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Towards Spatially Enabled Smart Nation

Dr. Victor Khoo,
Senior Deputy Director, Land Survey Division

Singapore - City in a Garden

Size - 719 sq km

Population - 5.5 million

Density – 7500/sq km

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Highly Populated - Well Organised

Creating Space Above and Below

Industry Space Above Roads

Underground Science City

(Source: JTC)

GOING UNDERGROUND

Source: ST Singapore

Jurong Rock Caverns

Singapore Land Authority (SLA)

Limited Land • Unlimited Space

Optimise and Manage Land Resource

Administer Property Transaction System

Manage Geospatial Information

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Cities of the Future

Smart **Sustainable** **Resilient**

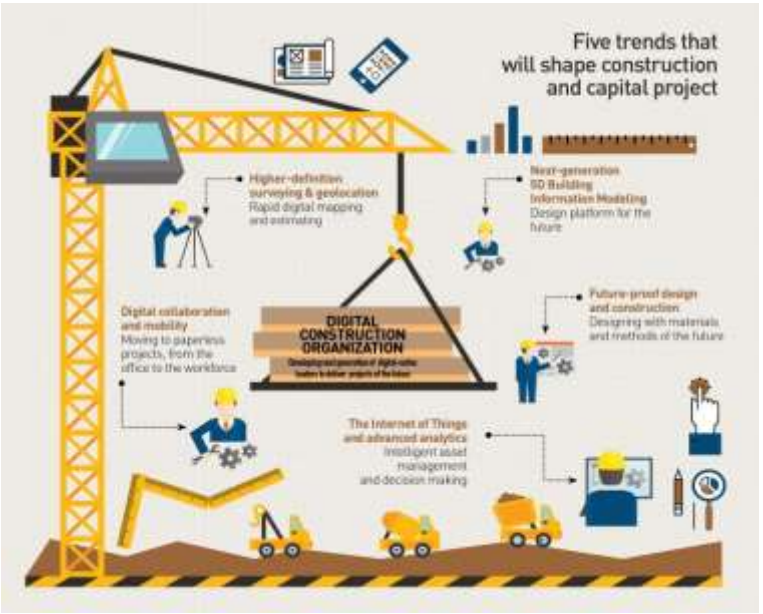
Source: Frost & Sullivan

- 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.

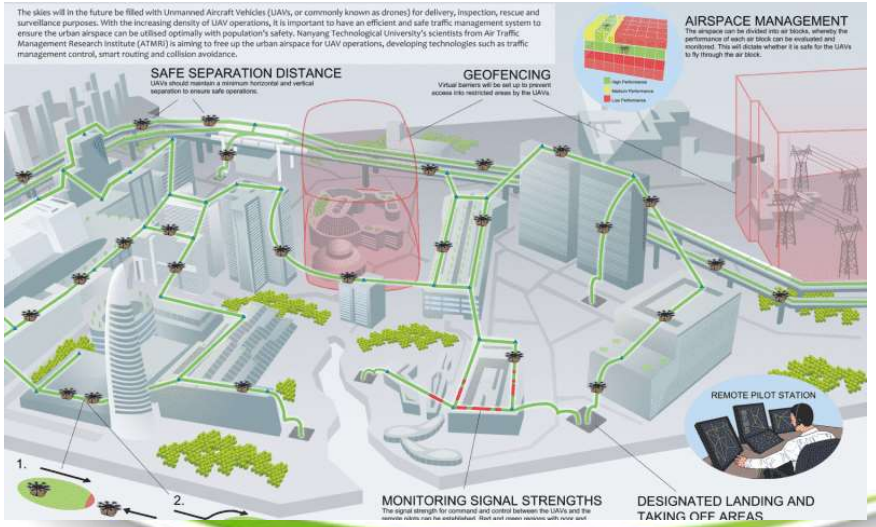
Measurement + Prediction = Performance

Smart Technologies and Applications

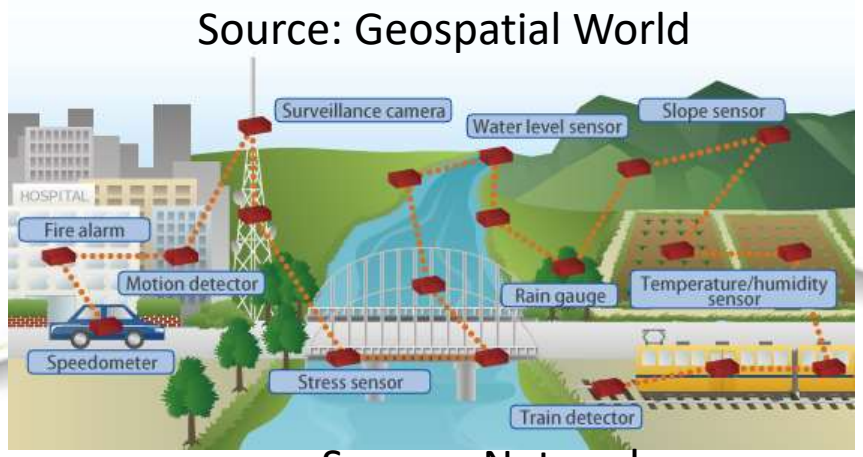
Smart Mobility 2030



Smart Construction
Source: Geospatial World



NTU Proposed concept for UAV air traffic management



Sensors Network

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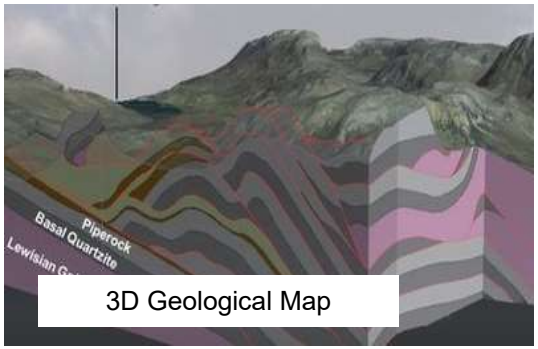
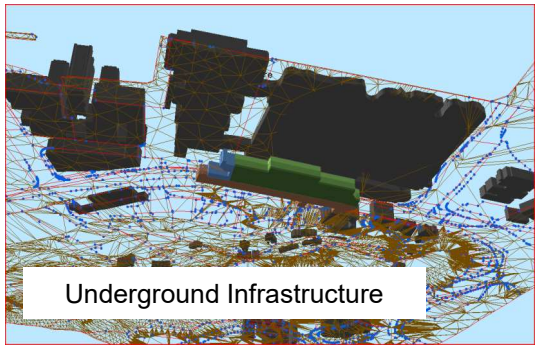
Sustainable and Resilient

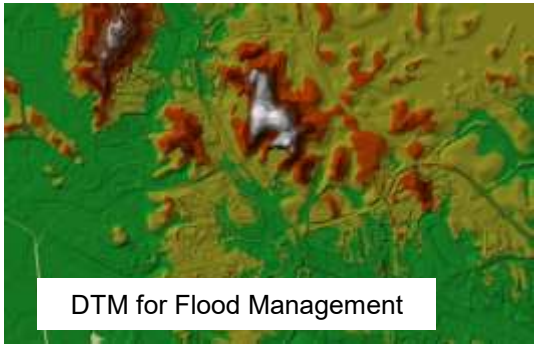

Development Planning



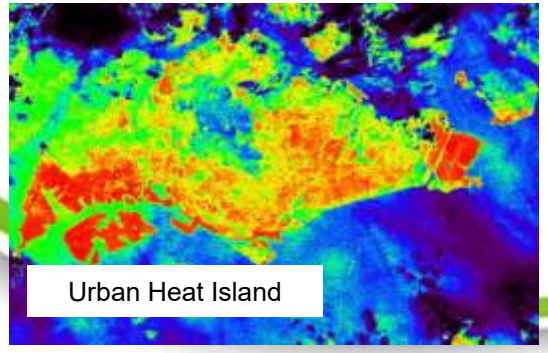
3D Geological Map

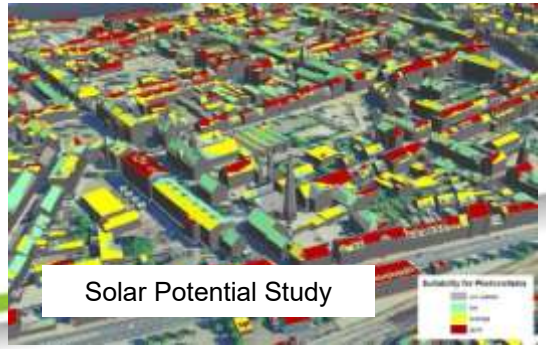

Underground Utilities

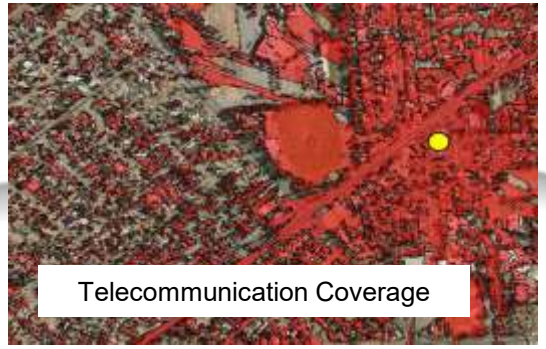

Underground Infrastructure


DTM for Flood Management

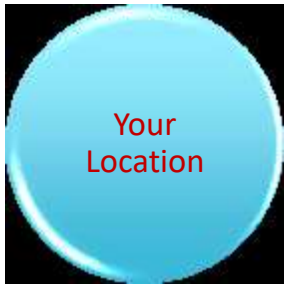

Urban Air Flow Dynamic


Urban Heat Island


Solar Potential Study


Telecommunication Coverage

Digital Geoinformation for Cities of the Future



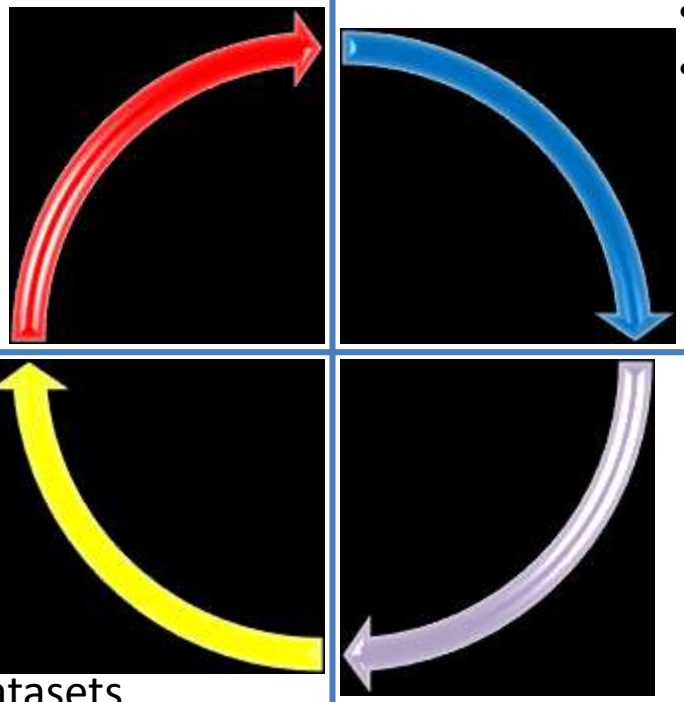
- Your Location (coordinates)
  - Coordinate system
  - Geodetic system
  - Differential GNSS services
- Your Surroundings (maps 2D+3D)
  - Cadastre Maps
  - Topographic Maps
  - Thematic Maps

