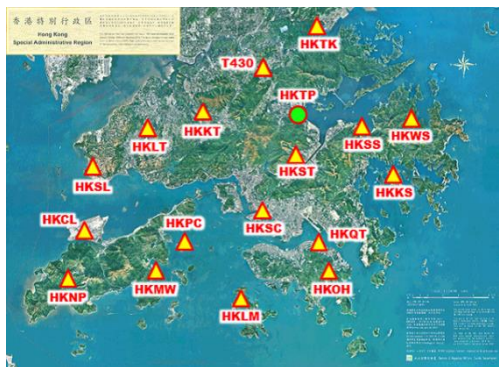# 3D MAPPING DEVELOPMENT

Ben CHAN
Assistant Director / Survey & Mapping
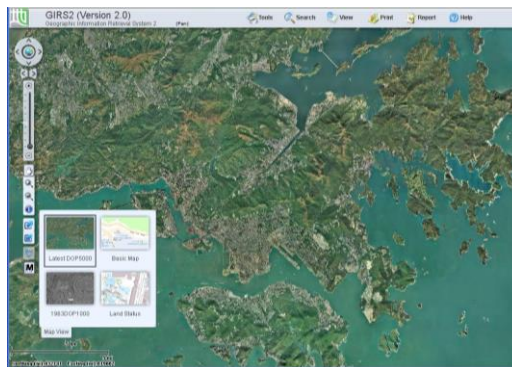**Lands Department**

Roles of the Survey and Mapping Office (SMO) of Lands Department

establishment and maintenance of a geodetic network;

provision of land boundary (cadastral) surveys, photogrammetric survey as well as cartographic and reprographic services;

maintenance of a computerised land information system for mapping data and land boundary records;

production and revision of maps and plans at different scales for different purposes; and
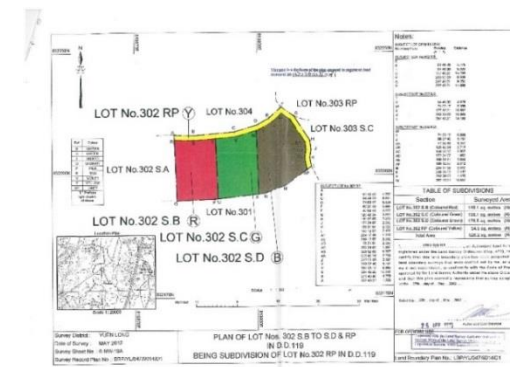

administration of the Land Survey Ordinance (Cap. 473).

3D MAPPING DEVELOPMENT

2D Topographic Map

Has been used for decades and it is a very effective topographical map for various applications

Applications:

- For topographical map applications
- For planning and works applications by architects, engineers, planners, developers, etc.
- For general and social applications
- For GIS developments / applications
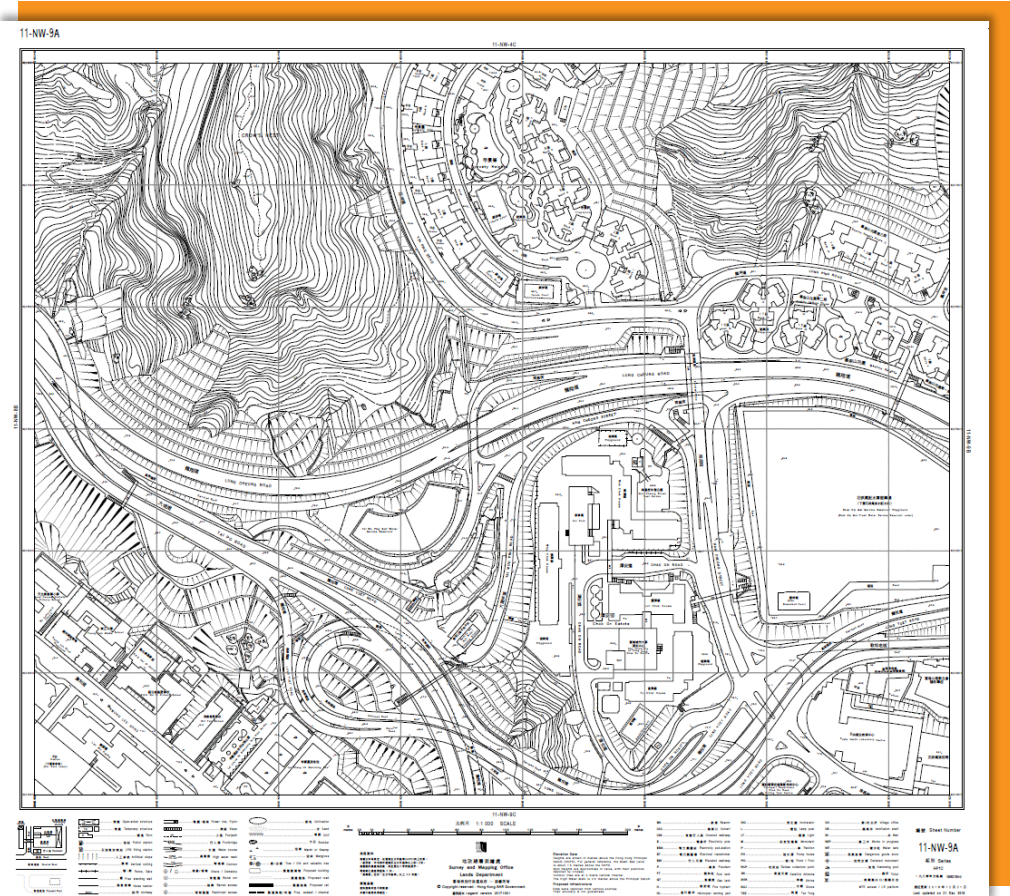
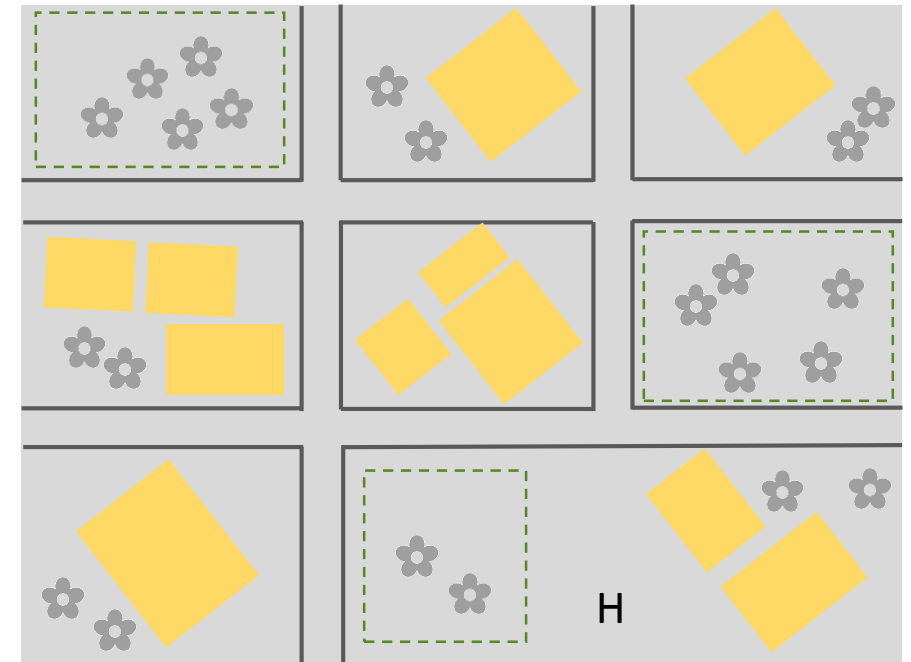

235 features in 1:1000 Basic Map

3D MAPPING DEVELOPMENT

3

2D map is insufficient

Our Real World

Change of Land Use

Conventional Map

3D MAPPING DEVELOPMENT

3D Spatial Data of LandsD

Started in 2007

Launched in 2012

3D Spatial Data of LandsD

~2000 models
~90 major roads

基礎設施模型
Infrastructure Model

第一細節層模型
Level 1 model

第二細節層模型
Level 2 model

第三細節層模型
Level 3 model

建築物模型
Building Model

第一細節層模型
Level 1 model

第二細節層模型
Level 2 model

第三細節層模型
Level 3 model

Building Height (>10m)
~53000 models

三維空間數據
3D Spatial Data

地形模型
Terrain Model

DSM

DTM

地面高程模型
Digital Terrain Model (DTM)

地表高程模型
Digital Surface Model (DSM)
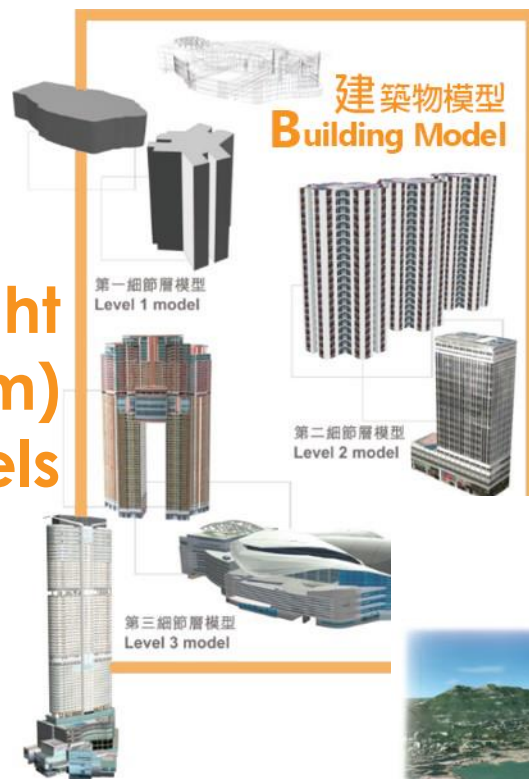
~210,000 models (L1)
~9,000 models (L2&L3)

Territory-wide

3D MAPPING DEVELOPMENT

6
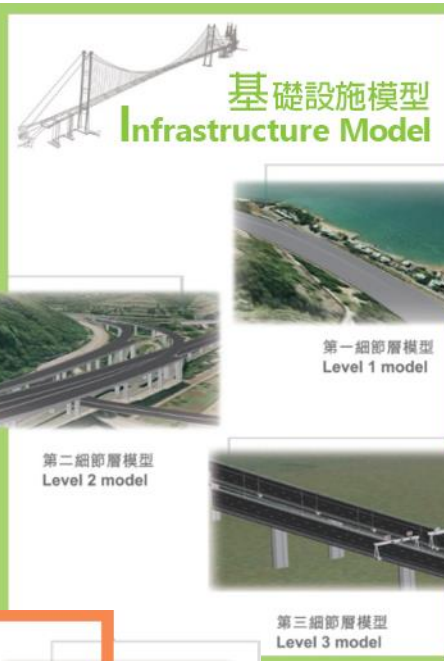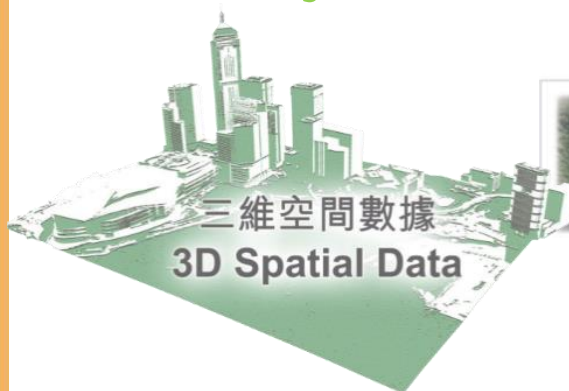
3 Aspects of
3D Mapping Development
- Now and Future

