FROM LOCAL TO EUROPEAN SDI – INSPIRING THE NEXT GENERATION OF SPATIAL INFORMATION IN GREAT BRITAIN

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ABSTRACT:

Over the last 40 years the world of "mapping" has changed dramatically – both in Great Britain and elsewhere. In 1968 our chief medium of communication was the paper map. As we enter a new paradigm where spatial information is being taken more seriously within mainstream information strategies this paper will examine how several apparently disconnected developments within the UK and Europe might be brought together to underpin the next generation of information users. The paper will describe how the infrastructure in the United Kingdom is changing to meet the needs of the dynamic and ever demanding world in which we live and one which increasingly values the knowledge of location.

1. MAPPING OR INFORMATION?

1.1 The only constant is change

Participants who attended at the ISPRS Congress in 1968 in Lausanne and who are at this event will recognise that the world of "mapping" has changed dramatically in that time – both in Great Britain and elsewhere. In Great Britain forty years ago our chief medium of communication was the paper map at large scale (1:1,250) or small scale (1:63,360). Where a user collected their own information they would often mark this on the paper records e.g. land registration property extents, gas pipes and electricity cables; either as coloured line work or as an abstract copied into a register of some kind (e.g. the Register of land ownership).

Following the advent of digital mapping in the 1970's – take up by users proved slow. This was because IT costs were still high at that time and into the 1980's. Users had adopted computers for their mainstream data processing (invoices, payrolls) but found it difficult to justify investment in doing this just to support "digital mapping". By the mid 1980's technology was starting to fuel the pace of change, driving new developments in:

- Tablet digitising
- Electronic distance measurement
- Photogrammetric encoding of data
- Printing and plotting developments
- Graphical editing (albeit specialist units in the 80's)
- Broadband development
- Digital Imagery (largely from space initially)
- Global Navigation Satellite Systems
- Personal Computing & MS-DOS, Apple Macintosh
- New forms of data collection (LIDAR, SAR)
- The Internet

It is important to recognise that the geographic information industry has never been a driver of this change. It has successfully ridden on the back of many of the underlying mainstream ICT developments, some of which will be recognised in the list above. For example a graphics workstation in 1985 cost around €20-25,000, whereas today we simply use an "off the shelf" personal computer with a good graphics card ~ €1000.

1.2 Exploiting the technology

Today we take for granted that we can use just about any computer to do almost anything, to access information and view data all from a desktop not just in our office but from the comfort of our home. Who could have predicted such a situation 20 years ago let alone 40? …. and what does this herald for the next 20 years?

As recently as the mid-1990's, one of the main challenges was seen to be in promoting awareness and access to information known to be hidden away in public sector organisations. Discovery metadata services were established and in some cases attempts were made to show the data in a portal (NSDI in the US and the NGDF in the UK). All this demonstrated that information collected without any form of standard specification and without consideration to its use beyond the immediate purpose for which the data was collected - will often be of little value in an integrated application. Further, it is unlikely be of any value in a fully automated application. Surprisingly such developments were promoted as "spatial data infrastructures" [SDI] but little thought was applied to a common information architecture (as exists in banking, telecoms and other mainstream domains).

1.3 What is a Spatial Data Infrastructure?

There are many views regarding the scope and nature of a Spatial Data Infrastructure (SDI). In a sense each country has always had some form of spatial information infrastructure since the publication of the first map.

The main questions now are – what will the next generation SDI look like? how will it work? and how will people use it?Perhaps the answer to this lies in an analogy to some other form of "infrastructure" – such as a national rail network (we could equally use the electricity supply system, the internet or road networks as illustrations). There are two main parts to an operational rail network:

1. The rail infrastructure
2. The rail services that run on the infrastructure

The *rail infrastructure* comprises several critical components:

- The railway tracks
- Bridges and crossings
- Stations (often linked to other forms of transport)
- Signalling & routing system (points etc)
- Communications systems
- Maintenance of all of the above

Few standards existed in the early days of railway development and different gauges of track were not uncommon, bridge heights varied and often two railway companies would develop independent routes to the same or similar locations. The majority of our cities can boast very grand, sometimes magnificent "railway termini". The resulting problem is that a terminus is not very helpful in operating a network!

Figure 1. Railway Termini in Central London (the large buildings are major rail termini from north, south, east and west) – as in many cities - none provide a "through service" in London.

The railway infrastructure supports a wide variety of "*rail services*". On these services trains can take travellers from one end of the country to another; different kinds and frequencies of rail services operate – largely seamlessly and effectively using a mix of complementing business models. Increasingly the services are now connecting and extending into a wider field of European services on a regular basis (as has been common in continental Europe for many years).