Role of Surveyors

- To **create**, **maintain** and **provide** **Digital Geoinformation** that underpins the development of a **Sustainable**, **Resilient** and **Smart** Singapore

Geomatics Framework

- Establish and maintain survey reference system
- Define accuracy
- Deploy capturing technology

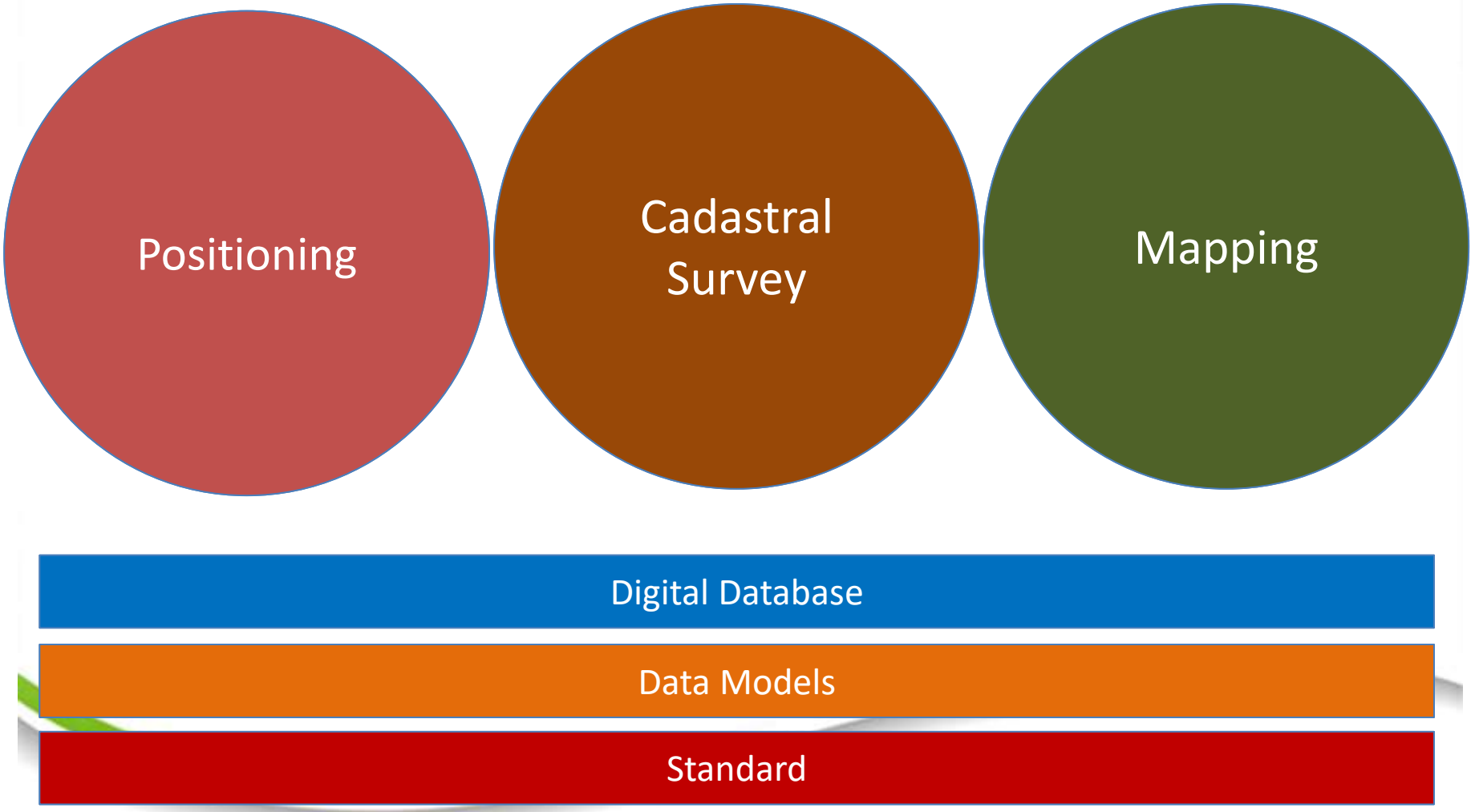


- Produce fundamental datasets
- Develop data models
- Develop and deploy modelling techniques and workflow

- Deliver specific produc
- Participate in solutionir
- Provide data services
- Create new thematic datasets

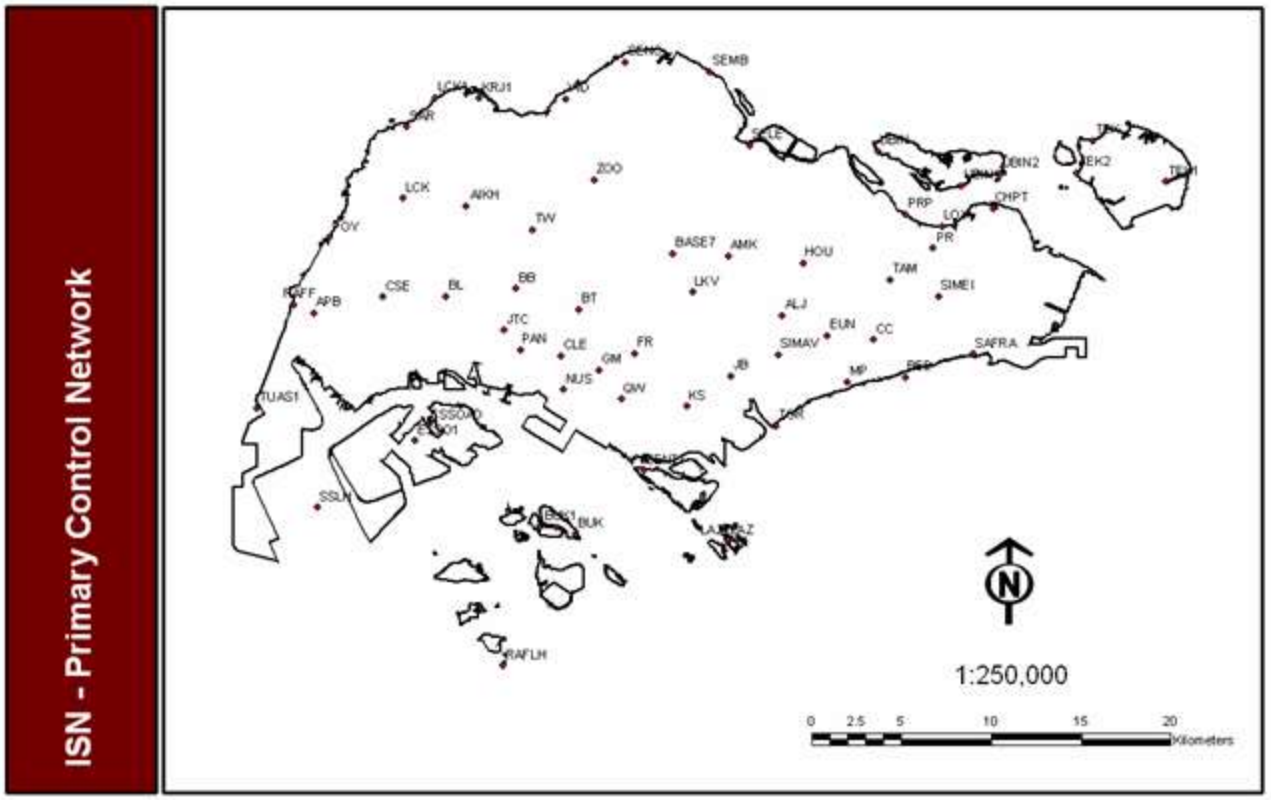
- Manage and maintain GIS and Database
- Detect changes and manage updating

