Interoperability in Geographic Information – Technological Idealism or Business Critical?

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Key words: Interoperability, e-government, e commerce, location based services.

SUMMARY

Interoperability is one of the latest terms used in the geographic information (GI) industry. From the literature it would appear to be a very flexible term itself and can mean different things to different people. This paper will investigate what we mean by interoperability and its relevance to the geographic information industry and its users. Is it simply something that is a new "technological component" and concerns only those involved in building GI systems? or is it something more than that which needs to be seriously considered as a primary requirement at the outset by senior managers when they express their needs?

The investigation will be undertaken in the context of emerging spatial data infrastructures at national level and the INSPIRE initiative, now gathering momentum within Europe. Much of this is also motivated by national policies to establish e-commerce targets over the next 2-3 years. The paper will look at trends in data linking in different countries and concentrate on two examples:

– at government level: there is current activity in several nations where work is taking place attempting to integrating two key national datasets, the cadastre and topographic information – how is the integration being achieved? What are the drivers for this? How successful have these been? And what are the perceived benefits?
– in the commercial world: the developments towards location based services (LBS) in exploiting the new 3G telecom networks has been slowed down by downturns in the world economy, but the main players are still working towards releasing new services – how will these work?, what data is involved and how will it be connected? are these services successful? And will good data integration enable growth in this market as predicted?

Finally the paper will examine the methods of data linking and the corresponding business benefits that might be achieved, such as data sharing, real time data linking and further implications for all of us. Such developments are not normally achieved without a cost and such an approach will bring with it new disciplines and take us further towards mainstream information technology.

The paper will employ a case study and contrast the approach currently employed with one where greater data connectivity might offer significant advantages for the future.

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1. INTRODUCTION

Interoperability is one of the latest terms used in the geographic information (GI) industry.

1.1. What does Interoperability Mean?

From the literature it would appear to be a very flexible term itself and can mean different things to different people and initial attempts to ensure that a straight forward definition is available proves difficult.

The Oxford English Dictionary does not provide a definition, the nearest that can be achieved is that it comprises two components: Inter meaning - mutual or reciprocal action or relationship and Operable: meaning - that can be operated upon, that can be treated by an operation.

Virtually anyone who has used a computer system is familiar with interoperability problems, even though the definition is elusive. Interoperability problems can occur at a number of levels: data, communications, exchange formats. The problem is solved when interoperability permits users to use data across system and organisational boundaries. Interoperability effectively means that the users of any system should be able to do so irrespective of any incompatibility that may be present in terms of data, communications or data format.

1.2. Why is Interoperability Important?

There are many business drivers behind the push to ensure that Geographic Information is interoperable, including government e-business initiatives with specific targets for service delivery (Traynor and McLaren, 2003) and the growing development of Location Based Services (LBS). These initiatives are taking the Geographic Industry into the mainstream domain of e-business strategies. Location is the one link that is ‘key’ to peoples understanding of how much data interrelates.

At the same time as the drive, from the private sector and governments for more e-business applications that will meet government targets, society is also looking for more transparency, auditability and liability within the provision of these services. To achieve these aspirations interoperability is essential or the business community will find itself with fixed links between specific systems and data that will never allow the full potential offered by e-business to be fulfilled. In order to move the ‘knowledge economy’ forward it requires access to data sets that can be linked automatically.

Interoperability engages at several levels and greater automation is already evident, especially at the computing systems and networking levels. However at the most fundamental level ie *data and information interlinking*, there remains further room for improvement in data interoperability both horizontally (ie geographically) and vertically (ie across the layers of information).

This has been recognised within Europe for some time but there is now more energy being devoted to establish a framework for the harmonisation and exchange of in formation at European member and accession state level through the INSPIRE (Infrastructure for Spatial Information in Europe) initiative. This is a long term development initiative and the initial research has demonstrated the magnitude of the challenge for the next 10-12 years (European Commission, 2003).

In the absence of anything better many of the GIS information solutions we witness today are simple graphical overlays where relationships are deduced or implied.

