Identification, Quality control, Copyright and Certification issues associated with GGOS products
DRAFT 1.0

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1 Introduction

The draft Terms of Reference (ToR) of the *Global Geodetic Observing System* (GGOS) include mission statements for each of the GGOS Working Groups. With respect to the Working Group *Copyright, Data Access Policy, Publishing, Certification* (CDPC), the ToR state: *"This WG should deal with the consistent assignment of the Digital Object Identifier (DOT) framework for IGGOS products and the usage of Data Set Citation rules in metadata documents for the definition and realization of copyright, data access, publishing and certification objectives.*"

The present document addresses the key issues included in this mission statement. These are

- **Identification of objects:** Identification of digital objects (data sets, documents, graphics, ...) in a global system allowing unique identification and facilitating easy access is increasingly of importance particularly for integrated global systems, and the contribution to systems of systems, such as the *Global Eearth Observing System of Systems* (GEOSS). The ToR mention the *Digital Object Identifier* (DOI®[1].) system as an option, however, it is not straight forward whether this is applicable to some or all GGOS objects such as sites, networks, observations, and derived products. Nevertheless, the consistent identification of observation sites independent of techniques, is an issue of increasing importance in the frame of GEOSS. Moreover, a coherent identification of object would entail a traceability of their use, which would support the agencies producing the data in getting the credit they deserve.
- **Data access policy:** A well defined and explicit data access policy of GGOS needs to be worked out. For that, GGOS can look at a number of examples from organisations like *World Meteorological Organisation* (WMO), the three *Global Observing Systems* (G3OS), the European programme of *GLobal Montoring for Environment and Security* (GMES), GEOSS as well as the current practice within the *International Earth Rotation and Reference Systems Service* (IERS) and the other services of the *International Association of Geodesy* (IAG).
- **Copyright, citation rules, and publishing:** Issues of copyright, citation rules, and publishing need to be addressed in the frame of GGOS and the IAG services. For those who produce data and products for the GGOS and the IAG services a proper citation to the origin of these items would be helpful in their documentation of the use of the data, which is often crucial for continued funding.
- **Validation, integrity and certification:** Considering the new, safety-of-live-critical applications of GNSS on the basis of ITRS, there will be a need for some kind of certification of processes implying the use of GGOS or IAG-provided products. The approach to that is already under discussion with respect to *Satellite-Based Augmentation Systems* (SBAS) such as the European EGNOS and North American WAAS. However, an initial step towards such a certification is the validation of the products as well as integrity information.

It needs to be pointed out that the issues addressed in the present document have considerable overlap with the other GGOS WGs:

[1]Note that DOI is registered in the U.S. Patent and Trademark office, see http://www.doi.org

- The issue of introducing a DOI-like identification for GGOS-related objects links clearly to the WGs on ”Infrastructure”, ”Data Info Systems”, and ”User Linkage”.
- The issue of data access policy links to the WGs on ”Data Info Systems” and ”User Linkage”.
- The question of sufficent validation, quality assessment and quality control as well as quality information needs to be discussed together with the WGs ”Infrastructure” and ”Data Info Systems”.
- The issue of certificiation clearly needs to be discussed in coordination with the WG ”User Linkage”

The material presented here is a starting point for the further discussion with these WGs and the GGOS community at large.

The document is written in view of the fact that IAG since the Earth Observation Summit (EOS-III) on 16 February 2005 in Brussels, Belgium, is a Participating Organization of the *Group on Earth Observations* (GEO[2]), and GGOS is one of the systems contribution to GEOSS. The document attempts to study the consequences with respect to the above listed issues of the linkage of IAG and GGOS to GEO and GEOSS, respectively. Therefore, in the next Section we first address the relevant background with respect to the expected development of GEOSS. Subsequently, we devote a section to each of the issues identified above.