Focus Areas

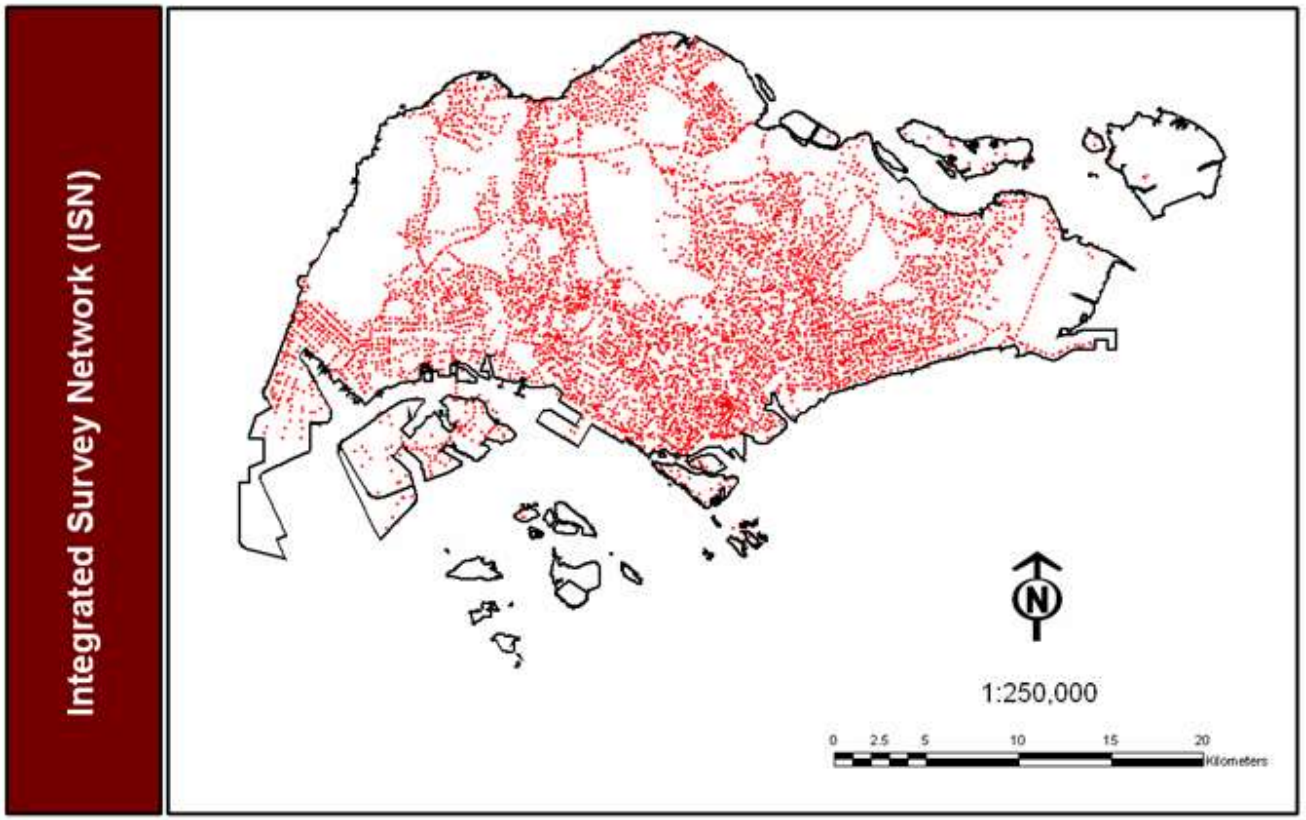

Positioning
Cadastral Survey
Mapping
Digital Database
Data Models
Standard

National Coordinate System

Integrated Survey Network (ISN) - Primary Control Network



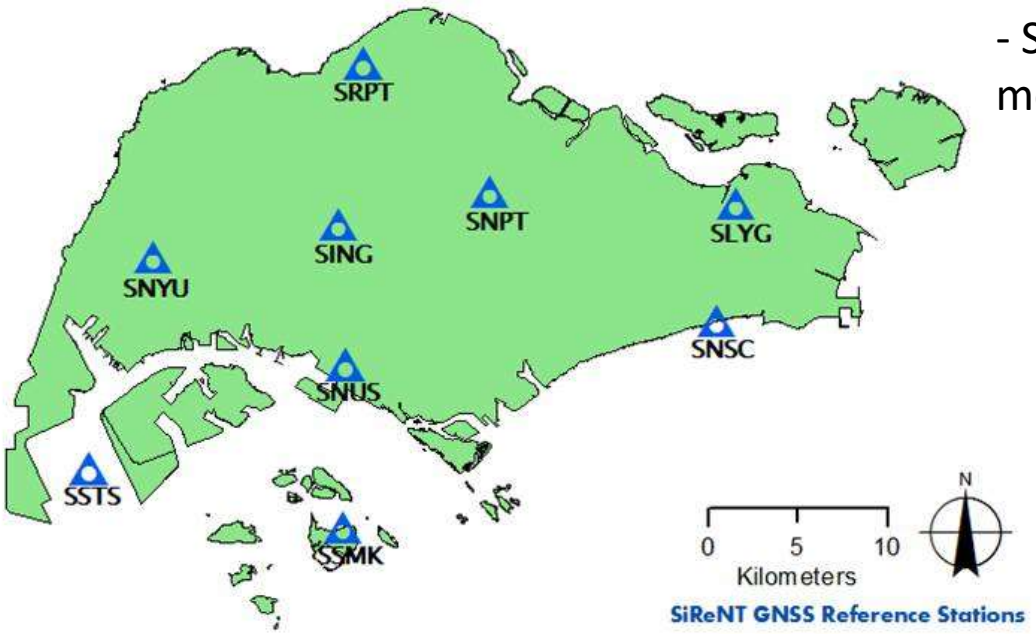
Integrated Survey Network (ISN) – Secondary Control Network

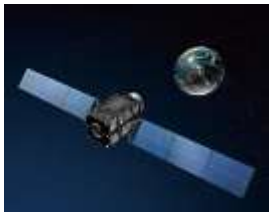


Enhancing Smart Nation with SiReNT

SiReNT - Precise GNSS Infrastructure in Singapore

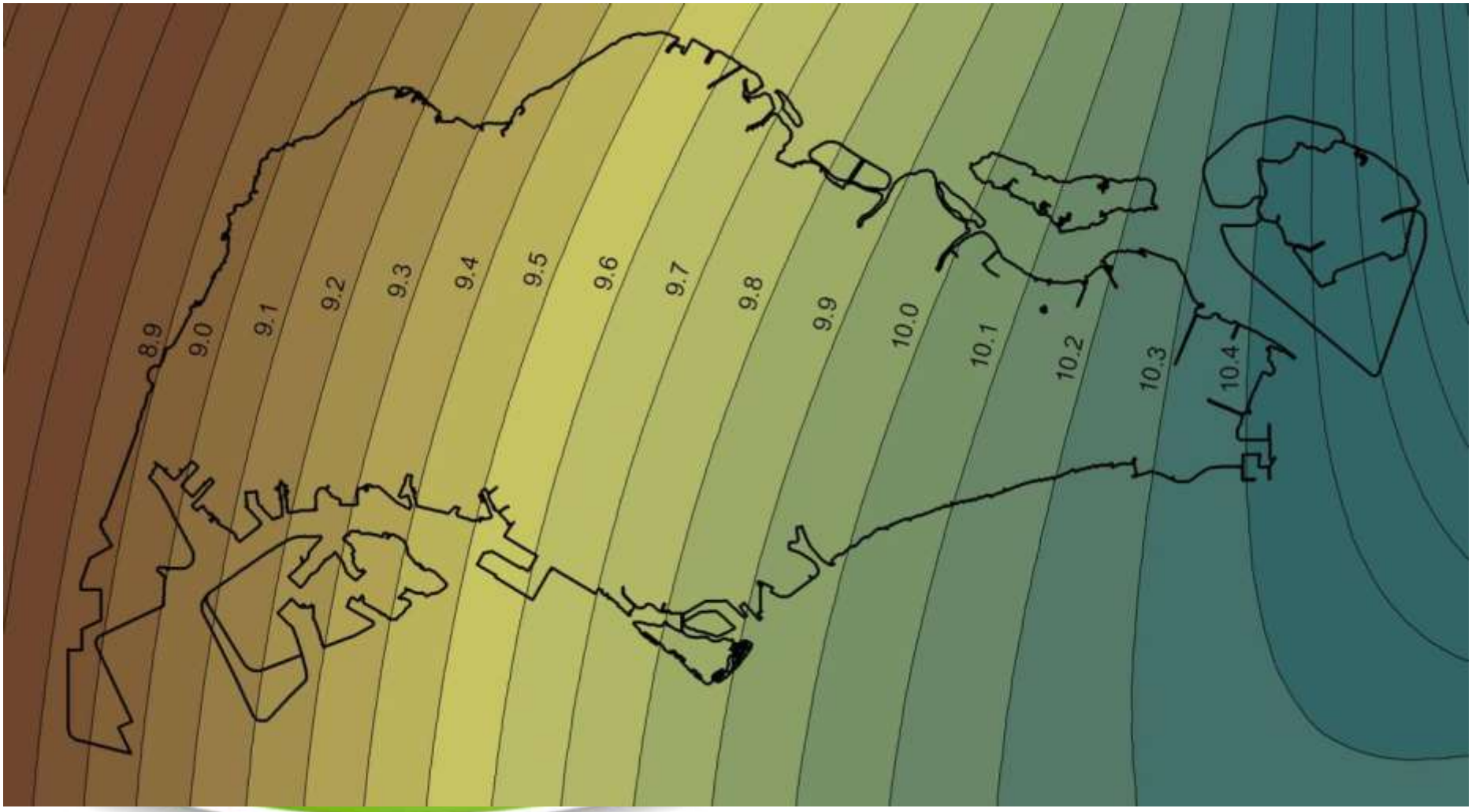
- National Reference System for Surveying, Mapping and GIS
- Support real-time precise navigation and monitoring





GNSS - Real-Time Kinematic (RTK)

Using GNSS for heights measurement - Geoid Model



Utility Assets Mapping

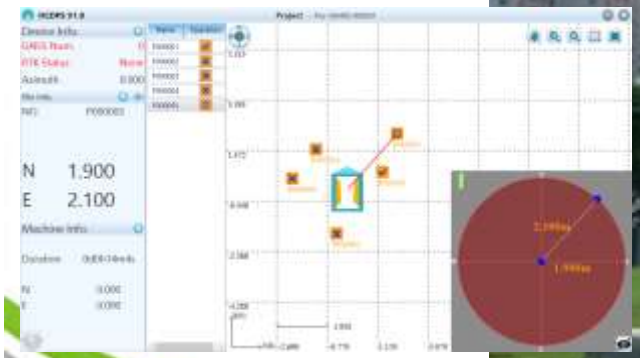
- Using DGNSS as part of the Mobile GIS Data Capture System (MGDCS) under the Water Supply (Network) Department.

Smart Construction - Height Monitoring

- Enforcement of height restrictions on a construction site
- Other methods mainly require line of sight to work
- Using RTK allows accurate machine height monitoring and enforcement

GNSS Assisted Piling System

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



Development of New Solutions

●●○○○ M1 9:13 PM 90%

C2 | BUSINESS

THE STRAITS TIMES | WEDNESDAY, APRIL 6, 2016

SMEs partner scientists for novel solutions

A*Star scheme allows companies to tap into R&D expertise

Marissa Lee

Dr Krishnan (second from right) explaining the system for land surveying that he helped SC Ang Consortium to develop. With him are A*Star managing director Raj Thampuran (second from left) and Mr Iswaran (centre, with red tie). They were at the annual SME Day organised by A*Star yesterday. ST PHOTO: NEO XIAOBIN

Land surveying firm SC Ang Consortium has joined forces with a senior scientist from the Agency for Science, Technology and Research (A*Star) to develop a user-friendly satellite-based technology that is helping the firm cut its reliance on unskilled labour at construction sites.

