OGC® Geospatial Technology Trends

Warning

This document is not an OGC Standard. This document is an OGC White Paper and is therefore not an official position of the OGC membership. It is distributed for review and comment. It is subject to change without notice and may not be referred to as an OGC Standard. Further, an OGC White Paper should not be referenced as required or mandatory technology in procurements

Document type: OGC® White Paper
Document stage:
Document language: English

Geospatial Technology Forecasting Consultation

The Open Geospatial Consortium (OGC) tracks trends in Geospatial Technology. Trends are identified and characterized based on OGC processes that then drive action in consortium programs. Geospatial Tech Trends consultation is available to any organization that could benefit from roadmaps of geospatial technology.

Geospatial Technology Trends

In a survey of global CEOs, technology innovation is anticipated to have the most transformative effect on their business over the next five years (according to PWC Global). Identifying technology trends and developing roadmaps for their development and effect on markets is key to reducing risk and identifying business opportunities. Geospatial technology advances with innovation in the application of location-based information and with general information technology innovations. OGC, as a consortium of over 500 of the most influential geospatial organizations, is the global forum for innovation and standards in geospatial technology. The OGC Technology Trends and roadmaps available to any organization to use in their business planning.

Disruptive Technologies Forecasting and Consultation

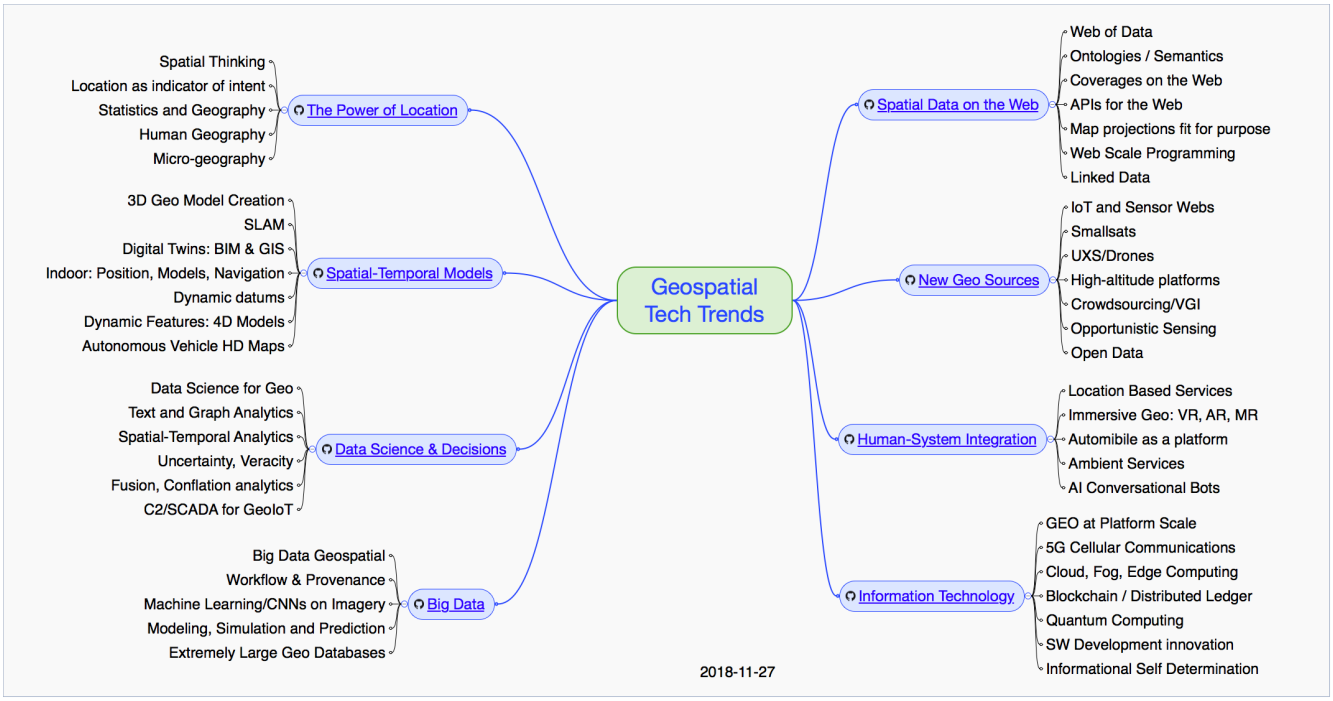
OGC's Geospatial Technology Forecasting Process is based on "best of breed" for persistent forecasting of disruptive technologies (National Academies) and honed by its use across OGC Programs. The identification and characterization steps are performed on a quarterly basis and reviewed by the OGC Architecture Board and OGC Technical Committee. Trends are posted publicly and receive public review and comments.

Action is Taken in the OGC Programs and through Strategic Consultation on an NDA basis providing tailored discussions and forecasts for any organization affected by geospatial and location-based technology innovations.

OGC-Technology-Trends

Geospatial technology trends as tracked by the Open Geospatial Consortium (OGC) and the OGC Architecture Board (OAB) are listed on this and linked pages. A summary of all tracked Trends is provided in the mindmap. A set of Ripe Trends have been identified as summarized in the Trend Assessment. Also avaiable is an overview of the Technology Trends process.

Each Trend is linked to a GitHub issue - **Comments are welcome and encouraged on the issue linked to the trend**



Trends grouped into meta-trends:

- The Power of Location
- Spatial and Temporal Models
- Data Science and Decisions
- Big Data
- Spatial Data on the Web
- New Geo Sources
- Human-System Integration
- Information Technology

Ripe Trends

A subset of the Tech Trends identified as "Ripe Trends" are assessed as highest and second priority through an analysis summarized in the graphic below.

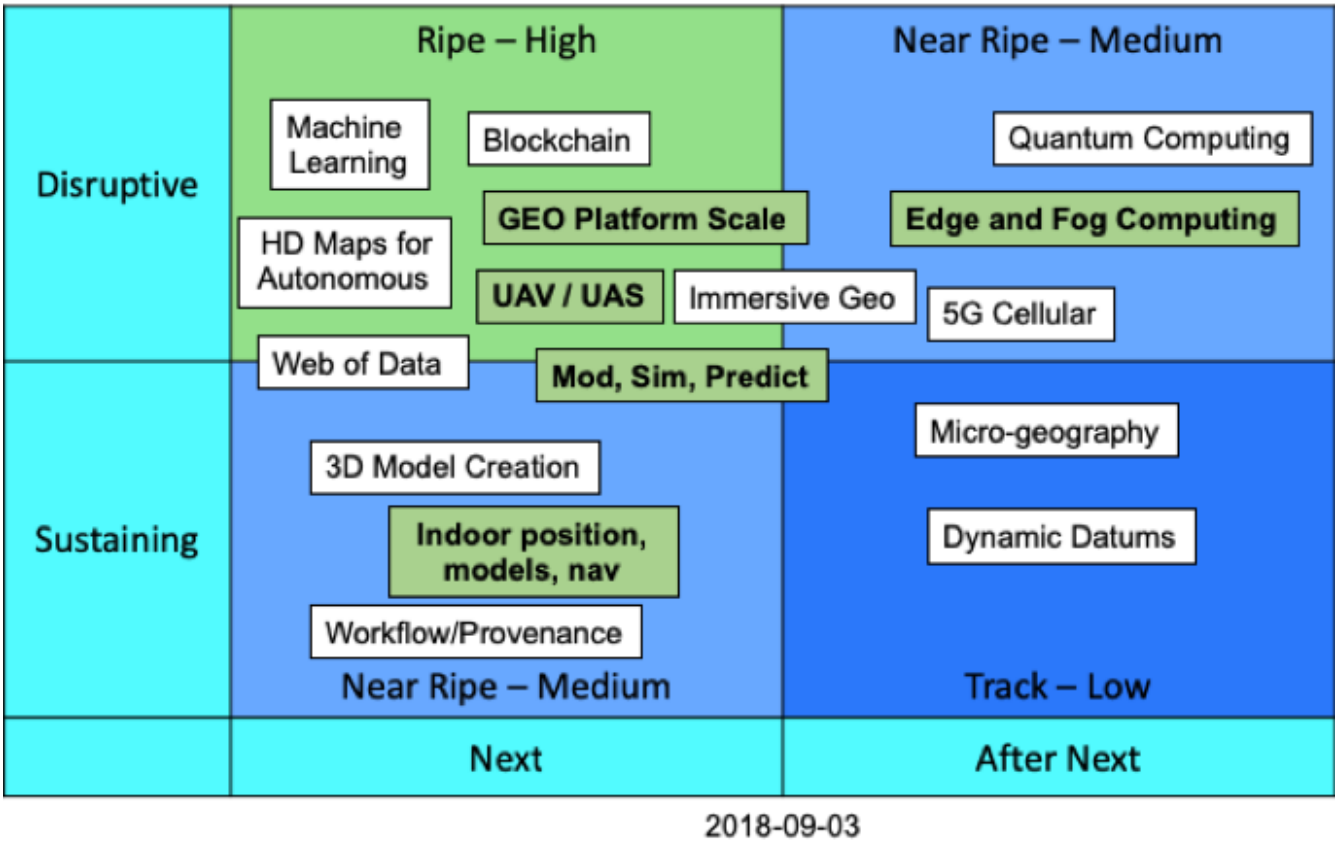
Highest Priority

- Autonomous Vehicle HD Maps
- Blockchain/Distributed Ledger
- GEO at Platform Scale
- Machine Learning/CNNs
- Modeling, Simulation and Prediction
- UAVs and Drones
- Web of Data

Second Priority

- 3D model creation
- 5G Cellular Communications
- Edge and Fog Computing
- Immersive Geo: AR, VR, Mixed Reality
- Indoor: Position, Models and Navigation
- Quantum Computing
- Workflow/Provenance

Ripe Trends are identified based on characterizations of trend Impact (Disruptive or Sustaining) and Horizon (Next or After Next). The trends for highest priority consideration are Trends assessed as Disruptive and Next.



Intellectual Property Rights

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. The Open Geospatial Consortium shall not be held responsible for identifying any or all such patent rights.

Recipients of this document are requested to submit, with their comments, notification of any relevant patent claims or other intellectual property rights of which they may be aware that might be infringed by any implementation of the standard set forth in this document, and to provide supporting documentation.

Chapter 1. The Power of Location (LOC)

Location and place are effectives means to organize, analyze and understand our world and how we live.

Title	Description
SpatialThinking	Trends in spatial thinking includes how GPS affects how we think about our world and navigation. Also the use of place, and how vernacular geography is used to describe it. One must avoid the temptation to think of place only as a location. (DSTL) A place is distinguished by its people, markets, governments, and institutions, as much as it is by its physical landscape and natural resources, transportation systems (including streets and roads), buildings, and boundaries- (US National Academies).
Location as indicator of intent	“Location targeting is holy grail for marketers”- Sir Martin Sorrell, WPP CEO, MWC 2011 By measuring the entropy of each individual’s trajectory, we find a 93% potential predictability in user mobility - Limits of Predictability in Human Mobility, Science 2010 1st law of geography: "Everything is related to everything else, but near things are more related than distant things.” - Waldo Tobler.
Statistics and Geography	As well as geospatial information, Governments and government bodies are increasingly reliant on statistical data to inform policy and decision making. As resources become constrained, it is increasingly important to make sure they are used in the most effective way possible. Geography is often the medium through which statistics are interpreted whether at global, regional, national or sub-national level. As the need for better statistics increases so does the need for greater integration of statistics and geospatial information, resulting in so called spatial statistics - (GGIM).

Title	Description
Human Geography	Well-organized and comprehensive human geography data can be applied to analysis that allows us to better anticipate the behavior of people over space and time and to inform decision-making that supports human security, including crisis mitigation and humanitarian response - (WWHGD_WG).
Micro-Geography	Personal electronic devices now measure much of our activity and context. New methods to capture, quantify and communicate individual human activity at a micro level are now available, e.g., OASIS's Classification of Everyday Living (COEL). Rating services for individual behaviors, e.g., risk rating, will develop similar to credit risk rating services.