1.4 The Next Generation SDI

The challenge for the future of spatial information is therefore to develop a vision for the information infrastructure that does not lead to "dead ends" but identifies and supports the kinds of joined-up "services" and applications that can be offered. Dedicated applications that reuse existing services, designed within a common framework, solve not only some of our pressing problems today, but can be extended to accommodate new developments in the future – whether that is in a modernised public sector or beyond in the private sector.

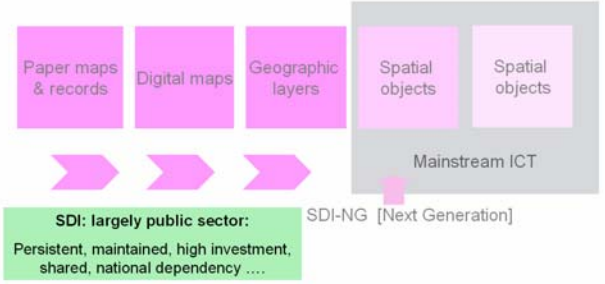

Figure 2. The transition of paper mapping to spatial information

The remainder of this paper will describe how some of the major components in the UK, and Great Britain in particular, are evolving rapidly and the opportunity that now exists to consolidate these into a more coherent national information infrastructure.

2. THE NATIONAL MAPPING DIMENSION

2.1 Ordnance Survey - continuous modernisation

In 1968 the large scale (1:1,250 - a 500x500 metre square plan) of central London or a "One Inch" map (1:63,360) for the general public were the main channels of publication from the surveys of the organisation. New editions of the large scale map often took 12-18 months from survey to publication in a limited print run (often less than 20 copies of the detailed plans).

Perhaps it will be a surprise to learn that Ordnance Survey was already using a metric base at that time. This had been one of the recommendations in 1938 in Davidson Report (Ordnance Survey, 1938) that was commissioned to determine the role that Ordnance Survey should play in the future. This was a fundamentally influential report, the consequences of the recommendations took until 1980 to fulfil and are still with us today. Another recommendation (no 15) put in place a "system of continuous revision" from the 1950's onwards. The maintenance of the maps and plans became a major task. *Maintenance is often taken for granted but it is technically and economically far more challenging than completing a new survey.*

In the 1970's the then Director General Brigadier St John Irwin initiated the move to further modernise the information held. Given the nature of the technology at the time this was a slow process, and as noted earlier, user take up was also slow. However it was the utility companies, following their privatisation in the 1980's, that provided the much needed acceleration and eventually tile based digital national coverage was completed by 1995 under David Rhind as Director General.

Already research into the integration of application information with the national reference base got under way almost as soon as the first digital maps appeared in the mid 70's. Trials with object based data in the late 1980's proved troublesome (limitations in both data, technology and funding) and further work during the 1990's did, after several iterations, prove the way forward in moving the digital mapping model forward to an object based structure.

2.2 OS MasterMap

Five years of tests were undertaken to maximise automation in the re-engineering of the digital map data - the decision was taken in 1999 to start the conversion. This decision was made on the back of a review of the current and rapidly evolving external environment. The new Director General (Geoff Robinson) also recognised that the world of spatial information was becoming increasingly fragmented:

"As a consequence, the geospatial world is in danger of becoming ever more fragmented – by technology, standards, applications and other parameters. Much of this is a healthy market response to new opportunities. Yet, as we embrace these new opportunities, how comfortable are we that we are not losing that common geospatial underpinning that Ordnance Survey provided in the pre-digital era? How ironic if, in a world of joined-up government and joined-up services, we inadvertently lose what joined-up geography we have historically had, and which provided so much economic and other benefit." (Robinson, 1999)

As part of a reappraisal of the role of the organisation he went on to recommend a change of direction: concentration of the core remit (Ordnance Survey, 2004) and withdrawal from activities that competed with the commercial sector outside the core remit. This included withdrawal from activities such as book publications and taking a leading role in commercial applications such as the National land Information Service (NLIS). It was concluded that if the organisation was to play a role in the next generation spatial information infrastructure this should centre on providing a modern georeferencing framework. This in effect being a modern extension of what it settled on in the mid 1800's when a lot of debate took place around the "scales of maps and plans that the organisation should adopt. The modern concept emerged as "the Digital National Framework" in 1999.

The conversion to object based data took a full 12 months of continuous processing. The story is well known that occasionally the chips on the processors failed because they overheated. The next step was to make this available to the users and if reflected the primary contribution of Ordnance Survey to the Digital National Framework. The data product became known as OS MasterMap and was launched in November 2001 a year after Vanessa Lawrence took up the reins as Director General.

