

GeoSpace for Singapore's Whole-of-Government Data Sharing

Ng Siau Yong, Lim Ming Khai, Lo Jing Lu & Anupam Mukherjee

ABSTRACT

Sharing of land information among government agencies is not new to Singapore. It goes back to the late 1980s when the Land Data Hub (LDH) was established to facilitate digital land data sharing among government agencies. The objective of LDH then was to provide a one-stop shop for land information. Over the years, LDH substantially eliminated the cost of data duplication through data pooling.

The LDH has now transformed from manual data exchange to online data sharing under Singapore's NSDI called the Singapore Geospatial Collaborative Environment (SG-SPACE) initiative. The goal of SG-SPACE is to unlock the potential of public sector geospatial information for better decision making and for creation of innovative applications.

This paper traces the transformation of Singapore's data sharing programme from manual exchange to online sharing enabled by GeoSpace which is the clearinghouse and backbone infrastructure used by public agencies to share, discover and access spatial data in an efficient and flexible way on a whole-of-government level under the SG-SPACE initiative.

Paper Body

Background

The Land Data Hub was established and managed by the Singapore Land Authority (SLA) to promote and enable sharing of spatial data among government agencies since it was first conceived in the late 1980s. SLA, the lead GIS agency in Singapore, collected the data from the agencies and enabled the data to be shared across the public sector. This one-stop spatial data resource centre eliminated duplicative efforts in acquiring spatial data already collected by other agencies. This was the beginning of the Singapore's national data sharing model and the forerunner of the NSDI.

Up till 2007, 15 participating agencies contribute more than 30 types or 200 layers of spatial data to the Land Data Hub for sharing. On average, a total of

1.2 million digitized map sheets¹ were shared (annualised). For every map sheet contributed by the agency, it was shared with and used by 10 other agencies. This underscored the often quoted ideal that data should be “created once and used many times”. The data sharing model has proven to be successful and well regarded both locally and internationally.

Online Data Sharing

SLA’s vision was to enhance the capacity and synergy amongst the public sector agencies through shared data, processes and systems. While the Land Data Hub in essence supported the vision, its operating model of manual data exchange every quarter was not in keeping with contemporary demands because of the limitations of the technology used.

Increasingly, public agencies wanted more up-to-date data for more efficient planning and operations and to deliver better public service. Demand for spatial data has increased in recent years for the management of security, environmental and health risks, as well as for the planning and management of land and resources. There has also been a desire to see on-line data sharing, e-consultation and even project collaboration as Singapore moved towards a networked government.

In exploring a new system for online sharing of GIS data, SLA first pilot tested the concept and prototype in 1998 among a few agencies. The concept worked but the system required costly satellite servers to be installed and maintained across many agency sites. The cost far outweighed the business benefits. The other critical business challenge that was needed to be tracked was to establishing data exchange standards to enable faster discovery and higher usability of spatial data.

Subsequently, as the necessary technologies became available and more cost effective, SLA again pilot-tested the concept of online sharing through a web GIS portal which provided the Land Data Hub with new capabilities, including up-to-date and online upload and download, map-based e-consultation, GIS formats conversion on the fly etc. The new system was known as LandNet.

LandNet was rolled-out in Jun 2007. It provided a web-based system that allowed agencies to view, access, perform spatial analysis, upload and download data directly from the Land Data Hub. In essence, LandNet enabled on-line and up-to-date data sharing across different agencies which used different GIS systems.

¹ The island of Singapore is divided into approximately 1500 map sheets, each covering an area that is 900*600 meter in size.

New Paradigm of Public Service Delivery

With Landnet in place, we took an important step in 2008. SLA embarked on a new phase of Public Service and led a whole-of-government initiative to establish a national SDI framework. This involved linking up the Land Data Hub with other national data hubs which host data on people, and businesses managed by various public agencies. Previously, these data hubs were developed and operated independently.

We have named this NSDI the Singapore Geospatial Collaborative Environment initiative, or SG-SPACE. The SG-SPACE's vision is "towards a spatially enabled nation". We aim to re-define and create an environment in which, not only the public sector but including the private sector and the community, can co-operate and collaborate in making available, sharing and using geospatial information to co-create innovative applications and for better decision making.

The key focus areas of the SG-SPACE initiative are to 1) make data from public agencies readily available and easily accessible, 2) through the establishment of data standards for interoperability and harmonising different data sharing policies, 3) build up the capacity of public officers to manage and exploit spatial information and 4) develop the infrastructure for data discovery, access and sharing.