Previous Trends

Title	Description
Learn To Think Spatially	Spatial thinking is a collection of cognitive skills. The skills consist of declarative and perceptual forms of knowledge and some cognitive operations that can be used to transform, combine, or otherwise operate on this knowledge. The key to spatial thinking is a constructive amalgam of three elements: concepts of space, tools of representation, and processes of reasoning. (US National Academies) OGC should consider how the innovation it promotes can extend this "learning spatial" to "doing spatial". (This topic has bee made part of SpatialThinking)
Location and Mobile communications	People who communicate digitally also tend to meet in person. 90% of users who have called each other have also shared the same space (cell tower), even if they live far apart.

Title	Description
Location based marketing/consumers	Targeted advertising is at the heart of the largest technology companies today, and is becoming increasingly precise. Simultaneously, users generate more and more personal data that is shared with advertisers as more and more of daily life becomes intertwined with networked technology. The online advertising ecosystem is built upon the ability of advertising networks to know properties about users (e.g., their interests or physical locations) and deliver targeted ads based on those properties - (Paul Vines, Franziska Roesner, and Tadayoshi Kohno).

Chapter 2. Spatial and Temporal Models (MOD)

Creating meaningful spatial representations of the world, the relationships in the world and its entities

Title	Description
3D Geo model creation including Point Clouds	Accurate 3D (Three Dimensional) model construction has been sought for many years as the key to unlocking many other related applications and scientific endeavors. This trend regards all aspects of 3D model construction from research aspects as well as focus on different types of sensing technologies being pursued. Both external and internal models are the topic of this trend. Methods are needed for rapid 3D model construction of urban areas.
Simultaneous Localization and Mapping (SLAM)	SLAM is a computational problem of constructing or updating a map of an unknown environment while simultaneously keeping track of progress within this unknown environment. Examples of approaches are self-driving cars, unmanned aerial vehicles, autonomous underwater vehicles, planetary rovers, newly emerging domestic robots and even inside the human body - (DSTL).
Digital Twins: BIM and GIS	A digital twin is a virtual representation of a physical object, which can be used to simulate how the physical object might behave in the physical world under different situations
Indoor: Position, Models and Navigation	Accurate indoor positioning unlocks a new set of possibilities for mobile services. Consumers will benefit from personalized, contextual information and offers, as well as new services such as indoor navigation. Venue owners will benefit from increased customer satisfaction and enhanced information on customer behavior - (InLocation Alliance).

Title	Description
Dynamic datums	This is now starting to be referred to as an “Earth-fixed” datum but previously was often referred to as a “dynamic datum”. Conceptually, the term “dynamic datum” confuses many people, who assume it to mean that the datum itself is constantly changing. This is obviously not the case – the datum is uniquely defined and fixed in orientation and location. Rather, an “Earth-fixed” datum allows the changes in coordinates of points on the Earth’s “dynamic” surface to be referenced and represented. (ANZLIC). The revision of ISO 19111 anticipates the need for Dynamic Datums.
Dynamic features: 4D models and positioning	The advance of mobile computing and internet-connected sensors (including sensors and GPS transponders in cell phones and notebook computers) brings with it a rapid rise in applications for moving feature data, typically representing vehicles or pedestrians. Many innovative moving feature applications will require the overlay and integration of moving feature data from different sources. Examples can easily be imagined for disaster risk management, traffic information services, security services, navigation for robots, aviation or maritime traffic monitoring, and wildlife tracking and conservation. (Moving Features press release).
Autonomous Vehicle HD Maps	Maps created at centimetre or sub-centimetre precision, typically to support driverless-cars and other autonomous ground vehicles that operate in built-up areas

Trends merged into above or retired

Title	Description
Spatial Temporal Point Cloud	Spatial Temporal Point Cloud. A point cloud refers to a set of data points in some coordinate system. Spatial Temporal components are incorporated (DSTL). Point clouds can be terrestrial, bathymetric, atmospheric. Streaming of point cloud data in real time.
Digital Twins: BIM and GIS integration	It's evident that bringing BIM and GIS together will benefit many application domains such as architecture, urban planning, disaster management, infrastructure engineering, facilities management, decision-making, construction, etc. However, there are many challenges in integrating BIM and GIS. M - (Kalantar in GIM International).
Indoor venue maps	The widespread adoption of smartphones by consumers worldwide has not only led to the advent of new indoor location technologies but also the increasing popularity and use of indoor venue maps. In the last several years, leading mapping technology companies have been competing to bring tens of thousands of high-quality indoor venue maps to smartphone users. There are indoor venue maps for thousands of museums, airports, shopping malls, restaurants and other venues - (Programmable Web).

Title	Description
Time stamps to support analytics	Time-Aware Applications, Computers, and Communication Systems (TAACCS) A new economy built on the massive growth of endpoints on the internet will require precise and verifiable timing in ways that current systems do not support. Applications, computers, and communications systems have been developed with modules and layers that optimize data processing but degrade accurate timing. State-of-the-art systems now use timing only as a performance metric. Correctness of timing as a metric cannot currently be designed into systems independent of hardware and/or software implementations. To enable the massive growth predicted, accurate timing needs cross-disciplinary research to be integrated into these existing systems- (NIST).
Multiscale	features that are represented at multiple scales, automatically (OAB).

Chapter 3. Big Data (BIG)

Big data methods and techniques applied to geospatial data

Title	Description
Big Geospatial Data	Big Data Geospatial builds upon Big Data Analytics and refers to the use of predictive analytics, user behavior analytics, or certain other advanced data analytics methods that extract value from data, and seldom to a particular size of data set - (DSTL). Big data, machine learning, and predictive data analytics allows researchers to extract insights from both scientific instruments and computational simulations (4th Paradigm) - (ACM Comm).
Workflow and provenance	Provenance is information about entities, activities, and people involved in producing a piece of data or thing, which can be used to form assessments about its quality, reliability or trustworthiness - (W3C PROV).
Machine Learning/CNNs on Imagery	Machine learning is the subfield of computer science that gives computers the ability to learn without being explicitly programmed. Deep learning and Convolutional Neural Networks (CNNs) - a sub type of machine learning - consists of multiple hidden layers in an artificial neural network - (Wikipedia).
Modeling, Simulation and prediction	Simulation modeling is the process of creating and analyzing a digital prototype of a physical model to predict its performance in the real world. Models and simulation can be used for analysis and for training.

Title	Description
Extremely Large Geo Databases	An extremely large database (XLDB) is a database that stores and processes enormous amounts of data and associated records and entries. As the largest database form factor, XLDB is created and managed by very few organizations around the world, typically scientific research institutes that have massive data sets at their disposal.

Chapter 4. Data Science and Decisions (DEC)

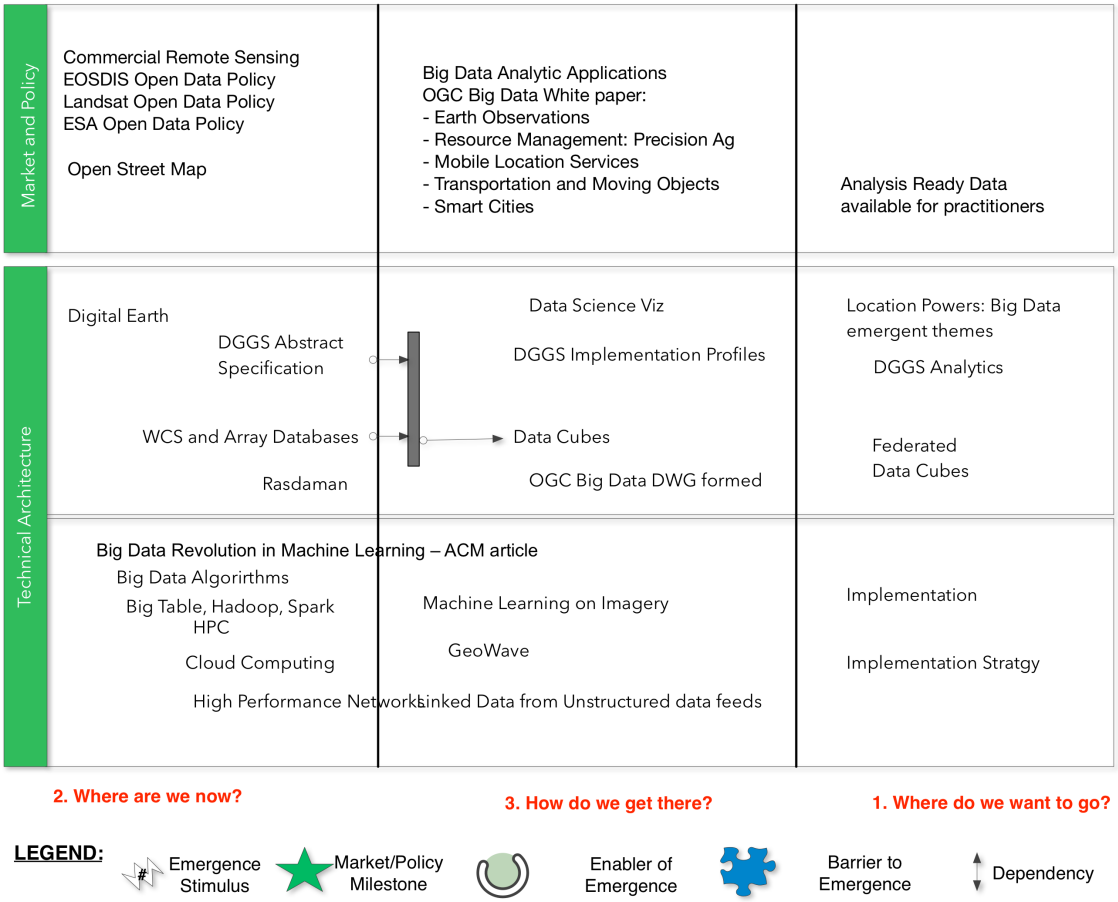
Data analytics and decision in the context of spatial-temporal data. Human cognition augmentation.

Title	Description
Data Science for Geo	The use of data mining and other functions provided by intelligent systems to facilitate the creation of knowledge.
Text and Graph Analytics	Text Analytics refers to the process of deriving high-quality information from text. Applications of this are Natural Language Processing (NLP) and Social Media harvesting. An example is to scan a set of documents written in a natural language and either model the document set for predictive classification purposes or populate a database or search index with the information extracted - (DSTL).
Spatial-Temporal Analytics	Although real-time spatiotemporal data are now being generated by almost ubiquitously and their applications in research and commerce are widespread and rapidly accelerating, the ability to continuously create and interact in real time with this data is a recent phenomenon. This real-time space–time interactive functionality remains today the underlying process generating the current explosion of fused spatiotemporal data, new geographic research initiatives, and myriad mobile geospatial applications in governments, businesses, and society - (NGAC).
Uncertainty, Veracity	Uncertainty is a situation which involves imperfect and/or unknown information, including aspects of cognition (the process of acquiring knowledge and understanding through thought, experience and senses) and plays a part in understanding Uncertainty Information. How this information is assessed for data quality is important - (DSTL).

Title	Description
Fusion, Conflation analytics	Conflation refers to the act of combining two distinct maps into one new map. It is similar to the practice of image mosaicking. It is usually carried out by registration of an overlapping area. Conflation for digital maps refers to the process of associating real world coordinates to digital ones and it is named Map Matching - (DSTL).
C2/SCADA for GeoIoT	Command and control (C2) a well established ability is the exercise of authority over assigned resources in the accomplishment of a common goal. Supervisory control and data acquisition (SCADA) is a information system architecture for high-level process supervisory management of industrial process plants. Applying C2 and SCADA to IoT environments will reuse existing control system technology in a new communications stack of broader reach.

Tue Oct 03 2017

Open Data Analytics Roadmap



Chapter 5. Spatial Data on the Web (WEB)

Making geospatial data accessible and usable in the most comprehensive information system ever built.

