The International Committee on Global Navigation Satellite Systems: A system of systems

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THE International Committee on Global Navigation Satellite Systems (ICG) was formed in 2005 to review and discuss matters relating to global navigation satellite systems (GNSS) and their applications. The ICG work plan includes compatibility and interoperability; enhancement of performance of GNSS services, information dissemination and capacity building, interaction with national and regional authorities and relevant international organisations and coordination. The ICG members co-operate on matters of mutual interest related to civil satellite-based positioning, navigation, timing and value-added services. In particular, they co-operate to the maximum extent practicable to maintain radio frequency compatibility in spectrum use between different GNSS systems in accordance with the *International Telecommunication Union (ITU) Radio Regulations*. The United Nations office for outer space affairs, as the executive secretariat of the ICG, develops a wide range of activities focusing on capacity building, specifically in deploying instruments for the international space weather initiative (ISWI), developing a GNSS education curriculum, and utilising regional reference frames that support sustainable development, particularly in developing nations.

The Soyuz-Fregat launch vehicle carrying GIOVE-B, the second of ESA's two Galileo in-orbit validation element demonstrators for the Galileo global navigation satellite system, in the final minutes before lift-off from from launch complex at the Baikonour spaceport, Kazakhstan, on 27 April 2008.
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The UN assists the process of the establishment of the ICG information centres for training and information dissemination on global applications of GNSS and their socio-economic benefits for humanity.

GNSS

GNSS consist of satellites, ground stations and user equipment and are utilised worldwide across many areas of society. GNSS operating in different constellations are the United States' global positioning system (GPS), the Russian Federation's GLONASS, Europe's GALILEO and China's Compass/BeiDou. Regional navigation satellite systems (RNSS), providing signal coverage over a number of nations or regions, are India's GPS-aided geo augmented navigation (GAGAN) and Japan's quasi-zenith satellite system (QZSS).

In an attempt to build a system of GNSS systems in the coming decade, the ICG was established in 2005 under the umbrella of the United Nations. The ultimate goal of ICG is to achieve compatibility and interoperability of GNSS systems thereby saving costs through international co-operation and making positioning, navigation and timing available globally for societal benefits, including monitoring all aspects of environment and security.

Following the third UN conference on the exploration and peaceful uses of outer space (UNISPACE III), held in 1999, the United Nations General Assembly endorsed *The Space Millennium: Vienna Declaration on Space and Human Development.* The Vienna declaration called for action to improve the efficiency and security of transport, search and rescue, geodesy and other activities by promoting the enhancement of, universal access to, and compatibility among, space-based navigation and positioning systems. In response to that call, in 2001, the United Nations committee on the peaceful uses of outer space (UNCOPUOS) established the action team on GNSS to carry out those actions under the chairmanship of Italy and the USA.

The action team on GNSS consisted of 38 member states and 15 inter-governmental and non-governmental organisations and recommended that an international committee on GNSS (ICG) be established to promote the use of GNSS infrastructure on a global basis and to facilitate exchange of information. Following workshops for the regions of Africa, Asia and the Pacific, Europe, Western Asia, Latin America and the Caribbean, and international preparatory meetings and actions at the inter-governmental level, the ICG was established.

It is an informal, voluntary forum where governments and interested non-governmental entities can discuss all matters regarding GNSS

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on a worldwide basis. The ICG promotes international co-operation on issues of mutual interest related to civil satellite-based positioning, navigation, timing and value-added services. The goal of the ICG is to promote the greater use of GNSS capabilities to support sustainable development and to promote new partnerships among committee members and institutions, particularly taking into account interests of developing nations.

International space weather initiative

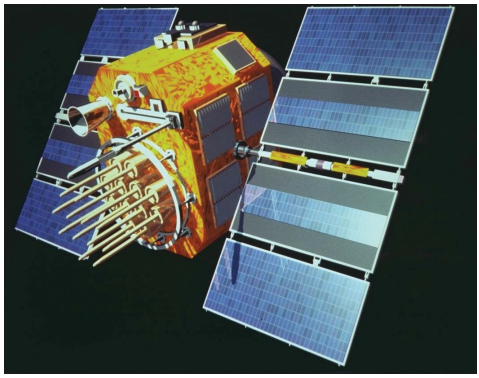
The UN basic space science initiative (UNBSSI) and its series of workshops dedicated to basic space science is a long-term effort to promote the development of astrophysics and space science, as well as efforts towards regional and international co-operation in this field on a worldwide basis, particularly for the benefit of developing nations. A first series of workshops dedicated to basic space science was held from 1991 to 2004 for Asia and the Pacific, Latin America and the Caribbean, Africa, and Western Asia.

