Concept Formulation of Geospatial Infrastructure

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Abstract

Technical trends in the field of surveying and mapping, including satellite positioning and information and communication technologies (ICT), require a new concept to explain the role of the National Geospatial Information Authority (NGIA). In order to facilitate international discussions including bi-lateral technical cooperation and global geospatial information management (GGIM), the concept of Geospatial Infrastructure is formulated.

Geospatial Infrastructure is, in short, what NGIA does to support the Geospatial Society. With further clarification of the subject and the purpose of Geospatial Infrastructure, this concept can be designed to be an instructive concept to guide NGIA.

1. Introduction

The concept of Spatial Data Infrastructure (SDI), and especially the concept of National Spatial Data Infrastructure (NSDI), are often used in discussions in international contexts such as in the United Nations Initiative on Global Geospatial Information Management (UN-GGIM) or in the context of providing technical assistance through Japan International Cooperation Agency (JICA) to various developing countries.

While there seems to be no authoritative definition of SDI or NSDI, some typical explanation can be found in the Presidential Documents [Federal Register] as follows:

> *"National Spatial Data Infrastructure" ("NSDI") means the technology, policies, standards, and human resources necessary to acquire, process, store, distribute, and improve utilization of geospatial data.*

In many cases, the definitions of SDI or NSDI involve technology, policies, standards and human resources, but these definitions themselves are not considered very instructive because they lack concrete and actionable instructions. This may be due to the following reasons: 1) the institutional arrangements amongst acting parties vary much, and therefore the concept of SDI or NSDI had to be abstract to cover various institutional arrangements; 2) the concept of SDI or NSDI had the role to *initiate* the discussion in the field of geospatial information, and because of its success, it had to cover many aspects of this particular field. Since the concept was formulated before its implementation, the concept fails to best describe the actual implementation.

Although the concepts of SDI or NSDI are useful, in order to concretely describe the existing implementation of NSDI in the context of Japan, a different and more concrete concept is required to foster better understanding of the realities of Japan as well as what is necessary to promote the advancement of utilizing geospatial information, as described in the NSDI Act of Japan [Government of Japan]. Thus, the concept of *Geospatial Infrastructure* is developed to provide clear perspective in this context.

In order to provide clear perspective for the National Geospatial Information Authority (NGIA), the concept of Geospatial Infrastructure is focused on the contribution of the Geospatial Information Authority of Japan (GSI).

2. Concept Formulation of Geospatial Infrastructure

2.1 Subject and Purpose-Oriented Approach

The existing concepts of SDI and NSDI are rather components or objects-oriented. But the concept of Geospatial Infrastructure is designed to guide NGIA

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to think about future actions. The subject-oriented and purpose-oriented approaches are used as follows.

(1) Subject-Oriented Approach

Priority is placed on who is in charge of the respective components. This makes the responsibilities of acting parties clear. This approach is useful because it facilitates thoughts on next actions of identified subjects.

(2) Purpose-Oriented Approach

Firstly, the purpose of the Geospatial Infrastructure is clarified. The definition of the purpose of Geospatial Infrastructure is as follows:

Various needs for geospatial information are fulfilled using various applications developed by various parties.

This definition of the purpose clarified the extent of the role or the responsibility of GSI or NGIA, and hugely helped to make the concept of Geospatial Infrastructure useful.

These approaches lead to the need to describe in more detail what GSI and NGIA do. Geospatial Infrastructure is actually the description of what GSI or NGIA do to fulfill the need for geospatial information.

2.2 The Dichotomy of Geospatial Infrastructure

After identifying what Geospatial Infrastructure is, the focus is shifted to what is the target user of the Geospatial Infrastructure in order to consider the favorable interaction between the subject and the target user. In this case, the target user is named the Geospatial Society as in Fig. 1.

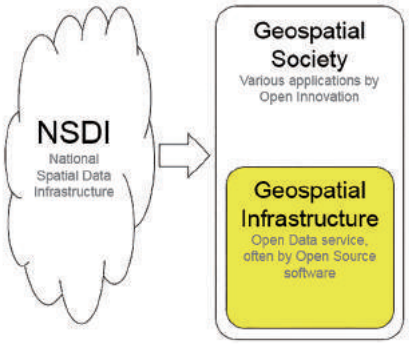

Fig. 1 Geospatial Society and Geospatial Infrastructure

(1) Geospatial Society

The target user of Geospatial Infrastructure is the Geospatial Society. The term Geospatial Society implies the various parties which enjoy the various applications of geospatial information, possibly in an Open Innovation manner (because GSI is required to publish its geospatial information on a non-discriminatory basis).

