A DIGITAL NATIONAL FRAMEWORK FOR TOPOGRAPHIC DATA IN GREAT BRITAIN

David Holland, Keith Murray
Ordnance Survey
dholland@ordsvy.gov.uk
kmurray@ordsvy.gov.uk

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ABSTRACT

In this paper we will present the Digital National Framework for Topographic Data in Great Britain, as outlined in the Ordnance Survey business model. The paper will show how Ordnance Survey intends to provide topographic and related data, linked using a unique national referencing system, to as wide a group of users as possible. Also addressed are the role of imagery within this framework; the benefits to the customer of integrated imagery and vector data; and the role of the framework in integrating all kinds of associated geodata, including addresses, census information, land use, property details and many others.

1 INTRODUCTION

1.1 The Role of a National Mapping Agency

The role of national mapping agencies is changing, as new technology and new business methods are adopted in the wider geospatial information community. Ordnance Survey, Britain's national mapping agency, has recently re-examined its role within this new environment (Ordnance Survey, 2000). Rather than completely redefine what we do, the new Ordnance Survey business model seeks to consolidate our traditional core business activities in a digital, networked world. These core activities were identified in Information Paper 13 (Ordnance Survey, 1999) as:

- To provide a unique national referencing system for geospatial information relating to Great Britain.
- To capture and maintain an authoritative definition of the topographic features of the landscape, both natural and man-made.
- To associate selected attributes and other non-topographic geospatial information with this topographic information.
- To make this information affordable and available to as wide a range of users as possible, while leaving it to them exactly how they use it.

These four roles together underpin the business model adopted by Ordnance Survey in 1999; the first two roles form what is now termed the Digital National Framework.

1.2 The Role of Imagery

Imagery will play a large part in the new Ordnance Survey Business Model, especially as a basic information source on which the framework data depends. It is expected that imagery will in time become part of the framework itself, as a source of data which adds to the information available from vector and polygon-based spatial data.

2 THE DIGITAL NATIONAL FRAMEWORK (DNF)

2.1 Definition of the DNF

The Digital National Framework is comprised of the national referencing system and the National Topographic Database. The referencing system has two elements, a direct reference based on coordinates and an indirect reference based on unique identifiers. The National Topographic Database is Ordnance Survey's central database of geospatial data, containing information on the man-made and natural features of Great Britain.

