Request for Information on Mixed Reality to the Edge: An OGC Concept Development Study

Architecture, Data, Services, Requirements & Constraints

RFI Issuance Date: January 7, 2019
Response Due Date: February 15, 2019

1. Abstract

The OGC Request for Information (RFI) is focused on seeking information on technologies that enable, enhance, and/or support automation of workflows that curate, discover, process, integrate, and publish (disseminate) 3d geospatial content to users at the edge, now and in the future. Specifically, there is a critical requirement to provide curated 3d content potentially fused and/or integrated from multiple sources to the user at the “edge”. Users at the “edge” include first responders, field deployed utility workers, and the warfighter. Users at the edge may have denied, degraded, interrupted, or limited (DDIL) internet access. There is also the requirement to provide the right data at the right time to the right user.

This Request for Information (RFI) is being managed as part of an OGC Innovation Program Concept Development Study (CDS). This activity is being sponsored by SOFWERX. The goal of this CDS is to demonstrate to stakeholders the diversity, richness and value of new and emerging technologies for 3d processing, curation[1], and analytics in support of users in potentially disconnected computing environments. Specifically, consider from an interoperability perspective what data sources, technologies, analytics and associated IT services are required for addressing the needs for the convergence of geospatial 3d modelling, simulation, and gaming integrated with machine learning for automated 3d workflows for such activities as enhanced decision support, mission rehearsal, and/or situational understanding. This includes the role of AI along with AR and VR for enhanced visualization and decision support.

Two major objectives for this CDS is to identify gaps in the work of the OGC and subsequently provide recommendations to the ongoing standards work of the OGC that enhance the interoperability for the integration, conflation, visualization and analytics of 3d and 4d content in automated workflows. Key considerations are the increasing use of machine learning and gaming technologies to create blended real and synthetic environments using real world 2d, 3d, and even 4d geospatial data that leads to enhanced situational understanding in support of the user at the edge. The blending of the real and synthetic environments can be thought of as mixed reality.

Therefore, the motivation for issuing this RFI is to gather information to enhance support for governments, agencies, non-governmental organizations and citizens to better and more cost effectively transform and integrate 3d/4d geospatial content into actionable intelligence for both the user at the edge and the decision maker supporting those users. While gaming and virtual

[1] Data curation is the management of data throughout its lifecycle, from creation and initial storage to the time when it is archived for posterity or becomes obsolete and is deleted. The main purpose of data curation is to ensure that data is reliably retrievable for the purposes intended, fit for purpose, and/or reuse.

environments have proven value, many communities now require enhanced seamless integration of synthetic, geospatial, sensor, and web available data to achieve an operationally realistic environment for planning and rehearsal of real world missions. With the advent of edge processing, fog computing, and the explosion in the volume and variety of 3d geospatial data being collected, processing must be offloaded to reduce cognitive burden. Standards-based, automated 3d workflows are required to reduce the operating burden on users and/or support machine-to-machine operations. In some cases, increasing use of virtual and augmented reality for area familiarization and mission rehearsal, and the corresponding technical requirements for interoperability of highly optimized and tightly coupled gaming technologies, may inform or enhance algorithmic development for future automated 3d workflows in support of the user at the edge.

The RFI results will provide information on the current state of the geospatial infrastructure(s) for automated 3D related activities with the goal of reducing human intervention (mouse clicks). In addition, analysis of results to assess interoperability, availability and usability of geospatial Web services and tools across different types of workflows along with identification of gaps, and definition of core components to support 3d workflows will be used to define reference use-cases and scenarios for use in ongoing OGC Domain Working Group discussions and standards development.

Results of the RFI responses will be analyzed and documented in an OGC Engineering Report that will serve as the basis for improvement of standards based approaches to support the 3D aspects of converging real and synthetic environments. RFI responses will lead to further discussion in the community focused on enhanced interoperability and potential changes to the OGC standards baseline.

Responses to the RFI are requested by February 15, 2019. This RFI includes instructions on how organizations can respond to and submit questions about the RFI.