We can see immediately that in an information systems world, such as financial systems or the electronic point of sale systems in the retail trade, income/outgoing transactions need to be tracked and *explicitly* assigned to the correct account. The type of "implied relationships" currently used in GIS overlay analysis would be far from suitable.

We live in a world of distributed information and it has been shown that this is far more effective than large centralised databases. We therefore need to be able to assemble data in a more effective way than we do today, while maintaining the freedom that distributed databases bring but operate within a bigger connected world of information. The adoption and cross referencing of unique identifiers as keys to the data is critical, but that is just one small step forward in assisting the linking and chaining of information.

An independent report in 1999 demonstrated that over £100 billion of the GDP in UK was based on the use of Ordnance Survey information (based on 1996 data) [Ordnance Survey, 1999]. Considering that at that time, much less information was "joined-up" than today, it is interesting to speculate just how much more value geographic information could bring to the national economy if it was better integrated and therefore able to play a much more direct role in everyday operations at government, business and consumer levels.

1.3. Who Owns the Interoperability Problem?

If society is to maximise the use of Geographic Information, it must have access to data that can be used by any system, is reliable and to a known quality or standard. The question is who owns the problem? Should data be regulated, or should a completely free market evolve naturally where the user accepts the liability resulting from the integration of two or more data. However, unless some understanding (or guarantee) of the quality of the data is available and fitness for purpose can be checked it is difficult to see how liability will be anything but open ended.

This dilemma requires new and innovative thinking to enable society to achieve all the benefits to be achieved through unrestricted interoperability of data, and provides some guarantee that that data is fit for purpose and meets a defined level of quality. The task may appear daunting, but it needs to be resolved if true interoperability is to be achieved.

This arises partly because interoperability is an infrastructure problem, just as the computing and networking issues were ten years or more ago, and the banking/financial information framework was 20 years ago. These problems do get solved, but it needs like-minded people from diverse parts of the industry to come together in a co-operative way and evolve approaches that work effectively. In time such approaches will be regarded as “industry standard” methodologies and processes.

Until such “standards” emerge investors will often be reluctant to take risks in building new information systems applications in the fear that they will “back the wrong horse” i.e. investing in an area that downstream proves to have been ill-advised or that technology and/or business decisions have focused developments in another direction.

2. EXAMPLES OF WHERE INTEROPERABILITY IS REQUIRED

2.1. Example 1: Land Markets

There are major advantages to be gained for a nation and its citizens from the creation and development of an effective and efficient land market (Dale, Mahoney & McLaren 2002). Amongst the criteria required to facilitate a land market are:

- Policy and legal framework, with equal rights of access
- An integrated institutional framework, including land value and land use
- An efficient land registration and cadastral system, with low transaction costs
- Availability of Physical planning information
- Land and property valuation information
- Consideration of public/private partnerships

The many countries where multi-purpose cadastre are present or under development are some way towards establishing an e-land market. However, unless there is a properly regulated market in land, investors will look elsewhere when searching for a secure investment. Where land markets are intended to work in an e-environment (and the trend is towards this approach), interoperability is ‘key’ to the successful delivery of these services.

Figure 1: Property information and base topographic reference information.
(Image and data courtesy of HM Land Registry and Ordnance Survey of Great Britain).

Land information is one view of the real world and the multi-purpose cadastre is key to linking information about land and property ownership and thereon who occupies such property. There are however, other "user-based views", these include the environment, agriculture, transport, crime and disorder, consumer services and many more. We therefore need to accommodate the operational needs of all these very different communities when considering data and information interoperability for sooner or later many of them will wish to exchange information where more often than not, the common denominator is "location".

2.2 Example 2: Location Based Services

The development of Location Based Services [LBS] appeared to be heading for major growth only two years ago. While the general downturn in the global economy has slowed the development of LBS, especially in Europe the "infrastructure" for such services is still developing. Putting aside the telecommunications industry developments of rolling out a 3G technology, what of the data and services? LBS is just one service based on 3G technology but the expected services are likely to include navigation, enquiry and booking facilities based on "where is my nearest…..?". Such services are likely to incorporate the following types of data and information:

- Current location (via cell or GPS)
- Networks for vehicle and personal navigation
- Addresses and Points of Interest (fuel stations, cafes, hotels, museums etc)
- Buildings and other topographic features of interest
- Access & egress points
- Web links, booking facilities, opening times etc.