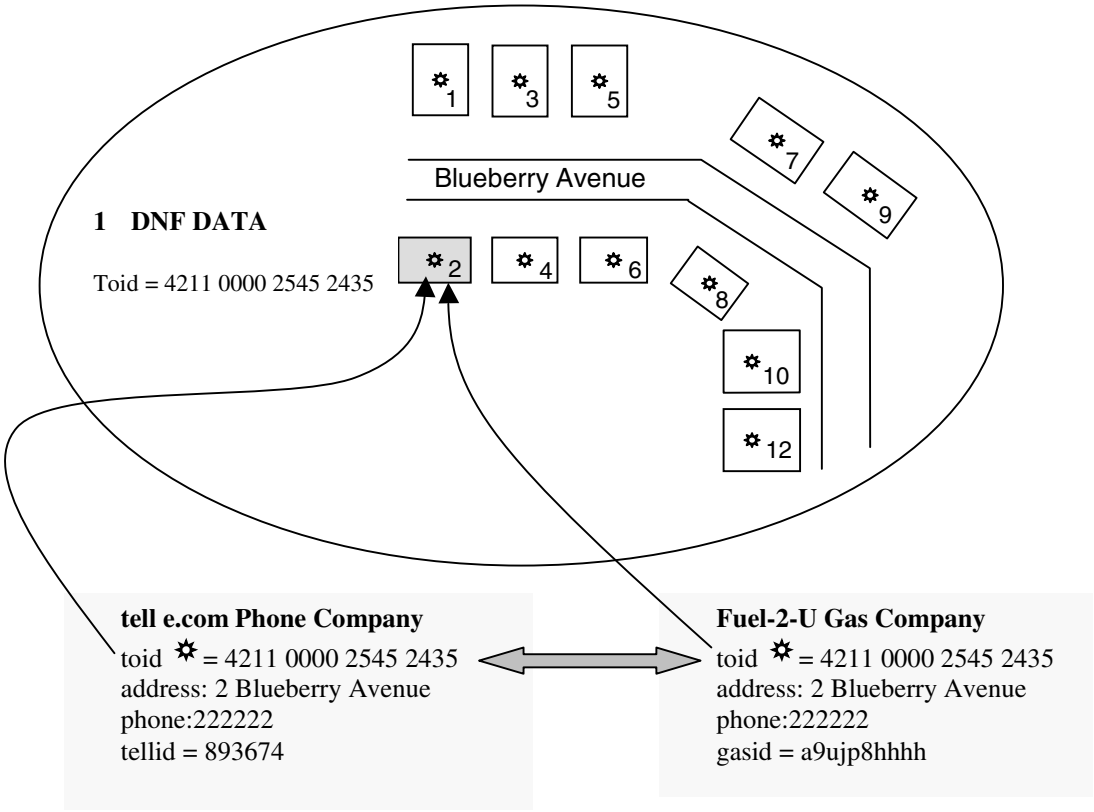


Figure 1: Many users can reference the same feature using the Topographic Object Identifier (TOID). They will be able to access change information from DNF on each feature they hold. They can also unambiguously share information about features they hold in common.

2.1.1 Direct referencing

The traditional geospatial reference system in Great Britain is the National Grid. The National Grid is defined by a network of triangulation stations, sited on prominent features in the landscape, which date back to the early decades of the last century. Recently, a new network of control monuments, sited in easily accessible points, has superseded these triangulation stations. This "passive GPS network" allows surveyors to determine their position quickly and accurately, without having to climb a hill in the process. The 900 passive stations supplement the network of active GPS stations, which will broadcast continuous GPS data to surveyors, engineers and anyone else who requires accurate positioning data in Britain. The GPS network uses the European Terrestrial Reference System 1989 (ETRS89), which is a high-precision terrestrial version of the WGS84 system used by GPS. All future OS geodetic data will be captured in the ETRS89 coordinate system and transformed to the National Grid using a freely-available transformation algorithm. In this way, the National Grid will be **defined by** the ETRS89 system and the transformation. This ensures that the National Grid will be maintained and that users of GPS will have a mechanism to convert their data between ETRS89 and National Grid coordinates.

2.1.2 Indirect referencing

There are many forms of indirect referencing in current use, such as property addresses, local administrative areas, parliamentary constituencies, postal areas and census districts. Each of these can reference a particular point or area without explicitly holding any spatial information. In practice, most information communities will have their own set of indirect references, which do not link to those in other communities. For example, a gas company may use a unique value to identify my house, but this won't be the same identifier as the one used by the phone company. This may even occur within the same community, for example the reference to my house on a gas network diagram may be completely different to the reference on my gas bill. This makes it more difficult to share information both within and between information communities.

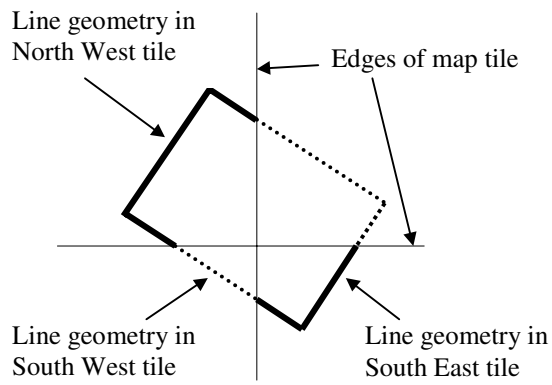
To ease this problem, as part of the Ordnance Survey role as the provider of a unique national referencing system, every feature in the DNF will be assigned a unique identifier. This Topographic Object Identifier (TOID) will be a simple 16-digit number, assigned from a "pot" of identifiers registered to Ordnance Survey features (in time, other organizations

may register for blocks of identifiers, to assign to their own data). The TOID will contain no intelligence (e.g. it will **not** be possible to infer the National Grid Reference from the TOID) but is there purely to uniquely label the feature. Identifiers will be used to provide a "hook" on which others may hang their own information; they will provide a common reference which will enable different information communities to share data. E.g my house may have different identifiers in the gas and phone company databases, but the TOID can be used to link them together, so that the gas company can inform the phone company that they have accidentally cut my phone cable. This is illustrated in Figure 1. The TOID is a type of Feature Identifier (as defined by OpenGIS, 1999) specifically intended for topographic features. Other types of Feature Identifiers may be used by different user communities for non-topographic data, such as images.

