OGC Program Update / Strategic Technology Trends

Mark E. Reichardt
President & CEO
Hyderabad, India
19 January 2018
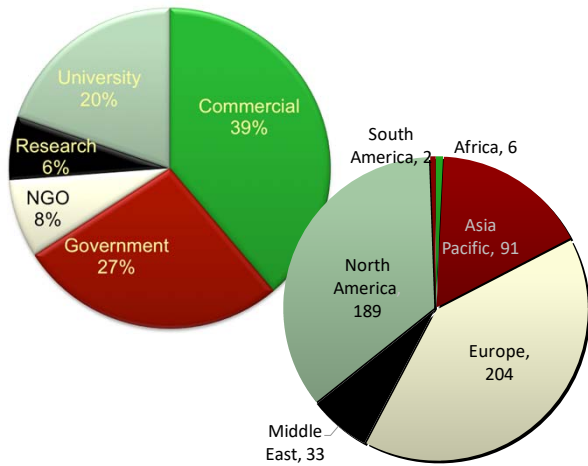
OGC®
Making location count.

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
- Compliance Certification Tests
- 230 OGC certified products
- Thousands of implementations
- Enabling access to 100K+ datasets

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University 20%
Commercial 39%
Research 6%
NGO 8%
Government 27%

South America, 2
Africa, 6
Asia Pacific, 91
North America 189
Europe, 204
Middle East, 33

2

The OGC Mission

To advance the development and use of international standards and supporting services that promote geospatial interoperability.

Global forum for the collaboration of geospatial data / solution providers and users.
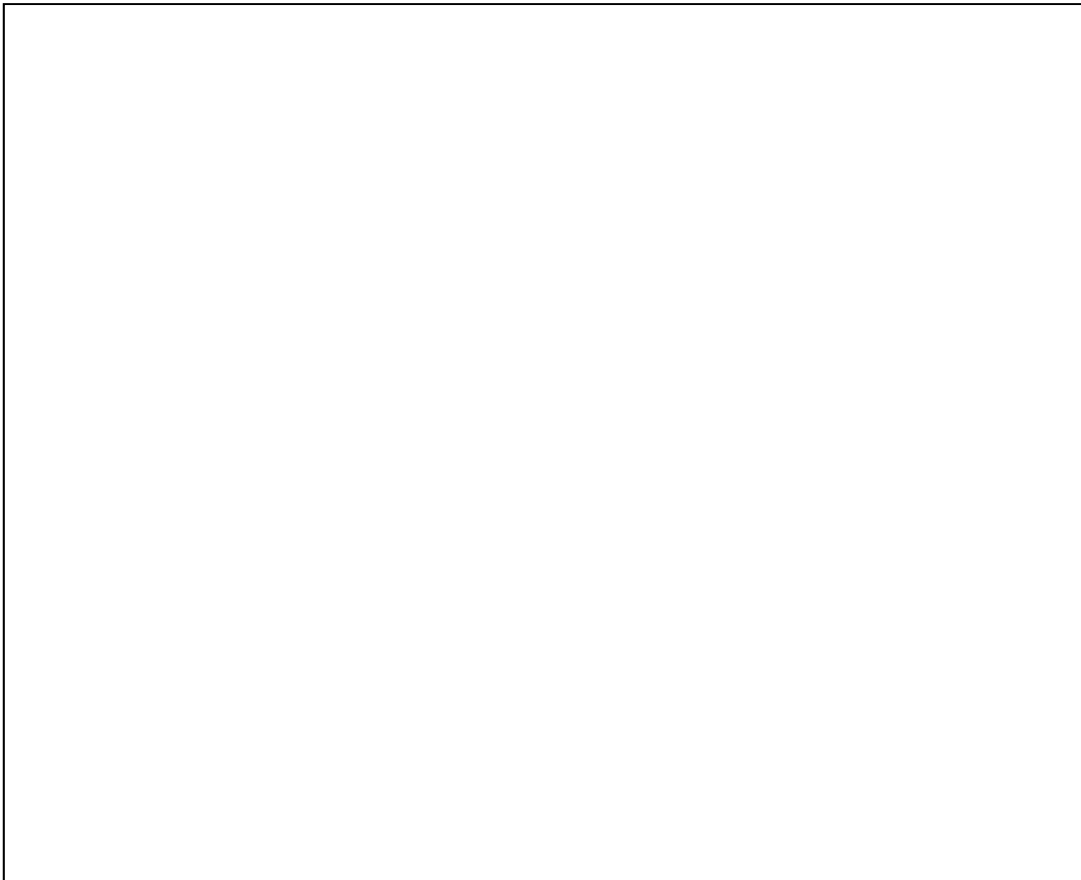

Value of Participation

- Achieve technical agreement on interoperability challenges

- Networking, partnership development

- Insight into emerging technologies and markets

- Discover solutions being advanced by others

- 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)
- Norwegian Building Authority   - Ordnance Survey (UK)
- Dept of Science and Technology (India)   - National Remote Sensing Center (India)
- Ministry of Land, Infrastructure and Transport (Korea)   - Vienna, Austria
- Dubai Electricity & Water Authority(UAE)   - Singapore Land Authority
- San Francisco City & County   - Others…

Over 100 Universities, Research institutes, NGOs; e.g., TU Berlin, Fund for the City of New York, Association of Geospatial Industries (India)

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Example OGC Commercial Members

These organisations bring domain expertise, their approach to standards based on their end customer requirements and they also build system architectures and solutions using standards. Some of them have even brought widely accepted solutions, such as KML into the OGC standards process.