Figure 3. OS MasterMap – Topographic objects

OS MasterMap currently consists of several themes: topographic objects (as in figure 3 above), an address layer, an integrated transport network layer and an imagery layer. These are all interoperable and all objects are identified by a common form of unique identifier (known as the TOID) – unlike the previous generation of datasets. They are all based on the DNF model to support consistency and integrity. Other themes such as Digital Terrain Model, Administrative and Electoral Boundaries may well be migrated in the future. At the same time out dated digital mapping products such as (Land-Line) and the old roads database (OSCAR) are being phased out.

Just as Ordnance Survey visited other mapping agencies around the world in developing the concepts and ideas that led to DNF and OS MasterMap, so too have others consulted Ordnance Survey since. We can now see several mapping agencies across Europe following a common direction with object based data (for example Denmark - TOP10DK, Netherlands – TOP10NL, Germany – ATKIS).

Figure 4. Ordnance Survey economic progress 1980-2005

Ordnance Survey is required to be self financing. The chart in Figure 4 summaries costs/revenues and staff numbers. (expenditure around £100mpa, staff numbers fallen from 3,500 in 1980 to around 1400 today and self funding (a requirement from HM Treasury) supports the organisation). This looks very healthy, though there are always a backdrop of issues that any mapping agency has to address over sustainable funding, terms and conditions of data supply and licensing models.

3. INTEGRATION DIMENSION

3.1 The Digital National Framework

The emergence of the Digital National Framework as noted above was part of the concept that was outlined in 1999. The concept was developed in conjunction with key players in the geographical information industry. Following a positive response at the 1999 AGI conference, several consultation papers followed. OS MasterMap was launched in late 2001 and the DNF element then took a backseat - but within 2-3 years users were starting to use the methods outlined in the consultation papers.

From these 4-5 practitioners the DNF Expert Group was formed and this now meets three times a year, with generally around 20 experts attending, to oversee the activity of the open and voluntary initiative.

3.2 A common approach to joined up geography.

The DNF provides guidance on the key topics required to support a common spatial information architecture for a SDI. It employs a set(s) of common base reference objects, so that all users can unambiguously know that they are referring to the same object at a location. Such objects have been selected and defined for the land surface but work continues on extending the base to support marine environments, atmospheric objects, underground man made objects and underground natural objects such as geology. There may be a case to support heritage/antiquity information in this way as well. User's geographies (application objects and business information) can then referenced to these objects and guidance on how to cross reference one object with another (data association) is based on current best practice. The DNF methods are published as Technical Guides and are freely available on the DNF website. Good examples of how the cross references operate can be found on the Manchester Geomatics website: http://www.mgeomatics.com/DNFDemo

Note - overlaying data in a GIS is not necessarily considered data interoperability. The inherent data integrity of one theme with another and within itself is paramount if people are going to make decisions and use the data in a future web services environment and especially where reliable automation is to be exploited. The key information components required to achieve interoperability are:

1. Adoption of a defined* coordinate system
2. Adoption of an object based model
3. Each object is given a unique identifier*
4. Each object is described semantically and are described in a feature catalogue*
5. Data association is employed as appropriate
6. The data is defined in an application schema
7. Each object holds metadata
8. Data quality information is provided

*The DNF Registry provides an index to conforming components.

3.3 Digital National Framework Case Studies

One of the best ways of demonstrating best practice is to show how third parties have already achieved organisational benefits through case studies:

The Atlantis Initiative: Market research for the Atlantis Initiative (which is developing new datasets to help manage flooding) has shown that a third of users spend up to 25-50% of their project costs in just making data from different sources fit for use. A new "Detailed River Network" has been developed by the Environment Agency using the DNF model so that all kinds of information can be shared using a common information base (until now the Agency had four separate models). With this a new height model that integrates land and bathymetry, and is hydrologically consistent, has also been developed by Ordnance Survey.

Dudley Metropolitan Borough Council: have developed a property database which is created in real-time ie the geometry is not stored. Cross references to the base objects form the user defined objects on demand and therefore always forces full data integrity in the data. This in turn significantly enables full integration with corporate information systems.

National Access Land: Following the 2000 Countryside and Right of Way Act – almost 10% of English land area became accessible (under certain conditions) to public access. The database that was used to establish this definitive record was the first to use the DNF model and is still the largest single example.

4. THE EUROPEAN DIMENSION

4.1 The INSPIRE Directive

On 15 May 2007 the European Union's INSPIRE Directive came into force. The legislation requires European member states to prepare their data to meet a set of defined "Implementing Rules". The aim is not to achieve full scale harmonisation but the achieve *"harmonisation through interoperability"*.