Among the major recommendations emanating from the workshops was that small astronomical facilities should be established in developing nations to enable and support research and education programmes at university level. Based on this recommendation, astronomical telescope facilities were inaugurated in seven nations and educational materials for teaching and observing programmes for optical telescopes were developed or adopted from existing resources and planetariums were established in 20 nations. From 2005 to 2009, the UNBSSI workshops were dedicated to the international heliophysical year 2007 and contributed to the deployment of 14 groundbased worldwide instrument arrays (GPS receivers, radio antennas, magnetometers, cosmic ray detectors) for research on climate change, space weather, and ionospheric phenomena.

Currently, more than 1000 instruments are operational in these instrument arrays. These instrument arrays will be used to constitute the international space weather initiative from 2010 to 2012.

Applications of global navigation satellite systems

Regional workshops on applications of GNSS were held in Zambia and China in 2006, Colombia in 2008 and Azerbaijan in 2009 to address applications of GNSS for socio-economic benefits. These workshops address *inter alia* space technology applications such as remote sensing, precision agriculture, aviation, transport and communications, and e-learning. The workshops aim at initiating pilot projects and strengthening networking in the regions. The workshops also address the areas of natural resources management and environmental



An artist's impression of a US military GPS.
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monitoring by applying GNSS technologies to thematic mapping, forest management and water resources management.

The use of GNSS could benefit various areas of the agricultural sector, ranging from basic rural cadastre and surveying to advanced precision agriculture. Agroclimatic and ecological economical zonings, crop inventory, monitoring and forecasting are only a few examples of agricultural activities where positioning is of paramount importance. In the area of climate change, different factors and mechanisms drive land use and land cover transformation. In many cases, climate, technology and economics appear to be determinants of land use change at different spatial and temporal scales. At the same time, land conversion is an adaptive feedback mechanism that farmers use to smooth the impact of climate variability, especially in extremely dry and humid periods.

Satellites have for several years been an indispensable resource in global observation of the Earth and weather systems. They bring undeniable added value to global climate models but much remains to be done in developing finer-scale models capable of use in a regional or national setting. Space-based systems such as GNSS have demonstrated their ability to make precise and detailed observations of key meteorological parameters, whose measurement stability, consistency and accuracy should make it possible to quantify long-term climate change trends.
In the area of transport domain, a number of studies have already shown that civil aviation will significantly benefit from the use of GNSS. These benefits include improved navigation coverage in

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areas currently lacking in conventional aids. Accurate and reliable information about aircraft positions and routes enables safe and efficient management of air traffic, and thereby safety on airport approaches. Road transport applications can automatically revise a route to account for traffic congestion, changes in weather or road works. Similarly, at sea GNSS technologies can provide efficient route planning, collision avoidance and increased efficiency in search and rescue situations. For rail transport, GNSS offer enhanced cargo monitoring and assist track surveying. In addition, communication systems, electrical power grids and financial networks all rely on precision timing for synchronisation and operational efficiency. For example, wireless telephone and data networks use GPS time to keep all of their base stations in perfect synchronization. This allows mobile handsets to share limited radio spectrum more efficiently.

Regional reference systems and frames

All regions (Africa, Latin America and the Caribbean, Western Asia, Europe, and Asia and the Pacific) are embracing the use and applications of GNSS technologies, particularly GPS, in various geo-information applications, services and products. With the increased use and application of GNSS and the requirements to relate GPS solutions with the already existing mapping products based on local and national coordinate reference systems, there is an urgent need to establish and determine the transformation data to and from such systems to GNSS reference systems. This will be achieved on full realisation of the regional reference frames, known as African geodetic frame

(AFREF), geocentric reference system for the Americas (SIRGAS), reference frame subcommission for Europe (EUREF), the European position determination system (EUPOS) and the Asia Pacific regional geodetic project (APRGP). The executive secretariat of ICG is using regional reference frames as co-operation partners in the implementation of ICG projects at the regional level.

This corresponds to the United Nations economic and social commissions for Africa, Latin America and the Caribbean, Europe, Asia and the Pacific, and Western Asia. ICG executive secretariat initiated a cooperation between the ICG and the regional reference systems in 2008. Co-operation between ICG and regional reference systems has vast potentials for geodesy, mapping, surveying, geo-information, natural hazards mitigation, earth sciences etc. As one element of the programme on GNSS applications this co-operation, also facilitated through the regional centres, may provide a major springboard for the transfer and enhancement of skills and knowledge in surveying, geodesy and especially GNSS with its applications.

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