Example OGC Alliance Partners
Our work cannot be done in isolation

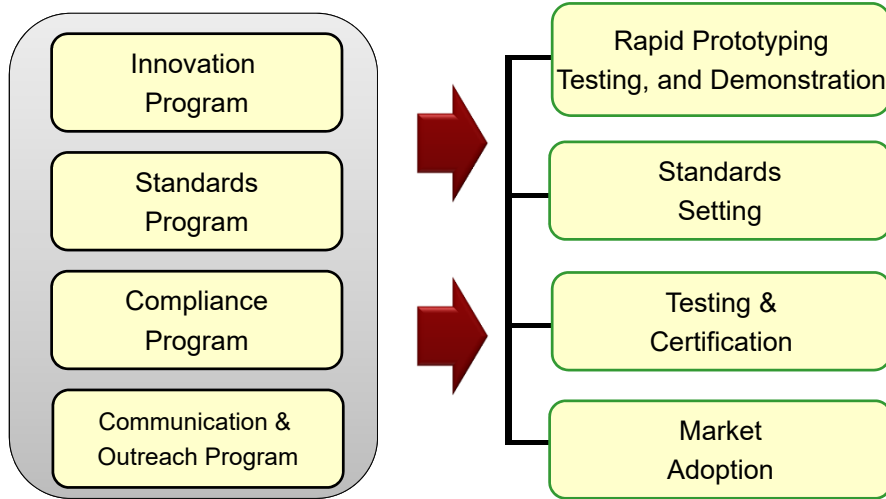The GSDI Association continues to perform its mission, evidenced in growth of SDI's worldwide

UNGGIM is now further organizing member states to advance useful geospatial information management

Standards community is working to facilitate leveraging and rapid integration of industry advancements in information technology

GEO – with over 100 countries and an array of Participating Organizations, GEO pushes on to drive open access to and application of Earth Observation, with emphasis on in-situ integration with overhead EO as a key challenge area.

Our collective future success in addressing sustainable development and other increasingly complex social, environmental and economic challenges will be based on our ability to access, process and apply an increasingly complex array of information. Our success will also hinge on our collective ability to engage across government, academia, research, NGOs with much greater emphasis on inclusion of industry and the broader developer community, as they are leading the charge in information and technology transformation.
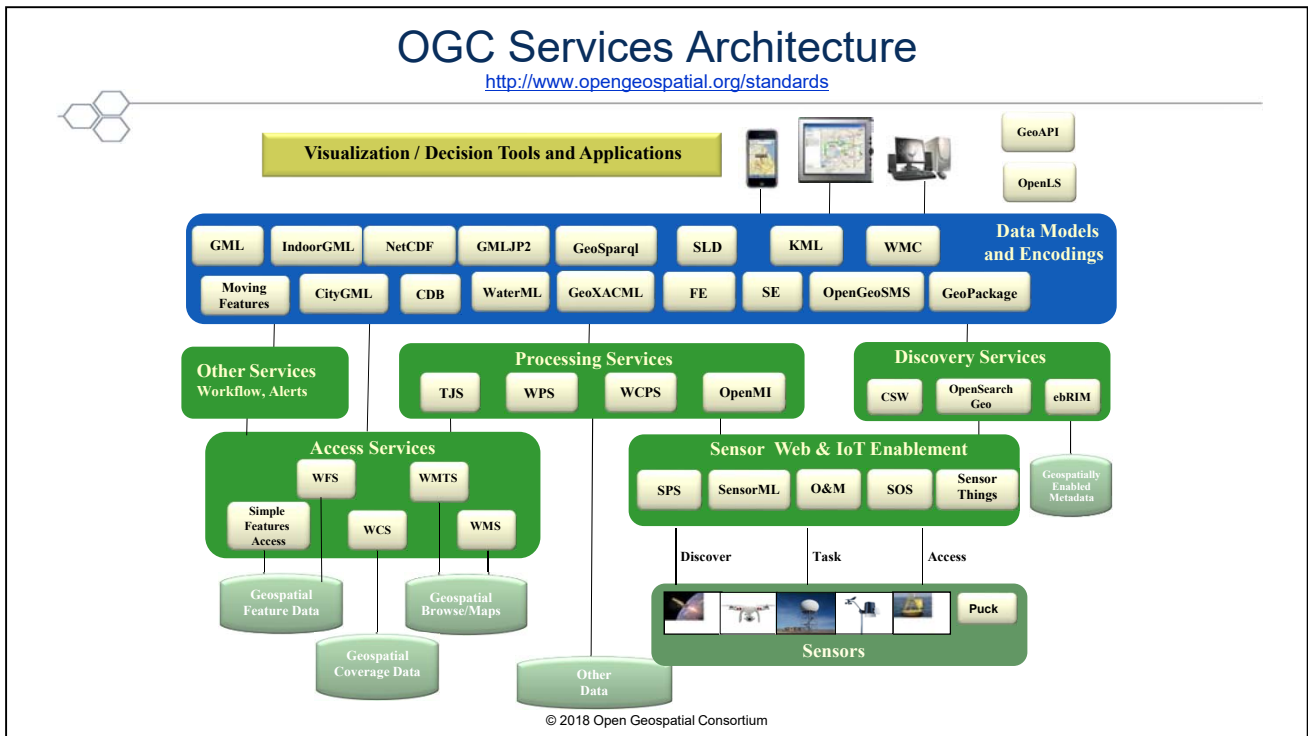
OGC's Approach for Advancing Innovation

