

# Underground Infrastructure Mapping and Modeling Workshop

April 24 & 25, Fund for the City of New York  
Organized by the Open Geospatial Consortium (OGC)

## Workshop Priorities

Scope of the workshop is focused on a limited set of topics: 1) Applications and benefits; 2) Utility data models; 3) Underground environment including soils; and 4) Examples of data collection, integration and visualization/analysis. For the moment, discussion of information security, legal/liability issues, and financial/societal will be handled only as they arise in the focus topics.. The RFI describes the broader scope of the initiative.

Expected outcomes for the workshop are

- *Identify methods for exchanging data* between disparate information models. The emphasis is on comparison of information models to identify common concepts that enable integration and not all inclusive data model that would aim to apply everywhere.
- *Review underground information systems* that aim to meet the desired Applications and benefits. Identify successes as well as challenges of past and current projects.
- *Plan for the next phases* of the project including a pilot implementation that advances best practices and open standards to meet the application and benefits.

## Workshop Sessions

- *Monday, April 24th*
  - 8:30 am – Doors open and coffee
  - 9:00 am Session 1 – Opening, Introductions and Project Overview
  - Session 2 – Cities with underground projects
  - Session 3 – Underground information systems practices
  - Session 4 – Underground Data models for integration and data sharing
  - 6:00 pm – Group Dinner hosted by GEO.works
- *Tuesday, April 25th*
  - 9:00 am Session 5 – Underground Environment data model
  - Session 6 – Data collection, curation, integration and visualization/analysis.
  - Session 7 – Breakout sessions
  - Session 8 – Workshop summary; Planning the Pilot phase
  - 4:00 pm – Adjourn

Logistics: <http://www.opengeospatial.org/ogcevent/170424underground>

List of Registrants Link: [https://portal.opengeospatial.org/public\\_ogc/register/170424underground\\_view.php](https://portal.opengeospatial.org/public_ogc/register/170424underground_view.php)

## Session 1 - Opening, Introductions and Overview

Session Objective. Introduce the objectives of the project. Review the activities to date. Present the plan for future phase. The Underground Infrastructure initiative seeks to lower the barriers to interchange and integration of infrastructure data in for large-scale efficiencies in the way that the “underground city” supports the life of a city as a whole.

Session Chair: Alan Leidner

0830	FCNY room open
0900	Welcome by FCNY Mary McCormick and Alan Leidner, FCNY
0910	Self Introduction by participants
0925	Underground Project overview and purpose George Percivall, OGC

### **Fund for the City of New York (FCNY)**

Mary McCormick, President of the Fund for the City of New York ([www.fcny.org](http://www.fcny.org))

- FCNY is our host for the workshop and a sponsor of the initiative.
- Connection to NYC activity
- Project overview and purpose

### **Underground Project overview and purpose**

George Percivall, CTO and Chief Engineer of the OGC

- The presentation will provide the objectives and past activities of The OGC Underground Infrastructure Mapping and Modeling Concept Development study.
- The project is conducted as an initiative of the OGC Innovation Program
- The Sponsors of the project are FCNY, Singapore Land Authority (SLA), Ordnance Survey (OS) UK

## Session 2 – Cities with Underground Projects

Session Objective. Explore and confirm the application areas and benefits by *review underground information programs*. Identify successes as well as challenges of past and current projects.

Session Chair: George Percivall

0945	1. New York City Jim McConnell, NYC OEM and Professor Sean Ahearn, Hunter College
1000	2. Underground Geospatial Information Management in Singapore Siau Yong NG, SLA
1015	3. Belgium, the Flanders region - an introduction to KLIP Jef Daems, Informatie Vlaanderen
	4. UK Projects Andy Ryan, Ordnance Survey (remote)
1030	Break

### **New York City**

Jim McConnell, Asst. Commissioner for Strategic Data at the NYC Office of Emergency Management (OEM). Jim has been designated to lead the City's underground infrastructure mapping project.

Professor Sean Ahearn directs the CARSI Lab at Hunter College and has been engaged in water and sewer mapping projects.

