Data, Information and Process Integration with Semantic Web Sevices

DIP

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SWS Enhanced GIS prototype (IRSIII) Final Version

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EXECUTIVE SUMMARY

This deliverable summaries the principles and functionalities of a prototype that contributes to the following golden bullet of DIP: *Real Use Case Implementation of SWS in the e-Government sector*. The prototype represents a SWS-based emergency management application (named eMerges) and has been developed to fulfil Essex County Council’s (ECC) needs to access geospatial data for emergency management and to share it with other partners (e.g.: police, ambulance services, meteorological office, other public organizations, etc) during an emergency situation.

The deliverable is intended to be read by DIP technical partners to inform them of the way in which the tools/technology has been used to create a use case scenario. In addition, it will be of interest to the end-user community and other data suppliers (e.g.: Essex County Council and other public authorities’ emergency planners, police, Essex Fire & Rescue Service, ambulance service, highways and transport, meteorological office, Ordnance Survey, BAA safety services, Essex Rover Rescue).

This deliverable is directly related to the previous deliverables D9.10 and D9.12 that detail the main prototype elements. However, a new functionality of the prototype is described in Section 3 of this deliverable.

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Abstract (for dissemination)	WP9 is an e-government use case. This document provides the description of the final version of the GIS emergency prototype implemented in the WSMO compliant Internet Reasoning Server (IRSIII).
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ACRONYMS/GLOSSARY

ECC Essex County Council

EO Emergency Officer

IRSIII Internet Reasoning Server 3

OU Open University

SO Spatial Objects

SWS Semantic Web Service

WS Web Service

WSMO Web Service Modelling Ontology

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1 INTRODUCTION

Currently, one of the main needs of Semantic Web is the development of real-world applications that demonstrate its added (business) values. In particular, the full potential application of SWS technology requires large-scale testing domains. Since it is an enormous challenge to achieve interoperability and to address semantic differences related to the great variety of datasets and information technology solutions which should be networked, e-Government may be a very effective test-bed for evaluating the SWS frameworks and tools developed within DIP. This deliverable summarises the results of implementing a compelling SWS-based prototype - named eMerges - in the e-Government domain.

1.1 eMerges

In an emergency situation, relevant information is needed to assist planning and decision making. Such information elements range from demographic data, weather forecasts and sensor data, available transportation means to the presence of helpful agents (people), land use and include statistics or values, etc. Moreover, the emergency management process is dynamic as it involves various defined sequential and alternative steps on the basis of the specific situation, described in standard procedures with which the Emergency Officer (EO) should always comply. Different agencies own different relevant data and emergency related knowledge, which needs to be shared with the other partners during an emergency.

eMerges is a decision support system that assists the EO in the tasks of retrieving, processing, displaying, and interacting with relevant information, more quickly and accurately. As a result, the involved agencies will be able to extend their knowledge about the emergency situation they are dealing with by making use of different functionalities based on data held by other agencies which otherwise might not be accessible to them or slow to obtain.

1.2 The eMerges Approach

Two main issues are related to eMerges: spatial data integration and context based navigation of data. In the following, we summarise these aspects of our approach.

1.2.1 Spatial Objects

Firstly, in order to describe and to reason about Spatial Objects (SO) in all their generality, a simple yet precise definition is needed. Our model is based on Galton's theory of objects and fields [5] which defines a spatial-object as an identifiable typed entity having a location component (some kind of 'whereness') and other attributes.

Mapping of arbitrary domain entities to spatial objects can be automatic or manual. In automatic mapping, a procedure collects each object's attribute value and transforms it into an attribute name/value pair of a spatial object, with a special treatment for id and location. In manual mapping, arbitrary transformations are possible. Once spatial objects are gathered, further efforts are needed to achieve independence between the client and the domain objects.

Therefore, secondly, to achieve generalization, an *Archetypes* ontology provides very high level abstractions (e.g. *container*, *house*, *agent*, etc.) to which entities have to be mapped. In this way even if the client application does not understand the type of element that is to be represented, a choice of representations and actions is still possible by reasoning on the attached archetypes, which clients are requested to be aware of. For example if a client application does not have a representation for a *hospital*, it would know how to represent a *house* as the attached archetype, with affordances including how to get there, which is in any case more sound than other archetypal representations such as *agent* or *link*.

