Effective Land Administration Underpinned by Reliable Geospatial Information: A Singapore Case

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Singapore Land Authority
“One must reserve land for future development. The government is not looking five years or ten years ahead. Being a responsible government, we must look 30 years or 40 years ahead, and when the time comes, we must have land available for the requirements for that age.”

Singapore Land Authority (SLA) is a statutory board under the Ministry of Law. It is formed in 1 June 2001. SLA acts as the main custodian’s of Singapore’s Land Assets to support the economic and social development of Singapore.

**Effective Land Administration is Core Business for SLA**

Limited Land  •  Unlimited Space

- Optimise land and space utilisation
- Be a trusted source of land-related information
- Drive a Geo-enabled Singapore
Survey & Geomatics Division

I. Uphold accurate national geospatial and positioning reference system

1. Geodesy
We establish national coordinate reference system and maintain the underlying control points infrastructure that underpin the data capture, map production and applications related to Geoinformation.

2. GNSS
We establish and maintain the national GNSS Continuously Operating Reference System (CORS) infrastructure and provide positioning services that enhance the GNSS positioning reliability and accuracy in Singapore.

II. Deliver reliable and trusted digital Geoinformation

3. Cadastre
We administer the cadastral survey legislation and approve cadastral survey plans to support registration of titles and maintain map database as the fundamental dataset for sustainable development of Singapore.

4. Mapping
We capture, create and maintain digital geoinformation of underground and above ground; and produce national map(s) to support sustainable development, environmental protection, digital economy and smart applications.

5. Monitoring
We collect, analyse and manage digital geoinformation over time to detect changes on land that support administration, risk management and environmental monitoring.

III. Drive industry innovation, standards and capacity

6. Research
We conduct innovative research and development on processes and technologies in the field of Geomatics Engineering to ensure we can continue to meet national needs and to lead the industry.

7. Standards
We develop and maintain technical standards and guidelines for the capturing, creation and exchange of digital geoinformation.

8. Education
We raise awareness and build capacity of Geomatics Engineering.

9. Collaboration
We collaborate with partners on technical and policy matters related to geodesy, land surveying, mapping and boundaries.

10. Advisory
We represent the State and advise public agencies on matters related to policy and technical practices of geodesy, land surveying and mapping.

IV. Lead WOG in the domain of Survey and Geomatics

1. Geodesy
2. GNSS
3. Cadastre
4. Mapping
5. Monitoring
6. Research
7. Standards
8. Education
9. Collaboration
10. Advisory
Digital Transformation in Cadastre since 2018

Cadastral Survey Management System (CSMS)

Registered Surveyors’ Portal
- Pre-validation
- Plan Generation
- Surveyor Workspace

SG LandXML

SLA Intranet for Inspection and Approval
- Cadastral Workflow
- Provenance GIS
- Inspection Officer Workspace
- Fully Digital
- Cadastral Validations
Innovations in Cadastre

Before 2004
- Paper Plan

2004
- Coordinated Cadastre with SVY21 (2004)
- Image Plan (2005)

2018
- Digital Cadastre with SG LandXML

2024
- 3D Cadastre in BIM (IFC)
Benefits of Digital Cadastre

Cadastral Survey Management System
- Cadastral Rules Validations
- Highly Automated
- Data Integrity Checks
- Online Plan Generation
- Quick Response

• Faster issuance of Titles
• Improves the quality of plan data
• Automates digital plan examination process
• Reduces submission errors due to missing or incorrect information
• Reduces duplication of data
• Saves time because data does not need to be re-entered
• Enhances the accuracy of the Cadastral database
• Provides a standard data exchange format for sharing and collaboration
• Single source of truth from SG LandXML
Cadastral Survey Submission Workflow

SG LandXML Specification

SG LandXML

Pre-validations

Registered Surveyors Portal

Download

Upload

Prepare

Submit

Correspondences

SG LandXML

- Plan Generation
- Supporting Docs
- Payment

Software

- Listech Neo,
- Geocadastre
- Data Stream

Field Work

Cadastral Survey Management System (SLA)
Cadastral Data Model based on ISO 19152 Land Administration Domain Model (LADM)
Managing Provenance of Cadastral Lots

The Development Tier has 5 Layers: Development Approved Lots, Development non-Approved Lots, RT Lots, Caveat Lots and Dummy Lots. These layers are exclusive, meaning that a lot exists in one layer will not appear in other layers in the Development Tier.

