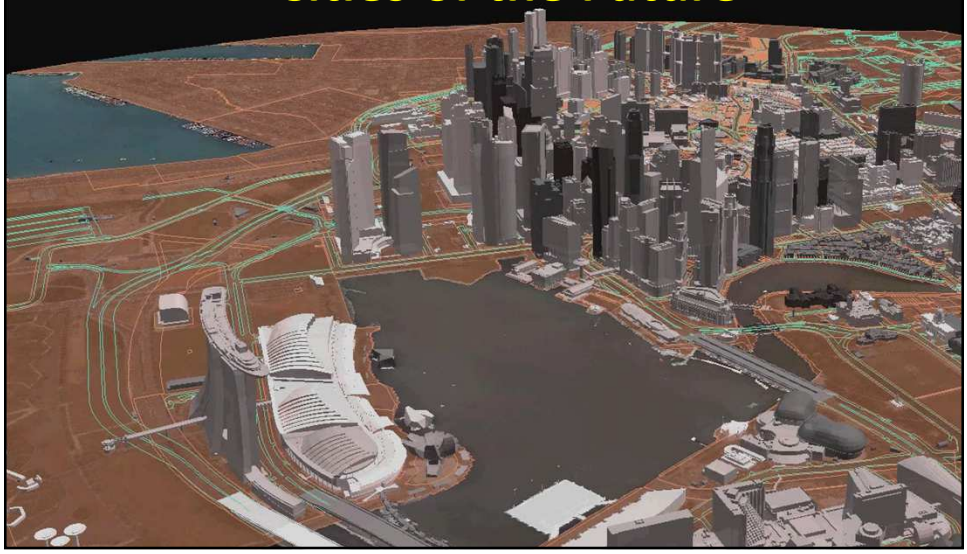
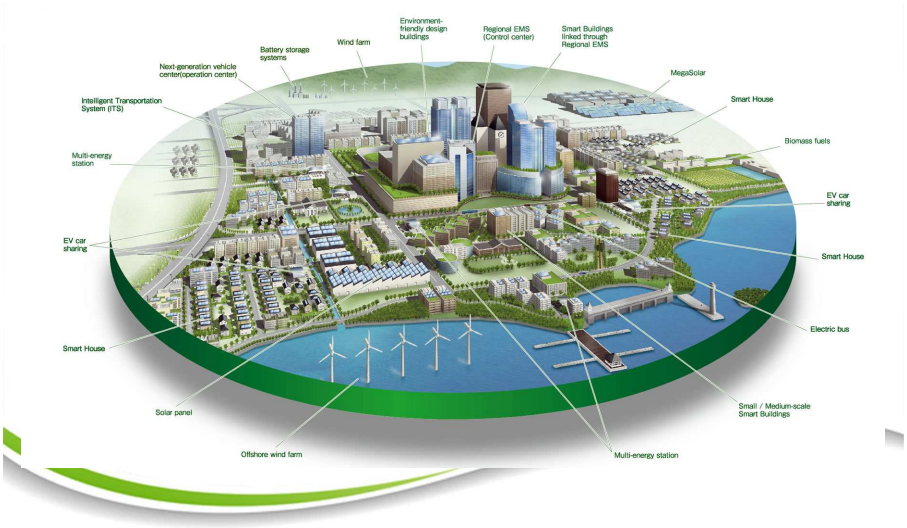
SINGAPORE LAND AUTHORITY

Fundamental Data for Cities of the Future



SINGAPORE LAND AUTHORITY

Cities of the Future – Smart, Resilient and Sustainable



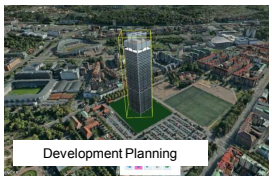
Source: Frost & Sullivan

- Singapore is building the World's first Smart Nation by harnessing technology and gathering insights from data to the fullest with the aim of
  - improving the lives of citizens,
  - creating more opportunities, and
  - building stronger communities.

Measurement + Prediction = Performance

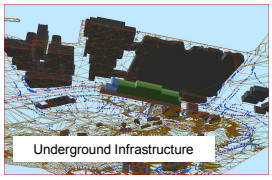
SLA
SINGAPORE LAND AUTHORITY

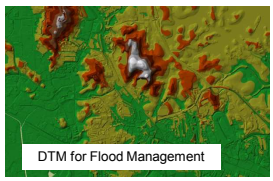
Resilient and Sustainable Growth - Growing Needs for 3D Information


Development Planning

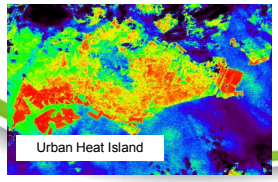

3D Geological Map


Underground Utilities

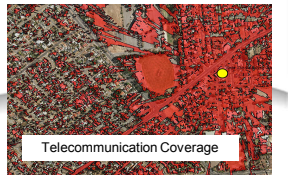

Underground Infrastructure


DTM for Flood Management


Urban Air Flow Dynamic


Urban Heat Island


Solar Potential Study


Telecommunication Coverage

Singapore Land Authority (SLA)

Limited Land • Unlimited Space

Optimise and Manage Land Resource

Administer Property Transaction System

Manage Geospatial Information

What is the Problem?