2 Relevant GEOSS requirements for GGOS

In the *Reference Document* (GEO, 2005b) to the *10-Year Implementation Plan* (GEO, 2005a), it is specified on Page 126 that

> In common with Spatial Data Infrastructures and service-oriented information architectures, GEOSS system components are to be interfaced with each other through interoperability specifications based on open, international standards. Access to data and information recources of GEOSS will be accomplished through various service interfaces to be contained within the data exchange and dissemination component. The actual mechanism will include many varieties of communications modes, with a primary emphasis on the Internet wherever appropriate, but ranging from very low technoclogy approaches to highly specialized technologies.
>
> A key consideration is that GEOSS catalogues data and services with sufficient metadata information so that users can find what they need and gain access as appropriate. {...} Users searching GEOSS catalogues will find descriptions of GEO Members and Participating Organizations and the components they support, leading directly to whatever information is needed to access the specific data or service in a harmonized way, independent of the specific provider. In this sense, the interoperable GEOSS catalogues form the foundation of a more general ’clearinghouse’.

[2] Note that prior to the EOS-III, the acronym GEO was used to denote the *ad hoc* Group on Earth Observation. At the Summit, the group was established permanently without changing the acronym.

Spatial Data Infrastructures

GEOSS will advocate further development of the Global Spatial Data Infrastructure (GSDI) and use of existing Spatial Data Infrastructure (SDI) components as institutional and technical precedents. SDI's are concerned with data and information that is 'geospatial', i.e. referenced to locations on the Earth, at all scales. In common with GEOSS, SDI's support a components-based, services oriented architecture that provides interoperability based on open, international standards. To the extent that GEOSS adopts identical or compatible standards, GEOSS and SDI components become interoperable with each other as well. This provides a powerful synergy as GEOSS addresses types of data and information that are not always geospatial, while SDI's address types of data and information that are not always Earth observation. Examples of SDI data and information types include transportation, population, political boundaries, land ownership, socio-economic data, cultural heritage, and minerals, among many others.

GSDI "encompasses the policies, organizational remits, data, technologies, standards, delivery mechanisms, and financial and human resources necessary to ensure that those working at the global and regional scale are not impeded in meeting their objectives."[17] A key operational feature of the GSDI is its Clearinghouse network, which now includes over 400 catalogues in which comprehensive metadata about available geospatial data is maintained.

Many countries and international organizations are members of GSDI or ongoing participants in the GSDI Clearinghouse. Among these are: Argentina, Australia, Barbados, Bolivia, Brazil, Canada, Chile, China, Colombia, Costa Rica, Czech Republic, Dominican Republic, Ecuador, El Salvador, Ethiopia, European Union, Finland, France, Germany, Guatemala, Honduras, Hungary, India, Indonesia, Ireland, Italy, Japan, Malaysia, Mexico, Namibia, Netherlands, Nicaragua, Norway, Poland, Senegal, South Africa, Spain, Trinidad and Tobago, United Kingdom, United States, and Uruguay.

Among the regional and topic-specific organizations participating in GSDI are: Antarctic Geographic Data Integration Project, Association for Biodiversity Information, Committee for Earth Observation Satellites (CEOS), Consultative Group on International Agriculture (CIGAR), Environmental Information Systems Africa, European Umbrella Organisation for Geographic Information, Geographic Information for Sustainable Development (Africa), Global Disaster Information Network (GDIN), Global Map (ISCGM), Global Resource Information Database (GRID), Global Water Information Network, Infrastructure for Spatial Information in Europe (INSPIRE), Intergovernmental Panel on Climate Change (IPCC), International Geosphere-Biosphere Program (IGBP), Open Geospatial Consortium (OGC), Permanent Committee on GIS Infrastructure for Asia and the Pacific (PCGIAP), Permanent Committee on SDI for the Americas, and World Bank Development Gateway.

