OGC's Underground Information Activities

Dr. Ingo Simonis representing Bart de Lathouwer
Director Innovation Program & Science, OGC
December 2017

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Making location count.

The OGC Mission

Global forum for collaboration of developers and users of spatial data products and services

Advance development of international standards for geospatial interoperability.

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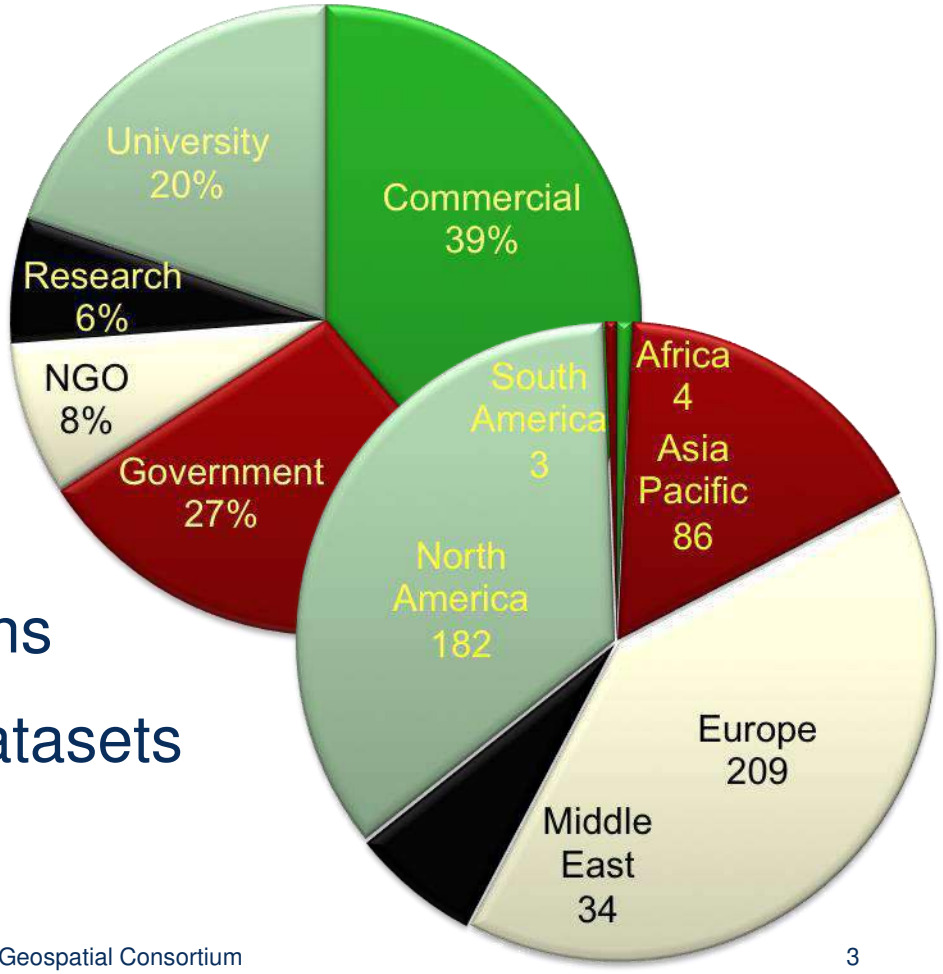
The Open Geospatial Consortium

Not-for-profit, international voluntary consensus standards organization; leading open innovation for geospatial data

- Founded in 1994
- 525+ member organizations
- 100 innovation initiatives
- 48 Open Standards
- 230 OGC certified products
- Thousands of implementations
- Enabling access to 100K+ datasets



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Value of OGC Participation

- Achieve technical agreement on interoperability challenges
- Networking, partnership development
- Insight into emerging technologies and markets
- Unique ability to share cost / resources in solving interoperability challenges

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Example Government Members

- IGN (France) - BRGM (France) - City of Helsinki, Finland
- DHS (US) - NASA (US) - NOAA (US) - NGA (US)
- USGS (US) - USACE (US) - DSTL (UK) - DLR (Germany)
- EU Satellite Center (Europe) - NR Canada - DIGO (Australia)
- United Nations - Norwegian Building Authority - Ordnance Survey (UK)
- Ministry of Land, Infrastructure and Transport (Korea) - Vienna, Austria
- Dubai Municipality (UAE) - Charlotte, NC
- San Francisco City & County - Others…

Over 100 Universities, Research institutes, NGOs; e.g., TU Berlin, FCNY

http://www.opengeospatial.org/ogc/members

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Example OGC Commercial Members

pitney bowes

DigitalGlobe

Google

esri

ORACLE

INTERGRAPH

SAFE SOFTWARE

AUTODESK.

HARRIS

BENTLEY

Spacemetric

ENVITIA
World Class Spatial Information Technologies

VENCORE

AIRBUS
DEFENCE & SPACE

NAVTEQ

PCI
Geomatics

agi
Analysis software for land, sea, air, & space

1Spatial

Trimble

LUCIAD

BAE SYSTEMS

ROLTA

Raytheon

galdos
systems inc

Skyline

Insurance Evolved FM Global

CubeWerx
Interoperable Services for the Geo-Spatial Web

Snowflake
software

LOCKHEED MARTIN

Leica
Geosystems

LIZARDTECH
a celartem Company

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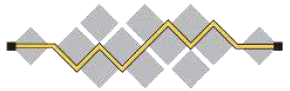
exactEarth

OGC Partners for Geospatial

JTC 1/SC 24 Computer Graphics
JTC 1/SC 41 Internet of Things
JTC 1/WG 9 Big Data
JTC 1/WG 11 Smart Cities

ISO/TC 211
ISO/TC 204



GSDI
Global Spatial Data Infrastructure Association

OBJECT MANAGEMENT GROUP

UN-GGIM

buildingSMART
International Alliance for Interoperability

oma
Open Mobile Alliance
For a Connected World

International Association of Oil & Gas Producers

OASIS
Advancing open standards for the information society

LBMA
Location Based Marketing Association

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What is a Standard?

- *"An agreed way of doing something"*
- **Standards are distilled wisdom** of people with expertise in their subject matter and who know the needs of the organizations they represent – people such as manufacturers, sellers, buyers, customers, trade associations, users or regulators.
- **Standards are knowledge**. They are powerful tools that can help drive innovation and increase productivity. They can make organizations more successful and people's everyday lives easier, safer and healthier.

EC: Practical standards guide for researchers - en

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Underground Information Projecta:

STANDARDS TO BUILD UNDERGROUND INFO

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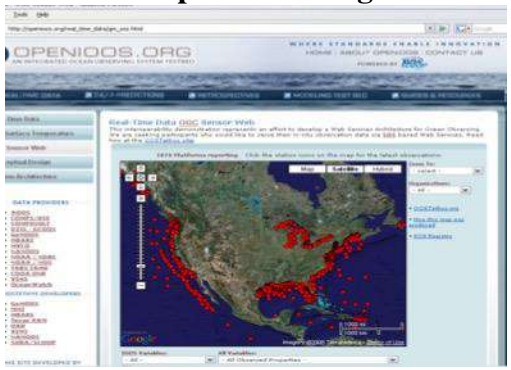
Basic Geospatial Interoperability Challenge Solved

Hundreds of thousands of maps and datasets accessible through 10,000 servers running OGC Web Services

