

Application of Laser Scanning in Singapore

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14th South East Asia Survey Congress (SEASC)

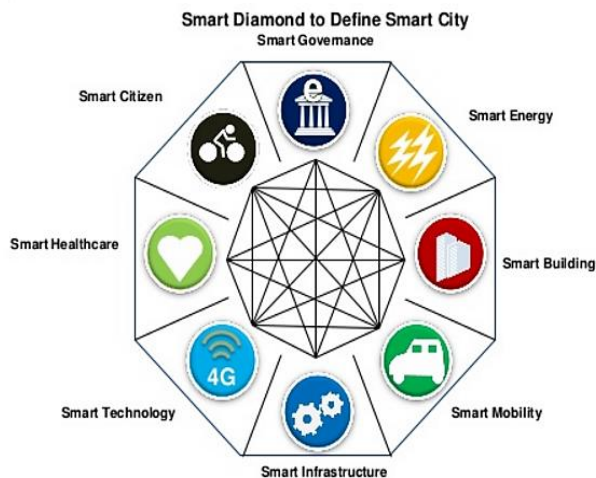


LiDAR Development

- 60s and 70s - First laser remote sensing instruments (lunar laser ranging, satellite laser ranging, oceanographic and atmospheric research)
- 80s - First laser altimetry systems (NASA Atmospheric and Oceanographic Lidar (AOL) and Airborne Topographic Mapper (ATM))
- 1995 - First commercial airborne Lidar systems developed.
- 90s- Significant development of commercial and non-commercial systems

- 1994 - SHOALS (US Army Corps of Engineers)
- 1996 - Mars Orbiter Laser Altimeter (NASA MOLA-2)
- 1997 - Shuttle Laser Altimeter (NASA SLA)
- Early 2000s - North Carolina achieves statewide Lidar coverage
- 2016 – Lightest sensor 590 grams





Source: Frost & Sullivan

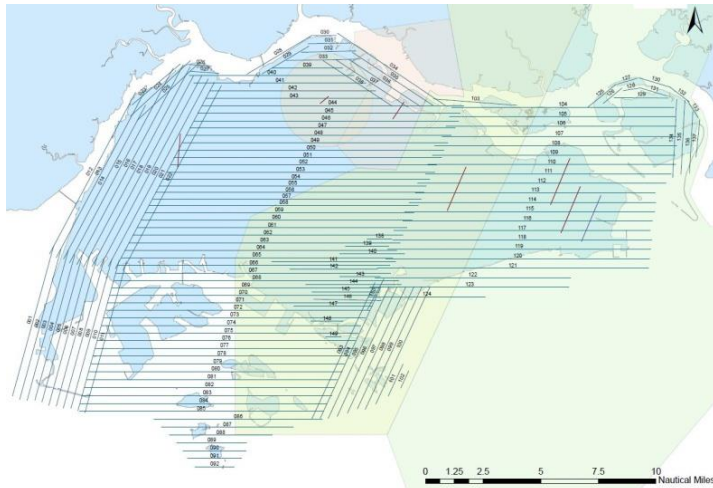
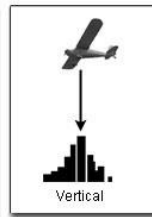
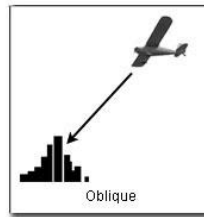
- Singapore is building the World's first Smart Nation by harnessing technology and gathering insights from data to the fullest with the aim of
 - improving the lives of citizens,
 - creating more opportunities, and
 - building stronger communities.

Measurement + Prediction = Performance

National 3D Mapping

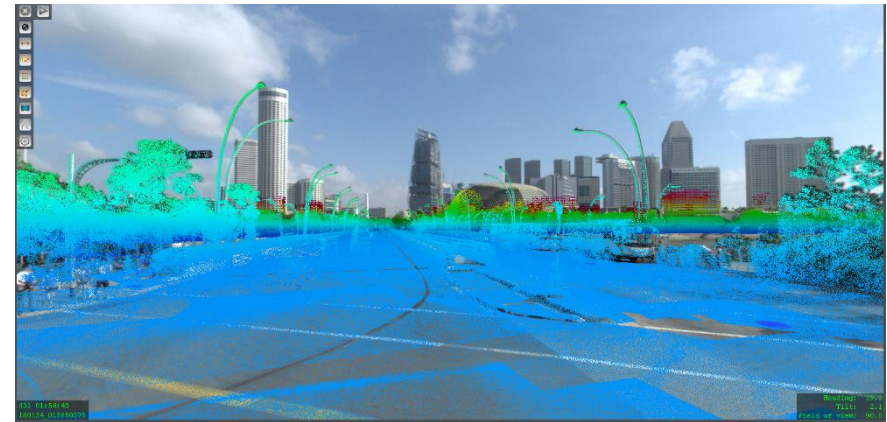
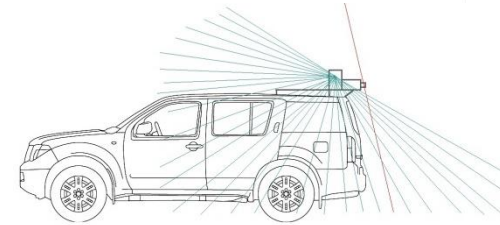
Phase 1