3 Aspects of 3D Mapping Development - Now and Future

(1) 3D Data Capture / Data Collection

(2) 3D Data Standards and Modelling

(3) 3D Data Sharing

(1)3D Data Capture/ Data Collection

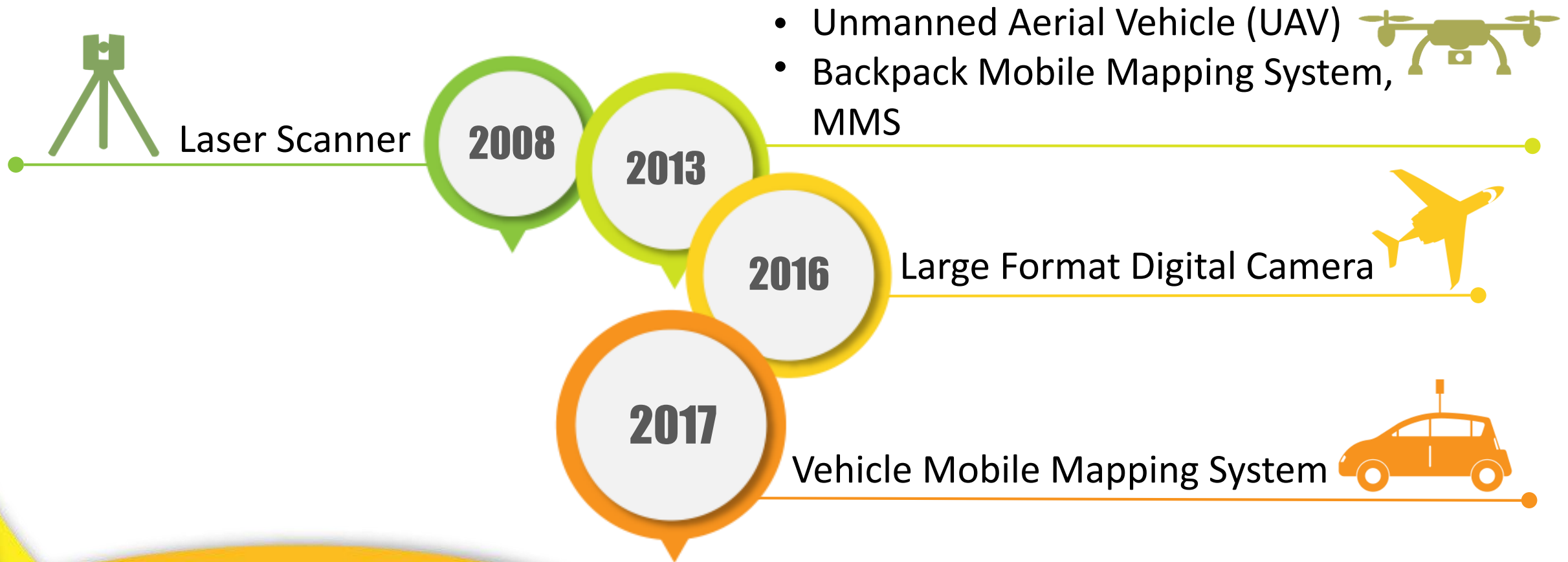# (1) 3D Data Capture / Data Collection

Advanced survey technologies replace conventional survey methods

- Unmanned Aerial Vehicle (UAV)
- Backpack Mobile Mapping System, MMS

Laser Scanner

2008

2013

2016 Large Format Digital Camera

2017 Vehicle Mobile Mapping System

3D MAPPING DEVELOPMENT

(1) 3D Data Capture / Data Collection

Outsourcing Mesh Model Projects

Phase I

- Fixed-wing Aircraft / Helicopter
- Captured at 6,000 and 7,000 Ft Altitude
- 10cm GSD
- 174 sq.km

Phase II

- Helicopter
- Captured at 1,000 and 2,000 Ft Altitude
- 8cm GSD
- 165 sq.km

3D MAPPING DEVELOPMENT

(1) 3D Data Capture / Data Collection
Photorealistic Mesh Model
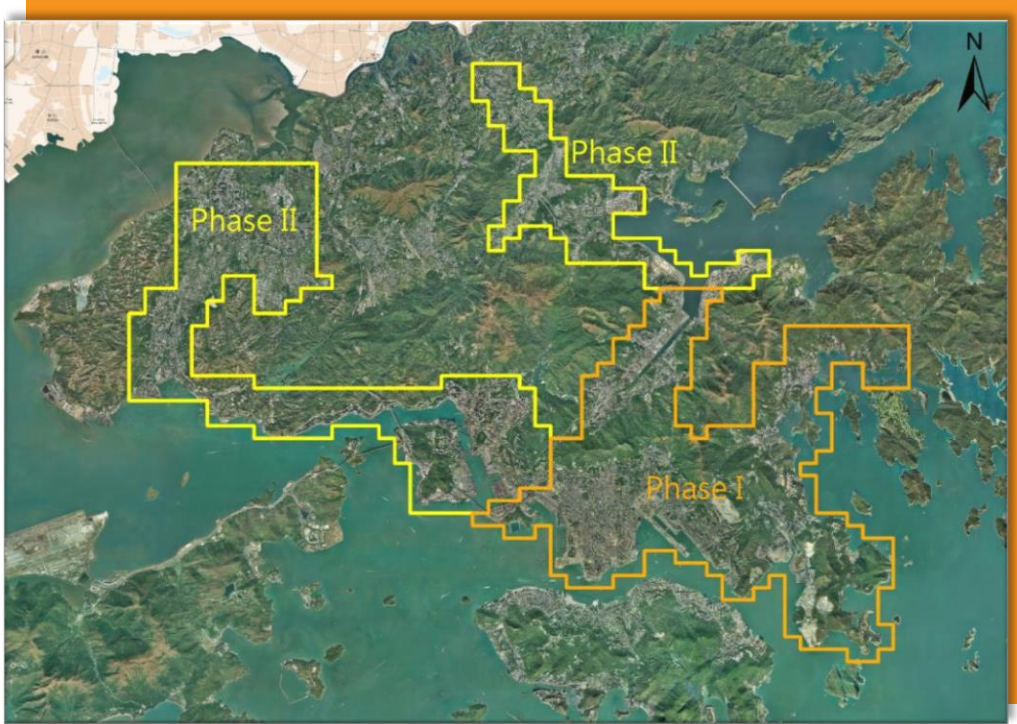
Project Areas

Mesh Models

3D MAPPING DEVELOPMENT

Provision of 3D Textured Mesh Model
To enrich the 3D Spatial Data of LandsD

3D Textured Mesh Model
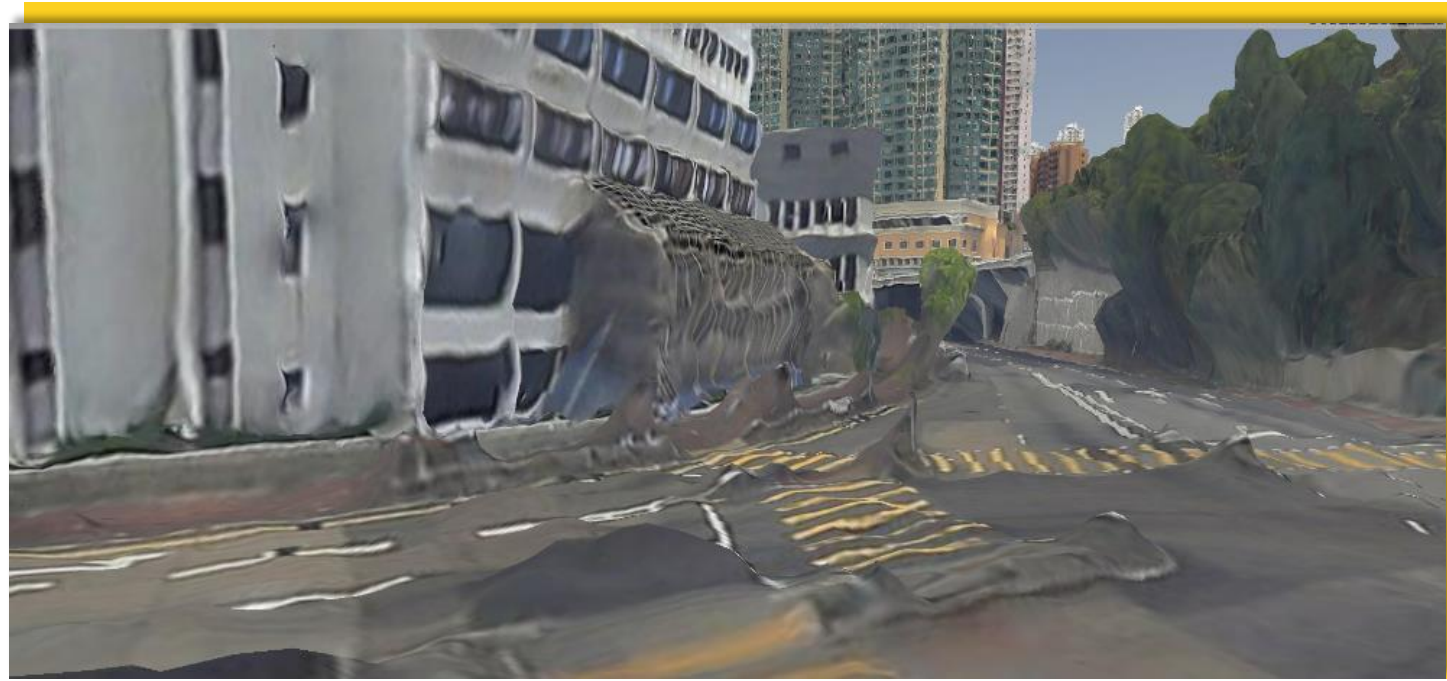
Limitations of 3D Textured Mesh Model

(1) 3D Data Capture / Data Collection

Image and laser points captured by Vehicle-based Mobile Mapping System (VMMS)

Enhancement of Mesh Model Street Level
Apply Vehicle-based Mobile Mapping System Data