Not all of this information can be regarded as "plug 'n play" today. The service provider still often has to conflate several sources of information, ie records have to be matched and linked to provide a basis for the service being provided. This can incur heavy costs for both data creation and especially for maintenance. This is critical if the service is going provide a real "value add" for the user and thereby generate the expected growth. The consumer today is more demanding than ever and expects to be able to gain new valued and reliable benefits from the technology.

One lesson learnt from the telecomm industry in the 1990's was standardisation. The adoption of GSM (Global System for Mobile Communications) as an agreed industry standard paved the way for interoperable service development and thereon massive growth. All of a sudden consumers had a flexible handset at an affordable price which allowed them to do things they were until then unable to do (international roaming, text messaging etc). Today, GSM technology is in use by more than one in ten of the world's population and it is estimated that at the end of 2002 there were 787 million GSM subscribers across the 190 countries of the world.

Figure 2: Mobile geographic information, the local landscape overlaid with selected "points of interest" can provide a powerful new service to users. (Image courtesy of Ordnance Survey of Great Britain).

3. CASE STUDY: FLOODING

The recent flooding across Europe exposed the need to bring together vast amounts of data, to deal with the immediate impact of the disaster, understand the downstream issues associated with the provision of improved flood defences and allow the insurance industry to assess its current and future exposure to risk. Data sets used during the recent flooding included:

– Large scale base mapping
– Flood plain data
– Flood defence data
– Agricultural data
– Water run off data
– Utility data
– Transportation routes
– Accessibility data
– Environmental data
– LiDAR data for height data
– Emergency planning data

Interoperability between these datasets proved to be inadequate as it failed to provide users with the holistic view of the situation being managed.

Consider then a potential scenario to manage a similar flood emergency in the future:
"The river level monitors were transmitting regular updates and it was clear water levels were rising fast, based on several days of wet weather. Added to this there were unusually high tides, confirmed again by telemetry from the network of coastal monitoring points. The multi-agency emergency team had swung into action and they were viewing the predicted water levels on the large bank of plasma wall screens in the emergency control centre. Past actual event records were being used to verify the current forecast and predictions were now confirmed at the 90% confidence level.

"The three dimensional overview of the entire local site of the emergency was integrated with the local transport and building/address information to determine which households would be affected. The implications for transport were determined to manage the local infrastructure through closures (roads, railway links and other vulnerable services eg sewage pumping stations. An evacuation plan is then calculated with priority status being given to the elderly and infirm."

Figure3. Predicted flood levels and two areas of known risk to life, and the primary access/evacuation route indication. An overview such as this would also allow teams to drill down to specific areas and access/record information at the level of the individual building and its address(es) etc. (Image courtesy of Ordnance Survey of Great Britain).

"Fortunately there was no risk to the local hospital although it was only 100m distance from the predicted limit of the highest water level. Unexpectedly a warning of high water levels is received in an area away from the flood plain, but on a part of the river network that drains in to the plain via a large culvert. This then followed by a message from a motorist reporting a landslip adjacent to the highway. Initial geolocation of these two events suggests that there may be a relationship and this could affect a nearby underground car park.

The communications team leader then prepared a 30 second graphics fly-through and indicator map of the areas estimated to be affected. This is then prepared for a flood warning on local television and radio channels within the next 30 minutes, and is made available on the internet. The same information had already activated the local phone warning system and was available to the field teams using 3G-based personal data units. These units are used to help in the evacuation eg to record which addresses have been emptied and use mobile GPS to locate and tag any other information where attention may be required immediately or later."