Annex I	Annex III
1. Coordinate reference systems	1. Statistical units
2. Geographical grid systems	2. Buildings
3. Geographical names	3. Soil
4. Administrative units	4. Land use
5. Addresses	5. Human health and safety
6. Cadastral parcels	6. Utility and governmental services
7. Transport networks	7. Environmental monitoring facilities
8. Hydrography	8. Production and industrial facilities
9. Protected sites	9. Agricultural and aquaculture facilities
	10. Population distribution – demography
	11. Area management/restriction /regulation zones & reporting units
	12. Natural risk zones
Annex II	13. Atmospheric conditions
1. Elevation	14. Meteorological geographical features
2. Land cover	15. Oceanographic geographical features
3. Ortho-imagery	16. Sea regions
4. Geology	17. Bio-geographical regions
	18. Habitats and biotopes
	19. Species distribution
	20. Energy Resources
	21. Mineral resources

Figure 5. INSPIRE themes Annex I – III

For each Annex I theme in the INSPIRE Directive a harmonised specification will be established by May 2009. Member States will then be given a period of time to adopt that specification. This does not mean that they will have to replace their existing specifications – but they will have to make modifications and adopt the rules to support an interoperable information service. Electronic access to the data in scope of INSPIRE and a level of business interoperability will also be required.

The specifications are being developed, not by European Commission officials but by those who create, maintain and user that data in the form of "Drafting Teams" and "Thematic Working Groups". The Implementing Rules will be heavily dependent on the existing ISO 19xxx family of standards (which will become a European profile) and OGC standards (particularly for web services).

The INSPIRE development is seen as a world leading example in international collaboration and data interoperability. Good progress is being made in all aspects of a very ambitious development.

5. THE UK DIMENSION

5.1 The UK Location Strategy

The UK has never had any form of over arching governing body to coordinate its spatial information. As consequence duplication has developed as well as a lack on information connectivity. It was against this background that a Minister in the then Office of Deputy Prime Minister commissioned a “GI Strategy” for the UK in 2005.

The Minister appointed members of a Geographic Information Panel from the public and private sectors and they their started work in 2005. A comprehensive survey and research was commissioned during 2006 and by early 2007 the second phase of the work started by engaging senior members of government.

The name change from “GI” Strategy to “Location” Strategy is significant. An early conversation with the new government Chief Information Officer in the Cabinet Office demonstrated the need for GI to move on to a new level. His view was that government needed solutions to all kinds of issues (people, organisations, assets etc) and if location could help – then that would be welcome. Hence the strategy was refocused and revised. The message was clear, GI has to move into and support the mainstream information industry if it was to be taken seriously, and hence the strategy title was changed to "The UK Location Strategy". The drivers of the strategy are more oriented towards societal (e.g. social exclusion) and national infrastructure (e.g. traffic management) needs.

The UK is made up of Great Britain and Northern Ireland and in Great Britain we now have two devolved administrations (Scotland and Wales). While not a formal federal structure as in Germany or Spain some of the issues attributable to such a structure are evident (e.g. freedom to make local policy decisions, different approaches to data standards and different information strategies etc).

The UK Location Strategy has now been completed and has been endorsed by the Minister. It is currently awaiting protocol clearance prior to publication and implementation.

6. DISCUSSION

6.1 Do these components work together?

The four major developments described above in sections 3 - 6 are clearly not the total of all the activities in spatial information in the UK. A growing number of organisations across the public sector are also creators, maintainers, consumers and publishers of geographic information – often using different approaches and standards as in many other countries. However these application areas can be reflected in the four components outlined earlier. In determining how the developments relate and how the future might look perhaps it would be useful to examine the relationships using the PEST model (Political, Economic, Social and Technological factors)

6.2 Political Factors

Of the four topics discussed only the INSPIRE Directive has a legal basis and where failure to conform could result in some kind of penalty for the member state. While Ordnance Survey can point to some modest legislation (administrative boundaries) its remit and activities are managed through agreement with the Minister of the day. Quite clearly the fulfillment of some kind of unique role within national need is paramount for longer term sustainability and the data investments required to support this.

Whether this is inside government or outside can be debated, but there is little evidence of private mapping agency operation in the world. In Great Britain we can reflect on the failure of the privatisation of the rail infrastructure in the 1990s, using our analogy above. More recently the management of the rail infrastructure has been brought back closer into government. Improvements are evident as a result of greater investment leading to significant increases in rail travel in recent years. This suggests that public sector is best placed in developing and better managing its own information and its national information infrastructure.

