

INCREASING MARKET OPPORTUNITIES FOR AUGMENTED REALITY THROUGH COLLABORATIVE DEVELOPMENT OF OPEN STANDARDS

A position paper for the International AR Standards Meeting February 17-19, 2011

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Abstract — Augmented Reality (AR) is a leading indicator of the next generation of location-based services (LBS). As with the initial generation of LBS, collaborative development of standards is vital to the effective development and communication of information. The OGC and other standards bodies define standards relevant to this emerging market. Through an innovative prototyping process and a consensus standards process, the OGC can help innovative companies increase market opportunities for AR.

1 INTRODUCTION

Location based services have become an established market for services such as maps and routing. With increasing network access to objects, location information and location based services will define new marketplaces. Augmented Reality (AR) is a leading indicator of the new types of LBS functions and marketplaces. AR shows how LBS is not just about maps but really about a seamless blending of reality and cyberspace based on context, particularly location.

In a multi-vendor AR environment, progress will be limited without the emergence of open, consensus standards that enable collaboration. Such standards will define an infrastructure that raises the level of services and quality of information for the marketplace thereby providing more opportunities, particularly for the vendors that collaborate to define the standards.

The AR Standards Workshop in Barcelona, February 2011, provides a unique opportunity to survey the landscape of the next generation of LBS and to position AR as a leading domain based upon collaborative development of open industry standards. In a position paper for the workshop, Christine Perey poses the question: Does Augmented Reality Need a Formal Industry Body? (Perey, 2011). This paper defines the advantages of an industry standards body as a catalyst for collaborative development of AR.

The OGC recommends the following steps for advancing the Augmented Reality marketplace:

- OGC endorsement of KML profiles for AR
- Coordination of standards for AR with other relevant standards, e.g., OpenLS, SWE, CityGML.
- Definition of a standards-based framework for the AR community to spur coordinated application development.
- Establishing an OGC Working Group for AR
- Conducting an OGC Testbed initiative for AR.

Moving beyond the current LBS applications, OGC members are leading the way in defining new marketplaces based on pervasive computing where billions of objects will be networked into the Internet of Things (see Section 3.3). Augmented Reality provides a valuable view on the Internet of Things by combining information about things within the user's view.

The OGC has a proven track record of rapidly developing industry-based open standards through an innovative prototyping process that can be applied to LBS and the GeoWeb to the Internet of Things.

2 CURRENT LBS STANDARDS

Standards from the Open Geospatial Consortium (OGC) and other organizations are the basis for successfully deploying a seamless, distributed information infrastructure for location-based services (LBS). Non-interoperability impedes sharing of information and advancement of applications in the marketplace. Collaborative development of standards has proven to be effective in providing the needed interoperability needed in the LBS domain.

2.1 OpenLS – OGC standards for LBS

Today's enterprise and consumer location based services depend on a set of open interfaces and encodings (e.g., OGC OpenLS, OMA SUPL) that support plug-and-play integration and that create market opportunities for the diverse businesses that provide the links in the LBS value chain. The OGC launched the first testbed of the OpenLS initiative in 2001 and released the OpenLS Standard in 2005. The standard enables developers to use existing standards or content models when possible, and to use any positioning technique. (OGC Standards, 2011)

The OpenLS standard facilitates use of geospatial technology in the wireless Internet industry. These services provide real time location information combined with location-enabled content to help answer basic questions such as: Where am I? , What is around me? And, how do I get there?

OpenLS defines seven core services that satisfy the most common requirements of these applications:

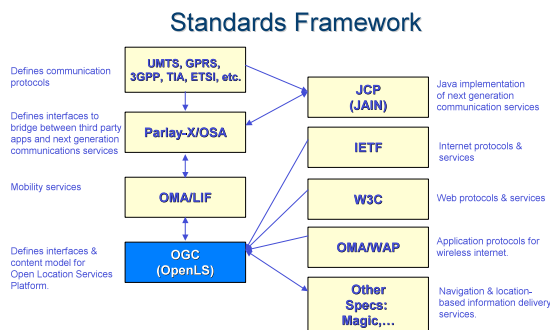
- Directory Service – provides access to an online directory to find the location of a specific or nearest place, product or service.
- Gateway Service – fetches the position of a subscriber using the OMA Mobile Location Protocol.
- Geocoder Service – transforms a description of a location into a point. For example, a postal address is transformed into a latitude / longitude pair.
- Presentation Service – renders a base map made up on geospatial data with a set of ADTs as overlays.
- Reverse Geocoder Service – transforms a position into a location synonym, such as postal address or street intersection.
- Route Service – Determines travel routes and navigation information between two or more points.
- Tracking Service – Allows an application to track a mobile GPS enabled device.

