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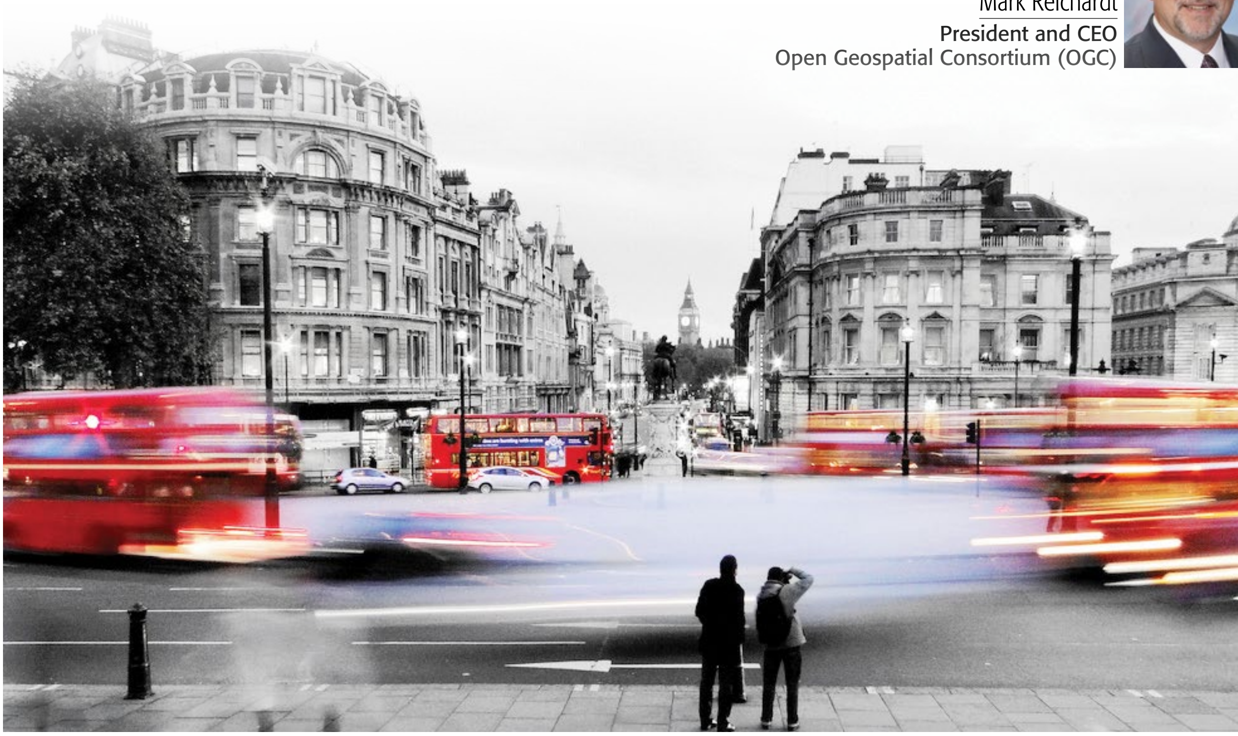


Smart Cities and Sensor Webs

The convergence of sensor webs and geospatial technologies is a trend that is on track to become increasingly obvious and important in the near future

The term 'sensor web' refers generally to multiple connected sensors providing data for use by Internet-connected applications.

Sensors play a key role in Smart City applications and their importance will increase with the growth in the number of sensors that are connected to the Internet. Smoke detectors, weather data, traffic radar, surveillance cameras, gunshot detectors, and mechanical strain gauges on bridge structures are examples of sensors that make cities safer by supporting disaster and emergency prevention, response and management. Air, water and radiation pollution monitors, hospital asset location and patient monitoring systems, and 'healthy building' sensors help us maintain health. Apps using smartphones' accelerometers and GPS can give cities the locations of street potholes, and systems using traffic counters can help distribute traffic for efficient transportation. The improved granularity of this data is partly a result of the growing number and improved resolution of satellite-borne remote sensors and partly a result of the increasingly dense spatial distribution of sensors on or near the earth's surface.

Exponential growth in the number of Internet-connected sensors is due to overall miniaturisation and reduction in cost and power requirements of digital devices in general. Not only the number but also the variety of Internet-connected sensors is increasing at a phenomenal rate. Smartphones are highly distributed location-aware sensor platforms for cameras, gyroscopes, accelerometers, thermometers, microphones, light meters, GPS, compasses, and sensors that enable WiFi and cellular and near-field communications. Every sensor observation can include location with varying degrees of precision and every observation can be time-stamped with extraordinary precision. Smartphone apps using combinations of these provide many capabilities. Network-connected sensors are making their way into vehicles, buildings, pipes, ducts, bridges, stores, and factories. In addition, a global network of satellite-borne imaging sensors, ocean sensors, weather stations, seismic monitors, etc., provides a broader regional and global picture of weather, ground cover, land use, etc.