- How 9/11 and Hurricane Sandy focused City attention on the need to accurately map and analyze infrastructure
- Progress made on mapping a number of infrastructure layers including transit, water and sewer
- Challenges and opportunities faced by NYC moving forward

### **Underground Geospatial Information Management in Singapore**

Siau Yong NG is Director of the GeoSpatial and Data Division at the Singapore Land Authority (SLA).

- SLA co-leads a government-wide programme driving the implementation of the National Spatial Data Infrastructure.
- A government-wide work group has been established to consolidate and develop underground data management, in synchronisation with the existing aboveground data management regime.
- A holistic framework and a collaborative approach are crucial to tackle the challenges of underground data management.

### **Belgium, the Flanders region - an introduction to KLIP**

Jef Daems, Project leader KLIP, INFORMATIE VLAANDEREN

- KLIP aims for the reduction of excavation damage by exchanging cable and pipe information before the work starts.

- The 3 main KLIP user roles are: map request initiator; utility network authority (UNA); public domain administrator (PDA).
- Use of KLIP by plan requestors and network utility operators is mandatory by law since 2009.
- Joint conceptual framework so utility network authorities are able to transmit information to KLIP in a standardized manner.
- Utility Network authority is free to use any data model to manage its network. However, in exchange with KLIP, the data should be mapped or converted to the IMKL structure before sending the answer to KLIP.
- The exchange of information can be established using a web portal or a web service API
- The answers to a map request can be viewed by use of an online or offline viewer
- Map requestors download digital information snapshots into their own information system or can be of use for electronic steering of excavation or drilling operations.

## Session 3 – Underground information systems practices

Session Objective. Explore and confirm the application areas and benefits by *review underground information programs*. Identify successes as well as challenges of past and current projects.

Session Chair: George Percivall

1045	1. Underground Infrastructure Mapping in Chicago Eric Bergstrom, HBK Engineering and Boris Tsypin, Accenture
1100	2. Underground Infrastructure Mapping: Common 3D asset database capable of serving applications across industries and domains Dave LaShell, Esri
1115	3. Underground Infrastructure Mapping and Modeling: Use Cases and Data Models Robert Mankowski, Bentley
1130	Morning session discussions
1200	Lunch

### **Underground Infrastructure Mapping in Chicago**

Eric Bergstrom, HBK Engineering

Boris Tsypin, Accenture – Underground Infrastructure Mapping Team

- Pilot underway in Chicago
- Value Tree & Value Quantification Method outline of the pain points for utilities and cities and quantify the dollar impact
- Underground Mapping platform for stages of the construction process, including project identification, design, and excavation/construction.

### **Underground Infrastructure Mapping: Common 3D asset database capable of serving applications across industries and domains**

Dave LaShell, Senior Account Executive at Esri

- Active projects involving underground mapping
- Underground Infrastructure Mapping: Creating a common 3D asset database capable of serving applications across industries and domains

### **Underground Infrastructure Mapping and Modeling: Use Cases and Data Models**

Robert Mankowski, Vice President, Product Development at Bentley Systems

- A quick review of some of the major use cases we see in mapping and modeling underground infrastructure throughout the lifecycle of the assets (i.e. from planning to operations), and the data models and standards that exist to support information mobility.

## Session 4 – Underground Data models for integration and data sharing

Session Objective. Discuss data models that support data interchange in support of use cases in Session 2. Identify methods for exchanging data between disparate information models. The emphasis is on comparison of information models to enable integration and not all inclusive data model that would aim to apply everywhere. What activities are needed in a pilot to develop and apply the data models?

Session Chair: Carsten Roensdorf

1230	1. CityGML Utility Network ADE - Scope, Concepts, and Applications Tatjana Kutzner and Thomas Kolbe, Technical University of Munich
1255	2. Data Models for underground assets: Rotterdam results, ideas for NYC-OEM Sisi Zlatanova and Ben Gorte, Technical University Delft
1320	3. IMKL and INSPIRE Luc Van Linden, HL Consulting and Liesbeth Rombouts, AGIV
1345	Discussion of data models
1400	Break
1420	4. BSI PAS 256 Les Guest (remote)
1440	5. OGC LandInfra / InfraGML Standards for Infrastructure Paul Scarponcini, Chair OGC Land and Infrastructure Standards Working Group
1500	6. ASCE Utility information standards Phil Meis, Chair of ASCE Construction Institute Utility "As-Built" Standard Committee; Chair of ASCE Utility Engineering and Surveying Institute Utility Investigation Committee
1520	7. Underground Modeling using Voxels Ben Gorte and Sisi Zlatanova, Technical University of Delft
1540	Discussion of data models
1700	Adjourn
1800	Dinner hosted by GEO.works <ul style="list-style-type: none"> <li>• <a href="#">Mae Mae Cafe</a>, 68 Vandam Street</li> </ul> RSVP to George Percivall, <a href="mailto:gpercivall@opengeospatial.org">gpercivall@opengeospatial.org</a>

