Demonstration of OpenGeoBase: the ICN NoSQL spatio-temporal database

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***Abstract*—This paper describes a demo of OpenGeoBase, a NoSQL spatio-temporal distributed database that exploits Information Centric Network technology. We show its basic operations and two applications based on it. The first one is an Intelligent Transport System application making possible to discover public transport information (GTFS files) all over the world. The second application concerns a citizen reporting application though which users can post and search for geo-tagged photos.**

I. Introduction

NoSQL databases are more and more replacing relational ones for their ability to easily scale by distributing data over different servers, while providing a flexible data model. In [1] we described the use of Information Centric Network (ICN) technology [2] to support distributed NoSQL databases and applied such architectural insights to implement a multi-tenant distributed spatio-temporal database, named OpenGeoBase (OGB) [3]. Database for spatio-temporal objects are deemed to be a pivotal component for IoT (and more) data management systems, indeed many data items exist both in space and time.

OGB stores GeoJSON objects, a popular format for encoding a variety of spatial data, such as point, multipoint, polygon, etc., with associated custom properties. To support database temporal features, we decorate the GeoJSON object with temporal properties, which indicate its validity period.

OGB is composed by front-end servers (FEs) which distributes the data over different back-end servers (BEs) using a geographical *sharding* strategy (fig. 1). Each back-end server stores objects of a given geographical area. Spatio-temporal queries are routed by name only towards the subset of back-end servers whose geographical area intersects the query one. For non-spatial queries, a query is flooded towards all back-end servers.

In this paper we describe a demo of OGB, which highlights its basic operations, and shows how it can be used for realizing two sample applications.

II. OGB demo

A. Demo architecture

As shown in fig. 1, the demo uses one front-end and three back-end servers, which serve the following geographical areas: Europe, East Asia and the rest of the world. For implementing the ICN, we used the NDN software [4].

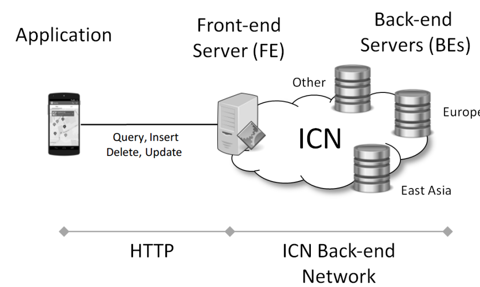

Fig. 1. OGB Demo Architecture

B. Basic operations demo

We developed a WEB *dashboard* through which we can simply carry out the main OGB operations (fig. 2), namely: login, insertions and spatio-temporal queries. The dashboard is based on the HTTP API offered by the front-end server.

The user logs in to the platform by entering its tenant identifier, username and password. Such information is used for OGB data-level access-control and security [1].

After login, it is possible to carry out an insert operation e.g. of the following GeoJSON object, which is a Point of Interest in the city of Rome:


```
{"geometry": {"type": "Point","coordinates":
[12.49, 41.89]},"properties": {"POI_name":
"Colosseum","city_name": "Rome"}}
```


During the insertion process, it is possible to observe (tcpdump) that only the European back-end server is involved in the storage operation, as the geometry is completely located in Europe. We can make a further insert example by using another GeoJSON object geo-referencing the venues of the previous LANMAN conference editions. The geometry type is a Multipoint intersecting all the BE server areas, thus this insertion involves all of them.


```
{"geometry": {"type": "MultiPoint","coordinates":
[[135.51, 34.66], [12.49, 41.89],
[116.32,40.00], [-119.82,39.51]]},
"properties": {"years": "2017,2016,2015,2014",
"cities_name": "Osaka , Rome ,
Beijing , Reno" }, "temporalExtent":
{"validTime":{"type":"interval",
"values":["01/01/2014", "31/12/2017"]}}}
```

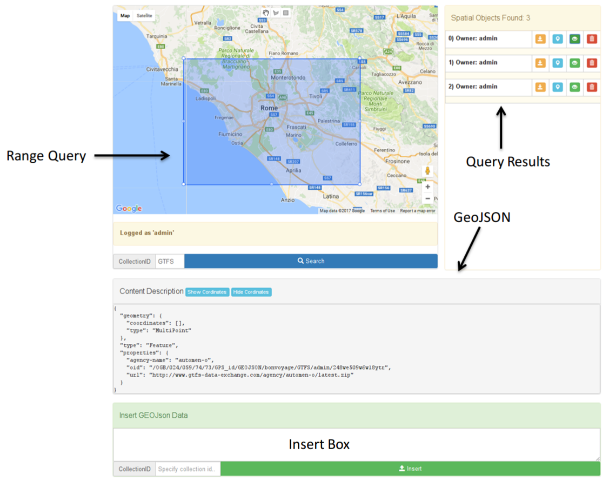

Fig. 2. OGB Dashboard

Fig. 4. Smart-city demo

Through the dashboard, it is possible to carry out a range query by drawing a box or a polygon over the area of interest. The range query returns all the objects intersecting the requested area. If, for instance, we execute a query over an European area we can observe (tcpdump) that OGB query routing is properly working by sending the query only towards the European BE. A similar example can be repeated for an Asian area observing that only the Asian BE is involved.

C. ITS demo application

Recent European Union directives recommend the deployment of a federated system of National Access Points providing ITS information, such as public transport details, traffic status, etc. We envisage OGB as a candidate technology for implementing that federated system and, accordingly, this demo concerns an Intelligent Transport System (ITS) Application based on OGB.

We fetched all information provided by the http://transit.land repository, about 1000 GTFS files, referring to different public transport providers all over the world. Each GTFS is inserted in OGB as a Multipoint GeoJSON object, whose points are the GPS coordinates of each stop.

The ITS application (fig.3) makes possible to query an interested area, discover the available GTFS files having a stop in that area, show all the contained stops and then download the files.

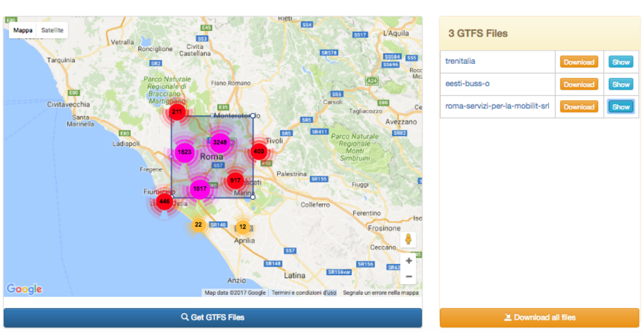

Fig. 3. ITS demo

D. Smart-city demo application

For this demo we devised a simple smart-city application used by citizens to report city problems, attractions, events, etc. by uploading photos referenced in time and space. Actually, the EXIF data of a smartphone photo contains many kinds of information, including the GPS position and the shot time. Exploiting this information we have developed a mobile application allowing the user to push such a geo-tagged photos to OGB. From a Web interface, users can explore the photo catalog using spatio-temporal queries, in order to obtain photos shot in a specific time interval and geographical area.

III. Conclusions

This demo paper practically shows the main features of the OpenGeoBase ICN NoSQL spatio-temporal database, highlighting some key functionality such as sharding and query-routing. Two sample applications have demonstrated OGB applicability for scenarios that are gaining momentum, such as Intelligent Transport Systems and smart-cities.

Acknowledgements

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References

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