Fundamental Data

Positioning Data

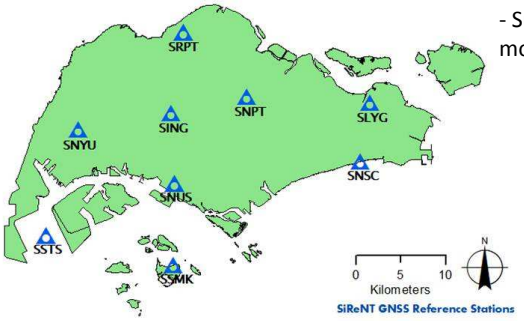
- National Positioning Infrastructure
- CORS Network
- Cm-level accuracy

Geospatial Data

- Reliable
- High quality
- High resolution
- Homogeneous

SiReNT - Precise GNSS Infrastructure in Singapore

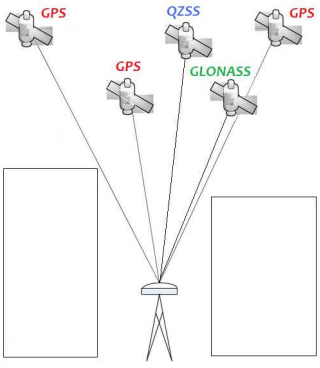
- National Reference System for Surveying, Mapping and GIS
- Support real-time precise navigation and monitoring

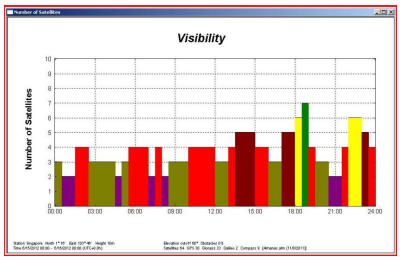


Smart Applications Need Precise Positioning

New Upgraded SiReNT based on GNSS

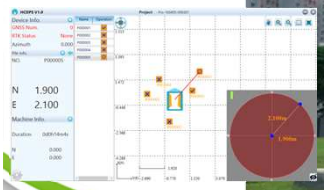
Enhanced satellite availability
Enhanced positioning efficiency





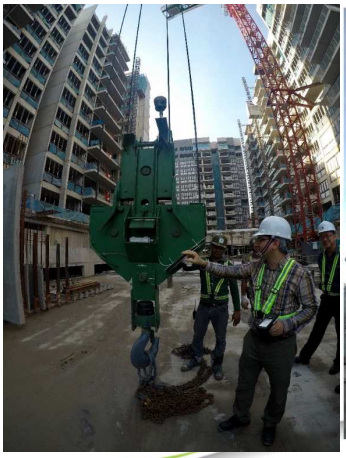
GNSS Assisted Piling System

- Incorporated SiReNT into the development of GNSS assisted piling system.



Smart Crane for Precast Building

- Development of a satellite assisted Smart Crane system
- Made possible by introducing the RTK technique



Intelligent Transport Systems

Junction Safety System: The development of an in-vehicle and roadside units positioning solution for crash detection and early warning.

Development of Driverless Vehicles

- SiReNT provides precise navigation capability for Self-Driving vehicle implementations in Gardens-by-the-Bay and LTA's Driverless Vehicle trials in One-North.

Delphi - Audi SQ5 prototype

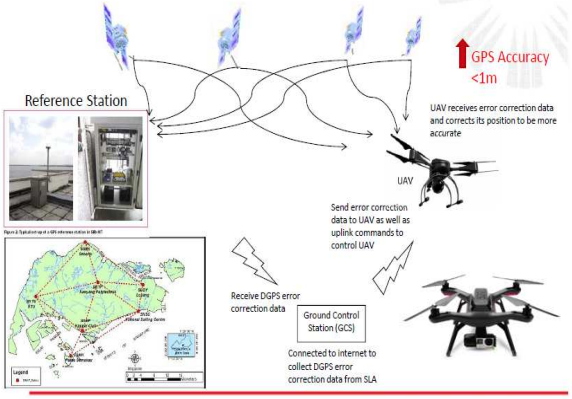
Gardens By The Bay – Auto Riders

A*Star – iiRAV Autonomous Vehicle

Drones Navigation (POC projects)

- Real-time autonomous navigation
- Post processing of flight path
- Post processing of data acquired from flight

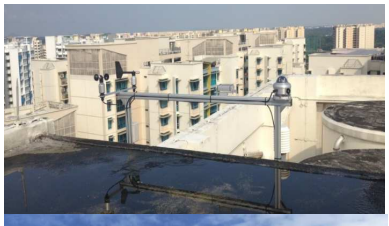
ST Engineering ST Aerospace H³ Dynamics



Solar Irradiance Study

- To collect ZTD and IPWV data from GNSS measurements and incorporate this information in a numerical weather prediction model to improve the solar irradiance forecasting

SERIS
Solar Energy Research Institute of Singapore



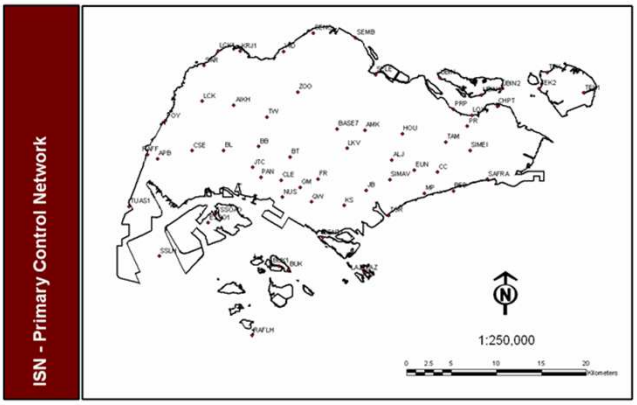
Fundamental Geospatial Data

- Survey Control Information
- Cadastral Survey Information
- Mapping Data
  - Terrain
  - Building
  - Road