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OGC Services Architecture

http://www.opengeospatial.org/standards

Visualization / Decision Tools and Applications

GeoAPI

OpenLS

Data Models and Encodings

GML | IndoorGML | NetCDF | GMLJP2 | GeoSparql | SLD | KML | WMC

Moving Features | CityGML | CDB | WaterML | GeoXACML | FE | SE | OpenGeoSMS | GeoPackage

Other Services Workflow, Alerts

Processing Services

TJS | WPS | WCPS | OpenMI

Discovery Services

CSW | OpenSearch Geo | ebRIM

Access Services

WFS | WMTS

Simple Features Access | WCS | WMS

Sensor Web & IoT Enablement

SPS | SensorML | O&M | SOS | Sensor Things

Geospatially Enabled Metadata

Geospatial Feature Data

Geospatial Browse/Maps

Geospatial Coverage Data

Discover | Task | Access

Puck

Sensors

Other Data

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Acronym List:

- **Catalog Web Service (CSW)** - Support the ability to publish and search collections of descriptive information (metadata) for data, services, and related information objects.

- **Web Map Service (WMS)** - XML encoding for the transport and storage of geographic information modeled according to the conceptual modeling framework including both the spatial and non-spatial properties of geographic features.

- **Web Map Tile Service (WMTS)** - Serves digital maps using predefined image tiles and complements the existing Web Map Service providing flexibility in the client request enabling clients to obtain the precise final image required.

- **Web Coverage Service (WCS)** – Provides access to detailed and rich sets of geospatial information in forms that are useful for client-side rendering, multi-valued coverages, and input into scientific models and other clients.

- **Web Coverage Service Transactional (WCS-T)** - Enables clients to add, modify, and delete grid coverages that are available from a WCS server.

- **Web Feature Service (WFS)** – Defines the interfaces for data access and manipulation operations on geographic features, feature information behind a map image.

- **Web Feature Service Transactional (WFS-T)** - Enables clients to add, modify, and delete feature data that are available from a WFS server.

- **Sensor Planning Service (SPS)** - Enables a client to determine collection feasibility for a desired set of collection requests for sensors and directly task those sensors.

- **Sensor Observation Service (SOS)** - Interface for requesting, filtering, and retrieving observations and sensor system information.

- **Sensor Model Language (SML)** - Enables users to access sensors; their location,

their capabilities, and the data they acquire along with the ability to process the data through a standards-based, non-proprietary web interface.

• **Observation & Measurements (O&M)** - Specifies the core model, framework, and encoding for measurements and observations.

• **Observation & Measurements XML (O&M XML)** - XML schemas for observations, and for features involved in sampling when making observations.

• **Geo eXtended Access Control Markup Language (GeoXACML)** - An extension to the eXtensible Access Control Markup Language (XACML) Policy Language that supports the declaration and enforcement of access restrictions on geographic information.

• **Styled Layer Descriptor (SLD)** – Provides analysts control of the visual portrayal of the data with which they work.

• **Symbology Encoding (SE)** - an XML language to encode user-defined styling information that can be applied to digital Feature and Coverage data.

• **Geography Markup Language (GML)** - XML encoding for the transport and storage of geographic information modeled according to the conceptual modeling framework.

• **KeyHole Markup Language (KML)** - XML language focused on geographic visualization and used to encode and transport representations of geographic data for display in web browser, including annotation of maps and images.

• **Filter Encoding (FE)** - an XML encoding of the OGC Common Catalog Query Language (CQL) as a system neutral query representation.