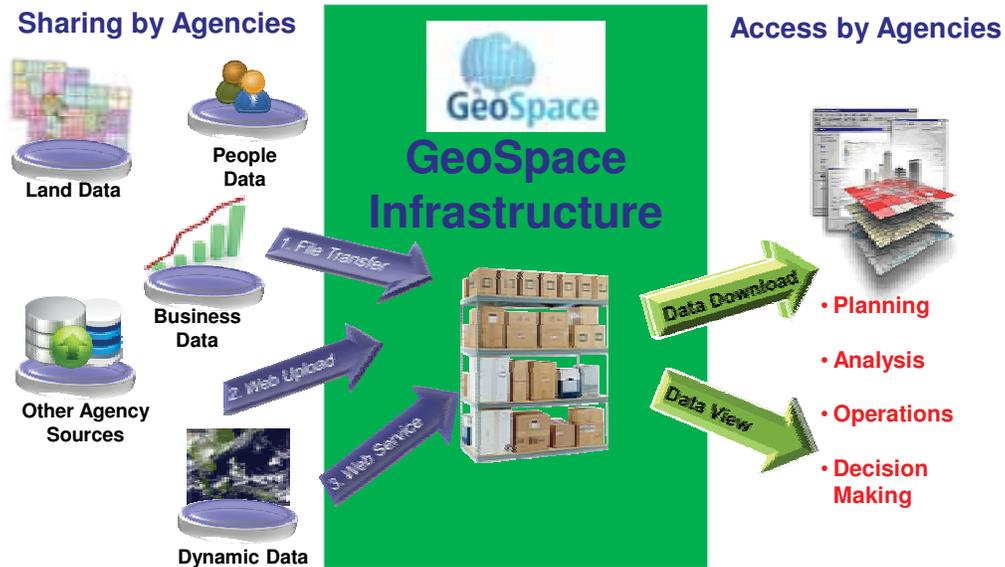
This paper focuses GeoSpace which is the central infrastructure of the SG-SPACE initiative.

GeoSpace for Whole-of-Government Data Sharing

GeoSpace supercedes LandNet as the platform for public agencies to share data within the government intranet. It also links up other data hubs to let public agencies gain access to a wealth of spatial and non-spatial data (see Illustration 1). It exploits existing high-speed government intranet for efficient data exchange and higher interoperability. Designed on a whole-of-government approach, it provides an effective means for agencies to discover and share spatial data to facilitate better decision making. Agencies can automatically upload and download data in variety of spatial data formats through GeoSpace directly to their GIS servers based on their preferred frequency.

Illustration 1: Overview of GeoSpace

GeoSpace – Gateway to Data Discovery



Operational since 1 Apr 2011, GeoSpace is the backbone and GIS engine of the SG-SPACE initiative. In essence, it is a government system that provides:

- a complete and automated end-to-end spatial data value-chain that bridges data suppliers and data users;
- one-stop data discoverability and accessibility on a whole-of-government basis;
- Web GIS with desktop GIS-like functionalities to discover, explore, query and analyse spatial data;
- instantaneous, online and up-to-date data upload by suppliers and data download by end-users;
- tools for automatically extraction, transformation and loading of data in most GIS formats;
- Web Service-based access to data and functionalities such as address geo-coding and address validation;
- automatic source data quality assurance; and
- online map-based e-consultation for enhanced communications and operational efficiency between government agencies.

To date, GeoSpace has 33 agencies sharing over 300 layers of spatial data (see Table 1). GeoSpace now plays an enabling role in realising the vision of a network government through agencies using shared data, processes and systems to deliver public service. It is also an important development towards the implementation of Singapore's NSDI.

Table1: List of 30 major categories of GIS data in GeoSpace.