National Coordinate System

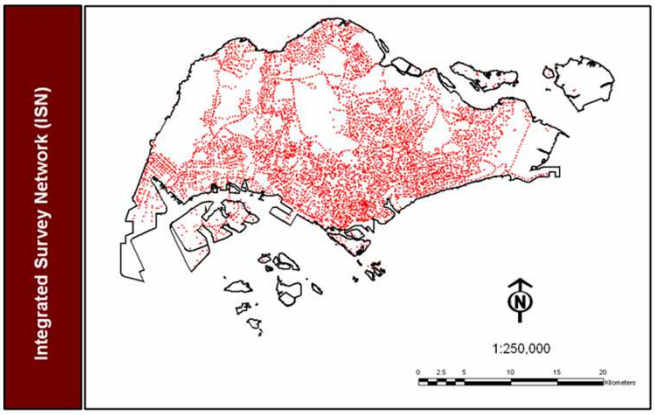
Integrated Survey Network (ISN) - Primary Control Network

ISN - Primary Control Network

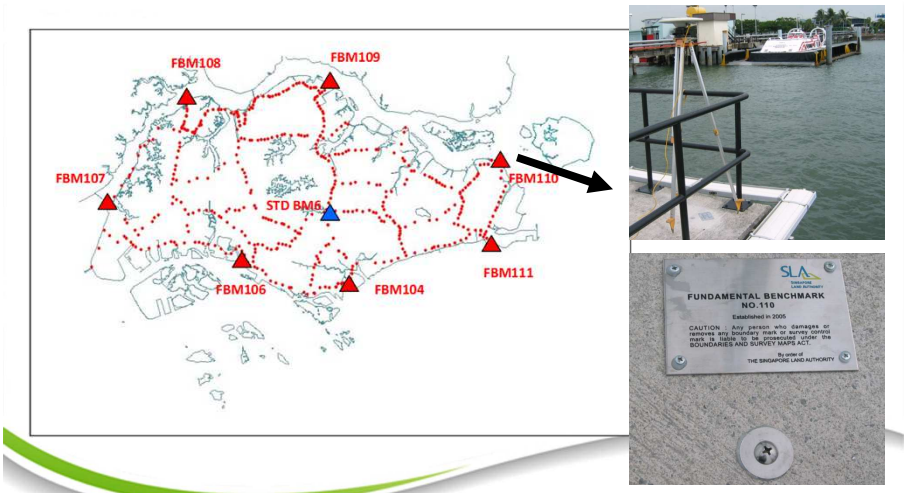


Integrated Survey Network (ISN) – Secondary Control Network

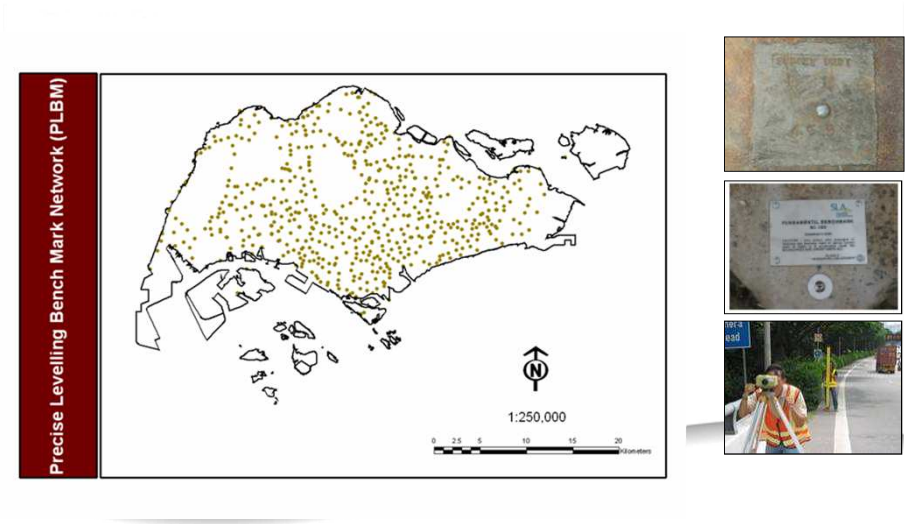
Integrated Survey Network (ISN)



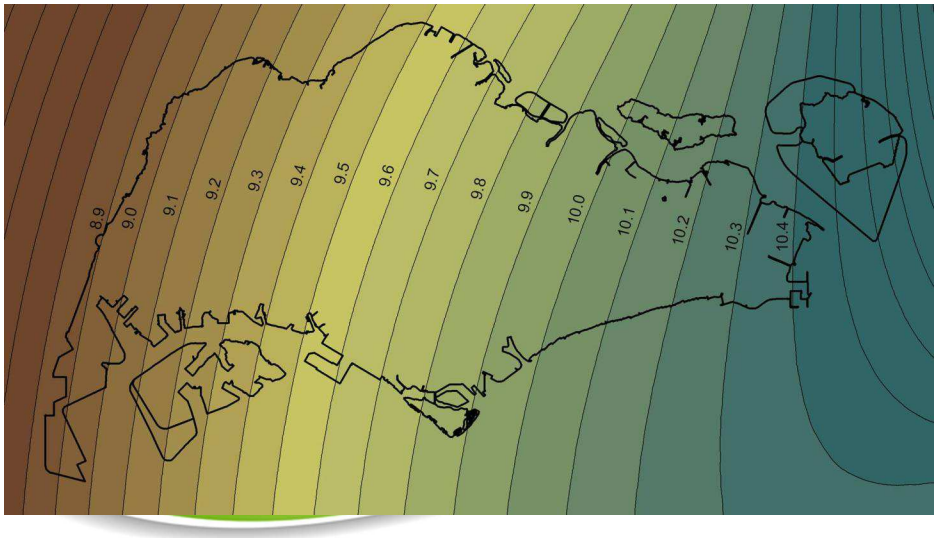
Fundamental Bench Mark (FBM)



