THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

GREAT Smart Cities Institute

FRIDAY SEMINAR SERIES

19 Feb 2021

Geospatial Contribution to Digital Twins for Smart City

Mr. Ben Chan
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Land Surveyor/BIM

Lands Department
Survey and Mapping Office

Challenges and Opportunities

Adoption of Technology

- Support adoption of technology by government departments to improve public services through dedicated funding
- Adopt Building Information Modelling (BIM) for major government capital works projects starting from 2018 and develop Common Spatial Data Infrastructure (CSDI) by 2021 to facilitate sharing of geo-spatial data across government departments and government-to-business (G2B) applications, including the launch of CSDI portal, 3D digital map, electronic submission hub for building plans
- Explore the development of smart city facilities, such as smart lampposts, smart rubbish and recyclables collection bins where appropriate

Opportunities
Tapping into Smart City Development

Challenges and Opportunities (Con't)

Opportunities Tapping into Smart City Development

Progress

Geospatial Lab

Finalising the project brief to invite bids from potential operators in December 2020 — December 2020

Common Spatial Data Infrastructure (CSDI)

Preparations for CSDI portal architecture design and data standardisation underway, with on-going liaison encouraging B/Ds to release as many spatial data as possible. Enhancing Map Application Programming Interface, conducting system analysis and design of Geo-tagging Tool, and preliminary design of District-based Spatial Information Dashboard and Address Data Infrastructure (GeoAddress)

Launch of Map API in Dec 2020, while design for the other three quick wins underway — Dec 2020

3D digital map

The pilot project for 3D digital map in East Kowloon commenced in October 2020 — October 2020

The pilot project for indoor map including 160 selected buildings in East Kowloon, Tsuen Wan and Central commenced in October 2020 — October 2020

Building Information Modelling (BIM) implementation and integration with Geographic Information System (GIS)

Design of the road map and use cases of BIM Data Repository underway

Study of harmonization of BIM standards for works departments underway

Explore the development of positioning infrastructure for smart city applications

Conduct a pilot project in a designated test site to study, evaluate and showcase the requirements and benefits enabled by a precise and seamless positioning infrastructure using Global Navigation Satellite Systems, Wi-Fi and other advanced positioning technologies in smart city applications — Q3 2021

Centre for Digital Built Britain

Gemini Principles

Centre for Digital Built Britain

What we do

National Digital Twin Programme

Resources: The Gemini Principles

Background to the Gemini Principles

Explaining the Information Management Framework (IMF)

Digital Twin Hub

Resources: The Roadmap

Resources: Pathway Towards an IMF

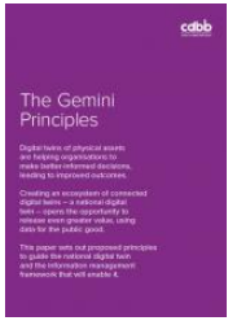
Resources: Top-Level Ontologies and Industry Data Models

Resources: Approach to Delivering an

The Gemini Principles paper, released in 2018, proposes principles to guide the national digital twin and the information management framework that will enable it.

What are the Gemini Principles?

[Download the report]



As an industry we are beginning to understand that data needs to be valued, managed effectively and shared securely. We now need a common set of definitions and principles that can be adopted across the sector to underpin the development of the national digital twin. The Digital Framework Task Group is bringing together stakeholders from government, industry and academia to build a consensus on these definitions and values, which it has called the Gemini Principles.

The Gemini Principles report was published by the Centre for Digital Built Britain in December 2018 to begin enabling alignment on the approach to information management across the built environment, as establishing agreed definitions and principles from the outset will make it easier to share data in the future.

These principles are effectively the conscience of the information management framework and the national digital twin. To ensure that these two initiatives are – and remain – for the public good, they need strong founding values to guide them.

Enshrined in these values is the notion that all digital twins must have clear purpose, must be trustworthy and must function effectively. All the Gemini Principles flow from this. They are deliberately simple, but their implications are far-reaching and challenging. They are descriptive of intent, but agnostic on solutions, to encourage innovation and development over time.

The Gemini Principles

Purpose:
Must have clear purpose

Public good
Must be used to deliver genuine public benefit in perpetuity

Value creation
Must enable value creation and performance improvement

Insight
Must provide determinable insight into the built environment

Trust:
Must be trustworthy

Security
Must enable security and be secure itself

Openness
Must be as open as possible

Quality
Must be built on data of an appropriate quality

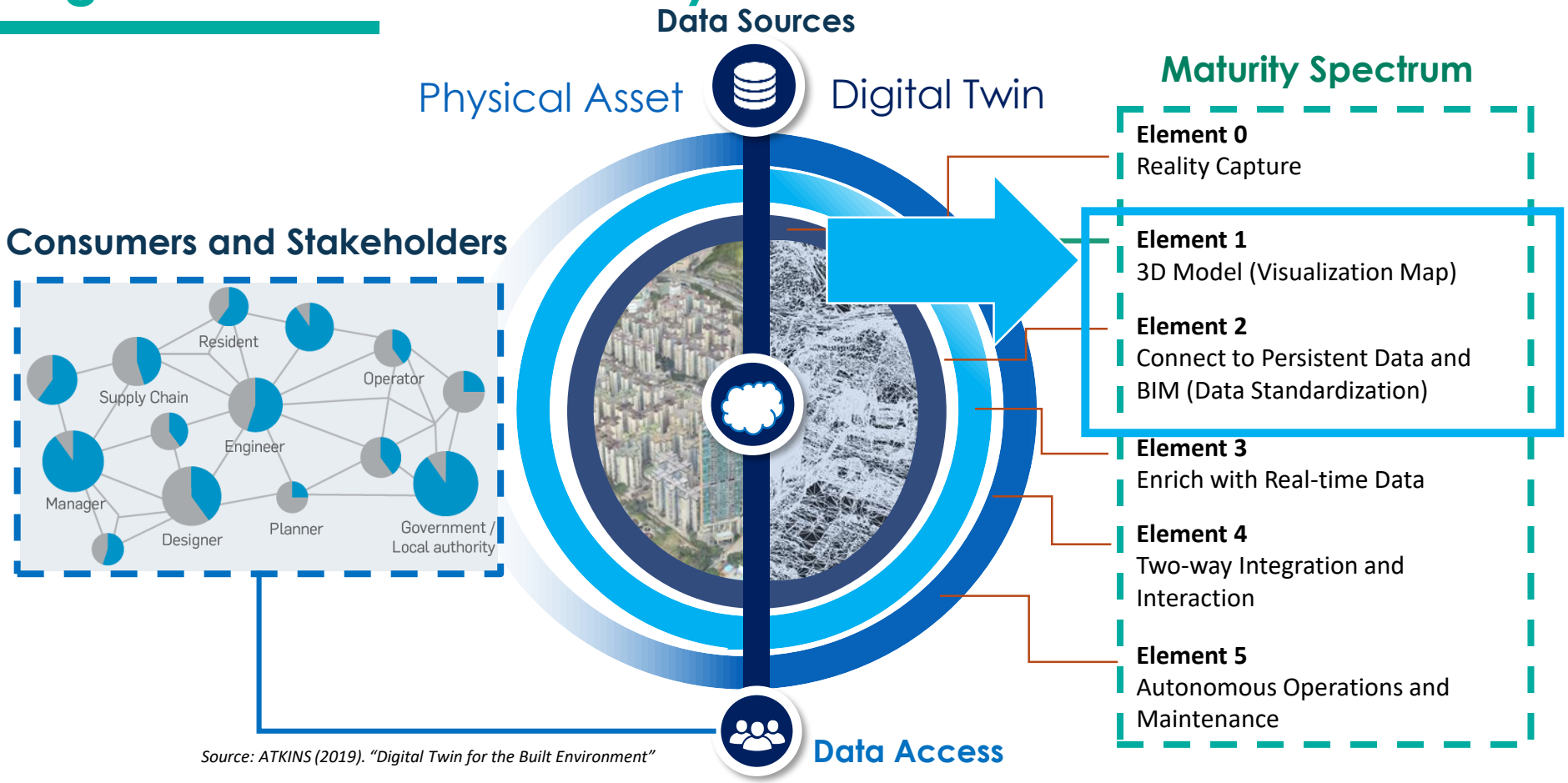
Function:
Must function effectively

Federation
Must be based on a standard connected environment

Curation
Must have clear ownership, governance and regulation

Evolution
Must be able to adapt as technology and society evolve

Digital Twin for A Smart City



Source: ATKINS (2019). "Digital Twin for the Built Environment"

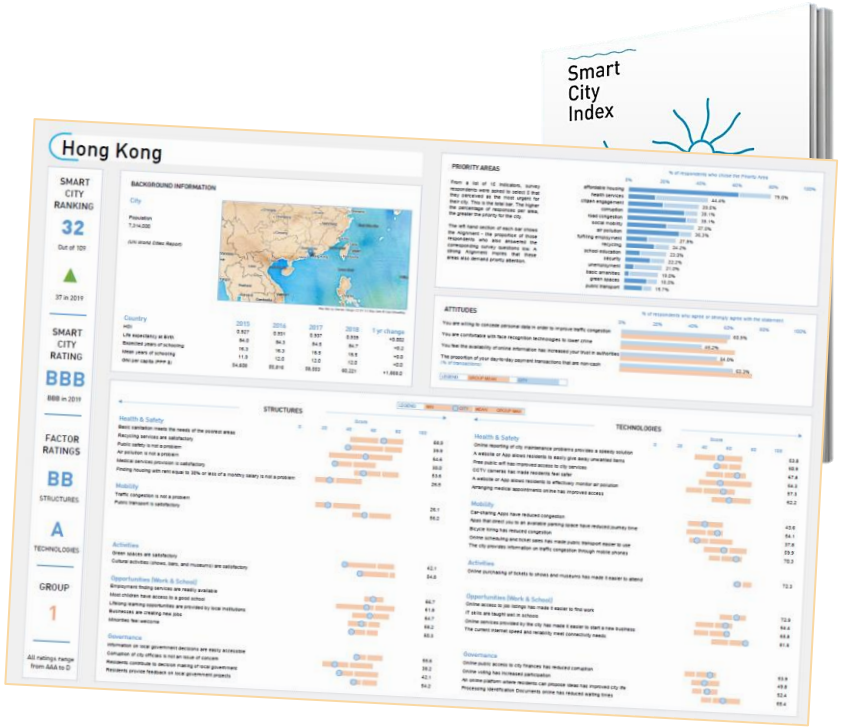
Leading Smart Cities on the use of Spatial Data

Smart City Index 2020 – Institute of Management Development (IMD) and Singapore University for Technology and Design (SUTD)

https://www.imd.org/smart-city-observatory/smart-city-index/

- IMD compared and ranked total 109 cities in the world
- Evaluated five key areas : health, mobility, activities, opportunities and governance of a city
- Assess the perceptions of residents on issues related to existing infrastructures and technology applications available to them in their city

City	Smart City Rank 2020	Change	Smart City Rating 2020	Smart City Rank 2019	Smart City Rating 2019
Singapore	1	— (0)	AAA	1	AAA
Helsinki	2	▲ (+6)	AA	8	A
Zurich	3	▼ (-1)	AA	2	AAA
⋮					
Hong Kong	32	▲ (+5)	BBB	37	BBB



Source: Institute for Management Development (IMD) World Competitiveness Center – Smart City Index 2020

Smart City Index 2020

World leading Smart Cities

City	Smart City Rank 2020	Change	Smart City Rating 2020
Singapore	1	— (0)	AAA
Helsinki	2	▲ (+6)	AA
Zurich	3	▼ (-1)	AA
Auckland	4	▲ (+2)	AA
Oslo	5	▼ (-3)	AA
Copenhagen	6	▼ (-1)	AA
Geneva	7	▼ (-3)	AA
Taipei City	8	▼ (-1)	A
Amsterdam	9	▲ (+2)	A
New York	10	▲ (+28)	A
Munich	11	new	A
Washington D.C.	12	▲ (+19)	A
Dusseldorf	13	▼ (-3)	A
Brisbane	14	▲ (+13)	A
London	15	▲ (+5)	A
Stockholm	16	▲ (+9)	A
Manchester	17	new	A
Sydney	18	▼ (-4)	A
Vancouver	19	▼ (-6)	A
Melbourne	20	▲ (+4)	A
Montreal	21	▼ (-5)	A
Hamburg	22	new	A
Newcastle	23	new	A
Bilbao	24	▼ (-15)	BBB
Vienna	25	▼ (-8)	BBB
Los Angeles	26	▲ (+9)	BBB
San Francisco	27	▼ (-15)	BBB
The Hague	28	▲ (+1)	BBB
Rotterdam	29	▲ (+7)	BBB
Toronto	30	▼ (-15)	BBB
Gothenburg	31	▼ (-3)	BBB
Hong Kong	32	▲ (+5)	BBB
Hanover	33	▼ (-7)	BBB
Dublin	34	▼ (-4)	BBB
Denver	35	▼ (-2)	BBB
Boston	36	▼ (-4)	BBB
Seattle	37	▼ (-3)	BBB
Berlin	38	▲ (+1)	BBB
Phoenix	39	new	BBB
Birmingham	40	▲ (+12)	BBB
Chicago	41	▲ (+12)	BBB
Abu Dhabi	42	▲ (+14)	BB
Dubai	43	▲ (+2)	BB
Prague	44	▼ (-25)	BB
Madrid	45	▼ (-24)	BB
Busan	46	▲ (+4)	BB
Seoul	47	— (0)	BB
Zaragoza	48	▲ (+1)	BB
Barcelona	49	▼ (-1)	BB
Tel Aviv	50	▼ (-4)	BB
Lyon	51	▼ (-28)	BB
Philadelphia	52	▲ (+2)	BB
Riyadh	53	▲ (+18)	B
Kuala Lumpur	54	▲ (+16)	B
Warsaw	55	▲ (+6)	B
Moscow	56	▲ (+16)	B
Ankara	57	▲ (+17)	B
Krakow	58	▲ (+11)	B
Tallinn	59	new	B
Brussels	60	▲ (+4)	B
Paris	61	▼ (-10)	B
Zhuhai	62	▼ (-22)	CCC
Tianjin	63	▼ (-22)	CCC
Chongqing	64	▼ (-22)	CCC
Hangzhou	65	▼ (-21)	CCC
Nanjing	66	▼ (-11)	CCC
Shenzhen	67	▼ (-24)	CCC
Guangzhou	68	▼ (-11)	CCC
Chengdu	69	▼ (-11)	CCC
Bologna	70	▼ (-52)	CCC
Bangkok	71	▲ (+4)	CCC
Medellin	72	▲ (+19)	CCC
St. Petersburg	73	— (0)	CCC
Milan	74	▼ (-52)	CCC
Lisbon	75	▲ (+1)	CCC
Bratislava	76	▲ (+8)	CCC
Budapest	77	▲ (+6)	CCC
Marseille	78	new	CCC
Tokyo	79	▼ (-17)	CCC
Osaka	80	▼ (-17)	CCC
Shanghai	81	▼ (-22)	CC
Beijing	82	▼ (-22)	CC
Ho Chi Minh City	83	▼ (-18)	CC
Hanoi	84	▼ (-18)	CC
Hyderabad	85	▼ (-18)	CC
New Delhi	86	▼ (-18)	CC
Bucharest	87	▼ (-2)	CC
Buenos Aires	88	▼ (-1)	CC
Sofia	89	— (0)	CC
Mexico City	90	▼ (-2)	CC

Source: Institute for Management Development (IMD) World Competitiveness Center – Smart City Index 2020

Findings: Areas that Hong Kong Requires more Effort

For group 1 (highest HDI quartile), scale	AAA–AA–A–BBB– BB
For group 2 (second HDI quartile), scale	A–BBB– BB–B– CCC
For group 3 (third HDI quartile), scale	BB–B– CCC–CC–C
For group 4 (lowest HDI quartile), scale	CCC–CC–C–D

Score: 26/100

Road Congestion

Score: 27/100

Affordable Housing

Score: 30/100

Air Pollution

Score: 40/100

Recycling Services

Score: 42/100

Citizen Engagement in Decision Making

Score: 42/100

Green Space

LEGEND: MIN CITY MEAN GROUP MAX

Source: IMD World Competitiveness Center – Smart City Index 2020

World No. 1 Smart City - Singapore makes use of Spatial Data to Tackle Road Congestion

https://www.smartnation.gov.sg/what-is-smart-nation/initiatives/Transport/open-data-and-analytics-for-urban-transportation-1

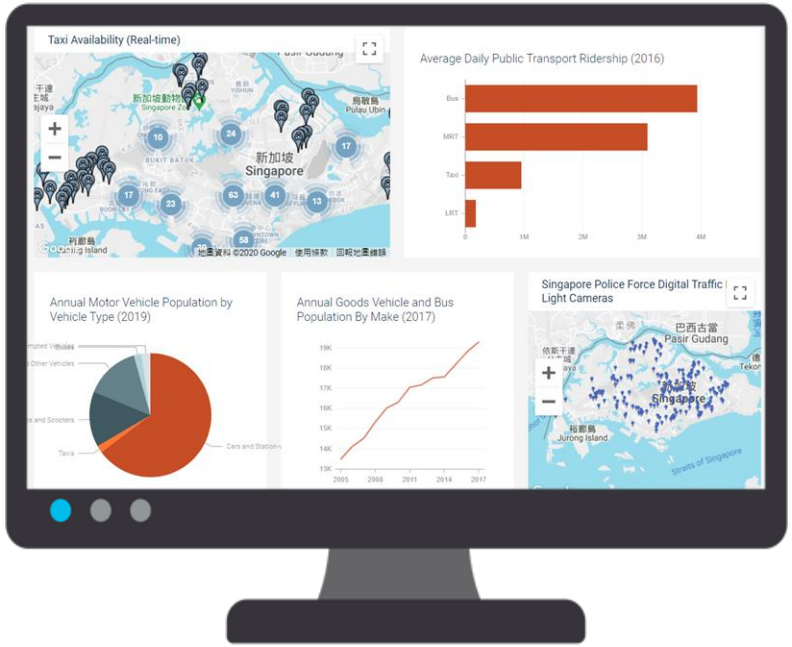
Traffic Condition

Road Works

More than 100 Dataset

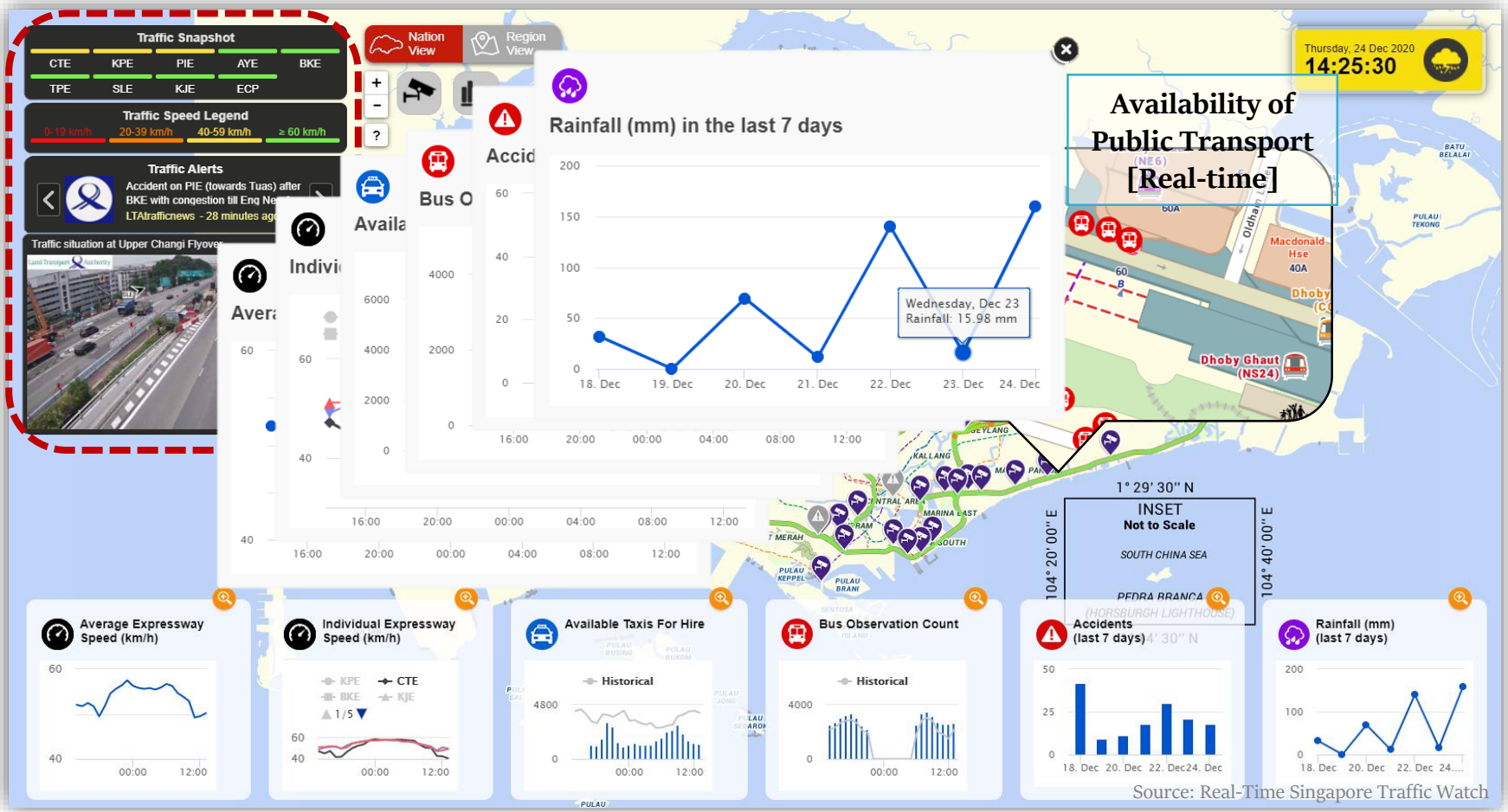
Taxi Availability

Passenger Volume of Stations



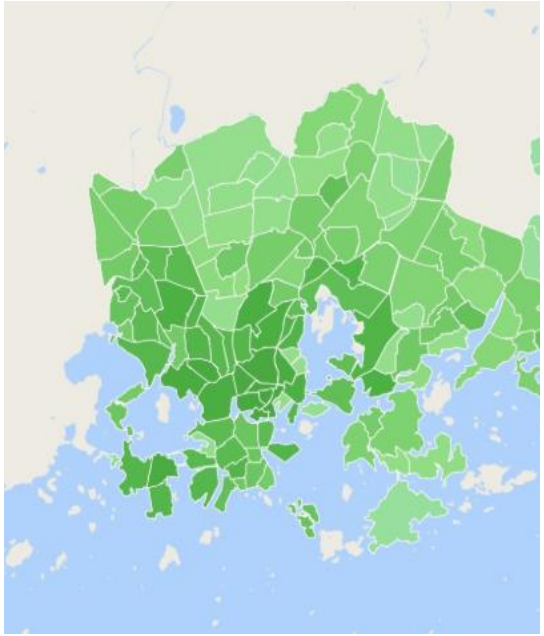
Source: Smart Nation Singapore: Open Data & Analytic for Urban Transportation (2020)

Singapore Traffic Watch



Source: Real-Time Singapore Traffic Watch

World No. 2 Smart City – Helsinki makes use of Spatial Data to show Suitable Living Areas for Family with Children



Oletko harkinnut näitä?

