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OGC Interoperable Simulation and Gaming (ISG) Sprint Initiative Proposal

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Contents

Overview

This proposal includes the following contributions:

- Deliverable I: The GeoVolumes API Server (AKA "3D Container API").
- Deliverable II: Updating Existing Models (3D Tiles).
- Deliverable III: The 3D Application Client - 3D Mobility Simulator (3D MS).
- Deliverable IV: The Demo Video and the Final Sprint Report of the Overall Result.

3D MS

In this 5-days sprint, we propose the development of a draft 3D web application called **3D Mobility Simulator (3DMS)** for simulating the modern city mobility such as air-taxi or E-bike in the 3D urban environment. In this application, our concept and implementation will include the **GeoVolumes API** for managing the standard 2D or 3D static geospatial resources such as GeoJSON, glTF, 3D Tiles, i3s, elevation model, or other standard geospatial formats. At the same time, the dynamic moving data such as taxi, air-taxi movement, e-bike movement will be managed by the **SensorThings API**.

Within the use case, the following issues of the Sprint Scenario:

Deliverable I:

- Test and evaluate the different organization of the underlying 3D data at the server. Three approaches will be compared using the "3DMS" use case with San Diego data set and a CityGML LoD 1 building model of California as an example:

    1. Organize the data on the server in one single bounding volume hierarchy
    2. Organize the data on the server in multiple bounding volume hierarchies per county and city
    3. Organize the data on the server in multiple bounding volume hierarchies per feature (buildings, road network, etc.)

- In addition, we would like to integrate the SensorThings API as it is a quick win and adds moving objects to the sprint scenario (optional)

Deliverable II:

- Investigate implementation issues with accessing multiple alternate distributions, esp. in the correlation of handling updates of the data store. In this case, all alternate distributions need to be updated.
- Investigate how model updates, originating from a CityGML or CDB data store and delivered as glTF, are integrated with 3D Tiles into the client environment. Special focus is on the integration of new models with existing elevation model and handling updates of the data store.

Deliverable III (optional):

- Client to showcase the developments and the use case

In the back-end, we will provide the GeoVolumes server developed in the OGC 3D container pilot for severing the 3D city model data in the area of New York. For the Sprint, we will add data sets from San Diego, and California, and are open for more areas of interest from other sprint participators. Then, the 3DMS will query and render these datasets available from Steinbeis GeoVolumes server and other available GeoVolumes servers. This application will be developed based on the CesiumJS which we have an existing prototype of 3D web client from the 3D Container pilot. Optionally, the new 3D client will be tested and developed based on the Unity3D game engine software.

In OGC 3D Data Container and Tiles API Pilot, Steinbeis has successfully implemented a GeoVolumes API service serving 3D geospatial resources in various standard formats such as 3D Tiles, i3s, and CityGML. Also, we developed the web-based 3D geoportal client, which queries and renders 3D datasets from servers implementing the GeoVolumes API. In OGC Testbed 14, Steinbeis has implemented a former called WFS 3.0 (now OGC API) 3D Portrayal Service Open API based on the implementation of a 3D Portrayal Service of Fraunhofer and others in Testbed 13. This API delivers a 3D building model (as one layer of the 3D city model) of Manhattan using 3D Tiles. Also, we were highly experienced in developing the 3D client based on various tools including CesiumJS, ESRI, Deck.gl, and Unity. Both in the OGC CityGML 3.0 challenge Manchester and the 3D IoT Platform for Smart Cities Pilot, Sensor Things API has been used in a 3D environment already.

Deliverables

Deliverable I: GeoVolumes API Server

In OGC 3D Container and Tiles API pilot, Steinbeis had successfully implemented the GeoVolumes API server to deliver geospatial resources supporting 3D Tiles, I3S, and CityGML formats in the area of New York City. This server supports the hierarchy and bounding box query through the collections and containers.

This server is available at http://steinbeis-3dps.eu:8080/3DContainerTile/

In this ISG sprint, we will expand the API mentioned above to serve the provided dataset given by OGC in the San Diego area[1] and an open-source CityGML dataset of LoD 1 buildings of California. The dataset in the API will be available in standard formats such as 3D Tiles, I3S, glTF. The available geospatial datasets which are not in the visualization-ready formats such as CityGML will be first converted to either glTF, 3D Tiles, or I3S before serving through the API. The draft hierarchical collections of Steinbeis GeoVolumes API is illustrated in Figure 1.