## **CityGML Utility Network ADE - Scope, Concepts, and Applications**

Tatjana Kutzner and Thomas Kolbe (remote), Technical University of Munich

- The CityGML Utility Network ADE is an extension of CityGML to represent multiple types of utilities in connection with the objects of the 3D city model.
- The ADE addresses the representation of 3D topographic and functional aspects (semantic modeling, 3D geometry, and 3D topology), the representation of relationships and dependencies between different types of utility networks, and hierarchical network modeling, i.e. feature hierarchies, network hierarchies, and multi-utility networks.
- The ADE allows for mapping and integration of ESRI, INSPIRE and IFC network models without information loss.
- The ADE has been developed and tested in the project SIMKAS 3D - Simulation of cascading effects caused by a failure of supply infrastructures using the 3D city model of Berlin, Germany - and has been extended and tested in the project Risk Analysis Supply Infrastructure - A study on the possibilities of utilising supply infrastructures in training simulators for crisis scenarios.
- The current development of the ADE is pushed forward by a joint SIG 3D and OGC working group. Further information and resources are provided here: <http://en.wiki.utilitynetworks.sig3d.org/> and <https://github.com/TatjanaKutzner/CityGML-UtilityNetwork-ADE>
- Public test data for the ADE is currently under development.

## **Data Models for underground assets: Rotterdam results, ideas for NYC-OEM**

Sisi Zlatanova and Ben Gorte, Technical University Delft

- Mapping, modelling, capturing, analysing and sharing data about underground infrastructure.
- Management of utility networks, investigations on data models, visualisation approaches and some legal aspects (i.e. registration of data).
- Case studies with the municipality of Rotterdam, the Netherlands.
- Results of Sabbatical studies in NYC, 2016
- Initial ideas for organisation of infrastructure information for OEM.

## **IMKL and INSPIRE**

Luc Van Linden, HL Consulting and Liesbeth Rombouts, AGIV

- high-level background to KLIP, some conceptual approach for the system and the explanation of the model used.
- highlight some of the main challenges for the utilities to become conformant, mainly from a technical point of view.
- provide some insight to a technical implementation being used in an automated hosted approach for the daily processing of these inquiries.
- Visualization of KLIP
- INSPIRE data specifications on Utility Services.

### **BSI PAS256**

- Andy Ryan, Ordnance Survey (remote).
- PAS256 (Buried assets – Capturing, recording, maintaining and sharing of location information and data – Code of practice).
- National Underground Assets Group (NUAG)
- London Proof of concept trial

### **OGC LandInfra / InfraGML Standards for Infrastructure**

- Paul Scarponcini, Chair OGC Land and Infrastructure Standards Working Group
- Topics:
  - LandInfra Conceptual Model Standard
  - InfraGML Encoding Standards
  - Available Foundation in support of Underground Infrastructure

### **ASCE Utility Information Standards**

Phil Meis, Chair of ASCE Construction Institute Utility "As-Built" Standard Committee; Chair of ASCE Utility Engineering and Surveying Institute Utility Investigation Committee; Committee Member - ASCE Standard for the Collection and Depiction of Existing Subsurface Utility Data (ASCE 38-17)

- ASCE Utility Standard for the Collection and Exchange of Utility Infrastructure Data (aka "As-Built") Standard: a) standard framework and accuracy Levels; b) application to 3D data model
- ASCE 38-17 Standard - Method for Communicating Reliability of Depicted Utilities a) Quality Levels
- OGC Collaboration for 3-D Representation

### **Underground modeling using voxels**

- Ben Gorte, Technical University of Delft
- Voxel data model for underground and how to use voxels/vectors together” - or similar title
- Results of Sabbatical studies in NYC, 2016



## Session 5 – Underground Environment data model:

Session Objective. Data models for underground environment in support of underground infrastructure planning and assessment: Including soils, water, built materials, foundations, road and land surfaces, geology. Discussion of methods for collection of underground observations. Data model supportive but potentially distinct from data models in Session 4. Dynamic analytical models in support of failure and other threat analysis.