Torkkelinmäki €€€
Myytäviä asuntoja: 9
Palvelut:

Siltasaari €€€
Myytäviä asuntoja: 6
Palvelut:

Vilhonvuori €€€
Myytäviä asuntoja: 10
Palvelut:

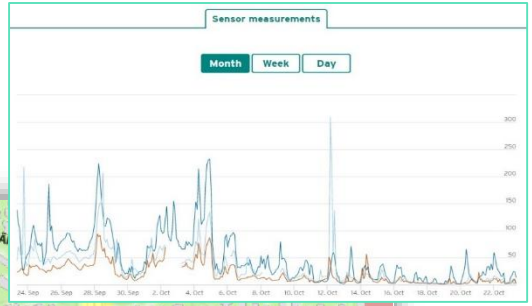
Linjat €€€
Myytäviä asuntoja: 13
Palvelut:

Source: Helsinki Region Infoshare

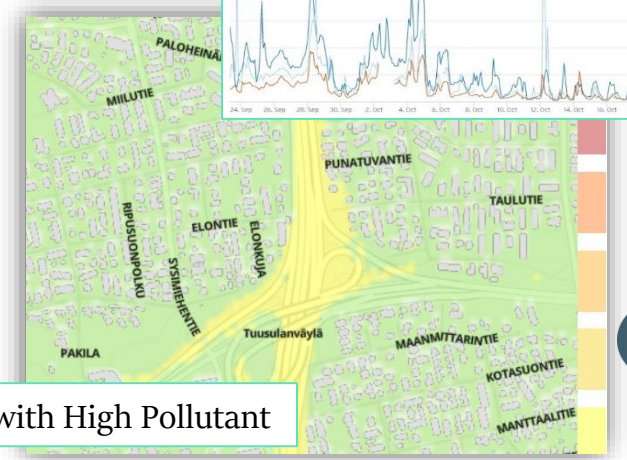
World No.2 Smart City - Helsinki makes use of Spatial Data to Monitor Air Quality

- Different spatial data in Helsinki are related to air quality
  - Metropolitan area air quality index, pollutant statistics
  - Area where annual limit of NO_2 has been exceeded
  - Air quality measurement device installed on trams

Dust from Construction Sites



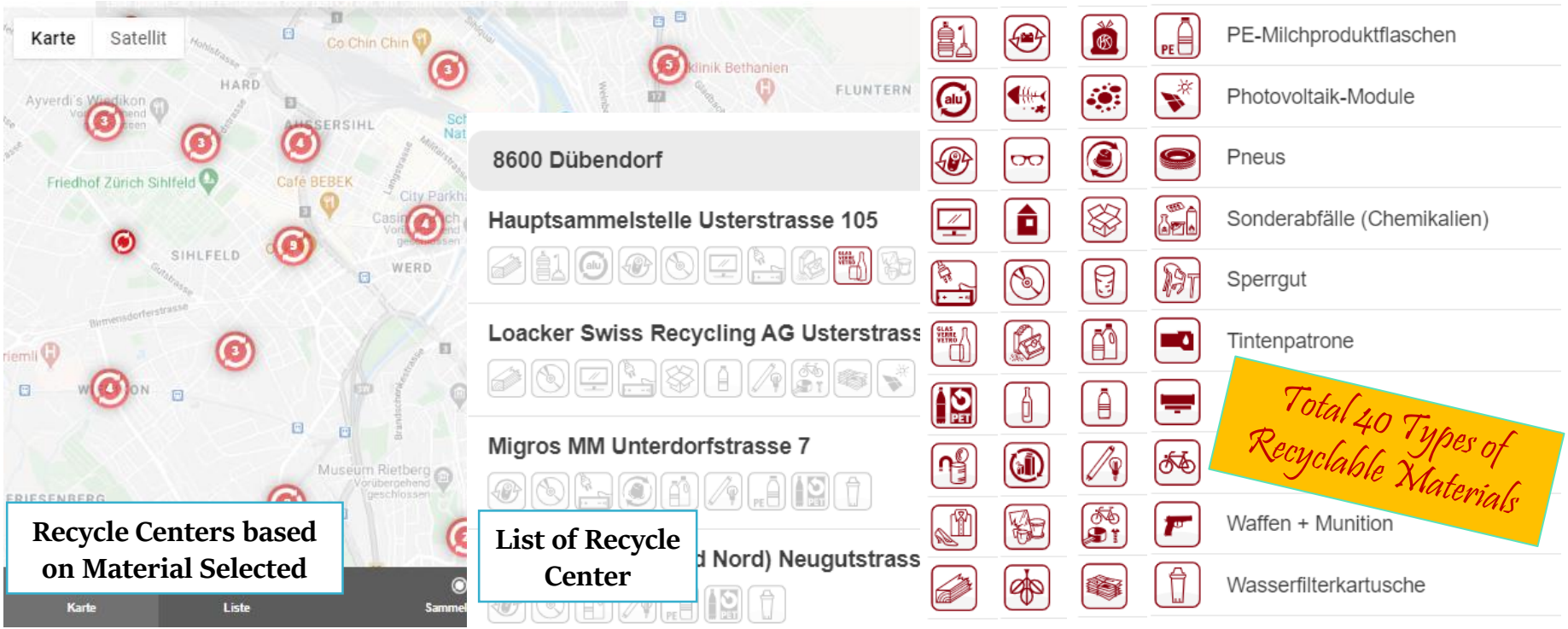
Streets with high NO_2



Map with High Pollutant

Source: Helsingin seudun ympäristöpalvelut HSY – Air Quality and Climate & Helsinki Region - Open Data Service

World No. 3 Smart City – Zurich makes use of Spatial Data to Support Recycling



Source: Recycling Map, IGORA Cooperative

The Geospatial Contribution to Digital Twin

Common Spatial Data Infrastrutcure

3D Digital Map

BIM Data Repository

Common Spatial Data Infrastructure

What is Infrastructure?

General purpose infrastructure like water pipe, gas pipe, electricity network and broadband that are fundamental for daily life activities

Water

Gas

Lighting

Network

10101001001011
10101101110010
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Data as Infrastructure

A strong data infrastructure would enhance the efficiency for data consumption and sharing

Spatial Data

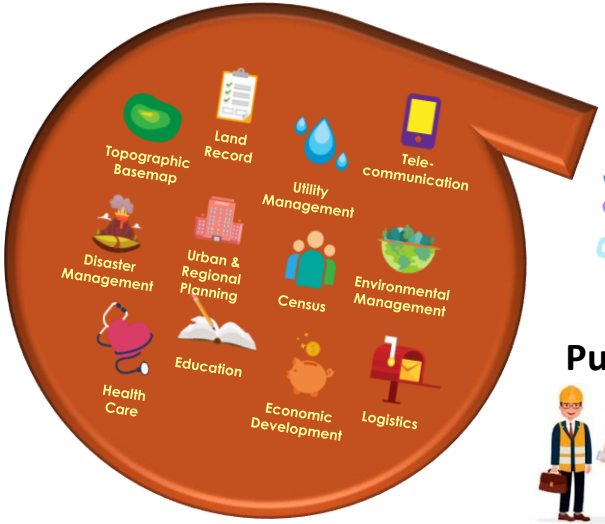
>85% data refers to location and their value can be greatly enhanced through geo-enabling and integration …

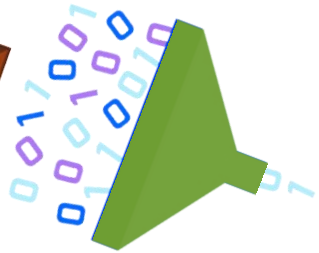
Support applications across virtually all sectors of human activities……

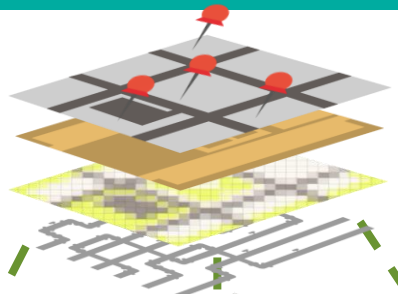
- Topographic Basemaps
- Land Records
- Utility Management
- Telecommunications
- Disaster Management
- Urban & Regional Planning
- Census
- Environmental Management
- Health Care
- Education
- Logistics
- Economic Development

Need for Common Spatial Data Infrastructure

A map-based information infrastructure leveraging GIS technology







Private Sector

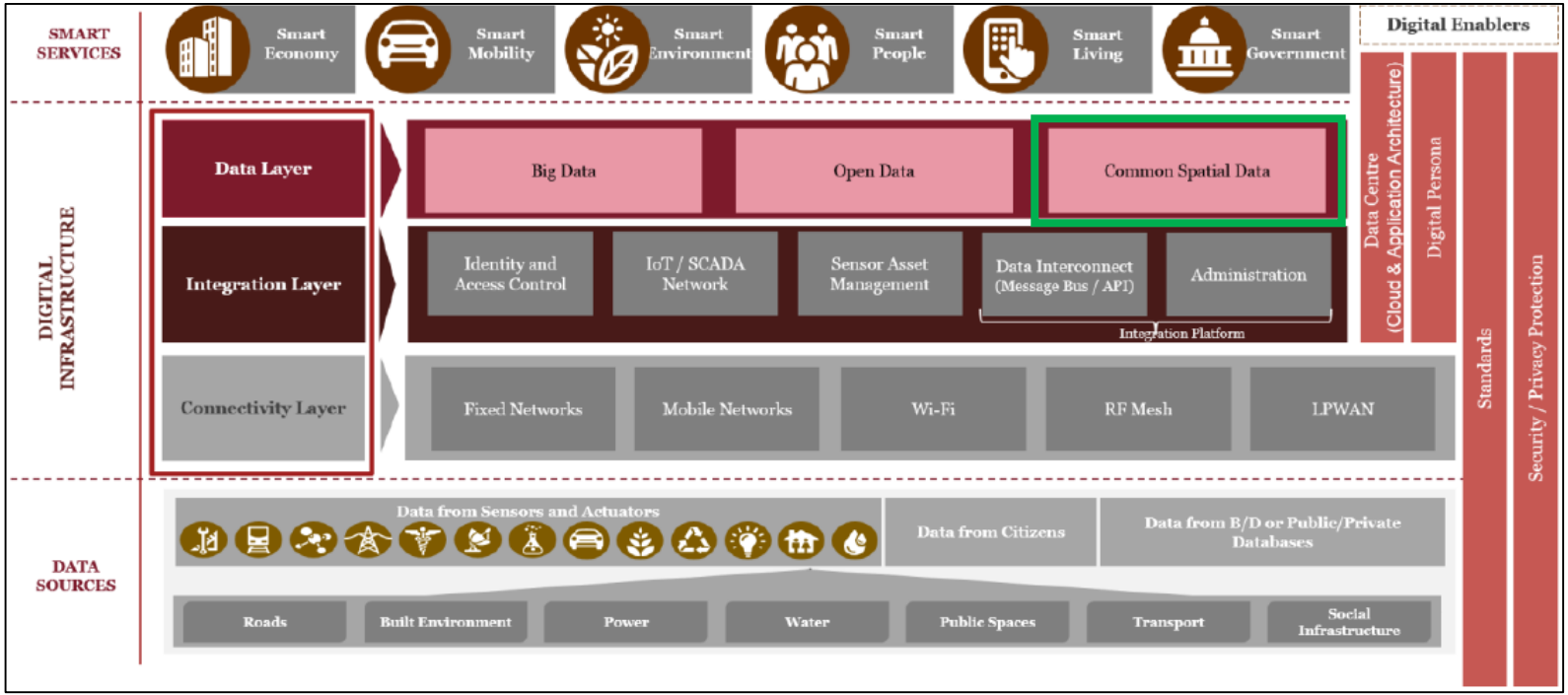
Academic/Research

Public Sector

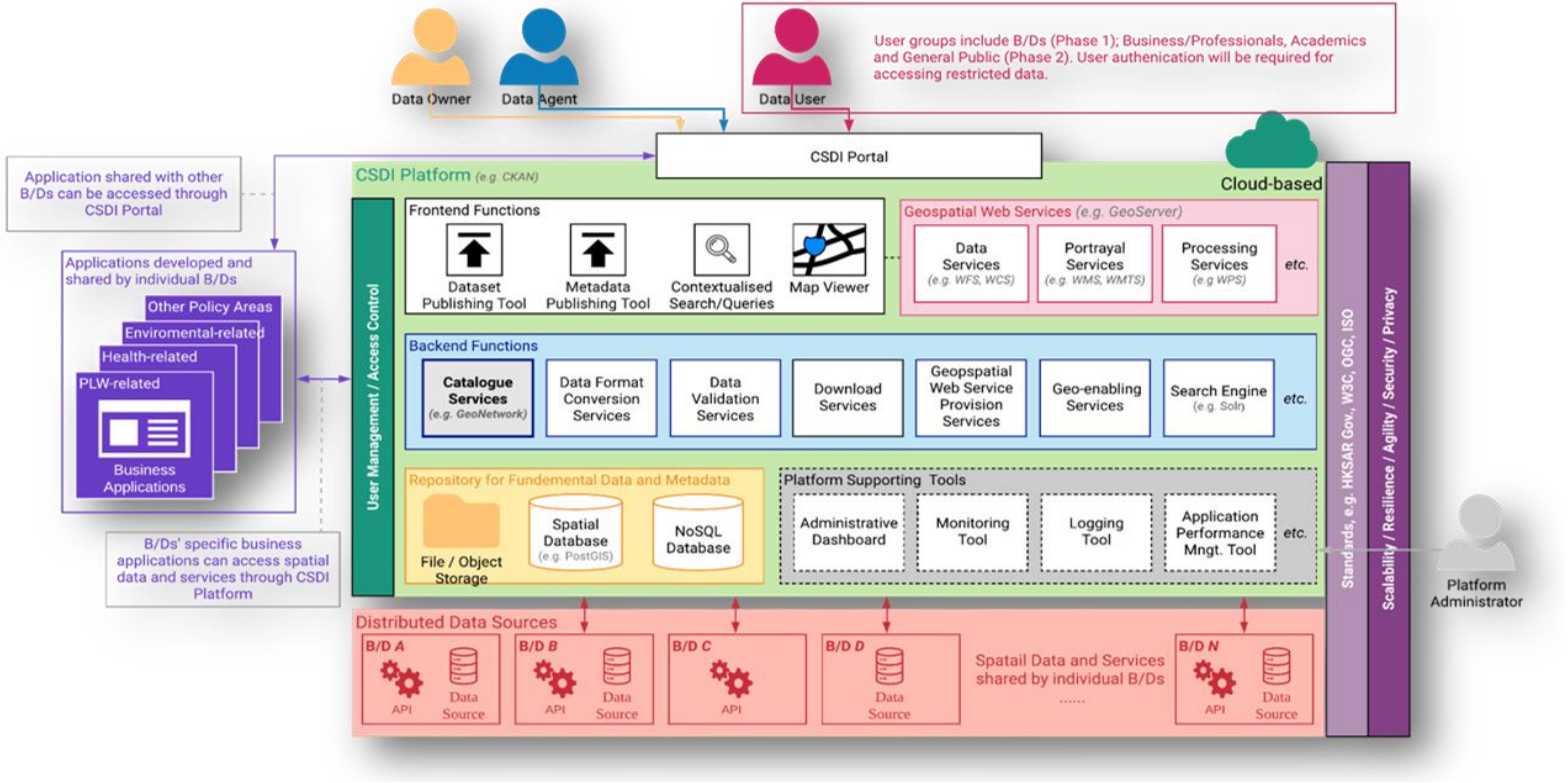
Public/Developers

Spatial data based on agreed standards can be stored, searched, shared, explored, assimilated and analyzed

Generic Digital Framework for Smart City



Architecture of a Common Spatial Data Infrastructure (CSDI) Platform



Evolution of Digital Map From 2D to 3D

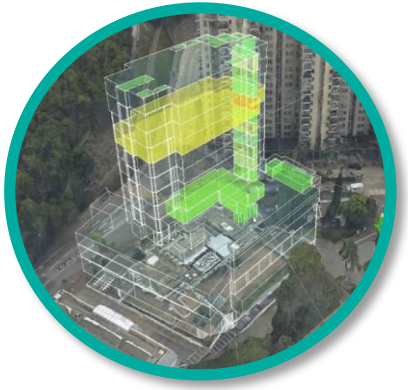
3D Digital Map

3 Stages of 3D Digital Map Development

Stage 1

3D Maps
for Visualization

Stage 2



3D Maps for Unit-based
Indoor Applications

Stage 3

3D Maps for
City Modelling

Stage 1 – 3D Maps for Visualization

HONG KONG GEODATA STORE
香港地理數據站

BIM
Building Information Modelling

Acceptance of BIM Format for General Building Plan (GBP) submission by BD

Feasibility Study on integration of BIM/GIS by LandsD

Collaboration with Construction Industry Council (CIC) on BIM Standards Phase 2

Setting up a BIM Data Repository Prototype by LandsD

Mandatory use of BIM of Works Project over $30M by DevB

Government Policy on BIM Adoption

香港特別行政區政府
The Government of the Hong Kong Special Administrative Region

政府總部
發展局
工務科
香港添馬添美道 2 號
政府總部西翼 18 樓

Works Branch
Development Bureau
Government Secretariat
18/F, West Wing,
Central Government Offices,
2 Tim Mei Avenue, Tamar,
Hong Kong

Ref : DEVB(W) 430/80/01
Group : 2, 5, 6

23 December 2020

Development Bureau
Technical Circular (Works) No. 12/2020

Adoption of Building Information Modelling for Capital Works Projects in Hong Kong

Scope

This Circular sets out the policy and requirements on the adoption of Building Information Modelling (BIM) technology.

2. This Circular applies to works either by government staff, consultants or contractors.

Effective Date

3. This Circular takes effect on **1 January 2021**.

Effect on Existing Circulars and Circular Memoranda

4. This Circular supersedes DEVB TC(W) No. 9/2019.

DEVB TC(W) No. 12/2020 *Page 1 of 17*

LandsD is commissioned to establish the BI Data Repository for storing BIM models from Works Departments

Smart City Planning

18. BIM models contain rich information of built assets which can facilitate the integration between BIM and Geographic Information System (GIS) as well as the development of Common Spatial Data Infrastructure (CSDI).

19. Therefore, WDs shall provide their design and as-built BIM models to LandsD to facilitate the development of the BIM data repository and should ensure that the models are prepared for information sharing according to the harmonised BIM standards, as far as practicable, which is being developed by CEDD and LandsD in a pilot study for a New Development Area (NDA) due for completion in 2021 tentatively.

BIM Horizontal Harmonisation for BIM/GIS Integration

Kwu Tung North

Fanling North

Selection of Kwu Tung North & Fanling North NDA for the Study

- Availability of design BIM model data (Advance Works and First Stage)
- Contain Different Types of Infrastructures from 6 Nos. of Works Departments
  - ArchSD – Visitor Centre of the Nature Park
  - CEDD – Slope
  - DSD – Drainage, Sewerage, Sewage Pumping Station
  - EMSD - Reprovisioning of Temp Wholesale Market
  - HyD – Roadworks
  - WSD – Waterworks, Fresh Water Services Reservoir, Flushing Water Services Reservoir

古洞北 粉嶺北 新發展區
KWU TUNG NORTH / FANLING NORTH
New Development Areas

Establish BIM Data Repository

Sharing of BIM data across WDs

BIM Data Repository Consultancy

- Define Development Roadmap of BIM Data Repository System
- Recommend Data Formats
- Provide functional requirements
- Develop a Proof-of-Concept application of BIM/GIS integration

3D Digital Map

SIX CHALLENGES FACING 3D DATA AS A PLATFORM

State of the Art in 3D City Modelling

Semantically enriched 3D city models have the potential to be powerful hubs of integrated information for computer-based urban spatial analysis. This article presents the state of the art in 3D city modelling in the context of broader developments such as smart cities and digital twins, and outlines six challenges that must be overcome before 3D data as a platform becomes a reality.

3D city models, as digital representations of urban areas, can be used to facilitate many applications, such as urban wind and dispersion simulations, energy studies, noise studies and various types of analysis that require a planned architectural design to be placed in its context (e.g. line of sight and shadow analysis, clash detection with cables and pipelines in the underground, impact of wind circulation, see Figure 1). These 3D models, which also contain semantics, are different from 3D meshes (as found in computer graphics and the gaming world) and from raw point clouds. These can be used for visualization and visual analysis, but they are not suitable for most other spatial analysis purposes.

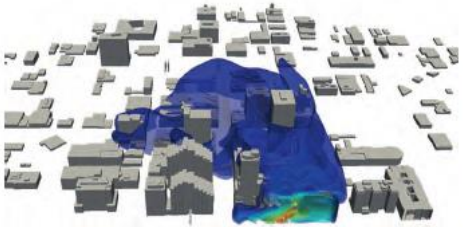


Figure 1: Determining the impact of wind circulation with 3D city models, taken from Garcia-Sanchez (2017).

In order to allow for the development of advanced applications, a 3D city model should describe the geometry and attributes of all the individual elements that are typically present in a city, e.g. the terrain, roads, water bodies and buildings (Figure 2). In addition, relevant semantic information can be included with the geometries, such as the year a building was constructed, the number of people living in it and the construction materials it is made of – all important information to optimize circular economy flows or energy consumption. Such semantically enriched 3D city models potentially represent powerful hubs of integrated information to be used for computer-based urban analysis purposes, including in the context of broader developments such as smart cities and digital twins.

Figure 2: Part of the 3D city model of Valkenburg, the Netherlands. Elements that can be represented in a 3D city model include: buildings, vegetation, water bodies, built-up areas, green areas, roads, etc. (Courtesy: Dutch Kadaster)

Advances in technologies for the collection of 3D elevation information through Lidar and photogrammetry have made it relatively easy for practitioners in different fields to automatically reconstruct 3D city models (see Figure 3 for a couple of examples). These models typically contain mainly buildings, but other object types are increasingly being

ABOUT THE AUTHORS

Prof Dr Jantien Stoter chairs the 3D Geoinformation research group at Delft University of Technology. She also works as innovations researcher at both Kadaster and Geonovum. Jantien did her PhD on 3D Cadastre (2004), received a personal grant from the Dutch Science Foundation on 5D modelling (2011) and was awarded a grant from the European Research Council for her current research on urban modelling in higher dimensions.

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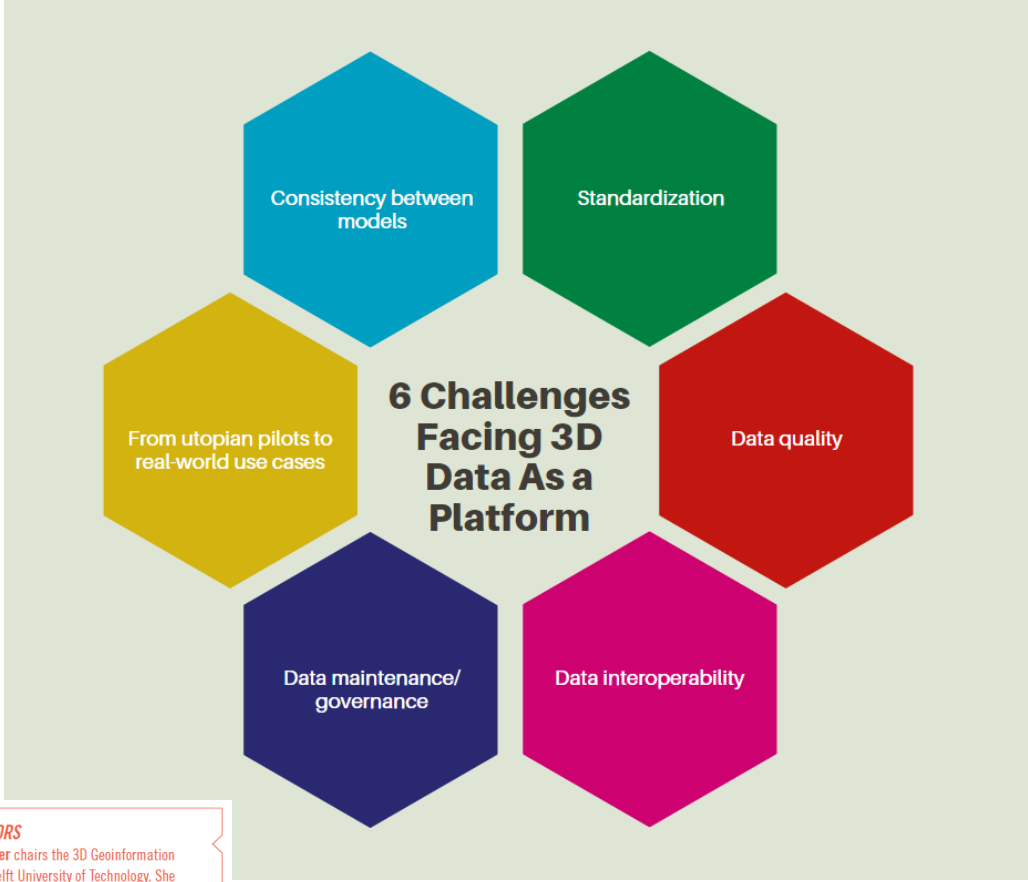
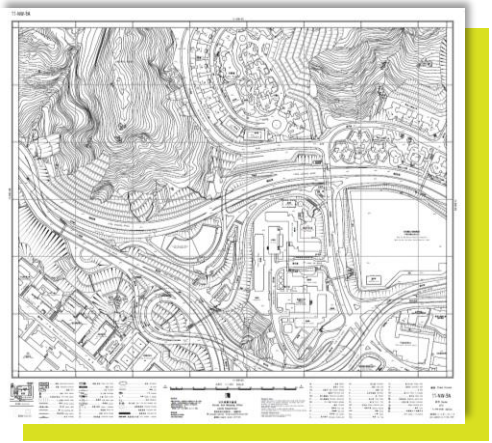


Source: https://www.gim-international.com/content/article/state-of-the-art-in-3d-city-modelling-2

Evolution of Digital Map from 2D to 3D

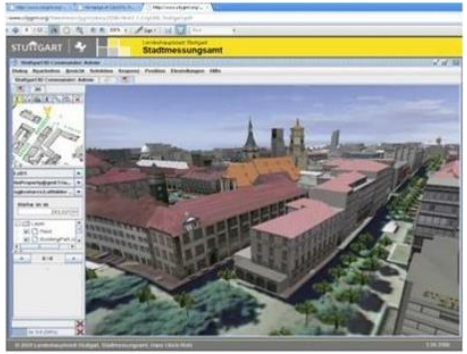
- Invite International Experts to develop the international / national mapping standard for 3D city model (e.g. Open Geospatial Consortium (OGC) Standards)
- Market research of technology edge on 3D mapping
- Interview stakeholders

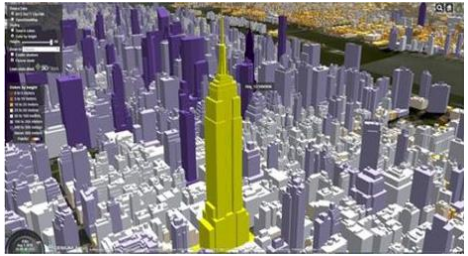


1:1000 Digital 2D Topographic Map

OGC®
Making location count.