Thirdly, to adapt the representation of an SO to a particular interface, the *HCI* ontology maps an object to its particular representation. For example some interfaces need "pretty names" selecting a feature to privileged display (e.g. on hovering on the object); an attribute of an adapted HCI concept allows us to specify which information should be displayed.

These ontologies, together with the attached mapping mechanisms, are called *integration ontologies* since they allow the integration of spatially related data sources ranging over very different domains. Alone, they allow to integrate spatial data sources in a generic way, however, as the number of data sources increases, the task of presenting objects and possible queries according to the context, in order for the user not to be overwhelmed by the amount of information, becomes essential. The notion of spatial context becomes essential to provide only relevant information and services.

1.2.2 Spatial Context

In order to alternate cognitively sound representations and actions *context-awareness* [6] is needed. In eMerges, the main components of context are related to *user role*, *task*, *location*, and *focus* of interest. Indeed a user identifies him- or herself as having a particular role, such as firemen responsible of transportation in a snow storm emergency, or police forces responsible for people's accommodation. Moreover, weather information is available only in the region covered by the service, and must be made available only in relation to objects related to weather investigation or emergency planning.

Object representations differ according to the context; e.g. emergency planners view shelters as points independently of scale, while fire brigade responsible for transport needs precise access plans at a greater proximity. Secondly, to spatial objects are linked possibilities of action, which allow getting more information in a precise context. For example an area defined as an evacuation zone may offer goals allowing finding the nearest supermarkets or hotels, etc. This links the SWS notion of *goal* to the cognitive notion of *affordances* attached to an object. When caught into a context, a spatial object receives specific affordances, i.e. what the object allows to do varies with context not only upon retrieval but as the situation evolves.

To achieve this, the question of whether a specific context reasoning engine has to be used is open. However, we believe that in the context of SWS, a more scalable solution may be achieved by distributing the task of context handling amongst *smart services* which also implement reasoning in our architecture. Indeed context pervades the elements of an application, and can be represented (a) at an affordances level, i.e. by offering very specific goals only, according to the context, e.g. a *get-heated-shelters* goal will be presented in an emergency case involving low temperatures, or (b) at a composition level, i.e. generic affordances are presented but smart composition between goals ensures context relevance, e.g. the generic goal *get-shelters* is presented to the user but highlights heated shelters according to the snow storm task. The first solution has the advantage of being more explicit, whilst the second is easier to implement since it requires fewer goal definitions. Being able to handle context at every level makes both solutions possible in SWS based applications.

1.3 The prototype

Following the approach described above, we developed a prototypical application based on a real past emergency situation: a snowstorm which affected the M11 motorway on 31st January 2003. To present the application, we adopted the following layered architecture:

- *Legacy System layer:* consists of existing data sources and IT systems provided by each of the involved governmental parties.
- *Service Abstraction layer:* exposes the functionalities of the legacy systems as WS, abstracting from the hardware and software platforms of the legacy systems. Whenever a new service is available at this layer, it will be semantically described and properly linked to existing semantic descriptions.
- *Semantic Web Service layer*: given a goal request this layer, implemented in IRS-III, will (i) discover a candidate set of Web services, (ii) select the most appropriate, (iii) mediate any mismatches at the data, ontological or business process level, and (iv) invoke the selected Web services whilst adhering to any data, control flow and Web service invocation requirements. To achieve this, IRS-III utilises the set of WSMO descriptions, which are composed of goals, mediators, and Web services, supported by relevant domain ontologies. This layer provides the flexibility and scalability of our application. Managing the semantic description, the semantic developer can introduce new functionalities of the application (e.g. new EO goals that can be invoked by the user interface) or updating existing ones.
- *Presentation layer:* is a Web application accessible through a standard Web browser. The goals defined within the previous layer are reflected in the structure of the interface and can be invoked either through the IRS-III API or as an HTTP request. The goal requests are filled with data provided by the user and sent to the Semantic Web Service layer.