This standard was produced immediately following the OpenLS 1 testbed initiative, October 2002. It also includes enhancements and fixes made subsequent to the testbed efforts.

The OpenLS Implementation Standard was adopted by the OGC based on a specification developed by the following organizations:

- Autodesk, Canada
- ESRI, USA
- Image Matters, USA
- Intergraph IntelliWhere, Australia
- MapInfo, USA (now Pitney Bowes Software)
- Navigation Technologies, USA (now Navteq)
- Oracle, USA
- Sun Microsystems, USA
- Webraska, France
- Tele Atlas, USA
- Telcontar, USA

OGC standards are developed in concert with other Standards Developing Organizations. Other standards activities that were reviewed and considered under the OpenLS initiative include related standards initiatives at ISO, W3C, IETF, LIF/OMA, 3GPP, AMIC, MAGIC, WAP, JAIN and Parlay, as well as other emerging and adopted OGC standards.



2.2 GeoWeb

The geospatial web is not just an array of mash-ups or even the hundreds of Spatial Data Infrastructures that have been successfully deployed. Rather, it is about the complete integration and use of location at all levels of the Internet and the Web. This integration will often be invisible to the user (Reed, 2011). The architecture for accomplishing this on the web – the GeoWeb - is well-defined within the OGC framework, using open standards:

- **OGC Web Map Service (WMS)** provides a simple HTTP interface for requesting geo-registered map images from one or more distributed geospatial databases.
- **OGC KML** is an XML language focused on geographic visualization, including annotation of maps and images: not only presentation on the globe, but also control of where to go and where to look.
- **OGC Geography Markup Language (GML)** is an XML grammar for expressing geographical features. GML serves as a modeling language for geographic systems as well as an open interchange format for geographic transactions on the internet.
- **OGC GeoSMS** defines a short messaging service (SMS) encoding to exchange lightweight location information between different mobile devices or applications.
- **GeoRSS** (www.georss.org) provides an information model and three serializations for geo-enabling, or tagging, “really simple syndication” (RSS) feeds
- **GeoJSON** (geojson.org) is a format for encoding a variety of geographic data structures: a geometry, a feature, or a collection of features. The features in GeoJSON are consistent with GML.

In order to achieve the full vision of the GeoWeb through the Internet infrastructure, OGC standards are used by and coordinated with other Standards Developing Organizations (SDOs) where location is an element of their framework, e.g., IETF PIDF-LO, OASIS CAP, NENA and others.

Most of the OGC Web Services (OWS) standards began in OGC Interoperability Program testbeds. All of the standards listed above have been implemented and advanced in OGC Testbeds or Pilots. Testbeds are experiments to generate new standards that move the market forward. Pilots deploy adopted standards in operational environments to define best practices.

3 EMERGING TOPICS IN NEXT GENERATION LBS

3.1 Augmented Reality

AR allows the user to see the real world, with virtual objects superimposed upon or composited with the real world. The potential application domains for AR are vast: including medical, manufacturing, visualization, path planning, entertainment and military (Azuma, 1997). Recently AR applications have emerged as popular on mobile devices equipped with sensors for orientation and location (iPhones, Android devices, etc.). “In fact, location-based services (LBS) — used with smart phones and other types of mobile technology — are a major driving force behind AR’s entering the mainstream.” (IEEE Computer, 2009)

Challenges exist in order to make AR applications effective and accurate in a wide range of application domains. Registration and sensing errors are two of the biggest problems in building effective AR systems. Key to this is accurate understanding of the sensor measurements in applications, understanding that needs to be reflected in standard ways of encoding sensor descriptions and measurements. The lack of standards impedes progress of AR in a multi-vendor environment. “There are no standards for AR APIs or data. Thus, developers must rewrite their AR applications for each OS and device platform they want to address...The lack of standards also affects interoperability, such as using AR data from one platform with applications written for another.” (IEEE Computer, 2009)

3.2 Context-aware computing

“Future generations of smart phones will be context aware, tracking your behavior, providing information about the immediate environment, and anticipating your intentions. For now, most of these context-aware mobile applications remain in the R&D stage. To bring contextual computing to the masses, phone manufacturers and software vendors will need to overcome some major hurdles. Not the least of these is the lack of open standards for exchanging context data between applications. In the absence of such standards, several companies are pursuing their own implementations, which demonstrate how this kind of contextual integration might eventually work.” (ACM 2009)

While the functionality of smart phones has rapidly advanced including location-aware applications now quite popular, the opportunities for additional functions based on collaborative developments far exceed the current state.