Tasks such as those in the scenario above are performed today, when emergencies arise. The teams have to currently make do with information from various sources and at different resolutions but very little of it is truly “joined up”. Hence it is not possible to use much the data in an intelligent and flexible way at the moment. Recent analysis in the US during the Mississippi floods (USGS, 1994) and in New York following the 9/11 terrorist attacks employed GIS. This was used but developed in a more integrated way *after the event* to record, log or information for further analysis.

Such a system requires better joined-up information and ability to “chain information” about a specific location. This requires the cross-referencing of information, often disparate datasets, which in turn will improve the quality of the data. The information also needs to be supported by easy and dynamic ways of communicating this and in ways different audiences can readily receive and understand the message.

Just as, or perhaps more importantly, such an information infrastructure will be used as a prevention tool, to aid planning, to analyse and manage risk and to evaluate the effectiveness of response teams in the case of the inevitable emergency.

4. CONCLUSIONS

This paper has raised several topical and strategic issues which affect all involved in the Geographic Information industry today. We conclude that:

– Interoperability of data and systems is becoming key to the successful delivery of e-based services where Geographic Information provides the most logical and understandable links between a variety of data sets.

– The present trend clearly indicates that the requirement for interoperability is not simply technical idealism, but a business critical requirement without which the goals of an e-business environment will not be deliverable to society.

– Although there are many governments and organisations moving towards resolving the interoperability requirements several critical issues remain, key amongst which are how to resolve the issues associated with transparency, liability and auditablity.

– New and imaginative thinking is required if regulation is to be imposed that will not inhibit progress and societies ability to exploit Geographic Information.

– Better information requires organisations to move on from the short term monoscopic view which leads to “stove pipe” solutions and to view the world in stereo and recognise that a small amount of cooperation can make a big difference in terms of the end solution for customers.

– This then requires collaboration and co-operation across organisations, clearer definitions of roles and responsibilities and the desire to eliminate duplication, wasted energy and resources.

- We would be advised to learn from other industries (eg banking, retail, telecomms) in developing better solutions which require explicit data linkage and "data chaining" to provide robust solutions in a distributed IT world.

- Data quality will improve with connectivity (the adoption of identifiers and cross referencing) which will lead to less duplication and greater confidence for the wider Geographic Information market as industry standards emerge with successful application.

- We could then expect further substantial growth as investment in applications supported by better joined-up location-based information.

- All of this will only be achieved successfully if our collaboration is prioritised by customers needs.

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BIOGRAPHICAL NOTES

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Head of Geographic Information Strategy, Ordnance Survey, Great Britain

Keith Murray is responsible for the overall Geographic Information Strategy for Ordnance Survey. Keith studied at the North East London Polytechnic and at University College London. He is a Member of the Royal Institution of Chartered Surveyors [RICS], an Associated Fellow of the Remote Sensing and Photogrammetric Society [RSPSoc], a member the American Remote Sensing and Photogrammetric Society [ASPRS], a member of the Association of Geographic Information [AGI]. Keith is also Chair of FIG Commission 3.2 [Spatial Information Management – Infrastructure].

As a surveyor with Ordnance Survey Keith was involved in a wide range of projects and programmes in Great Britain before periods on Photogrammetry, Research and Development and IT led him to his current post. He has worked closely with Ordnance Survey Director

Generals in recent years developing the Digital National Framework in Great Britain upon which OS MasterMap is based. Current assignments include several cross government collaborative initiatives aimed at better integrating geographic information in Great Britain and beyond.

Robert Mahoney FRICS, FBCartS
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Rob Mahoney is a Director of Business Information. Rob studied Land Surveying at the Polytechnic of the South Bank, is a Fellow of the Royal Institution of Chartered Surveyors, a Fellow of the British Cartographic Society and an active member of FIG Commission 3.

Rob's career has included a wide variety of national and international GIS projects that have covered the whole GIS project lifecycle. Significant projects have included: the feasibility Study for the National Land Information Service (NLIS); its Scottish equivalent ScotLIS; and advisor to the Hungarian, and Isle of Mann Governments on the computerisation of the land registration systems.

Rob is a regular contributor at international GIS conferences and guest lecturer at many masters courses in GIS.

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