1	Address Point	16	Land Ownership
2	Administration Boundary	17	Land Survey Control Point
3	Amenity	18	Master Plan
4	Building	19	Meteorologic
5	Business & Company Registration	20	MOE School
6	Cadastral	21	Natural Resources
7	Demographic	22	Point of Interest
8	Drainage Network	23	Public & Open Space
9	Environment	24	Road Safeguarding
10	Hawker Centre	25	Roadside Tree
11	Health	26	Special and Detailed Controls Plan
12	Height Limit Contour	27	Street Directory
13	Hydrographic	28	Sewerage Network
14	Imagery	39	Transportation
15	Land Forms	30	Utilities Network

Table 2 : Improved Data Sharing and Usage Indicators

	Before (LandNet)	Now (GeoSpace) (as of Jun 2011)
No. of Data Layers Shared	230	300
No. of Agencies Sharing Data	23	33
No. of Agencies Accessing Data	16	71
No. of Registered Users	300	1015

Salient features of GeoSpace include profile-based access to data, map browser with map view, query and analysis tools. It is now possible for non-GIS users to personalize their viewing preference of multiple types of spatial data (e.g. road lines, cadastral, land ownership) using a web browser without the need for a GIS software (See Illustrations 2 – 4 for selected screen shots of GeoSpace). Non-spatial data such as business listing and demographics can be layered easily and viewed in the map browser.

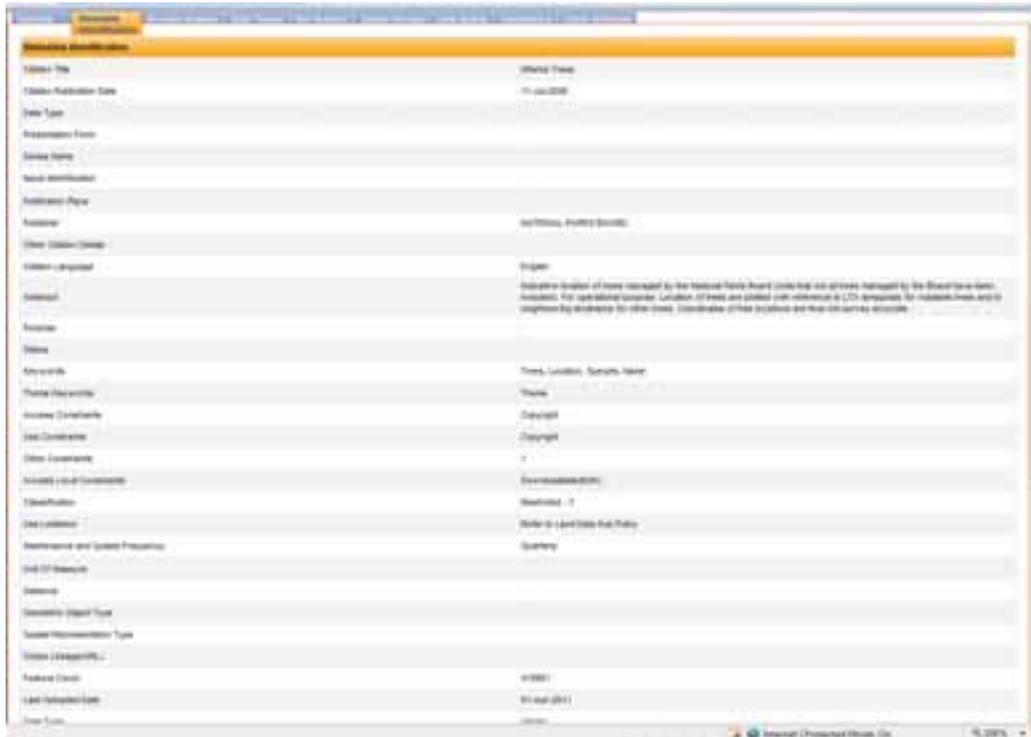
Illustration 2: Screen shot of GeoSpace user interface



Illustration 3: GeoSpace showing buffer analysis tool



Illustration 4: Full metadata search in GeoSpace



Innovative use of Technologies and Standards

GeoSpace is one of the first nation-wide NSDI system worldwide to adopt Oracle Enterprise Service Bus (OSB) 11g to register and provide SOA capability for Geospatial services and APIs. The OSB based architecture facilitates complex registration and access to Open GIS Consortium (OGC) based data services (WMS, WFS, WCS etc) as well as geo-processing tools and API's in REST, Java Script and ESRI Web ADF formats. The architectural agility powered by OSB enabled integration of heterogeneous services in a seamless manner, apart from offering standard features such reusability, governance, monitoring, auditing and reporting of all data services and APIs.

It provides one-stop search for both textual and spatial data, which is facilitated by integrated metadata search with SG-DATA, the central textual data repository of Singapore Government. Google Search Appliance (GSA) is customised to provide powerful geospatial / location search capability.