Limitations of
3D Textured Mesh Model

With Vehicle-based Mobile Mapping System (VMMS) Data

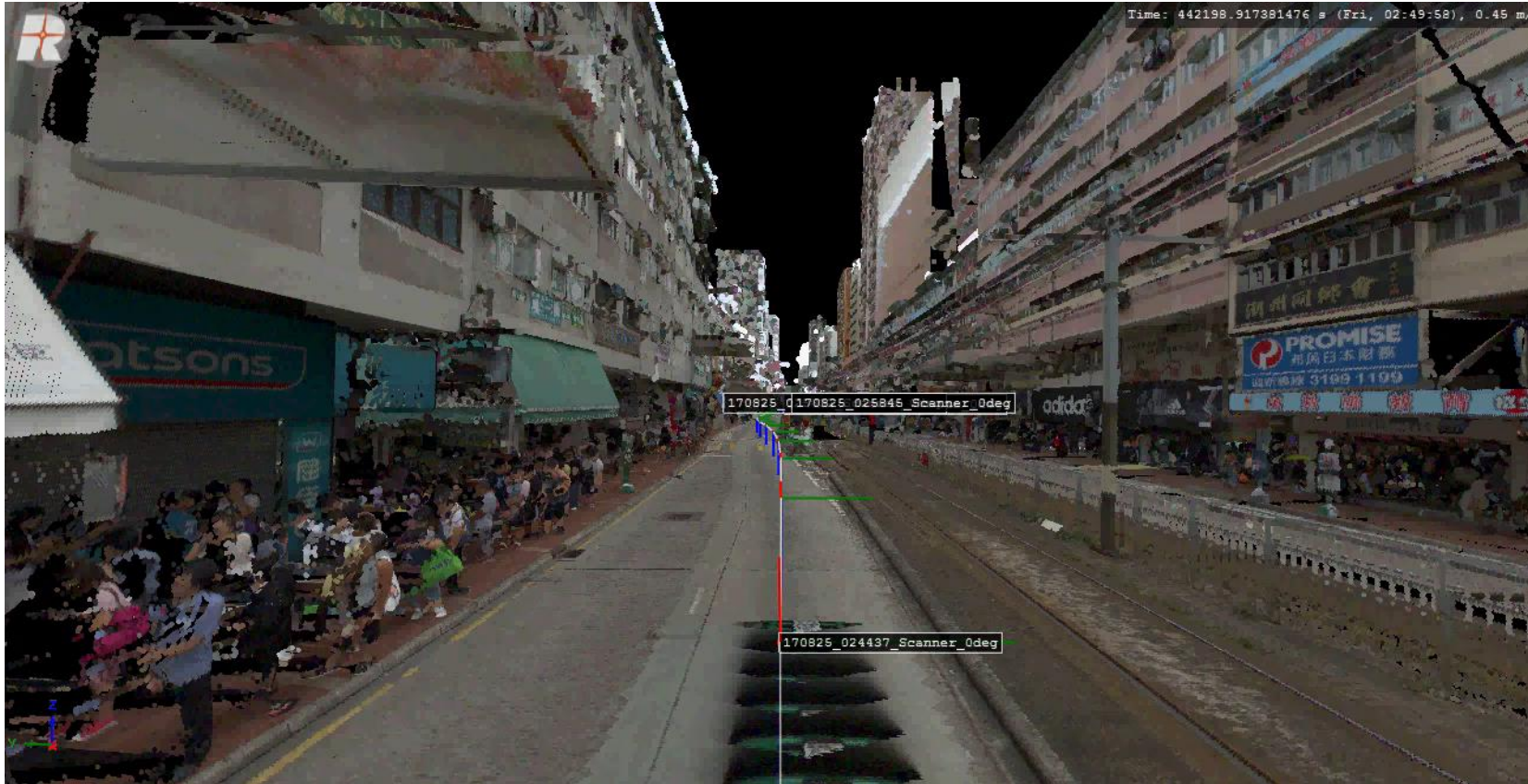# Enhancement of Mesh Model Street Level

Survey → Context Capture → DP-Modeler → 3dsMax

- Aerial photos & MMS photos etc.
- Generate mesh in .osgb format
- Create .obj model
- Export to other format such as .3ds and .dae

UAV/Aerial photo

Mobile Mapping System

Handheld Camera
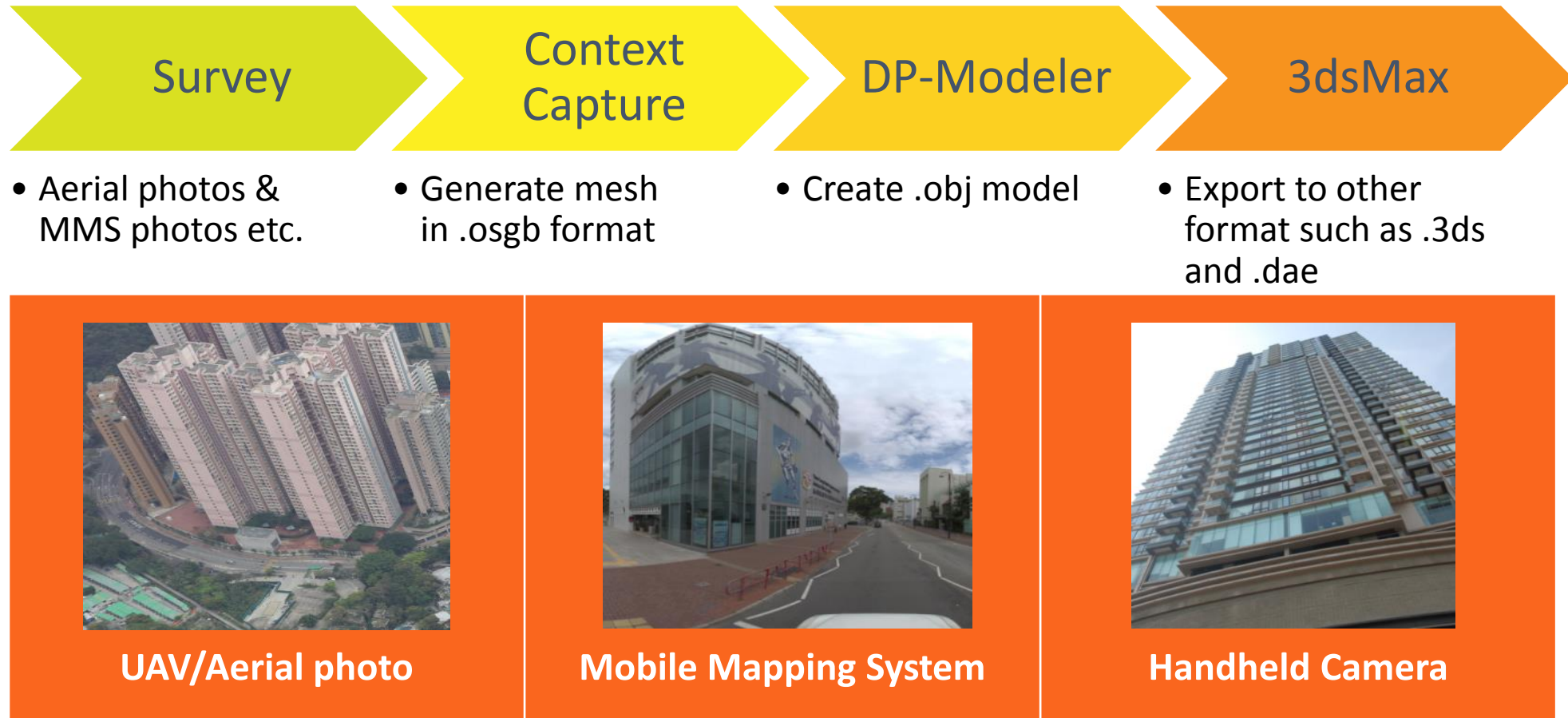
Based on the 2D building outline, add textures and structures that are greater than 4 meters

3D MAPPING DEVELOPMENT

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Individualized Building Model from Mesh Model
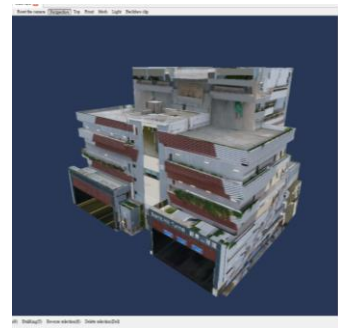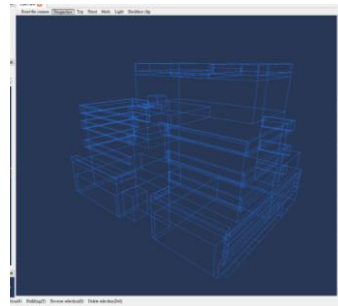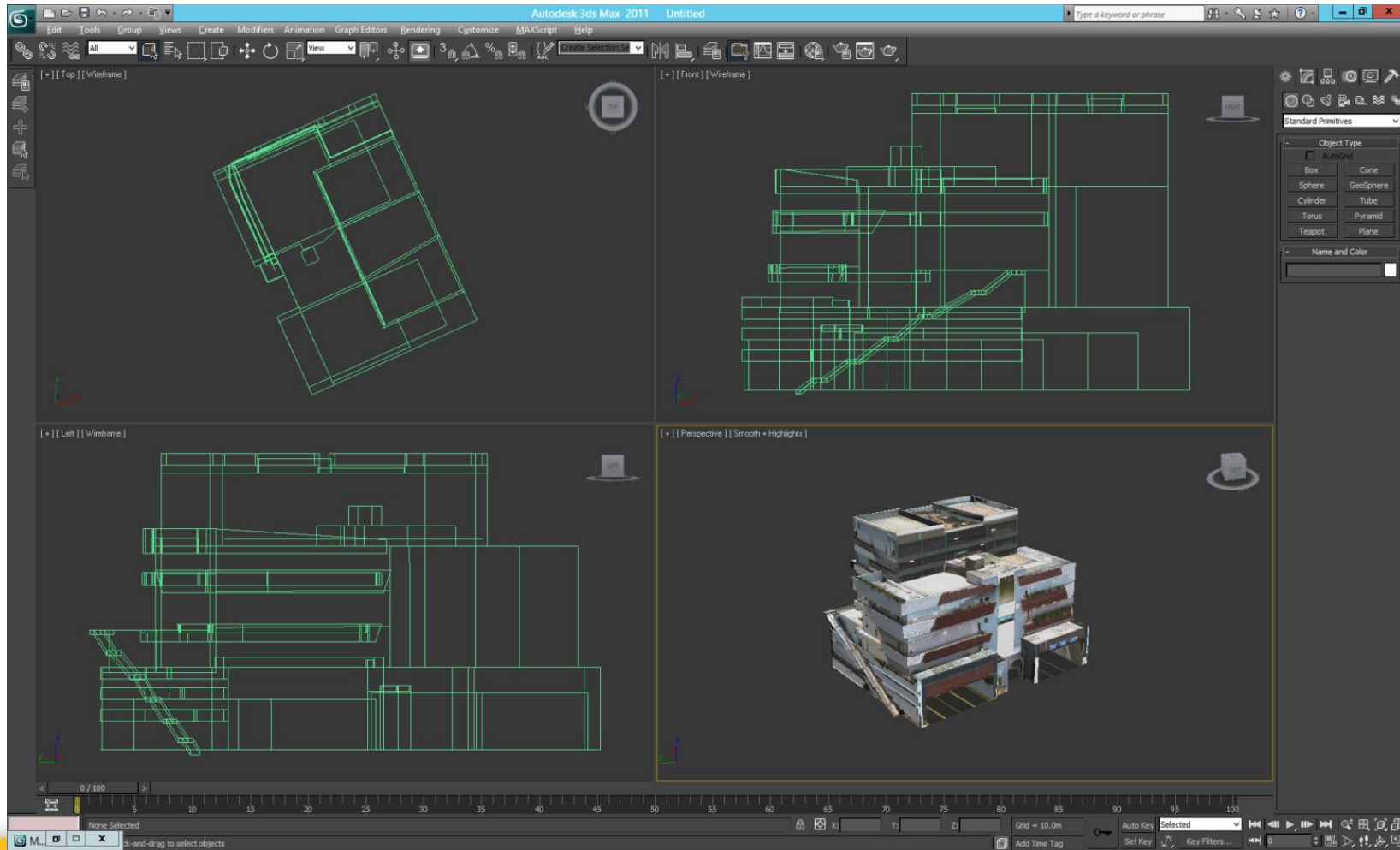
(1) 3D Data Capture / Data Collection
Use Artificial Intelligence (A.I.) for mapping
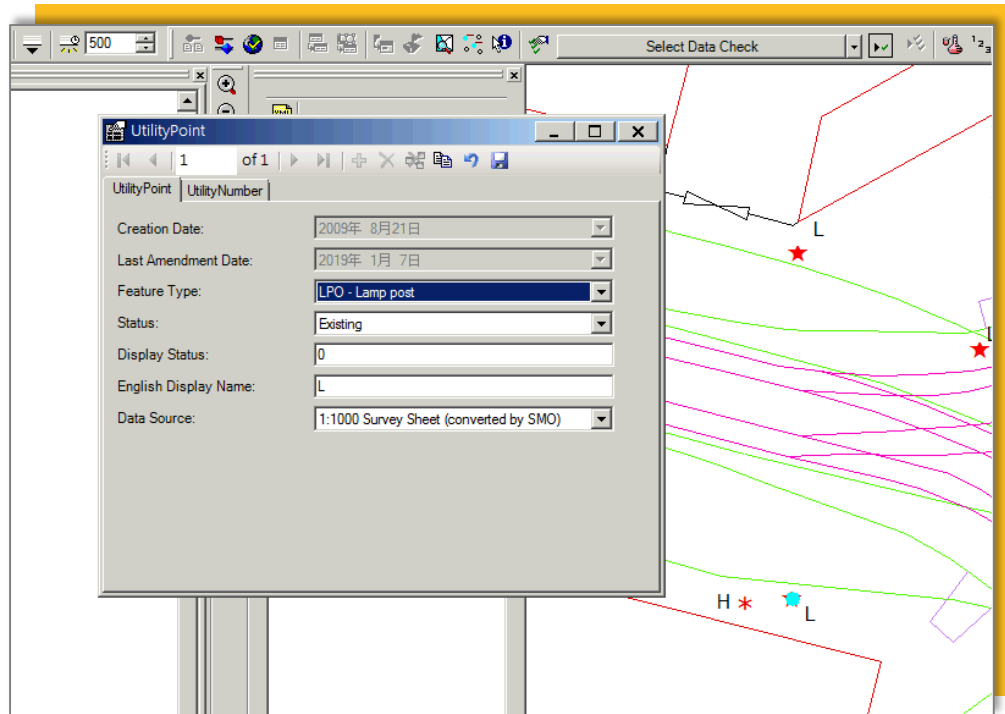
Conventional Feature Extraction
by Coding
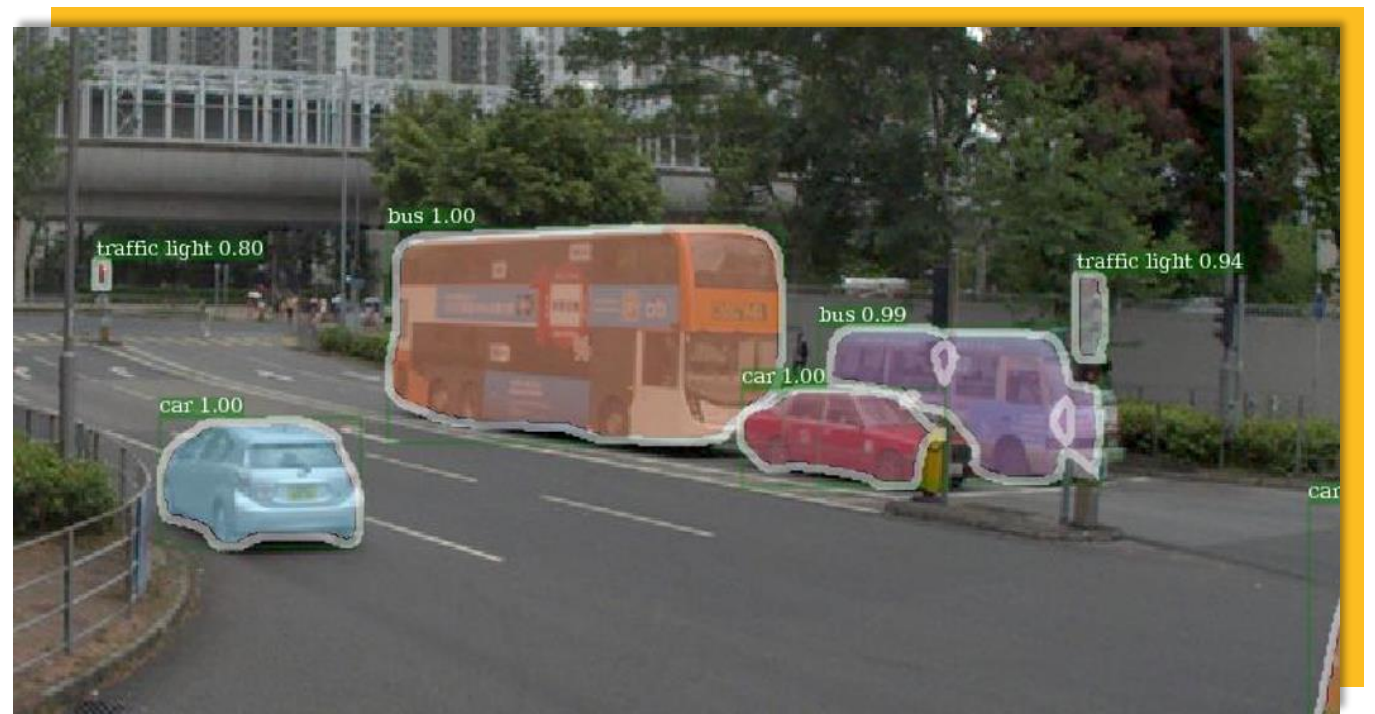
Automatic Feature Extraction by A.I.

