

# IVS Terms of Reference

## 1 Summary

### 1.1 Charter

The International VLBI Service for Geodesy and Astrometry (IVS) is an international collaboration of organizations which operate or support Very Long Baseline Interferometry (VLBI) components. IVS provides a service which supports geodetic and astrometric work on reference systems, Earth science research, and operational activities. IVS is a Service of the International Association of Geodesy (IAG) and of the International Astronomical Union (IAU).

### 1.2 Objectives

IVS fulfills its charter through the following objectives:

1. foster and carry out VLBI programs. This is accomplished through close coordination of the participating organizations to provide high-quality VLBI data and products.
2. promote research and development activities in all aspects of the geodetic and astrometric VLBI technique.
3. advance the education and training of VLBI participants through workshops, reports, and other means.
4. support the integration of new components into IVS.
5. interact with the community of users of VLBI products. IVS represents VLBI in the Global Geodetic

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Observing System (GGOS) of the IAG and interacts closely with the International Earth Rotation and Reference Systems Service (IERS).

In support of these objectives, IVS coordinates VLBI observing programs, sets performance standards for VLBI stations, establishes conventions for VLBI data formats and data products, issues recommendations for VLBI data analysis software, sets standards for VLBI analysis documentation, and institutes appropriate VLBI product delivery methods to ensure suitable product quality and timeliness. IVS coordinates its activities with the astronomical community because of the dual use of many VLBI facilities and technologies for both astronomy and astrometry/geodesy.

### 1.3 Data Products

VLBI data products contribute uniquely to these important activities:

- defining and maintaining the celestial reference frame,
- monitoring universal time (UT1), and
- monitoring the coordinates of the celestial pole (nutation and precession).

These results are the foundation of many scientific and practical applications requiring the use of an accurate quasi-inertial reference frame, such as high-precision positioning, navigation, and timing. In addition IVS provides a variety of VLBI products with differing applications, timeliness, detail, and temporal resolution, such as:

- all components of Earth orientation parameters,
- terrestrial reference frame,
- baseline lengths, and
- tropospheric parameters.

All VLBI data and products are publicly available in appropriate formats from IVS Data Centers.

## 1.4 Research

The IVS data and products are used for research in many areas of geodesy, geophysics, and astronomy, such as:

- UT1 and polar motion excitation over periods of hours to decades,
- solid Earth interior research (e.g., mantle rheology, anelasticity, libration, and core modes),
- characterization of celestial reference frame sources and improvements to the frame,
- tidal variations (solid Earth, oceanic, and atmospheric),
- improvements in the terrestrial reference frame, especially in the scale,
- climate studies (e.g., sea level change, deglaciation, and water vapor),
- regional and global geodynamics, and
- general relativity.

To support these activities, there are ongoing research efforts to improve and extend the VLBI technique in areas such as:

- instrumentation, data acquisition, and correlation,
- data analysis techniques,
- spacecraft tracking and navigation (Earth-orbiting and interplanetary), and
- combination of VLBI data and results with other techniques.

## 2 Permanent Components

IVS acquires, correlates, and analyzes VLBI data to produce geodetic, astrometric, and other results that are archived and publicized. IVS accomplishes its objectives through the following permanent components:

- Network Stations,
- Operation Centers,
- Correlators,
- Analysis Centers,
- Data Centers,
- Technology Development Centers, and
- Coordinating Center.

### 2.1 Network Stations

The IVS observing network consists of high performance VLBI stations.

- Stations may either be dedicated to geodesy or have multiple uses (including astronomical observations or satellite tracking applications).
- Stations comply with performance standards for data quality and operational reliability specified by the Directing Board.
- Stations provide local tie information, timing and meteorological data to the IVS Data Centers.
- VLBI data acquisition sessions are conducted by groups of Network Stations that may be distributed either globally or over a geographical region.

### 2.2 Operation Centers

The IVS Operation Centers coordinate the routine operations of specific networks. Operation Center activities include:

- planning network observing programs,
- supporting the network stations in improving their performance,
- generating the detailed observing schedules for use in data acquisition sessions by IVS Network Stations, and
- posting the observing schedule to an IVS Data Center for distribution and archiving.

IVS Operation Centers follow guidelines from the Coordinating Center for timeliness and schedule file formats.