By taking references from more satellites than the typical GPS, SC Ang's GNSS (Global Navigation Satellite System) gives surveyors an accuracy of 3cm with just one receiver instead of two, even under cloudy skies. GPS has a more than 10m margin of error.

Dr Sivanand Krishnan, a positioning and localisation scientist, was seconded to SC Ang from A*Star's Institute for Infocomm Research in 2014.

Dr Krishnan said yesterday: "There's a lot of satisfaction because we get to bring the product all the way to the end user, test it in the field, get feedback from them and improve on it."

SC Ang Consortium was one of about 30 small and medium-sized enterprises (SMEs) showcasing their innovations to about 1,000 visitors, scientists and other SME bosses at the annual SME Day organised by A*Star yesterday.

Mr S. Iswaran, the Minister for Trade and Industry (Industry), told the event that more SMEs should partner with A*Star and other government agencies to embark on new innovation projects.

Noting the challenges SMEs face in today's economic climate, Mr Iswaran said: "The most robust strategy across all scenarios is really to invest in our capabilities in terms of enhancing productivity and innovation capacity so that we are ready to seize opportunities when the upturn comes, which it will."

One less-known scheme offered by A*Star is "T-Up", or Technology for Enterprise Capability Upgrading. T-Up matches SMEs to scientists with the skills they lack, and the scientists are seconded to the SME to lead research and development.

A total of 620 scientists and researchers have been seconded to 340 SMEs here since T-Up was started in 2003, with A*Star paying 70 per cent of the researchers' salaries during the secondment.

The next phase for SC Ang Consortium, said director Ang Soo Cheng, is for the surveyor to move from the one-man-operated model to a "no-man" operated technology, via remote monitoring and control.

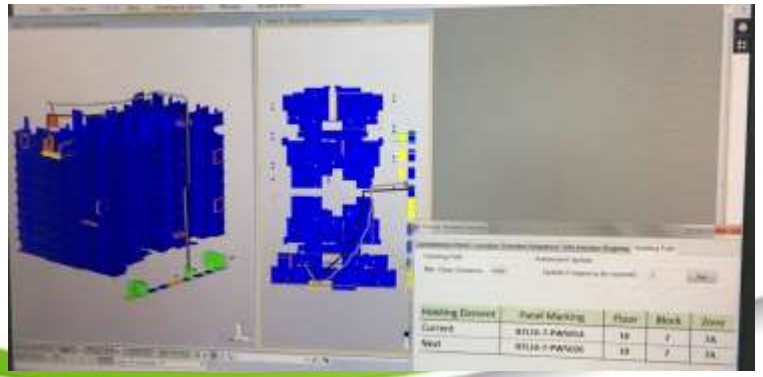
And surveying just scratches the surface of what their new tech could be used for. With more refinements, the GNSS can be used for autonomous vehicle navigation or armoured vehicle training, Mr Ang said.

marlee@sph.com.sg

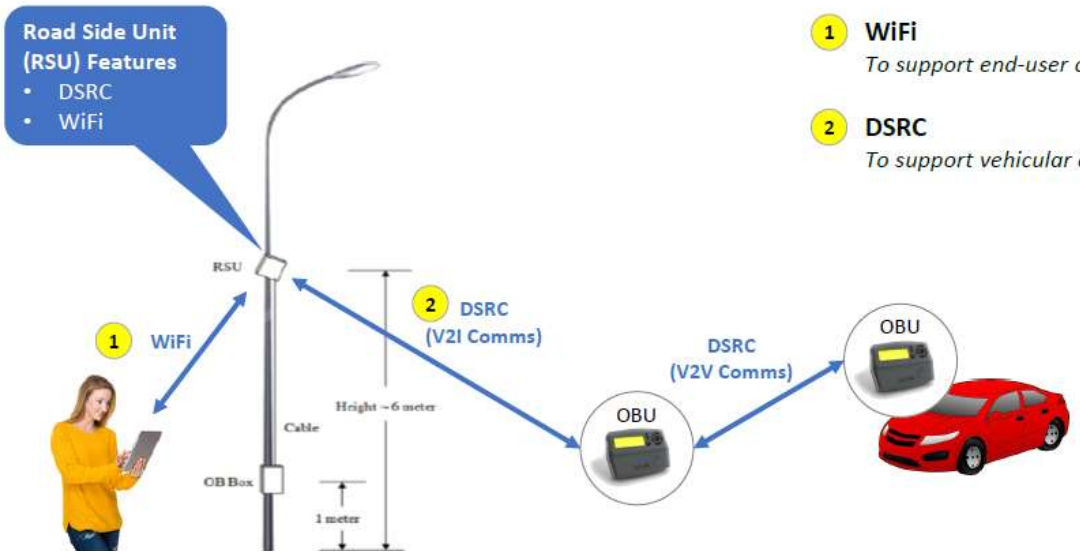
A*Star SME Day 2016

Smart Crane for Precast Building

- Development of a DGNSS-BIM guided precast element hoisting system
- Made possible by introducing the RTK technique



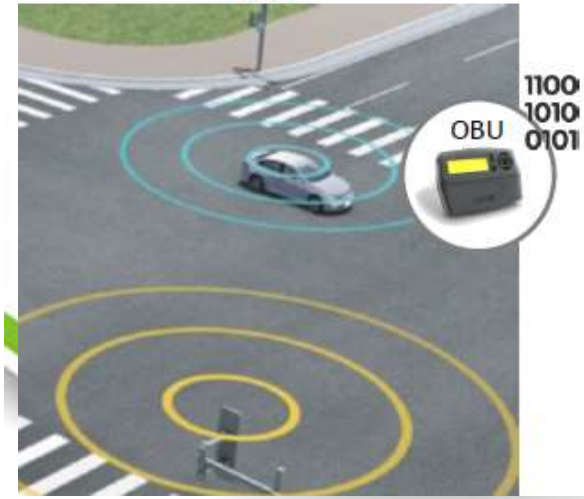
Location Positioning Pilot



1 **WiFi**
To support end-user communications

2 **DSRC**
To support vehicular communications (V2I and V2V)

RSU



1 **Driver Behaviour/Performance**
E.g. Harsh acceleration, braking, cornering, speeding

Applications

Driver Benchmarks – Training/Incentives
Driver Safety
Fleet Management
Insurance Risk Assessment
...

Unmanned Surveillance System

SiReNT RTK supports the development of Unmanned Surveillance System

Development of Driverless Vehicles

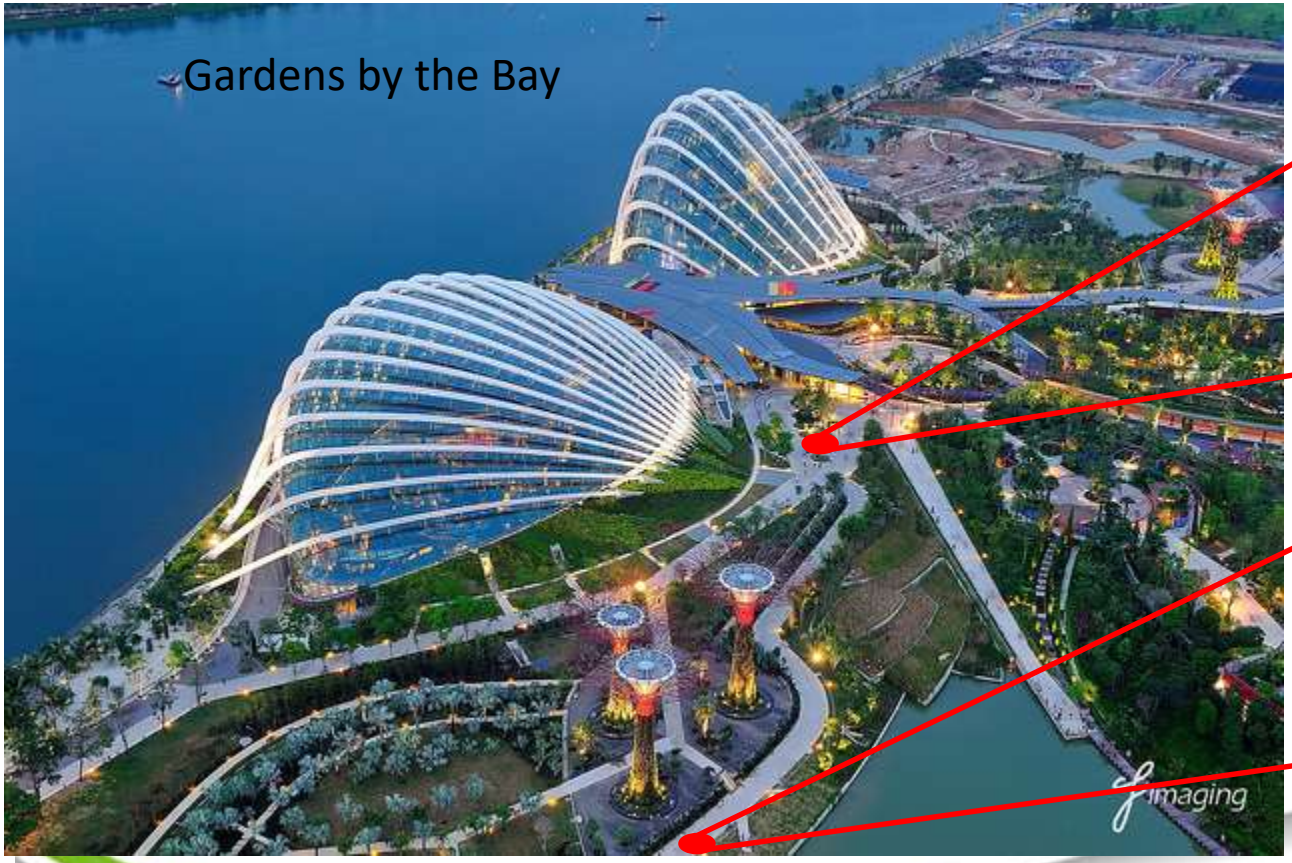
- SiReNT provides precise navigation capability for Self-Driving vehicle implementations in Gardens-by-the-Bay and LTA's Driverless Vehicle trials in One-North.