(1) 3D Data Capture / Data Collection
Use Artificial Intelligence (A.I.) for mapping

Video courtesy of Data-Enabled Scalable Research (DESR) Laboratory, HKUST

(1) 3D Data Capture / Data Collection

Video courtesy of Data-Enabled Scalable Research (DESR) Laboratory, HKUST

(1) 3D Data Capture / Data Collection

BIM data as a source of 3D map data

BIM Data and 3DSD Integration
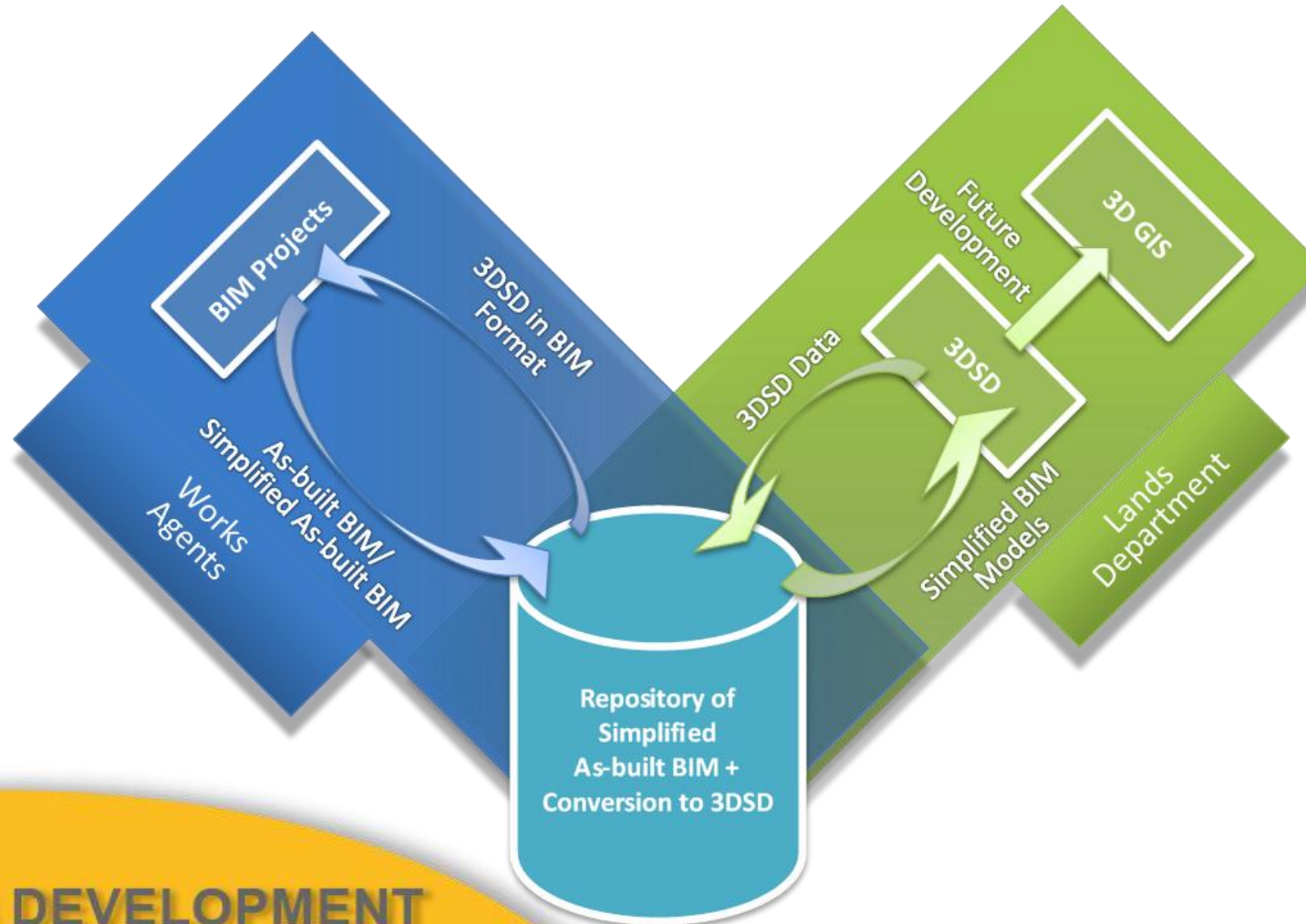
(1) 3D Data Capture / Data Collection
Crowdsourced bathymetry

MAY 31, 2018 BY KRISTEN.CROSSETT

NOAA announces launch of crowdsourced bathymetry database

By Lt. Cmdr. Adam Reed, Integrated Oceans and Coastal Mapping (IOCM) assistant coordinator

Today NOAA announces the end of a testing phase in the development of a new crowdsourced bathymetry database. Bathymetric observations and measurements from participants in citizen science and crowdsourced programs are now archived and made available to the public through the International Hydrographic Organization (IHO) Data Centre for Digital Bathymetry (DCDB) Data Viewer. The operationalized database allows free access to millions of ocean depth data points, and serves as a powerful source of information to improve navigational products.