Title	Description
Web of Data	Data published on the web are made discoverable, accessible and interoperable using WWW best practices for data formats, data access, data identifiers, metadata, licensing and provenance.
Ontologies and Semantics	Ontology is a formal naming and definition of the types, properties, and interrelationships of the entities. Semantics is primarily the linguistic, and also philosophical study of meaning—in language, programming languages, formal logics, and semiotics - (DSTL).
Coverages on the Web	Coverages are geospatial datasets as matrices or tensors that map a spatial-temporal coordinates to a corresponding set of data values, e.g., geophysical parameters. The Web is fundamentally organized as a graph structure with node addresses and relation links. Spatial Data on Web Best Practices are needed to that define Web-native access to Geospatial Coverages.
APIs for the Web	The explosive growth of public APIs for geospatial applications, and the accompanying variability in API practices across the IT industry, as well as in geospatial APIs specifically, has created new opportunities and challenges in supporting geospatial services. The application of standards in APIs to ensure interoperability is an apparent next step - (API CDS Press Release).
Map projections: fit for purpose	Best Practice 8: State how coordinate values are encoded. Provide enough information for users to determine how coordinate values are encoded - (SDWWG Best Practice).

Title	Description
Web Scale Programming	Web scale platforms hosted on large cloud services with web-friendly techniques, enable extreme levels of service delivery as compared to many of their enterprise counterparts.
Linked Data	Linked Data refers to a method of publishing structured data that can be interlinked. It builds upon standard Web technologies such as HTTP, RDF and URIs. It enables data from different sources to be connected and queried - (DSTL).

Chapter 6. New Geo Data Sources (SRC)

New sensor technologies, sensor platforms and new observers

Title	Description
Internet of Things (and sensor webs)	The internet of things (IoT) is the inter-networking of physical devices, vehicles (also referred to as "connected devices" and "smart devices"), buildings and other items—embedded with electronics, software, sensors, actuators, and network connectivity that enable these objects to collect and exchange data (DSTL).
Smallsats	MicroSatellite is referring to small and compact satellites. They are often the size of two shoe boxes (smaller than 50kg in weight). (DSTL) Planet “will be imaging the entirety of Earth’s earth daily.” (Wired).
UXS and Drones	While large UAVs have been in use for defense, ISR, and remote sensing purposes for many years, the platforms now range in complexity from large, jet-propelled aircraft to palm-sized drones. Similarly, Unmanned Underwater Vehicles (UUVs) also have a long history of operations, becoming increasingly sophisticated in recent years with respect to capabilities and autonomy - (OGC WG Charter).
High-altitude platforms	High-Altitude Platforms (HAPs) are aircraft or airships that operate in the stratosphere at altitudes of up to 22 km, typically to provide communication facilities that can exploit both terrestrial and satellite schemes (IEEE)

Title	Description
Crowdsourcing and VGI	Geo Crowdsourcing includes Social Media and Voluntary Geographic Information (VGI). Crowdsourcing refers to the process of obtaining geo inspired services, ideas, or content by soliciting contributions from a large group of people, especially an online community, rather than from employees or suppliers (DSTL). VGI) is the harnessing of tools to create, assemble, and disseminate geographic data provided voluntarily by individuals (Goodchild, 2007). VGI is a special case of crowdsourcing.
Opportunistic Sensing	An opportunistic sensing approach is proposed, where noise-level data is collected without informing smartphone users.
Open Data	“Open data and content can be freely used, modified, and shared by anyone for any purpose” http://opendefinition.org/.

Chapter 7. Human-System Integration (HSI)

Human Systems Integration (HSI) is the relationship between humans and their environment and how systems are design and used relative to that relationship. The principle goal is to ensure a safe and effective relationship between humans and system. HSI increases the efficiency, usability, and quality of its products because human needs have been considered from the beginning

Title	Description
Location Based Services	Location-based services (LBS) are computer applications (specifically, mobile computing applications) that provide information depending on the location of the device and the user, mostly through mobile portable devices (e.g., smartphones) and mobile networks
Immersive Geo: AR, VR, MR	Virtual reality (VR) refers to computer technologies that use software to generate realistic images, sounds and other sensations that replicate a real environment. Augmented reality (AR) is a live direct or indirect view of a physical, real-world environment whose elements are augmented by computer-generated sensory input such as sound, video, graphics or GPS data.
Automobile as Platform	Maps and Apps for Automotive: The battle around connected cars and autonomous driving will continue this year. Both are impossible without geospatial technology. Hyper-precise and up-to-date maps as well as real-time analytics of sensor data are just two examples. We will see a lot of geo-enabled apps that get integrated into the car (GeoAwesomness).

Title	Description
Ambient services	Ambient intelligence (AmI) refers to electronic environments that are sensitive and responsive to the presence of people. In an ambient intelligence world, devices work in concert to support people in carrying out their everyday life activities, tasks and rituals in an easy, natural way using information and intelligence that is hidden in the network connecting these devices (see Internet of Things). As these devices grow smaller, more connected and more integrated into our environment, the technology disappears into our surroundings until only the user interface remains perceivable by users (Wikipedia).
AI Conversational Bots	Platforms that allow users to interact with software through conversation in natural language (or in nearly natural language).

Chapter 8. Information Technology (IT)

General software development platforms that may affect geospatial technology

Title	Description
GEO at Platform Scale	Today's networked platforms are able to achieve massive success by simply connecting producers and consumers. A platform allows for alignment of incentives of producers and consumers, vastly increasing the products created and then allowing quality control through curation and reputation management. Users of the platform should be able to pull raw information and easily produce their own GEO data and insights, then and contribute those back to the same repository for further analysis.
5G Cellular Communications	The promise of 5G networks is already propelling innovators to design new modes of communication. From remote robotic surgery to ultra-responsive autonomous cars, the 5G network leans into a world of higher reliability and lower latency.
Cloud, Fog, Edge Computing computing continuum	Fog computing is a system-level horizontal architecture that distributes resources and services of computing, storage, control and networking anywhere along the continuum from Cloud to Things (OpenFog Consortium).
Blockchain and distributed ledger	Distributed ledger technology based on cryptographic systems that manage, verify and publicly record transaction data; the basis of "cryptocurrencies" such as bitcoin - (World Economic Forum).
Quantum Computing	Quantum computing capabilities are are growing as the number of Qubits in an array grows. Algorithms based on qubits are being defined. As programming languages for Quantum Computing are developed the applications for geospatial applications are anticipated to emerge.

Title	Description
Software development innovations	Software Programming languages and development methods are rapidly changing. New programming languages drive new capabilities for geospatial information. Software development process improvements including collaborative cross-functional teams, adaptive planning, evolutionary development, and continuous integration.
Informational Self Determination and Privacy	The term informational self-determination was first used in the context of a German constitutional ruling relating to personal information collected during the 1983 census. The German Federal Constitutional Court ruled that: “[…] in the context of modern data processing, the protection of the individual against unlimited collection, storage, use and disclosure of his/her personal data is encompassed by the general personal rights of the German constitution. This basic right warrants in this respect the capacity of the individual to determine in principle the disclosure and use of his/her personal data. Limitations to this informational self-determination are allowed only in case of overriding public interest.”

Trends that have graduated or retired

Title	Description
Event-Driven: Pub-Sub	Publish–Subscribe is a messaging pattern where entities can subscribe to a type of message (defined by a criteria) and receive messages that satisfy that criteria from publishers as and when those messages become available (that is, as and when the events that satisfy that criteria occur).

Appendix A: Trends

3D Urban Model Creation

Meta Trend	Spatial and Temporal Models
Title	3D Urban model creation
Description	Accurate 3D (Three Dimensional) model construction has been sought for many years as the key to unlocking many other related applications and scientific endeavors. This trend regards all aspects of 3D model construction from research aspects as well as focus on different types of sensing technologies being pursued. Both external and internal models are the topic of this trend. Methods are needed for rapid 3D model construction of urban areas.
What is new or emerging?	Much work has been done to generate capabilities to reconstruct surfaces that are openly available to Unmanned Aerial Systems (UAS), mobile ground based sensors and space based sensors. The remaining frontier in this realm is the more closed environment of dense urban canyons and the interior structures of manmade and naturally occurring features (e.g. buildings, caves, etc.). To date many different approaches have been proposed to address this desire for accurate 3D reconstruction for inexpensive, potentially wearable, man-portable, sensing devices.
Why might it matter?	Rapid and efficient construction of 3D models will enable multiple applications that will use the models as the base framework for context, analysis and decision making.
Horizon	**Next**: Developments are underway in OGC Innovation and Standards Programs.
Impact	**Sustaining**: The main gains will be about efficiency and quality of the models as many of the applications are known but lacking the needed models.

Gartner Hype Curve phase	
Technology readiness level	TRL-5 in OGC activities.
Discussion Issue	Discussion of Trend on GitHub
References	- Levels of Detail in 3D Building Reconstruction from LiDAR Data - Validation of 3D GIS primitives according to the international standards
Examples	URL to technology implementation examples
Geospatial Tech Category	Databases, Data models, Semantics, Mark-up Languages
OGC Working Groups	- 3D Information Management (3DIM) DWG - CityGML SWG

5G Cellular Communications

Meta Trend	Information Technology
Title	**5G Cellular Communications**
Description	The promise of 5G networks is already propelling innovators to design new modes of communication. From remote robotic surgery to ultra-responsive autonomous cars, the 5G network leans into a world of higher reliability and lower latency.
What is new or emerging?	
Why might it matter?	When the communication latency becomes lower, and the capacity of the communication gets higher with 5G communications, the Internet will be an even more prominent platform to control real and virtual objects in different parts of our lives, such as healthcare, education, manufacturing, smart grids, and many more.
Horizon	**After Next:** There are a number of new technologies likely to be applied - but standards haven't been hammered out yet for all 5G protocols.
Impact	**Disruptive**
Gartner Hype Curve phase	
Technology readiness level	TRL-1 in OGC activities.
Discussion Issue	Discussion of Trend on GitHub
References	
Examples	URL to technology implementation examples
Geospatial Tech Category	
OGC Working Groups	

ADINT: Ad Targeting for Surveillance

Meta Trend	TBA
Title	ADINT: Ad Targeting for Surveillance
Description	Targeted advertising is at the heart of the largest technology companies today, and is becoming increasingly precise. Simultaneously, users generate more and more personal data that is shared with advertisers as more and more of daily life becomes intertwined with networked technology. The online advertising ecosystem is built upon the ability of advertising networks to know properties about users (e.g., their interests or physical locations) and deliver targeted ads based on those properties - (Paul Vines, Franziska Roesner, and Tadayoshi Kohno).
What is new or emerging?	TBA
Why might it matter?	TBA
Gartner Hype Curve	TBA
TRL	
Issue	https://github.com/opengeospatial/OGC-Technology-Trends/issues/68
References	URLs to technology written descriptions
Examples	URL to technology implementation examples
Geospatial Tech Category	TBA
OGC Working Groups	TBA

AI Conversational Platforms

Meta Trend	TBA
Title	AI Conversational Platforms
Description	Platforms that allow users to interact with software through conversation in natural language (or in nearly natural language).
What is new or emerging?	TBA
Why might it matter?	TBA
Gartner Hype Curve	TBA
TRL	
Issue	https://github.com/opengeospatial/OGC-Technology-Trends/issues/77
References	URLs to technology written descriptions
Examples	URL to technology implementation examples
Geospatial Tech Category	TBA
OGC Working Groups	TBA

APIs for the Web

Meta Trend	
Title	APIs for the Web
Description	The explosive growth of public APIs for geospatial applications, and the accompanying variability in API practices across the IT industry, as well as in geospatial APIs specifically, has created new opportunities and challenges in supporting geospatial services. The application of standards in APIs to ensure interoperability is an apparent next step. (API CDS Press Release)
What is new or emerging?	OGC Geospatial APIs White Paper . Netflix has recently has the 5 billion API request (Wikipedia) . Web API ambitious
Why might it matter?	Standardisation of geo processing of geo location query such as OGC Rest research in TestBed.
Gartner Hype Curve	Innovation Trigger
TRL	
Issue	https://github.com/opengeospatial/OGC-Technology-Trends/issues/35
References	URLs to technology written descriptions
Examples	http://docs.opengeospatial.org/wp/16-019r4/16-019r4.html
Geospatial Tech Category	Web Services and APIs
OGC Working Groups	Spatial Data on the Web Working Group