OneGeology.Org

OpenIOOS.Org



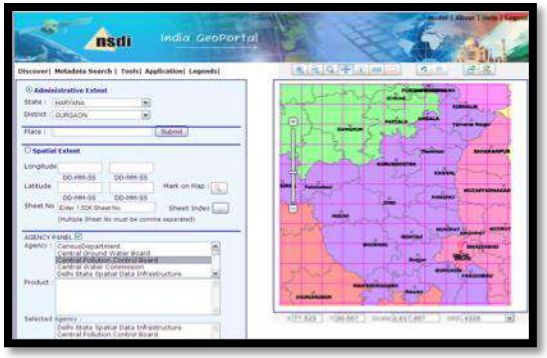
OGC Web Services

Web Map Servers (WMS)

Web Feature Servers (WFS)

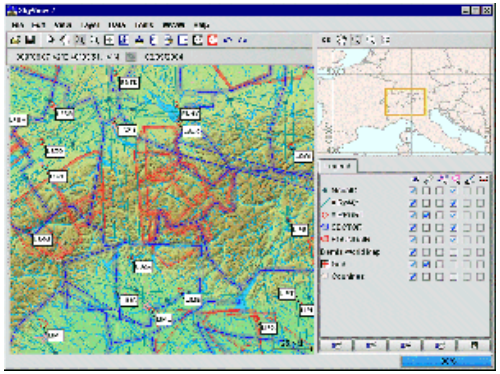
Web Coverage Servers (WCS)

NSDI - India GeoPortal Map Viewer



GEOSS Portal geoportal.org

Skyview2, Eurocontrol



http://www.opengeospatial.org/standards

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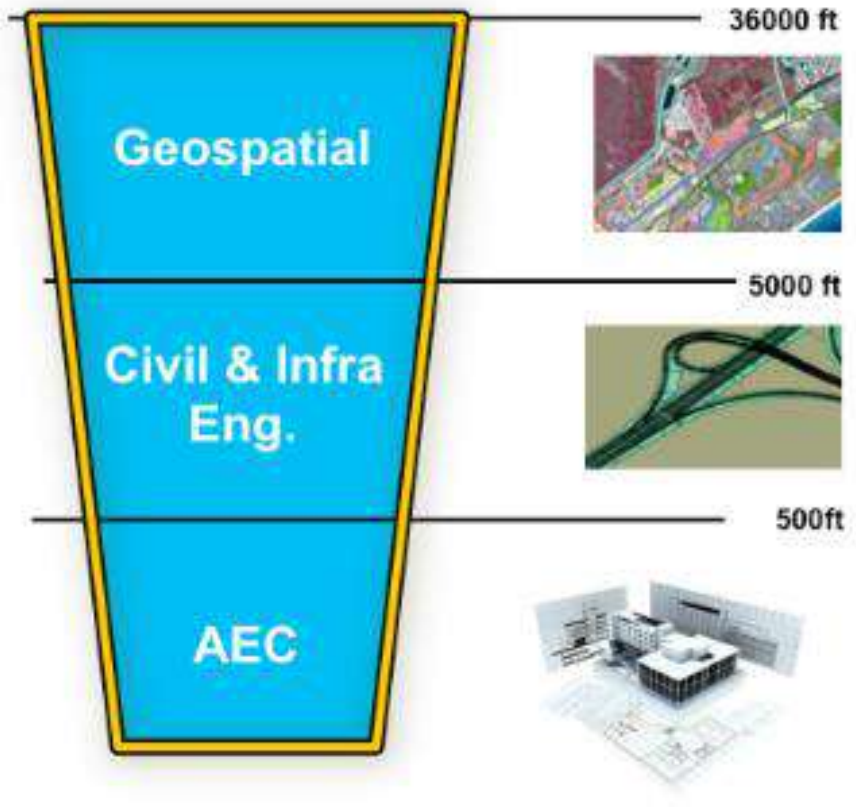
Merging of spatial domains

Geospatial,

Civil Engineering &

BIM

come together in the Urban environment and are destined to work together



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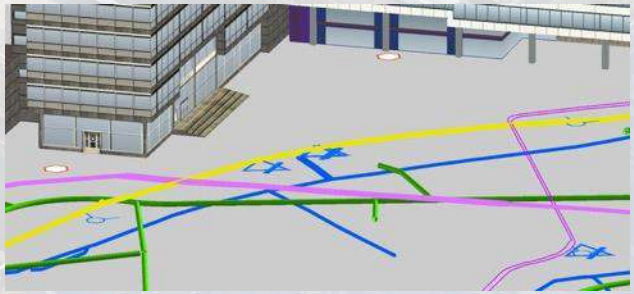
OGC CityGML for Urban Applications

CityGML - Berlin

>500,000 buildings;

- **fully-automatically generated from 2D cadastre footprints & airborne laserscanning data.**
- **textures (automatically extracted from aerial images)**
- **semantic information (includes data from cadastre)**
- **3D utility networks from the energy providers**



- **modeled according to CityGML**

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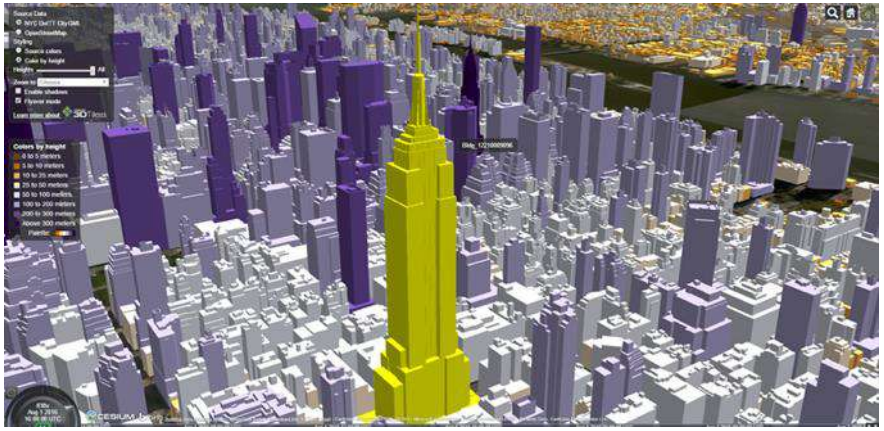
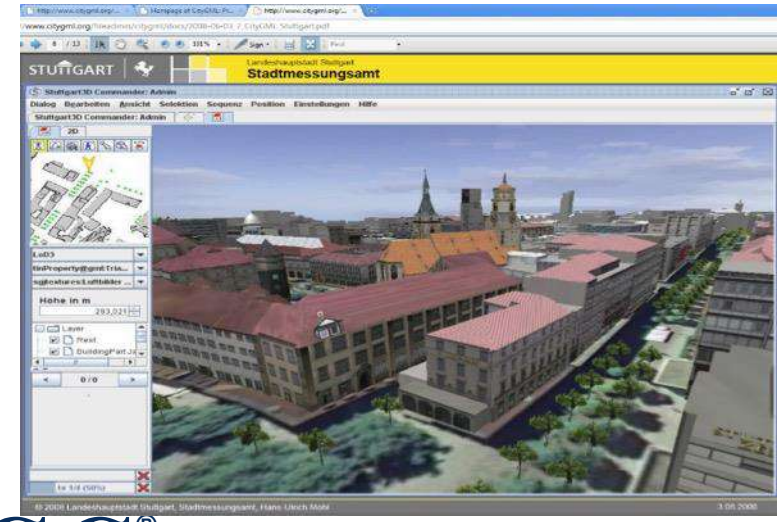
Source: Nagel, Kolbe, 2010

OGC CityGML for Urban Applications



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



CityGML models for 3D visualization and analysis based on semantics

- 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…

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Software supporting CityGML

- Oracle 11g
- VirtualCitySystems
- Bentley: Bentley Map
- Autodesk: LandXplorer
- Safe Software FME
- University of Bonn: Aristoteles
- Snowflake software: Go Publisher
- Interactive Instruments: WFS
- HST Stuttgart: QS-City 3D
- MetGeoInfo: CityGRID
- ESRI: ArcGIS10
- CPA: SupportGIS3D
- GTA: Tridicon CityDiscoverer
- Ptolemy3D:
- RhinoTerrain:
- FH GK: CityGML-Toolchain
- FZ Karlsruhe: FZKViewer
- Revisitor: WI-MAP
- LibCitgyGML
- Bitmanagement: BS Contact Geo 3D