• **Web Map Context (WMC)** - XML schemas for observations, and for features involved in sampling when making observations.

• **Table Join Service (TJS)** –Provides a mechanism to expose corporate tabular data, with geographic identifiers so that it can be discovered, accessed, and merged with spatial data to enable mapping or geospatial analysis.

• **Table Join Service Transactional (TJS-T)** - Enables clients to add, modify, and delete tabular data available from a TJS server.

• **Web Processing Service (WPS)** - WPS provides client access across a network to pre-programmed calculations and/or computation models that operate on spatially referenced data.

• **Geo Short Message Service (GeoSMS)** - Facilitate communication of location content between different LBS (Location-Based Service) devices or applications by extending Short Messaging Service (SMS).

• **GeoSynchronization Service (GeoSynch)** - Enables data collectors to submit new data or make modifications to existing data without directly affecting the data in the provider's data store(s) until validation has been applied.

OGC Regional and National Forum Activities

"Recognizing that different places in the world have different market dynamics, and recognizing the barriers of long distances, differences in language, culture & policy, OGC encourages OGC members to find ways to work together in their countries and world regions." http://www.opengeospatial.org/ogc/regions

- Asia Forum
- Australia and New Zealand Forum
- China Forum
- Europe Forum
- France Forum
- ILAF (Iberian and Latin-American Forum)

- India Forum
- Korea Forum
- Middle East and North Africa Forum
- Nordic Forum
- North American Forum
- UK & Ireland Forum

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Compliance Certification

Software companies that want to get certified need to follow the OGC compliance procedure. They go to the online testing engine facility. If the results are successful then they fill up a test result form that it gets process by OGC staff. Depending on the membership level, the company needs to pay a license fee to use the OGC certification branding in their marketing materials.

How to ask for compliance in Tenders and Acquisitions

" … Purchaser seeks geospatial products that provide maximum interoperability with purchaser's and data sharing partner's systems. To accomplish this, purchaser seeks to make maximum use of open standards provided by the Open Geospatial Consortium (OGC), ISO …"

OGC Compliance Overview - Guide for Software Acquisition White paper (15-002r5)

http://docs.opengeospatial.org/wp/15-002r5/15-002r5.html

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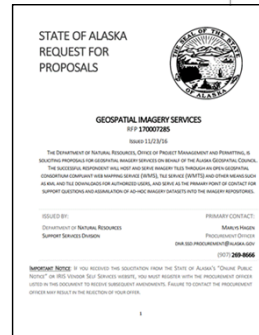
OGC has released the **Guide for Software Acquisition White paper,** that will help those acquiring software to put the correct wording in their procurement documents.

Basic Geospatial Interoperability Challenge Solved

http://www.opengeospatial.org/standards

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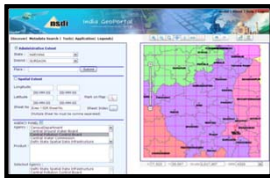10,000+ servers running OGC Web Services

OneGeology.Org

Web Map Service (WMS)
Web Feature Service (WFS)
Web Coverage Service (WCS)
Web Processing Service (WPS)
Geography Markup Language (GML)
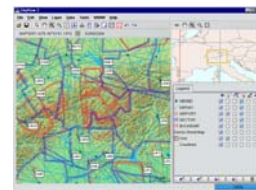**Sensor Observation Service (SOS)**
WaterML

USGS Water Services

NSDI - India GeoPortal Map Viewer

GEOSS Portal   geoportal.org

© 2018 Open Geospatial Consortium

Skyview2, Eurocontrol

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USGS Water Services   http://waterservices.usgs.gov/nwis/iv/?format=waterml,2.0&sites=08

A major are of current emphasis:

SMART, SAFE, RESILIENT CITIES

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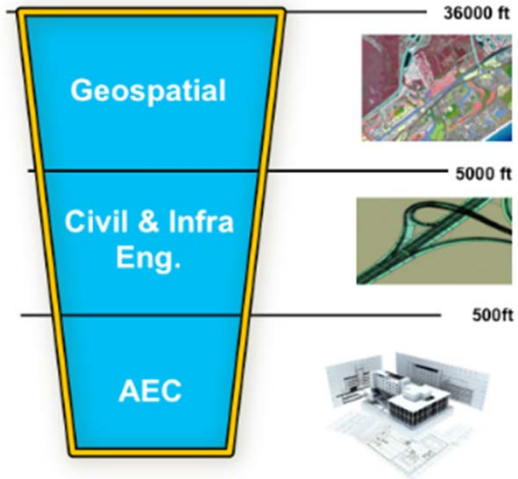
Merging of spatial domains

- Geospatial,
- Civil Engineering &
- BIM

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

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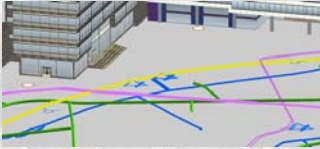
OGC CityGML for Urban Applications