Gartner Hype Curve

Agile Geo Processing Chains

Meta Trend	TBA
Title	Agile Geo Processing Chains
Description	Agile Processing Chains is focusing on Workflow management and linking of geospatial data models - (DSTL).
What is new or emerging?	TBA
Why might it matter?	TBA
Gartner Hype Curve	TBA
TRL	
Issue	https://github.com/opengeospatial/OGC-Technology-Trends/issues/83
References	URLs to technology written descriptions
Examples	URL to technology implementation examples
Geospatial Tech Category	TBA
OGC Working Groups	TBA

Ambient services

Meta Trend	
Title	Ambient services
Description	Ambient intelligence (AmI) refers to electronic environments that are sensitive and responsive to the presence of people. In an ambient intelligence world, devices work in concert to support people in carrying out their everyday life activities, tasks and rituals in an easy, natural way using information and intelligence that is hidden in the network connecting these devices (see Internet of Things). As these devices grow smaller, more connected and more integrated into our environment, the technology disappears into our surroundings until only the user interface remains perceivable by users. (Wikipedia)
What is new or emerging?	Intelligent always on ambient service devices, able to respond with a geospatial query at the ask of a question "[Ambient Service] Will it rain today?"
Why might it matter?	Could possibly be the Gadget of this "holiday season", with Apple HomePod and Microsoft device. Mapbox has demoed integration into Amazon Alexi using Mapbox Travel APIs.
Gartner Hype Curve	Peak of Inflated Expectations
TRL	
Issue	https://github.com/opengeospatial/OGC-Technology-Trends/issues/57
References	URLs to technology written descriptions
Examples	URL to technology implementation examples
Geospatial Tech Category	Sensing, IoT, Sensor Web, Imaging
OGC Working Groups	SensingThing; IoT; Sensor Web;

Gartner Hype Curve

Artificial Intelligence

Meta Trend	TBA
Title	Artificial Intelligence
Description	The central problems (or goals) of AI research include reasoning, knowledge, planning, learning, natural language processing (communication), perception and the ability to move and manipulate objects (Wikipedia).
What is new or emerging?	TBA
Why might it matter?	TBA
Gartner Hype Curve	TBA
TRL	
Issue	https://github.com/opengeospatial/OGC-Technology-Trends/issues/59
References	URLs to technology written descriptions
Examples	URL to technology implementation examples
Geospatial Tech Category	TBA
OGC Working Groups	TBA

Assisted Knowledge Building

Meta Trend	TBA
Title	Assisted Knowledge Building
Description	The use of data mining and other functions provided by intelligent systems to facilitate the creation of knowledge.
What is new or emerging?	TBA
Why might it matter?	TBA
Gartner Hype Curve	TBA
TRL	
Issue	https://github.com/opengeospatial/OGC-Technology-Trends/issues/72
References	URLs to technology written descriptions
Examples	URL to technology implementation examples
Geospatial Tech Category	TBA
OGC Working Groups	TBA

Automotive

Meta Trend	TBA
Title	Automotive
Description	Maps and Apps for Automotive: The battle around connected cars and autonomous driving will continue this year. Both are impossible without geospatial technology. Hyper-precise and up-to-date maps as well as real-time analytics of sensor data are just two examples. We will see a lot of geo-enabled apps that get integrated into the car (GeoAwesomness).
What is new or emerging?	TBA
Why might it matter?	TBA
Gartner Hype Curve	TBA
TRL	
Issue	https://github.com/opengeospatial/OGC-Technology-Trends/issues/56
References	URLs to technology written descriptions
Examples	URL to technology implementation examples
Geospatial Tech Category	TBA
OGC Working Groups	TBA

Autonomous Vehicle HD Maps

Meta Trend	Spatial and Temporal Models
Title	**Autonomous Vehicle HD Maps**
Description	Maps created at centimetre or sub-centimetre precision, typically to support driverless-cars and other autonomous ground vehicles that operate in built-up areas [1] footnote:].
What is new or emerging?	Although mapping organizations are likely to embrace standards to allow them to incorporate data from many sources, a fully open ecosystem seems unlikely. The companies involved will prefer to maintain semi-closed ecosystems [2]
Why might it matter?	To achieve the CAV ambition, geospatial data is key. Not just to the creation of a realistic simulation environment to test in, but also to the eventual deployment of a new infrastructure to enable improved connectivity and mobility.[3]
Horizon	**Next**:
Impact	**Sustaining**:
Gartner Hype Curve phase	
Technology Readiness Level	TRL-4
Discussion Issue	Discussion of Trend on GitHub
References	1. HD Maps: New age maps powering autonomous vehicles 2. Digitizing the world 3. Survey underpins UK driverless car testing 4. https://www.wsj.com/articles/Toyota investing 500 million in Uber in driverless car pact
Examples	URL to technology implementation examples
Geospatial Tech Category	
OGC Working Groups	Coordination with ISO TC 204

BIM and GIS integration

Meta Trend	TBA
Title	BIM and GIS integration
Description	It’s evident that bringing BIM and GIS together will benefit many application domains such as architecture, urban planning, disaster management, infrastructure engineering, facilities management, decision-making, construction, etc. However, there are many challenges in integrating BIM and GIS. M - (Kalantar in GIM International).
What is new or emerging?	TBA
Why might it matter?	TBA
Gartner Hype Curve	TBA
TRL	
Issue	https://github.com/opengeospatial/OGC-Technology-Trends/issues/11
References	URLs to technology written descriptions
Examples	URL to technology implementation examples
Geospatial Tech Category	TBA
OGC Working Groups	TBA

Big Geo Data

Meta Trend	Big Geospatial Data
Title	**Big Geo Data**
Description	Big Data Geo Technologies is building upon Big Data and referring to the use of predictive analytics, user behaviour analytics, or certain other advanced data analytics methods that extract value from data, and seldom to a particular size of data set.
What is new or emerging?	Big Data technologies are transforming how geospatial data is processed. Many of these new technologies were developed outside of geospatial domain enabled by cloud-computing and machine learning.
Why might it matter?	Themes that emerged from the Location Powers: Big Geo Data workshop, September 2016 were: - We live in a download mentality. How do we move to answering questions? Analytics on the fly - Focus shifting from understanding what happened last week to being able to predict what will happen next week - Big data, machine learning, and predictive data analytics have been hailed as the fourth paradigm of science, allowing researchers to extract insights from both scientific instruments and computational simulations - (ACM Comm). - Multiple Applications: Telecommunications, property casualty insurance, financial services, Energy Monitoring and prediction, Population Dynamics, Settlement Mapping - Address Big data in OGC Testbeds

Horizon	**Next**: Multiple CNNs have been applied to remote sensed data with impressive results. Questions remain about provenance and uncertainty. There is a need for trained models. Transferability of trained models and interoperability of CNNs are open questions.
Impact	**Sustaining**:
Gartner Hype Curve phase	
Technology Readiness Level	
Discussion Issue	Discussion of Trend on GitHub
References	- Big Geospatial Data – an OGC White Paper
Examples	URL to technology implementation examples
Geospatial Tech Category	
OGC Working Groups	Big Data DWG

Big data analytics

Meta Trend	TBA
Title	Big data analytics
Description	“Big data,” machine learning, and predictive data analytics have been hailed as the fourth paradigm of science, allowing researchers to extract insights from both scientific instruments and computational simulations - (ACM Comm).
What is new or emerging?	TBA
Why might it matter?	TBA
Gartner Hype Curve	TBA
TRL	
Issue	https://github.com/opengeospatial/OGC-Technology-Trends/issues/24
References	URLs to technology written descriptions
Examples	URL to technology implementation examples
Geospatial Tech Category	TBA
OGC Working Groups	TBA

Blockchain and distributed ledger

Meta Trend	Information Technology
Title	Blockchain and distributed ledger
Description	Distributed ledger technology based on cryptographic systems that manage, verify and publicly record transaction data; the basis of "cryptocurrencies" such as bitcoin - (World Economic Forum).
What is new or emerging?	Over recent years, there has been a steady increase in the level of industry interest in distributed ledgers. Propelled by the apparent success of cryptographic currencies such as Bitcoin.
Why might it matter?	Distributed ledger technologies such as Blockchain are now being explored in application areas such as land registration [1], law enforcement trust models for sharing digital evidence (e.g. collected from body-worn cameras) [2], the next generation of space technologies [3] and several others.
Horizon	**Next**: Developments are underway in OGC Standards Program.
Impact	**Disruptive**: Distributed ledger technologies change the market place and institutional policy regarding trust.
Gartner Hype Curve phase	
Technology Readiness Level	TRL-3 in OGC activities.
Discussion Issue	Discussion of Trend on GitHub
References	- 1. The Land Registry in the blockchain - 2. FOAM–The Consensus Driven Map of the World - 3. Beyond Bitcoin Leveraging the Blockchain for Space 4.0
Examples	URL to technology implementation examples
Geospatial Tech Category	Databases, Data models, Semantics, Mark-up Languages

OGC Working Groups	An OGC Ad-hoc Session was held on Geospatial Standardization for Distributed Ledger Technologies

C2/SCADA for IoT

Meta Trend	Data Science and Decisions
Title	C2/SCADA for IoT
Description	Command and control (C2) a well established ability is the exercise of authority over assigned resources in the accomplishment of a common goal. Supervisory control and data acquisition (SCADA) is a information system architecture for high-level process supervisory management of industrial process plants. Applying C2 and SCADA to IoT environments will reuse existing control system technology in a new communications stack of broader reach.
What is new or emerging?	
Why might it matter?	IoT is becoming pervasive. The ability to command and control IoT devices acoording to supervisory goals will bring new emergent behaviors.
Affect	(Incremental or disruptive)
Gartner Hype Curve	
Technology readiness level	
Issue	(link to GitHub issue for discussion)
References	- How do you Command an Army of Intelligent Things? - The Open Geospatial Consortium and Industrie 4.0
Examples	URL to technology implementation examples
Geospatial Tech Category	IoT, Sensor Webs, Control Systems
OGC Working Groups	

Cloud and HPC

Meta Trend	TBA
Title	Cloud and HPC
Description	Cloud computing is defined by US NIST as five essential characteristics of cloud computing: on-demand self-service, broad network access, resource pooling, rapid elasticity or expansion, and measured service. It also lists three "service models" (software, platform and infrastructure), and four "deployment models" (private, community, public and hybrid) that together categorize ways to deliver cloud services - (NIST).
What is new or emerging?	TBA
Why might it matter?	TBA
Gartner Hype Curve	TBA
TRL	
Issue	https://github.com/opengeospatial/OGC-Technology-Trends/issues/19
References	URLs to technology written descriptions
Examples	URL to technology implementation examples
Geospatial Tech Category	TBA
OGC Working Groups	TBA

Connectivity and Bandwidth

Meta Trend	TBA
Title	Connectivity and Bandwidth
Description	Narrowband is the flow of data over a network where there is a constraint in the network bandwidth. Interested in raster, vector and compression of geo data over network bandwidth. As well as smart use of networks.
What is new or emerging?	TBA
Why might it matter?	TBA
Gartner Hype Curve	TBA
TRL	
Issue	https://github.com/opengeospatial/OGC-Technology-Trends/issues/55
References	URLs to technology written descriptions
Examples	URL to technology implementation examples
Geospatial Tech Category	TBA
OGC Working Groups	TBA

Coverages on the Web

Meta Trend	Spatial Data on the Web
Title	Coverages on the Web
Description	Coverages are geospatial datasets as matrices or tensors that map a spatial-temporal coordinates to a corresponding set of data values, e.g., geophysical parameters. The Web is fundamentally organized as a graph structure with node addresses and relation links. Spatial Data on Web Best Practices are needed to that define Web-native access to Geospatial Coverages.
What is new or emerging?	
Why might it matter?	Increasing data, more important to be searched.
Affect	(Incremental or disruptive)
Gartner Hype Curve	
Technology readiness level	
Issue	(link to GitHub issue for discussion)
References	Spatial Data on the Web Best Practices, 2017 See BPs #TBD.
Examples	URL to technology implementation examples
Geospatial Tech Category	Databases, Data models, Semantics, Mark-up Languages
OGC Working Groups	Spatial Data on the Web