Source: https://www.nauticalcharts.noaa.gov

3D MAPPING DEVELOPMENT
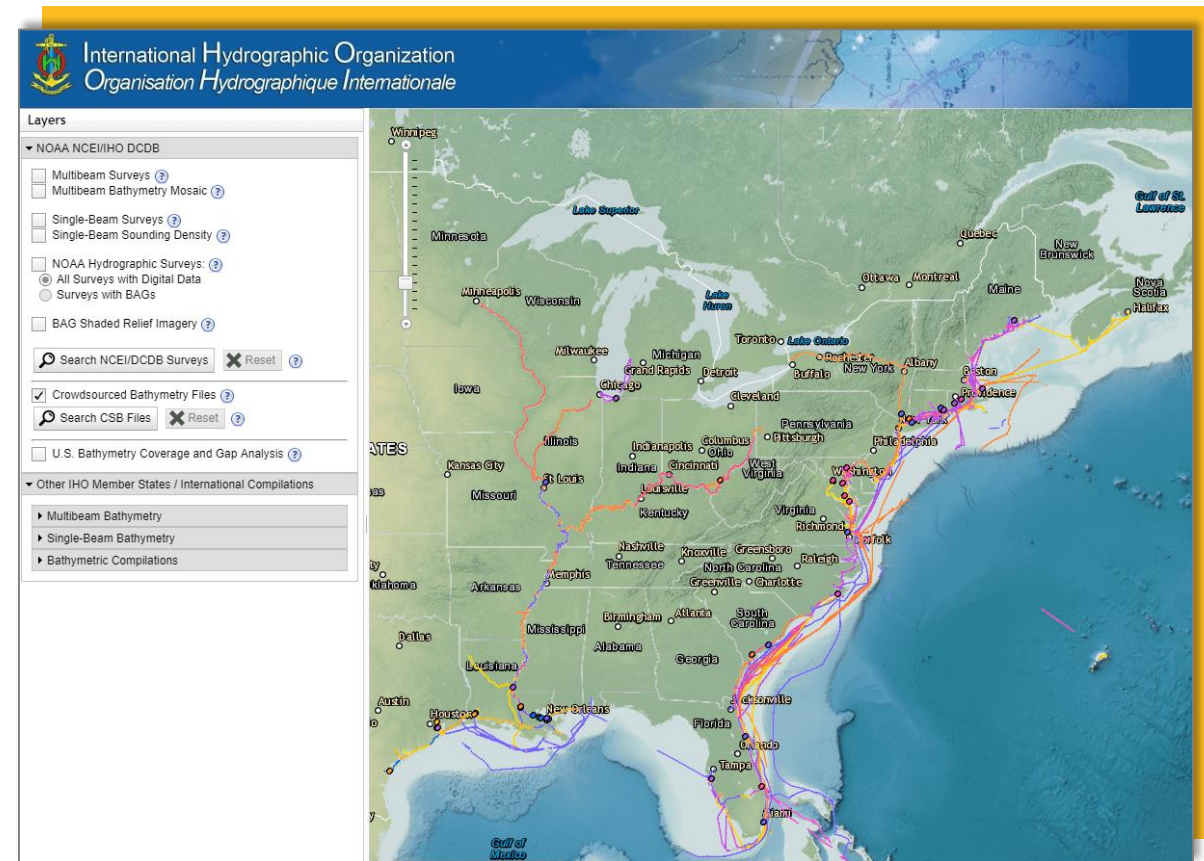
3D Digital Map Development

Exploration of 3D Digital Map updating by crowdsourcing

3D MAPPING DEVELOPMENT

(2) 3D Data Standards and Modelling

(2) 3D Data Standards and Modelling

Define 3D Data Standards and Modelling Specifications, including **3D Geometry** and **3D Map Information**
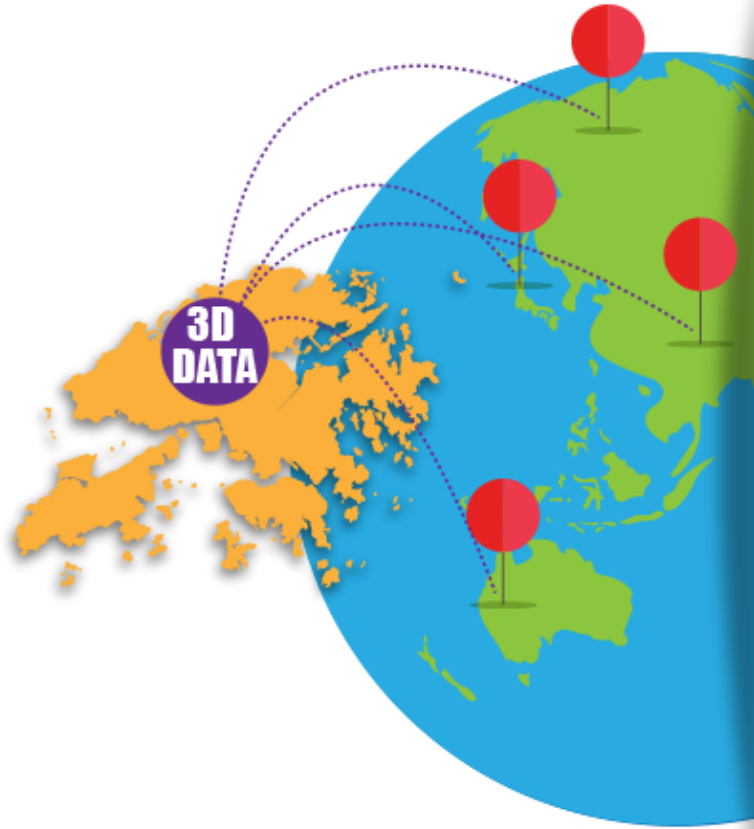
3-step approach:

1. Find out any international standards, adopt the standards and modified to fit HK situation

2. Proof of concept with prototype development

3. Full implementation

3D DATA

3D MAPPING DEVELOPMENT

(2) 3D Data Standards and Modelling
3 Stages of 3D Digital Map Development

Stage 1

3D maps for visualization

Stage 2

3D maps for floor/unit-based applications

Stage 3

3D maps for city modelling

(2) 3D Data Standards and Modelling
3 Stages of 3D Digital Map Development

Stage 1
- 3D maps for visualization

Territory-wide Photorealistic 3D Models
by Aerial and Street View Images

(2) 3D Data Standards and Modelling
3 Stages of 3D Digital Map Development

Stage 1
- 3D maps for visualization

Stage 2
- 3D maps for floor/unit-based indoor applications

Bldg No.	10
Use	Industrial
Height	56m
Floor	17
Unit	100
Creation Date	21/2/1995

Enhanced Models with Floor and Unit Information (Major Government Buildings and Estates)

(2) 3D Data Standards and Modelling
3 Stages of 3D Digital Map Development

Stage 2

OGC®
Making location count.

About ˅   Standards ˅   Innovation ˅   Ne

Indexed 3D Scene Layers (i3s)

1) Overview
2) Downloads
3) Related News

1) Overview

A single I3S data set, referred to as a Scene Layer, is a container for arbitrarily large amounts of heterogeneously distributed 3D geographic data. Scene Layers are designed to be used in mobile, desktop, and server-based workflows and can be accessed over the web or as local files.

The delivery format and persistence model for Scene Layers, referred to as Indexed 3d Scene Layer (I3S) and Scene Layer Package (SLPK) respectively, are specified in detail in this OGC Community Standard. Both formats are encoded using JSON and binary ArrayBuffers (ECMAScript 2015). I3S is designed to be cloud, web and mobile friendly. I3S is based on JSON, REST and

Geospatial Datasets

3D Tiles

CESIUM® 3DTiles™
Optimized for streaming

and other tile formats

glTF

CESIUM®

3D Engines

OSGB

3D MAPPING DEVELOPMENT

(2) 3D Data Standards and Modelling

3 Stages of 3D Digital Map Development

OGC CityGML LOD specification for 3D city models / need improved specification (CityGML 3.0) ?

Source: http://filip.biljecki.com/phd.html

(2) 3D Data Standards and Modelling
3 Stages of 3D Digital Map Development

OGC CityGML & IndoorGML
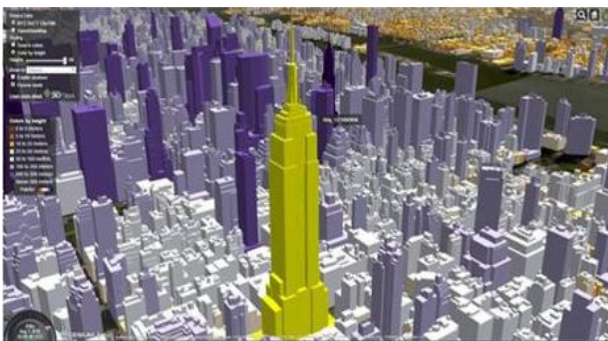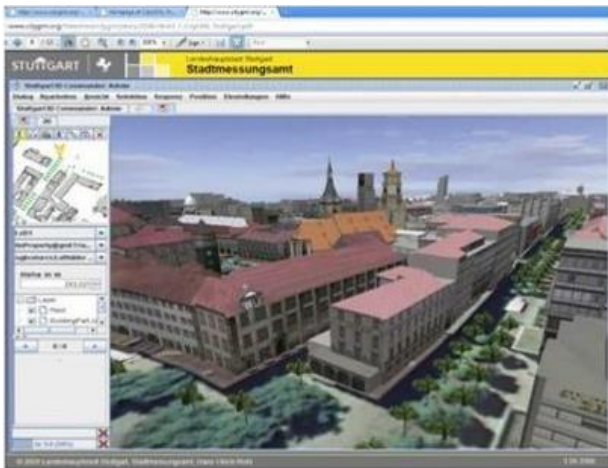
Source: www.directionsmag.com

Gate → AnchorSpace or AnchorBoundary

Room → GeneralSpace

Stair → TransitionSpace

Hallway → TransitionSpace

Door → ConnectionSpace or ConnectionBoundary
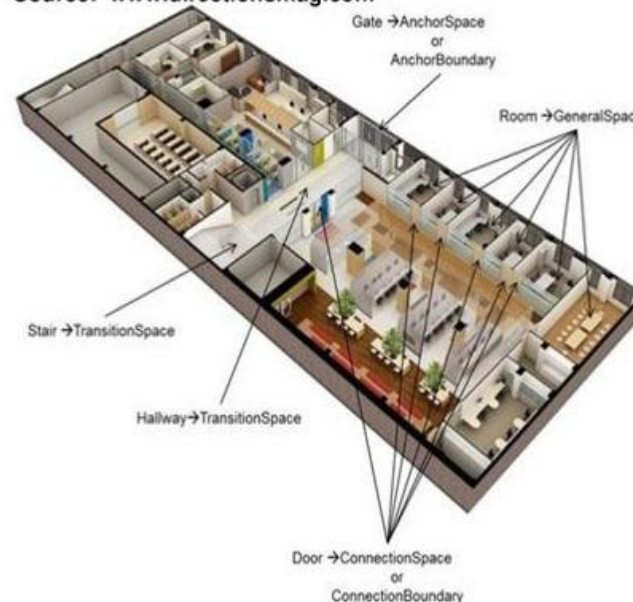
- Urban Planning / Operations
- Emergency Mgt / Response
- Transportation / Routing / Logistics
- Indoor navigation
- Retail Site analysis
- Sustainable / Green Communities
- City Services Management
- Noise abatement
- Telecommunications placement
- Many other uses…

Source:
http://www1.nyc.gov/site/doitt/initiatives/3d-building.page

3D MAPPING DEVELOPMENT

(2) 3D Data Standards and Modelling

3 Stages of 3D Digital Map Development

Stage 2

3D Geometry with Information

Building	**Site**

Existing Topographic Dataset

1

BuildingID

*

FloorPoly

FloorPolyID
BuildingID
EnglishDisplayName
ChineseDisplayName
Headroom
DataSource
LevelSource
BaseLevel
RoofLevel
Notes

FloorPolyID

1   *

UnitPoly

UnitPolyID
FloorPolyID
EnglishUnitDescription
ChineseUnitDescription
UnitUsage
BaseLevel
RoofLevel
Notes
FloorPolyName

3D MAPPING DEVELOPMENT

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(2) 3D Data Standards and Modelling

3 Stages of 3D Digital Map Development

3D Geometry with Information

Stage 2

FloorPoly	
Attribute	**Description**
FloorPolyID	Unique ID
BuildingID	Building which the floor situated at
EnglishDisplayName	English Description (e.g. G/F, 1/F)
ChineseDisplayName	Chinese Description (currently unused)
Headroom	Headroom of the floor
DataSource	Data Source of the information (e.g. building plan, BIM)
LevelSource	Data Source of Floor Elevation
BaseLevel	Base Level of the Floor
RoofLevel	Roof Level of the Floor
Notes	Notes and Remarks

UnitPoly	
Attribute	**Description**
UnitPolyID	Unique ID
FloorPolyID	Indicate the floor polygon it belongs to
EnglishUnitDescription	Description of the unit as stated on plan
ChineseUnitDescription	Description of the unit as stated on plan
UnitUsage	Usage of the unit
BaseLevel	Base Level of the unit
RoofLevel	Roof level of the unit
Notes	Notes and remarks
FloorPolyName	State the floor name where the unit situated

(1) 3D Data Standards and Modelling

CIC (Task Force on BIM Standards Phase 2)

1. Standards for common BIM procedures such as project coordinates, project units model management and file naming convention

2. LOD Responsibility Matrix that sets out potential modelled elements by discipline and attaches a CAT Code to those elements.