Gardens By The Bay – Auto Riders

Delphi - Audi SQ5 prototype

A*Star – iiRAV Autonomous Vehicle

Driverless Vehicles in Garden by the Bay



Autonomous vehicle 1

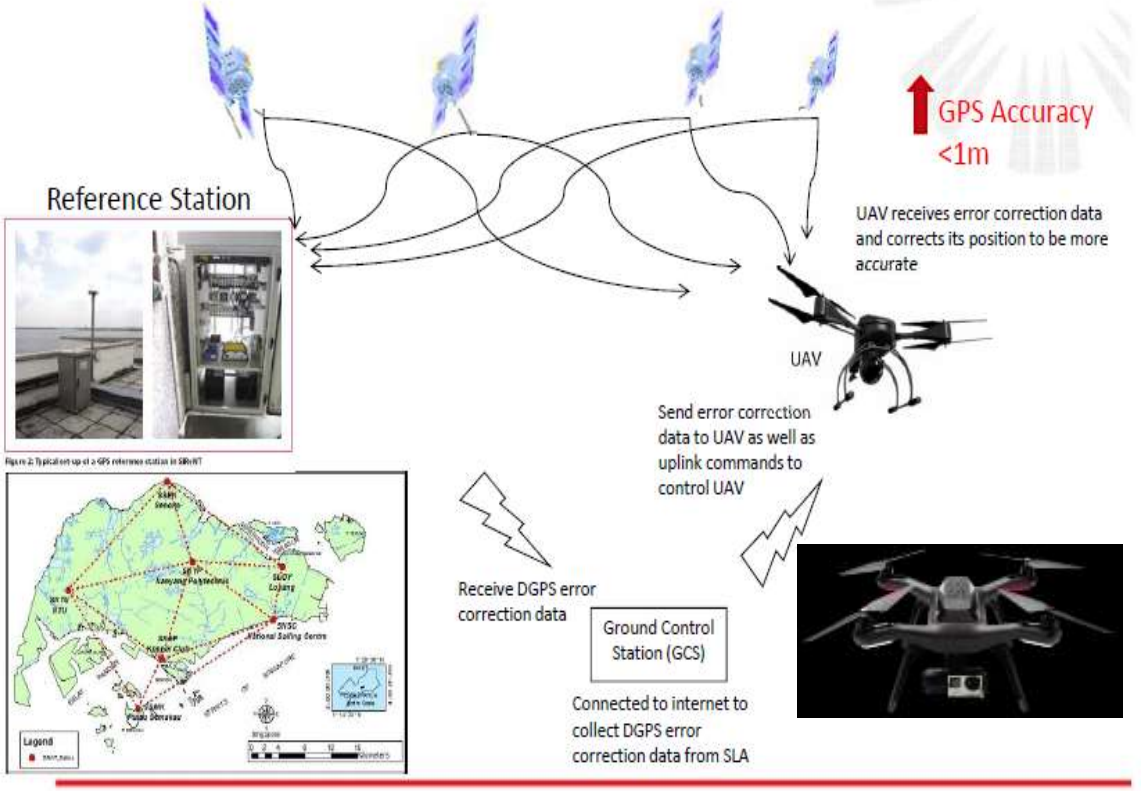
Autonomous vehicle 2

- Requires accurate navigation and real-time localization (up to 0.2-0.5m accuracy).

Drones Navigation (POC projects)

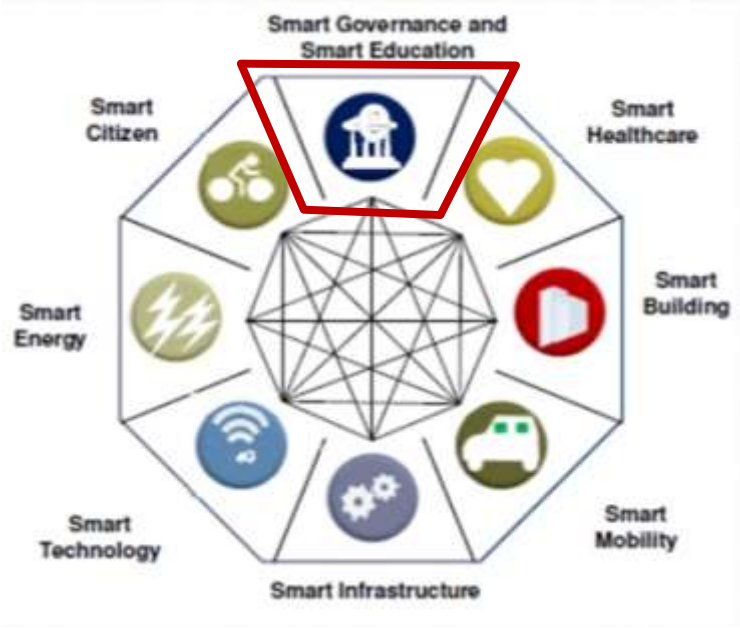
- Real-time autonomous navigation
- Post processing of flight path
- Post processing of data acquired from flight

ST Engineering ST Aerospace H³ Dynamics



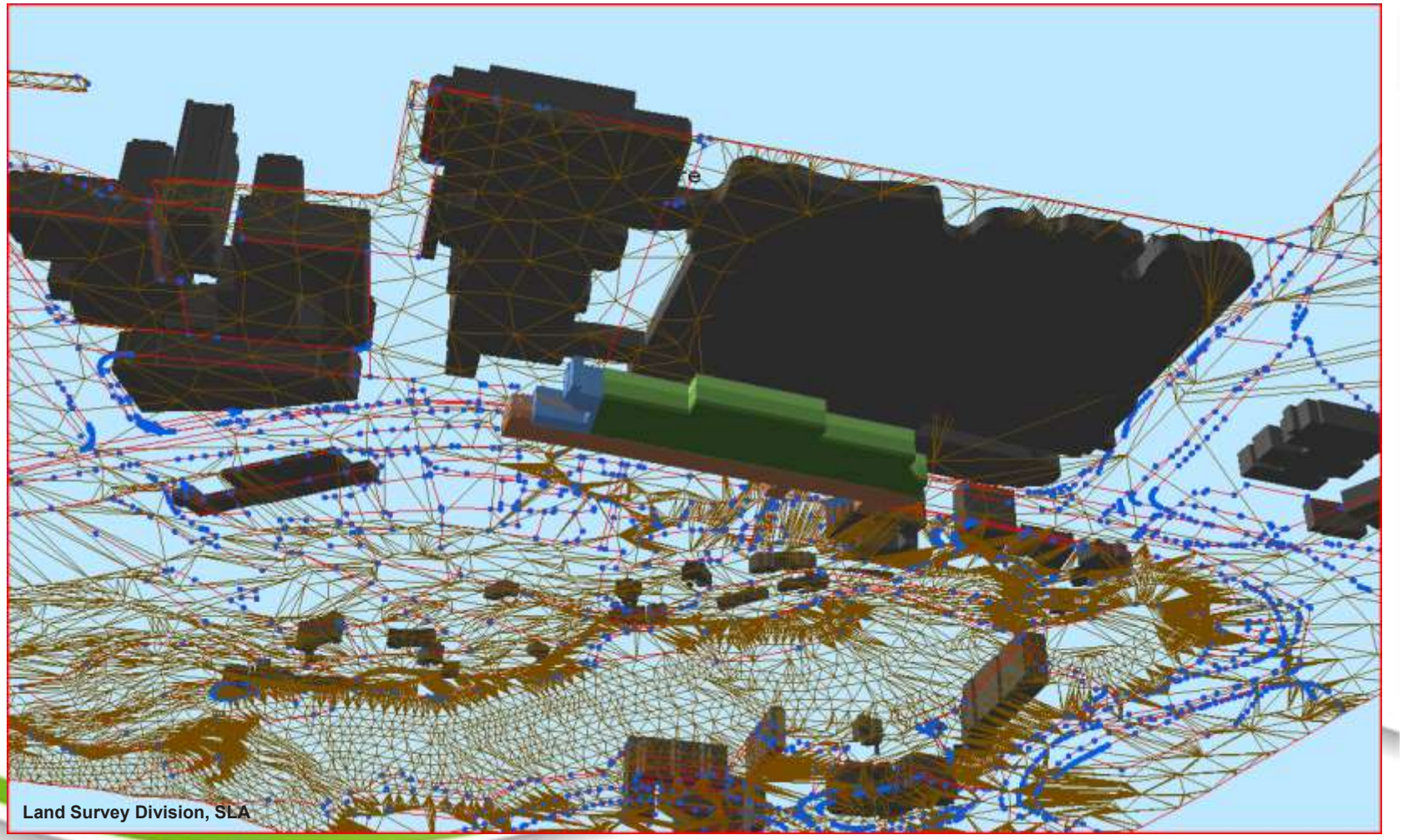
Smart Cadastre System

- What is Smart Cadastre?
  - Fully Digital Data Management
  - Automated and Intelligent Processing
  - Adopt Open Source Standard
  - Expanded into 3D and 4D
  - Data Analytics

