Why Standards Matter – The objectives and roadmap of the International Open Geospatial Consortium (OGC)

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The vision and mission of the Open Geospatial Consortium is discussed, with emphasis on its role to bring the power of location to decision makers around the world. OGC standards have significantly improved location information sharing worldwide and enable rapid integration of location data and technologies used in traditional mapping. OGC's focus now is to improve decision making through the efficient application of location to a range of social, economic and environmental topics. OGC standards facilitate the rapid mobilization of new data sources (e.g. commercial imagery, LIDAR) and new and disruptive technologies (e.g. IoT, autonomous and unmanned systems) to address challenges related to climate change, water resource availability, urban planning and management, insurance risk assessment, public safety, alternative energy placement, and land administration to name a few.

Throughout history, maps not only shaped humanity's local and global exploration, they provided a powerful tool that informed important decisions about countless social, political, economic, and environmental topics – from knowing the location of wild herds 14.000 years ago [1] to John Snow's famed closure of a cholera-infested water source [2] in 1854.

Today's digital maps keep us abreast of severe weather, monitor and manage our natural resources, guide commercial and unmanned aircraft, affirm land ownership, improve traffic safety, understand climate change and mitigate its impacts, and keep us in touch with friends. Mapping today underpins massive business enterprises such as Google, Uber, Lyft, and the hospitality and insurance industries. Mapping is key to good governance from the local to international levels. The ability to know our location and to find our way in our communities and around the world is assumed and expected in our daily lives.

But the ubiquity and usefulness of location information arrived quite some time after the creation of Geographic Information Systems (GIS) in the 1960s – it took not only the creation of robust, reliable, and widespread communication networks, but also the creation and implementation of standardized data formats and interfaces that allowed location information to travel upon them.

The Open Geospatial Consortium (OGC) was formed in the early 1990s as an international, not-for-profit industry consortium dedicated to uniting the rapidly growing geospatial information and technology industry. OGC's vision statement offers insight into the organization's global mandate.

A world in which everyone benefits from the use of geospatial information and supporting technologies

Simply put, OGC's vision is to improve our understanding of, and decision making regarding, social, economic, and environmental topics by removing all barriers to the sharing and application of location information. OGC achieves this by facilitating an international forum and programs that bring together geospatial technology providers and

(1) https://www.telegraph.co.uk/news/worldnews/europe/spain/5978900/Worlds-oldest-map-Spanish-cave-has-landscape-from-14000-years-ago.html
(2) https://en.wikipedia.org/wiki/John_Snow

Figure 1: OneGeology portal giving access to national geological maps served by distributed OGC web services (source: www.onegeology.org).

users to cooperatively develop freely available open standards that enable different sources of location information and different technologies to work together – or to "interoperate" – making it easier for everyone to access and use location information.

The challenge in the early 1990's was the inability to easily share geospatial information among organizations using different vendor products. Agreed-upon open international standards became the approach to ensure that geospatial information sources (those with a location component) and technologies could quickly and cost effectively work together (interoperate) while simultaneously allowing a healthy, diverse, and non-monopolistic software marketplace to exist.

By the late 1990s, OGC standards had become a globally adopted open standards framework implemented by technology providers to easily enable a common way for location information to be discovered, shared, integrated, processed, and exploited by users across a range of different products, systems, organizations, and jurisdictions.

This shift to OGC standards:

- Freed geospatial technology users from being locked-in to a single vendor architecture;
- Increased users' choice of interoperable IT solutions in the marketplace;
- Enabled technology providers to easily integrate their products into different customer environments and with different vendor products;
- Benefitted traditional mapping organizations by making it easier to accept new geospatial information sources in to their production processes and distribute products to customers;
- Reduced duplication of geospatial data by allowing authoritative geospatial data to be accessed directly over the web; and
- Reduced IT systems costs by eliminating the need for custom software interface development.

With this standardization work completed, what's OGC doing now? Standards need to evolve in-step with technology, so 25 years since its inception, experts from over 520 OGC member organizations representing industry, academia, research, and government continue to participate in OGC's international committees, working groups, and innovative rapid prototyping initiatives to advance new standards and interoperability best practices that address global needs in a shifting technology environment.

Indeed, France is no stranger to OGC, with membership from French organizations such as: Airbus Defence & Space, ATOS, BRGM, Capgemini, e-Science Data Factory, GEOMATYS, IGN, Lab-STICC CNRS UMR 6285, Laboratoire d'Informatique de Grenoble, LiRis, METEO-FRANCE, METSAFE, MINES ParisTech, Ministère de la Transition Ecologique et Solidaire, THALES S.A., among others.