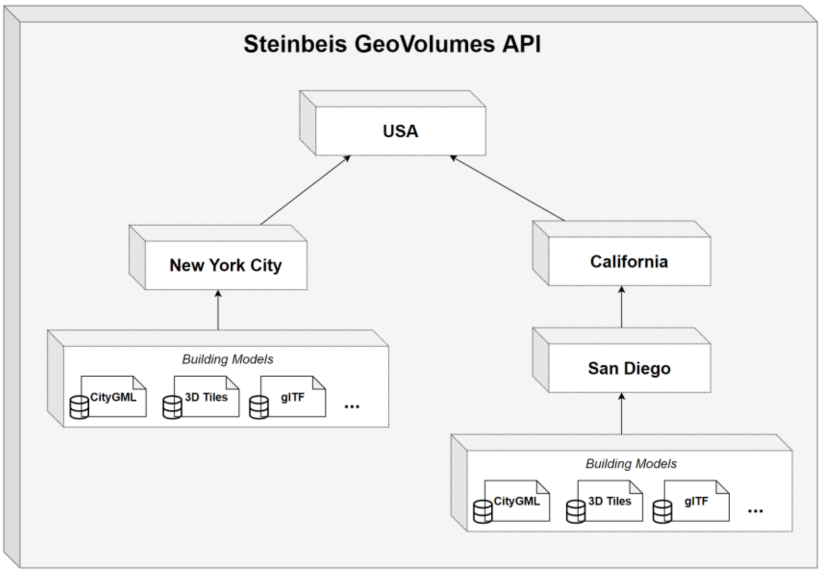

Figure 1: Draft hierarchical collections of Steinbeis GeoVolumes API for the ISG Sprint.

[1] https://gsa-temp-public.s3.us-east-1.amazonaws.com/CDB_san_diego_v4.1.zip

Deliverable II: Updating existing models (3D Tiles)

Harpreet has worked on the topic entitled: "Concept and Evaluation of a Geodata Server for Automatic Updates and the Visualization of 3D City Models based on OGC standards" as his Master Thesis[2]. The primary data used in this thesis was CityGML which was stored in the GeoRocket database and the secondary data used were 3D Tiles as well as I3S. One of the major goals of this thesis work was to trigger automatic updates to the existing secondary 3D models as soon as the changes are made to the primary data store i.e. CityGML. Figure 6 shows the methodology used to implement automatic updates originating from CityGML updating 3D models (3D Tiles and I3S). In the sprint, this approach will be extended further and implementing updates to the existing 3D model (3D Tile) as the changes are made to the primary data store which in this case will be the CDB. We focus on building features to be updated (added or removed) from the 3D tiles to showcase the update pipeline.

