

FIG Commission 5

Annual Report of Activities 2021

1. General

The onset of the COVID virus definitely reduced the volume of work accomplished in Commission 5. Nevertheless, significant accomplishments were completed that furthered the Commission 5 2019-2022 work plan. Engagement with UN-GGIM's UN-SCoG has intensified. In conjunction with the FIG Capacity Development Network and Commission 2, collaboration on opportunities for capacity development have flourished. This is particularly true with the UN-SCoG WG on Education, Training and Capacity Building. Presentations last year and this year focused on bringing various aspects of the UN-GGIM agenda in front of members of the FIG.

There is an ongoing collaboration with United Nations Agencies to address global problems such as sustainable development and humanitarian needs. The disciplines covered by Commission 5 will deliver solutions for the spatial aspects of these important global problems. Specific activities aimed at developing countries include examination of Low Cost Surveying Technologies, assistance with implementation of modern Geodetic and Vertical Reference Frames and associated infrastructure and contribution to appropriate Continuing Professional Development programs.

Additionally, Commission 5 continued to work closely with the International Association of Geodesy (IAG) and the United Nations Global Geospatial Information Management (UN GGIM) on the development of new models, standards and tools for implementing a Global Geodetic Reference Frame (GGRF) that includes aspects of the International Terrestrial Reference Frame (ITRF) and the International Height Reference Frame (IHRF). The GGRF will serve as a global standard for all Nations to implement their respective national datums. As such, this directly impacts FIG Members who must implement these new datums and the requirements to access them. Likewise, FIG has engaged with ISO TC211 to ensure that internationally recognized GIS standards are consistent with those for national reference frames utilized by FIG Member organizations.

Commission 5 also continued support to FIG Task Forces, the Standards Network, and regional Capacity Development Networks (e.g., AP CDN). The Commission will also respond to the FIG Council to address new issues as they emerge.

For 2021, Commission 5 supported efforts with FIG CDN to host a virtual *Technical Seminar on Reference Frame in Practice* on 02 December 2021 for Member states in the Americas region. This was, in part, a recruitment effort to gain interest from potential Member and Associate organizations. (see below). The plan remains to hold in-person RFIP seminars at the FIG 2022 Congress in Warsaw, the SIRGAS 2022 Symposium in Santiago, Chile and the FIG 2023 Working Week in Orlando, USA. A summary of the working group activities in 2021 follows.

2. Working Groups

WG 5.1 – Standards, Quality Assurance and Calibration

Chaired by David Martin

Standards play an important role in surveying and particularly with modern instrumentation that give black box solutions and measurements that are not necessarily understood by the average practicing surveyor. Although surveyors are generally not directly implicated in standards and standardisation, they are implicitly very reliant upon standards underpinning the correct functioning of their instruments.

Working Group 5.1 actively participates in technical sessions, technical seminars and presentations for FIG Working Weeks and Congresses. Working Group 5.1 is also very closely linked to the FIG Standards Network and standards work of the other FIG Commissions (e.g. the Land Administration Domain Model being developed through Commissions 4,7,8 and 9. Importantly Working Group 5.1 is the contact for FIG liaison to the ISO Technical Commission (TC) 211 and Technical Committee ISO/TC 172/SC 6.

ISO TC 211 works on standardization of digital geographic information establishing a structured set of standards associated with a location relative to the Earth. These standards may specify, for geographic information, methods, tools and services for data management (including definition and description), acquiring, processing, analysing, accessing, presenting and transferring such data in digital/electronic form between different users, systems and locations. Nic Donnelly, from Land Information New Zealand, (also FIG Commission 5.2) is the FIG liaison to TC211.

ISO/TC 172/SC 6 deals more closely with surveying instruments. These standards deal with field procedures for testing geodetic and surveying instruments such as theodolites, total stations, levels, laser scanners and GNSS in real-time kinematic (RTK). Ingo Neumann from the Geodätisches Institut Leibniz Universität Hannover is the FIG representative to ISO/TC 172/SC 6.