Lots in the Development Tier that do not become approved lots will move to the History Tier, e.g. Dummy Lots.

Once a child lot is created in the Allocated Tier, the existing lot in the Allocated Tier will be moved to the Development Tier.

Any lots in the Development Tier, once approved, will be moved to the Approved Tier.

Any lots in the Approved Tier that their associated CP Plan is no longer current, will be moved to the History Tier.

The Allocated Tier only has one layer in which each parcel lot is associated with the most current lot number. A new cadastral lot will be created in this layer when a new lot number is allocated during the allocation of lot number stage.

The Development Approved Lots layer contains Approved lots that are being taken certain action (e.g. subdivision).

Lots are linked with Parent-Child Relationship and Order IDs.

The Development non-Approved Lots layer contains lots that are neither Approved lots, RT lots, Caveat lots nor Dummy lots, i.e. the "normal" lots before approval. In other words, most lots will come to this layer, if the lot is not made live, does not have RT or CP Plan number, or is not a dummy lot.

The RT Lots layer contains lots that have RT Plan Numbers. Once a RT Plan is approved, the respective lots will be moved to this layer.

The Caveat Lots layer contains live lots. Once a lot is made live, the lot will be moved to this layer.

The Dummy Lots layer contains lots that have lot numbers but do not even exist.

The Submitted Lots layer contains lots that are submitted by RSs to CSMS. Once the RS submitted his job, the respective lots will be populated here. The layer is mainly used for field survey checks.

The Approved Lots layer contains all lots that are approved, i.e. have CP Plan Numbers. Once a CP is approved, the respective lots will be moved to this layer.

The History Lots layer contains old lots that are no longer used/valid or no longer under certain action. These include RT lots, non-Approved lots or Caveat lots that have new CP number, Approved lots that are dead, dummy lots and unused lots. These lots should be retrievable for later investigation.
3D Cadastre

- Complexities of structures and related rights – 2D representation is not sufficient
  - Above and on ground
  - Underground
- Urbanisation – need planning in third dimension
- Trends in cadastre - AEC industry has moved to BIM
Visualisation of 3D Strata Boundaries in Building Information Model (BIM)
3D Building Models (LOD2) in CityGML

- CityGML is an XML base data format
- CityGML captures
  - 3D geometry, 3D topology, semantics, and appearance
  - 5 discrete scales (Levels of Detail, LoD)

3D Geometry + Topology + Semantics + Appearance

Source: Thomas Kolbe
3D Building Models

3D Map
Downtown Singapore
Supporting Public and Private Needs

- Develop Flood Risk Map to mitigate impact of sea level rise
- Support adoption of solar energy using Solar Potential Map
- Develop 3D Aerodrome Terrain and Obstacle map
- Support Whole Of Government (WOG) Regulatory Approval for Building Works
- Support National Parks Board in tree mapping

Urban Planning
Digital Underground Research Project: Towards developing a reliable map of subsurface utilities in Singapore for planning and land administration

2017

Mapping strategy for underground utilities:
- Ensure quality of new data
- Improve quality of legacy data
- Create central repository of data

2019

Foundations of utility mapping
- Framework for data quality governance
- Reviewed Utility Survey Standards

2021

Workflows for reliable subsurface utility data quality
- Consolidated data platform
- Data quality management
4 Key Data Management Strategies to Ensure Reliable GeoInformation

1. **Single Source Of Truth** - a single reference to ensure consistency throughout entire lifecycle.

2. **National Data standards** – a common vocabulary/ontology to achieve interoperability

3. **Open and interchangeable formats** – to allow the use of multiple technologies (vendor-neutral)

4. **Automated validations** using machine processable formats (e.g. XML) – to reduce human errors and achieve higher data integrity
Thank You

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