Session Chair: Josh Lieberman

0900	1. Mapping Underground Soils in New York City George Deodatis, Columbia University
0920	2. Towards a complete subsurface information system Mickael, Beaufile, BRGM
0940	3. Underground environmental properties and processes: Integrating evidence from highly varied sources to provide accessible data services, models and interpretations. Carl Watson, BGS
1000	4. City Infrastructure Lifecycle Management - a platform approach Ingeborg Rucker, Dassault
1020	Discussion of Underground Environment data models
1045	Break

### Mapping Underground Soils in New York City

George Deodatis, Professor and Chair, Civil Engineering & Engineering Mechanics, Columbia University

- Techniques and approaches to map the underground soils based on geotechnical borings.
- The importance of these techniques to underground maps and models
- See Accenture RFI Response for input from Columbia University.

### Towards a complete subsurface information system

- Mickael, Beaufile, Data Interoperability Manager, BRGM
- Details:
  - Combining urban and geological modeling: experiences from BRGM
  - Environmental modeling: map of the problematique
  - Initiatives on the run
  - Propositions of actions

**Underground environmental properties and processes: Integrating evidence from highly varied sources to provide accessible data services, models and interpretations.**

Carl Watson, British Geological Survey

- Scientific, societal and commercial drivers for the open sharing of above and below surface data (and models)
- From traditional linear, map producing, dataflows to prioritised strategic and responsive, multi-stakeholder data exchanges
- Standardisation of highly varied data acquisitions and the growing use of open APIs to disseminate data and models
- Lessons learnt from selected projects, including standards driven exchange of geotechnical data to support construction and groundwater model integrations that inform resilience planning

**City Infrastructure Lifecycle Management - a platform approach**

Ingeborg Røcker, PhD. Vice President, 3DEXPERIENCE City | Geosphere, Dassault Systemes Corporate Strategy Team

- Platform for data collection, storage, integration, management, analysis, and visualization;
- Project experiences in above and underground infrastructure modeling and mapping;
- use of international standards such as GeoSciML and CityGML in particular
- use of STEP, IFC and xmplant?
- possible integration capabilities of Standards via 3DEXPERIENCE Platform (now, future)
- Dynamic modeling and prediction

## **Session 6 – Data collection, curation, and integration for visualization and analysis.**

Session Objective. Methods to collection underground infrastructure data. Curation of past data collections perhaps with more modern methods on old data. Integration of data for visualization and analysis. Verification and uncertainty assessment during data collection. Data model support but potentially distinct from data models in Session 4.

Session Chair: Josh Lieberman

1100	1. Utility Rediscovery from Field Investigation to 3D Model/BIM Lapo Cozzutto, Berenice and Phil Meis, UMS
1120	2. ‘Ground- truthing’ data from the scanning & sensing technologies - Photography. (Chicago/Accenture team)
1135	3. Use of geophysical techniques and analysis to infer underground structures and unknown voids. Albert Boulanger, Columbia University
1200	Discussion of Collection, curation integration, analysis, viz
1230	Lunch

### **Bringing Utilities into 3D Project Delivery: a case study at LAX**

Lapo Cozzutto, GEO.works President, Principal Scientist for the Consorzio Futuro in Ricerca (CFR) WebGIS and Chairman Berenice International Group

Philip J. Meis, M.S., P.E., President and Principal Engineer Utility Mapping Services Inc. (UMS), Chairman ASCE Utility As-Built Standard Committee

- Utility Rediscovery from Field Investigation to 3D Model/BIM
- Acquiring Utility Data for Civil Project Development using survey and geophysical tools: RTK GPS, Ground Penetrating Radar, Acoustic Pipe Locator, LiDAR
- Use of GML 3D Utility Repository with any database
- Los Angeles World Airport – Automated People Mover (APM) Project Development, Delivery, Operations and Maintenance