Airborne Laser Scanning and Imaging



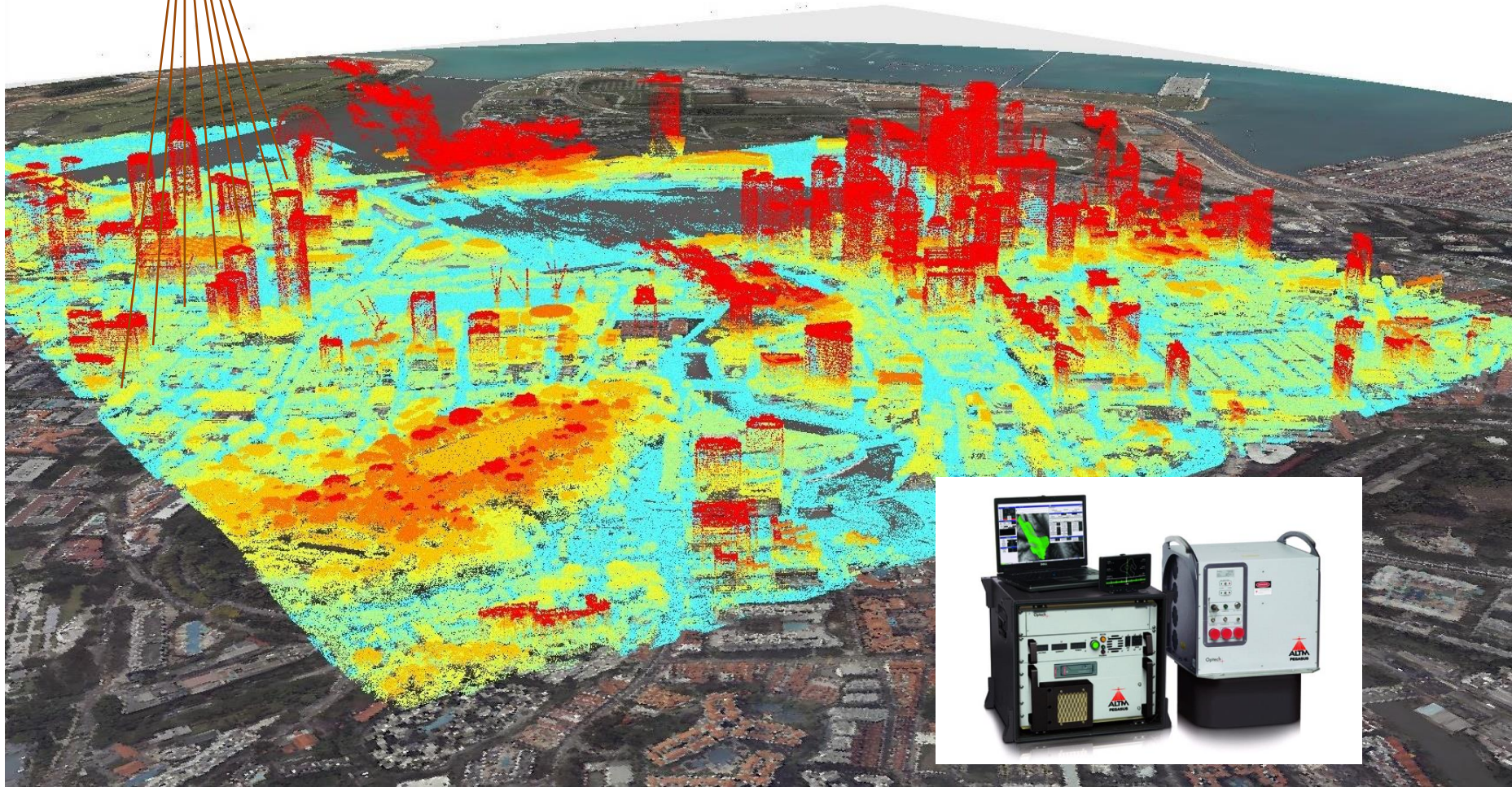
Phase 2

Mobile Laser Scanning and Imaging



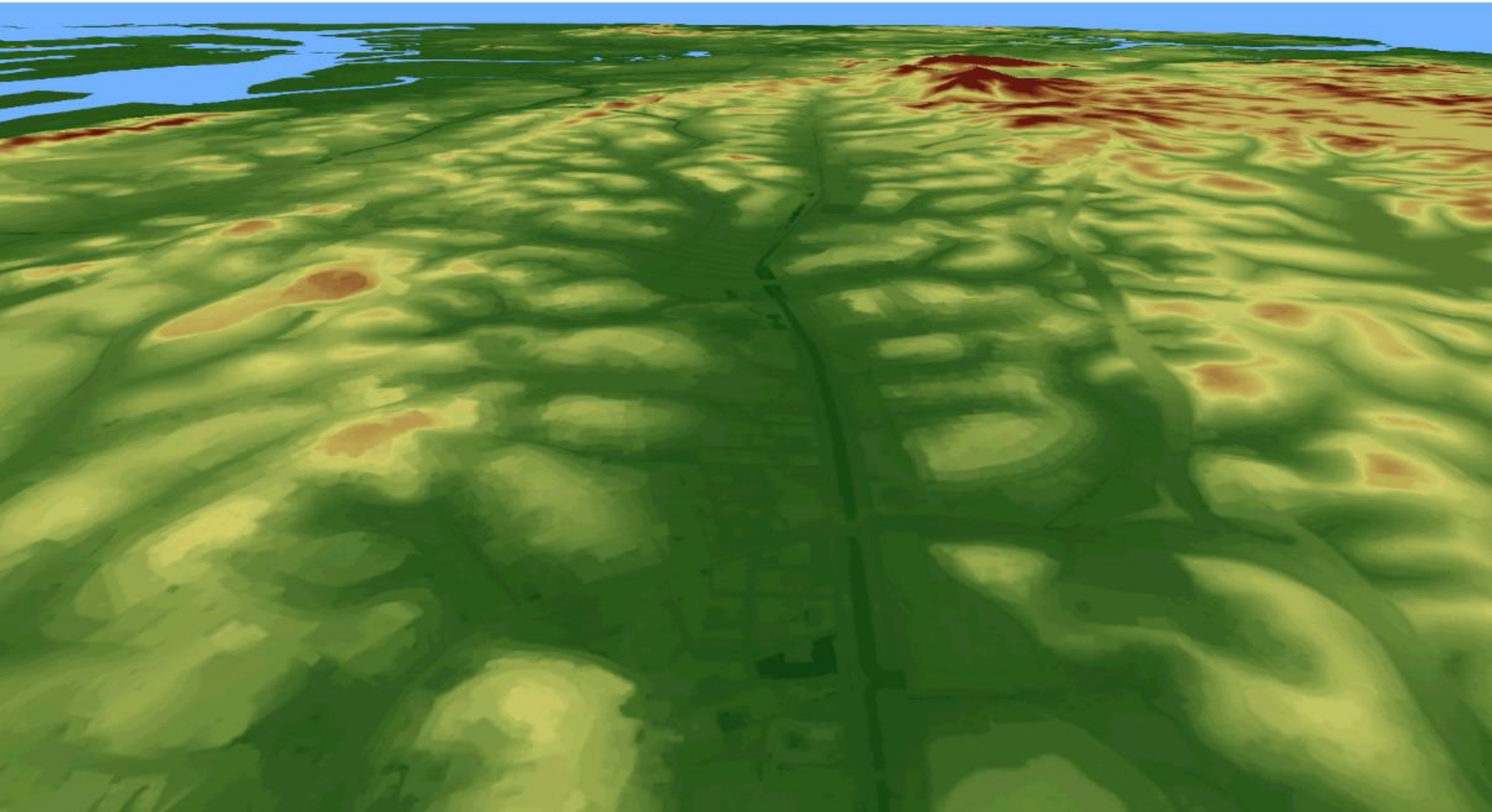


Airborne Laser Scanning

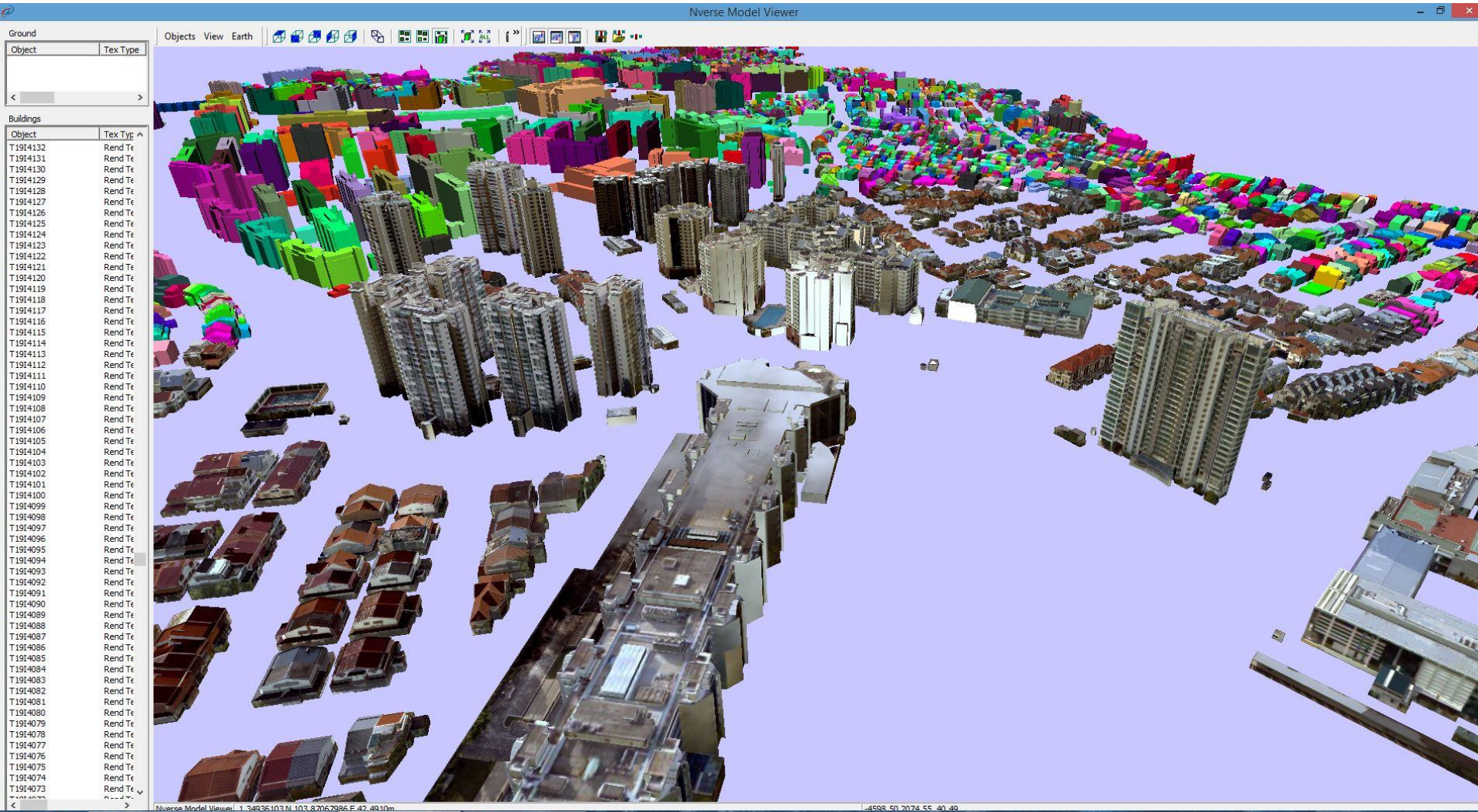


Optech Pegasus ALTM

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



3D Building



Mobile Mapping



360 Spherical Camera -
Ladybug 5



Mobile Laser Scanner – Riegl
VMX-450



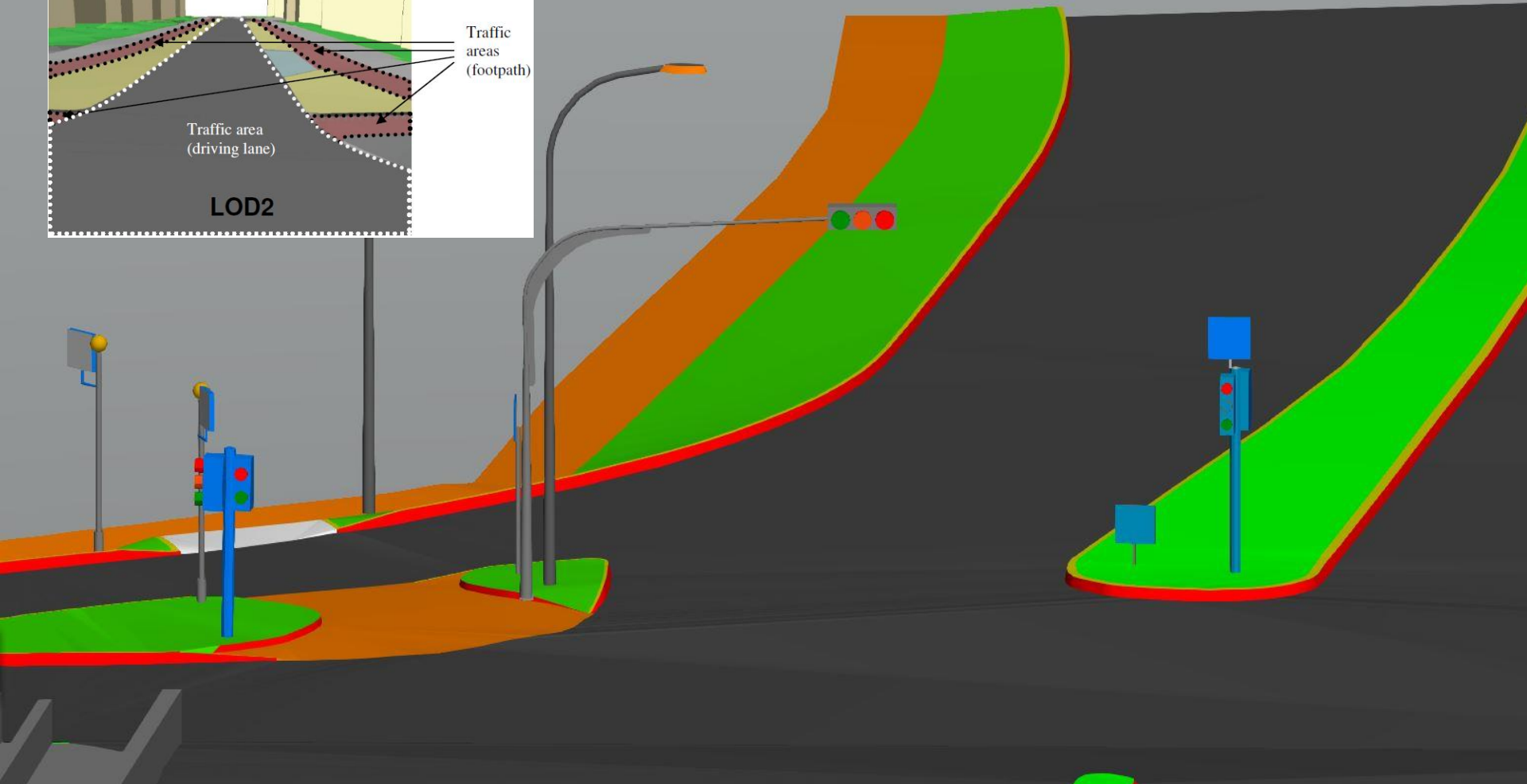
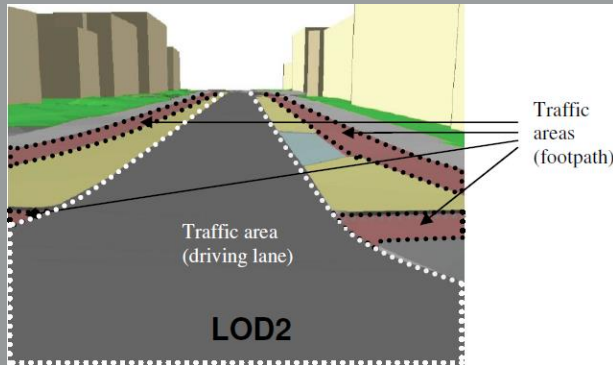
GNSS Receiver



DMI – Distance Measuring
Instrument

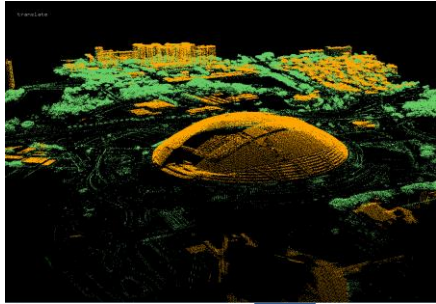


3D Transportation & Street Furniture

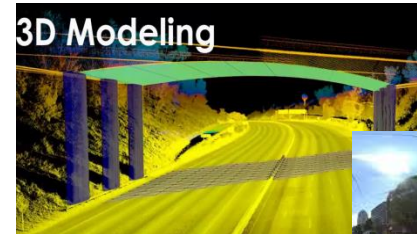


3D Data

Airborne Laser Scanning Data



Airborne Vertical / Oblique Images

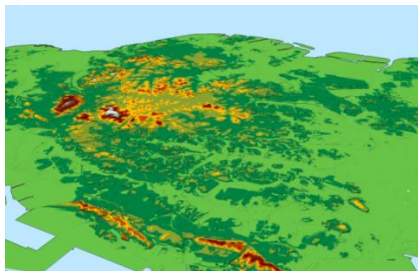


Mobile Laser Scanning Data

360 Camera Imagery



3D Products



Digital Terrain Model &
Digital Surface Model



Photo Map



3D Building Models



3D Road Models

VIRTUAL SINGAPORE

Creating an intelligent 3D model to improve experiences of residents, business and government



Powered by sophisticated analysis of images and data collected from public agencies and real-time sensors, Virtual Singapore is designed to give a whole new meaning to the term “smart city.” By giving the city-state’s citizens, businesses, government agencies and research community dynamic 3D visualizations of wildly diverse scenarios, it can be used to plan everything from emergency evacuations to a perfect night on the town.

Singapore is a small country with a giant plan. In one of the world’s most ambitious information technology experiments, the city-state is building a system that will virtualize the buildings, infrastructures, green spaces and almost every aspect of life in Singapore and then display the results as an interactive, 3D replica.

The project, called Virtual Singapore, is led by the National Research Foundation Singapore together with the Singapore Land Authority (SLA) and Infocomm Development Authority of Singapore (IDA), and is expected to be progressively developed, with completion in 2018. Although many cities are working to assemble and analyze their data in hopes of improving city life, Virtual Singapore is unusual because it will allow all users to visualize in 3D how the city will develop and evolve with time in response to population growth, new construction and other major events.

