NEW GENERATION 3D WEB-BASED GEOGRAPHICAL INFORMATION SYSTEMS
The Importance of Integrated Infrastructures for Territory Management

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Abstract: This paper highlights the importance of developing new tools capable of providing interactive web-based access to cross-border geographical data. This new generation of tools could be essential to improve the management of the territory and its infrastructures as well as to support training of operators responsible for crisis management at large scale. The paper illustrates the benefit of integrating the potential of 3D computer graphics with integrated web-service based geographical infrastructures. The paper discusses how recent technical developments, together with the definition of an international legal framework, is paving the way for such a new generation of management and training tools.

1 INTRODUCTION

In recent days web-based geographical information system are undergoing a profound evolution. This is characterised by a radical shift from traditional monolithic systems, composed by think clients accessing centralised geo-databases, to more distributed architectures based on web-services, providing integrated and interoperable access to geographical data and service.

This major evolution is being sustained by the emerging EU legislation in the domain of public access and use of geographical data. Most notably the INSPIRE directive (INfrastructure for SPatial InfoRmation in Europe) represent a turning point as it will oblige all EU countries to converge towards a European interoperable infrastructures of geographical web services.

Concurrently the availability of 3D Geobrowsers, usually considered as the natural evolution of Web-based Geographical Information Systems (GIS), is enjoying an increasing success due to the popularity of applications such as Google Earth or Microsoft Virtual Earth. The potential of these application should be extended from its present state to planning and management use based on the access of interoperable geographical data and service which is being made available.

This unique circumstance is paving the way to a new generation of applications, capable to benefit from interactive 3D-based access to distributed cross-border geographical data and services.

These applications could be used for a wide range of territory management activities but most importantly for training of administrators and operators who are responsible for managing acute crisis. In fact the use of 3D visualisation technologies and GIS can be combined with simulation tools to provide training application capable to improve the decision support during relief operation following security large scale incidents.

2 THE ROLE OF SPATIAL DATA INFRASTRUCTURES

Widespread diffusion of web-based geographical information systems is having a profound effect on the process of management of a territory as it is yielding to the creation of integrated systems of geographical services to be used by politicians, administrators, technicians and citizens.

This scenario is providing the condition for the widespread diffusion of the so-called Spatial Data Infrastructures (SDIs), whose concept goes far beyond the concept of centralised web-centred geo-

database as it yields to integrated frameworks capable to provide access to a large number of geographical web services. These in turn can be built on top of a wide range of geographical data owned by private companies as well as by public administrations.

However it would not be appropriate to consider SDIs as just a mere set of interoperable technologies communicating through some well know protocol. Rather a more general perspective should be taken, in order to consider them as an entangled set of politics, institutional frameworks, technologies, data and people that can make the sharing of geographical information more efficient and accurate.

SDIs in fact represent a tool of fundamental importance for the governance of a territory as they deployment allows more precise analysis, more efficient control and a more attentive planning, effectively responding to the real needs of a territory. The deployment of an SDIs can represent the basis for the creation of a wide range of web-based services capable to provide integrated management of regions. At the same time they can provide citizens with access to data repositories of public interest containing spatial as well as statistical information relative to the territory.

From a mere technological perspective an SDI can then be considered as a complex system of hardware and software components geographically distributed yet interconnected in a Service Oriented Architecture (SOA). They can deploy web services which can be used to provide specific functionalities to clients, to access data repository as well as to transform data within a fully interoperable environment.

Such an interlinked approach allows the definition of cross dependencies and competency regions within and among different SDIs. In fact as each operator becomes responsible for the management and publication of its own data and services while it can seamlessly benefit from having interoperable access to data and services managed by other operator.

It is acknowledged that SDIs will play a fundamental role in the governance of a territory as they can provide different institutional actors such as politicians, administrators, technicians, decision makers, with the proper tools for a complete planning activity and integrated management of the territory. A further advantage is that SDIs can provide access to certified spatial data both to the professionals and to the citizens according to a paradigm that promotes e-democracy.

The interest being raised by SDIs at the global level is testified by the significant economical resources allocated in the last few years to their deployment. According to a recent study (Crompvoets, 2006) from the University of Wageningen in The Netherlands, the absolute majority of countries in the world already has or it is in the process of deploying a National SDI or, as often referred to, a NSDI.

These initiative at regional or national level are accompanied by similar relevant initiatives at the international stage both within and outside the EU, all aiming at the integration of geographical services beyond the national borders.

Web-based data and service interoperability at the international level in fact is essential to guarantee immediate response in case of large scale crisis. Having fast access to geographical data from other countries in fact can be essential to coordinate international cooperation activities in case of large natural or manmade large scale disaster such as widespread floods, major earthquakes or terrorist attacks.

Cross-border interoperable access to geographical data is particularly important to manage data on large scale pan-European critical infrastructures such as the so-called Trans-European Transport Network TEN-T (European Commission 2007a). TEN-T, as well as other EU-wide key strategic assets, are highly complex cross-border interconnected networks and they are naturally very vulnerable to natural or man-made disaster events. Several recent major accidents such as those at the Gotthard and Tauern tunnels, with complete closures of weeks and sometimes months, have highlighted such problems (El-Araby, 2002). The social and economical costs for the consequent disruption are enormous as closing down a motorway such as the A9 in France, can cost up to 300,000 Euros/day only in terms of revenues lost (ASECAP, 2006).

The deployment of web-based systems based on systems of SDIs plays a strategic role as it can provide coordination of information in case of exceptional events or crisis, when being able to access geographical data in a transparent yet interoperable manner becomes essential for the public safety.