Although national SDI's share a common architecture and commitment to standards-based interoperability, specific policies and operational components can vary widely. As one example, United States law (44 USC Ch 36) and policy (OMB Circular A-16) establishes the U.S. National Spatial Data Infrastructure (NSDI). The policy states that the NSDI "assures that spatial data from multiple sources (federal, state, local, and tribal governments, academia, and the private sector) are available and easily integrated to enhance the understanding of our physical and cultural world". This policy puts specific requirements on all agencies that collect, use, or disseminate geographic information to assure that the resulting data, information, or products can be readily shared and integrated among federal agencies and non-federal users. In their activities, they must require adherence to the SDI standards for data and metadata, and must make metadata available online through the GSDI Clearinghouse. The U.S. NSDI includes various interoperability standards, including Framework Data Standards, Web Mapping Service, Web Feature Service, and Geographic Markup Language, among other ISO and national standards.

Figure 1: Overview of Spatial Data Infrastructure (SDI). From GEO (2005b).

GEO (2005b) does not explicitly address the usage of a DOI-like system. Rather, the use of open, international standards is strongly requested and a number of such standards for formating, documenting, archiving, structuring, and dissemination of data are discussed. For metadata, the standard ISO 19115: '*Geographic Information - Metadata*' is pointed out. This standard also provides the rules for identification. It can be expected that a unified system for the identification of objects made available through GEOSS will have to be developed and implemented, based on an open, international standard. However, it is not clear whether the DOI is a likely candidate for the identification of digital objects made available through GEOSS. Taking into account the emphasis of GEO on *Spatial Data Infrastructure* (SDI), this will most likely depend on the future development of SDI with respect to identification.

GEO (2005b) provides an overview of the existing Global Spatial Data Infrastructures (GDSI), which is reproduced in Figure 1 for reference.

GGOS needs to consider carefully not only the DOI as one candidate for identification, but also other standards such as ISO 19115. An issue related to identification is the precise definition of data formats and how the data are accessed. GEO (2005b) denotes this access mechanism as 'service' and requests that

> the systems interoperating in GEOSS should use any one of four open standard ways to describe service interfaces: CORBA, Common Object Request Broker Architecture; WSDL, Web Services Definition Language; ebXML, electronic business Extensible Markup Language, or UML, Unified Modelling Language.

With respect to the data retrieval, GEO (2005b) recommends the ISO 23950 '*Protocol for Information Search and Retrieval*', which ensures interoperability with GSDI and other services based on ebXML metadata models or UDDI (Universial Description, Discovery, and Integration).

In order to ensure interoperability between GGOS and GEOSS, it will be important to follow the development in GEOSS with respect to data format description, archiving, service definition and search services. It can be expected that these issues will be evolving very fast after the recent endorsement of the Implementation Plan through EOS-III. It is certainly important for GGOS to ensure that the internal development of concepts, data infrastructure, and dissemination infrastructure is supportive of the establishment of GGOS as one of the systems in GEOSS. Adoption of a DOI-like system for identification is just one detail to be consider in the design, planning, and implementation of the GGOS.

GEOSS appears to put considerable weight on the development of and coordination with GSDI. Therefore, it is recommended that, if IAG is not participating in GDSI, then IAG should ensure that GGOS participates in an appropriate way in GSDI.

3 Identification of digital objects

In this section we focus on the DOI mainly because it was mentioned in the mission statement for the WG. As discussed above, the decision of whether or not to adopt the DOI or a similar system for identification of digital objects in the frame of GGOS is closely linked with the overall concept for metadata, archiving, and service definition. Therefore, in this section we provide some background for the DOI and report on the current situation in the IAG services with respect to object identification and data organisation.

Some advantages of adopting a DOI-like systems are

- The DOI is a way to be recognized both inside the geodetic community as well as from the outside community, and it is a tool to protect Intellectual Property Rights (IPR).
- The DOI naturally provides credits to all contributors (e.g. station observation, network management, data center, individual technique analysis center, individual technique combination, multi-technique combination, i.e. individual AC or combination, central bureaus, Web managers, etc.). The level of details to which information is associated with a DOI is up to the providing system (i.e. GGOS), depending on the advantage versus the work load involved.
- The DOI informs users if a product is obsolete and has been replaced by a newer and better product. This would be of particular importance for some products, such as time series, sets of station coordinates and velocities, etc.