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**
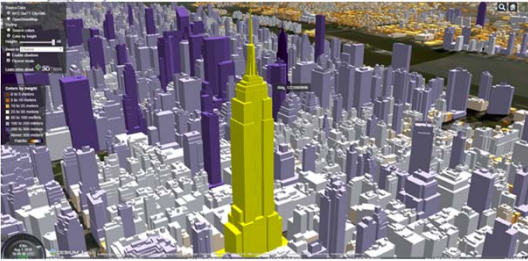
- **modeled according to CityGML**

www.virtual-berlin.de

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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 <u>and</u> 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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Source: Singapore Land Authority, and Geospatila Media
https://www.geospatialworld.net/news/3d-mapping-singapore-geospatial-award/

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IndoorGML Graphic from: www.directionsmag.com/pressreleases/ogc-adopts-indoorgml-standard-for-encoding-indoor-navigation-data/432265

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.
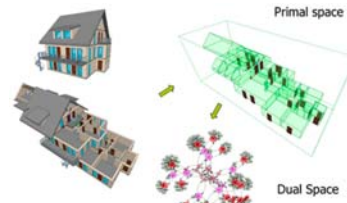https://www.citygml.org

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The Next Frontier

- Indoor Location and Navigation
  - OGC IndoorGML standard is a major step in addressing indoor navigation
  - Additional focus on 3D streaming, Augmented Reality

Source: Alattas, Zlatanova, Van Oosterom, Chatzinikolaou, Lemmen and Li, http://www.mdpi.com/2220-9964/6/12/384/pdf , CC 4.0

- Underground Infrastructure is a major focus now
  - Understanding and addressing Smart City challenges is not complete without a detailed understanding of infrastructure below ground.
  - Establishing standards-based Underground Infrastructure Information (UGII) will complement CityGML and IndoorGML
  - Huge cost efficiencies will be achievable
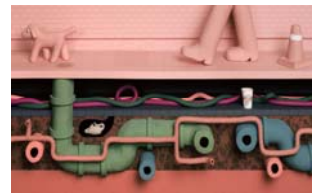
"Nobody Knows What Lies Beneath New York City" Greg Milner Bloomberg Businessweek, 8.10.17

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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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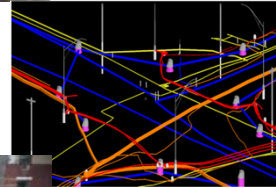
OGC Underground Concept Development Study Report
http://docs.opengeospatial.org/per/17-048.html

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Further Illustrating the Need for UGII

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

Source: OGC underground workshop, NYC

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Underground Information (UGI) Initiatives

http://www.opengeospatial.org/projects/initiatives/ugipilot

- OGC UGI Concept Study – completed 2017
  - Findings and Recommendations
- UGI Data Model – under development
  - Necessary foundation for the Pilot
- OGC Pilot Implementation – planned 2018
  - Develop, Test and Demonstrate
    a common standards based approaches
  - Provide basis for city procurements
  - Call for Sponsors announced
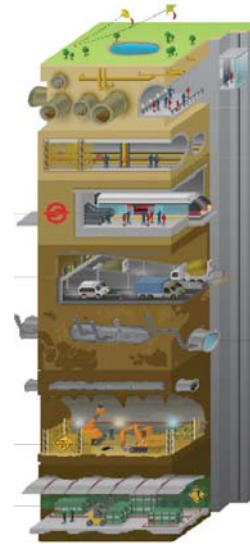
Source: Singapore Land Authority

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Published Results from Concept Study

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 Infrastructure Concept Study Engineering Report

Publication Date: 2017-08-31
Approval Date: 2017-08-17
Reference number: OGC 17-048
Category: Public Engineering Report
Editor: Josh Lieberman, Andy Ryan

http://docs.opengeospatial.org/per/17-048.html

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.

Underground Infrastructure Pilot Planned for 2018:
http://www.opengeospatial.org/projects/initiatives/ugipilot