A principal aim of Working Group 5.1 remains the examination and promotion of guidelines and recommendations for standards and quality in survey measurements based on the ISO Guide to Uncertainty in Measurement (GUM) and its supplements.

WG 5.2 – 3D Reference Frames

Chaired by Nic Donnelly

The main activity for Working Group 5.2 was the organisation of a short seminar on Reference Frames in Practice held online on 02 December 2021. This focussed on the Americas region and was organised with the support of the SIRGAS. The Agenda is given below and represented the viewpoints of FIG Member and non-Member organizations for the Americas region. There were 65 participants from about 17 countries present with much of the presentation material given in Spanish and presentations in English with discussions facilitated by bilingual speakers. Ongoing challenges were mainly related to bringing the Nations together into a coherent plan of action. SIRGAS, PAIGH, and other organizations have a Joint Plan for the Americas focused on implementing the Global Geodetic Reference Frame. However, Education, Training and

Capacity Development remain critical issues. In turn, this impacts the surveying and associated geomatics communities that rely in these regional and global reference frames to accomplish their professional duties. The intent of the Seminar was to bring awareness to the various groups and a synergy to the efforts to unify these ETCB activities. The co-conveners of the seminar were Dr. Daniel Roman (Chair, FIG Commission 5) and Dr. Demian Gomez (President, SIRGAS WG II). The link to the recorded session is <https://attendeegotowebinar.com/recording/1316877799453483021>

FIG/SIRGAS Technical Seminar		Reference Frames in Practice	
Agenda	Times (UTC)	Discussion Area	Presenters
	1800-1805	Welcome and Opening Remarks	Dr. Daniel Roman
	1805-1820	FIG Overview	Dr. Daniel Roman Mr. David Avalos
	1820-1830	SIRGAS Overview	Dr. Demian Gomez
		Participant Briefs	
	1830-1840	Bolivia: National Perspective	Dr. Arturo Echalar
	1840-1850	Canada: Canadian Institute of Geomatics	Dr. Mir Abolfazl Mostafavi
	1850-1900	French Guiana: Ordre des Géomètres-Experts	M. Paul Chambon
	1900-1910	Jamaica: Land Surveyors Association of Jamaica	Mr. Christopher Grant
	1910-1920	Trinidad and Tobago: Institute of Surveyors of Trinidad and Tobago	Dr. Dexter Davis
	1920-1940	Discussion	All Participants
	1940-1950	Future Seminars	Dr. Daniel Roman
	1950-2000	Closing Remarks	Dr. Demian Gomez Dr. Daniel Roman

02 Dec 2021 1800-200 UTC Virtual Session

Figure: Agenda for RFIP Seminar during the 2021 SIRGAS Symposium

Working group members continue to be active in a number of relevant international groups. These include the OGC project teams working on the standardisation of a deformation model functional model, the GGXF geodetic format, the ISO Geodetic Registry as well as the IAG's Working Group 1.3.1 on Time-dependent transformations between reference frames in deforming regions.

WG 5.3 – Vertical Reference Frames

Chaired by David Avalos-Naranjo

Modern concepts about the gravity field of the Earth are changing the way vertical control is being implemented, not only for monitoring and maintaining a precise and time-consistent reference system, but also to advance making it globally accessible. As part of the GGRF, this trend is leading the effort to modernize the vertical reference frame in a number of countries, which implies a transition the surveying community shall inevitably embrace.

During 2021, WG5.3 supported the organization of technical session 5.3 at FIG Working Week 2021, where a series of key topics were presented on the evolution of vertical reference frames, ranging from basic concepts to complex implementations that allow users easy access from

modern positioning platforms. The session was not only well attended but attendees enthusiastically engaged with comments and questions that sent a clear message that these kind of sessions are much needed.