3.1 The DOI®

A *Uniform Resource Identifier* (URI) is a compact string of characters for identifying an abstract or physical resource adhering to the specification provided by the *Internet Society* (for the lastet version see RFC3986 of January 2005, Berners-Lee et al., 2005, available at http://www.ietf.org/rfc/rfc3986.txt). The DOI®is an URI, and hence, the DOI system forms an identifier system which implements the URI specification.

A full description of the DOI®is provided in Paskin (2004). We first repeat from this document two definitions:

- The DOI is an *identifier which conforms to the DOI System;* it *may also be used colloquially as an abbreviation for the System itself. Since a DOI may be used to identify any entity, it is a digital identifier of any object (in the sense of entity), not solely an identifier of digital objects.*
- The DOI System is *the integrated system – comprising enumeration, description, resolution, and policymaking – managed by the* International DOI Foundation *(IDF), providing an identifier, i.e. an implemented system of labels through a numbering scheme in an infrastructure using a specification.*

The term 'resolution' refers to the process in which an identifier is used in a request to a system in order to receive in return specific output of one or more pieces of current information related to the identified entity. In the simplest case, the output would be a URL allowing to locate the entity. However, normally the output will consist of more information. To give an example, for a given DOI, e.g. 10.1007/s10291-004-0110-x, the request http://dx.doi.org/10.1007/s10291-004-0110-x will provide a considerable information about the entity, in this case the paper by Ray et al. (2004), and also allow access to the paper itself. In this case, the Handling System provided by the IDF was accessed through http://dx.doi.org. In other case, application specific handling systems can be made available.

Here we summarize some of the main characteristics of the DOI.

Main goals of the URI and DOI are to provide unambiguous (digital) identification of (digital) objects, to allow for an unlimited growth of set of objects to be identified, and to protect the IPR for 'creations', Thus, the DOI is a system providing a mechanism to interoperably identify and exchange intellectual property in the digital environment. It is not only a identifier of digital objects but (more widely) a digital identifier of objects.

The DOI is a persistent identifier. While a Unified Resource Locator (URL), for example, identifies the location of an object, the DOI identifies an object as a 'first-class entity', not just some of its attributes.

The DOI is an actionable identifier. Thus, a user can use the DOI to do something. In this sense, it is more than a URL, which points to location only. A DOI may in fact resolve to the object itself but most often will not.

The DOI is an interoperable identifier. It is designed to interoperate with past, present, and future technologies

The formal specification of the syntax for creating the DOI identifier string is given in ANSI/NISO Z39.84-2000 '*Syntax for the Digital Object Identifier.*' Very recently, there appers to be also an ISO standard defining DOI.

The use of DOI is not free. The organisation of the IDF and the underlying business model, the role of the IDF as a maintenance agency, the role of Registration Agencies, and the operational principles are described in detail in Paskin (2004). It is suggested that the conditions for adopting DOI in the frame of GGOS are studied by a small group chaired by the IERS CB Director and that a proposal including the estimated costs and potential cost recovery models is prepared for the next GGOS meeting.

3.2 Identification of observations and derived products

To be added.

3.3 Technique-independent identification of observing sites and networks

To be added.

3.4 Current state in the IERS and the IAG services with respect to identification

The geodetic and geophysical data available at CDDIS or other data centres existing world-wide are usually organized in simple file systems, which typically provide no meta information with respect to the available data. Thus, the search within the available data sets is very much limited. Besides, the respective data centres provide only data series from their own field of activity, which are defined in very heterogeneous formats. Cross references to related data from geodetic, geodynamic or other Earth sciences research fields are not given. Therefore, it is difficult to discover and compare all the data that have to be considered in the context of GGOS or GEOSS and their integrated treatment is hardly possible.