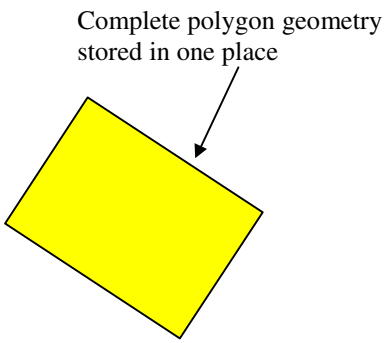
2.1.3 National Topographic Database

The National Topographic Database contains the basic geospatial data from which Ordnance Survey products are derived. This database is currently undergoing a major re-engineering process, both in terms of its content and its structure. The traditional OS data has consisted of points and lines, primarily captured to service the production of paper maps. Use of the data as a "background map" has to some extent continued into the digital age: many users still use the data as a visual backdrop on which to place their own information. Now that geospatial data and GIS are becoming integrated into ubiquitous desktop information systems, users require more intelligent data, which can be analysed as spatially structured information, rather than as a "digital map". In recognition of this, Ordnance Survey is converting its data into a more structured, polygon-based form. The traditional method of chopping the country up into "map-tiles" (square units which are individually updated, maintained and stored) will be replaced by a seamless database in which features will be preserved as polygons. The problem of features crossing map edges (e.g. a building on the corner of a map will have part of its geometry in three other map tiles) will disappear (See Figure 2).

Each of the features in the database will be assigned a Topographic Identifier (TOID), as described in section 2.1.2. In the short term, a TOID will be allocated to the centroid of every building in the database. Once the data has been converted to the new seamless structure, every feature in the database will have a TOID, producing a complete mosaic of identified polygons which collectively cover the whole country. Products derived from the TOIDs will be used in many different systems, including non-GIS software. Identifiers may then be used to keep track of changes to features. Holders of DNF data may wish to be notified if any of the features in their database has changed since they last updated it. Once the changed features have been identified, via the TOID, they may be extracted from the DNF by the customer on a feature-by-feature basis. There will be no need to re-supply the whole tile in which the feature resides, as is the case at present.



The traditional tile-based system splits features up at tile edges.



The new seamless data system keeps features intact.

Figure 2: Polygons crossing tile edges in the old system will be retained as single objects in DNF.

3 IMAGERY AND THE DNF

Imagery has several roles to play in the Digital National Framework. The major role will be as the raw source data from which our point, vector and polygon data are derived. In future, imagery may become part of the basic Framework itself, and will increasingly be used as a geospatial data product in its own right.

3.1 Imagery as a raw material for topographic data update

The Ordnance Survey currently uses scanned aerial photographs within digital photogrammetric systems as a major source of data collection and maintenance. These are described in a separate paper in these proceedings (Allan, 2000). In brief, around 40% of the features surveyed by Ordnance Survey are captured using photogrammetric systems. These systems range from analytical stereoplotters, through digital "monoplotting" stations, to stereo digital photogrammetric workstations (DPWs). The digital production systems are generally used for updating data in rural areas, using scanned monochrome photography at 1:6500 scale. The production areas are currently in the process of changing to an almost totally digital environment, in which the analytical and monoplotting machines will eventually be replaced by DPWs.

We are constantly evaluating new methods of update, such as digital photography, airborne laser scanning (lidar), Synthetic Aperture Radar (SAR) and multispectral imagery from airborne scanners. Most of these have been evaluated for specific tasks such as the capture of Digital Elevation Models (using SAR and lidar) or the classification of land cover (using multispectral imagery). It is expected that digital cameras will replace conventional cameras in time, and in the meantime we continue to track the improvements in digital camera technology. New types of data will continue to become available to us, including images from Space Imaging's IKONOS satellite or the similar QuickBird and Orbview satellites due to fly this year; or from new high-resolution airborne digital scanners and cameras. As these data appear, we will evaluate the opportunities they provide, both to a national mapping agency and to our customers.

Our use of satellite imagery in the past has been limited to a few specialized tasks, such as mapping inaccessible areas of the world (including Christmas Island, Tanzania and Yemen). Up until now, the resolution of satellite data has not been sufficient to allow us to update the National Topographic Database (which includes data of nominal scales 1:10,000, 1:2500 and 1:1250). An evaluation of simulated 1m satellite data, completed in 1997 (Ridley *et al*, 1997) concluded that even imagery of this resolution would not be sufficient for our needs. Further evaluations of real 1m satellite data will determine whether this conclusion still holds. If data from even higher resolution sensors becomes commercially available in future, this may have a much greater impact on the national mapping agencies, both as a source for updating vector and polygon data, and as a substitute for conventional products.

A continuing research programme at Ordnance Survey will investigate new methods and processes that will benefit the collection, maintenance, storage and supply of data. Research topics in the future are likely to include the automatic detection and classification of features; the detection of topographic change between an image and an archived digital map; the use of novel data collection techniques and new ways of integrating data from different sources.

