based Consortium encouraging international scientific exchanges and collaboration in Earth science research.

In recognition of a need to enhance awareness of seismological research in education and by the general public, the Education and Outreach (E&O) program was established in 1997 as a fourth core facility. E&O provides resources for K–16 teachers, for other formal and informal educators, for research scientists contributing to education, and a framework for outreach to public, professional, and other Earth science communities. These resources have become increasingly sophisticated and effective. Excellent examples are the creation of the “Teachable Moments” web resource and the “Active Earth” kiosk displays that provide various forms of educational content related to significant seismic events. The content is both timely (much of it is produced within a day of the event) and versatile (the level of the content can be customized for audiences ranging from elementary to university-level students and the general public).

With close links to all four “core” programs, IRIS has played a major role in the creation and operation of EarthScope and USArray since their inception. In the context of a data-collection enterprise, IRIS’s role in this effort is an unqualified success. IRIS has completed the assembly of the Transportable Array (TA), which constitutes the main component of USArray, oversees the operation and maintenance of the array as it rolls across the country, and manages and archives the openly available, real-time data through the DMS. It also provides the means for EarthScope-funded investigators to carry out ancillary projects by maintaining a Flexible Array (FA) pool, which combines the PI-controlled experiment design of PASSCAL, with more complete data collection and archiving services akin to the TA. By including a magnetotelluric (MT) component in USArray, IRIS has helped to establish a complementary observational facility and revitalized U.S. community involvement in this geophysical discipline.

Management Structure

IRIS management is based on linked operational structures for the five, semi-autonomous programs—the Global Seismographic Network, the PASSCAL program for portable instrumentation, the Data Management System, Education and Outreach, and USArray. The central administrative and business functions are carried out through a Headquarters Office in Washington, DC. The programs are managed through offices or subawards linked to each of the core programs. Overall management is under the direction of a full-time President, appointed by the Board . .

Although each of the core programs has a standardized management and oversight structure consisting of a Program Manager and Standing Committee, each program operates through a combination of direct employees, subawards, and partnerships. The facilities programs each have their own unique structure, optimized for their particular circumstances. USArray has a parallel management and oversight structure consisting of a Director and Advisory Committee. USArray has elements that are very similar to those of the core programs. Each of the core programs has been expanded to support its respective element of USArray. The Permanent Array was implemented by GSN, the Flexible Array by PASSCAL, Data Management by the DMS and Siting Outreach by E&O. This is the most efficient and effective way to take advantage of IRIS expertise in implementing USArray. Two unique elements of USArray, the Transportable Array and Magnetotellurics, have their own separate management structure.

Full-time staff devoted to IRIS activities are located at the Data Management Center in Seattle; the PASSCAL Instrument Center in Socorro; the IDA and Array Network Facility groups at UC San Diego and IRIS Headquarters in Washington DC. There are approximately 125 full-time scientists and technicians involved in the operation of IRIS facilities and IRIS-related programs: approximately 50 full-time employees on IRIS payroll, and an additional 75 supported full time through major IRIS subawards. Partial support is also provided through subawards for important IRIS-related programs at the University of Washington (as host for the DMC) and the University of Texas, El Paso (for support of Texan instruments). The USGS facility in Albuquerque, NM provides significant dedicated support for the GSN, but is separately funded by the USGS.

The IRIS Business Services are responsible for accounting and financial reporting, contracts and awards, procurement, inventory, insurance, and general office assistance. The goals of the business services are to implement good business practices in all areas such that:

- Business operations are effective and efficient.
- Activities are in compliance with applicable laws, regulations, award terms and conditions, and internal policies and procedures.
- Program personnel receive the appropriate support for their programs.
- Organizational assets are protected.

The Business Services are grouped under two main areas:

- Financial Services - responsible for accounting, audits, purchasing, inventory and financial tracking
- Sponsored Projects Office – responsible for award administration , subawards, reporting, compliance and legal.
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To establish more integration between programs, changes were made in IRIS management structure in 2010 to ensure that the core programs and USArray have flexibility and vitality and are well integrated to ensure their future success. These changes improve IRIS services by encouraging more interaction between the current programs and opening up new initiatives, especially in instrumentation, enhanced data services, international engagement, and polar programs.

The most significant high-level change integrates the key technical activities of IRIS under three primary elements: Instrumentation Services, Data Services, and Education and Public Outreach. The IRIS governance structure will remain the same, with the Board of Directors and Standing Committees for each of the core programs, and with the Standing Committees continuing to provide community input directly to the Board. The three primary IRIS service areas illustrated by the organizational chart below are:

- Instrumentation Services: Enhances coordination of technical activities (involving GSN, PASSCAL, and the instrumentation components of USArray) in sensor development, field practices, communication systems, and the exploration of new technologies.
- Data Services: Focuses existing Data Management System activities and enhances user-centric, data-related services, quality control, and products.
- Education and Public Outreach: takes an expanded role in bringing the activities of IRIS and the seismology community to the public as well as continuing the traditional E&O activities in formal and informal education.