Active community providing help, documentation, tips, example datasets, and tutorials, etc.
https://www.citygml.org

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Moving Underground

- CityGML is a mature standard for above ground
  - Data model standard defined
  - Datasets widely available
  - Software implementations of standard to exploit data model
  - Maturity allows focus on data quality and efficiency

- Underground Infrastructure is the place to be now
  - The New Frontier of modeling the entire urban manmade and natural environment.
  - Add to CityGML to model the complete urban environment
  - Huge cost efficiencies will be achievable

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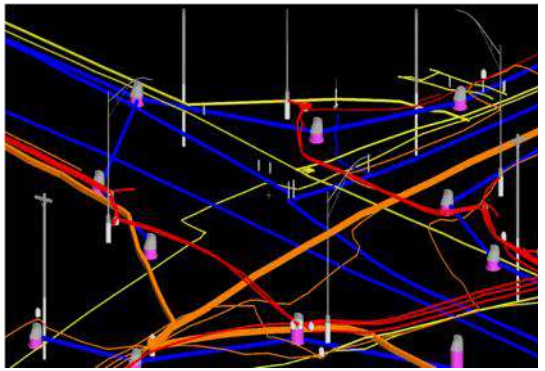
Underground Infrastructure Information (UGII) – Current State of Affairs –

- Present UGII data quality is poor
  - Different data models
  - Stored in different ways
  - Different geometry and semantics
- Inability to exchange UGI data
  - Maintainers have different purposes
  - Ownership, governance challenges
  - Interoperability issues
- Costs of UGII failures are recognized
  - Routine excavations can be disastrous
  - Inefficiencies in construction
  - Unable to predict cascading failures



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Catastrophes coming from underground

NYC steam pipe explosion

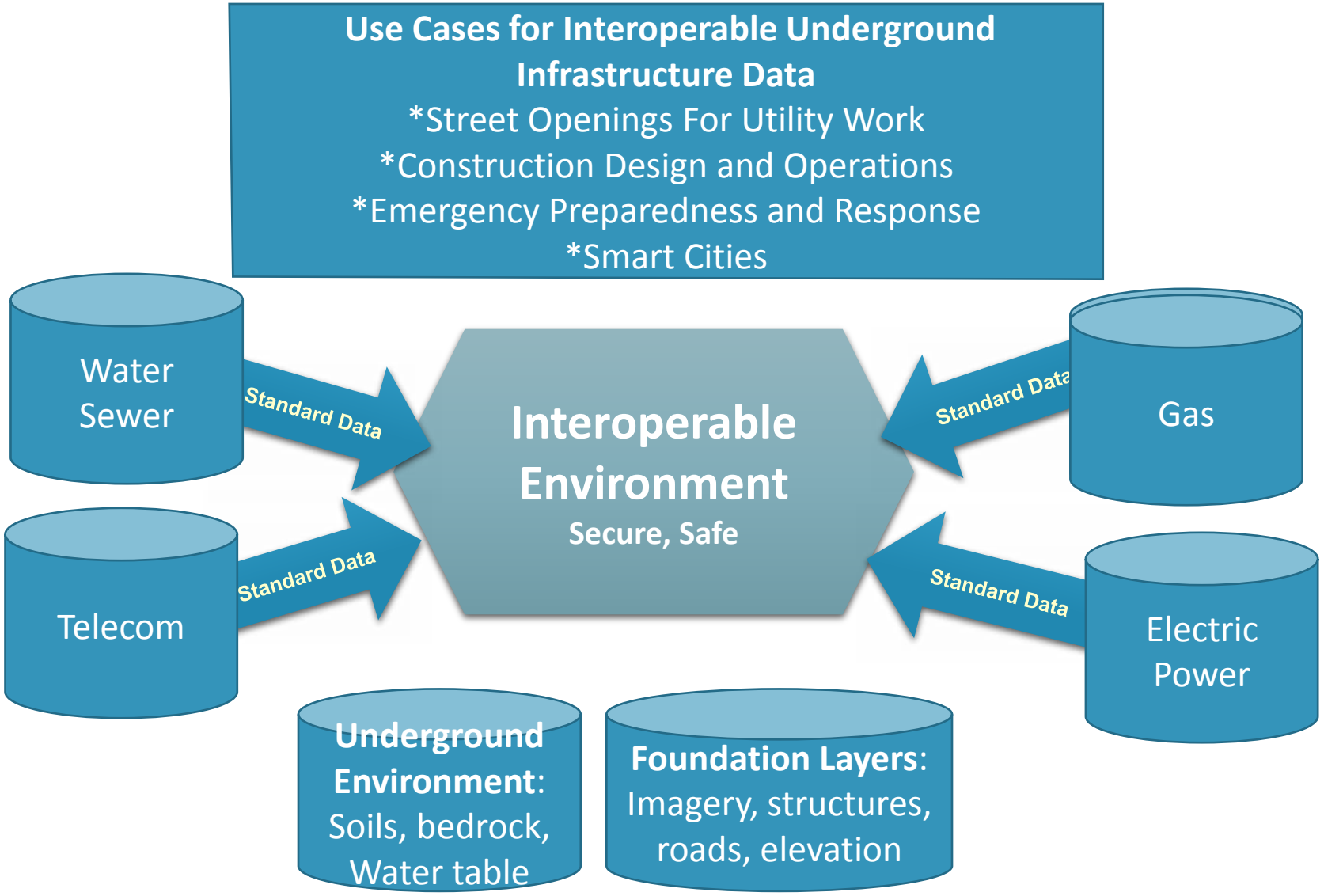
Steam Pipe Explosion at Lexington Avenue and East 41st Street, Manhattan, July 18, 2007 (https://www.flickr.com/photos/lorcanotway/848506700)

Belgian natural gas pipeline

July 30, 2004. High-pressure natural gas pipeline ruptured following recent third party damage: 24 died and 150 hospitalised. Damage to pipeline during the final stages of construction project. https://en.wikipedia.org/wiki/Ghislenghien