The continual innovation and evolution of OGC and complementary standards has resulted in their use across a broad range of useful location-based technologies and services, including:

- European INSPIRE Directive [3] – OGC and ISO geospatial standards form the basis of a key European Directive designed to ease important geospatial information sharing across the nations of the European Union. In France, public organizations such as BRGM, IGN and METEO-FRANCE, as well as local authorities have implemented OGC standards to support this Directive.
- OneGeology [4] – Geological Surveys around the world use OGC standards to make their data shareable across national boundaries. This allows surveys to view geologic conditions on a much broader regional and international basis.

(3) https://www.ecologique-solidaire.gouv.fr/directive-europeenne-inspire
(4) www.onegeology.org

- Satellite Earth Observation (EO) Providers – Government and commercial imagery providers, such as the European Space Agency, Airbus and DigitalGlobe make imagery accessible to their customers and partners via OGC standards. For example, the European Union Copernicus Marine Environment Monitoring Service [5] provides a range of global ocean analysis and forecast digital map products via the OGC Web Mapping Service standard, which is implemented in hundreds of geospatial and location-enabled technologies in use today.
- New Zealand Government – numerous New Zealand government agencies use OGC's Web Services, Sensor Web Enablement, and WaterML standards to rapidly and cost effectively integrate hundreds of water quality observation stations maintained on different systems by 16 regional and unitary water councils and 3 federal Crown Research Institutes. The result is a nationally integrated and publicly web-accessible resource for citizens to understand how suitable any rivers, lakes, and/or coastal water resources are for a range of uses – from recreation to resource management.

'Living' maps are growing more commonplace due to real-time data from location-aware fixed and mobile sensors and IoT devices being integrated into wider geographical 2D and 3D contexts. OGC's Sensor Web Enablement and SensorThings API standards [6] make this integration easy. Further, OGC's CityGML and complementary geospatial standards [7] also enable the integration of 'as built' engineered structures, such as Building Information Models, into geospatial contexts to construct detailed 3D models of urban environments. These models help government, private sector representatives, and citizens to better plan and manage various city planning and services requirements. Examples of these standards in use include:

- Smart and Resilient Cities – Major urban centers around the world are constructing and maintaining 3D city models – digital twins of cities - that are enabling efficient urban development & planning, expedient delivery of city services, optimized placement of retail stores, improved safety and flow of pedestrian and vehicle traffic, and a better understanding of and protection against the impacts of extreme weather events. A dedicated partnership has been established between OGC and BuildingSMART International (bSI) to increase interoperability between the geospatial (i.e. geological, geotechnical, geographic) and built environment domains.
- Air Quality Monitoring – Over 90% of Earth's population are living in areas exceeding the World Health Organization's recommended limits on air pollution, and an estimated 3.7 million annual deaths are attributable to air pollution [8]. As part of a pilot project funded by Natural Resources Canada, citizens across 10 cities are actively monitoring air quality and associated health risks through a network of inexpensive citizen-built and -maintained air quality sensors linked together with OGC's SensorThings API standard [9].

(5) http://marine.copernicus.eu/services-portfolio/access-to-products/
(6) www.opengeospatial.org/projects/groups/sensorwebdwg
(7) https://www.opengeospatial.org/domain/built
(8) https://www.who.int/airpollution/en/
(9) https://www.nrcan.gc.ca/earth-sciences/geomatics/canadas-spatial-data-infrastructure/funded-projects/21465#li3

