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ORDNANCE SURVEY: UNDERPINNING THE INFRASTRUCTURE OF GREAT BRITAIN

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Ordnance Survey is Great Britain's national mapping agency. It provides the most accurate and up-to-date geographic data relied on by government, business and individuals.

The organisation dates back to 1791 when the Government realised that in planning adequate defences to repel any invasion from Napoleonic France, the south coast of England needed to be comprehensively and accurately mapped. So it instructed its Board of *Ordnance* – the defence ministry of its day – to speed the necessary *survey* work.

That decision led to the detailed mapping of the whole country, and is also the source of the name 'Ordnance Survey' – an organisation which eventually grew to become one of the world's leading map-makers and a major provider of digital geographical information.

Ordnance Survey's first paper map, of the county of Kent, was published in 1801. In fact, the organisation was entirely map-driven until 1971. But by the late 1990s, Ordnance Survey had completely digitised all its large-scale mapping of Great Britain – some 230,000 individual maps.

Based in Southampton with field offices across Britain, Ordnance Survey is a Government Department and Executive Agency reporting directly to a Government minister. It became a wholly civilian organisation in 1983. Since 1999 it has had government 'Trading Fund' status, giving it more responsibility for its own finances and planning and more freedom to develop new initiatives under a business plan approved by Ministers.

As a Trading Fund, Ordnance Survey is totally funded from customer revenues rather than the tax payer. Revenues come from licensing data under Crown Copyright as well as direct sales of paper maps. Being successful offers a sustainable funding model, which in turn means that Ordnance Survey can create high-quality, accurate information and encourage widespread licensing. This is done directly and through partners, with revenues used to offset operating costs and fund continuous investment in improved data quality. Ordnance Survey also pays a dividend to government based on its financial performance.

By maintaining and enhancing one of the world's most detailed geographic referencing frameworks, Ordnance Survey improves the quality of life for millions of people. Its information is pervasive in crucial public-sector activities, from registering land and property titles to locating suitable derelict sites for house building; from identifying areas of deprivation to planning new access to the countryside; and from controlling the flow of urban traffic to helping the police monitor crime patterns and catch offenders. In just one of the agre-

ements supporting emergency response, more than 80 mountain rescue teams, all made up of volunteers, have access to digital mapping data to help with their growing use of GPS technology on hand-held devices.

In the private sector the uses are even wider, from customer profiling to calculating insurance premiums, and from managing property portfolios to developing transport logistics systems. Ordnance Survey data is an integral component of web directories, in-car navigation systems and mobile phone applications – virtually any product or service that relies on location in Great Britain has Ordnance Survey data embedded in it.

Links with around 500 commercial partners – software companies, systems integrators, consultancies and publishers – have made Ordnance Survey one of Europe's biggest onward licensors of geographic information. Partners play a vital role in delivering the benefits as they use their expertise to add value, producing the best available products and services for particular applications.

In fact, so vital is Ordnance Survey information – and so diverse its customer base – that an independent report put its annual value to the British economy at more than Ł100 billion.

The organisation's ongoing challenge is to create and maintain the underpinning geographic framework used within all aspects of British life.

Data collection and maintenance

Geographic information is collected in a number of different ways. Under a continuous revision policy, Ordnance Survey uses several sources of intelligence to identify significant change on the ground such as new construction and demolition. There is fundamental reliance on a workforce of some 300 field surveyors.

They use a range of equipment to gather information, including theodolite 'total stations' with lasers to measure distances and hand-held pen computers to plot the latest changes.

Surveying staff also pinpoint precise locations at ground level by using GPS receiving equipment to lock on to signals from a network of 24 orbiting satellites.

Ordnance Survey has established a national network of around 100 base stations which constantly transmit their GPS-observed positions to a central processing hub. The network, known as OS Net, provides real-time positional accuracy down to centimetre level, a huge efficiency boost in data collection. Previously thousands of triangulation stations – including the familiar concrete 'trig pillars' on high ground – were the bedrock for positioning calculations, but this method has now been superseded.

The investment in OS Net is helping to bring real-time accuracy to both sub-metre and centimetre level wherever the user is in Great Britain. This is a dramatic improvement on the GPS capability found in personal and in-car navigation devices, which typically gives a positional accuracy of around 10 metres.

