

(SEC) SINGAPORE-ETH Centre

Digital Underground

Towards a reliable underground utility map in Singapore

地下數碼化:建立新加坡可靠地下管線地圖

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DIGITAL MARCH

Organisers 主約機構



HE HONG KONG OLYTECHNIC UNIVERSITY UND SURVEYING AND BLOW 治理工大学

"Underground Utility Survey Based on Nondestructive Testing, Surveying, Imaging and Diagnostic (NDTSID) Approaches" Webinar 「地下管線無損檢測、測量、成像和診斷」 網上研討會

ABOUT SLA

Singapore Land Authority (SLA) is a statutory board under the Ministry of Law. It is formed in 1 June 2001 from the merger of 4 different entities. We act as the main custodian's of Singapore's Land Assets to support the economic and social development of Singapore.





SG Digital Twin - Motivation

Cities of Tomorrow will be powered by Digital Twin



SG Digital Twin – Geodata Framework



Digital Twin Going Underground

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Sel?

The need for a reliable map of subsurface utilities in Singapore



Going underground demands quality data

- Mindset shift: From land to space
- Systematic and continuous management of underground space as asset is required
- Planning and land administration need to integrate space above and below the surface

Reliable 3D data on what lies beneath is essential

Finding space for the future

To use our space more efficiently, the Government is looking to launch its Underground Master Plan in 2019. Here are some subterranean ideas that are being explored.

Substations Electrical substations, which are essential for providing electricity to estates, currently occupy small tracts of land at the ground level,

tracts of land at the ground level, even though they are connected to the underground cabling network. To save space, these can be housed underground, and can still be serviced through access points with a smaller footprint.

Bus interchange

The new Bidadari housing estate will be home to Singapore's first underground air-conditioned bus interchange below Housing Board flats. Slated for completion by 2019, it will sit below a carpark and a garden, and will likely cater to five bus services.

Road and rail networks -

To enhance our living environments, future major road and rail networks, especially those that will cut through built-up areas, will be located underground. This reduces the impact of noise and dust on homes.

Deep Tunnel Sewerage System

This is a network of tunnels that operates on gravity, and transports sewage and waste water across the island to two centralised water reclamation plants.

Jurong Rock Caverns

The Jurong Rock Caverns under Jurong Island is for petrochemical storage. In phase one, its five caverns are as high as nine storeys, saving approximately 60ha of land.

Ammunition facility

The underground ammunition facility built under a quarry in Mandai in 2008 stores ammunition and explosives. It frees up land about half the size of Pasir Ris town.

NOTE: Illustration not drawn to scale

- SecureMyBike

In Admiralty, the Land Transport Authority completed the first automated underground bicycle parking space, known as SecureMyBike. Users can leave their bikes at kiosks located above ground, which then houses them in storage cells extending up to 10m underground.

- Pedestrian links

Underground pedestrian links make it easier to connect between buildings or cross busy streets. For a more extensive underground pedestrian network, the Urban Redevelopment Authority offers an incentive scheme to co-fund the construction of selected linkages in Orchard Road and the Central Business District.

— Common Services Tunnel

More than just space-saving measures, underground pipes are less prone to external wear and tear. The Common Services Tunnel in Marina Bay is a creative way of housing all utilities together. This frees up land, with lesser maintenance disruptions on the roads.

— Waste disposal

In housing estates, trash can be carried away to a centralised bin centre through a suction force via underground pipes, using pneumatic waste conveyance systems. Such a waste disposal network can be seen in an HDB estate in Yuhua, removing the need for refuse workers to manually collect waste from each block.

Air-conditioning pipes

Chilled water used for air-conditioning could be supplied centrally through an underground network of pipes, known as a district cooling system. This is already done in Marina Bay, and the authorities are looking to implement them in the Punggol Digital District.

Reservoirs

Water can be stored in underground reservoirs, with the national water agency PUB currently looking into an idea that can free up significant parcels of land for development. The 17 reservoirs currently occupy 3,700ha, or around 5 per cent of Singapore's total land.

Source: URA STRAITS TIMES GRAPHICS

Underground space

- Underground space is a valuable asset
- Planning and use of underground space is often uncoordinated and chaotic
- Systematic, continuous management is required
- Good information is essential



Reliable information on underground utilities will lead to better decisions and save resources



Planning and land administration

Better planning outcomes; land use optimisation



Infrastructure development

Elimation of uncertainty and risks during planning and design



Construction and engineering works

Minimisation of disruptions to environment and services; increased safety

How reliable is the available data?

Data quality is insufficient

Data is often locationally inaccurate, not up to date, and incomplete.