DevB

1. BxP Execution Plan Template to advise the modelling methodology for discipline by providing examples of different elements typical for each discipline's model and associated an object type to that specific element.

2. Update the DevB TC No.16/2000 for as-built and design BIM data

(2) 3D Data Standards and Modelling

3 Stages of 3D Digital Map Development

Address Data Infrastructure

2D GeoAddress (2019)

- an identifier to linking services and address related information maintained in B/Ds

3D GeoAddress Code (under planning)

- matching the proposed 2D GeoAddress
- unique identifier in floor and unit levels
- facilitate the development of more innovative applications

3D MAPPING DEVELOPMENT

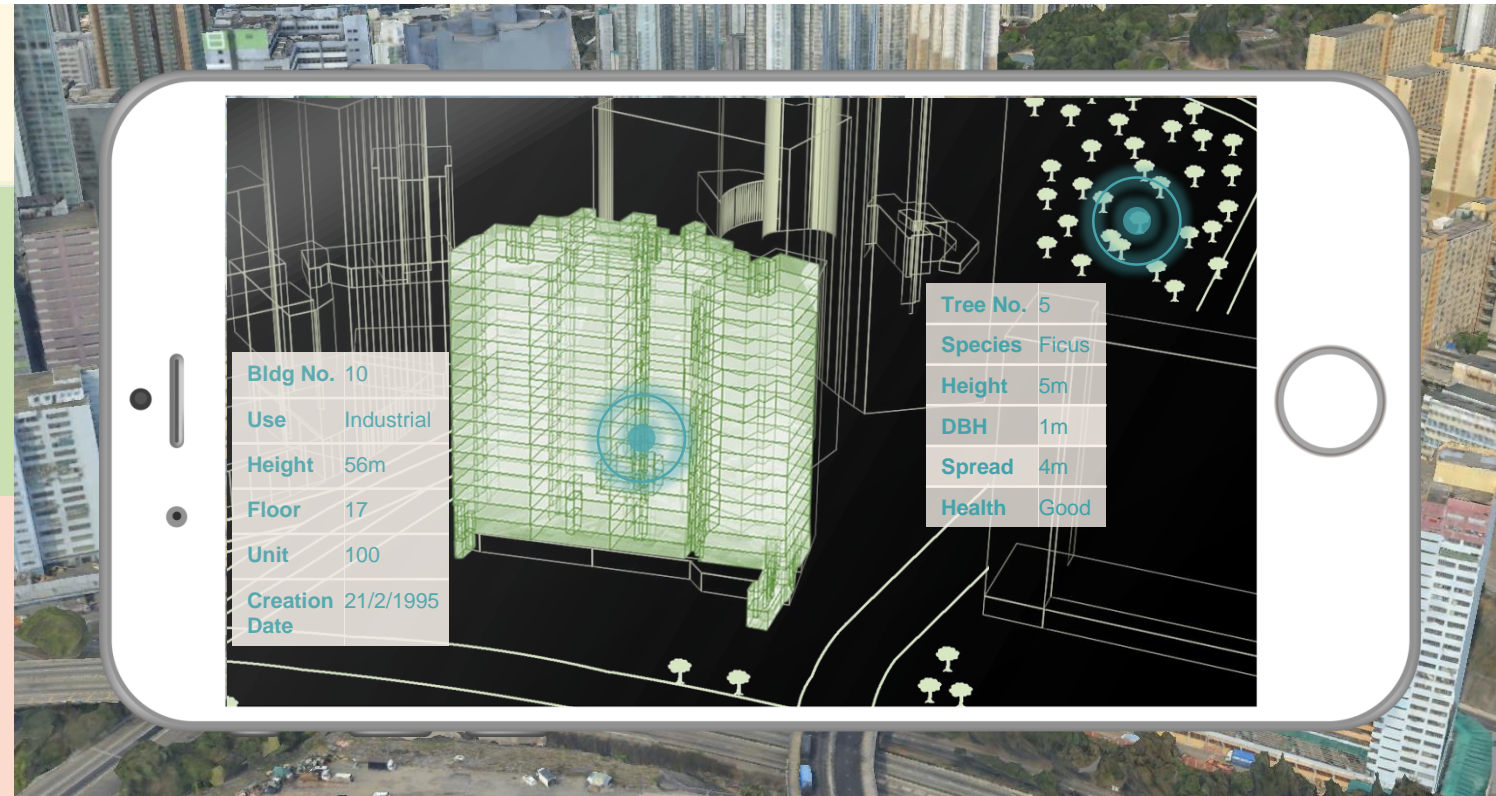# (2) 3D Data Standards and Modelling
3 Stages of 3D Digital Map Development

Stage 1
- 3D maps for visualization

Stage 2
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Stage 3
- 3D maps for city modelling

Bldg No.	10
Use	Industrial
Height	56m
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Unit	100
Creation Date	21/2/1995

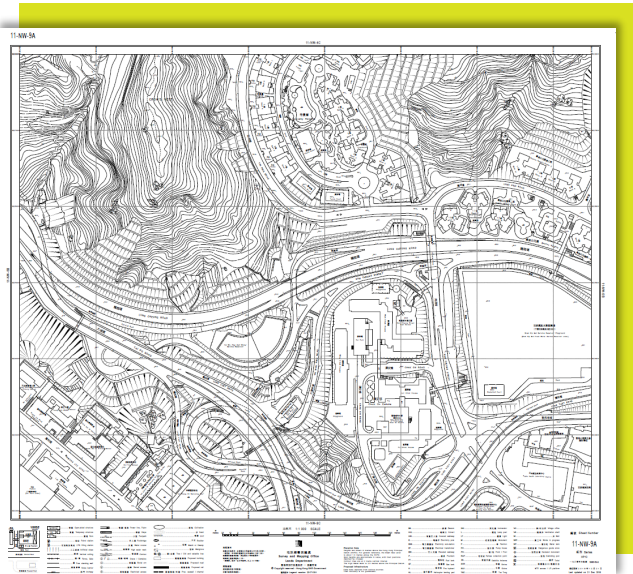| Tree No. | 5 |
Species	Ficus
Height	5m
DBH	1m
Spread	4m
Health	Good

Comprehensive 3D Map Objects

3D MAPPING DEVELOPMENT

(2) 3D Data Standards and Modelling
Study on 3D Digital Map Development

- International / national mapping standards
- Technology edge on 3D mapping
- Interview stakeholders
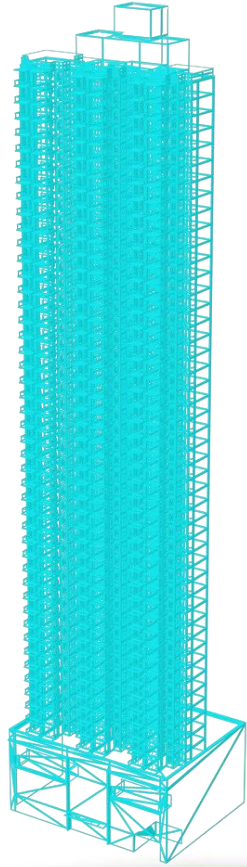
1:1000 Digital 2D Topographic Map (235 Features)

(3) 3D Data Sharing

3D MAPPING DEVELOPMENT

(3) 3D Data Sharing

Provision of Services for the Study on Integration of BIM data and 3D Spatial Data

2017 – – – – **2018**

Purpose
To create a BIM-friendly data environment to facilitate works and land development processes

Provision of Service Contract
LandsD started a project for the study on Integration of BIM Data and 3D Spatial Data in March 2017 and completed in March 2018

(3) 3D Data Sharing

Provision of Services for the Study on Integration of BIM data and 3D Spatial Data

Interviewees

Project Steering Committee

Development Bureau

Construction Industry Council

Government Departments

Contractor Project Team

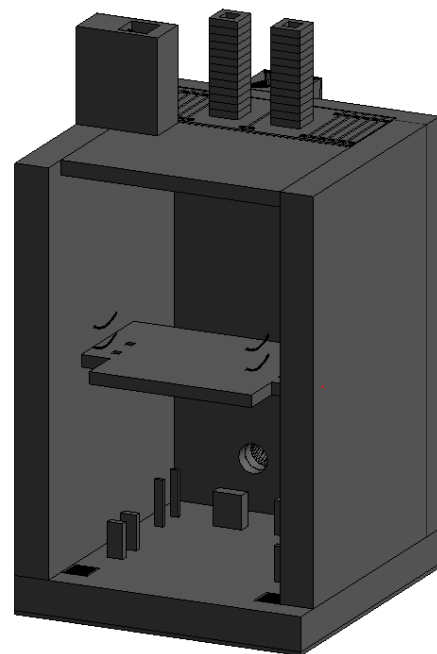Project Manager

BIM Specialist

GIS Specialist

System Analyst

3D MAPPING DEVELOPMENT

BIM data sharing for 3D map updating

Simplification Result
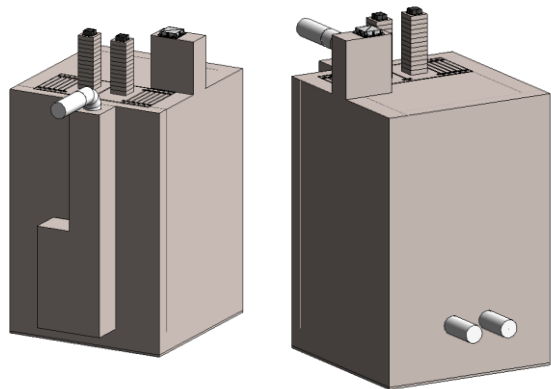
▲ Source BIM Data

▲ Simplified BIM Data
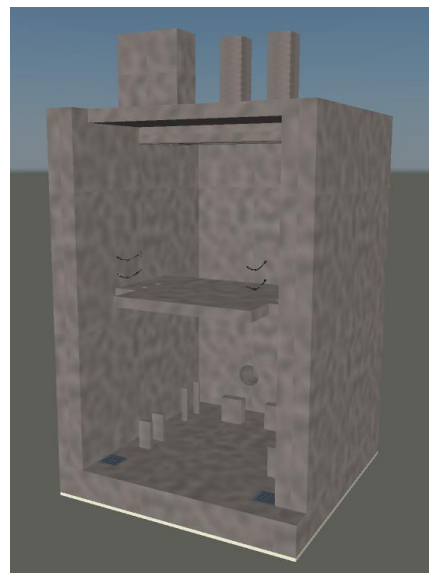
▲ Simplified FBX
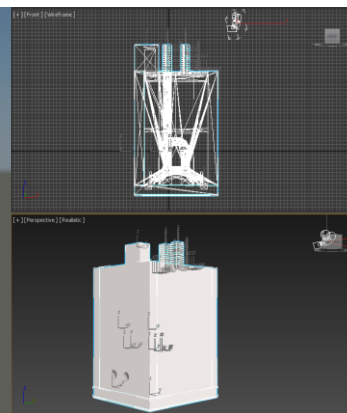
▲ ArcGIS & Skyline 3DSD