3.3 Internet of Things

Connecting our world with accessible networks is scaling to trillions of everyday objects. The Internet of Things and Pervasive Computing are research names for this development. Planetary Skin, Smarter Planet and CeNSE are several corporate names. The Internet will be

augmented with mobile machine-to-machine communications and ad-hoc local network technologies. At the network nodes, information about objects will come from barcodes, RFIDs, and sensors. The location of all objects will be known and the objects will interact extensively with fixed and mobile clients.

“Physical mobile interaction takes advantage of mobile devices that physically interact with tagged objects to facilitate interaction with associated information and services. Simply by touching or pointing at objects, users can interact with them. (A) framework for integrating Web services and mobile interaction with physical objects relies on information typing to increase interoperability.” (IEEE Internet Computing, 2009)

The GeoWeb and LBS will expand to this Internet of Things. New functions and applications will be enabled by geographic location and location relative to surrounding objects. Many of the objects will be indoors in a 3D setting. Relevant technologies to this development in location determination, geocoding, schemas for points of interest, ad-hoc network formation based on location, processing of information of the objects to detect phenomena of interest and location based services. Technology standards will be important for interoperability at this scale and diversity of applications. (COM.Geo 2011)

3.4 Indoor Navigation and building models

City Geography Markup Language (CityGML) is an OGC Encoding Standard for the representation, storage and exchange of virtual 3D city and landscape models. CityGML is implemented as an application schema of the Geography Markup Language version 3.1.1 (GML3). CityGML models use both complex and georeferenced 3D vector data along with the semantics associated with the data. In contrast to other 3D vector formats, CityGML is based on a rich, general-purpose information model in addition to geometry and appearance information. For specific domain areas, CityGML also provides an extension mechanism to enrich the data with identifiable features under preservation of semantic interoperability.

In April 2008, the OGC issued a call for sponsors for an OGC Web Services, Phase 6 (OWS-6) Testbed activity. The OWS-6 activity completed in June 2009. In October 2009 the OGC published a document describing the Outdoor and Indoor 3D Routing Services, which are used in the OWS-6, services that are based on data encoded as CityGML and provided by an OGC WMS interface. The service retrieves the datasets used in navigation scenarios and display map information for purpose of navigating the user. The objective was to enhance a network topology for the current CityGML standards based on the knowledge acquired through the development and experimental evaluation of this project.

In December 2009, the OGC held a special session of the OGC 3DIM Domain Working Group and hosted the Indoor Location and Floor Plan Standards Forum to bring together professionals representing standards development organizations and activities working on encoding standards for indoor location and routing, floor plans, and other built environment information. Among the groups represented were the OGC, the Internet Engineering Task Force (IETF) GeoPRIV Working Group, the Open Floor Plan initiative, the OASIS EM Technical Committee, buildingSMART alliance™, the Korean Spatial Awareness initiative, and the ISO TC 211 Dynamic Position Identification Scheme for Ubiquitous Space (u-Position) activity. Discussion focused on standards approaches that would be simple, compatible with emerging standards for more comprehensive building

information and indoor navigation models, and easily deployed in solutions that require minimal input from building owners.

Presenters and attendees in the Indoor Location workshop explored the OGC CityGML Encoding Standard; IndoorML; indoor spatial awareness research; proposed Interior Location Extensions to the IETF's proposed PIDs-LO standard; and the Open Floor Plan Display Project of Carnegie Mellon Silicon Valley and the Golden Gate Safety Network. The OGC 3DIM Working Group continues to advance recommendations from the workshop.

3.5 Sensor Web

A Sensor Web refers to web accessible sensor networks and archived sensor data that can be discovered and accessed using standard protocols and application program interfaces (APIs). OGC Sensor Web Enablement (SWE) is a unique and revolutionary framework of open standards for exploiting Web-connected sensors and sensor systems of all types: flood gauges, air pollution monitors, stress gauges on bridges, mobile heart monitors, Webcams, satellite-borne earth imaging devices and countless other sensors and sensor systems. (OGC, 2007)

While many sensors can be mobile, these applications are increasing the notion of mobile sensing to areas referred to as Participatory Sensing and People-centric sensing.

3.6 Modeling and Simulation - “Serious Games”

The combination of geospatial, sensor, LBS and complementary processing standards, points towards development of seamless interoperability with the modeling and simulation community and the virtual reality community.

In this regard, the OGC is working with the Serious Games Initiative, which is focused on uses for games in exploring management and leadership challenges facing the public sector. Part of its overall charter is to help forge productive links between the electronic game industry and projects involving the use of games in education, training, health, and public policy. All of which is based on a common and robust model of the spatial environment.

