UNIFICATION OF REGIONAL REFERENCE SYSTEMS

W. Augath, University of Hannover
J. Manning, Australian Survey and Land Information Group

The Topic 5 question set for discussion the IERS review was: What should be the role of IERS in unifying the national datums into ITRS ?

The definition of global reference systems is a permanent international scientific task, which is suitably undertaken by IERS, but at the national level, the realization of the global system can only be done by, or in conjunction with the respective individual national survey agencies. This report is prepared from their point of view.

1. REQUIREMENTS OF NATIONAL REFERENCE SYSTEMS

Every national administration needs to maintain a uniform national geodetic reference system and a realization for the whole country. The establishment of a fixed national datum requires the definition of a set of coordinates at a particular epoch, preferably within a global reference system. Due to the costs involved in establishing or changing this fundamental datum, every government is interested in preserving a long life for the declared datum to gain maximum utility in respect to :

accuracy,
point density,
access to the data,
actuality of coordinates due to crustal movements.

There are varying accuracy requirements for national datums; from countries in Europe, where centimeter accuracy is required; to the large number of developing countries throughout the world which do not have such a high immediate accuracy requirement. Whilst IERS can promote the tools to facilitate the establishment and subsequent unification of national datums into regional and global systems, the choice of required accuracy level remains with the national agency. But for IERS to meet the full range of options required, the highest level of accuracy must be met by the provision of a 1cm reference frame.

In practice GPS will be used by countries in virtually every case to establish ITRF (or WGS84) points for a national datum, whether it is to upgrade existing terrestrial trig networks or to establish new geodetic frameworks.

Where a fixed IRTF epoch is used to determine a coordinate data set to establish a national datum, the crustal motion velocities of fundamental sites also need to be monitored in scientific solutions. The fixed datum can then be subsequently upgraded when the crustal movement from the ITRF epoch has become significant to the national agency, or data can be transformed to different epochs using published IERS values. Where a fixed epoch approach is not suitable for establishing a national datum, due to significant differential motions across the country, the problems are more complex and will require more frequent revision of the national datum or maintenance of a dutum in a kinematic mode. Two strategies therefore need to be considered :

Stable areas

The reference system is established at a certain epoch and the values of all coordinates in the datum and geodetic network are kept fixed. In that case, the reference system moves in the same way as the plate. This solution fulfills the requirements of a large number of national users, due to the fact that they only work in their national system.

Unstable areas

In unstable areas the user of a reference frame can encounter problems with differential or abnormal (non linear) movements of points within the datum set of coordinates or extended geodetic network. Where the movements of the reference points are larger than the internal accuracy of the geodetic network, constant remeasurement of either the whole country or the unstable parts may be required to continually redefine the datum epoch.

2. UNIFICATION OF NATIONAL AND REGIONAL REFERENCE SYSTEMS

Although most users of national reference systems work only in local areas, there are also important requirements, which can only be fulfilled within a regional (ie continental) or a global system such as:

- internal infrastructure projects (highways, railways, water ways),
- navigation of cars, vessels,
- spatial data bases,
- geographic information systems,
- land information systems,
- global navigation of ships and airplanes.

For these purposes reference systems beyond local national borders have to considered, defined and realized. From the economic point of view it would be desirable if all requirements could be fulfilled within one global system, so that data can be readily integrated without overlap or duplication. So an orderly approach to integrate or unify national systems into regional networks must be developed. Where national datums are established within IRTF then it is possible to meet these requirements using IERS values.

3. NATIONAL AND REGIONAL REQUIREMENTS ON GLOBAL REFERENCE SYSTEMS AND THEIR REALIZATIONS.

The highest accuracy definition and realization of a global reference system for national use should be on the 1cm level, as this can be achieved by users of modern GPS techniques over the whole country. The global system must then be realized at least on the same accuracy level to support long life aspects of a national datum.

It is desirable that at least three ITRF points be established in each national datum. Additionally permanent geodetic trackers (such as GPS) should be established to monitor the crustal motion applicable to that national datum.Iin areas of high tectonic activity the movement of the respective plates need to be monitored to evaluate the expected useful life of an established datum.

4. REQUIREMENTS OF IERS

There are a number of requirements of IERS in order to facilitate the orderly unification of national datums:

- For IERS to maintain 1cm global solutions a point density of 20-30 fundamental permanent, collocated techniques sites, well distributed over the continents is essential.
- Additional densification (such as is being undertaken by IGS) of a large number of permanent geodetic regional stations is needed, to facilitate establishment of national datums within ITRF.
- A further epoch densification is required at the border of continents and plate/microplates to monitor differential velocities.
- To facilitate transformations between epoch values of the kinematic ITRF, the frequency of published solutions should be used to allow a linear interpolation between such epochs.
- There should be minimal time delays between computation and publication of these values IERS conventions should be made readily available for use by national agencies and for regional solutions.
- Time series of coordinate positions, velocities and transformation parameters between the epochs should be available electronically through IGS or IERS.

5. RECOMMENDATIONS

Recommendations to the Directing Board from the Topic 5 review group are.

IERS should :

1. Provide a consistent global reference frame, and transformations between ITRF solutions, based on a homogeneously distributed network of stations at the highest possible level of accuracy.

2. Maintain the coordinates and velocities of a homogeneously distributed global network of accurate permanent stations, and parameters, so that any agency can undertake a national ITRF based datum.

3. Encourage national agencies to establish their precise national datums within ITRF so that these datums can be linked into regional or continental solutions.