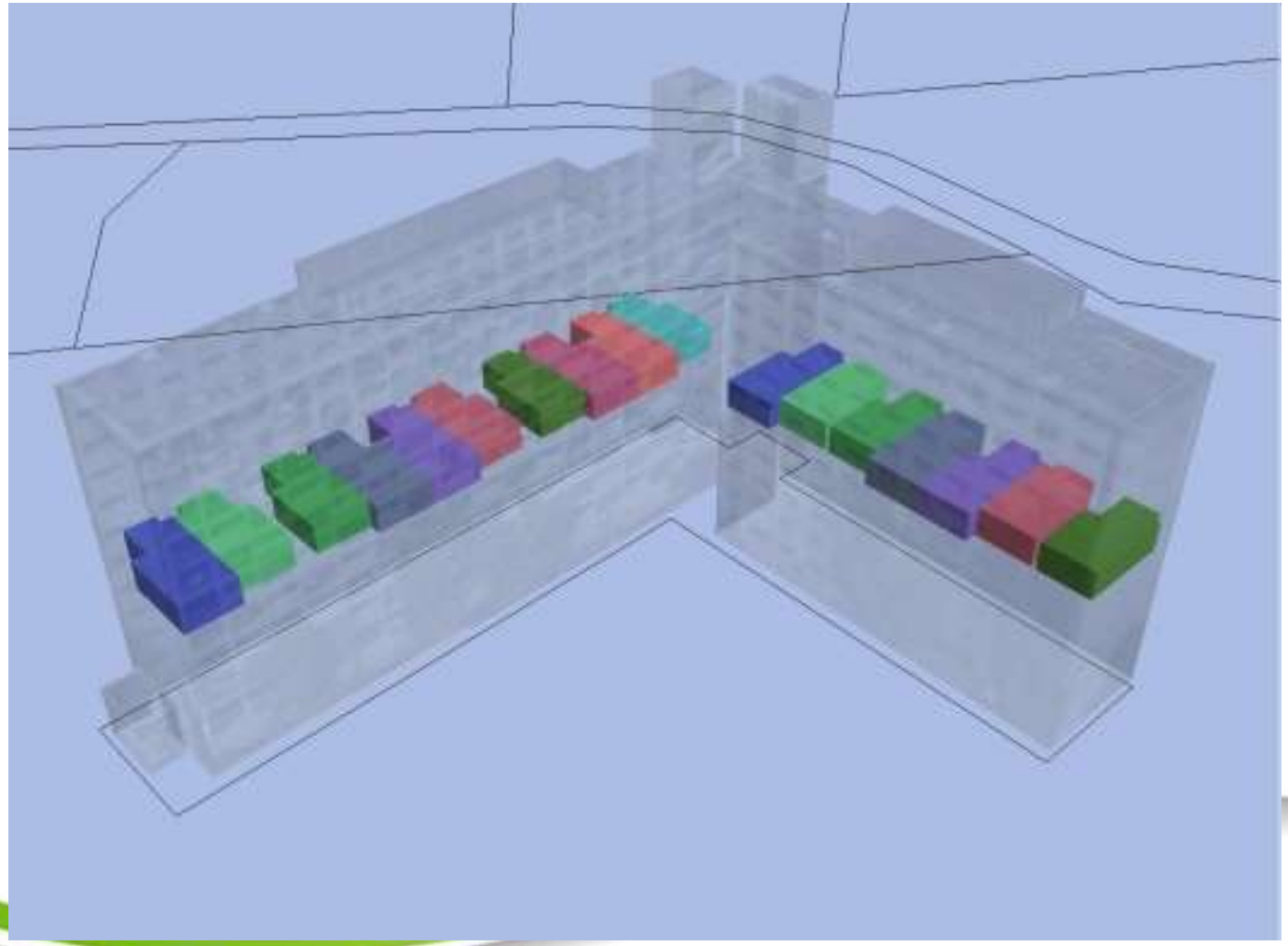


- Key Components
  - Smart Data Model
  - Standard (LandXML)
  - IT system - CSMS

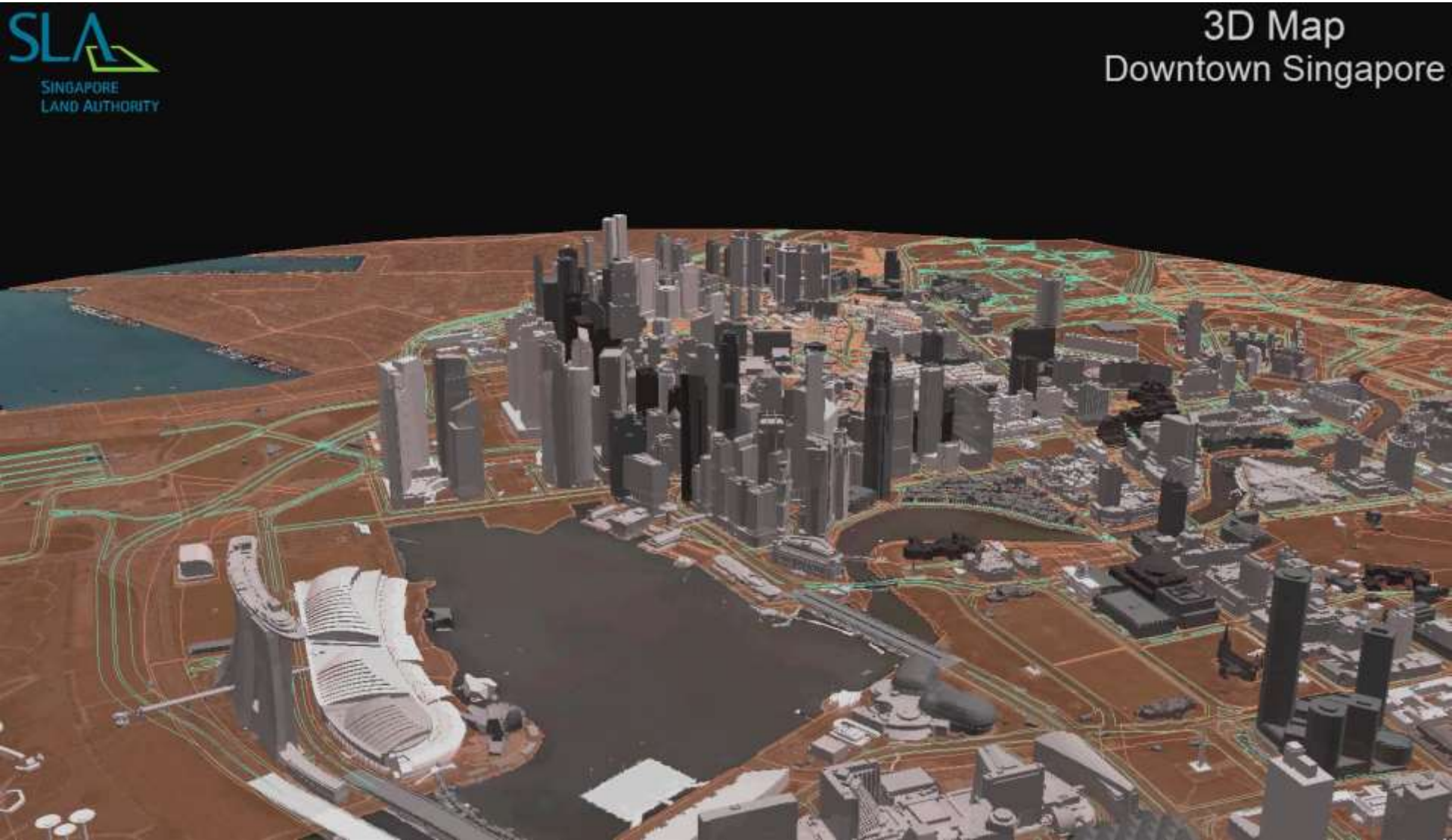
3D Cadastre – Subterranean



3D Cadastre – Building Subdivision



3D Mapping for City Models



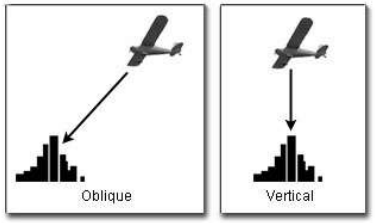
3D National Mapping

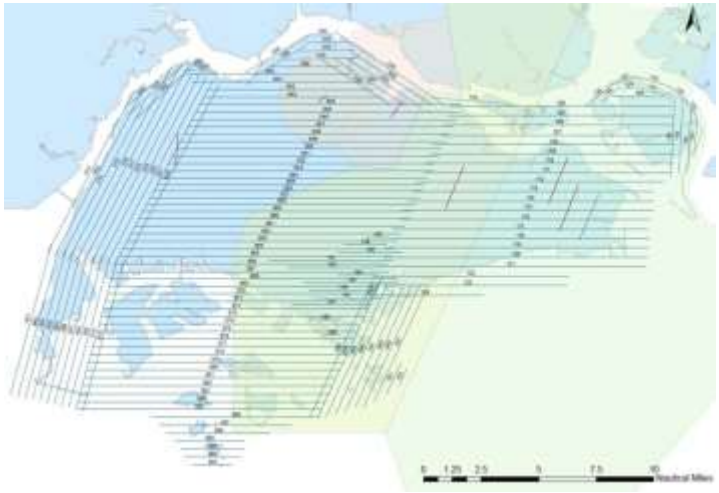
Partners

Phase 1

Airborne Laser Scanning and Imaging

(completed: 2015)

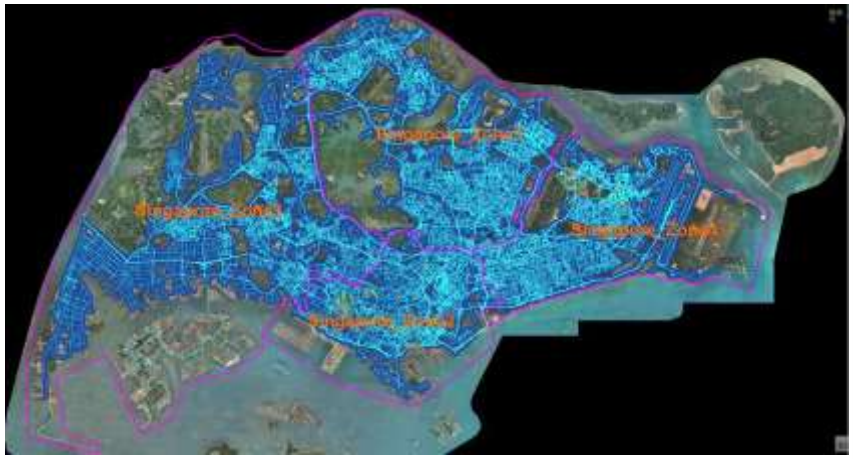




Phase 2

Mobile Laser Scanning and Imaging

(completed: 2017)