6.3 Economic Factors

Both at the European and UK level – several business models operate side by side. As with the technical aspects any attempt to promote a more integrated approach also requires a level of business interoperability as well as technical. Likewise changes in external circumstances which may drive changes in the technical content and structure. These also affect the business environment and the impact of the web is having far reaching implications in all of the topic areas discussed.

One of the chief areas of debate revolves around the “free data” vs “user pays” model. Of course someone has to pay in the end and the idea that “one size fits all” generally fails here - as it often does elsewhere. For example once a geological survey has been undertaken (at say 1:50,000) it rarely requires maintenance since there is no significant change. (New surveys at higher resolution may be commissioned e.g. 1:10,000 or a 3D model invested in – but this is a separate decision). At the other extreme meteorological information changes by the minute and the topographic landscape changes daily – hence the need for sustainable funding *to maintain this data* and also invest to ensure it remains relevant for future users as well.

The world continues to change and business models need to modernise as well. There are tensions over funding and licensing of spatial information in the UK because a vibrant market has developed off the back of the national infrastructure. As always there are options and examples of best practice. And there may be questions over whether best practice is transferable but new approaches (eg Norway Digital) appear to be working successfully and can be learnt from.

6.4 Social Factors

As noted at the start of this paper, the internet has made a massive impact on all of us and that has been a great leveler for many organisations. The citizen now expects to access information they perhaps did not know existed 5-10 years ago eg flood information for their property. Many believe that much more information remains locked up in public sector organisations and should be made accessible. In this new paradigm, where we are all still adjusting, the basic lessons in data management are perhaps more important today than they ever were. While the likes of Google Maps and Microsoft Virtual Earth and others provide simple tools for many intelligent consumers – there remains a need for the public sector to improve and ensure the integrity of their information – since lives and livelihoods will depend on it.

6.5 Technological Factors

While the rate of change is increasing, one of the reassuring aspects of the four topics above is that they are all future oriented and to a certain extent are all moving in the same direction. INSPIRE outlines "what" needs to be done and the DNF complements this by describing "how" to do it in many of the areas of information interoperability. The INSPIRE Implementing Rules are therefore complemented by the DNF model (DNF Technical Guides) in describing the technical information framework. (DNF, 2008)

The UK Location Strategy now also aligns with the INSPIRE framework and a common governing body will be established to coordinate how the UK, as a European Member State, will deliver an INSPIRE solution as well as the UK Location Strategy. Within all of this OS MasterMap is designed to provide a common foundation for anyone to use – providing the unambiguous references that ensures all users can be sure that they are referring to the same location.

Figure 6. The objective: alignment of the key components described in this paper.

6.6 Knowledge Sharing

Sharing of knowledge and know how is important in an industry where there are few individuals at a national level with who to discuss a topic. This is where the unique network of EuroSDR has added value by bringing together the key players to share knowledge and distil best practice in recent years. Workshops on"NMA & the Internet", Features and Objects", "Land-Marine Integration", Spatial Databases", "Positional Accuracy Improvement" have all contributed to the collective thinking and determination of the state of the art in these developments.

7. CONCLUSIONS

7.1 Conclusions

- The EU INSPIRE Directive provides a common European framework and defines "what" needs to be done to achieve interoperability across Europe (the European SDI).

- The UK Location Strategy is a first attempt to coordinate how the public sector better manages its spatial information. While it has different drivers from INSPIRE a common information infrastructure can be shared.

- The Digital National Framework supports all of this by describing "how" the national infrastructure will connect up and this fully complements the INSPIRE framework.

- In operationalising the initiatives described - OS MasterMap is well positioned and is increasingly being used intelligently as the common reference base.

- The four developments therefore fit together well and with careful stewardship can contribute to a step change in the use and exploitation of spatial information in the UK.

- This is not to say that there are no challenges – there are many in moving forward especially on organisational engagement and alignment, as well as licensing issues. Nevertheless it is a unique moment in time and one that holds great promise. There is certainly great potential for "the whole to be greater than the sum of the parts".

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The Author

The views expressed in this paper are those of the author and do not necessarily represent those of the Ordnance Survey or the UK government. The author has worked for the Ordnance Survey in several capacities (surveyor, photogrammetrist, research scientist, IT manager, geospatial programme manager and information strategist). More recently as Head of Geographic Information Strategy, Secretary to the UK Geographic Information Panel and is also contracted by the European Commission to contribute to the INSPIRE drafting process. He is therefore well placed to observe and comment on the current state of play in this field.

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