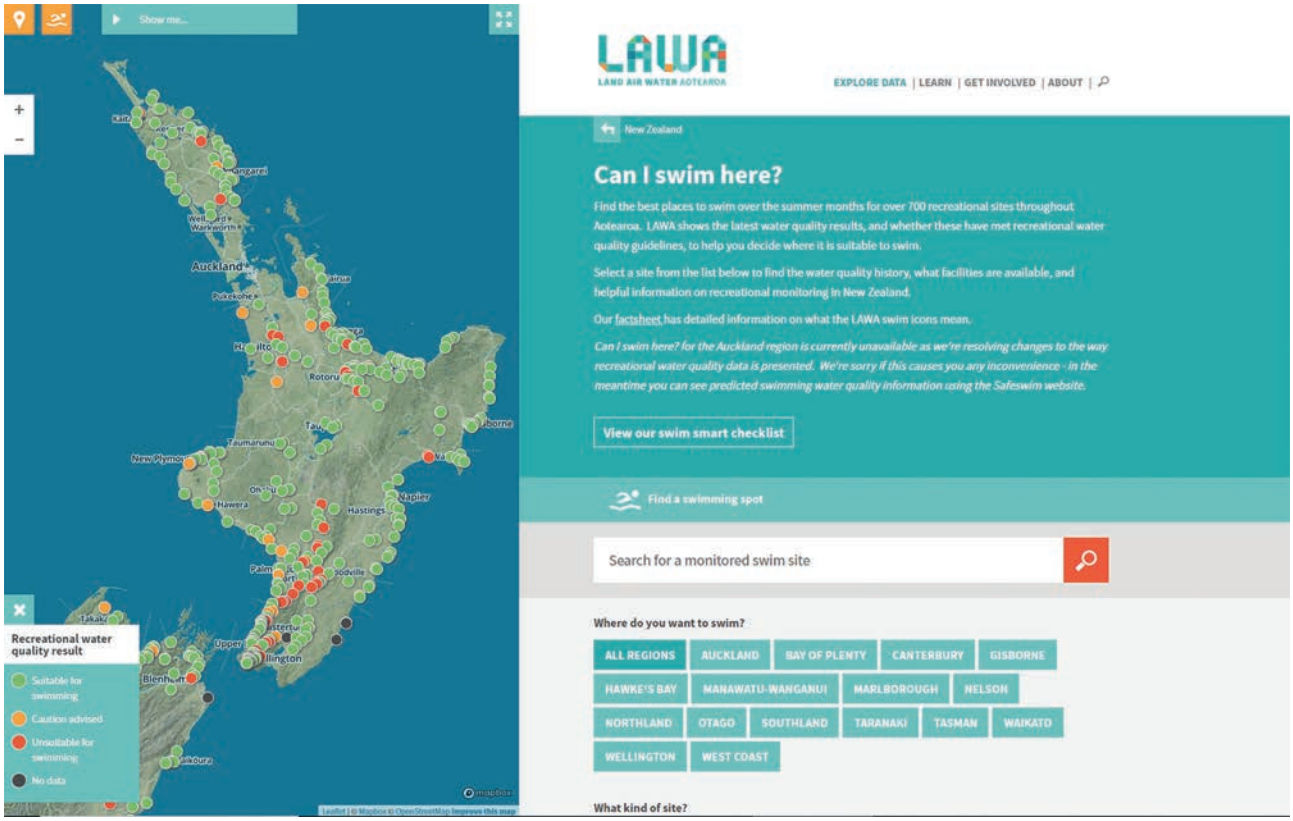

Figure 2: Land and Water Aotearoa (LAWA) Can I Swim Here Website, leverages OGC standards to integrate water quality data from over 1400 point source water observations across New Zealand (source: https://www.lawa.org.nz/).

- Ocean monitoring – OGC Sensor Web Enablement standards help the US National Oceanographic and Atmospheric Administration (NOAA) and European research programs such as SeaDataNet to connect hundreds of coastal and inland buoys and sensors that measure water quality, temperature, wave height, and other phenomena. These real-time observations provide important environmental information for researchers and inform decision makers and citizens affected by climate change and increasingly severe weather events.

OGC members, working collectively with experts in the community, are keeping an eye on key geospatial technology trends and working to identify and prioritize roadmaps to address emerging and disruptive technologies that would benefit from early attention in terms of interoperability arrangements. Through this process, led by OGC's Chief Technology Officer, trends are identified and prioritized for attention in OGC development programs. This allows standards and associated interoperability best practices to evolve quickly to support the rapid implementation of these capabilities into user environments. Examples of current trends include: geospatial big data processing; modeling, simulation, and prediction; immersive geospatial capabilities, such as augmented and virtual reality; indoor positioning, models, and navigation; and unmanned/autonomous systems. OGC maintains a public thematic map of these trends, as well as detailed roadmaps for each specific trend topic, to assist in the prioritization of topics for action by OGC members [10].

OGC members have identified several of these trends as priorities for near-term action within OGC programs and in cooperation with OGC partner organizations such as the World Wide Web Consortium (W3C) and bSI.

- Indoor location, models, and navigation – these important initiatives are underway in OGC to address the major challenge of mapping, locating, and navigating in an indoor environment and to better understand and manage assets located underground. While the outdoor location challenge has been largely solved via GPS and other global navigation technologies, efficient indoor location and mapping continues to be a challenge. OGC has developed an IndoorGML standard to address indoor navigation and is advancing a Pilot Initiative to address indoor mapping based on LIDAR scanning of interior spaces.
- Underground Infrastructure Information Management – work is also underway by OGC members in cooperation with New York City, London, and Singapore to advance a common data model and standardized approach for managing underground infrastructure in urban areas. The urgency of having detailed and accurate underground infrastructure maps in 3D has been accentuated by recent disasters such as a construction-related rupture of a high-pressure gas pipeline in Belgium that caused multiple fatalities, injuries, and property damage [11]; and the