2. Background

Computer generated simulations are in wide use for modeling scenarios, training, and rehearsal in many disciplines and communities. The fidelity and usefulness of these simulations is frequently enhanced by the creation of a virtual rendering of a 3D environment within which entities in the environment operate. Most computer-based gaming systems have technical architectures that are different from more traditional GIS and simulation systems, and considerable innovation and enhancements in virtual environment fidelity (and reductions in system costs) are expected to result from increased use of computer game based technical architectures. Therefore, one aspect of this RFI is to assess how gaming technology - specifically for rendering and visualization on mobile devices - might be further leveraged for for users at the edge. In recent years there has been more widespread use of realistic depictions of real-world environments and capabilities of gaming systems to represent large areas of the Earth.

Geospatial data are increasingly used as a primary source of information from which to generate virtual simulation environments. High performance and high fidelity simulations have generally required that geospatial source data be converted for optimization, and frequently “to” proprietary formats in order to support fast and deterministic storing, retrieval and rendering of high quality 3D virtual environments. Another aspect of this RFI is to explore leading edge approaches to architectures and workflows that optimize performance, enhance integration, and enhance reusability without reliance on proprietary algorithms, APIs, and so forth.

Another area of focus for this RFI is the role and technologies for machine learning, deep learning) and AI in automated 3d/4d workflows. An example is the use of artificial intelligence (AI)-based programs intended to detect and classify objects in full-motion video collected by drones and alert analysts when potentially interesting items or patterns are found (Kimmons,et. al. 2017). An excellent resource on the use of ML and DL for image classification can be found in the OGC Testbed-14: Machine Learning Engineering Report (2019). The role of human analysts will evolve over the next six years as computers assume an active (vice today's mainly passive) role in GEOINT exploitation: human analysts will spend more time interrogating and validating the machine's work, exploiting the gaps and applying broader contextual awareness to the algorithmic outputs. (NGA 2020 plan). ML, DL, and AI are seen as a critical technology to achieve this goal.

A major interoperability challenge is that differences in the rendering and perception of 3D virtual environments within systems that have chosen to interoperate are sometimes major obstacles to the effective use of these systems. The impacts of the design experience for the end user has significant implications when AR and VR systems are considered[2]. The end user experience has significant impacts on such architecture elements as storage, structuring, processing, and dissemination of the geospatial content to the client device. This is another area of interest in responses to this RFI.

The following are two example use cases where enhanced 3D automation provides tremendous value. First, geospatial information has been proven effective in supporting both the understanding of and response to disasters. The supported activities include identifying at-risk areas by building scientific models and analyzing historical data, assessing damage and coordinating response teams using near real-time imagery and data in the wake of a crisis, and a myriad of other applications. Second, training and rehearsal capabilities for individual vehicle and system operations may be significantly enhanced by interoperation of traditional and game-based simulations.

[2] See the OGC Testbed 14 Engineering Report on using CityGML in mobile AR apps.

The ability to effectively share, use, and re-use 3D geospatial content and applications across and between governments and Non-Government Organizations (NGOs) in support of modelling and simulation for critical applications such as disaster response and resilience and training and field support of the warfighter. There are also additional economic impacts such as reducing costs through enhanced production capabilities, much wider reuse of existing content, and faster and more effective integration of content from multiple sources. .

Figure 1 below depicts how a concept known as Application Ready Data is a foundation architectural concept in numerous modern modeling and simulation communities[3]. Certain applications need more than general information about projected changes in the environment. These applications require projections as input to further analyses or modelling to explore the impact of particular scenarios in detail. This requires application-ready, locally-relevant future forecasts of environmental data:

- Application-ready: data in a form compatible with the applied model or analysis, including a representation of environmental variability (such as weather) compatible with the data used to calibrate the model;
- Locally-relevant: made relevant to the local spatial scale of interest, including the local environmental and human influences (e.g. accounting for local topography).

The choice to use application-ready data and the method to produce it are part of a wider set of choices in using environmental projections . In making these choices, it is important to have an overall clear perspective on projections and the sources of uncertainty and confidence.

The requirement for application ready data for users at the edge provides a number of areas of interest for this RFI. Beyond the areas of interest defined above, techniques for integration of near real time sensor feeds (such as weather) are of interest. Also, and of critical importance, is how uncertainty, provenance, and other metadata elements are provided. These metadata are essential to meet “fit for purpose” decisions as well as the “capture once, use many times” requirement.