(2) Geospatial Infrastructure

Geospatial Infrastructure is what GSI or NGIA provides to support the Geospatial Society. The Open Data approach is proven useful from the experience of GSI. The Open Source approach is often useful to 1) foster traceability and reliability, 2) reduce running cost, 3) make the service scalable, and 4) promote the application of its geospatial information by various external parties.

2.3 Choice of Words

The following are the background for the choice of words for Geospatial Infrastructure:

1) Term lacks the word “data” or “service” on purpose. The separation of data and service does not matter, especially after Representational State Transfer (REST) [Roy Thomas Fielding] and its further promotion [Ben Balter].
2) Term lacks the word “data” or “information” on purpose. If “data” or “information” is included in the term, it may imply that the term is only related to information and communication technology (ICT). “Geospatial” involves a lot of ICT, but ICT does not cover all aspects of geospatial, such as satellite positioning and Global Navigation Satellite System (GNSS) Continuously Operating Reference Stations (CORS).
3) Term lacks the word “cartography”, “photogrammetry” or “geodesy” on purpose. Such traditional classifications do not foster uniform vision, and do not foster unification of existing resources.

3. The Concept of Geospatial Infrastructure

After defining the concept of Geospatial Infrastructure, major components of Geospatial Infrastructure were identified. As in Fig. 2, in the recent

and current context, the three major components are as follows:

1) GNSS CORS Infrastructure
2) Institutional Arrangements
3) Web Maps

These three components do not actually cover all aspects of Geospatial Infrastructure. But these components are often the topic of discussion as far as *operations* of NGIA in both domestic and international perspective.

Aspects other than operations, such as technology development, technology transfer, human resource development, education, are interrelated but clearly different from operations aspect. They are placed outside the concept of Geospatial Infrastructure; and need to be discussed in other contexts.

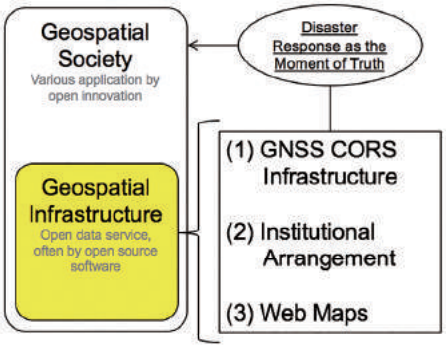

Fig. 2 Main components of Geospatial Infrastructure

3.1 GNSS CORS Infrastructure

GNSS CORS Infrastructure consists of GNSS CORS, its data center, and precise positioning services running on them. GSI has been operating the infrastructure for more than 20 years since 1994, and has more than 1,300 CORS.

Various innovative results have been achieved by opening up the observation data to the academic and private sector since 2002.

Sometimes the discussions on NSDIs leave out discussion on GNSS CORS Infrastructure or any other Geodetic Infrastructure. But the concept of Geospatial Infrastructure includes GNSS CORS Infrastructure as the first primary component because it provides very fundamental framework to making the geospatial services possible and reliable.

3.2 Institutional Arrangement

Institutional Arrangement is a term sometimes used in international initiatives such as UN-GGIM. E/C.20/2014/5/Add.1 [the Economic and Social Council] defines National Institutional Arrangements for Geospatial Information Management as follows:

> *The formal and informal cooperation structures that support and link public and private institutions and/or organizations and which are used to establish the legal, organizational and productive frameworks to allow for sustainable management of geospatial information, inclusive of its creation, updating and dissemination, thereby providing an authoritative, reliable and sustainable geospatial information base for all users.*

In the Japanese context, the legal framework for geospatial information is mainly supplied by 1) the Survey Act enacted in 1949, 2) the NSDI Act (Basic Act on the Advancement of Utilizing Geospatial Information) enacted in 2007, and 3) the Basic Act on Disaster Control Measures enacted in 1961. The organizational and productive framework for Basic Survey and Public Survey constitutes solid supporting structure for the development and the continuous updating of Fundamental Geospatial Data (FGD), which is available online since 2008.

The Government of Japan has the organizational framework for promoting utilization of Geospatial Information under the Cabinet Office according to the NSDI Act.