In the future (Stage 3) – 3D Maps for City Modelling (Object-Oriented 3D Model)

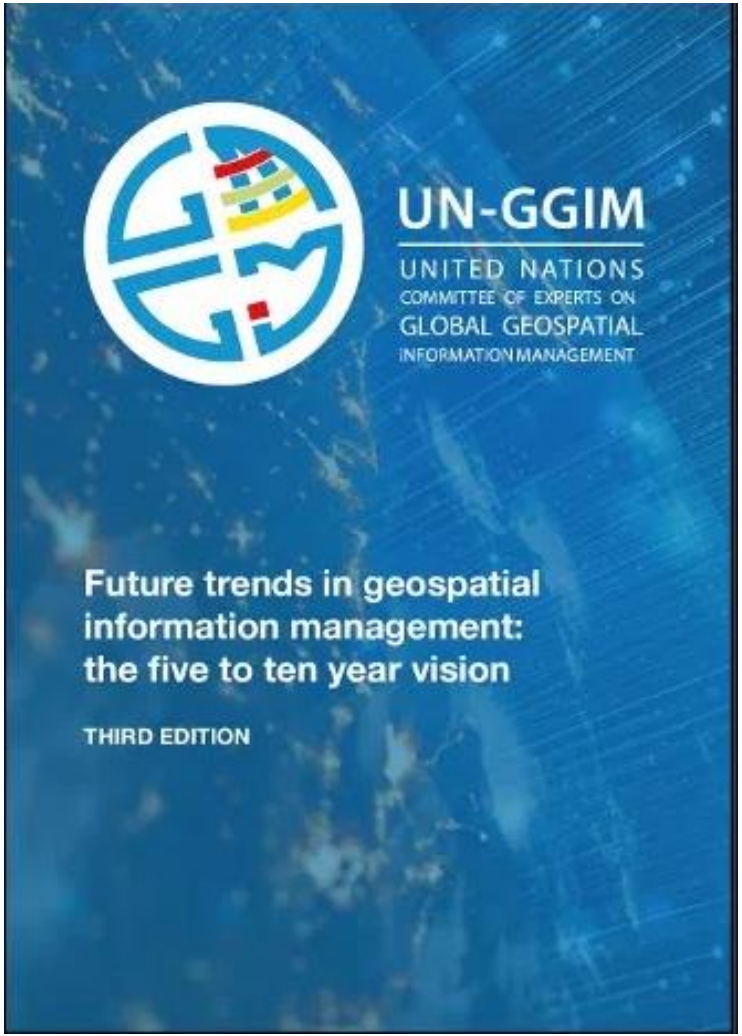




3D City Modelling Standards - OGC CityGML & IndoorGML

- 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



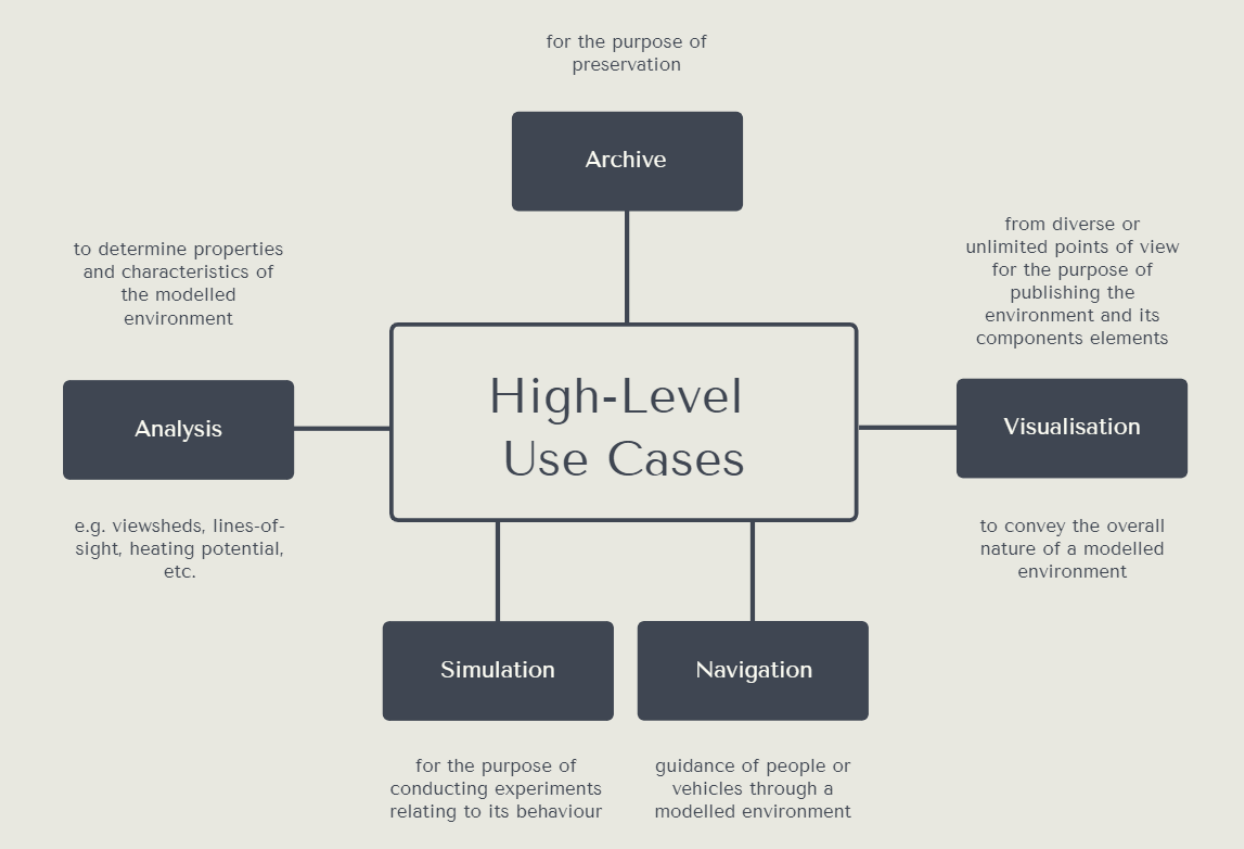
This document was produced by Ordnance Survey of Great Britain at the request of the United Nations Committee of Experts on Global Geospatial Information Management.

Lead author: Christin Walter, Ordnance Survey of Great Britain

Source: https://ggim.un.org/future-trends/

Technology plays a prime role in disrupting the geospatial industry

3D Digital Map – High-Level Use Cases



OGC® Making location count.

High-Level Use Cases

The top-level use cases for CityGML models can be divided into five groups:

- **Archive** is creation and use of a model for the purpose of preservation of the former or current state of an environment, or the preservation of a proposed environment, for example an existing city, an archaeological site, or a new airport. Even though the principle reason for modelling is to capture an environment, archived models will normally also be used in one or more of the following top-level use cases.
- **Visualisation** is generation of views of a modelled environment from diverse or unlimited points of view for the purpose of publishing the environment and its component elements in a way that is well integrated with native human perception of a three-dimensional world, optionally with the flow of time. Visualisation is often the best way to convey the overall nature of a modelled environment.
- **Navigation** is the guidance of people or vehicles through a modelled environment. It may also include the derivation of guidance data, such as IndoorGML, from a model for the purpose of navigation. Semantic structure enables route-finding and guidance in terms of object categories that are directly meaningful to humans. For example, a door can afford transition between two enclosed spaces and a roadway is strong enough, large enough, and smooth enough to afford motion of wheeled vehicles.
- **Simulation** is the use of a model as a substitute for the corresponding real-world environment for the purpose of conducting experiments relating to its behaviour in terms of electromagnetic wave propagation, sound propagation, flooding effects, blast effects, lighting, earthquakes, and other physical processes.
- **Analysis** is the use of a model to determine properties and characteristics of the modelled environment such as solar electric and heating potential, viewsheds and lines-of-sight, obstructions to flight, parcel contents, and other intrinsic joint properties of the modelled elements.

Source: https://github.com/opengeospatial/CityGML-3.0CM

ISPRS Int. J. Geo-Inf. **2015**, *4*, 2842-2889; doi:10.3390/ijgi4042842

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ISPRS International Journal of
Geo-Information
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Review

Applications of 3D City Models: State of the Art Review

Filip Biljecki [1,*], Jantien Stoter [1], Hugo Ledoux [1], Sisi Zlatanova [1] and Arzu Çöltekin [2]

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Academic Editor: Wolfgang Kainz

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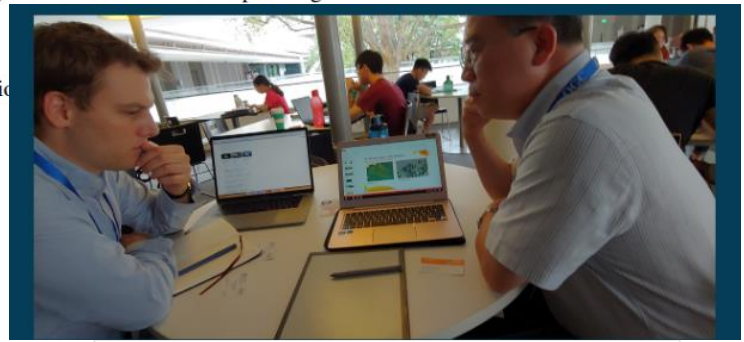
Abstract: In the last decades, 3D city models appear to have been predominantly used for visualisation; however, today they are being increasingly employed in a number of domains and for a large range of tasks beyond visualisation. In this paper, we seek to understand and document the state of the art regarding the utilisation of 3D city models across multiple domains based on a comprehensive literature study including hundreds of research papers, technical reports and online resources. A challenge in a study such as ours is that the ways in which 3D city models are used cannot be readily listed due to fuzziness, terminological ambiguity, unclear added-value of 3D geoinformation in some instances, and absence of technical information. To address this challenge, we delineate a hierarchical terminology (*spatial operations, use cases, applications*), and develop a theoretical reasoning to segment and categorise the diverse uses of 3D city models. Following this framework, we provide a list of identified use cases of 3D city models (with a description of each), and their applications. Our study demonstrates that 3D city models are employed in at least 29 use cases that are a part of more than 100 applications. The classified inventory could be useful for scientists as well as stakeholders in the geospatial industry, such as companies and national mapping agencies, as it may serve as a reference document to better position their operations, design product portfolios, and to better understand the market.

Table 1. Overview of the documented use cases of 3D city models, divided into two groups: non-visualisation and visualisation use cases.

§	Use Case	Example of an Application
4.1.1	Estimation of the solar irradiation	Determining the suitability of a roof surface for installing photovoltaic panels
4.1.2	Energy demand estimation	Assessing the return of a building energy retrofit
4.1.3	Aiding positioning	Map matching
4.1.4	Determination of the floorspace	Valuation of buildings
4.1.5	Classifying building types	Semantic enrichment of data sets
4.2.1	Geo-visualisation and visualisation enhancement	Flight simulation
4.2.2	Visibility analysis	Finding the optimal location to place a surveillance camera
4.2.3	Estimation of shadows cast by urban features	Determination of solar envelopes
4.2.4	Estimation of the propagation of noise in an urban environment	Traffic planning
4.2.5	3D cadastre	
4.2.6	Visualisation for navigati	
4.2.7	Urban planning	

29 use cases
>100 applications



Applications of 3D City Models: State of the Art Review
Filip Biljecki, Jantien Stoter ,Hugo Ledoux, Sisi Zlatanova and Arzu Çöltekin
3D geoinformation, Delft University of Technology, 2628 BL Delft, The Netherlands;
Published: 18 December 2015

Google Is Improving Android's Urban GPS Accuracy

BY FRANK VAN DIGGELEN, PRINCIPAL ENGINEER AND JENNIFER WANG, PRODUCT MANAGER
GOOGLE

At Android, we want to make it as easy as possible for developers to create the most helpful apps for their users. That's why we aim to provide the best location experience with our application programming interfaces (APIs) like the Fused Location Provider (FLP).

However, we've heard from many of you that the biggest location issue is inaccuracy in dense urban areas, such as wrong-side-of-the-street and even wrong-city-block errors.

This is particularly critical for the most-used location apps, such as rideshare and navigation. For instance, when users request a rideshare vehicle in a city, apps cannot easily locate them because of the GPS errors.

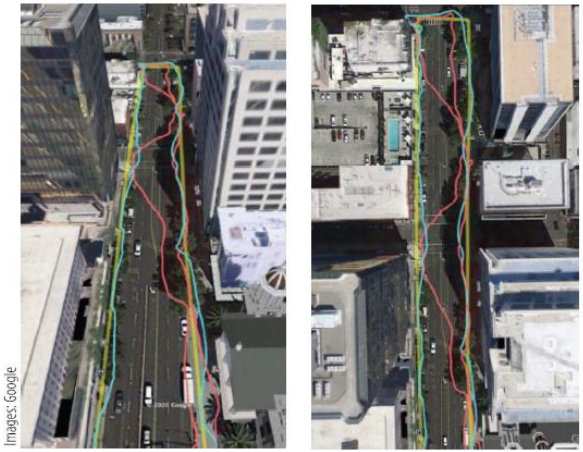
The Last Great Unsolved GPS Problem

This wrong-side-of-the-street position error is caused by reflected GPS signals in cities, and we embarked on an ambitious project to help solve this great problem in GPS. Our solution uses 3D mapping-aided corrections, and can only be done at scale by Google because it comprises 3D building models, raw GPS measurements, and machine learning.

December's Pixel Feature Drop (for Pixel smartphones) adds 3D mapping-aided GPS corrections to Pixel 5 and Pixel 4a (5G). With a system API that provides feedback to the Qualcomm Snapdragon 5G Mobile Platform that powers Pixel, the accuracy in cities — also known as urban canyons — improves spectacularly.

The two images on the next page show that without 3D mapping-aided corrections, the GPS results frequently wander

Photo: swelldf+/Getty Images



Images: Google

PEDESTRIAN TEST. Equipped with a Pixel 5 phone, a pedestrian walks along one side of the street, then the other. Yellow = path followed, red = without 3D mapping-aided corrections, blue = with 3D mapping-aided corrections.

CORRECTIONS MODULE: Tiles with 3D models will be downloaded and cached on the phone.

With the December Pixel Feature Drop, we are releasing version 2 of 3D mapping-aided corrections on Pixel 5 and Pixel 4a (5G). This reduces wrong-side-of-street occurrences by approximately 75%.

Other Android phones, using Android 8 or later, have version 1 implemented in the FLP, which reduces wrong-side-of-street occurrences by approximately 50%. Version 2 will be available to the entire Android ecosystem (Android 8 or later) in early 2021. We will also soon support more modes, including driving.

Android's 3D mapping-aided corrections work with signals from GPS as well as other GNSS: GLONASS, Galileo, BeiDou and QZSS.

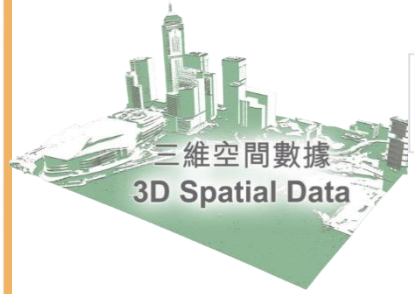
3D Spatial Data of Lands Department (2012)

Launched in 2012

Building Height (>10m)
~53000 models

~215,000 models

~2000 models
~90 major roads

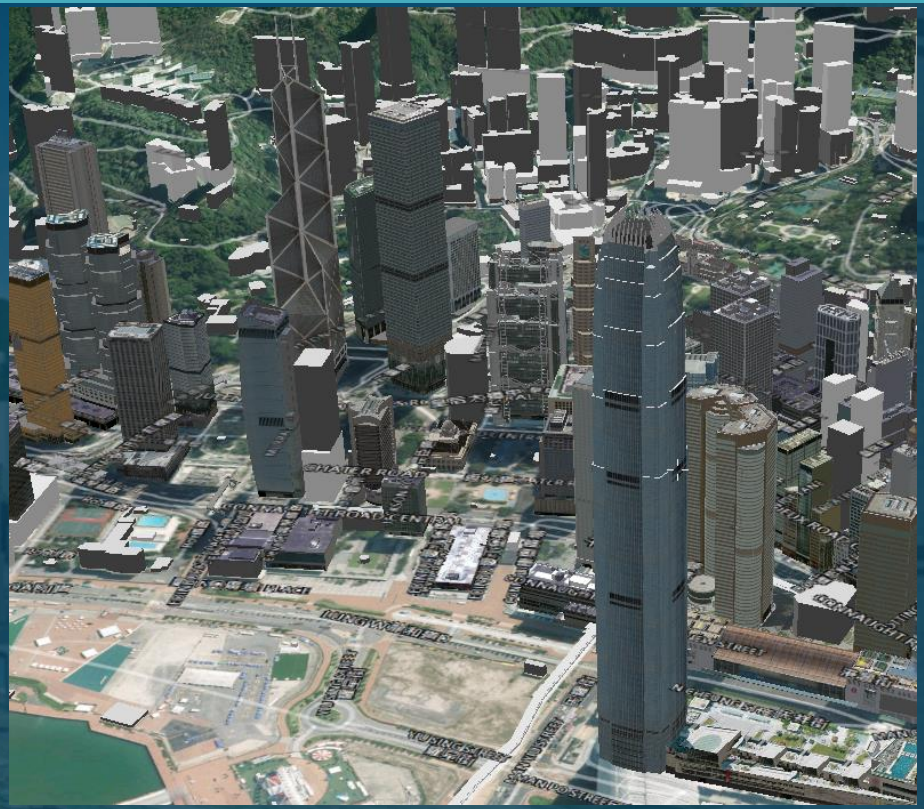


Territory-wide

3D Spatial Data of Lands Department

??%

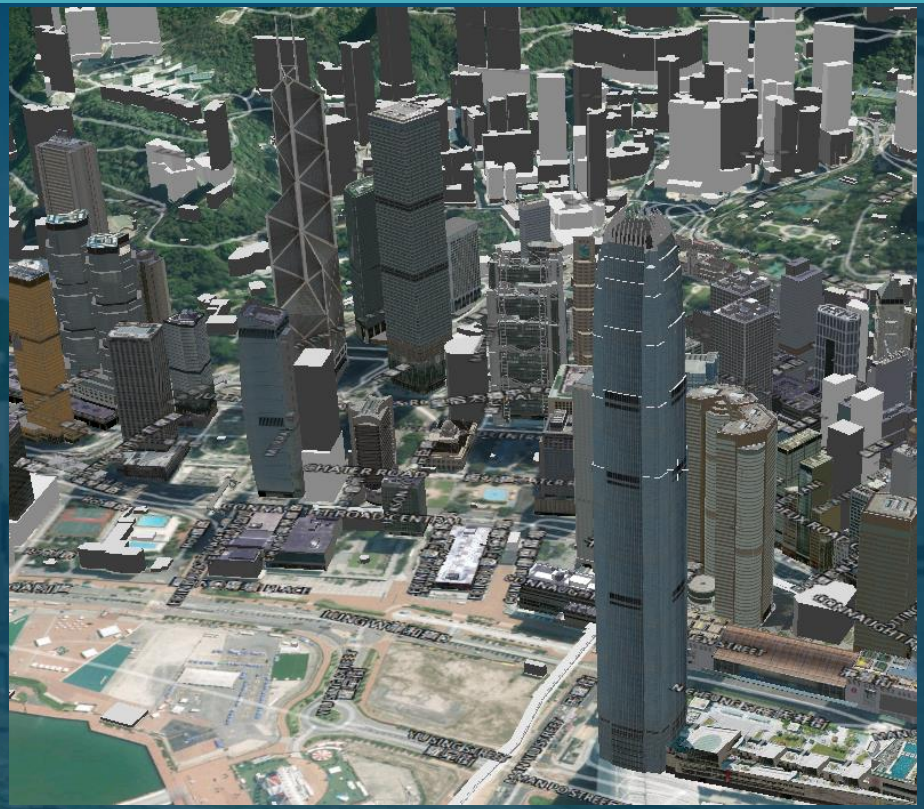
3D INDIVIDUAL BUILDING MODELS
(L2/L3 - PHOTO REALISTIC MODELS)



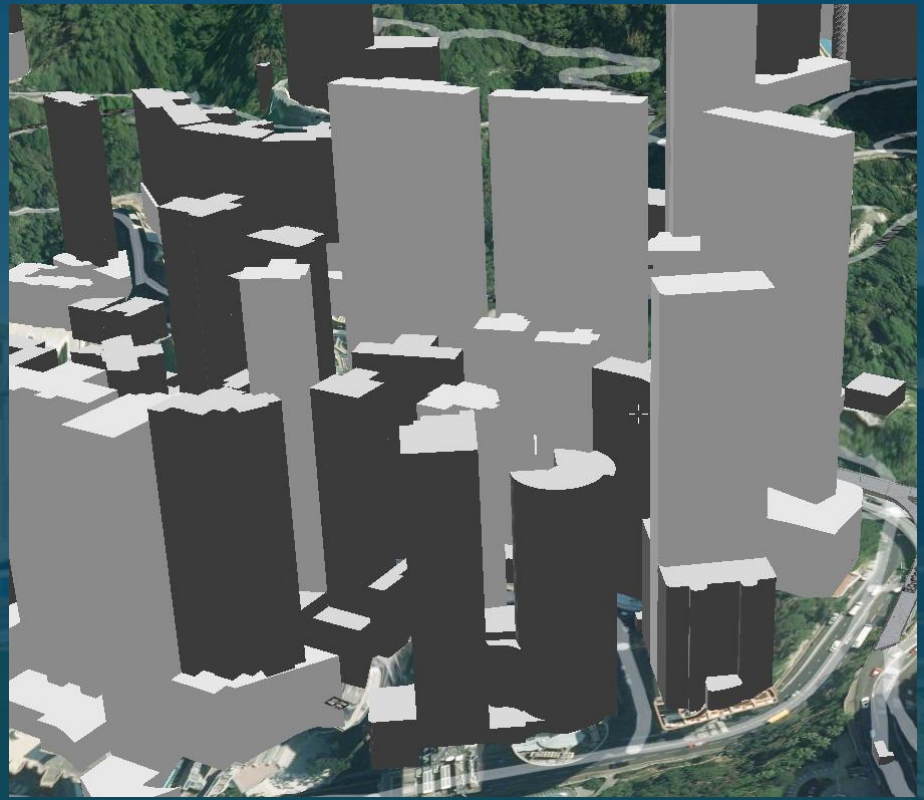
3D Spatial Data of Lands Department

<10%

3D INDIVIDUAL BUILDING MODELS
(L2/L3 - PHOTO REALISTIC MODELS)