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The New Zealand Experience

INTEROPERABLE LOCAL TO NATIONAL WATER RESOURCE MONITORING

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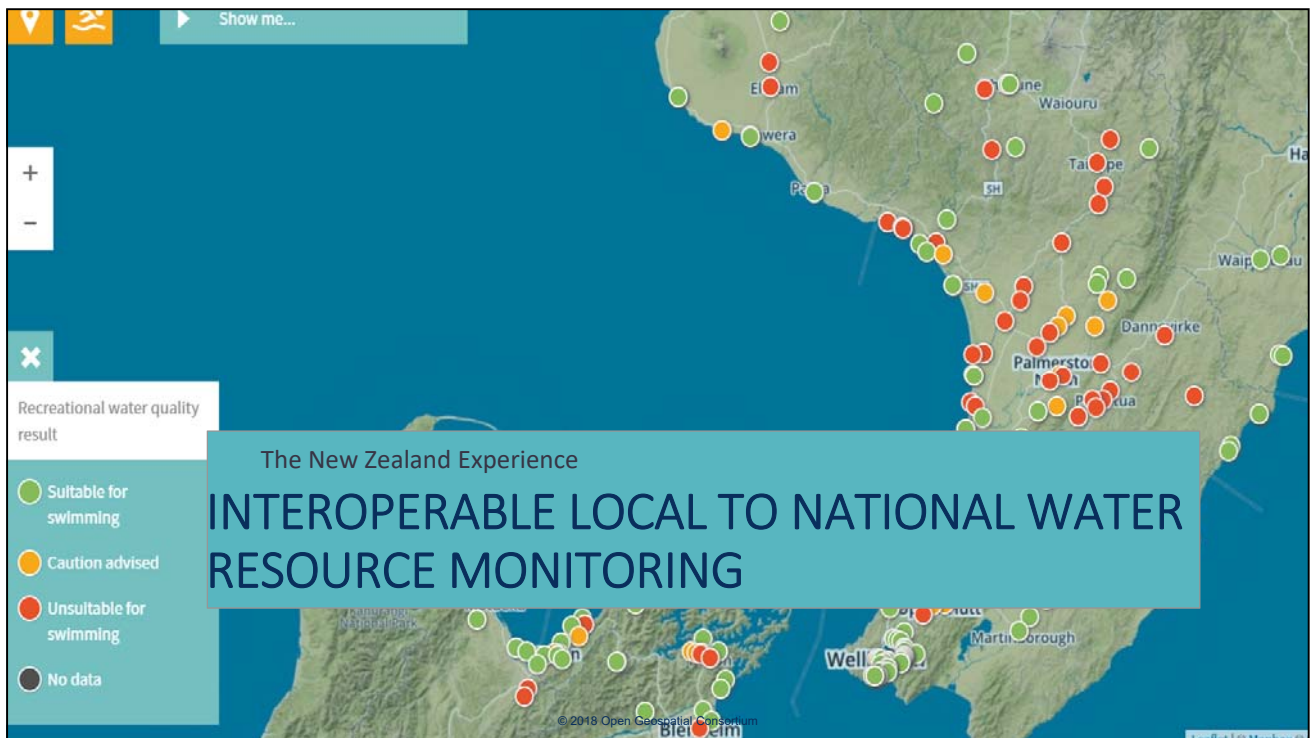
New Zealand Water Information System
established from 16 formerly separate systems

NIWA operates about 20% of 1300 hydrometric stations
Regional authorities operate about 80% of stations

- Auckland Council
- Bay of Plenty Regional Council
- Environment Canterbury
- Environment Southland
- Gisborne District Council
- Greater Wellington Regional Council
- Hawkes Bay Regional Council
- Horizons Regional Council
- Marlborough District Council
- National Institute of Water and Atmospheric Resea
- North Shore City Council
- Northland Regional Council
- Otago Regional Council
- Taranaki Regional Council
- Tasman District Council
- Waikato Regional Council
- West Coast Regional Council

Develop a federated hydrological information infrastructure . . .
. . . linking nationally and regionally collected data

Current State of Play for NZ – all Done!

Based on OGC Sensor Observation Service and OGC WaterML 2.0

Local Government

✓ **16**

National - CRIs

✓ **3**

SOS = Sensor Observation Service
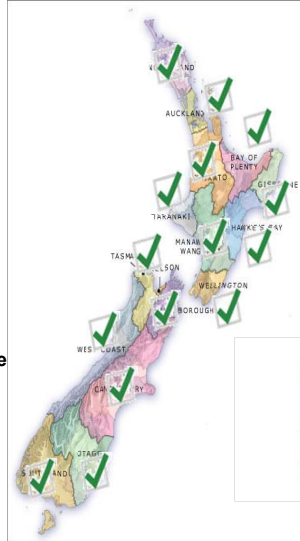
Slide: Brent Watson, HRC

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Data Sharing using Open Standards in LAWA

- **Each region maintains its own data**
- **Data are accessed through OGC web services**
- **Common language for water: WaterML2**
- **Open Geospatial Consortium standards**
- **All information "looks the same" to user**
- **Globally accessible**

- *A tremendous technological achievement for New Zealand!!!*

December '17 Technical and Planning Committee Meeting - Palmerston North, New Zealand
OGC TC/PC - December 3rd, 2017 - December 7th, 2017
Read More...

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PARTICIPATE!