The Geodetic Reference Frame of Japan has been aligned with the global geodetic reference frame in 2001 after the revision of the Survey Act. JGD2000 and JGD2011 are geodetic data provided and maintained by GSI.

Adoption of the Open Data Policy by the Government of Japan in 2014 further lowered remaining barriers to develop the application of the geospatial information provided by GSI.

3.3 Web Maps

GSI has been running tile-based web maps since 2003. Renamed as “GSI Maps” in 2013, the web map policy of GSI has emphasis on interoperability. The core component is the infrastructure to provide tiles with high availability. In order to do so, the tiles are institutionally

well arranged under the Survey Act. On the other hand, GSI is eagerly adopting new technology such as elevation tiles and vector tiles and especially binary vector tiles.

The pursuit of Open Data, Open Source and Open Innovation are very apparent in the web map policy of GSI. The tile data provided by GSI, which is called GSI Tiles, complies with the Open Data Policy of the Government of Japan in terms of copyright. The GSI Maps is running under 100% Open Source software, and GSI promotes Open Innovation by running the GSI Maps Partner Network, a participatory network of developers who use or are going to use GSI Tiles.

3.4 Considerations

1) Differences in Constant Changes

Progress in various aspects leads to changes for subcomponents of Geospatial Infrastructure. In general, changes in the technological aspect occur every few years, while changes in the legal aspect occur every few decades. Thus, it would be useful to classify components depending on their life span so that actionable items can be easily identified and an action plan can be clearly defined.

2) Disaster Response

Disaster response is one of the most important activities of GSI. But disaster response itself is considered to be a component of Geospatial Infrastructure. Rather, disaster response is considered the 'moment of truth' [Jan Carlzon] where the Geospatial Infrastructure directly faces the urgent need for geospatial information from Geospatial Society. The dynamic interaction between Geospatial Society and Geospatial Infrastructure in a state of emergency determines an impression about the brand, product or service of the Geospatial Infrastructure.

4. Comparison

4.1 Comparison with Digital Bangladesh

"Digital Bangladesh" is a concept formulated by the Prime Minister's Office of the Government of Bangladesh [Prime Minister's Office] to promote the broad use of computers in various fields. JICA is running the "Project for Strengthening the Capacity of Advanced Mapping of SOB for Building Digital Bangladesh" from October 1, 2013 to December 31, 2016 (planned) to improve technical competence in digital mapping. GSI has the concept of "Digital Japan" to promote the sharing of geospatial information through the Web, which has some similarity with the concept of Digital Earth. The concept of Digital Bangladesh is broad, but involves the digitization of surveying and mapping.

The concept of Geospatial Infrastructure was first introduced in the presentation by Dr Hiroshi MURAKAMI, Deputy Director-General of GSI, titled "Geospatial Infrastructure for NSDI in Japan" at the International Seminar on NSDI for Bangladesh held on June 1, 2016. Because Geospatial Infrastructure is more concrete and focused, it might be of some help for implementing Digital Bangladesh when it comes to further implementing stage.

4.2 Comparison with Geospatial Information Infrastructure in Indonesia

Indonesia has the concept of Geospatial Information Infrastructure based on the Geospatial Information Law published in 2011. Geospatial Information Infrastructure consists of 5 components, namely: Policy, Institutional Arrangement, Technology, Standard and Human Resources, which is a similar concept with SDI.

Geospatial Infrastructure is more concrete and focused, but where the concepts overlap, they have similar components and philosophies.

5. Application and Evaluation

GSI has been introducing the concept of Geospatial Infrastructure since June 1, 2016 at various kinds of presentations, including briefing sessions for international visitors from other NGIAs to GSI. No serious concerns have been identified in connection with this concept.

The concept of Geospatial Infrastructure is believed to provide simple and uniform view on the mission of NGIA, and the concept of Geospatial Infrastructure is worth further elaborating.

On the other hand, there seems to be some

dependence on Japanese context. Open Innovation is a reliable tool to implement various applications of our geospatial infrastructure. This presumes advanced technological expertise of private sector and presumes a culture to share technical specifications among stakeholders, both seen in the Japanese context.

Although the concept of Geospatial Infrastructure is useful to describe the practice in Japan, if the concept of Geospatial Infrastructure is applied in the international context, the context needs to be carefully captured, and the concept needs to be customized for further discussion.

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