• *by William J. Holstein*

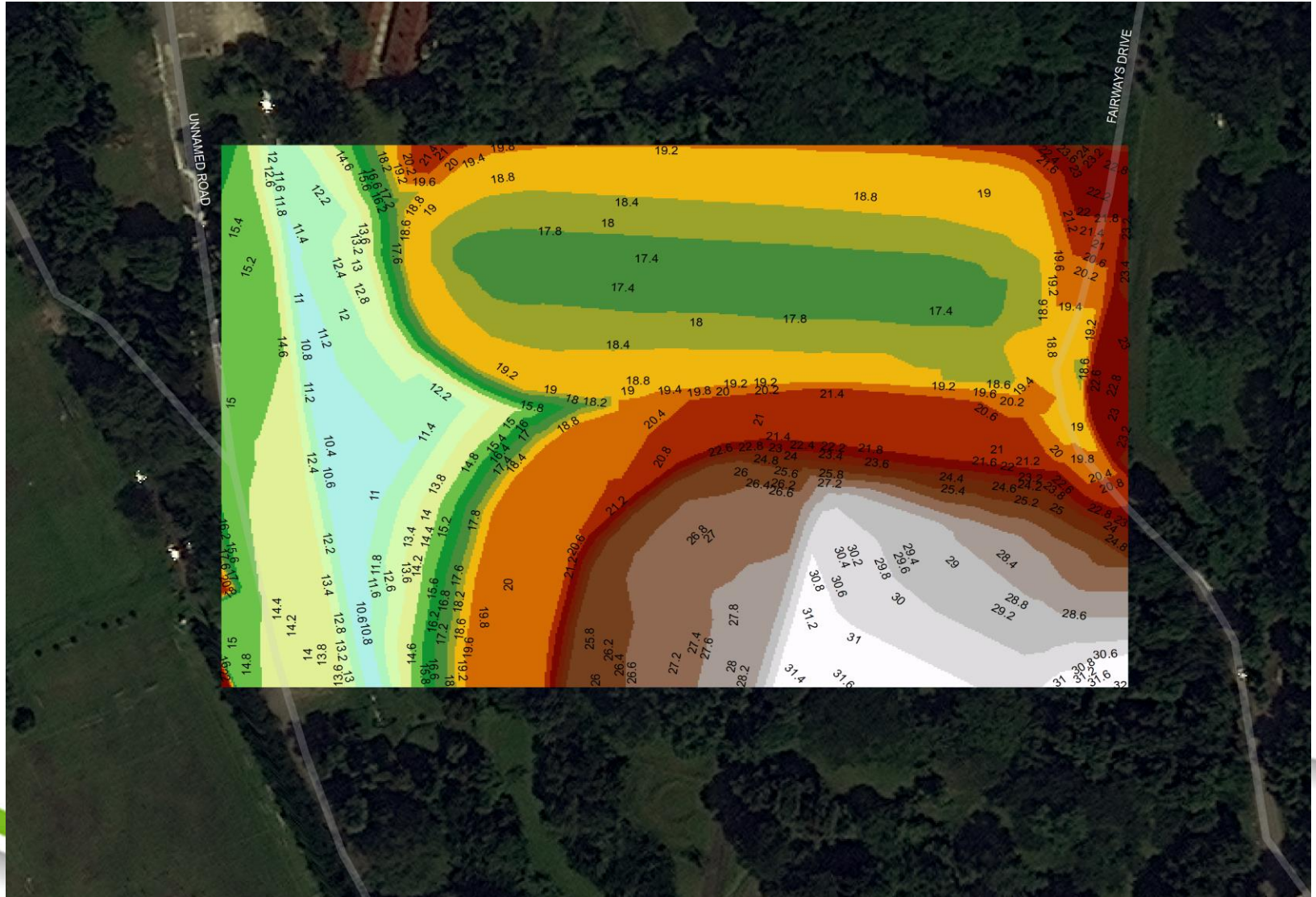
SUMMARY

- ➔ ACCESS FOR ALL
- ➔ THE POWER OF ‘WHAT IF?’
- ➔ A SMARTER CITY, A BETTER CITY
- ➔ BY THE PEOPLE, FOR THE PEOPLE

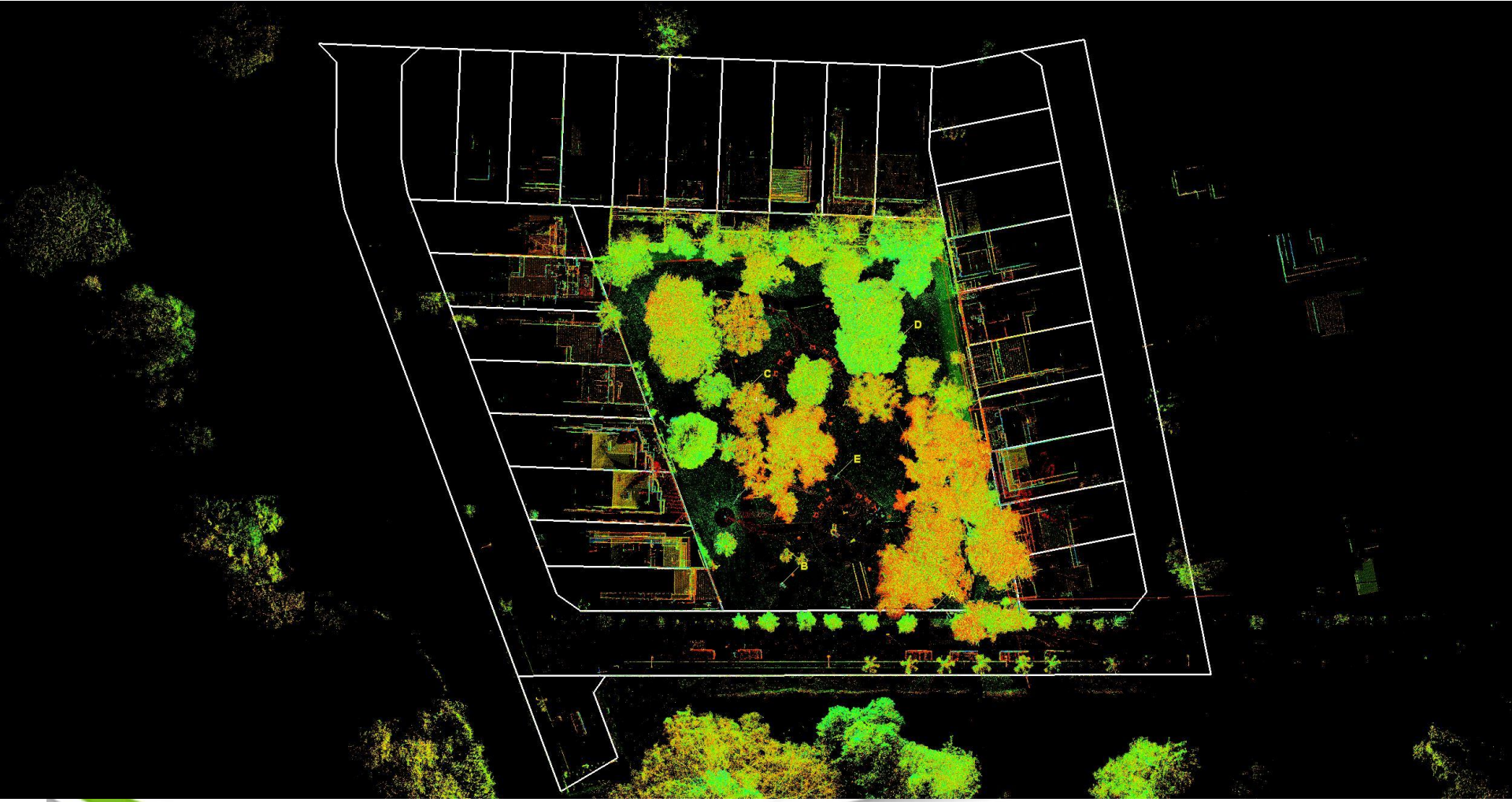
OTHER INFORMATION

Experience Virtual Singapore:
<https://youtu.be/9byat0VhqFk>

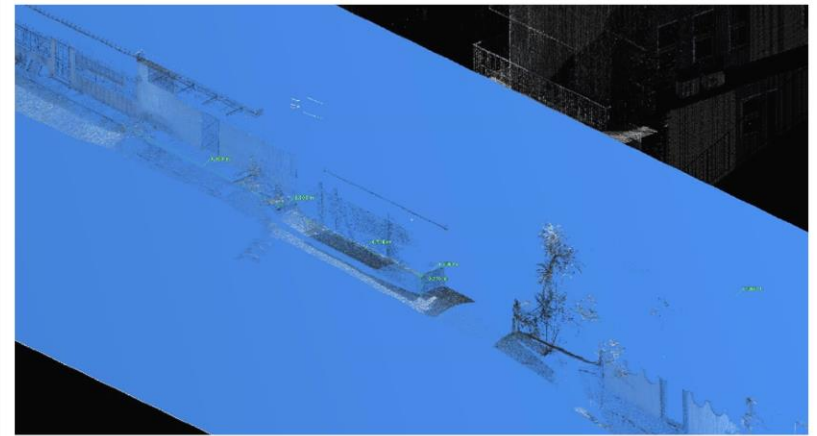
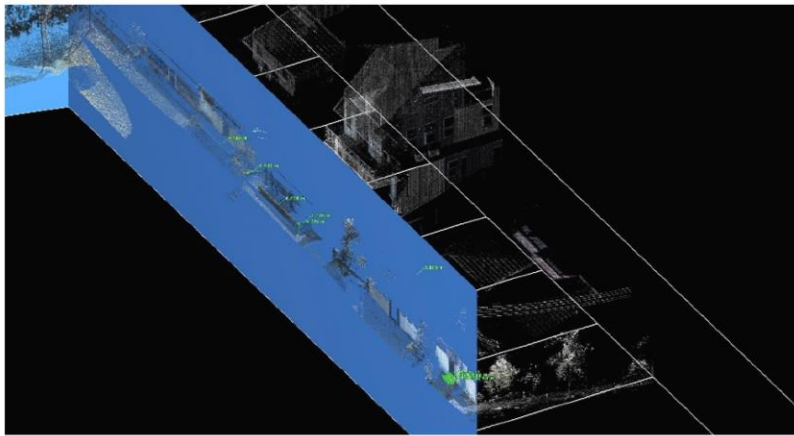
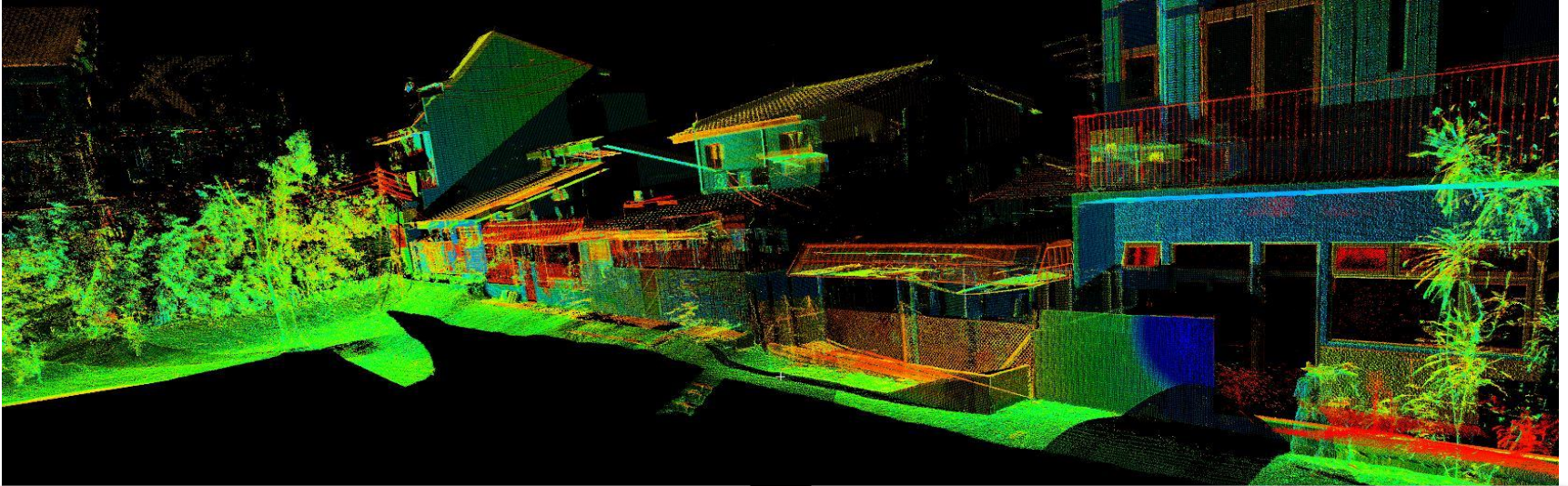
Land Management