### 2.3 Correlators

The IVS Correlators process raw VLBI data. Their other tasks are to:

- provide timely feedback to the Network Stations about data quality,
- jointly maintain the geodetic/astrometric community's media pool and transport,
- manage electronic data transfer,
- make processed data available to the Data Centers, and
- regularly compare processing techniques, models, and outputs to ensure that data from different Correlators are identical.

### 2.4 Analysis Centers

The IVS coordinates VLBI data analysis to provide high-quality products for its users. The analyses are performed by:

- Operational Analysis Center,
- Associate Analysis Centers,
- Special Analysis Centers for Specific Observing Sessions, and
- Combination Centers.

All Analysis Centers maintain and/or develop appropriate VLBI analysis software.

Operational Analysis Centers are committed to producing results to the specifications of the IVS Analysis Coordinator and always on schedule to meet IVS requirements. In addition, Operational Analysis Centers may produce Earth orientation parameters, station coordinates, and source positions in regular intervals.

Operational Analysis Centers place their final results in IVS Data Centers for dissemination to researchers and other users. They adhere to IVS recommendations for the creation of high-quality products and their timely archiving and distribution. Any deviations that an Operational Analysis Center makes from IVS recommendations are properly documented. Operational Analysis Centers provide timely feedback about station performance. In addition to these regular services, Operational Analysis Centers may also perform any task of an Associate Analysis Center.

Associate Analysis Centers are committed to regularly submit specialized products using complete series or subsets of VLBI observing sessions. The analysis is performed for specific purposes as recognized by the Directing Board, such as exploitation of VLBI data for new types of results, investigations of regional phenomena, reference frame maintenance, or special determinations of Earth orientation parameters. The Associate Analysis Centers place their final results in IVS Data Centers for dissemination to researchers and other users. They adhere to IVS recommendations for the creation of high-quality products and their timely archiving and distribution. Any deviations that an Associate Analysis Center makes from IVS recommendations are properly documented.

Special Analysis Centers for Specific Observing Sessions have responsibility for ongoing series-related investigations of one or more existing session types. They perform detailed and comparative analyses of each session of a series within a reasonable time after correlation. In addition, they report deficits and technical complications to the observing sites, the correlators, and to the schedulers as well as to the IVS Network and Analysis Coordinators.

Combination Centers are committed to produce combination results from the individual submissions of the Operational Analysis Centers as official IVS products. For this purpose they monitor the quality of the submissions. The official IVS products include, but are not limited to, EOP time series derived from session-based results for 24-hour network sessions and one-hour Intensive sessions. Combination Centers also contribute to the generation of the official IVS input to International Terrestrial Reference Frame (ITRF) computations. The combination work is done in a timely fashion and in close cooperation with the IVS Analysis Coordinator.

### 2.5 Data Centers

The IVS Data Centers are repositories for VLBI observing schedules, station log files, data and products. Data Centers may mirror other Data Centers to make the distribution and maintenance of data more efficient and reliable.

- Data Centers are the primary means of distributing VLBI products to users.

- Data Centers work closely with the Coordinating Center and with the Analysis Centers to ensure that all the information and data required by IVS components are quickly and reliably available.

Data Centers provide the following functions:

- receive and archive schedule files from Operation Centers,
- receive and archive log files and ancillary data files from the Network Stations,
- receive and archive data products from the Analysis Centers, and
- provide access and public availability to IVS data products for all users.

## **2.6 Technology Development Centers**

The IVS Technology Development Centers contribute to the development of new VLBI technology for improvement of the VLBI technique. They:

- investigate new equipment and approaches,
- develop, test, and document new hardware, firmware, and software for operations,
- assist with deployment, installation, and training for any new approved technology, and
- maintain and support operational equipment.

## **2.7 Coordinating Center**

The IVS Coordinating Center is responsible for coordination of both the day-to-day and the long-term activities of IVS, consistent with the directives and policies established by the Directing Board. Specifically, the Coordinating Center monitors, coordinates, and supports the activities of the Network Stations, Operation Centers, Correlators, Data Centers, Analysis Centers, and Technology Development Centers. The Coordinating Center works closely with the Technology Coordinator, the Network Coordinator, and the Analysis Coordinator to coordinate IVS activities.