WG5.3 expects to collaborate in the organization of two RFIP seminars and a technical session at the FIG Congress 2022, providing up to date material regarding the International Height Reference Frame (IHRF) and sharing experiences on the transition from the classical approach. In collaboration with the International Association of Geodesy, WG5.3 continues to promote guidelines, recommendations and best practices in the use of vertical reference frames.

Modern concepts about the gravity field of the Earth are changing the way vertical control is being implemented, not only for keeping track of a precise and time-consistent reference system, but to advance making it globally integrable. As part of the GGRF, this trend is leading the effort to modernize the vertical reference frame in a number of countries, which implies a transition the surveying community shall give an impulse.

WG 5.4 – GNSS

Chaired by Suelynn Choy and Ryan Keenan

The GNSS working group continues to support multi-constellation GNSS activities through in the UN International Committee on GNSS (UN ICG) with collaboration from the International GNSS Services (IGS), International Association of Geodesy (IAG) and Multi-GNSS Asia (MGA).

The global pandemic has affected every country, lives, and the activities within FIG. At the same time, the GNSS industry is adapting to the pandemic and helping to address some of challenges, e.g., in playing a role in controlling the virus, for positioning data acquisition, reporting of location information, distribution of relevant information, and for describing and analyzing the occurrence of outbreaks. In 2020-2021, FIG WG 5.4 is contributing and participating in the IAG General Assembly, ION GNSS+ online/hybrid conferences as well as various online webinar series on GNSS. WG 5.4 chairs welcome ideas and contributions from members of the FIG on ways to better engage and support our community in the post-COVID-19 world.

In terms of capacity building activities, FIG WG 5.4 has been actively involved in the ongoing efforts of the UN GGIM's Subcommittee on Geodesy (SCoG)'s Education, Training and Capacity Building (ETCB) working group. Following the WG ETCB presenting a paper at FIG WW 2020 on the results of a global Questionnaire around the perceived geodetic Reference Frame competency levels around the world, an updated global Questionnaire is set to be released in mid-2021 with greater focus on the regional competencies and needs. It is expected the new regional insights gathered will contribute significantly to the strategic activities planned by the UN GGIM Global Geodetic Centre of Excellence (GGCE).

Additionally, FIG WG 5.4's involvement in the work of ISO TC20/SC14/WG1 to review WD24246 - the development of a new standard for 'GNSS positioning augmentation centers' continues, with an expected publication near the end of 2021. With this new standard, it is

expected that the dissemination of GNSS augmentation information from solution providers will be open, unambiguous and accessible to the growing user community.

In summary, FIG WG 5.4 is actively involved with those groups responsible for helping to define the future of GNSS positioning into the next decade, and beyond.

WG 5.5 – Multi-Sensor-Systems

Chaired by Allison Kealy and Günther Retscher (IAG)

WG efforts focus on processing techniques in three primary areas – firstly, more representative statistical error distributions for the non-traditional sensors such as Wi-Fi and Ultra Wideband based on real-world data; secondly, the implementation of novel techniques such as differential Wi-Fi and information grammar as approaches to improving the positioning solution achievable from traditional sensor fusion techniques and thirdly, robust, decentralised fusion algorithms for scalable and practical collaborative networks.

This WG undertook a follow up to the outreach program in Sri Lanka started in 2018. Working collaboratively with the Sabaragamuwa University (Geomatics Department), two workshops were conducted (July 2018 and July 2019) specifically with a knowledge transfer focus. A key aspect of these workshops was a data collection campaign to evaluate the performance of GAGAN and NavIC, the Indian contributions to GNSS. Since January 2021 Sabaragamuwa University is serving as Sri Lanka’s National coordinating institution in a joint project under the lead of TU Wien funded by European Union’s Erasmus+ Capacity Building in Higher Education programme entitled ‘Curricula Enrichment delivered through the Application of Location-based Services to Intelligent Transport Systems / LBS2ITS’. The project website is:

<https://lbs2its.net/>

A further activity started in 2020 with an international measurement campaign of TU Wien, Ghent University and KU Leuven concerning an investigation of the suitability of Bluetooth RSSI measurements for covid-19 contact tracing. This activity continued in 2021 with further results presented at virtual conferences. For further information see:

<https://www.youtube.com/watch?v=x6y8W80qH8M>

Members of this WG are also very active in promoting the women in positioning, navigation and timing (PNT) activities underway in other professional associations such as the ION and RIN.