Information gathered by ground staff is complemented by an intensive programme of aerial photography, particularly of rural areas, which can be viewed in 3D. The resulting high-definition images – which show detail as sharp as the pattern of road markings – can then be overlaid with existing map data to check where features have changed; so that instant updates can be recorded.

Third party data from organisations such as local authorities and commercial sources is combined with the information collected by the field surveyors and aerial survey team.

The aim is that all significant change is captured within six months of completion. The position of the features and attributes are then established and recorded in the national geographic database from which the mapping data is derived for digital and paper products.

The database holds around 440 million features. It is a seamless, continually updated replacement for the 230,000 individual large-scale maps which were digitised originally. An average of 5,000 changes are made to the database every day, reflecting new buildings and developments, demolitions, road routing restrictions, and other natural and man-made changes.

Ordnance Survey provides a wide product portfolio including large-scale, multi-layered OS MasterMap information suitable for embedding in a database environment. Digital height data is available as both contours and digital elevation models while mid-scales products are suitable for regional analysis and presentation. Most famous with the general public are the national series of paper maps for walking and touring including OS Explorer Map (1:25 000 scale) and OS Landranger Map (1:50 000 scale) titles.

For digital data, Ordnance Survey offers online ordering facilities and delivery through a range of methods such as CDs, DVDs and online. Data is provided in industry standard formats suitable for export into a wide range of desktop packages, including GIS and CAD systems.

One of the key delivery channels is a specialist network of retail partners called Ordnance Survey Mapping and Data Centres. These mainly serve the professional land and property market but are also used by customers typically requiring maps to support planning applications for property extensions. Ordnance Survey Mapping and Data Centres are strategically located around Great Britain, each with a computer link to Ordnance Survey's database so they can supply customers with the latest mapping on demand. The channel includes a desktop mapping service for customers preferring to choose and organise maps and data at their own premises, with real-time access to the database.

National consistency

Base 'framework' data of a country or region has an essential underpinning role, but it needs to be sustainable and universally maintained. Because Ordnance Survey collects and maintains data to a unified, national specification, it can support the joining up of spatial information for consistent decision making anywhere in Britain.

The most highly detailed product portfolio, OS MasterMap, consists of a number of separate layers – Topography, Address 2, Imagery and Integrated Transport Network (ITN). The data is given added strength by the fact that each object represented has a unique topographic identifier (TOID) allowing other information to be linked to it. Data already held by the user can be connected to geographic objects via these TOIDS.

Underpinning OS MasterMap is the Digital National Framework (DNF), an industry-wide set of principles and operational rules that facilitate the integration of geographic and other business information. DNF offers a way of linking multiple sources to a definitive location reference through unique identifiers such as OS MasterMap's TOIDs.

In the utility sector, for example, the water company Bristol Water is using OS MasterMap Address Layer 2 to verify the addresses of thousands of properties, carry out complex enquiries and share information through a mapping interface on a corporate-wide Intranet. The cross-referencing capabilities are also supporting Wessex Water in its practice of classi-

fying service locations by function. A third company, Northumbrian Water, has developed a networked GIS that enables call-centre staff to bring up a large-scale map of a caller's address and locality. The map is updated in real time by advisers and engineers in the field reporting on repair and maintenance work. Such utilities are reporting greater cost efficiencies in their operations through the use of Address Layer 2.

To build and maintain Address Layer 2, Ordnance Survey adds high-resolution spatial references to more than 27 million postal addresses. Also incorporated is a dataset of multiple residences, which provides complete address details of flats and apartments without individual postal delivery points. Ordnance Survey supplies these with the reference details of their parent delivery address, enabling easy identification of all properties receiving utility and other non-postal services.

Ordnance Survey classifies all addresses into residential or commercial and provides a geographic alternative address such as the locality or district name. Business premises are placed in sub-categories if their trading or brand name provides clear details of their function.