(10) https://github.com/opengeospatial/OGC-Technology-Trend
(11) https://www.aria.developpement-durable.gouv.fr/wp-content/files_mf/FD_27681_Ghislengheinv_2004ang.pdf

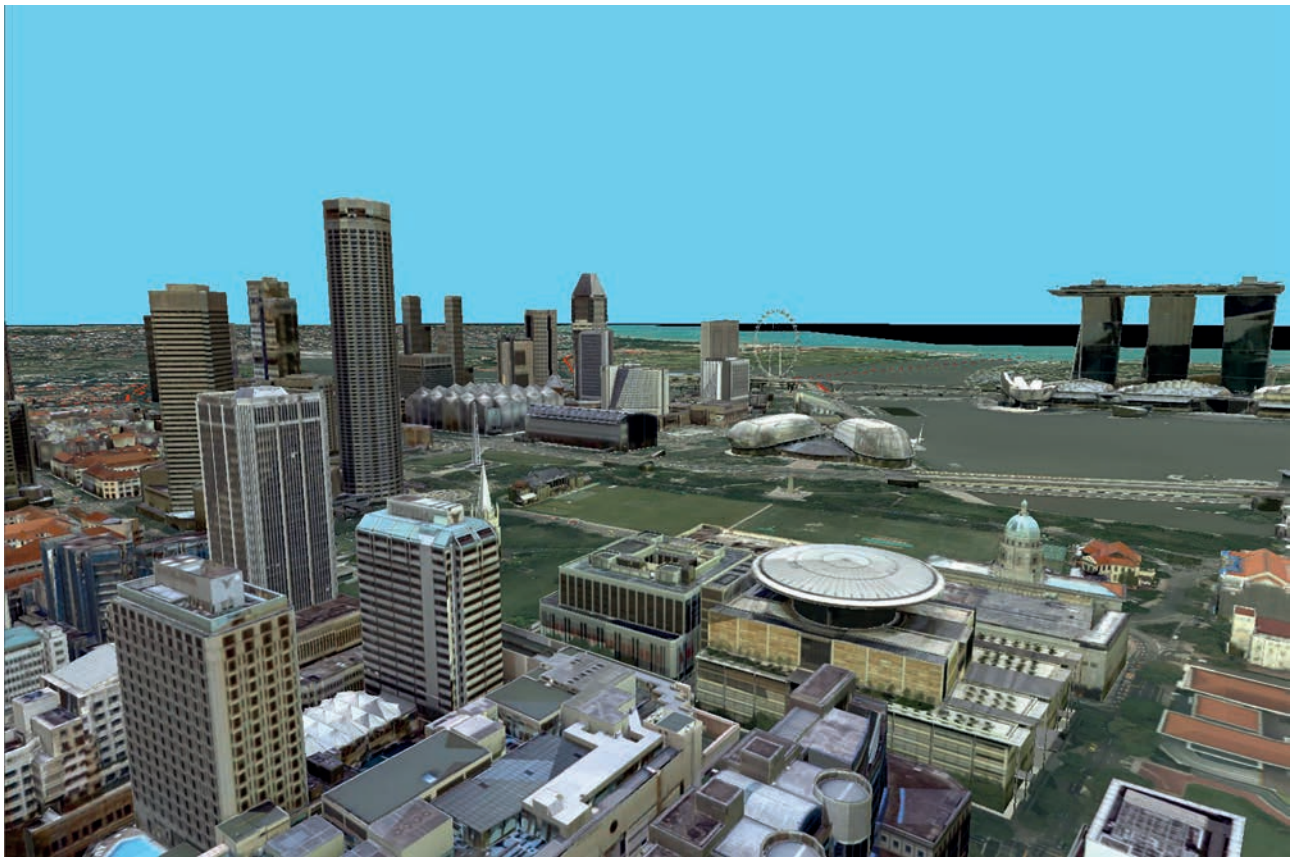

Figure 3: View of Singapore 3D City Model managed using the OGC CityGML standard (source: Singapore Land Authority).