WG members participated in various capacities in the following conferences:

- ION ITM 2021, USA (virtual)
- GIS Ostrava 2021, Ostrava, Czech Republic (virtual)
- ISPRS 2021, Nice, France (virtual)
- ION GNSS+ 2021, USA (virtual)
- LBS 2021, Glasgow, Scotland (virtual)
- Symposium on Geospatial Approaches to Combating Covid-19, Florence, Italy.

WG 5.6 – Cost Effective Positioning

Chaired by Leonid A. Lipatnikov and Li Zhang

In 2021, WG continued its activities in educating associations and individual surveyors on when to use which surveying instrument or software taking into account economic reasons, supporting decision makers for establishing cost-effective positioning solutions, and designing fit-for-purpose surveying systems that are cost-effective.

WG members participated in the following conferences:

- FIG Working Week;
- Geo-Siberia, May 2021, Novosibirsk, Russia;

A number of R&D projects were elaborated by the WG 5.6 members in 2021. Among them:

- Low-Cost GNSS Equipment for Monitoring;
- Open Software & Hardware Inclinometer;
- Collaborative Precise Positioning Demonstrator;
- Low-Cost multisensor system for kinematic application.

The work on the 2nd edition of FIG report 74 "Cost effective precise positioning with GNSS" was under way. Compared to the previous one, the new edition will contain the latest updates on high-precision low-cost GNSS hardware, software-defined receivers, CORS networks, free data and information sources, versatile free open-source software, free online post-processing and real-time correction services, and SBAS. The recent events including BeiDou reaching full operational capability, start of Starlink trials, fast growing number of dual-frequency smartphones, and their impact on cost and availability of high precision positioning will be covered in the report. Especial emphasis will be made on new opportunities for worldwide mass-market high-precision positioning services with seamless coverage.

The recent updates on those topics and the first results of the aforementioned R&D projects by WG members are planned to be discussed at the second Cost Effective Positioning Seminar which is to be held in 2022 online.

In 2021 particular results were achieved in the project aimed at developing cost-effective monitoring systems for remote polar areas. The software for the system was shared on GitHub: <https://github.com/DanielMamaev/MonCenter>. After two years of successful field tests in all Siberian weather conditions, with temperatures from -44°C to +32°C, a joint test with potential customers is being planned.



Figure 2: Elements of the cost-effective geodetic monitoring system

This project can be used to illustrate the contribution of the WG to achieving the Sustainable Development Goals adopted by the UN. The primary motivation for the project is an urgent problem of increasingly fast melting of permafrost in polar regions, particularly in Siberia. Apart from potentially further accelerating global warming that leads to ground deformations on huge territories, which imposes additional risks to cities, industrial facilities, and other infrastructure including pipelines. In order to mitigate the risks effective systems of geodetic monitoring are needed. Given the current prices on GNSS equipment for geodetic monitoring and the number of the required sensors capable of working in extremely low temperatures the overall price of such a monitoring system will be prohibitively high. The project is aimed at developing a low-cost high-precision geodetic monitoring system that would solve the problem. Apart from enabling extensive high-precision monitoring and positioning, which can benefit the developing countries, the efforts of FIG WG 5.6 members contribute also to quality education. The most active members involved in WG activities are university teachers and students. Their projects evolve with time, helping the authors and contributors to find their way in the world of technology and establish professional connections across borders.

