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RISK ASSESSMENT FOR THE ROAD NETWORK IN THE FRENCH-ITALIAN BORDER REGION USING WEB SERVICES

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SUMMARY

The EC Framework Programme 6 Integrated Project Open Architecture and Spatial Data Infrastructure for Risk Management (ORCHESTRA, <http://www.eu-orchestra.org/>) is concerned with the creation of an information technology architecture and associated web services for risk management. Its aim is to improve the interoperability of risk management data and software and influence international software standards (such as those provided by the Open Geospatial Consortium) in the context of the EC INSPIRE directive. In particular, multi-risk and cross-border issues are addressed since these are important within the European context. In order that the outcome of the project is useful in real-life risk management situations a number of pilot projects are being undertaken to test different aspects of the developed service networks. It is also expected that these pilots will also demonstrate the utility of the ORCHESTRA project to end users.

This paper discusses the pilot project being undertaken by BRGM, JRC and Ordnance Survey with the collaboration of local partners in the French-Italian border region between Nice and Genoa. The basis of the project is the evaluation of risk to the road network and the impact of road network disruption by, for example: earthquakes, landslides, floods, fires and chemical spills. Road closures can have a dramatic impact on the economic, social and functional life of a region and these impacts can spread far from the site of the blockage and, even, across international borders. The region chosen for this pilot project is especially prone to hazardous events and also, due to the lack of redundancy in the road network within the region, disruption to a major route can have a large effect. This pilot will seek to create a distributed network of web services that will access hazard, route and traffic information held within databases based at the data providers.

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1. INTRODUCTION

In today's rapidly changing world it is becoming more and more important that risk coming from natural and hazards with a human-origin is correctly managed. Increasing urbanisation and the undertaking of high value projects means that, in some areas, risk is increasing. In addition, due to climate change there is some evidence that the hazard level due to weather-related hazards is increasing. As in all aspects of modern life information technology (IT) is playing an increasing role in risk management since it allows the undertaking of tasks and makes others easier to perform.

However, risk management in Europe and elsewhere is made more difficult by interoperability problems due to IT systems that cannot easily communicate with each other. Even those in organisations concerned with the same risk, e.g. two institutes concerned with different aspects of earthquake risk, may be running different computer systems. The problem is even worse when viewed across risk domains, e.g. IT systems concerned with industrial risk cannot often communicate with those concerned with earthquake risk, limiting the ability to undertake true multi-risk analysis. Multi-risk analysis is being increasingly recognised as an important tool because it gives a better overall picture of the level of and the interactions between risks in a region (e.g. Douglas, 2005). In order to get around these problems, users often must spend valuable time reformatting files, for example, to the detriment of undertaking more fundamental risk management tasks. In addition, this effort is, in some sense, wasted since, in all probability it will need to be repeated when data is sourced from another organisation or when a new IT system is developed. These interoperability problems limit the work that can be achieved since it is difficult to access and use existing data; data which cost much time and effort to collect.

In Europe, these problems arise not only across different types of risk, but also across regional and national borders. In addition to interoperability difficulties, language differences also become an issue. It is often important to undertake risk management across borders because impacts of events are not limited by human borders and actions undertaken to mitigate risk are also not contained by political boundaries.

In order to address these difficulties on a large scale addressing the whole range of geographical data, an EC directive called INSPIRE (<http://inspire.jrc.it>) was launched in 2001. It is planned that this directive will be fully implemented by 2013 (implementation will begin in 2007). The directive is concerned with the setting up of a European Spatial Data Infrastructure, to implement metadata rules for data and services, to implement rules for harmonised spatial data specifications (exchange and update, ID systems, thesauri, key attributes, etc.) and to implement rules for network services (upload, discovery, view, download, transformation, etc.).