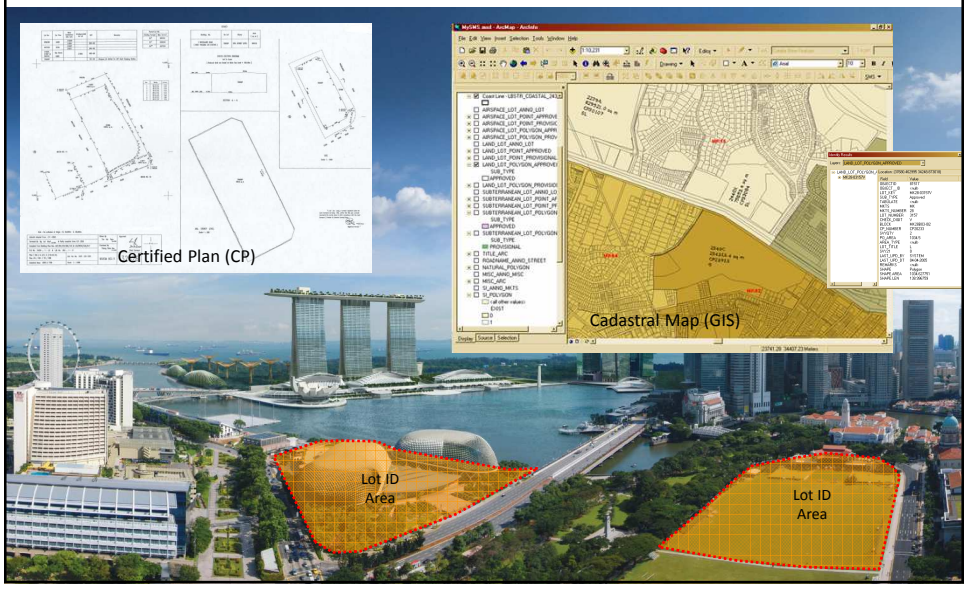
Precise Levelling Bench Mark Network (PLBM)



Using GNSS for heights measurement - Geoid Model

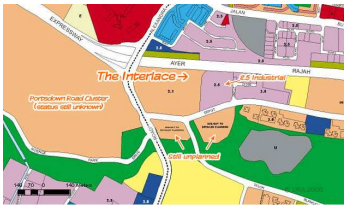


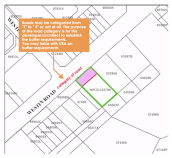
"The Map" - Cadastral Survey Information



Cadastre Information is Important

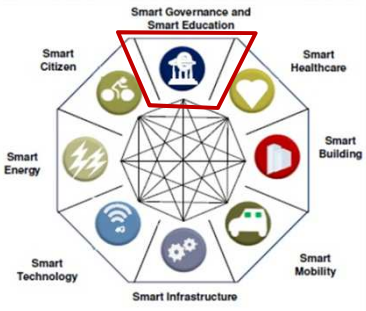
- Property Title Registration
  - Property Ownership
  - Property Transaction
  - Property Tax
- Sustainable Development
  - Road Reserved Line
  - Reserved zone
  - Compulsory Acquisition
  - Government Land Sales
- Planning
  - Master Planning
  - Infrastructure Planning





Smart Cadastre System

- What is Smart Cadastre?
  - Fully Digital Data Management
  - Automated and Intelligent Processing
  - Adopt Open Source Standard
  - Expanded into 3D and 4D
  - Data Analytics
- Key Components
  - Smart Data Model
  - Standard (LandXML)
  - IT system - CSMS



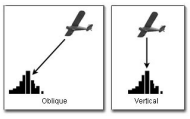
Source: Frost & Sullivan

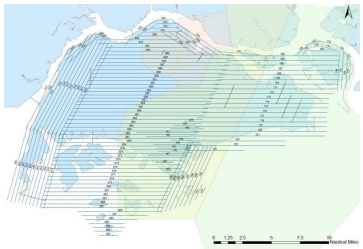
Data - Electronic to Digital

Hardcopy	Electronic	Digital
•Manual Submission	•Electronic Submission •Scanned raster images	•Digital Submission •LandXML •Online cadastre information and policy •Pre-submission check •Semi-Automatic Processing of Jobs