2014 2015 2016 2017

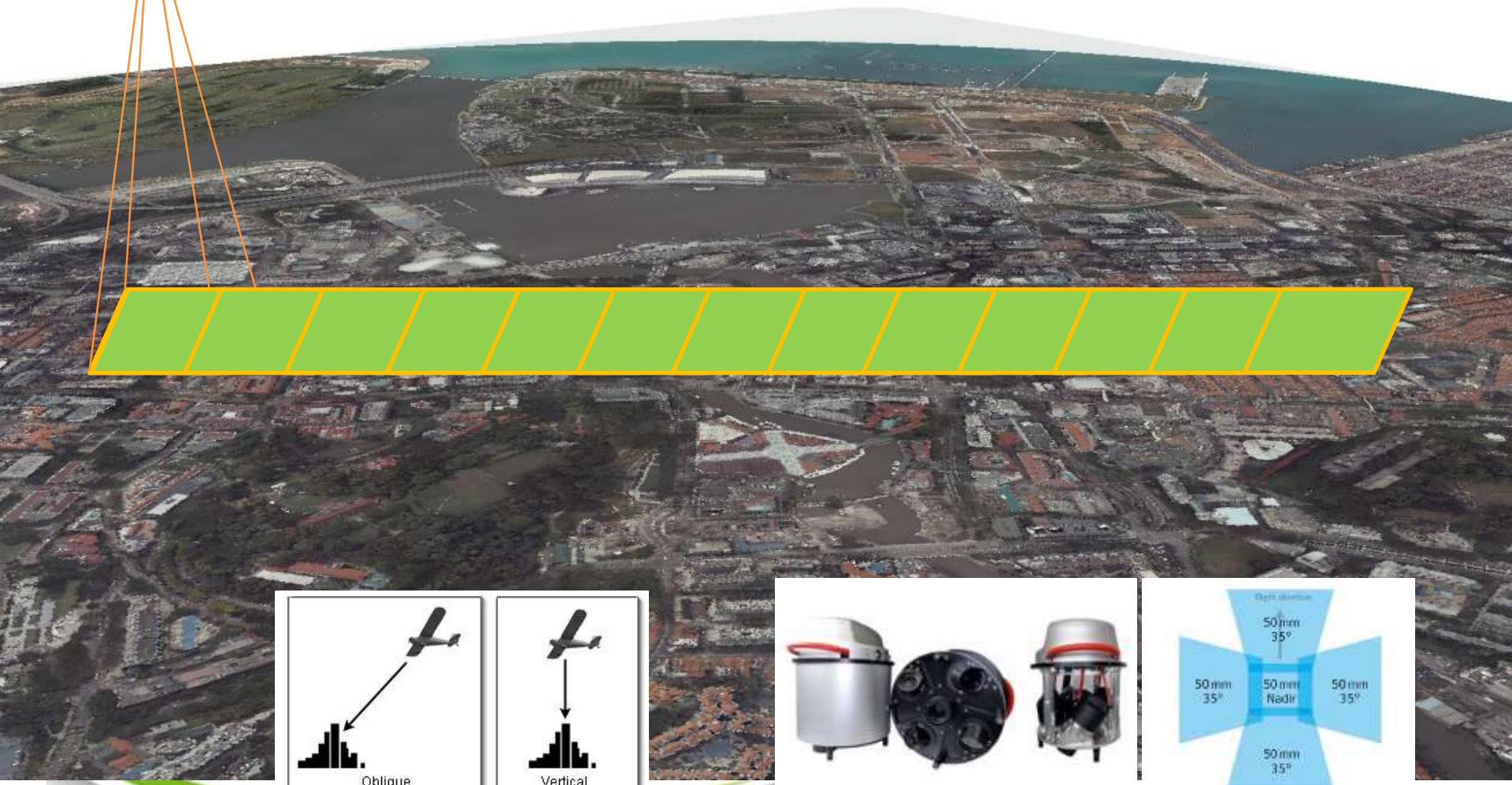
Phase 1

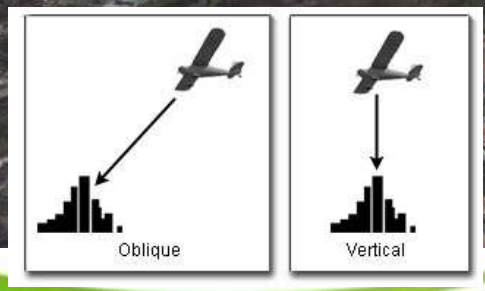
Phase 2

Aerial Laser Scanning

Optech Pegasus ALTM

Aerial Photogrammetry Technique





Leica RCD 30 Oblique Camera

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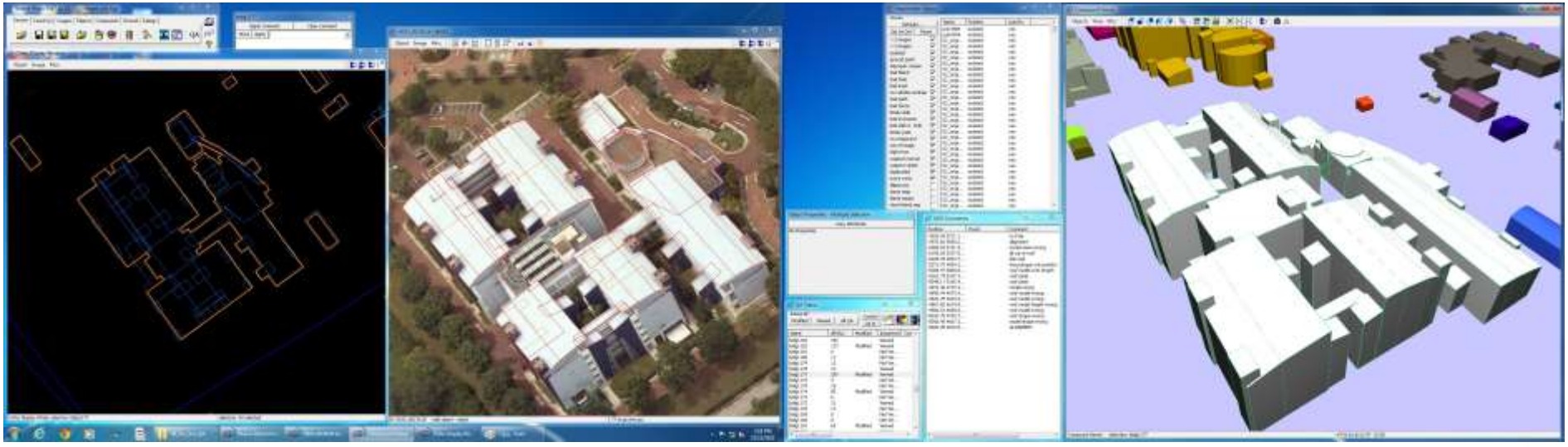
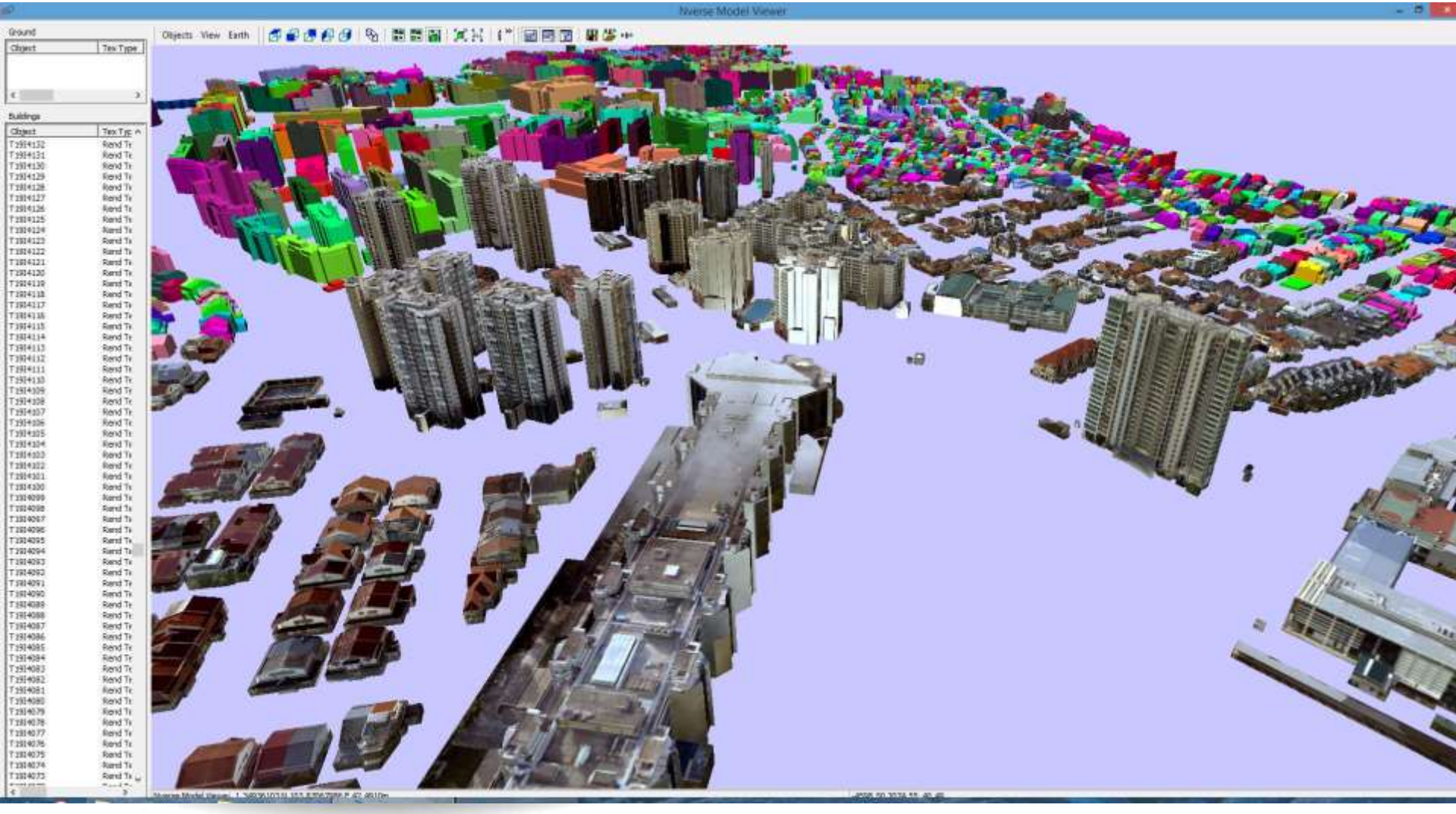
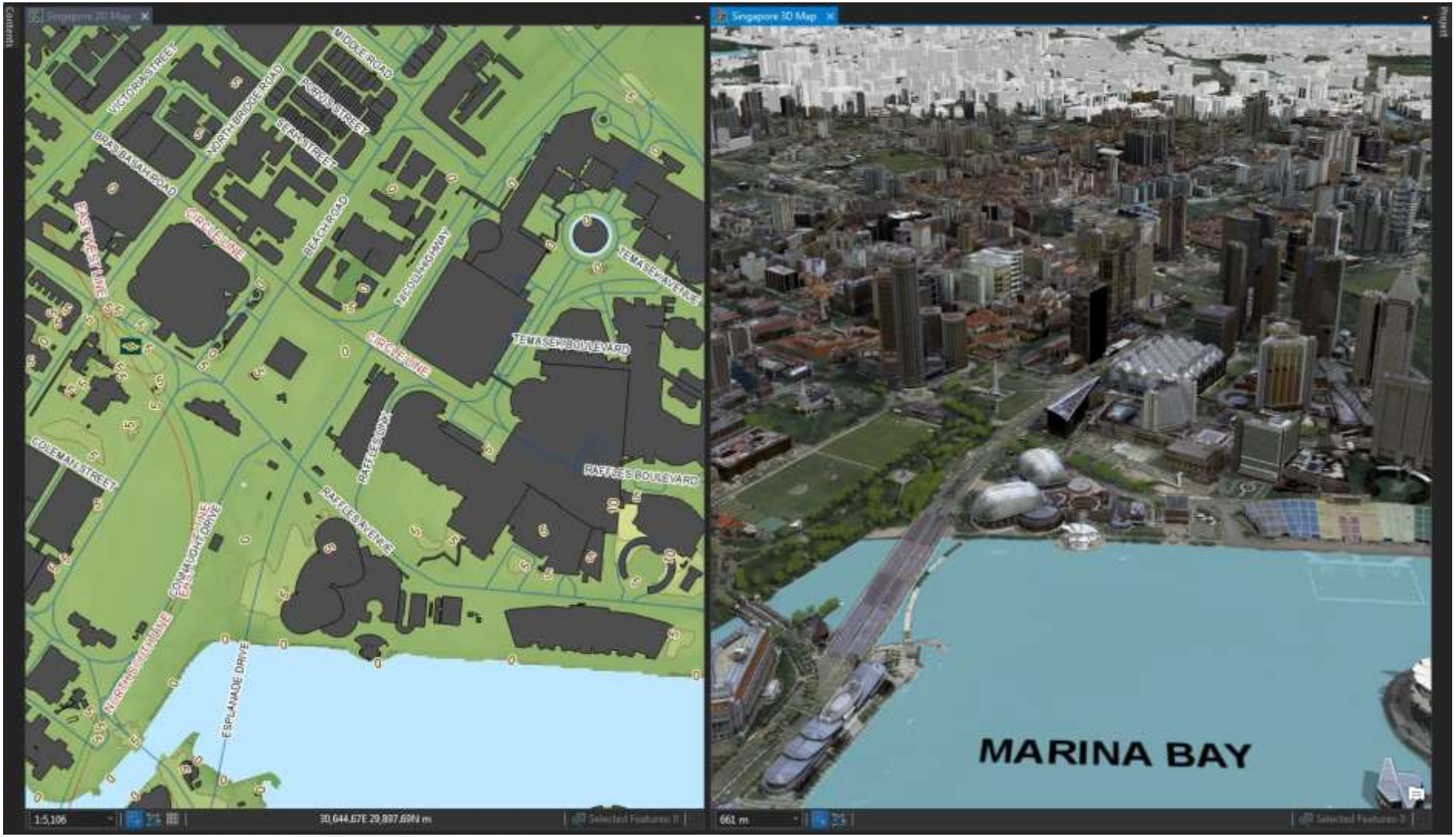
Building Modelling using Imagery