To develop these ideas the field of risk management, a Framework Programme 6 Integrated Project called Open Architecture and Spatial Data Infrastructure for Risk Management (ORCHESTRA, <http://www.eu-orchestra.org>) was launched in September 2004. In the following section the ORCHESTRA project is briefly introduced. The following sections are then concerned with the pilot implementation of an ORCHESTRA system in order to aid in undertaking risk assessments for the road network in the border region of France and Italy.

2. ORCHESTRA

ORCHESTRA involves 15 partners both from the risk management domain and from the IT industry. The purpose of the project is to design a platform-independent open service-oriented architecture (SOA) for risk management purposes, and implement it for Internet-based applications (web services) that can be called via the web to undertake a given process. They could be seen as subroutines located on the web to be used when needed by any user. The 'open' part of the project refers to the fact that the specifications of these services will be made public and free of charge so that they can be implemented by any interested party and can be accessed by all potential users. The actual procedure followed by the web service to perform the required task is not considered and will not be specified; however, the inputs and outputs to the service and the actions it must undertake will be specified. The philosophy behind this approach is that if the specifications are followed then risk management systems using these web services will be fully interoperable without needing to be created by a common entity. This philosophy has key advantages with respect to other approaches. For example, it is expected to favour the emergence of an operational market for risk management services in Europe, it eliminates the need to replace or radically alter the hundreds of already operational IT systems in Europe (drastically lowering costs for users), and it allows users and stakeholders to achieve interoperability while using the system most adequate to their needs, budgets, culture etc. (i.e. it has flexibility).

Interoperability of IT systems is a subject of much research and development in many countries. For example, the Open Geospatial Consortium (OGC) is an organisation that seeks to develop software standards in the field of systems concerned with geographical information. In addition, there are existing and under-development ISO and EC standards. ORCHESTRA bases its architecture on these standards and seeks to influence their development in order to make them applicable to risk management applications.

An additional advantage of the SOA approach in the risk management domain is that it allows applications to be updated with minimal effect on the services that call them. Procedures involved in risk management change often as experience is gained through disasters. Consequently it is important that the systems developed are agile allowing developments to be rapidly implemented in practice.

ORCHESTRA is divided into the following five subprojects (SPs):

- SP1: Management, exploitation, dissemination and consolidation
This SP is concerned mainly with project management issues and will not be discussed here.
- SP2: User requirements and policy watch
This SP is concerned with the specification of the risk management requirements to which the develop services and architecture must conform.
- SP3: Open architecture
This SP is mainly concerned with the specification of the system architecture.
- SP4: Risk management services
This SP is mainly concerned with the development of risk management services through the implementation of the selected pilot projects.
- SP5: Community building and training
This SP seeks to develop links between the project and potential end users and to provide training on the use of the developed architecture and services to interested parties. This SP will not be discussed here.

So that it is firmly rooted in risk management applications, the ORCHESTRA project includes a considerable input from experts in different risks, within SP2 in particular. The risks particularly represented by experts involved with the project are: earthquake, systemic/industrial, floods, forest fires and coastal (oil spills etc.). SP2 is concerned with supplying the rest of the project with requirements, from the risk manager point of view, that the ORCHESTRA system must obey in order to be useful for risk management purposes.

The user requirements coming from SP2 have influenced the system architecture being developed by SP3 and the list of services that will be developed within the rest of the project within SP3 and SP4.

In the second half of the ORCHESTRA project four concurrent pilot projects concerned with different aspects of risk management in various European regions are being undertaken within SP4. The aim of these pilot projects is to validate the services and architecture developed during the course of the project and to demonstrate the results of the project to potential end users. In order to build on work already undertaken in earlier workpackages of the project and since it addresses truly multi-risk and cross-border aspects, BRGM, JRC and Ordnance Survey decided to develop a pilot project based on the risk to the road network from different hazardous events, such as earthquakes, landslides and industrial accidents. The following sections briefly introduce the problem and the work planned.