Data Capturing using Rapid 3D Mapping Technology

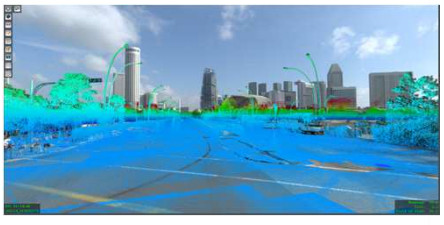
Phase 1 – FY13 to FY15



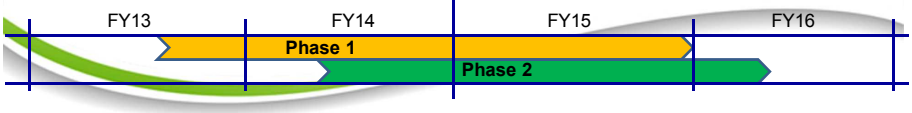


Airborne Laser Scanning & Imaging

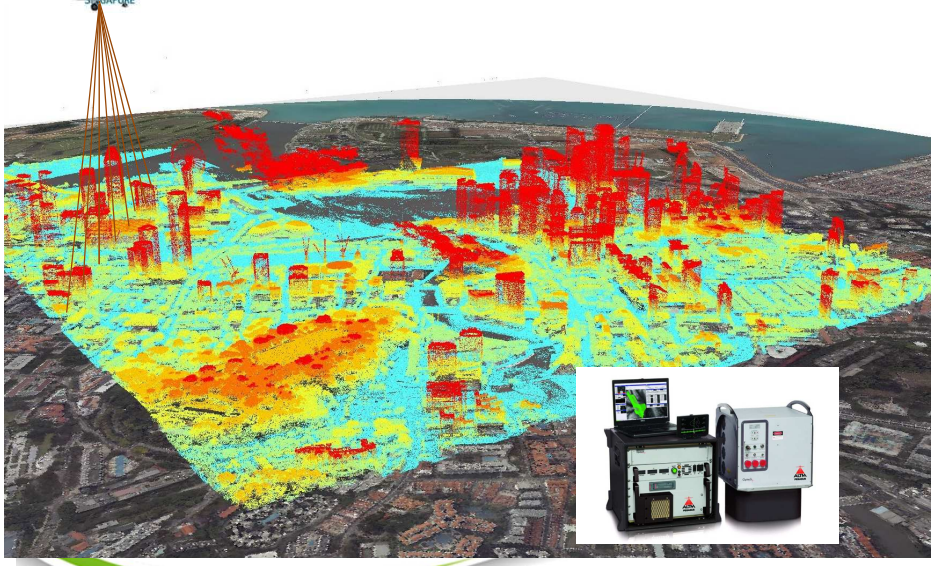
Phase 2 – FY14 to FY16



Mobile Laser Scanning & Imaging

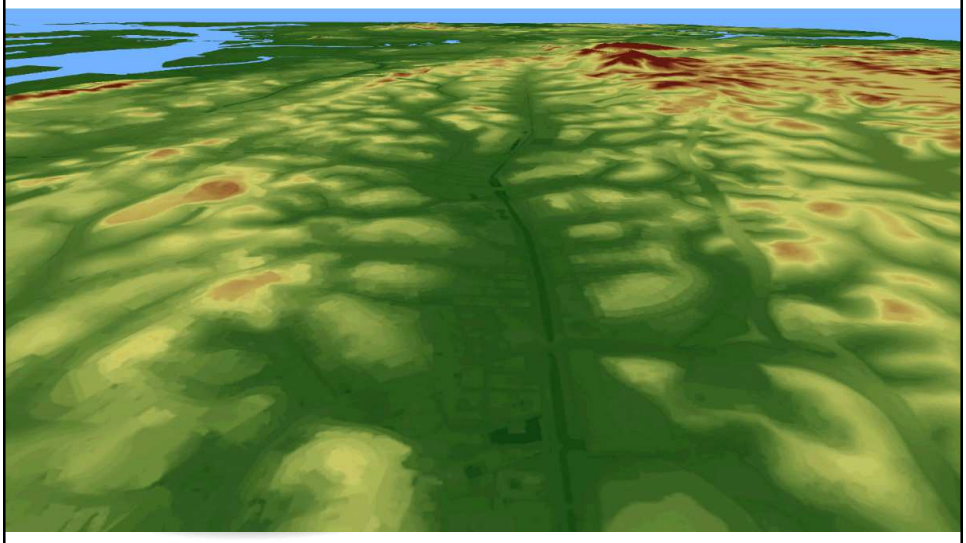


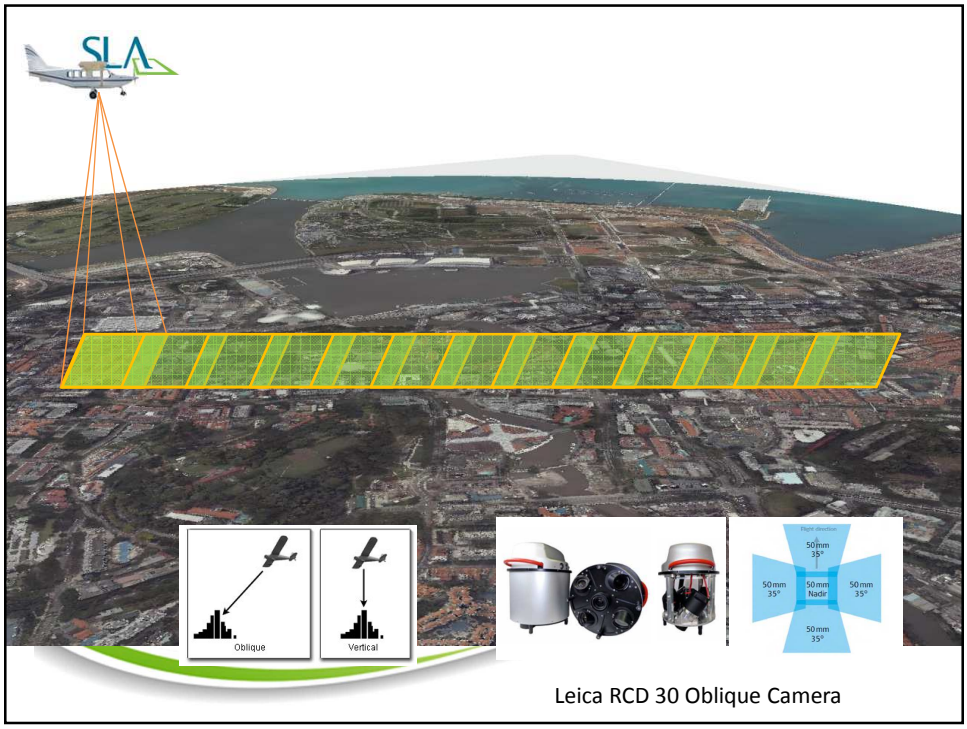
Airborne Laser Scanning



Optech Pegasus ALTM

Digital Surface Model (DSM) / Digital Terrain Model (DTM)