Crowdsourcing and VGI

Meta Trend	New Geo Data Sources
Title	**Crowdsourcing and VGI**
Description	Geo Crowdsourcing includes Social Media and Voluntary Geographic Information (VGI). Crowdsourcing refers to the process of obtaining geo inspired services, ideas, or content by soliciting contributions from a large group of people, especially an online community, rather than from employees or suppliers (DSTL). VGI) is the harnessing of tools to create, assemble, and disseminate geographic data provided voluntarily by individuals (Goodchild, 2007). VGI is a special case of crowdsourcing.
What is new or emerging?	
Why might it matter?	
Horizon	**Next**
Impact	**Sustaining**
Gartner Hype Curve phase	
Technology Readiness Level	
Discussion Issue	Discussion of Trend on GitHub
References	1. Crowdsourcing, Citizen Science or Volunteered Geographic Information? The Current State of Crowdsourced Geographic Information. 2. Volunteered geographic information (VGI) and Crowdsourcing
Examples	URL to technology implementation examples
Geospatial Tech Category	
OGC Working Groups	

Data Science Analytics

Meta Trend	Data Science and Decisions
Title	**Data Science Analytics**
Description	Data Science Analytics refers to a number of data science advances including Machine Learning (gives computers the ability to learn without being explicitly programmed), Anomaly detection (he identification of items, events or observations which do not conform to an expected pattern or other items in a dataset.) (DSTL).
What is new or emerging?	
Why might it matter?	
Horizon	**Next**
Impact	**Disruptive**
Gartner Hype Curve phase	
Technology readiness level	TRL-5 in OGC activities.
Discussion Issue	Discussion of Trend on GitHub
References	
Examples	
Geospatial Tech Category	
OGC Working Groups	

Digital Twins

Meta Trend	TBA
Title	Digital Twins
Description	A digital twin is a virtual representation of a physical object, which can be used to simulate how the physical object might behave in the physical world under different situations [1: https://www.ice.org.uk/knowledge-and-resources/information-sheet/what-is-a-digital-twin].
What is new or emerging?	TBA
Why might it matter?	TBA
Gartner Hype Curve	TBA
TRL	
Issue	https://github.com/opengeospatial/OGC-Technology-Trends/issues/71
References	URLs to technology written descriptions
Examples	URL to technology implementation examples
Geospatial Tech Category	TBA
OGC Working Groups	TBA

Dynamic datums

Meta Trend	Spatial and Temporal Models
Title	Dynamic datums
Description	This is now starting to be referred to as an “Earth-fixed” datum but previously was often referred to as a “dynamic datum”. Conceptually, the term “dynamic datum” confuses many people, who assume it to mean that the datum itself is constantly changing. This is obviously not the case – the datum is uniquely defined and fixed in orientation and location. Rather, an “Earth-fixed” datum allows the changes in coordinates of points on the Earth’s “dynamic” surface to be referenced and represented. (ANZLIC). The revision of ISO 19111 anticipates the need for Dynamic Datums.
What is new or emerging?	
Why might it matter?	
Horizon	**After Next**: Standards have been developed (ISO 19111) but the need and the implementations are not yet available.
Impact	**Sustaining**: Dynamic datums are a technical challenge that can be addressed without disruption of markets.
Gartner Hype Curve phase	
Technology Readiness Level	TRL-3 in OGC activities.
Discussion Issue	Discussion of Trend on GitHub
References	- Implications of a Dynamic Datum on the Cadastre - ITRF2014: A new release of the International Terrestrial Reference Frame modeling nonlinear station motions
Examples	URL to technology implementation examples
Geospatial Tech Category	Databases, Data models, Semantics, Mark-up Languages
OGC Working Groups	OGC CRS DWG

Dynamic features: 4D models and positioning

Meta Trend	TBA
Title	Dynamic features: 4D models and positioning
Description	The advance of mobile computing and internet-connected sensors (including sensors and GPS transponders in cell phones and notebook computers) brings with it a rapid rise in applications for moving feature data, typically representing vehicles or pedestrians. Many innovative moving feature applications will require the overlay and integration of moving feature data from different sources. Examples can easily be imagined for disaster risk management, traffic information services, security services, navigation for robots, aviation or maritime traffic monitoring, and wildlife tracking and conservation. (Moving Features press release).
What is new or emerging?	TBA
Why might it matter?	TBA
Gartner Hype Curve	TBA
TRL	
Issue	https://github.com/opengeospatial/OGC-Technology-Trends/issues/16
References	URLs to technology written descriptions
Examples	URL to technology implementation examples
Geospatial Tech Category	TBA
OGC Working Groups	TBA

Cloud, Fog, Edge Computing Continuum

Meta Trend	Information Technology
Title	**Cloud, Fog, Edge Computing Continuum**
Description	Cloud computing is defined by US NIST as five essential characteristics of cloud computing: on-demand self-service, broad network access, resource pooling, rapid elasticity or expansion, and measured service. It also lists three "service models" (software, platform and infrastructure), and four "deployment models" (private, community, public and hybrid) that together categorize ways to deliver cloud services - (NIST). Fog computing is a system-level horizontal architecture that distributes resources and services of computing, storage, control and networking anywhere along the continuum from Cloud to Things (OpenFog Consortium).
What is new or emerging?	IEC White paper on Edge Intelligence[1]: “Driven by the internet of things (IoT), a new computing model – edge-cloud computing – is currently evolving, which involves extending data processing to the edge of a network in addition to computing in a cloud or a central data centre.
Why might it matter?	Cloud players continue to set record revenues and profits while the telcos grapple with stalled revenues. The telcos have lost the ‘Cloud 1.0’ battle to the OTTs. But, is there a way for the telcos to be more competitive? More specifically: can edge computing provide the telcos a competitive advantage over the cloud players? - Frank Rayal, Xona Partners
Horizon	**After Next**: Proprietary offerings are available. Conceptual architectures are being developed [2], but have not advanced to interoperability based on open standards.

Impact	**Disruptive**: Similar to the emergence of cloud computing, edge and fog computing will shift the economics of the "computing on demand" marketplace.
Gartner Hype Curve phase	
Technology Readiness Level	Currently no OGC implementation activities.
Discussion Issue	Discussion of Trend on GitHub
References	1. Edge intelligence - An IEC White Paper 2. OpenFog Reference Architecture for Fog Computing, OpenFog Consortium 3. The Role of Geospatial in Edge-Fog-Cloud Computing - An OGC White Paper 4. AWS Deep Lens brings machine learning to edge computing
Examples	URL to technology implementation examples
Geospatial Tech Category	
OGC Working Groups	no specific WG in OGC

Cloud and HPC merged into this Trend: Cloud computing is defined by US NIST as five essential characteristics of cloud computing: on-demand self-service, broad network access, resource pooling, rapid elasticity or expansion, and measured service. It also lists three "service models" (software, platform and infrastructure), and four "deployment models" (private, community, public and hybrid) that together categorize ways to deliver cloud services - (NIST).

Event-Driven: Pub-Sub

Meta Trend	TBA
Title	Event-Driven: Pub-Sub
Description	Publish–Subscribe is a messaging pattern where entities can subscribe to a type of message (defined by a criteria) and receive messages that satisfy that criteria from publishers as and when those messages become available (that is, as and when the events that satisfy that criteria occur).
What is new or emerging?	TBA
Why might it matter?	TBA
Gartner Hype Curve	TBA
TRL	
Issue	https://github.com/opengeospatial/OGC-Technology-Trends/issues/79
References	URLs to technology written descriptions
Examples	URL to technology implementation examples
Geospatial Tech Category	TBA
OGC Working Groups	TBA

Extremely Large Geo Databases

Meta Trend	Big Data
Title	Extremely Large Geo Databases
Description	An extremely large database (XLDB) is a database that stores and processes enormous amounts of data and associated records and entries. As the largest database form factor, XLDB is created and managed by very few organizations around the world, typically scientific research institutes that have massive data sets at their disposal.
What is new or emerging?	
Why might it matter?	
Horizon	**Next**
Impact	**Disruptive**
Gartner Hype Curve phase	
Technology readiness level	TRL-5 in OGC activities.
Discussion Issue	Discussion of Trend on GitHub
References	WCS
Examples	Geospatial Data Cubes
Geospatial Tech Category	
OGC Working Groups	

Fusion, Conflation analytics: Scalable Analysis Portals

Meta Trend	TBA
Title	Fusion, Conflation analytics: Scalable Analysis Portals
Description	Conflation refers to the act of combining two distinct maps into one new map. It is similar to the practice of image mosaicking. It is usually carried out by registration of an overlapping area. Conflation for digital maps refers to the process of associating real world coordinates to digital ones and it is named Map Matching - (DSTL).
What is new or emerging?	TBA
Why might it matter?	TBA
Gartner Hype Curve	TBA
TRL	
Issue	https://github.com/opengeospatial/OGC-Technology-Trends/issues/30
References	URLs to technology written descriptions
Examples	URL to technology implementation examples
Geospatial Tech Category	TBA
OGC Working Groups	TBA

Geo at Platform Scale

Meta Trend	Information Technology
Title	Geo at Platform Scale
Description	Today's networked platforms are able to achieve massive success by simply connecting producers and consumers. A platform allows for alignment of incentives of producers and consumers, vastly increasing the products created and then allowing quality control through curation and reputation management. Users of the platform should be able to pull raw information and easily produce their own GEO data and insights, then and contribute those back to the same repository for further analysis. (Chris Holmes, Christopher Tucker, Ben Tuttle). [1]
What is new or emerging?	Cloud computing, containers and other big data technologies are now widespread and standardized commodities. Big Data analytics on these computing technologies are have made disruptive leaps, e.g., Macine Learning
Why might it matter?	Cloud analytics provided by platform scale enable application of geospatial data, in particular Earth Observation data, on a scale with unseen before efficiency.
Horizon	**Next**: Geo Platforms have been built and are operational with a variety of functions, components and interfaces. Standardization activities are underway that will enable reuse of valuable platform patterns and interoperabilty between platforms [3].
Impact	**Disruptive**: The combination of cloud computing, platform scale and machine learning provides data products that will establish new data markets. This is a long anticipated leap in remote sensing from providing images/pixels to providing information.
Gartner Hype Curve phase	

Technology Readiness Level	Currently no OGC implementation activities.
Discussion Issue	Discussion of Trend on GitHub
References	1. GEOINT at Platform Scale 2. Generalizing a Data Analysis Pipeline in the Cloud to Handle Diverse Use Cases in NASA's EOSDIS 3. OGC seeks public comment on new Earth Observation Exploitation Platform Domain Working Group 4. Big Geospatial Data – an OGC White Paper
Examples	URL to technology implementation examples
Geospatial Tech Category	
OGC Working Groups	OGC Big Data DWG. OGC EO Exploitation DWG - being formed [3].

High-altitude platforms

Meta Trend	TBA
Title	High-altitude platforms
Description	High-Altitude Platforms (HAPs) are aircraft or airships that operate in the stratosphere at altitudes of up to 22 km, typically to provide communication facilities that can exploit both terrestrial and satellite schemes (IEEE)
	What is new or emerging?
TBA	Why might it matter?
TBA	Gartner Hype Curve
TBA	TRL
	Issue
https://github.com/opengeospatial/OGC-Technology-Trends/issues/75	References
1. IEEE - High-altitude platforms for wireless communications	Examples
URL to technology implementation examples	Geospatial Tech Category
TBA	OGC Working Groups

Human and Place

Meta Trend	TBA
Title	Human and Place
Description	Topic is focused on Human and Place (Geography). This refers to the use of place, and how vernacular geography is used to describe it. One must avoid the temptation to think of place only as a location. (DSTL) A place is distinguished by its people, markets, governments, and institutions, as much as it is by its physical landscape and natural resources, transportation systems (including streets and roads), buildings, and boundaries- (US National Academies).
What is new or emerging?	TBA
Why might it matter?	TBA
Gartner Hype Curve	TBA
TRL	
Issue	https://github.com/opengeospatial/OGC-Technology-Trends/issues/86
References	URLs to technology written descriptions
Examples	URL to technology implementation examples
Geospatial Tech Category	TBA
OGC Working Groups	TBA

Also consider: Spatial thinking is a collection of cognitive skills. The skills consist of declarative and perceptual forms of knowledge and some cognitive operations that can be used to transform, combine, or otherwise operate on this knowledge. The key to spatial thinking is a constructive amalgam of three elements: concepts of space, tools of representation, and processes of reasoning. (US National Academies) OGC should consider how the innovation it promotes can extend this "learning spatial" to "doing spatial".