3. PILOT PROJECT ON RISK ASSESSMENT FOR THE ROAD NETWORK

Road transport plays an important role in the economic, functional and social life of a region. For example, roads enable the transport of commodities from their source (e.g. a factory) to the distribution centre (e.g. a shop) and the consumers from their homes to the distribution centre. Therefore, disruption to a road can have a dramatic impact and lead to extra costs, inconvenience and, within the post-event phase of the disaster cycle, difficulties in accessing affected communities. Roads can be disrupted (i.e. blocked) by a number of different events, for example: direct surface rupture or liquefaction caused by an earthquake, landslides (however caused), fire (forest or otherwise), floods, chemical incidences, avalanches, volcanoes and storms (through the falling of trees). Cova and Conger (2003) provide a good review of the types of hazard that can affect the road network and also their consequences. By focusing on the effect of an event, where the cause of the event is not specified, the proposed

pilot is multi-risk. In addition, many of the services required to undertake the pilot are risk-neutral and can be used for various other projects.

As an example of the large impact that disruption to an important trans-frontier road can have, consider the closure of the Frejus road tunnel in the Alps between France and Italy due to a fire on 4th June 2005, which killed two people. The average truck traffic each day through the tunnel was 3 800, all of which had to find alternative routes, such as through the Mont Blanc tunnel, which required a detour of about 200km. The tunnel accounts for about four-fifths of the commercial road traffic between France and Italy. The tunnel remained shut for about two months. This closure lead to large additional transportation costs. The three-year closure from 1999 to 2002 of the Mont Blanc tunnel due to another fire, which killed 39 people, was estimated to have cost the Italian economy 2.6 billion euros. Léone (1996) presents a detailed analysis of the effect of landslides on the road network in the region of Diois in France.

The geographical location of a pilot based on the effect of disruption to the road network is not important since roads are vulnerable in all regions of the world and also, by their very nature, are often cross-border (local, regional or national frontiers). However, the area chosen for this project is the department of Alpes-Maritimes (06) in France and the Piedmont and Liguria regions in Italy, where BRGM and JRC already have good contacts with potential end users. The cross-border roads in this region, for example the E80 (A8 in France and A10 in Italy) motorway from Nice to Genova, pass through mountainous areas and feature many tunnels and viaducts. These make them particularly susceptible to hazards that block the road because it is not possible to easily bypass or remove the blockage due to access difficulties. In addition, the mountainous relief in the region means the number of alternative routes is quite low. The map in Figure 1 shows the road network in the considered area.

In this pilot it is planned to particularly focus on the following three different situations that feature different types of instrument and data: the motorway (E80) from Nice to Genoa, roads in the valley of Roya and departmental roads (in order to integrate the departmental authorities in the project). This choice of three different levels of roads should allow potential problems with wider-scale implementation of the developed system to be highlighted.



Figure 1: Location of the zone considered in the pilot project.

4. USE CASES

In this pilot project it is planned to implement six general well-defined procedures undertaken by end users (commonly called ‘use cases’ in IT parlance). It is hoped that these six will test many aspects of the system and will demonstrate its ability to overcome current interoperability problems. Also the selected use cases involve varied interactions between different parties, e.g. different data providers and various end users. Figure 2 shows the relationships between the different use cases that will be considered. The following sections give brief details of these use cases. In order to aid with the implementation of these use cases their details have been transformed to Unified Modeling Language (UML). This pilot project is split into three phrases of about six months each, during which two use cases will be implemented.