[3] The following content is a rewrite of content from https://www.climatechangeinaustralia.gov.au/en/support-and-guidance/using-climate-projections/application-ready-data/

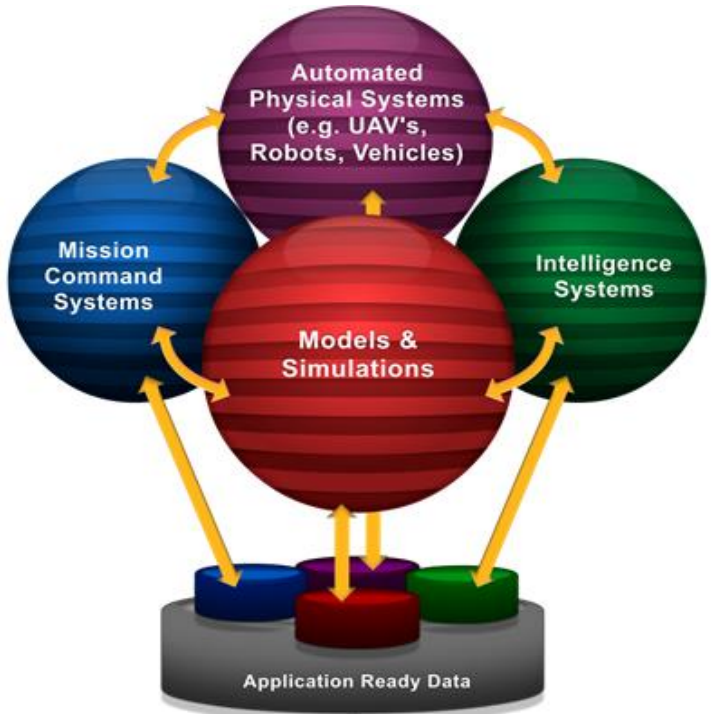

Figure 1: Concept of Application Ready Data

Several recurring challenges are common in the above background discussion:

- Lack of an integrated policy and operational framework to facilitate rapid acceptance, qualification, ingest and use of relevant geospatial information from a range of government, commercial providers and citizens.
- Inability with existing metadata approaches to quickly discover and understand which information sources are most useful in the context of a user's need.
- Inability to properly fuse and synthesize multiple data sources locally to derive knowledge necessary for rapid simulation decision support.
- The need for persistent platforms to organize and manage modelling and simulation related geospatial information and tools necessary for collaborating organizations to address the full 3d content lifecycle.

3. 3D Mixed Reality to the Edge Concept Development Study

Goal: This OGC Concept Development Study (CDS) will bring together diverse stakeholders from the global geospatial modeling, simulation, machine learning, and gaming community to assess the current state of components, including technology gaps, for the use of automated 3D automated workflows that support the user at the edge.

4. RFI response outline

Stakeholders interested in responding to this RFI should respond to the following questions **as applicable** to your role or experience. There is not a requirement to answer all questions. You may also submit any documents you feel are applicable to this RFI.

As a further point of clarification, we are not interested in literature reviews, paper-based studies, non-technical solutions or marginal improvements to existing capabilities. Please reference products and technologies as appropriate. However, product “pitches” are discouraged. This is not a competition and therefore we are not asking for costed proposals. This is a market request for information and there is no commitment to subsequently launch a formal funded OGC Pilot.

Abbreviations used in the following questions:

- AI: Artificial Intelligence
- AR: Augmented Reality
- CDS: Concept Development Study
- DL: Deep Learning
- ML: Machine Learning
- VR: Virtual Reality

4.1. Respondent information

4.1.1. What is your contact information?
4.1.2. What organization are you affiliated with and what is your role dealing with 3d/4d data curation, analytics, and provision?
4.1.3. Are you a provider or a consumer of technology, data, services, and so forth?
4.1.4. What user community(ies) do you work in or represent?

4.2. Architecture

4.2.1. Do you use any automated processes for analyzing, modelling, and/or visualizing 3d/4d content in your organization?
4.2.2. Do you use any automated processes for integrating 3d/4d content from multiple sources into AR/VR applications?

4.2.3. What do you think should be the key technology components (e.g., standards, networks, clients, web services, data storage) for more automated workflows for provision and use of 3d/4d geospatial content to a user at the edge?

4.2.4. How important is the use of controlled vocabularies (e.g. ontologies) in automated workflows especially in the use of machine learning as related to automated processing and curation of 3d/4d content?