Leica RCD 30 Oblique Camera

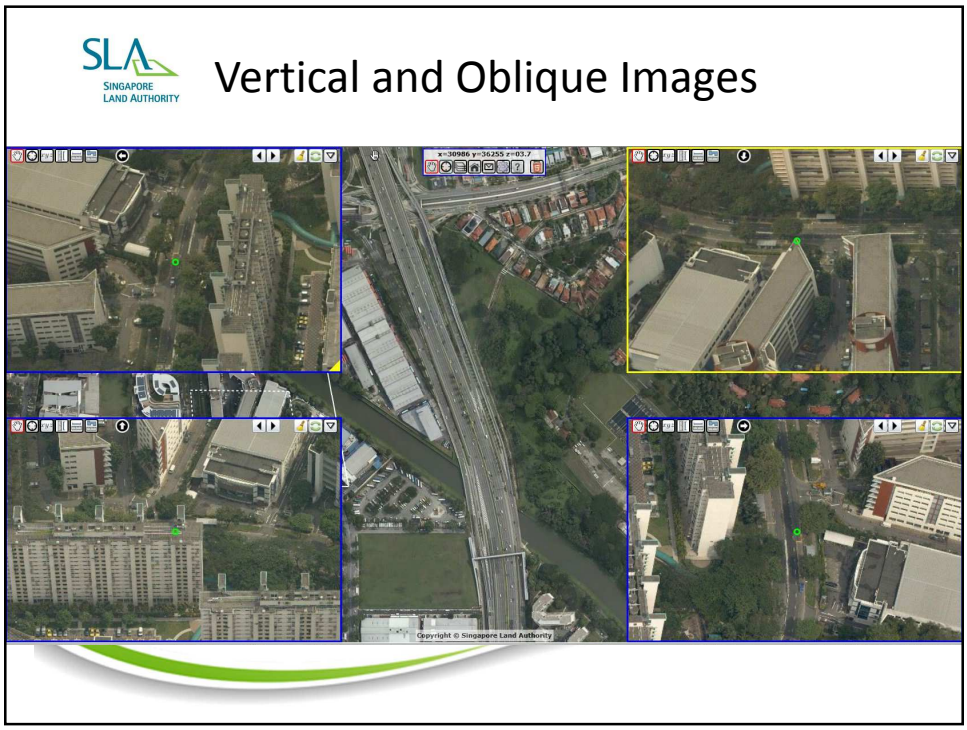
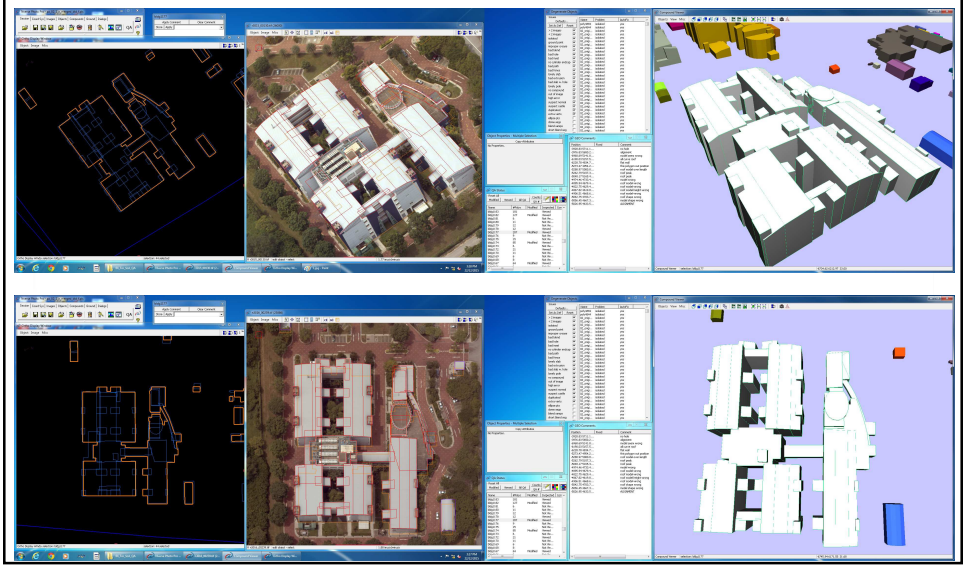
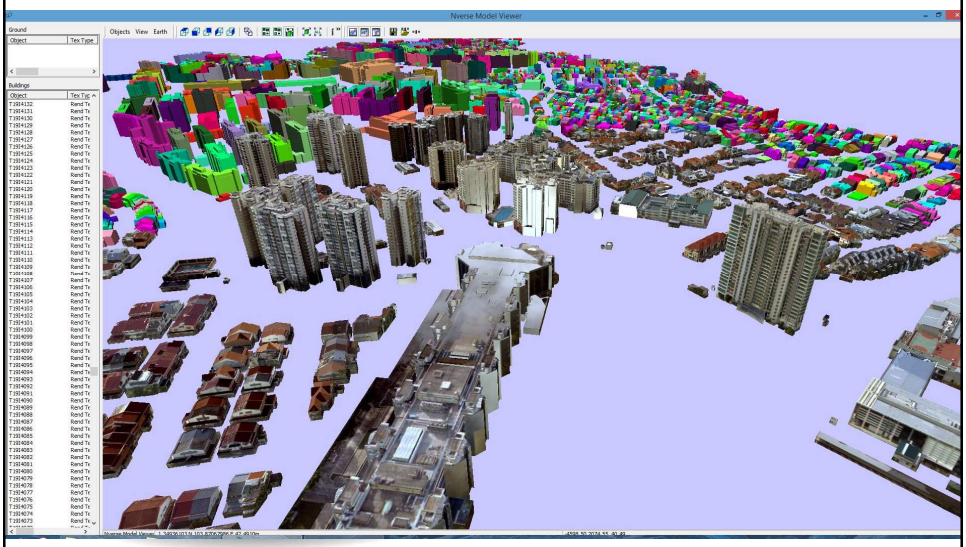