In addition, Address Layer 2 contains more than 1.5 million properties that do not have postal addresses. Among them are utility works, community halls, churches and public conveniences. Their locations are vital for emergency response, civil contingency planning, risk assessment, asset insurance, planning, customer services and maintenance. They have been given an intuitively useful address referenced to road, locality and postcode. They are also allocated alternative classifications derived from Ordnance Survey information and other sources.

A cross-reference table that links unique address identifiers is designed to provide easy navigation between the various themes within Address Layer 2 and address data created by other organisations. The aim is to make it as straightforward as possible to share and integrate different address information. The table is available free of charge and there are plans to link it to further datasets in the future.

Integrated route network information

The OS MasterMap ITN Layer offers a nationally consistent base for the development of a range of traffic-related applications.

It includes more than 740,000 named roads with 99.21% of road links present (up 0.39% from 2006). There are correct classifications of 99.70% of 'A' roads, 99.94% of 'B' roads and 99.93% of 'minor' roads.

The Layer consists of two themes; the Roads Network and Road Routing Information (RRI). The Roads Network represents all navigable roads across Great Britain for those who require increasingly sophisticated geographic data to support their services and applications. The data has all official Department for Transport road categories such as motorways and primary routes as well as named and unnamed minor roads, local streets and alleyways. In line with DNF principles, each road link is supplied with a TOID that can be shared with other users across different applications and systems.

The RRI theme extends data functionality with features that may affect a driver's choice of route including traffic calming, turn restrictions and one-way roads as well as vehicular access and time restrictions. In October 2006, RRI customers were given access to the weight, width and height restrictions applying to road bridges in Great Britain, making it the

only geographic information product to contain such nationwide data. This is already delivering huge benefits for emergency services, freight companies, hauliers, local and central government, and others.

The ITN Layer supports the local authority aim of guiding freight onto appropriate roads for safety and efficiency. This will help to address the issue of heavy goods vehicles travelling on unsuitable roads in both rural and urban areas, something that concerns members of the public, local authorities and the transport industry itself.

It is not only in freight management that the ITN Layer is helping local authorities. Redditch Borough Council is one example of an authority using ITN to improve community transport. Running conventional fixed-route, fixed-stop services to timetable is expensive and inflexible. Demand-responsive transport (DRT) enables local authorities to be more cost-effective and environmentally friendly. The Dial-a-Ride service in Redditch has seen increases in demand that a manual booking and routing system would have difficulty coping with. To solve this problem the council is using the ITN Layer in an application that allows staff to assess journey booking requests and select the most appropriate and efficient routes. Redditch now manages 25% more journeys with the same number of vehicles by optimising the routes. This has reduced fuel consumption while increasing fare income.

Mapping for emergencies

As part of its national interest role, Ordnance Survey runs a Mapping for Emergencies (MFE) service, which enables its information, mapping and expertise to be used in response to civil emergencies such as floods, fires, contamination leaks, disease outbreaks, searches for missing people and major security incidents.

The MFE scheme has recently helped with the response to various high-profile events including the severe summer flooding across large parts of England. Ordnance Survey was able to respond immediately to a request for digital map data from emergency planners managing the evacuation of hundreds of people in South Yorkshire. The team used highly detailed spatial address and height data to identify properties within specific height bands around the Ulley dam near Rotherham, offering the planners a sound basis for determining flood risk and priorities.

A few weeks later, water utility contractors requested street-level data across the flood-stricken Severn region to help map the locations of nearly 1,000 fresh water bowsers distributed by a fleet of tanker drivers. Pinpointing and sharing the temporary positions of the bowsers was crucial for delivering refills and managing transport logistics. Ordnance Survey mapping also provided the basis for overlays of aerial images and road traffic information as various agencies and incident response crews tried to visualise the extent of current and potential flooding and gauge optimal rescue routes. One of the key scenarios was evacuation planning around a vital electricity station in Gloucester.

Free at the point of use

The MFE scheme is just one of many examples where Ordnance Survey information can be accessed free at the point of use. Another is a service enabling tens of thousands of

students, staff and researchers at universities and further education colleges across Britain to download mapping into suitable application software on their own desktops. It has supported a vast range of studies, from archaeology to zoology, since its launch seven years ago. OS MasterMap has recently been added to the portfolio available.