### **‘Ground- truthing’ data from the scanning & sensing technologies.**

Boris Tsypin, Accenture/Chicago team

- Data Collection and Analysis Techniques
- Ground Scanning & Sensing Technology to Capture Data: Sensor, Scanning and Survey Technologies.
- Photos for Construction Documentation

## **Use of geophysical techniques and analysis to infer underground structures and unknown voids.**

Albert Boulanger, Director Smart-X Group, Center for Computational Learning Systems Columbia University

- The value of using multiple geophysical techniques (like GPR, magnetic, E/M, acoustic, etc and in combination) to help locate and infer properties of underground structures and their embedding matrix to compliment asset owners mapping their infrastructure and to further see what might be unknown like growing voids.
- See Accenture RFI Response for input from Columbia University.

## **Introduction on Key Technologies of Underground Pipeline Data Acquisition and Modeling** (Not able to attend)

Cai Zhouyang and Shi Mingtai, Spacetime Technologies

- SLAM-based hand-push IMMS mobile mapping system to get the 3D point cloud and panoramic images of underground pipelines and underground pipe gallery,
- accurate and realistic 3D models of the underground pipe gallery and the facilities based on high precision 3D laser scanning
- Standards
  - urban underground pipeline detection technical regulations" (CJJ61-2003);
  - "urban measurement standards" (CJJ8-2011);
  - "satellite positioning and urban measurement technical specification" (CJJT 73-2010);
  - the national primary scale map schema, the first parts of 1:500, 1:1000, 1:2000 topographic map schema (GBT 20257.1-2007);
  - "global positioning system (GPS) measurement specification" (GBT 18314-2009)
  - "urban three-dimensional modeling technical specifications" (CJJT 157-2010)

## Session 7 – Breakout sessions

Session Objective. Focused, interactive discussion of the topics discussed earlier in the day. Each session will have its own room and is asked to prepare a summary of the most important issues and opportunities for their topic.

1300	Breakout sessions <ul style="list-style-type: none"><li>• Applications/Use Cases</li><li>• Data models</li><li>• Underground Environment</li><li>• Collection, Curation Integration, Viz, Analysis</li></ul> Conveners and Rapporteurs
1430	Break

Breakout sessions workgroups invited to contribute to workshop report

### Rapporteurs

- Applications/Use Cases – Boris Tsypin, Accenture
- Data models – Carsten Roensdorf, OS
- Underground Environment – Josh Lieberman, Tumbling Walls
- Collection, Curation Integration, Viz, Analysis – Frederic Houbie, Luciad

## Session 8 – Workshop summary; Planning the Pilot phase

1445	<p>Reports from breakout sessions and summary prep</p> <p>Rapporteurs</p> <ul style="list-style-type: none"> <li>• Applications/Use Cases – Boris</li> <li>• Data models - Carsten</li> <li>• Underground Environment - Josh</li> <li>• Collection, Curation Integration, Viz, Analysis – Frederic</li> </ul>
1515	<p>Overview of next steps, planning</p> <p>George Percivall, OGC</p>
1530	<p>Panel discussion with participation by all</p> <ul style="list-style-type: none"> <li>○ Alan Leidner, FCNY</li> <li>○ Siau Yong NG, SLA</li> <li>○ Carsten Roensdorf, Ordance Survey</li> <li>○ Josh Lieberman, Tumbling Walls</li> <li>○ Panel chair: George Percivall, OGC</li> </ul>
1600	<p>Adjourn</p>

### Overview of next steps, planning - George

- Workshop publication
  - Greg Milner article for publication about the underground initiative
  - IJ3DIM Special issue based on Workshop, guest Editor Sisi Zlatanova
    - <http://www.igi-global.com/journal/international-journal-information-modeling-ij3dim/41967>
  - OGC Public page updates
    - RFI responses publication – any others public?
- Plan for report of the Concept Development Study phase
  - To be publish as a public OGC Engineering Report
  - Findings and recommendations based on RFI responses, workshop
  - Schedule
  - Contributors:
  - Break out sessions leading to report sections.
  - Editors – rapporteurs plus
  - Lead editors: Josh, Andy,
  - Publish as OGC ER
- Plan for OGC Pilot initiative including implementation and testing
  - Rough Schedule
  - Objectives
  - Seeking sponsors