3D MAPPING DEVELOPMENT

As-built/Simplified BIM Data Repository
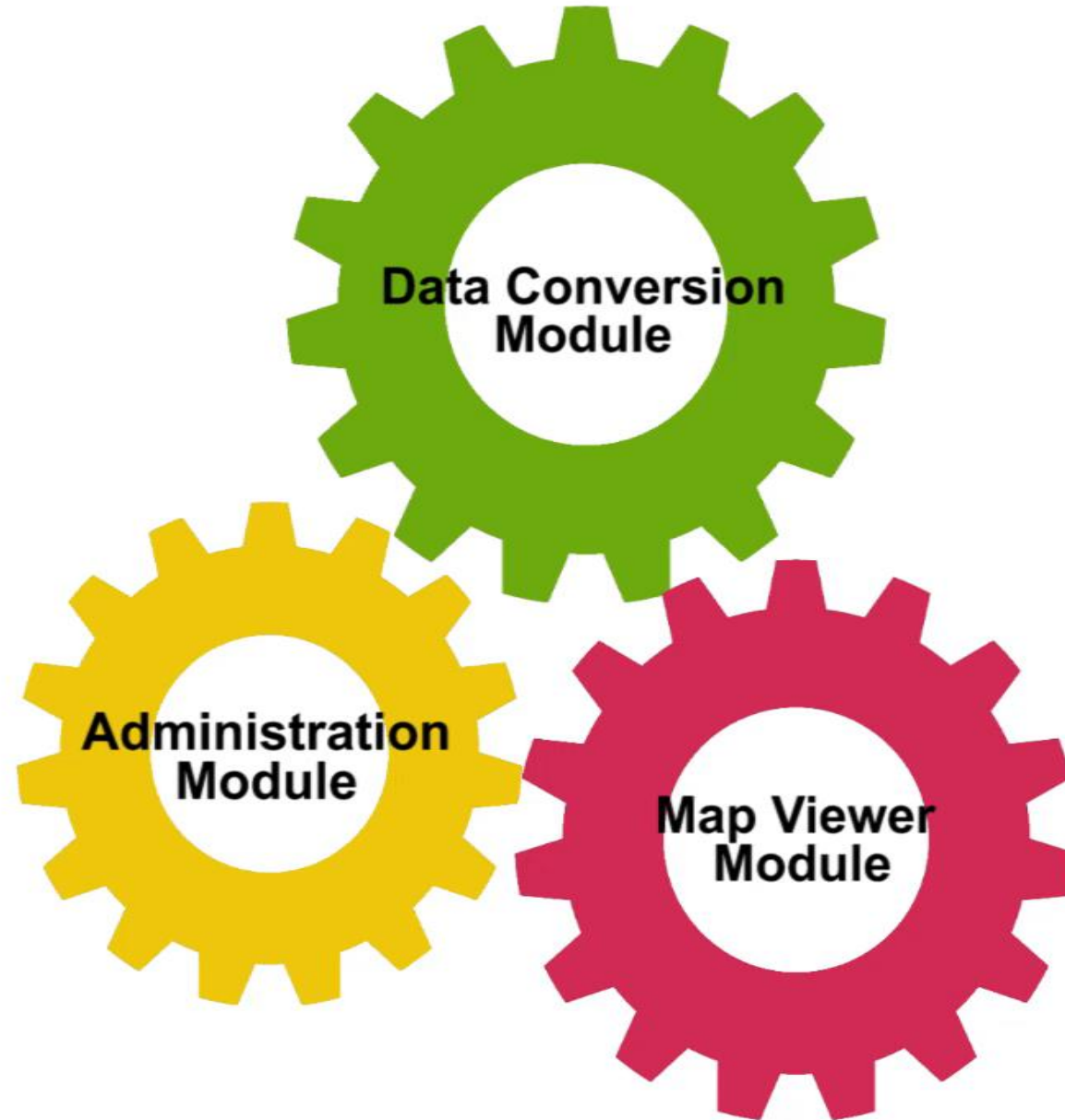
(3) 3D Data Sharing

Release new BIM compliant data formats for 3D Spatial Data

NEW

2019

FBX format

IFC, CityGML or other formats (Proposing)

Source: Autodesk

3D MAPPING DEVELOPMENT

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(3) 3D Data Sharing

Establish Building Information Modelling (BIM) Data Repository

2018

2019

Start Design and As-built Data Management System

- Define simplified BIM Standard
- Establish BIM Data Repository for map updating and proptech

- As-built/Simplified BIM Data Repository Prototype
- Revise Works Bureau Technical Circular No. 16/2000 –Provision and Collation of Land Survey and Mapping Data

(3) 3D Data Sharing

Announce 3D Spatial Data updating schedule in 2019 to avoid duplication of work on 3D model creation and encourage data sharing

(3) 3D Data Sharing

Types	Number of Existing Buildings (whole territory of HK) 210,000 (about)			
	Buildings (Height >= 10m) 53,000 (about) (25%)		Buildings (Height < 10m) 157,000 (about) (75%)	
	Available in 2019	After 2019	Available in 2019	After 2019
3D Mesh Models (LandsD & PlanD)	45,000 (21%)	8,000 (4%)	87,000 (42%)	70,000 (33%)
Individualized 3D Building Models (LandsD)	28,000 (13%)	25,000 (12%)	18,000 (9%)	139,000 (66%)
Individualized 3D Building Models (Enhanced with Street-level Imagery) (LandsD)	800 (0.5%)	52,200 (24.5%)	nil	157,000 (75%)

3D MAPPING DEVELOPMENT

(3) 3D Data Sharing

Release new type of 3D map product, i.e. 3D Mesh Model

Target 01

About one-third of Hong Kong area covered

Target 02

Whole territory of Hong Kong area covered

(3) 3D Data Sharing
3D Spatial Data publishing / updating schedule

Target 03

50% of about 210,000 individualized building models updated in **Level 2** / **Level 3**

Target 04

All individualized building models updated in **Level 2** / **Level 3**

3D MAPPING DEVELOPMENT

3D Data Sharing for Government Departments

3D Spatial Data Viewer for LandsD

3DXplorer in GIH for Government Departments

3D MAPPING DEVELOPMENT

(3) 3D Data Sharing

3D Digital Map forms the basis of essential spatial data and supports Common Spatial Data Infrastructure, CSDI
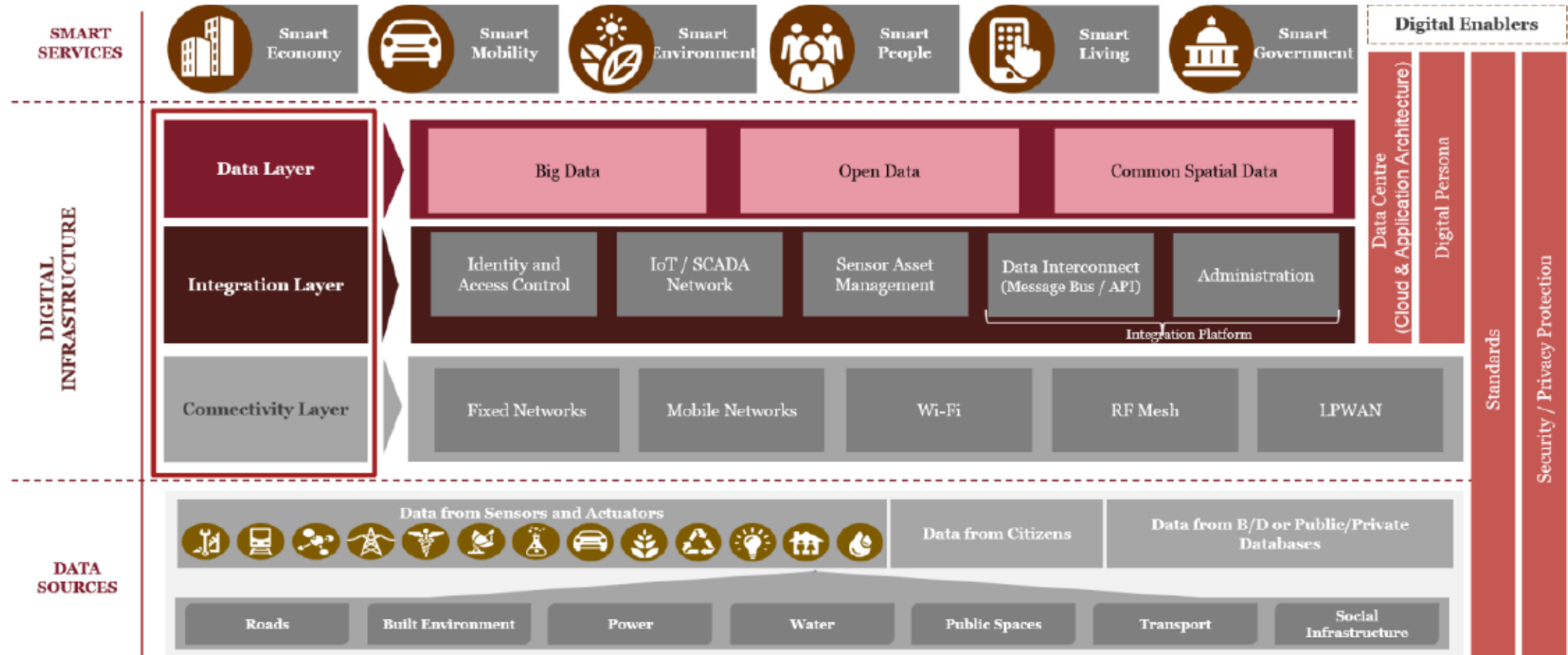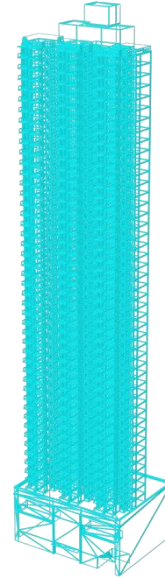

CSDI Digital Framework

(3) 3D Data Sharing
Technology Convergence

Supported by 3D Digital Map

Collaboration with BIM

Property Technology (PropTech)

ICMS, IPMS, ILMS Standards
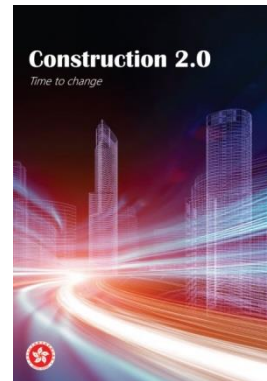
Construction 2.0