3D Spatial Data of Lands Department



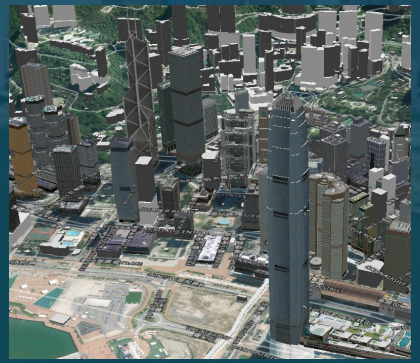
>90%

3D INDIVIDUAL BUILDING MODELS
(L1 - BLOCK MODELS)

3D Spatial Data of Lands Department

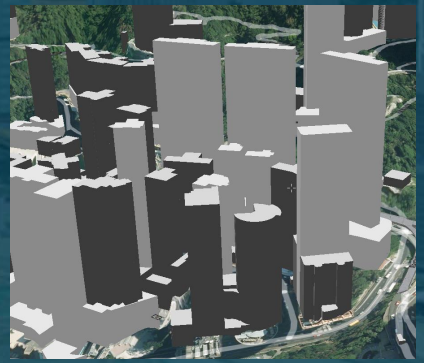
<10%

3D INDIVIDUAL BUILDING MODELS
(L2/L3 - PHOTO REALISTIC MODELS)



>90%

3D INDIVIDUAL BUILDING MODELS
(L1 - BLOCK MODELS)



3D Digital Mapping Project

The 3D digital mapping project comprises

- Full-fledged 3D visualisation map
- 3D indoor maps for 1 250 nos. of buildings
- 3D pedestrian network

To be completed **by end 2023**

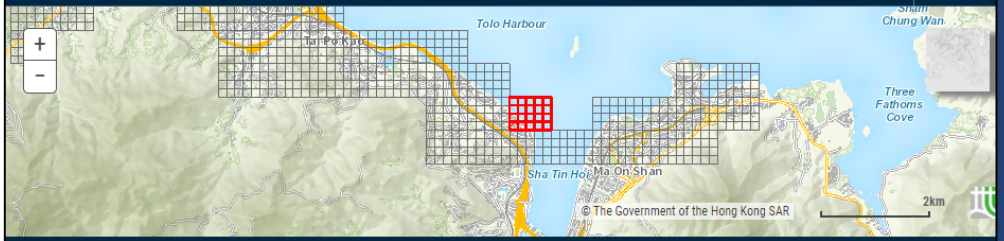
Stage 1 – 3D Maps for Visualization

HONG KONG GEODATA STORE
香港地理數據站

HONG KONG GEODATA STORE

3D Visualisation Map

中文



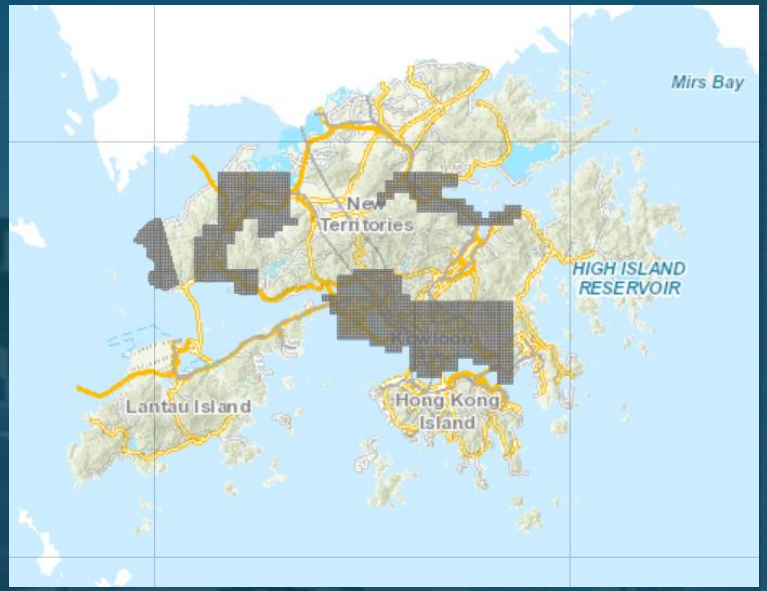
Showing 1 - 20 of 20 Record(s)

	Mesh Index	Area Code	English Name	Chinese Name	Sheet No	View	OBJ	OSGB
1	7-NE-17B-1	P10,R23	Tai Po Kau,Chun Ma	大埔滘,駿馬	7-NE-17B	View	Download	Download
2	7-NE-17B-2	P10,R23	Tai Po Kau,Chun Ma	大埔滘,駿馬	7-NE-17B	View	Download	Download
3	7-NE-17B-3	P10,R23	Tai Po Kau,Chun Ma	大埔滘,駿馬	7-NE-17B	View	Download	Download
4	7-NE-17B-4	R23	Chun Ma	駿馬	7-NE-17B	View	Download	Download
5	7-NE-17B-5	R23	Chun Ma	駿馬	7-NE-17B	View	Download	Download
6	7-NE-17B-6	P10,R23	Tai Po Kau,Chun Ma	大埔滘,駿馬	7-NE-17B	View	Download	Download

Viewable

20% Area Covered

3D MESH MODELS
(NOW AVAILABLE)

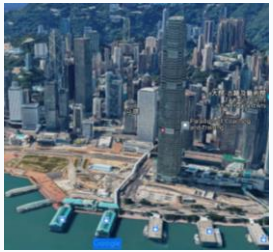


3D Activities

GOOGLE & SINGAPORE

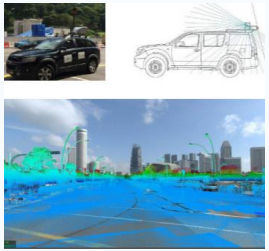
GOOGLE STREET VIEW (HONG KONG)
March 2010

3D GOOGLE MAP (HONG KONG)
October 2015



3D NATIONAL MAPPING (SINGAPORE)
January 2016

STREET-LEVEL SURVEYS (SINGAPORE)
June 2016



VIRTUAL SINGAPORE PLATFORM
2018

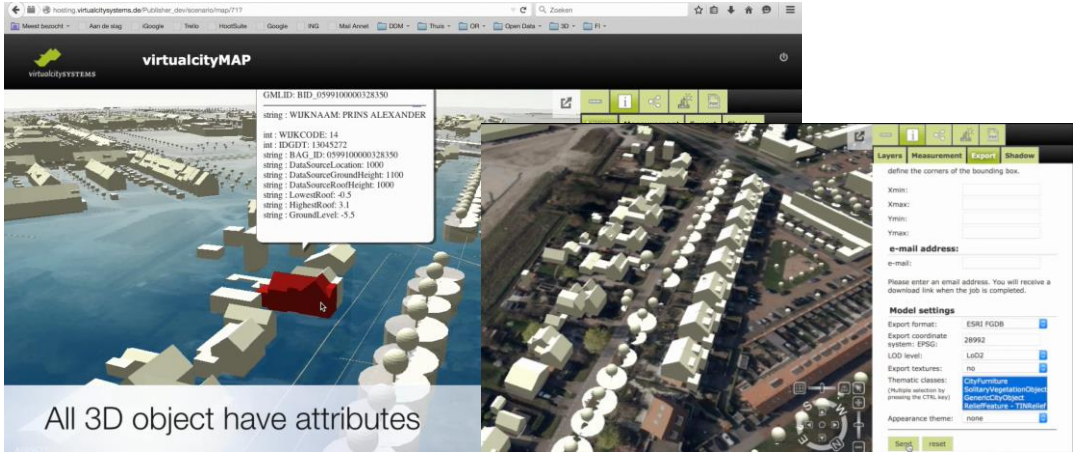
Source: https://www.google.com.hk/maps/
https://www.youtube.com/watch?v=ohA1jRvcHFk&feature=emb_title
https://www.nrf.gov.sg/programmes/virtual-singapore
https://geospatialworldforum.org/speaker/SpeakersImages/gis-3d-map-for-smart-cities.pdf

Germany

- Around 550,000 LoD2 building objects created within the whole city area (890 km²) in 2015
- The models are free of charge, available for download in the Berlin 3D download portal

Netherlands

Rotterdam's 205,000 buildings and bridge 3D models were created in 2017



- The USD53 million Virtual Singapore scheme is part of the government's "Smart Nation" plan, data-rich, live digital replica of the actual city

- Integrates data from government agencies, information from IoT devices and sensors

Switzerland

Singapore

- Switzerland, the only country to have switched entirely to 3D for its national object-oriented topographic database

- It took ten years to build an object-oriented topographic database in 3D, with the last objects having been completed in 2019

What mainland China is doing in 3D map?

日前，自然资源部在2019年全国国土测绘工作座谈会上透露，将启动“十四五”基础测绘规划编制工作，并将实景三维中国建设等领域作为凝练形成大项目、大工程的重点关注方向。

李德仁（两院院士、摄影测量与遥感学家）

李德仁院士介绍称，**目前全国已有武汉、上海、南京、广州、嘉兴、深圳、成都、重庆等600多个地区在不同应用场景尝试了三维模型或实景三维模式**并获好评。如深圳在几个区用2-3cm分辨率无人机倾斜摄影，为城市三维查处违章建筑，和城管配合发挥了很好的效果。

单就实景三维中国建设来看，现阶段已具备充分的技术条件，且市场具备足够的进取心，上层推动将充分激活产业动力，符合各方期待。

http://main.sgg.whu.edu.cn/keyan/gaoduanzhiku/gaoduanluntan/2019/0401/4120.html
http://www.glac.org.cn/index.php?m=content&c=index&a=show&catid=2&id=1016

Countries and Cities in 3D mapping

BERLIN (GERMANY)

2015

ROTTERDAM (NETHERLANDS)

2017

VIRTUAL SINGAPORE PLATFORM

2018

SWITZERLAND

2019

SHENZHEN (CHINA)

2020

How about Hong Kong?

Where do we come from?

What are we?

Where are we going?

Artist	Paul Gauguin
Year	1897–1898
Medium	Oil on canvas
Movement	Post Impressionism
Dimensions	139 cm × 375 cm (55 in × 148 in)
Location	Museum of Fine Arts, Boston

Crossing the river by feeling the stones?

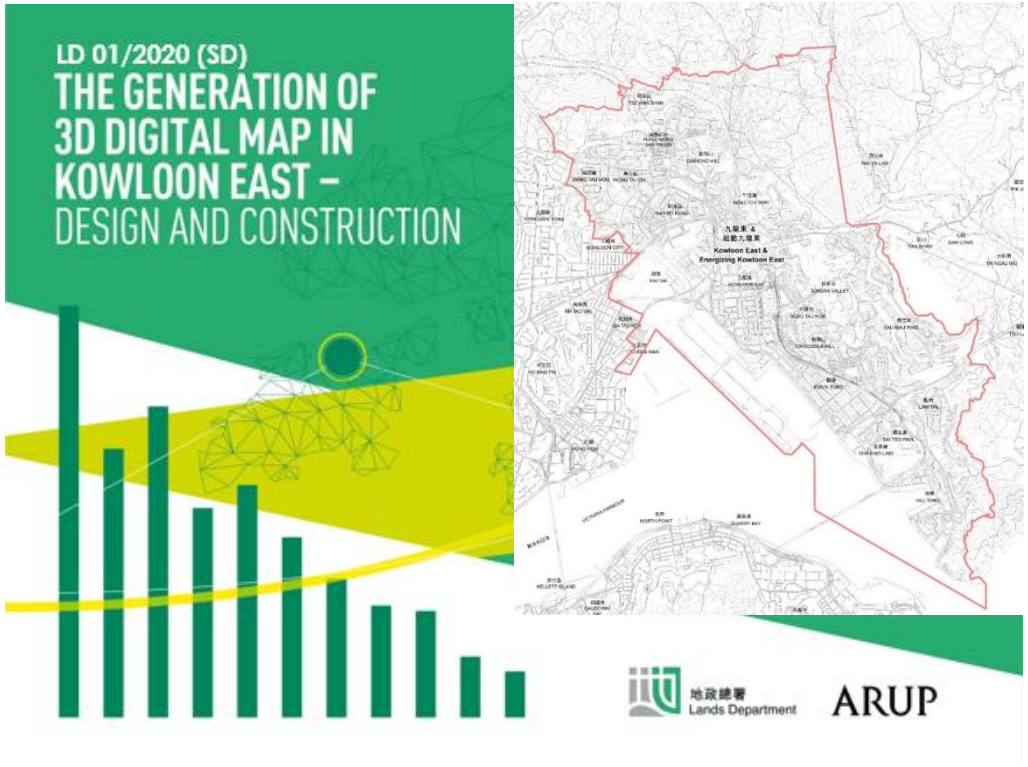
Source: From Wikipedia
https://matthewandrews.typepad.com/the_limits_of_institution/2013/02/getting-reform-done-step-by-step-poco-a-poco-or-crossing-the-river-by-feeling-the-stones.html

Down to Earth…What LandsD is doing

Consultancy Services (Kowloon East)

Start from Oct 2020 (8 months)

- Stakeholder Interviews
- Market Research
- Recommendation strategy for KE



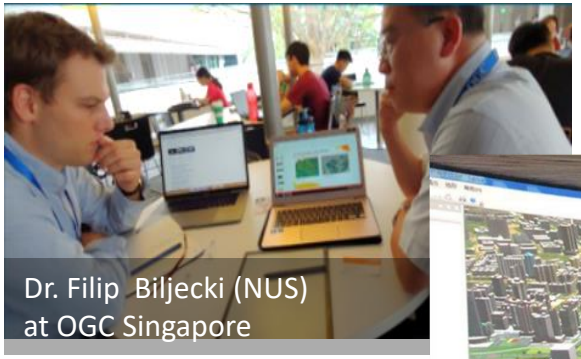
Stakeholder Interviews

- Agriculture, Fisheries and Conservation Department
- Architectural Services Department
- Buildings Department
- Census and Statistics Department
- Civil Engineering and Development Department
- Department of Health
- Development Bureau
- Drainage Services Department
- Efficiency Office, Innovation and Technology Bureau
- Environmental Protection Department
- Fire Services Department
- Highways Department
- Home Affairs Department
- Hong Kong Observatory
- Housing Department
- Land Administrative Office, Lands Department
- Legal Advisory and Conveyancing Office, Lands Department
- Marine Department
- OGCIO, Innovation and Technology Bureau
- Planning Department
- Rating and Valuation Department
- Survey and Mapping Office, Lands Department
- Transport Department
- Water Supplies Department
- Airport Authority Hong Kong
- Hong Kong Productivity Council
- Urban Renewal Authority
- Construction Industry Council
- The Hong Kong Institute of Architects
- The Hong Kong Institution of Engineers
- The Hong Kong Institute of Planners
- The Hong Kong Institute of Surveyors
- The Hong Kong Institute of Urban Design
- The Hong Kong Institute of Building Information Modelling
- The Hong Kong Institute of Civil and Building Information Management
- Smart City Consortium
- The University of Hong Kong
- The Hong Kong University of Science and Technology

Total 38 Interviewee Groups

Government B/Ds (24) Quasi-Government (4) Institutions (10)

The experts we met.



Dr. Filip Biljecki (NUS)
at OGC Singapore

Visit at Shenzhen

Dr. Tatjana Kutzner (TUM, Germany)
at OGC Singapore

Visit at Wuhan/Jinan

Visit at Shenzhen

Key Comments from International Experts – "*Ambitious*" & "*Forefront*"

Prof. Lutz Plumer

(Professor in Geoinformation at Universitat Bonn, Germany)

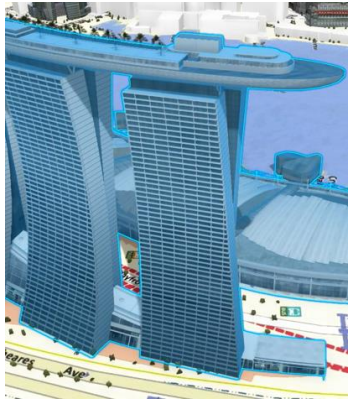
> Trend tallies with international 3D mapping development
> Photorealistic model is significant improvement
> LOD3 is challenging as model production cannot be automated, and Hong Kong environment is also challenging
> Follow CityGML v2.0 in LOD2 for now
> Updating can be demanding and costly – if two master datasets are produced in parallel
> Applications should lead the quality requirements. Do not limit applications to visualization as semantic models can bring broader use of data

Prof. Christian Heipke

(Professor in Photogrammetry and Remote Sensing at Leibniz Universitat Hannover, Germany)

> Trend tallies with international 3D mapping development
> Germany, Rotterdam, Helsinki, Singapore is currently at LOD2, higher LOD will be useful if data extraction and respective analytics are further developed
> There is no data accuracy (on position) standard, may be a good exercise for HK to create and contribute the best practices/lesson learnt to global community
> Accuracy, LOD, semantic information and update frequency should be aligned with intended application

Singapore

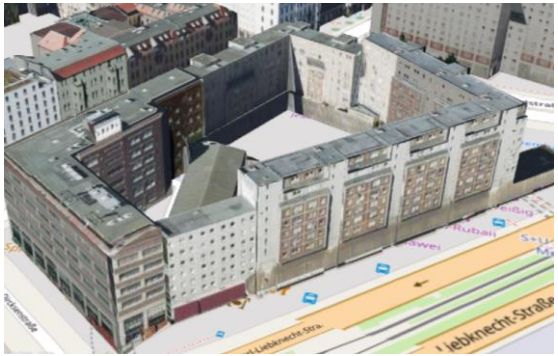


Mainland China

VS

Hong Kong

Germany



Aerial data only (LOD2 mainly)

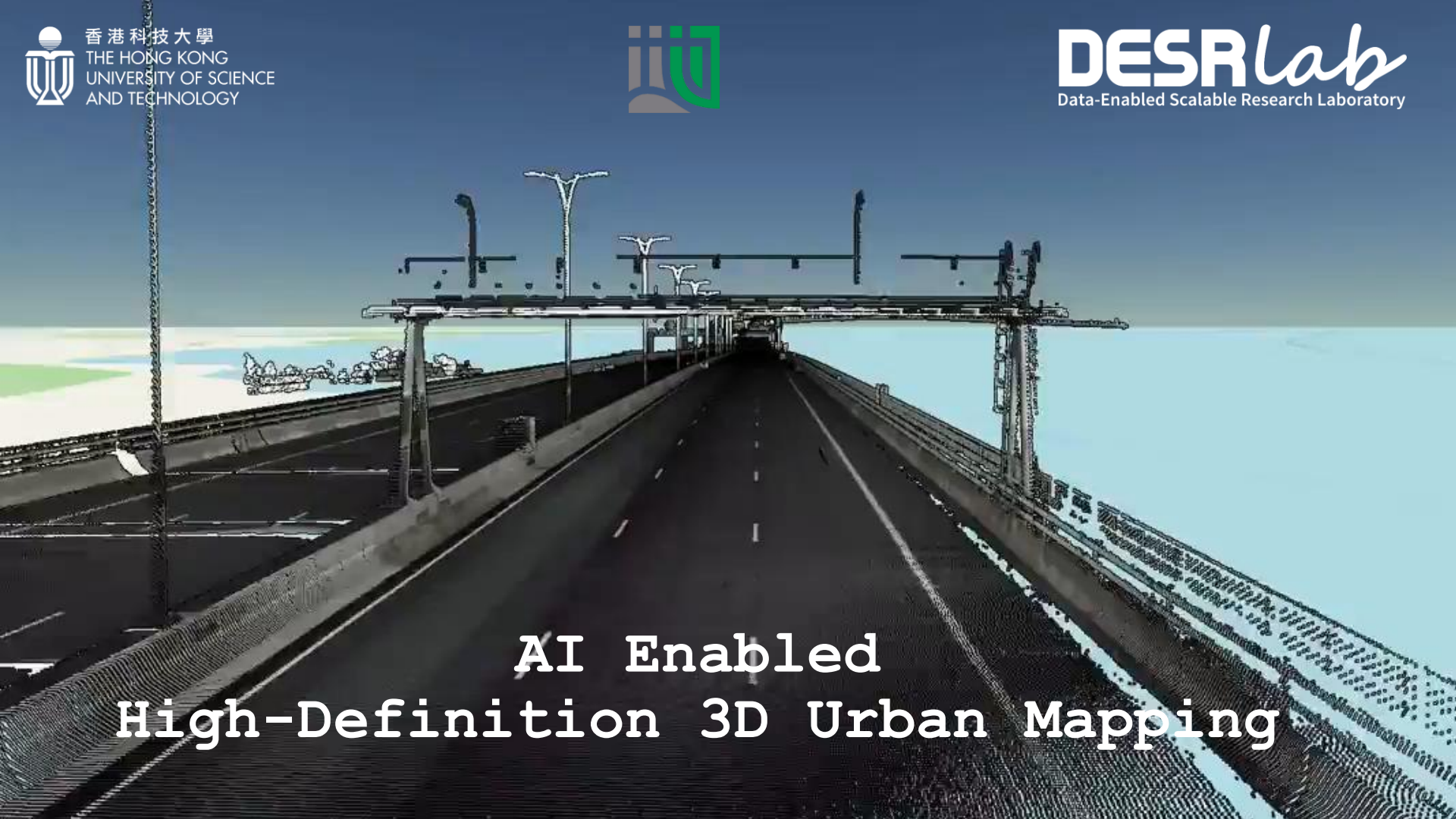
Aerial & Ground data integrated (LOD3 mainly)

Enhanced MMS
For Hong Kong

Hong Kong's 360° Panorama

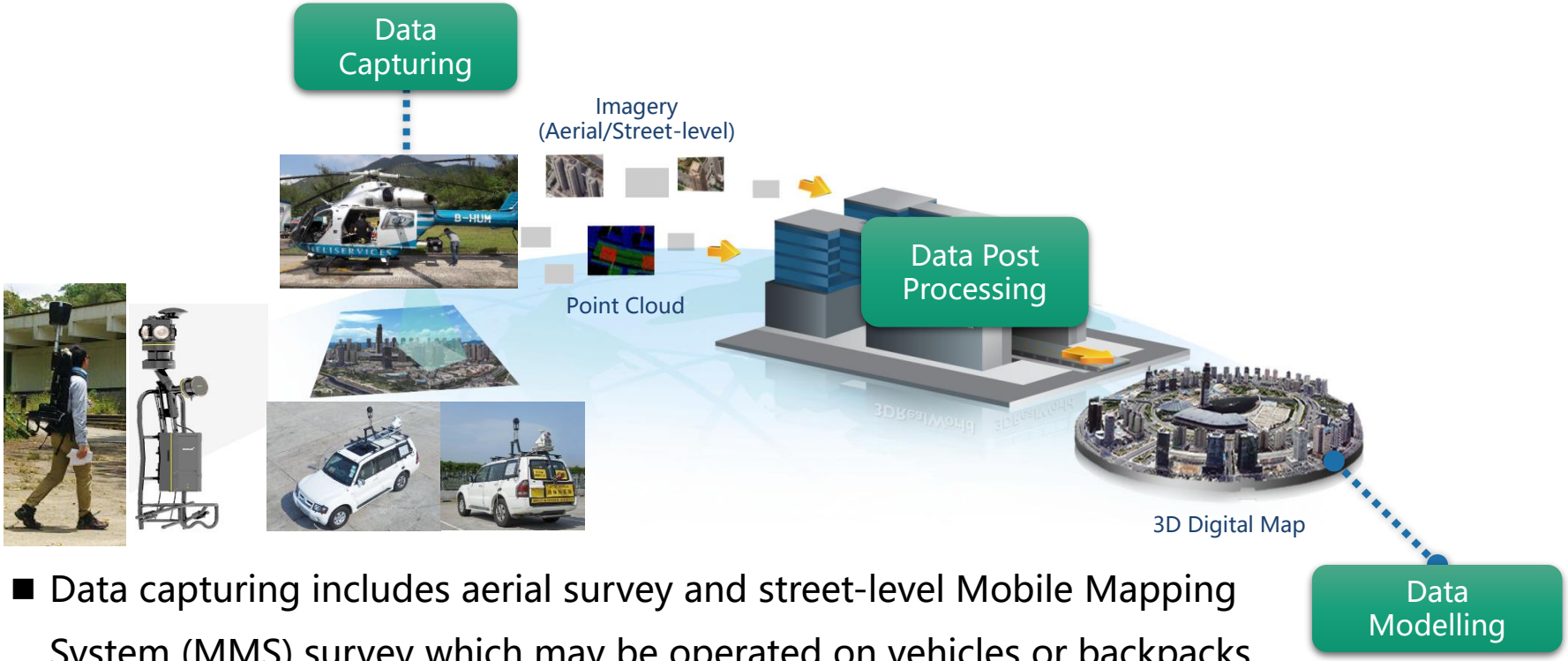
香港科技大學
THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

DESRlab
Data-Enabled Scalable Research Laboratory



AI Enabled High-Definition 3D Urban Mapping

Generation of the 3D Digital Map involves:
1) data capturing, 2) data post processing and 3) data modelling



- Data capturing includes aerial survey and street-level Mobile Mapping System (MMS) survey which may be operated on vehicles or backpacks.