Thus FIG WG 5.6 contributes to achieving the following UN Sustainable Development Goals and specific targets:

Goal 4. QUALITY EDUCATION

- By 2030, substantially increase the number of youth and adults who have relevant skills, including technical and vocational skills, for employment, decent jobs and entrepreneurship

Goal 9. INDUSTRY, INNOVATION AND INFRASTRUCTURE

- Develop quality, reliable, sustainable and resilient infrastructure, including regional and transborder infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all
- Facilitate sustainable and resilient infrastructure development in developing countries through enhanced financial, technological and technical support to African countries, least developed countries, landlocked developing countries and small island developing states

Goal 13. CLIMATE ACTION

- Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries.

3. Cooperation, Seminars and Workshops

3.1 Cooperation with Other Commissions

Joint Sessions were held during FIG 2021 Working Week and assistance on the Scientific Committee was provided for the Joint International Symposium on Deformation Monitoring (JISDM) of 2022.

Other areas include:

- Commission 4 regarding Hydrographic Surveying on the Ellipsoid
- Commission 6 and ISPRS on Laser Scanning
- Commission 6 on UAV Usage for Surveying
- Commission 7 and 3 on Cost-Effective Positioning
- Regional Capacity Development efforts in Asia-Pacific, Africa, and the Americas
- Provided significant input to SDG WG on relationship with Commission 5 activities

3.2 Cooperation with Sister Organisations

Commission 5 continued to maintain a successful working relationship with the International Association of Geodesy (IAG), PGSC (with AP CDN) and SIRGAS. This was achieved by convening joint Technical Seminars on Reference Frames in Practice, technical sessions and holding joint administrative meetings on significant issues. Additionally multidirectional exchange on Seminars and Symposia are practised e.g.

During 2021, a Technical Seminar on Reference Frame in Practice was held virtually for the Americas region. See notes in the WG 5.2 for further details.

3.3 Cooperation with UN

FIG and IAG are both supporting the UN International Committee on GNSS (UN ICG) as well as the UN Global Geospatial Information Management (UN GGIM) Committee. The UN GGIM has implemented the Global Geodetic Reference Frame (UN GGRF) that is being implemented by the UN GGIM SubCommittee on Geodesy (UN SCoG). The UN SCoG has several working groups including one on Education, Training and Capacity Building (WG ETCB). The FIG Leadership as well as Commissions 2 and 5 are working closely with ETCB to evaluate the geodetic and surveying capabilities of Nations and to catalog available training resources for surveyors around the world.

3.4 Cooperation with ISO

There has been ongoing interaction with ISO/TC211, the geographic information technical committee of ISO. Nic Donnelly continues as the Special Liaison from FIG to ISO/TC211. ISO TC211 has focused on maintaining and expanding the ISO Geodetic Registry to ensure all national and international reference frames and vertical datums are listed officially. This enables GIS and other programmers to accurately transform positions and measurements for FIG Members.

4. Events

2021

- The FIG virtual Working Week hosted by the Netherlands in June
 - Three Commission specific sessions
 - One joint session with Commission 4
 - Supporting the UN-GGIM specific meetings
- RFIP in conjunction with SIRGAS
 - Met with Americas surveying and geodetic organizations
 - Prospective new Members
 - Coordination with UN SCoG WG ETCB and SIRGAS WG II

2022

In 2022, Commission 5 plans to participate in

- UN-GGIM-AP/Pacific Geospatial Surveying Council meeting in June
- The FIG Working Congress hosted by the Poland in September
 - Four Commission specific sessions
 - Supporting the UN-GGIM specific meetings on ETCB
- An in-person RFIP during a SIRGAS seminar in November

5. Communication and Publications

Commission 5 has issued numerous reports and periodic newsletters to our delegates. These information can also be found on websites -

- <http://www.fig.net/organisation/comm/5/index.asp>

Daniel R. Roman,
Chair

Chair of FIG Commission 5
June 2022