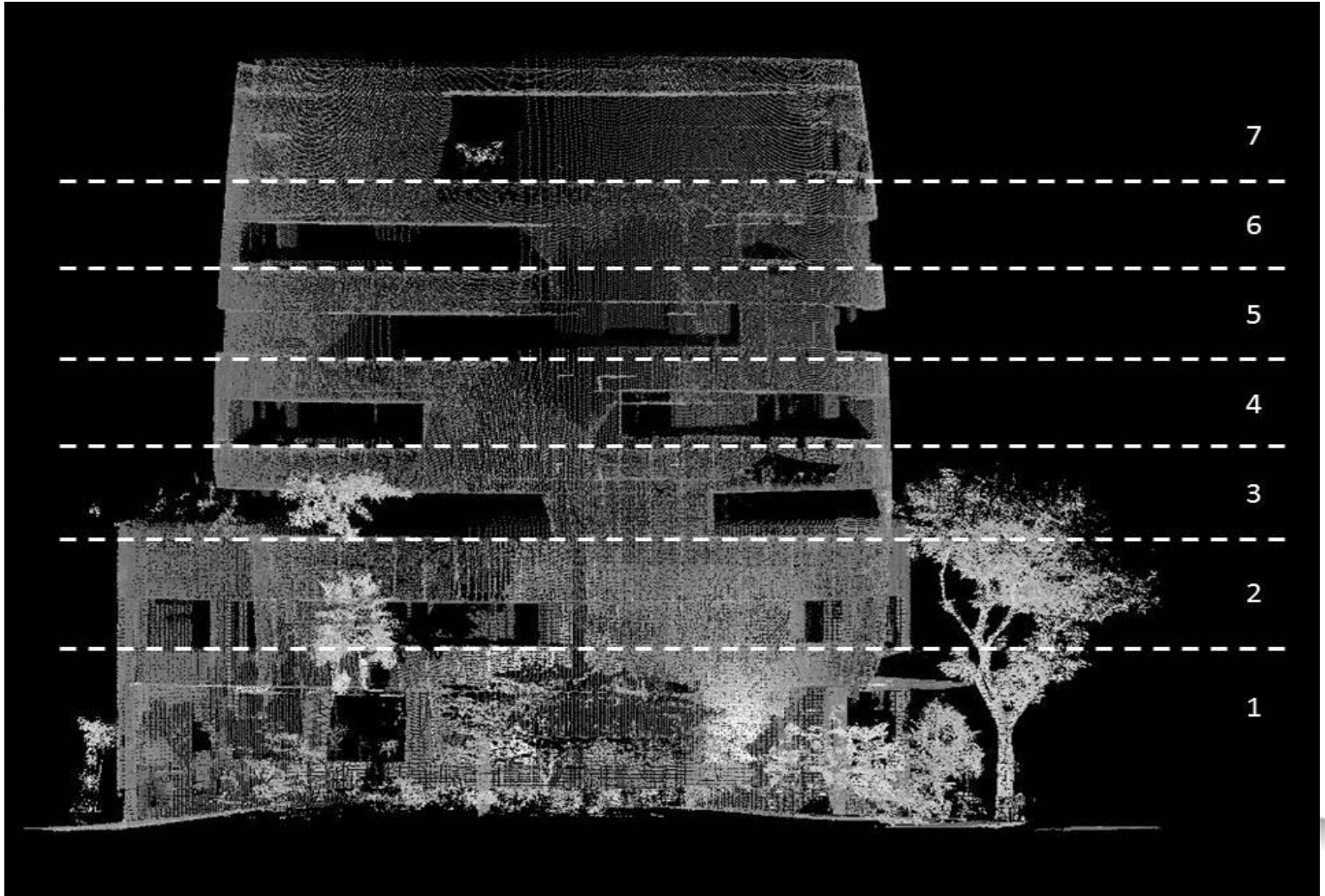
Land Management



Determine Encroachment



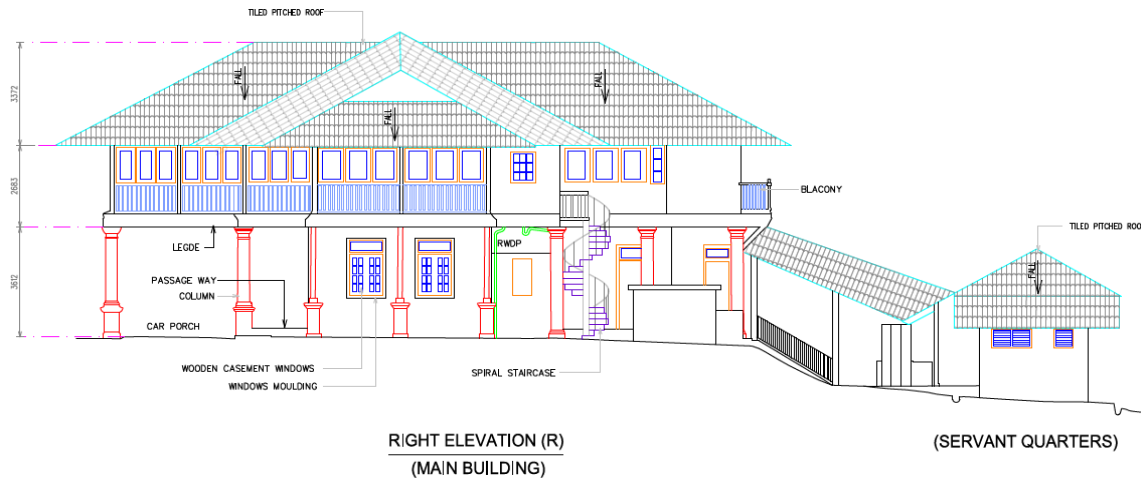
Determine Encroachment



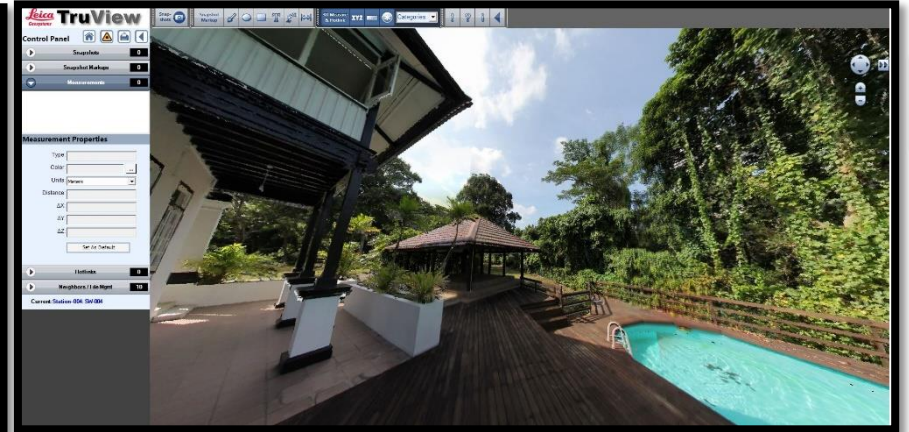
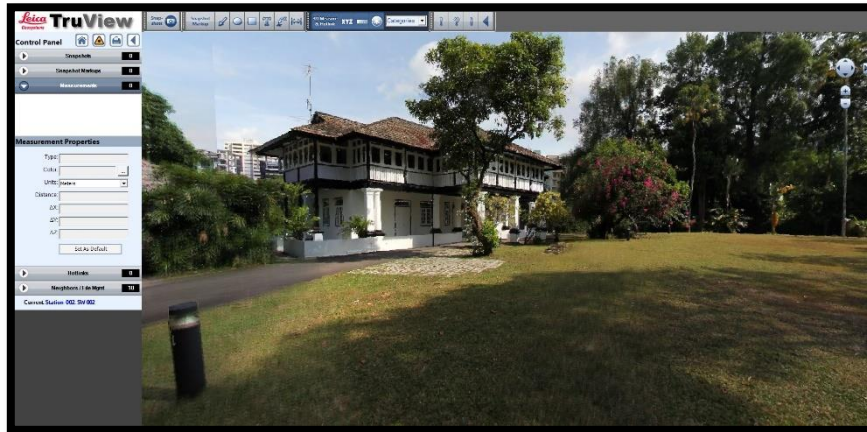
Property Management



- Preservation
- Plans generation
- Restoration
- Change detection
- Virtual tour



Online Communication



Real-time 3D applications

Academia, industry and government agencies across Singapore are starting to combine three-dimensional indoor maps, physical sensors and powerful data analytics to take Singapore into the future.

3D INDOOR MAPPING



- A laser scanner is set up at various locations in a building. It emits a moving laser which makes an automatic 360-degree scan of an indoor space, taking measurements of many points in quick succession.
- At each point, the distance of the object is calculated based on the time taken for the laser to travel to it and be reflected back. The result is a "point cloud" data set that can be turned into a 3D indoor map using computer software.
- A camera mounted on the scanner takes photographs at the same time. Computers can be "trained" to automatically identify objects in the photographs and append the information to the 3D map.