3.2 Imagery as part of the Framework

There is a strong case for treating imagery as a basic constituent of the Digital National Framework. One of the goals of the national framework is the integration of vector data with orthorectified imagery and any other type of information which has a location, e.g. terrestrial images, CAD data, or even sound and video. This integration will enhance the value of each type of data to the user. Vector data on its own lacks the visual impact and spectral richness of an image; while imagery alone lacks the cultural and topological richness of vector data. For example, it is not easy to infer land-cover information from a topographic map, and is just as difficult to navigate a road network from an aerial photograph. Combining different types of data will help in both cases:

- Land cover information derived from imagery can be associated with the topographic polygons. E.g. a unique land-cover type may be associated with a field polygon, which can then be associated with other information relating to ownership, or agricultural subsidy information.
- Topographic road-networks can be combined with imagery to give extra information. E.g. a given road intersection could be easily identified by a distinctive building or tree which shows up well in the image.

In many cases, imagery will be available which depicts features that are either not yet captured, or do not form part of the DNF data specification and will therefore never be captured. An imagery layer in the DNF could help to plug these gaps in the data, especially if it was maintained on a rolling 2-3 year cycle.

In order for imagery and structured vector data to mutually enhance each other, both types of data must rely on the same referencing system. Part of the task of promoting the DNF will be to encourage organizations which capture imagery in Britain do so to a standard which links them to the national reference system. In practice, this means registering orthorectified imagery to the National Grid, and using GPS control data that is in sympathy with the National GPS Network. We are already working with our partners in the imagery capture industry to encourage them to develop products that conform to these standards.

3.3 Imagery as a product

Imagery has not traditionally been part of Ordnance Survey's standard product portfolio. Most of the imagery we capture is used solely for the purpose of updating the topographic data. When imagery becomes integral to DNF, this situation will change, as users will have access to any of the spatial data within the database. For example, a user may only require data relating to buildings, so they may extract the building outlines, the addresses and topographic identifiers, and the image layer. The image will add extra information such as the shape of the roof and any extensions to the building (e.g. conservatories) which are not included in the topographic data specification, or it may merely act as a visual backdrop to the building data.

3.4 Accessibility

Linked with the subject of integration of data sets, users must be able to search for and access compatible datasets over the Internet. As part of this process, Ordnance Survey continues to support initiatives of the National Geospatial Data Framework (NGDF, 2000), such as the production of a geospatial metadata service. As members of the OpenGIS Consortium, we follow the progress of the various OpenGIS and ISO specifications, adopting them as they mature into industry standards. These will facilitate services such as the discovery of geospatial information sources and ability to access, display and analyse geospatial data from diverse sources over the Internet. All these initiatives, together with the provision of a national framework, help to provide our customers with a rich source of geospatial data for the Information Age.

4 IMAGERY AND ASSOCIATED DATA

4.1 Association

One of the roles of a National Mapping Agency as defined in Information Paper 13/1999 (Ordnance Survey, 1999) is to associate attributes and non-topographic geospatial information with the DNF. In many cases, this will be done using the topographic identifiers. In the case of imagery, however, some other type of feature identifier may replace the topographic identifier, since an image does not fit the definition of a topographic object (which is a "real world object" like a building or a field). Images may be associated using direct referencing (e.g. "this building is centred on National Grid Reference 423500,326444, which is covered by image X"). The image rectification process itself is a form of association, in that it relates objects in the image to their position on the earth's surface, rather than merely their position as pixels at a given offset from the corner of the image.

4.2 Identifiers on images to facilitate association

Users of DNF data may wish to associate features to the images in which they appear (e.g. this farm building appears in image X, 1998 and image Y, 1999). Such associations would benefit from a unique identification system for images, used throughout the industry. Although such an identification system is not strictly within the remit of the DNF, it is a topic which Ordnance Survey could promote as a way of improving "joined-up-geography" in Great Britain. An extension to this could be a metadata service, in which flight diagrams and image metadata could be collated to form an image gazetteer, indexed via the unique identifier.

5 CONCLUSIONS

This paper has introduced the Digital National Framework as the foundation for geospatial information in Great Britain. The DNF will provide the referencing system and the core geospatial data, to which other organizations and individuals may link their own data. Topographic identifiers will allow users to track changes to topographic features, and to share their information with other users. The identifiers will allow DNF data to be associated with other information, and will facilitate the joining up of disparate data from different user communities, including postal services, utilities, local government, central government, the European Union, etc.

Imagery will play a major role in the update of the data within the DNF, and could eventually become an integral part of the framework. Using imagery and topographic data together will provide a different view of the world, in which each type of data enhances the other, and will lead to a richer description of the landscape which will have benefits for everyone.

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