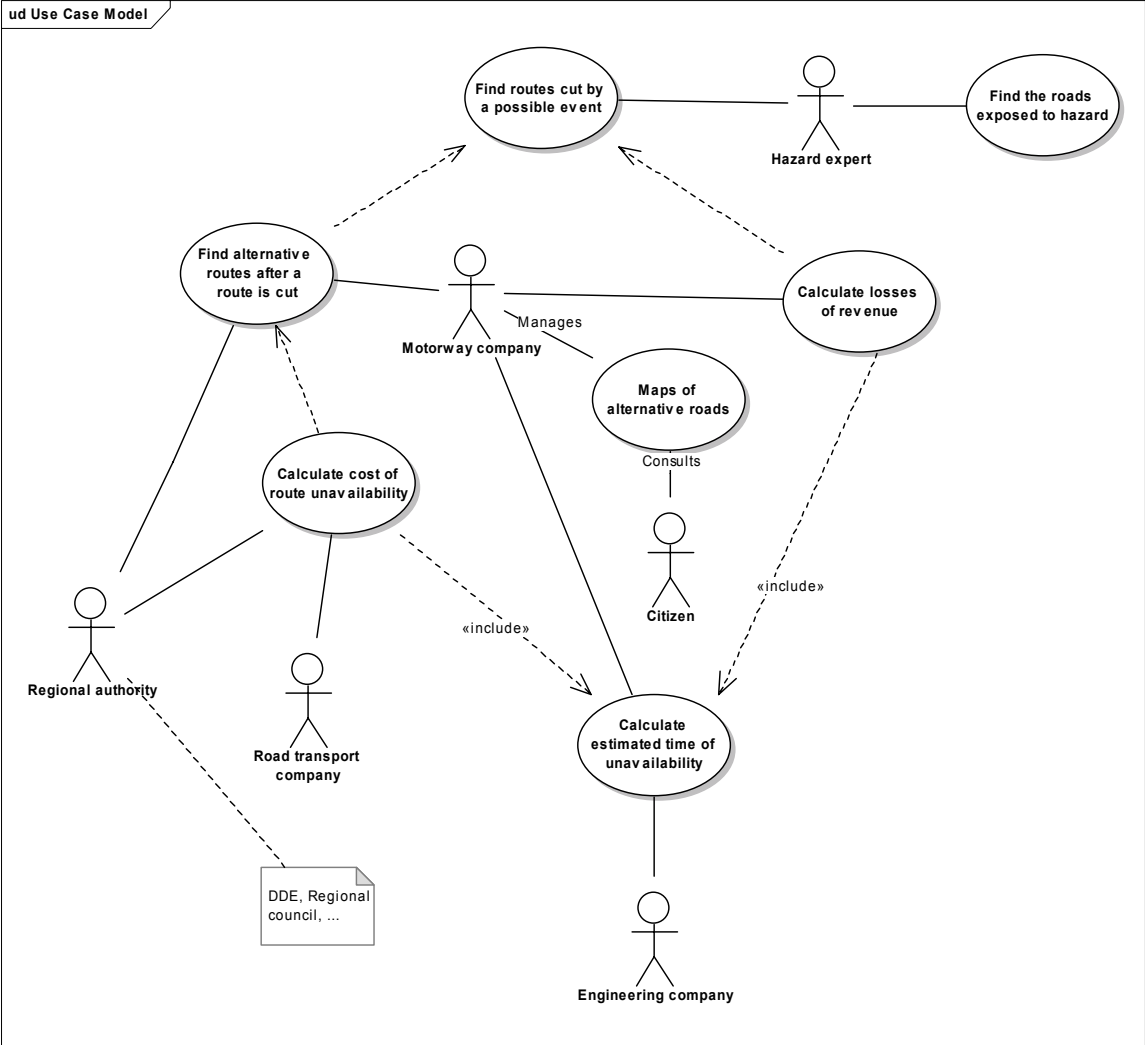


Figure 2: Relationships between the different use cases that will be considered in the pilot project.

4.1 Find roads cut by a possible event

In this use case, the end user retrieves data on the road network and the possible hazardous events in the region. Then they simulate the triggering of an event and the system is used to identify which roads will be cut by such an event. This information is stored for use by other use cases.

4.2 Find roads exposed to hazard

In this use case, the end user collects data on the road network and maps of the level of hazard for different types of event (earthquake, landslide, flood etc.). From this information they compile an inventory of the roads that are at risk.