OTHER INITIATIVES AND ACTIVITIES

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OGC Community Standards

- OGC Community standards
  - Bring de facto standards in from the marketplace to be a stable reference point that can be normatively referenced by organizations
  - Allow for assessment and advancement of interoperability with other OGC standards.
- Examples:
  - Approved:
    - 3D Streaming: Indexed 3D Scene Layer Package Format (Esri)
    - RSS Feeds for geographic information: GeoRSS
  - In-Work
    - 3D Streaming: 3D Tiles (AGI)
    - 3D Modeling: OpenFlight (Presagis)

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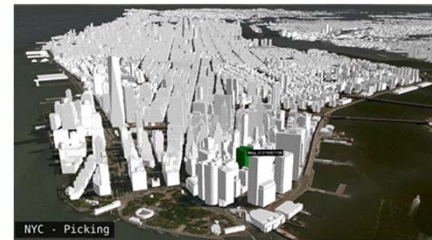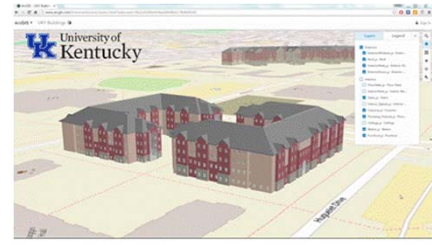
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OGC Innovation Initiatives Planned / Underway

http://www.opengeospatial.org/ogc/programs/ip

Disasters Interoperability Concept Development Study

http://www.opengeospatial.org/projects/initiatives/disasterscds

OGC Testbed 14

http://www.opengeospatial.org/projects/initiatives/testbed14

Future Cities Pilot Phase 2

http://www.opengeospatial.org/projects/initiatives/fcp2

Geospatial to the Edge Plugfest

http://www.opengeospatial.org/projects/initiatives/geoedgeplugfest

Augmented Reality Pilot (With the World Wide Web Consortium)

http://www.opengeospatial.org/projects/initiatives/arpilot2017

Precision Agriculture Pilot

OGC ® http://www.opengeospatial.org/projects/initiatives/agripilot2018

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Technical Committee Domain Working Groups

- Agriculture
- Aviation
- Big Data
- Citizen Science
- Defence & Intelligence
- Emergency & Disaster Mgt
- Energy & Utilities
- Health
- Hydrology
- Land Administration
- Law Enforcement / Public Safety

- SensorThings (IoT)
- Sensor Web Enablement
- Smart Cities
- 3D Information Mgt
- Unmanned Systems (UXS)
- Earth System Sciences
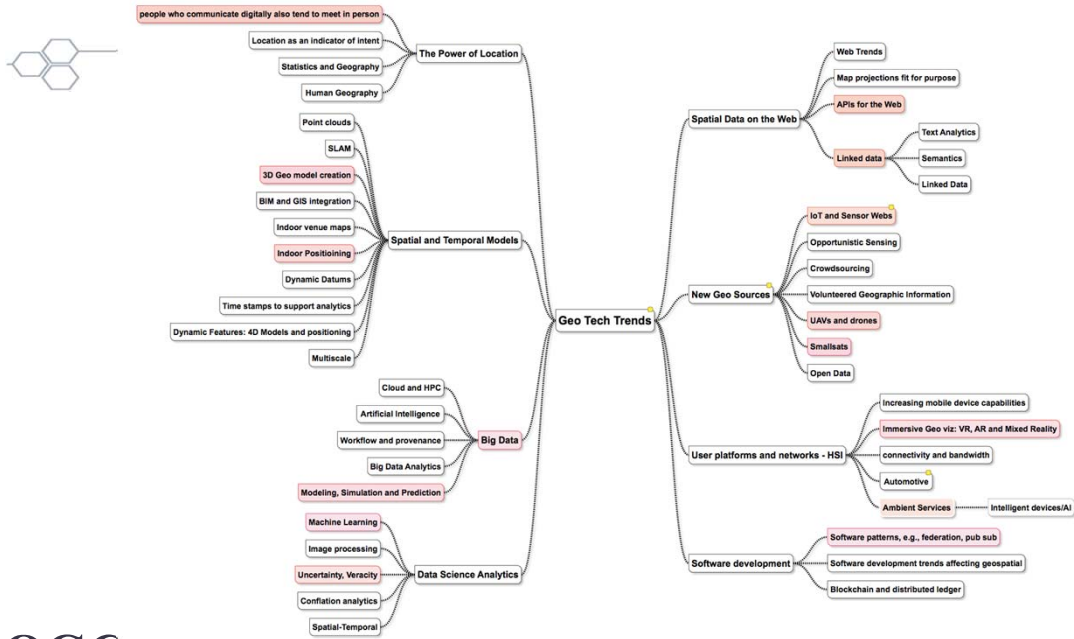- Meteorology and Oceans
- University

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OGC TECHNOLOGY STRATEGY, TECHNOLOGY TRENDS

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https://github.com/opengeospatial/OGC-Technology-Trends

Geo Tech Trends

- **The Power of Location**
  - people who communicate digitally also tend to meet in person
  - Location as an indicator of intent
  - Statistics and Geography
  - Human Geography