Recommendation Strategy for KE

THREE KEY STRATEGIES

INCREMENTAL IMPLEMENTATION	VARIOUS ASPECTS OF DIGITAL MAPPING AND TECHNOLOGICAL CAPABILITIES CAN BE TESTED OUT USING THE PILOT BEFORE FULL SCALE IMPLEMENTATION
OUTCOME-BASED, NOT OUTPUT-BASED	THE MAPPING PRODUCT WOULD ADDRESS USER EXPECTATIONS BY PROVIDING DELIVERABLES TO DIRECTLY ADDRESS THE APPLICATION OF 3D SPATIAL DATA
SET OUT BEST PRACTICE AND EXEMPLARS	THE EXPERIENCE GAINED FROM THE KE PILOT HELP SHAPE THE REQUIREMENTS FOR IMPLEMENTATION IN THE NEXT MAPPING AREA AS WELL AS SETTING OUT BEST PRACTICES

ARUP

Recommendation Strategy for KE

THREE KEY STRATEGIES

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ARUP

	Stage 1 (This Contract)	Stage 2
Data Format	• Non-CityGML tiled-based mesh modal (OBJ/OSGB/Cesium Tile) • Individual models in 7 types (non-CityGML) • CityGML models (Ver2.0) for 3 buildings and 3 infrastructures	• CityGML models (Ver2.0) for remaining buildings and infrastructures
Data Accuracy	• Sub-structure dimension for individual based model (ALL building and infrastructure): 0.5m • Photorealistic textures accurately attached on ALL types • Backpack MMS to cover peripheral area of 10 selected buildings (total length 50km) • Accuracy requirements – Absolute accuracy 0.3m (H) and 0.5m (V), relative accuracy 0.2m(H) and 0.2m (V)	

	Stage 1 (This Contract)	Stage 2
Data Features	• Provide attributes / semantics for the 3 selected buildings (Choi Wui House, Hong Kong Children's Hospital, Kai Tak Cruise Terminal) and 3 selected infrastructures (Kwun Tong Bypass, crossroad of Wai Yip Street and Lai Yip Street, footbridge at Kwun Tong Bypass) in CityGML model	• More detailed attributes/semantics provided for CityGML • Test out OGC compliance mechanism

Recommendation Strategy for KE

THREE KEY STRATEGIES

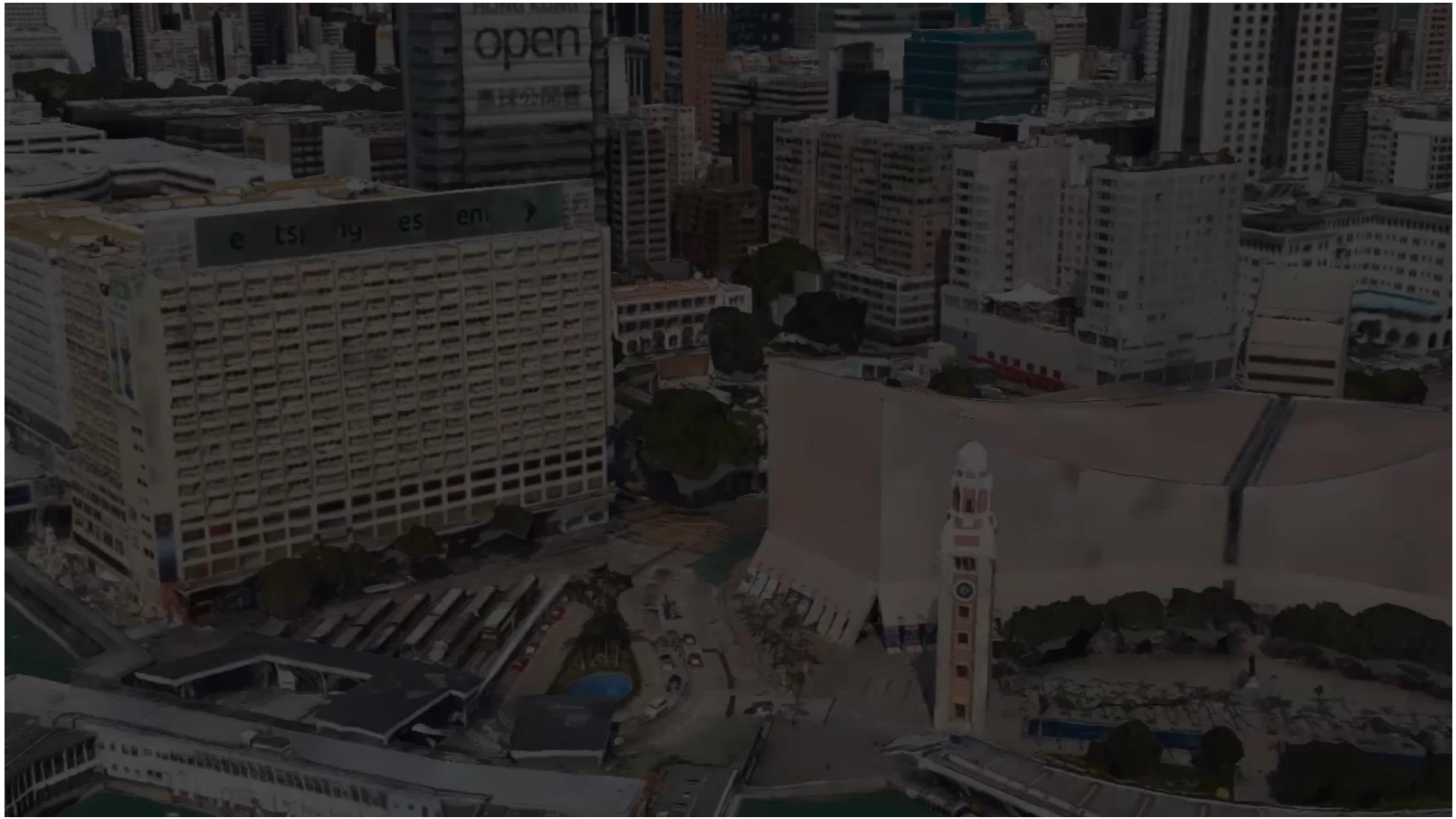
INCREMENTAL IMPLEMENTATION	VARIOUS ASPECTS OF DIGITAL MAPPING AND TECHNOLOGICAL CAPABILITIES CAN BE TESTED OUT USING THE PILOT BEFORE FULL SCALE IMPLEMENTATION
OUTCOME-BASED, NOT OUTPUT-BASED	THE MAPPING PRODUCT WOULD ADDRESS USER EXPECTATIONS BY PROVIDING DELIVERABLES TO DIRECTLY ADDRESS THE APPLICATION OF 3D SPATIAL DATA
SET OUT BEST PRACTICE AND EXEMPLARS	THE EXPERIENCE GAINED FROM THE KE PILOT HELP SHAPE THE REQUIREMENTS FOR IMPLEMENTATION IN THE NEXT MAPPING AREA AS WELL AS SETTING OUT BEST PRACTICES

Use Cases

- **Valuation Section of Lands Department** used the 3D spatial data to produce 3D animations of the subject land sale sites to facilitate Valuation Conference members' study and assessments.
- **Hong Kong Observatory** used the 3D spatial data for impact assessment of inundation arising from storm surges.
- **Housing Department** integrated the 3D spatial data with their in-house 3D geo-referenced models and BIM to support the quality 3D presentation of the proposed housing project.
- **Water Supplies Department** used the 3D spatial data to produce high-definition 3D animations for illustrating raw water treatment processes.
- **Civil Engineering and Development Department** used the 3D spatial data to produce 3D animations for the future development projects.
- **Civil Aviation Department** has acquired the 3DSD around the two airports (Chek Lap Kok and Shek Kong) to assess any obstacles when enhancing the flight path information.

ARUP

3D Digital Map - Applications



Recommendation Strategy for KE

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ARUP

3D Digital Mapping Technical Specifications

Preamble

This Technical Specification is to set out detailed technical requirements for 3D Digital Mapping with reference to the following publications:

1. *OGC City Geography Markup Language (CityGML) Part 1: Conceptual Model Standard*
2. *OGC City Geography Markup Language (CityGML) Encoding Standard*
3. *ICS 91 Construction Materials and Building (https://www.iso.org/ics/91/x/)*
4. *BS ISO 6707-1:2017 Buildings and civil engineering works — Vocabulary, Part 1: Overview and principles, Part 1: General terms*
5. *ISO 19115-1:2014 Geographic information - Metadata - Part 1: Fundamentals*
6. *ISO 19157:2013 Geographic information – Data Quality*
7. *CH/T 9016-2012 Specifications for the producing of three-dimensional model on geographic information. National Bureau of Surveying and Mapping (replaced by Ministry of Natural Resources), China*
8. *CH/T 9015-2012 Specifications for the digital products of three-dimensional model on geographic. National Bureau of Surveying and Mapping (replaced by Ministry of Natural Resources), China*
9. *Standard and Specifications for 3D Topographic Surveying (Mapping) in Singapore (Version 1.0, November 2013)*
10. *Anderson, J. R. (1976). A land use and land cover classification system for use with remote sensor data (Vol. 964). US Government Printing Office.*
11. *1:1000 Basic Mapping Specifications. (Version 4.2, October 2017). Survey & Mapping Office, Lands Department, Government of Hong Kong SAR.*
12. *iB1000 Data Dictionary Digital Topographic Map File Geodatabase. (Version 9.3.1, January 2019). Survey & Mapping Office, Lands Department, Government of Hong Kong SAR.*
13. *Biljecki, F., et al. (2014). Formalisation of the level of detail in 3D city modelling. Computers, Environment and Urban Systems, 48, 1-15.*
14. *Stoter, J., et al. (2016). State-of-the-art of 3D national mapping in 2016. The International Archives of Photogrammetry, Remote Sensing and Spatial Information Sciences, 41, 653.*

This Technical Specification intends to ensure standardised and consistent quality of output using best practices standard and survey techniques as possible in future industry surveys.

Preparation of the data used in this Technical Specification needs a collaborative effort from different data sources providers, including various government departments namely Architectural Services Department, Buildings Department, Census and Statistics Department, Housing Department, Lands Department, Planning Department.

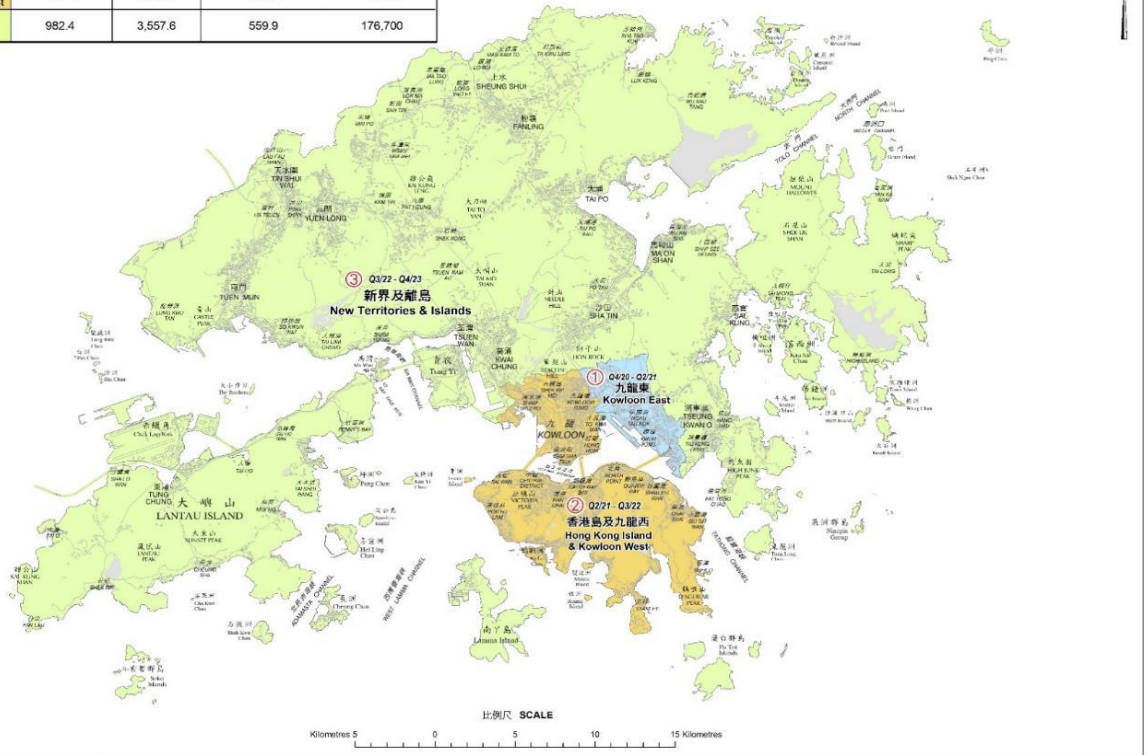
Contents

Page i

3D Digital Mapping Project Schedule

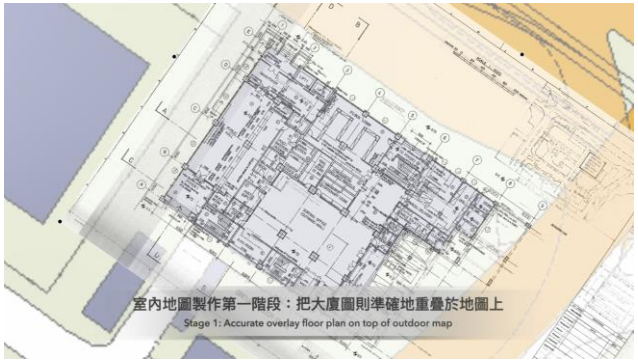
	Land Area (km²) (About)	Road Length (km) (About)	Infrastructure Length (km) (About)	Number of Buildings (About)
① 九龍東 Kowloon East	23.2	304.7	49.6	6,300
② 香港島及九龍西 Hong Kong Island & Kowloon West	104.5	1,207.2	181.6	37,500
③ 新界及離島 New Territories & Islands	982.4	3,557.6	559.9	176,700

To be completed **by end 2023**



3D Indoor Map (Pilot Project)

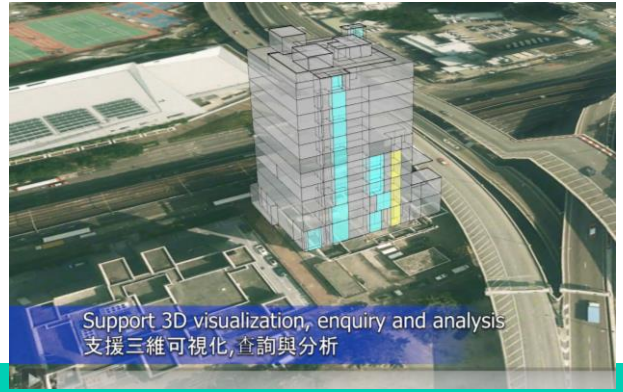
Data conversion (to be completed in Q1 2021)

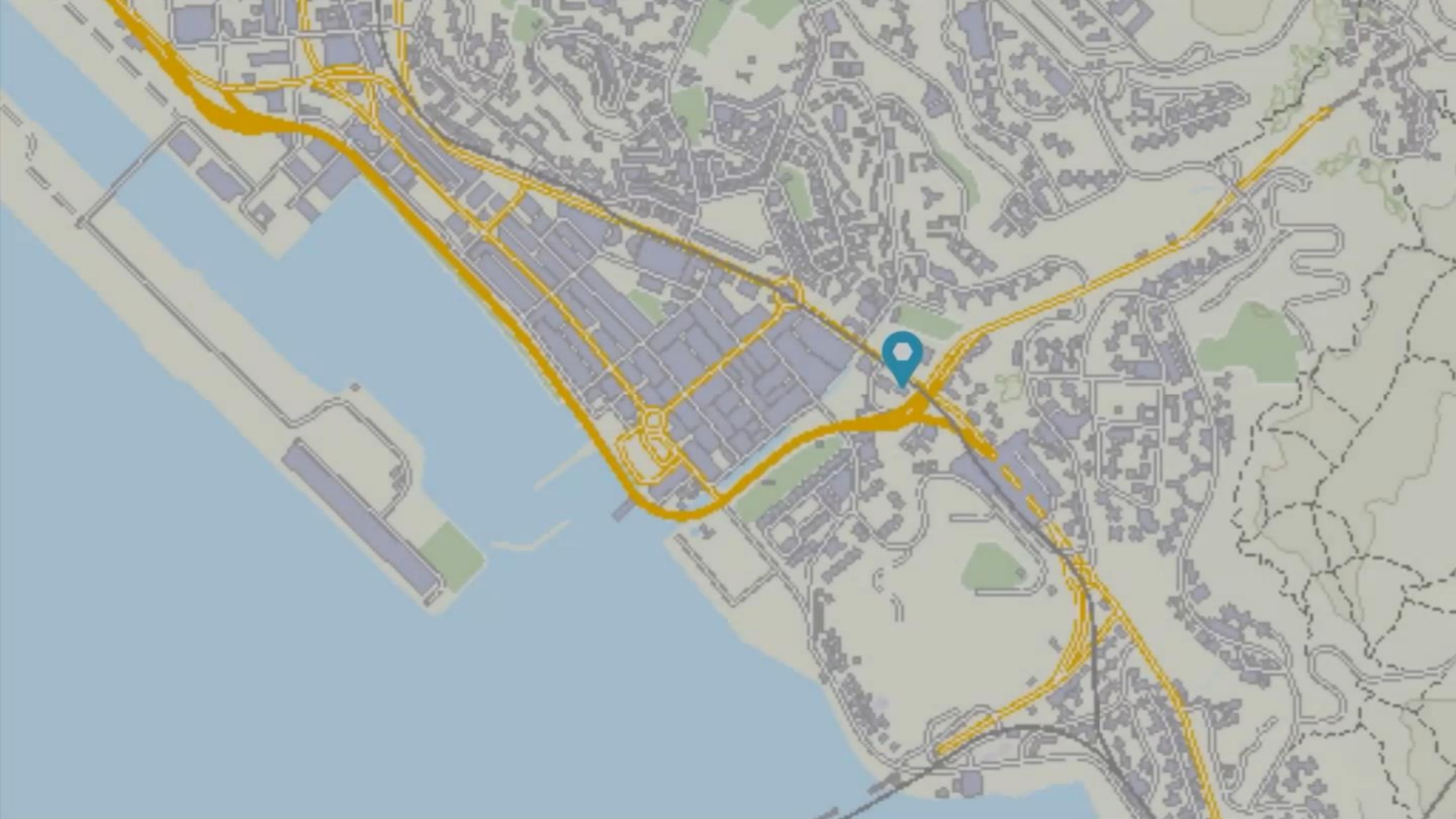


Accessibility to floor and unit information

Supporting indoor routing applications

Supporting 3D visualisation, enquiry and analysis



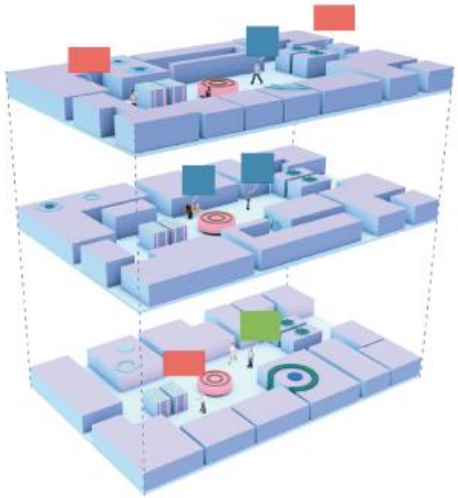


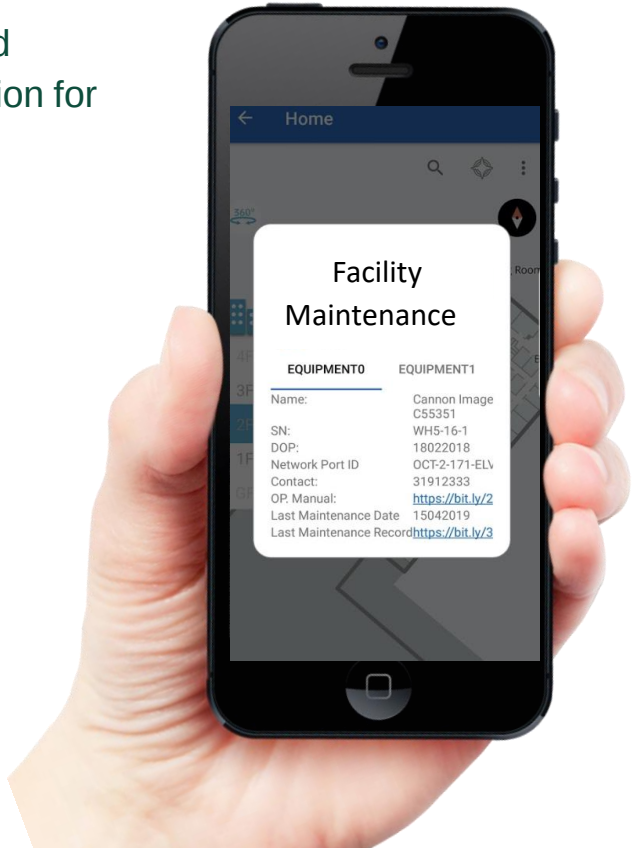
用家可使用室內導航到訪大廈不同樓層

Indoor navigation enables a point to point way finding experience for the user

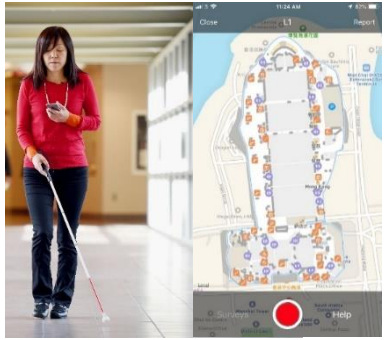
Potential location-based applications - Integration with IoT and Systems

- Instant & handy access to location based information with VLC location identification for operation maintenance purpose

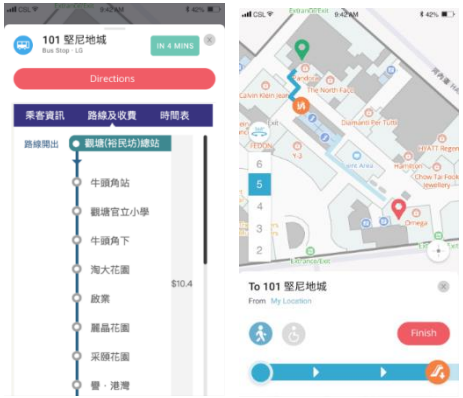




Potential location-based applications - Empowering all of use cases on top



Corporate Social Responsibility
(Barrier Free Wayfinding)

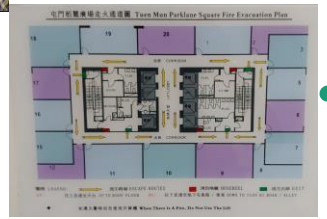


Smart Mobility

New Insight
(Location Based Analytics)

Better Service Quality
(Digital Directory)

3D Indoor Map



Emergency
(Fire Evacuation)

Operating Efficiency
(Building Management / Facility Management)

3D Pedestrian Network (Attribute-based 3D Objects)

Launched on
3 Dec 2020

- For supporting the routing services used by the general public and needy-groups, in particular to the visually impaired
- Adopt "universal design" approach in designing the 3D pedestrian road network model, concepts like weather proof, elderly-friendly, barrier-free, etc would be taken in consideration in the design

Statistics Division

TOPICS DATA METHODOLOGY EVENTS PUBLICATIONS ABOUT

UN-GGIM

Future Trends in Geospatial Information Management

Source: https://ggim.un.org/future-trends/

Overview | Previous Reports | Consultation (August 2019) | Documents

At its eighth session in August 2018, the Committee of Experts requested that a third review be undertaken to understand the future trends that impacts geospatial information management over the coming five to ten years. The United Kingdom of Great Britain and Northern Ireland, through the Ordnance Survey of Great Britain, whom led the previous editions of the Future Trends report, and supported by the UN-GGIM: Europe, led this third review in close collaboration with the Secretariat. The third edition highlights changes to the trends identified in the previous two reports, showing how geospatial information and technology underpin national governments, and documenting the increasing role that geospatial information will play as part of the 2030 Agenda for Sustainable Development.