3D Building Models



2D – 3D Photo-Realistic Map



Aerial Vertical and Oblique Images

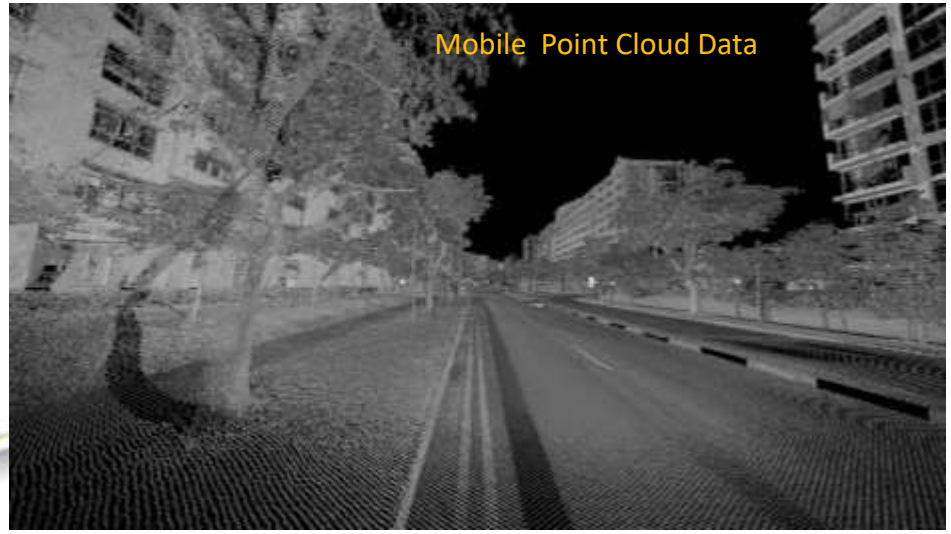
Working with Partners and Agencies

- Partners
  - PUB – terrain model for flood management
  - CAAS – building height information for flight safety
- Internal SLA
  - Identify Priority Area for Tree Maintenance in State Land
  - Identify illegal dumping and unauthorised uses of state land
- Other Agencies
  - Environmental
  - Energy
  - Transport

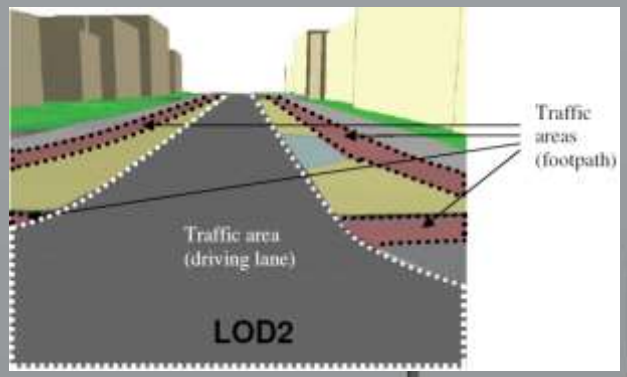
Mobile Mapping System

Mobile Laser Scanner – Riegl VMX-450

360 Spherical Camera - Ladybug 5



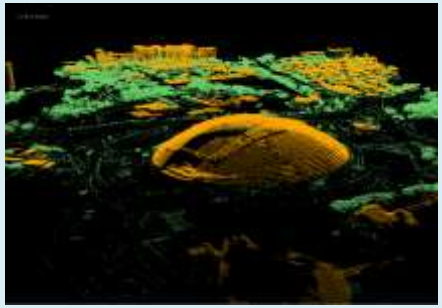
3D Modelling using Point Cloud data



Benefits for Agencies

3D Data

Airborne Laser Scanning Data



Airborne Vertical / Oblique Images

Mobile Laser Scanning Data

360 Camera Imagery

3D Products

Digital Terrain Model & Digital Surface Model

Photo Map

3D Building Models and Building Height Information

Road Surface and 3D Road Models

Applications

Flood Risk Map

PUB

Underground Master Plan

Urban Redevelopment Authority

National Geological Map

Building and Construction Authority

Slope Risk Analysis Map

SLA Singapore Land Authority

Coastal Protection Map

Building and Construction Authority

Planning

Housing & Development Board

jtc

Virtual Singapore

National Research Foundation Prime Minister's Office Singapore

SLA Singapore Land Authority

iDA Singapore

Flight Safety Planning

CAAS

Urban Heat Island Study

Urban Redevelopment Authority

SolarNova Project

EDB Singapore

SERIS

3D Cadastre

SLA Singapore Land Authority

Tree Mapping

National Parks

Driverless Vehicle Development

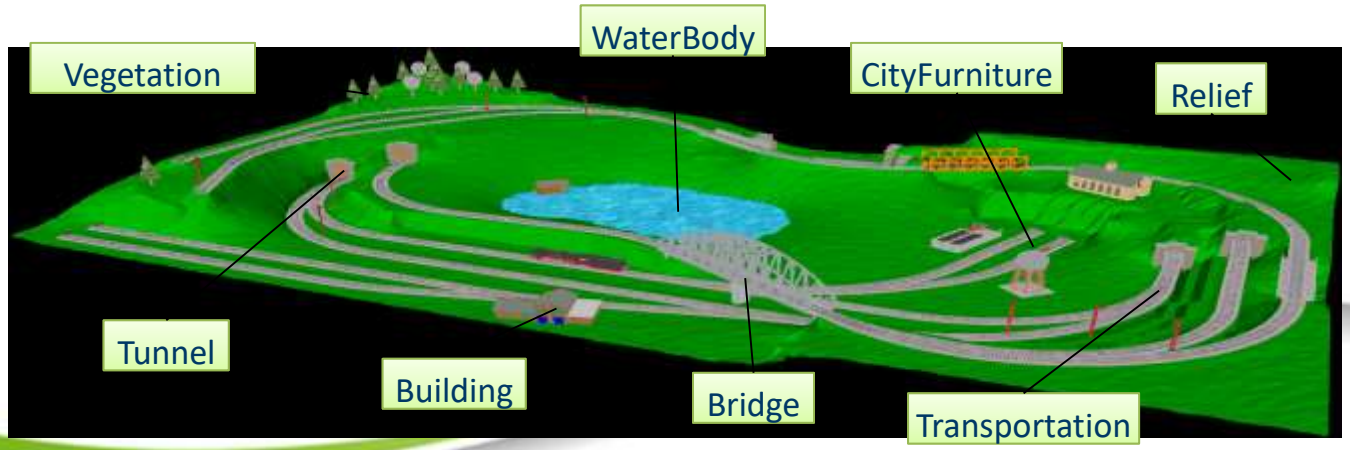
Ministry of Transport

Land Transport Authority

Heritage Preservation using Terrestrial Laser Scanners

Interoperability

- Adopt standards
- Sharing
  - capture once, use by many
  - Spatial data infrastructure



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Integrated Above and Underground 3D Map

Singapore BIM Roadmap

THE BIM ISSUE

BCA's BIM initiatives will make it easier for build environment businesses and professionals to harness the computer-aided building-modelling tool in their operations and work

Building Information Modelling (BIM) is an advanced computer technology that allows building performance to be simulated digitally so that design conflicts can be collectively resolved upfront to avoid costly abortive work at the construction stage.

It is widely accepted as an essential tool for built environment professionals to improve their productivity from the design to the downstream construction stages.

The Roadmap comprises strategies and initiatives to facilitate businesses and professionals' transition from conventional 2D building plans to 3D models.

Expediting BIM Adoption Industry-Wide

BIM has been proven to save costs and time. It also improves the efficiency of manpower resources for businesses. However, BCA understands the challenges that businesses face in considering the use of a new technology in their

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BIM Models as a Source for City Model (3D GIS)

3D Convergence - Ubiquitous Cadastre


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Thank You