Simple Model of Infrastructure Data Integration

Cost of Data Creation Off-Set By Vast Uses of Combined Data



Source: Alan Leidner, FCNY

Underground Information Project

LEADERSHIP IN STANDARDS INNOVATION

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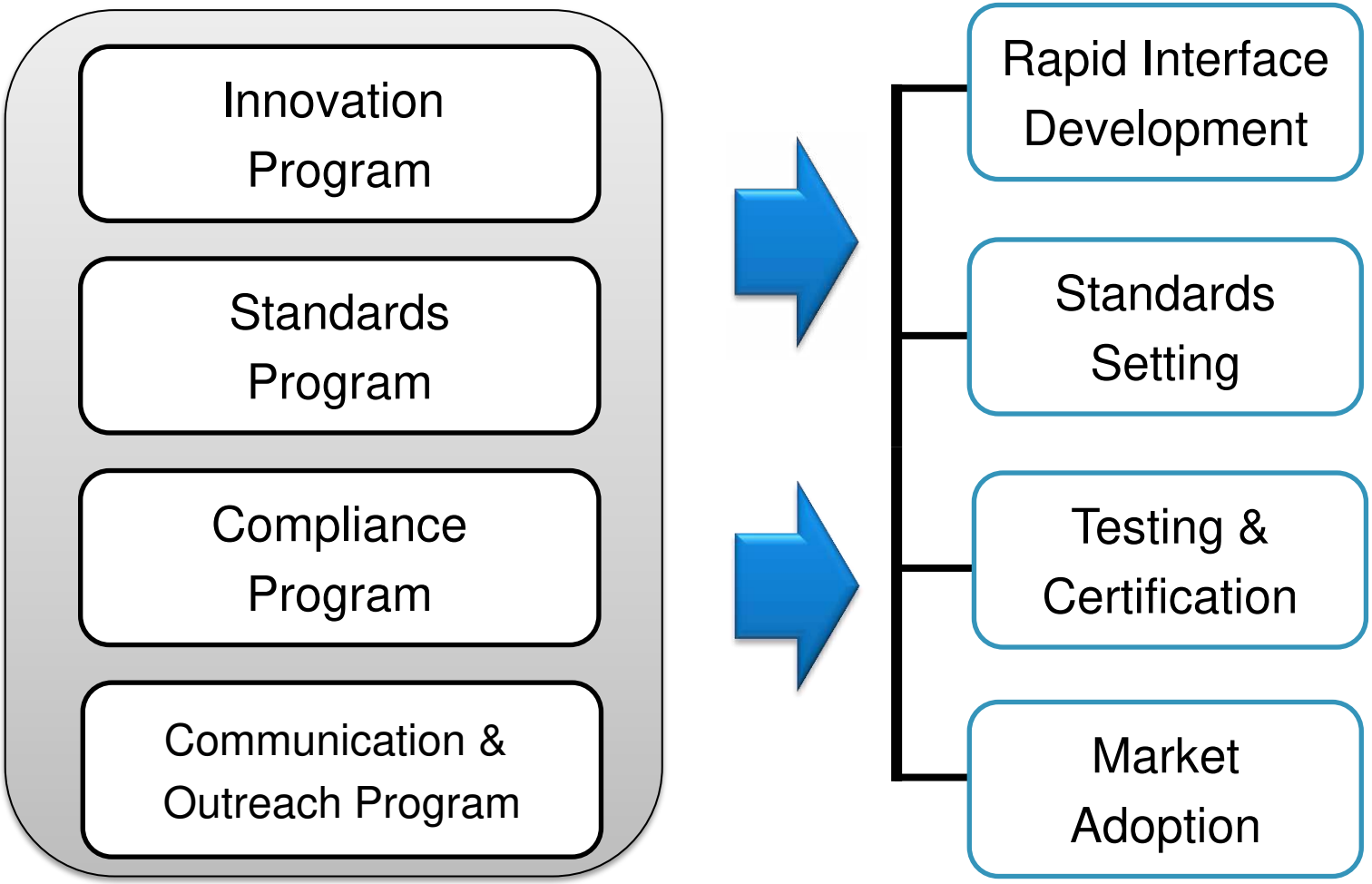
OGC's Approach for Advancing Innovation



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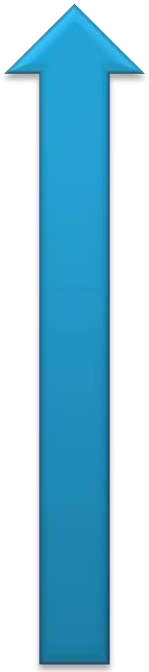
OGC Innovation Program Projects:

1999 to 2017

Total	**100**
Pilots	30
Plugfests	4
Experiments	20
Testbeds	20
Concept Development	16
Support Services	8



Increasing Technology Readiness

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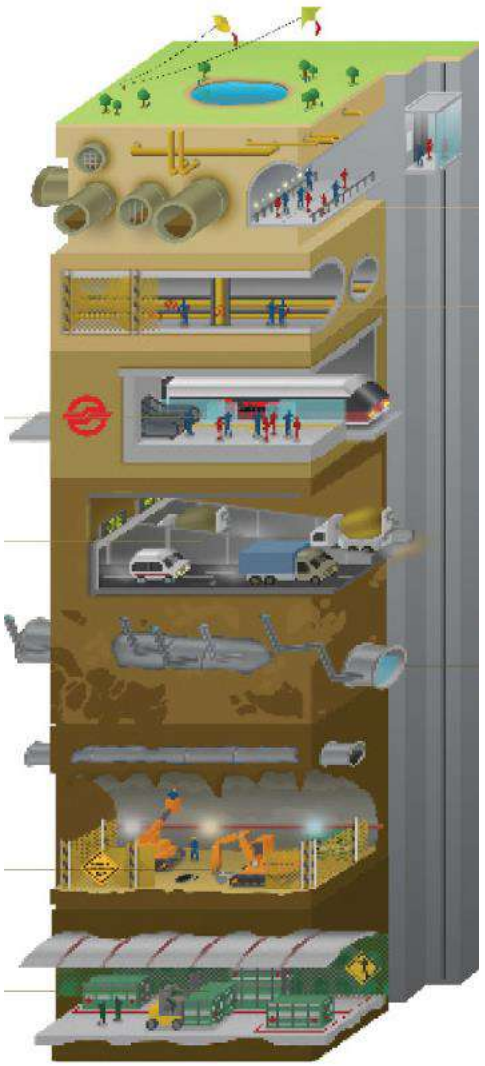
Underground Information (UGI) Projects

1. Concept Study - complete
   - Findings and Recommendations
2. Data Model – under development
   - Necessary foundation for the Pilot
3. Pilot Implementation - planned
   - Develop, Test and Demo technology advancements
   - Provide basis for city procurements



Source: Singapore Land Authority

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UNDERGROUND CONCEPT STUDY

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OGC Concept Development Study

- To assess state-of-technologies available to support innovation initiatives and open standards development
- Process
  1. Request for Information (RFI) posted to public
  2. Workshop to review RFI results
  3. Report as outcome and basis for Pilot

Thanks to Study Sponsors:
FCNY, Ordnance Survey, Singapore Land Auth.

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Underground RFI Responses - March 2017

Accenture	Bentley	BGS
Boston City	BRGM	Cesar Quiroga
CityGML Chair	Dassault Systemes	Delft University
Dubai Elec/Water	EPRI	Erik Stubkjaer
Geoweb 3D	HERE	HL Consulting
Informatie Vlaanderen	LandInfra SWG	Les Guest Assoc.
Luciad	Robin Danton	Rotterdam City
Sewer Network	Spacetime Technology	St Paul Minnesota
Swiss Water SJIB	Technics Group	Tech. Univ München
	UMS Bernice	