Human Computer Interaction (HCI)

Meta Trend	TBA
Title	Human Computer Interaction (HCI)
Description	Human Computer Interaction refers to the interfaces between people (users) and computers and how does human behavior affect this interaction. This includes Voice interaction, such as Amazon's Echo; Google Home/(Google Now); Apple Siri; Microsoft Cortana.
What is new or emerging?	TBA
Why might it matter?	TBA
Gartner Hype Curve	TBA
TRL	
Issue	https://github.com/opengeospatial/OGC-Technology-Trends/issues/82
References	URLs to technology written descriptions
Examples	URL to technology implementation examples
Geospatial Tech Category	TBA
OGC Working Groups	TBA

Human Geography

Meta Trend	TBA
Title	Human Geography
Description	Well-organized and comprehensive human geography data can be applied to analysis that allows us to better anticipate the behavior of people over space and time and to inform decision-making that supports human security, including crisis mitigation and humanitarian response - (WWHGD_WG).
What is new or emerging?	TBA
Why might it matter?	TBA
Gartner Hype Curve	TBA
TRL	
Issue	https://github.com/opengeospatial/OGC-Technology-Trends/issues/6
References	URLs to technology written descriptions
Examples	URL to technology implementation examples
Geospatial Tech Category	TBA
OGC Working Groups	TBA

Image Processing and Machine Learning

Meta Trend	TBA
Title	Image Processing and Machine Learning
Description	Digital image processing refers to the use of computer algorithms to perform image processing on digital images. Advances in machine learning, such as Deep Learning, are changing the way digital image processing is occurring [2: https://www.gislounge.com/transforming-satellite-imagery-classification-deep-learning/].
What is new or emerging?	TBA
Why might it matter?	TBA
Gartner Hype Curve	TBA
TRL	
Issue	https://github.com/opengeospatial/OGC-Technology-Trends/issues/28
References	URLs to technology written descriptions
Examples	URL to technology implementation examples
Geospatial Tech Category	TBA
OGC Working Groups	TBA

Immersive Geo: AR, VR, Mixed Reality

Meta Trend	Human Computer Interaction
Title	Immersive Geo: AR, VR, Mixed Reality
Description	Virtual reality (VR) refers to computer technologies that use software to generate realistic images, sounds and other sensations that replicate a real environment. Augmented reality (AR) is a live direct or indirect view of a physical, real-world environment whose elements are augmented by computer-generated sensory input such as sound, video, graphics or GPS data.
What is new or emerging?	After an initial flourish of AR Applications by Layar, Metaio and Wikitude - including interoperability based on open standards [1, 2] - the AR market cooled until recent product announcements by large vendors: Pokemon Go in Summer 2016; Apple demoed new take on AR at WWDC 2017; Microsoft Hololens.
Why might it matter?	Increased understanding of the world around us, such as accurate location of utilities networks.
Horizon	**AfterNext**: Eyewear that is acceptable to mass market remains elusive. Commercial applications, e.g., construction and maintenance industries, may lead deployments.
Impact	**Disruptive**: Predictions have been made that AR/VR will be as disruptive as cellular feature phones and that AR will be the 8th Mass Media
Gartner Hype Curve phase	Peak of Inflated Expectations
Technology Readiness Level	Previous Augmented Reality standards and operational products (TRL9) need to be re-hosted and extended in new device web technologies. TRL3
Discussion Issue	Discussion of Trend on GitHub

References	1. OGC Augmented Reality Markup Language 2.0 (ARML 2.0) 2. Interoperable Mass Market AR first demonstrated 3. Keynote at AWE 2013: Augmented Reality is the 8th Mass Medium by Tomi Ahonen
Examples	URL to technology implementation examples
Geospatial Tech Category	
OGC Working Groups	Augmented Reality (AR) Pilot under development

Increasing mobile device capabilities

Meta Trend	TBA
Title	Increasing mobile device capabilities
Description	With the coming of driverless cars; drones; wearables and implantables; and an ecology of embedded devices and services in the everyday environment, there has never been a more exciting and pressing time to debate and explore what digital mobility means. MobileHCI brings together people from diverse areas which provides a multidisciplinary forum for academics, hardware and software developers, designers and practitioners to discuss the challenges and potential solutions for effective interaction with and through mobile devices, applications, and services (MobileHCI).
What is new or emerging?	TBA
Why might it matter?	TBA
Gartner Hype Curve	TBA
TRL	
Issue	https://github.com/opengeospatial/OGC-Technology-Trends/issues/50
References	URLs to technology written descriptions
Examples	URL to technology implementation examples
Geospatial Tech Category	TBA
OGC Working Groups	TBA

Indoor: Position, Models and Navigation

Meta Trend	Spatial and Temporal Models
Title	**Indoor: Position, Models and Navigation**
Description	Accurate indoor positioning and models unlock a new set of possibilities for mobile services. Consumers will benefit from personalized, contextual information and offers, as well as new services such as indoor navigation. Venue owners will benefit from increased customer satisfaction and enhanced information on customer behaviour [1].
What is new or emerging?	Location Based Service, Indoor Vendors Marketing. Google's Visual Positioning System (VPS) as mentioned at Google I/O in May 2017. Need for indoor venue maps consistently developed in large scale and Indoor positioning methods that are common and pervasive in mobile devices.
Why might it matter?	Indoor navigation for disabilities, increasingly technology can empower navigation. Indoor is the next horizon in Mod/Sim.
Horizon	**Next**:
Impact	**Sustaining**:
Gartner Hype Curve phase	Trough of Disillusionment
Technology Readiness Level	
Discussion Issue	Discussion of Trend on GitHub
References	1. OGC Benefits of Indoor Location - Use Case Survey of Lessons Learned and Expectations 2. FCC Defining Dispatchable Location to implement Ray Baum's Act 3. InLocation Alliance
Examples	URL to technology implementation examples
Geospatial Tech Category	Positioning, Navigation and Timing; CRS; Geodesy, Data Models

OGC Working Groups	IndoorGML SWG; Mobile Location Services DWG; NIST/OGC Indoor Mapping and Navigation Pilot

Indoor Venue Maps

Title	**Indoor Venue maps**
Description	Indoor location technologies are enjoying an increasing market success. Technologies in the market have achieved maturity and have become a key driver for innovation and business activities in several value-added scenarios, e.g. e-government services, eHealth, personal mobility, logistics, mobility, facility management, retail, to name but a few. (OGC 16-084) The widespread adoption of smartphones by consumers worldwide has not only led to the advent of new indoor location technologies but also the increasing popularity and use of indoor venue maps. In the last several years, leading mapping technology companies have been competing to bring tens of thousands of high-quality indoor venue maps to smartphone users. There are indoor venue maps for thousands of museums, airports, shopping malls, restaurants and other venues - (Programmable Web).
What is new or emerging?	
Why might it matter?	
Horizon	**Next**
Impact	**Disruptive**
Gartner Hype Curve phase	
Technology readiness level	New standards development in OGC are at TRL-6
Discussion Issue	Discussion of Trend on GitHub
References	* OGC Benefits of Indoor Location - Use Case Survey of Lessons Learned and Expectations, OGC 16-084 * Apple's Indoor Mapping Data Format
Examples	
Geospatial Tech Category	
OGC Working Groups	Mobile Location Services DWG

Internet of Things (and sensor webs)

Meta Trend	
Title	Internet of Things (and sensor webs)
Description	The internet of things (IoT) is the inter-networking of physical devices, vehicles (also referred to as "connected devices" and "smart devices"), buildings and other items—embedded with electronics, software, sensors, actuators, and network connectivity that enable these objects to collect and exchange data (DSTL)
What is new or emerging?	Increasing number of devices, new technological security on IoT. Recent hacks/attacks around the world.
Why might it matter?	Precise geographic location, location of things, also precise geographic dimensions will be integral (Wikipedia)
Gartner Hype Curve	Peak of Inflated Expectations
TRL	
Issue	https://github.com/opengeospatial/OGC-Technology-Trends/issues/41
References	URLs to technology written descriptions
Examples	URL to technology implementation examples
Geospatial Tech Category	Sensing, IoT, Sensor Web, Imaging
OGC Working Groups	SensorThings SWG

Gartner Hype Curve

Learn To Think Spatially

Meta Trend	TBA
Title	Learn To Think Spatially
Description	Spatial thinking is a collection of cognitive skills. The skills consist of declarative and perceptual forms of knowledge and some cognitive operations that can be used to transform, combine, or otherwise operate on this knowledge. The key to spatial thinking is a constructive amalgam of three elements: concepts of space, tools of representation, and processes of reasoning. (US National Academies) OGC should consider how the innovation it promotes can extend this "learning spatial" to "doing spatial".
What is new or emerging?	TBA
Why might it matter?	TBA
Gartner Hype Curve	TBA
TRL	
Issue	https://github.com/opengeospatial/OGC-Technology-Trends/issues/67
References	URLs to technology written descriptions
Examples	URL to technology implementation examples
Geospatial Tech Category	TBA
OGC Working Groups	TBA

Linked Data

Meta Trend	
Title	Linked Data
Description	" Linked Data is a method of publishing structured data so that it can be interlinked and become more useful through semantic queries. It builds upon standard Web technologies such as HTTP, RDF and URIs, but rather than using them to serve web pages for human readers, it extends them to share information in a way that can be read automatically by computers." (Wikipedia)
What is new or emerging?	
Why might it matter?	• Increasing data • more important for it to be related • more important for computers to understand the relationships.
Gartner Hype Curve	Peak of Inflated Expectations
TRL	
Issue	https://github.com/opengeospatial/OGC-Technology-Trends/issues/36
References	Documents Videos • What is Linked Data? video - Manu Sporny
Examples	URL to technology implementation examples
Geospatial Tech Category	Databases, Data models, Semantics, Mark-up Languages
OGC Working Groups	Big Data DWG, Geosemantics DWG

Gartner Hype Curve

Location as indicator of intent

Meta Trend	TBA
Title	Location as indicator of intent
Description	“Location targeting is holy grail for marketers”- Sir Martin Sorrell, WPP CEO, MWC 2011 By measuring the entropy of each individual’s trajectory, we find a 93% potential predictability in user mobility - Limits of Predictability in Human Mobility, Science 2010 1st law of geography: "Everything is related to everything else, but near things are more related than distant things.” - Waldo Tobler.
What is new or emerging?	TBA
Why might it matter?	TBA
Gartner Hype Curve	TBA
TRL	
Issue	https://github.com/opengeospatial/OGC-Technology-Trends/issues/4
References	URLs to technology written descriptions
Examples	URL to technology implementation examples
Geospatial Tech Category	TBA
OGC Working Groups	TBA

Machine Learning and CNNs on Imagery

Meta Trend	Big Data
Title	**Machine Learning and CNNs on Imagery**
Description	Machine learning is the subfield of computer science that gives computers the ability to learn without being explicitly programmed. Deep learning and Convolutional Neural Networks (CNNs) - a sub type of machine learning - consists of multiple hidden layers in an artificial neural network - (Wikipedia).
What is new or emerging?	Deep Learning is advancing rapidly based on increasing computing capabilities, image databases and trained CNNs.
Why might it matter?	The ability to detect features using CNNs
Horizon	**Next**: Multiple CNNs have been applied to remote sensed data with impressive results. Questions remain about provenance and uncertainty. There is a need for trained models. Transferability of trained models and interoperability of CNNs are open questions.
Impact	**Disruptive**:
Gartner Hype Curve phase	
Technology Readiness Level	
Discussion Issue	Discussion of Trend on GitHub
References	1. ImageNet Classification with Deep Convolutional Neural Networks 2. Big Geospatial Data – an OGC White Paper 3. NYC task force on automated decision systems used by agencies 4. Team Breaks Exaop Barrier With Deep Learning Application
Examples	URL to technology implementation examples
Geospatial Tech Category	

OGC Working Groups	Big Data DWG, OGC Testbed 14 includes work on Machine learning.