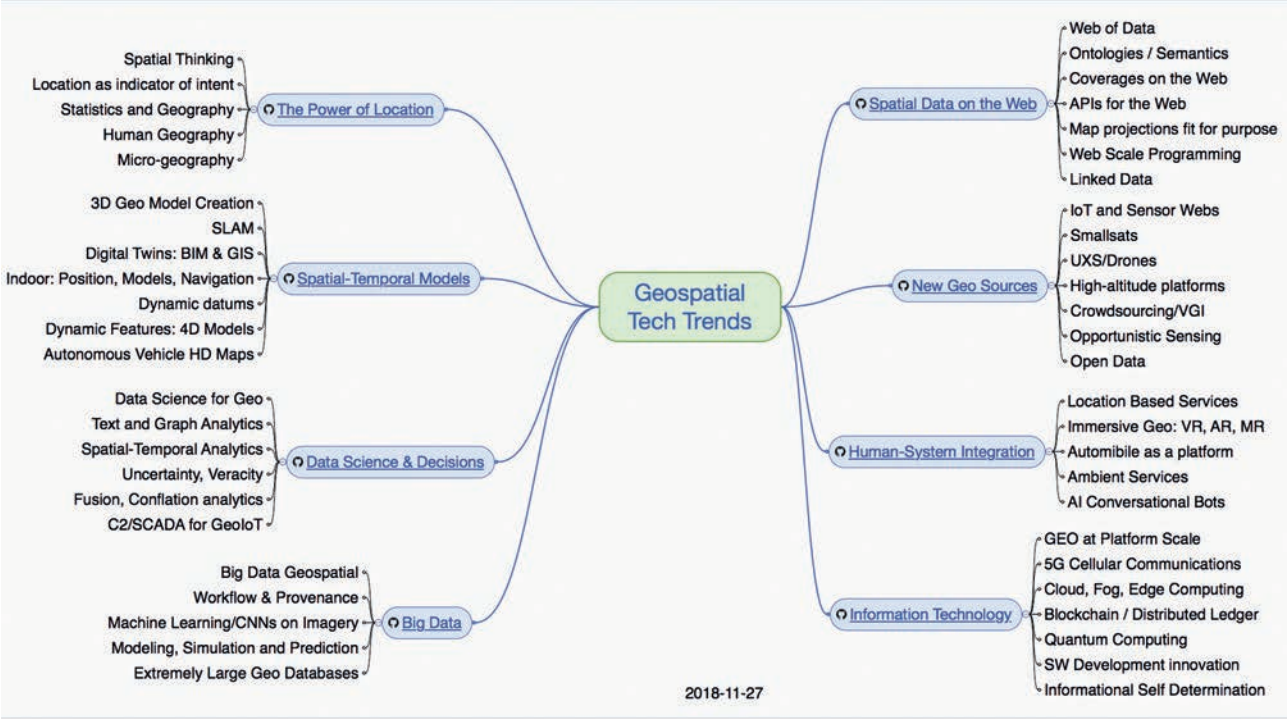

Figure 4: OGC Technology Trends MindMap.

2012 Hurricane Sandy storm surge that resulted in 3-day blackout of lower Manhattan in New York City [12]. A common data model will allow both geo (where) and semantic (what) interoperability of underground infrastructure datasets coming from multiple organizations.

- Web of Data [13]: Spatial Data on the Web – OGC has partnered with W3C to advance standards solutions that make it easier to work with location information on the web. Much of the location information available is maintained and published via portals or "silos" on the web, making discovery and access difficult. With a proliferation of new technologies producing and publishing more and more location-based data, identifying a common standardized framework to discover, access, and exploit any available location information on the web is an important objective.
- Modeling, Simulation, and Prediction [14] – establishing visual and/or predictive models of the real world on a range of computing platforms – including mobile devices – is becoming commonplace thanks to advances in Graphical Processing Units (GPU) and associated hardware. OGC has organized the defense, public safety, and earth & environmental science communities to explore standards and interoperability arrangements that will: accelerate the transition from 2D maps to 3D models of the earth; facilitate the federation of models to render high fidelity environmental predictive models; and to streamline the ingesting of geospatial and associated information to a point that allows the production of new 3D models in near real-time. Predictive models add the temporal dimension, resulting in 4D models that are important in the training, preparation, and response to natural disasters.

Understanding, avoiding and mitigating the impacts of human activities on our planet is becoming increasingly important as a growing population realizes that our consumptive demands are not aligned with the hard limitations of earth's resources. As shown here, the work of OGC and many other standards organizations is improving the discovery, integration, and application of local to global information that has the power to inform decisions concerning how to sustainably address a range of critical environmental, social, and economic issues.

(12) Bloomberg Businessweek, https://www.bloomberg.com/news/features/2017-08-10/nobody-knows-what-lies-beneath-new-york-city
(13) https://github.com/opengeospatial/OGC-Technology-Trends/blob/master/Trends/WebofData.adoc
(14) https://github.com/opengeospatial/OGC-Technology-Trends/blob/master/Trends/ModSimPredict.adoc