The American project *Inter-service Data Integration for Geodetic Operations* (INDIGO) has been started recently in order to provide a uniform access to the data centres of the geodetic space techniques and to allow the integrated usage of the various data series. This happens in close cooperation with the IERS and in coordination with the IERS data centre, since the product centres of the IERS obtain their data from the services of the geodetic space techniques.

A homogenisation of the formats currently in use could be achieved so far only for the geodetic space techniques. Here the SINEX format version 1.00 and 2.00 first developed by IGS and later adapted by the other space techniques, provides a uniform format. Furthermore, within the IERS data centre, implemented during the first funding phase, the eXtensible Markup Language (XML) is being used as uniform format for all IERS products. During the last years XML has become a standard for data exchange over the web and is going to be used in more and more Earth sciences applications for format definitions (See for instance http://sopac.ucsd.edu/projects/xml/ or http://www.opengis.net/gml/).

In the last years the enormous meaning of the administration of meta information assigned to a data set has already been considered in some few data centres, e.g. in the SOPAC, the CHAMP ISDC or in the IERS data centre. However, there has been no coordination between the data centres. Although so-called Meta Information Systems (MIS) are to be expected to increase the publicity of the data, the available meta information were hardly integrated into super ordinate MIS (exception: IERS data centre and GeoMIS.Bund®). In order to be able to use a MIS, the meta data usually have to be structured according to e.g. the ISO standard 19115. Unfortunately, the required additional work to re-format the meta data is often not recognized.

In the same context of earlier work by the National Committee of CODATA, the committee on Data for Science and Technology of the International Council for Science (www.icsu.org), financed by the German Research Foundation (DFG), deficits in the availability of scientific data, in particular with respect to an interdisciplinary usage, were identified and their causes were analysed. This working group compiled a concept for the improvement of the electronic data supply, based on the DOI.

3.5 Discussion

It is expected that the interoperability requirement of GEOSS will stimulate considerable changes in definition of the services (understood as the access to data and information) with consequences for metadata formats and concepts. Both, the activities in the IERS and in the frame of INDIGO demonstrate that progress towards the goal of interoperability of the IAG services and easy access for users to the data and products has started in parts of the IAG services independent of the linkage of GGOS to GEOSS. The added emphasis on this development through GEOSS requirements is likely to create significant benefit not only for users outside of the IAG but also to a wide range of internal users.

It is recommended that the concept of the DOI is further investigated with focus on the question of how it can be applied to GGOS and the IAG services in order to make the data and information available to a wider audience, including the nine social benefit areas identified by EOS-I (GEO, 2005a, se), and to protect the 'property right'. Beside other advantages like a standard numbering syntax for the IAG product entities, a data dictionary component could be designed to ensure maximum interoperability with existing metadata element sets in and outside the IAG/IUGG as well as in preparation of contributions to GEOSS.

However, the transition to fully interoperable systems does not come for free. The amount of work is expected to be considerable. Consequently, GEOSS has set up realistic goals for the first two years, that clearly take this into account. GGOS will also have to plan this process realistically.

For GGOS, it will be very important to avoid duplication of activities and to ensure optimal coordination of the resources and developments. The implementation of GEOSS should provide for an opportunity to obtain (certainly limited) funds for the transition from the current data and information systems, but the success certainly depends on the level of coordination across all components of GGOS.

Another challenge is the fact that many individuals and institutions are not yet familiar with DOI and other access systems discussed above. Thus, many of the advantages will only become visible in the long-term perspective. But the disadvantages of required efforts and costs are immediate. For example, researchers are presently most often evaluated on peer-reviewed publications. The DOI System would be of significant interest for them if the criteria for evaluation would be changed to make use of information available through the DOI System. Likewise, the DOI would only help to give credit to institutions providing data if these would be assessed on the basis of DOI-related information.