3 THE INTERNATIONAL OUTLOOK

The deployment of SDIs at the EU level has been subject of the forthcoming European legislation and specifically of the INSPIRE directive which will enforce the creation of the ESDI – European Spatial Data Infrastructure. This is emerging as the result of a significant effort at the European level and it is bringing to a network of interoperable SDIs of national as well as regional level.

The INSPIRE directive (INfrastructure for SPatial InfoRmation in Europe), in force since 15-05-2007, is in fact promoting the development of the ESDI, the European network of Spatial Data Infrastructures based on the definition of specific rules for interoperable data and web services. Today a vast technological as well as political effort is being spent to produce the implementing rules which will define the specification of processes, data and services that each country will have to deploy.

Other significant EU initiatives include GMES (Global Monitoring for Environment and Security), the proposal for a EU Directive on "the Identification and Designation of European Critical Infrastructure and the Assessment of the Need to Improve their Protection" (European Commission, 2006a) as well as the "European Programme for Critical Infrastructure Protection (EPCIP)" (European Commission, 2006b).

All these initiatives clearly show how the control of the territory and its security has very high priority in the EU agenda.

4 THE NEED FOR ADVANCED 3D SERVICES

Within such a scenario the evolution of web services capable to provide interactive access to 3D geographical data can play a decisive role.

Interactive web-based systems such as 3D geobrowsers in fact can be used as front end to access data and services made available by SDIs. Furthermore these can represent the basis to build effective training systems for managing the territory, to plan its activities as well as to train administrators, decision makers and crisis managers. This is of utmost importance to provide the most adequate decision support during relief operation following security incidents.

For this reason it is essential to foster the development of collaborative real-time simulation systems capable to access data from SDIs and to support coordination during crisis management.

Specifically developed 3D interactive geo-referenced simulation environments need to be developed to support training of cross-boundary emergency teams. The use of technologies such as virtual and augmented reality technologies, on top of standard web-based services, may ensure high level of immersiveness and realism. The ability of interacting in real time with the 3D environment becomes extremely important. This requires real-time visualisation of 3D representation of data patterns coming from sensors, 3D representation of features present in a database, interactive creation and modification of existing geometries representing specific data sets, the possibility to introduce objects retrieved from existing libraries.

As illustrated in Figure 1 new generation systems will further need to be supported by the use of novel forms of Visual Analytics, essential for fast filtering of complex information and for the identification of key data patterns emerging from the simulated crisis scenario.

This position is shared by several institutions such as AISCAT (AISCAT, 2006), the association that groups all motorway and tunnel concessionaire companies operating in Italy, EU's first top priority actions should be to provide adequate support for crisis and management of major events. These must not be limited to terrorist attacks but they have to provide support to major accidents as well as major weather-related events which can affect all major infrastructures. This position is also in line with European Programme for Critical Infrastructure Protection (European Commission 2007b) which fosters the development of simulation and training tools to anticipate proper countermeasures, to help assess the level of defence and improve security flaws.

Recent geo-political developments, generated by the enlargement of the EU countries to new nations, further amplifies the scope of this issue and it poses new challenges in terms of cross-border scenarios, where having access to harmonized and interoperable data is essential importance.

New generation of web-based services, based on access of geographical data made available by SDIs, could provide an adequate response to this issue.

Planning on how to handle acute crises is of prime importance for adequate response. The impact of proper modelling and simulation tools is very high both in social and economical terms as proper

cross border crisis management can potentially save lives and bring to huge costs saving.

The ability to react to critical events during a crisis is therefore a crucial skill for crisis managers which can only be developed through comprehensive training. This needs to be capable of accessing, distributing and processing a wide range of Geographic Information (GI), such as sensor data, to support strategic large-scale decision-making process. To be able to provide full immersiveness and realism crisis manager need to be supported by simulation systems capable to create cross border 3D virtual environments capable to respond interactively to the managers' actions.
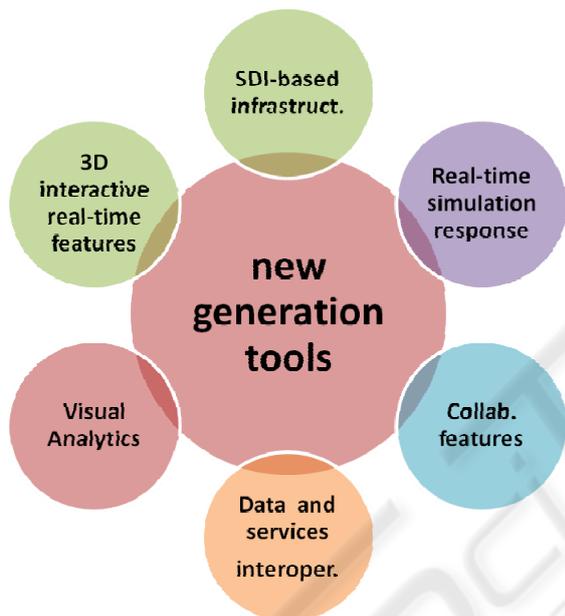

Figure 1: features required by next generation management and training infrastructures.

5 CONCLUSIONS

The emerging need for new tools capable of providing adequate control over the territory is driving a number of international initiatives with the aim of deploying harmonised international network of geographical web services. The concurrent technical development has brought to the development of 3D real-time applications capable to deal with very large geographical dataset.

This convergence is setting the base for a new technological and methodological shift, by providing the basis for the arrival of a new generation of management and training systems for large scale scenarios.

Their development, grounded upon the deployment of EU wide Spatial Data Infrastructures, will represent a major achievement as it will allow interactive interoperable access to pan European geographical data. This will be essential to the development of new management and training systems for politicians, administrator, decision makers and crisis managers.

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