Reponses from gov, biz, research sectors - from around the globe

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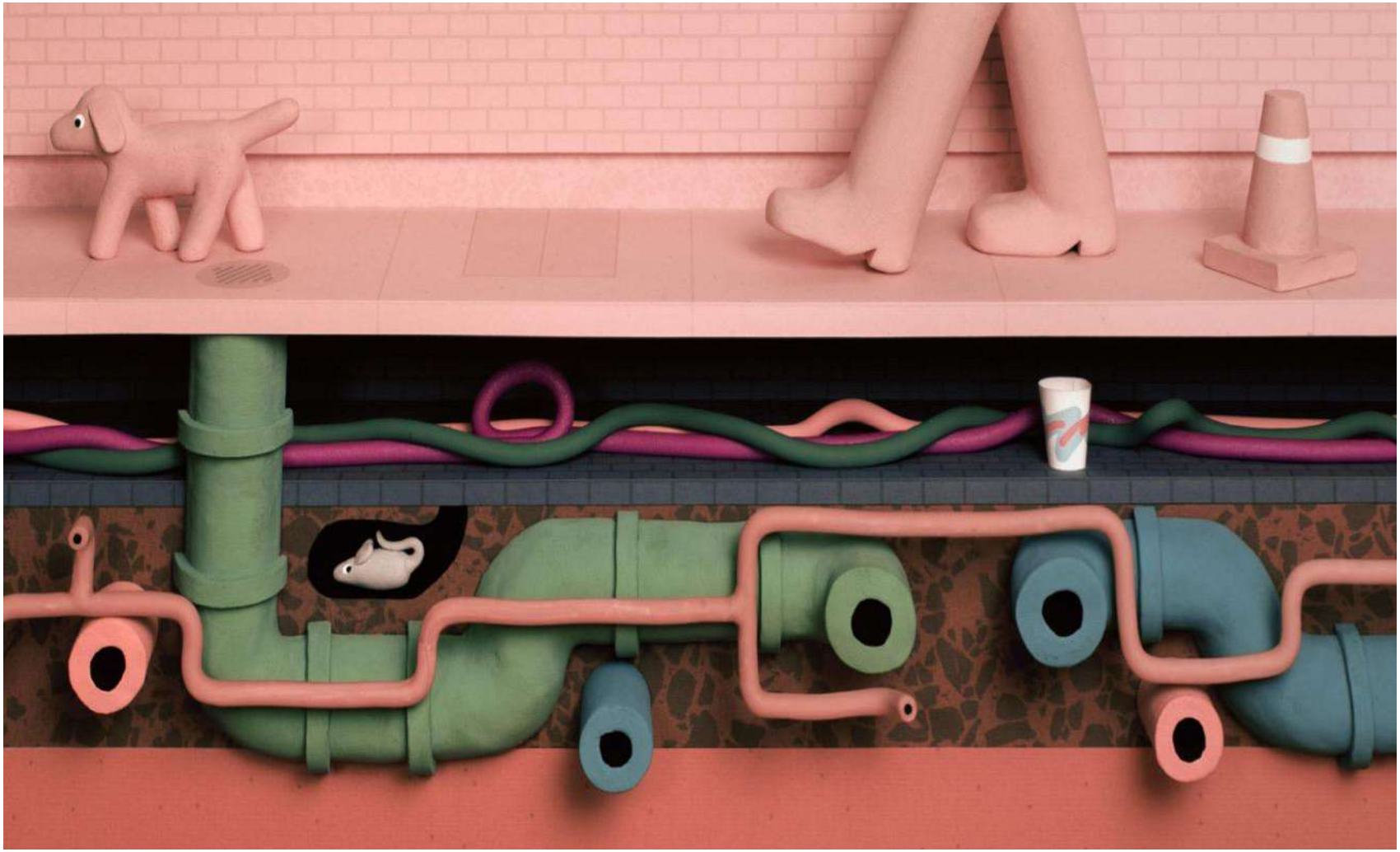
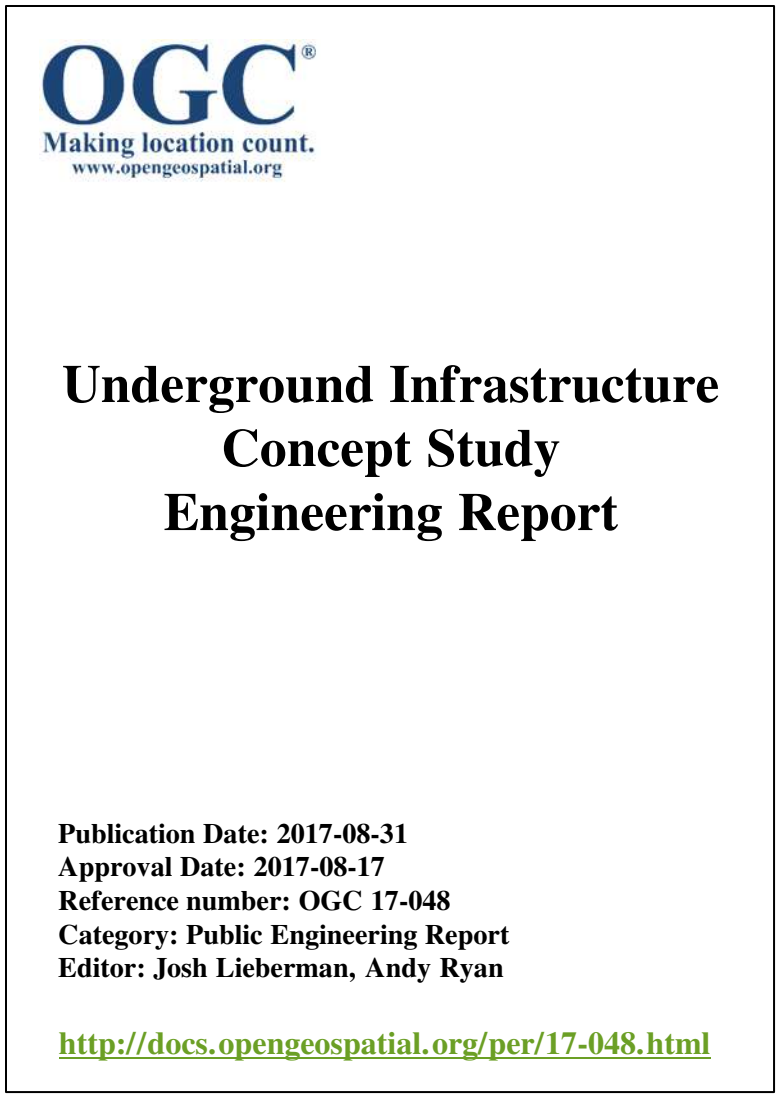
“Nobody Knows What Lies Beneath New York City”
Greg Milner Bloomberg Businessweek, 8.10.17



https://www.bloomberg.com/news/features/2017-08-10/nobody-knows-what-lies-beneath-new-york-city

Published Results from Concept Study



- Executive Summary
- Request for Information
- Workshop
- Discussion and knowledge synthesis
- Findings
- Recommendations
- Next steps

Use cases and case studies

Through the input of RFI responders and Workshop participants, major categories of use case were identified:

- **Routine street excavations**
- Emergency response
- Utility maintenance programs
- **Large scale construction projects**
- **Disaster planning and response**
- Smart cities programs.

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Concept Study Recommendations

1. Develop interoperable common data models for underground infrastructure
2. Conduct research on legal, security, financial, and cultural challenges
3. Conduct collaborative pilot projects to validate UGI data models and architectures for handling the UGI data.

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UNDERGROUND DATA MODEL

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Underground Data Model

- Developed by review of multiple existing data models identified in the Concept Study
- Multiple interfaces to a common core model support multiple use cases and applications
- Data model focuses initially on priority use cases
  - Routine street excavations
  - Large scale construction projects
  - Disaster planning and response
- Primary structures to be modeled
  - Networks: water supply, sanitary sewer, storm drainage, natural gas, steam, electric power and telecommunications lines.
  - Subways, vaults, footings, foundations
  - Underground environment of soil, water, rock

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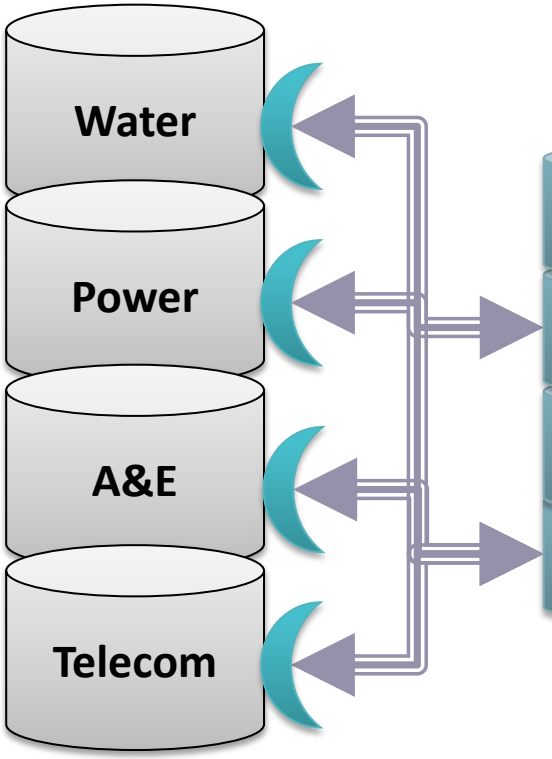
Data Integration Architecture