In 2019, an inclusive global engagement and consultative process was initiated that sought views on the future trends that will impact geospatial information management over the coming five to ten years. This provided the global geospatial information community the opportunity to inform the third edition of the report. In response to the many challenges and interests faced by Member States and stakeholders, it was vital to ensure that the Future Trends report assist countries in their efforts to successfully develop, augment and maintain thei information management.

The Secretariat has initiated a broad global consultation process on the draft Future Trends report (third ed relevant stakeholders. Please provide your contributions to the Secretariat no later than 26 June 2020. The comments, feedback and suggestions, will ready and then provide the Future Trends report to the Committ adoption

- Broad global consultation - Announcement Letter
- Draft Future Trends Report (third edition)

Annual sessions

- Tenth session
- Ninth session
- Eighth session
- Past sessions

Overview

- Mandates
- Aims and Objectives
- Bureau
- Regional Committees
- Expert and Working Groups
- Thematic Groups

Quick links

- UN-GGIM Events
- Past Events
- Group of Experts on Geographical Names
- Photo gallery
- UN-GGIM Quarterly Volume 2

Tweets by @UNGGIM

UN-GGIM Retweeted

UN-GGIM:Americas
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This document was produced by Ordnance Survey of Great Britain at the request of the United Nations Committee of Experts on Global Geospatial Information Management.

Lead author: Christin Walter, Ordnance Survey of Great Britain

80.lv/articles/lidar-3d-scanning-app-for-iphone-pro/

LIDAR 3D Scanning App For iPhone Pro

Arti Sergeev
Senior Editor

The real-time LIDAR scanner app called Polycam can now be used on iPhone Pro.

Published
05 November 2020

Tags
News

Join conversation

'Everything happens somewhere': The new wave of data creation!

THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY | HKUST ALUMNI

ALUMNI KALEIDOSCOPE

Keywords | Category | Please choose

Frank Wang

MPhil(ECE)
BEng(ELEC)

Founder, Chief Executive Officer and Chief Technology Officer
DJI

Like Share Sign Up to see what your friends like.

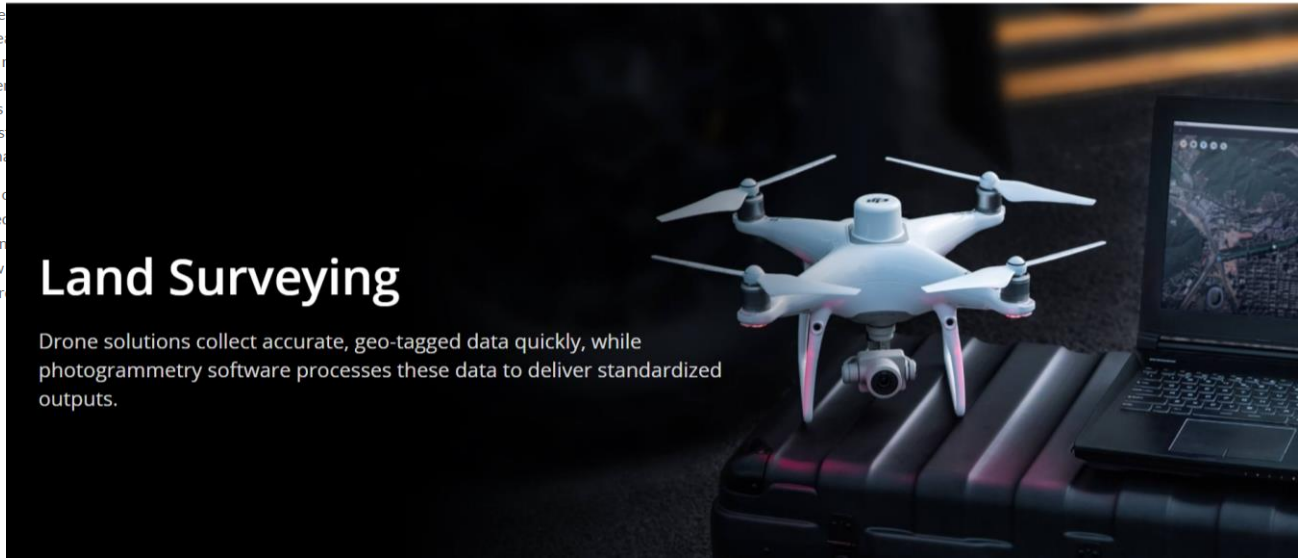
Share:

Frank has had a dream of flying from a young age, and he showed a keen interest in the research and development of unmanned helicopter technology during his time at HKUST. In 2005, he and his team participated in ABU Robocon and won third prize among teams competing from across Asia. In 2006, he completed his final thesis at HKUST, which included the development of a flight control system for unmanned platforms. He then founded DJI based on this system, and became the Chief Executive Officer and Chief Technical Officer of the company.

Based in Shenzhen, DJI i
use. It operates in the An
research and developme
innovation, he and his te
of Intellectual Property
committed to making ae
anywhere. Thanks to his
and recipient of the pres
civilian drones, aerial im

Frank is grateful for the
autonomously controlle
"I started my company i
help the university grow
in support of ECE resear

DJI ENTERPRISE | Industries | Products | Dealers | Insights | Explore | Support | Contact Us



Trends in 'professional' data creation and maintenance

Mobile laser scanning, becoming a newly established way in measuring road and urban environments

Trimble and Hilti collaborate to test robotic reality capture

BY CARLA LAUTER ON NOVEMBER 27, 2019

TECHNOLOGY: CONFERENCES, RELATED & NEW TECHNOLOGIES INDUSTRIES: ARCHITECTURE ENGINEERING & CONSTRUCTION (AEC), BOSTON DYNAMICS, HILTI, SURVEYING & MAPPING, TRIMBLE

引入兩部機械狗　助監察山泥傾瀉情況

為提升效率，土木工程處引入新科技協助監察斜坡安全及處理山泥傾瀉事故。當中引入機械狗「SPOT」，設有雷達素描器及自動導航，可遙距控制，方便於山泥傾瀉後取代工程師親身前往視察。當局現時引入兩部，每年研發費用約為數十萬，已準備隨時投入運作。

此外，土木工程處已於9處地方安裝智能泥石壩，當有泥石撞擊感應器時，可即時通知當局的管理系統。潘偉強稱已委托承辦商研發系統，可就事故通知附近居民，透過電話或收音機向他們發出通知，同時希望將智能智能泥石壩擴至全港大部分斜坡。

土木工程處引入機械狗。（土木工程處提供圖片）

Boston Dynamics "Spot" platform with a Trimble X7 Scanner

Source: https://www.spar3d.com/news/related-new-technologies/trimble-and-hilti-collaborate-to-test-robotic-reality-capture/

https://www.hk01.com/%E7%A4%BE%E6%9C%83%E6%96%B0%E8%81%9E/565722/%E5%9C%9F%E6%9C%A8%E5%B7%A5%E7%A8%8B%E8%99%95%E9%95%B7%E6%BD%98%E5%81%89%E5%BC%B7%E9%80%80%E4%BC%91%E5%9C%A8%E5%8D%B3-%E9%9B%A3%E5%BF%98%E7%A2%A7%E7%91%A4%E7%81%A3%E4%BA%8B%E6%95%85-%E5%BC%95%E5%85%A5%E6%A9%9F%E6%A2%B0%E7%8B%97%E5%8A%A9%E7%9B%A3%E5%AF%9F

"A high quality trusted and authoritative national base map leads to a geospatially enabled nation; one that shares, integrates, and uses a wide range of data to achieve economic, social and environment benefits…

…and thereby help us tackle some of the biggest challenges the world faces, today and in the future."

National Mapping Agencies can help transform economies by providing trusted data that can be used by anyone.

David Henderson
Chief Geospatial Officer
at Ordnance Survey

Source: The power of place | A sustainable future with geospatial insights, 2020
(Co-authored by the Knowledge Transfer Network and Ordnance Survey)

Building Information Modelling (BIM)

We will share you…

- Current BIM Data Repository Prototype
- Roadmap of Territory-wide BIM Data Repository development
- Recommendations from the BIM Data Repository Consultancy
  - Sharing of CEDD's BIM Horizontal Harmonisation for BIM / GIS Integration
  - Sharing of CIC's Consultancy Services for the Development of Digital Hong Kong
  - Suggestion on the Simplified and Shareable BIM
  - Vision of the BIM Data Repository
- New development of Building Plan (BP) Checking Tool

BIM Data Repository Prototype

[BIM Data Repository]

Lands Department
地政總署

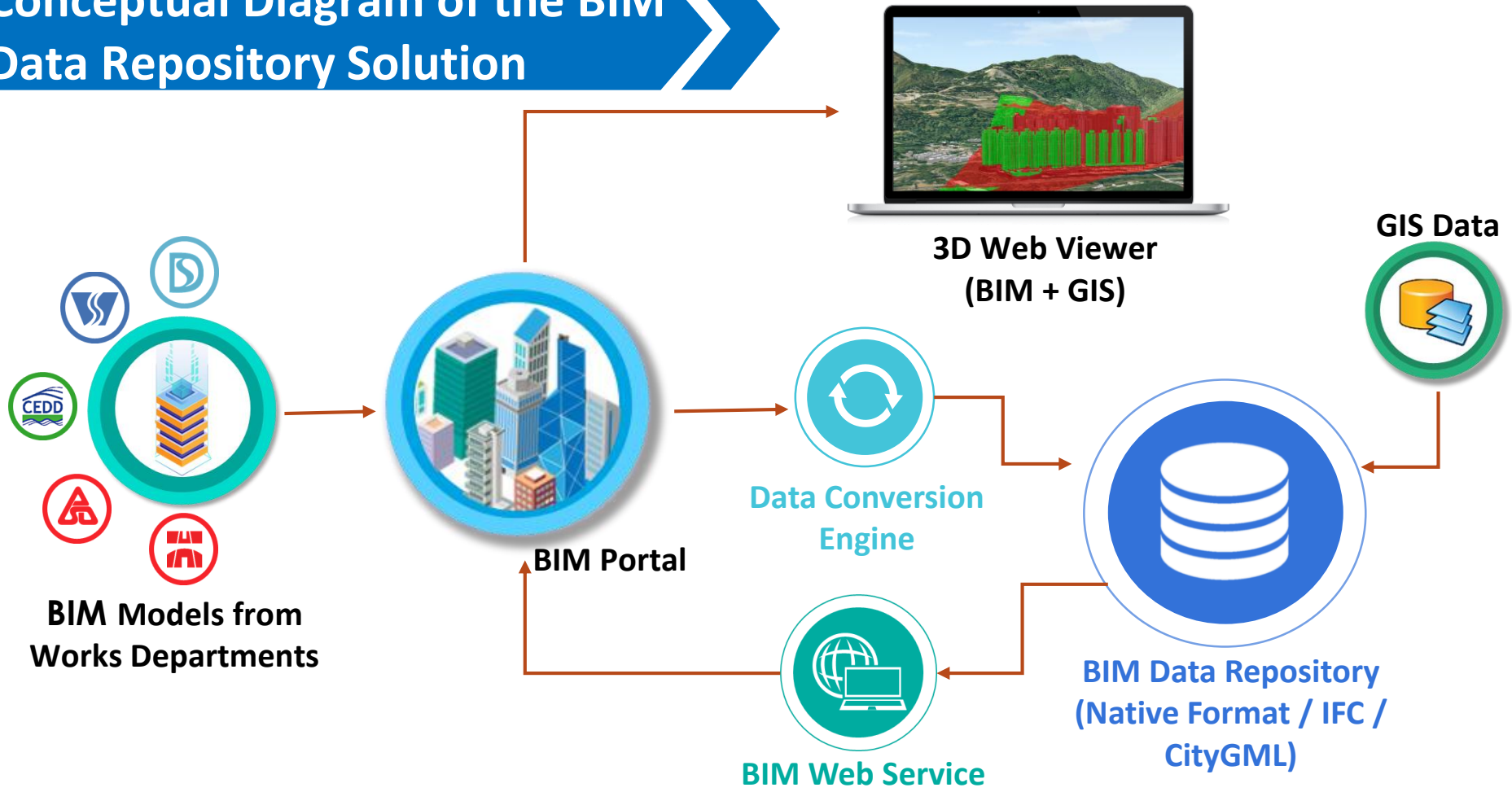
Problems Hinder the Data Sharing

- More and more quality BIM Data are available at government and private development projects, but they are not easy to exploit in a broader context
  - Fragmentation in sharing of BIM Data
  - Problems of identifying, accessing or using data
  - Gaps in standard BIM Data

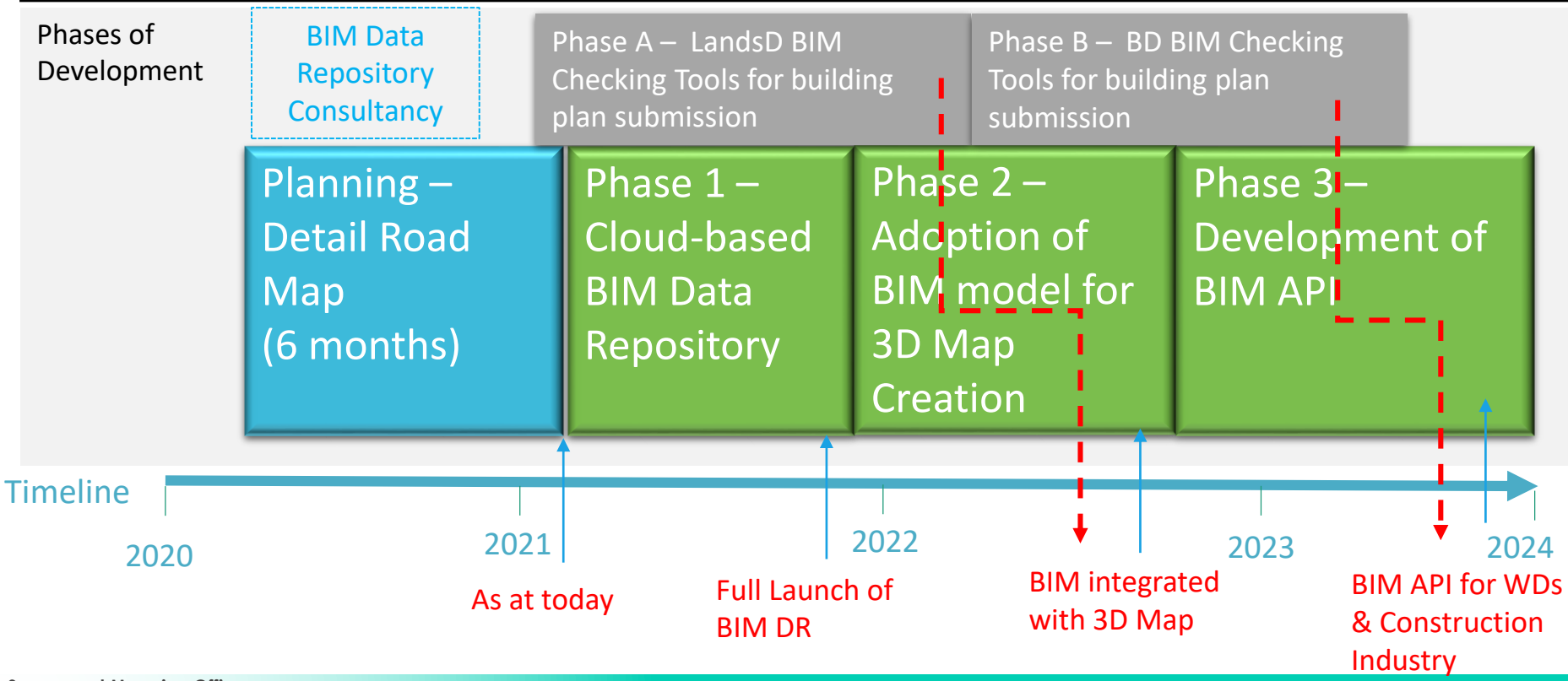
- Those problems hinder the sharing of BIM data across Bureaux and Departments (B/Ds) as well as integration of BIM Data and 3D Map of Lands Department

Roadmap of Territory-wide BIM Data Repository

Conceptual Diagram of the BIM Data Repository Solution



Timeline of Development of BIM Data Repository



BIM Data Repository Consultancy to Define the Roadmap

Related
BIM Horizontal Harmonisation Consultancy (NDO, CEDD)

Deliverables
- Horizontal aligned BIM Standards
- Sharable BIM Standards

Related
3D Map Consultancy (LandsD)

Deliverables
- 3D Map Requirements for Smart City

Related
Digital Hong Kong Consultancy (CIC)

Deliverables
- 10 Use Cases for Construction Industry

Subject
BIM Data Repository Consultancy (LandsD)

Deliverables
- Implementation Road Map
- Data Model/Data Content/Data Format
- Functional Requirements of BIM Data Repository
- Open BIM + Open GIS PoC of a Use Case

Legend
1 Task 1 2 Task 2 3 Task 3 4 Task 4

Offer expert study & professional support

Convert into functional requirements

BIM Horizontal Harmonisation for BIM / GIS Integration under First Phase of KTN and FLN NDA

AECOM

CEDD

Scope of the Study

- Carry out a BIM horizontal harmonisation study to formulate an aligned BIM standard under the First Phase development of KTN and FLN NDA.
- Revamp the design BIM models under the First Phase development of KTN and FLN NDA in accordance with the aligned BIM standard.
- Design and develop data conversion engines to convert the revamped BIM models to shareable format to facilitate effective information exchange among Works Departments (WDs)
- Establish a BIM Data Repository (BIM DR) to store the revamped BIM models for efficient information sharing among LandsD and WDs
- Establish a BIM Object Library for aligned BIM objects
- Formulate BIM standards for WDs to adopt in their future projects

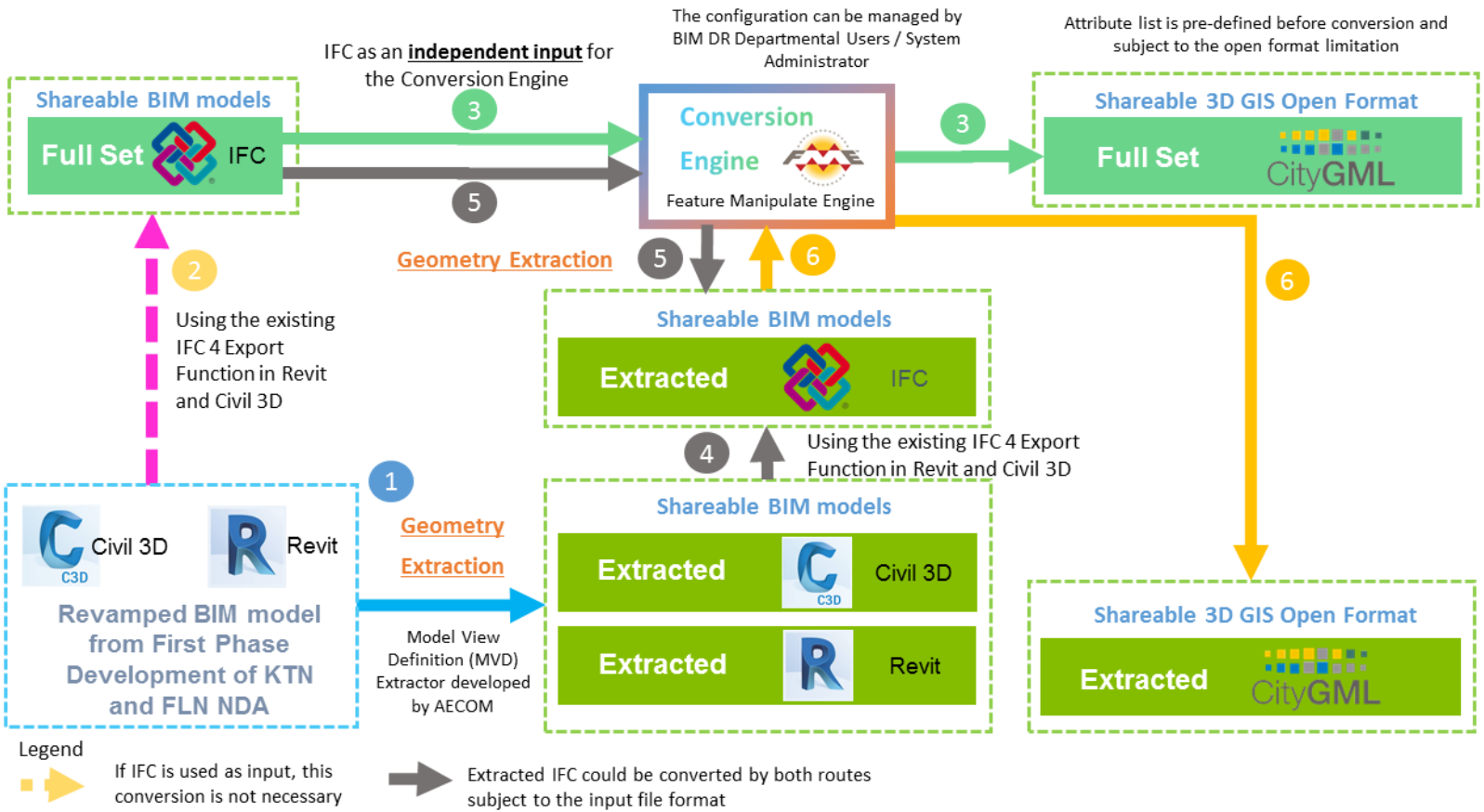
(Courtesy of CEDD and AECOM)