- **Spatial and Temporal Models**
  - Point clouds
  - SLAM
  - 3D Geo model creation
  - BIM and GIS integration
  - Indoor venue maps
  - Indoor Positioining
  - Dynamic Datums
  - Time stamps to support analytics
  - Dynamic Features: 4D Models and positioning
  - Multiscale

- **Big Data**
  - Cloud and HPC
  - Artificial Intelligence
  - Workflow and provenance
  - Big Data Analytics
  - Modeling, Simulation and Prediction

- **Data Science Analytics**
  - Machine Learning
  - Image processing
  - Uncertainty, Veracity
  - Conflation analytics
  - Spatial-Temporal

- **Spatial Data on the Web**
  - Web Trends
  - Map projections fit for purpose
  - APIs for the Web
  - Linked data
    - Text Analytics
    - Semantics
    - Linked Data

- **New Geo Sources**
  - IoT and Sensor Webs
  - Opportunistic Sensing
  - Crowdsourcing
  - Volunteered Geographic Information
  - UAVs and drones
  - Smallsats
  - Open Data

- **User platforms and networks - HSI**
  - Increasing mobile device capabilities
  - Immersive Geo viz: VR, AR and Mixed Reality
  - connectivity and bandwidth
  - Automotive
  - Ambient Services — Intelligent devices/AI

- **Software development**
  - Software patterns, e.g., federation, pub sub
  - Software development trends affecting geospatial
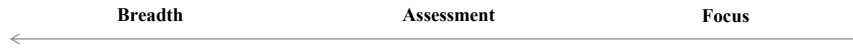 - Blockchain and distributed ledger
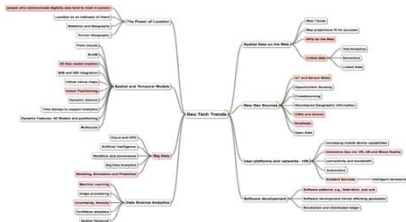
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OGC Tech Trends Process

Identification of Technology Trends

Continual process to Gather from many sources
Stay alert for Disruptions , triggers

Characterize and Prioritize Trends

Ripe Trends

- Location and Mobile communications
- 3D model creation
- Indoor positioning
- Big Data Geo
- Modeling, Simulation and Prediction
- Machine Learning
- Uncertainty, Veracity
- APIs for the Web
- Linked Data
- Internet of Things (and sensor webs)
- UAVs and Drones
- Smallsats
- Immersive Geo: AR, VR, Mixed Reality
- Ambient services

Take Action

Innovation Program

e.g. planning Testbeds

Standards Program

e.g. Future Directions

Compliance Program

e.g. implementation maturity

Communications & Outreach

e.g. location Powers

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Addressing Future Needs

- Innovation
  - Increased emphasis on prototyping ideas with user community and developers
  - Focus on Apps and lightweight standards for developers
  - Taking industry's lead -- defacto industry standards as a driver of SDO work
  - Increased collaboration among SDOs to address the growing complexity
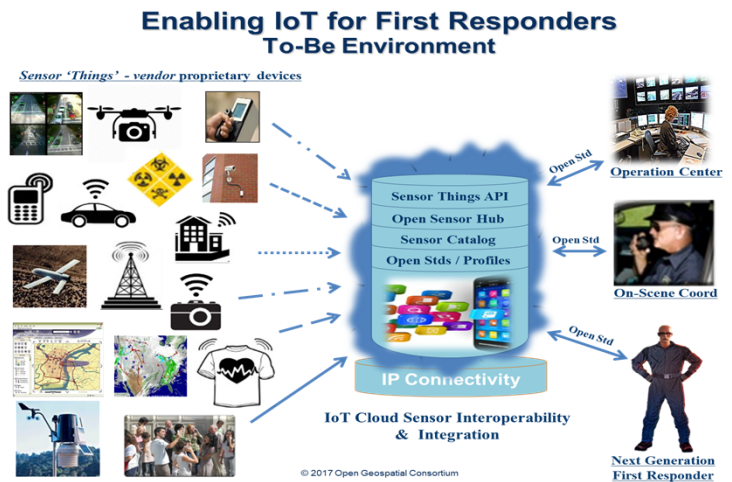 - Addressing the Innovator's Dilemma

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Summary

- Progress is being made to access, automate, and exploit the ever widening expanse of location information being generated by people, sensors and processes.

- Open standards are key for rapid integration of the ever growing body of geospatial information and technologies

- Participation in international standards programs assures that local, national, and regional needs are addressed

Enabling IoT for First Responders
To-Be Environment

Sensor 'Things' - vendor proprietary devices

Sensor Things API
Open Sensor Hub
Sensor Catalog
Open Stds / Profiles

IP Connectivity

IoT Cloud Sensor Interoperability & Integration

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Open Std — Operation Center
Open Std — On-Scene Coord
Open Std — Next Generation First Responder

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Thank You

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