To obtain more details about the prototype architecture, developed ontologies, and WSMO descriptions, please refer to [7] and [8].

2 Fact Sheet

2.1 Deliverable Name

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2.2 Contact person with contact details

For technical information or questions about eMerges, please contact Vlad Tanasescu by email at v.tanasescu@open.ac.uk.

2.3 Short description of purpose, scope and functionality

eMerges illustrates the way in which spatially related data delivered through SWS can ease the management of specific use cases by aggregating data originating from different sources, and presenting it in a way which is both consistent and task relevant. Indeed it allows the end user to handle tasks in a data rich environment without being overwhelmed by the amount of information or by the complexity of the queries, and to the expert an easier approach to data integration.

eMerges provides this integration by mediating legacy spatial data sources to high level spatial ontologies through SWS and by presenting for each object context dependent affordances. It adopts WSMO [2] and IRS-III [1] to (i) provide an infrastructure, in which new services can be added, discovered and composed continually; (ii) allow the automatic invocation, composition, mediation, and execution of complex services.

2.4 Technical requirements for using the prototype

The prototype implementation is a Web interface using Google Maps [3] for the spatial representation part of the application. The interface is built using the Google Web Toolkit [4], using AJAX techniques on the client to communicate with a Java servlet, which itself connects to IRS-III [1] through the IRS implementation of the DIP APIs.

Thus, simply adopting a Web browser[1], it is possible to access all of the functionalities provided by the prototype, without installing any library or third party product.

2.5 Detailed information on how to use/evaluate the prototype

To use the prototype, access the live version available at the following URL: http://irs-test.open.ac.uk:8080/EMerges/

More information about the prototype and a screencast of an usage example are available at the same URL.

2.6 Detailed licence information

The eMerges prototype, available at http://irs-test.open.ac.uk:8080/EMerges/ is usage free. It is not for commercial use. eMerges comes with absolutely no warranty.

2.7 Roadmap on future plans for further developing the prototype

eMerges is evolving into a generic framework for spatial data integration through SWS; it will allow the unified representation and manipulation of generic heterogeneous spatial data sources (not emergency situations only). This involves extending the existing context and spatial objects ontologies of the prototype.

[1] eMerges has been tested with Mozilla Firefox and Internet Explorer; the best results (in terms of GUI usability) have been obtained with Mozilla Firefox.

3 Documentation

The significant components of the interface are a central *map*, displaying *spatial objects*. A spatial object can have an area based location, in which case it is represented as a polygon, or a point based one, in which case it is represented by a custom image (Figure 1). All objects present the same interface, with *affordances (Goals)* and *features (Attributes)*, displayed in a pop up window or in a hovering transparent region above it (Figure 1, Figure 2).

The interface allows the user to define spatial objects that can be associated to a given type of emergency from the existing ontology. Each emergency type presents different affordances that can be invoked in order to retrieve contextually relevant emergency related elements. In a similar way, the interface allows the user to browse the ontologies in order to associate an emergency type to a new area, i.e. polygon (Figure 3).