Diverse Data Sources, Systems, Formats

Unified Model with Multiple Perspectives

Distinct Data-driven Applications



Disaster Planning

Large-scale Construction

Safe Excavation

Planning, Investment, Lifecycle

Standard Model Interfaces

- On-demand Query
- Proxy / Cache
- Authoritative Repository

Unified / Harmonized Data Access

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Reference models for built / utility infrastructure

- CityGML Utility Network ADE (Application Domain Extension)
- INSPIRE Utility Networks
- IMKL (Information model for cable and pipes)
- Land and Infrastructure Conceptual Model (LandInfra)
- Underground Pipeline Information Management System
- Power Utilities
- Enterprise Systems for Utilities –
- Wastewater Pipeline & Manhole Condition Assessment Gas Distribution
- Water/Wastewater Modeling
- GEOfeature

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Ordnance Survey

Reference underground environment models

- BGS National Geological Model
- BRGM SCUDD
- GeoSciML
- EarthResourceML
- INSPIRE
- GeoTOP
- GroundwaterML

Models are designed for different purposes (engineering, water management, hazard assessment). The model intents need to be understood to allow for meaningful translation and combination between them.

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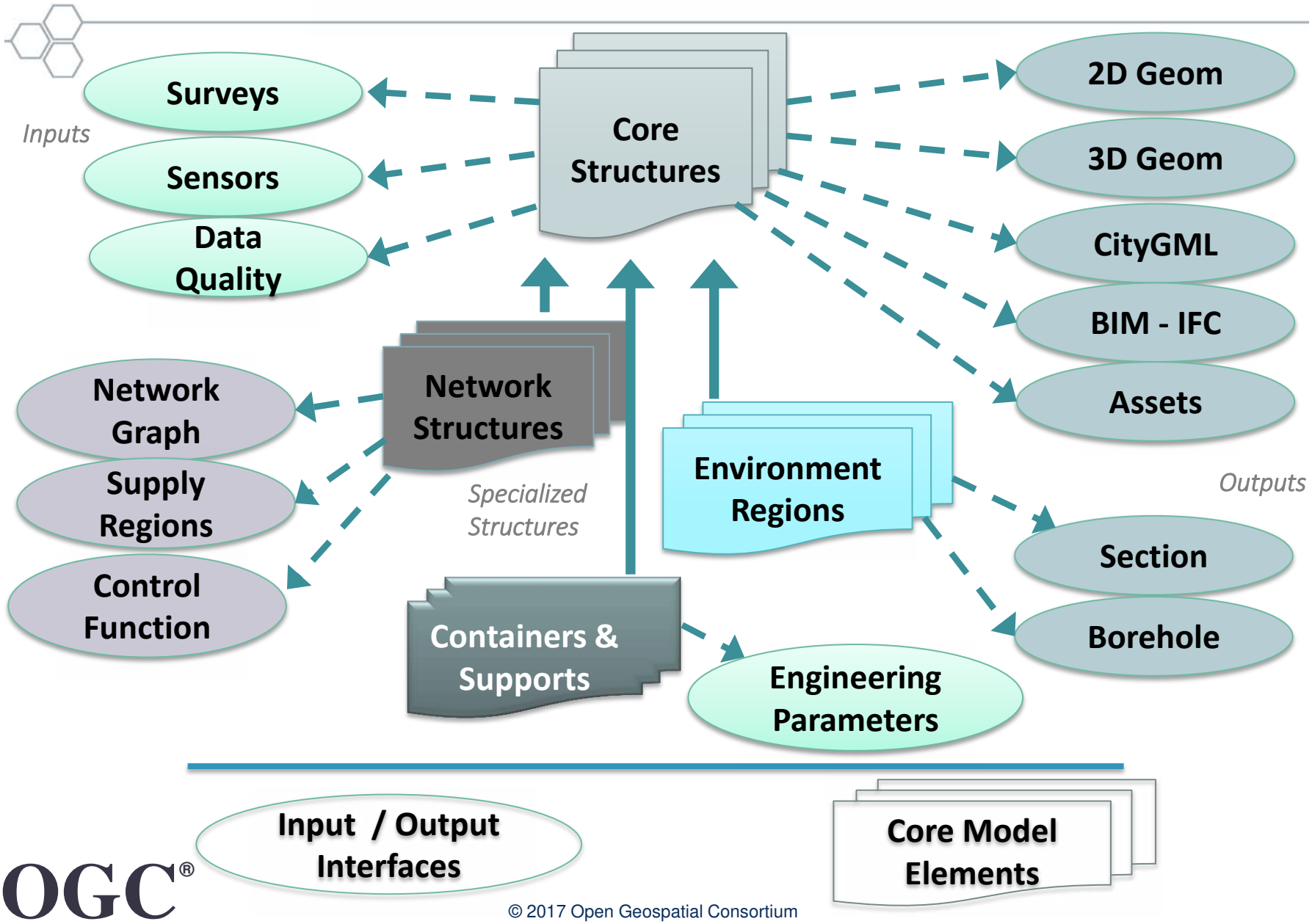
Ordnance Survey

UGIIIM Model Structure



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Questions to Ask (of the Data)

Queries	Interfaces
3D image of all the UGI elements within 10m of planned excavation	2D geometry 3D geometry
Minimum distance between 2 underground utility networks	3D geometry Network graph
Major transmission lines as distinguished from distribution elements	2D geometry Network control
Important control components in a neighborhood	Network control Network supply
Age, material composition, thickness of the UGI elements	Asset Surveys
Likely composition, moisture, chemistry of soils surrounding particular UGI elements	2D geometry Section
Likely extent of corrosion of these elements, potential vulnerability to vibration and accidental strikes, spatial extent of network vulnerability	Asset Sensor Network graph