4.2.5. What do you think is the best way to provide interoperable, automated 3D workflows that support the user at the edge?

4.2.6. How important is provenance and metadata in these automated workflows?

4.2.7. How important is it for the end user to have access to provenance and metadata information?

4.2.8. Does your organization have a ML/AI plan for geospatial data analytics? If so, please provide a brief description if you are able.

4.2.9. Currently, what are the key geospatial standards you use to access and disseminate 3d geospatial content and/or services to users at the edge?

4.3. Data Analytics

4.3.1. What 3d/4d data does your organization already use? This may be either indoor or outdoor or both.

4.3.2. What 3d/4d geospatial content do you regularly use whose value would be enhanced by the use of ML/AI analytics?

4.3.3. What 3d geospatial storage formats or encodings do you use?

4.3.4. What needed data sharing (interoperability) capabilities are missing and should be made available, revised, or developed?

4.3.5. Is the data you have access to “fit for use”? Available in the formats you require? Are the datasets updated in time intervals that meets your needs?

4.3.6. Are there adequate tools for your analysis, dissemination, and visualization of the 3d/4d data?

4.3.7. Are the tools or data you have only accessible to limited, experienced people, or are they also accessible by general populations?

4.3.8. Do you use conceptual or domain models, and if so, how?

4.4. Scenarios and Use Cases

4.4.1. What do you see as key workflow use cases for automated 3d/4d analytics?

4.4.2. What do you see as key use cases involving provision of 3d/4d content and other information assets to the user at the edge?

4.5. Operation & Organization

4.5.1. What policy, organizational, and administrative challenges do you have that must be addressed to improve provision of curated 3d/4d content to the user at the edge?

4.5.2. Are there unique needs that need to be considered at various levels of operations (local, state, regional, national, international levels, and by various players (government, commercial, NGO, academia/research)?

4.6. Technologies & Applications

4.6.1. Are you aware of national, regional or topical portals that can be used to support your automated 3d/4d workflows? How might they be improved?

4.6.2. What other type of applications, tools, and services do you believe should be developed or integrated that enhance the currency and value of provision of 3d/4d content to the user at the edge.?

4.7. Other Factors

4.7.1. What sensor inputs, computing architectures, communications networks, and/or other technologies would enable additional 3d/4d capabilities at the edge?

4.7.2. Does a DDIL environment change your workflow for 3d/4d information at the edge?

4.7.3. What other success factors or considerations do you see as needed for successful automated or semi-automated 3d/4d workflows?

Readers of this RFI are encouraged to respond with recommendations for the aspects listed above or any additional procedures, technology, data, borderline conditions, or open standards issue that you think should be considered for automated 3D/4d mixed reality workflows and applications. The recommendations can address needs of any phase of the 3d/4d content lifecycle.

5. Organizations issuing this RFI

The **Open Geospatial Consortium** (**OGC**) is an international consortium of more than 500 companies, government agencies, research organizations, and universities participating in a consensus process to develop publicly available geospatial standards. OGC standards support interoperable solutions that "geo-enable" the Web, wireless and location-based services, and mainstream IT. OGC standards empower technology developers to make geospatial information and services accessible and useful with any application that needs to be geospatially enabled. OGC has planned and completed over 100 initiatives – testbeds, pilots, and experiments – designed to join the public and private sectors in hands on collaborative development, testing, prototyping and demonstration of enhanced or new interoperable, standards-based approaches. Recommendations from these initiatives become new or revised open standards and best practices which help to improve decision making, reduce the time and cost in mobilizing new capabilities, and to save lives and minimize the impact to property and the environment.

SOFWERX (www.sofwerx.org) is designed and operated to help solve challenging warfighter problems through increased collaboration and innovation. Its charter is to create and maintain a platform to accelerate delivery of innovative capabilities to U.S. Special Operations Command (USSOCOM), and to facilitate capability refinement through exploration, experimentation and assessment of promising technology from industry, academia, labs, and non-traditional solution providers. SOFWERX operates under a Partnership Intermediary Agreement (PIA) with USSOCOM. DEFENSEWERX, a 501(c)3, non-profit organization headquartered in Niceville, FL, manages and executes the SOFWERX platform.