BIM Harimonisation Guidelines

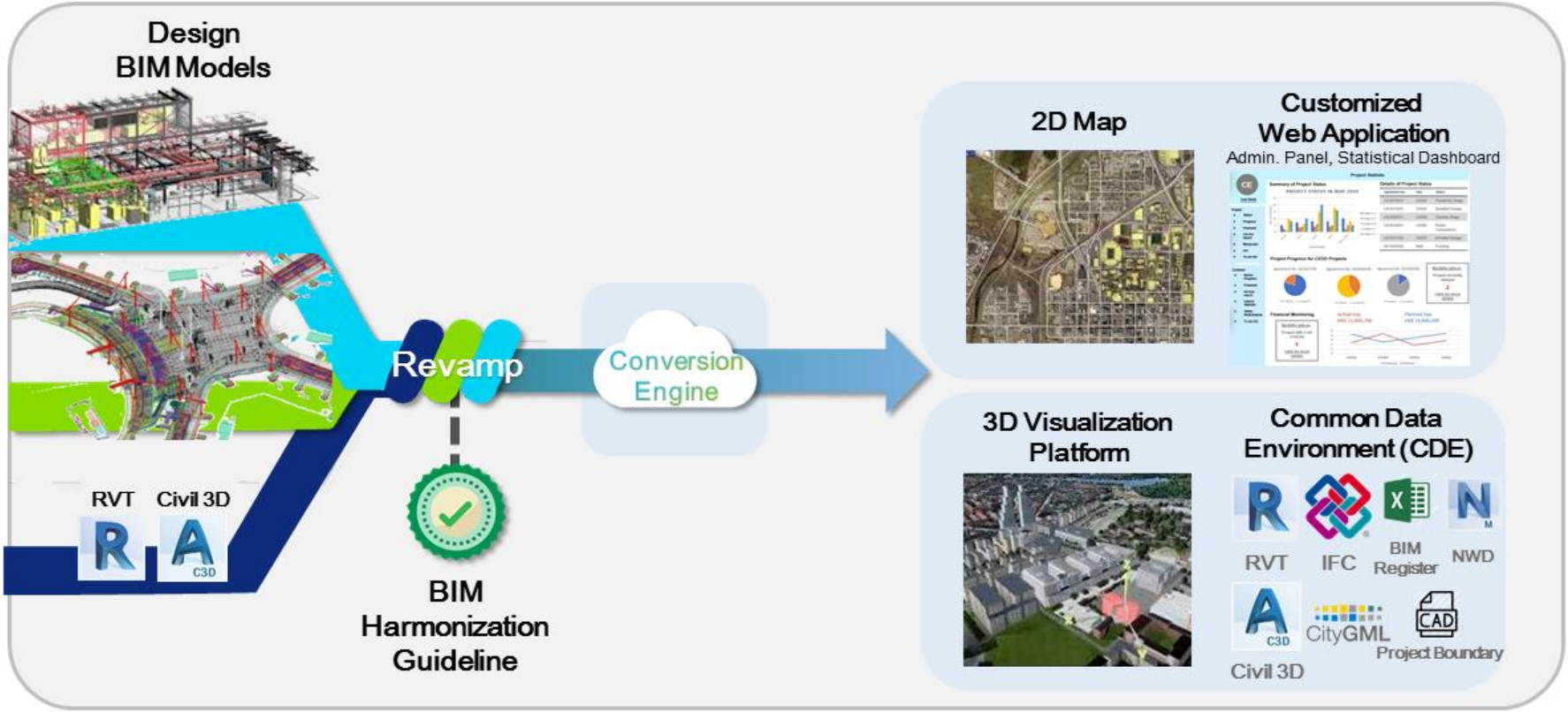
- To address data policy initiatives at the DEVB and WDs, local professional bodies, construction industry and GIS industry professionals;
- To enable submission, sharing, dissemination and maintenance of BIM models and BIM attribute across the WDs and LandsD under the Study;
- To ensure coherence with LandsD's **3D digital map** and the forthcoming **3D Land Information System**;
- To provide a basis for DEVB to request WDs to adopt BIM standards formulated under the Study in their future projects

(Courtesy of CEDD and AECOM)

Workflow of Data Conversion Engine



BIM Data Repository



The BIM DR will be handed over to Lands Department upon completion of the Study

Consultancy Services on the 3D and BIM Data Use Case Requirements for the Development of Digital Hong Kong

AECOM

CONSTRUCTION INDUSTRY COUNCIL
建造業議會

Scope of the Study

- Propose the best approach for CIC to accelerate the development of 3D Digital Hong Kong for the construction industry.
- Collect 3D & BIM data use case requirements of the construction industry in order to tie in with the Smart City initiative.
- Recommend suitable actions for the collection of 3D & BIM data from the local construction industry
- Further recommend the relevant data standards for the industry to adopt
- Develop a BIM GIS Solution (the Solution) to facilitate the BIM data sharing, BIM and GIS integration and support 3D Map

(Courtesy of CIC and AECOM)

Top 10 Use Cases

1. Underground Utilities Study and Space Management
2. Visualisation of Construction Project Lifecycle
3. Geotechnical Study
4. Traffic Impact Assessment (TIA)
5. Foundation Design
6. Excavation Permit (XP) Application
7. Environmental Impact Assessment (EIA)
8. Building Energy Monitoring and Facility Management
9. Air Ventilation Assessment
10. Premium Assessment and Property Valuation

(Courtesy of CIC and AECOM)

Top 10 Use Cases

1. **Underground Utilities Study and Space Management**
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8. Building Energy Monitoring and Facility Management
9. Air Ventilation Assessment
10. **Premium Assessment and Property Valuation**

(Courtesy of CIC and AECOM)

Current Situation

Poor management of underground utilities

Accidental destruction and a deterioration of services

Extra cost including both time and money for repairing

Delay of planned construction programme

Postpone of Smart City development

(Courtesy of CIC and AECOM)

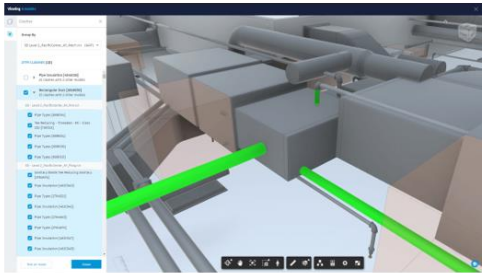
Recommended Potential Development – Provision of Centralized Data Platform for UU

1

Ability of Data Exchange

- Ability to upload and to view UU data for reference.
- Data should be easily uploaded with various types of attributes including pipes' 3D coordinates, dimensions, models in 3D and any other attributes important for utilities undertakers to plan for their next UU project.

2

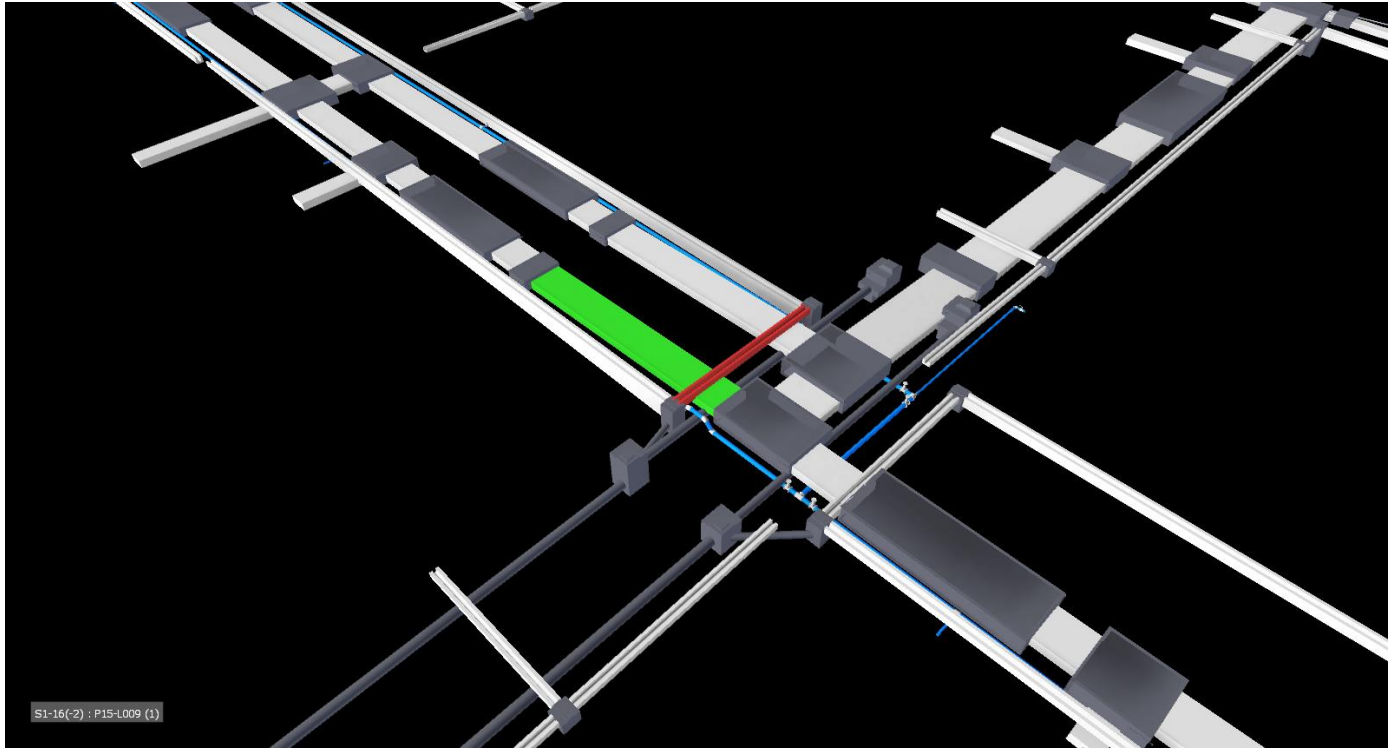


Utilities Strike Avoidance by Clash Analysis

- Centralized data platform hosts different UU models to be viewed, navigated, measured and generate a combined model to be downloaded for further design and analysis e.g. clash analysis.

(Courtesy of CIC and AECOM)

Clash Analysis Application with Centralized Data Platform



(Courtesy of CIC and AECOM)

Standardizing UU Records

Presentation of as-built UU record varies among different utility owner

Different Legend	Different Base map	Different Annotations

A standardized format is necessary to fit-in the digital data platform, for example:

OGC®
Making location count.

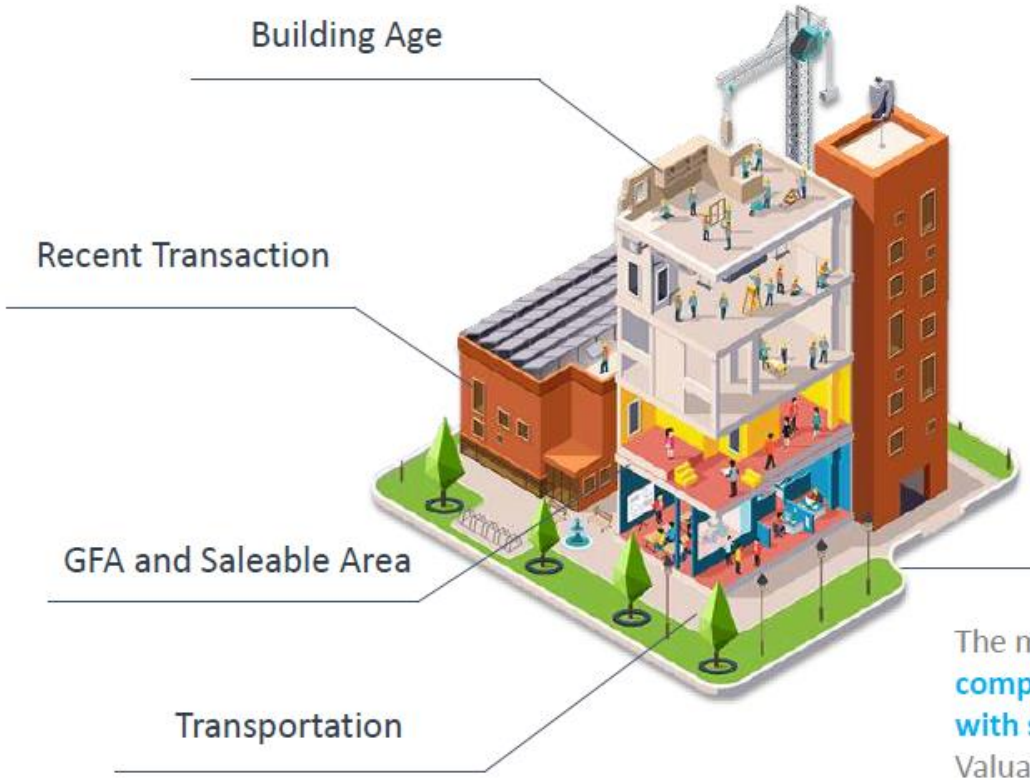
MUDDI
(Model for Underground Data Definition and Interchange)

The OGC's (Open Geospatial Consortium) underground information initiative is intended to provide an open standards-based way to share information about the below ground.

MUDDI is adopted in the UK's NUAR project

(Courtesy of CIC and AECOM)

Premium Assessment and Property Valuation



Property Valuation

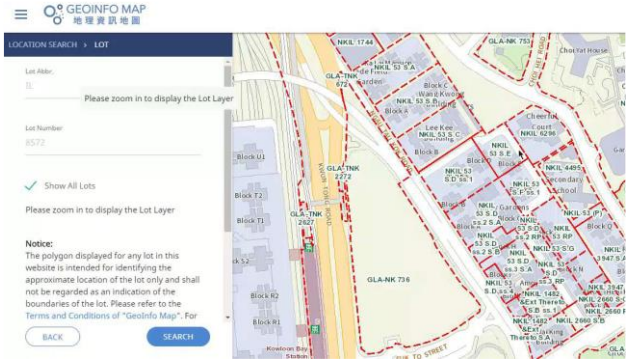
The market value of a property is estimated mainly by **comparing the information and recent transactions with similar buildings in the neighbourhood.** Valuation is carried out from time to time as the price of property in Hong Kong is fluctuated.

(Courtesy of CIC and AECOM)

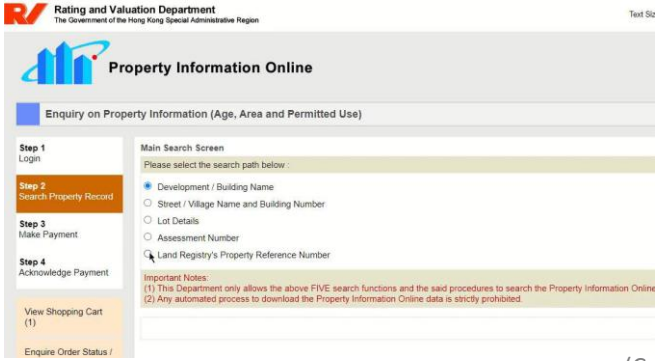
Premium Assessment and Property Valuation

Current Constrain

- The location and boundary of the property kept in LandsD does not directly link with the information stored in LR. The data from RVD is also stored in another system.



- Land or property owners have to go through three different online systems to inquire, purchase and obtain his property details.
- Data downloaded from LR are in html or pdf, which is not structured and consumable.



(Courtesy of CIC and AECOM)

Premium Assessment and Property Valuation

Recommended Potential Improvement – Establish a 3D GIS Web Property Information Platform

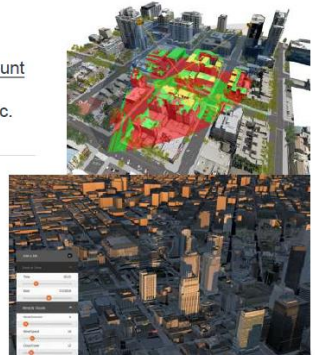
Access Level

Level 1: For Public
- LR and RVD data upon purchase

Level 2: For professionals
Level 3: Government with registered account
- With more sensitive data
- e.g. Floor plan from BD, tax record etc.

Proposed Platform Functions

- Search by address/PRN/Lot No. (align with GeoAddress by CSDI)
- Display attributes & floor plans
- Sunlight and shadow simulation (e.g. summer and winter solstice)
- Viewshed analysis



(Courtesy of CIC and AECOM)

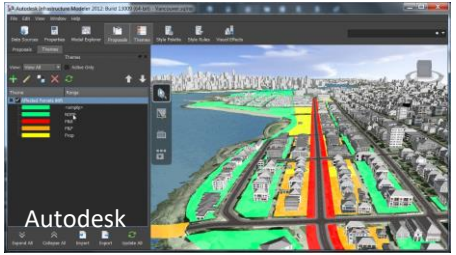
Recommendations on Simplified and Shareable BIM

strategic buildinginnovation

bim SCORE

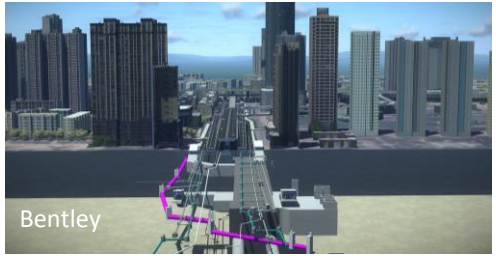
Why Simplify?

- City-level analyses typically do not require high LOD



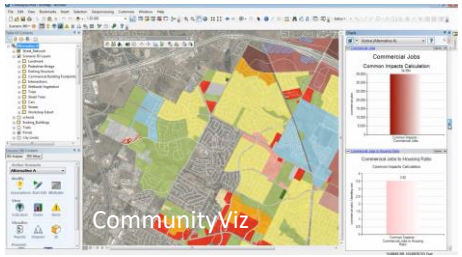
Road Impact Analysis (LOD100-200)

Zoning Analysis (LOD100)



Plan v. Existing Pipeline Analysis (LOD200)

Shadow Analysis (LOD200)

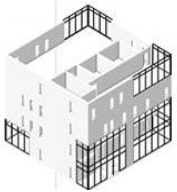


Employment Analysis (LOD100)

Electricity Consumption Analysis (LOD100)

(Courtesy of bimScore)

Simplification of LOD-I (IFC + IoT Scenario)



Source: https://dlpng.com/png/6868392

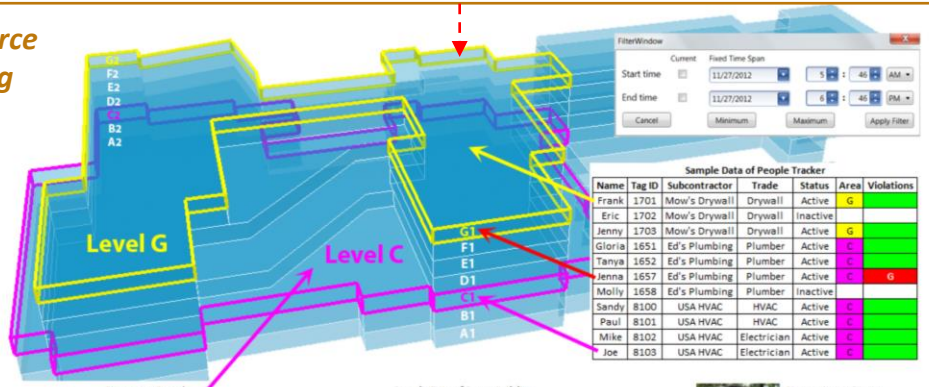
Source: https://www.pngitem.com/

Source: https://www.phytec.com/

Planning	Design	Tender	Construction	Operation

IfcSpatialZone ⟷ IfcRelAssigns ⟷ IfcBuildingElement

Workforce Tracking



Sample Data of People Tracker

Name	Tag ID	Subcontractor	Trade	Status	Area	Violations
Frank	1701	Mow's Drywall	Drywall	Active	G	
Eric	1702	Mow's Drywall	Drywall	Inactive		
Jenny	1703	Mow's Drywall	Drywall	Active	G	
Gloria	1651	Ed's Plumbing	Plumber	Active	C	
Tanya	1652	Ed's Plumbing	Plumber	Active	C	
Jenna	1657	Ed's Plumbing	Plumber	Active	C	G
Molly	1658	Ed's Plumbing	Plumber	Inactive		
Sandy	8100	USA HVAC	HVAC	Active	C	
Paul	8101	USA HVAC	HVAC	Active	C	
Mike	8102	USA HVAC	Electrician	Active	C	
Joe	8103	USA HVAC	Electrician	Active	C	

Name: Joe Sample
Tag ID: 8103
Worker ID: 1234100
Subcontractor: USA HVAC
Trade: Electrician
Status: Active
Job Function: Crew A

Sample Data of Space Activity

Tag ID	Entry Point	Entry Time	Exit Point	Exit Time	Area	Violations
8103	Main Gate	11/27/2012 07:30:12	Buckhoist 1	11/27/2012 08:15:48	Entry	
9950	Main Gate	11/27/2012 07:35:12	Main Gate	11/27/2012 07:35:12	Entry	Entry/Exit
8103	Buckhoist 1	11/27/2012 08:15:48	Level C1	11/27/2012 08:18:10	Lift	
8103	Level C1	11/27/2012 16:05:35	Staircase C2	11/27/2012 16:11:01	C	
9103	Staircase A2	11/27/2012 16:17:01	Main Gate	11/27/2012 16:21:47	Entry	

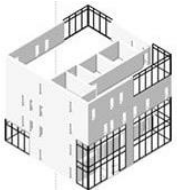
Name: Aaron Costin
Tag ID: 9950
Worker ID: 1234201
Subcontractor: Georgia Tech
Trade: Visitor
Status: Inactive
Job Function: Researcher

IoT devices
(RFID readers) at turnstile

IoT devices
at construction zone entry

(Adapted from Costin et al. (Georgia Tech.), 2015—PoC at UCSF Medical Center)

Simplification of LOD-G (IFC Scenario)



Source: https://dlpng.com/png/6868392

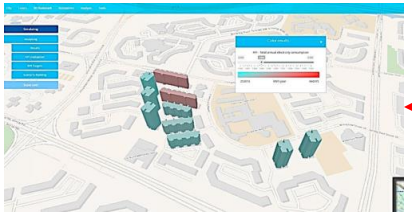
Source: https://www.pngitem.com/

Source: https://www.phytec.com/

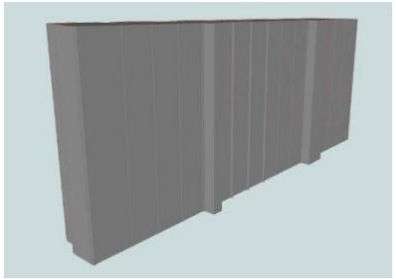
Planning	Design	Tender	Construction	Operation

Simplification

CityGML ← Extrusion ← Extract Boundary ← IfcSlab



Electricity Consumption Analysis



LOD100
(CityGML LOD2)

SAFE SOFTWARE

Feature Manipulation Engine

Simplification

LOD300

(Adapted from Jusuf et al. (Singapore Institute of Tech.), 2017)

Recommended LOD for CIC 10 Use Cases

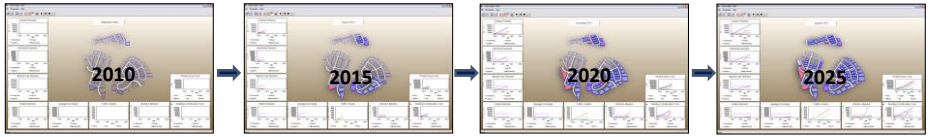
1. Underground Utilities Study and Space Management – LOD300
2. Visualisation of Construction Project Lifecycle – LOD100/200
3. Geotechnical Study – LOD200
4. Traffic Impact Assessment (TIA) – LOD200
5. Foundation Design – LOD200
6. Excavation Permit (XP) Application – LOD300
7. Environmental Impact Assessment (EIA) – LOD100
8. Building Energy Monitoring and Facility Management – LOD200
9. Air Ventilation Assessment – LOD100
10. Premium Assessment and Property Valuation – LOD200

(Courtesy of bimScore)

Recommendations on the BIM Data Repository Development

4D-based Decision Support System

City-Scale 4D Model - Qatar Economic Zone



During an urban planning stage, a **4D model can be developed on an abstract level**

A **decision support system** used in the planning stage can rely on ballpark estimates and a **low Level of Development (LOD)**

Rough coefficient metrics can be linked with a 4D model

- Government leaders and city planners can gain insights on different scenarios of urban planning and their impact on metrics (e.g., the **growth of population, jobs, construction workers, and energy demand**)

This can help **government leaders and city planners establish mid- to long-term strategies**

(Courtesy of bimScore)

Proof of Concept - 4D-based Decision Support System

- Demonstrate the value of 4D to better support in making informed decisions for master plans

Vision of BIM Data Repository

Government Agencies hold the **key** to the data
(Not affected by software version and type)