Merged previous separate trend: Image Processing and Machine Learning

Map projections - fit for purpose

Meta Trend	TBA
Title	Map projections - fit for purpose
Description	Best Practice 17: State how coordinate values are encoded. Provide enough information for users to determine how coordinate values are encoded - (SDWWG Best Practice).
What is new or emerging?	TBA
Why might it matter?	TBA
Gartner Hype Curve	TBA
TRL	
Issue	https://github.com/opengeospatial/OGC-Technology-Trends/issues/34
References	URLs to technology written descriptions
Examples	URL to technology implementation examples
Geospatial Tech Category	TBA
OGC Working Groups	TBA

MicroGeography

Meta Trend	The Power of Location (LOC)
Title	**MicroGeography**
Description	Personal electronic devices now measure much of our activity and context. New methods to capture, quantify and communicate individual human activity at a micro level are now available, e.g., OASIS's Classification of Everyday Living (COEL). Rating services for individual behaviors, e.g., risk rating, will develop similar to credit risk rating services.
What is new or emerging?	Standards for MicroGeography. Rating services based on MicroGeography
Why might it matter?	Increased understanding of human behavior at a individual human scale. Unclear affect of rating services on individual and collective behavior.
Horizon	**AfterNext**: Standards are nearing final (COEL) while the industry behind using the data are nacent with policy and privacy (or information self-determination) policies and laws needed to be clarified.
Impact	**Sustaining**:
Gartner Hype Curve phase	
Technology Readiness Level	Previous Augmented Reality standards and operational products (TRL9) need to be re-hosted and extended in new device web technologies. TRL3
Discussion Issue	Discussion of Trend on GitHub
References	OASIS Classification of Everyday Living (COEL)
Examples	Members of Coelition use the COEL standard to create "new opportunities in data-based services that are fast to implement, with less risk and at lower cost."
Geospatial Tech Category	
OGC Working Groups	

Location Based Services

Meta Trend	TBA
Title	**Location Based Services**
Description	Location-based services (LBS) are computer applications (specifically, mobile computing applications) that provide information depending on the location of the device and the user, mostly through mobile portable devices (e.g., smartphones) and mobile networks
What is new or emerging?	Recent years witnessed rapid advances in LBS with the continuous evolution of mobile devices and telecommunication technologies. Emerging topics include outdoor and indoor positioning, context modeling, user interfaces and interaction, innovative LBS applications, social aspects of LBS, and analysis of LBS data.
Why might it matter?	LBS has become more and more popular not only in citywide outdoor environments, but also in shopping malls, museums, airports, big transport hubs, and many other indoor environments. They were applied in emergency services, tourism services, navigation guidance, intelligent transport services, entertainment (gaming), assistive services, healthcare/fitness, social networking, etc. Additional trends in this area will have impact across these many markets.
Horizon	**Next**
Impact	**Disruptive**
Gartner Hype Curve phase	
Technology readiness level	New standards development in OGC are at TRL-4. (Previously developed OpenLS standards are at TRL-9)
Discussion Issue	Discussion of Trend on GitHub
References	- Current Trends and Challenges in Location-Based Services
Examples	

Geospatial Tech Category	
OGC Working Groups	Mobile Location Services DWG

Location and Mobile communications

Meta Trend	
Title	Location and Mobile communications
Description	People who communicate digitally also tend to meet in person. 90% of users who have called each other have also shared the same space (cell tower), even if they live far apart.
What is new or emerging?	Research as shown co location appears highly indicative of coordination call occurring just before face to face meetings.
Why might it matter?	Face to Face contact important, important quality time.
Gartner Hype Curve	Innovation Trigger
TRL	
Issue	https://github.com/opengeospatial/OGC-Technology-Trends/issues/66
References	URLs to technology written descriptions
Examples	URL to technology implementation examples
Geospatial Tech Category	
OGC Working Groups	Mobile Location Services DWG

Gartner Hype Curve

Modeling, Simulation and Prediction

Meta Trend	Big Data
Title	**Modeling, Simulation and Prediction**
Description	Simulation modelling is the process of creating and analyzing a digital prototype of a physical model to predict its performance in the real world. Models and simulation can be used for analysis and for training.
What is new or emerging?	Increases in development of Graphical Processing Units (GPU)s on computers and mobile devices is enabling, more on the fly modelling, simulation and prediction. Federation of Models: Integrated Environmental Modeling and JLVC - Joint Live Virtual and Constructive. Increased fidelity of predictive environmental models will provide increasingly realistic information for simulated situations.
Why might it matter?	Improved ability of M&S products and services to be better used by the community, and to further advance the vision of a common, comprehensive model of Earth. In scenarios such as Humanitarian disaster response, being able to process on the fly models, simulations, ensures more timely responses. Mod/Cim helps with dealing with the transition from data scarcity to data overabundance. Coordination of predictive model outputs and machine learning. Mod/SIM can used to support training of predictions/analysis.
Horizon	**Next**:
Impact	**Sustaining**:
Gartner Hype Curve phase	
Technology Readiness Level	
Discussion Issue	Discussion of Trend on GitHub

References	1. OGC CDB Standard 2. OGC Open Modelling Interface (OpenMI) Interface Standard 3. Exploration of Next Generation Technology Applications to Modeling and Simulation (ENGTAM) Standing Study Group (SSG) 4. From Maps to Models. National Academies report
Examples	URL to technology implementation examples
Geospatial Tech Category	
OGC Working Groups	

Multiscale

Meta Trend	TBA
Title	Multiscale
Description	features that are represented at multiple scales, automatically (OAB).
What is new or emerging?	TBA
Why might it matter?	TBA
Gartner Hype Curve	TBA
TRL	
Issue	https://github.com/opengeospatial/OGC-Technology-Trends/issues/17
References	URLs to technology written descriptions
Examples	URL to technology implementation examples
Geospatial Tech Category	TBA
OGC Working Groups	TBA

On-The-Fly Programming

Meta Trend	TBA
Title	On-The-Fly Programming
Description	On The Fly is a phase and used to describe code that is being changed while the process that the change affects is ongoing. This is aimed a generating products on the fly - (DSTL). Software interaction patterns Geospatial Architecture Federation refers to approaches in federation (information technology) including information and geospatial data flows across networks. Also includes incorporating event based architectures and messaging - (DSTL).
What is new or emerging?	TBA
Why might it matter?	TBA
Gartner Hype Curve	TBA
TRL	
Issue	https://github.com/opengeospatial/OGC-Technology-Trends/issues/84
References	URLs to technology written descriptions
Examples	URL to technology implementation examples
Geospatial Tech Category	TBA
OGC Working Groups	TBA

Ontologies and Semantics

Meta Trend	TBA
Title	Ontologies and Semantics
Description	Ontology is a formal naming and definition of the types, properties, and interrelationships of the entities. Semantics is primarily the linguistic, and also philosophical study of meaning—in language, programming languages, formal logics, and semiotics - (DSTL).
What is new or emerging?	TBA
Why might it matter?	TBA
Gartner Hype Curve	TBA
TRL	
Issue	https://github.com/opengeospatial/OGC-Technology-Trends/issues/38
References	URLs to technology written descriptions
Examples	URL to technology implementation examples
Geospatial Tech Category	TBA
OGC Working Groups	TBA

Open Data

Meta Trend	New Geo Data Sources
Title	**Open Data**
Description	“Open data and content can be freely used, modified, and shared by anyone for any purpose” http://opendefinition.org/.
What is new or emerging?	
Why might it matter?	
Horizon	**Next**
Impact	**Sustaining**
Gartner Hype Curve phase	
Technology Readiness Level	
Discussion Issue	Discussion of Trend on GitHub
References	1. The State of Open Data Report 2018 2. Enabling FAIR Data Across the Earth and Space Sciences
Examples	URL to technology implementation examples
Geospatial Tech Category	
OGC Working Groups	

Opportunistic Sensing

Meta Trend	TBA
Title	Opportunistic Sensing
Description	An opportunistic sensing approach is proposed, where noise-level data is collected without informing smartphone users.
What is new or emerging?	TBA
Why might it matter?	TBA
Gartner Hype Curve	TBA
TRL	
Issue	https://github.com/opengeospatial/OGC-Technology-Trends/issues/43
References	URLs to technology written descriptions
Examples	URL to technology implementation examples
Geospatial Tech Category	TBA
OGC Working Groups	TBA

Privacy and Informational self-determination

Meta Trend	Information Technology
Title	Privacy and Informational self-determination
Description	The term informational self-determination was first used in the context of a German constitutional ruling relating to personal information collected during the 1983 census. The German Federal Constitutional Court ruled that: “[…] in the context of modern data processing, the protection of the individual against unlimited collection, storage, use and disclosure of his/her personal data is encompassed by the general personal rights of the German constitution. This basic right warrants in this respect the capacity of the individual to determine in principle the disclosure and use of his/her personal data. Limitations to this informational self-determination are allowed only in case of overriding public interest.”
What is new or emerging?	
Why might it matter?	
Affect	(Incremental or disruptive)
Gartner Hype Curve	
Technology readiness level	
Issue	Discussion of Trend on GitHub
References	Spatial Data on the Web Best Practices, 2017 See BPs #TBD.
Examples	URL to technology implementation examples
Geospatial Tech Category	Databases, Data models, Semantics, Mark-up Languages
OGC Working Groups	

Quantum Computing

Meta Trend	Information Technology
Title	**Quantum Computing**
Description	Quantum computing capabilities are are growing as the number of quantum bits (“qubits”) in an array grows. Algorithms based on qubits are being defined. As programming languages for quantum computing are developed the applications for geospatial applications are anticipated to emerge.
What is new or emerging?	With initial research steps in the 1980s, recent improvements in device performance and qubit approaches show the possibility of moderate-scale quantum computers in the near future.[1] Multiple approaches are under development for implementing qubits. Combining qubits into a computer is a current challenge - keep track of the latest on the Qubit Conuter. Algorithms and programming languages will be needed - Simulators are available: IBM Quantum Experience, Google Cirq and Quantum Benchmark. A example from D-Wave uses the Map Coloring Problem to describe quantum programming.
Why might it matter?	Hard to imagine all of the possibilities, but several traditional geospatial problems are the focus, such as quantum algorithms that solve pattern recognition tasks in machine learning [2].
Horizon	**After Next**:
Impact	**Disruptive**:
Gartner Hype Curve phase	
Technology Readiness Level	TRL1
Discussion Issue	Discussion of Trend on GitHub
References	1. A Quantum Future Awaits 2. Implementing a distance-based classifier with a quantum interference circuit

Examples	URL to technology implementation examples
Geospatial Tech Category	
OGC Working Groups	

Simultaneous Localization and Mapping (SLAM)

Meta Trend	Spatial and Temporal Models
Title	**Simultaneous Localization and Mapping (SLAM)**
Description	SLAM is a computational problem of constructing or updating a map of an unknown environment while simultaneously keeping track of progress within this unknown environment. Examples of approaches are self-driving cars, unmanned aerial vehicles, autonomous underwater vehicles, planetary rovers, newly emerging domestic robots and even inside the human body - (DSTL).
What is new or emerging?	
Why might it matter?	
Horizon	**Next**:
Impact	**Disruptive**:
Gartner Hype Curve phase	
Technology Readiness Level	TRL3
Discussion Issue	Discussion of Trend on GitHub
References	
Examples	URL to technology implementation examples
Geospatial Tech Category	
OGC Working Groups	