The Geospatial Cloud Computing model of GeoSpace provides flexibility to government agencies in deploying business applications by consuming GeoSpace data, tools and application APIs. This in turn cuts down start-up cost and lead time needed to deliver new services and application

Table 3: Key Technologies implemented in GeoSpace

Technology	Business Requirements
ESRI ArcGIS Advance Enterprise Server Suite 9.3.1	<ul style="list-style-type: none"> • Increase usage of accurate and timely geospatial information • Map data visualization and spatial analysis • Hub Integration tools for enabling geo-coding, aggregation, generalization and other data modeling capabilities
SAFE FME Sever 2011	<ul style="list-style-type: none"> • Facilitating government agencies in sharing data in different GIS formats • Efficient sharing of agencies data via data transformation services
Oracle Web Center11g Web 2.0 & Oracle Enterprise Database 11g (RAC)	<ul style="list-style-type: none"> • Online portal to discover, share and collaborate spatial and non-spatial data • Collaboration of agencies via Spatial Communities • Web based metadata publication and harvesting using custom built metadata tools • Centralised spatial data repository
Google Search Appliance (GSA)	<ul style="list-style-type: none"> • Ensuring quick discovery and high usability of spatial and textual data
Oracle Service Bus 11g	<ul style="list-style-type: none"> • Providing a single platform to register and serve GIS services to all the agencies. • Registering of data services and Map API for better monitoring and tracking • Common Map, Vector/Raster and Network Geo Processing services as geospatial tools to consume and integrate by the agencies
VMWare	<ul style="list-style-type: none"> • Efficient usage of underlying infrastructure by using server virtualization

Enabling Enhanced Public Service and Delighting Citizens

With its good inter-agency connectivity, GIS functionalities and the ready availability of rich spatial data, GeoSpace has become the enabler and preferred GIS platform to support other national initiatives and map-based applications.

- **Integrated Land Information Services (INLIS)** – A one-stop shop on www.inlis.gov.sg allows citizens to purchase property and land related information from multiple agencies. INLIS uses GeoSpace as a conduit to pull GIS data from participating agencies. For examples, INLIS allows prospective property buyers and conveyancing lawyers to obtain

up-to-date information on property ownership details and future road widening works which may affect the enquired property

- **OneMap Singapore** (www.onemap.sg) – OneMap Singapore is one of the key outcomes of SG-SPACE initiative. It is developed as a common map platform for public agencies to share spatial information and deliver services to the public. Businesses and communities can also leverage on OneMap APIs to develop innovation applications for the benefit of the masses. OneMap also helps to spur innovation in the private and people sectors.

Illustration 5: Screen shot of OneMap Singapore



Key Learning Points

Key learning points from the implementation of GeoSpace are:

1. Implementation of a multi agency project of this magnitude is inherently challenging. Before the project inception, SLA conducted briefings to senior management of the key stakeholder agencies to ensure buy-in and participation. With strong senior management support and endorsement from all participating agencies, the project took off without much difficulty.

2. Investment of time and resources for a comprehensive pilot testing of the online data sharing paid rich dividends as it helped in exposing potential technical and process related pitfalls. For example, sending large chunks of data over high speed network was not only a data security concern; it was also vulnerable to network failures. During the full project implementation, appropriate measures and solutions were put in place to deal with these challenges.

3. While designing the user interface of the system, the project team was faced with a huge challenge to come up with a simple user interface. SLA project team conducted feedback sessions and technical workshops for the staff of various levels from the agencies. As a result, one of the key features of GeoSpace is a simple web-browser user interface, which a lay-person can easily use without the need for GIS trainings. This helps to pave the way for widespread proliferation in the adoption and use of GIS in the public sector.

4. Streamlining data standards and ensuring compliance is a challenging task. Concerns of major data producer agencies needed to be addressed as conformation to standards requires changes to their operational procedures and investment in new systems and infrastructures. To allow agencies more time to deal with these issues, the GeoSpace project team came up with innovative data transformation tools well integrated within GeoSpace system which helped agencies to supply data in standard formats, while helping agencies to revamp their systems.

Author Information

Ng Siau Yong, Director, Geospatial Division, Singapore Land Authority (ng_siau_yong@sla.gov.sg)

Lim Ming Khai, Head, Geospatial Operations and Development, Singapore Land Authority (lim_ming_khai@sla.gov.sg)

Lo Jing Lu, Manager, Geospatial Information, Singapore Land Authority (lo_jing_lu@sla.gov.sg)

Anupam Mukherjee, Senior IT Manager, Application Services, Singapore Land Authority (Mukherjee_anupam@sla.gov.sg)