A concern arises from the particular IAG characteristics as an organisation based on the best effort principle and the availability of experts. The internal structures of the IAG services are changing quite rapidly and groups providing a certain product today may easily be exchanged with another group tomorrow (e.g. tropospheric products in IGS). Any system claiming to ensure credit to the originators will have to be flexible enough to account for such changes. The system also will have to ensure that credit is given to those actually contributing and not to all those who promised a contribution but, for various reasons, were not able to deliver.

Based on the requirements of interoperability with other systems contributing to GEOSS, GGOS will have to adopt a system for identification of objects as well as data access that is in agreement with relevant international standards. Currently, it is not clear whether this implies to adopt the DOI System. However, the DOI System seems to have significant advantages, which should be studied further. A disadvantage are potentially considerable costs associated with the DOI.

Thus, any decision on using DOIneeds careful consideration by the GGOS community and users. In particular, the question how GGOS could contribute to minimizing the work load and required budget for the IAG services for the transition to interoperable data and information systems as well as an object identifier system needs to be addressed in detail. Moreover, it has to be taken into account that the IERS CB together with INDIGO is already in the process of making progress towards using DOI and/or similar systems for the identification of the digital objects available throught the IERS and its components. It is strongly recommended that these activities are closely coordinated with the further process in GEOSS.

4 Data Access Policy

4.1 Introduction

To be added

4.2 Overview of existing data policies

The following are initial indications of what can be a basis for the further discussion.

Potential sources for existing data policies are

- The recent GMES Report ”Data policy assessment for GMES” (Harris & Browning, 2003) Browning, 2003) gives a good overview of the international context and reviews the existing documented policies. It also summarises aspects of ”good practice” and comes up with general recommendations (including access policies).
- The GEOSS 10-yrs implementation plan ’Reference document’ (GEO, 2005b) basically requests full and open exchange, recognizing relevant international and national frames. All shared objects have to be made available with minimum time delay and at minimum cost. All shared objects are encouraged to be available free of charge for education and research.
- Other sources are for example the very well defined data policy of the WMO, but also the practice of the IAG-Services and INDIGO.

The importance of having an explicit data policy is obvious. Therefore, GGOS should prepare an explicit data policy addressing at least two classes of usage, namely in research and eduction, and all other usages. It is reported here that as one of the 2 Year Targets, GEO will develop cost-and-benefit-sharing mechanism(s) for observations by which an optimum observation system can be realized (GEO, 2005b, Page 134). It is recommended that GGOS actively participates in this process.

There are considerable national and regional difference in the degree to which access to data is provided freely and a low or no costs. These differences will affect any data policy for GGOS products and need careful consideration to design as data policy that, in an international context such as GGOS and GEOSS, meets the needs of the agencies providing data as well as those of the users wanting access to the data and products.

5 Copyrights, publishing and citation rules

This still needs to be added. The following are some initial ideas.

As a short-term oriented activity for IAG, the problem in citation of the service-type activity in peer-reviewed journals could be considered. On longer terms, it is expected that introduction of a DOIlike system will considerably change the situation.

The following steps should be considered: A small group of people (3-6 persons) could for a few years follow the citation practice in a selected list of relevant journals (peer-reviewed and non peer-reviewed, read by geodesist or in which geodesists publish) and monitor the way support from IAG-Services and usage of products provided by the IAG services are cited. The group would contact the Editors in chief of these journals in order to explain initially the citation issue, using examples from their journals and discuss the proper citation. The Editors would also be informed about the intended monitoring. After one or two years, the outcome of the monitoring would be brought to the attention of the Editors and progress towards proper citation would be discussed with them.

It is expected that these fairly easy steps would rapidly lead to an improvement in the situation.