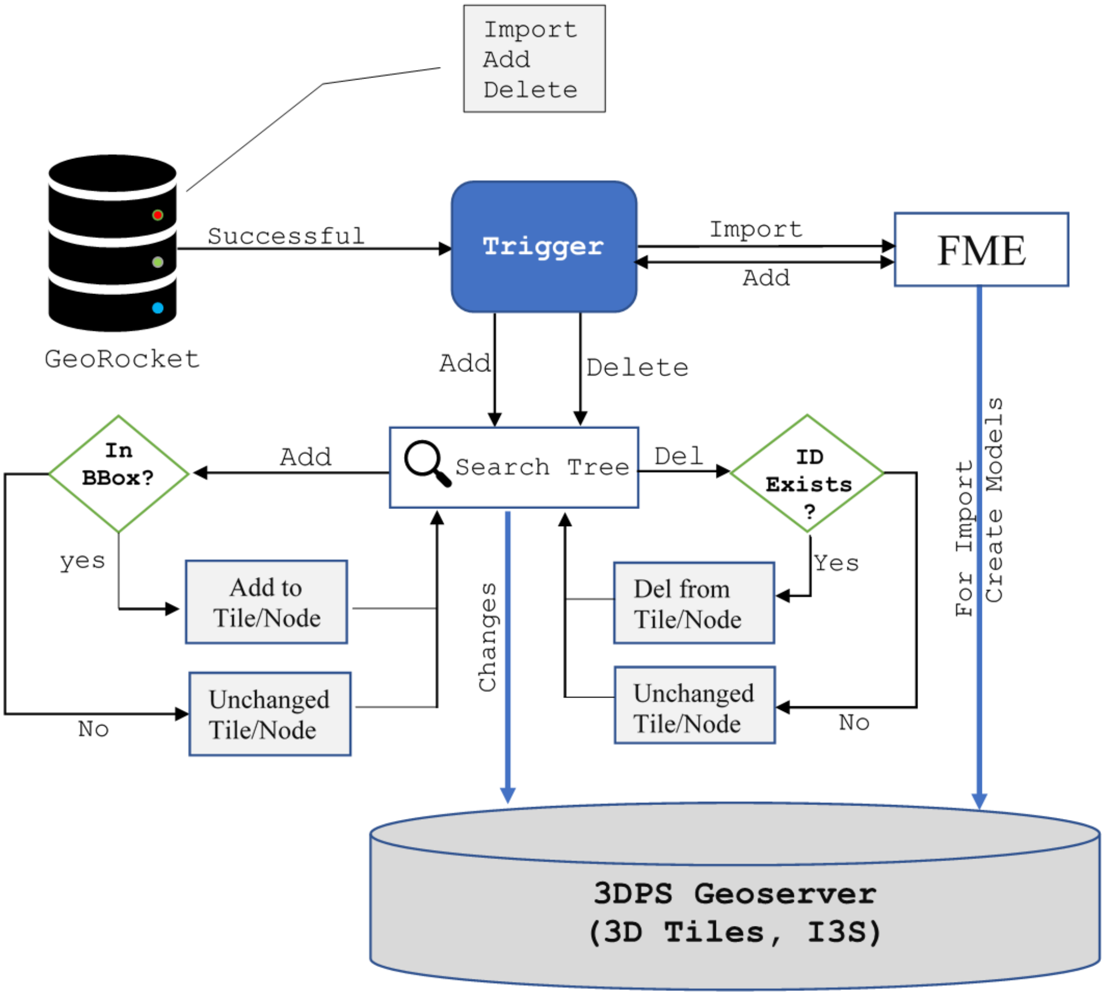

Figure 2: Methodology used to implement Automatic Updates[5]

As an example, the dataset shown in the following images is LOD-2 data of Niedernhall, Germany provided by LGL Stuttgart for the purpose of thesis work[5]. Figure 7 & 8 show the ESRI and Cesium

[2] Singh, H., Coors, V., & Bludovsky, S. (2020), "*Concept and Evaluation of a Geodata Server for Automatic Updates and the Visualization of 3D City Models based on OGC standards*", Master Thesis, University of Applied Sciences, Stuttgart, Germany.

clients respectively in which left images shows the original 3D models (I3S & 3D Tiles) whereas right images show a snapshot of the same existing models in which automatic updates were triggered.

A short demonstration of this work is available on YouTube: https://youtu.be/-r-q4n7-b30

Figure 3: ESRI client rendering I3S data. Right image shows a new building added to the existing I3S dataset.

Figure 4: Cesium client rendering 3D Tiles data. Right image shows a new building added to the existing 3D Tile dataset.

Deliverable III: The 3D Application Client - 3D Mobility Simulator (3DMS) (optional)

In the ISG Sprint, we will develop the 3D web application called 3D Modern Simulator (3DMS) for simulating the modern city mobility such as air-taxi or E-Vehicles in the 3D urban environment. This client will be developed by the CesiumJS digital globe integrating various datasets from the available **GeoVolumes API** servers. The dynamic data from the moving sensors from vehicles can be managed using the SensorThings. Then, the client can access and render these datasets from **SensorThings** to simulate the 3D urban mobility. The overview of the concept is shown in Figure 5.

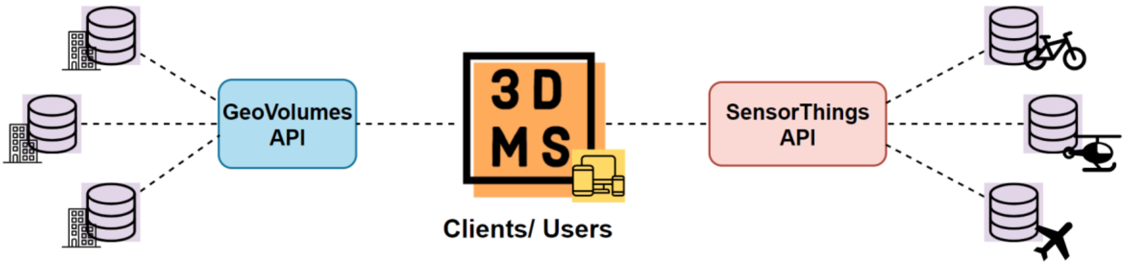

Figure 5: Overview of the 3D MMS application architecture.

This concept had been proved and implemented according to Joe's Master thesis[3], as he developed the Cesium application "i_city E-bike sharing" to simulate the historical E-bike route on the Cesium application using the SensorThings. This client is illustrated in Figure 6 left. In October 2019, Joe and Patrick had participated in the OGC CityGML challenge with their developed Manchester3D application simulating the Manchester 3D city models with the air quality data with the SensorThings as illustrated in Figure 6 right.