Smallsats

Meta Trend	
Title	Smallsats
Description	MicroSatellite is referring to small and compact satellites. They are often the size of two shoe boxes (smaller than 50kg in weight). (DSTL) Planet “will be imaging the entirety of Earth’s earth daily.” (Wired)
What is new or emerging?	Planet launch 88 Smallsats in one attempt earlier this year.
Why might it matter?	Ever increasing amount of Earth Observation satellites
Gartner Hype Curve	Slope of Enlightenment
TRL	
Issue	https://github.com/opengeospatial/OGC-Technology-Trends/issues/47
References	URLs to technology written descriptions
Examples	https://www.planet.com/pulse/record-breaking-88-satellites/
Geospatial Tech Category	Positioning, Navigation and Timing; CRS; Geodesy
OGC Working Groups	Technical Committee

Gartner Hype Curve

Software Development processes

Meta Trend	Information Technology
Title	Software Development processes
Description	Software Programming languages and development methods are rapidly changing. New programming languages drive new capabilities for geospatial information. Software development process improvements including collaborative cross-functional teams, adaptive planning, evolutionary development, and continuous integration.
What is new or emerging?	TBA
Why might it matter?	TBA
Gartner Hype Curve	TBA
TRL	
Issue	https://github.com/opengeospatial/OGC-Technology-Trends/issues/60
References	URLs to technology written descriptions
Examples	URL to technology implementation examples
Geospatial Tech Category	TBA
OGC Working Groups	TBA

Spatial-Temporal Analytics

Meta Trend	Data Science and Decisions
Title	**Spatial-Temporal Analytics**
Description	Although real-time spatiotemporal data are now being generated by almost ubiquitously and their applications in research and commerce are widespread and rapidly accelerating, the ability to continuously create and interact in real time with this data is a recent phenomenon. This real-time space–time interactive functionality remains today the underlying process generating the current explosion of fused spatiotemporal data, new geographic research initiatives, and myriad mobile geospatial applications in governments, businesses, and society - (NGAC).
	What is new or emerging?
	Why might it matter?
Horizon	**Next**
Impact	**Disruptive**
Gartner Hype Curve phase	
Technology readiness level	TRL-5 in OGC activities.
Discussion Issue	Discussion of Trend on GitHub
References	
Examples	
Geospatial Tech Category	
OGC Working Groups	

Spatial Temporal Point Cloud

Meta Trend	TBA
Title	Spatial Temporal Point Cloud
Description	Spatial Temporal Point Cloud. A point cloud refers to a set of data points in some coordinate system. Spatial Temporal components are incorporated (DSTL). Point clouds can be terrestrial, bathymetric, atmospheric. Streaming of point cloud data in real time.
What is new or emerging?	TBA
Why might it matter?	TBA
Gartner Hype Curve	TBA
TRL	
Issue	https://github.com/opengeospatial/OGC-Technology-Trends/issues/8
References	URLs to technology written descriptions
Examples	URL to technology implementation examples
Geospatial Tech Category	TBA
OGC Working Groups	TBA

Statistics and Geography

Meta Trend	TBA
Title	Statistics and Geography
Description	As well as geospatial information, Governments and government bodies are increasingly reliant on statistical data to inform policy and decision making. As resources become constrained, it is increasingly important to make sure they are used in the most effective way possible. Geography is often the medium through which statistics are interpreted whether at global, regional, national or sub-national level. As the need for better statistics increases so does the need for greater integration of statistics and geospatial information, resulting in so called spatial statistics - (GGIM).
What is new or emerging?	TBA
Why might it matter?	TBA
Gartner Hype Curve	TBA
TRL	
Issue	https://github.com/opengeospatial/OGC-Technology-Trends/issues/5
References	URLs to technology written descriptions
Examples	URL to technology implementation examples
Geospatial Tech Category	TBA
OGC Working Groups	TBA

Text and Graph Analytics

Meta Trend	Data Science Analytics
Title	**Text and Analytics**
Description	Text Analytics refers to the process of deriving high-quality information from text. Applications of this are Natural Language Processing (NLP) and Social Media harvesting. An example is to scan a set of documents written in a natural language and either model the document set for predictive classification purposes or populate a database or search index with the information extracted - (DSTL).
What is new or emerging?	
Why might it matter?	
Horizon	**Next**
Impact	**Disruptive**
Gartner Hype Curve phase	
Technology readiness level	TRL-5 in OGC activities.
Discussion Issue	Discussion of Trend on GitHub
References	
Examples	
Geospatial Tech Category	
OGC Working Groups	

Time stamps to support analytics

Meta Trend	TBA
Title	Time stamps to support analytics
Description	Time-Aware Applications, Computers, and Communication Systems (TAACCS) A new economy built on the massive growth of endpoints on the internet will require precise and verifiable timing in ways that current systems do not support. Applications, computers, and communications systems have been developed with modules and layers that optimize data processing but degrade accurate timing. State-of-the-art systems now use timing only as a performance metric. Correctness of timing as a metric cannot currently be designed into systems independent of hardware and/or software implementations. To enable the massive growth predicted, accurate timing needs cross-disciplinary research to be integrated into these existing systems- (NIST).
What is new or emerging?	TBA
Why might it matter?	TBA
Gartner Hype Curve	TBA
TRL	
Issue	https://github.com/opengeospatial/OGC-Technology-Trends/issues/15
References	URLs to technology written descriptions
Examples	URL to technology implementation examples
Geospatial Tech Category	TBA
OGC Working Groups	TBA

UAVs and Drones

Meta Trend	New Geo Sources
Title	**UAVs and Drones**
Description	While large UAVs have been in use for defense, ISR, and remote sensing purposes for many years, the platforms now range in complexity from large, jet-propelled aircraft to palm-sized drones. Similarly, Unmanned Underwater Vehicles (UUVs) also have a long history of operations, becoming increasingly sophisticated in recent years with respect to capabilities and autonomy. (OGC WG Charter)
What is new or emerging?	The UXS domain is rapidly evolving and includes participants from diverse practice areas, not all of which are mature or geospatial in nature. While large Unmanned Aerial Vehicles (UAVs) have been in use for defense, ISR (intelligence, surveillance and reconnaissance), and remote sensing purposes for many years, the platforms now range in complexity from large, jet-propelled aircraft to palm-sized drones. Similarly, Unmanned Underwater Vehicles (UUVs) also have a long history of operations, becoming increasingly sophisticated in recent years with respect to capabilities and autonomy.
Why might it matter?	11 Million drones sold in USA (March 17, Wikipedia). Increasing government legislation to register these devices. NASA has invented technology, which allows a drone to land safely in an emergency landing. Also can now buy insurance cover for flying a drone.
Horizon	**Next**
Impact	**Disruptive**
Gartner Hype Curve phase	
Technology readiness level	TRL-5 in OGC activities.
Discussion Issue	Discussion of Trend on GitHub
References	

Examples	https://uavcoach.com/drone-companies/
Geospatial Tech Category	Databases, Data models, Semantics, Mark-up Languages
OGC Working Groups	UXS DWG - The mission of the UXS DWG is to document the use of UXS technology in the collection of geospatial data as well as identify the geospatial context of UXS operations in order to discuss the adoption of existing best practices and standards and/or recommend the creation of new standards to support the successful use of UXS technology.

Uncertainty, Veracity

Meta Trend	
Title	Uncertainty, Veracity
Description	Uncertainty is a situation which involves imperfect and/or unknown information, including aspects of cognition (the process of acquiring knowledge and understanding through thought, experience and senses) and plays a part in understanding Uncertainty Information. How this information is assessed for data quality is important. (DSTL)
What is new or emerging?	Portrayal, ever change world and increasing understanding is needed.
Why might it matter?	Every increasing amounts of information, how do you describe uncertainty in the data, so the right information rises above the noise?
Gartner Hype Curve	Technology Trigger
TRL	
Issue	https://github.com/opengeospatial/OGC-Technology-Trends/issues/29
References	https://en.wikipedia.org/wiki/Uncertain_data
Examples	URL to technology implementation examples
Geospatial Tech Category	Processing, Models, Workflow, Cloud
OGC Working Groups	Technical Committee; Portrayal AdHoc

Gartner Hype Curve

Volunteered geographic information (VGI)

Meta Trend	TBA
Title	Volunteered geographic information (VGI)
Description	Volunteered geographic information (VGI) is the harnessing of tools to create, assemble, and disseminate geographic data provided voluntarily by individuals (Goodchild, 2007).[1]VGI is a special case of the larger Web phenomenon known as user-generated content.[2] Some examples of this phenomenon are WikiMapia, OpenStreetMap, and Google Map Maker (Wikipedia).
What is new or emerging?	TBA
Why might it matter?	TBA
Gartner Hype Curve	TBA
TRL	
Issue	https://github.com/opengeospatial/OGC-Technology-Trends/issues/45 Crowdsourcing, Citizen Science or Volunteered Geographic Information? The Current State of Crowdsourced Geographic Information. Discussed at https://github.com/opengeospatial/OGC-Technology-Trends/issues/45
References	URLs to technology written descriptions
Examples	URL to technology implementation examples
Geospatial Tech Category	TBA
OGC Working Groups	TBA

Web Scale Programming

Meta Trend	Spatial Data on the Web
Title	Web Scale Programming
Description	Web scale platforms hosted on large cloud services with web-friendly techniques, enable extreme levels of service delivery as compared to many of their enterprise counterparts.
What is new or emerging?	TBA
Why might it matter?	TBA
Gartner Hype Curve	TBA
TRL	
Issue	https://github.com/opengeospatial/OGC-Technology-Trends/issues/33
References	URLs to technology written descriptions
Examples	URL to technology implementation examples
Geospatial Tech Category	TBA
OGC Working Groups	TBA

Web of Data

Meta Trend	Spatial Data on the Web
Title	**Web of Data**
Description	Data published on the web are made discoverable, accessible and interoperable using WWW best practices for data formats, data access, data identifiers, metadata, licensing and provenance. Individual data instances are each given an URI identifier and published at that URI; using links, these instances are integrated with other data, thus creating the Web of Data. The Web thus becomes the exchange medium for data as well as documents - you might think of it as 'one big database'.
What is new or emerging?	Enormous volumes of data are available on the Web today but it is typically published through portals that act on behalf of multiple agencies, not on the Web sites operated by those agencies themselves. These portals are effectively data silos and inaccessible to search engine crawlers, making it hard to discover the data inside portals. Also, data is typically made accessible on the dataset level: datasets can be discovered, downloaded, viewed etc. With the Web of Data, it becomes possible to discover, and link to, individual instances inside datasets from all over the world, without having to peruse metadata catalogs, download the data, query a service, etc.
Why might it matter?	The amount of data being created and published continues to increase, with the explosive growth in positioning technologies attached to mobile vehicles, portable devices, and autonomous systems. Being able to discover and access this data is thus becoming more and more important. Using general Web architecture and standards will enable cross-community uptake of spatial data.
Horizon	**Next**

Impact	**Disruptive**
Gartner Hype Curve phase	
Technology readiness level	TRL-5 in OGC activities.
Discussion Issue	Discussion of Trend on GitHub
References	- Spatial Data on the Web Best Practices, 2017 See BPs 1,2,and 3. - Location Powers:Big Linked Data
Examples	- Geocoded National Address File (G-NAF) Linked Data Demonstrator - Spatial Data on the Web Demonstrator for Cadastral and Topographic data in North-Rhine Westphalia
Geospatial Tech Category	Databases, Data models, Semantics, Mark-up Languages
OGC Working Groups	Spatial Data on the Web SDW Strategy Funnel

Workflow and provenance

Meta Trend	Big Data
Title	**Workflow and provenance**
Description	Provenance is information about entities, activities, and people involved in producing a piece of data or thing, which can be used to form assessments about its quality, reliability or trustworthiness - (W3C PROV).
What is new or emerging?	
Why might it matter?	
Horizon	**Next**
Impact	**Sustaining**
Gartner Hype Curve phase	
Technology readiness level	TRL-5 in OGC activities.
Discussion Issue	Discussion of Trend on GitHub
References	
Examples	URL to technology implementation examples
Geospatial Tech Category	Databases, Data models, Semantics, Mark-up Languages
OGC Working Groups	