Funding and Budget Process

The primary source of IRIS funding since its inception has been the National Science Foundation under five-year Cooperative Agreements, which charge IRIS with “establishing, operating, maintaining, and managing the IRIS core programs...” with statements of work that are developed by the NSF Program Officer, in consultation with IRIS, based on the tasks identified in the five-year proposal submissions.

In addition to funding from the NSF Earth Sciences Division, Instrumentation and Facilities Program (EAR/IF), IRIS receives significant awards under NSF's EarthScope Program to build and operate USArray and from NSF GEO/EAR as an REU (Research Experience for Undergraduates) award for support of the E&O Internship program. NSF allows supplements from other NSF programs, other Federal agencies, or other funds, to be provided through amendments to the Cooperative Agreement, up to a maximum approved by the National Science

Board. NSF's Polar Programs has funded IRIS through this mechanism for the past three years. IRIS has also received external funding from a variety of public and private sources, including the Department of Defense, Department of Energy, National Imagery and Mapping Agency, the Comprehensive Nuclear-Test-Ban Treaty Organization, the Keck Foundation, the W. Alton Jones Foundation, and Japanese organizations.

IRIS maintains a separate account of unrestricted funds, built from membership fees, investments and management fees. These monies are used for expenses that are not or cannot be supported by a Federal award. The Board of Directors appoints a three-member Budget & Finance Committee to work with the Director of Finance and Administration and take responsibility for receiving and reviewing monthly budget reports, for oversight of the unrestricted funds, and to initially receive the auditor's reports. The committee identifies and communicates issues in these areas to the Board of Directors for further action when needed.

The bulk of IRIS core support has come from the Earth Sciences Division, Instrumentation and Facilities Program and, starting in 2003, from EarthScope, but additional funds have been provided under smaller awards through the Cooperative Agreement via interagency transfer from other federal agencies; limited funds have come from private sources. Two significant enhancements to the IRIS programs came from special Congressional appropriations through the Department of Defense (1988 -1996, for support of a joint program with the Soviet Academy of Science and for multi-use application of the GSN including nuclear monitoring) and the Department of Energy (2001-2004, for replacement of PASSCAL data loggers).

Under the Cooperative Agreement with NSF, IRIS is required to submit to NSF an annual Program Plan and Budget, which summarizes the activities over the past year, outlines the program for the year ahead and presents the budget request for the following year. These annual reports are not proposals (which are submitted every five years) but progress reports to the NSF Program Manager and form the basis for annual funding increments. The details of the annual plan and budget are not constrained by the original proposal, but are expected to follow the general plan presented in the proposal and the nominal levels of annual funding increments specified in the Cooperative Agreement.

Typically in January, based on funding targets and guidelines received from NSF, the IRIS Board of Directors meets to set overall policy goals and recommend the balance among programs for the next fiscal year, which begins on July 1. In the early spring, IRIS Standing Committees meet to develop detailed program plans and budgets, review work statements and proposals for subawards, and identify material for the Program Plan and Budget. After the Standing Committee meetings, the

IRIS Coordination Committee (CoCom) reviews and reconciles differences between program budgets, develops options for an overall budget plan for presentation to the Board, and prepares an outline for the Program Plan and Budget. In the late spring, the Board meets again to review or modify the overall funding structure, and approves final budgets for the year. IRIS staff then prepares the Program Plan and Budget for submission to NSF based on the guidance from the Board. The new fiscal year for IRIS, and the usual budget year for the core programs, begins July 1. Throughout the year, Program Managers receive monthly budget reports that show variances between budgeted and actual costs. During the early fall, after the accounting books are reviewed and closed and the annual A-1331 audit has been completed, final account balances are reported and programs identify any funds that were not expended as of June 30. The CoCom meets again in the fall and reviews the prior year unspent funds, if any, and makes adjustments to budgets or activities, with recommendations for Board approval.

Overlain upon the IRIS management structure and budget process is the management oversight provided by the National Science Foundation. The Annual Program Plan and Budget, as proposed through the Board of Directors and approved by the NSF Program Officer, forms the basis for each year's program activities. The Cooperative Agreement sets thresholds under which IRIS can make internal changes in budget allocations and provides mechanisms by which requests for more significant changes in the plan can be presented to NSF for approval. The ongoing interaction among the NSF Program Officer, IRIS management and the community representatives on IRIS committees, coupled with the flexible structure of the Cooperative Agreement, has proven to be effective in allowing IRIS to establish and develop its core facilities in response to the evolving needs of the university research community.