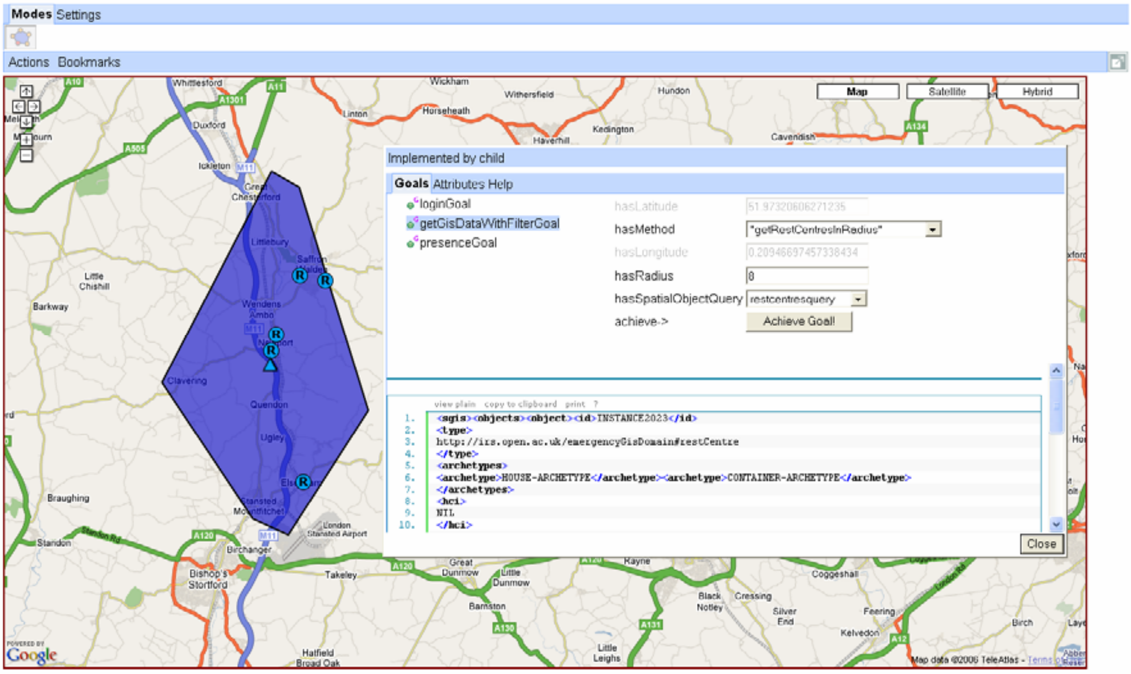

Figure 1. The eMerges User Interface.

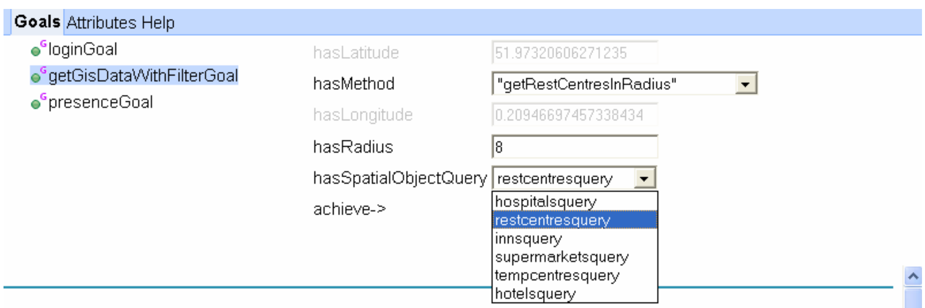

Figure 2. Pop up window associated to a spatial object

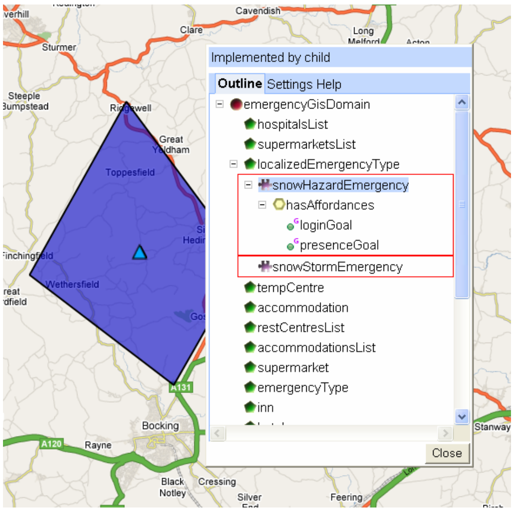

Figure 3. Ontology browsing for new area type attribution.

The last version of the prototype adds a new functionality based on the availability of new Web services that query spatial data using polygonal instead of circular regions. As a result, we can obtain an exact mapping between the polygonal region defined on the map by the user and the legacy system queries provided by the Web services. Previously this mapping was realized by mediation services that provide a circular region inscribing the input polygon region [9]. However, such an approach introduces some inaccuracies that can be really evident in cases where a circle approximation is inappropriate for a polygon (cf. Figure. 4).