Scans up to

**1 million
points**

a second

Ranges up to

120m

Resolution about

1cm

About

30

measuring stations
for a vacant two-
storey bungalow

CALCULATING A PERSON'S POSITION USING SIGNALS FROM MULTIPLE RADIO TRANSMITTERS



Indoor positioning

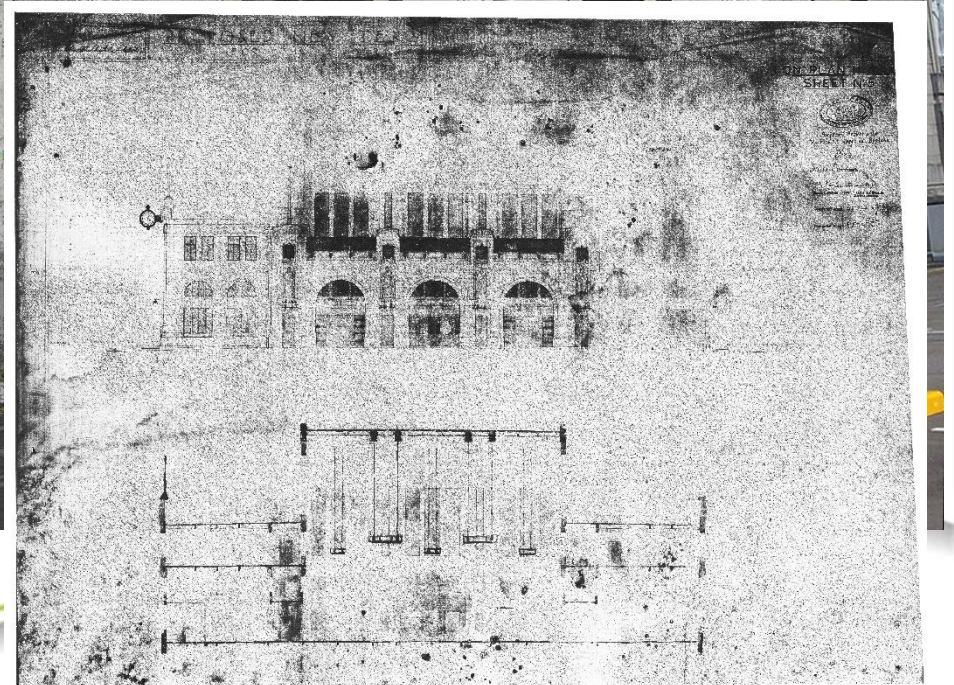
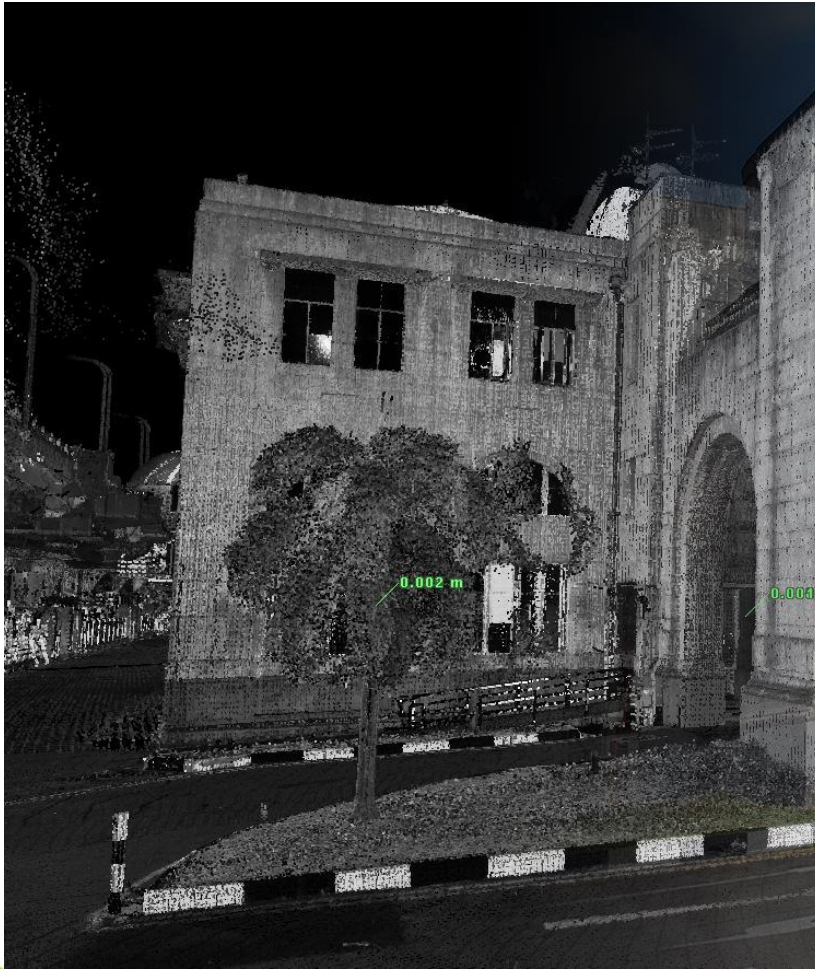
- Devices such as smartphones can be configured to detect signals from Wi-Fi, Bluetooth or ultra-wideband transmitters located around the building. The signals weaken with increasing distance. The relative signal strengths of the different transmitters can be measured to determine the user's position.
- Ultra-wideband transmitters send out regular pulses of radio energy, each pulse covering a large range of frequencies. While triangulation using Wi-Fi or Bluetooth is accurate to several metres, ultra-wideband could potentially take it down to about 20cm.

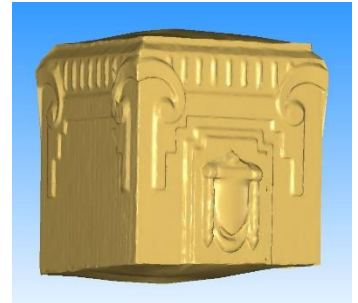
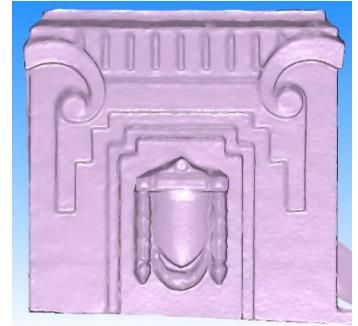
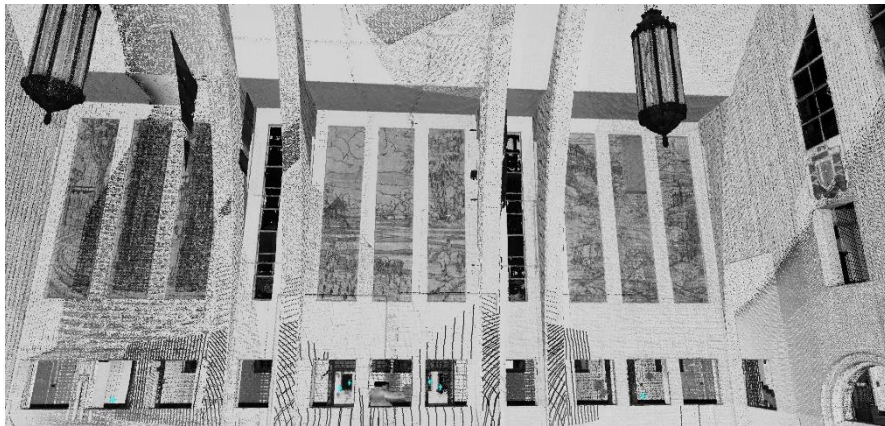
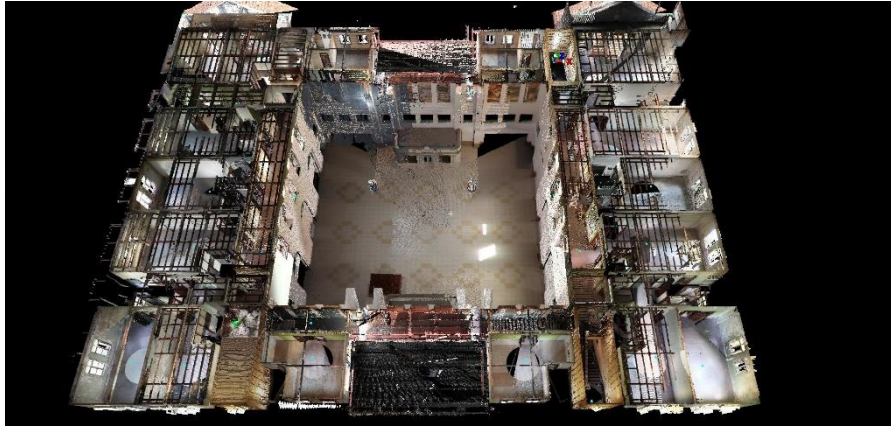
SOME POTENTIAL APPLICATIONS OF 3D INDOOR MAPS WITH REAL-TIME DATA

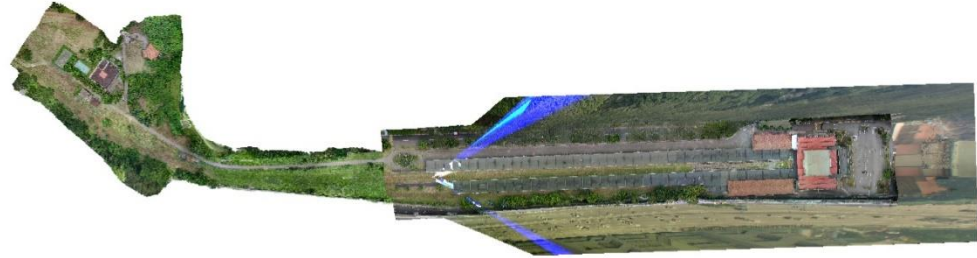
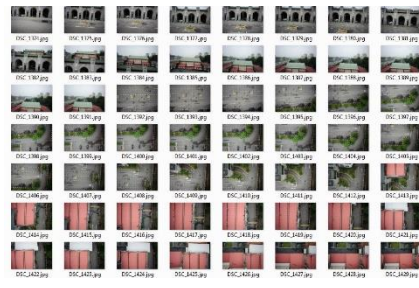
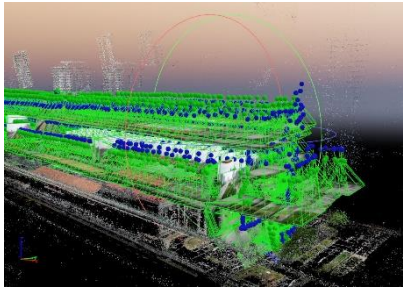
- Building maintenance and heritage preservation
- Understanding customer preferences in shopping malls
- Managing crowds at big events
- Military war games and counterterrorism exercises