The primary functions of the Coordinating Center are to:

- coordinate observing programs approved by the Directing Board,

- create and maintain the master schedule of observing sessions in coordination with IVS Network Stations and astronomical observing programs,
- foster communications among all components of the IVS,
- coordinate the best use of community resources,
- develop standard procedures for IVS components,
- organize training in VLBI techniques,
- organize workshops and meetings, including IVS technical meetings,
- produce and publish reports of activities of IVS components,
- maintain the IVS information system and archive all documents, standards, specifications, manuals, reports, and publications,
- coordinate IVS outreach and educational activities,
- provide liaison with the IAU, IAG, GGOS, IERS, and other organizations, and
- provide the Secretariat of the Directing Board.

## **2.8 Becoming a Permanent Component**

IVS will accept proposals at any time to become a permanent component. Such proposals will be reviewed for approval by the Directing Board.

## **3 Coordinators**

Specific IVS activities regarding network data quality, products, and technology are accomplished through the functions performed by three coordinators: a Network Coordinator, an Analysis Coordinator, and a Technology Coordinator.

### **3.1 Network Coordinator**

The IVS Network Coordinator is selected by the Directing Board from responses to an open solicitation to all IVS components. The Network Coordinator represents the IVS Network Stations on the Directing Board and works closely with the Coordinating Center. The Network Coordinator is responsible for stimulating the maintenance of a high quality level in the station oper-

ation and data delivery. The Network Coordinator performs the following functions:

- monitors adherence to standards in the network operation,
- participates in the quality control of the data acquisition performance of the network stations,
- tracks data quality and data flow problems and suggests actions to improve the level of performance, and
- coordinates software development for station control and monitoring.

The Network Coordinator works closely with the geodetic and astronomical communities who are using the same network stations for observations. The Network Coordinator takes a leading role in ensuring the visibility and representation of the network stations.

### **3.2 Analysis Coordinator**

The IVS Analysis Coordinator is selected by the Directing Board from responses to an open solicitation to the IVS Analysis Centers. The Analysis Coordinator is responsible for coordinating the analysis activities of IVS and for stimulating VLBI product development and delivery. The Analysis Coordinator performs the following functions:

- fosters comparisons of results from different VLBI analysis software packages and different analysis strategies,
- encourages documentation of analysis and combination software,
- participates in comparisons of results from different space geodetic techniques,
- monitors Analysis Centers' products for high quality results and for adherence to IVS standards and IERS Conventions,
- ensures that IVS analysis and combination products from all Analysis Centers are archived and are available to the scientific community, and
- supervises the formation of the official IVS products specified by the IVS Directing Board.

The Analysis Coordinator plays a leadership role in the development of methods for generation and distribution of VLBI products so that the products reach the

users in a timely manner. The Analysis Coordinator interacts with GGOS and the IERS and promotes the use of VLBI products by the broader scientific community. The Analysis Coordinator works closely with the astronomical communities who are using some of the same analysis methods and software.

### **3.3 Technology Coordinator**

The IVS Technology Coordinator is selected by the Directing Board from responses to an open solicitation to the IVS Technology Development Centers. The Technology Coordinator performs the following functions:

- stimulates advancement of the VLBI technique,
- maintains awareness of all current VLBI technologies and ongoing development,
- coordinates development of new technology among all IVS Technology Development Centers,
- encourages technical compatibility with the astronomical community,
- encourages and oversees development of VLBI-related technical standards,
- coordinates the distribution of and access to technical documents and standards, and
- helps promulgate new technologies to the IVS community.

The Technology Coordinator works closely with the astronomical community, both to maintain technical compatibility between the geodetic and astronomical communities and to take advantage of technology development activities in the astronomical community.

## **4 Directing Board**

### **4.1 Roles and Responsibilities**

The Directing Board sets objectives, determines policies, adopts standards, and sets the scientific and operational goals for IVS. The Directing Board exercises general oversight of the activities of IVS including modifications to the organization that are deemed appropriate and necessary to maintain efficiency and reliability. The Directing Board may determine appropriate actions to ensure the quality of the IVS products.

The Directing Board will receive and review proposals for non-IVS research programs that request IVS resources.