Ordnance Survey also makes a free OS Explorer Map available for every Year 7 school pupil in Great Britain. Since the scheme started five years ago, around 4 million free maps have been distributed for use in and out of class making it the biggest initiative of its kind in British schools.

Other free examples include a recently launched outdoor exploration portal where users can share suggestions for walking routes in a web 2.0 environment. Map extracts can also be downloaded from the Get-a-map service on Ordnance Survey's website while a separate election maps website offers useful information for parliamentary and council candidates, party workers and teachers.

Many local authority websites and free-to-air services from private sector companies such as Google also embody Ordnance Survey information. Free access to GPS survey control data is also made available over the web - vital for the construction industry, utilities and national infrastructure projects.

Underpinning all of these examples, and not least the Mapping for Emergencies scheme, is the need for accurate and up-to-date geographic information. Sustaining the quality of that information is vital for the national infrastructure and entails substantial investment to cover the costs of data collection and maintenance.

Working in collaboration

Ordnance Survey collaborates with organisations across business and government to maximise the benefits of geographic information. This approach recognises ever-increasing interdependencies across organisations.

In one project, the Atlantis Initiative, Ordnance Survey is providing the base geographic datasets for better flood management. With climate change predicted to have an increasing effect on the environment, Atlantis aims to improve information on rivers and terrain together with many related datasets for assessing the impacts of changes in flood frequencies, flood magnitudes and sea levels. This should lead to better management of development within the areas at risk and an improved ability to cope with any emergencies.

Ordnance Survey has provided the topographic data for the creation of terrain models and structured digital river networks. The new digital terrain model (DTM) will be a variable resolution grid that meets the needs of environmental managers, the water industry and researchers, and will be especially suited to flood management. In the spirit of collaborative working and interoperability of data, the datasets are in line with DNF principles. This provides the added benefit of simplifying the process of merging users' own data with Atlantis partners' data.

As well as Ordnance Survey, the Atlantis partners are the Environment Agency, British Geological Survey, Centre for Ecology and Hydrology, the Met Office and the United Kingdom Hydrographic Office.

Ordnance Survey is also supporting a DNF-based national project looking to increase the visualisation of underground assets via 3-D mapping and satellite navigation technology.

VISTA (Visualising integrated information on buried assets to reduce street works) is a collaboration of 21 organisations developing an integrated infrastructure to enable data sharing for buried assets.

OS MasterMap Topography Layer is the reference base underpinning preliminary trials by researchers at Leeds and Nottingham Universities to integrate disparate records of buried pipes, cables, ducts and wires. VISTA's data integration and exchange concept is being developed according to the principles and operational rules of the DNF. The aim is to provide a consistent, flexible way to identify, collect, exchange, reuse and record the relevant information.

In further collaborative work, Ordnance Survey is heavily involved with colleagues across government in developing an official location strategy for the UK emphasising the importance of 'place' in all kinds of policy making and frontline service delivery. A draft strategy has just been submitted for Ministerial consideration at the time of writing.

Ordnance Survey is also working with others on the implementation of a new legal framework for the European Spatial Data Infrastructure (ESDI). The framework helps the exchange of spatial data among public bodies and EU institutions for environmental purposes – and ensures public access. The European Commission has established a work programme that will develop detailed implementing rules for metadata, data specifications, network services, data sharing and monitoring of implementation. Ordnance Survey is closely involved in the work programme on the changes required by the new law.

In this way, Ordnance Survey will be able to play its part in making the ESDI a reality. Just as with the moves towards a location strategy for the UK, and the development of industry initiatives such as DNF, Ordnance Survey believes that the ESDI can greatly enhance the contribution of spatial information to EU decision making.

Conclusion

All mapping organisations are facing a period of intense and rapid change. Customer demands, new technologies and evolving business practices are creating challenges and opportunities that did not exist before. However, there is an enduring need for geographic framework data that is consistent and well maintained. The use of Ordnance Survey information and the growing focus on collaboration offer prime examples of that need.

Summary

Ordnance Survey provides a consistent and authoritative geographic framework to underpin the national infrastructure of Great Britain, but how is the organisation facing up to this ongoing challenge at a time of increasing customer demand and changing technology?

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