Photo Map from Airborne Images

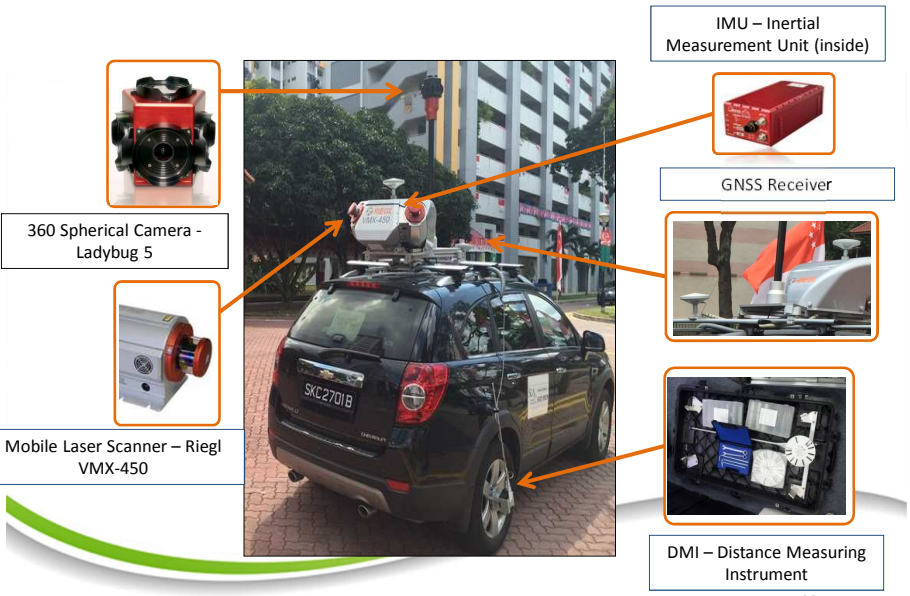
Building Modelling using Imagery



3D Building Modelling



Mobile Mapping System Components



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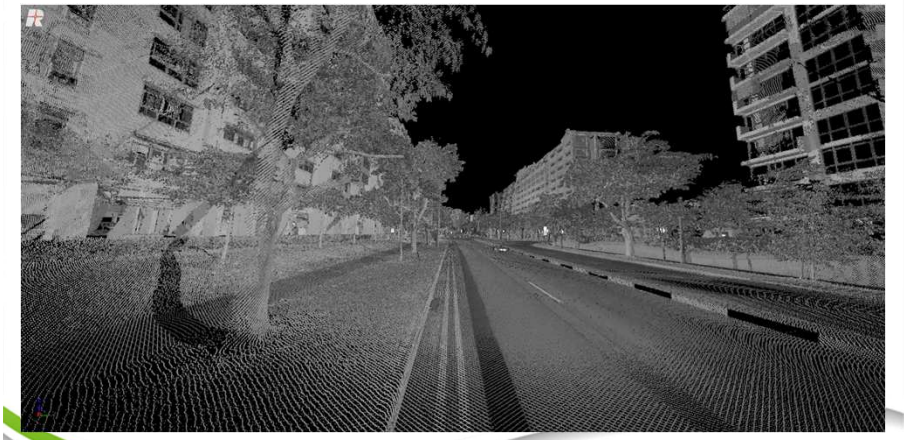
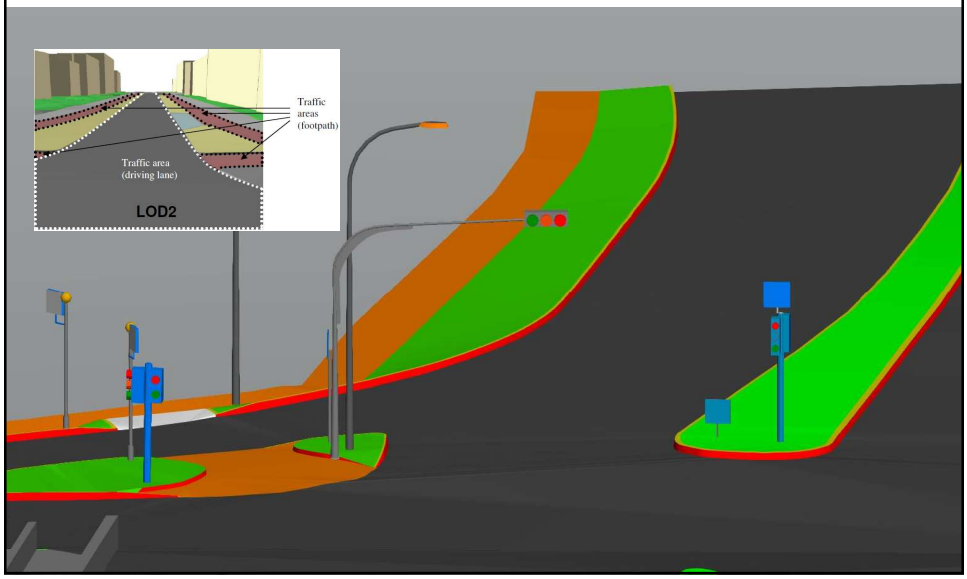
Mobile Laser Scanning Point Cloud