## 4.2 Membership

The Directing Board consists of representatives of the IVS components, members at-large, appointed members, and ex officio members. The members are:

Representatives of IVS Components (see below):

- Correlators and Operation Centers representative (1)
- Analysis and Data Centers representatives (2)
- Networks representatives (2)
- Technology Development Centers representative (1)

Elected by the Directing Board upon recommendation from the Coordinating Center (see below):

- Members at large (3)

Selected by Directing Board upon review of proposals from IVS Member Organizations:

- Coordinating Center Director
- Network Coordinator
- Analysis Coordinator
- Technology Coordinator

Appointed members:

- IAU representative
- IAG representative
- IERS representative

Through a reciprocity agreement between IVS and IERS, the IVS serves as the VLBI Technique Center for IERS, and as such its designated representative(s) serve on the IERS Directing Board. In turn, the IERS Directing Board designates a representative to the IVS Directing Board. This arrangement is to assure full cooperation between the two services.

Total number: 16

The members appointed by IAU, IAG, and IERS are not subject to institutional restrictions.

The six members who are the representatives of the IVS components are elected by the IVS Associate Members. All elected members serve staggered four-year terms once renewable.

At-large members are intended to ensure representation on the Directing Board of each of the components of IVS and to balance representation from as many countries and institutions and IVS interests as possible. At-large members serve two-year terms once renewable.

A Directing Board member who departs before the end of his/her term is replaced by a person selected by the Directing Board. The new member will serve until the next official elections. The position will then be filled for a full term.

An individual can only serve two consecutive full terms on the Board in any of the representative and at-large positions. Partial terms are not counted to this limit. After serving two consecutive full terms, an individual becomes eligible again for a position on the Board following a two-year absence.

The three Coordinators are selected by the Directing Board on the basis of proposals from IVS Member Organizations. On a two-thirds vote the Directing Board may call for new proposals for any Coordinator when it determines that a new Coordinator is required. Coordinators are encouraged to give at least six months notice before resigning.

## 4.3 Elections

Election of Board members from the IVS components shall be conducted by a committee of three Directing Board members, the chair of which is appointed by the chair of the Directing Board. The committee solicits nominations for each representative from the relevant IVS components. For each position, the candidate who receives the largest number of votes from the Associate Members will be elected. In case of a tie the Directing Board will make the decision.

## 4.4 Chair

The chair is one of the Directing Board members and is elected by the Board for a term of four years with the

possibility of reelection for one additional term. The chair is the official representative of IVS to external organizations.

#### **4.5 Decisions**

Most decisions by the Directing Board are made by consensus or by simple majority vote of the members present. In case of a tie, the chair decides how to proceed. If a two-thirds quorum is not present, the vote shall be held later by electronic mail. A two-thirds vote of all Board members is required to modify the Terms of Reference, to change the chair, or to replace any of the members before their normal term expires.

#### **4.6 Meetings**

The Directing Board meets at least annually, or more frequently if meetings are called by the chair or at the request of at least three Board members. The Board will conduct periodic reviews of the IVS organization and its mandate, functions, and components.

### **5 Definitions**

#### **5.1 Member Organizations**

Organizations that support one or more IVS components are IVS Member Organizations. Individuals associated with IVS Member Organizations may become IVS Associate Members.

#### **5.2 Affiliated Organizations**

Organizations that cooperate with IVS on issues of common interest, but do not support an IVS component, are IVS Affiliated Organizations. Affiliated Organizations express an interest in establishing and maintaining a strong working association with IVS to mutual benefit. Individuals affiliated with IVS Affiliated

Organizations may become IVS Corresponding Members.

#### **5.3 Associate Members**

Individuals associated with organizations that support an IVS component may become IVS Associate Members. Associate Members take part in the election of the incoming members of the Directing Board representing the IVS components.

#### **5.4 Corresponding Members**

IVS Corresponding Members are individuals who express interest in receiving IVS publications, wish to participate in workshops or scientific meetings organized by IVS, or generally are interested in IVS activities. Ex officio Corresponding Members are the following:

- IAG Secretary General
- Chair of GGOS
- President of IAG Commission 1 – Reference Frames
- President of IAG Commission 3 - Earth Rotation and Geodynamics
- President of IAU Division I – Fundamental Astronomy
- President of IAU Commission 8 – Astrometry
- President of IAU Commission 19 – Rotation of the Earth
- President of IAU Commission 31 – Time
- President of IAU Commission 40 – Radio Astronomy
- President of URSI Commission 52 – Relativity in Fundamental Astronomy
- President of URSI Commission J – Radio Astronomy

Individuals are accepted as IVS Corresponding Members upon request to the Coordinating Center.

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