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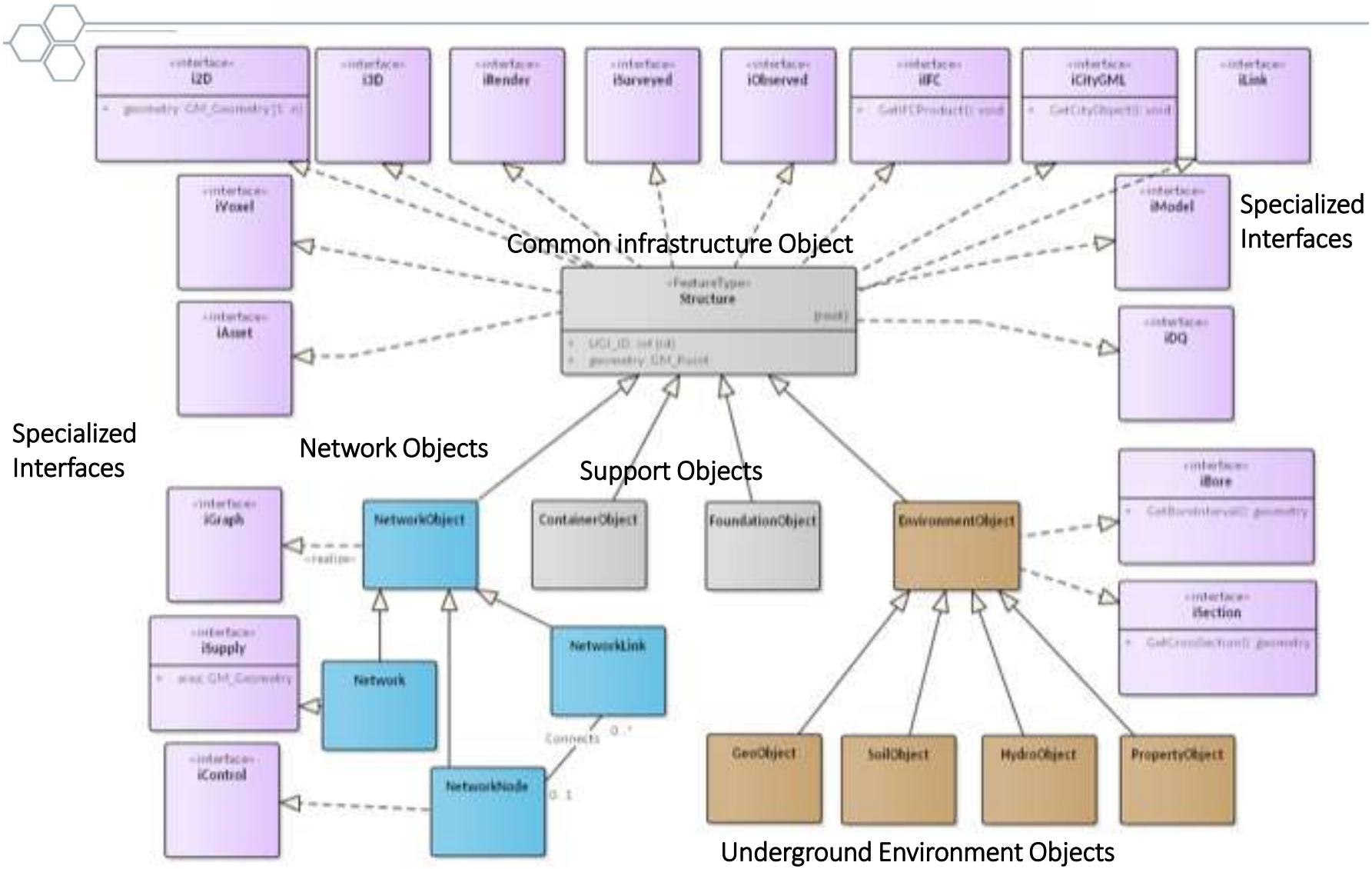
Core UGIIIM Model Schema



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PILOT

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Build on Previous OGC Pilot Projects

- **Future City Pilot** demonstrated how use of CityGML and IFC together to enhance financial, environmental, and social outcomes for citizens living in cities.
- **Empire Challenge Pilot** enabled sharing of sensor data in the defense and intelligence domain based on the OGC Sensor Web Enablement standards.
- **Aviation Pilot** produced proven standards that are now operational for sharing of civilian aeronautical information management (AIM)
- **GEOSS Architecture Implementation Pilots** defined the architecture for the Group on Earth Observations tested through an initial operating capability.
- **Arctic Data Pilot** demonstrating the diversity, richness and value of a Spatial Data Infrastructure (SDI) to Arctic stakeholders.

OGC IP initiatives: http://www.opengeospatial.org/projects/initiatives/past

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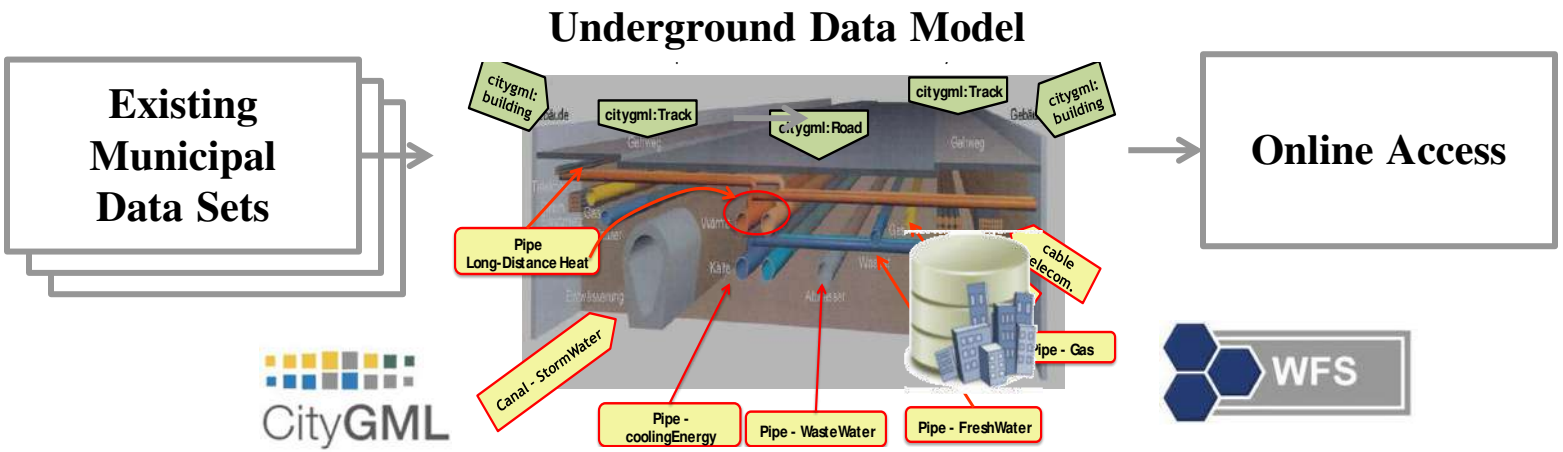
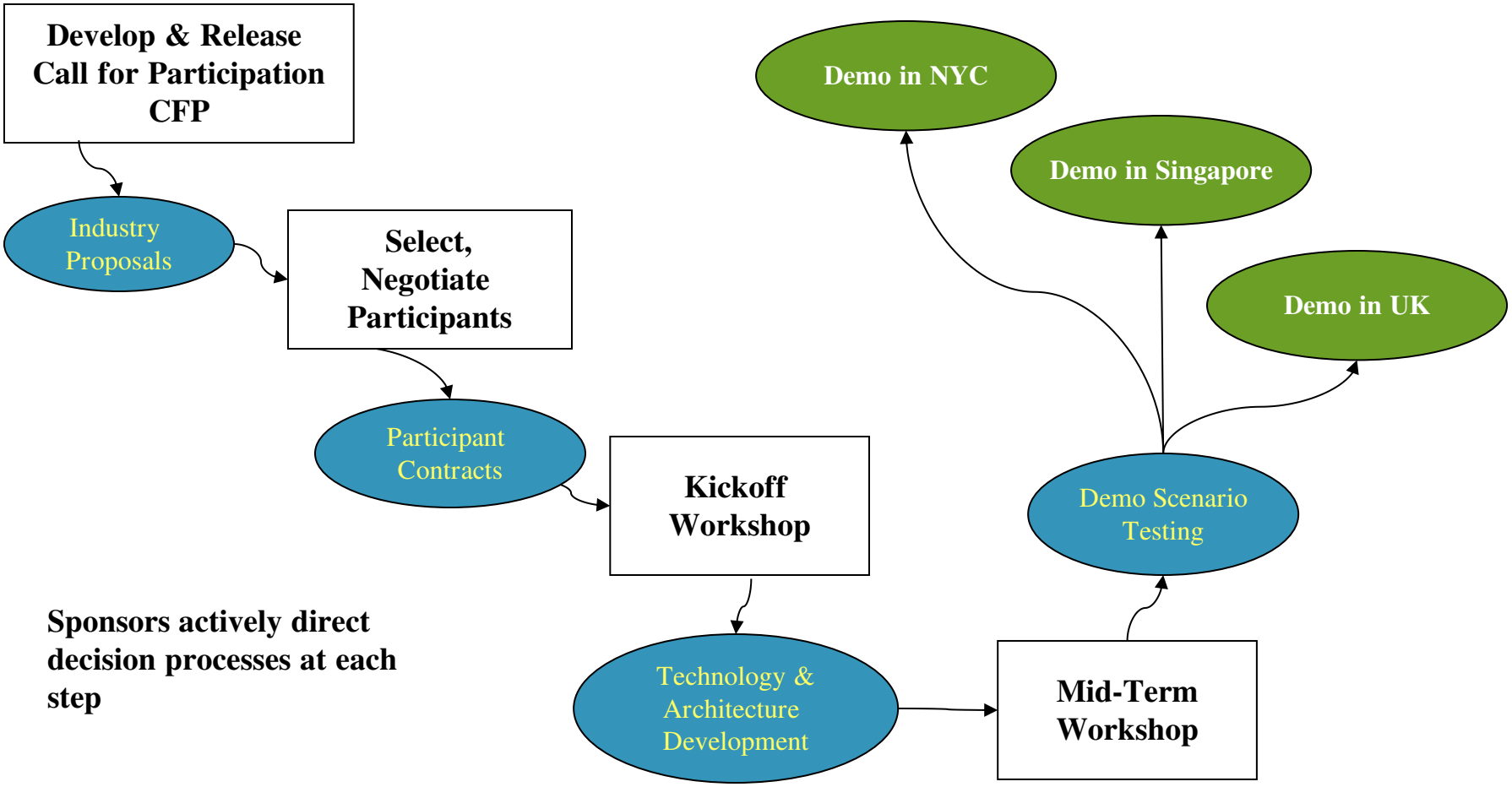
Underground Pilot