4.3 Find alternative routes after a route is cut

This use case consists of the following steps. Firstly the user retrieves road and traffic information for the region. Next they collect information on which roads will be blocked by an event (e.g. from the first use case) and they indicate within the road network information where these blockages are. Finally the system calculates alternative routes for different types of traffic and stores these routes for future use.

4.4 Calculate estimated time of unavailability

This use case simply retrieves from an external source an estimate of the amount of time that a road will not be usable. This estimate is stored for later use.

4.5 Calculate losses of revenue

In this use case, the user compiles information on the length of time that given roads will be unavailable (from the previous use case). Then they search for traffic that uses these roads and from combining these pieces of information arrives at an estimate of the loss of toll revenue due to the closure of the road.

4.6 Calculate cost of route unavailability

This use case combines information coming from previous use cases to estimate the overall economic cost of a road being unavailable. In the first step, the user collects information on the road network, the traffic that uses the unavailable roads and how long these roads will be unavailable for. From this information and the list of alternative routes for each traffic type the system computes an estimate of the cost of the road being blocked.

5. DATA NEEDED

The following types of data have been identified as having to be accessible via web services in order to fully be able to follow the use cases described above. Some of these data will need to be translated into French and Italian. Also due to organisational differences between France and Italy the levels of political divisions may vary between the two countries. It is planned to access these data by using ontologies and schema mappings that can take these variations in structure into account.

5.1 Hazard data

Information required on previous hazards will include: location polygon of area affected by previous event, type of previous event (landslide, earthquake etc.), date and time of event and severity of event (e.g. magnitude or macroseismic intensity). Information on many previous hazardous events that affected France are already available at BRGM in a form accessible via web services (e.g. SISFRANCE: <http://www.sisfrance.net/>)

5.2 Traffic (per road considered)

Traffic information required will include: name of traffic type, number of vehicles of each type of traffic that use a road per hour/day etc. (this will vary with time of day/time of year etc.), average number of people carried by the vehicle type and types of roads that can be used by the traffic type.

5.3 Road network (per traffic type considered)

Road network information that will be required includes: name of road, type of road (motorway, national road etc.), name of organisation responsible for road, location of road and their connectivity, type of traffic that can use the road, road capacity (how many vehicles can use the road per hour/day etc.) and average traffic speed for different types of traffic (this varies with time of day/time of year etc.).

5.4 Political divisions

This data will be used to know which commune, department, region and country a road or event is within.

5.5 Topographical information

This information will be used as a base layer for overlaying other information over.

6. DIGITAL RIGHTS MANAGEMENT

An important part of this pilot project is a consideration of data security and the handling of access rights to data. In risk management, as in other domains, some data is sensitive and it is important that access to this data is well managed so that it can only be viewed by authorised users. In addition, there are important issues over payment and access rights to some types of information and services. All these important considerations will be investigated and will be implemented within the pilot in the following three step approach.

- Stage 1: Open Access Services – initial integration of services with no authentication and authorisation. The objective of this phase is to build the initial pilot capability and test the implemented services.
- Stage 2: Authentication and Authorisation Services – installation and configuration of the ORCHESTRA Service Network Architecture Services for authentication and service authorisation.
- Stage 3: Prototype Digital Rights Management Capability – this stage will address the higher risk aspects of implementing technical measures to manage and protect the content owners intellectual property. The content owners requirements will be understood during stage 1 and 2, and key elements of these requirements will be prototyped during this stage.

7. CONCLUSIONS

As in many aspects of IT, risk management is currently hampered by interoperability difficulties due to a variety of data formats, procedures, platforms etc. These difficulties are being addressed, on a general, scale by the ORCHESTRA project and, for specific cases, by a series of associated pilot projects. This brief article discusses the pilot project being undertaken by BRGM, JRC and Ordnance Survey concerned with assessing the risk to the road network in the France-Italy border region. The complete implementation of this pilot project should be completed by summer 2007.

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