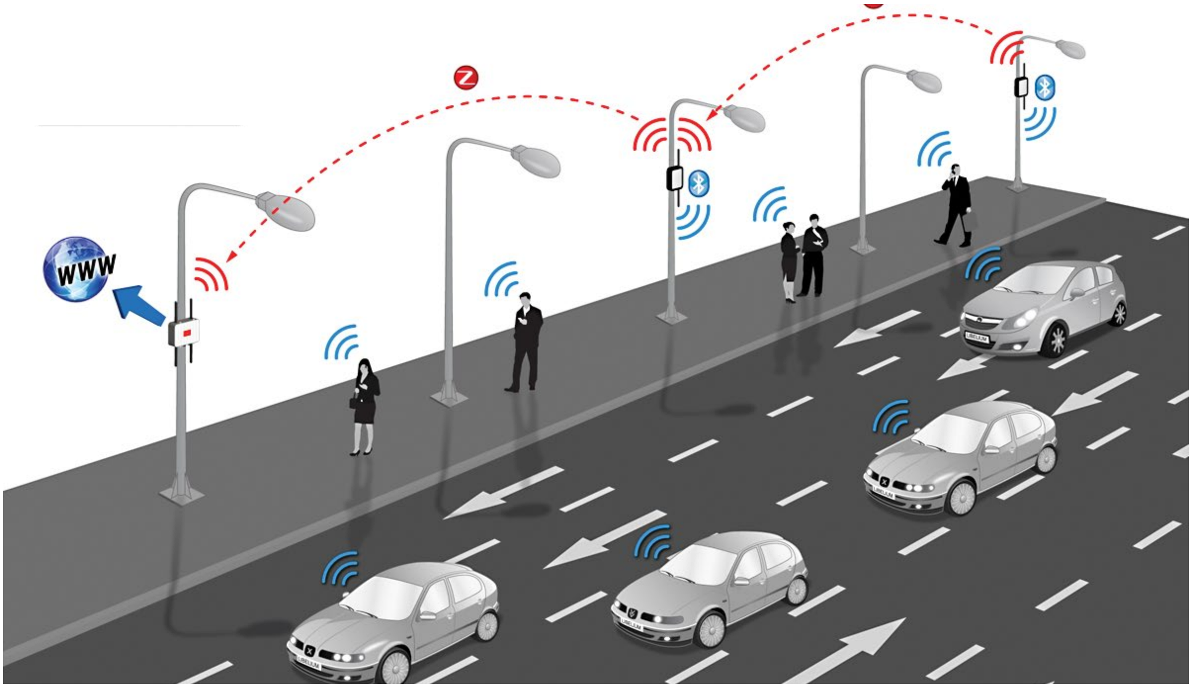
Silos of automation

Unfortunately, most sensor systems are limited by their technical isolation — also known as silos of automation — resulting from proprietary interfaces, APIs, and data encodings. Every sensor observation is collected in a particular place at a particular time by a device with particular technical characteristics, metadata, history, and ownership. This information is usually important and must be made available. Unfortunately, all too often, communication involves proprietary or custom-built encodings and interfaces that can't easily be discovered and exploited. Typical security monitor networks, building temperature control systems, subway tunnel flood monitoring systems, etc., are deployed for specific purposes by contractors who are usually not asked to make their systems conform to a master plan for interoperable systems. This is understandable because the sensor industry evolved without widespread connectivity and without a comprehensive set of open standards that enable interoperability. If such open standards had been available 15 or 20 years ago, we would already be realising the benefits of connecting sensor systems with each other and with geospatial systems. Fortunately, today those standards are available.

Future proofing sensor webs

Open standards for sensor web enablement, 3D urban models, geospatial processing systems, building information models, indoor location and other spatial technologies are now available from OGC, ISO and other standards organisations. These standards are mature to the point where comprehensive Smart Cities information system architectures enable integration of all of this information.

Urban information system experts are using these standards to connect sensor arrays to the Internet using open interfaces and data encodings that enable sensors and sensor data



Source: www.libelium.com

Vehicle Traffic Monitoring Platforms, such as one developed by IoT platform provider, Libelium, for its Smart Cities solution, is capable of sensing the flow of Bluetooth devices in a given street. Sensor data is then transferred by a multi-hop ZigBee radio, via an internet gateway, to a server. The traffic measurements can then be analysed to address congestion of either vehicle or pedestrian traffic.

collections to be described (along with location), catalogued (for searches), discovered, controlled, and read by diverse applications. Access control is often important, of course, but so are flexibility and 'future proofing'. The value of sensors and sensor data increases when multiple applications are able to combine information from different sensors — including spatial and temporal information — so that sensor data can be used in combination with other kinds of location data.

For instance, the OGC Sensor Web Enablement (SWE) standards are open standard interfaces and encodings that make it possible for sensors to be connected to the Web, located, described, read, and controlled remotely. SWE is part of the larger framework of widely adopted OGC standards, so integration with other kinds of spatial data can be accomplished without developing or adapting to special purpose spatial encodings or interfaces. OGC standards are closely aligned with and sometimes are the source of related ISO standards. A variety of ISO standards are the basis of the OGC Abstract Specification.

Convergence of sensor data with spatial data in smart cities advances along with convergence of indoor 'building-spatial' encodings and outdoor geospatial encodings. Urban sensor integration will benefit from all of these developments:

- The OGC Sensor Web Enablement (SWE) SensorThings API candidate standard for the Internet of Things builds on the OGC's SWE standards suite, but it is designed to be lightweight and easily implemented.
- buildingSMART International is working with OGC to harmonise the Industry Foundation Class Building Information Model (BIM) standards with OGC standards.
- The OGC CityGML standard allows users to share virtual 3D city and landscape models for analysis and display tasks.
- The candidate OGC IndoorGML Encoding standard specifies an abstract model and XML schema for indoor spatial information to support navigation.
- The candidate OGC Moving Feature Encoding standard defines an abstract model, an OGC Geography Markup Language (GML) application schema and also a simple CSV (comma-separated value) format for encoding moving feature data.
- The OGC LandInfra Standards Working Group is working on a standard to integrate land information contained in various CAD formats into the OGC standards framework.
- The OGC Urban Planning Domain Working Group (SWG) is defining the role for OGC standards and related activities within the Urban Planning discipline.

Implementation of these and related standards will enable integration of many different kinds of data and many-to-many communication among urban users of different kinds of information systems. Deployments specified with this kind of integration in mind are wise deployments that will deliver a much greater return on investment than choices that impose technical interoperability limitations.