3D Spatial Infrastructure for the Smart City - Singapore
ESRI 3D Forum - 18 July 2015
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Agenda

• A Vision for Singapore
• Singapore Land Authority
• AAM
• What is a Smart City?
• Rigorous Spatial Foundation
• Complex Data Acquisition
• 3D Modelling Program
• 3D SDI
• Benefits
• Questions

Click here for link to GeoConnexion magazine article
A Vision for Singapore

• President Tony Tan’s **government priorities** prominently feature **GIS**
• Seven different ministries are working towards making Singapore a “**liveable city and endearing home**”
• The Ministry of Law will develop a high resolution, **3D national topographic map**
  • Urban Planning
  • Flood Control, and
  • Civil Aviation
• Singapore Land Authority (SLA) leads the geospatial component of this vision
A smart city would allow Singapore to develop solutions to tackle urban problems more effectively and efficiently...geospatial data are the building blocks of a Smart City. Smart Cities of the future would require a robust 3D land information system to organize the increasing amount and richness of geospatial information

- SLA chief executive, Vincent Hong, Switzerland, May 2014
Leads the geospatial component of the vision for a Smart City

- Scoped, researched and designed the geospatial component
- Whole-of-government approach
- Analysis and visualisation capabilities extended to include height
  - Accurate Terrain
  - Detailed Surface Models
  - High Resolution Imagery
  - High quality photorealistic building models
Following open tender processes, SLA engaged AAM Pty Ltd to provide geospatial data and software, for both aerial and terrestrial survey phases

Dedicated provider of Geospatial Services

- ~650 staff, Multiple Offices
- Aerial Photography and LiDAR
- Unmanned Airborne Solutions
- GIS and Web Mapping
- 3D GIS and Visualisation
- High-Definition Surveying and Monitoring
- Land, Engineering and Industrial Survey
- Click here for AAM overview
What is a Smart City?

- Multi-purpose 3D Spatial Infrastructure

- Greenfields Planning
- Infrastructure
- Land Cover
- Terrain Analysis
- Tourism
- Natural Environment
- Population Distribution
- Energy
- Soil Suitability
What is a Smart City?

- Concept planning – town design and growth center modelling
- Master planning – density modelling and rezoning
What is a Smart City?

- Planning - 3D GIS Tools aid planning process reforms
What is a Smart City?

- Planning - 3D GIS Tools
  - Help answer questions
  - Used to test assumptions
What is a Smart City?

- Environmental conditions
What is a Smart City?

- Urban Forest Management
What is a Smart City?

- Energy Management - solar potential assessment
What is a Smart City?

- Energy Management - solar PV mapping and array siting
What is a Smart City?

- Energy ratings and building sustainability indices from BIM
What is a Smart City?

- 3D Cadastre
What is a Smart City?

• Smart Buildings in Smart Cities
Rigorous spatial foundation

...geospatial data are the building blocks of a Smart City.

A virtual 3D City Model supports a Creative, Knowledgeable, Sustainable, and Connected Intelligent Virtual EcoCity which allows you to interact with Smart City outputs
Complex Data Acquisition

- **Aerial Survey Challenges**
  - Frequent low cloud, tight international borders and very busy airspace
  - 750 sq. km of LiDAR and Imagery data within small survey window

- **Terrestrial Survey Challenges**
  - 5,500 km road of mobile laser scanning and image data
  - Rain contingency
  - GPS availability

12 minutes...
Complex Data Acquisition

- **Aerial Survey Outcome**
  - Successful data capture in April 2014
  - Two survey aircraft
  - First order Optech Pegasus LiDAR Sensor
    - Terrain and all above ground features including, building, trees, powerlines and other structures
    - Minimum density of 5pts per sq. m, with point densities reaching over 15pts per sq. m
  - Leica RCD30 oblique camera sensor
    - Quality nadir for high resolution orthophotos
    - Oblique photos for building modelling and realistic texturing

- **Terrestrial Survey**
  - Riegl VMX-450 MLS Sensor
  - Ladybug5 360 degree Camera
  - Capture...stay posted!
3D Modelling Program

- Aerial Survey
  - LOD 0 Accurate Terrain Relief and Digital Surface Model
  - High resolution Orthophoto
  - LOD 1 Building Block Models
  - LOD 2 Building and Bridge Models
  - Waterbodies and Vegetation Models

- Terrestrial Survey
  - LOD 0 Accurate Terrain Relief Model
  - LOD 1 Directional Road Network
  - LOD 1 and LOD 2 Road, Bridge and Tunnel Models
  - LOD 2 City Furniture Models
  - LOD 3 Building Models
Relief Terrain Model

LOD0 TIN and Grid Relief

1. Ground and Non-Ground Classified Point Cloud
2. Ground Classified Terrain Data Only
3. TIN Relief Creation
4. Grid Relief Creation
 Relief Terrain Model

LAS to GeoTIFF, CityGML and LandXML Translation

LAS Dataset To Raster

Select LAS List text file:

Add LAS class codes (separated by ;):

Input LAS Return Number:

Input Coordinate System:

OUTPUT LAS Dataset:

Raster Interpolation Type:

Output Folder:

Grid Cell Size:

Create ASCII Grid (optional):

Create ERSI ASCII Grid (optional):

Create ASCII XYZ Grids (optional):

Output Grid Name (Tiles = False) or Output Tiled Grid Folder Name:

Create ERSI ASCII Grid(s):

Create ASCII XYZ Grid(s):

ASCII XYZ Definitions:

Destination Python Script:
LiDAR Building Model

CityGML, ESRI Multipatch and 3DS LOD1
CAD to CityGML Translation, including specified attributes such as
• Class: Road Traffic – 1040
• Function:
  • Driving Lane – 1
  • Footpath – 2
• Usage:
  • Car - 2
  • Pedestrian – 1

MLS Transportation Models
MLS City Furniture Models

City Furniture LOD2 Closed Solids

Classified Point Cloud

Class Filter

City Furniture Models
MLS City Furniture Models
Terrestrial Survey Derived Models
3D Modelling Program

Automatic harvesting of oblique imagery
Terrestrial Survey Derived Models
Terrestrial Survey Derived Models
Smart cities of the future would require a robust 3D land information system to organize the increasing amount and richness of geospatial information.
Benefits

- Government Authorities - better understand their environment
Benefits

- Government Authorities - 3D visualisation and realistic simulations
Benefits

- Government Authorities – Complex spatial analysis
Benefits

- Government Authorities – better communication to public
Benefits

• Public Utilities Board – enhanced modelling for stormwater management
Benefits

• Civil Aviation Authority – enhance design process of flight paths
Benefits

- Civil Aviation Authority – monitor obstacles surrounding airports
Benefits

- Building Authorities – design
Benefits

• Building Authorities – promote proposed developments via the web
Benefits

- Building Authorities – interior extension / tools to ingest BIM submissions
Benefits

- Land Transport Authority – traffic simulation / real time vehicle animation / detail for engineering and construction
“A Smart City is more than its sensors, fibre optics networks or other hard infrastructures. Ultimately it is its citizens who make a Smart City truly smart and who are its greatest asset.”
- SLA chief executive, Vincent Hong, Switzerland, May 2014