Sources: SINGAPORE LAND AUTHORITY, GOVERNMENT TECHNOLOGY AGENCY PHOTO: SINGAPORE LAND AUTHORITY STRAITS TIMES GRAPHICS

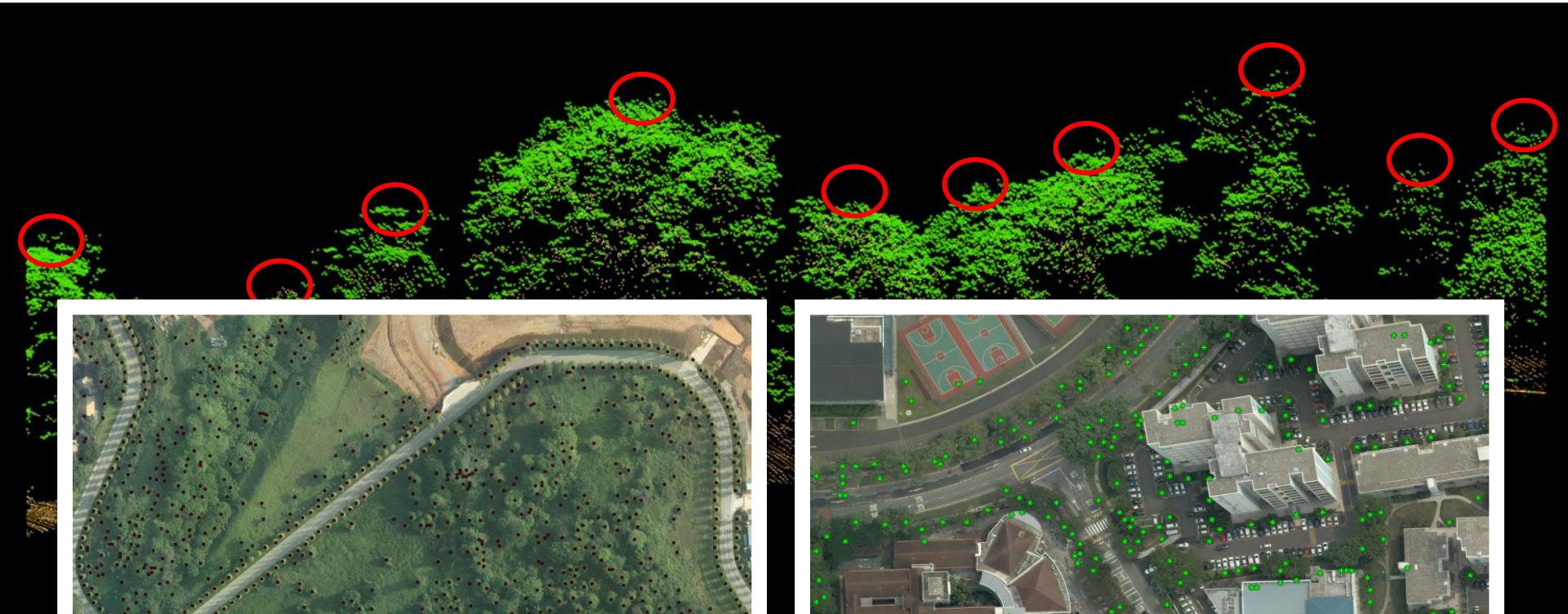
Historical Monument

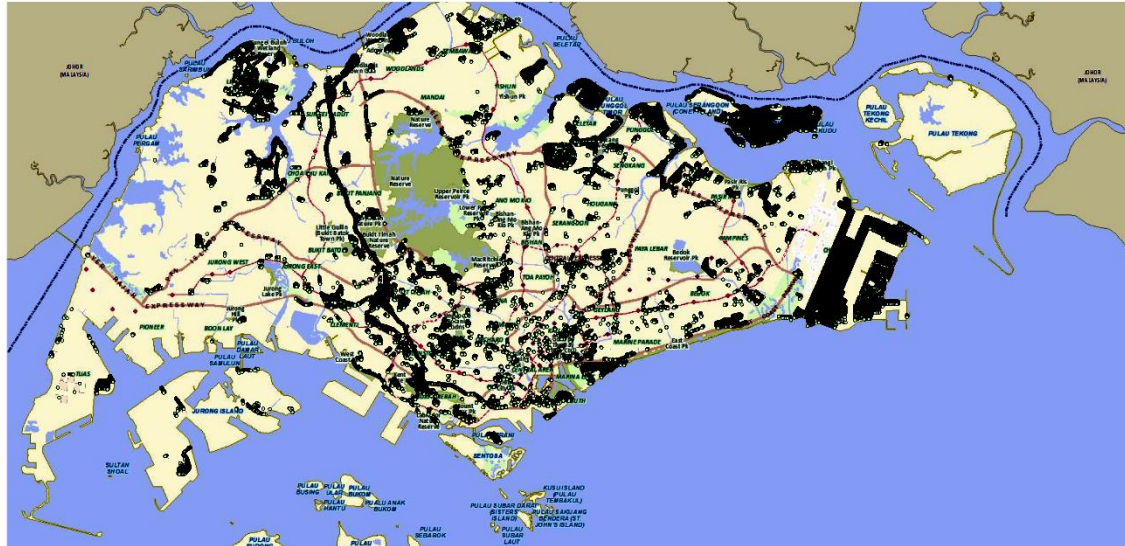




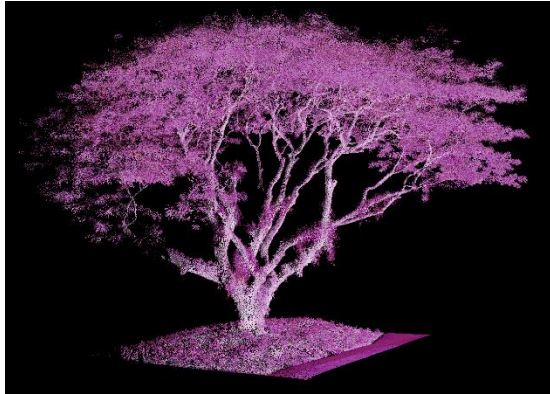


Tree Management

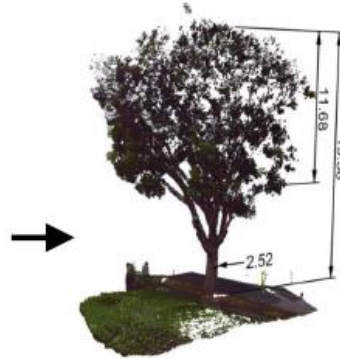




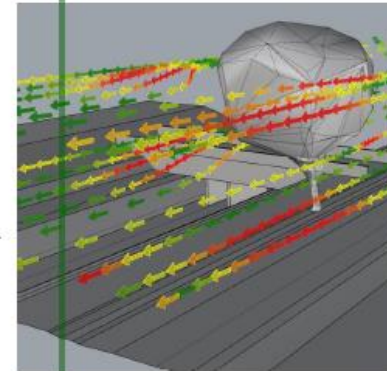
Detailed Representation



Data Acquisition,
Processing
& Management

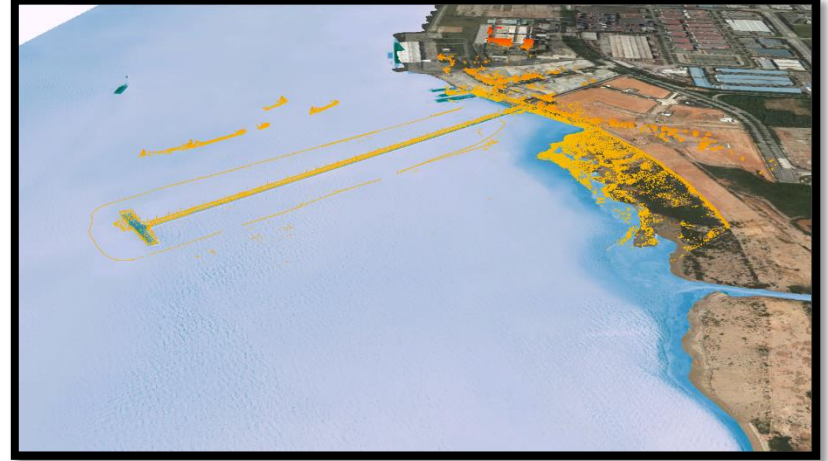
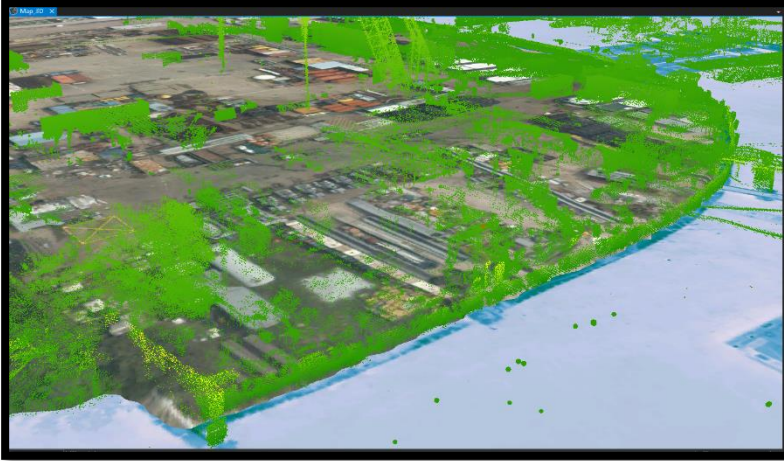


Extraction and
Modelling of
Semantics



Identification of
Potential
Applications

Coastal Management



Other Application

Published: 16 May 2013 01:43PM (Singapore)

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3D Laser Scanner set to speed up crime scene investigations

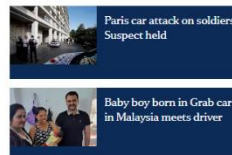
There has been a new addition to the variety of tools that the Singapore Police Force (SPF) uses for crime scene investigation. Home Team News checks out the 3D Laser Scanner, which SPF hopes could cut the time needed to solve cases.

By Aylm Tan

Fatal BKE accident: Deliveryman charged with rashly causing deaths of 2 motorcyclists



ST VIDEOS



singapore

Decapitated body found in Sungei Whampoa



A body was found in the canal near Block 110 McNair Road on Dec 12...