6 Quality information, validation, integrity, and certification

6.1 Introduction

The increasing use of the geodetic products provided by the IAG services by both scientific and non-scientific users requires a focus on issues such as quality information and validation of the products. For particular applications such as safety-of-live application may also require that integrity information is attached to the products. Moreover, systems using these products may require certification. Here, we first clarify the mean of the terms before we address each term separately.

Quality information is general information about the quality checking performed and the result of that check. The accuracy of the observations and derived products is an integral part of the quality information. Such information allows the user to determine whether the products fullfil specifications the user may have.

Validation is used in the sense of Oreskes et al. (1994), i.e. validation is the agreement of a group on which solution to a problem to consider as the accepted one. Taking the realisation of ITRS as an example, then validation of a version of ITRF, e.g. ITRF2000, would consist of the steps to show convincingly that ITRF2000 is the best available realisation of ITRS and thus to be considered as the valid realisation of ITRS. The term verification is not considered here, since in most case, a verification is not possible (for a more detailed discussion of these terms, see Oreskes et al., 1994).

Integrity of data is the information on the 'correctness' of the data. Particularly for safey-of-life applications, integrity is a central concept. A working definition of "integrity" is as follows[3]: *Integrity is that quality which relates to the trust which can be placed in the correctness of the information supplied by the total system. Integrity risk is the probability of an undetected failure of the specified accuracy. Integrity includes the ability of a system to provide timely warnings to the user when the system should not be used for the intended operation.*

In this definition, the term *correctness of information* needs further explanation. In our discussion, we consider information in form of a quantitative value given for a parameter as correct, if the information itself plus the uncertainty attached to it does not violate the accuracy specifications for this particular parameter. Consequently, integrity requires clear specification of the accuracy of the quantitative information, and this specification depends on the intended operation for which the information is to be used. We can conclude that integrity most often will be provided for specified applications. Assessing the integrity of information provided by a system requires knowledge of the system performance. Based on appropriate *system monitoring*, integrity information can be derived, e.g. in form of an integrity flag. Estimation of the integrity risk is far more difficult.

The primary goal of *system monitoring* thus is to assess compliance of the system with its specifications. Thus, system monitoring is relative to system specifications. System monitoring is important to ensure operational performance within the system specification and the integrity of the products.

While the importance of validation for the products of IAG Services and for GGOS is easy to see, it is more difficult to attach high priority to integrity information made available together with the products of the IAG services. Only some of the products are candidates to require in near-real time knowledge

[3]Concept Paper 1 (WP/43), AWOP (All Weather Operations Panel) Working Group Meeting, Kobe, Japan, February/March 1994, "Required navigation performance (RNP) - Considerations for the Approach, Landing and Departure Phases of the Flight"

of their integrity. In particular, near-real time applications of the satellite orbits and clocks provided by IGS may in the future require some integrity information attached to them.

Another term important in the frame of GEOSS is 'performance assessment'. The primary goal of the *performance assessment* is to measure system performance in an absolute metric thus giving information of the overall quality, performance and capabilities of the system. Performance assessment is important whenever changes are made to the system and their impact are to be measured and when new application of the system requiring a performance better then the system specifications are discussed.

To clarify an issue often misundertsood, we state that *certification* is a term that applies to a process rather than the products. Here we understand certification in its legal definition with particular emphasis on safety-of-life application. Certification of a system making use of geodetic coordinates or other geodetic products thus does not require 'certification' of the individual coordinates or the actual products but rather the processes used to determine the coordinates or to prepare the other products.

6.2 Quality information

To be added.

6.3 Validation

To be added.

6.4 System monitoring and integrity

To be added. See e.g. Zumberge & Plag (2005).

6.5 System performance

A key issue in performance assessment is the definition of an appropriate *system metric*, which can be used to measure the system in an absolute sense. In most cases, the metric is defined on the basis of parameters connected to the final system products. However, a full performance assessment would also include parameters related to internal components and intermediate products.