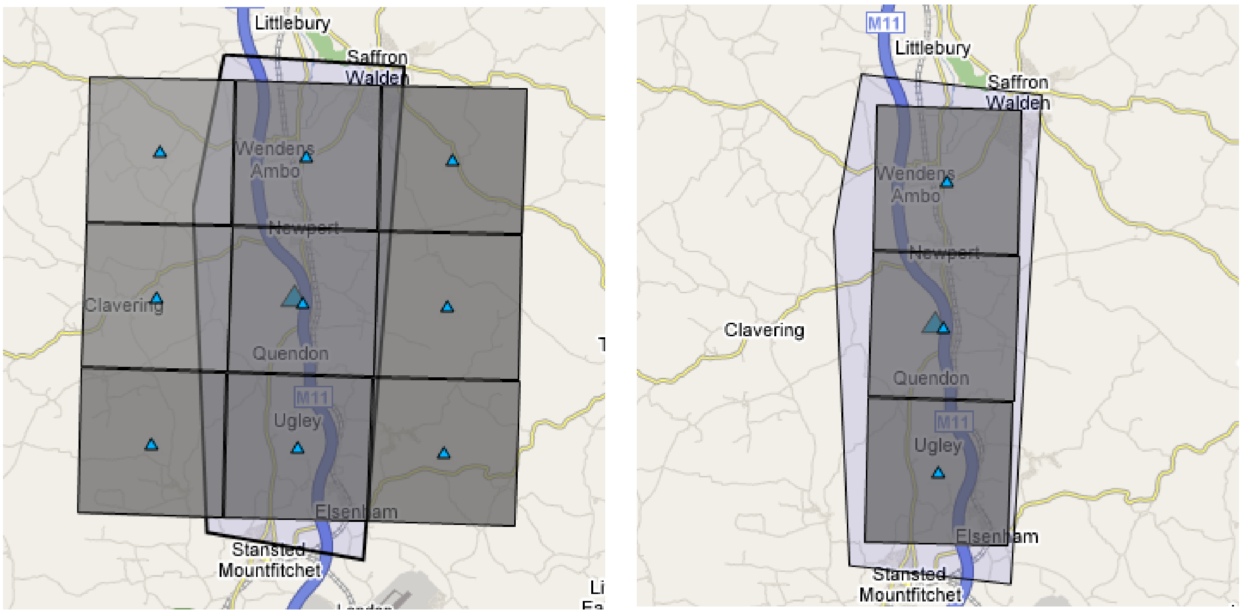

Figure 4. Using a circle approximation of the polygon (left) vs. querying data inside a polygonal boundary (right).

Finally, useful integrations of the present documentation are the following documents: [9] and [10].

4 Demonstration Information

As an example of practical usage, we describe how an Emergency Officer (EO) gathers information regarding an emergency situation, and the affordances which are available depending on the context. The procedure is as follows:

1. Based on external information about the possibility of a weather emergency the EO defines an area of interest on the map.
2. A popup window containing a tree view appears showing the elements of the available ontologies whose location is an area. The choice is *Weather-Investigation-Area*.
3. Described in an ontology, the new instance has attached *features* and *affordances*. One affordance allows to login into Buddyspace to ask field agents for more information, while another one accesses met office information.
4. The EO requests snow information in the area.
5. The result is a field of *snow-value* objects attached to regions.
6. Depending of the results the original investigation area becomes a *low-snow-hazard-emergency* or a *high-snow-hazard-emergency*, as described in the ontology.
7. A *high-snow-hazard-emergency* provides affordances which allow the user to ask for more information, e.g. to request all *rest centres* inside the region.
8. Rest centres are retrieved with their features and attached goals.
9. These goals can be used to get more context relevant information, such as resources nearby (e.g. *hospitals*).
10. The EO can also choose to *log* into BuddySpace to *contact* the relevant persons to request action or information.

A live demo of the prototype is available at: http://irs-test.open.ac.uk:8080/EMerges/. Moreover, further information and a presentation about the eMerges approach are available at http://irs-test.open.ac.uk/sgis-dev/index.php?nav=h (slideshow) and http://www.ordnancesurvey.co.uk/oswebsite/partnerships/research/research/terracognita.html (PowerPoint slides).

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