[MORE]

SCDF divers continuing to search canal near Serangoon Road; Police have classified case as one of unnatural death

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Autonomous Vehicle

Singapore gears up for autonomous vehicle technology

By Tan Wee Kwang | 2017-04-19

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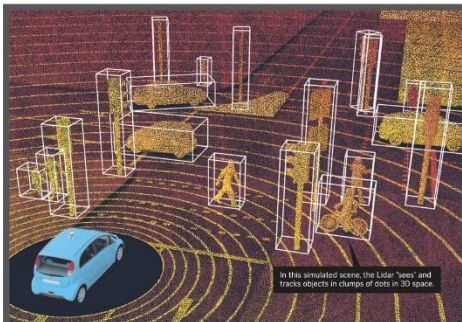
From autonomous public buses, driverless taxis to truck platooning, Singapore is looking to catalyse the development and deployment of autonomous vehicles (AVs) to enhance its transportation system. The Land Transport Authority (LTA) is exploring how self-driving technology can be applied to bring in new forms of shared mobility, and also address constraints in land and manpower.

"We are focusing on self-driving technology in a big way because they have the potential to dramatically improve public transport. For instance, we could have a fleet of shared self-driving pods or shuttles that can be called upon to bring us from our doorstep to the MRT station. Self-driving buses, on the other hand, could address our problem of driver shortage," said Second Minister for Transport Ng

Chee Meng

How an autonomous car works

Autonomous vehicles rely on a host of sensors linked to a central computer to plot their trajectory and avoid accidents.



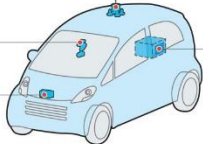
Lidar (Light Detection and Ranging)
Lidar beams are shot and bounced off the environment. This creates a cloud of points that maps out the surroundings in 3D. The computer is programmed to recognise certain profiles such as people and other vehicles. The roof sensor is able to scan 360 degrees around the car with a range of 100m.

Smart camera

The intelligent camera scans for traffic lights and pedestrians, and provides a second layer of verification to what the Lidar devices see.

Front Lidar

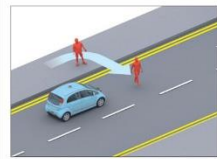
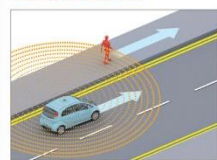
The front sensor has a longer range of 150m to allow for earlier detection of danger.



Central computer

The computer processes the information gathered from the sensors and makes sense of it all. It then makes intuitive decisions based on the information. The computer is responsible for manipulating the steering, accelerator and brakes.

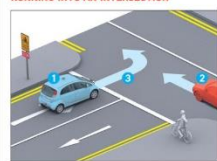
REACTING TO PEDESTRIANS



1 When the Lidar sensor detects a pedestrian on the side of the road, the car's computer tracks the actions of the pedestrian and is able to make decisions at intervals of 15 milliseconds.

2 When the car notices that the pedestrian may be stepping out onto the road, it slows down. It comes to a stop when the pedestrian walks in front of it.

RUNNING INTO AN INTERSECTION



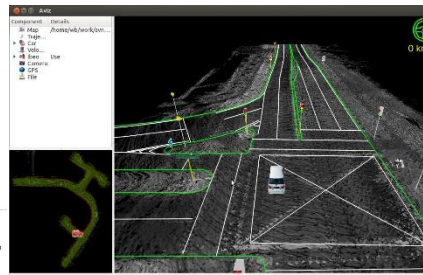
1 A pre-programmed map tells the car to stop at the intersection. The car's Lidar sensors detect and track the oncoming cars.

2 Its computer makes an inference on the speeds of the cars and predicts where they will be in the next few seconds.

3 The car will make the turn when there is no chance of a collision.



The A-List: Things a car needs to be autonomous

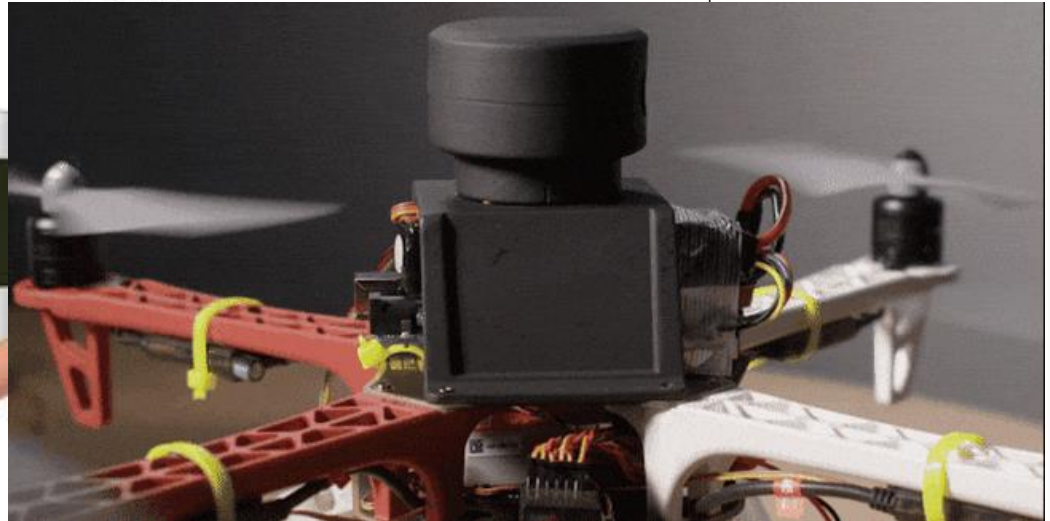


What's Next?



Source: AMR Analysis

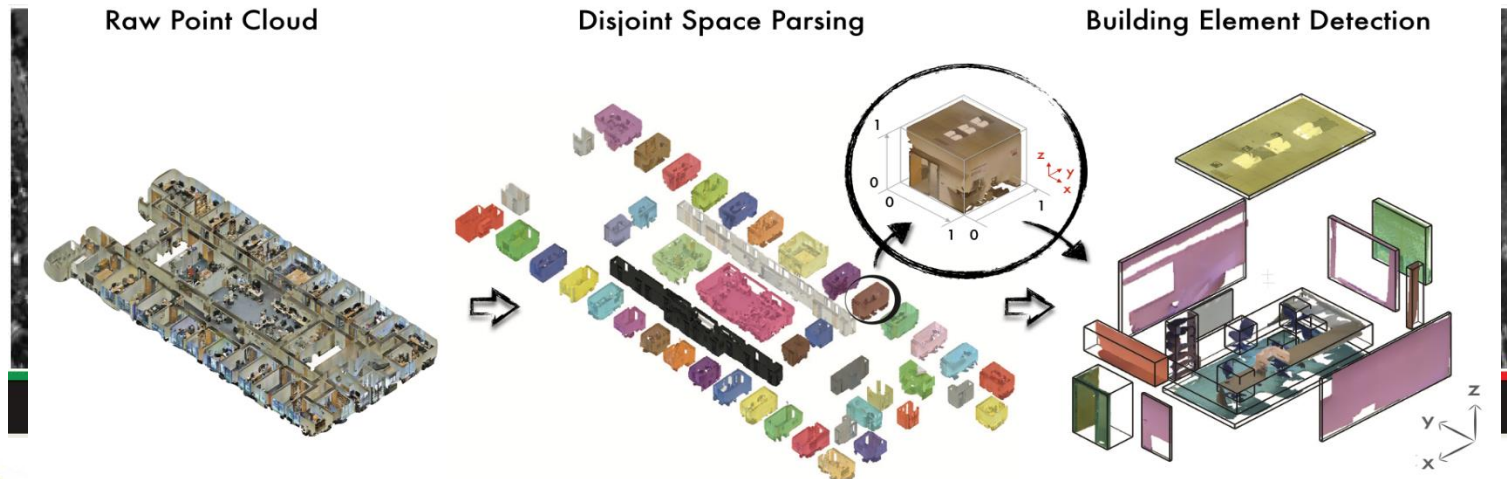
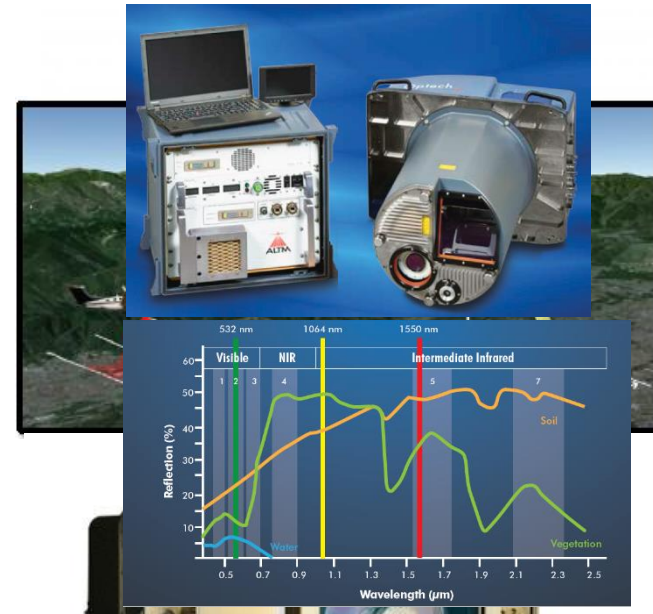
Automated systems



■ 2014 ■ 2020

- Cheaper, smaller sensor footprints at decreased weight and with lower power consumption

- Solid state LiDAR sensor
- Geiger mode & single photon
- Multispectral LiDAR
- 3D Semantic Parser



Source: Stanford University



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