The Reference Document for the GEOSS 10-Year-Implementation Plan emphasizes the importance of defining the appropriate performance indicators. The use of a broadly recognized four-part system of indicators is recommended for the assessment of GEOSS, which specifies indicators for input, output, outcome, and impacts. A similar system could also be used for GGOS. Such a performance assessment would be rather supportive for gaining continuous funding.

6.6 Certification

For certification in the field of geodesy, that can be of legal relevance, some kind of *Geodetic Regulation Authority* (GRA) is required. For geodetic coordinates and products, currently the national geodetic authorities are considered as the national GRAs. Consequently, certification of systems involving geodetic products requires to contact all national GRAs or relevance. For systems to be used in regions or globally, this can induce a large amount of work.

Taking the European SBAS System EGNOS as an example, certification of EGNOS would include a certification of the process used to determine and maintain the geodetic coordinates of the reference stations within the stated accuracy limits. Currently, certification of EGNOS just for Europe would require to contact all national GRAs. Therefore, a process has been started to discuss whether a regional GRA can be established, also with view to future certification of GALILEO, but it is not clear whether this is achievable.

However, it is very unlikely that a global GRA can be established. Even if such a global GRA could be implemented for certain aspects, e.g. as an Intergovernmental Commission for Reference Systems, then, considering the nature of IAG as a best effort scientific organisation, it appears to be clear that IAG should not formally take part in this function.

However, IAG and GGOS could consider to take a supportive role for certification. An important requirement for certification is traceability of the process, information on the validation status of the process, and, optimally, a 'justification file' giving a detailed error budget of the products. Provision of this information for relevant products would certainly aid certification of systems making use of products provided by the IAG services. In particular, such information would be of value for the different versions of ITRF as well as the satellite orbits and clocks and Earth rotation parameters provide by IGS. Provision of expert knowledge to any national GRA in cases where this is needed could be another contribution of IAG to certification.

It is recommended that IAG through relevant components follows the development in safety-of-life applications potentially requiring certification of processes in the field of geodesy. One such activity if currently taking place, where ESA and EUREF are starting a dialog on this issue.

7 Conclusions and Recommendations

The following recommendations are in a draft state and need to be discussed at the GGOS WS:

- In order to progress towards interoperability of GGOS and GEOSS, it is recommended that GGOS ensures through appropriate participation in GEOSS that the internal development of concepts, data infrastructure, and dissemination infrastructure is supportive of the establishment of GGOS as one of the systems in GEOSS.
- Considering the emphasis of GEOSS on the further development of and coordination with GSDI, it is recommended that GGOS participates in an appropriate way in GSDI.
- Considering the many advantages and disadvantages of adopting the DOI as the URI system for GGOS, it is recommended to set up a small group chaired by the IERS CB Director with the task to study the conditions for adopting DOI in the frame of GGOS, and to prepare a proposal including the estimated costs and potential cost recovery models for the next GGOS meeting.
- Considering the fact that the IERS CB together with INDIGO is already progressing towards using DOI and/or similar systems for the identification of the digital objects available throught the IERS and its components, it is strongly recommended that these activities are closely coordinated with the further process in GEOSS.

- Considering the requirements of GEOSS for interoperability of the contributing systems, it is recommended that GGOS – in order to meet these requirements with the limitted resource available – ensures optimal coordination of the developments, activities and resources and explores opportunities to utilize the implementation of GEOSS to obtain funds for the transition from the current data and information systems to interoperable systems.
- It is recommended that GGOS prepares an explicit data policy taking into account the data policy of GEOSS and also that GEOSS will develop cos-benefit-sharing mechanism(s) for observations exchanged through GEOSS.
- It is recommended that IAG through relevant components follows the development in safety-of-life applications potentially requiring certification of processes in the field of geodesy.
- It is recommended that GGOS supports – through provision of relevant documentation or advocation of such – the certification process of systems using products of GGOS or the IAG services.

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