Data quality is undefined

Data quality is a largely unknown and technique of measure is undefined



Repeated pains felt due to unreliable data



Sub-optimal use of underground space; loss of opportunity



Long and costly planning, design, and development of infrastructure

Nuisances, incidents, and disruptions

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Cut cables disrupt fibre broadband in eastern Singapore

Feng Ming Construction fined for damaging water main, which disrupted supply to nearly 40 homes in Bukit Timah area



Construction work ruptures gas pipe near Lau Pa Sat By ROBIN CHOO



Digital Underground Initiative



The Digital Underground project

Objective

Towards developing a reliable map of subsurface utilities in Singapore for planning and land administration

| | Project period |
|---------|---------------------|
| Phase 1 | Jan 2018 - Jun 2019 |
| Phase 2 | Jul 2019 - Jun 2021 |

*co-funded by SLA and Underground Studies Project Fund



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Long-term vision

| PLAN | DESIGN | TEST | EMBED | | | | |
|---------------------------|--|-------------------------------|---|--|--|--|--|
| Phase 1 Roadmap | Phase 2 Foundations of a utility mapping ecosystem | Phase 3 | Operation phase | | | | |
| Roadmapping | Concept development System design | Living lab | Agile operation Continuous improvement | | | | |
| () 1.5 yrs | () 2 yrs | () 1.5 - 2 yrs (est.) | | | | | |
| ENABLE | | | | | | | |
| | Community of Practice | Underground Living Testbed | Centralised / standardized data collection | | | | |

Phase 1: Roadmap (2017-2019)



Stakeholder engagement and roadmapping

UTILITY



Looking overseas







Exploration of mapping techniques







CASE STUDY: LARGE AREA MAPPING

Objectives

Assess the practical feasibility of operating a 3D GPR mobile mapping platform on the streets of Singapore

Assess the feasibility and viability of large volume, large area data subsurface capture to improve the quality of data on existing utilities.

Data capture technology: Leica Pegasus:Stream

38 antennae, 6cm spacing

Two polarisations

200Mhz and 600Mhz

Integrated above and below surface data capture

Approach

Data capture in nine distinct locations

- Post-processing and extraction of detected utilities
- Evaluation of practical operation and effort spent

Visual comparison with existing map data based on overlap, proximity, and similarity













366.068 m; -0.555 m

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A national mapping strategy for subsurface utilities

- Ensure reliable as-built records for newly built utilities
- Capitalize on opportunities (e.g. capital underground infrastructure projects, trial trenches) to reconcile quality of legacy information
- Strong quality controls at the front-end of the information supply chain
- A central repository to assess and understand information quality patterns, issues, and potential interventions







Roadmap

Integrated approach towards a thriving utility mapping ecosystem



Coordination Coordination of a national mapping strategy



Consolidation Consolidation of subsurface utility information in a national map



Capture

Reliable data capture for newly built and existing utilities



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Capacity

Develop the required capacity

Community

Engage a community of practice from industry, government, and academia

Phase 2: Foundations of an ecosystem (2019 - 2021)



Phase 2 work package structure

WP1 GOVERNANCE

Development of a framework for the governance of data quality

| WP2 DATA COLLECTION AND MANAGEMENT PLATFORM | WP3 DATA CAPTURE | WP4 CAPACITY DEVELOPMENT |
|---|--|--|
| Development of a proof of concept database and data management infrastructure | Development of a proposal for improved and extended survey standards | Development of proposals for capacity development instruments (training and certification framework, testbed for research and training, Community of Practice) |

WP1 Governance

Our Approach

Whole ecosystem engagement of asset owners, contractors, and surveyors to understand current practices and challenges



Desktop study on overseas data quality governance and data availability governance

Conduct learning visits to selected overseas jurisdictions i.e. Japan, Malaysia



Preliminary outlines of governance framework

Data capture responsibility

Accountability of Registered Surveyors for data quality, supported by technological innovation and smart capacity increase

Data quality improvement responsibility

Key role for asset owners, questions to be resolved about (technical) feasibility

Data quality management responsibility

- Whole-of-government task force to oversee data quality governance and guide evidence-driven quality improvement efforts
- Dedicated and central capacity + infrastructure to collect and consolidate data and regulate data quality

SLA's role

- Regulation of surveyors and data capture
- Critical value-add to whole-of-government effort through geomatics engineering expertise



WP2 Data Collection and Management Platform



WP3 Data capture



Potential areas for extension of survey standards

- 1. New utility types (e.g PWCS)
- 2. New utility installation scenarios (e.g. trenchless)
- 3. Subsurface Utility Engineering and Mapping (trial trenches, geophysical techniques)
- 4. A standard format for data submission

Exploring new workflows for newly built utilities and trial trenches











Measurable and traceable



Usable from a distance

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A thriving community of practice as key enabler

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With gratitude to our partners:













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