CSDI Consultancy Study Institutional Framework

CSDI – Digital Infrastructure for Smart City

A Bridge between Digital and Real World - Digital Twin

Data Modeling

Decision Making

Smart City
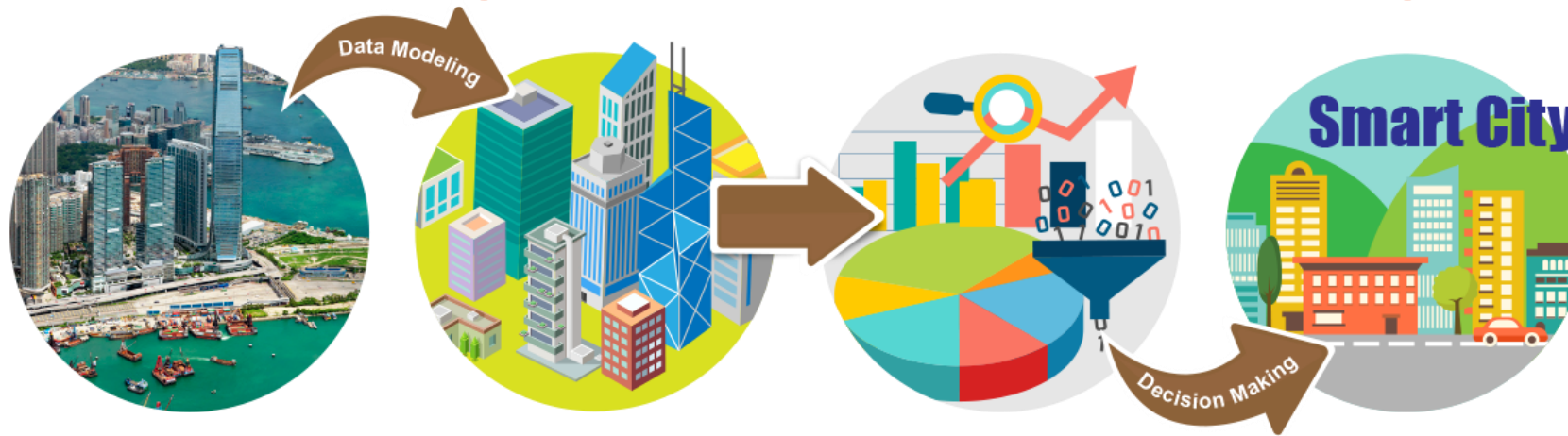
With the support of three building blocks
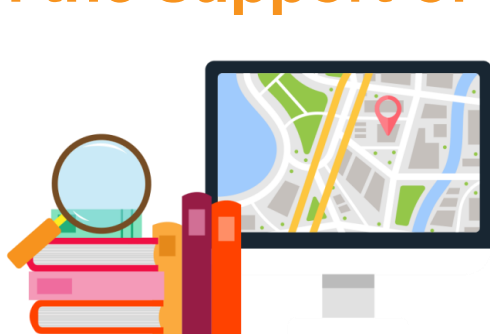
CSDI Portal

3D Digital Map

Positioning infrastructure

Overseas example

- National SDI (NSDI) for the United States
- INSPIRE(NSDI) for the European Union
- Abu Dhabi SDI
- National SDI for Singapore

3D MAPPING DEVELOPMENT

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What is the future 3D Map ?

Example : Helsinki's 3D City Models

The models are available as open data

Source:
https://www.hel.fi/helscinki/en/administration/information/general/3d/3d

2 Types of 3D Model
- 3D Reality Mesh Model
- CityGML 3D Information Model
  - ▲ includes a terrain model and individualized building models
  - ▲ buildings are presented in two formats: LoD1 - flat-roofed LoD2 - with differentiated roof structures and textured

Citizenry / City officials / Companies / Innovators

Pilot portfolio

Open 3D data

UNITY

DATA UTILIZATION   3D Web services   New work practices   Service and product Innovations

3D SPATIAL DATA INFRASTRUCTURE   3D REALITY MESH MODEL   CityGML 3D INFORMATION MODEL

DATA MAPPING LAYER / Import / Export / Update

GIS DATA   Point Clouds   Oblique Images   GIS DataBases   Registers   IFC / InfreModel   New Geodata

3D MAPPING DEVELOPMENT

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What is the future 3D Map ?

Example : Berlin's 3D City Models

- Fully textured
- Individualized building models created by aerial photogrammetry and their roofs were measured with lasers
- Various 3D formats including CityGML format

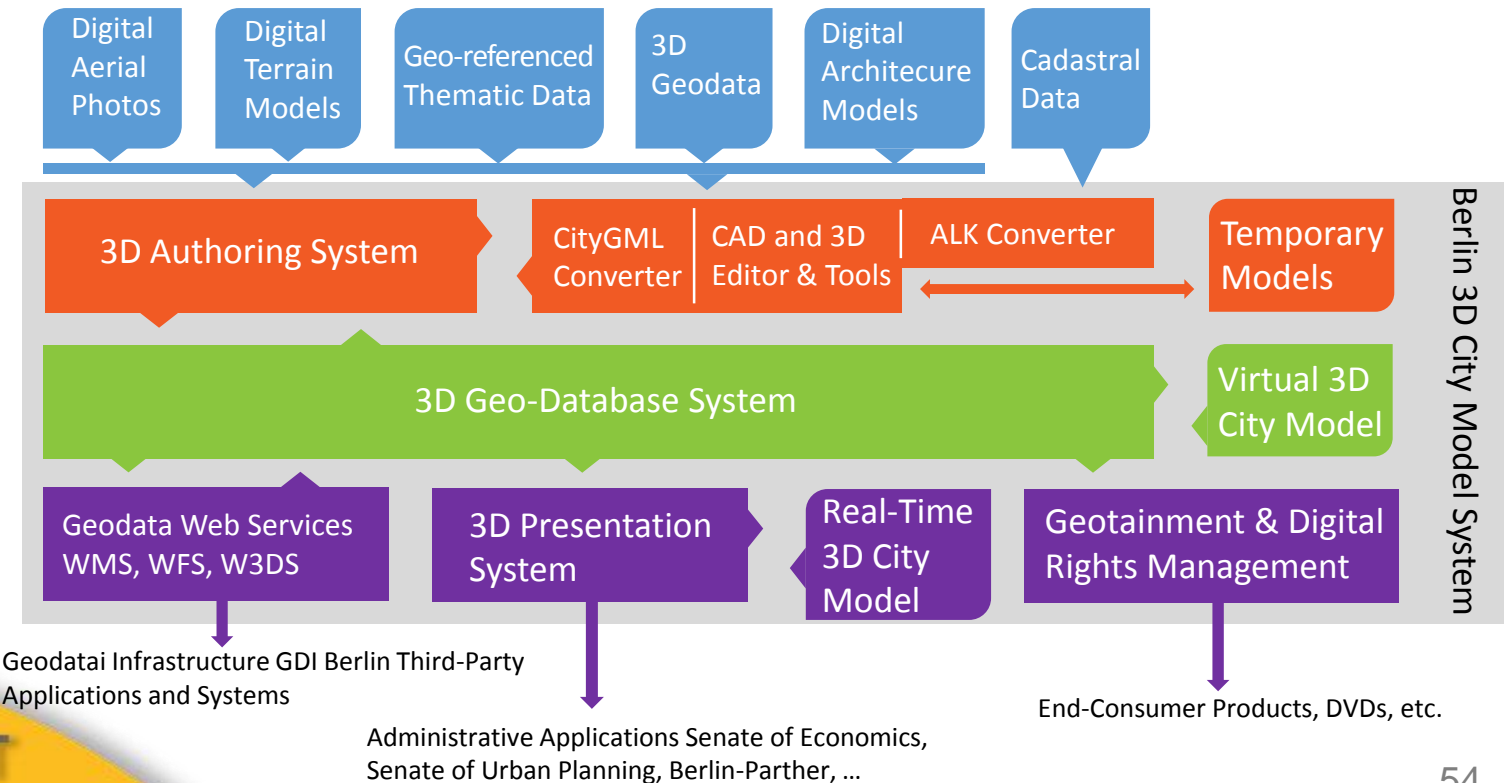The models are free of charge, available for download in the Berlin 3D download portal

Source:
https://www.businesslocationcenter.de/en/WA/B/seite0.jsp

Berlin 3D City Model System

| Digital Aerial Photos | Digital Terrain Models | Geo-referenced Thematic Data | 3D Geodata | Digital Architecure Models | Cadastral Data |

3D Authoring System

CityGML Converter | CAD and 3D Editor & Tools | ALK Converter

Temporary Models

3D Geo-Database System

Virtual 3D City Model

Geodata Web Services WMS, WFS, W3DS

3D Presentation System

Real-Time 3D City Model

Geotainment & Digital Rights Management

Geodatai Infrastructure GDI Berlin Third-Party Applications and Systems

Administrative Applications Senate of Economics, Senate of Urban Planning, Berlin-Parther, …

End-Consumer Products, DVDs, etc.

3D MAPPING DEVELOPMENT

What is the future 3D Map ?
Example : Virtual Singapore

- Dynamic 3D city model built of national 3D map developed with the use of LiDAR as well as real-time dynamic data
- Integrates data from government agencies, information from the internet, from IoT devices and sensors
- Various 3D formats including CityGML format

3D MAPPING DEVELOPMENT

Source: https://www.geospatialworld.net/blogs/singapores-smart-nation/

What is the future 3D Map ?
Example : Rotterdam 3D

The models are available as free open data

- 3D representation of the municipality based on a number of key registers, height data, data management and photographs
- Includes buildings, trees, lampposts and cables and pipes
- Various 3D formats including CityGML format

Source: https://www.rotterdam.nl/werken-leren/3d/

3D MAPPING DEVELOPMENT

Collaborations among the Government, Industry, Academia and the Research Sector

3D Data Collection

MMS

UAV

PropTech

3D Modelling

3D Data Sharing

A.I.

3D GeoAddress

3D Mapping Standards

3D Indoor Map

3D Data Capture

BIM

Mesh Model

3D Geometry

Data Formats

CSDI

3D Mapping Standards · MMS · A.I. · 3D Modelling · BIM · 3D Data Collection · UAV · Data Formats · 3D Indoor Map · Mesh Model · 3D GeoAddress · 3D Data Sharing · 3D Geometry · CSDI · 3D Data Capture · PropTech

3D MAPPING DEVELOPMENT

Summary

- The Survey and Mapping Office (SMO) of the Lands Department is **serving the community by providing quality mapping services and products.**

- We will consider the requirements for geospatial information (2D/3D) by:
  - Continuing to play a key role in providing a **reliable, trusted and maintained** geospatial information base; and
  - Providing data that is **accessible, interoperable and standardised**.

- The 3D Digital Map development in Hong Kong requires **collaboration of the Government, Industry, Academia and Research sectors**.

- Together, we can support the Hong Kong Smart City Blueprint and various **smart city** applications and developments.

3D MAPPING DEVELOPMENT
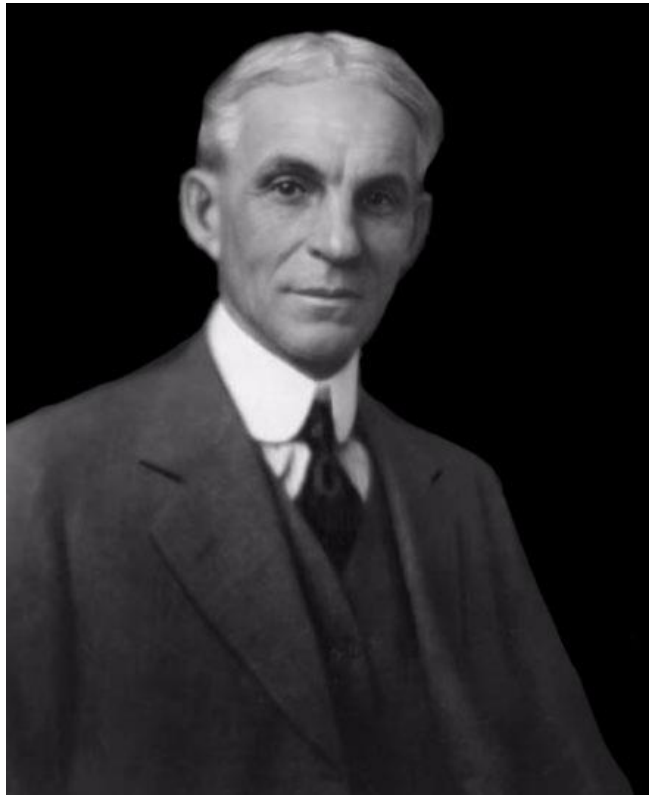
Henry Ford
(the founder of the Ford Motor Company)

"Coming together is a beginning, staying together is progress, and working together is success." - Henry Ford

3D MAPPING DEVELOPMENT