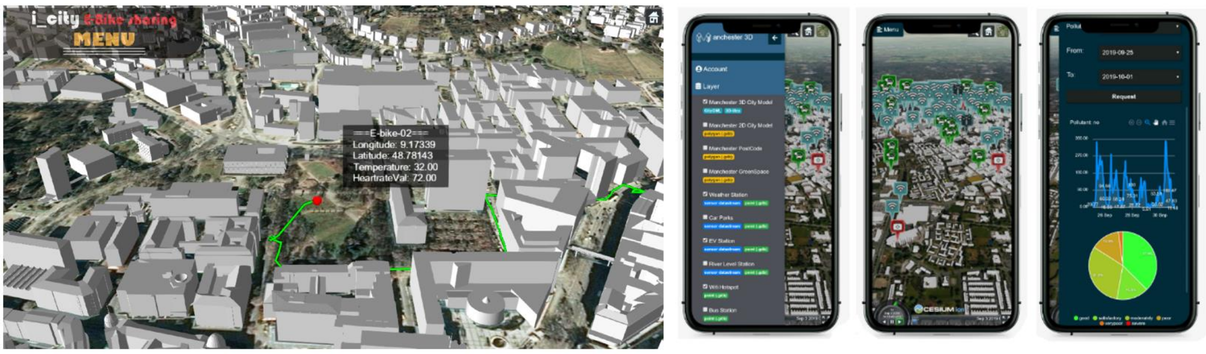

Figure 6 - Left: the i_city E-Bike sharing application simulating the E-bike route in Stuttgart. (Video demo at https://www.youtube.com/watch?v=GzvrmpM9zmw) Right: the Manchester3D application.

Also, Steinbeis had implemented the 3D web-client based on the multiple WebGL libraries, including CesiumJS, ESRI ArcGIS for JavaScript, and Deck.gl in the OGC 3D Container and Tiles API pilot. This client is illustrated in Figure 7 and Figure 8.

[3] Thunyathep Santhanavanich. (2018). Visualization and Analysis of E-bike Usage in 3D City Model by Integration of Heterogeneous Sensor Data. Unpublished. https://doi.org/10.13140/RG.2.2.14606.00324

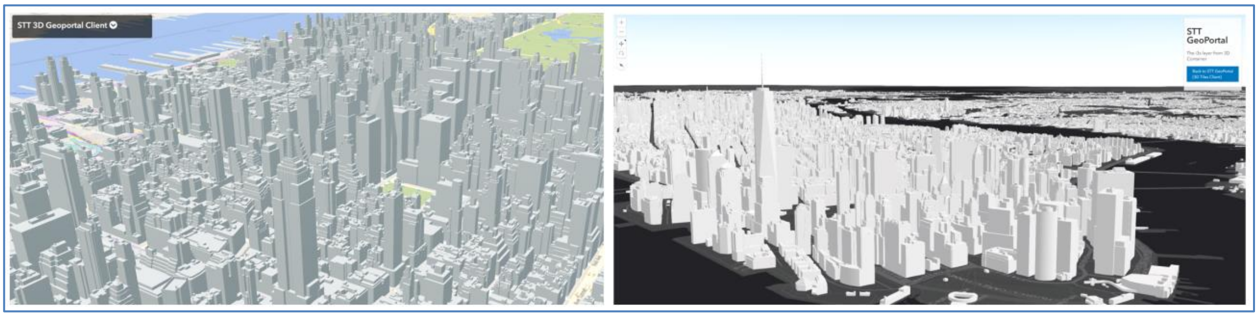

Figure 7: Steinbeis 3D Client in the OGC 3D Container and Tiles API pilot rendering the 3D city models in New York City. (Left: Cesium client rendering 3D Tiles models, Right: ArcGIS for JavaScript Client rendering i3s models.

