International Federation of Surveyors
Fédération Internationale des Géomètres
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Commission 5: Positioning and Measurement

FACT SHEET

Reference Frames, Datums and GNSS CORS Networks

Introduction

Today it is common to determine a point's position using Global Navigation Satellite Systems (GNSS). If GNSS - "GPS" is used then the point's position is determined in the reference system 'WGS 84'. Observing in a good GNSS environment, the absolute accuracy for a 'single point position fix' will be ± 5 - 10 metres in the horizontal – ie 2 dimensions at the 2 sigma (2σ) confidence level. It is however possible to increase the accuracy of point positioning but positional services such as 'Fugro Omnistar' are needed OR post-processing using precise orbits is usually necessary. If higher accuracy is required (mm to cm) then GNSS data from points of 'known position' in the region are needed. The resulting co-ordinates for the point will then be in the same reference frame as the local point. This local point could be a permanent GNSS station in continuously operating reference station (CORS) network that is linked to an International Terrestrial Reference Frame (ITRF).

In a GNSS CORS network the surveyor will normally derive a height based on the reference ellipsoid ie Geodetic Reference System 1980 (GRS80). Most users however are working with 'physical' heights based on a local height datum (ie local mean sea level) and thus need to relate the derived ellipsoid height to this local height datum. This is achieved by using a geoid model for the subject survey area.

From a spatial information perspective, it is common for spatial datasets and geographical information data to extend over national or regional boundaries. In this situation it is needed to have a common reference frame for the collection, storage, visualisation and exchanging of the information. ITRF is the most accurate reference frame that exists internationally and consequently more countries are using a national solution based on ITRF.

What is ITRS and ITRF?

Co-ordinates in an International Terrestrial Reference System (ITRS) are computed at different epochs and the solutions are called ITRF. Due to plate tectonics and tidal deformation, the co-ordinates changes for a certain point between the different ITRF. The latest version of ITRF is ITRF 2005. In simple terms the ITRF is a realisation of the ITRS.

What is the difference between ITRF based datums and WGS84 co-ordinates?

WGS84 or the World Geodetic System 1984 is the geodetic reference system used by the GNSS - "GPS". WGS84 was developed for the United States Defence Mapping Agency (DMA), now called NGA (National Geospatial - Intelligence Agency). Although the name WGS84 has remained the same, it has been enhanced on several occasions to a point where it is now very closely aligned to ITRF and referenced as WGS 84 (G1150). The origin of the WGS84 framework is also the earth's centre of mass.

For all practical purposes, an ITRF based geodetic datum or CORS network and WGS84 are the same. The difference is of the order of cms.

What are ITRF Co-ordinates?

ITRF co-ordinates or positions are articulated as three dimensional geocentric or Earth Centred Cartesian co-ordinates ie "X, Y and Z". To convert these Cartesian co-ordinates to geographic co-ordinates (latitudes and longitudes and ellipsoid height) the GRS80

ellipsoid is normally used as it is the best fitting scientific and mathematical global figure or model for the earth's surface.

Note - in some cases it is necessary to describe an ITRF position in plane (grid) co-ordinates (eg two dimensions – eastings and northings) hence a mathematical map projection is used. A popular map projection which retains the angle is the Transverse Mercator projection.

What are the benefits of a geodetic datum based on ITRF?

Adopting an ITRF based geodetic datum allows for a single standard for collecting, storing and using geographic or survey related data. This will ensure compatibility across various geographic, land and survey systems at the local, regional, national and global level. This is the main reason that the ITRF based CORS networks should form the basis for Spatial Data Infrastructure (SDI) which is the enabling infrastructure to manage a country's key spatial data sets ie it underpins or is the reference layer for the cadastre, transit / road networks, infrastructure corridors like gas, water, power, communications etc.

An ITRF based geocentric datum or CORS network will also:

- provide direct compatibility with GNSS measurements and mapping or geographic information system (GIS) which are also normally based on an ITRF based geodetic datum;
- minimise the need for casual users to understand datum transformations;
- allow more efficient use of an organisations' spatial data resources by reducing need for duplication and unnecessary translations;
- help promote wider use of spatial data through one user friendly data environment;
- reduce the risk of confusion as GNSS, GIS and navigation systems become more widely used and integrated into business and recreational activities.

What is a CORS? What is a network?

A GNSS CORS comprises a GNSS receiver and antenna mounted on a stable monument (pillar) or structure (building) at a safe and secure location with a reliable power supply. The receiver operates continuously, logging raw data, perhaps also streaming (continuously outputting) raw data, and often outputting real time kinematic (RTK) and differential GNSS (DGNSS) data for transmission to RTK, GIS and GNSS navigation devices. The GNSS receiver is usually controlled by a computer that can be located remotely. This personal computer (PC) will usually download GNSS data files at regular intervals and pass them to a file transfer protocol (FTP) server for access by the GNSS user community.

Reference stations and networks can vary considerably in extent / size, level of service and complexity. Organizations that are investigating the establishment of reference stations should consider carefully what the stations will be used for, what services they will have to provide, and what will be the appropriate levels of sophistication and cost.

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