Develop and integrate open BIM and open GIS data

CityGML

Create Scalable, Shareable and Serviceable BIM DR

Serviceable CityGML
Shareable CityGML LandsD
Scalable CityGML

Preserve the **original** data as much as possible

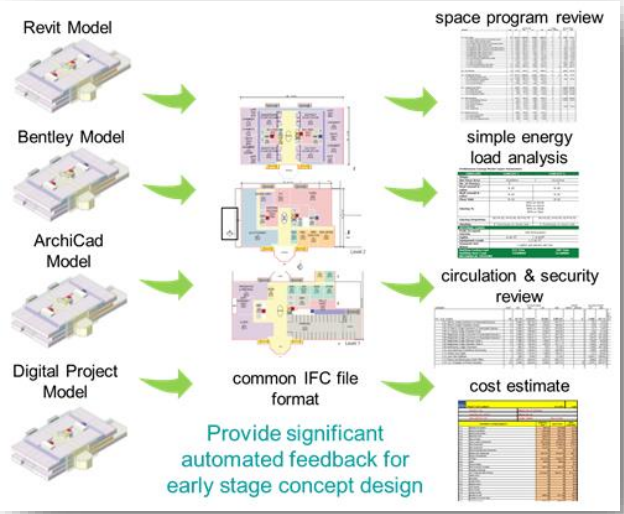
Revit
Civil3D

Maintain and provide the original BIM and GIS data

(Courtesy of bimScore) strategic buildinginnovation bim SCORE

Open Standards – Adopted in other Countries

- 8,700 buildings
- 32.5 km²

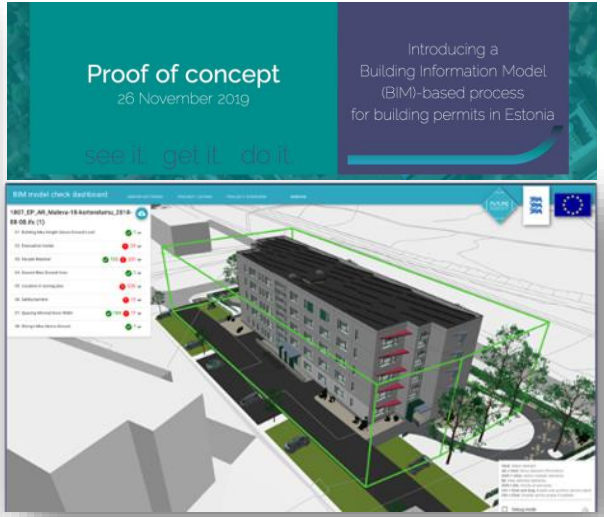


U.S. General Services Administration

- 205,000 Buildings
- 324 km²

The Netherlands: Digital Rotterdam

- 3D Digital Twin
- BIM based permit checking



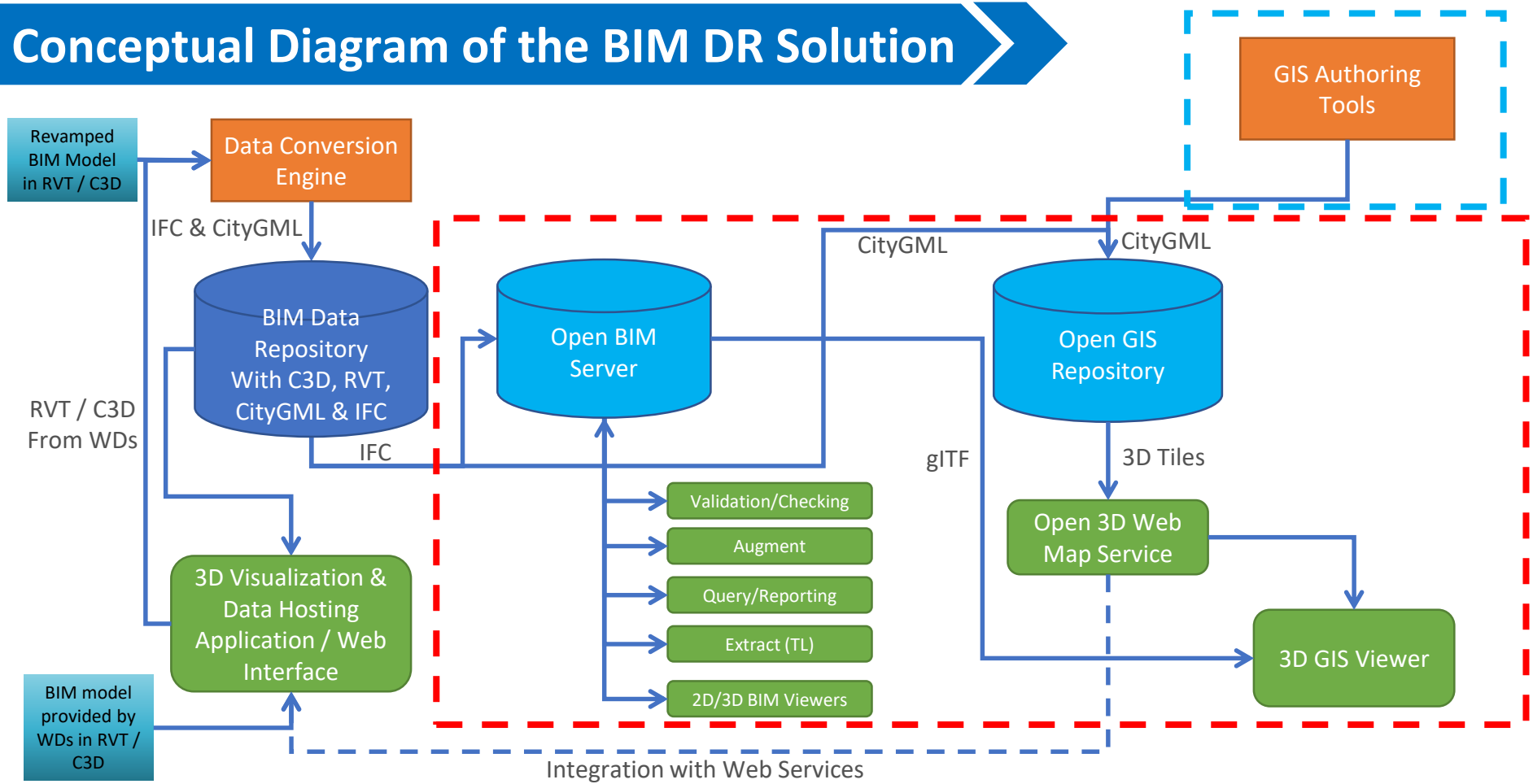
Estonia: BIM-based Building Permit Check

(Courtesy of bimScore)

Phase 1 – Cloud-based BIM Data Repository

- Implement a Cloud-based BIM Data Repository System
- Establish scalable and sustainable system infrastructure
- Facilitate BIM data sharing and collaboration
- Provide a centralized platform for managing BIM data in Object-based approach
- Support integrating BIM and GIS data in a single environment

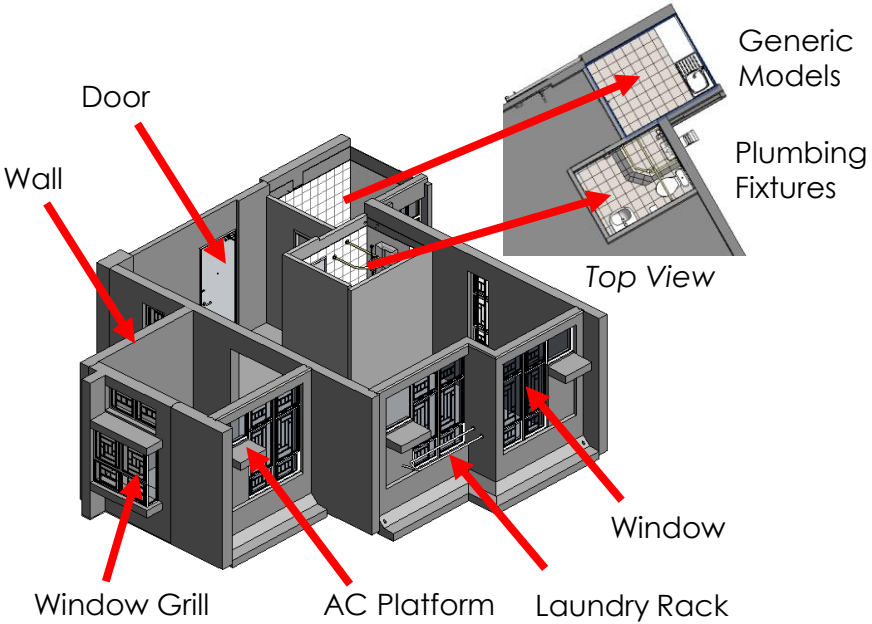
Conceptual Diagram of the BIM DR Solution



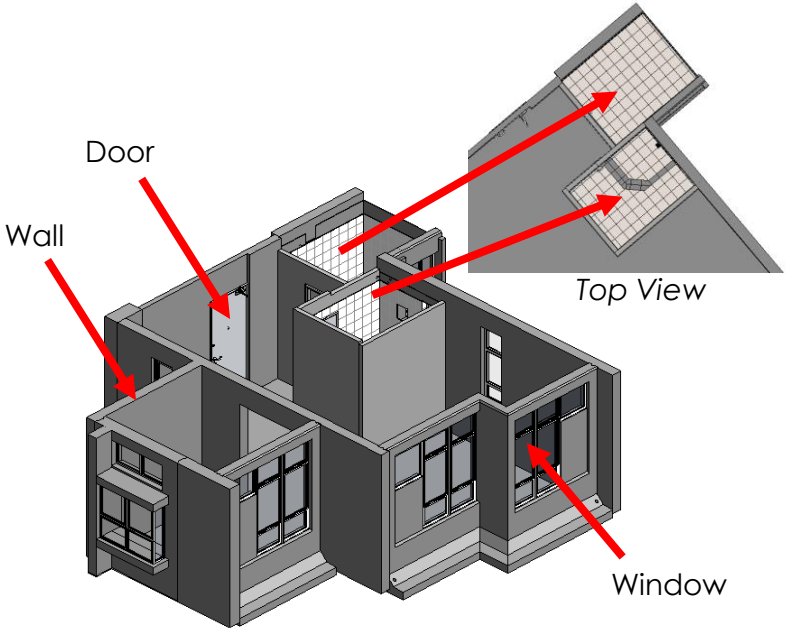
Phase 2 – Creation of 3D Map with BIM

- Extract BIM model elements for 3D Map creation and updating
- Automate and streamline the workflow from BIM to GIS
- Enrich the 3D Map features and analytical capabilities

Enrichment of 3D Map using BIM Models



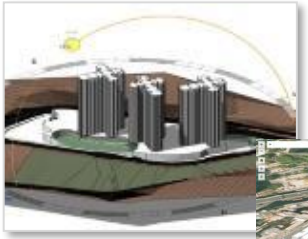
Source BIM



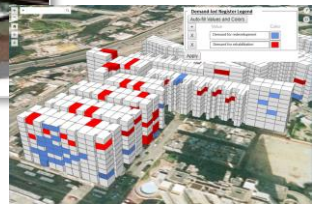
Simplified BIM for indoor mapping purpose

BIM helps to enrich 3D Maps

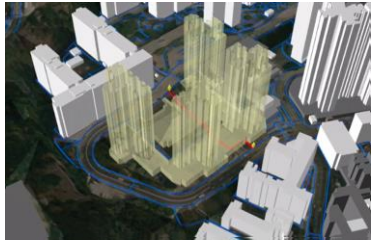
3D Digital Map Streamlines the Construction Life Cycle



Feasibility Study



Re-development Study

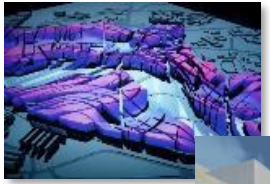


Optimum route finding in different development stages with Intelligent Pedestrian Network

Inspection with indoor 3D map

Planning & Design

Design Options



Visualisation / Simulation

Construction

Progress monitoring with IoT and UAV integration

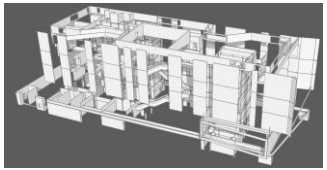
Operation & Maintenance

Efficient asset locates for on-going maintenance

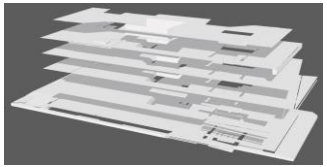
Phase 3 – Development of BIM API

- Sharing of BIM elements with open standard web services Application Programming Interface (API)
- Enhance the BIM data adoption and integration
- Provide BIM analytical features
- Access rich BIM context without the need of BIM software
- Simplify system integration with BIM

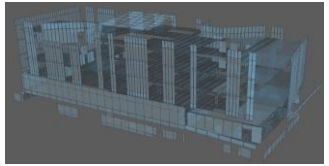
Provide Flexibility of Accessing BIM Data



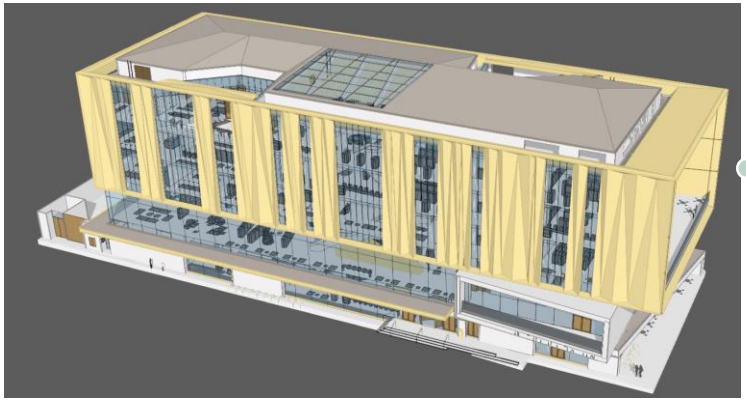
Walls

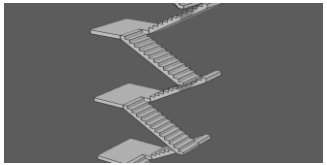


Floors

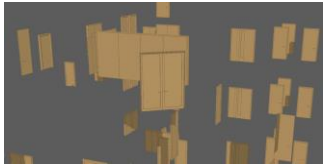


Curtain Walls Panels





Stairs



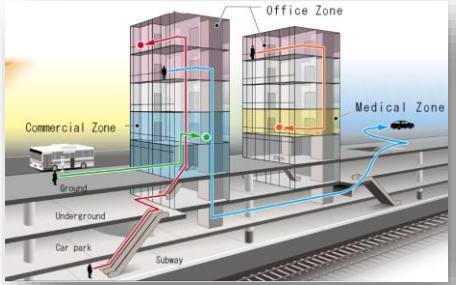
Doors

Web API

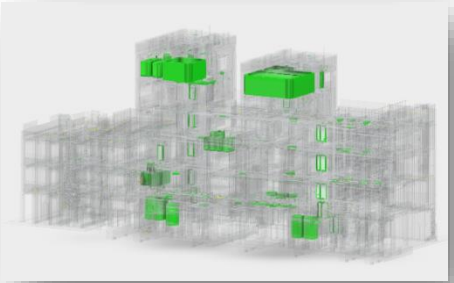
- IFC Data import & export
- IFC geometry
- IFC data query
- IFC data extraction
- IFC data management

Database of BIM Data Repository

Potential Use Cases of BIM API

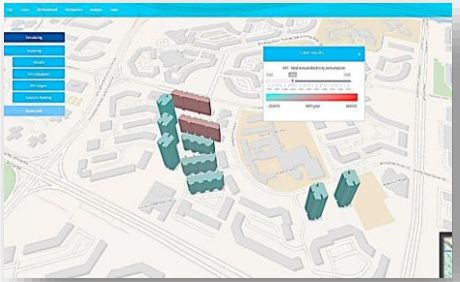


Smart Indoor Service

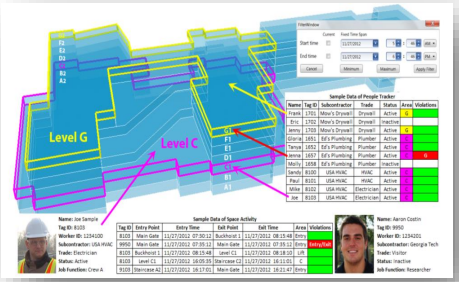


Facilitates Management

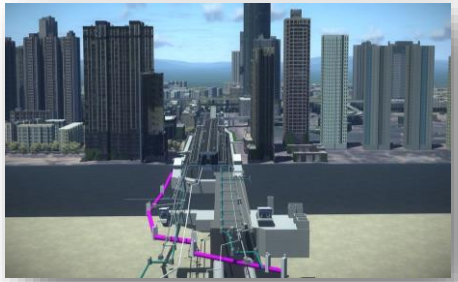
Environmental Impact Assessment



Energy Consumption Analysis



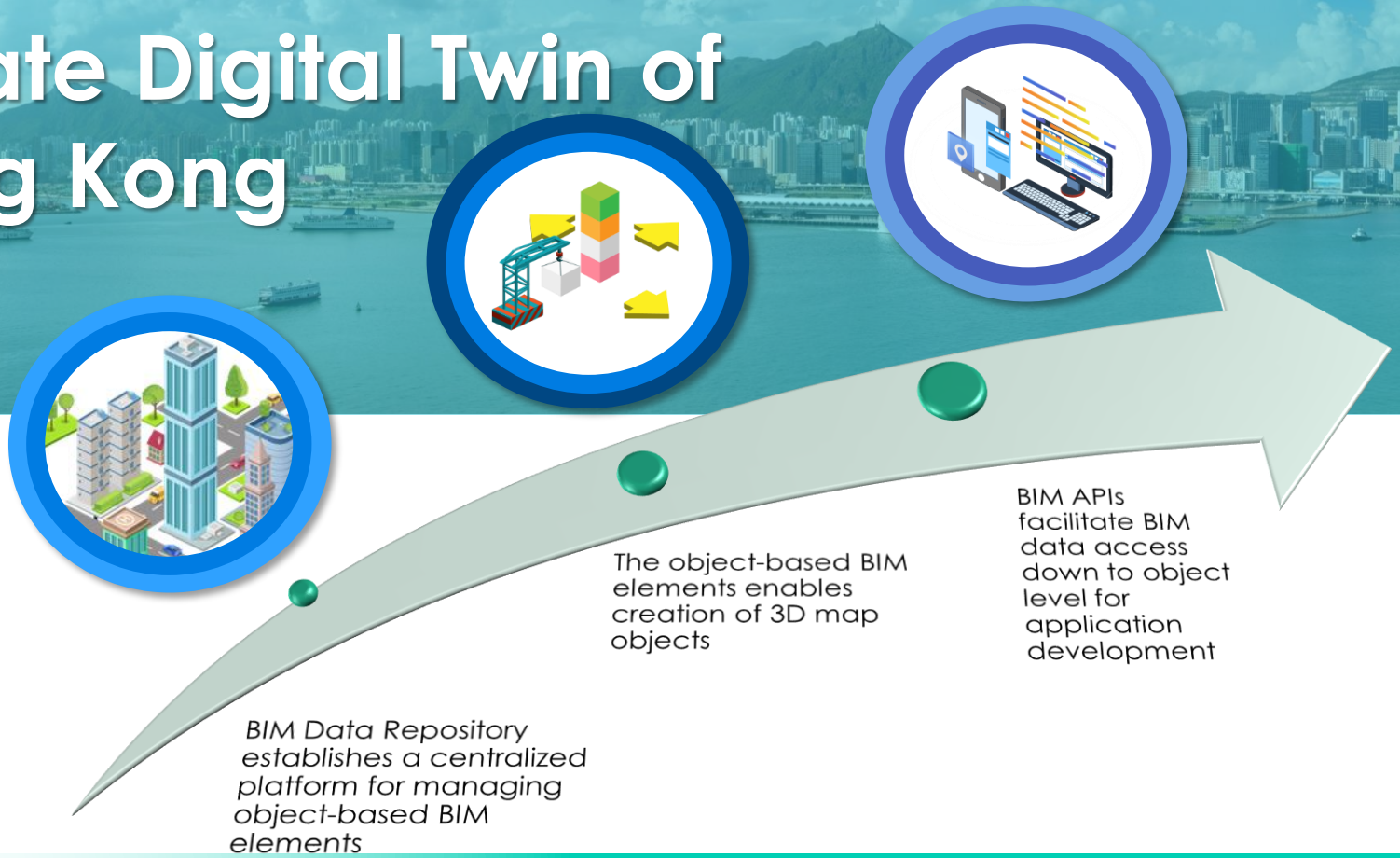
Workforce Management



Underground Utilities Management

And more…

3 Phases Connected To Create Digital Twin of Hong Kong

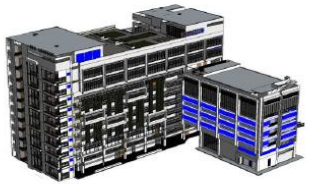


New Development of Building Plan Checking Tools

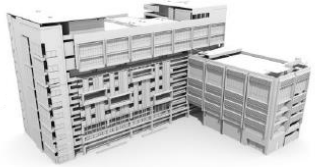
屋宇署
BUILDINGS DEPARTMENT

Building Plan Checking

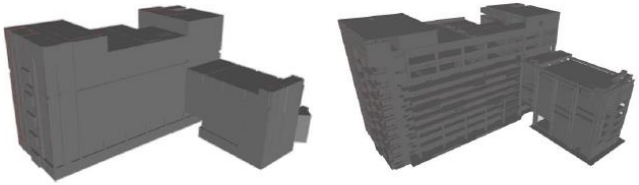
- Flow of Electronic Building Plan Data in BIM Format from Authorized Persons to LandsD



Developer
Internal BIM Model

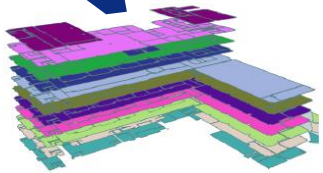


Developer
BIM Model for GBP Submission



SMO
3D Map & CSDI

BPU
- **Area calculations**
- **Compliance checks**
- **Other information extracted from BIM**



DLO/DSO
For future wavier/modification applications

Project Program of the Building Plan Checking Tool Development

Currently in Tendering Stage

- Target to be awarded in March 2021

1st Phase Implementation

- Mar 2021 – Jun 2022
- For the requirements of Lands Department

2nd Phase Implementation

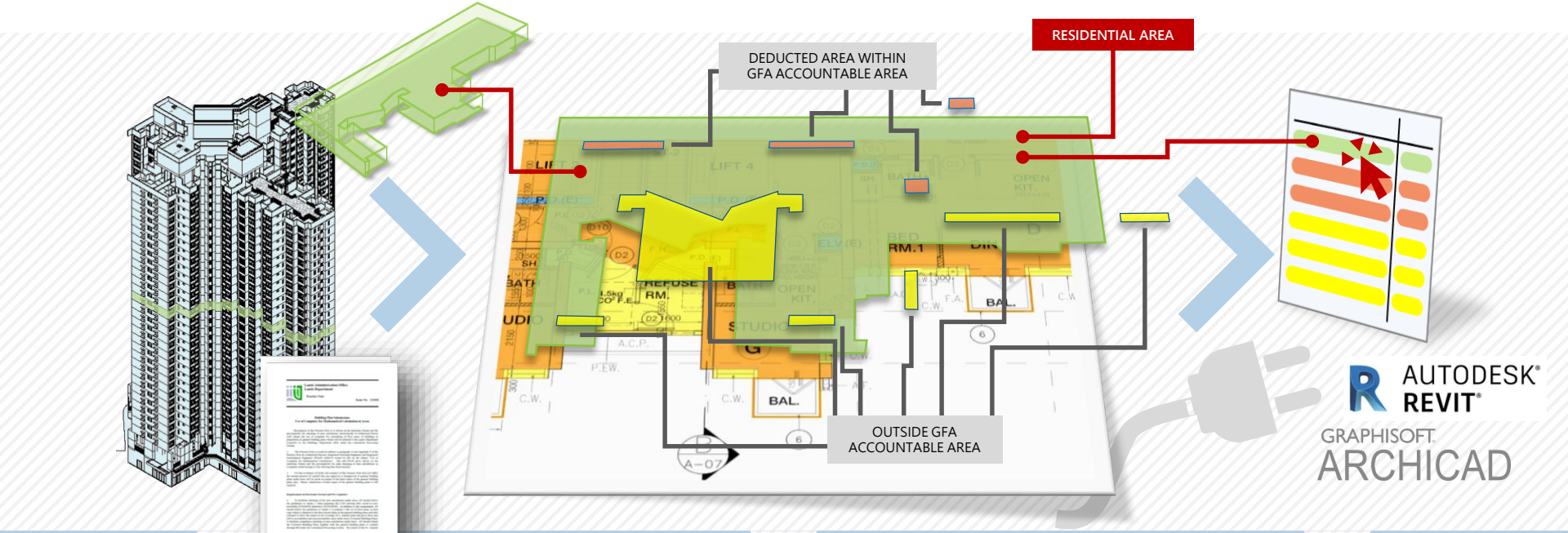
- Mar 2022 – Jun 2023
- For the requirements of Buildings Department

Project for New Building Plan Checking Tool

Major deliverables:

- New Practice Notes and BIM Data Guidelines
- Checking Tools in form of BIM Software Plug-in

Concept for New Building Plan Checking Tool



1

New practice notes and BIM data guideline for regulating eBP submission

2

Plug-in tool in BIM software environment for area computations

3

Area calculation results for verification with lease conditions

The Geospatial Contribution to Digital Twin

CSDI

3D Digital Map

BIM Data Repository


thank you!
111011011000
0010111
101011011000
001011001010
111011011000
0010111
101011011000
001011001
101111101100
000101
111011011000
00
101011011000
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011011000000
111
111011011000
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