3D Modelling – Transportation and Street Furniture



Data Management Strategies

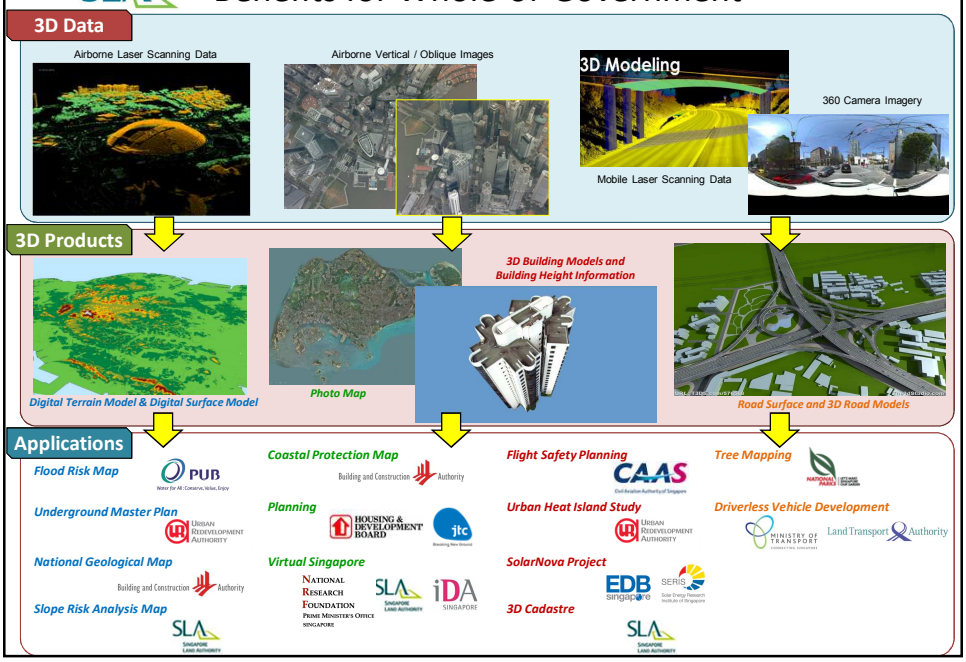
Collect once, use by many

1. Single point of truth (SPOT) is managed and maintained in Open Source Data Format and Data Schema
   - Embrace international open standard (e.g Open Geospatial Consortium (OGC) standard, ISO standards)
   - Ensure government data is technology-independent

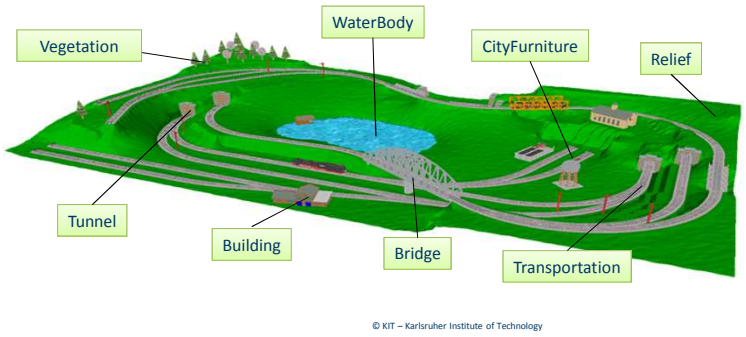
2. Data standard
   - Establish 3D data standard to ensure interoperability and support inter-agency data sharing
   - Actively contribute and influence international 3D standard

3. Multiple source / technology

Benefits for Whole-of-Government



Data Model - CityGML Modelling Theme



Themes to describe the City

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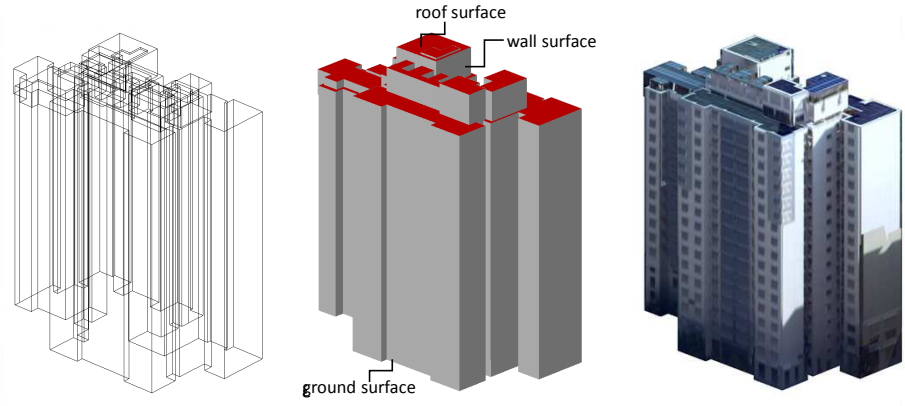
CityGML 3D Building (LoD2)



3D Geometry + Topology + Semantics + Appearance

Where is the Data?

- Government play an important role
  - Providing fundamental data
  - Ensuring standards
  - Build and sustain ecosystem
- Fundamental Data
  - Collect Once – Use by Many
  - Open Standard
  - Future-proof