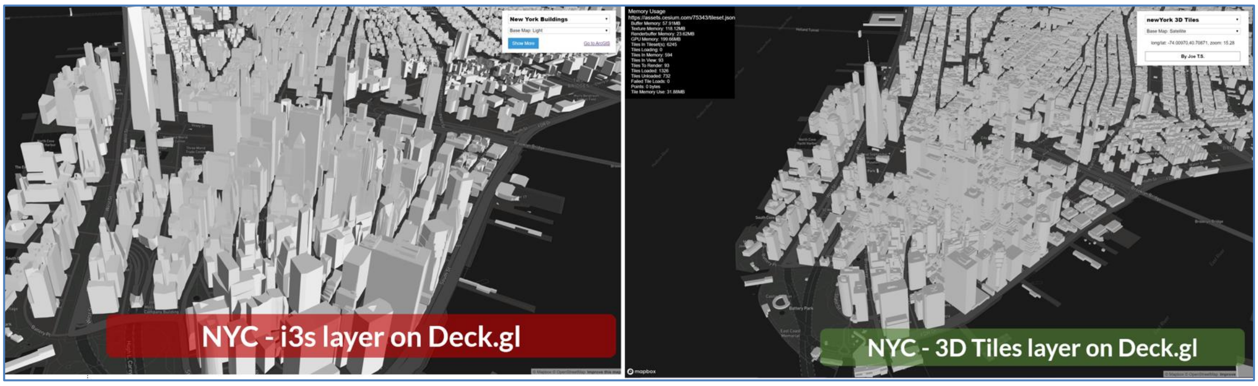

Figure 8: Steinbeis 3D Client in the OGC 3D Container and Tiles API pilot rendering the 3D city models in New York City using Deck.gl framework. (Left: rendering i3s models, Right: rendering 3D Tiles models.

The live demo of this client is available at http://steinbeis-3dps.eu/STT3DClient/index.html

Additionally, Steinbeis will observe client development based on the Unity3D game engine[4] as an optional goal. The Unity3D is designed for gaming and simulation environment, several simulating productions can be added to the client; for example, simulation of the city traffic with the AI pathfinding using the Unity NavMesh components[5] and much more. After the sprint, several research topics can be studied, such as finding hot spots for traffic problems, optimizing routing algorithms to distribute cars on the different roads for faster average travel times for everyone, a tool for city planners.

[4] https://unity3d.com/get-unity/download

[5] https://learn.unity.com/tutorial/unity-navmesh#

Deliverable IV: Demonstration Video and Sprint Report

After the implementation of the GeoVolumes API and the 3D client had been done, we will contribute to the sprint report and create a final video for the demonstration purpose. The Sprint Report will be mainly authored in the AsciiDoc format, including the result of the implementation result, discussion about the general lessons-learned, and recommendations for future works or improvements.

The demo video will be recorded and edited with the Camtasia software. Please see some of our example demo videos as listed in Table 1. These demos are our 3D clients in past projects.

Project	**Demo Video URL**
OGC 3D Container and Tiles API Pilot (2020)	https://www.youtube.com/watch?v=IWXsWSasF5A
OGC 3D IoT Pilot (2020)	https://www.youtube.com/watch?v=OpQtVV3iE9A
CityGML Challenge (2019) Manchester3D Application	https://www.youtube.com/watch?v=B_pPfbPsuMU
OGC Testbed 14 (2019) Complex Feature Handling	https://www.youtube.com/watch?v=3nHOvJMaKIs

Table 1: Steinbeis Video Demos

Personnel

Name	About
Prof. Dr. Volker Coors	Chair 3D Portrayal SWG, Editor of the 3D Portrayal Service Standard, the 3D IoT pilot. Contributor in 3D Container and Tiles API pilot.
Thunyathep (Joe) Santhanavanich	Ph.D. candidate. Familiar with glTF, 3D Tiles, I3S, and CesiumJS. Client developer and video demo production in the Testbed 14 complex feature handling, 3D IoT Platform for Smart Cities Pilot, the 3D Container and Tiles API pilot, and the OGC CityGML 3.0 challenge Manchester. Developing the GeoVolumes API server in 3D Container and Tiles API pilot. SensorThings API Expert; developed SensorThings for COVID-19 (COVID-STA) Award-winning in the WorldWind Challenge Finland 2017 and 2018 (sponsored by United Nations, NASA, ESA).
Patrick Wuerstle	Ph.D. candidate. Familiar with glTF, 3D Tiles, and CesiumJS. Client developer in the OGC CityGML 3.0 challenge Manchester Award-winning in the WorldWind Challenge Finland 2017 and 2018 (sponsored by United Nations, NASA, ESA)
Harpreet Singh	Familiar with glTF, 3D Tiles, I3S, CesiumJS, ESRI software. Master Thesis "Concept and Evaluation of a Geodata Server for Automatic Updates and the Visualization of 3D City Models based on OGC standards" at the intern. Master Photogrammetry and Geoinformatics at HFT Stuttgart, Sep 2019 to Feb 2020.
Martin Storz	Familiar with Unity3D. Expert in AR/VR technologies.