4 COLLABORATIVE DEVELOPMENT OF STANDARDS

Collaborative development is key to consensus adoption and wide use of information technology standards. The mission of the OGC is to serve as a global forum for the development and promotion of open standards and techniques in the area of geoprocessing and related information technologies.

The OGC has 410+ members - geospatial technology software vendors, systems integrators, government agencies and universities - participating in the consensus standards development and maintenance process. In support of meeting the interoperability requirements of the geospatial web, the OGC also supports a major commitment to collaborate with other standards developing organizations that have requirements for using location-based content.

Technology and content providers collaborate in the OGC because they recognize that lack of interoperability is a bottleneck that slows market expansion. They know that interoperability enabled by open standards positions them to both compete more effectively in the marketplace and to seek new market opportunities.

Through its Specification Program, Interoperability Program, and Marketing and Communications Program, the

OGC develops, releases and promotes open standards for spatial processing.

- The OGC Specification Program Technical Committee (TC) is where the formal OGC standard consensus discussion and approval process occurs. The Technical Committee is comprised of a number of working groups (WGs). Technical Committee Working Groups provide an open, collaborative forum for discussions, presentations and recommendations.
- The OGC Interoperability Program provides a rapid engineering process to develop, test, demonstrate, and promote the use of OGC standards and other specifications. The IP organizes and manages Interoperability Initiatives that address the needs of industry and government sponsors.

In the OGC, technology and content provider members:

- Position themselves early to *influence the definition of new open standards*.
- Bring in their experience, knowledge and know-how.
- **Reduce costs** through cooperative standards development with other OGC members.
- **Shorten time to market** by using OGC standards rather than custom interfaces.
- Develop standards that help them *enter new markets and find new customers* because of "plug and play".
- Have a convenient *forum for discussing industry issues* and solving shared problems.
- **Form customer relationships and business partnerships**.
- **Deliver solutions more quickly and at lower cost**.
- Develop standards that help them *mobilize a range of products across open interfaces*, rather than performing resource intensive custom integration.
- **Provide precise solutions** to meet specific needs, solutions that plug and play.
- **Reduce the long-term risks and costs of their technology investments**

The development of these standards does not require members to give up intellectual property or trade secrets. The use of open standards to connect components, applications, and content – allowing a “white box” view on the components’ functionality and interfaces without revealing implementation details – fulfills the industry requirement for protection of intellectual property and the user requirement for transparency. Such transparency supports both interoperability and the credibility of enterprise, or federated, solutions.

The OGC’s **Interoperability Program** (IP) is an essential part of the Consortium's fast, inclusive and effective user-driven process to develop, test, demonstrate, and promote the use of OGC® standards. These standards make it possible for technology providers to meet their customers' needs for efficient discovery, access, sharing and use of geospatial data and geospatial processing services.

Development of effective open standards is a balancing act. The standards need to be agile and adaptive to the rapidly changing developments in the marketplace. The standards also need to have a sound engineering foundation and respect relevant aspects of the existing technology base. This balance applies to simple standards and complex standards. The deceptively simple order of coordinates for a location has a long history of causing confusion and errors. Coordinate order based on history (navigation and surveying) is the opposite of coordinate order defined by engineering (physics and graphics). The OGC’s processes for standard development based on rapid prototyping to an established standards baseline is well equipped for this balance in effective standards development.

5 RECOMMENDATIONS TO ADVANCE AR MARKETPLACE BASED ON CONSENSUS STANDARDS

The AR Standards Workshop and the co-located GSM World Congress in February 2011 are excellent opportunities to discuss how organizations can increase their business based on quality location information in the Internet of Things.

Quality information in a multi-vendor environment can only be obtained using standards. An industry-based consortium is needed to establish effective standards for information sharing about location in the Internet of Things. The OGC has a proven process for industry-wide collaborative development of efficient standards for LBS.

The OGC recommends the following steps for advancing the Augmented Reality marketplace:

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- Coordination of standards for AR with other relevant standards, e.g., OpenLS, SWE, CityGML.
- Definition of a standards-based framework for the AR community to spur coordinated application development.
- Establishment of an OGC Working Group for AR that includes application developers and software vendors, as well as data providers.
- Conducting an OGC Testbed initiative for AR.

6 CONCLUSION

The OGC staff and members feel it is timely to stand up a multi-vendor, collaborative prototyping environment that will establish the next generation of location based services (LBS) standards with AR as the leading topic. The OGC’s background in open standards for location including the OpenLS standard and the unique OGC Interoperability Program offer the necessary experience and much-needed collaborative environment.

An industry consortium supporting AR will build higher functionality in the marketplace through increasing interoperability and thus lead to increased economic value of place-based information from mobile phones and other devices to the Internet of Things.

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