Actions for the recognition of the International Terrestrial Reference System and Frame

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The International Terrestrial Reference System (ITRS) is the recommended Terrestrial Reference System (TRS) for the geoscience community, thanks to a resolution adopted by the International Union of Geodesy and Geophysics (IUGG) during its General Assembly of Perugia in 2007. The ITRS is also recognized by the International Astronomical Union (IAU). The General Conference on Weights and Measures (CGPM) (Resolution 9, 24th Meeting of the CGPM) recommends the adoption of the ITRS as the unique terrestrial reference system for all metrological applications.

In the frame of the Global Geodetic Observing System (GGOS) project of the International Association of Geodesy (IAG), one of the IUGG associations, a working group on the ITRS standard was established in 2008 to investigate the strategy to obtain the adoption by the International Standardization Organization (ISO) of a standardization document related to the ITRS.

Following the initial work done by the group, a proposal was submitted to ISO by France. This proposal was a New Work Item Proposal (NWIP) related to the ITRS submitted to the ISO TC 211 on Geographical information, to which IAG is a liaison.

ISO finally decided that a preliminary study demonstrating the importance of geodetic references at large was necessary before going further in the direction of the initial proposal. A project (19161) was therefore established within ISO TC211 WG4 and chaired by myself. The project report was finalized in January 2015, reviewed and finally submitted early August 2015 to the WG4 for approval and decision of further actions.

The report ends with some recommendations:

- To develop a standard related to the ITRS
- To make further studies about the interest and feasibility of a standard on vertical references
- To make similar action for the universal identification of geodetic stations
- To work to improve geodetic terminology, including update of existing standards

Metrology was one of the domains discussed in the 19161 report. It is therefore useful to quote here some sentences :

"The CGPM in 2011, considering the significant and increasing number of Global Navigation Satellite Systems (GNSS), that the proliferation of time and geodesy reference systems in use in these navigation systems creates ambiguities for users, rendering their interoperability more difficult; and considering that the adoption of a common reference

system is beneficial for users, adopted a resolution recommending that "the ITRS, as defined by the International Union of Geodesy and Geophysics (IUGG) and realized by the International Earth Rotation and Reference Systems Service (IERS), be adopted as the unique international reference system for terrestrial reference frames for all metrological applications ». The adoption of this resolution by the CGPM (Resolution 9, 24th CGPM, 2011, http://www.bipm.org/en/worldwide-metrology/cgpm/resolutions.html), puts in evidence the necessity of using a standard terrestrial reference in metrology.

Impact of the geodetic references on time and frequency metrology

The foundations of time and frequency metrology are

- *the realization of the SI unit of time, based on an atomic transition at the level of a few parts in 10^{16},*
- *the construction and dissemination of atomic time scales based on the SI second.*

International Atomic Time (TAI) is a coordinate time scale defined in a geocentric reference frame which unit is the SI second as realized on the rotating geoid. The transformation between proper time (provided by an individual clock in a laboratory) to TAI, requires the actual value of the gravity potential of the geoid. In the practical transformation, the orthometric height of the clock is a parameter, together with the average value of gravity between the geoid and the clock.

The best clocks (primary and secondary frequency standards) realize the SI second with a few parts in 10^{16} accuracy. Assuming that the geoid, the reference level of the height system and the height are all measured with an uncertainty below one metre, it is possible to realize TAI as defined.

However, the situation will change when considering clock accuracy of order 10^{-17} and below, for which uncertainty of order 1 cm or below is needed.
Accurate clocks can also be useful to geodesy, provided that accurate frequency transfer techniques are developed for comparing clocks accurate to 10^{-17} level. Under these conditions, accurate frequency comparisons could provide a means of computing the difference of gravity potential between the locations of the clocks."

Following the recommendation of the report, France reiterated its proposal of a NWIP on the ITRS which is hopefully on the way of approval. Therefore, it is highly desirable that the BIPM join the future working group as liaison, through ISO TC211 to which the BIPM must adhere. Its role should be in particular to take care of the adequacy of the future text of the standard with the concerns of the metrological community.