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# A SERVICE ORIENTED ARCHITECTURE FOR SPATIAL AND BUSINESS DATA APPLICATIONS: AN eCAMPUS CASE STUDY

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## EXTENDED ABSTRACT

Location-dependent queries of geospatial data are indispensable for users in today's era of "Smart" environments. At general scales, Google Maps and Google Earth with satellite and street views have provided some utilities for users to query specific locations. However, at local scales, where detailed 3D geometries and linked business data are needed, there is a general lack of related information for in depth exploration of an area. For instance, the following kinds of questions cannot be answered when interacting with Google Maps/Earth on a typical university campus: what classes are scheduled in that room over there? Whose office window is that up there? What buildings/objects can I actually see around me while standing at a specific location on campus? Or in a hospital, by spatial querying hospital datasets we can ask what the surgery schedule is in that operating room? What medical equipment is installed in that room? How far is it to move from this room to another?

Linking spatial data and business data helps to enrich the user experience by fulfilling more user needs, in particular for applications that need to explore detailed local scale data such as in a Zoo, Museum, Hospital, Campus, Business Park, etc. There are normally two types of users for such applications: public users (e.g. visitors to an area) and local users (e.g. staff and students). Access privileges and query levels depend on the user type.

In general, spatial data does not change much over time, but business data changes faster depending on the nature of the business. The flexibility, interoperability, heterogeneity, and stability of this kind of linked search application demands a suitable software architecture, at the current time a service oriented architecture (SOA) seems a good solution. This work presents a general SOA for local scale spatial and business data applications and its test implementation at the National University of Ireland, Maynooth (NUIM) campus; known as the eCampus Demonstrator.

The SOA architecture includes three main layers; *User Interface Layer*, *Web Services Layer* and *Database* Layer: 1) The User Interface Layer is web-based where it receives user queries in the form of user interactions with a map where it overlays any corresponding query/search results; 2) The Web Services Layer is composed of Web Map Services (i.e., OpenStreetMap, Google Maps and Google Earth), Spatial Data Retrieving web services (i.e. querying 2D and 3D spatial data), Business Data Retrieving web services (i.e., querying business data according to context, usually based on user location), Visualisation web services (i.e., an aggregate web service which analyzes a user query and then calls the corresponding Spatial Data Retrieving web service and Business Data Retrieving web service and displays the final query result on a map); 3) The Database Layer includes 2D data (i.e., the 2D building footprints), 3D model data (i.e., individual building components including floors, rooms, windows, doors, pathways, etc. linked to their attributes), and the business data (e.g., class schedules, lab times, office hours, etc.) that can be hosted separately in an enterprise database management system (e.g., Oracle DBMS).

Our demonstrator is developed within the framework of the SFI funded StratAG project where various web services have been developed by different research groups on different platforms. OpenStreetMap and Google earth are used for both 2D and 3D query. Querying the 2D data web service returns vector data in JSON format, meanwhile querying the 3D data web service returns vector data in KML files. Querying the business data web service with the Web Logic server also returns data in JSON format. OpenLayers APIs are used for the Visualisation web services. 2D and 3D datasets are stored in Oracle Spatial, in which 2D data is obtained from OpenStreetMap, and 3D buildings data are reconstructed from terrestrial LiDAR scans. Finally, the business data is also stored in an Oracle DBMS.

In order to evaluate the proposed architecture, we have based our tests on metrics identified in the literature including granularity, performance, and interoperability. However, the measurement is subjective. It has been shown that the proposed framework satisfies the requirements for such an application with regard to heterogeneity, flexibility and interoperability.

In the near future we aim to test the architecture in the hands of real students/staff/visitors to NUIM Campus on mobile devices which, apart from interacting with the map to indicate specific locations and ad hoc queries as usual, the real-time user location and personal preferences can also be identified and exploited together as input query parameters to the eCampus Demonstrator application.

**Keyword:** spatial data, service oriented architecture, business data, query, maps

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