- Deploy, Test and Demonstrate Interoperability of underground information based on open standards
  - Use Cases: Excavations; Construction design; Disaster planning
  - Examine alternatives for exchange of underground information from multiple independent organizations
  - Produce basis for future procurements by cities



OGC Pilot Process – DRAFT

Duration from start to demo: 15 months



Sponsors actively direct decision processes at each step

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Pilot Outcomes will support Procurements

- Technical Deliverables usable in procurements
  - Data model
  - Architecture
- Validation that industry is ready to respond to procurement
  - Technology maturity advanced by pilot deployment and testing
- Guides available for municipalities
  - Guidance for adapting architecture to specifics of city data holders
  - Apply architecture to production environment
  - ROI models to develop cost rationale

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OGC Pilot Outcomes

- ***Reduce technology risk*** through accelerating development, testing and acceptance of interoperability standards with the refinement of standards and best practices
- ***Expand the market and improve choice*** by encouraging industry adoption of new standards and best practices, ensuring market availability of interoperable solutions
- ***Mobilize new technologies*** through providing participants with real world experience and a platform to innovate while driving early adoption of standards
- *Provide* ***cost effective method*** for sponsors and participants to share expertise and development while gaining early marketplace insight and advantage

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Estimating costs of the pilot

- Estimate for pilot implementation is based on this scope:
  - 3 urban locations for scenario definitions and demonstrations
  - 22 work items total; subcontracted to participants receiving cost-share funding matched by their funds
  - OGC staff provides program management and systems engineering
  - Duration: 62 weeks starting late 2017/early 2018

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Benefits to Sponsors of Underground Pilot

- Affect market direction to sponsor's needs
- Amplification of funding with multiple sponsors
- Leveraging 3.5x based on participant in-kind effort
- Accelerated process for innovation
- Procurements use proven standards-based results
- Leading to safer and more efficient cities.
- Visibility as global leader

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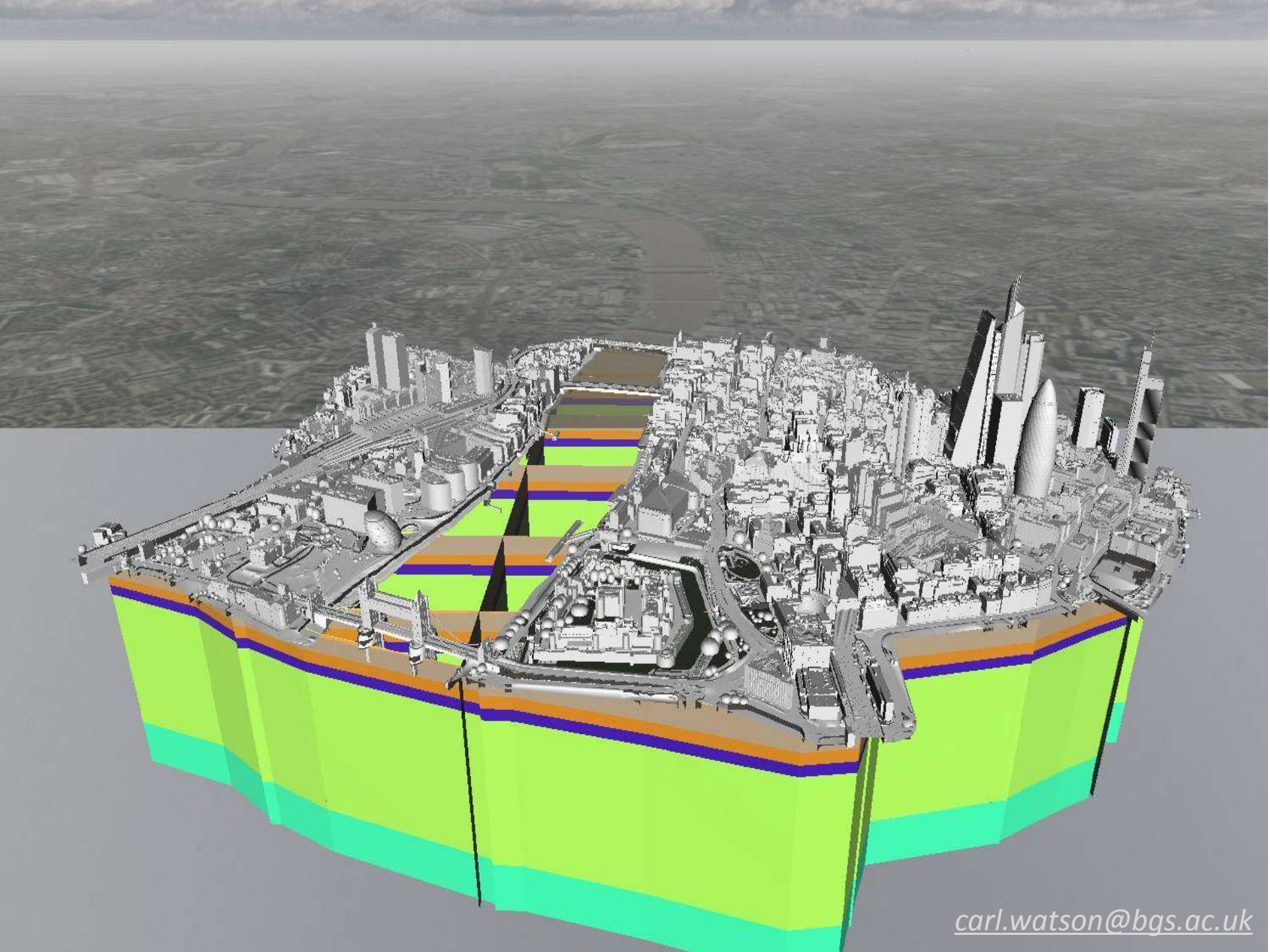

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