6. Responding to this RFI

6.1. General terms and conditions

Responses to this RFI are due by February 15, 2019, as listed in the Master Schedule (see Section 8). Responses will be distributed to members of the organizations listed in section 1. Submissions will remain in the control of this group and will be used for the purposes identified in this RFI. A summary of the RFI responses will be captured in a public OGC Engineering Report. However, respondent names and organization affiliation will not be made public. If you wish to submit proprietary information, contact (techdesk@opengeospatial.org) in advance of sending the response.

6.2. How to transmit a response

Send your response in electronic version to the OGC Technology Desk (techdesk@opengeospatial.org) by the submission deadline. Microsoft® Word format is preferred, however, Rich Text Format, or Adobe Portable Document Format® (PDF) are acceptable.

6.3. RFI response outline

A response to this RFI shall respond to as many applicable aspects defined in section 5 as possible. No particular format is required, but any response should be structured in a way that allows understanding of the respondents' position on key aspects as listed in Section 5: stakeholders, architecture, data, scenarios & use cases, requirements & constraints, operation & organization, and applications and technologies. Respondents are free to add any additional topic as they think appropriate.

6.4. Questions and clarifications

Questions and requests for clarification should be sent to techdesk@opengeospatial.org.

Questions received as well as clarifications from the RFI developers will be posted publicly at the 3D Mixed Reality CDS web site: http://www.opengeospatial.org/projects/initiatives/disasterscds

6.5. Reimbursements

The organizations issuing this RFI will not reimburse submitters for any costs incurred in connection with preparing responses to this RFI.

7. Master Schedule

The following table details the major events associated with this RFI and the follow-on Pilot.

Activity/Milestone	Date
RFI issued	January 7, 2019
RFI responses due	February 15, 2019
1st Planned Workshop	April 2019
RFI result ER publication	June 2019

8. Reference Documents and Resources

Big Geospatial Data – an OGC White Paper. Percivall, Reed, Simonis, Lieberman, Ramage. 2017	http://docs.opengeospatial.org/wp/16-131r2/16-131r2.html
Curation Reference for Geospatial data. Accessed Dec. 3, 2018	http://www.dcc.ac.uk/resources/briefing-papers/introduction-curation/curating-geospatial-data .
Every Second Counts: Integrating Edge Computing and Service Oriented Architecture for Automatic Emergency Management. Chen and Englund. 2018	https://www.hindawi.com/journals/jat/2018/7592926/
Edge Computing for the Internet of Things: A Case Study Premsankar, Di Francesco, and Taleb, 2018	https://users.aalto.fi/~premsag1/docs/premsankar2018edge.pdf
Geospatial to the Edge Interoperability Plugfest, Bermudez. 2018.	http://www.opengeospatial.org/projects/initiatives/geoedgeplugfest

Establishment of an Algorithmic Warfare Cross-Functional Team (Project Maven), Deputy Defense Secretary Bob Work, memo of April 2017	https://www.scribd.com/document/346681336/Establishment-of-the-AWCFT-Project-Maven#from_embed
Fog Computing: Focusing on Mobile Users at the Edge. 2015. Luan et. al.	https://www.researchgate.net/publication/272027182_Fog_Computing_Focusing_on_Mobile_Users_at_the_Edge
FogGIS: Fog Computing for Geospatial Big Data Analytics.	https://arxiv.org/pdf/1701.02601
GeoFog4Health: a fog-based SDI framework for geospatial health big data analysis, Barik et.al., 2018	https://link.springer.com/article/10.1007/s12652-018-0702-x
Remaking Intelligence Processing, Exploitation, and Dissemination, Kimmons, Makuta, Gilmer, 2017	https://www.defenseone.com/media/ped-thought-piece-presentedby-booz-allen.pdf
RedEdge: A Novel Architecture for Big Data Processing in Mobile Edge Computing Environments, 2017.	https://www.mdpi.com/2224-2708/6/3/17/pdf
The future of geospatial intelligence. 2017. Dold and Groopman	https://www.tandfonline.com/doi/full/10.1080/10095020.2017.1337318
The Gamification of the Geospatial Industry. 2018. GITA Newsletter.	https://www.xyht.com/spatial-itgis/the-gamification-of-the-geospatial-industry/
The Role of Geospatial in Edge-Fog-Cloud Computing - An OGC White Paper. 2018. Percivall	http://docs.opengeospatial.org/wp/18-004r1/18-004r1.html